Oil & Gas Authority

Enhanced Oil Recovery (EOR) Delivery Programme

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1. Foreword

The Oil and Gas Authority (OGA) was established to regulate, influence and promote the UK oil and gas industry, in conjunction with other regulatory authorities, and has a range of powers to deliver this remit.

The development of a series of strategies and associated delivery programmes represents a key step in setting out how the OGA, government and industry should work together to Maximise Economic Recovery (MER) from the United Kingdom Continental Shelf (UKCS) – a core recommendation of the Wood Maximising Recovery review.

The MER UK Strategy underpins the OGA remit and became a legal obligation on licensees in March 2016. It describes how MER should operate in practice, setting out a legally binding obligation on licensees and others to take the steps necessary to secure the maximum value of economically recoverable hydrocarbons.

The MER UK Strategy also sets out a range of supporting obligations and safeguards, as well as the actions and behaviours required to achieve collaboration and cost reduction. The purpose of these strategies and delivery programmes, developed in collaboration with industry and the MER UK Boards, is to promote a new way of working across the oil and gas lifecycle.

The strategies set the key direction and the delivery programmes provide further direction and detail on the implementation of each strategy.

2. Executive summary

The Enhanced Oil Recovery (EOR) Strategy, which was published separately and precedes this document, sets out a high-level overview of EOR UKCS opportunities. The importance of encouraging industry uptake of EOR was outlined in the Wood Maximising Recovery review and subsequently EOR is an integral theme of the MER UK Asset Stewardship Board.

Successful EOR can play a significant role in maximising economic recovery from the UKCS by increasing the volume of recovery, extending field life (by as much as 10 years), creating and maintaining jobs, helping stimulate field redevelopments and deferring decommissioning activities.

However, offshore EOR is often unattractive due to being capital intensive and requiring higher operating costs than conventional water flood schemes.

The OGA's ambition for EOR is to:

- **Drive** economic development of 250 million boe 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 by technical and economic improvement
- **Demonstrate** a proven offshore operation of low salinity EOR by 2021 and encourage EOR evaluations for all new projects
- **Advance** the next tranche of EOR technologies and develop a roadmap for their economic implementation

In order to create the right conditions to meet this ambition, the following areas are crucial to advance polymer EOR:

- **Cost reduction** – the creation of a competitive, robust supply chain to improve polymer EOR economics and reduce risk
- **Collaboration** – share lessons learned to build EOR knowledge and competency in the UKCS and reduce barriers to EOR development at both producing and future fields; collective approaches will be developed to manage the risk profile of EOR developments and mitigate common risks
- **Sustainability** – identify potential standardisation of EOR-related technologies such as industry standards for testing EOR polymers

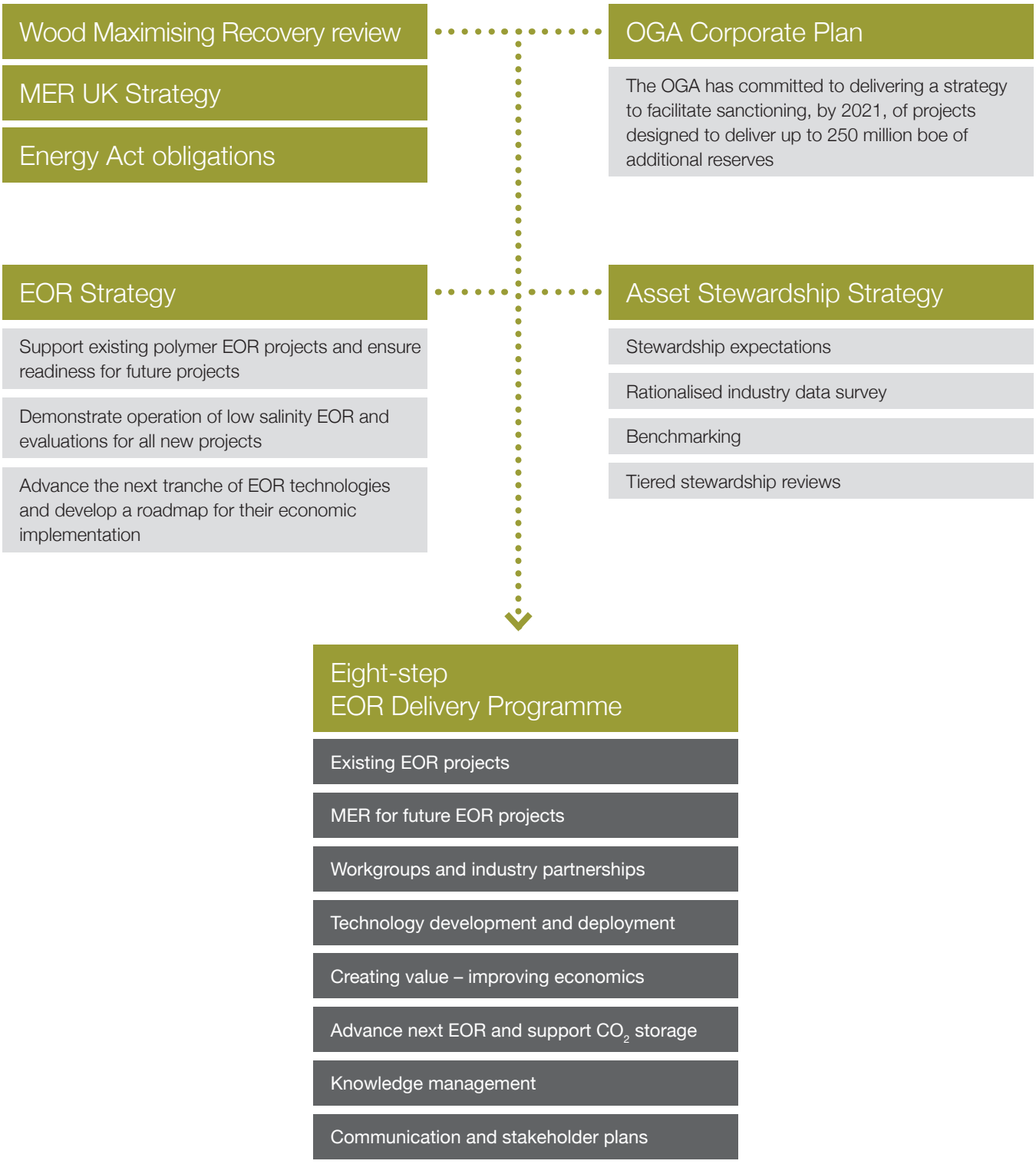
This EOR Delivery Programme builds on the EOR Strategy and describes in more detail how and when the near-term priority areas in EOR will be delivered. It takes into account the various obligations and commitments from the MER UK Strategy, the Energy Act and the OGA Corporate Plan 2016–2021, as well as the principles of stewardship outlined in the Asset Stewardship Strategy.

The activities in the EOR Delivery Programme will be monitored by a joint industry/OGA task group and reviewed annually by the MER UK Asset Stewardship Board and updated as necessary.

It is structured in two parts. In Section 3, there is a brief narrative of each of the eight EOR Delivery Programme areas, indicating how the inputs have been considered and detailing planned deliverables. In Section 4, there are schedules for each area, indicating the timing of the deliverables.

Figure 1: Building the EOR Delivery Programme

The inputs and resulting areas of delivery for the programme are shown in Figure 1 below.



3. EOR Delivery Programme elements

The following eight-step programme has been developed to aid the delivery of additional economic hydrocarbons by developing EOR projects, as follows:

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 CO_2 storage
7. Knowledge management
8. Communication and stakeholder plans

These eight elements are aligned to the obligations in the MER UK Strategy and the principles and expectations outlined in the Asset Stewardship Strategy.

This section describes how each element mitigates a specific risk to delivering the Strategy in the following structure:

Objective

Inputs

Activities

Responsibilities

Deliverables

3.1 Element 1: Existing EOR projects

Objective

The objective is to ensure current polymer and low salinity EOR projects are progressed in line with their Field Development Plans (FDPs).

It is believed that polymer EOR presents the greatest opportunity for medium-term success in the UKCS and a number of oil fields could have their recovery factor increased through polymer EOR. There are three polymer EOR projects which have FDPs in place. In addition to heavy oil EOR, there is one low salinity water flood EOR project with an approved FDP:

Captain polymer EOR pilot and staged development project, with execution of the first phase in 2017 – in front end design phase

Clair Ridge (to implement world's first offshore low salinity EOR scheme) – in construction

Mariner polymer pilot scheme – in construction (pre-investment in tanks, pumps and infrastructure has been approved)

Schiehallion/Loyal Quad 204 polymer ready scheme – 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)

The aim of this element of the programme is to support the above four EOR projects to achieve their FDP goals.

Inputs

Field Development Plans

Asset stewardship of specific polymer and low salinity EOR projects

Findings from previous PILOT EOR workgroup and current ongoing polymer EOR workgroup

Experience and lessons learned in deployment of polymer and low salinity technology from the oil and gas industry

Activities

Support the Captain polymer EOR pilot and staged development project

Support Clair Ridge to implement the world's first offshore low salinity EOR scheme

Support the implementation of the Mariner polymer pilot programme

Support the implementation of Schiehallion/Loyal Quad 204 polymer EOR scheme through standardisation of polymer test methods and injectivity improvements

Responsibilities

Single Point Accountable (SPA) are the relevant OGA area managers for the northern North Sea (NNS) and central North Sea (CNS)

Directional oversight and steering from MER UK Asset Stewardship Board EOR workgroup

Development and progression of EOR technical activities from MER UK EOR workgroup membership

EOR Delivery Programme Management from the OGA EOR specialist

EOR facilities interactions from the OGA facilities engineers

Deliverables

Progress to next stage of Captain polymer staged development

Clair Ridge low salinity EOR scheme start-up

Mariner polymer pilot programme started

Schiehallion/Loyal Quad 204 polymer scheme start-up

Lessons learned from these projects are made available for future offshore EOR schemes by both the OGA and the existing UKCS EOR workgroup membership

3.2 Element 2: MER for future EOR projects

Objective

The objective is to ensure EOR opportunities are identified early enough in field life cycle to maximise economic recovery.

This element of the programme will focus on progressing future EOR projects. Current low oil prices have resulted in the OGA developing 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, while screening new project obligations at FDP review stage.

A number of other low salinity water flood and chemical EOR (polymer and surfactant) experimental and simulation studies have been completed which have helped determine the potential prize of these chemical EOR technologies.

Inputs

FDPs and asset stewardship for future projects

The potential EOR prize which was initially presented in the PILOT[1] EOR Workgroup Report in April 2014 and also summarised in 'Maximising Enhanced Oil Recovery Opportunities in the UKCS through Collaboration' (Society of Petroleum Engineers (SPE) 172017, 2014)

New EOR technology ideas from global EOR experts

Previous OGA and operator EOR study reports

Activities

Introduce early EOR screening for regulatory approval in draft FDPs

EOR is part of regulatory approval process in FDPs

Obligation for operators to justify why EOR is not being used

The OGA will ensure that in preparation of FDPs, the appropriate level of EOR modelling and screening has been completed and future EOR forecasts (production/capital expenditure/operating expenditure) are presented

Promote the progression of high-graded EOR resource opportunities

Ensure operators maximise EOR benefits and economics

Support EOR reviews to identify barriers to deployment and help provide mitigations

Support and encourage EOR in heavy oil fields, e.g. Quad 9

Promote EOR use elsewhere, e.g. Buzzard, Golden Eagle, Foinaven and Alba

[1] Cross Industry/regulator work group comprising DECC, BP, CNR, EnQuest, Fairfield Energy, Nexen, Talisman and TAQA. PILOT has been superseded by the MER UK Forum. Implementing EOR is performed by industry but is a key activity in the OGA Corporate Plan. Responsibility to deliver tangible and quantifiable results falls upon the Asset Stewardship MER UK Board

Activities (cont)

Create and maintain an inventory of EOR projects to track their progress and success

Develop and use an annual EOR resource tracking process as part of the broader asset stewardship performance reviews

Adapt Reserves & Resource (R&R) stewardship to include EOR

Annual review of the EOR target – currently 250 million boe

Plan and conduct specific OGA studies to evaluate future EOR opportunities

Study 1 – polymer EOR potential for viscous oil reservoirs with active aquifers

Study 2 – thermally activated polymer screening for UKCS fields (proposed)

Future studies will be defined during the programme (one or two per year)

Responsibilities

OGA area managers (NNS and CNS) are responsible for the first two activities

OGA EOR specialist is responsible for the second two activities

Direction oversight and steering from the MER UK Asset Stewardship Board EOR workgroup

EOR Delivery Programme Management from the OGA reservoir specialist

EOR Facilities interactions from the OGA facilities engineers

Deliverables

Updated FDP guidance and regulator approval process which include EOR screening

EOR screening being conducted in draft FDPs

Operators progress high-graded EOR resource opportunities in all relevant new FDPs and FDP addendums

Central database of EOR projects, tracking their progress and success and aligned with to the OGA Reserves & Resources (R&R) stewardship

Technical reports from the specific OGA studies carried out to evaluate future EOR opportunities

3.3 Element 3: Workgroups and industry partnerships

Objective

The objective is to ensure that EOR technology and implementation lessons are shared.

The key priority of this element of the programme will be around developing workgroups and industry partnerships to progress polymer EOR. This will be achieved through the following:

Collaboration – where possible, share lessons learned to build EOR knowledge and competency in the UKCS and reduce barriers to EOR development at both producing and future fields; this will involve operators, supply chain, the OGA, academia etc.

Sustainability – identify industry standardisation of testing methods for polymer EOR and other EOR technologies

Risk reduction – collective approaches will be developed to manage the risk profile of EOR developments and mitigate common risks

Offshore EOR offers the supply chain great potential to develop UK skills and expertise and ultimately become a world leader in a relatively immature sector with significant global export potential

To develop the understanding of key EOR technology deployable in the UKCS, a number of Joint Industry Partnerships (JIPs) will be supported depending on priority and budget availability

The current approved and funded projects are:

Dolphin JIP, 2014 to 2016 – IFPEN[2]

Carbonated Water JIP, 2015 to 2016 – Heriot-Watt University

Future proposed projects:

Polymer EOR Molecular Weight Distribution Analytical Techniques – University of Warwick

Dolphin JIP Study – Second Phase of Studies, 2017 to 2019 – IFPEN

Low salinity EOR JIP, 2017 – Heriot-Watt University

Inputs

FDP expectation and Asset Stewardship review

PILOT EOR Workgroup report (April 2014)

SPE Paper 'Maximising Enhanced Oil Recovery Opportunities in the UKCS through Collaboration' (SPE 172017, 2014)

Polymer EOR workgroup

University and industry global EOR expertise

Supply chain, in particular polymer suppliers, water treatment and logistics

EOR technology learning and expertise from industry Enhanced Oil Recovery conferences, e.g. SPE's Tulsa EOR Conference, IEAEOR Workshop and Symposium, EAGE IOR Conference

[2] IFP Energies nouvelles (IFPEN) is a major research and training player in the fields of energy, transport and the environment. From research to industry, technological innovation is central to all its activities, structured around three strategic priorities: sustainable mobility, new energies and responsible oil and gas

Activities

Drive operator collaboration and partnerships proactively via EOR workgroups – recognising the need for companies to protect their intellectual property

Develop an EOR workgroup with a small group of operators who have UKCS polymer EOR projects in design/execute/operational phases of development to share lessons learned on subsurface/design/operations/implementation; the aim is to share offshore polymer EOR lessons and identify key success criteria

Develop a low salinity EOR workgroup or 1:1 sessions to support UKCS operators to: screen reservoirs; conduct core floods; implement Single Well Chemical Tracer Test (SWCTT) and field trials; develop new facilities to underpin successful evaluation, and implementation of new offshore low salinity water EOR schemes

Develop a UKCS future polymer EOR workgroup with a wider group of operators with interests in both current and future polymer EOR opportunities

Actively support industry partnerships and collaboration

Engage in specific EOR JIPs through project specification, funding support, steering technical direction and ensuring knowledge transfer

Four initial focus areas have been agreed to be pursued in the following areas:

Health, Safety and Environment

Injectivity

De-risking of pilot programmes

Standardisation

Responsibilities

SPA is the OGA EOR specialist

Directional oversight and steering from the MER UK Asset Stewardship Board EOR Workgroup

EOR Delivery Programme Management from the from OGA facilities engineers

Deliverables

Operator collaboration and partnerships via EOR workgroups conducted

Industry partnerships formed and collaboration conducted

EOR JIPs supported and results communicated

A “starter pack” that assists operators in UK evaluate EOR, to accelerate learnings on key issues and mitigations

3.4 Element 4: Technology development and deployment

Objective

The objective is to try to ensure that EOR technologies are developed and deployed.

The aim of this element of the programme is to gain additional buy-in from EOR technology providers and operators to develop and then deploy economical EOR technology applicable to the UKCS.

The two focused EOR areas are to:

- Drive operators to optimise existing EOR technologies
- Progress new polymer EOR projects and to develop and trial low salinity EOR technology in the UKCS

In addition, this element of the programme will seek out emerging EOR technology that arises through other worldwide EOR projects (R&D and deployment) and engage global expertise which has a longer term applicability to the UKCS.

There is the perception that effective implementation of EOR could be stifled due to concerns with sharing Intellectual Property (IP). This work programme will address how to deploy and license current solutions through the supply chain. Efforts will be made to manage this process within the boundaries of IP.

Inputs

MER UK Boards – Asset Stewardship and Technology Leadership Board

EOR technology Society of Petroleum Engineers (SPE) papers/EOR conference papers

New EOR technology developments from industry, vendors and academia

EOR chemical supplier information on new innovative EOR chemicals systems

Industry deployed EOR field study results and experience that become available for wider industry use

Activities

Address industry concerns with IP:

Find working space in order to navigate between respecting rights for preserving IP and developing technologies

Support technology providers and operators to develop and deploy low-cost EOR through:

Collaborative EOR developments

Early piloting of EOR technology

Regional and longer-term vision

Drive operators to optimise polymer EOR technology, for example:

Overcome injectivity issues through low cost effective low shear equipment

Develop and trial new polymer chemical systems to improve polymer injectivity

Appraise the synergy of polymer EOR with low salinity EOR to reduce costs

Develop new low cost improved surfactants, active polymer systems

Field trial thermally activated polymer in reservoirs that have poor sweep

Activities (cont)

Drive operators to develop further and trial low salinity EOR technology, for example:

Design and implement a single well trial to demonstrate low salinity EOR

Develop low weight and cost equipment for seawater and produced water desalination

Progress the Liverpool University Brent Petrography study to establish future opportunities

Develop designed or smart water EOR to go beyond low salinity EOR

Actively support emerging EOR technology and engage with global expertise, for example:

Appraise an offshore steam injection pilot for the recovery of heavy oil resources

Appraise combined desalination and chemical delivery through tankers or barges

Support studies to improve oil recovery from small pools through EOR technology

Promotion of EOR technology is included in the new UK Oil and Gas Technology Centre

Responsibilities

SPA is the OGA operations director

Key support from OGA reservoir specialist

Deliverables

An annual review describing how technology providers and operators have developed and deployed low cost EOR technology in the UKCS

An annual review of the work conducted to optimise polymer EOR technology for use in the UKCS

An annual review describing the further development and trials of low salinity EOR technology in the UKCS

An annual review describing emerging EOR technology and new EOR expertise applicable to the UKCS

3.5 Element 5: Creating value – improving economics

Objective

The objective is to ensure the economics of marginal EOR projects do not stifle investment.

The oil price has declined significantly and this currently affects EOR economics making the task of maximising economic recovery through EOR even more challenging.

Current low oil prices have resulted in the OGA developing 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.

This element of the programme is focused on creating value through understanding and improving the economics of polymer EOR. This will be achieved through the following:

- **Understanding** the economics of polymer EOR in existing UKCS projects
- **Cost reduction** to create a competitive, robust supply chain to improve polymer EOR economics and reduce risk
- **Risk reduction** via collective approaches to manage the risk profile of EOR developments and mitigate common risks

Inputs

MER UK Boards

Asset Stewardship

Technology Leadership Board

Efficiency Task Force

OGA economics analysis

Operator economic analysis

Chemical EOR supplier costs

OGA and industry economic experts, e.g. department of economics, University of Aberdeen[3]

Governments, Department for Business, Energy and Industrial Strategy (BEIS) and Scottish Enterprise

Activities

Develop an improved economic understanding

Detailed EOR economic evaluations for current projects including all cost assumptions and predicted incremental recovery profiles used

Develop an understanding of how the commerciality can be improved for current and future UKCS projects

Review the interpretation of investment allowance for EOR projects and ensure UKCS operators are aware of the allowances

Develop a compelling business case for EOR technology

Specific cases – from existing project experience

Generic cases – various future scenarios economic analysis

Facilitate a competitive polymer supply chain and drive down costs

Develop and lead a powerful promotional campaign for polymer EOR

Responsibilities

SPA is the OGA EOR specialist

Directional oversight and steering from the MER UK Asset Stewardship Board EOR workgroup

Economic advice from the OGA senior economist

Key support from EOR Delivery Programme Management from the OGA area managers

Deliverables

A report outlining the development of a compelling business case for EOR technology

A report describing the polymer HPAM[4] supply chain and ways to drive down costs through scale of use

Communication material including conference presentations that promotes the creation of value from EOR applied in the UKCS which results from improved economics

[3] The Economics of CO_2-EOR Cluster Developments in the UK Central North Sea/Outer Moray Firth, Professor Alexander G Kemp and Dr Sola Kasim, January 2012

[4] HPAM – hydrolysed polyacrylamide

3.6 Element 6: Advance next EOR and support CO_2 storage

Objective

The objective is to ensure that, while prioritising polymer and low salinity EOR, other EOR technologies are not missed.

This element of the programme focuses on assessing the next tranche of EOR technologies, progressing miscible gas EOR opportunities, developing a future CO_2 EOR strategy.

Many new EOR technologies have been developed over the past decade when high oil prices led to a stimulus in EOR research and development among governments, oil companies and universities. A review of these new technologies will be conducted and a roadmap for their economic implementation will be developed to assist in prioritising their future value and applicability in UKCS. From this roadmap, the most promising EOR technologies will be identified and progressed by the EOR Delivery Programme.

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

Miscible CO_2 EOR is a future opportunity that could use CO_2 which becomes available from CCS projects. A 2015 study by the Energy Research Partnership (ERP)[5] reviewed the interaction of CCS on CO_2 EOR and made a number of recommendations. In addition to oil price, low cost of carbon, a lack of CO_2 supply and the ageing facilities of the UKCS will be key factors influencing whether CO_2 EOR economics will be viable.

Inputs

OGA screening for miscible gas EOR and CO_2 EOR

OGA miscible gas studies conducted for UKCS

Global miscible gas and CO_2 EOR operator expertise (including USA CO_2) EOR experience

UKCS miscible gas experience – for example Magnus EOR

Miscible gas and CO_2 miscible EOR papers and conferences

CCS industry, Global CCS Institute, Carbon Capture and Storage Association (CCSA) and Scottish Carbon Capture and Storage (SCCS)

Government, BEIS and Scottish Enterprise

[5] PROSPECTS FOR CO_2-EOR IN THE UKCS, Energy Research Partnership, October 2015

Activities

Advance the next tranche of EOR and develop a roadmap for economic implementation to assist in prioritising future applicability in the UKCS, for example:

- Foam or other chemicals to improve miscible gas sweep (including CO2 EOR)
- Technologies to optimise CO2 EOR when CO2 becomes available from CCS including carbonated water injection
- Development and use of low cost microbial EOR
- Use of offshore thermal EOR such as continuous steam flood and hot water injection to improve recovery of heavy oil
- Use of CO2 injection for aquifer pressure support of hydrocarbon reservoirs
- Improved heavy oil production via novel downhole injection or production technologies

Support miscible gas EOR opportunities in specific fields

- Miscible and immiscible hydrocarbon water-alternating gas (WAG)
- CO_2 EOR where CO_2 becomes available for specific EOR candidate projects, e.g. Miller

Develop a CO_2 EOR strategy and plan, including:

- Relevant learnings from miscible gas EOR projects
- Review of recent SCCS and ERP CO_2 EOR reports
- Review of CO_2 supply for EOR from CCS projects
- Updated screening of UKCS CO_2 EOR opportunities
- Review of licence status of key CO_2 EOR opportunities

Continue to regulate offshore CO_2 storage

Responsibilities

- SPA is the OGA EOR specialist
- Directional oversight from the OGA operations director
- Directional oversight and steering from the MER UK Asset Stewardship Board EOR workgroup
- Economic advice from the OGA senior economist
- UKCS regional advice from the OGA area managers

Deliverables

- A report describing the next tranche of EOR technologies and develop a roadmap for their economic implementation which can assist in prioritising future applicability in the UKCS
- A report outlining updated screening of UKCS miscible gas EOR opportunities
- Publish a CO_2 EOR strategy and plan
- Continue to regulate offshore CO_2 storage
- A report summarising the lessons learned from Magnus miscible gas EOR scheme which will benefit future offshore miscible gas schemes

3.7 Element 7: Knowledge management

Objective

The objective is to improve EOR awareness and knowledge transfer.

This element of the programme focuses on ensuring that EOR knowledge is widely available. An OGA library for EOR technologies will be developed to ensure EOR information is readily available from a variety of industry sources.

Two international EOR conferences will be supported through the OGA membership on their committee and active participation. The OGA EOR specialist currently sits on both these committees.

There will also be regular engagement with other government organisations, e.g. Norwegian Petroleum Directorate (NPD), Agência Nacional do Petróleo (anp) Brazil and IOR/EOR centres and universities which are focusing on offshore EOR technologies.

Inputs

Historical OGA EOR studies (where appropriate)

EOR technology SPE papers and other EOR conference papers

EOR technology ideas from global EOR experts – operators' R&D and universities

EOR vendors, chemical supplier information, EOR simulation and EOR consultancy

EOR studies/reports from past OGA work

Activities

Create and manage an OGA EOR library for EOR technologies

SPE EOR/EAGE IOR/other IOR and EOR conferences

EOR vendor materials

OGA EOR study reports

Actively support international EOR conferences

International Energy Agency – EOR[6]

EAGE[7] IOR

Actively co-operate with other governments and their technology centres

NPD, Norway IOR Centre, International Research Institute of Stavanger University, Bergen University, and Brazil

Danish Technological Institute

IFPEN

Responsibilities

SPA is the OGA EOR specialist

Specific UKCS EOR information from the OGA area managers and asset teams

Directional oversight from the OGA operations director

Deliverables

Creation of an OGA library for EOR technologies

OGA heritage EOR study reports

Annual update on the support given to the IEA EOR Technology Collaboration Programme

Annual update on the support given to the EAGE IOR Conference

Annual update on the co-operation with other governments and their technology centres

[6] IEA's Technology Collaboration Programmes (or IEA TCP – formally organised under the auspices of an Implementing Agreement) for research, development and demonstration on EOR was created to address all aspects of EOR through international collaboration. Over the years, it has proved to be an ideal platform for fruitful exchange between academia and industry

[7] EAGE – The European Association of Geoscientists and Engineers (EAGE) is a global professional, not-for-profit association for geoscientists and engineers with more than 19,000 members worldwide. It provides a global network of commercial and academic professionals to all members. The association is multi-disciplinary and international in form and pursuits

3.8 Element 8: Communication and stakeholder plans

Objective

The objective is to ensure investment in EOR projects is not limited by lack of senior industry leadership buy-in to the deployment of EOR technology.

The final element of the programme is to ensure there are clear communication and stakeholder plans developed and to encourage more cross industry collaboration in an attempt to stimulate more EOR on the UKCS.

Responsibility to deliver tangible and quantifiable results falls upon the MER UK Asset Stewardship Board, including senior industry leadership engagement on EOR.

Inputs

EOR assessments made during the FDP process

Asset Stewardship relating to reservoir technical limits review processes

Operating companies – senior managers, development leads, operational engineers and research and development teams

MER UK Boards – Asset Stewardship, Regional Development and Infrastructure, Technology Leadership Board and Efficiency Task Force

Universities and EOR R&D organisations

Supply chain in particular EOR chemical suppliers and EOR simulation vendors

Oil & Gas UK

CCS industry, CCSA, SCCS

Governments, BEIS and Scottish Enterprise

Activities

Develop a clear stakeholder plan

Develop and lead a powerful promotional campaign for EOR

Responsibilities

SPA is the OGA area managers

Key support from MER UK Asset Stewardship Board

Key support from OGA EOR specialist

Deliverables

EOR stakeholder plan created and updated as necessary

EOR communication plan created and regularly updated

Promotional material developed and published

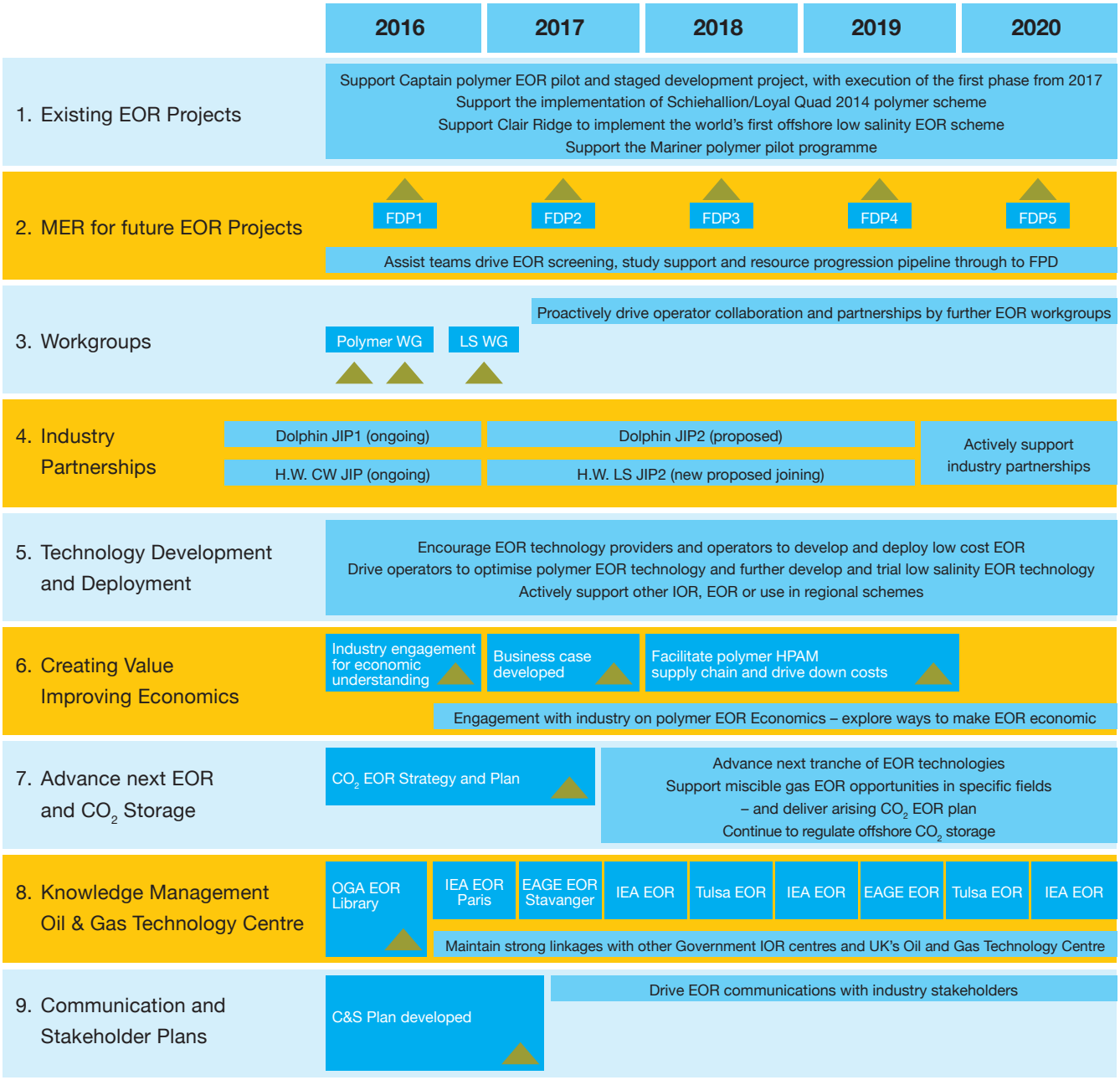
4. EOR Delivery Programme schedules

The following schedules indicate the key activities and dates by which the deliverables described in Section 3 will be achieved.

Figure 2 below shows an overview of how the EOR Delivery Programme will be implemented.

A separate schedule for each delivery programme element is provided in the following sections.

Figure 2: OGA EOR Strategy – Delivery Programme, Tier 1 Plan



4.1 Existing EOR projects

The planned schedule to deliver this element includes:

Stage	Key Deliverable	Planned Date
1	Progress to next stage of Captain polymer staged development	Q3 2017
2	Schiehallion/Loyal Quad 204 polymer scheme start-up	Q4 2017
3	Clair Ridge low salinity EOR scheme start-up	Q3 2017
4	Mariner polymer pilot programme started	Q4 2020
5	Lessons learned from these projects are made available for future offshore EOR schemes by both the OGA and the existing UKCS EOR workgroup membership	Q4 2020

Figure 3 below illustrates the activities and timings for **existing EOR projects**.

Figure 3: Delivery Programme 1 – existing EOR projects

Programme Element	Programme Tasks	2017 Q1	2017 Q2	2017 Q3	2017 Q4	2018 Q1	2018 Q2	2018 Q3	2018 Q4	2019 Q1	2019 Q2	2019 Q3	2019 Q4	2020 Q1	2020 Q2	2020 Q3	2020 Q4
		1 2 3	4 5 6	7 8 9	10 11 12	1 2 3	4 5 6	7 8 9	10 11 12	1 2 3	4 5 6	7 8 9	10 11 12	1 2 3	4 5 6	7 8 9	10 11 12
1. Existing EOR projects	Support Captain polymer EOR pilot and staged development project, with execution of the first phase from 2017	**Support Captain polymer EOR pilot and staged development project, with execution of the first phase in 2017**															
	Support the implementation of Schiehallion/ Loyal Quad 204 polymer scheme	**Support the implementation of Schiehallion/Loyal Quad 204 polymer scheme**															
	Support Clair Ridge to implement the world's first offshore low salinity EOR scheme	**Support Clair Ridge low salinity EOR implementation and subsequently demonstrate reliable operation to realise the Maximum Economic Recovery**															
	Support the Mariner polymer pilot programme	**Support Mariner Polymer EOR pilot implementation**															

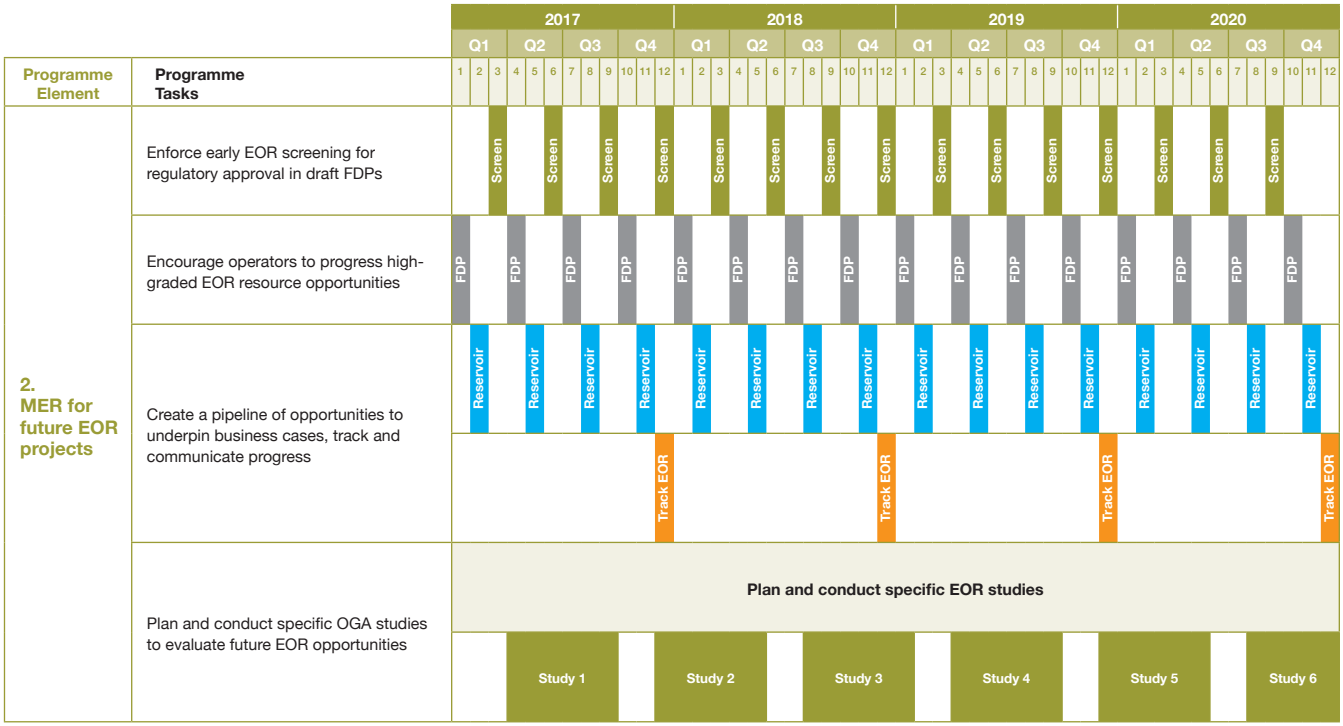
4.2 MER for future EOR projects

The planned schedule to deliver this element includes:

Stage	Key Deliverable	Planned Date
1	Update FDP guidelines and regulator approval process to include EOR screening	Q1 2017
2	EOR screening being conducted in draft FDPs	Ongoing
3	Operators progress high-graded EOR resource opportunities in all relevant FDPs and FDP addendums	Ongoing
4	Central database of EOR projects, tracking their progress and success and aligned with to the OGA Reserves & Resources (R&R) stewardship	Q1 2017
5	Technical reports from the specific OGA studies carried out to evaluate future EOR opportunities	Q4 2020

Figure 4 below illustrates the activities and timings for **future EOR projects**.

Figure 4: Delivery Programme 2 – MER for future EOR projects



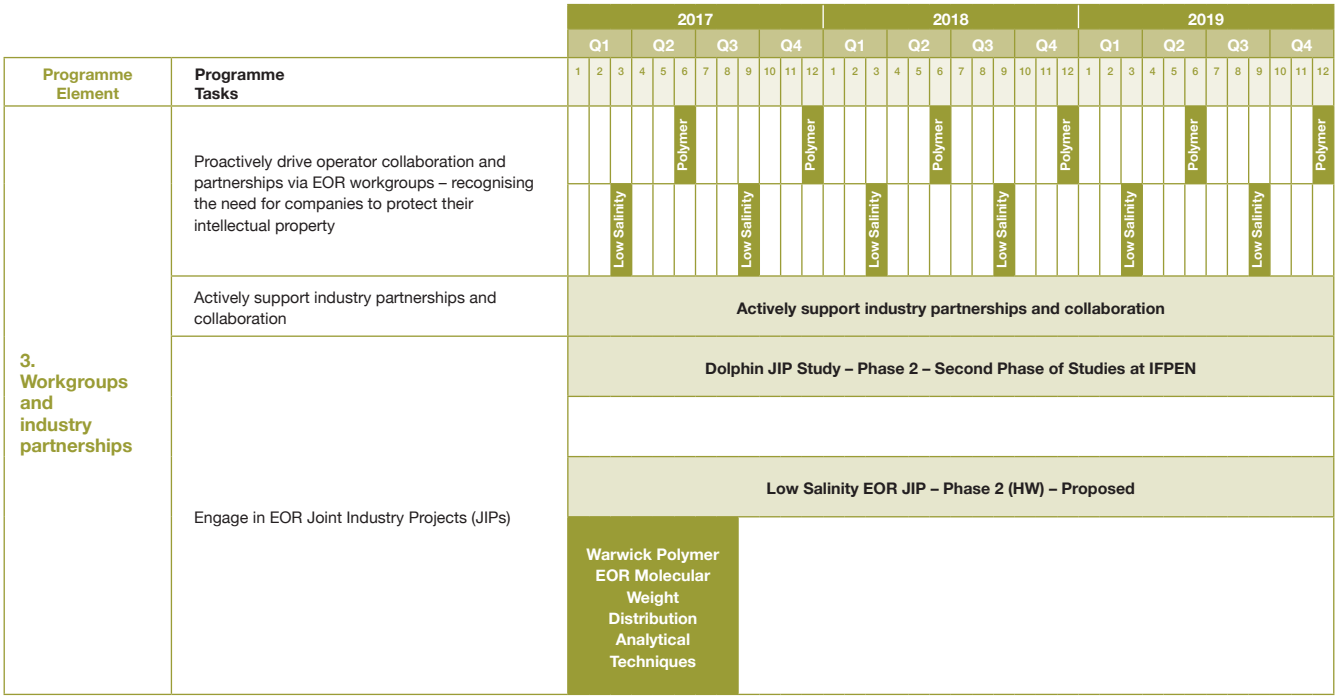
4.3 Workgroups and industry partnerships

The planned schedule to deliver this element includes:

Stage	Key Deliverable	Planned Date
1	Operator collaboration and partnerships via EOR workgroups conducted	From Q2 2016
2	Industry partnerships and collaboration conducted	From Q2 2016
3	EOR JIPs supported and results communicated	From Q2 2016
4	A "starter pack" that assists operators in UK evaluate EOR, to accelerate learnings on key issues and mitigations	Q3 2017

Figure 5 below illustrates the activities and timings for **workgroups and industry partnerships**.

Figure 5: Delivery Programme 3 – workgroups and industry partnerships



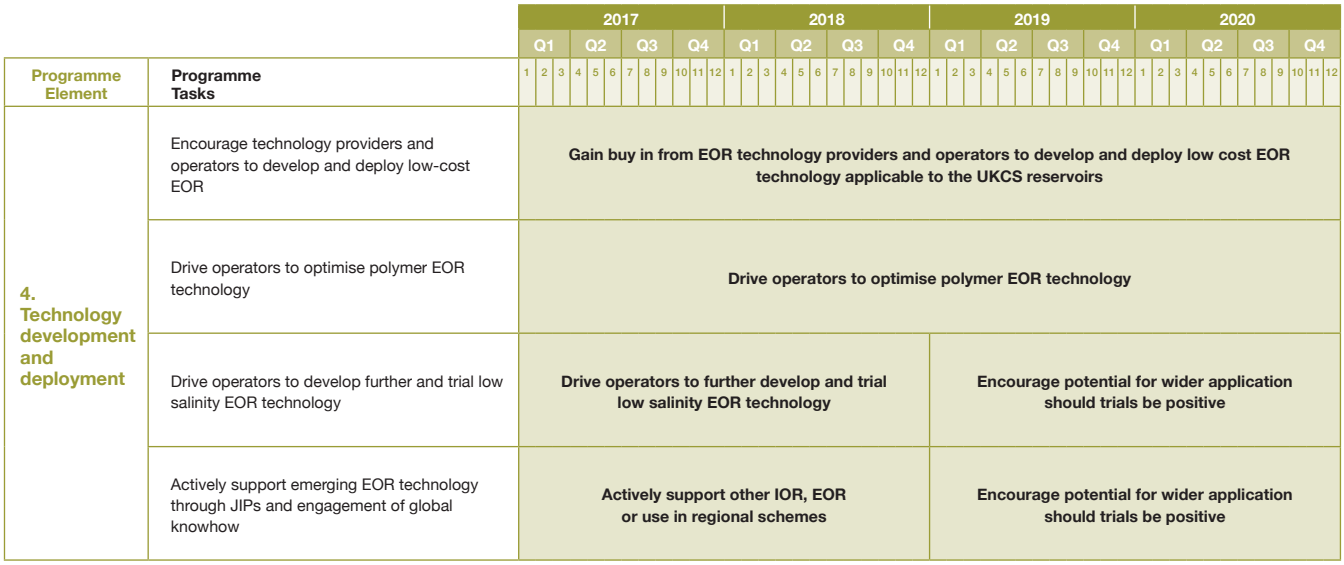
4.4 Technology development and deployment

The planned schedule to deliver this element includes:

Stage	Key Deliverable	Planned Date
1	An annual review describing how technology providers and operators have developed and deployed low cost EOR technology in UKCS	Q4 2018
2	An annual review of the work conducted to optimise polymer EOR technology for use in UKCS	Q2 2017
3	An annual review describing the further development and trials of low salinity EOR technology in UKCS	Q4 2017
4	An annual review describing emerging EOR technology and new expertise applicable to UKCS	Q4 2017

Figure 6 below illustrates the activities and timings for **Technology development and deployment**.

Figure 6: Delivery Programme 4 – technology development and deployment



4.5 Creating value – improving economics

The planned schedule to deliver this element includes:

Stage	Key Deliverable	Planned Date
1	A report outlining the development of a compelling business case for EOR technology	Q1 2017
2	A report describing the polymer HPAM supply chain and ways to drive down costs through scale of use	Q4 2019
3	Communication material including conference presentations that promotes creating value from EOR applied in the UKCS which results from improved economics	Q4 2017

Figure 7 below illustrates the activities and timings **for creating value – improving economics**.

Figure 7: Delivery Programme 5 – creating value – improving economics

		2017				2018				2019			
		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Programme Element	Programme Tasks	1 2 3	4 5 6	7 8 9	10 11 12	1 2 3	4 5 6	7 8 9	10 11 12	1 2 3	4 5 6	7 8 9	10 11 12
5. Creating value – improving economics	Develop an improved economic understanding to facilitate informed discussions	**Develop and lead a powerful promotional campaign for the polymer EOR**											
	Develop a compelling business case for EOR technology; generic and specific cases	**Develop an improved economic understanding of polymer EOR**											
	Facilitate a competitive polymer supply chain and drive down costs	**Continue to facilitate UKCS polymer HPAM supply chain and drive down costs through scale of use**											

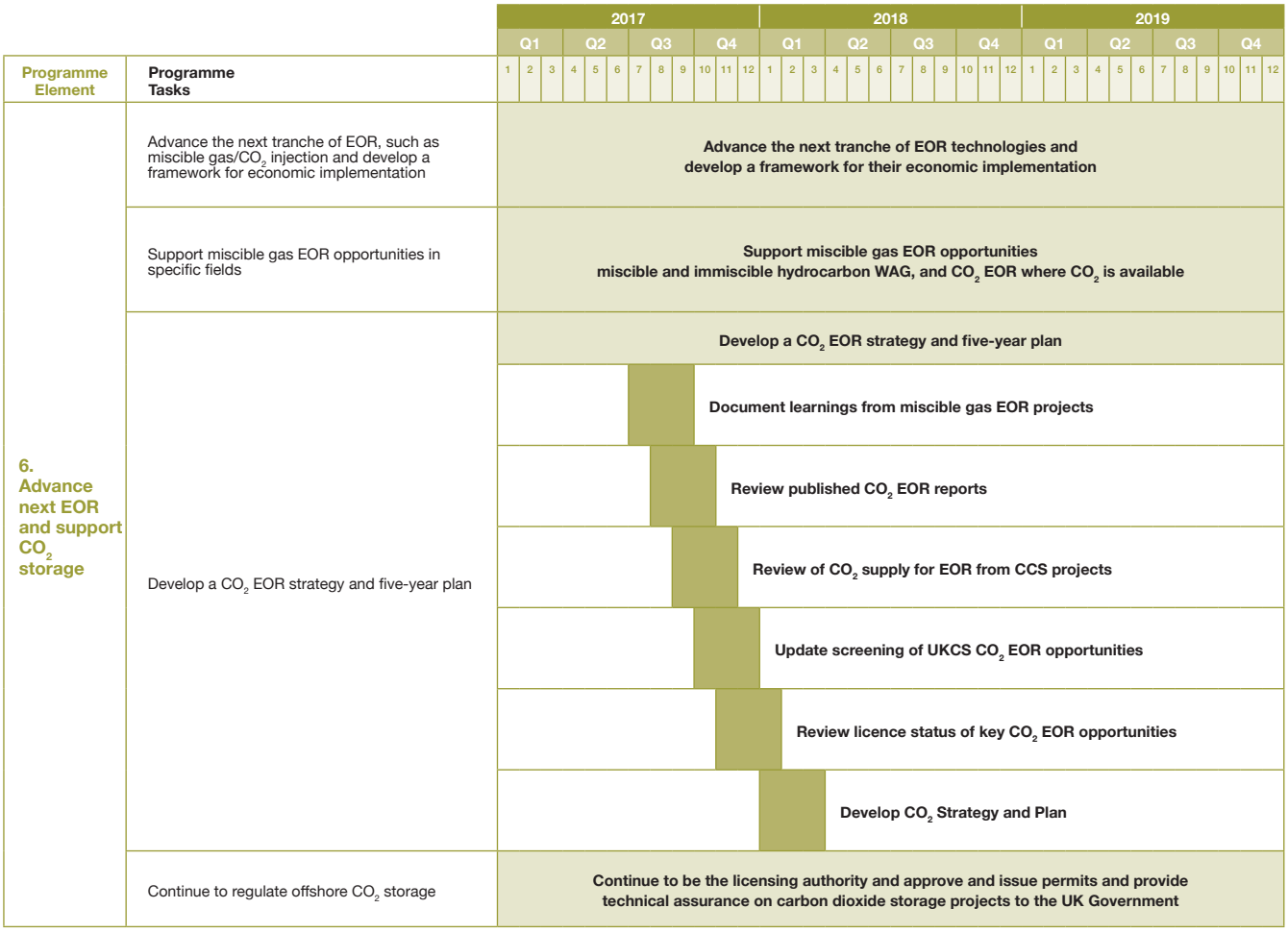
4.6 Advance next EOR and support CO2 storage

The planned schedule to deliver this element includes:

Stage	Key Deliverable	Planned Date
1	A report describing the next tranche of EOR technologies and develop a roadmap for their economic implementation which can assist in prioritising future applicability in UKCS	Q4 2017
2	A report outlining updated screening of the UKCS miscible gas EOR opportunities	Q4 2017
3	Publish a CO_2 EOR strategy and plan	Q2 2018
4	Technical and regulatory support for CO_2 storage as part of any future CCS agenda	Ongoing
5	A report summarising the lessons learned from Magnus miscible gas EOR scheme which will benefit future offshore miscible gas schemes	Q2 2018

Figure 8 below illustrates the activities and timings for **advance of next EOR and support of CO_2 storage**.

Figure 8: Delivery Programme 6 – advance next EOR and support CO_2 storage



4.7 Knowledge management

The planned schedule to deliver this element includes:

Stage	Key Deliverable	Planned Date
1	Creation of an OGA library for EOR technologies	Q1 2017
2	Annual update on the support given to the IEA EOR Technology Collaboration Programme	Ongoing
3	Annual update on the support given to the EAGE IOR Conference	Ongoing
4	Annual update on co-operation with other governments and their technology centres	Ongoing

Figure 9 below illustrates the activities and timings for **knowledge management**.

Figure 9: Delivery Programme 7 – knowledge management

		2017												2018												2019											
		Q1			Q2			Q3			Q4			Q1			Q2			Q3			Q4			Q1			Q2			Q3			Q4		
Programme Element	Programme Tasks	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
7. Knowledge management	Create and manage an OGA EOR library for EOR technologies	**Create and manage an OGA EOR Information Library for all EOR technologies, which will enable informed discussions and decisions to be made with industry**																																			
	Actively support international EOR conferences	**Actively support international EOR conferences to ensure OGA maintains awareness of latest R&D, development, deployment and expertise**																																			
	Actively co-operate with other governments and their technology centres	**Actively co-operate with other governments and their IOR centres to progress offshore EOR technology in the North Sea**																																			

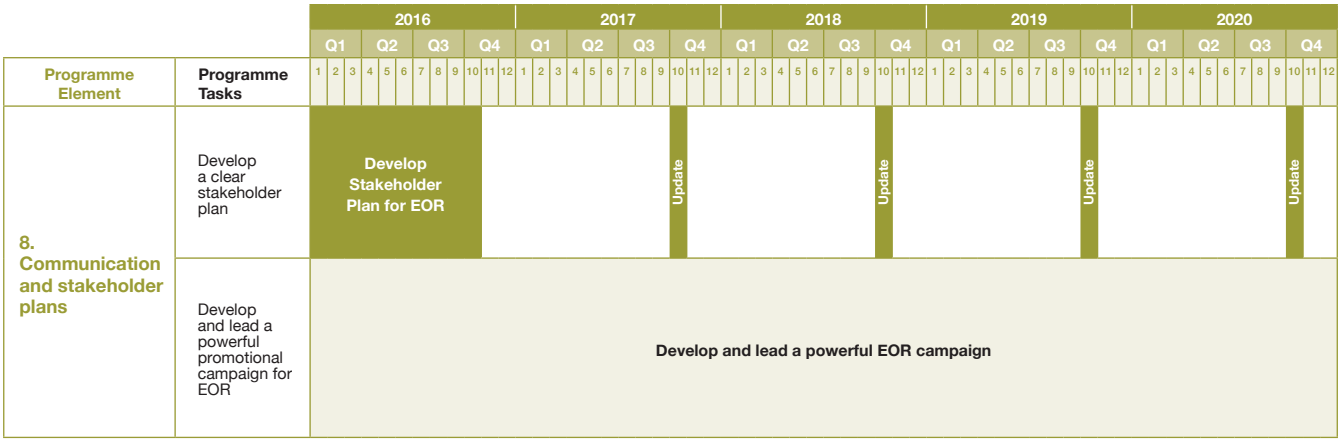
4.8 Stakeholder engagement

The planned schedule to deliver the stakeholder engagement element includes:

Stage	Key Deliverable	Planned Date
1	EOR stakeholder plan created and updated as necessary	Ongoing
2	EOR communication plan created and regularly updated	Q4 2016 to Q4 2020
3	Promotional material developed and published	Q1 2017

Figure 10 below illustrates the activities and timings for preparation and completion of the stakeholder engagement element.

Figure 10: Delivery Programme 8 – communication and stakeholder plans



4.9 EOR implementation plans single point accountable and support role

Figure 11 below shows a summary of the EOR Delivery Programme Single Point Accountable (SPA) and support.

Figure 11: EOR Delivery Programme SPA and support

		EOR implementation plans – SPA and support role									
EOR Role	**Key EOR responsibility**	**EOR Strategy**	**Progress of implementing EOR Strategy**	**Plan 1: Existing EOR projects**	**Plan 2: MER for future EOR projects**	**Plan 3: Workgroups and industry partnerships**	**Plan 4: Technology development and deployment**	**Plan 5: Creating value-improving economics**	**Plan 6: Advance next EOR and support CO_2 storage**	**Plan 7: Knowledge management**	**Plan 8: Communication and stakeholder plans**
OGA E&P EOR Manager	Develop EOR Strategy and interactions on economics/cost improvements	1	2					2			1
MER UK Asset Stewardship Board	Deliver tangible and quantifiable results, including senior leadership engagement on EOR	2	1	2	2	2					2
OGA Operations Director	Linkage of EOR Strategy to technology	2					1		2	2	
OGA Senior Economist	Linkage of EOR Strategy to economics							2	2		
OGA EOR Reservoir Specialist	Cross-field team EOR support, workgroups, JIPs, technology development and innovation, future miscible gas EOR, CO_2 EOR policy and knowledge capture	2	2	2	2	1	2	1	1	1	2
OGA Area Managers	Existing EOR projects and engaging operators early to promote readiness for future polymer EOR projects		2	1	1			2	2		2
OGA Facilities Engineers	Existing EOR facilities and readiness for future polymer EOR projects			2	2	2					

1 SPA 2 KEY SUPPORT

5. Acknowledgements

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- Nexen
- North Sea Midstream Partners
- Petrofac
- Ramboll
- Repsol Sinopec Resources UK
- Subsea UK
- Wood Group

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- Chevron
- OGA
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- Statoil

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