

STEAMING RESOURCES TO RESERVES

North Sea Heavy Oil: Steam Flooding – Twice the oil in half the time March 2016







STEAM ENABLED PRODUCTION

- Nearly 2 million bbls per day of steam enabled production around the world
- Chevron, Oxy and Shell are the leaders in steam flood
- Exxonmobil (Imperial) and PDVSA are the top companies in cyclic steam stimulation
- Cenovus, Suncor, CNRL, Lukoil, Devon, CNOOC (Nexen), Husky and MEG are the pioneers of SAGD
- Shell and Wintershall are steam flooding the Schoonebeek/Emlichheim field on the Dutch/German border in Europe's biggest steam flood

2013 production data from Oil & Gas Journal 2014 EOR review, except Canada (Alberta Energy Regulator & company data) and Middle East (project specific estimates)











KERN RIVER

Chevron Corporation







Viscosity correlation derived from the Excel Macro PVTProps.xla based upon the Petroleum Fluids Pack developed by Hewlett Packard for use in their HP-41 series programmable hand-held calculators. GOR = 100 scf/bbl, Pressure = 1500 psi, bubble point = 1500 psi

Reservoir Temperature °F



Viscosity correlation derived from the Excel Macro PVTProps.xla based upon the Petroleum Fluids Pack developed by Hewlett Packard for use in their HP-41 series programmable hand-held calculators. GOR = 100 scf/bbl, Pressure = 1500 psi, bubble point = 1500 psi

Reservoir Temperature °F

Increases reserves by a factor of 2 – 10 times compared to primary heavy oil recovery.

Production is both incremental and accelerated





RECOVERY FACTOR POTENTIAL

Chevron Corporation



WHY STEAM FROM THE START



After diagram on page 8 of Shell's 2012 EOR brochure







OFFSHORE STEAM FLOODING

- A proven technology onshore since the 1960's; recent steam floods use horizontal wells
 - Schoonebeek, 2011 & Kern River infill, in 2013 Kern River was producing 24% of its oil from horizontal wells that made up just 4% of the well stock
- Horizontal wells are the key to a successful offshore steam flood, because
 - Horizontal wells enable development with an order of magnitude fewer wells
 - Heat loss is not a problem with high steam injection rates





Perenco's Emeraude steam injection facilities in Congo







P2244 - 21/27b & 28/2a

- Promote licence awarded in the 28th Round; start Date 1st Dec 2014; Steam Oil interest 100%
- Contains Pilot & Harbour discoveries with over 270 mmbbls of oil in place









A WELL APPRAISED DISCOVERY

- Harbour & Pilot discovered by Fina in 1989
- Fields appraised by 6 wells, plus 2 sidetracks/horizontals, Pilot South discovered in 1990
- The block is fully covered by the Western Geco Quad 21 3D survey which was reprocessed in 2009 and a new survey by Fugro which completed processing in 2013
- Six wells were cored, three wells were tested including a horizontal well that tested at rates over 1,800 bopd despite being in the most viscous part of the field







POTENTIAL WELL PATTERN







- Target the area with greater than 30' of net pay
- Alternating producers and injectors, 100m apart
 - potential to increase spacing, though this spacing is similar to that planned for Bressay, Mariner Heimdal & Bentley
- Wells between 1000m to 1800m long
 - Inflow control devices to achieve conformance control
- 42 alternating producers and injectors



GRAVITY ASSISTED STEAM DRIVE



Cross-section view at initial conditions, injection well low in section, production well mid way in oil leg



Steam chamber forms above injector and water cone forms below production well







Steam chamber sweeps top of reservoir and bank of condensed water sweeps the lower part of the reservoir



As steam breaks through the affected section of the production well is closed in to force steam to sweep the whole length of the well

PILOT MAIN PRODUCTION PROFILE



Full field production profiles based upon replication of representative sectors across the whole field.



- Based upon thermal reservoir simulation of 0 representative sectors using CMG STARS[™] simulator
- Injecting c. 100,000 bcwe/day of steam produces c. 35,000 bopd for 11 years
- Pilot main production profile recovers 132mmbbls
- Recovery factor c. 57%





PILOT – POTENTIAL 2C RESOURCES



All oil-in-place estimates based upon EnQuest internal reservoir studies, provided to Steam Oil



Field	STOOIP	RF	Potential 2C Resources
• ¥	270		mmbbls
ain*	230	5/%	152
outh [†]	33	60%	20
ſ	9	~	~
ered Resources	272		152

* Pilot Main recovery factor based on thermal reservoir simulation of representative sectors of the Pilot Main performed by Steam Oil using CMG STARS[™] simulator.

† Pilot South based upon an assumed recovery factor for steam flood in reservoir with oil at the lower end of the





WESTERN PLATFORM STEAMFLOOD A WHALE OF A PROJECT

Field	STOIP (mmbbls)	Recoverable (mmbbls)	Recove Facto
Pilot Main	230	132	
Pilot South	33	20	
Harbour	9		
Narwhal	41	21	
Elke (Minke)	185	93	
Total Discoveries	498	265	

50% recovery factor assumed for all bottom water fields Elke & Narwhal: Based upon preliminary thermal reservoir simulation. These estimates are internal Steam Oil estimates of likely recoverable resources, using the techniques described in GB Patent application GB1517936.9, and have not been verified by an independent auditor.





PILOT – CONCEPTUAL DEVELOPMENT PLAN

- Wells drilled from a jack-up rig positioned above a single wellhead tower
- Wellhead tower equipped with steam generation facilities
- Process facilities located on a bridge linked Sevan type cylindrical FPSO
- Seawater would be processed on the FPSO to provide fresh, very high quality, boiler feedwater.
- Gas imported for fuel







PILOT – COSTS

COST \$/BBL UNESCALATED	PILOT MAIN & SOUTH	WPSF TARGE1
Facilities costs	\$9.9	\$7.5
Drilling costs	\$6.5	\$6.0
Operating costs	\$9.6	\$8.0
Fuel costs	\$11.5	\$8.5
Total costs	\$37.4	\$30.0







UKCS REMAINING OIL RESERVES

Clair Schiehallion Buzzard Mariner Bressay Rosebank Pilot et al Bentley Lancaster Kraken Golden Eagle et al Cambo et al Forties ETAP Catcher et al MonArb Wytch Farm Perth et al Alba Darwin Magnus Cheviot et al Foinaven Captain





Remaining Reserves, mmbbls



STEAM FLOODING – TWICE THE OIL IN HALF THE TIME



25/9/13, water profile Environmental statement; Capex 3Q 2015 results

PILOT

Capex \$2.4 billion 152 mmbbls (recoverable) 95 mmbbls (discounted at 10%) WHP (with steam generators) & FPSO 48 platform wells (conductors shared)

KRAKEN

Capex \$2.9 billion + FPSO Lease 147 mmbbls (recoverable) 87 mmbbls (discounted at 10%) Leased FPSO 25 subsea wells

MARINER

Capex \$7.7 billion 251 mmbbls (recoverable) 129 mmbbls (discounted at 10%) Fixed Platform plus FSO 50 wells with 92 sidetracks; 142 reservoir penetrations

BENTLEY

Capex \$4.4 billion 265 mmbbls (recoverable) 109 mmbbls (discounted at 10%) MOPU & FSO, likely leased, but included in capex above 35 quad-lateral platform wells 6 water injection wells & 1 gas well; 147 reservoir penetrations















MER-UK: HEAVY OIL POTENTIAL



Area of bubble is proportional to oil in place, not a complete inventory of all UKCS heavy oilfields





STEAM OIL STRATEGY

- Build a significant and concentrated resource base
- Focus on doing excellent sub-surface work
- Don't over-engineer the projects
- Keep G&A low
- Bring in major oil company to operate
 - Therefore a farm-out/divestment process that is congruent with big oil company investment decision process



Blakeney Crinan Feugh Dandy 21/27a **Pilot Main** Harbour **Pilot South 7** ⊸ 28/2a 28/2b Elke 28/3b Narwhal -**--2** Steam (subject to OGA approval)







POTENTIAL PILOT PILOT FACILITIES CONFIGURATION

- Test of steam flood technique on a slice of the Pilot field
- Validates the development concept and confirms performance of key technologies, such as conformance control
- Produces c. 5 mmbbls in 500 days, potential to be breakeven
- We are working on it...

Jack-up drilling rig with steam boiler







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