Enhancing Recovery in the Indian E&P Sector

Background note

June 20, 2017
Towards design of a policy to promote Enhanced Recovery in Indian Oil & Gas Industry

1. The Indian Oil & Gas Context
   The Indian domestic production and consumption context, recent and proposed initiatives by the Government to support domestic production

2. Developments in Recovery techniques
   Techniques used for enhancing recovery, global EOR context and EOR incentives based on contracting regimes

3. Experiences from across the world
   Global case studies on enhancing recovery factor

4. Way forward
   DGH’s plan of action towards design of EOR policy
**India domestic production**

Indian crude production has lagged behind the growth in demand, EOR may present an opportunity

**Use of Enhanced Oil Recovery (EoR) techniques could potentially increase output by 45%**

- Demand for oil is expected to grow at a CAGR of ~ 4% from 2015-2035
- Domestic crude production as a percentage of consumption has reduced from ~ 69% in 1985 to ~ 18% in 2015. Major production fields of ONGC, OIL ONGC, PMT etc. have matured
- Since Cairn (almost a decade ago), no major discoveries have been made

**Sources:** MoPNG, EIA, DGH, Indian Bureau of Mines, BP Energy Outlook 2017, Annual corporate filings of RIL, Cairn India etc.

**Notes:**
1) Pie-charts for share of production have been provided for FY2003 and FY2016 for representation; 2) OOIP recovery upside is assumed as 3% (conservative case) and 5% (optimistic case); 3) Assumes an average lifespan of 20 years for oil-fields;
The Government and DGH have undertaken numerous measures to improve hydrocarbon production.

Focus areas

1. **Uniform licensing**
   - India is now among the few countries that allow conventional and unconventional activity with a single license. **Company free to explore all avenues for production**

2. **Pricing and marketing freedom**
   - Implementation of marketing and pricing freedom, in line with changes earlier introduced for deepwater and HPHT\(^1\) fields, will reinvigorate the ailing upstream natural gas industry.

3. **Successful Bidding for DSF Round**
   - The recently concluded Discovered Small Fields bid round was a success and drew >140 bids for 34 contract areas. These are expected to produce >50,000 bpd of Crude Oil & 25,900 boe/ld of Natural Gas over the next 15 years.

4. **Open acreage licensing (OALP)**
   - Companies can directly approach the government to prospect currently unlicensed territory. This eliminates the need to wait for bid rounds, and is expected to generate interest in prospecting activities in available areas and drive exploration.

5. **Resource sharing model**
   - The newly introduced Hydrocarbon Exploration & Licensing Policy (HELP) has, amongst other initiatives, installed a revenue sharing model in place of the production sharing system of the past. This will curtail cost recovery disputes of the past.

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**Sources:** Wood Mackenzie, news articles, Government announcements

**Notes:** 1. High Temperature, High Pressure
Engagement objectives
DGH intends to create an EOR/IOR policy for India

Objectives
- Growth of domestic crude oil production to reduce import dependency (and enhance energy security)

Key scope elements
- Review of global policies for Enhanced Oil Recovery (EOR) and Improved Oil Recovery (IOR)
- Benchmark the leading practices for EOR/IOR processes across the world
- Develop a policy framework for adoption of EOR/IOR in India

Understanding leading practices in adoption of EOR

- Is a separate policy necessary to enhance production?
- Should the policy consider investment, operating cost or output?
- Should there be any differentiation based on technology being adopted?
- Should there be any differentiation based on type of reserves viz. onshore, offshore or based on size?
- How should fields be identified for EOR/IOR projects? Should there be an additional approval process?
- How can the administration of policy be made simpler?
- How will the policy impact the overall production trends?
Enhancing recoveries

Secondary and tertiary recovery methods are important for extracting maximum value of a reservoir

**Lifecycle of a petroleum reservoir**

<table>
<thead>
<tr>
<th>Costs</th>
<th>Exploration</th>
<th>Appraisal &amp; Construction</th>
<th>Operation</th>
<th>Redevelopment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Production</td>
<td>Natural flow</td>
<td>Artificial Lift (Pumps etc.)</td>
<td>Secondary Recovery</td>
<td>Tertiary Recovery</td>
</tr>
<tr>
<td>5 – 15% OOIP target</td>
<td>Primary Recovery</td>
<td>Secondary Recovery</td>
<td>Tertiary Recovery</td>
<td>20 – 40% OOIP target</td>
</tr>
</tbody>
</table>

**Sources:** EIA

**Notes:** 1) Water alternating gas

**Improved Oil Recovery and Enhanced Oil Recovery** are capital investments done to recover additional oil from the reservoirs.
## Global EOR

EOR contributes ~3% of world crude oil production; Investments into EOR compete against other non-conventional investments

<table>
<thead>
<tr>
<th>Extraction Cost</th>
<th>Lead Time to Production</th>
<th>Risk Profile</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>US$ / bbl</strong></td>
<td><strong># Years</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Onshore Conventional</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• MENA: ~5 to 18</td>
<td>3 – 5 years</td>
<td>• Exploration risk is medium-to-high</td>
</tr>
<tr>
<td>• Russia: ~35 to 60</td>
<td></td>
<td>• Technology is widely available</td>
</tr>
<tr>
<td>• RoW: ~24 to 60</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Offshore</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Shallow: ~15 to 43</td>
<td>9 years</td>
<td>• Exploration risk is medium-to-high</td>
</tr>
<tr>
<td>• Deep: ~25 to 53</td>
<td></td>
<td>• Technology is available with experienced operators</td>
</tr>
<tr>
<td><strong>Shale/ Tight Oil</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• USA: ~28 to 58</td>
<td>&lt; 1 year</td>
<td>• Exploration risk is Low, as shale-rich US basins are well-mapped</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Technology is available with experienced operators</td>
</tr>
<tr>
<td><strong>Enhanced Oil Recovery (EOR)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• CO2 EOR: ~20 to 70</td>
<td>5 – 8 years</td>
<td>• Exploration risk is Low as EOR is implemented on existing wells</td>
</tr>
<tr>
<td>• Other EORs: ~30 to 80</td>
<td></td>
<td>• Technology is evolving and available with experienced operators</td>
</tr>
</tbody>
</table>

Conventional extraction has a weighted average cost of ~US$15/ bbl in MENA, ~US$51/ bbl in Russia, and ~US$44/ bbl in the Rest of the World.

Shallow water and deep-water projects have a weighed average cost of ~US$32/ bbl, ~US$38/ bbl respectively.

Extraction costs have declined sharply for USA Shale - from weighted averaged cost US$60-84/ bbl in 2014 to US$31-37 in 2016, leading to continued investments.

Economic returns limited as projects have an higher ongoing operating expenditure and also the volumes upside is lower.

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### Sources:
- IEA, Wood Mackenzie, Rystad, Columbia Energy Institute, Oil and Gas Journal, News Articles

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**Petroleum regimes across the world and potential EOR incentives**

Major regimes are concessions, product sharing contracts and service contracts

<table>
<thead>
<tr>
<th>Regime</th>
<th>Risk Sharing</th>
<th>Factors for consideration</th>
<th>Potential EoR / IoR Incentive Mechanisms</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concessions</td>
<td></td>
<td>Example countries¹</td>
<td>Reduces royalty and/or tax rates</td>
<td></td>
</tr>
<tr>
<td>Concessions – Royalty and tax regime</td>
<td></td>
<td>US, Colombia</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Concessions – Pure tax regime</td>
<td></td>
<td>UK, Norway</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Production sharing contract regime</td>
<td></td>
<td>India², Angola</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pure Production Sharing Contract regime</td>
<td></td>
<td>Indonesia, Egypt, Malaysia³</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Service Contracts regime</td>
<td></td>
<td>Iran, Philippines</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Notes:**
1) Some of the other countries have a mix and match of these regimes; 2) India, along with royalty and production sharing contract, recently introduced revenue sharing contract regime; 3) Malaysia also has a service contract regime for marginal fields
Market forces drive the concession based US market, which requires EOR to compete with unconventional sources.

### Case study 1: USA

The US EOR production has declined from 0.76 to 0.72 Mn BBL during the period 1992–2014. Number of active projects have also declined from 273 to 218 during the same period.

Tax credit linked to crude oil prices made the policy unavailable for almost 10 years from 2005 to 2015.

**Introduction**  
Section 43 of the internal revenue code provides an EOR tax credit as a component of the general business credit.

**Detailed guidelines**  
Detailed guidelines issued on cost allowed under qualified tertiary injectants for claiming credit.

**Unavailability of credit as crude prices increase**  
Credit was unavailable as crude prices were greater than the threshold value for claiming incentives.

**Credit available due to drop in crude prices**  
Credit again available due to fall in crude prices.

**Incentive process**  
- EOR to commence after December 1990
- Applicable to both oil and gas fields
- A qualified engineer is required to certify eligibility of a project, technology used and eligible production to claim benefits

**Investor/Stakeholder views**  
- The scheme is viewed by O&G companies as a valuable scheme in the current low price environment to manage their tax burden and improve cash flow.
- However following concerns are raised
  - No differentiation between onshore & offshore fields
  - Only specific technologies are covered

**Latest developments**  
- Carbon dioxide (CO2) enhanced oil recovery (EOR) has received increased attention and US has laid large infrastructure to support transport of CO2 from source to fields

**Pros**  
- Cost based incentive based on audited numbers
- Simple to administer
- Applicability notified by IRS leaving little scope for disputes
- No delays in incentive realization

**Cons**  
- Only specified technologies allowed for EOR
- No differentiation for onshore/offshore
Alberta in the recent policy has allowed enhanced recovery incentives for all hydrocarbons, thus EOR would need to compete with enhanced recovery measures for other hydrocarbons.

### Case study 2: Alberta, Canada

**Conduct study**
- Alberta Energy Regulator (AER) determined the Enhanced Oil Recovery potential in Alberta.

**Introduced policy**
- Government introduced the Enhanced Oil Recovery Program ("EORP") for tertiary EOR techniques with royalty rate floored at 5%. The policy was applicable to Oil fields only.

**Revised policy launched**
- Government replaced existing EORP with Enhanced Hydrocarbon Recovery Program which allowed even secondary EOR technique with royalty rate of flat 5%. The new program is applicable for crude oil, natural gas, gas product or oil sand.

The new policy has reduced royalty rate to flat 5% for EOR project whereas average royalty rate has been in the range of 15% to 20% for oil.

### Figures in MMBOE/day

<table>
<thead>
<tr>
<th>Total oil demand</th>
<th>Total oil production</th>
<th>Unconventional oil production</th>
<th>Primary contract type</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.87</td>
<td>4.05</td>
<td>2.47</td>
<td>Concession with Royalty Payments</td>
</tr>
</tbody>
</table>

### Incentive process
- The new program is applicable for crude oil, natural gas, gas product or oil sand.
- Every applicant has to submit supporting technical and financial information along with expected additional production to claim the EOR incentives.

### Incentive mechanism
- Alberta Government provides royalty rate reduction to incentivize EOR.
- The term is predetermined and dependent on the percentage of incremental crude oil recoverable from pool through tertiary methods.
- For secondary EOR techniques, the term is determined on case to case basis.

### Investor/Stakeholder views
- Petroleum producers welcomed the policy as it recognized the higher risks and greater project costs of drilling and implementing secondary recovery schemes.

### Latest developments
- In 2017, to support oil production, the country also allowed incentives for secondary EOR techniques.

### Pros
- Secondary EOR techniques are also eligible for incentives.
- Applicable to all fossil fuels.

### Cons
- Benefits like additional production has to be quantified with a field development report.
- Case to case basis analysis requires a strong regulator.
- Same incentive for all fields & techniques.

### Sources
- Alberta Energy website, Parkland institute, EIA, EIU.
Case study 3: Malaysia

The Government is using the existing production sharing regime to promote EOR activities by signing EOR specific PSC with large companies.

<table>
<thead>
<tr>
<th>Year</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008</td>
<td>PSC for EOR: Exxon and Petronas entered into a PSC for development of 7 Oil fields through EOR activities</td>
</tr>
<tr>
<td>2010</td>
<td>Incentive scheme launched: Government rolls out incentive mechanism for promotion of EOR activities and is applicable even for existing fields</td>
</tr>
<tr>
<td>2011</td>
<td>PSCs signed for 2 large projects: Shell &amp; Petronas enter into two 30 years PSC Contracts for Chemical EOR projects – Sabah and Baram Delta fields. Expected increase in recovery factor from 36% to 50%</td>
</tr>
<tr>
<td>2014</td>
<td>PSC expanded to include gas: Commencement of operations from the Exxon-Petronas Tapis EOR project. Expanded BaramDelta PSC with Shell to include Natural gas production</td>
</tr>
<tr>
<td>2016</td>
<td>Large # projects undertaken: 24 IOR / EOR / IGR production enhancements projects under way</td>
</tr>
</tbody>
</table>

**Production Sharing Model with project specific approval allowance has no bearing on crude prices and recovered for the life for the project**

**As per Petronas estimate 1 billion barrel plus of oil from 14 fields have been identified for EOR projects**

**Pros**
- Capital expenditure based incentive de-risking operators
- PSC signed considers actual field conditions on case to case basis

**Cons**
- Needs a strong regulator to appreciate EOR techniques being used and accordingly modify PSC
- Largely off-shore fields which makes EOR costly and difficult

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**Incentive mechanism**
- Investment allowance equal to 60% of the capital expenditure to be deducted against statutory income.
- Maximum 70% of statutory income can be deducted in a year
- Investment Allowance can be recovered during the life of the project until it has been fully recovered

**Incentive process**
- EOR applicable for tertiary methods
- The incentive provided is technology agnostic and the same for all the tertiary methods
- Separate PSCs are signed for EOR projects

**Investor/Stakeholder views**
- “EOR activities could boost oil production from Tapis by up to 35,000 barrels per day (bpd) from the present 3,000 to 4,000 bpd, increase the economic value of the field by more than 25 years” – Director – Petronas
- “Malaysian Government has given tax incentives to encourage more EOR projects and PETRONAS has provided a lot of facilitation for PS contractors and new PSC arrangements to make it attractive” - Head of Technology – Petronas

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Sources: Petronas; Shell; Exxon Mobil; Newspaper articles; Petroleum Regulations 2013; Oil and Gas Overview by Malaysia International Chamber of Commerce and Industry; EIA, EIU

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Case study 4: UK

With most large fields reaching maturity and not much large discoveries happening the Government has created a detailed plan to increase the recovery from the existing fields

<table>
<thead>
<tr>
<th>Total oil demand</th>
<th>Total oil production</th>
<th>Unconventional oil production</th>
<th>Primary contract type</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.6</td>
<td>1.01</td>
<td>NA</td>
<td>Concession – Pure tax regime</td>
</tr>
</tbody>
</table>

Figures in MMBOE/day

**Fall in Production**
Decline in domestic production by 37% largely due to declining efficiency and declining exploration activity. In 2013 govt. did a review of the fall

**The Wood Review**
The committee submitted a detailed report and steps to revitalize the UKCs. Maximising Economic Recovery also highlighted

**Oil & Gas Authority (OGA)**
Establishment of the Oil & Gas Authority in April 2015 in line with Wood’s recommendation. It was executive agency of the Dept. of business & energy

**MER UK & EOR Strategy**

**OGA independent**
OGA made an independent body. OGA launches corporate plan 2016-2021 with one of its vision to increase production by 250 mmboe using EOR

**Currently no incentive to promote EOR activity; In Dec 2016 Govt. launched an 8 step process to increase EOR production which is under implementation.**

### Incentive mechanism
- Currently no incentive mechanism which has been defined by the Govt.
- By Q4 2017, as part of the 8 step program OGA plans to outline a business case for EOR activities in the UKCS.

### Incentive process
- To be decided once the incentive processes are finalized

### Investor/Stakeholder views
- “Companies stated that not only is EOR prohibitively expensive to provide an economically viable solution in the UKCS but there is also no supply chain to offer these techniques at competitive price. Thus, organizations call for fiscal incentives targeted at encouraging companies to take up and develop technologies pertinent to EOR to meet MER UK plans”
  - Summary of interview of various oil & gas executives

### Latest developments
- Captain polymer EOR project to start production by Q3 2017
- Clair ridge low sanity EOR scheme start-up by Q3 2017
- strong collaboration between the industry, operators and oil & gas authority
- An 8 step plan clearly charted out with defined timelines

### Pros
- Slow progress of recommendations of the Wood committee
- Lack of fiscal incentives to promote areas like EOR

### Cons

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Sources: Oil & Gas Authority; newspaper articles; BP energy outlook 2017
DGH would be engaging with all relevant stakeholders to develop a policy that would lead to increase in production.
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