Global Oil and Gas Development Advancement and Tendency

CNPC RIPED
December, 2019
Who did it: CNPC RIPED Technical Team

What were analyzed: 7 Million Data, 270 Reports, 13789 O&G Fields, 133 Countries

Information Covered: Situation, Features, Potential, Tendency

Anything different: Full Life Cycle Scenario
In Depth Analysis by Features, by Regions, by Sectors, by Stages

Value added: for CNPC
for IOC/NOC/Independents
for Stakeholders
for Services
…….
Situation and Distribution of Oil & Gas Development

Advancement and Features of Oil & Gas Development

Characteristics and Tendency in Key Sectors
By the end of 2018, 133 countries in 6 regions
Total 423 basins and 13789 O&G fields (Oil: 8291, Gas: 5498)
3624 on stream O&G fields (Oil: 2441, Gas: 1183)
**Situation and Distribution of Oil & Gas Development**

### Global 2018 O&G Production by Region & Type

- Major producing regions: 2 high, 1 medium, 3 low
- Oil Vs Gas: **59: 41** (Yoy gas production ↑ 1%)
- Different contribution by types

<table>
<thead>
<tr>
<th>Region</th>
<th>On Stream O&amp;G Fields</th>
<th>Production in 2018</th>
<th>Production Contribution By Type</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Crude oil 100 MT</td>
<td>Natural Gas 100 MCM</td>
<td>O&amp;G 100 MToE</td>
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<tr>
<td>Americas</td>
<td>1591</td>
<td>14.14</td>
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<td></td>
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<tr>
<td>Middle-East</td>
<td>199</td>
<td>15.41</td>
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<tr>
<td>Central Asia-Russia</td>
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<tr>
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<td>Africa</td>
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<tr>
<td>Europe</td>
<td>475</td>
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<td>2515</td>
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<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>TOTAL</td>
<td>3624</td>
<td>45.97</td>
<td>38112</td>
</tr>
</tbody>
</table>
Situation and Distribution of Oil & Gas Development

### Regional O&G Production & the Additional by Year
- Annually average in a decade: $+1.94\%$
- Faster growth in 2018: $263\ MT, +3.48\%$
- **Gas** faster than oil: $4.85\% & 2.57\%$
- **Americas:** Largest production contributor: $179\ MT, 68.1\%$ of total Production Increment

<table>
<thead>
<tr>
<th>Region</th>
<th>2017</th>
<th>2018</th>
<th>2018 Production Increment</th>
<th>2018 Rate of Growth (%)</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Crude Oil 100 MT</td>
<td>NG 100 MCM</td>
<td>O&amp;G 100 MToE</td>
<td>Crude Oil 100MT</td>
</tr>
<tr>
<td>Central Asia- Russia</td>
<td>6.97</td>
<td>8256</td>
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<td>4.03</td>
<td>2271</td>
<td>5.95</td>
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<td>Americas</td>
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<td>10925</td>
<td>22.23</td>
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<tr>
<td>Asia-Pacific</td>
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<td>Europe</td>
<td>1.75</td>
<td>2646</td>
<td>3.99</td>
<td>1.75</td>
</tr>
<tr>
<td>Total</td>
<td>44.82</td>
<td>36349</td>
<td>75.52</td>
<td>45.97</td>
</tr>
</tbody>
</table>
Situation and Distribution of Oil & Gas Development

### Regional O&G Production & the Additional by Type/ by Year

- **Oil: Gas 59: 41** (Gas ↑ 1%)
- **Contribution by Type:** 4: 2: 1
- **Additional by Oil Vs by Gas:** 44: 56 (Gas > Oil)
- **Additional by Sector:** Onshore Conventional ≈ Offshore + Unconventional

<table>
<thead>
<tr>
<th>Type</th>
<th>Year</th>
<th>2017</th>
<th>2018</th>
<th>2018 Production Increment</th>
<th>2018 Rate of Growth (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Crude Oil 100 MT</td>
<td>NG 100MCM</td>
<td>O&amp;G 100 MToE</td>
<td>Crude Oil 100MT</td>
</tr>
<tr>
<td>Onshore conventional oil&amp;gas</td>
<td>2017</td>
<td>25.42</td>
<td>19073</td>
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<td>25.92</td>
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<td>Offshore oil&amp;gas</td>
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<td>10961</td>
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<td>12.33</td>
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<td>Unconventional oil&amp;gas</td>
<td>2017</td>
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<td>6315</td>
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<td>Total</td>
<td>2017</td>
<td>44.82</td>
<td>36349</td>
<td>75.52</td>
<td>45.97</td>
</tr>
</tbody>
</table>
Situation and Distribution of Oil & Gas Development

## Global None Producing O&G Fields Analysis by Region

- Onstream O&G fields: None-producing O&G fields: 3624: 10165
- None-producing **gas fields**: 78% of Total gas fields
- None-producing oil fields: 70% of Total gas fields
- **Key factor**: poor economy: 6363
- Pre-commission: 1963, Decommission: 1031
- None-producing: On stream: Decommission 7: 2: 1

### None Producing O&G Fields in 2018

<table>
<thead>
<tr>
<th>Reason</th>
<th>Asia-Pacific</th>
<th>Central Asia-Russia</th>
<th>Europe</th>
<th>Americas</th>
<th>Africa</th>
<th>Middle-East</th>
<th>Total</th>
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<tbody>
<tr>
<td>Relinquished</td>
<td>14</td>
<td>10</td>
<td>165</td>
<td>46</td>
<td>11</td>
<td>1</td>
<td>247</td>
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<tr>
<td>Decommission</td>
<td>238</td>
<td>149</td>
<td>368</td>
<td>145</td>
<td>107</td>
<td>24</td>
<td>1031</td>
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<tr>
<td><strong>Uneconomical</strong></td>
<td>1590</td>
<td>1528</td>
<td>1058</td>
<td>814</td>
<td>1073</td>
<td>280</td>
<td>6343</td>
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<tr>
<td>Lack of technology</td>
<td>123</td>
<td>48</td>
<td>99</td>
<td>70</td>
<td>78</td>
<td>72</td>
<td>490</td>
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<tr>
<td>Under construction</td>
<td>19</td>
<td>8</td>
<td>30</td>
<td>12</td>
<td>15</td>
<td>7</td>
<td>91</td>
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<tr>
<td>Pre-commission</td>
<td>389</td>
<td>314</td>
<td>295</td>
<td>827</td>
<td>76</td>
<td>62</td>
<td>1963</td>
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<tr>
<td><strong>Total</strong></td>
<td><strong>2373</strong></td>
<td><strong>2057</strong></td>
<td><strong>2015</strong></td>
<td><strong>1914</strong></td>
<td><strong>1360</strong></td>
<td><strong>446</strong></td>
<td><strong>10165</strong></td>
</tr>
</tbody>
</table>

Reasons for non-production include:
- Relinquishment
- Decommission
- Uneconomical
- Lack of technology
- Under construction
- Pre-commission
Outline

Situation and Distribution of Oil & Gas Development

Advancement and Features of Oil & Gas Development

Characteristics and Tendency in Key Sectors
Advancement and Features of Oil & Gas Development

**Oil:** Steady enhancement, Americas outstanding

**Gas:** Fast growth, all types involved

**Investment:** Stable increasement, efficiency improved

**Transaction:** Moderate Asset transaction, portfolio optimized

**Oil Prices:** High level fluctuating, downside risks there

**International Relationships:** Intensified geopolitics, “hotspot” countries obvious
Steady enhancement, Americas outstanding

- **Average growth rate**: 1.54%,  +Production > 100 MT/Year: 6 years /10 years
  - **Unconventional**: major contributor --- annual average growth rate : 9.58 %, 2018: 6.34%
  - Onshore conventional: Uneven--- - 50 MT → +59 MT, 2018: ↑ 50 MT
  - Offshore oil: Challenge, fluctuation

- **Americas: Major Production Contributor, the US**: 107 MT
  - Americas: the largest: 114 MT, 8.77%
  - Central-Russia, Africa: ← 11 MT, 10 MT, 1.58%, 2.48%
  - Asia-Pacific, the Middle East, Europe: ↓ 12MT, 7MT, 2 MT, 3.24%, 0.43 %, 0.86%
Fast growth in 2018: 115 million tons (2.57%), fastest in the past decade

3 Types of oil grew differently:
- Onshore conventional: largest: 50 MT (43.48%), major contributors: the US, Iraq, Canada
- Unconventional oil: fastest: 46 MT (6.34%), major contributors: USA
- Offshore oil: slight: 19 MT, major contributors: Saudi Arabia, Brazil

Challenges for sustainable growth in short:
- Unconventionals: slow down
- Onshore conventional: lack large scale
- Offshore: high development cost
Fast growth, all types involved

- **Dramatically growth in the recent 2 years**
  
  2018: 176.3 BCM, (4.85%), > 2.57% (annual average in the past decade)

- **Contributed by all types**

  Onshore conventional: 56.5% mainly from: the US, Russia, Canada; sustainability?
  Offshore: instable increasement, dominated by Egypt, Australia, Iran;
  2018 & 2017
  Unconventional: stable increased, mainly from: the US, Oman
  China, less contribution
Gas Production & the additional by Region

- **Americas**: both the largest in output and increase
- **Africa**: small output, but high growth rate
- **Central-Asia & Russia, Middle East and Asia-Pacific**: relatively large output, steady growth
- **Europe**: continuous decline
Stable increase, efficiency improved

- **E&D investment:** 407.91 $ bln (2018) ↑ 7.7% YoY

- **Onshore:**
  - + ↑ 33.51 $ bln
  - North America/Total: 20.4 $ bln, 63.64%

- **Offshore:**
  - ↓ 2.91 $ bln
  - + ↑ 1.46 $ bln (ME), ↑ 6.78% YoY

Global Oil & Gas Investment by Year

Data from IHS

Onshore Additional Oil & Gas Investment by Region & Year

Offshore Additional Oil & Gas Investment by Region & Year
7 Majors’ Investment Review in 2018

- Average net profit: $10.3 bln (2018) < $12.2 bln (the average in 10 years)
  - Annual Average: ExxonMobil, SHELL, Chevron, TOTAL
  - Best performance: BP (151.43%)

- Average ROIC: 8.4%
  - Average: EXXON, Eni, SHELL, Chevron
Moderate asset transaction, portfolio optimized

**IOCs: Portfolio Optimization, Operational Excellence**

- Portfolio Optimization: Core Potential Asset, highly diversity
- Strategies Highlight: **Technical driven**
  - *e.g.* Exxon Mobil: Unconventionals, back to North America
  - Shell: Natural Gas integration
- Operational Excellence: cost effective + operation efficiency ➔ Enhanced SHs’ returns

**Advancement and Features of Oil & Gas Development Transaction**

- **2013**: Chevron/YPF, Shell/Brazil, BP/Azerbaijan
- **2014**: Total/PNG
- **2015**: Shell/BG, Statoil/Brazil Deep Water, BP/Abu Dhabi
- **2016**: Exxon Mobil/PNG, Exxon Mobil/Mozambique
- **2017**: Shell/Oil sand, Shell/the UK Shallow Water, ENI/Exxon Mobil (Mozambique)
- **2018**: Total/Australia, Shell/Australia, Europe, the Middle East, BP/Europe, BP/the US

- **Enriched SHs’ returns**
Global 2018 Upstream M&A Review

- **M&A Transactions**: 672, **Capital**: USD$127.5 bln, **YoY**: ↓ 11%,
  - Asset: USD$74.9 bln
  - Inter firm: USD$52.6 bln

- **North America**: 68%, the US unconventional assets: most attractive
  - Tight and shale O&G: 57%

- **Permian Basin**: Major target, >40.83% (the recent annual average)
  - Reasons: Asset deal price, Transportation restriction

**Global upstream M&A Market**

**Transaction Activities by Basin by Year**
High level fluctuating, downside risks there

- Fluctuating periodically
- Long cycle: Supply & Demand.
- Short cycle: Unexpected & Significant events
- Current Oil: Plateau of the long cycle
- Positive factors: Geo-Political & Regional Turmoils
High level fluctuating, downside risks there

**Downside Risks**
- Unbalance supply & demand, excess inventory
- Depressional Manufacturing & Hard Rejuvenation: Global manufacturing PMI: ↓ <50,
- Trade frictions, anti-globalization

![Commercial Crude Oil Inventory in the US](chart1)

![PMI of China and the US](chart2)
Intensified geopolitics, “hotspot” countries obvious

- the US-China-Europe-Russia
- Security Issues

Data from: Control Risks
Iran: Tension with US + Wars risks, Energy supply from the ME countries
- Venezuela: Fragile Politics, Hard Economic Rejuvenation Production decline
- Saudi Arabia, Iraq, Libya, Sudan, Ecuador, etc.: Uncertainty political situation

International Relationships: Intensified geopolitics, “hotspot” countries obvious

Advancement and Features of Oil &Gas Development
Situation and Distribution of Oil & Gas Development

Advancement and Features of Oil & Gas Development

Characteristics and Tendency in Key Sectors
Characteristics and Tendency in Key Sectors

Deep Water

LNG

Tight Oil

Oil Sand
Deep Water Oil & Gas Development & Outlook

Since 2000
- Offshore resources: major contributor to reserves increase
- Global average annual newly added reserves from offshore: 61% >84% in 2018

In 2018
- Newly added reserves > 100 mmb: 17 O&G fields
- 16 Offshore

<table>
<thead>
<tr>
<th>No.</th>
<th>Country</th>
<th>Basin</th>
<th>Oil&amp;Gas field</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Brazil</td>
<td>Santos basin</td>
<td>Guanxuma block A</td>
</tr>
<tr>
<td>2</td>
<td>Cyprus</td>
<td>Eratosthenes platform</td>
<td>Crisspo gas field 1</td>
</tr>
<tr>
<td>3</td>
<td>Russia</td>
<td>West Siberian basin</td>
<td>North orbi gas field</td>
</tr>
<tr>
<td>4</td>
<td>Guyana</td>
<td>Guyana basin</td>
<td>Langjie block 1</td>
</tr>
<tr>
<td>5</td>
<td>Guyana</td>
<td>Guyana basin</td>
<td>Longtaier oil fieldl block 1</td>
</tr>
<tr>
<td>6</td>
<td>Australia</td>
<td>Roebuck basin</td>
<td>Duoladuo oil field block 1</td>
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<td>7</td>
<td>Russia</td>
<td>Northern sakhalin basin</td>
<td>Triton oil field</td>
</tr>
<tr>
<td>8</td>
<td>Norway</td>
<td>Viking graben</td>
<td>Norway block 6506/11/10</td>
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<tr>
<td>9</td>
<td>the UK</td>
<td>Frysseland basin</td>
<td>the UK block 206/04a-04</td>
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<tr>
<td>10</td>
<td>Grenada</td>
<td>Tobago basin</td>
<td>Nutmeg block 2</td>
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<td>11</td>
<td>the US</td>
<td>Mexico bay deep water basin</td>
<td>Dover oil field</td>
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<td>12</td>
<td>Malaysia</td>
<td>Northwest shaba geosyncline</td>
<td>Trepat oil field block 1</td>
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<td>13</td>
<td>Guyana</td>
<td>Guyana basin</td>
<td>Hammerhade oil field block 1</td>
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<td>14</td>
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<td>Central lucania basin</td>
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<td>15</td>
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<td>Niger delta basin</td>
<td>Hoyo block 1</td>
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<td>16</td>
<td>the US</td>
<td>Slope basin in the north</td>
<td>Willoughby west oil field</td>
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<tr>
<td>17</td>
<td>Mexico</td>
<td>Surist basin</td>
<td>Mulah oil field block 1</td>
</tr>
</tbody>
</table>
Great Potential for Deep-water & Ultra-deep-water Petroleum Resources

Deep-water and ultra-deep-water O&G resources

- Remaining technical reserves: 26,021 BTOE
- Recovery Factor: 19.03%
- Production: fast growth and long term sustainable

Global Deep Water Crude Oil Production Prediction

Global Deep Water Natural Gas Production Prediction

Data from: Wood Mackenzie
Cost is the challenge for Deep-Water Oil & Gas Development

Deep-Water O&G Development Cost
- Cost reduction by: $37\%$
- Breakeven UTC < USD60$: $70\%$
- Regional uneven UTC: Africa > South America, >USD60$

Pre-FID Deep-Water Breakeven Price profile since 2014

Remaining recoverable reserves (1 Bln BOE)

Data from: Wood Mackenzie
Petrobras and Majors are in command of Global Deep-water Oil & Gas Resources

Petrobras & Majors (Shell, Exxon, BP, Chevron and Total)
- Remaining technical recoverable reserves / Total: 45%
- Production / Total: 68%

Chinese oil companies
- Strategies & Methodologies
- Development & Capability

Characteristics and Tendency in Key Sectors

Deep Water

Top 10 oil companies by deep-water oil & gas resources

Top 10 oil companies by deep-water oil & gas production
LNG Operation & Outlook

- LNG trade: Volume (2018): 320 MT, ↑ 9.6%,
  LNG/NG: 36% → 28% → 36% (10 years)

- 19 LNG exporters: Qatar, Australia, Malaysia, the US
  Supply Contribution: 61% of total LNG supply

- 42 LNG importers, Asia-Pacific region
  Demand: 75% of total demand
LNG Price Rebounded While Construction Cost Rising

The average LNG construction cost by project stage

- Operational projects: 1005 USD$ /ton VS 404 USD$ /ton
- Brand new project: 1501 USD$ /ton VS 527 USD$ /ton
- Expanding project: 58 USD$ /ton VS 321 USD$ /ton

LNG is greatly affected by seasonal factors. The price trend shows U-shaped.

In 2018, the annual average LNG price by region

Asia-Pacific Spot price: US$9.78/MMBTU YoY↑ 43%
European NBP price: US$7.98/MMBTU YoY↑ 38%
the US HH price: US$3.13/MMBTU YoY↑ 6%
Remaining technical recoverable reserves: 10.35 bln tons

Major producing basins:
- Delaware Basin: 3.596 bln tons
- Bayshore Basin: 1.724 bln tons
- Midland Basin: 2.477 bln tons
- Williston Basin: 1.191 bln tons

2018 Tight oil production contribution: >44%
2018 crude output: 748 MT
Sweet spot remaining recoverable reserves: 4.294 Bln tons, 41.49% of the tight oil remaining total

Sweet spots highlight

- **Prolific**: Sub-zones in Midland, Eagle Ford: 87-94%
- **Major future producing target**

- **Inferior**: Delaware sub-zone
- **Challenge & Cost**

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**Tight Oil Development & Outlook—the US**

**Characteristics and Tendency in Key Sectors**

- **Tight Oil Development & Outlook—** the US

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**Remaining Recoverable Reserves**

- **Type 1 Sweet Spots**
- **Type 2 Sweet Spots**
- **Non Sweet Spots**
- **Remaining Recoverable Reserves**

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**Proportion of Sweet Spots (%)**

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**Reserves (100 million tons)**

- Bakken
- S riforks
- Niobrara
- Burnsprings
- Delaware
- Midland
- Eagle Ford
The US Tight Oil Production will Peak around 2025

Prediction for tight oil plateau production of the US tight oil in 2025

- **Wood Mackenzie**: 520 MT
- **IEA & OPEC**: 425 MT
- **CNPC RIPED**: Similar with IEA & OPEC
  Plateau production in 2025, then declining rapidly
Characteristics and Tendency in Key Sectors

Oil Sand Development & Outlook — Canada

- Technical Remaining recoverable reserves: **19.124 bln tons**
  - 80.8% of national total, 36.8% of North America total production: 134 MT, increased by 9.11%
- Reserves by region: **Alberta (3 Districts)**
  - Athabasca: 80%, Porosity↑, Permeability↑, Oil saturation↑
  - Open pit mining & SAGD
  - Cold lake: 12%, poor reservoir properties, CSS
  - Peace lake: 8%, deep & poor reservoir properties, CSS

![Oil Sand Development & Outlook Chart](chart.jpg)
## Large Variation on Development Efficiency

### 83 oil sand projects in Canada
- Operational projects: 28
- Commercial potential: 34
- No favorable condition for commercial: 49

<table>
<thead>
<tr>
<th>Classification</th>
<th>Open pit</th>
<th>In-situ</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>CSS</td>
<td></td>
</tr>
<tr>
<td>Production (10k tons/d)</td>
<td>&gt;1.4</td>
<td>1</td>
<td>5</td>
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<tr>
<td></td>
<td>0.14&lt;production&lt;1.4</td>
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<td>14</td>
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<tr>
<td>Breakeven (USD/barrel)</td>
<td>&gt;50</td>
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<td>11</td>
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<tr>
<td></td>
<td>&lt;50</td>
<td>3</td>
<td>8</td>
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<tr>
<td>IRR (%)</td>
<td>&gt;10</td>
<td>2</td>
<td>4</td>
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<td></td>
<td>5--10</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>&lt;5</td>
<td>1</td>
<td>13</td>
</tr>
</tbody>
</table>

- Development restriction:
  - Reservoir conditions
  - Single well daily production
  - Investment & Cost

Operation before 2012: IRR >10%
Operation after 2012: IRR < 5%

Data from: Wood Mackenzie
Slow Oil Sand Development Due to Low Oil Price

Production (2018): 13,400 tons, YoY↑9.11%
In-situ production: 47.75%. after 2020: Slow down
Production Prediction: Scaled back by the agencies
IHS & Wood Mackenzie: 2030 Production Prediction: 195 MT, 60% from in-Situ

![Graph showing oil sand production prediction in Canada from 2010 to 2030. The graph indicates a decrease in production after 2020, with a predicted slowdown in oil sand development due to low oil prices. The data is from Wood Mackenzie.]
Thanks!