Key success factors of emerging Indonesian unconventional plays

Kim Morrison
9 September 2014
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Competent Persons Statement: Qualified Petroleum Reserves and Resources Evaluator

Pursuant to the requirements of the ASX Listing Rules Chapter 5, the technical information, reserve and resource reporting provided in this document are based on and fairly represent information and supporting documentation that has been prepared and/or compiled by Mr Kim Morrison, Chief Executive Officer of Lion Energy Limited. Mr Morrison holds a B.Sc. (Hons) in Geology and Geophysics from the University of Sydney and has over 28 years’ experience in exploration, appraisal and development of oil and gas resources - including evaluating petroleum reserves and resources. Mr Morrison has reviewed the results, procedures and data contained in this report. Mr Morrison consents to the inclusion of this announcement of the matters based on the information and context in which it appears. Mr Morrison is a member of AAPG.
PRESENTATION OVERVIEW

Why Indonesia?
US, Australian lessons
Unconventional plays
Focus basins
Way forward
Lion’s position
WHY INDONESIA?
Many elements in-place for successful unconventional industry

- Worlds 4\(^{th}\) largest population (~250mm)
- Fast-growing economy (GDP ~ 6\%pa) with oil and gas demand growing at > 5\%pa
- Declining conventional oil/gas production, rapidly rising demand
- Indonesia approaching becoming net BOE importer
- Rising domestic gas prices, moved from average US$2-3/mmbtu in 2005 to current US$9+/mmbtu (LNG pricing link)
- Regulatory changes promoting unconventional investment
- Prolific onshore basins

Projected Indonesian Oil and Gas Supply and Demand Balance

- Undeveloped
- Natuna D Alpha
- Under Development
- Producing

INDONESIA UNCONVENTIONAL STATUS

Early days, however Government keen to foster business

- Regulation and fiscal terms specific for unconventionals
- 2012 regulation: ”Non-conventional oil and natural gas ... shall be defined as oil and natural gas that is exploited using fracking technology from the reservoir where oil and natural gas with low permeability is formed. “
- Contractor take: ~40% oil, ~45% gas
- Currently over 70 Joint Study Applications
- Two unconventional PSC’s awarded to date (North and Central Sumatra)

Application Process

Companies select areas with unconventional potential (up to 5,000 km²)

If no existing claims, MIGAS approves right to conduct Joint Study (~6 month) undertaken with assigned Indonesian University

Area (up to 3000 km²) selected for PSC. Open gazettal, JS participants have a right to match highest bid
US UNCONVENTIONAL/CONVENTIONAL COMPARISON

Unconventional reserves/resource assessment of similar order of magnitude to produced conventional in mature basins

Williston Basin
Conv.¹: 3.8 bbo & 0.47 tcfg
Bakken²: 3.2 bbo (EIA proved reserve 2012)
USGS 2013 Unconv. 4.4-11.4 Mean 7.4 bbo 3.4-11.2 Mean 6.7 tcfg

Appalachian Basin
Conv.¹: 3 bbo & 42 tcfg
Marcellus²: 42.8 tcf (EIA proved reserve end 2012)
2013 USGS Unconv: 66-210 mean 125 tcfg, 0.6-1.4 mean 0.9 bbo

Denver Basin
Conv.¹:1.05 bbo & 3.67 tcfg
Niobara³: 0.98 bbo

Anadarko Basin
Conv¹: 2.3 bbo & 65.5 tcfg
Woodford² 11.1 tcf

Permian Basin
Conv¹: 41 bbo & 47 tcfg
Barnett²: 23 tcf

Arkoma Basin
Conv¹ 8.0 tcfg
Fayetteville²: 9.7 tcfg

Gulf Coast onshore
Conv: ~20 bbo⁴ 100’s tcfg (est)
Eagleford²: 3.37 bbo/c 6.2 tcfg
2013 USGS unconv 23 – 91 Mean 50 tcf
Haynesville²: 17.7 tcfg
2013 USGS unconv, 44-81 Mean 61 tcf

¹ USGS various repots: produced HC through 1992/1993
² EIA 2014
³ USGS 2013 Mean estimate)
⁴US Dept Energy 2006

Conv. = conventional oil and gas
Unconv. = unconventional or continuous oil and gas

A New Approach to Asian Energy
“GO TO WHERE THE OIL IS”

Areas of significant shale gas and oil potential tend to have existing significant conventional production

- USGS mean estimate plotted for unconventional potential (2013), larger than EIA proven reserves shown on previous slide
- Clearly varying estimates for ultimate potential of any play
- Understanding the rocks and unique properties of each basin critical to success

Source:
Unconventional: USGS National Assessment Of Oil And Gas Resources Update (March, 2013)
Conventional: USGS reports, US Dept of Energy
INDONESIAN, AUSTRALIAN COMPARISON

Indonesia has 9x more onshore discovered reserves than Australia despite only a ¼ of the land mass.

Indonesian and Australian Onshore Productive Basins

Australia onshore
• 4.2 bboe conventional (75% gas)
• Active unconventional program

Indonesia onshore
• 37.8 bboe conventional (40% gas)
  No dedicated shale wells as yet
• ~70% of onshore HC’s in Sumatra

> $1.5 billion committed to Australian shale/tight oil & gas exploration since 2010

Attention is now focussing on Indonesia
ELEMENTS FOR UNCONVENTIONAL PLAY

Work to be done but Indonesian plays meet some key criteria from US experience

- Proven, active petroleum system
  - TOC 1.5%+
  - Late oil/gas window (VR >1.1)
- Rocks susceptible to fracture stimulation
  - Carbonate or silica enriched
- Some level of overpressure
  - Provides “reservoir” energy
- Isolation from conventional reservoirs
  - Important for effective stimulation
- Appropriate stress regime

Lion is targeting shale gas/oil and tight gas/oil plays at 2,000-4,000m

**Shale gas/Shale oil**
- Very fine grained low permeability organic rich sediments – both source and reservoir
- Requires fracture stimulation to flow at commercial quantities

**Tight gas/Tight oil**
- More like conventional reservoir, sandstone, carbonate but low permeability and also requires fracture stimulation to flow

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Sumatran/Java/Kalimantan Unconventional plays
Basins have a range of plays at a variety of maturity windows

1. Organic rich lacustrine/restricted marine shales
2. Tight, finely laminated graben fill sandstone
3. Tight, platform carbonates
4. Condensed organic-rich, high stands marine shales/carbonates
5. Tight, finely laminated outer shelf to turbidite sands

Key:
- Marine shales
- Fluvio-Deltaic sst
- High stand shales/carb
- Carbonate
- Tight sandstone
- Lacustrine/restricted marine shales
- Alluvial non marine sandstone

After Doust and Noble 2008
INDONESIAN KEY ONSHORE BASINS

Sumatra basins standout for unconventional focus in terms of discovered HC’s, multiple plays, market access & infrastructure

**Sumatra** 18.8 bbo, 41 tcfg, 1.2 bbc
- Market, infrastructure
- Accessible terrain
- Marine, lacustrine source
- Fluvial-deltaic source
- Areas of complex structure

**Kalimantan** 1.7 bbo, 18.4 tcfg, 0.2 bbc
- Bontang LNG
- Structural complexity
- Fluvial-deltaic source
- Remoteness

**Java** 1.3 bbo, 9.3 tcf, 0.2 bbc
- Market, infrastructure
- Tight carbonate play
- Fluvial-deltaic source
- Population density

**East Indonesia** 0.7 bbo, ~6 tcfg, 0.1bbc
- Tangguh LNG
- Jurassic marine source
- Depth to targets
- Remoteness
- Lack of infrastructure
- Terrain issues

**Note** marine source rocks in North Sumatra and Eastern Indonesia (most successful shale plays in US involve marine source rocks)

Source oil and gas reserves: IHSE, various (Onshore volumes only shown), Sumatra number updated Sept 17 2014
### SUMATRAN SHALE TARGETS

Challenge will be defining “sweet spots” of potential plays

<table>
<thead>
<tr>
<th>Properties</th>
<th>North Sumatra</th>
<th>Central Sumatra</th>
<th>South Sumatra</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Lower Baong</td>
<td>Belumai Formation</td>
<td>Bampo Shale</td>
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<tr>
<td>Rock Description</td>
<td>Marine shale with carbonate lenses</td>
<td>Marine calcareous shale, carbonate</td>
<td>Restricted marine black claystone,</td>
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<td>Recorded TOC</td>
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<td>0.5-3.4</td>
<td>0.5-1.0% (limited data)</td>
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<td>Maturity window</td>
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<td>Gas window</td>
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<tr>
<td>Pressure</td>
<td>Generally moderately to occasionally high overpressure</td>
<td>Normal to moderately over pressured</td>
<td>Normal to moderately over pressured</td>
</tr>
</tbody>
</table>

Source: Lion in-house, various

**Unconventional Potential Assessment for Key Parameters**

- **Positive**
- **Reasonably Positive**
- **Uncertain**
- **Negative Factors**
- **Negative**

**A New Approach to Asian Energy**


September 2014
# Sequence Stratigraphy Key

## High Stand Events Result in Enhanced Source Rock Potential

### North Sumatra Basin Stratigraphy

#### Sequence Stratigraphy Key

<table>
<thead>
<tr>
<th>Chronostratigraphy</th>
<th>Lithostratigraphy</th>
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<tr>
<td><strong>In MM Years</strong></td>
<td><strong>K-Zone</strong></td>
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<tr>
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</tbody>
</table>

**High Stand Events Result in Enhanced Source Rock Potential**

- **Belumai**
- **Bampo**
- **Low Stand Tight Sands**

**Sequence Stratigraphy Diagram**

- **New Approach to Asian Energy**
- **www.lionenergy.com.au**
- **September 2014**
NORTH SUMATRA BASIN WELL CORRELATION

Multiple potential unconventional plays, late uplift brings prospective targets to drillable levels

- **Eocene - Oligocene**
  - Bampo Fm syn-rift shales with interbedded tight sst and carbonates

- **Middle Miocene**
  - Baong Fm tight sandstone/siltstone play

- **Early Middle Miocene**
  - Lower Baong Fm condensed shales/carbonate and sandstone

**Datum: MSL**
INDONESIAN WAY FORWARD

“Cracking the code” has a way to go - earliest success expected in hybrid (tight oil and gas) plays

Phase I – Study Phase

- Compile/access data (sporadic, limited deep basinal tests)
- Core, cuttings analysis
- Seismic interpretation
- Basin modelling
- Stress analysis

Joint study phase
~6-12 months

Phase II – Leverage conventional exploration

- Detailed seismic analysis, modelling
- Modify conventional well to build shale, tight plays knowledge (shale coring, specialist logging)
- Sweet spot identification
- Plan dedicated unconventional well

Initial PSC phase
2-3 years

Phase III – Concept Proof

- Hydraulic stimulation in vertical well
- Evaluate results
- Horizontal well, multi-stage stimulation
- Economics
- Plan pilot development
- Environmental analysis
- Infrastructure review

Extended PSC
3+ years

Key challenges: well deliverability, costs, regulator flexibility, land access
LION UNCONVENTIONAL CLAIMS “STAKED”
Four Joint Study Applications (JSAs) submitted

- Lion has over 17,000km$^2$ under application
- 2 in North Sumatra, 2 in Central Sumatra
- Potential world-class shale and tight gas/oil opportunities
- USGS & KESDM estimate the North & Central Sumatran basins have 10’s of TCF and multi-billion barrel oil unconventional resource potential
- Ready access to infrastructure (including pipelines to Singapore, Java)
- Conventional/unconventional exploration synergies, critical component of Lion strategy

<table>
<thead>
<tr>
<th>Basin</th>
<th>Conventional EUR (Discovered)</th>
<th>Unconventional In-Place (Undiscovered)</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Oil/Cond (bil bbl)</td>
<td>Gas (tcf)</td>
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<tr>
<td>North Sumatra Basin</td>
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<tr>
<td>Central Sumatra Basin</td>
<td>13.2</td>
<td>3.9</td>
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</tbody>
</table>

$^1$USGS 2000, $^2$Badan Geologi KESDM 2013, $^3$EIA 2013, $^4$Lion internal
Thank you

For more information please contact:

Kim Morrison
Chief Executive Officer
kmorrison@lionenergy.com.au
Office: +61 8 9211 1500
Mobile: +61 404 490 964