Discussion Paper

Commercialisation issues, opportunities and challenges in the event of substantive gas-rich exploration success in New Zealand

13 May 2014
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Agenda

1. Why? And why now?

2. South Island commercialisation
   - Supply-side
   - Demand-side
   - Aggregation

3. North Island commercialisation
   - Supply-side
   - Demand-side
   - Risks, opportunities

4. Policy
Agenda

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4. Policy
NZ upstream sector never busier

- Extensive programmes, multiple international players
- $2 billion committed or signalled
- Some targeting high-impact gas
- 2-3 of genuine international scale
- Contrarily, increasing concern towards existing NI gas market
- Independent issues, opportunities, challenges analysis
- Dovetail into detailed Concept Consulting studies:
  1. Gas Supply/Demand Outlook
  2. Gas Commercialisation
Much in the way of public attention, but arguably little in the way of public discussion
Starting frame: broad-based global consensus towards outlook for gas

- **IEA**: “The Golden Age of Gas Scenario”

- **UNIPCC**: gas a valid transition fuel that should replace coal in electricity generation
  - Energy: coal combustion 1,182gCO2/kWh vs gas 610gCO2/kWh
  - Transport fuel: energy efficiency of gas similar to liquid fuels but tailpipe emissions ≤25% lower

- **EIA**: US leading the way in commercialising unconventional gas
  - US natural gas production to increase 56% to 2040, to 38tcf pa
  - Gas-fired electricity generation to overtake coal by 2035
  - US to become net gas exporter by 2020

- **Supermajors**: BP, Shell, ExxonMobil et al: growth in gas to strongly outperform liquids

- **Markets**: Citigroup says gas-fired generation a likely temporary bridge between the age of coal and the age of renewables
What’s happening in the world’s most advanced economy

- US gas production forecast to reach 81bcf/d (31tcf/pa) by 2020, up ~30% this decade
- US expected to become net gas exporter by 2020 – a status not held since 1957
- Natural gas share of power generation has doubled in a decade, from ~15% in 2003 to ~30% now.
- By 2020 installed gas-fired generation capacity expected at 140,000MW, up from 75,000MW in 2003
- Since 2011, 46,000MW of coal-fired capacity has been retired with a further 14,000MW expected out to 2020
- Gas-oil arbitrage attracting wave of investment capital
- Enormous increases in petrochemical build:
  - Installed nitrogen capacity expected to increase 60% to 26mt by 2018
  - Installed methanol capacity to increase tenfold in just five years, from 1.2mt in 2012 to 12.4mt by 2016
- By 2020, NGVs expected to account for 25% of US domestic truck fleet sales
- Competitiveness of US manufacturing base sharply up on lower natural gas prices
- Standalone attributable real GDP increase of 2.0% to 3.3% by 2020
- By 2020, GHG emissions from generation to fall ~20% to 2.1 bln tonnes, approximating 1995 levels.

Source: Citi Research, Woodward Partners
What’s happening in the world’s most advanced economy?

The shale natural gas and oil revolution: enablers and sector/macro implications

- **Enablers**
  - Abundant Shale Gas Resources
  - Surging oil output boosting associated gas

- **Sector-Level Implications**
  - Power generation: Fuel-switch from coal to gas
  - Residentials and Commercials: Fuel-switch from oil to gas
  - Industrials: Low cost feedstock/energy
  - Transportation: Fuel-switch from oil to gas
  - Energy Exports: Pipeline gas to Mexico and Canada; LNG to the world

- **Macro Implications**
  - Enhance national economic competitiveness
  - Lower air emissions
  - Influence global geopolitics

Source: Citi Research
Across the ditch, market outcomes delivering some winners but many losers

- A$200 bln wave of new-build LNG liquefaction capacity nearing completion in WA, NT and QLD
- A$65 bln concentrated towards CSG-to-LNG Surat/Bowen Basin projects feeding 3x separate liquefaction plants for 25mtpa capacity total under construction on Curtis Island, QLD
- Huge cost overruns, very few projects immune
- East Coast gas market to transform from status of internal subsistence (of ~180PJ pa) into structural net-export (~1,600PJ pa) in two years
- LNG producer/exporters competing directly with domestic buyers for gas
- Producers thought to be DCF-neutral at 10% IRR to buy gas on-market at A$7/GJ to offset drilling
- Substantial upswing in conventional oil and gas exploration to meet market demand
- Domgas prices at least doubled in less than five years, from A$2-4/GJ in 2009/10 to A$6-8/GJ today

Source: Citi Research, Woodward Partners
Across the ditch, market outcomes delivering some winners but many losers

East Coast Australia gas market with LNG ramp-up

Source: Citi Research
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4. Policy
Supply-side: Best available analysis infers Maui-like prospectivity

- Extremely shallow knowledge base
- Canterbury & Great South Basins the frontier provinces with strongest intelligence

### P50 estimates

<table>
<thead>
<tr>
<th>Basin</th>
<th>Onshore Taranaki</th>
<th>Offshore Taranaki</th>
<th>Deepwater Taranaki</th>
<th>Northland</th>
<th>Raukumara</th>
<th>East Coast</th>
<th>Canterbury</th>
<th>Great South</th>
<th>Pegasus</th>
<th>Reinga</th>
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<td>&gt;10 tcf</td>
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<tr>
<td>Minimum statistical field size</td>
<td>Fields less than 0.05 tcf not considered</td>
<td>Fields less than 0.25 tcf not considered</td>
<td>Fields less than 0.75 tcf not considered</td>
<td>Fields less than 0.75 tcf not considered</td>
<td>Fields less than 0.3 tcf not considered</td>
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<td>Fields less than 0.75 tcf not considered</td>
<td>Fields less than 1 tcf not considered</td>
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<td>638</td>
<td>1343</td>
<td>441</td>
<td>612</td>
<td>418</td>
<td>732</td>
<td>1183</td>
<td>461</td>
<td>561</td>
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<td>1000 - 301 MMbbl</td>
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<td>3</td>
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<td>300 - 101 MMbbl</td>
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<td>100 - 31 MMbbl</td>
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<td>&lt; 10 MMbbl</td>
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<td>Minimum statistical field size</td>
<td>Fields less than 5 MMbbl not considered</td>
<td>Fields less than 25 MMbbl not considered</td>
<td>Fields less than 150 MMbbl not considered</td>
<td>Fields less than 150 MMbbl not considered</td>
<td>Fields less than 50 MMbbl not considered</td>
<td>Fields less than 30 MMbbl not considered</td>
<td>Fields less than 100 MMbbl not considered</td>
<td>Fields less than 150 MMbbl not considered</td>
<td>Fields less than 200 MMbbl not considered</td>
<td>Fields less than 200 MMbbl not considered</td>
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</tbody>
</table>

Source: GNS
Supply-side: Best available analysis infers Maui-like prospectivity

- Best estimate field scale: <10tcf
- Most likely range: 1-3tcf
Demand-side: Commercialisation options centre on export

- Absence of existing onshore SI sector a significant, but not insurmountable commercialisation issue
- End-user commercialisation spectrum would rely on:
  1. scale
  2. pricing parameters

<table>
<thead>
<tr>
<th>Gas reserves scale</th>
<th>Potential production</th>
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<td>Maui</td>
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Source: Woodward Partners
Demand-side: Top-down commercialisation options centre on export

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Source: Woodward Partners
Demand-side: Bottom-up scope of projects supports export focus

- Beyond LNG, large scale projects 30PJ+ centre on petrochemicals and GTL
- Only become valid if development involves a shore-based umbilical component to FDP

<table>
<thead>
<tr>
<th>Scale</th>
<th>Discrete downstream new-build options</th>
<th>Analogue Taranaki plants</th>
<th>Indicative capex</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small</td>
<td>Low- to mid-merit electricity generation</td>
<td>Fonterra Whareroa cogeneration</td>
<td>&lt;$200m</td>
</tr>
<tr>
<td>&lt;10PJ pa</td>
<td>Smaller urea/ammonia/nitrogen manufacture</td>
<td>Todd Energy Mangahewa peakers</td>
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</tr>
<tr>
<td></td>
<td>Site-specific heat and industrial applications</td>
<td>Ballance Agri-Nutrients urea</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Transport fuel (LNG, CNG)</td>
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</tr>
<tr>
<td>Mid-scale</td>
<td>High-capacity electricity generation (eg CCGT)</td>
<td>Contact &amp; Genesis CCGTs</td>
<td>$200m - $1 bln</td>
</tr>
<tr>
<td>10-30PJ pa</td>
<td>Larger urea and/or ammonia manufacture</td>
<td>Methanex Waitara Valley plant</td>
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<tr>
<td></td>
<td>Small/mid-format methanol</td>
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<tr>
<td>Large-scale</td>
<td>Large-format methanol</td>
<td>Methanex Motunui plants</td>
<td>&gt;$1 bln</td>
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<tr>
<td>&gt;30PJ pa</td>
<td>GTL</td>
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</tr>
</tbody>
</table>

Source: Woodward Partners
FLNG absolutely the future for gas that is big(ish), wet & lonely

Financial & strategic benefits deeply compelling:
- Monetisation of smaller, more remote fields
- Construction in controlled cost environment
- Mobility dramatically reduces project risk
- Regulatory flexibility
- Replicable for scale, akin to FPSO

Shell the first to FID:
- **Shell**: Prelude 3.6mtpa
- **Petronas**: Kanowit 1.2mtpa, Rotan 1.5mtpa
- **Woodside**: Browse 3x4mtpa

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**Australian LNG project capex**

<table>
<thead>
<tr>
<th>Project</th>
<th>Capex (US$bln)</th>
</tr>
</thead>
<tbody>
<tr>
<td>QCLNG</td>
<td>20</td>
</tr>
<tr>
<td>APLNG</td>
<td>15</td>
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<tr>
<td>GLNG</td>
<td>10</td>
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<tr>
<td>Gorgon</td>
<td>50</td>
</tr>
<tr>
<td>Ichthys</td>
<td>40</td>
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<tr>
<td>Prelude</td>
<td>60</td>
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<tr>
<td>Browse</td>
<td>50</td>
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**Australian LNG project capital intensity**

<table>
<thead>
<tr>
<th>Project</th>
<th>Capital Intensity (US$/t)</th>
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<tbody>
<tr>
<td>QCLNG</td>
<td>2.0</td>
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<tr>
<td>APLNG</td>
<td>3.0</td>
</tr>
<tr>
<td>GLNG</td>
<td>3.5</td>
</tr>
<tr>
<td>Gorgon</td>
<td>4.5</td>
</tr>
<tr>
<td>Ichthys</td>
<td>5.0</td>
</tr>
<tr>
<td>Prelude</td>
<td>6.0</td>
</tr>
<tr>
<td>Browse</td>
<td>6.5</td>
</tr>
</tbody>
</table>

*Source: Citi Research, Woodward Partners*
“Son of Maui” would likely meet IOC materiality test

Prelude
- Shell-led JV 67.5% + Inpex, CPC & KOGAS
- Northwest Shelf, to moor 200km from coast
- World’s first FLNG facility
- World’s largest floating structure:
  - 488m long  Petronas Towers, KL
  - 74m wide  Boeing 747 wingspan
  - 105m high  Big Ben
  - 600,000t weight  6 x US aircraft carriers
  - 436,000m³ storage  175 x Olympic-sized pools
- Capex: ~US$12 bln
- Economics at FID (ex Citi): IRR 18.1%, NPV US$5.7 bln
- Commissioning: late 2016

Source: Shell
FLNG economics already strong, and likely to become stronger

Citi estimated LNG cost curve – LNG price delivered to Nth Asia required to achieve 12% IRR

Source: Citi Research
Maui a highly valid FLNG analogue

<table>
<thead>
<tr>
<th></th>
<th>2P gas reserves</th>
<th>2P condensate reserves</th>
<th>2P LPG reserves</th>
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</thead>
<tbody>
<tr>
<td>Prelude</td>
<td>4,500 PJ</td>
<td>160 mmbbl</td>
<td>8 mt</td>
</tr>
<tr>
<td>Maui</td>
<td>4,000 PJ</td>
<td>140 mmbbl</td>
<td>4 mt</td>
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<tr>
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<td>435 ktpa</td>
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<tr>
<td>Maui</td>
<td>150 PJ</td>
<td>10 mmbbl</td>
<td>300 ktpa</td>
</tr>
</tbody>
</table>

Source: Woodward Partners
Conclusion: Offshore-only likely as the FDP the market would deliver

- FLNG would be highly defendable as an economically efficient solution to an offshore frontier basin discovery, but that would likely be concluded on the basis of assessment against global cost/benefit benchmarks and tests.
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4. Policy
North Island very different above-ground context

- Mature, arguably saturated gas market
- Infrastructure well established, highly reliable
- Direct price-based competition in a number of fuel markets, particularly electricity generation
- A number of larger gas users running plants on a short-run cash margin basis
- Substantial recent growth in market size, but attributable entirely to just one player
- Growing concern towards market concentration and downside risks
NI spectrum of big gas commercialisation options very similar to onshore SI

- Entirely feasible, perhaps even likely, that FLNG could also be favoured FDP in event of substantive Maui-like success
- Demand-side of local market of insufficient existing size to absorb substantive new production
- Scale and gas economics would determine viability of new-build demand-side options
NI new-build option spectrum materially the same as for onshore SI

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- Larger urea and/or ammonia manufacture  
- Small/mid-format methanol                     | - Contact & Genesis CCGTs                     | $200m - $1 bln   |
|            |                                                                                                       | - Methanex Waitara Valley plant               |                  |
| Large-scale >30PJ pa | - Large-format methanol  
- GTL                                                     | - Methanex Motunui plants                     | >$1 bln          |

Source: Woodward Partners
Increasing demand-side risk in gas market undergoing rapid growth

- Energy transformation has typically accounted for >80% of NZ gas market.

- Currently strongly divergent trend:
  - Generation gas in sharp decline as CCGT plant relegated to mid-merit / hydro-firming
  - Methanex taking up all slack, and some

- Load risk weighted to downside, particularly with Tiwai Point uncertainty

- Market concentration becoming an increasing issue.

- Main commercial difficulty towards supporting load growth centres on (a) securing long-term gas to underwrite investment decisions; and (b) certainty of gas price.

Contact Energy CCGT utilisation 2008-13

Source: EA, Woodward Partners
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Gas market concentration

Source: Woodward Partners
LNG paradigms changing rapidly, no longer available in just one shape and size

• **Conventional model**: LNG = bulk international trade
  - First LNG shipment 1959. Then ~25,000m$^3$. Today ~270,000m$^3$ ≈ 100 Olympic-sized pools ≈ 5PJ per voyage
  - Today ~240mtpa traded globally (~12,000PJ pa) between 22 nations
  - Numerous countries trade via both LNG and pipeline:
    - Net buy-side: US, UK, France, Spain, China
    - Net sell-side: Russia, Canada, Indonesia

• New Zealand’s thinking has traditionally fitted the conventional model, eg Gasbridge

• New model much broadens focus towards smaller scale & local market deployment
Mid-scale: Modular export LNG

- Emerging technology
- Strong conceptual appeal
- Technical and economic performance not yet sufficiently established
- EWC Sempang concept project in Indonesia:
  - Gas resource ~175PJ
  - 500ktpa stackable cold boxes:
    - 25PJ pa
    - 70TJ/d
  - Regional Asian export trade focus

Source: EWC
Small-scale: Micro-LNG for local market supply

- Two generic concepts:
  1. **Supply-side**: Commercialisation of very small otherwise uneconomic fields; and/or
  2. **Demand-side**: Compete with liquid fuels, particularly diesel

- Becoming established in increasing number of countries incl US, Canada, Australia

Australian projects

- **BOC Westbury (TAS)**:
  - Operating since 2011
  - Bass Strait gas supply, ~6TJ/d
  - 18,000tpa liquefaction facility
  - ~25ml pa diesel
  - Consortium 7 truck fleet owners, 125 trucks

- **EWC Gilmore project (QLD)**:
  - 20PJ resource base
  - 13TJ/d for <5PJ pa
  - 56,000tpa liquefaction facility planned
  - Potential applications remote electricity generation & road freight

Source: Linde
Agenda

1. Why? And why now?

2. South Island commercialisation
   - Supply-side
   - Demand-side
   - Aggregation

3. North Island commercialisation
   - Supply-side
   - Demand-side
   - Risks, opportunities

4. Policy
Much potential thinking ahead for policymakers

- North and South Islands present conceptually very different public policy contexts:
  - SI: blank sheet of paper, discussion one of benefit maximisation
  - NI: established sector, discussion one of disturbance risk to existing energy markets

- CMA requires every application for a mining permit to be approved by the responsible Minister
  - Minister must act “to promote prospecting for, exploration for, and mining of Crown owned minerals for the benefit of New Zealand”
  - FDP a central component of mining permit application process
  - Potential for strong government influence over FDP

- National cost/benefit analysis would be part of the process

- Agency resourcing/capability not where it would need to be to engage with authority with industry, but time is typically your friend in O&G sector

- In event of substantive frontier success, scope for thinking well beyond FDP

- Nothing new here – Kapuni and Maui developments 40-50 years ago involved explicit government involvement and much in the way of special-purpose policy & statute

- A nice problem to have.
Conclusions

• In the event of substantive SI exploration success, an offshore-only development scenario is the most likely, probably via FLNG, unless a compelling land-based alternative can be identified.

• A range of potential onshore demand-side new-build options exist that could support a new, large and gas-rich SI discovery.

• In the existing NI market, major structural change to existing market arrangements is well advanced.

• Significant demand-side downside risk is evident in the existing NI gas market, centring on electricity demand.

• NI market growth options do exist, particularly via small-scale LNG and petrochemicals.

• Existing regulatory frameworks provide explicitly for potentially intensive engagement between project leaders and government on development options.

• Overseas experience, particularly in Australia, suggests deep policy thinking would be required in the event of a major gas find.