Discussion Paper

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

13 May 2014

Woodward Partners

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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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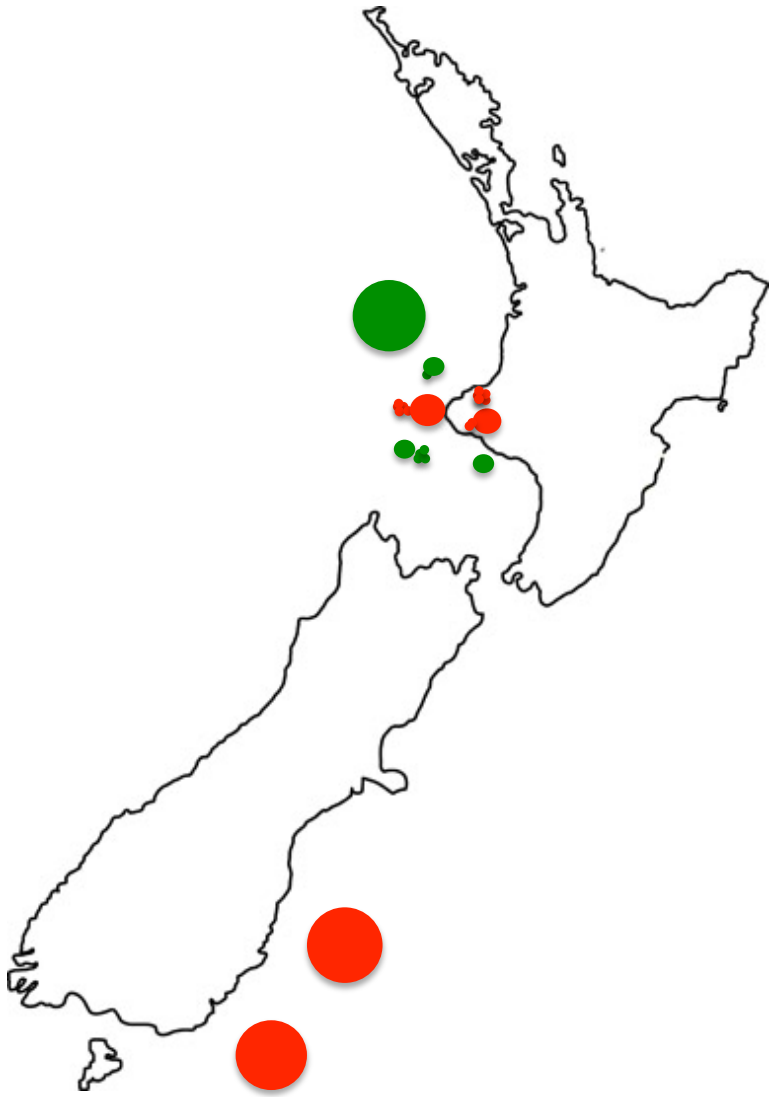
   - Risks, opportunities

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

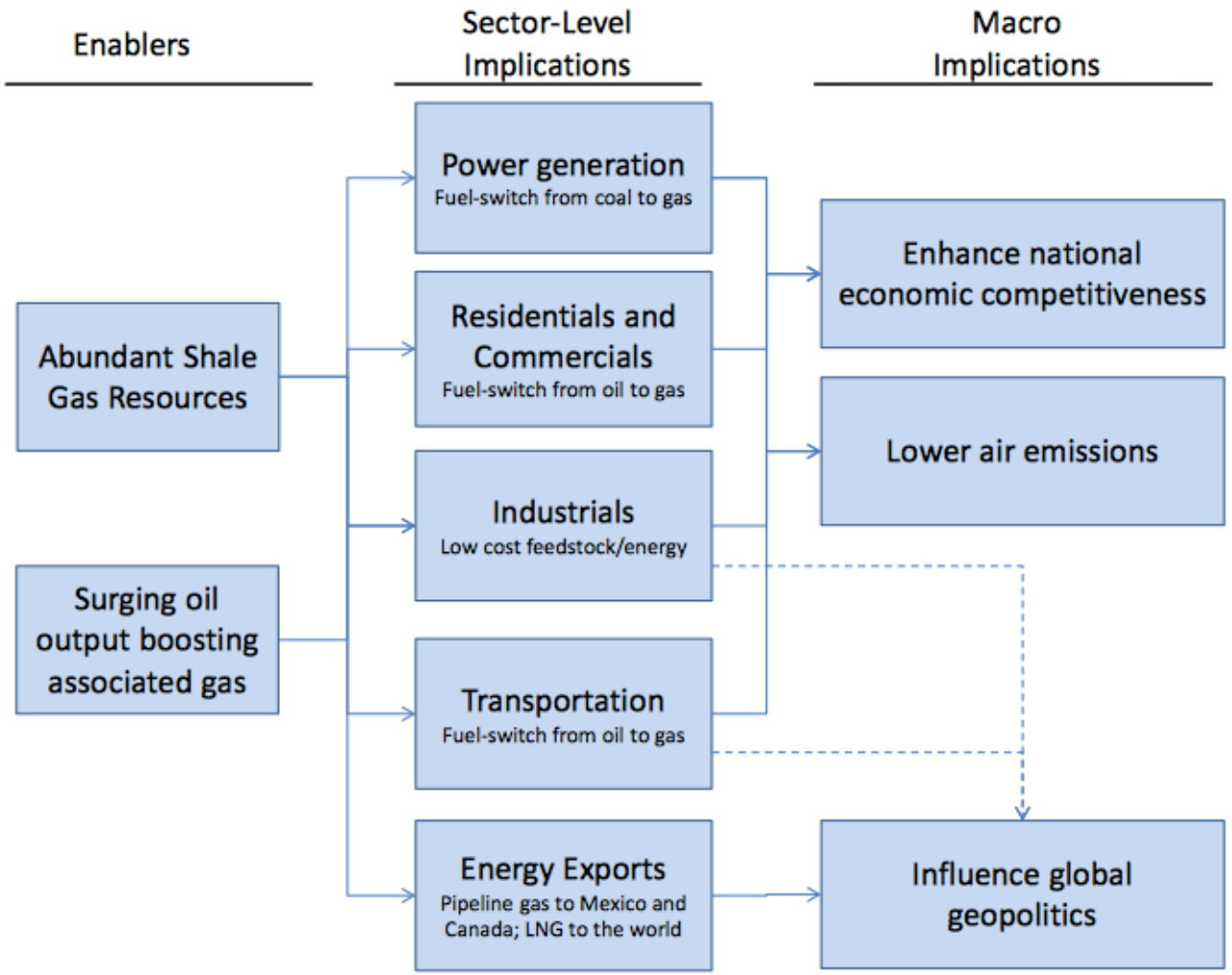
What's happening in the world's most advanced economy

- 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



Source: Citi Research

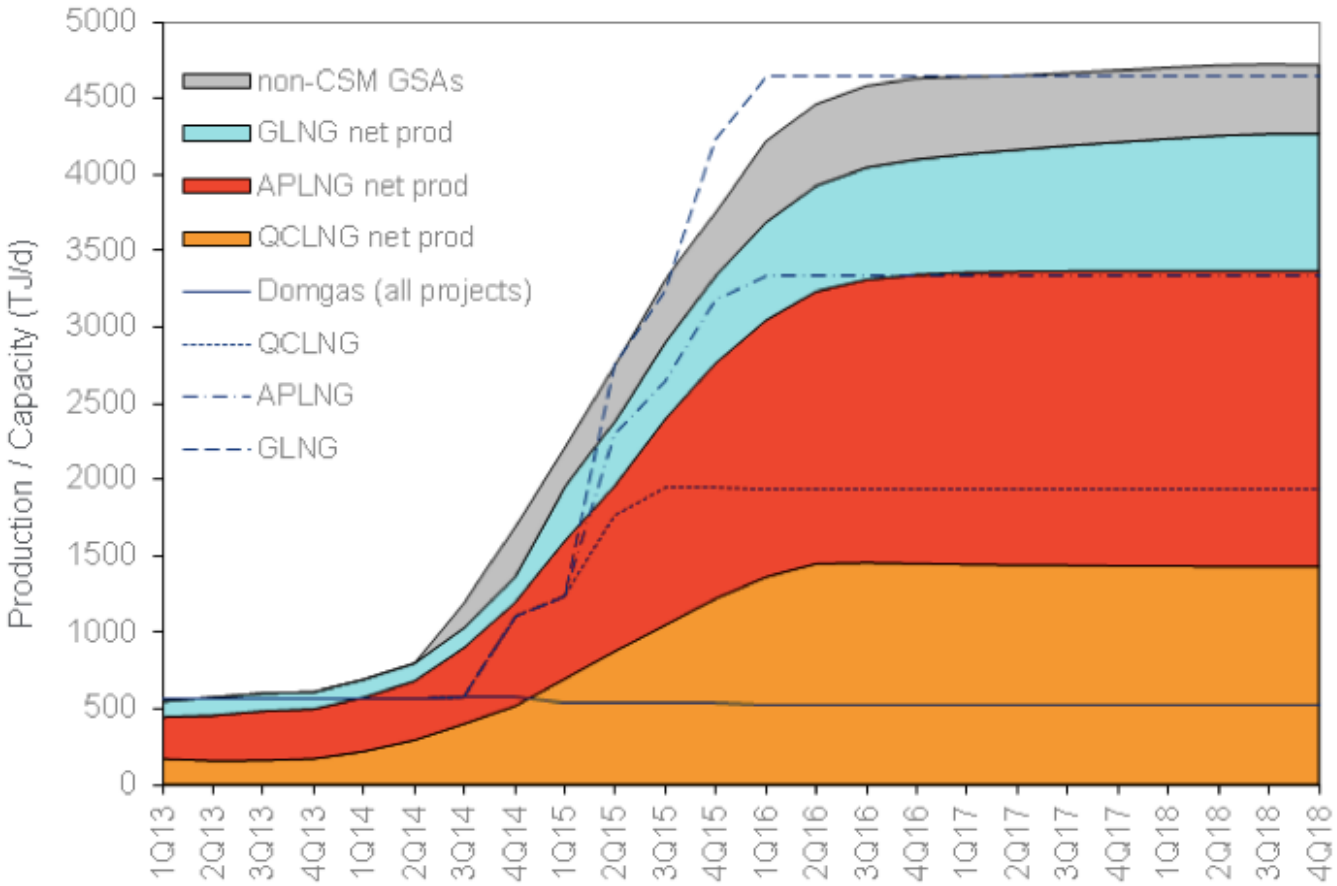
Across the ditch, market outcomes delivering some winners but many losers

- 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



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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

Basin	Onshore Taranaki	Offshore Taranaki	Deepwater Taranaki	Northland	Raukumara	East Coast	Canterbury	Great South	Pegasus	Reinga
Gas resource (tcf)	1.61	3.55	7.47	4.16	2.58	3.42	2.68	7.97	2.74	3.87
Gas Field Sizes	No. of fields	No. of fields	No. of fields	No. of fields	No. of fields	No. of fields	No. of fields	No. of fields	No. of fields	No. of fields
>10 tcf										
10 - 3.1 tcf			1					1		
3 - 1.1 tcf		1	2	1	1	1	1	2	1	1
1 - 0.31 tcf	1	3	2	5	1	3	2	2	1	1
0.3 - 0.11 tcf	4	2				3	1			
< 0.1 tcf	6									
Minimum statistical field size	Fields less than 0.05 tcf not considered	Fields less than 0.25 tcf not considered	Fields less than 0.75 tcf not considered	Fields less than 0.3 tcf not considered	Fields less than 0.75 tcf not considered	Fields less than 0.2 tcf not considered	Fields less than 0.3 tcf not considered	Fields less than 0.75 tcf not considered	Fields less than 0.75 tcf not considered	Fields less than 1 tcf not considered
Oil resource (MMbbl)	158	638	1343	441	612	418	732	1183	461	561
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> 1000 MMbbl										
1000 - 301 MMbbl			1		0		1	1		1
300 - 101 MMbbl		2	3	2	2	1	2	3	1	1
100 - 31 MMbbl	1	5		2		3	1		1	
30 - 11 MMbbl	3	2				1				
< 10 MMbbl	6									
Minimum statistical field size	Fields less than 5 MMbbl not considered	Fields less than 25 MMbbl not considered	Fields less than 150 MMbbl not considered	Fields less than 50 MMbbl not considered	Fields less than 150 MMbbl not considered	Fields less than 30 MMbbl not considered	Fields less than 100 MMbbl not considered	Fields less than 150 MMbbl not considered	Fields less than 150 MMbbl not considered	Fields less than 200 MMbbl not considered

Source: GNS

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

- Best estimate field scale: <10tcf
- Most likely range: 1-3tcf

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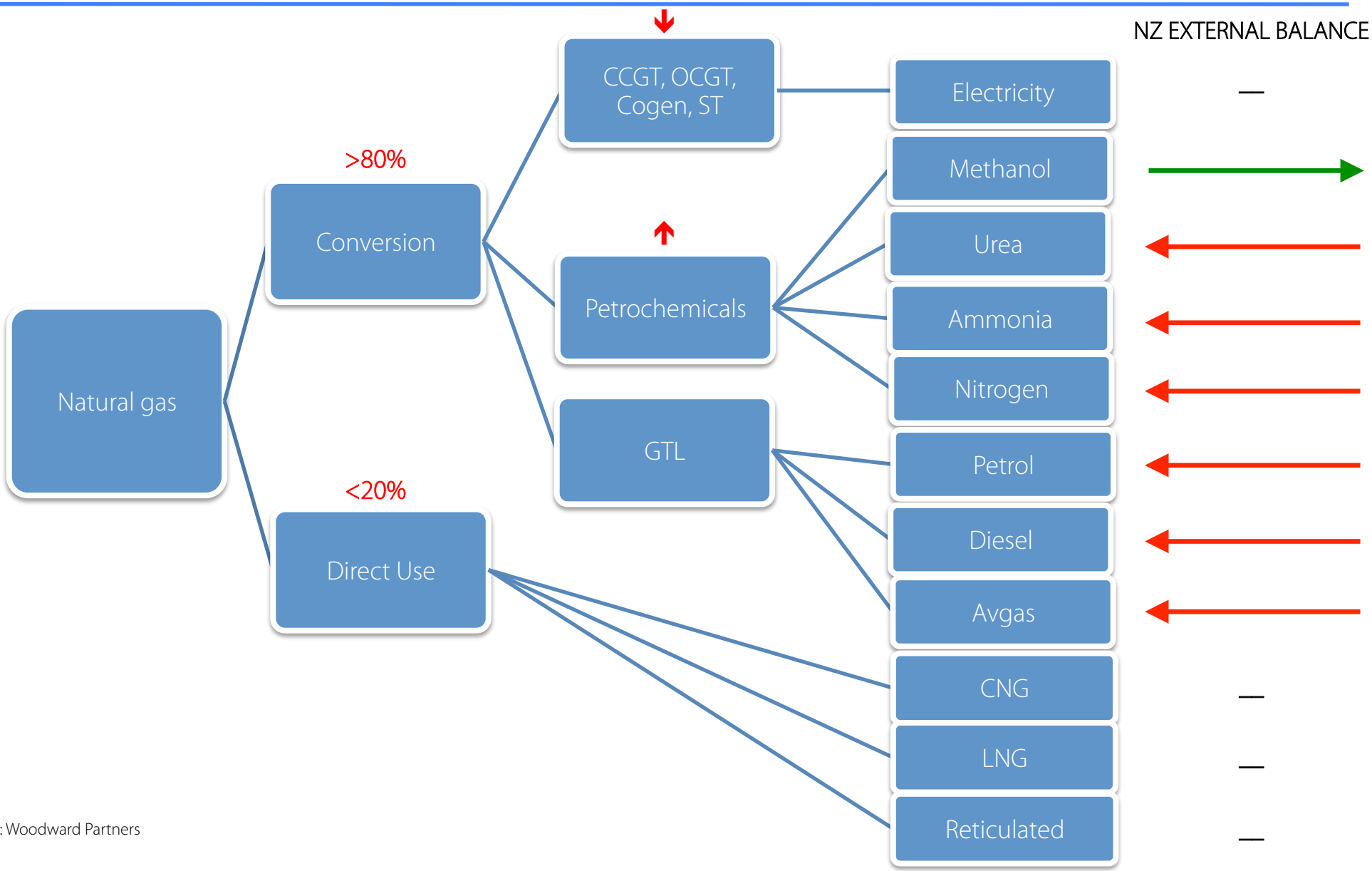
Source: GNS

Gas commercialisation spectrum



Source: Woodward Partners

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

Gas reserves scale	Potential production	Existing NZ field analogues	Potentially viable commercialisation concepts for South Island offshore discovery
Small < 500PJ	≤50PJ pa	Kupe	Probably none. Cost of commercialising, particularly in deepwater environment, very unlikely to support standalone development economics.
Medium 500-2,000PJ	30-300PJ pa	Pohokura	Smaller-scale (<2mtpa) FLNG. Onshore relay a possibility but deepwater economics likely to rule out viability of smaller fields, particularly if field presents little or no associated liquids stream.
Large 3,000-10,000PJ	200-500PJ pa	Maui	Larger-scale (>2mtpa) FLNG. Shell's Prelude FLNG project is a valid analogue. Relay to shore likely to be viable for LNG and onshore industry.
Very large 10,000-50,000PJ	>400PJ pa	None	World-scale shore-based multi-train LNG liquefaction facility plus supply to onshore gas sector. Multi-vessel FLNG fleet also potentially viable.
Global > 50,000PJ		None	Large shore-based multi-train LNG liquefaction facility plus to supply onshore gas sector. Multi-vessel FLNG fleet potentially feasible, but scalability likely to be a limiting factor.

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

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

Source: Woodward Partners

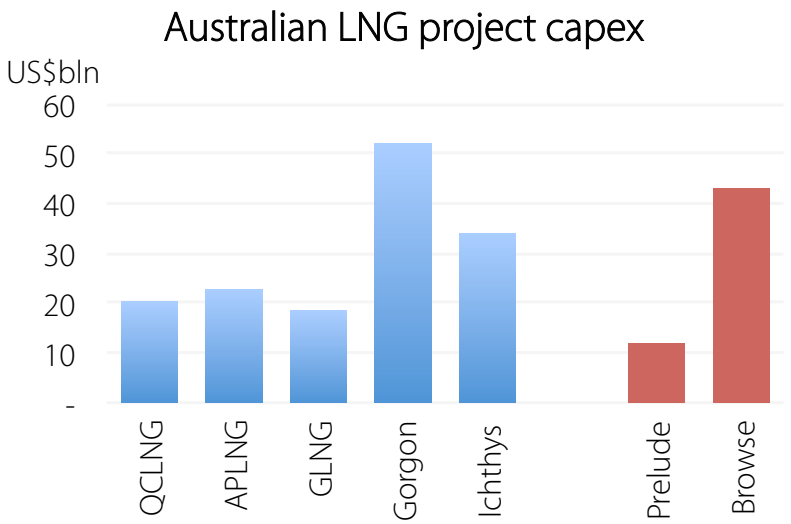
FLNG absolutely the future for gas that is big(ish), wet & lonely

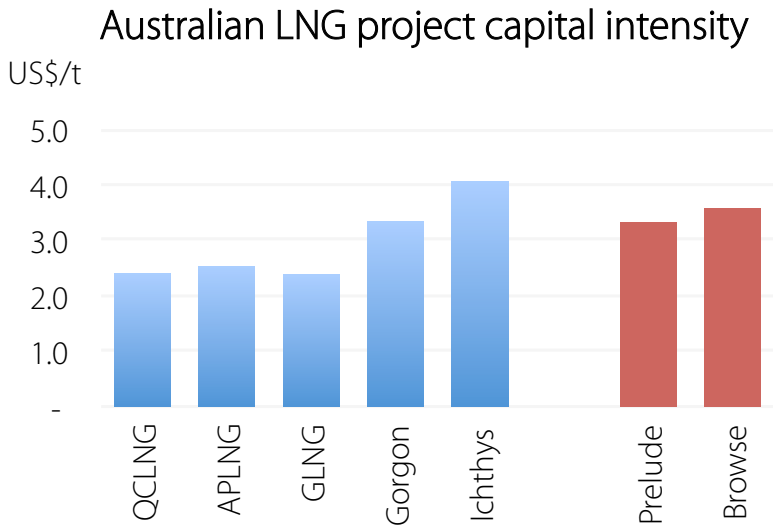
Financial & strategic benefits deeply compelling:

- 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





Source: Citi Research, Woodward Partners

"Son of Maui" would likely meet IOC materiality test

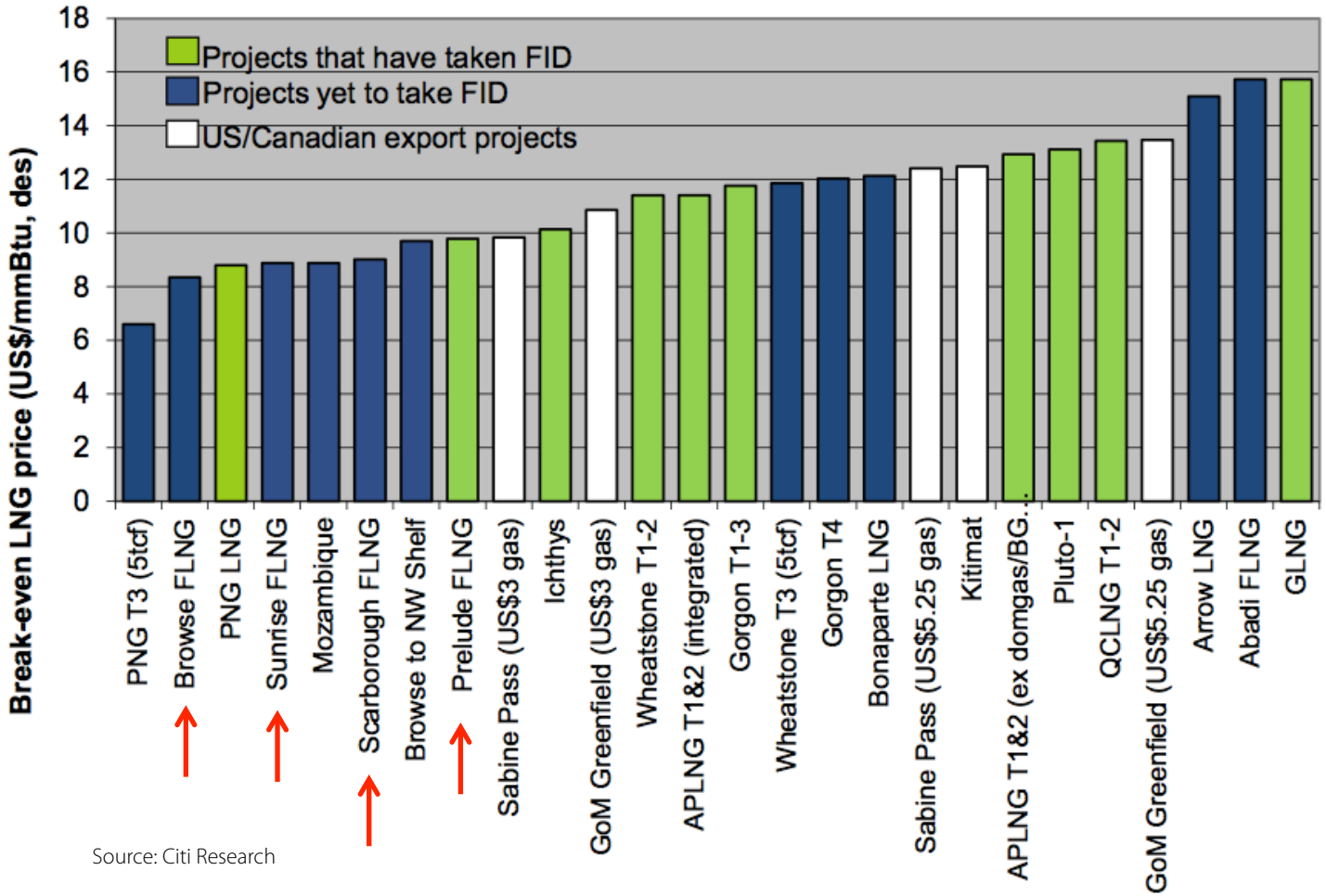
Prelude

- 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
  - 436,000m^3 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

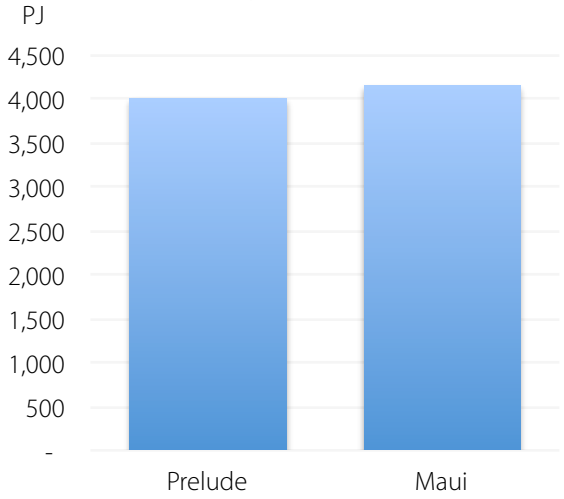
Citi estimated LNG cost curve – LNG price delivered to Nth Asia required to achieve 12% IRR



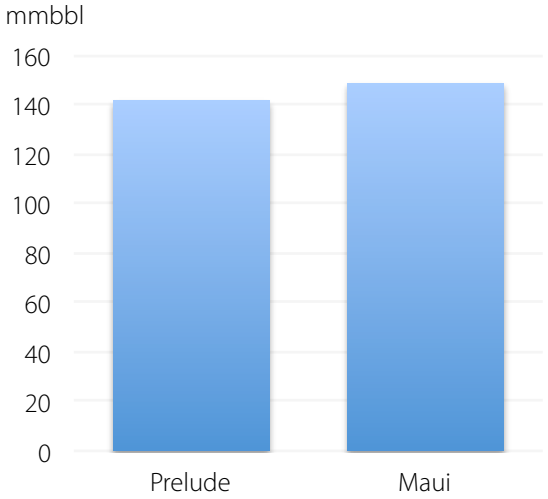
Source: Citi Research

Maui a highly valid FLNG analogue

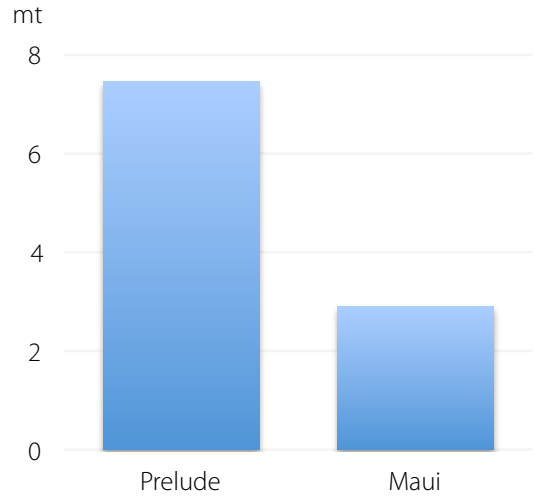
2P gas reserves



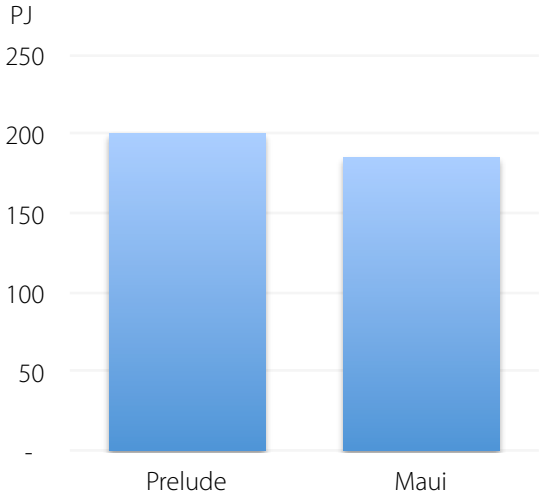
2P condensate reserves



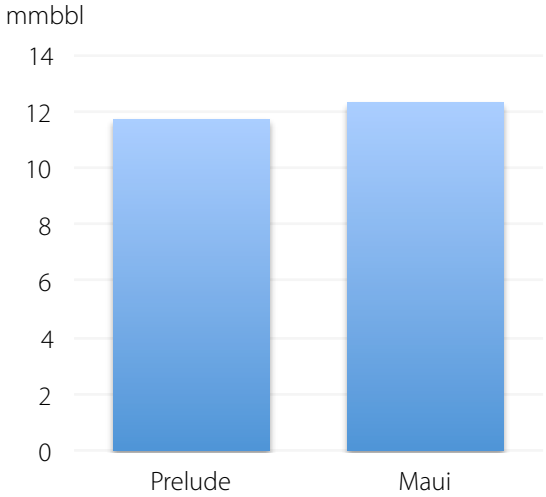
2P LPG reserves



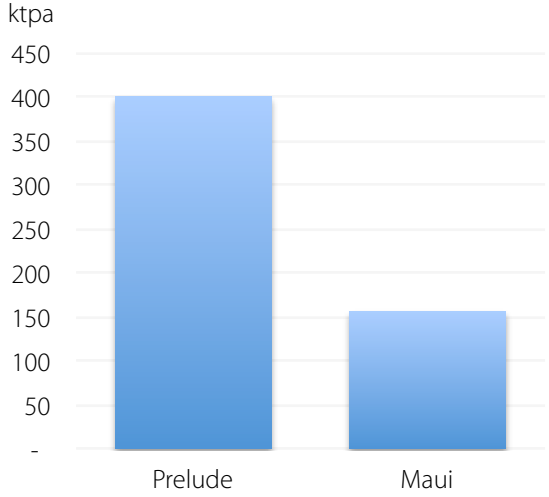
Gas production



Condensate production



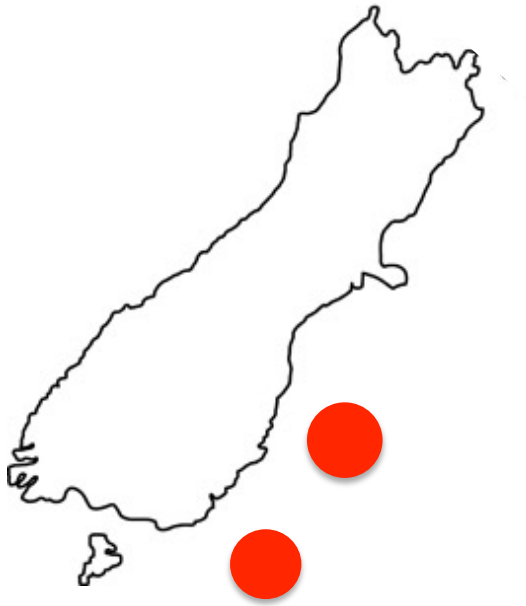
LPG production



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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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

Scale	Discrete downstream new-build options	Analogue Taranaki plants	Indicative capex
Small <10PJ pa	▪ Low- to mid-merit electricity generation ▪ Smaller urea/ammonia/nitrogen manufacture ▪ Site-specific heat and industrial applications ▪ Transport fuel (LNG, CNG)	▪ Fonterra Whareroa cogeneration ▪ Todd Energy Mangahewa peakers ▪ Ballance Agri-Nutrients urea ▪	<$200m
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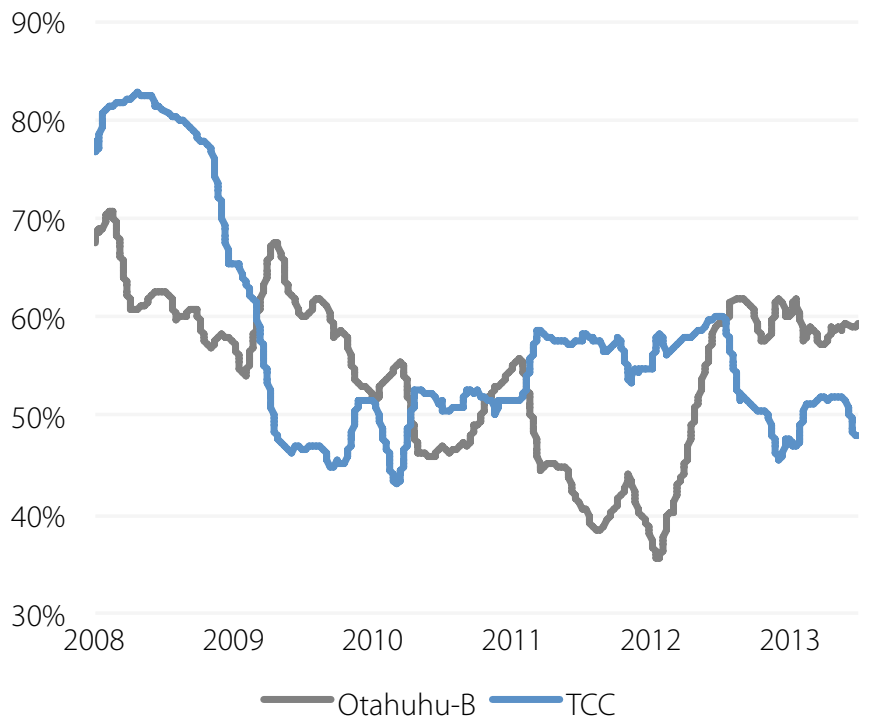
Large-scale >30PJ pa	▪ Large-format methanol ▪ GTL	▪ Methanex Motunui plants	>$1 bln

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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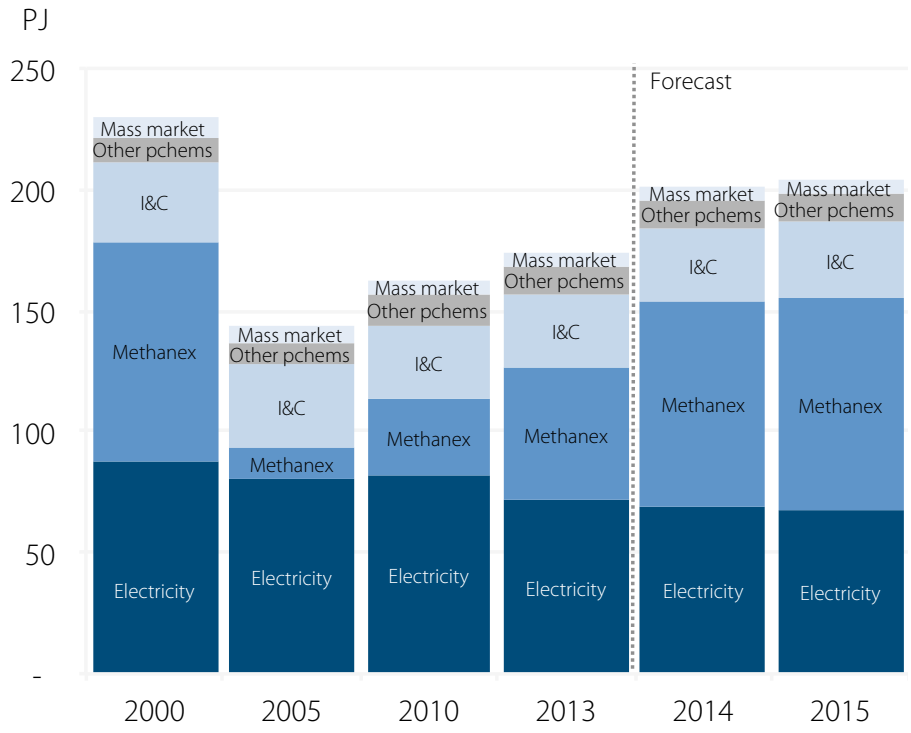
Gas market concentration



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

Source: Linde

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

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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.

John Kidd

Director, Equity Research

john.kidd@woodwardpartners.co.nz
DDI 04 974 7394
Cell 021 543 448

Woodward Partners