Domestic LNG:
Energy Security +
Economic Growth

Presentation to Australian Institute of Energy SA
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Andrew White, Founder and Managing Director, Mobile LNG Pty Ltd
Current Energy Issues:

Energy Demand:

International Energy Agency (IEA) projection:

“The World will require **53 per cent** more energy in **2035** that it did in **2008**, just to maintain the same level of modest economic growth”
Current Energy Issues

The Environment:

CO2 emission increases linked to economic growth which is linked to cheap and plentiful energy

Renewables are costly (for now at least) and reduce economic growth:

“by the end of the century, Germany’s $145b solar panel subsidies will have postponed temperature rises by 37 hours”

“The EU is committed to cutting CO2 emissions by 20% below 1990 levels by 2020......at an average annual cost of $US280b/yr. By the end of the century (after a total cost of more than $US20 trillion), this will reduce the projected temperature increase by a mere 0.05C”

Quotes from “Gas is greenest in the short term” The Weekend Australian, July 12-13, 2014.
Using LNG

Power Generation
+
Transportation (road, rail, marine)
+
Process heating (replace LPG)
Currently: Europe, Nth & Sth America, Asia lead the way

Norway – LNG “Green” Box  
Japan – LNG ISO Tanks  
Spain – LCNG re-fuelling

On-Road Nth America  
Rail - Russia  
Australian Built InCat Ferry in Argentina!

Off-Road Cat 793Evo  
Rail – Nth America  
Norway – Ferry with LNG tanks on Rear Deck (image below)
Natural Gas in Vehicles

Total Natural Gas Vehicles (Worldwide) 1991 - 2012

CAGR 10 Years to 2012 = 21.6%

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LNG vs CNG

- Operators have experienced problems with CNG variability in Heat Rate
- These bad experiences still affecting transition to LNG
- CNG Heat of Compression on transfers and refuelling issues
- LCNG available where LNG is available
LNG around the World

China
+
USA
+
Europe
Australia vs The World

1. Differences between the Australian market and that of the US, Europe and China.

2. Our slow take up of Domestic LNG opportunities compared with the global shift.

3. Australia’s huge potential for energy security and international competitiveness by using Domestic LNG.
LNG in China

Market characteristics:
Major importer of LNG
Major coal power generator
Significant pollution issues
Strong growth
Major industrialisation and urbanisation

Small Scale LNG Focus
• 60 small scale LNG plants operating
• 5 plants under construction
• 1,325 LNG refuelling stations
• > 100,000 LNG vehicles on the road
• Small scale LNG Production now at 1 bcf/d or 20k Tonnes LNG / day
• Estimate LNG vehicles to exceed 1.3m by 2020

(Source FGE : FACTS Global Energy)
**LNG in the USA**

**Market characteristics:**
Shale Gas Revolution and Energy Independence
Low gas prices (Henry Hub US$4- $5)
Extensive gas pipeline infrastructure
LNG Export licensing (more about trade control than energy security)

End Uses (in order of Priority):

1. On-road Transport
2. Off-Road HDV’s & MHV’s
3. In-field services (O&G related)
4. Rail
5. Marine
6. Remote Power

This is almost the direct opposite to LNG in Australia!
USA LNG and CNG Map

Natural Gas Fueling Stations in the United States

Liquefied Natural Gas (LNG) Stations

Compressed Natural Gas (CNG) Stations

Source: U.S. Department of Energy
LNG in Europe

**Market characteristics:**
Extensive LNG Import Terminals
Extensive gas pipeline infrastructure (from Eastern Europe)
Costly move to renewables is being reversed (even back to brown coal)

End Uses (in order of Priority):

1. On-road Transport
2. Marine (Leading the way in LNG Bunkering)
3. Rail
4. Remote Power

Again, this is almost the direct opposite to LNG in Australia!
European CNG & LNG Map

NGVGlobal.com Interactive trip planner
LNG Technology Overview

• **Power Generation**
  • Available now

• **Marine**
  • Available now
  • Improvements with LNG storage tanks for volume constrained ships (as opposed to weight constrained)

• **On-Road**
  • Available now
  • OEM’s main US market 450 HP
  • Australian 600 HP road trains not used elsewhere

• **Off-Road (HDV’s & MHV’s)**
  • Rapidly developing for US market

• **Rail**
  • Urban Rail available now
  • Freight rail to 3500 HP available now
  • Heavy Haul (Pilbara Iron Ore) to 4500 HP not used elsewhere
Energy Security and Growth

The real opportunity for Australia is Domestic LNG:

- We **import $40.2b** of Petroleum products annually
- We **export 99%+** of our LNG

- Are the countries we export to smarter than we are?
- Why don’t they just import diesel, like we do?

We should **use our gas as LNG in Australia** for Transportation and Remote Power Generation.

Opportunities for **Energy Security and Economic growth** will come from **Domestic LNG**
Domestic LNG for Australia

Energy Security
+
Economic Growth
A New Industry for Australia

Mobile LNG will create a whole new industry for Australia and will deliver wide ranging benefits:

1. Unlock investment in our regions and create jobs
2. Reduce the Cost of Living: 20% – 40% Cheaper than diesel
3. Improve Australia’s Export Competitiveness

At the same time, it will significantly reduce Australia’s Carbon Footprint and increase Australia’s Energy Security
Project of National Significance

In April 2014, the Australian Government recognised the importance of the Mobile LNG initiative and project developments to Australia’s economic development and security.

Mobile LNG added to Major Project Facilitation Programme:

www.majorprojectfacilitation.gov.au

Purpose of MPF programme:
• Assist and coordinate project approvals across State, Territory and Federal jurisdictions
• Develop and promote policy direction to advance the industry

Programme is facilitated within the Australian Government Department of Infrastructure and Regional Development
Mobile LNG
The Virtual Gas Pipeline
2 Minute Video Presentation

Please note:
The Virtual Gas Pipeline video is available online at www.mobileLNG.net.au;
- and is not reproduced in these printable notes.

Thank you
The Virtual Gas Pipeline (VGP)

Australian gas via pipeline →

Liquefaction Plants → VGP Distribution → Storage & Regas

→ to Australian customers
South Australian Hub Status

Location
Three locations under consideration North of Adelaide
Two locations under consideration near Port Pirie

Feed Gas
Under negotiation

Liquifaction Technology
Short Listed Technology Providers – Under negotiation

LNG Off-takes
Working with end-users in Mining, Transport and Process with binding agreements building progressively towards FID in Late Q4 2014 / Q1 2015

First LNG Production Target H1 2016
VGP Hub Details

**Initial “Starter” Plant:**
- 100 Tonnes / day
  \[= 35,000 \text{ TPA LNG}\]
- $45m Capex
- Approx 12 months FID to Start-up
- 300 direct Construction Jobs
- 35 direct Operational Jobs

**Main Plant:**
- 400 Tonnes / day
  \[= 140,000 \text{ TPA LNG}\]
- $250m Capex
- Approx 22 months FID to Start-up
- 300 direct Construction Jobs
- 65 direct Operational Jobs
4 x VGP Hubs: Outputs and Impacts

- Use 32 PJ’s / Yr of Australian Gas
- Produce 580,000 TPA of LNG
- Replace 820,000,000 litres of imported diesel
- Reduce CO² emissions by almost 500,000 TPA
- Reduce fuel imports by almost $650 million PA
- Create Jobs
- Increase competitiveness
VGP – The Big Picture

Mobile LNG is targeting the **Virtual Gas Pipeline** (VGP) to **replace just 25%** of the diesel consumed in Australia. This scale of development will:

- Use 230 Petajoules of Australian Gas
- Produce 4 m Tonnes of LNG
- Replace 5.7 b litres of imported diesel
- **Reduce CO2 emissions by more than 3.2m Tonnes**
- **Reduce fuel imports by almost $4.5b**
- Generate a whole new industry in Australia around Domestic LNG
Mobile LNG

Objectives
+
Experience
+
Services
Mobile LNG

Mobile LNG Pty Ltd (MLNG) is an Australian company dedicated to ensuring the Australian economy makes better use of its own natural gas resources through liquefied natural gas (LNG) as a replacement fuel for imported diesel.

The rest of the world is moving ahead fast with increasing use of LNG in the power and transportation sectors whilst Australia continues to import expensive diesel fuel and export our own LNG for other countries to benefit.

Mobile LNG is working to bring LNG as the new fuel for use within Australia to improve our environmental performance and to increase our energy security as well as provide a more cost effective fuel alternative to diesel.

Mobile LNG is planning to build the Virtual Gas Pipeline in Australia to make LNG available to businesses across the country.

Mobile LNG – it’s the future!
Mobile LNG experience

**Global experience** extending across the complete LNG supply chain:

- Gas Management
- LNG Production
- LNG Distribution & Storage
- Regasification & Refuelling
- Power Generation
- Engineering, Construction and Project Management

The skills and experience to deliver safely, reliably.
Assisting the transition

Mobile LNG provides Customer Assistance for:

• Technical evaluations to replace diesel with LNG for:
  - Power Generation
  - Transportation
  - Process
• LNG vs Diesel consumption estimates
• Safety and Environment Management assistance
• LNG Fuel cost saving estimates
• LNG conversion assistance
• LNG / Gas technology assistance
• Power Generation
Converting to LNG

Customer / User options are:

- Plan for new LNG equipment
- Replace old with new equipment at normal intervals
- Convert old equipment (consider age and condition)

Australia is being left out, new LNG capable plant and equipment is available, but…

- The US and Europe now have first choice
- China is manufacturing for internal use
- Australian demand for LNG equipment non-existent (LNG supply issue)
- Australia still seen as a diesel consumer
What is LNG?

Characteristics
+
Safety
+
Environment
Liquified Natural Gas – LNG

LNG is Liquefied Natural Gas

- When natural gas is cooled to -161°C it becomes a liquid
- The cooling process is called Liquification
- LNG consists mainly of methane, ~90%

600 to 1 volume ratio gas to liquid

- Makes transportation and storage much more efficient
- Better than CNG for transport efficiency and safety

LNG is produced for gas transportation where no pipelines exit.
Safety Aspects

Ignition
• LNG does not explode
• Narrow ignition area (Methane / Air mix 5% to 15%)
• High ignition temperature (> 500 °C)
• Slow flame rate in atmospheric pressure

Leaks
• Pipe leak environment is too “lean” for ignition
• Storage tank environment is too “rich” for ignition

Spills
• evaporate and disperse
• no residue
Environmental advantages

LNG Compared with Diesel produces:

- 25% less CO2
- 100% less Particulates
- 85% less Nitrous Oxides (NOX)
- 100% less Sulphur Oxides (SOX)
- Less noise in gas engines
The Benefits of Domestic LNG

Power Generation
+
Transportation (road, rail, marine)
+
Process heating (replace LPG)
Positive Impacts for a Prosperous Australia

Mobile LNG’s VGP Projects positively impact Australia’s:

- **Trade:** Cost reductions, Productivity Improvements, Competitiveness
- **Industry:** New Industry, New Activity, New Jobs
- **Security:** Improved Energy Self Sufficiency
- **Regional Development:** Reduced Cost of Living and Increased job opportunities
- **Environment:** Cleaner, Healthier Environment
The Benefits of LNG

Customer Benefits:

- Reduces **fuel costs** by 20% to 40%
- Reduces CO2 **Emissions** by 25%
- Reduces SOX, NOX, Noise and Particulates
- Increases **competitiveness** of Exports
- Increases **operating life** of equipment
- Reduces **maintenance** down time and costs
- Reduces **CapEx** on Developments
- Increases **profits** for business
- Improves **Health and Safety**
The Benefits of LNG

Australian Benefits:

- Reduces Diesel Imports
- Improves Australia’s energy security
- Increases value of Australian Gas Resources
- Increases Australian Employment Opportunities
- Increases Indigenous Employment Opportunities
- Increases competitiveness of Australian Exports
- Reduces CO² and other harmful emissions

Our VGP is the foundation of a national gas pipeline grid
Accelerating advantages for Australia with LNG use

Incentives
+
Policy direction
Accelerating Domestic LNG

Australian initiative required:

- Global oil companies are conflicted
- Domestic LNG will displace diesel imports
- Mobile LNG will provide relatively large scale LNG production for domestic consumption

Cost reduction incentives required:

Savings using LNG vs Diesel (Approx.):

- 40% fuel cost reduction (no rebate)
- 20% fuel cost reduction (with rebate)
Remote Power Case Study

Mobile LNG has extensive experience with Gas Power Generation for remote applications. Below is a general case study to compare diesel & LNG:

### DIESEL FUEL USE CASE:

**Typical Diesel Fuel Consumption Costs and Rates in the Annual Power Generation**

<table>
<thead>
<tr>
<th>Plant Size</th>
<th>Generation Type</th>
<th>Litres per kilowatt hour</th>
<th>Litres per Day</th>
<th>Daily Fuel Cost $</th>
<th>ANNUAL FUEL COST $</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.5 Mw</td>
<td>High Speed</td>
<td>0.256</td>
<td>3,076</td>
<td>$3,241</td>
<td>$1,182,941</td>
</tr>
<tr>
<td>5 Mw</td>
<td>High Speed</td>
<td>0.249</td>
<td>29,902</td>
<td>$31,502</td>
<td>$11,498,188</td>
</tr>
<tr>
<td>25 Mw</td>
<td>High Speed</td>
<td>0.244</td>
<td>146,434</td>
<td>$154,268</td>
<td>$56,308,000</td>
</tr>
<tr>
<td>100 Mw</td>
<td>Medium Speed</td>
<td>0.226</td>
<td>541,438</td>
<td>$570,405</td>
<td>$208,197,647</td>
</tr>
</tbody>
</table>

### LNG FUEL USE CASE:

**Typical Gas Fuel Consumption Costs and Rates in the Annual Power Generation**

<table>
<thead>
<tr>
<th>Plant Size</th>
<th>Generation Type</th>
<th>Kilojoules per kilowatt hour</th>
<th>Litres per Day</th>
<th>Daily Fuel Cost $</th>
<th>ANNUAL FUEL COST $</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.5 Mw</td>
<td>High Speed</td>
<td>9,500</td>
<td>4,556</td>
<td>$2,280</td>
<td>$832,200</td>
</tr>
<tr>
<td>5 Mw</td>
<td>High Speed</td>
<td>9,250</td>
<td>44,357</td>
<td>$22,200</td>
<td>$8,103,000</td>
</tr>
<tr>
<td>25 Mw</td>
<td>High Speed</td>
<td>8,800</td>
<td>210,997</td>
<td>$105,600</td>
<td>$38,544,000</td>
</tr>
<tr>
<td>100 Mw</td>
<td>Medium Speed</td>
<td>7,900</td>
<td>757,673</td>
<td>$379,200</td>
<td>$138,408,000</td>
</tr>
</tbody>
</table>

### COST BENEFIT OF USING LNG TO REPLACE DIESEL, IN POWER GENERATION SUMMARISED

<table>
<thead>
<tr>
<th>Plant Size</th>
<th>As % of Diesel Costs</th>
<th>In Daily Fuel Cost Savings</th>
<th>Cumulative Cost Benefit Per Annum</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.5 Mw</td>
<td>30%</td>
<td>$961</td>
<td>$350,741</td>
</tr>
<tr>
<td>5 Mw</td>
<td>30%</td>
<td>$9,302</td>
<td>$3,395,188</td>
</tr>
<tr>
<td>25 Mw</td>
<td>32%</td>
<td>$48,668</td>
<td>$17,764,000</td>
</tr>
<tr>
<td>100 Mw</td>
<td>34%</td>
<td>$191,205</td>
<td>$69,789,647</td>
</tr>
</tbody>
</table>
Regulatory Support

Domestic LNG can improve environmental performance, promote regional development without pushing costs up.

Positive regulatory measures and support include:

• Move to Clean Ports with introduction of MARPOL’s Sulphur Emissions Controlled Areas (SECA’s) regulations

• Support the transition of Remote Community Power generation from Diesel to LNG

• Support the transition of urban and inter-urban public transport and freight networks from Diesel to LNG

• Adjust the Diesel Fuel Rebate scheme to increase the incentives to transition from diesel to cleaner LNG
Research and Development

Domestic LNG also provides opportunities for local research and development.

Recent discussions with Adelaide University for a joint research centre to explore new fuel opportunities:

- "Drop-In Fuels"
- Hydrogen
- Bio LNG (Renewables)
- Hybrid solutions
- other new ideas ????

Mobile LNG is keen to establish and promote these R&D links to keep Australia at the cutting edge of technology development.
Domestic LNG for Economic Growth and Energy Security

- **Trade:**
  Cost reductions, Productivity Improvements, Competitiveness

- **Industry:**
  New Industry, New Activity, New Jobs

- **Security:**
  Improved Energy Self Sufficiency

- **Regional Development:**
  Reduced Cost of Living and Increased job opportunities

- **Environment:**
  Cleaner, Healthier Environment
THANK YOU!

Mobile LNG Pty Ltd
mobileLNG.net.au

Australia’s Energy Future