Small Scale LNG
Emerging Technologies for Small-Scale Grids

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DataFusion Associates

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We offer a wide range of services:

• Strategic consulting
• Business and Project Development (feasibility studies, business case)
• Project Management
• Asset development & enhancement
• Due diligence
• Financial advisory services
• Organizational Development

Whilst focused on Asia and based in Singapore, we have a presence in the cities of Beijing, Melbourne, and London.

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The traditional LNG business model

- **Integrated model**
  - Production/transportation and storage
  - Long term offtake agreements

- **New model emerging**
  - Integration within a country
  - Local production
  - More suppliers
  - Transportation by ship, truck, train
  - Delivery to a single end user
  - Many more buyers
  - Simpler lower cost infrastructure
  - Still underpinned by long term offtake agreement
LNG Trade Flow

- **LNG Production**
  - Small Scale (<1 mtpa) [100+ Plants]
  - Large Scale (2-8 mtpa) [34 Plants]

- **Vessels** [478 LNG Carriers]
  - Trains
  - Floating Terminal [25 Terminals]
  - Onshore Terminal [101 Terminals]

- **Power**
  - Base Load
  - Industry
  - Domestic

- **Emerging Market**
  - Transport
    - Ships
    - Trucks
Example of small/medium scale LNG market

- Large scale LNG – Snohvit 4.1 million tonnes/annum
- Small Scale LNG- 15,000 tpa at Tjeldbergodden, Norway + 3 more
  - 28 small LNG terminals
  - Small scale storage
  - Feeder vessels – 7,500 – 20,000 cu.m
  - Small LNG carriers – 1,100 – 10,000 cu.m
  - Trucks 20-40 tonnes
  - Rail tank cars – 60-100 tonnes
  - Pipelines
  - 7 LNG bunker terminals

- Customers
  - Industry
  - Power
  - Trucking companies
  - Ferries
  - Offshore service vessels/Coastguard

China market developing along these lines, Indonesia could be next
What do we mean by small scale?

- Conventional LNG – 3-7 million tonnes per annum trains
- Mini size 20 – 100 tonnes/day
- Small size 100-500 tonnes/day
- Mid size 500 – 3000 tonnes/day

32 million tonnes per annum

10 tonnes per day
What do we mean by small scale?

Singapore LNG terminal – 11 mtpa

Nynashamn LNG terminal 0.25 mtpa

Large bullets
760 cu.m
What do we mean by small scale?

Conventional LNG carrier – circa 145,000 m³
Q Flex 220,000 m³
Q Max 244,000 m³

Small LNG carriers
• Coral Methane 7,500 m³
• Coral Energy 15,600 m³
What do we mean by small scale?

Trucks
Trains
Ships
Iso tanks
China

- 20 LNG receiving terminals
- 4 small scale LNG terminals
- 100+ small scale liquefaction plants
- 5 million NGV’s
- 250,000 LNG fuelled trucks
- 3,300 LNG service stations
- 10,000 LNG trucks
- 106 inland river LNG fuelled vessels
Substantial large scale infrastructure to support emerging small scale – many supply hubs.
Indonesia

Note the small volumes in the blue boxes

West Java FSRU 400 mmuscfd
Kupang 5 mmuscfd

Source: SKK MIGAS
25 floating terminals in operation
FSRU storage capacity ranges from 125,000 to 263,000 cu.m. but most about 170,000 cu.m.
These too big to support many of the emerging gas to power opportunities
Need some small/medium size FSRU’s
First small scale floating terminal

Separate Floating Storage Unit and Floating Regasification Unit (0.5 mtpa)
Benoa, Bali
Small scale LNG value chain

More complex than large scale value chain – more options
Small scale can be relatively expensive

Small is relatively expensive:
- Conventional 170,000 m³ LNG carrier – approx US$210 million
- Mid scale 30,000 m³ LNG carrier (Type C) – approx US$105 million
- Small scale 12,000 m³ LNG carrier (Type C) – approx US$50 million
How do costs compare with conventional LNG

Higher unit costs than for large scale LNG

• Costs more to transport a cubic metre of gas in a small carrier compared with a large carrier

• Costs much more to store a cubic metre of LNG in a small bullet than a full size terminal tank

BUT

• Small or midscale does not need to be more expensive if concept is properly chosen around cost optimisation, considering logistics, technologies and if possible existing available infrastructure or natural shelter.
Small and mid scale v conventional

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Optimization

Optimization of logistic chain cost can bring advantage in the order of $0.5/MMBtu. This may include:

• Storage minimization

• Utilisation of existing key infrastructure such as berths.

• Slower steaming of LNG carriers – sailing at 10 knots rather than 14 knots can result in a 70% fuel saving.

• Maximisation of LNG carrier utilization – sharing with other projects

• LNG supply within a range of approximately 1,000 nautical miles for small scale and less than 2,500 nm for midscale.
SNG™ Barge with 6000m³ Storage 20-30mmSCFD

SNG™ Barge with 3X 2270m³ (100%) Storage Regas Capacity Modular : From 3-30mmSCFD Gas Engine for Power Generation on Board 8-52barg.

Source: INCITIAS

Draught<4m, LOA=100m, B=33m, Loading rate 800m³/hour
IMO-IGC, SIGGTO, ISGOTT, ISO and ASME Standard compliant.
SNG Barge™ 30-110mmSCFD for use with FSU

Source: INCITIAS
SNG™ Barge with 8X 2100m³

SNG™ Barge with 8X 2100m³ (100%) Storage Regas Capacity Modular: From 3-75mmSCFD Gas Engine for Power Generation on Board 8-52barg.

Draught<4m, LOA=120m B=36m, Loading rate 1200m³/hour IMO-IGC, SIGGTO, ISGOTT, ISO and ASME Standard compliant.

Source: INCITIAS
Shallow Water Multi Modal LNG distribution

- 3x 2270m³ LNG storage in C-type tank
- Transhipment on Barge to 20” and 40” ISO Container, to enable sub distribution
- Draught 3.4m
- L=95m
- B=30m
- Speed: 8kn-10kn
- Tug Push or Pull
- Can moor and offload to standard 6000DWT wharfs available in most south east Asian island ports
- Optional: Articulated Tug Barge solution.

Source: INCITIAS
Large Scale to Small Scale Regas Comparison

Assumption 20 year Design life, within Tropic of Capricorn

Jetty CAPEX 65-85 million
~3-4.5 cent/MMBtu

Onshore Regas 750mmSCFD
90-150 million
16-25 cent/MMBtu

Onshore Storage 180K
160-220 million
8-12 cent/MMBtu

Onshore Power
Generation 25 million
1.5-2.5 cent/MMBtu

Infrastructure
(breakwater/access,
routes, dredging, ETC)
50-200 million
25-100 cent/MMBtu

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75mmSCFD Onshore Regas

53.5 cents - $1.44 per MMBtu

75mmSCFD Std. Small Scale Regas

53.5 cents per MMBtu

75mmSCFD Optimized Shallow Water Regas Barge

53.5 cents per MMBtu

Based on a real project in Indonesia (with execution currently on hold) with local infrastructure provider based on turnkey pricing firm quotation and in country barge construction to meet local content with design done by reputable engineering house and reputable cryogenic equipment vendor and construction supervision accuracy +/-20% as BOOT contact.
Last word

• Small may be beautiful but it can also be high cost. First movers found it very difficult to find economically viable solutions

• Now, after much R&D, we have a good suite of economically viable solutions but challenges remain

• However, if one selects the right technology based on the site and local requirements and optimise around the logistic chain, minimise storage and avoid costly infrastructure developments (such as extensive capital dredging, construction of breakwaters) and by smart selection of site, technology and contracting strategy (say BOOT or EPCM, but also lease) then small scale LNG project economics can be low enough to enable gas to be supplied to even the smallest power plants

• Optimise the entire supply chain and scale equipment to the demand and unit costs can be comparable with large scale – 53 cents/MMBtu

• We now have economically viable solutions for the small scale market