Opportunities and Challenges of Using LNG as Fuel in Small- to Medium-Size Power Generation

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LNG Can Be an Attractive Alternative Fuel for Small-Scale Oil-Fired Power Generation

• In many power markets, heavy fuel oil and diesel are used as primary fuel sources for small-scale power generation

• High fuel costs lead to high power cost, and have a negative impact on local economies

• LNG is a potential alternative fuel – but need to solve challenges of:
  – Logistics
  – Supply source
  – Commercial structure
Case Study
Central America & Caribbean Region
Power Generation Facilities Tend to Be Relatively Small

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<th>Area</th>
<th>45 - 100 MW</th>
<th>100 - 200 MW</th>
<th>200 - 300 MW</th>
<th>300 - 400 MW</th>
<th>400 - 500 MW</th>
<th>500 - 1000 MW</th>
<th>&gt; 1000 MW</th>
<th>Total</th>
<th>Power Generation Capacity (MW)</th>
<th>Potential LNG Volume (MTPA)</th>
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</table>

~ 80% of Facilities
~ 50% of Installed Capacity
Switching to LNG Delivers Several Key Benefits

• Reduced environmental impact
  – Lower carbon footprint and emissions
  – Reduced opacity

• Lower operating costs
  – Reduced maintenance expenses
  – Potential for higher generation efficiencies
  – Potentially cheaper fuel than HFO or Diesel

• Fuel supply diversity
  – Mitigates risk of potential refinery strategy changes
  – New source of fuel to replace/complement fuel oil
  – Platform for additional natural gas uses
Price Spread Between Gas Price & Fuel Oil Offers Significant Switching Incentives

Gas Prices vs. Diesel and Heavy Fuel Oil

* Projections based on 3/19/2013 NYMEX forward curve for Henry Hub and Brent
Challenges with “Standard Scale” LNG Logistics Have Hindered Progress

• Shipping logistics
  – Deep water access
  – Tug support & other port services

• Terminal siting & costs
  – Land requirements & availability
  – High Working Capital
    • ~ 125 days of inventory per cargo for 150 MW plant
  – High up-front CAPEX
  – High terminal unit cost can absorb much of the spread
    • 150 MW Plant: LNG requirement ~24,000 MMBtu per Day
    • LNG Terminal CAPEX: $250 MM (Simple) to $500 MM (Complex)
    • Terminal Unit Cost Estimate: $4.30/MMBtu to $8.20/MMBtu
Small/Mid-Scale LNG Solutions Address Logistical Challenges

• Small-scale ships or barges
  – Reduce fuel inventory working capital
  – May be able to use existing port facilities

• Small Terminals (onshore or floating)
  – Lower CAPEX
  – Smaller footprint
  – Lower Unit Cost
But, Finding Near-term LNG Supplies Continues to Be Challenging

• Access to “global” LNG market is limited
  – Opportunities generally too small for “traditional” suppliers
  – Liquefaction plants reluctant to accommodate small ships
  – Competing with traditional Asian and European markets

• New regional small/mid-scale LNG plants are being developed and are targeting regional rather than global markets

• Potential for “Hub & Spoke” terminals to unload full-sized cargoes and redistribute via smaller ship/barge(s)
Question Remains How to “Allocate” Potential Fuel Savings Amongst Stakeholder

Gas Prices vs. Diesel and Heavy Fuel Oil

* Projections based on 3/19/2013 NYMEX forward curve for Henry Hub and Brent

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Interests of Multiple Stakeholders Must Be Addressed to Implement Small-Scale Project

**LNG Buyer**
- Fuel cost savings to lower power prices
- Security of fuel supply
- Justify conversion/newbuild to natural gas

**LNG Supplier**
- FOB Netbacks no worse than primary alternative markets
- Credit quality customers
- Ability to integrate into existing supply chain

**"Integrator"**
- "Glues the pieces together"
  - Originates, structures, and coordinates commercial and technical arrangements
  - Can be any one of the stakeholders, or a 3rd party developer

**Infrastructure Provider(s)**
- Adequate returns
- Term agreements to support financing
- Credit quality
Case Study
Direct Distribution vs. Hub & Spoke Model

Direct Distribution from USGC Plant

Hypothetical U.S. Small/Mid-Scale LNG Export Project
Case Study
Direct Distribution vs. Hub & Spoke Model

Hub & Spoke

Hypothetical U.S. Small/Mid-Scale LNG Export Project
Hypothetical Regional Transshipment Terminal
One of the Challenges for the Hub & Spoke Model is Achieving Sufficient Scale

• High development & timing risk
  ➢ Potential significant equity risk – “build it and they will come”
  ➢ Development risk and timing – “line up the dominoes”

### Est. Hub Cost

![Graph showing estimated hub cost vs. aggregated load requirement in MW.](image)
Hub vs. Direct Deliveries Examples: Streamlined Logistical Costs

~ 15% Substitution Value Improvement

300 MW Diesel Plant
500 nm from Hub; 2,000 nm from Liquefaction Plant
Hub “at Scale” (1,000 MW)
Although Streamlining Logistics is Important, Real Value Driver is Cost of Fuel

300 MW Plant
500 nm from Hub; 2,000 nm from Liquefaction Plant
Hub “at Scale” (1,000 MW)
Key Takeaways

• LNG can become the “fuel of choice” for many small power generators currently burning HFO and Diesel

• But need to solve several issues
  – Logistics: Small/Mid-scale LNG shipping and terminal solutions are readily available and can be economic
  – Supply Sources: Small-scale liquefaction and “hub” projects under development to serve smaller fuel-oil substitution markets
  – Commercial Structure: Interest of multiple stakeholders need to be aligned and substitution value shared \(\rightarrow\) Need for Integrator
Thank you!

GALWAY GROUP LP
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