Techno-economic analysis of virtual gas pipeline: LNG on wheels

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Disclaimer:

• The contents of this presentation are based on study performed by Dr. Nawaz Ahmad in an individual capacity
• Presented in Gastech 2020
• Neither SAARC Energy Centre nor my employer is responsible for any statement, findings or results of this study
• The outcomes of this study are not any project specific but very generic in nature
Presentation Contents

• Introduction
  o Gas transport options (pipeline Vs LNG containers)

• Study results
  o Base-case model
  o Sensitivity analysis
  o Diesel Vs LNG powered Truck Fleet
Gas transport: LNG import terminal to the consumers

**Pipeline**
- High capital cost
- LNG is re-gasified at the terminal
- Gas is supplied to the consumers through pipeline network
- Non-scalable
- Limited to consumers En-Route

**LNG Tankers (virtual pipeline)**
- Less capital cost
- LNG is transported in road tankers/ train
- LNG is stored and re-gasified at the consumer premises
- Easily scalable
- Flexible access
Virtual Pipeline

• Components of virtual pipeline
  o Truck loading facility at LNG import terminal
  o Tankers’ fleet
  o Satellite storage and regasification facilities at consumers premises
## Reference Case Study

### Transport of LNG from Pennsylvania to Massachusetts (570 km)

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Mode-1</th>
<th>Mode-2</th>
<th>Mode-3</th>
<th>Transport Cost (US$/MMBtu)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Truck</td>
<td>Truck (MC-338)</td>
<td>---</td>
<td>----</td>
<td>0.85</td>
</tr>
<tr>
<td>Truck</td>
<td>Truck (ISO)</td>
<td>---</td>
<td>---</td>
<td>0.85</td>
</tr>
<tr>
<td>Intermodal</td>
<td>Truck (ISO)</td>
<td>Rail (ISO)</td>
<td>Truck (ISO)</td>
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<tr>
<td>Rail</td>
<td>Rail (DOT-113C120W)</td>
<td>Truck (MC-338)</td>
<td>---</td>
<td>0.64</td>
</tr>
</tbody>
</table>

Ref: US DOT, 2019 _Risk Assessment of Surface Transport of Liquid Natural Gas_
Base-Case Modeling
### Base-Case Input/parameters

#### Base-Case Test Variables

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>LNG supplies (MMCFD)</td>
<td>50-600</td>
</tr>
<tr>
<td>One-way distance (km)</td>
<td>50-1,000</td>
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</tbody>
</table>

#### Financial Parameters

<table>
<thead>
<tr>
<th></th>
<th>Equity</th>
<th>Debt</th>
</tr>
</thead>
<tbody>
<tr>
<td>Equity IR (%)</td>
<td>19.25%</td>
<td></td>
</tr>
<tr>
<td>Debt IR (%)</td>
<td>18.85%</td>
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</tr>
<tr>
<td>DES price (USD/MMBtu)</td>
<td>6</td>
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<tr>
<td>Marketing margin (USD/MMBtu)</td>
<td>2.42</td>
<td></td>
</tr>
<tr>
<td>Project life (years)</td>
<td>15</td>
<td></td>
</tr>
</tbody>
</table>
Truck Fleet

Truck Fleet

- 250 km
- 500 km
- 750 km
- 1000 km

Number of Trucks vs. Gas sales (mmcfd)

Truck Loading Frequency

- 250 km
- 500 km
- 750 km
- 1000 km

Loadings per day vs. Gas sales (mmcfd)
Transport Opex

Transport Boil-Off Opex

Transport Opex

Management Opex

Total Opex
Project IRR and Pay-back Period

**Project IRR (%)**

- 250 km
- 500 km
- 750 km
- 1000 km

**Gas sales (mmcfd)**

**Project Discounted Pay-Back Period**

- 250 km
- 500 km
- 750 km
- 1000 km

**Years**
Sensitivity Analysis
Sales Margin Sensitivity

Project IRR (%) Vs Sales Margin (Distance 1000 km)

- 2.00
- 2.25
- 2.75
- 3.00

Gas sales (mmcf/d)

0% 10% 20% 30% 40% 50% 60%
100 200 300 400 500 600
Diesel Vs LNG Operated Trucks
Diesel Operated Trucks

LNG Operated Trucks

![Project Discounted Pay-Back Period](#)

- 250 km
- 500 km
- 750 km
- 1000 km

Years

Gas sales (mmcfd)

0.0 0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5

0 100 200 300 400 500 600
Key take-away

• Gas supply through LNG tankers is a flexible (scalable) and competitive alternative of pipeline (non-scalable)

• LNG fueled trucks are more economical and less pollutant than Diesel ones, particularly for long haul distances

• Efficient operations of virtual pipeline requires precise project assessment and development
Many Thanks

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