Does (Train) Size Really Matter?

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Agenda – Does (Train) Size Really Matter?

- Introduction
- Purpose
- Big is Beautiful – Economies of Scale
- Small is New and Beautiful – Economies of *Unit* Scale
- Issues Discussed in the Paper
- Does it Really Matter?
- Conclusion and Acknowledgements
Introduction – Does (Train) Size Really Matter?

• Discuss liquefaction train size to achieve a certain facility size
  – Does the decision affect project economics (CAPEX or US$/tonne)?

• Following the past (or not): Is bigger always better?
  – Economies of Scale (EOS) vs.
  – Economies of Unit Scale (EOUS)
Is Bigger Always Better?

Sometimes, yes....
Is Bigger Always Better?

Depends on your needs.....
Is Bigger Always Better?

Yao Ming: 7’ 6”
Tallest Houston Rockets player, played 8 seasons in NBA and 5 seasons for the Shanghai Sharks in CBA

Mugsy Bogues: 5’ 3”
Shortest player in NBA history, played 14 seasons
Purpose – Does (Train) Size Really Matter?

- What can we deduce from the current list of potential LNG projects?
  - Large facilities with large trains
  - Large facilities with small trains
  - Small facilities with small trains
  - Etc.

- Facility sizes range from 2.0 to 27.0 Mt/a (13.5 to 1 ratio)
  - Train sizes of 0.25 to 7.0 Mt/a (28 to 1 ratio)
Purpose – Does (Train) Size Really Matter?

• What is the decision making behind trains size for projects of the same facility size?

• Why is there little to no alignment on train size and why do some projects appear to deviate from proven experience?

• Both large scale (LS) and small scale (SS) projects are “technically right”, but can both schemes hit their cost and schedule targets?
Big is Beautiful – Economies of Scale

- History has embraced EOS through 2015
- Post 2015:
  - LNG Canada
  - Golden Pass LNG
  - Others…
Big is Beautiful – Economies of Scale

Onshore Train Size Growth - Past, Present and Future

Train Capacity (Mt/a)

EPC Award Year

Existing and Committed Trains

Future Prospects
Big is Beautiful – Economies of Scale

• LS trains still have issues to consider:
  – Do we have diminishing returns as we get “too large”?
  – Can equipment size become too large: require designs in parallel?
  – How does complexity in design (e.g. piping) influence fabrication costs?

• Is LS at an inflection point where the momentum shifts away from EOS?

• From the Train Size Growth chart, we see two sides of the debate:
  – LS vs. SS (in this paper, SS includes “mid-scale”)

Small is New and Beautiful – Economies of Unit Scale

- EOUS seeks to find gains from the repeatability of multiple small units integrated over time to build up to a large capacity
  - Success in the power generation and nuclear industries (see references)
  - In Oil and Gas, benefits may be seen by the 3rd or 4th repeatable unit

- Seeks benefits offered by automation – if LNG design was a perfect science, could we press a button and then easily manufacture trains?
  - Requires excellence in fabrication, logistics, integration, & construction
  - Gains are achievable if you execute projects with precision
Small is New and Beautiful – Economies of *Unit* Scale

- Elba LNG
- VG CP LNG / PL LNG
- Driftwood LNG
- Cheniere CC Mid-Scale
- Magnolia LNG
- Texas LNG
- Woodfibre LNG
- Jordan Cove LNG
Issues Discussed in the Paper

• Liquefaction Process Technology Selection
• Construction and Modularization
• Sacrificing CAPEX for OPEX?
• Safety (e.g. Simultaneous Operations, SIMOPS)
• Operational Flexibility and Maintenance
• LNG Sales and Marketing (Commercial)
Does it Really Matter?

• Not really, but realistic execution plans do matter!
  – Moving from LS to SS is a huge change in project execution strategy
  – Projects are influenced more by civil & infrastructure than train size
  – Industry is parking decades of experience and now reinventing itself

• “Success lies in the familiarity in what you do”
  – a.k.a. “time in the saddle”
Does it Really Matter?

• Heed the advice from Independent Project Analysis (IPA):
  – Schedule pressure dooms more megaprojects than any other [factor]
  – Projects routinely skimp on the front end – “speed kills projects”
  – Taking risks with megaproject schedules is a fool’s game
Does it Really Matter?

- Little correlation of facility size to train size
  - Data from LNG Journal, Nov/Dec, 2018
- Many believe in LS
- Many believe in SS
Conclusion - Does (Train) Size Really Matter?

- Both sides have valid points to support LS or SS based facilities
  - Estimating assumptions will heavily influence if EOUS can beat EOS
- Parallel production should not put additional cost/risk into the project
  - “Mass produced and modular” is challenging for the first few projects
- No clear answer until SS projects are delivered
- US$ / tonne is not a good key performance indicator (KPI) of the health of a project prior to FID:
  - Certainty of outcome is determined by a realistic execution plan
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