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

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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)

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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)

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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?

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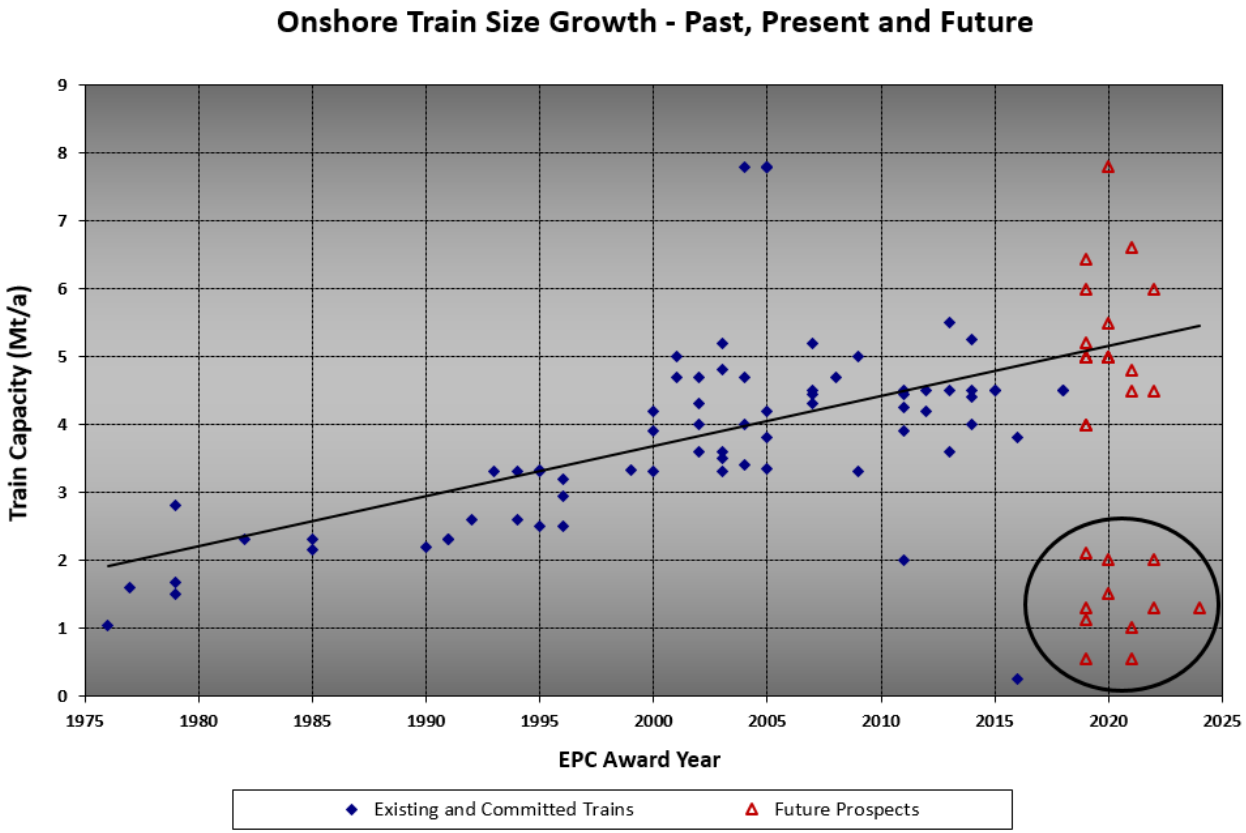
Big is Beautiful – Economies of Scale

- History has embraced EOS through 2015
- Post 2015:
  - LNG Canada
  - Golden Pass LNG
  - Others…

SEGAS LNG, 5 Mt/a Single Train

Big is Beautiful – Economies of Scale



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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”)

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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

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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

Image with permission: KBR FEED work done for Stage 3 of Cheniere Corpus Christi LNG

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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”

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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

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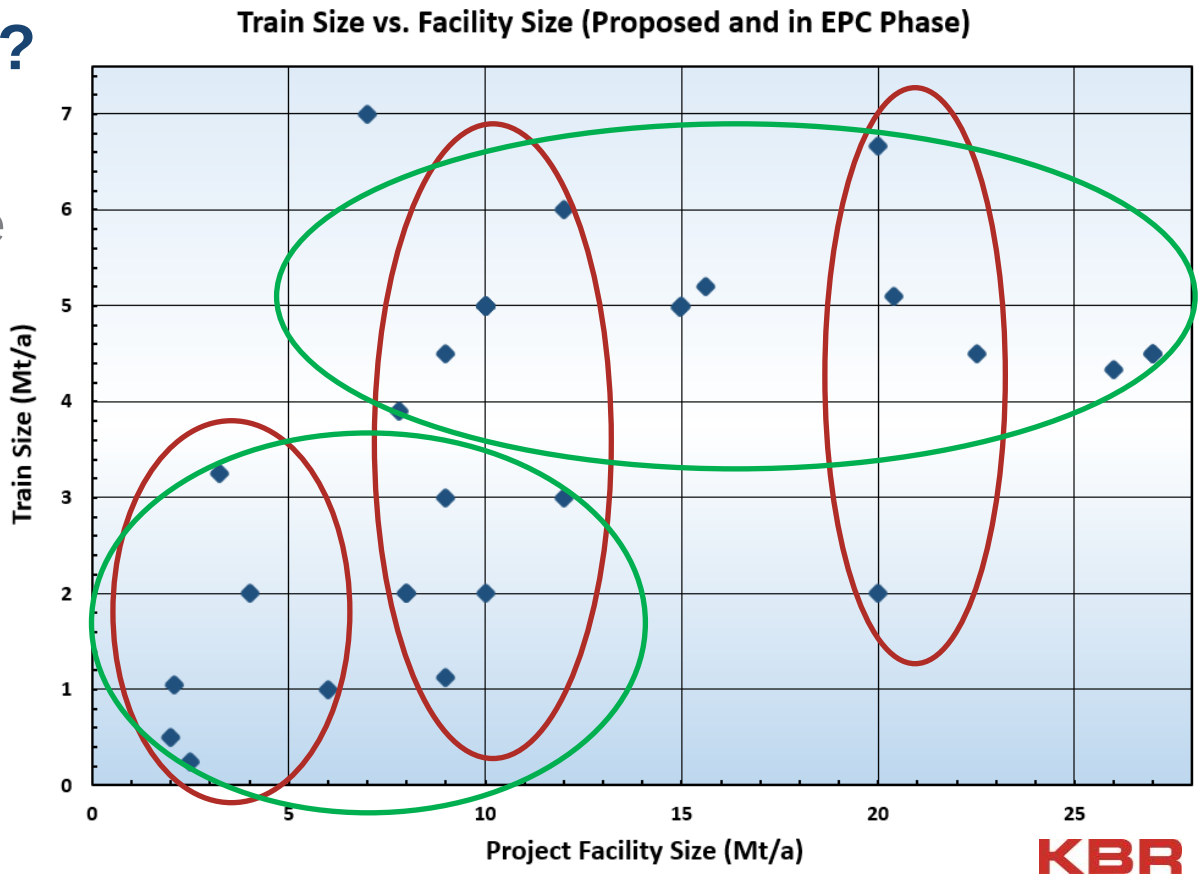
Does it Really Matter?

- Little correlation of facility size to train size
  - Data from LNG Journal, Nov/Dec, 2018
- Many believe in LS
- Many believe in SS



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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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