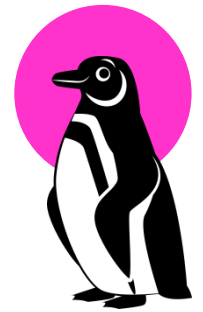


# What makes FSRU Projects Economic?



PENGUIN ENERGY  
CONSULTANTS LTD



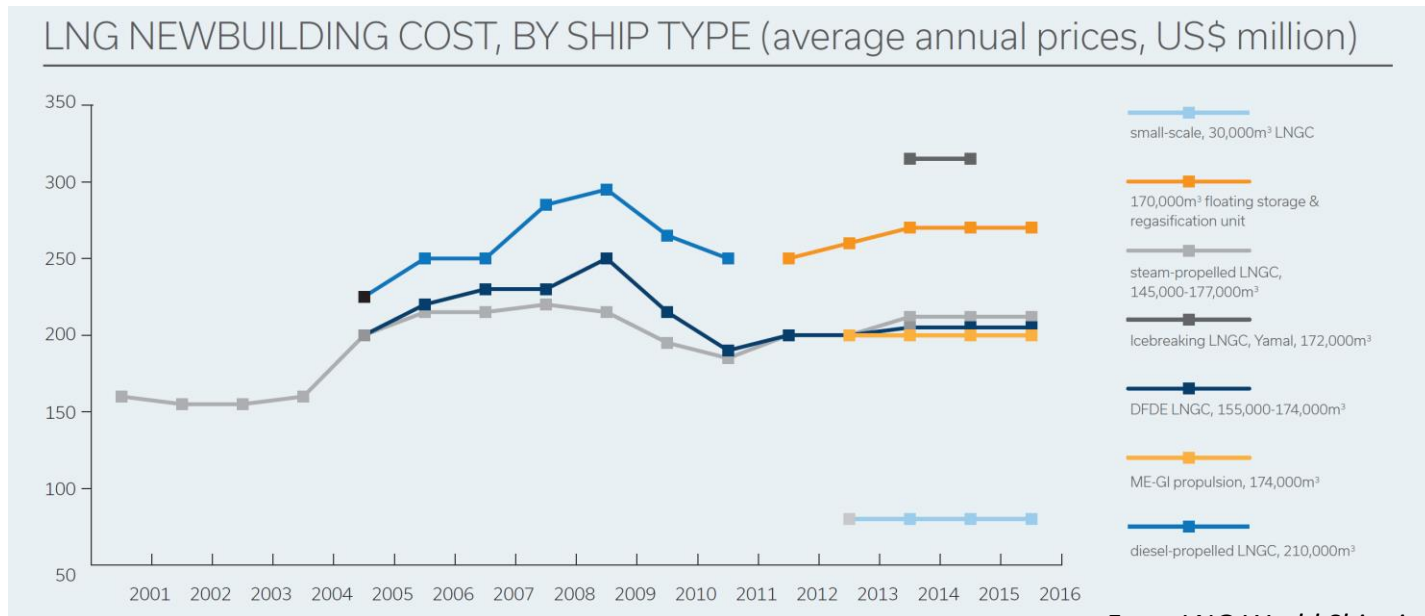
# Why FSRUs?

- Everyone wants LNG!
- Actually people want electricity and gas to power is fastest
- Why FSRUs?
- Perception that they are
  - faster to market
  - cheaper to install
- than conventional onshore terminals



# FSRUs cost drivers

- Complex ships
  - Shipbuilding cost model rather than process plant
  - Ship building costs relatively static
  - Known quality and no local content/skills issues
- Easier to finance
  - Relocatable to other projects
  - Can trade if no import terminal work
- Competition
  - 3 usual suspects have become 4
  - Many trying to enter the market



From LNG World Shipping Nov/Dec 2016

# Are FSRUs good or import terminals bad?

## Import terminal

- Normal scope
  - Dredging/harbour works
  - Marine facility/jetty
  - LNG storage tanks
  - LNG pumps and vaporisers
  - Fiscal metering
  - Utility systems
  - Pipeline connection to gas user

**FSRU does not equal a shipyard unit**



## FSRU

- Normal scope
  - LNG storage tanks
  - LNG pumps and vaporisers
  - Fiscal metering
  - Utility systems
- Who does?
  - Dredging/harbour works
  - Marine facility/jetty
  - Fiscal metering
  - Pipeline connection to gas user

# How much do FSRUs really cost?

- Very location and use specific
- FSRUs are common in developing markets for power generation
- How much gas does power generation need?
  - Now
  - In the future
- Where is the power generation required?
  - Centrally
  - Distributed (by pipe or by wire)





# Case study

- Xanadu has been producing gas for many years but now existing gas production is declining
- Exploration for new reserves is underway but with a 8-10 year lead time to production (if reserves are there)
- Economy growing – more power required for industry (and everyone wants a mobile phone)
- Traditional power sources (hydro) too slow to develop and environmental impact high
- Need soft loans or grants to develop country – coal doesn't attract these
- Poor creditworthiness of government owned utilities
- FSRU looks like just the job!



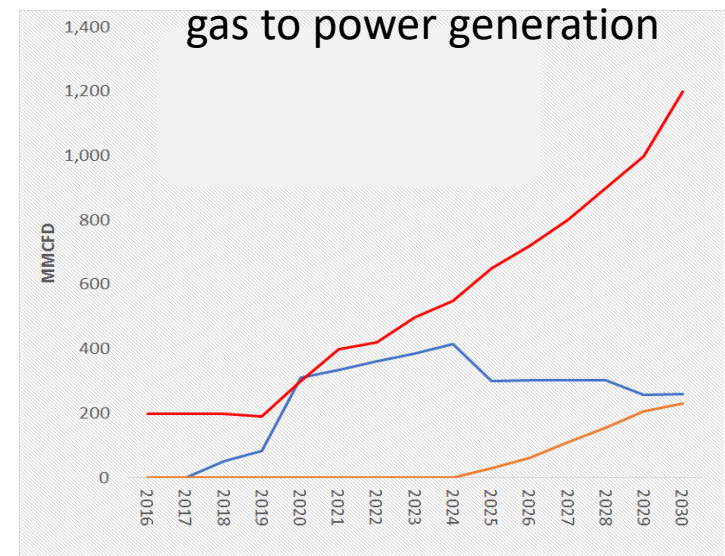
# Host nation issues

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- Creditworthiness
  - They are not – how do they afford permanent LNG?
  - For a FSRU substantial debt is not required - can pay monthly!
- Contract longevity
  - Not sure – FSRUs can be hired for short periods
- Nationalisation
  - May want it but economy more important
- Control
  - Something has to happen now – can give up some control for that
  - But politicians need to be seen to be doing something (schedule) and get re-elected (need benefits)
- Permitting system
  - Offshore oil and gas system can be adapted

# Risk

- Is the power generation growth known sufficiently well?
  - 2 GW around the capital
  - 500 MW around the capital and 500 MW in the east
  - 1 GW around the capital, 500 MW in the east and 500 MW in the north
- What is the timescale for operation – now to when?
- Multiple sites and strategies need to be examined



CCGT MW	Gas mmscfd	LNG mtpa
2000	254	1.8
1000	139	0.9
500	76	0.5



# What most people want to sell you

## The traditional model

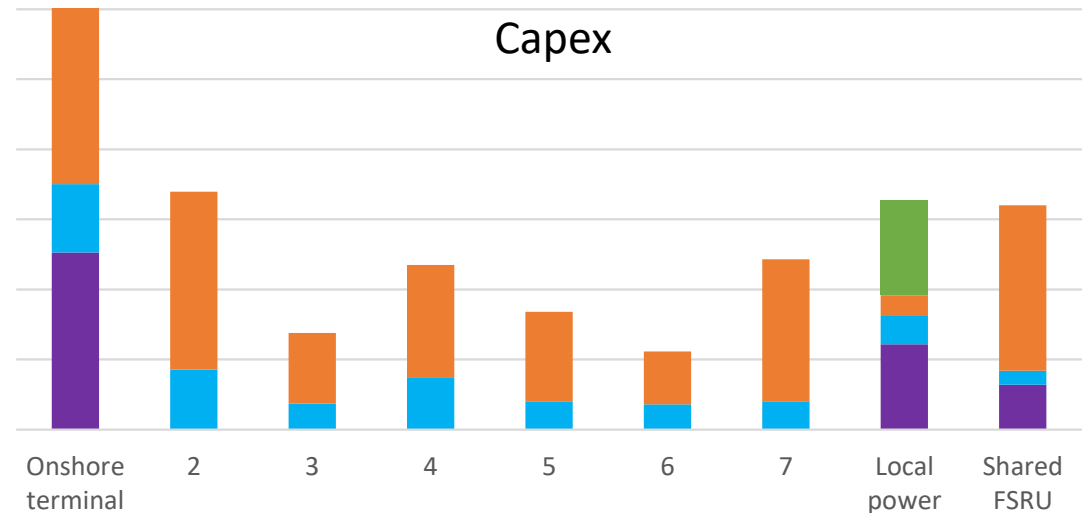
- Industry has standardised on FSRU sizes – primarily 173,000 m<sup>3</sup> for new builds
- Is this not enough or too much?
- Not a technical question
- FSRU needs to be the same size or preferably larger than the LNGC supplying it
- Where is the LNG coming from?
- Latest LNGCs are 175 – 180,000 m<sup>3</sup>
- Delivered annual capacity could be very large (3- 5 mtpa)



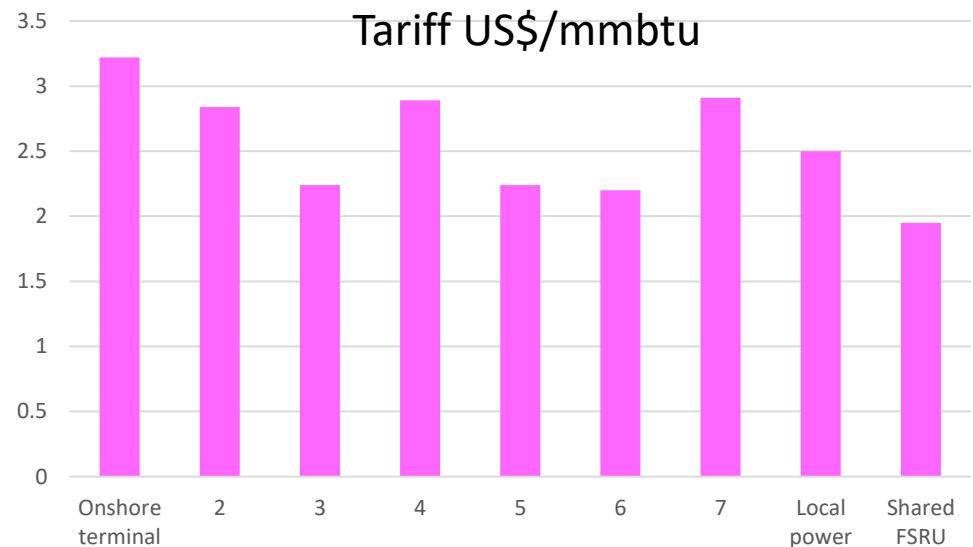
- 173,000 m<sup>3</sup> FSRU
- 100 – 1200 mmscfd seawater vaporisers
- 294 m x 46 m x 26.5 m x 12.5 m
- 83,200 dwt
- DFDE engine capable of 18 knots

# Traditional economics

- 5 sites considered
- FSRUs have the advantage of low Capex
- Traditional onshore terminal looks poor
- Pipeline connection costs dominate – no deep water close to demand centre



- Capex advantage doesn't follow through into discounted economics
- FSRUs better than onshore terminal



**FSRU 3, 5 or 6 preferred**

# Xanadu conclusions

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- Timescales and uncertainty favour a floating solution
- Large FSRU gives lowest through life costs
- Three lower cost sites identified – two have short gas pipelines
  - FSRU 3 has significant social/environmental impacts
  - FSRU 5 is on a tower yoke mooring and more detailed availability studies required to confirm uptime
  - FSRU 6 requires a small breakwater
- FSRU 5 preferred
- But terminalling cost too high (>2 US\$/mmbtu)
  - Gas demand for power is too small to efficiently cover costs

# Are there other options?

## Hub and spoke models

- Import centrally and redistribute to multiple import facilities
- Is this still a FSRU?
  - Possibly if one market dominates
  - If it doesn't a converted LNGC (FSU) may be better as the hub
- Do FSRUs work as the spokes?
  - Maybe, but need to be small
  - Onshore terminals can be attractive when small

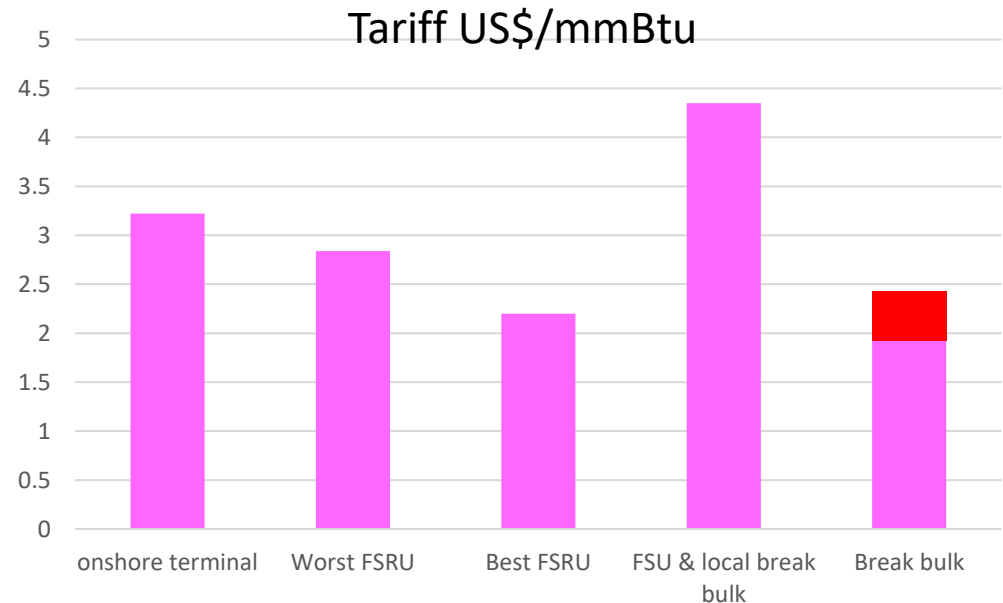
## Break bulking

- Do bulk LNG elsewhere
- Only looking at small parcel sizes
- Small LNGCs
- Do FSRUs still work?
  - Maybe, but need to be small
  - Onshore terminals can be attractive when small



# Case study economics

- Break bulking looks to be the preferred solution
- Final choice will be determined by the size of the terminalling cost at the regional LNG terminal
  - If low tariff then small ship supply from regional terminal is better
  - If high tariff then bulk import to a FSRU is better

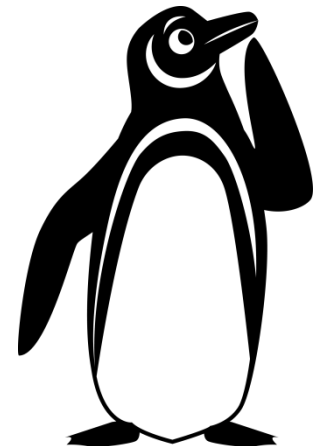


**Economics marginal**  
**Gas pipelines too long for small volume of gas required for power generation**

# Summary

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- Power generation needs small gas supplies
- Break bulking if terminally fee is low looks best
- FSRU looks best if terminalling fee is high or power generation grows
- FSRUs have many advantages
- A small FSRU can be replaced by a larger one when (or if) demand grows
- FSRUs alone are extremely cost effective
- Impact of the additional infrastructure required to get the gas to market can be significant and may overwhelm positive FSRU economics







# Thank you for your attention

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