


# 4<sup>th</sup> METI-EU Workshop

## Recent Trends in LNG Liquefaction Costs and Shipping



**Akos Losz**  
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Nagoya, Japan



# About Us



*Where the World Connects for Energy Policy*

CGEP's mission is to enable public and private sector leaders to make more informed choices about the world's most pressing energy issues by providing an independent and interdisciplinary platform for insights and data-driven analysis, convening and education, and actionable recommendations on the current and future global energy system.

# Agenda



## LNG Liquefaction Costs



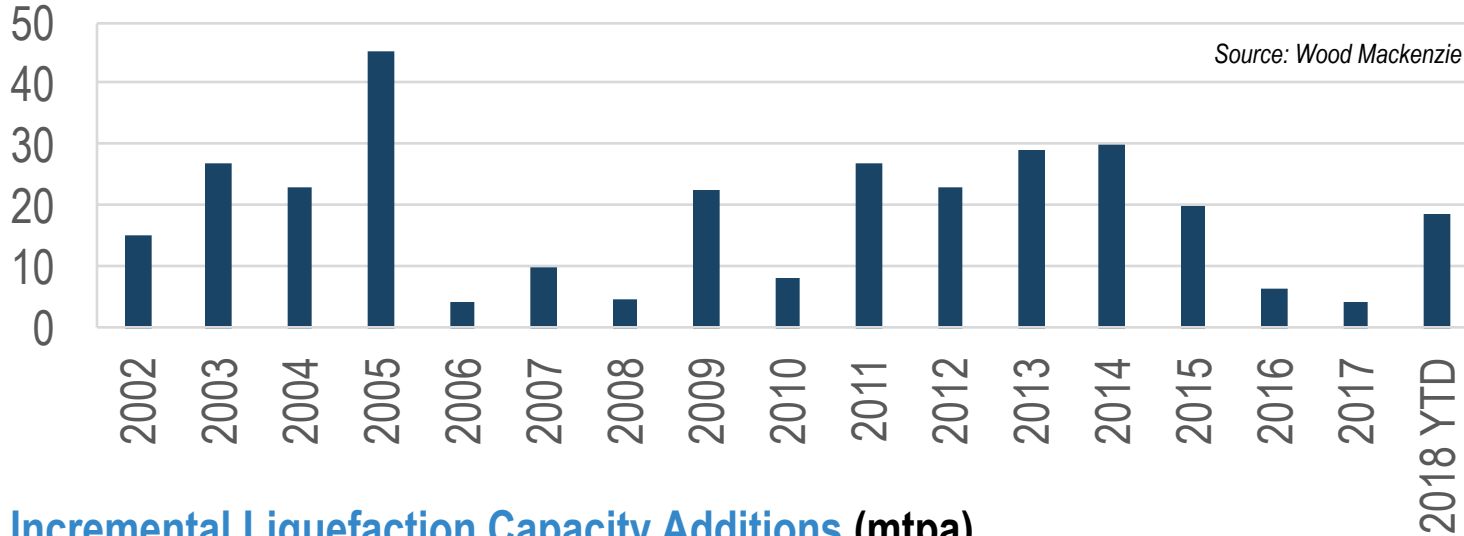
## Trends in LNG Shipping



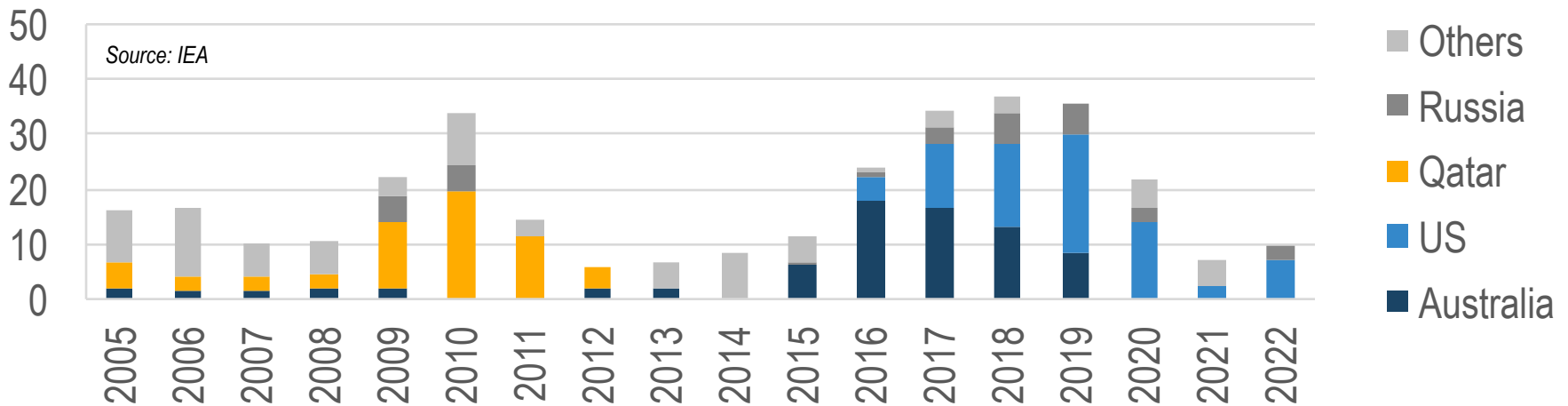
# LNG Liquefaction Costs

# The LNG Industry Is Highly Cyclical

## LNG Liquefaction Capacity Final Investment Decisions (mtpa)

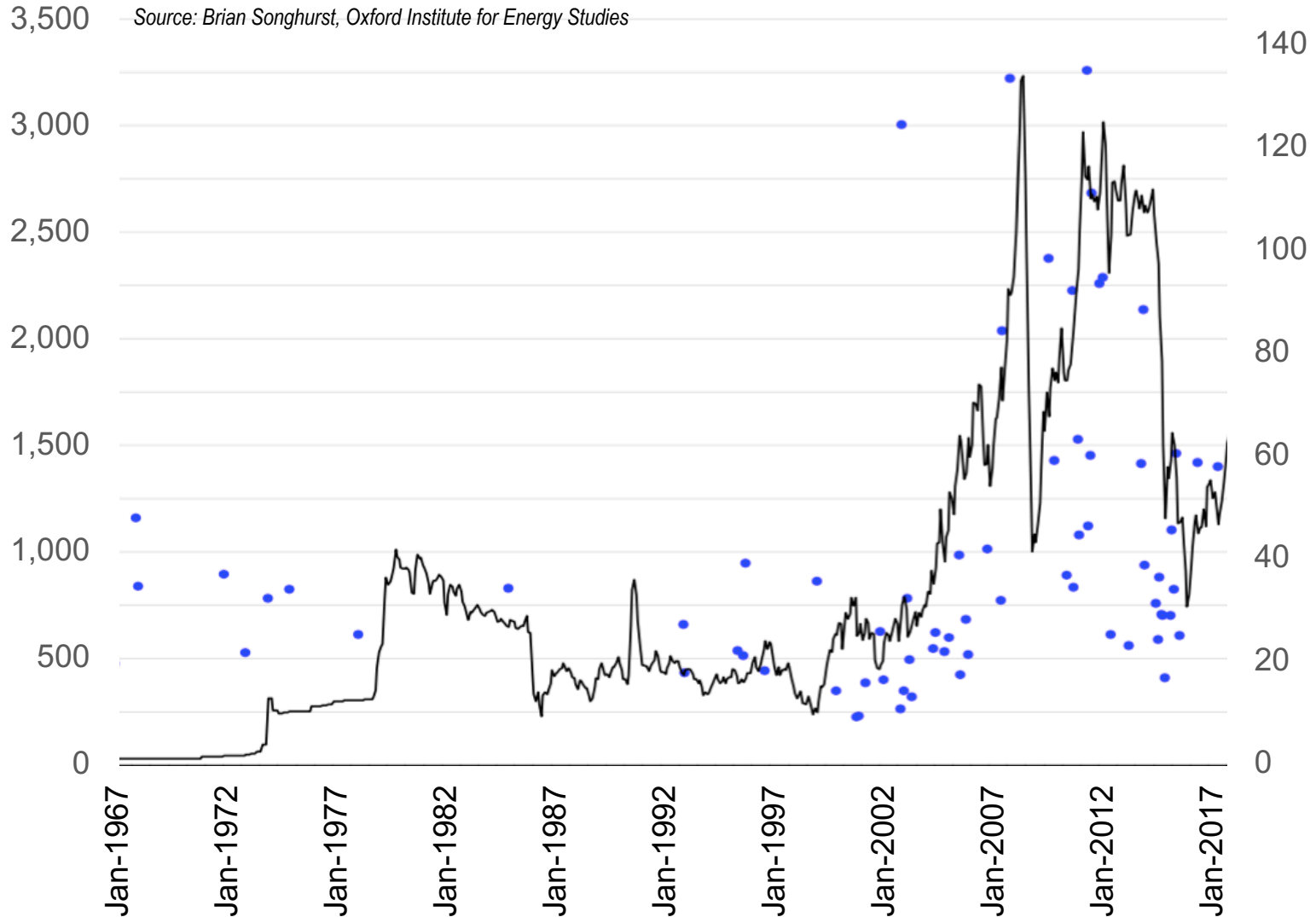


## Incremental Liquefaction Capacity Additions (mtpa)



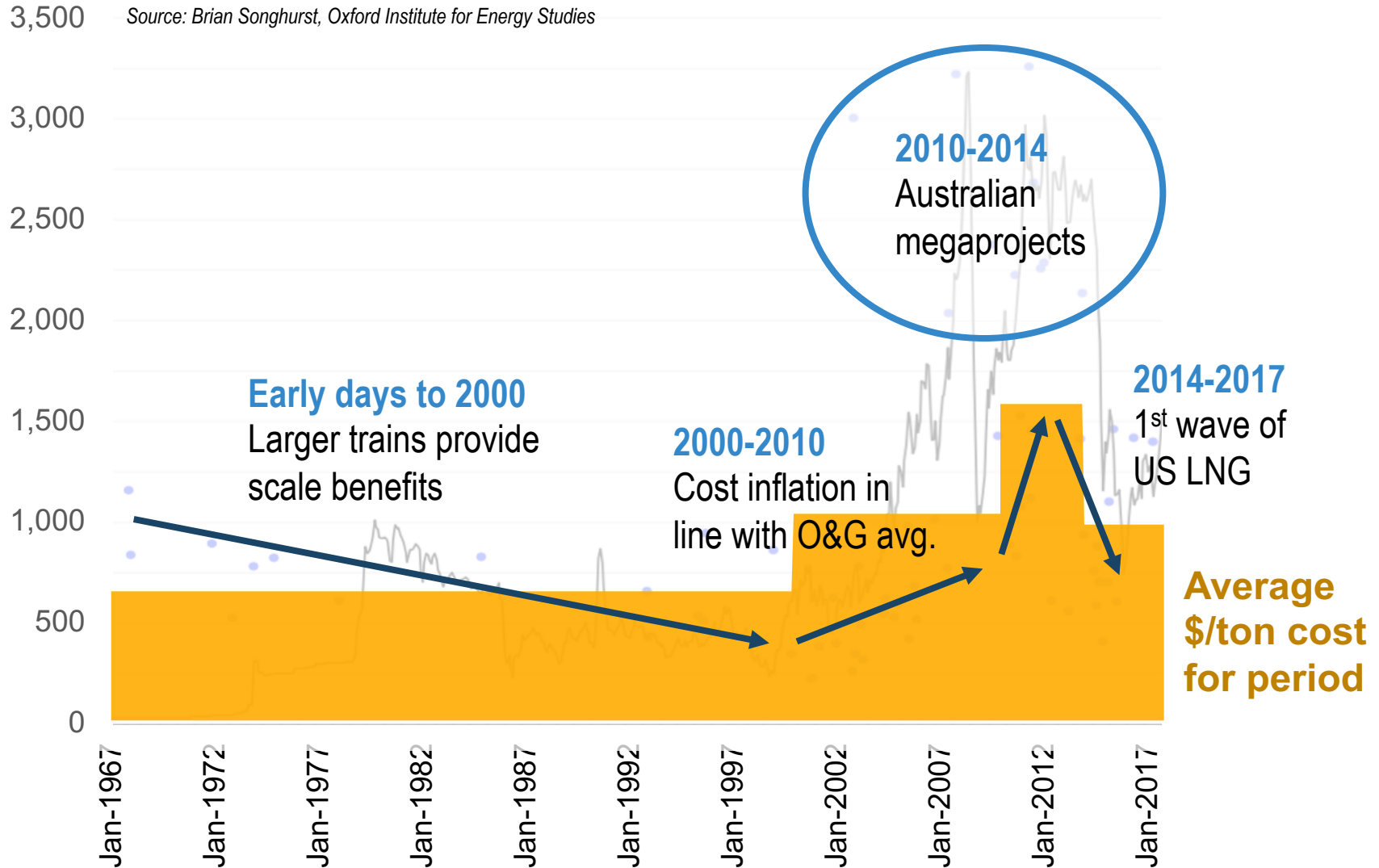
# Liquefaction Capex Is Cyclical, Too

Cost of Liquefaction Plants at the Time of FID (2018 \$), and Corresponding Oil Prices (nominal \$)



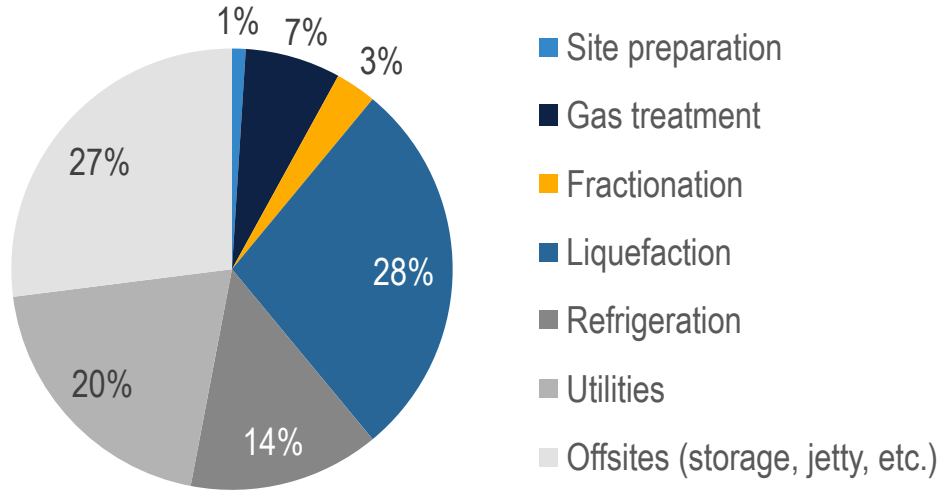
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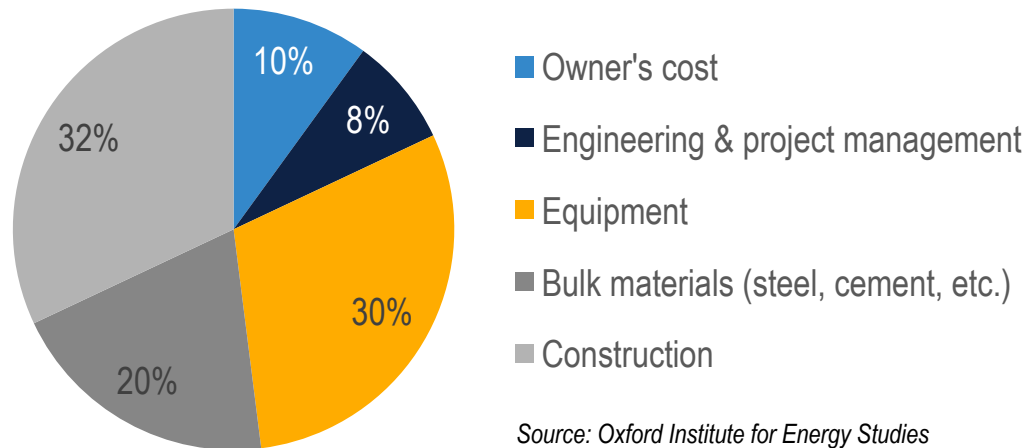


# What's Driving LNG Liquefaction Costs?

## Liquefaction Plant Cost Breakdown by Component



## Liquefaction Plant Cost Breakdown by Expense Category



Source: Oxford Institute for Energy Studies

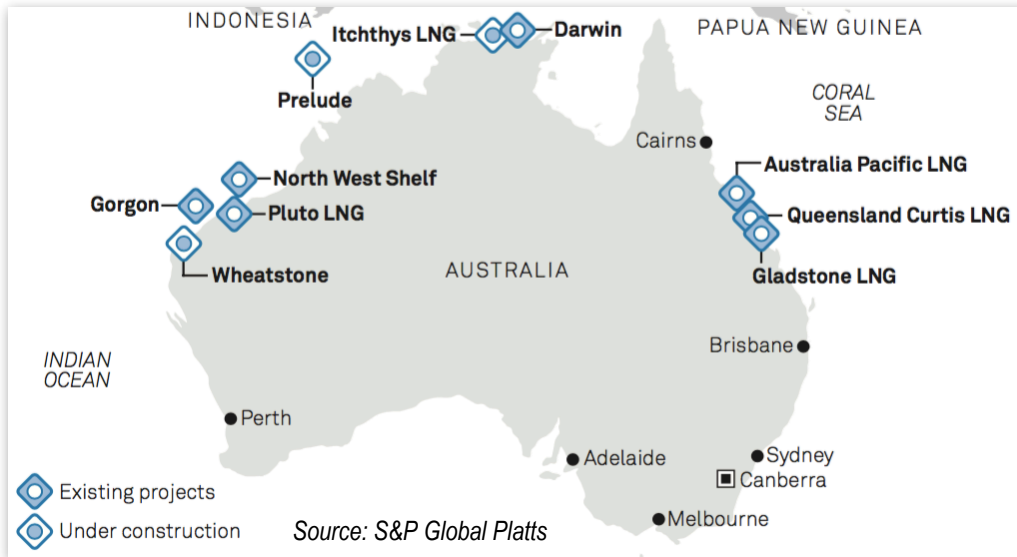
### Unit cost drivers

- Plant capacity
- Project scope
- Project location
- Project complexity
- Labor costs and availability
- Design choices
- Material and equipment costs
- EPC sector costs

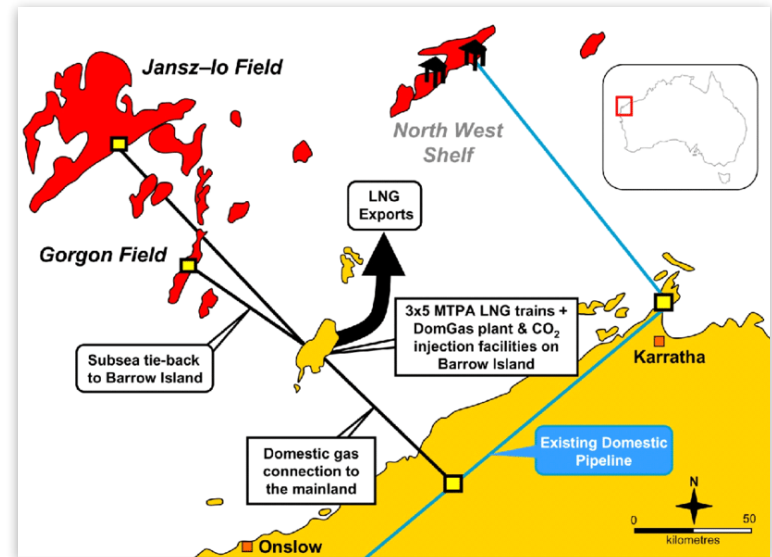


# What Went Wrong in Australia?

## Map of Australian LNG Projects



## Gorgon LNG Development Plan



**“Welders [in Australia] can apparently earn \$250,000 a year.”**

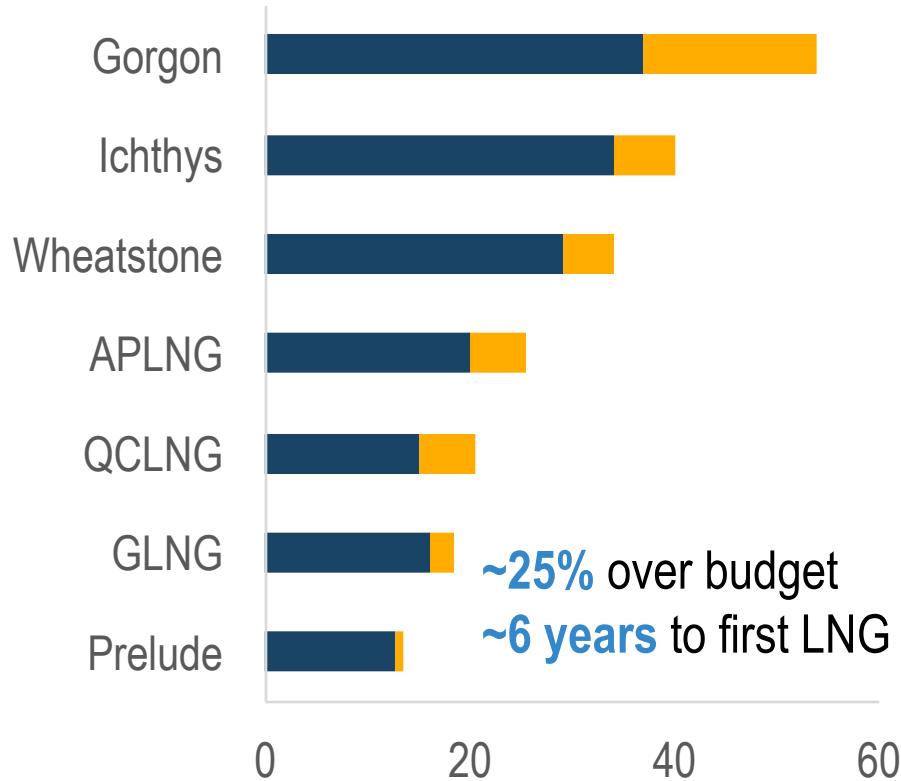
**Shell executive (2013)**

## Some challenges were foreseen...

- Remote locations
- Complex megaprojects
- High-cost labor

# Australia: Outlier or the New-Old Normal?

## Australian LNG Project Cost Overruns (\$ billion)



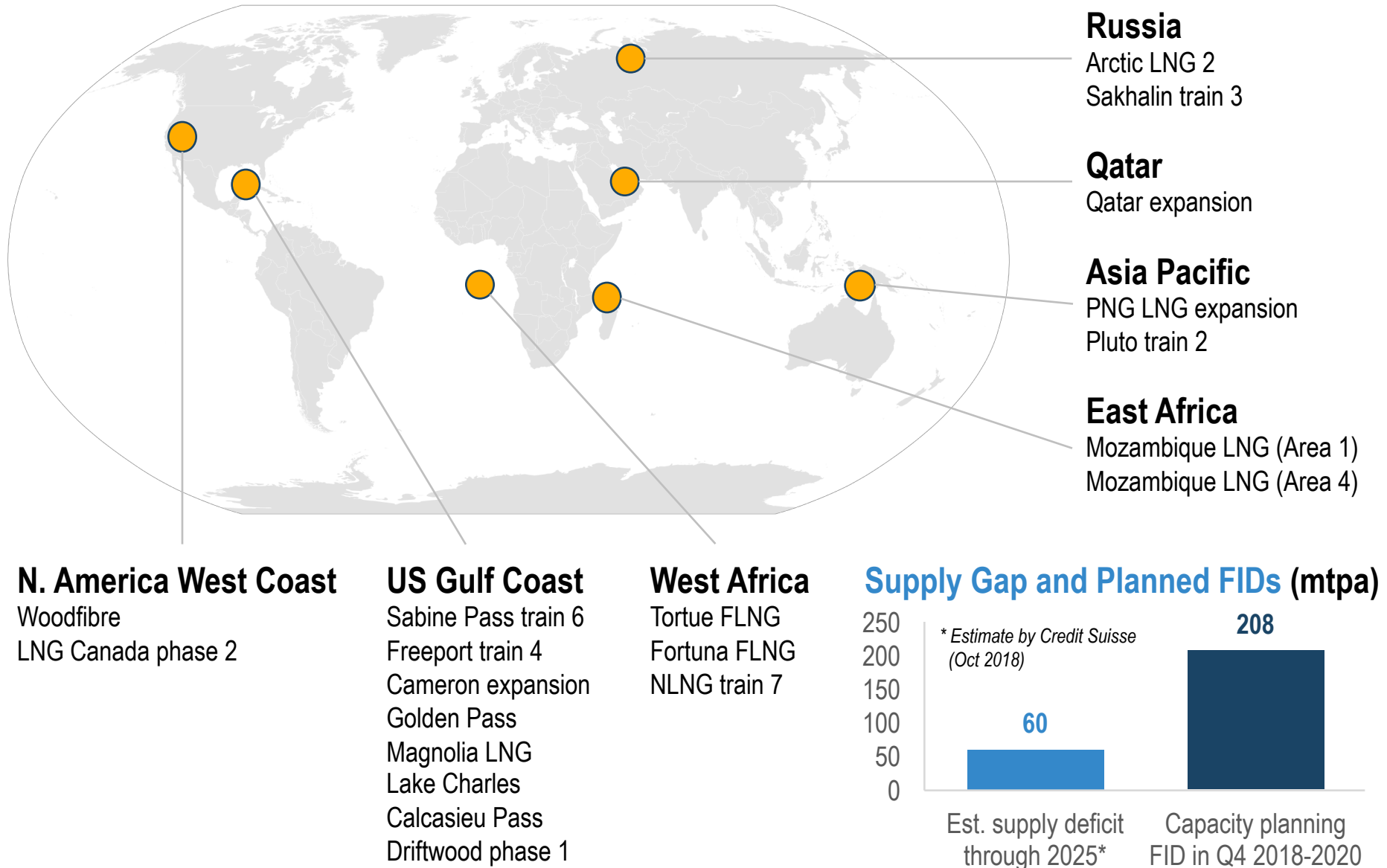
Source: Own research based on publicly available sources

■ Initial budget ■ Cost overrun

## Some challenges were unique and unexpected

- Local currency appreciation
- Simultaneous buildout (no cooperation)
- Labor shortage and productivity issues
- Many “firsts,” including:
  - First CSG-to-LNG projects
  - First (and biggest) FLNG sanctioned
  - First LNG megaproject in a “Class A” nature reserve

# What Will Keep Costs in Check: Supplier Competition



# Cost Mitigation Strategies in the Next Wave of Projects

## Russian Arctic



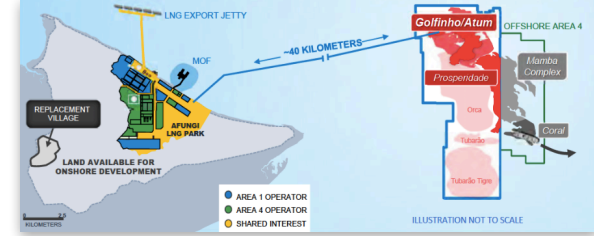
- Modular design
- Substantial tax breaks
- Gov't funded icebreaker and ice-class tanker fleets
- Gov't funded infrastructure
- Russian-built modules, GBS structures, upsized trains at Arctic LNG 2
- Arctic cascade process tested at Yamal Train 4

## LNG Canada



- Modular construction
- Government support
  - Steel tariff exemption
  - Ceiling on BC carbon tax
  - Relief from BC sales tax
  - Electricity at industry rate
  - No LNG income tax
- EPC re-contracted on lump-sum turnkey basis

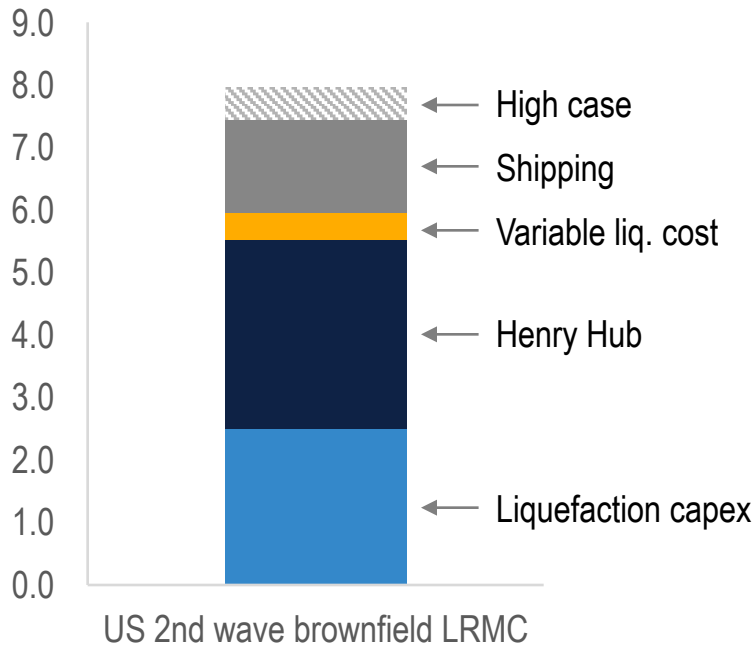
## Mozambique



- Exxon and Anadarko-led projects use joint site, shared infrastructure
- Anadarko cut capex by \$4bn in 2018 via scope optimization vs. 2016
- Exxon-led Area 4 project switched to supersized (7.6 mtpa) megatrains

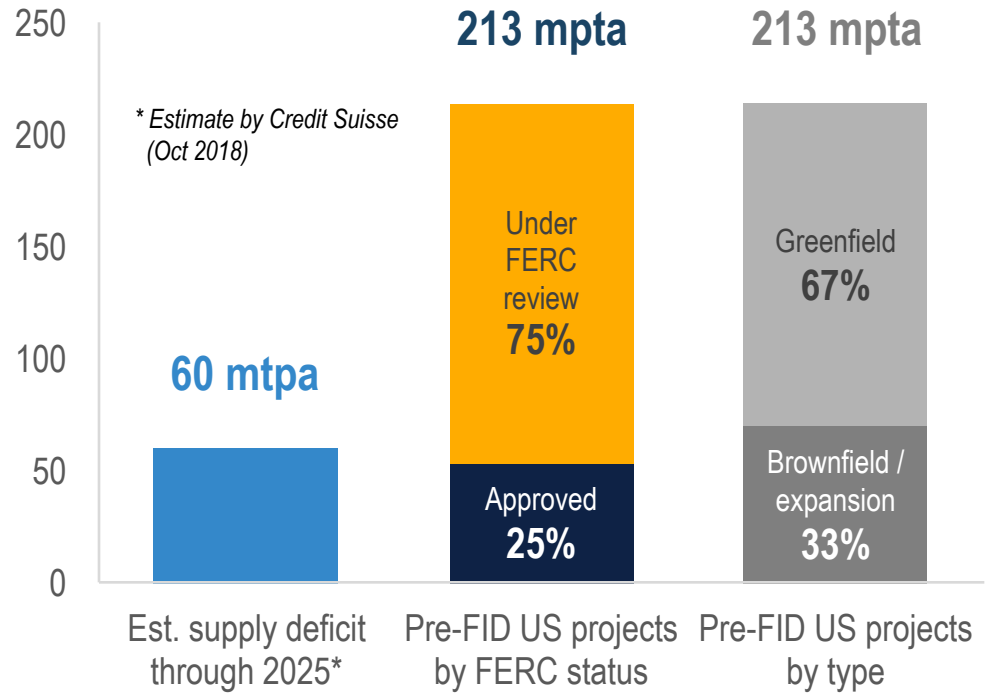
# What Will Keep Costs in Check: US LNG as a Backstop

## Long-Run Marginal Cost (LRMC) for 2<sup>nd</sup> Wave US LNG Projects (\$/MMBtu)



Source: Own estimates

## Global LNG Supply Gap and Pre-FID US Capacity (mtpa)

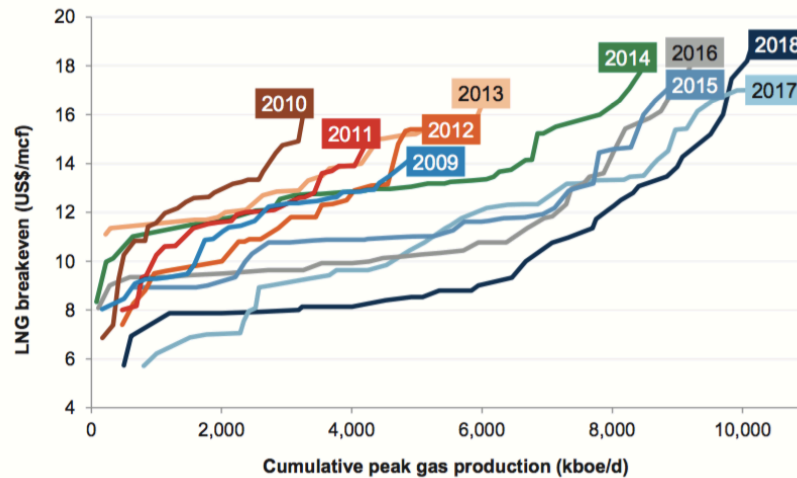


Source: FERC



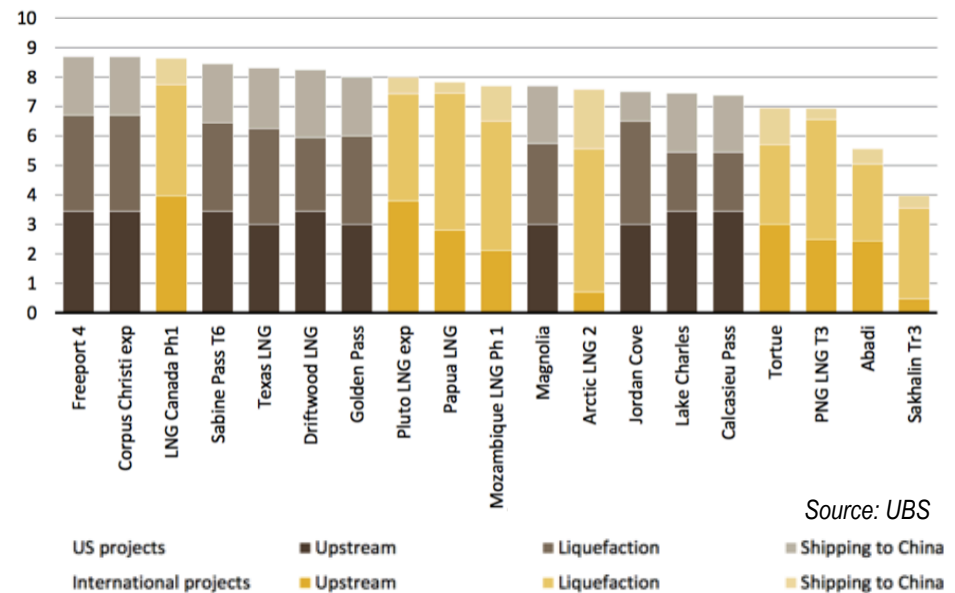
# The LNG Cost Curve Has Shifted Lower and Become Flatter

## Evolution of the Global LNG Cost Curve Over Time



Source: Goldman Sachs

## Breakeven Cost of Selected LNG Projects (\$/MMBtu, delivered to East Asia)



Source: UBS

*A large number of projects are now competitive in the \$7-9 per MMBtu range*

# Is FLNG a Game-Changer?



**“FLNG has every potential to be a game changer for the liquefaction industry...”**

**Brian Songhurst, OIES (2016)**

## The promise of FLNG

- No need for pipelines to shore
- No need for land
- No need for onshore infrastructure
- No need for marine facilities
- Shipyard construction
- Option to lease
- Vessel can be reused

# FLNG Comes in “High-End” and “Low-End” Configurations

## High-End Solution



- Large and highly expensive
- Newly built and custom-designed
- Engineered to perfection
- All-weather operations

## Low-End Solution



- Small and cheap
- Old unit converted to new purpose
- Simple low-cost engineering
- Fair-weather operations only

## Newbuild FLNG

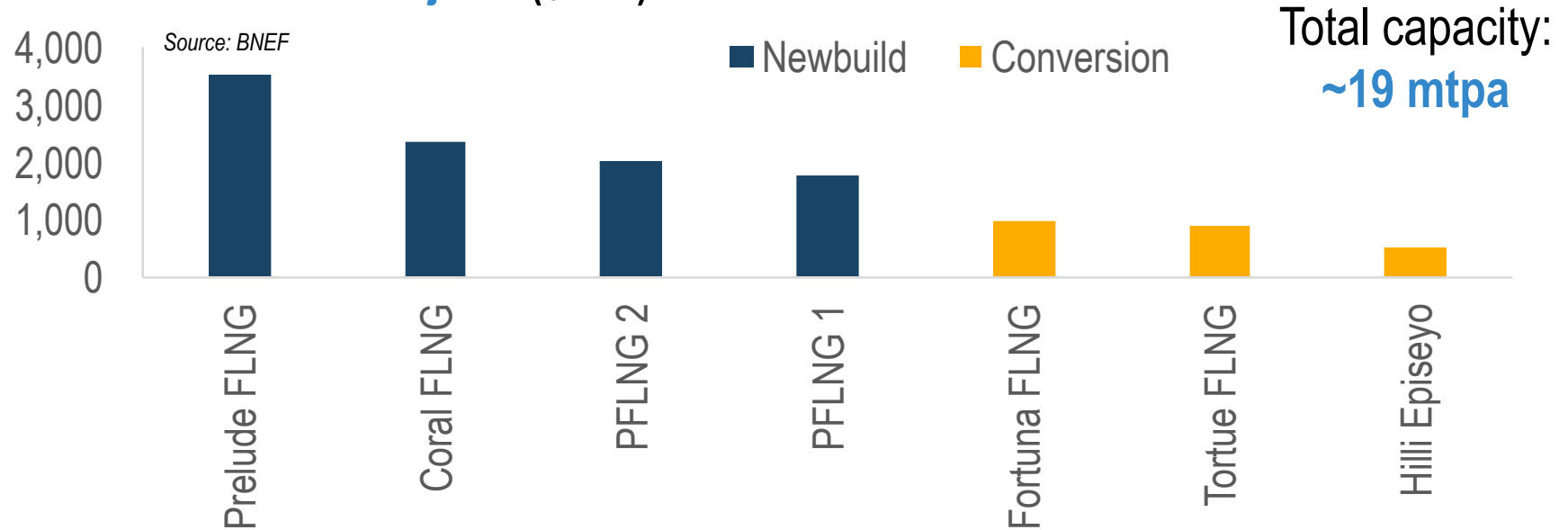


## FLNG Conversion



# FLNG Is a Small Game Changer For Now

## Unit Cost of FLNG Projects (\$/ton)



### Newbuild FLNG

- No evidence of low cost, shorter lead-time
- Limited opportunity set globally
- Major IOC's and NOC's game for now

### FLNG Conversion

- Cost savings and fast deployment a reality
- Leasing/tolling model, new players
- Niche application in West Africa for now

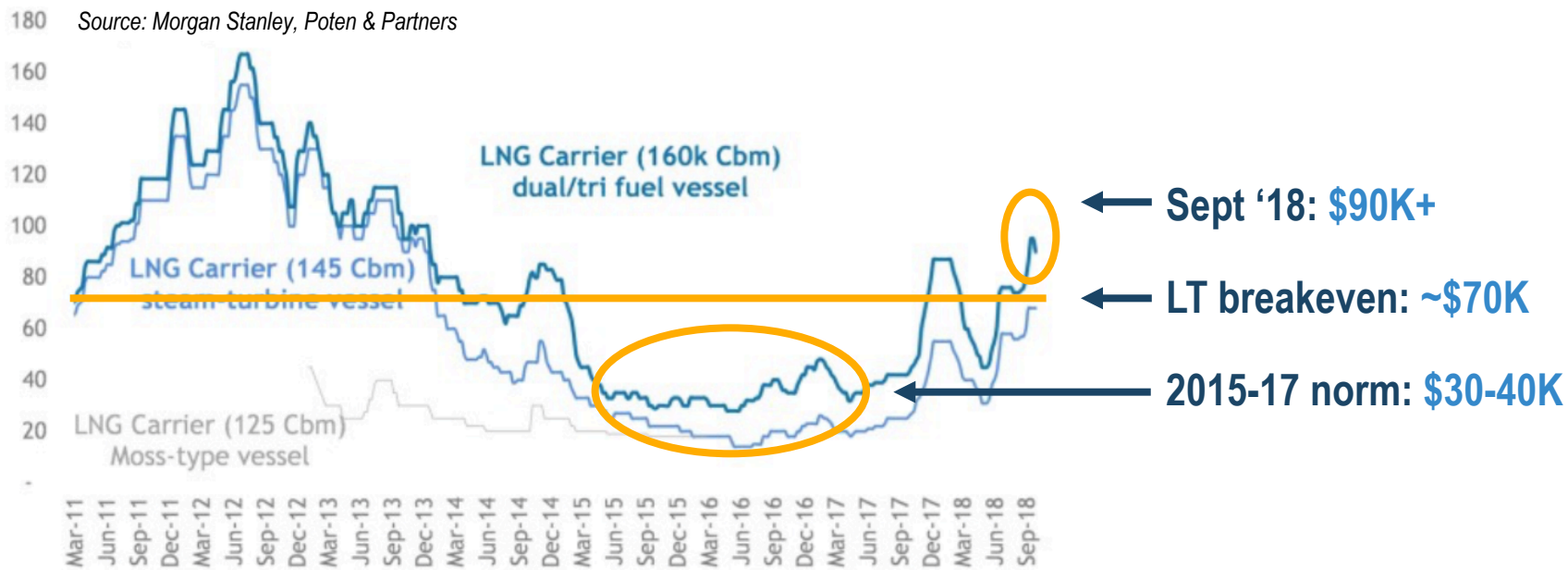
A blue horizontal banner with a diagonal cut on the right side. Inside the banner, there is a row of white icons representing various energy sources: an oil derrick, a wind turbine, a solar panel array, a power transmission tower, a factory with smokestacks, and an offshore oil platform.

# Trends in LNG Shipping



# Spot Charter Rates Reached an Inflection Point in Late-2017

## LNG Carrier Spot Charter Rates (thousand \$/day)

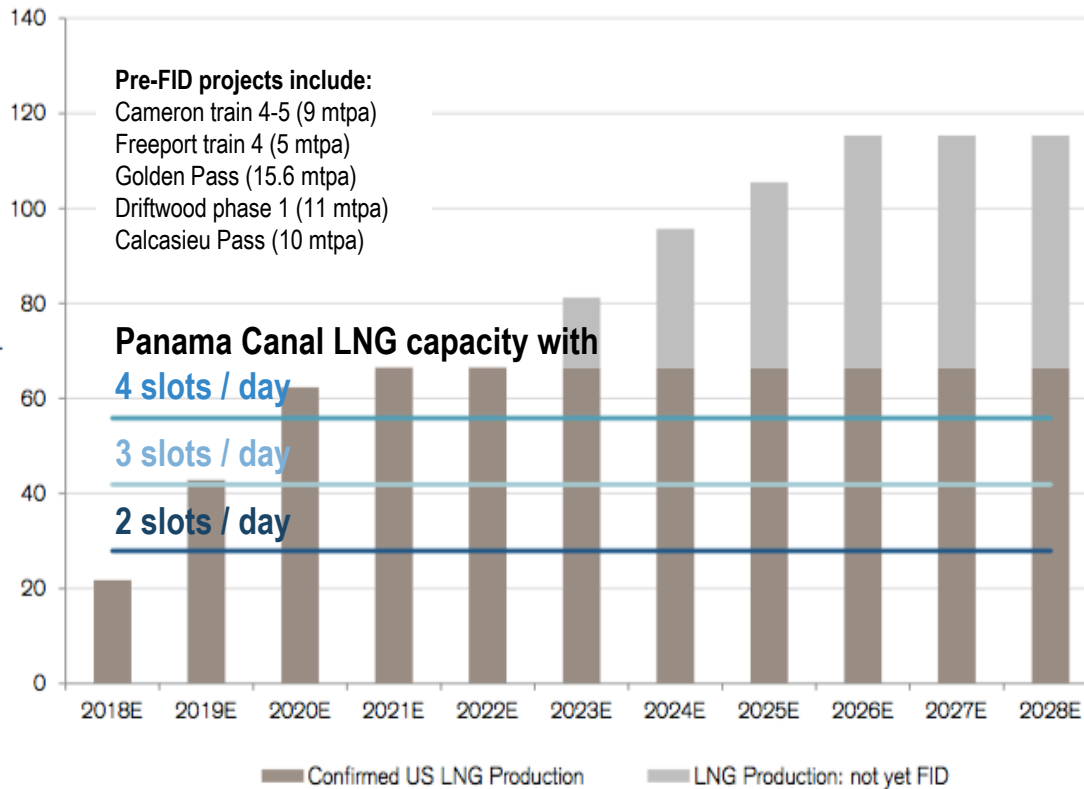


LNG carrier charter rate	\$/day	\$30,000	\$70,000	\$90,000
US LNG shipping cost to Asia via Panama	\$/MMBtu	1.5	2.0	2.3

**Main assumptions:** Henry Hub gas price at \$3.00 per MMBtu, Asian LNG price at \$10 per MMBtu, vessel capacity at 170,000 cubic meters, Panama Canal fee (round-trip) at \$770,000, bunker fuel cost at \$500 per ton, journey times (one-way) at 24 days. Own estimates.

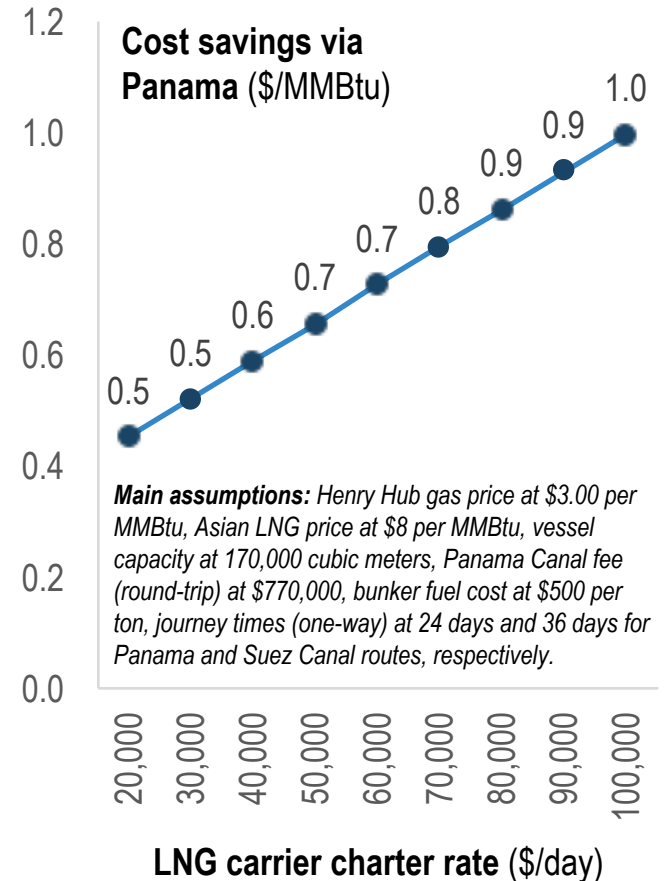
# Will the Panama Canal Become a Bottleneck?

## US LNG Exports and Panama Canal Capacity (mtpa)



Source: Credit Suisse

## Cost Savings via Panama Canal vs. Suez Canal Route (\$/MMBtu)



Source: Own estimates

# Thank You

For more information contact

**Akos Losz**

*Senior Research Associate  
Center on Global Energy Policy  
Columbia University*

**[al3371@sipa.columbia.edu](mailto:al3371@sipa.columbia.edu)**



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