

Liquefied Natural Gas and Regasification

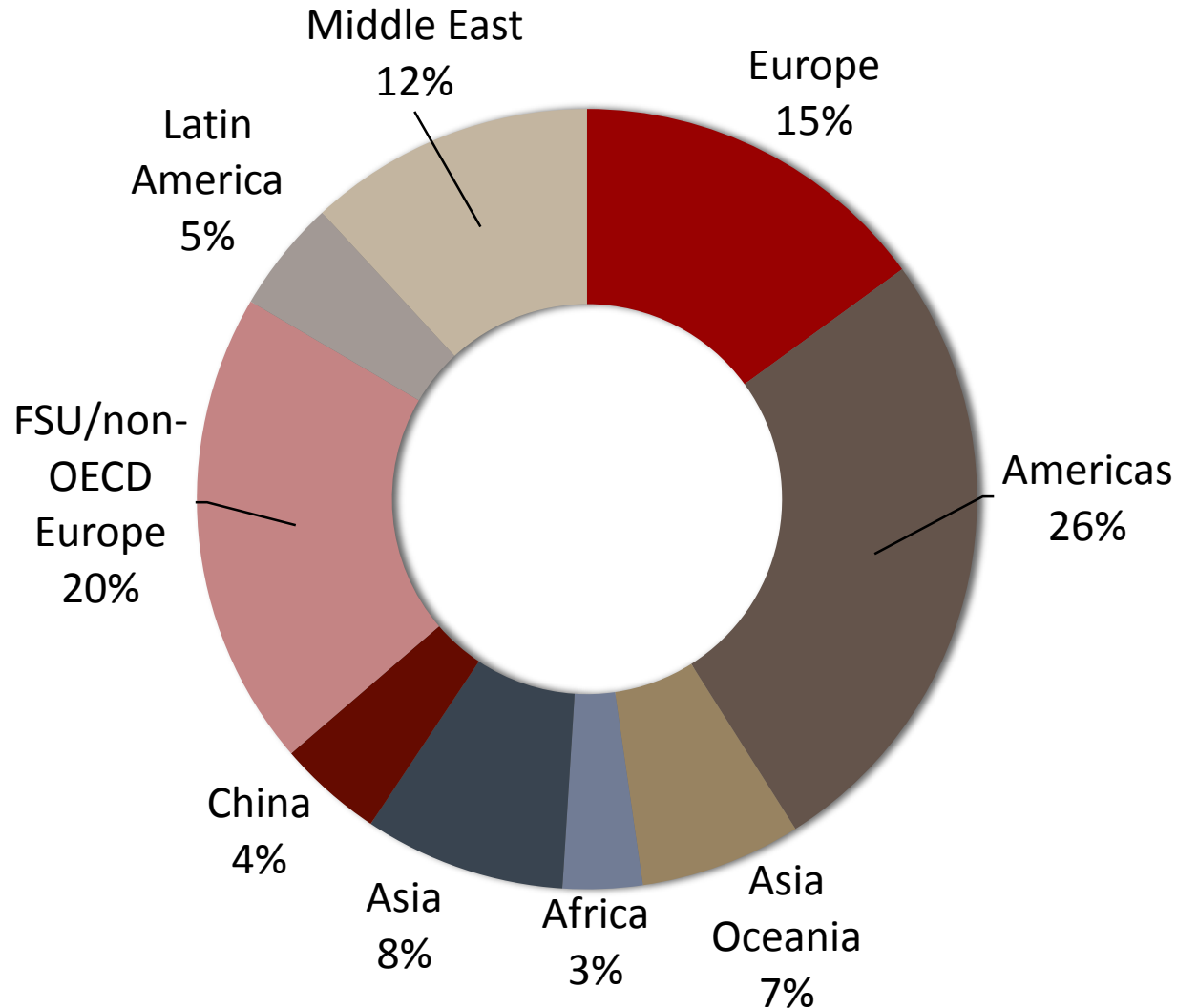
Harvard Energy Journal Club

April, 2015

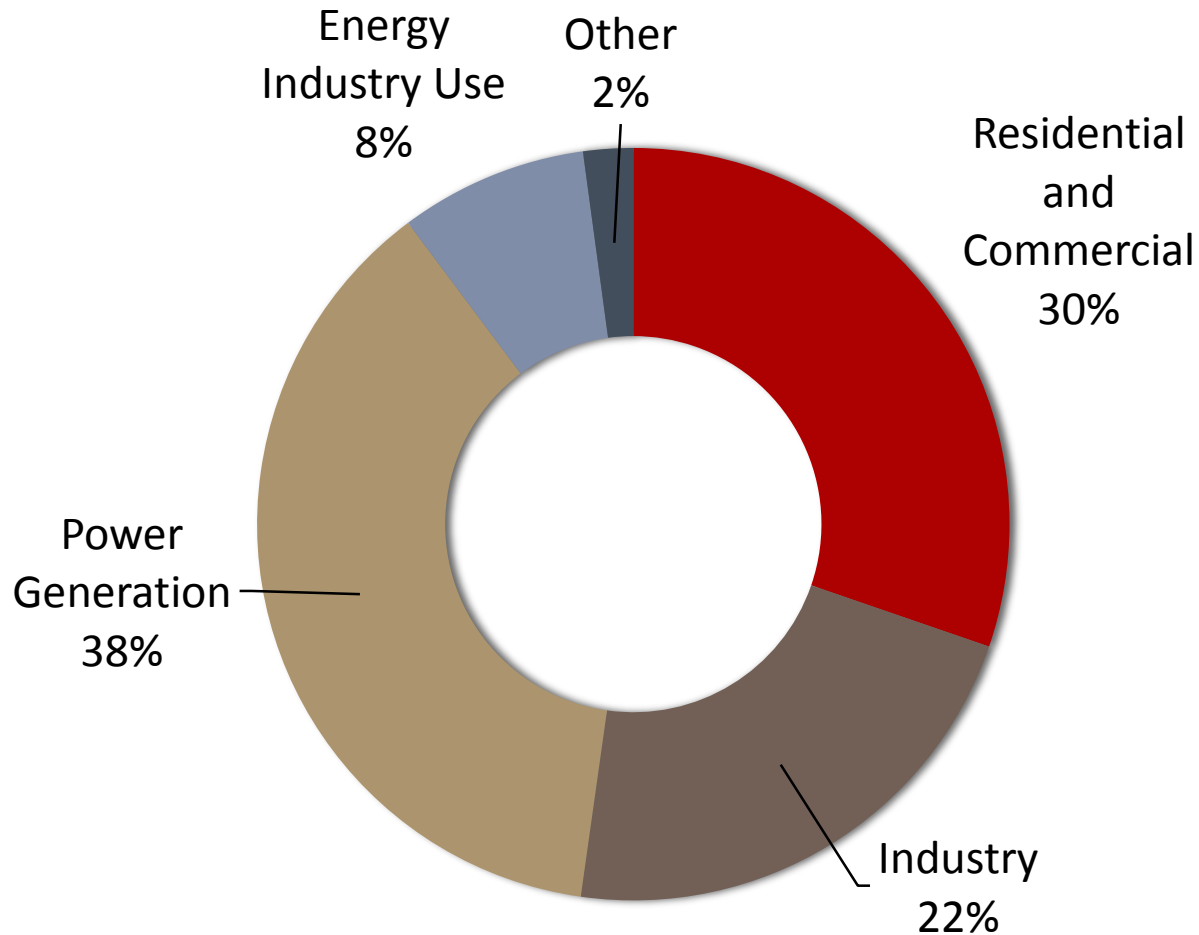
Talk outline

- Natural Gas Market Overview
- What is LNG?
- Market Outlook

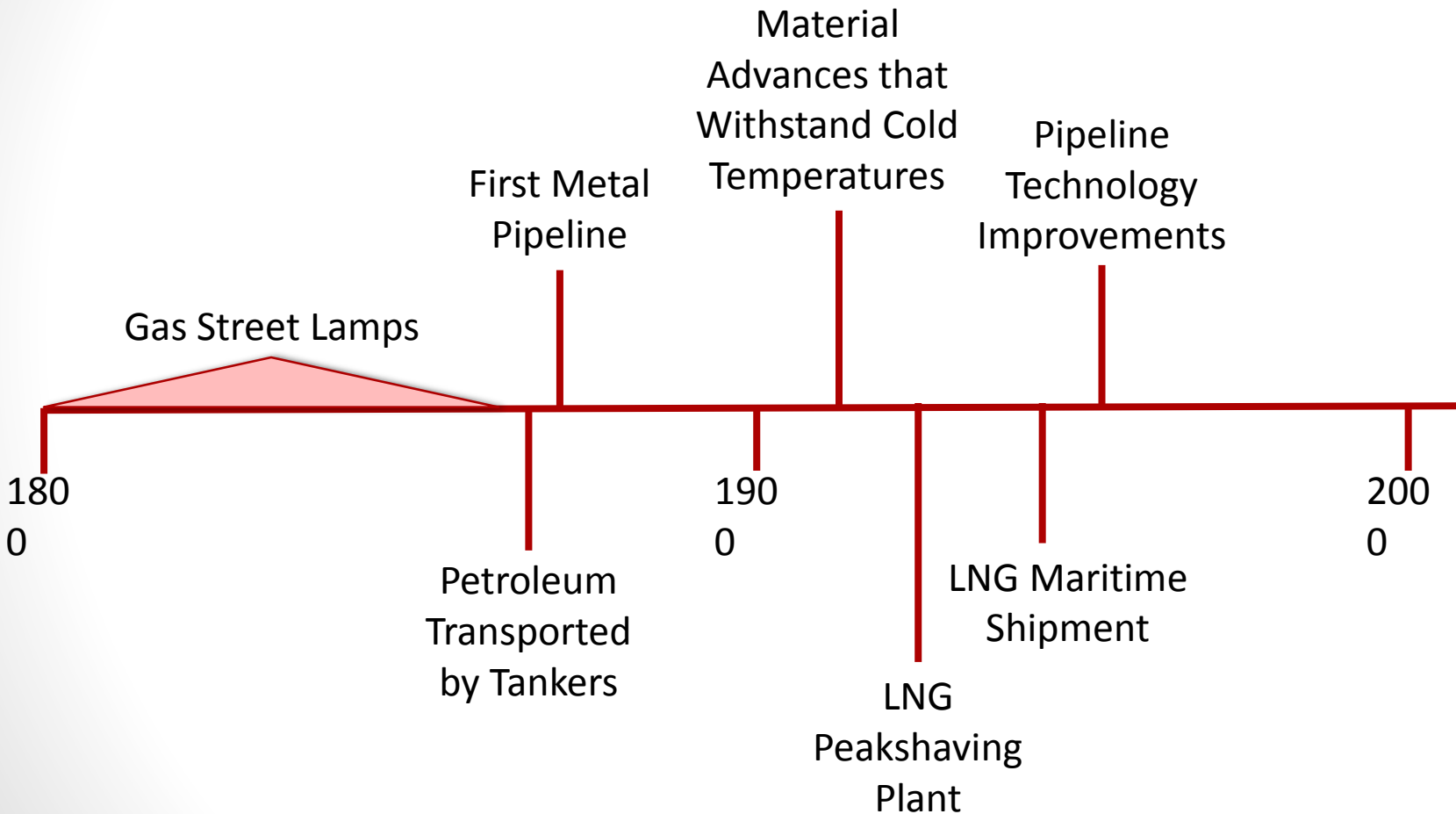
Global Natural Gas Demand 3,427 BCM



Natural Gas Sector Use

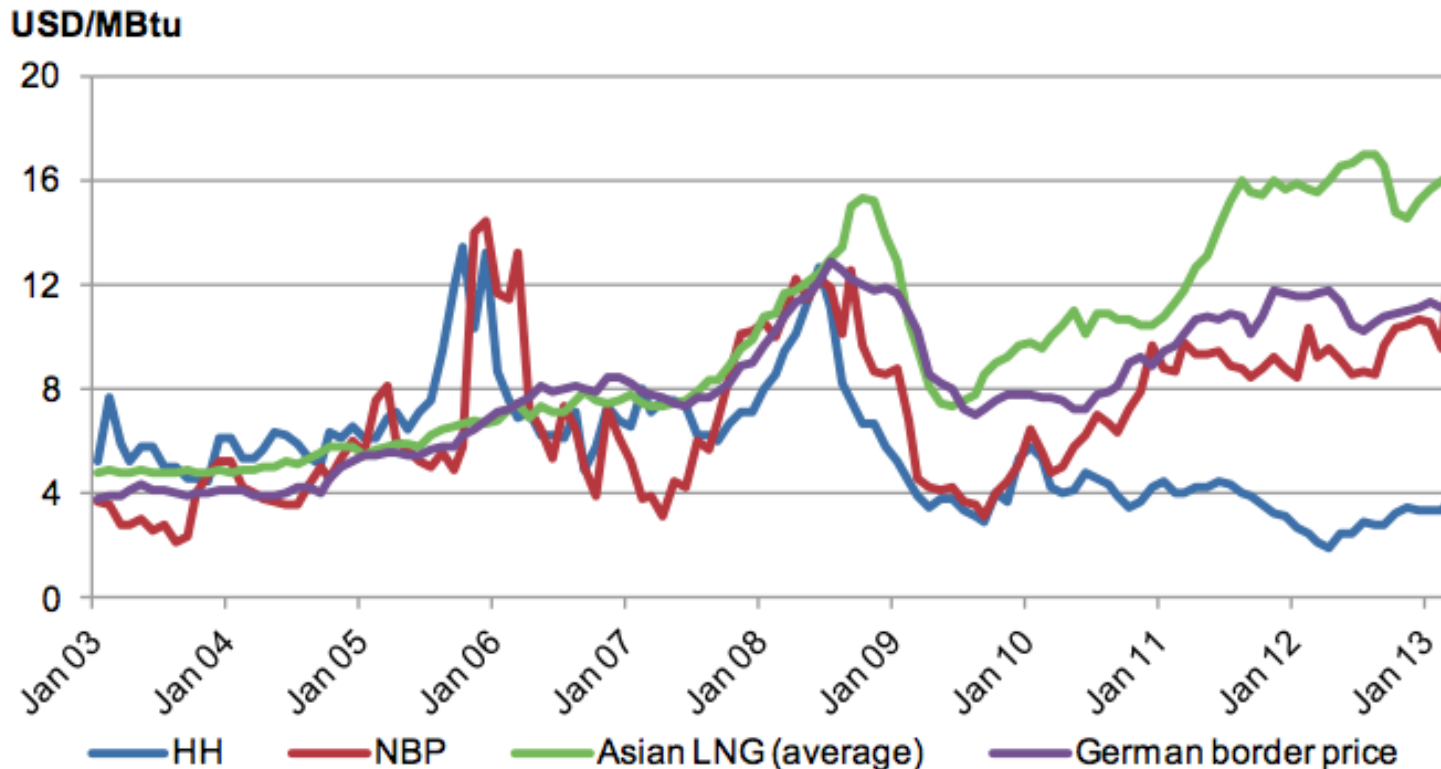


Natural Gas Timeline



Natural Gas Pricing

Figure 54 Gas price developments in the three main regional markets, Jan 2003-Jan 2013



LNG

- Reduce volume via cooling the gas to a liquid
 - Boiling Point: -163°C
 - Volume reduction > 600 fold
- Auto-refrigeration sustains liquid form
- Either use as LNG, or reheat to return to gas state

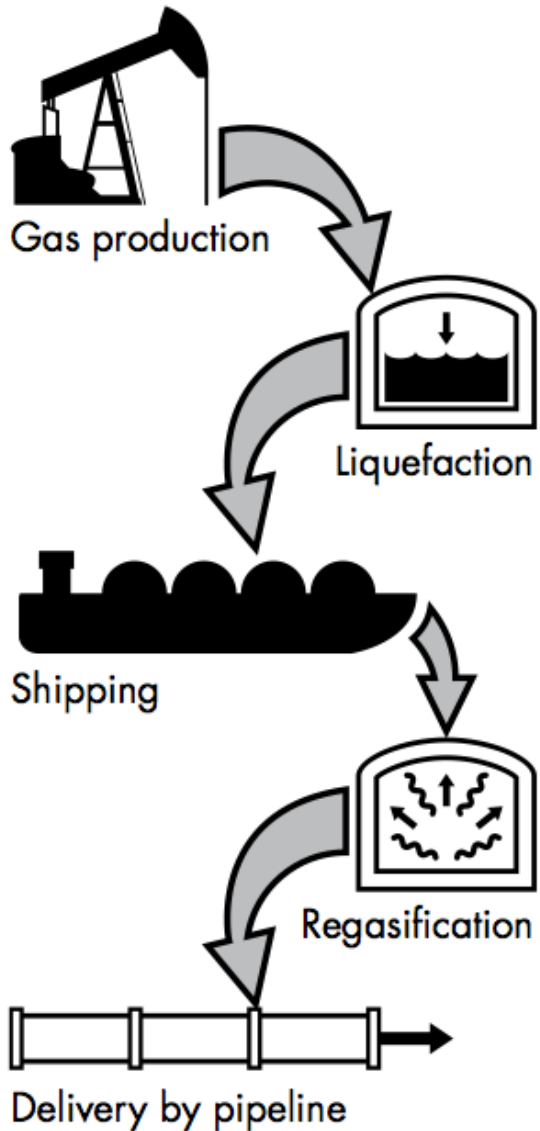


*When liquefied, natural gas
that would fill a beach ball...*

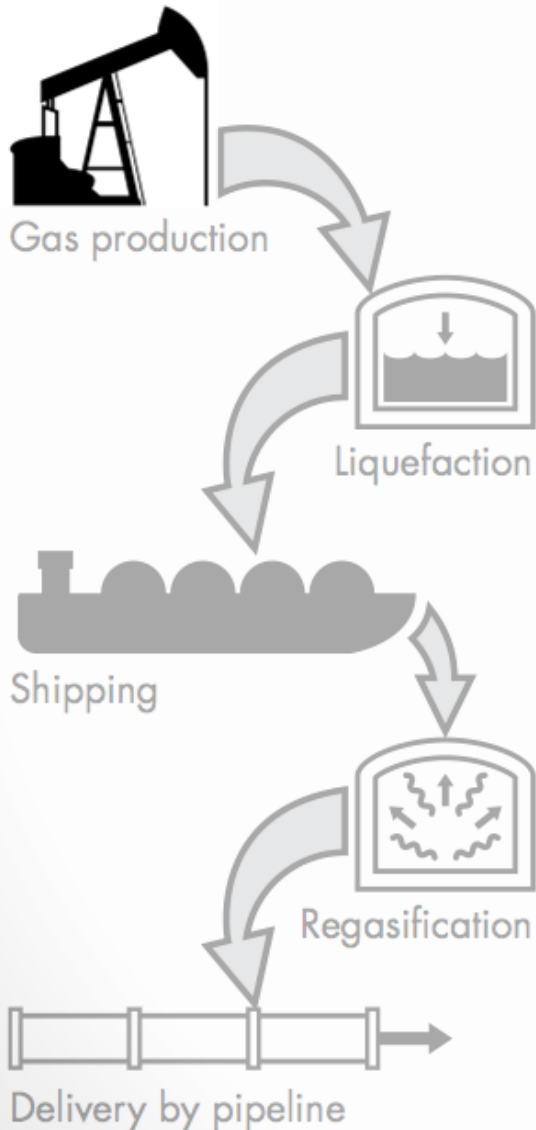


*...becomes LNG that can fit
inside a ping-pong ball.*

LNG Value Chain

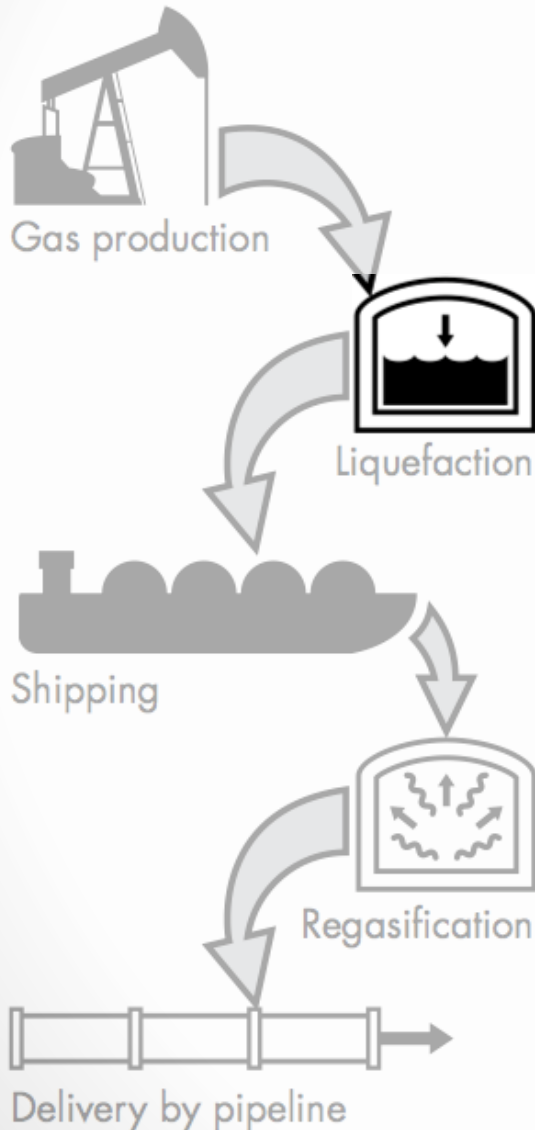


LNG Value Chain – Gas Production



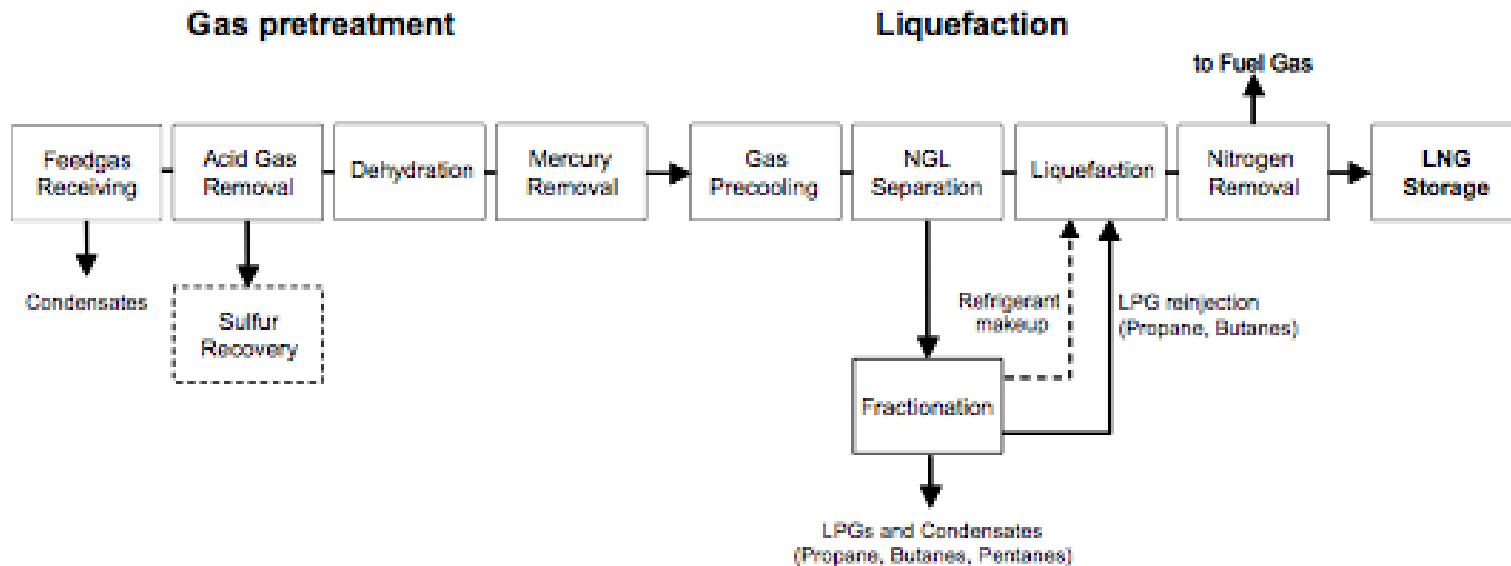
- Expands viability of various gas production sites
- 15-20% of capital cost

LNG Value Chain – Liquefaction

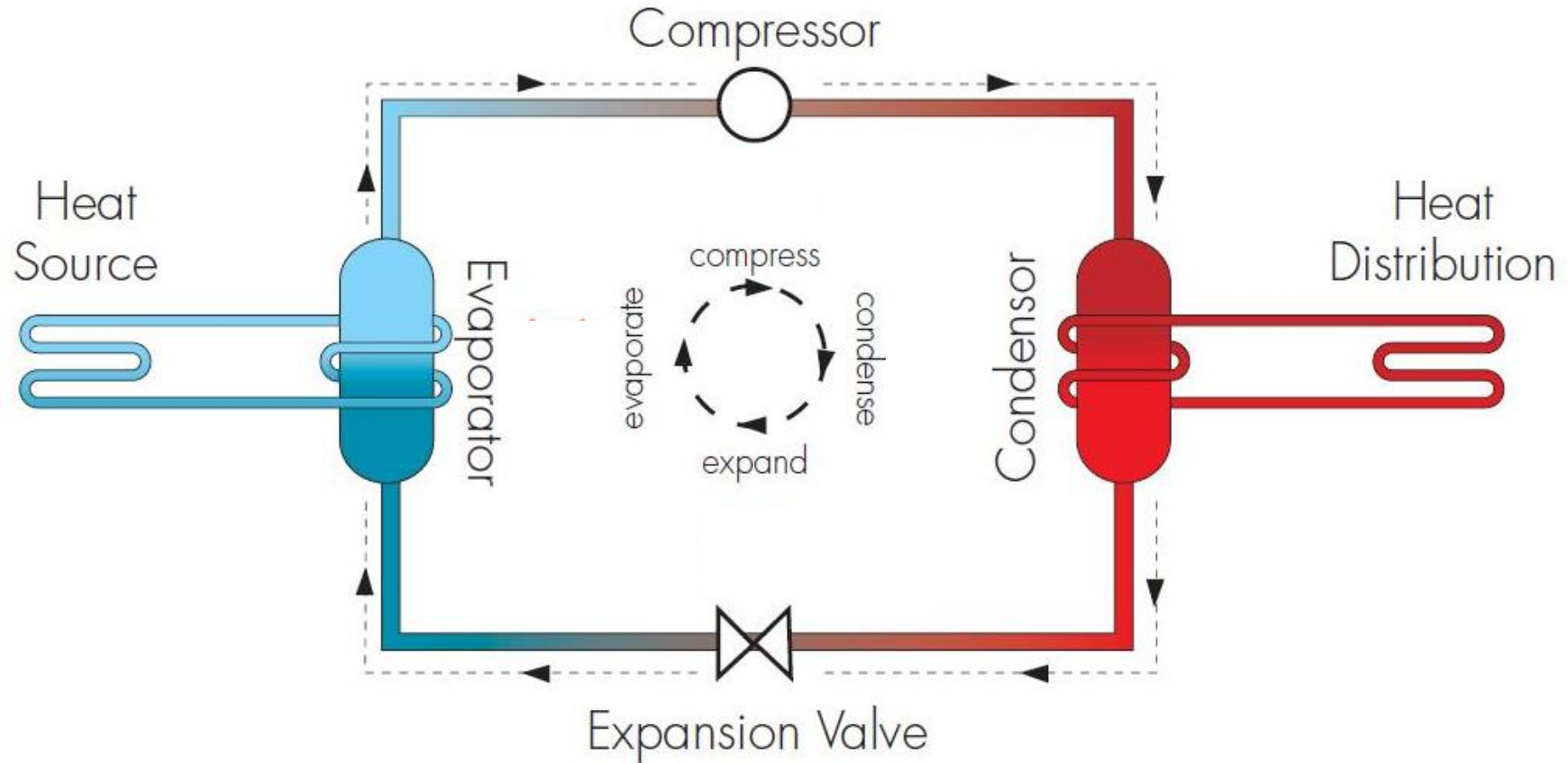


- Essentially just a giant refrigerator
- (Plus some pretreatment for impurities)
- 30-45% of capital cost

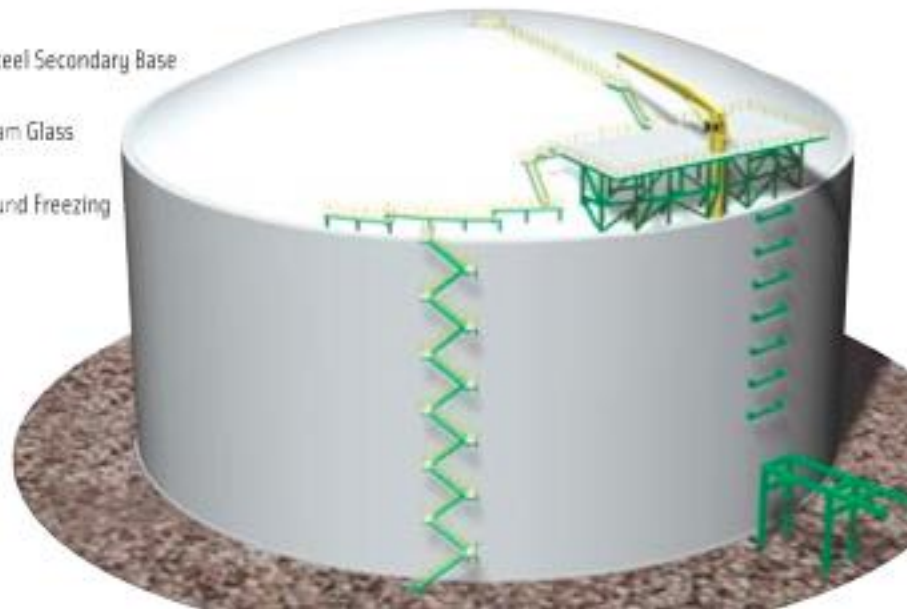
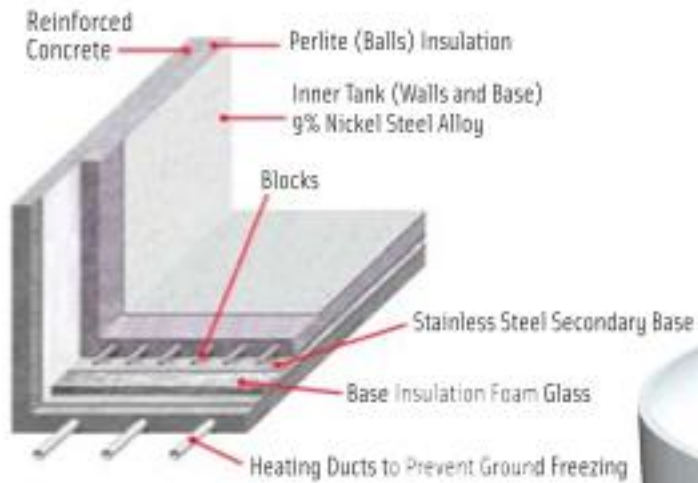
Liquefaction Process



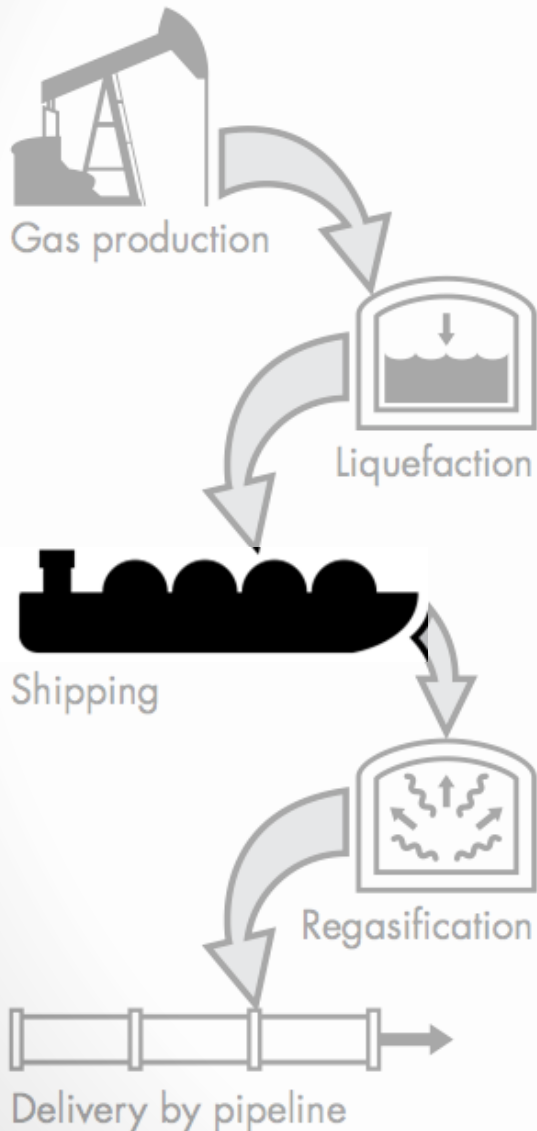
Simple Refrigeration Schematic



Storage Tanks



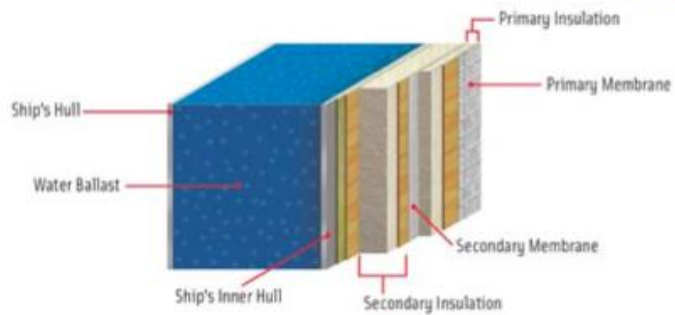
LNG Value Chain – Shipping



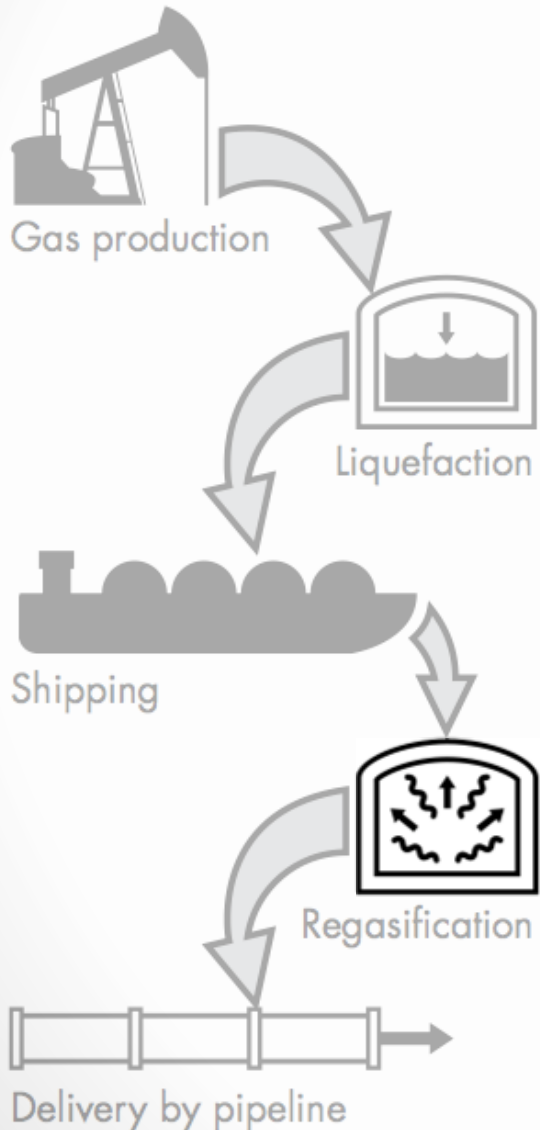
- 10-30% of capital cost
- Substantial component of operational costs
- Tanker must be cooled before loading

LNG Shipping

An LNG ship's hull and containment system, more than six feet thick, as shown in cross-section.



LNG Value Chain – Regasification



- 15-25% of capital cost
- Unloading arms, storage tanks, and vaporization equipment

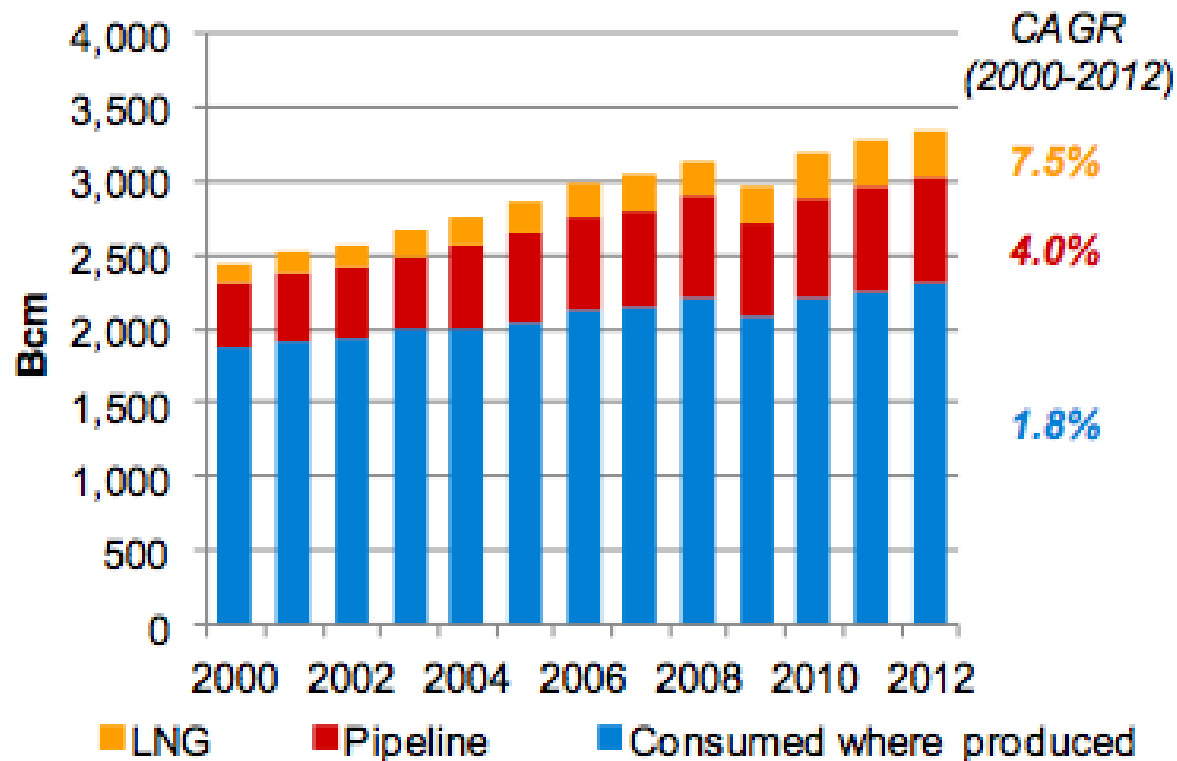
LNG Value Chain – End Use



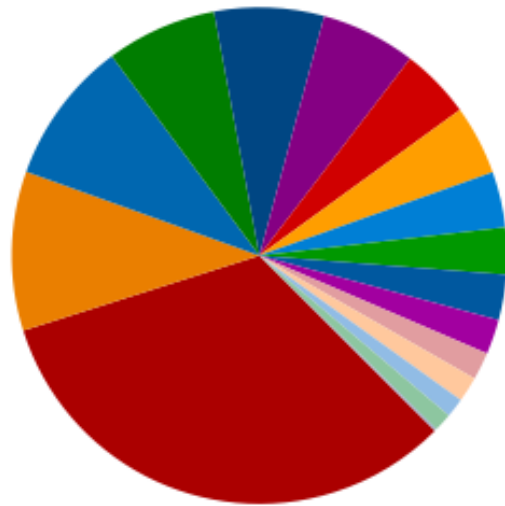
Project Timeline

Two-Train LNG Project	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7
Conceptual Idea	◆						
Feasibility Study	■						
Basis of Design (BOD)		■					
Front-End Engineering and Design (FEED) Bid			◆				
FEED			■				
EPC Bid				◆			
EPC Contract				■	■	■	■
Ready for Start of Train 1						◆	
Ready for Start of Train 2							◆

Current State of LNG

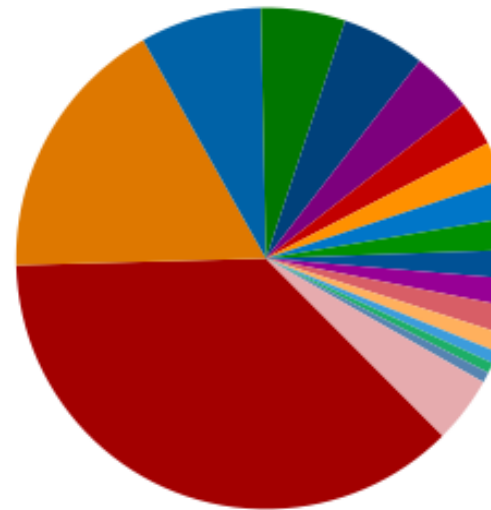


Current State of LNG



Exports

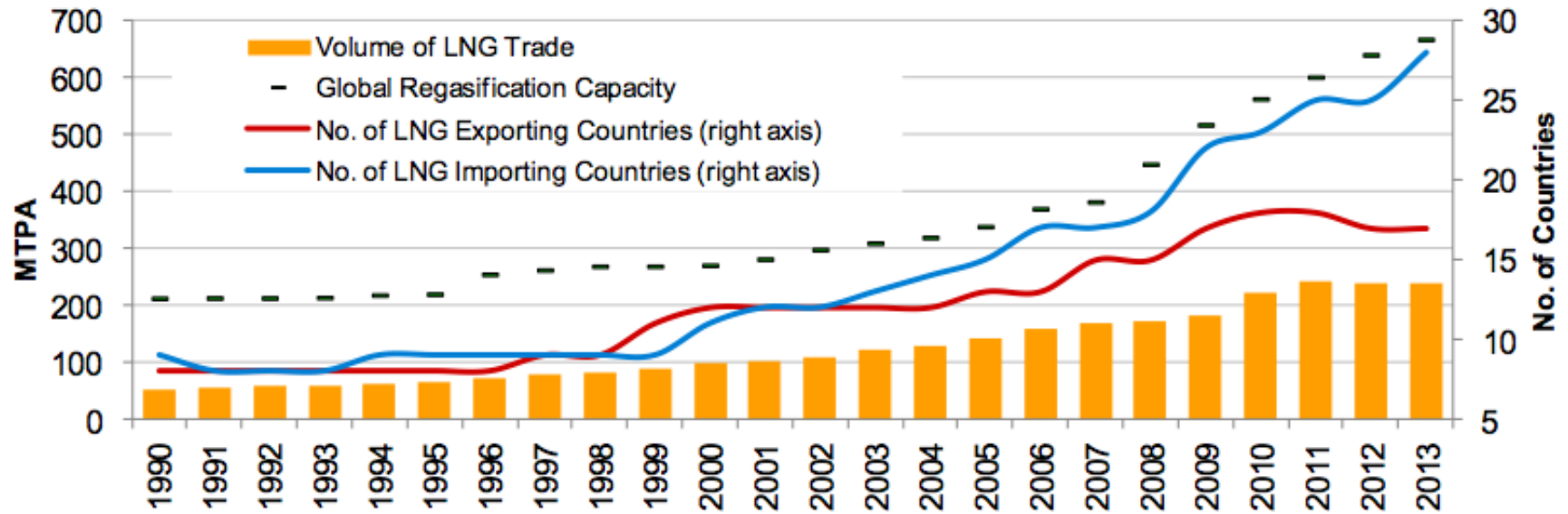
■ Qatar, 77.2, -0.2
■ Malaysia, 24.7, +1.6
■ Australia, 22.2, +1.4
■ Indonesia, 17.0, -1.1
■ Nigeria, 16.9, -3.1
■ Trinidad, 14.6, +0.2
■ Algeria, 10.9, -0.1
■ Russia, 10.8, -0.2
■ Oman, 8.6, +0.6
■ Yemen, 7.2, +2.1
■ Brunei, 7.0, +0.2
■ UAE, 5.4, -0.2
■ Peru, 4.3, +0.4
■ Eq. Guinea, 3.9, +0.1
■ Norway, 3.0, -0.4
■ Egypt, 2.8, -2.3
■ Angola, 0.3, +0.3



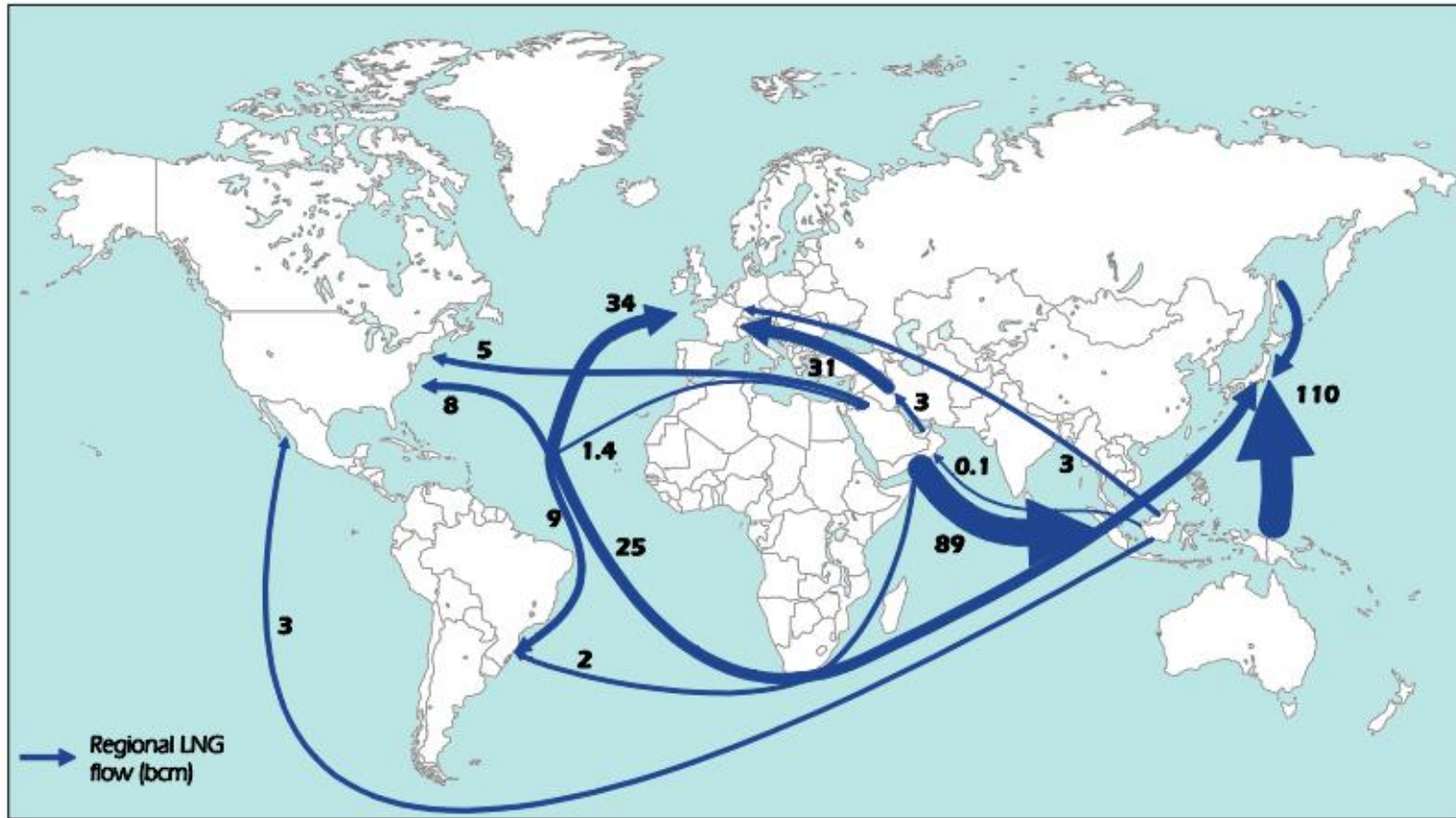
Imports

■ Japan, 87.8, +0.5
■ South Korea, 40.9, +4.1
■ China, 18.6, +3.8
■ India, 12.9, -1.1
■ Taiwan, 12.8, +0.1
■ Spain, 9.4, -4.9
■ UK, 6.8, -3.6
■ Mexico, 6, +2.4
■ France, 5.8, -1.7
■ Argentina, 4.9, +1.1
■ Brazil, 4.4, +1.9
■ Turkey, 4.2, -1.5
■ Italy, 4.2, -1
■ Chile, 2.9, -0.2
■ US, 1.8, -1.4
■ Kuwait, 1.6, -0.5
■ Malaysia, 1.6, +1.6
■ Other, 10.1, -0.5

Current State of LNG

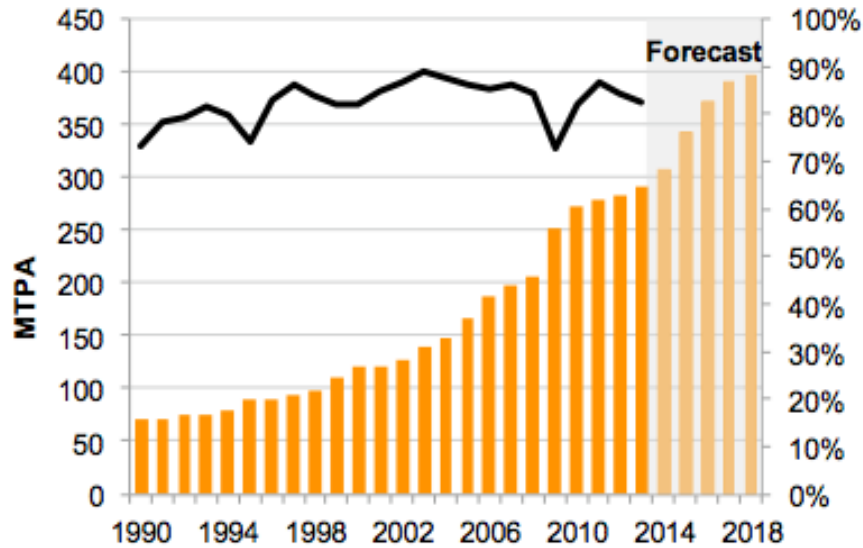


LNG Flows

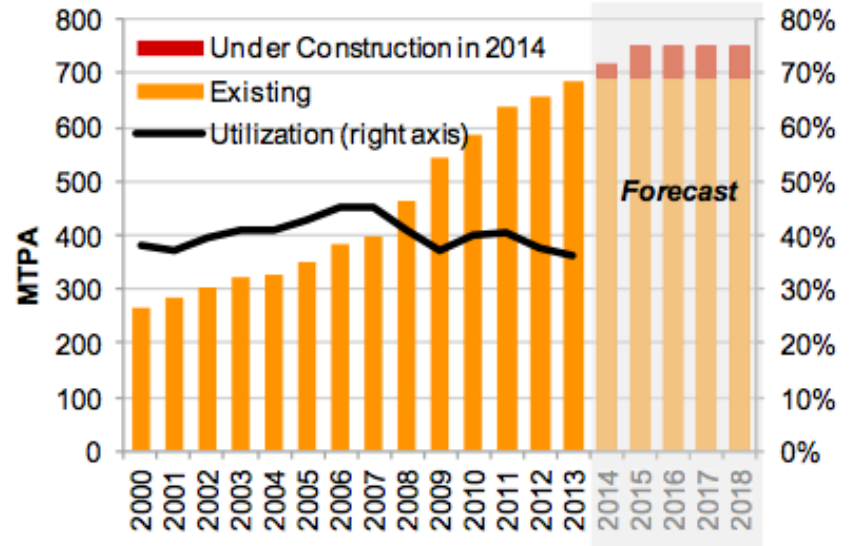


LNG – A Tight Market

Liquefaction Capacity

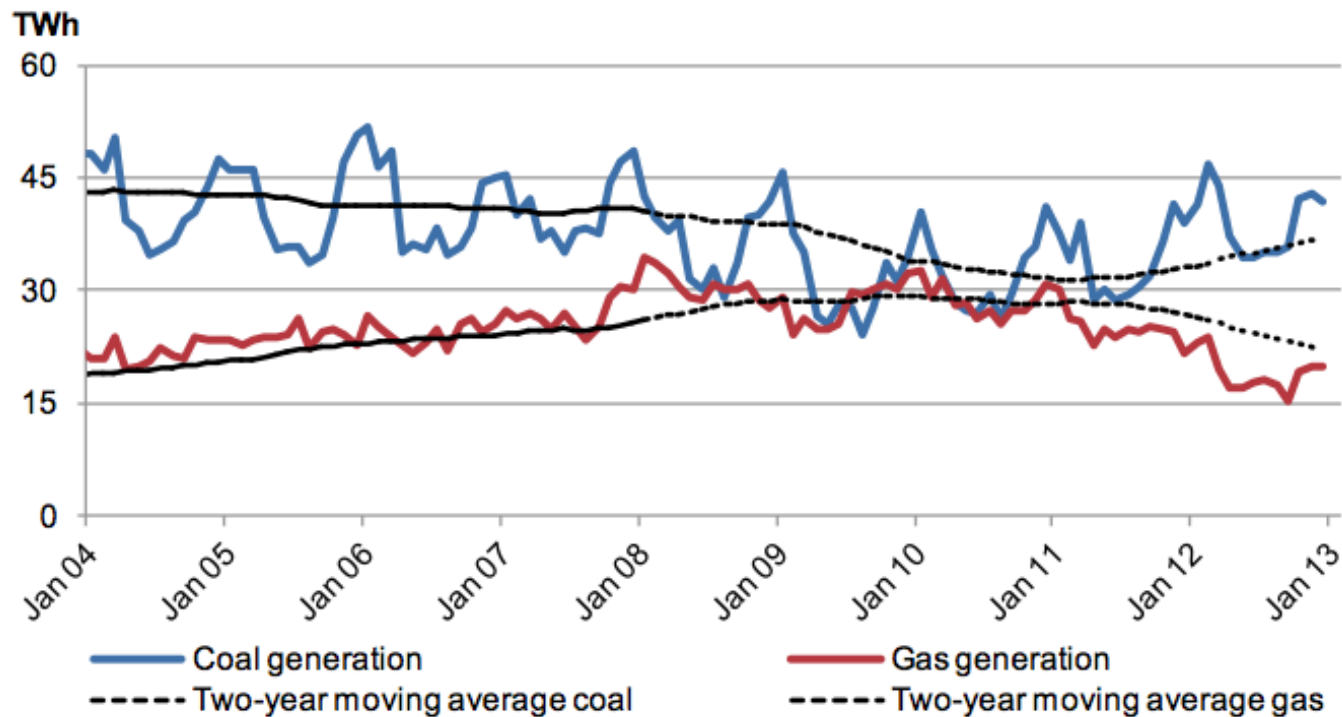


Import Capacity



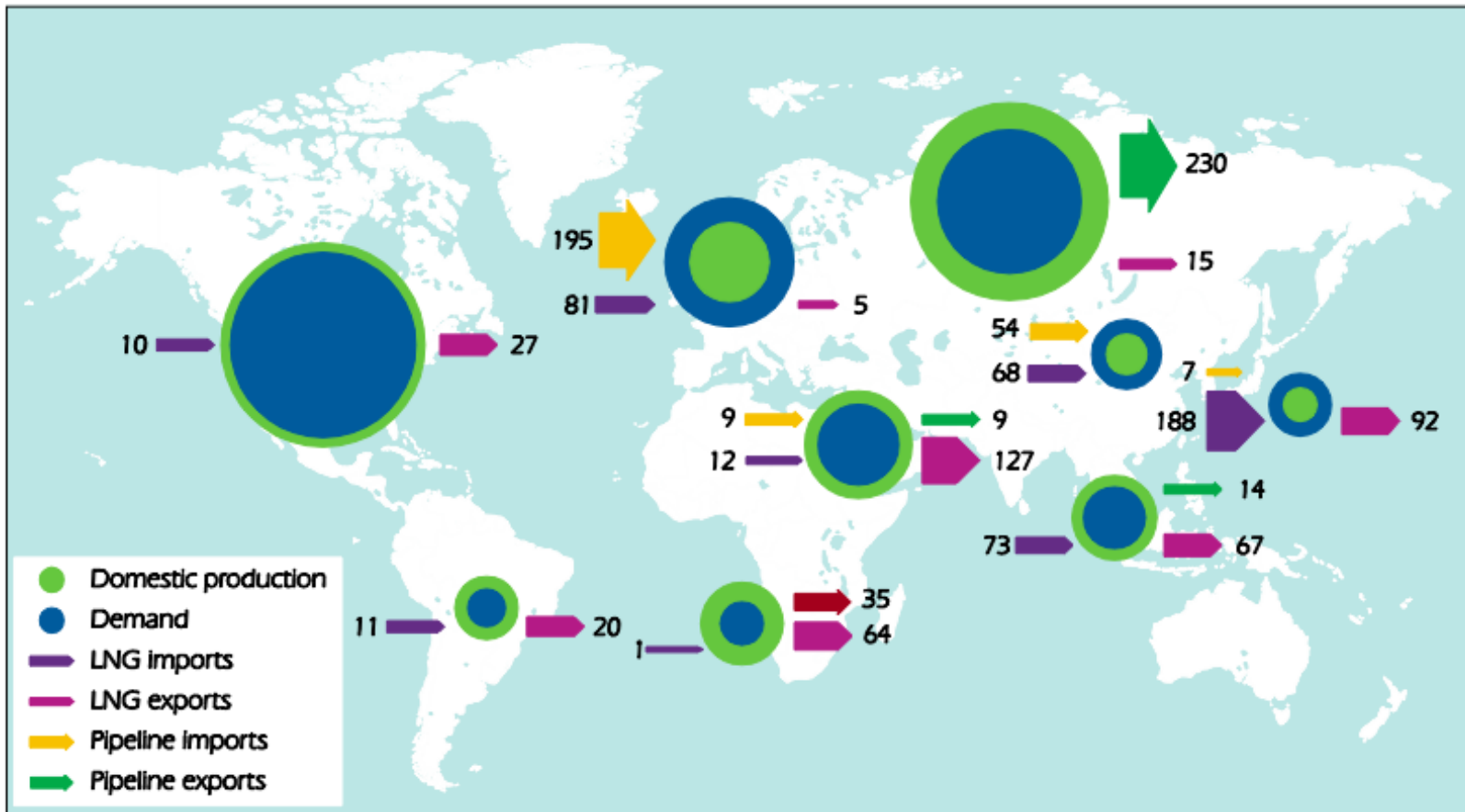
Future Trends in Europe

Figure 12 Monthly quantity of power produced by coal and gas in Germany, Spain, United Kingdom, Jan 2004-Jan 2013



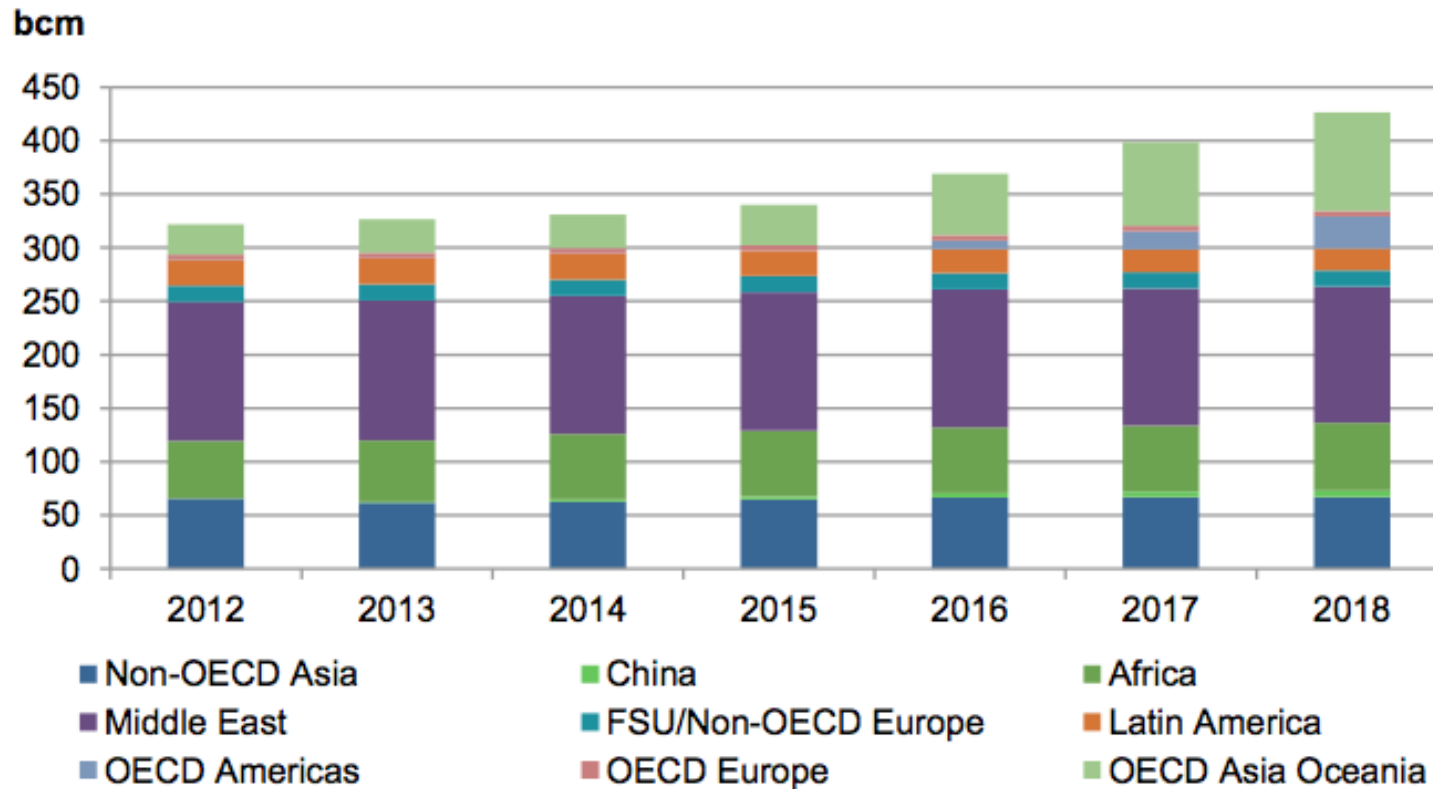
Natural Gas Interregional Trade

Map 9 Interregional trade in 2018 (bcm)



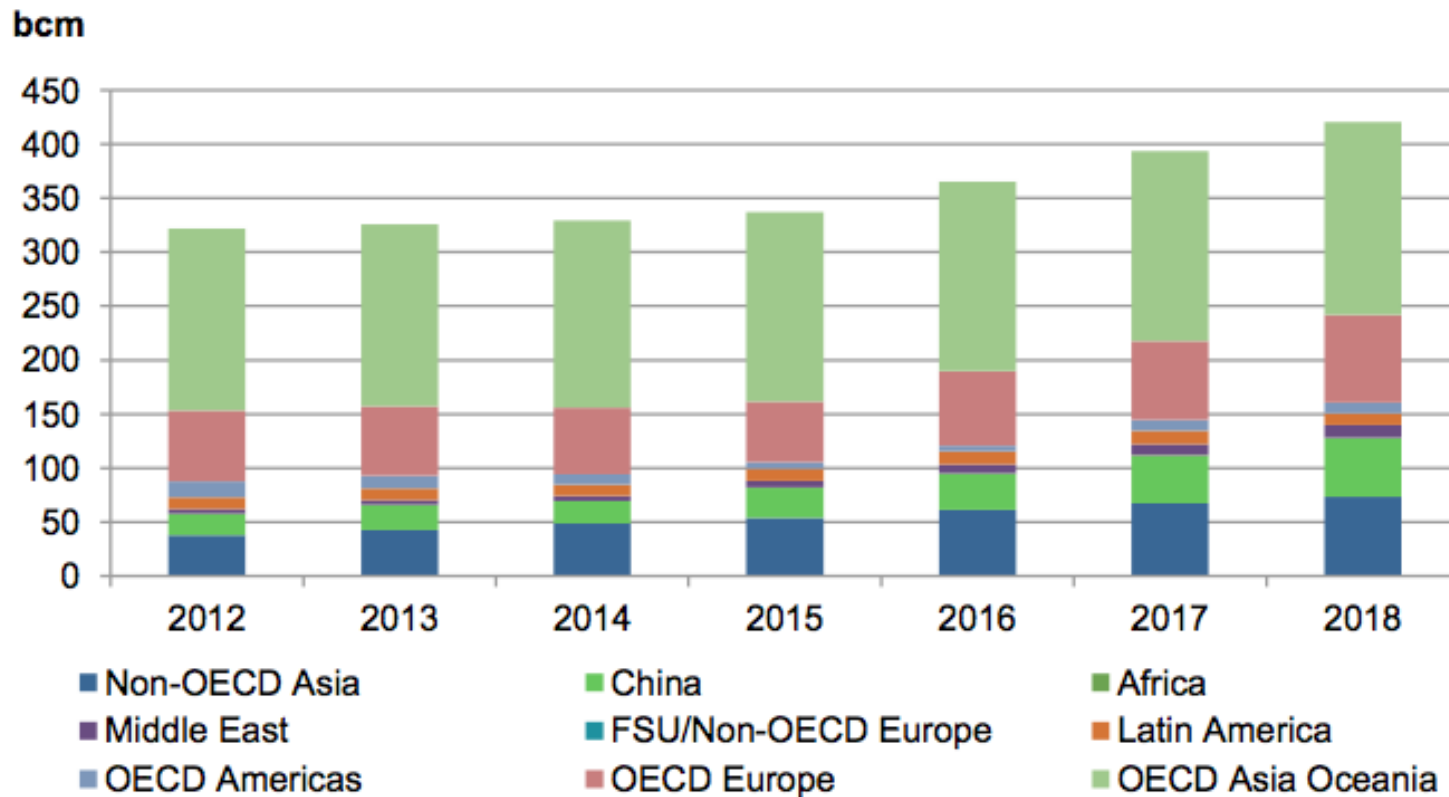
LNG Exports

Figure 48 Evolution of LNG exports, 2012-18

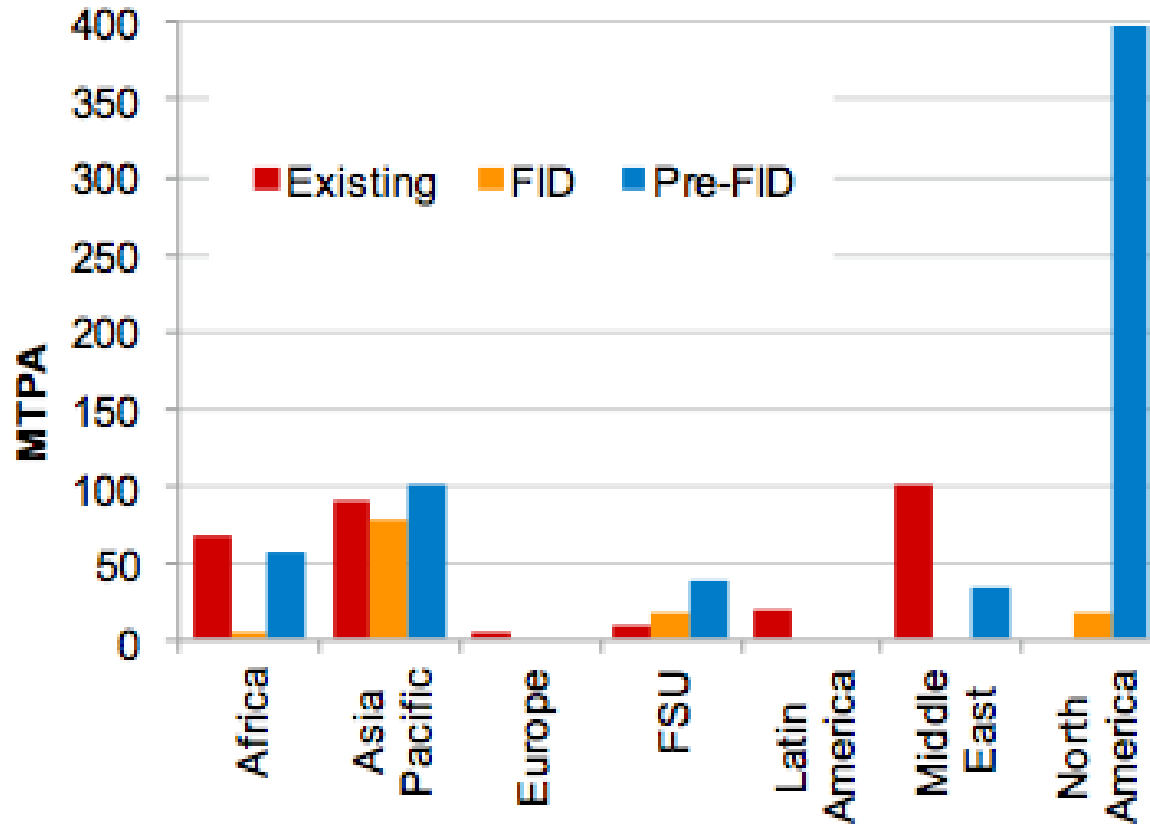


LNG Imports

Figure 49 Evolution of LNG imports, 2012-18



LNG plants under construction



Natural Gas for Transportation

Figure 28 Evolution of gas demand in the transport sector, 2000-18

