The Essential Understanding of Gas Supply

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Development of Oil and Gas

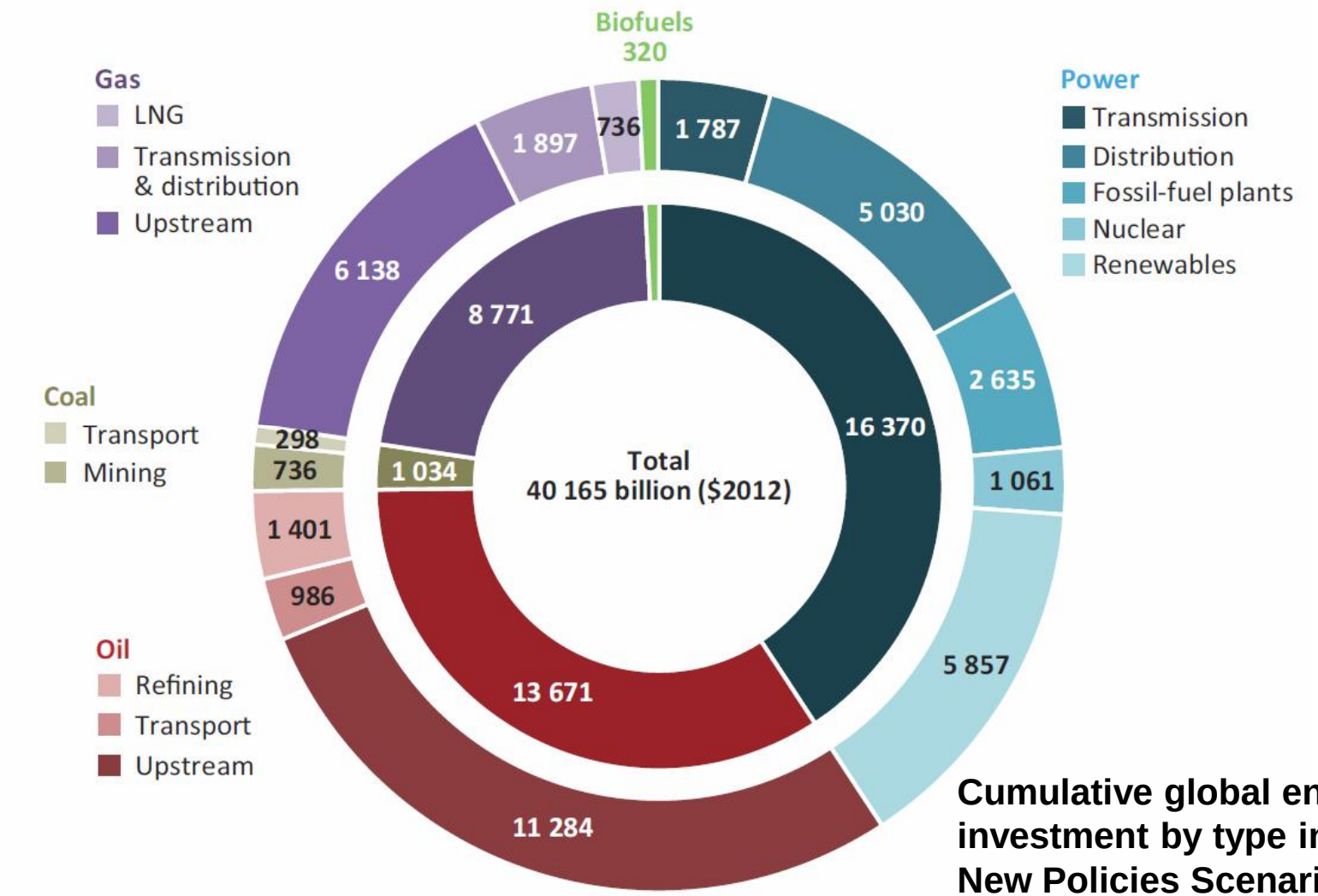
- Highly specific to the mineral extraction sector of industry: industrial activity must take place in the location where resources are found.

- The upstream oil and gas industry is set in a background of cross-border, international trade, with production frequently in a region with a challenging commercial environment.

- Oil and gas exploration and development projects are characterised by very large capital costs and very long lead times before revenue is seen.

- Aside for the obvious Exploration Risk, the development of oil and gas projects carries significant risks for all Parties. Often with incomplete information and unreliable forecasts.

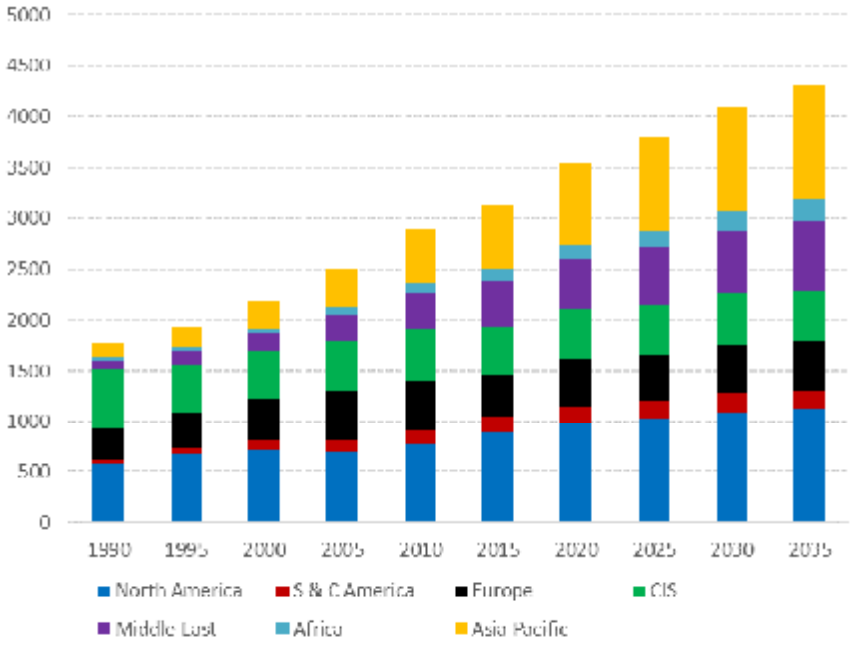
Scale of the Global Energy Business



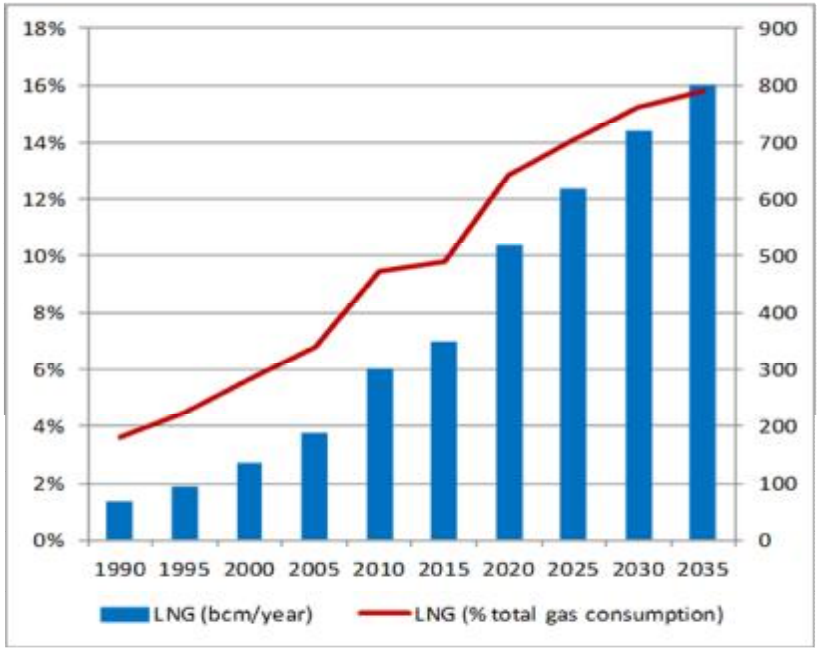
Cumulative global energy supply investment by type in the New Policies Scenario, 2014-2035

Forecast the Global Energy Business

Global gas consumption (bcm/year)



Global LNG consumption (bcm/year) and LNG as a % total gas demand

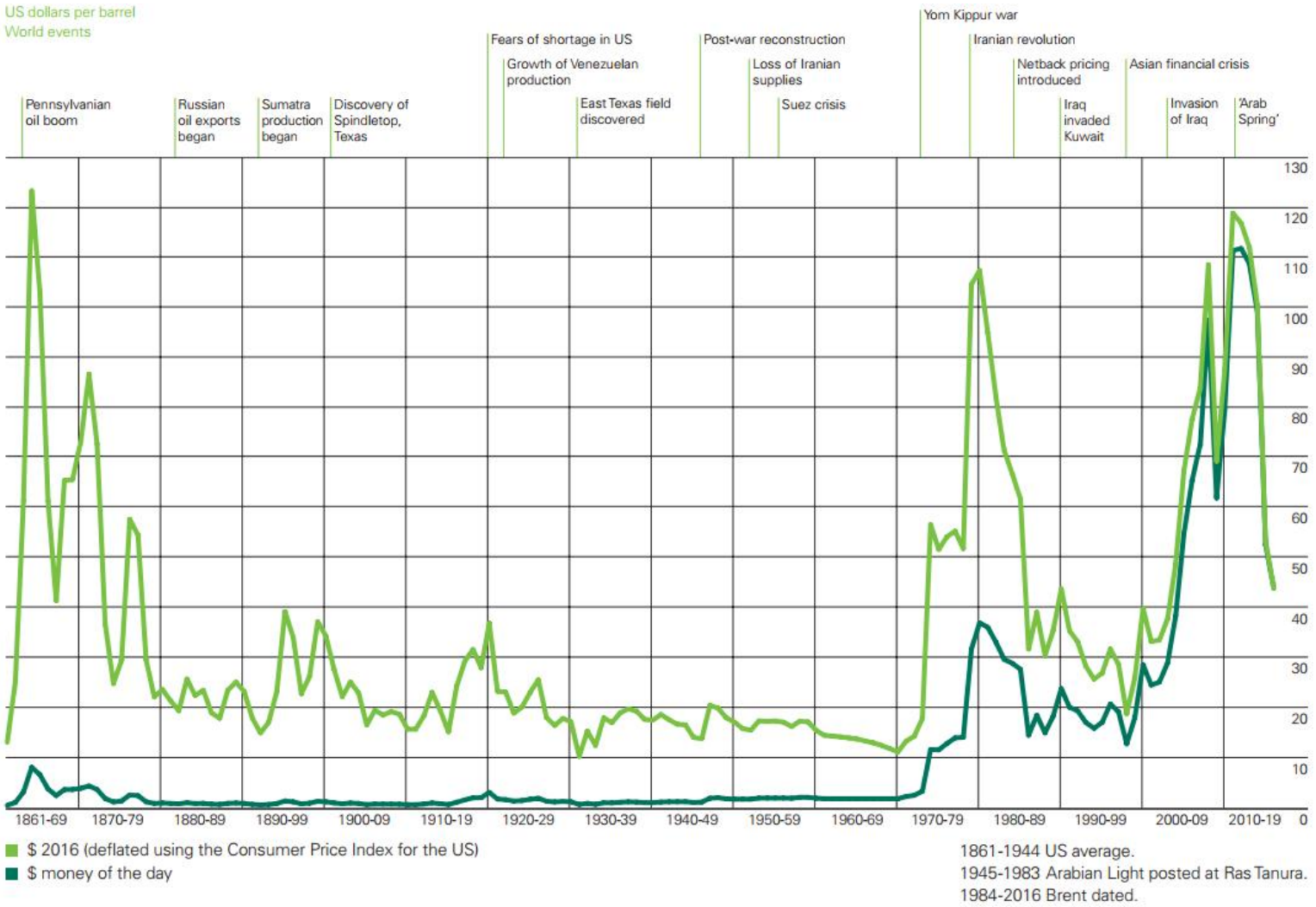


Source: BP Energy Outlook 2017

"a steady increase in energy needs of 1% per year on average means that – by 2040 – primary energy demand is almost 30% higher than today…the largest contribution to the increase in global demand – almost 30% – comes from India..."

IEA World Energy Outlook 2017

Crude Oil prices since 1861



BP Statistical Review of World Energy 2017

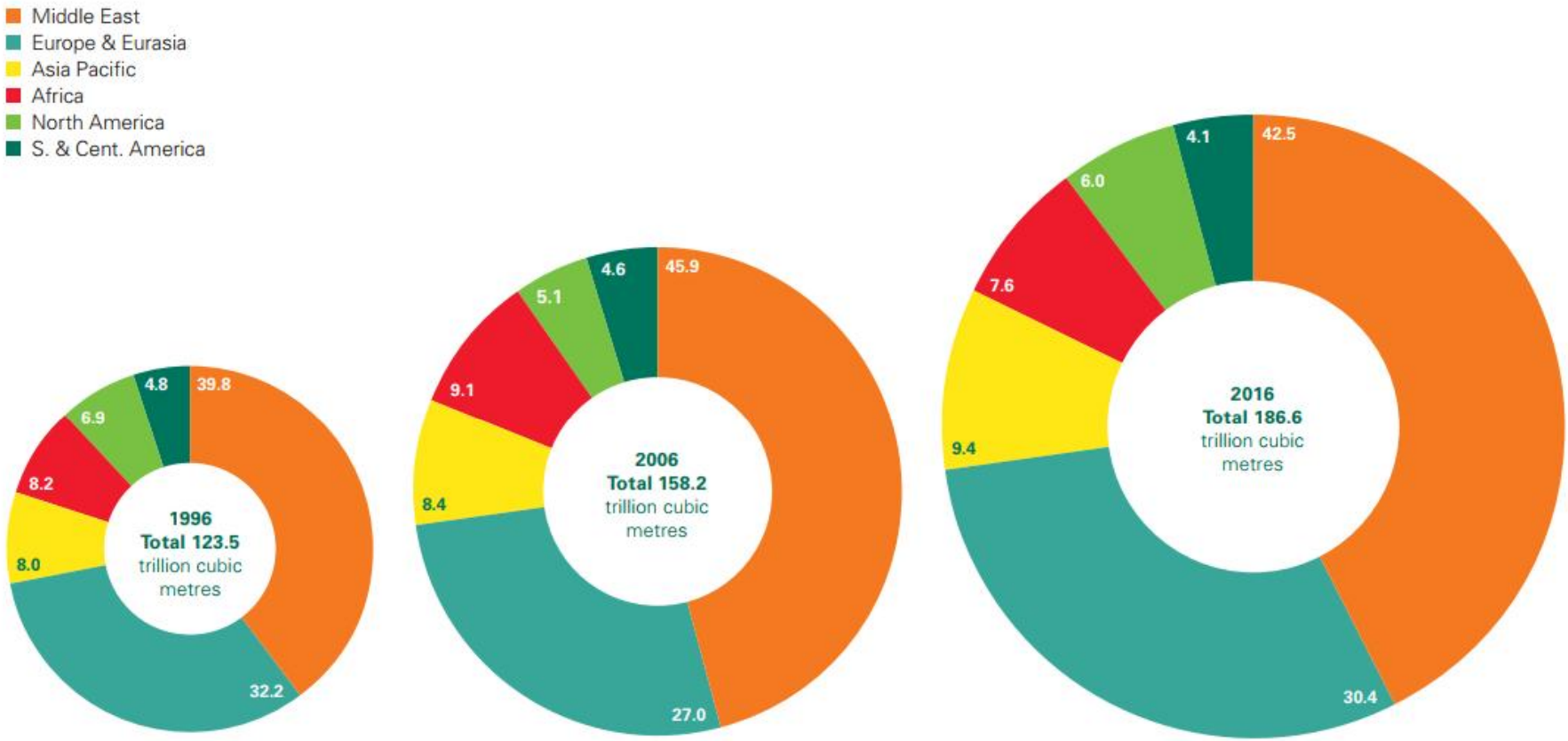
Commodity Prices – 5 year history

Brent crude $/bbl

Gold $/100 oz

Natural gas $/mmbtu

Proved Natural Gas Reserves



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Development of Natural Gas

- Gas reserves are booked only upon commercialisation unless can freely access a gas commodity market.
- Many gas developments commerce with fuel to gas fired power, which requires a large scale supply (e.g. 120 MW open-cycle power generation requires 180 bcf gas reserves).
- LNG development of remote, stranded gas is generally not feasible below 5 tcf gas reserves
- Commercial transactions still dominated by long-term bilateral trades, with traded short-term activity limited in Asia

Different Types of Gas/LNG Sales

Long Term Sales from Non Associated Gas Fields

- Field pressure management and gas production is managed to provide a steady or ‘plateau’ production rate for most of the field life.

Long Term Sales from Associated Gas Fields

- Gas is produced in accordance with the requirements for oil.
- Gas is only one of the phases present in the reservoir.
- Oil will be produced preferentially in the early years, with gas ‘blown down’ during the later part of the field life.
- Gas may be re-injected to maintain reservoir pressure

Spot and Short Term Sales

- Gas or LNG sales agreements for less than 5 years are becoming more and more popular.
- Gas Trading dominates Europe and N America, mainly spot.

Gas Buyer and Sellers

- Long term gas and LNG sales contracts (with Take or Pay) are generally between a limited set of Sellers and Buyers. Worldwide, the sale of wholesale gas is generally between:

Sellers: Gas Producers
Gas Wholesalers

Buyers: Gas Distribution Companies
Electricity Producers
Industrial Consumers
Gas Traders

Financial Strength of Buyers and Sellers

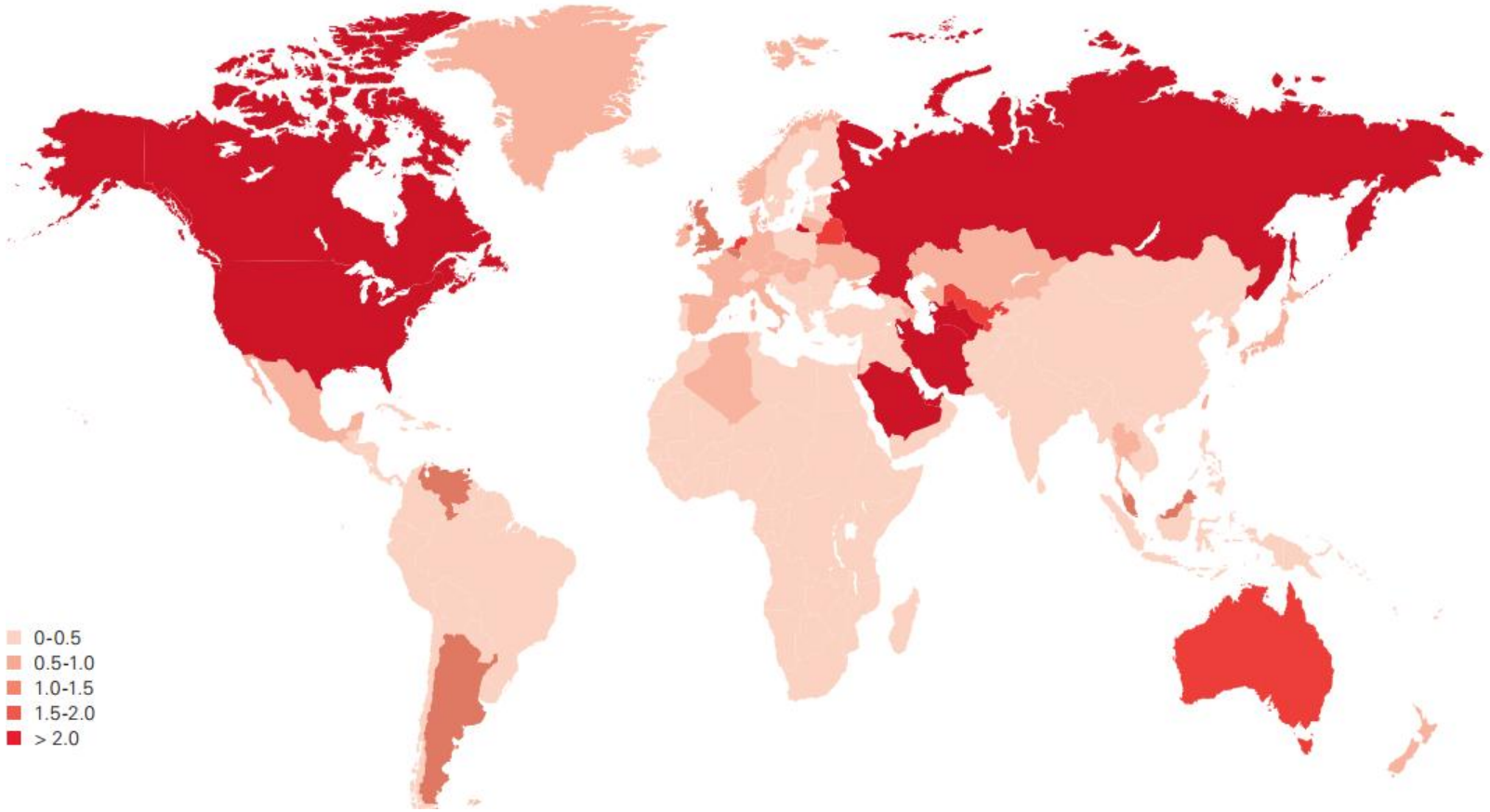
- It seems inevitable that trading patterns in natural gas will change, and that large scale traded markets in wholesale gas and LNG will spread internationally. Concerns over market liquidity and the financial strength of trading companies as counter-parties are major factors causing unease.

- A 15-year contract for 3 bcm/yr of gas (2.1 million tonnes/yr LNG; 290 MMSCFD gas) carries a Take-or-Pay of US$ 8 billion.

Natural Gas consumption per capita

Consumption per capita

Tonnes oil equivalent



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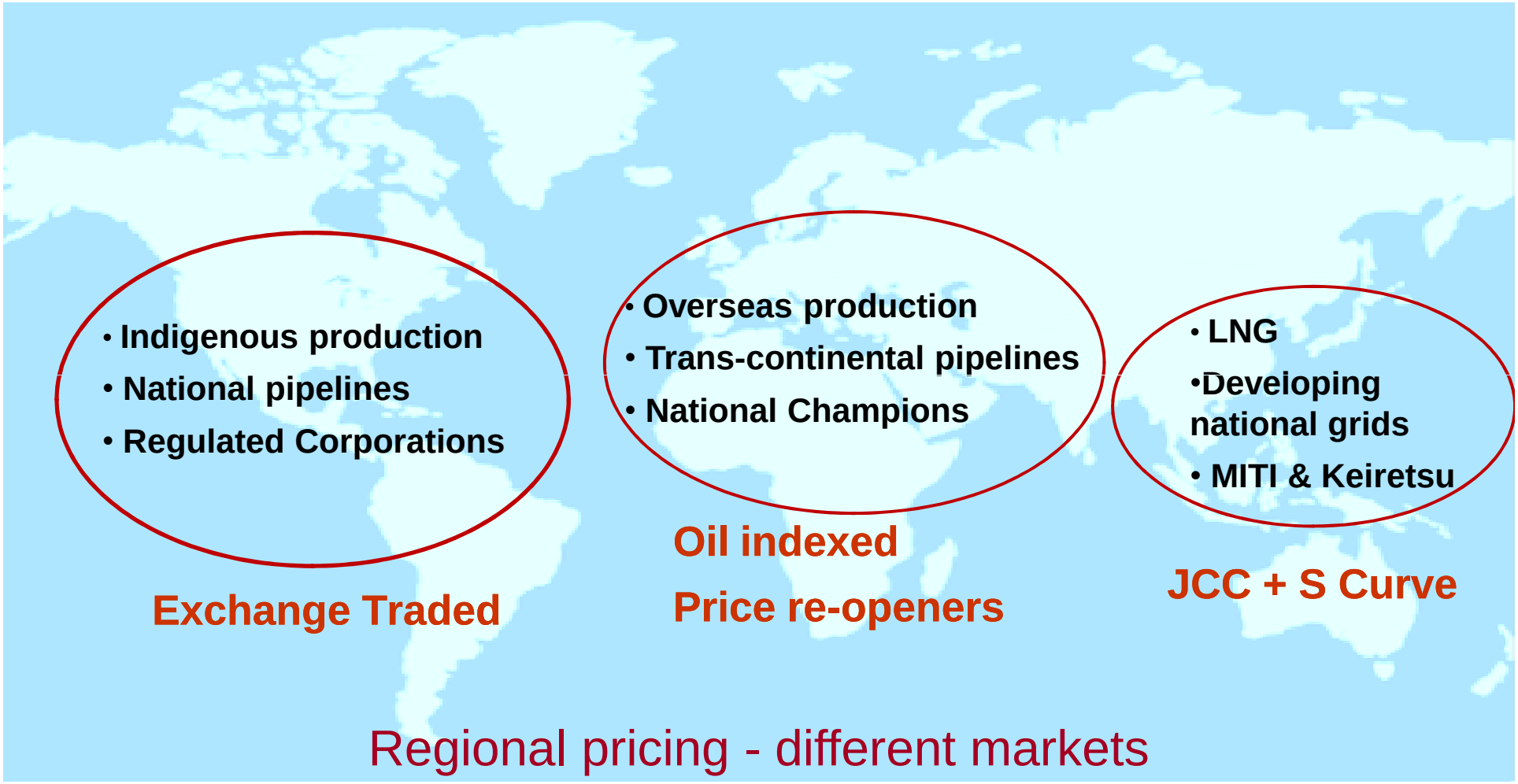
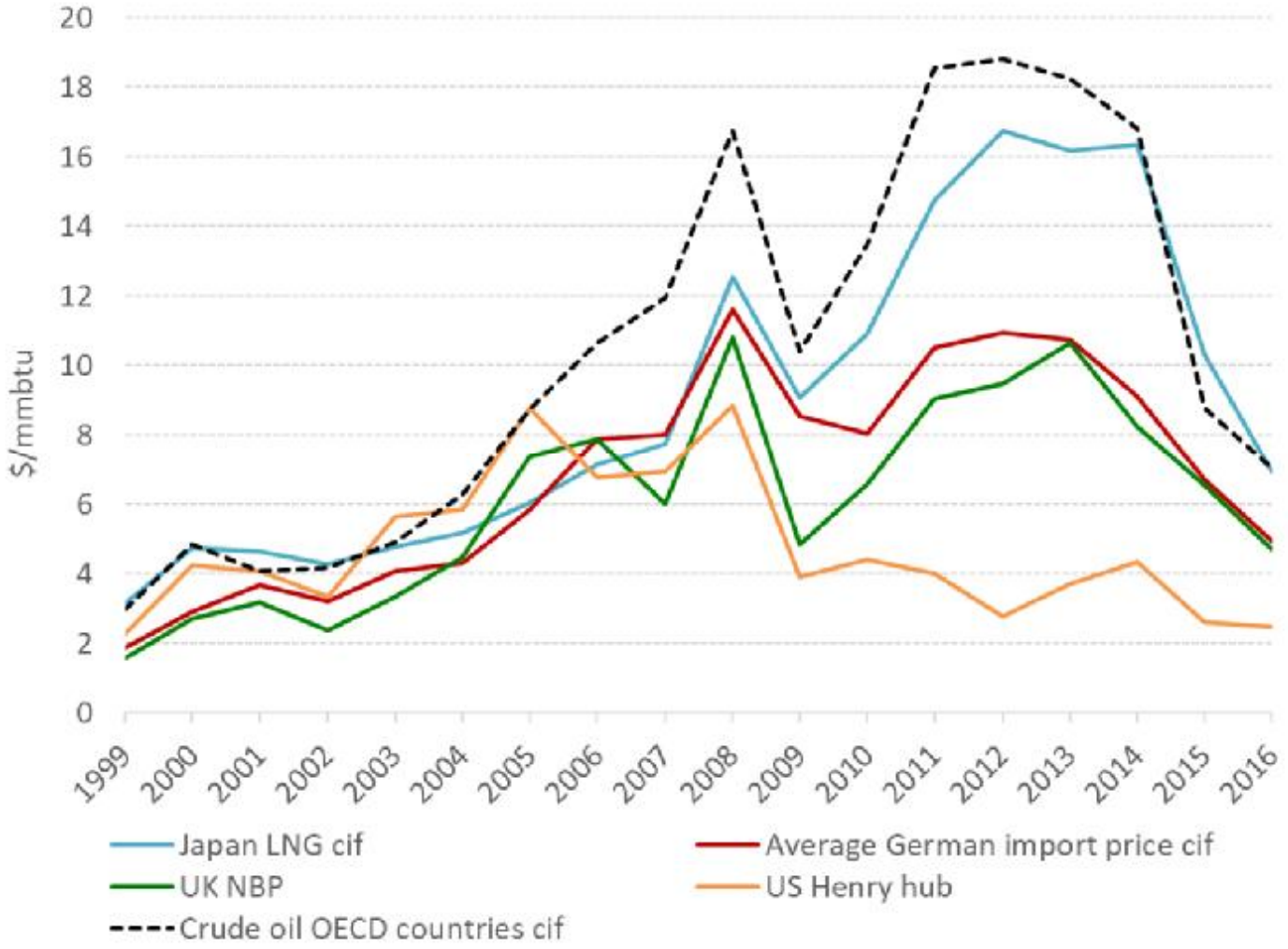
Regional evolution of the gas industry



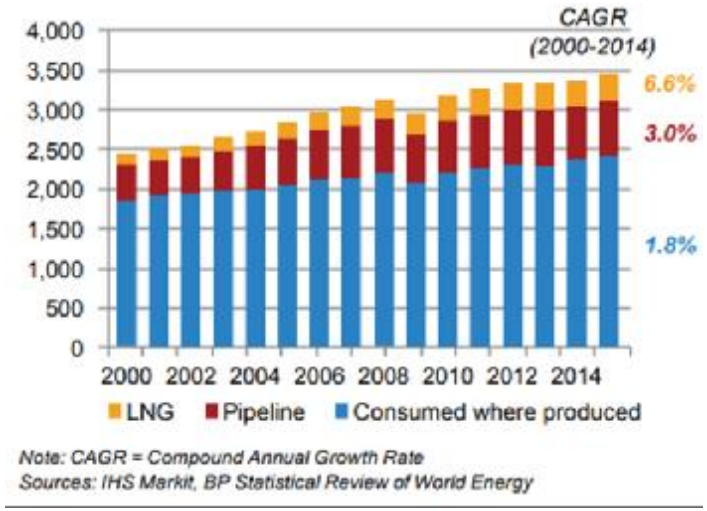
International gas prices - regional



Source: BP Statistical Review of World Energy 2017

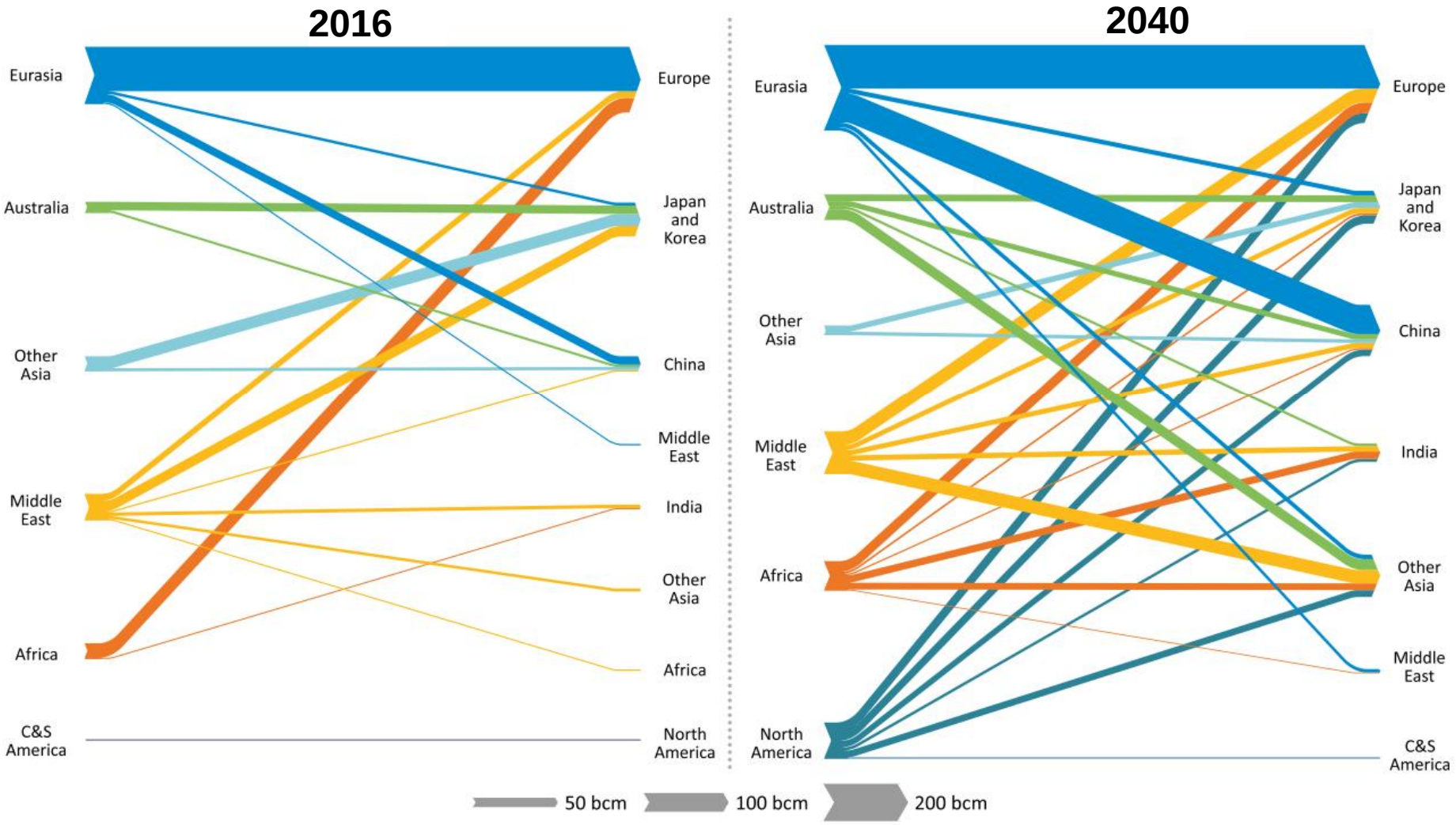
Gas trade

- The gas market cannot be considered a uniform international market. In 2016 world gas consumption was 3543 bcm
  - 31% was traded internationally
  - 738 bcm by pipeline and 347 bcm as LNG
- Regional gas markets rarely interconnect as a result of the high Cost of Carry
- Changing:
  - Ø worldwide growth in gas sales
  - Ø many governments want gas-to-gas competition
  - Ø outside the US & EU there is almost no traded gas market.
- The most significant price connector between the separate gas markets is the price of its main competitor – oil.
- In gas developments, a long term Gas Sales Agreement is the key to success.
- GSA can be for up to 25 years, with price indexed to another commodity
- Negotiation of long term GSAs has traditionally been the time-consuming cornerstone of a gas development.



Source: IGU 2017 World LNG Report

Global gas trade flows – 2016 vs 2040 forecast



IEA World Energy Outlook 2017

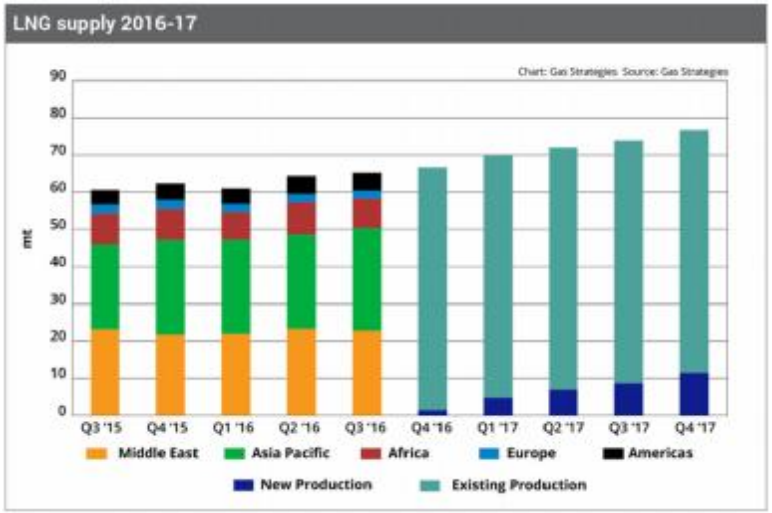
Liquefied Natural Gas

- Increasingly, the long-distance, international trade in natural gas is by means of Liquefied Natural Gas (LNG). Natural gas (predominately methane and some ethane) is cryogenically liquefied to very low temperature of -163^{0}C (-260^{0}F).

- LNG is about 1/600th of the volume of gas, and transportation around the world by specially-built tankers is feasible.

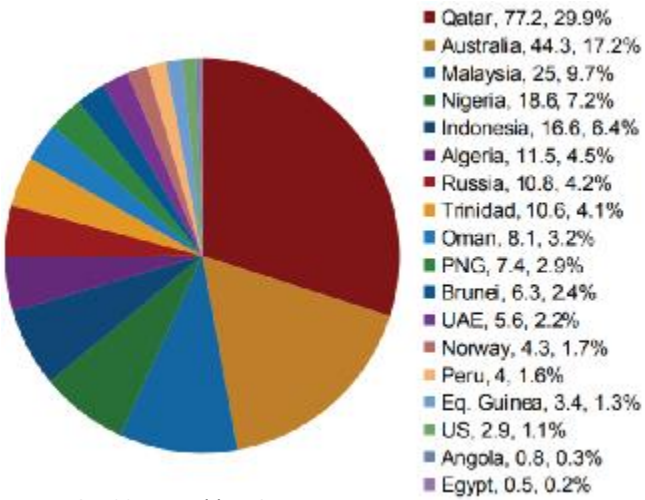
- This process, although incredibly expensive, is nonetheless more economic than the alternative of pipeline connection between the source and the market.

Worldwide LNG Production by Region



Source: Gas Strategies LNG Outlook 2017

LNG Exports (MTPA) and Market Share (%) by Country



Source: IGU 2017 World LNG Report

LNG is currently produced and exported by 20 countries worldwide

Total LNG production nameplate capacity in the world

End 2016: 340 mtpa (432 bcm)

2020: 452 mtpa (574 bcm)

Some export capacity restricted by feed stock shortages

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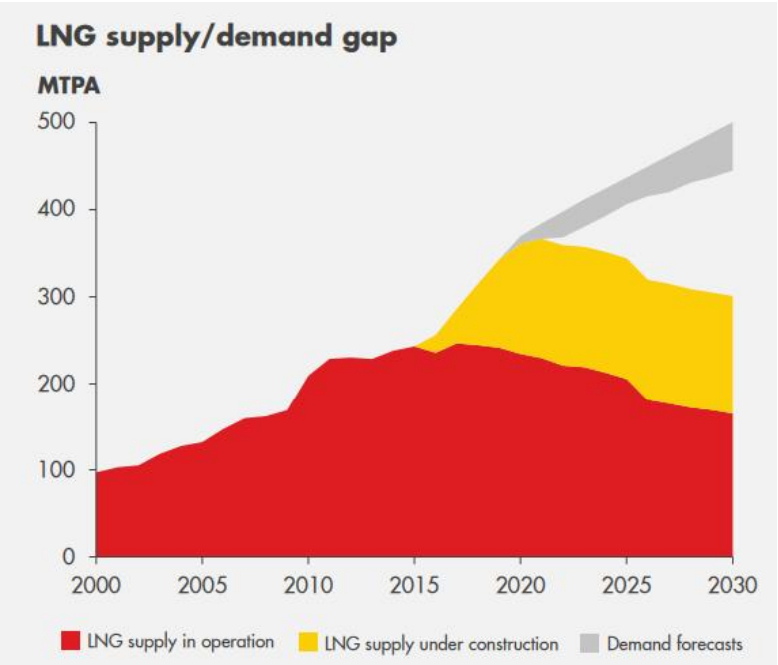
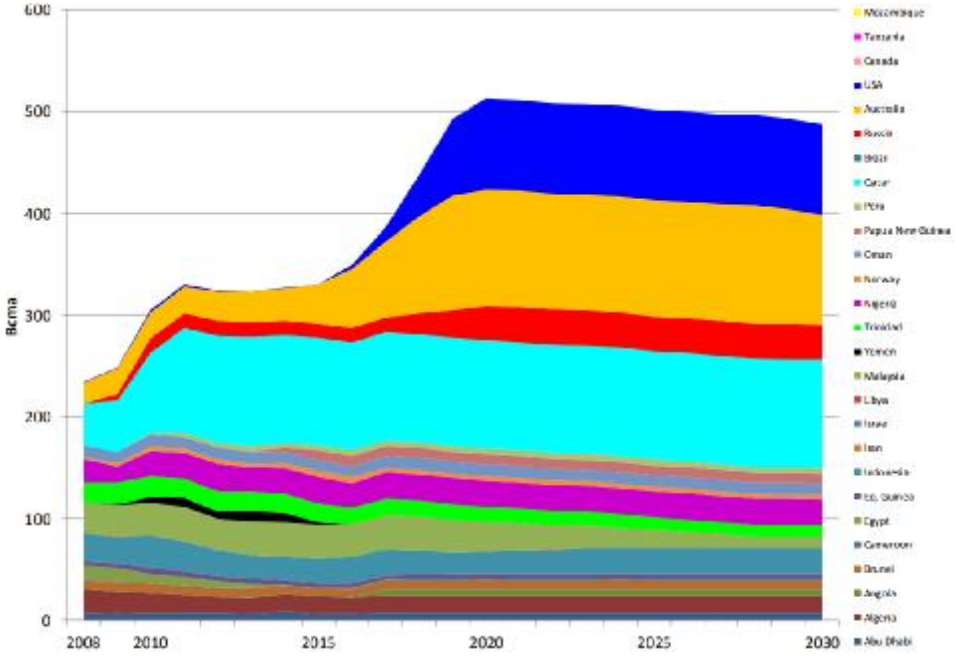
Worldwide LNG Production surge

Global LNG capacity and demand



Source: Shell LNG Outlook 2017

Global LNG Supply 2008 – 2030 from Existing Facilities and Projects under Construction

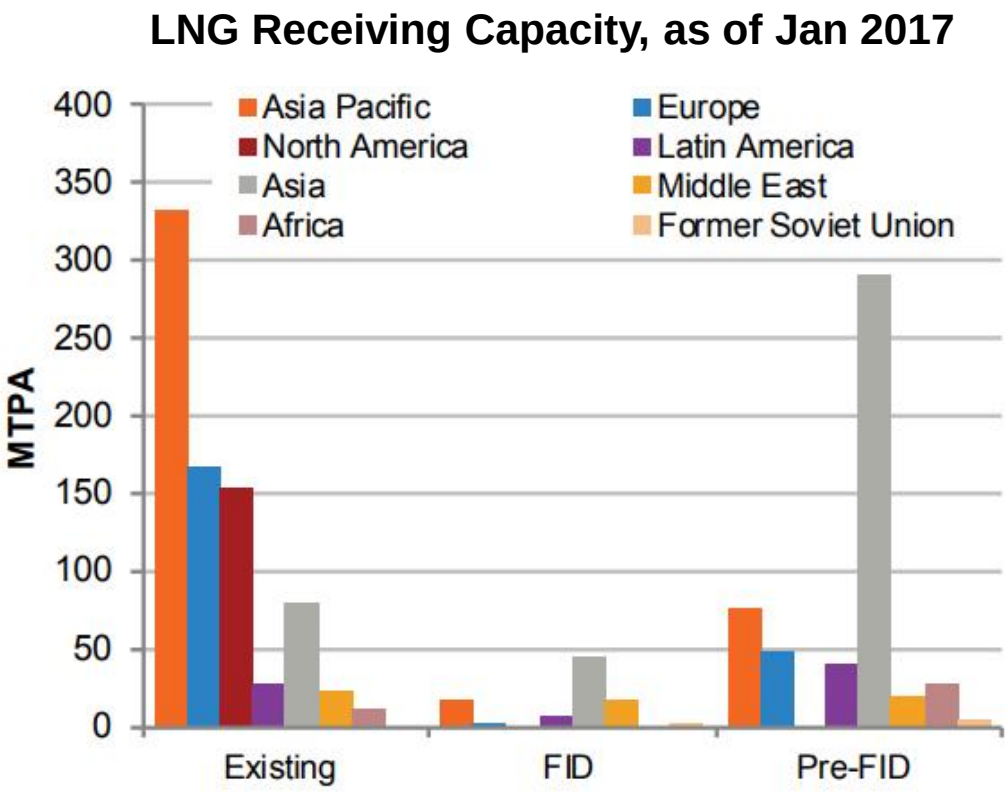


Source: OIES, 2017

90% of new this production has long term contracts

- 30% of LT contracts are with portfolio traders
- The rest sold direct to end users

Worldwide LNG Regasification by Region



Source: IGU 2017 World LNG Report

LNG is currently imported by 39 countries worldwide with 2 more due to start by end of 2018

The total capacity of the 121 LNG regasification terminals existing worldwide is 830 mtpa (1120 bcm/y), more than twice that of worldwide LNG production capacity

New terminals 2015-16 in Colombia, Egypt, Jordan, Malta, Pakistan, Poland

GIIGNL 2017

LNG Facilities – Typical Costs / Dimensions

3.5 mtpa supply:

Gas Production	Liquefaction	Shipping	Regasification
$ 2-3 bn	$7-8 bn	$200m each	$1000

1 mt = 1.4 bcm

The Essential Commerce Balance - Gas

- Pipeline sales of gas under a long-term Gas Sales Contract have always followed a certain commercial balance:

Seller: Each day will tender gas up to a daily maximum quantity;

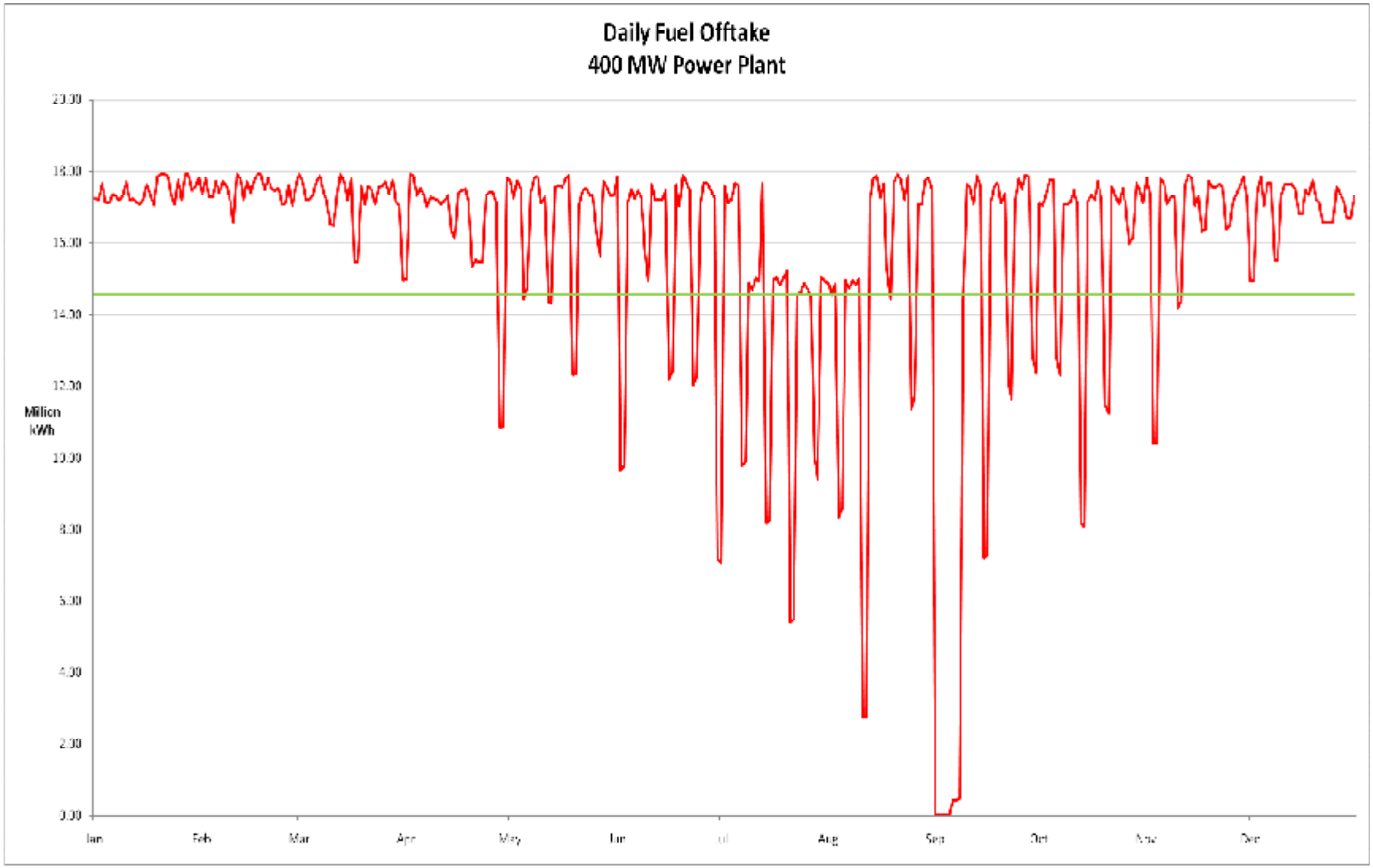
Buyer: Each year will commit to take a fixed quantity, or pay if not taken

- Buyer nominates for delivery each day but has no obligation on any day to take gas.

- For supplies to an LNG production facility, nominations are generally Monthly, Weekly and Daily – production is base load therefore contract swing is minimal (5 – 10%)

- Seasonality is an issue as summer / winter temperature differential will impact the LNG process and therefore quantity nominated by the Buyer / Plant operator

The Essential Commercial Balance – Gas



The Essential Commercial Balance - LNG

- Long-term sales of LNG under a LNG Sales Contract have followed a similar commercial balance.

- However, LNG sales contracts are simpler as the product is delivered in discrete cargo lots, and with the majority of sales into Japan this commercial balance is virtually un-tested.

  Seller: Each month will deliver LNG up to the cargo schedule

  Buyer: Each year will commit to take a fixed quantity, or pay if not taken

Gas and LNG Agreements - Quantities

- Gas and LNG Sales Contracts contain well-defined terminology relating to Quantities

- The three essential concepts are:

ACQ
Annual Contract Quantity

DCQ
Daily Contract Quantity

MDQ
Maximum Daily Quantity

The Scale of Gas Sales Agreements

- The scale of the Gas Sales Contract is set by the Daily Contract Quantity (DCQ).

290 MMSCFD | **303,319 MMbtu per Day** | **320,020 Gj/Day**

The DCQ is a measure that the maximum delivery capacity is set against, and the sum of the DCQs for a year (the Annual Contract Quantity) is the basis for the Take-or-Pay level

3.0 bcm per year

- Gas supply for conventional, base load LNG plants must be sourced from one or more fields which can support the production of very large volumes of gas for long periods, typically for a 2.1 mtpa production train at least 100 bcm (3.5 Tcf) proved reserves would be required to support a sales contract of 20 - 25 years duration.

- Certification of reserves by a qualified reserves auditor is essential to ensuring that the contract quantities can be met, plus a margin in addition.

The Scale of LNG projects

In LNG sales, the scale of the LNG Sales Contract is set by the Annual Contract Quantity (ACQ)

Typically:

- 400 MW combined cycle power plant burns 18,000 MWh/day gas or 0.6 bcm/year gas

- Therefore a 3 bcm train of LNG can support 2,000 MW power plant
  → Trains of up to 10.6 bcm/year are in operation

2.1 MM tonnes per Year

3.0 bcm per year

1,107.11 MM therms/Years

116,807,255 Gj/Year

Units Of Measurement in LNG

	Unit	Metric	Imperial
Feedstock Gas	Volume	mmcm/day bcm/year	scf/day
LNG Production	Weight	mtpa	
Ship Capacity	Liquid Volume	m^3	
Re-gas Capacity	Liquid Gas Send-Out	mtpa bcm/year	scf/day
Sales	Energy	Gj MW	mmbtu therm

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