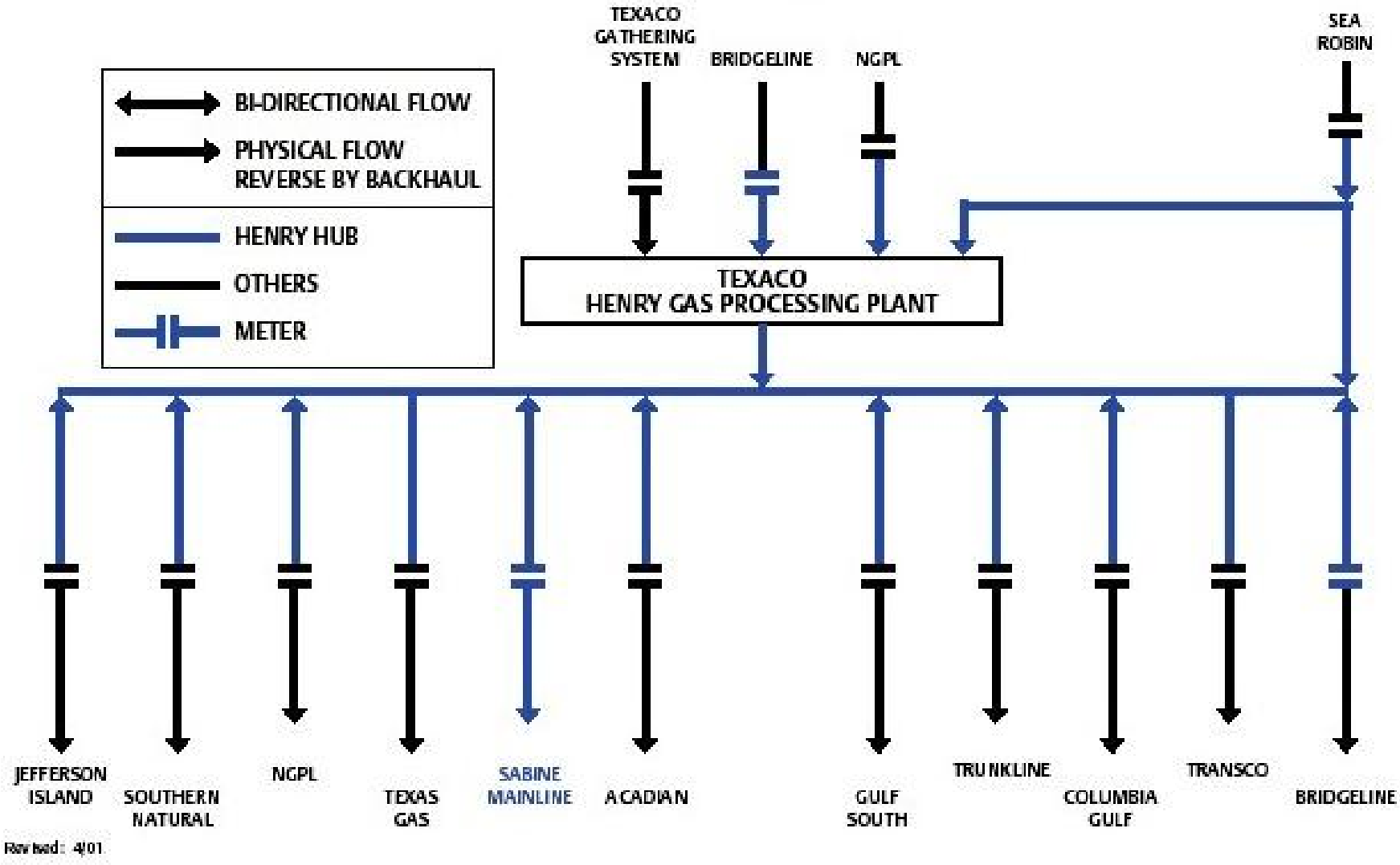
NORTH AMERICA: ESTABLISHED PRICE FORMATION, MAJOR PRICE LEVEL UNCERTAINTY

North American Gas Price Formation History (1950s to 1990)

- Regulated "cost of service" pricing – including international trade – US/Can//Mex
- A short period of oil related pricing in the late 1970s/early 1980s
- Hub pricing takes over around the mid-1980s with Henry Hub as the dominant price discovery point
- First NYMEX futures contract April 1990

The focus in North America has been on spot and futures pricing for the past 25 years, BUT the US and Canada went through a similar price formation cycle to most other countries

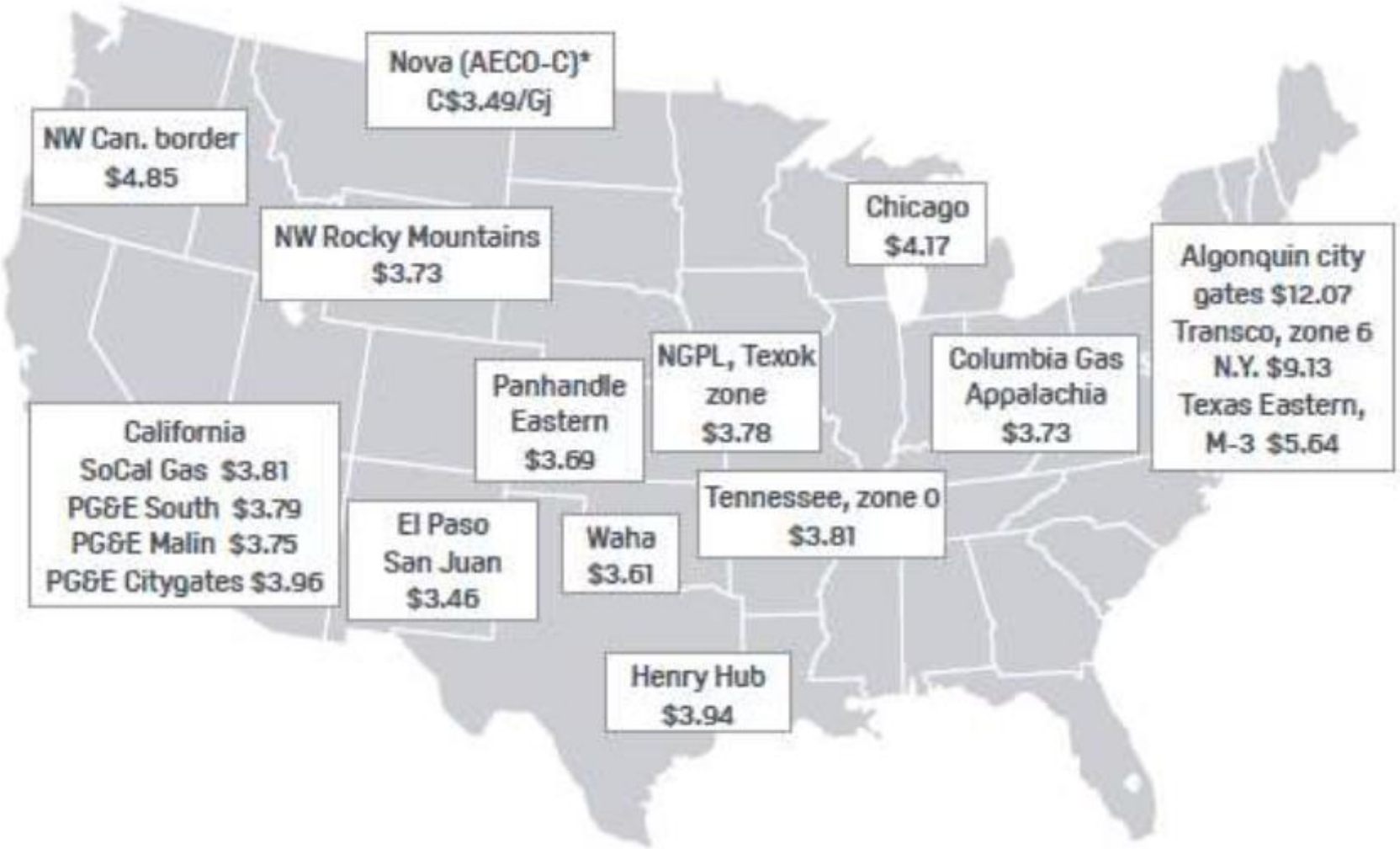
Henry Hub: a physical location



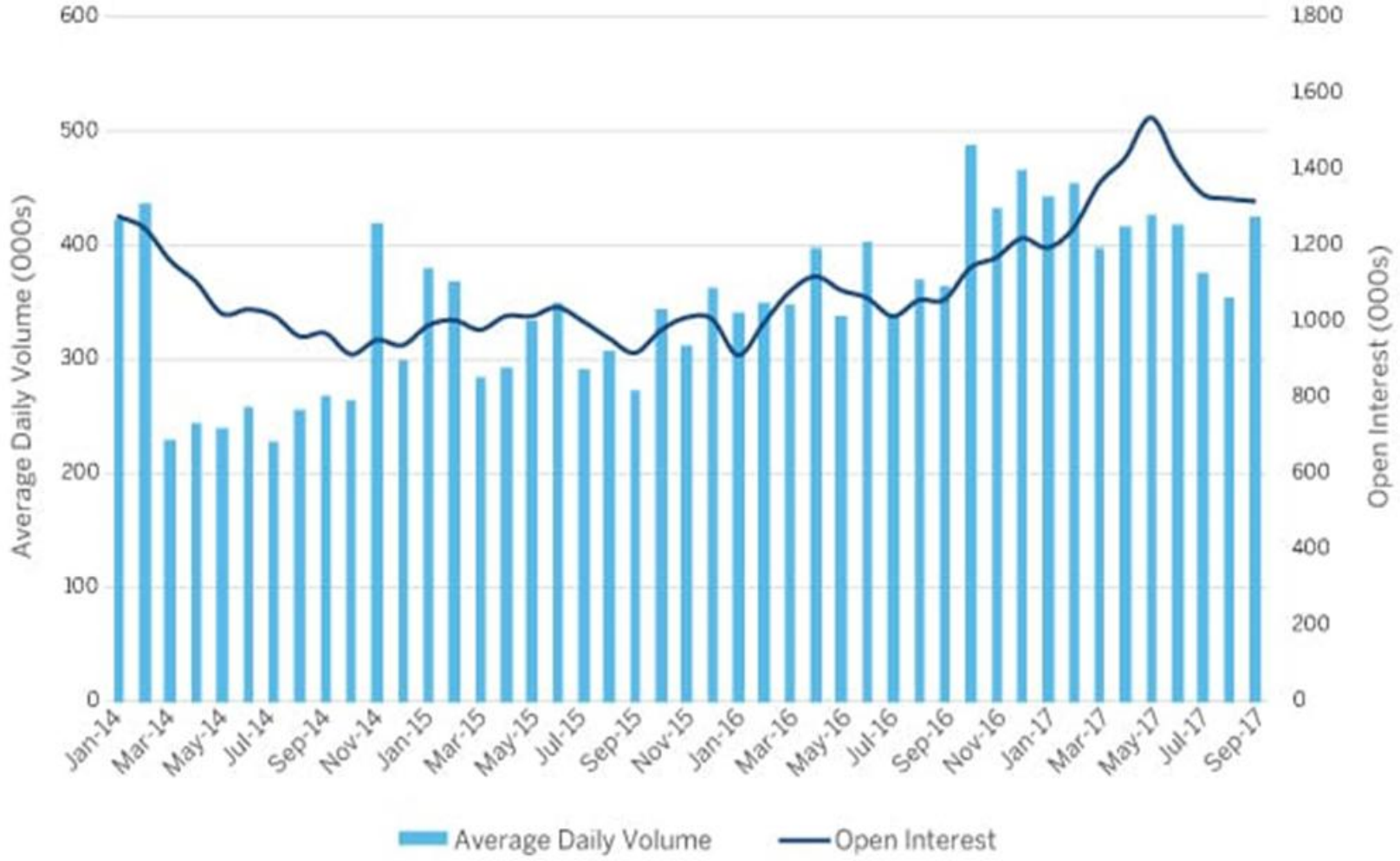
Source: http://www.sabinehubservices.com/public/sysmap.asp

North American Hub Prices (January 2017)

Source: Platts

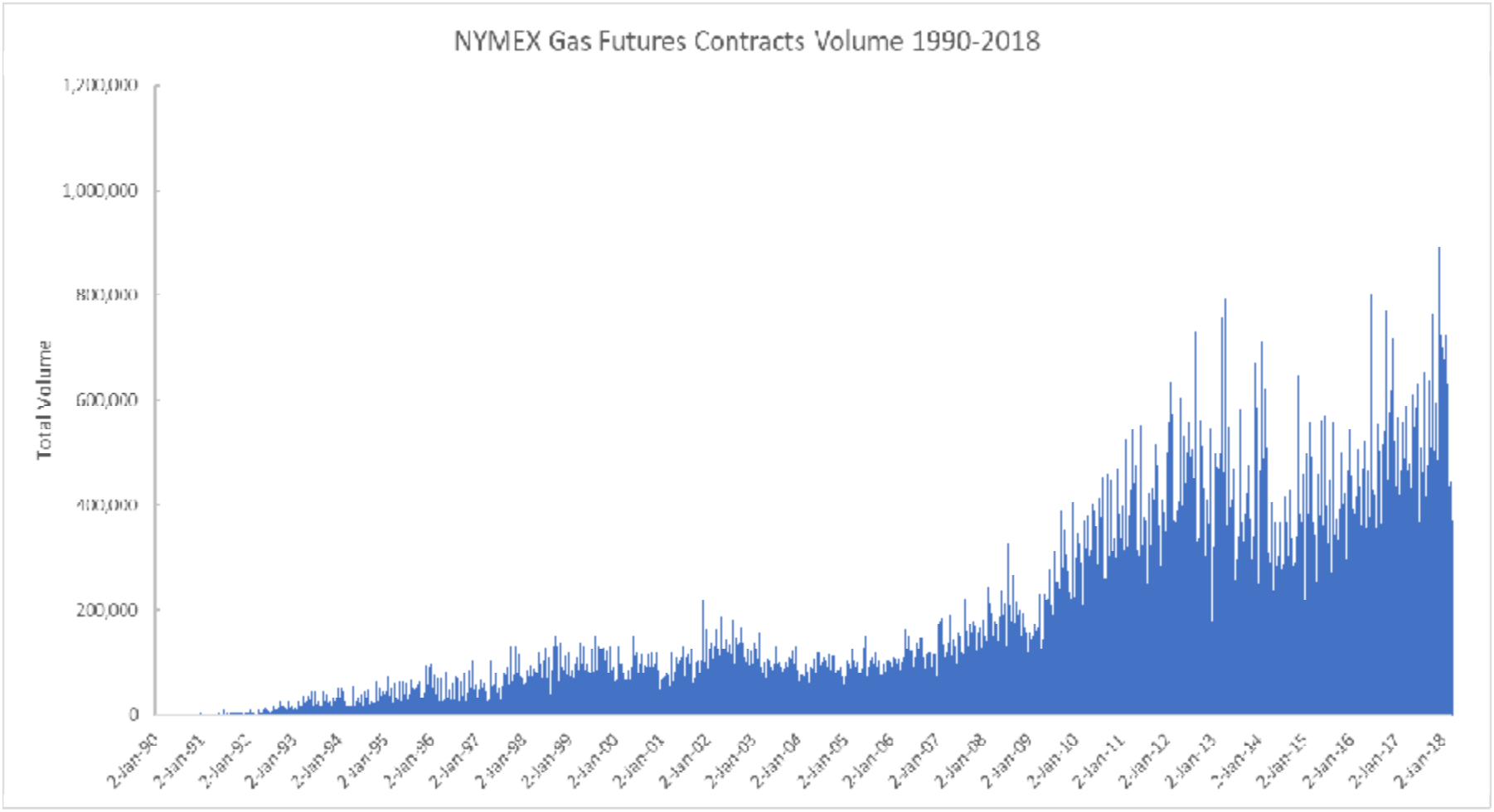


Henry Hub Natural Gas Futures (NG): Average Daily Volume and Open Interest

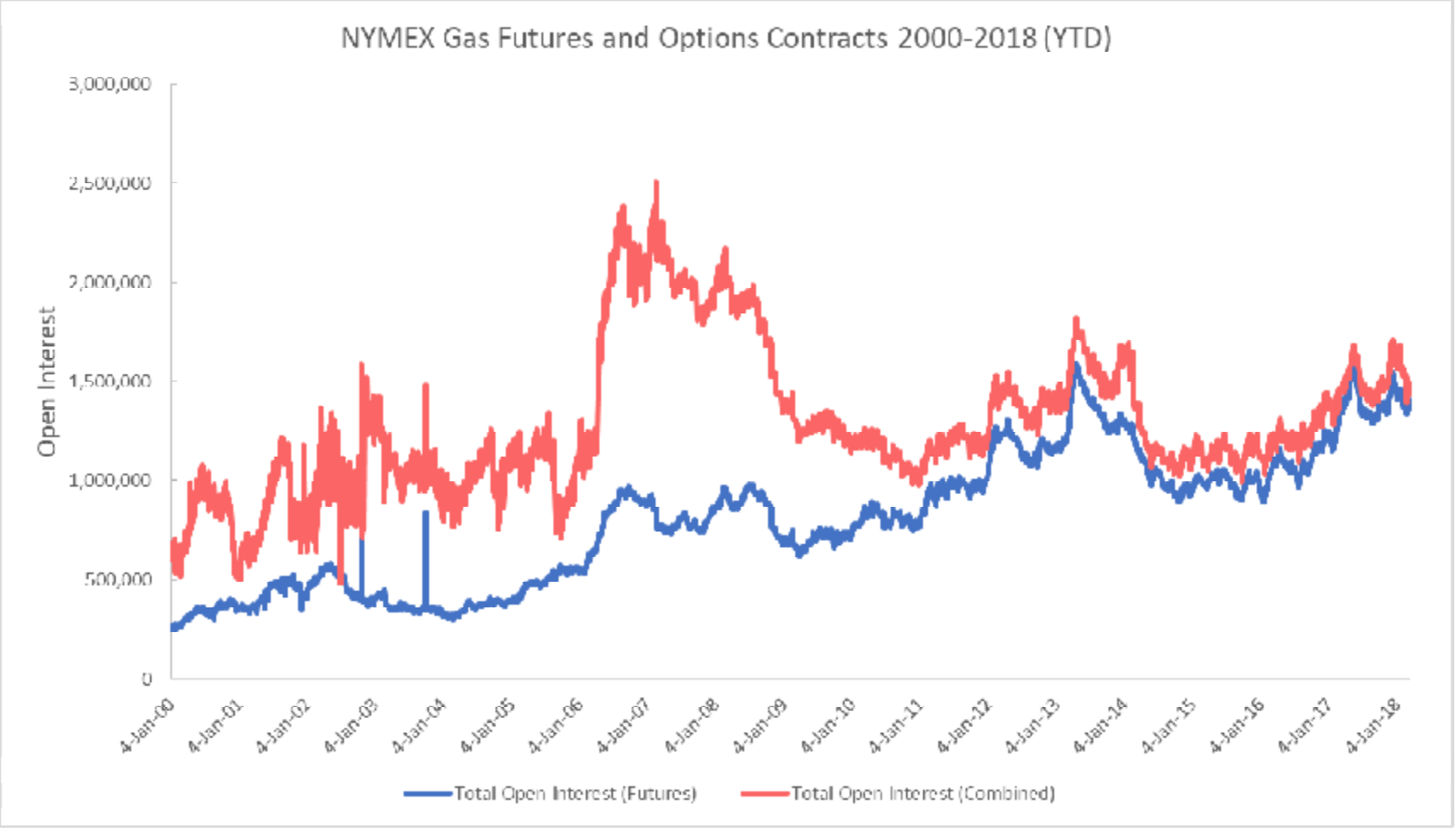


Source: CME

NYMEX Gas Futures Contracts 1990-2018



NYMEX Gas Futures and Options Contracts 2005-2018



Source: CFTC/CME

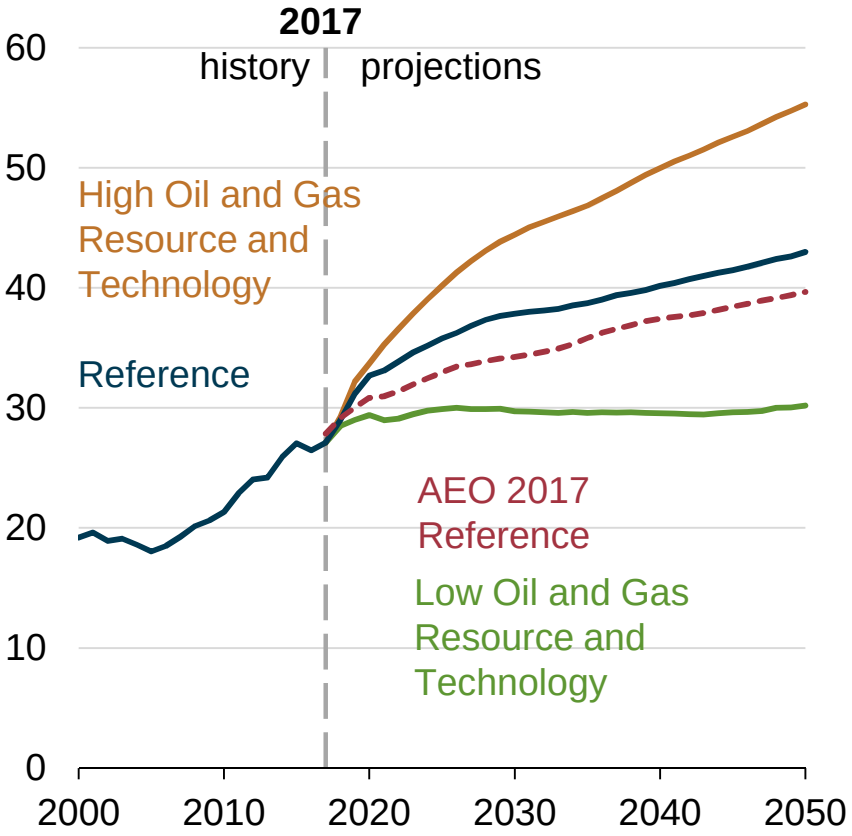
NORTH AMERICAN GAS PRICES IN THE 2010s and 2020s: $2-8/MMbtu?

The price ceiling is likely to be set by the marginal cost of dry shale gas – in the early 2010s this was generally assessed as $5-7/MMbtu; in 2017 – reference secenario prices are $3-5/MMbtu over the next several decades

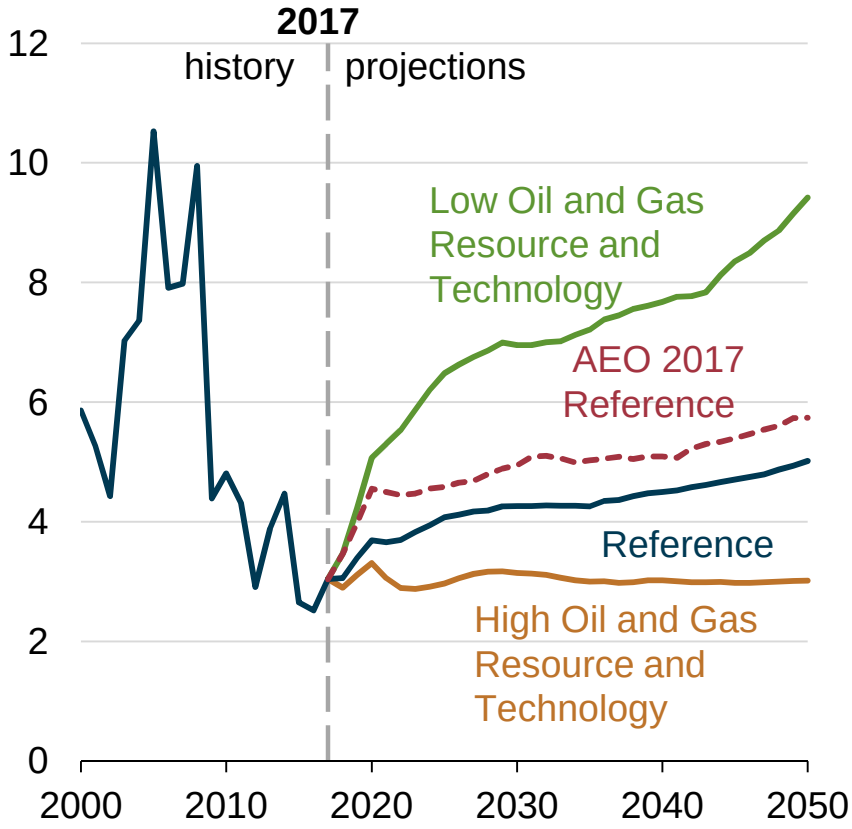
BUT: PRICE FORMATION – HENRY HUB/NYMEX SPOT AND FUTURES – NOT IN DOUBT

Natural gas prices across cases are dependent on resource and technology assumptions—

Dry natural gas production
trillion cubic feet

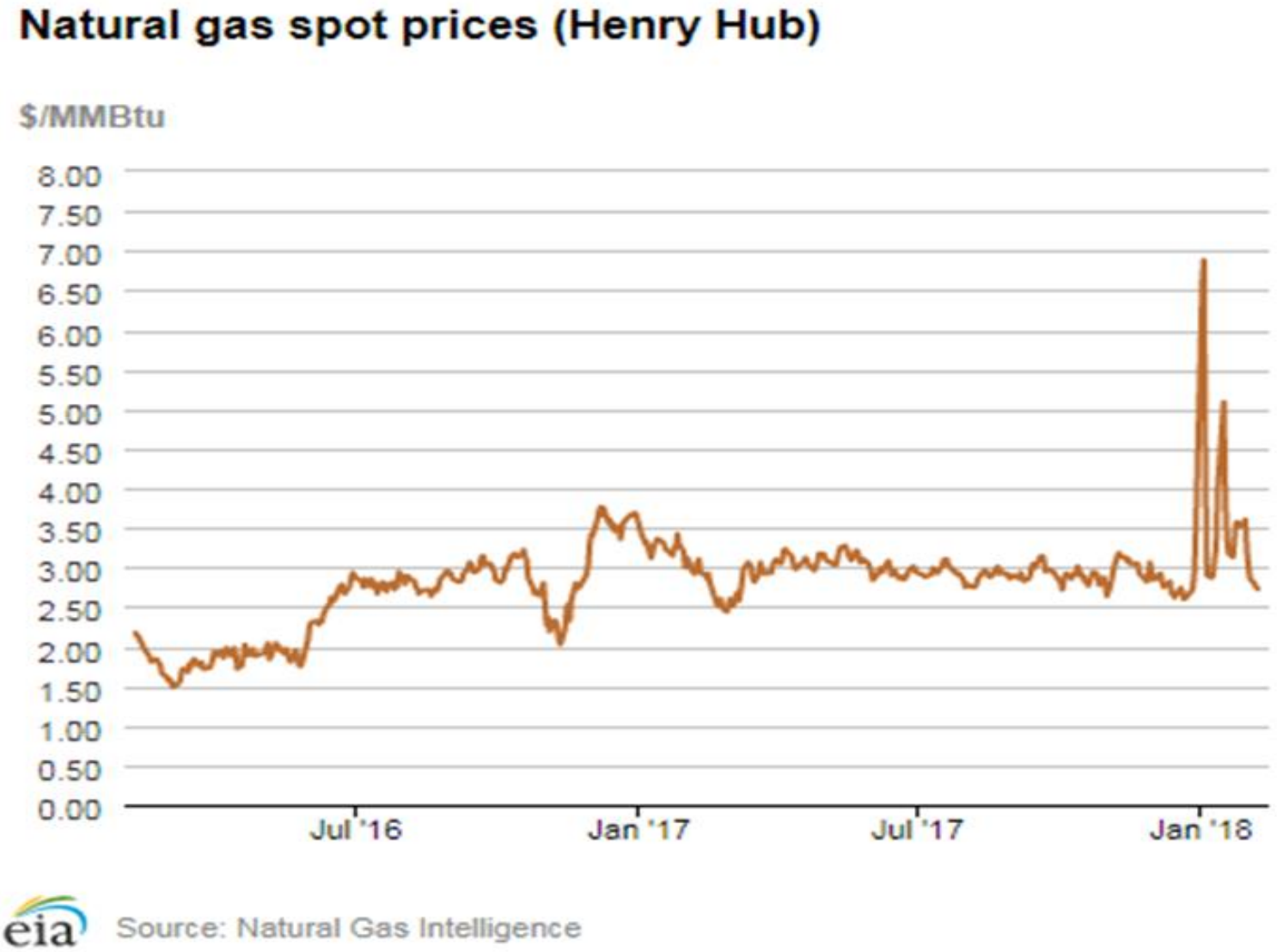


Natural gas spot price at Henry Hub
2017 dollars per million British thermal units



Henry Hub Prices: from the "Polar Vortex" of February 2014 to the trough of 2015/16

Henry Hub Prices: sustained $2.00-3.50 during 2016-18; polar vortex in January 2018



North American Price Levels: cycles and stranded assets

- 1980's – first LNG regas terminals built and closed as prices fell;
- 1990's – Prevailing perception of plentiful, low cost natural gas supply launched 220 GW of CCGT's;
- 2000-06 – prices increase, CCGTs closed down; US production declined by 2% p.a; 200 bcm of North American regas capacity built.
- 2006 – 2014 – Shale gas boom, prices crash, regas capacity closes, gas displaces coal in power sector; LNG export terminal construction `stampede' begins (2011)
- 2016+ the start of LNG exports – investment in new LNG terminals on hold

THE UK (GREAT BRITAIN) – ONE OF THE TWO LARGEST GAS MARKETS IN EUROPE: FROM COST-BASED TO HUB-BASED PRICING

Gas Pricing in Britain up to 1986: before privatisation and liberalisation

- All gas was bought by monopsony (state-owned) British Gas Corporation on long term "depletion" contracts from North Sea producers
- Cost-related pricing with indexation to operating costs PPI (not alternative fuel) and inflation, regulated by government
- Major Norwegian import contract was oil product based and indexed

Monopsony power of single buyer held this regime in place until privatisation

Gas Pricing in Britain After Privatisation and Liberalisation: the early years 1986-94

The start of gas trading and the demise of long term contracts:

- **Mainly direct between counterparties:**
  - **The first broker, EES, started in ~1993**
  - **However, very few brokered deals in first 3 years!**
- **Negotiated contracts only:**
  - **Each contract individually negotiated**
  - **Each different from the other**
- **All contracts 'at the beach':**
  - **Traded before entry in to the NTS**
- **All contracts were 'physical' with Swing, Take Or Pay, etc…**

Before the creation of the NBP

The Network Code (1996)

- The set of rules and procedures for the use of a network to which all parties must agree to adhere to before they can become shippers, specifically parties must agree to..
- Daily balancing: putting the same volume of gas into the network as they take out of the network on a daily basis (within agreed limits); this requires…
- Daily trading and within-day trading in order to ensure that all parties (and therefore the network) "balance".

Financial penalties for failing to balance are severe

The NBP - National Balancing Point – a virtual hub

- This 'location' was created by the Network Code
- It is a notional point, effectively the whole NTS
- Invented to permit the balancing mechanism of the Network Code
- Where Shippers nominate their buys and sells
- System balanced daily by network company (National Grid Gas)
- Rapidly evolved as a trading point too
- This is in stark contrast to the 'old world', where gas was mostly traded at the landfall of the gas more commonly known as "at the beach"
- Used as basis for NBP'97 trading document
- Became the delivery point for the ICE futures

Created in 1996

"NBP'97" Contract: still in use after 20 years

- Need for a common trading contract - 8 page document agreed by the industry:
  - Short Term Flat NBP Trading Terms & Conditions
  - Known as NBP'97
- Covers all necessary aspects needed to trade gas at the NBP:
  - From the practical terms (definitions, confirmation procedure, trade nominations, contract price, billing and payment)…..
  - to the legal clauses
- Standardised contracts dominated:
  - All deals were the same except for delivery period, quantity, price
  - Traded in 'clips' (multiples) of 25,000 therms per day

Very Important Features of NBP '97

- 'Flat' meaning volumes traded are delivered at a constant 'flow rate' during the delivery period
- 'Kept whole' meaning volumes delivered guaranteed to equal volumes traded:
  - No interruption or volume tolerance permitted
- Very limited force majeure (FM):
  - No relief of obligation to deliver/take gas from NTS
  - Field/exit point shutdown does not constitute FM
  - FM is only an event beyond the control of the affected party resulting in the inability to get a trade nomination into or accepted by Gemini
  - Reasonable endeavours required to overcome the FM but, if it continues for 7 days or more, either party can give 3 days' notice of termination

The UK On-The-Day Commodity Market (OCM)

- The concept of a balancing market was developed with the implementation of the OCM – the On-the-day Commodity Market – providing the within-day trading tool for the UK gas industry. Additionally it provides a market for trading on the UK National Balancing Point (NBP) up to 7 days in advance of delivery.

- UK NBP gas contracts:
  - Spot/OCM: NBP title, physical, locational
  - Prompt: DA, days, WE, BoW, WDNW

ICE-Endex (previously APX and UKPX) operates the OCM

An Established Traded Market: 2000-18

Trading during this period is:

- **Almost entirely through brokers or exchanges:**
  - **Either voice or electronic**
- **Almost entirely NBP based:**
  - **Except for some inter-shipper 'balancing' at specific points**
  - **Either NBP'97 OTC forwards or NBP-based ICE futures or NBP-indexed Long Term Contracts**
- **The market is very liquid and transparent**
- **A mainly 'physical' market with increasing volumes of pure 'Financial' trading (with no delivery)**

ICE Natural Gas Futures Contract

Launched in January 1997 based on physical delivery at NBP:

- Market penetration of about 10% within first year, about one third of total trade in 2012; used as reference for Month Ahead indexed deals
- Used primarily as hedging tool: to manage price risk
- And an investment vehicle: to speculate
- But also to effect physical delivery: a small % goes to delivery
- Can negate counterparty credit risk: by 'giving up' trades for clearing – "exchange for physical" EFP's
- NBP is a gas benchmark and so too is the ICE contract:
  - Nearly all UK gas traded at the NBP
  - More and more UK gas traded against ICE Month Ahead Index

Market Transparency

Price reporting:

- **NBP prices and volumes are reported in many ways:**
  - **'real time': ICE and broker screens; Reuters, Bloomberg and other wire services**
  - **historic: Price Reporting Agencies (ICIS, Argus, Platts), national press**

Indices:

- **The ICE publishes a Month Ahead Index**
- **A variety of indices (PRAs and Brokers)**

Very good price discovery and reporting in the British gas market

CONTINENTAL EUROPE: TRANSITION FROM OIL-LINKED TO HUB-BASED PRICING 2008 ➡

Traditional Long Term Gas Contracts in Continental Europe (and Asia)

- 15-25 year – large (10-20 Bcm) "annual contract quantity"
- A "take or pay" clause which requires the buyer to take a specific percentage of the volume (usually 80-85%) or, if the buyer is unable to take, then to pay for that percentage of the volume
- Prices linked to oil products (fuel oil/gas oil)

This is standard contractual practice in monopoly gas markets, required for financing of very large capital intensive projects and operates well in monopoly markets

Continental European Oil-Linked Pricing

In the 1970s and 1980s:

- **gas replaced oil products in industrial, commercial, residential uses**
- **customers retained the ability to switch back to oil products if gas prices rose above oil products**

BUT during the 1990s and especially the 2000s, <u>in most countries</u>:

- **oil products were eliminated from stationary energy (restricted to transport)**
- **the ability to switch back to oil products became severely limited due to: new technology, lack of oil storage, emission limits**

In <u>most</u> countries, original market logic disappeared

Netback Market Value: the concept

The Netback Market Value Concept

The netback market value of gas to a specific customer at the beach or border is defined as follows:

Netback	=	Delivered price of cheapest alternative fuel to the customer (including any taxes) adjusted for any differences in efficiency or in the cost of meeting environmental standards/limits;
	minus	Cost of transporting gas from the beach or border to the customer;
	minus	Cost of storing gas to meeting the customer's seasonal or daily demand fluctuations;
	minus	Any gas taxes.

The weighted average netback value of all customer categories is used as the basis for the negotiation of bulk prices at the beach or border.

Aka: replacement value or Groningen principle

Traditional Continental European Long Term Contract Gas Price Formula: Base Price (Po) and Index

$$Pm = Po + 0.60 \times 0.80 \times 0.0078 \times (GOm - GOo) + 0.40 \times 0.90 \times 0.0076 \times (HFOm - HFOo)$$

Pm: price applicable in month m = starting gas price Po and the price of competing fuels – gas oil and heavy fuel oil in the proportions 60:40, subject to pass through factors of 0.80 and 0.90, and technical equivalence factors of 0.0078 and 0.0076 to convert units of prices for oil products into gas price units

This example assumes that gas oil and fuel oil are the replacement products for gas in the end-use market; most formulae would be much more complicated than this and would have more light and less heavy product

What Happened Post-2008?

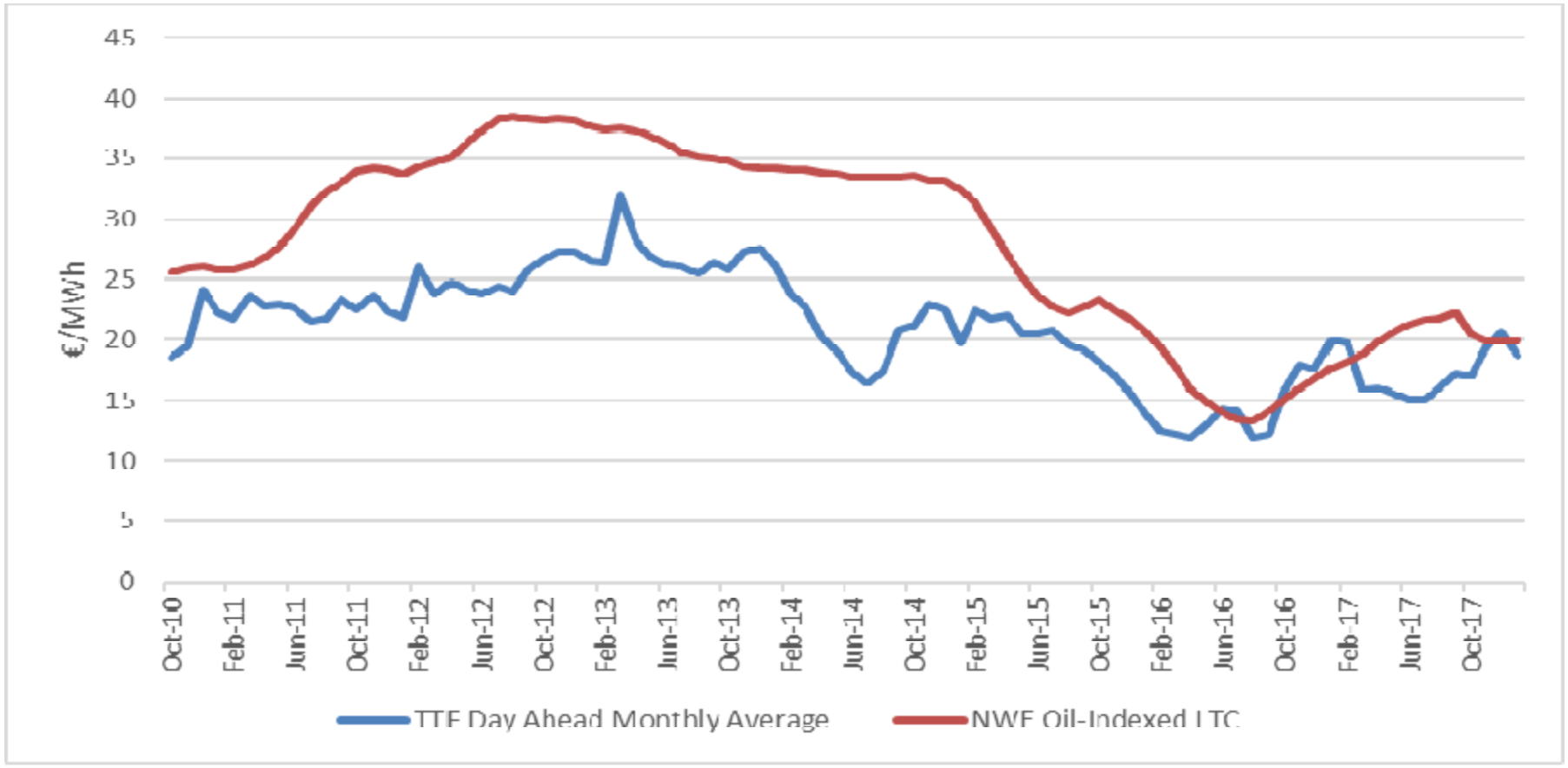
- Major recession hit Europe (and the world) causing economic growth, energy/gas demand reduction
- Gas supply was in surplus already due to LNG boom of the mid/late 2000s and inflated by US shale gas (which eliminated LNG imports)
- Liberalisation and competition measures, under way since the late 1980s, finally began to have effect in (especially) north western part of Continental Europe
- Continental European hubs (not just NBP) began to acquire “materiality”
- Oil (and therefore long term gas) prices rose substantially

Post-2008 Oil-Indexed Pricing in Europe: no longer tenable for midstream players

- can no longer "pass through" prices of oil linked imported gas to their customers
- increasingly forced to sell to customers at hub-based (market) prices or lose those customers to competitors (creating take or pay problems)
- in 2011, companies such as E.ON and RWE made trading losses of nearly €1bn on long term gas contracts

This accelerated corporate and regulatory break-up of traditional European gas companies

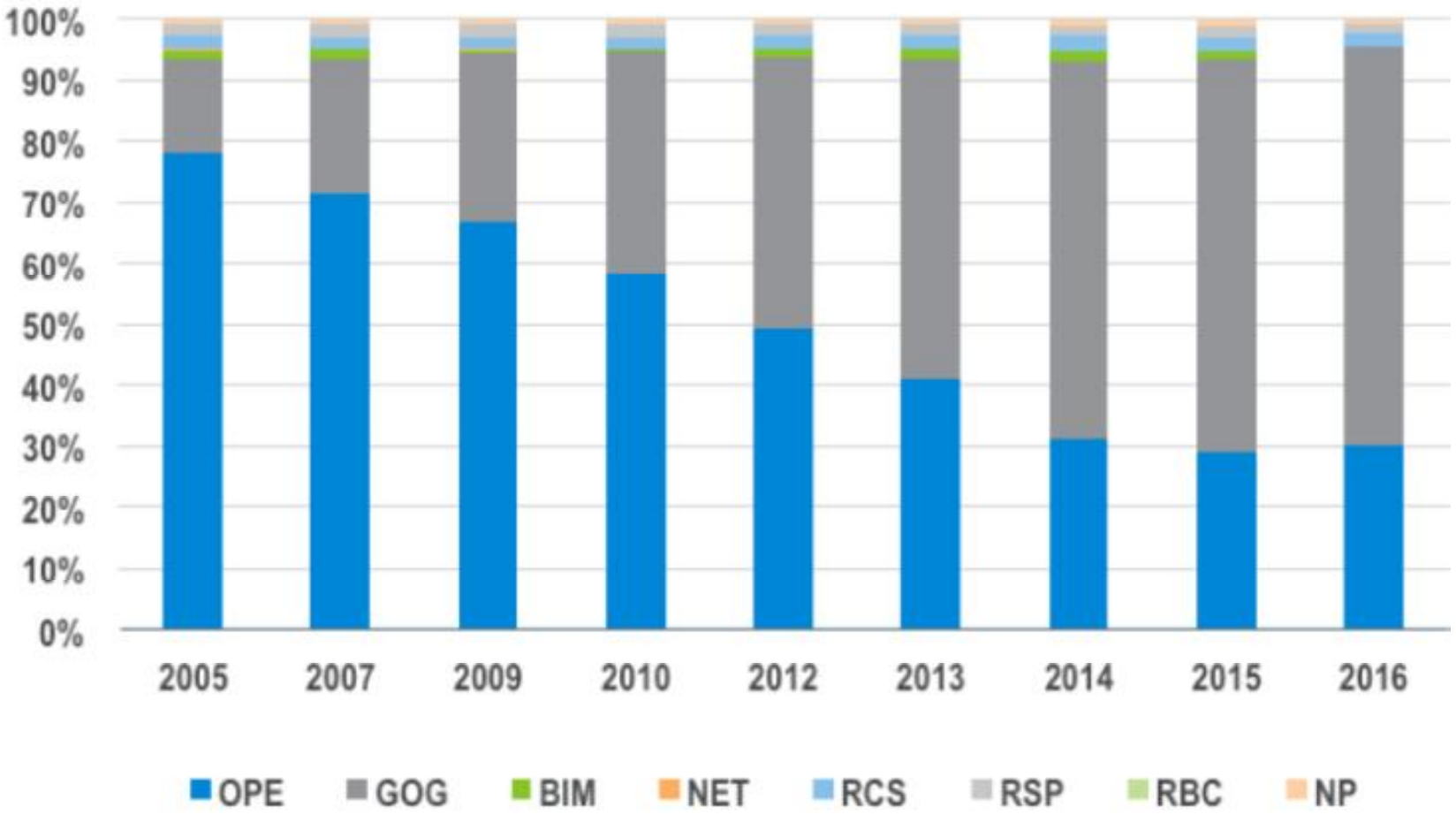
TTF (Hub) and Oil-Linked Contract Gas Prices, August 2010-January 2018 (Eur/MWh)



Source: Platts European Gas Daily, Monthly Averages

As the 2010s progressed the hub/oil price spread narrowed from 25-33% in the early years

European Wholesale Gas Pricing 2005-16 (%)

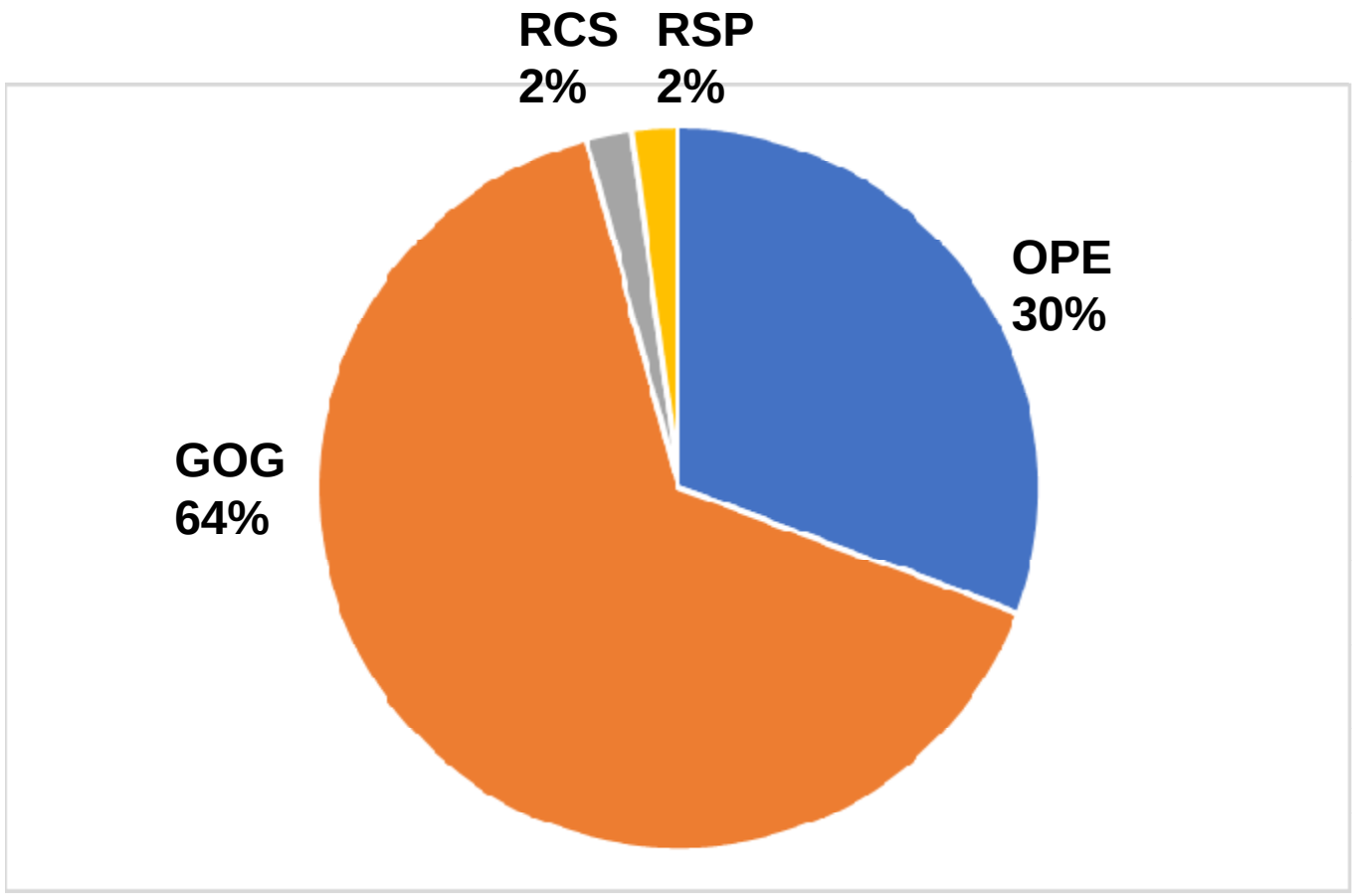


OPE = oil-indexed pricing; GOG = gas on gas/hub-based pricing

Source: IGU Wholesale Gas Price Survey 2016, May 2017, Figure 5.4, p.41.

European Wholesale Gas Pricing 2016

Source: IGU Wholesale Gas Price Survey 2017



OPE: oil-indexed; GOG: gas/gas competition; RCS: regulated cost of service, RSP: regulated social pricing,

European Wholesale Gas Pricing 2016 (%)

Source: IGU, Wholesale Gas Price Survey 2017, June 2017, pp.41-44

Region and approx % total European demand	OPE	GOG	RCS	RSP
North West Europe 50%	9	91		
Central Europe 10%	28	58		14*
Medit'nean Europe 30%	68	32**		
South East Europe	38	5***	52	5
Scandinavia and Baltics	46	28	26 (NP)	

*Hungary and Poland **mainly Italy ***Croatia

NW Europe: Belgium, Denmark, France, Germany, Ireland, Netherlands, UK
Central Europe: Austria, Czech Rep, Hungary, Poland, Slovakia, Switzerland
Mediterranean Europe: Greece, Italy, Portugal, Spain, Turkey
SE Europe: Bosnia, Bulgaria, Croatia, FYROM, Romania, Serbia, Slovenia
Scandinavia/Baltics: Estonia, Latvia, Lithuania, Norway, Sweden

Transition is about prices but also about contracts

- North American and UK gas markets moved to market pricing and away from `long term' 15-25 year contracts in the 1980s and 1990s; 5-10 years now the longest contracts
- In both cases this was a horribly painful process which took 5-10 years to complete
- Continental Europe faced the same changes but more complex because most major sellers operate under a different legal/regulatory framework

Unlike North America and UK, it looks like Continental European contracts will be allowed to expire rather than being terminated