Integrated course „Energy Economics“
- Natural Gas Markets

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Outline

- Natural gas reserves and production
- Long distance gas pipelines
- Gas storage
- LNG markets
- Wholesale markets for natural gas
- Retail gas markets

Gaseous Fuels

- Natural gas – mainly methane
  - H gas – high-calorific natural gas (higher CH_4 content $\rightarrow$ heat value)
  - L gas – low-calorific natural gas (produced in GE &NL)

- Liquefied petroleum gas (LPG) – mainly propane and butane, byproduct of oil refinery process

- Town gas (cooking gas) – byproduct of coke plants

Properties of Gaseous Fuels

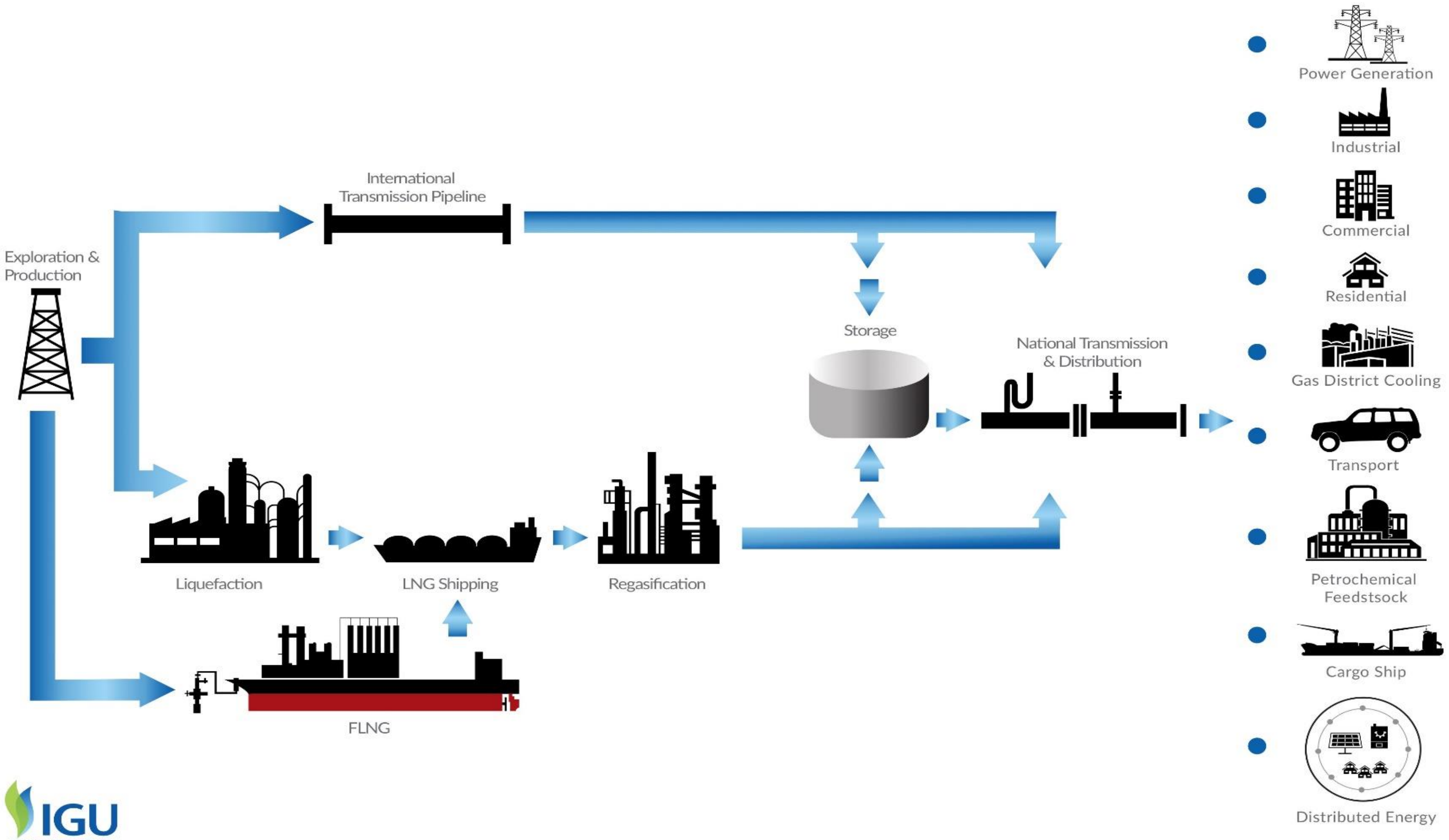
		Density [kg/m³]*)	Upper Heating Value H_s (*Brennwert*) [MJ/m³]	Lower Heating Value H_i (*Heizwert*) [MJ/m³]
Methane	CH_4	0,7175	39,819	35,883
Ethane	C_2H_6	1,3550	70,293	64,345
Propane	C_3H_8	2,0110	101,242	93,215
Butane	C_4H_{10}	2,7080	134,061	123,810
Hydrogen	H_2	0,08988	12,745	10,783
Carbon monoxide	CO	1,25050	12,633	12,633
Nitrogen	N_2	1,2504		
Oxygen	O_2	1,4290		
Carbon dioxide	CO_2	1,9770		
Air		1,2930		
Natural gas H		0,79	~41	~37
Natural gas L		0,83	~35	~32
Biogas		1,12	~27	~24

Natural gas

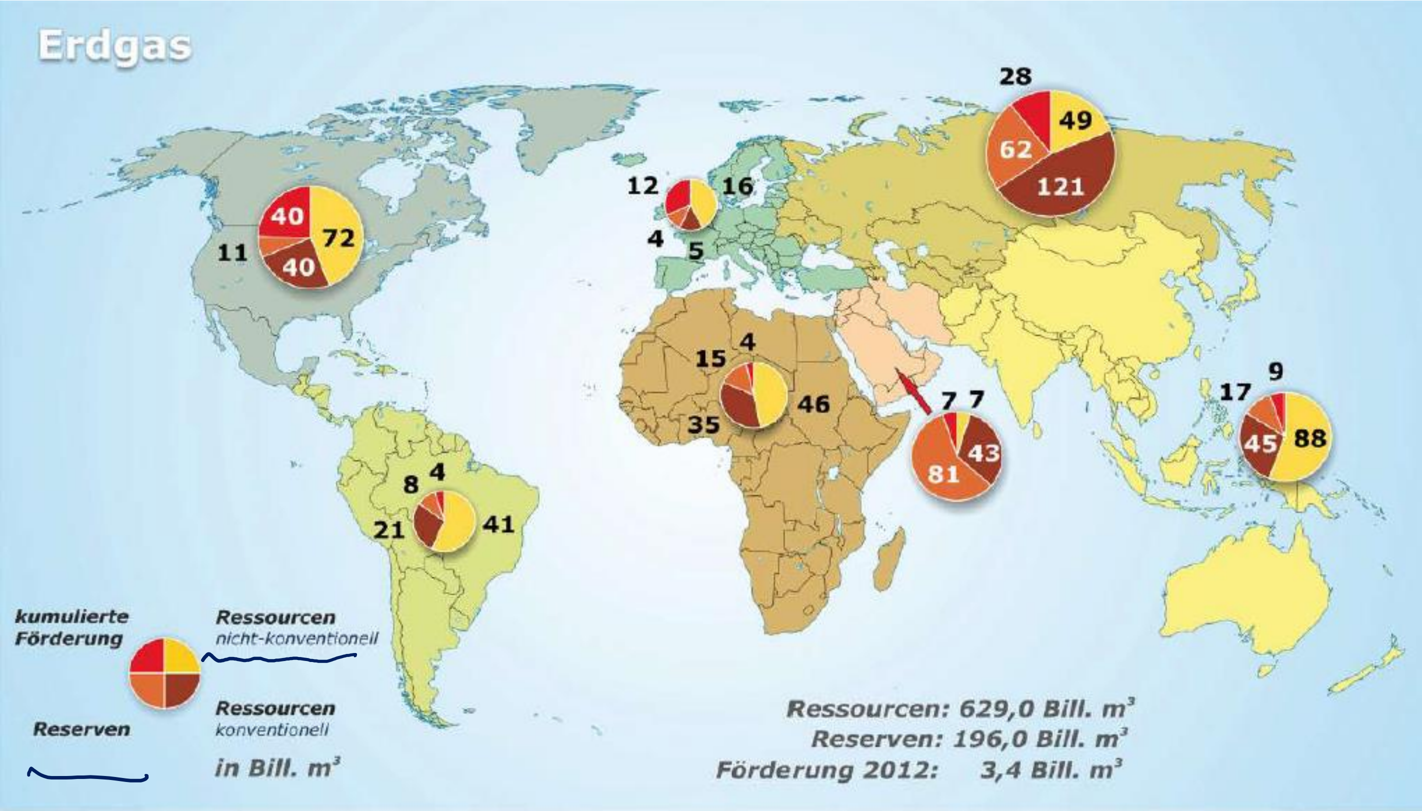
- Conventional natural gas
  - Extracted from gas deposits by conventional means
  - Associated gas – released during oil extraction (often flared but can be utilised)

- Unconventional natural gas
  - Shale gas (>1000 m deep) – extracted by fracking
  - Coal bed methane – found in coal formations (300-1000 m deep)
  - Methane hydrates – found on ocean seabed

Natural gas value chain



Global Gas Resources



Source: BGR, 2013

Resources are all useful raw materials available in nature.
Reserves are resources existing with high probability and economically feasible for extraction.

Reserves and extraction of natural gas

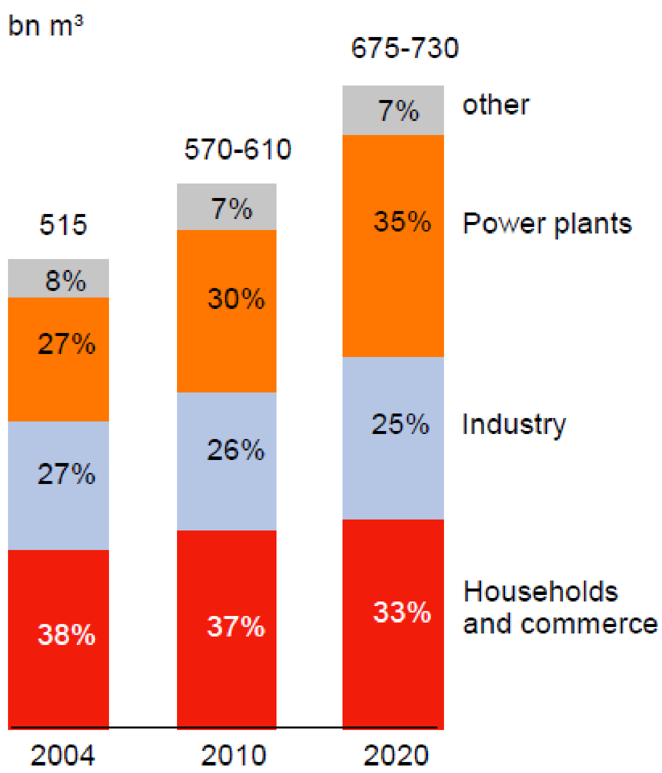
	Natural gas reserves 2013		Natural gas extraction 2013	
	(tn m^3)	Share (%)	(bn m^3)	Share (%)
Iran	33.8	18.2	167	4.9
Russia	31.3	16.8	605	17.9
Qatar	24.7	13.3	158	4.7
Energy ellipse *	132.5	71.4	1325	39.3
United States	9.3	5.0	688	20.6
Norway	2.0	1.1	109	3.2
The Netherlands	0.9	0.5	69	2.0
Great Britain	0.2	0.1	37	1.1
World	185.7	100.0	2763	100.0

- The Persian Gulf and the Caspian Sea areas

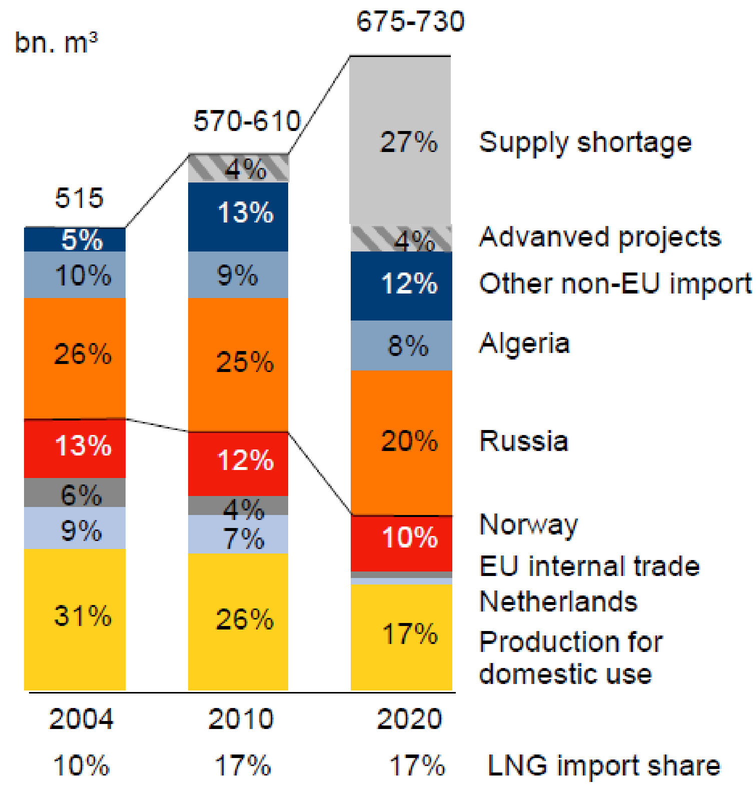
    (Bahrain, Iran, Iraq, Kuwait, Oman, Qatar, Saudi Arabia, Syria, UAE, Yemen, other Middle East;
    Azerbaijan, Kazakhstan, Russia, Turkmenistan, Uzbekistan, other Europe & Eurasia)

Source: Zweifel / Praktiknjo / Erdmann (2017) after BP (2014)

Natural Gas in the EU



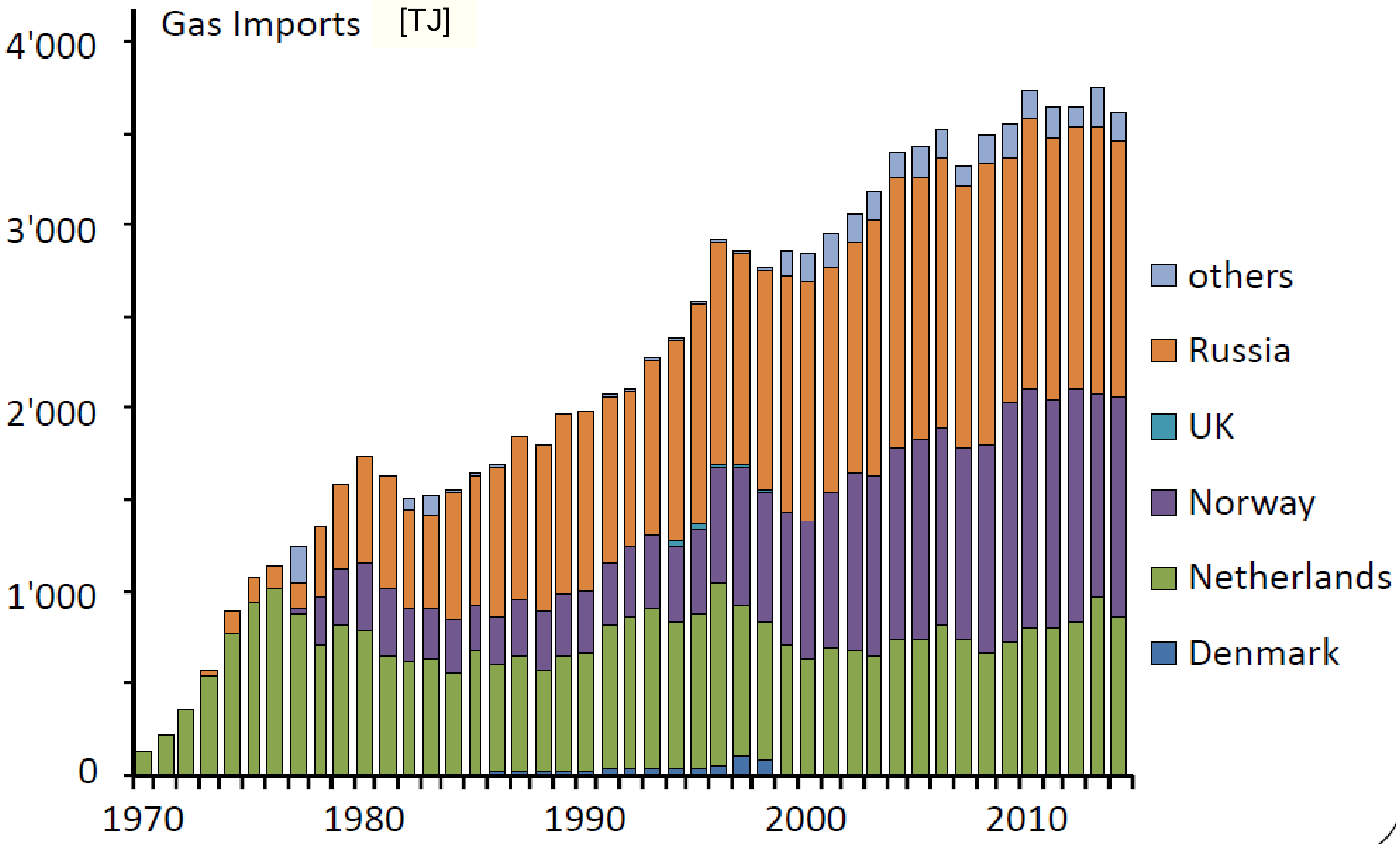
Natural Gas Demand



Natural Gas Supply

German Gas Imports

Source: BAFA, 2015



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Economics of Gas Pipelines

$$Q \sim \sqrt{\frac{P_1^2 - P_2^2}{l / d^2}}$$

Throughput is the volume of gas passing through a pipeline in a period of time.

[m³/h]

Pipeline capacity is the maximum throughput.

- Q Gas transport volume
- P_1 Presure at the beginning of the section
- P_2 Pressure at the end of the section
- l Length of the pipeline section (between two compressor stations)
- d Diameter of the pipeline

- Long-distance gas tranasport no natural monopoly (Pipe-to-Pipe competition, Pipe-in-Pipe competition)
- *Hold-up*-Problem: After realizing a pipeline project, the investor finds himself in a strategically weak position based on the irreversible nature of the investment: The Pipeline operator's profit depends on the goodwill of the contract partner located at the end (beginning) of the pipeline

Game Theory: Double Marginalisation

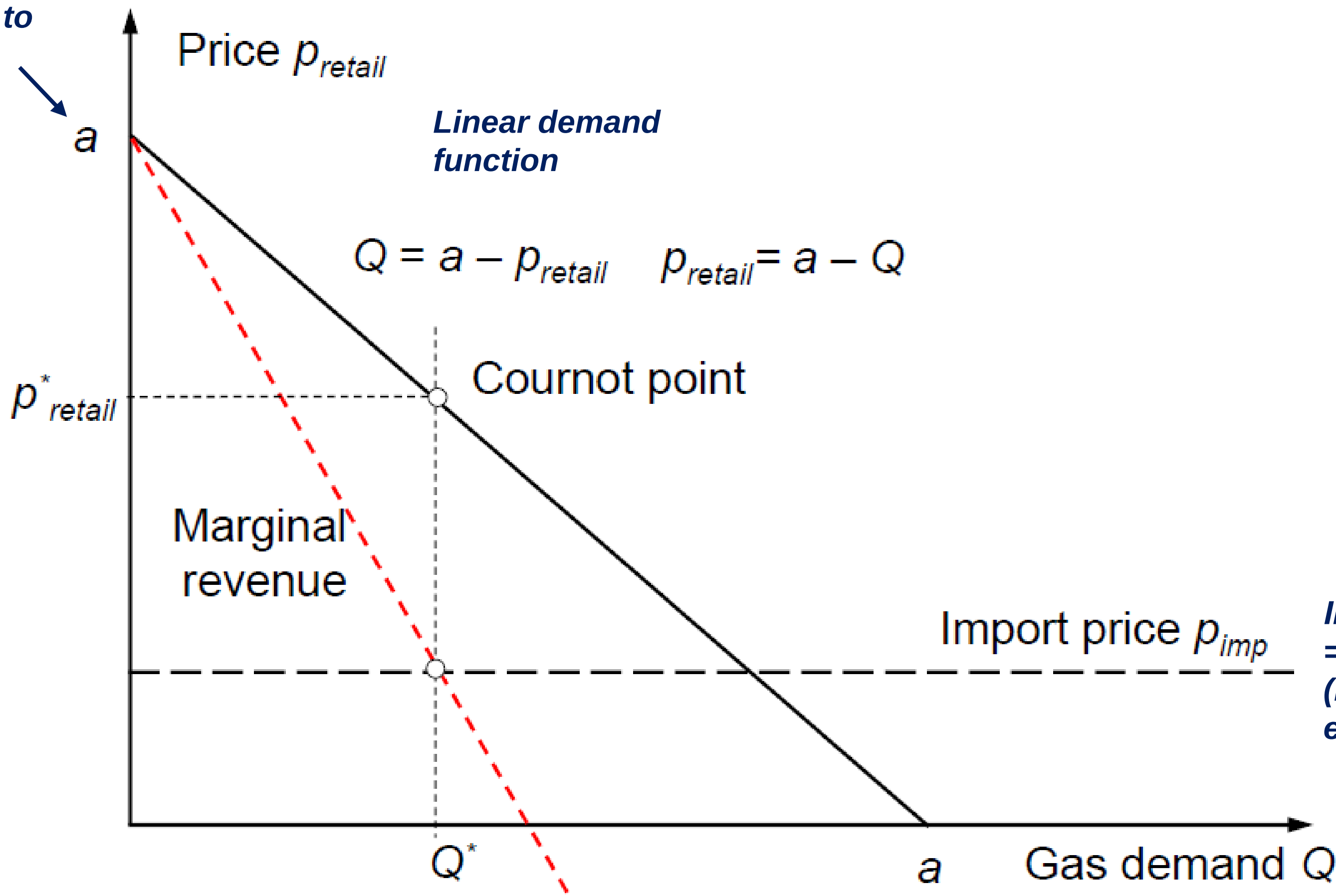
- Two companies: monopolistic gas importer who supplies the retail market, and a monopolistic pipeline operator who is also a dominant gas producer in the exporting country
- In the first step of the game theoretic model the pipeline operator optimizes his pipeline capital stock *K*. In the second step the import price $p_{imp}(K)$ is determined by negotiations between the two monopolists
- Both parties optimize independent from each other their profit (non-cooperative game)

Gas producer is able to infer on the import price resulting from gas importer's optimisation based on the domestic demand curve. It then optimises its profit at the given import price.

- Mathematical solution of the model in the opposite order: First the condition for the import price is determined, i.e. the result of the negotiations between the two monopolists in step 2

Retail Gas Price set by the Monopolistic Gas Importer

Willingness to pay for the first unit = max. retail price



Importer's marginal cost = import price (neglecting other cost elements)

Game Theoretical View of the Gas Importer

$$Q = a - b \cdot p_{retail}, \quad b = 1$$

Q	Gas demand
a	Maximal gas retail price
p_{retail}	Gas retail price

$$\Pi_{importeur} = \underbrace{(p_{retail} - p_{imp})}_{\Delta p} \cdot \underbrace{(a - p_{retail})}_{Q}$$

$\Pi_{importeur}$	Profit of the importer
p_{imp}	Import price

$$p^{*}_{retail} = \frac{a + p_{imp}}{2}$$

Profit maximizing gas retail price

$$Q^{*}(p_{imp}) = \frac{a - p_{imp}}{2}$$

Optimal sales volume

Game Theoretical View of the Gas Importer

$$\pi_{imp}(p_{retail}) = p_{retail} \cdot a - p_{imp} \cdot a - p_{retail}^2 + p_{imp} \cdot p_{retail}$$

$$p_{retail} = x; \quad \pi_{imp}(x) = x \cdot a - p_{imp} \cdot a - x^2 + p_{imp} \cdot x$$

$$\frac{d\pi_{imp}}{dx} = a - 2x + p_{imp}$$

$$0 = a - 2x + p_{imp}$$

$$2x = a + p_{imp}$$

$$p_{retail} = \frac{a + p_{imp}}{2}$$

$$Q = a - p_{retail}$$

$$Q = a - \frac{a + p_{imp}}{2}$$

$$Q = \frac{a - p_{imp}}{2}$$

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Game Theoretical View of the Pipeline Operator

$$\Pi_{produzent} = \left(p_{imp} - c(K)\right) \cdot Q^* = \left(p_{imp} - c(K)\right) \cdot \frac{a - p_{imp}}{2}$$

$\Pi_{produzent}$	Profit of the pipeline operator
p_{imp}	Import price
K	Pipeline Capital stock
c	Unit cost of pipeline operation

Transactions are only possible under $a > c(K)$

$$p^*_{imp}(K) = \frac{a + c(K)}{2} > c(K)$$

Deviation of the profit function to p_{imp} under the condition that the unit cost $c(K)$ is independent from the transport volume Q and thus independent from the import price p_{imp}

The solution is a Nash equilibrium of a non cooperative game between two mopololists along the value chain: Each player selects the individually optimal price given the price of the other player

Game Theoretical View of the Pipeline Operator

Correction: differentiation with respect to the import price to be agreed with the gas importer.

$$\Pi_{prod} = (p_{imp} - c(K)) \cdot \frac{a - p_{imp}}{2}$$

$$\Pi_{prod} = \frac{p_{imp} \cdot a}{2} - \frac{c(K) \cdot a}{2} - \frac{p_{imp}^2}{2} + \frac{c(K) \cdot p_{imp}}{2}$$

$$\frac{d\Pi_{prod}}{d p_{imp}} = a - 2p_{imp} + c(K)$$

$$2p_{imp} = a + c(K)$$

$$p_{imp} = \frac{a + c(K)}{2}$$

$$Q = \frac{a - p_{imp}}{2}$$

$$Q = \frac{a - \frac{a + c(K)}{2}}{2}$$

$$Q = \frac{a - c(K)}{4}$$

Solution under "Cooperation"

$$\Pi_{coop} = (p_{retail} - c(K)) \cdot (a - p_{retail})$$

Π_{coop} Common profit under cooperaton

$$p^*_{retail,coop} = \frac{a + c(K)}{2} < \frac{a + p_{imp}(K)}{2} = p^*_{retail}$$

There is a welfare loss if two monopolists along the value chain don't cooperate („double marginalization")

What is worse than a monopoly: Two monopolies

The aggegate profit under cooperation is

$$\Pi^*_{coop} = \left(\frac{a - c(K)}{2}\right)^2$$

$$\Pi_{no-coop} = \Pi^*_{importeur} + \Pi^*_{produzent} = \frac{3}{4}\left(\frac{a - c(K)}{2}\right)^2$$

Solution under "Cooperation"

$$\pi_{coop} = (p_{retail} - c(K)) \cdot (a - p_{retail})$$

$$\pi_{coop} = p_{retail} \cdot a - c(K) \cdot a - p_{retail}^2 + c(K) \cdot p_{retail}$$

$$\frac{d\pi_{coop}}{d\,p_{retail}} = a - 2p_{retail} + c(K)$$

$$0 = a - 2p_{retail} + c(K)$$

$$p_{retail} = \frac{a + c(K)}{2}$$

$$Q = a - \frac{a + c(K)}{2}$$

$$Q = \frac{2a - a + c(K)}{2}$$

$$Q = \frac{a + c(K)}{2}$$

Decision of the Pipeline Investor

$$\frac{\partial c}{\partial K} < 0 \quad \frac{\partial^2 c}{\partial K^2} \geq 0$$

Implications of investments *dK* on the Unit costs *c* of pipeline operation

$$\max_{K \geq 0} \left(\frac{1}{2} \left(\frac{a - c(K)}{2} \right)^2 - K \cdot ic(K) \right)$$

Pipeline investment decision under non-cooperation

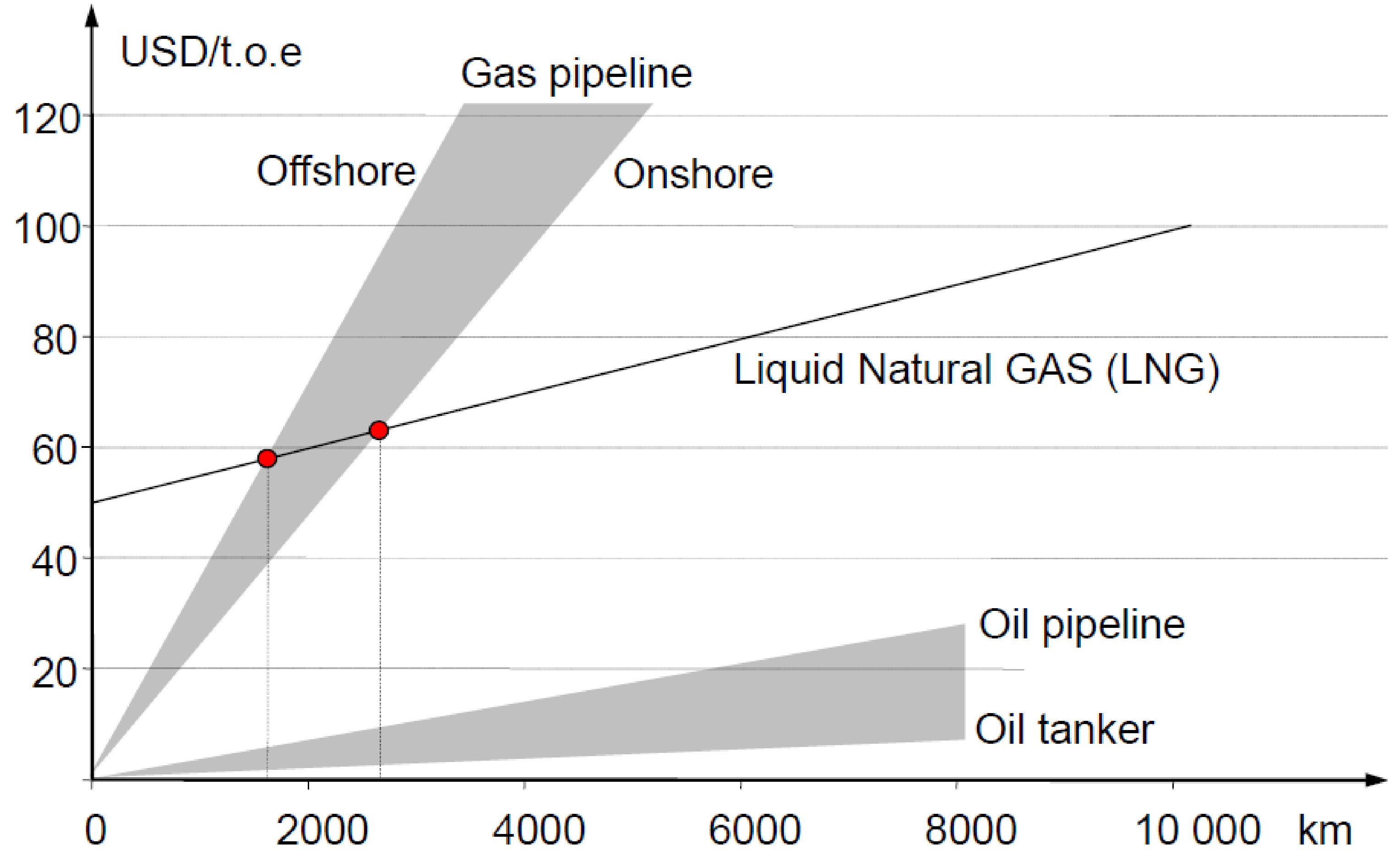
ic Capital User Cost

$$\max_{K \geq 0} \left(\left(\frac{a - c(K)}{2} \right)^2 - K \cdot ic(K) \right)$$

Pipeline investment decision under cooperation

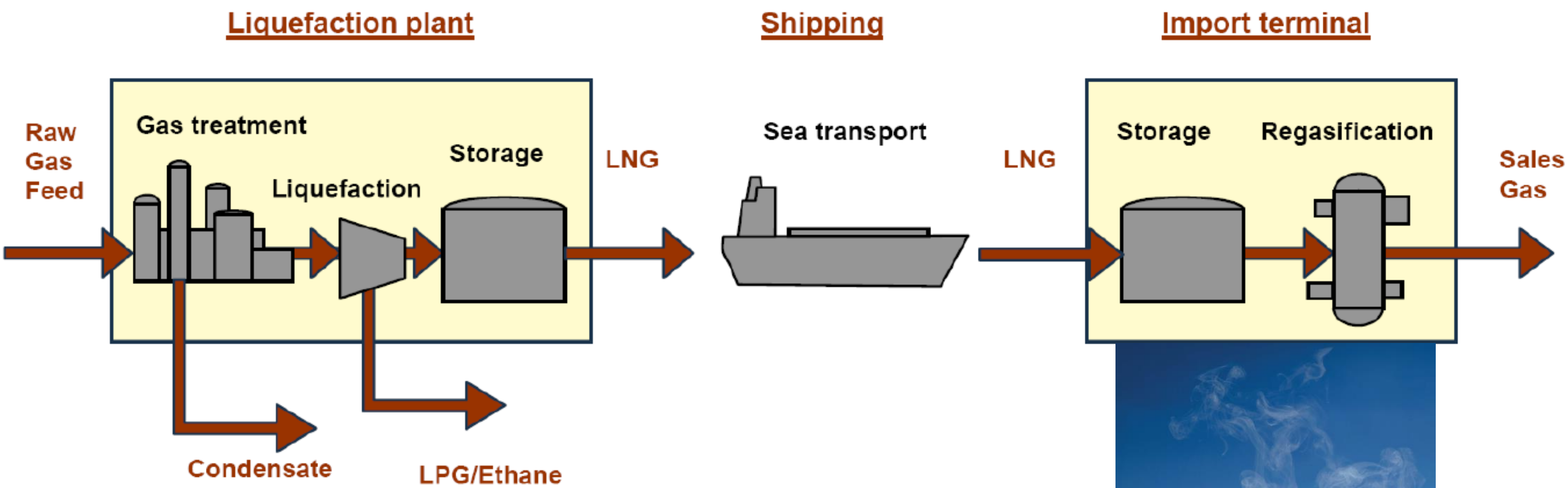
Investment under cooperation exceeds investment under non-cooperation. Without cooperation the pipeline operator expects to receive only 50% of cost reduction as own benefit

Transportation Cost of Hydrocarbons



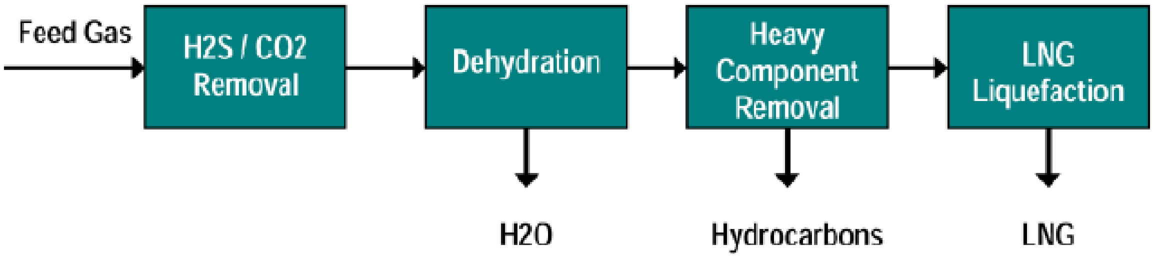
Source: Zweifel / Praktiknjo / Erdmann, 2017

LNG Process Chain



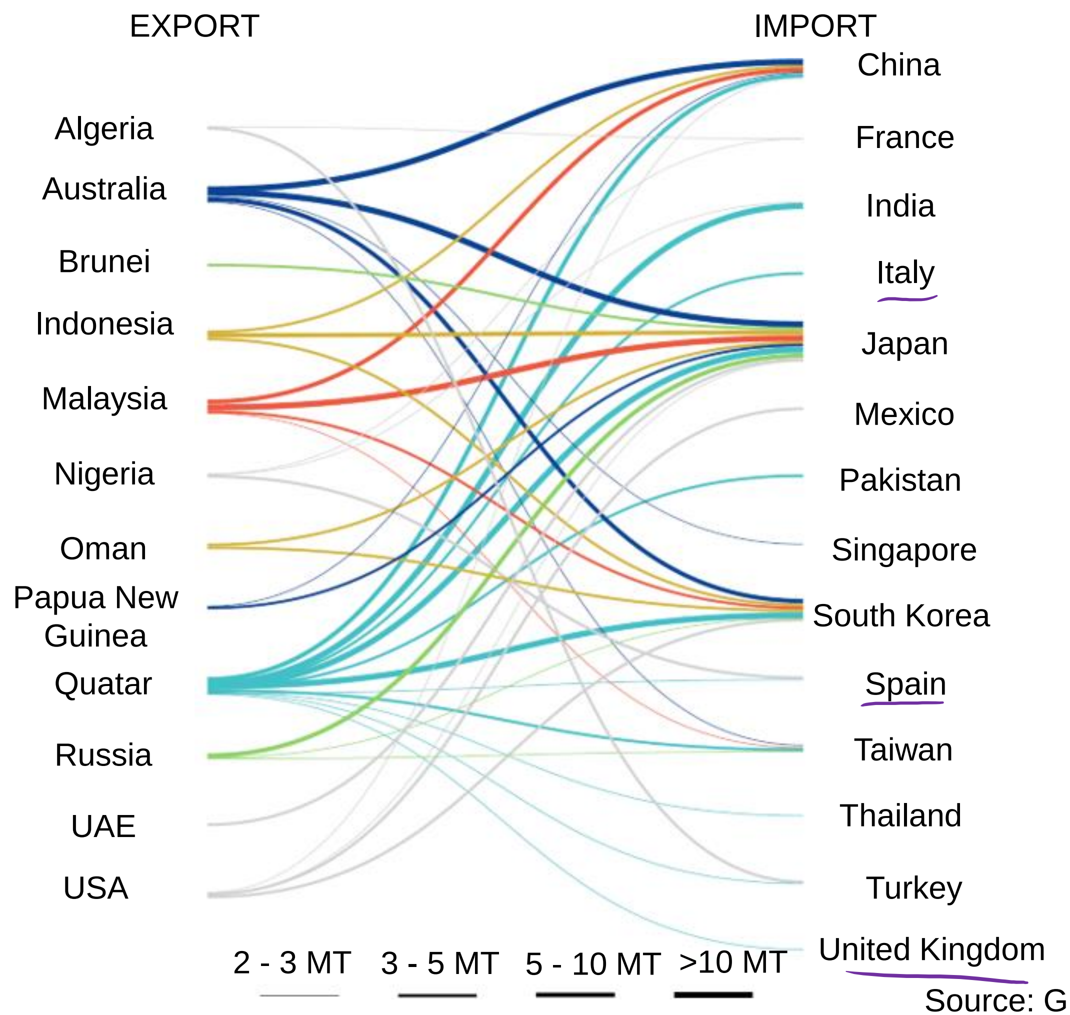
Source: Osaka Gas

Boiling point of methane −162 °C (−259.6 °F)
Approx. 600 times volume reduction



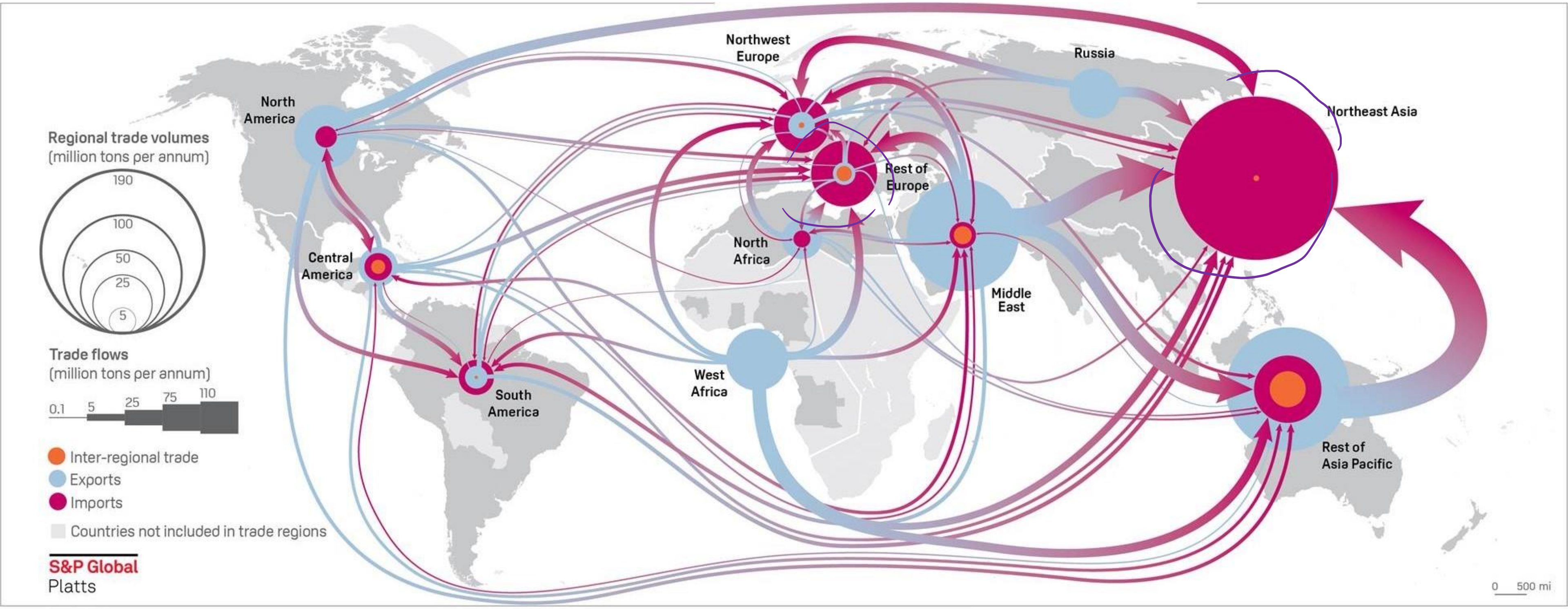
Source: BV 2009 / GIIGNL

Major LNG Trading Flows in 2018



Source: GIIGNL, 2019

LNG Flows in 2018



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Cost Structure of LNG Process Chain

Liquefaction plant:	
Investment outlay	900M €
Operating expenses	0,04 €/m^3
LNG tanker fleet	*e.g. 2 vessels á 135T t each*
Investment outlay	360M €
Operating expenses	0,014 €/m^3
Regasification plant w. storage	e.g. 80T m^3 (Cartagena)
Investment outlay	320M €
Operating expenses	0,015 €/m^3
Own gas requirement	1/3 of transported gas

Source: Zweifel / Praktiknjo / Erdmann (2017), after Cayrade (2014)

Cost Comparison of LNG Projects

				Project			Liquefaction Plant			
Project	Location	mtpa	Trains	CAPEX $bn	$/tpa	$/mmbtu	% project CAPEX	CAPEX $bn	$/tpa	$/mmbtu
Gorgon	Australia	15.6	3	53.0	3,397	11.9	62%	32.9	2,106	7.37
Prelude FLNG	Timor Sea	3.6	1	12.0	3,333	11.7	60%	7.2	2,000	7.00
Wheatstone	Australia	8.9	2	34.0	3,820	13.4	52%	17.7	1,987	6.95
Ichthys	Australia	8.4	2	36.0	4,286	15.0	45%	16.2	1,929	6.75
Queenland Curtis	Australia	8.5	2	20.0	2,353	8.2	60%	12.0	1,412	4.94
PNG	PNG	6.9	2	19.0	2,754	9.6	49%	9.3	1,349	4.72
Yamal	Russia	16.6	3	27.2	1,639	5.7	80%	21.8	1,311	4.59
Angola LNG	Angola	5.2	1	10.0	1,923	6.7	60%	6.0	1,154	4.04
Donggi-Senoro	Indonesia	2.0	1	2.9	1,450	5.1	90%	2.6	1,305	4.57
Gladstone	Australia	7.8	2	19.0	2,436	8.5	53%	10.1	1,291	4.52
Pacific LNG	Australia	9.0	2	26.0	2,889	10.1	45%	11.7	1,300	4.55
Tangguh Expansion	Indonesia	3.8	1	8.0	2,105	7.4	50%	4.0	1,053	3.68
Petronas PFLNG1	Malaysia	1.2	1	1.5	1,290	4.5	75%	1.2	968	3.39
Elba Island	USA	2.5	1	2.3	924	3.2	90%	2.1	832	2.91
Petronas PFLNG2	Malaysia	1.5	1	1.7	1,100	3.9	75%	1.2	825	2.89
Freeport	USA	15.0	3	13.3	887	3.1	90%	12.0	799	2.80
Corpus Christi T1-2	USA	9.0	2	10.4	1,160	4.1	90%	9.4	1,044	3.66
Corpus Christi T3	USA	4.5	1	3.0	667	2.3	100%	3.0	667	2.33
Cameron LNG	USA	13.5	3	11.0	815	2.9	90%	9.9	733	2.57
Cove Point	USA	5.3	1	4.2	789	2.8	90%	3.8	710	2.48
Bintulu Train 9	Indonesia	3.6	1	2.5	694	2.4	90%	2.3	625	2.19
Caribbean FLNG	TBA	0.5	1	0.4	800	2.8	75%	0.3	600	2.10
Golar FLNG	Cameroon	2.4	1	1.9	800	2.8	75%	1.4	600	2.10
Sabine Pass Trains 1-4	USA	18.0	4	11.0	611	2.1	90%	9.9	550	1.93
Sabine Pass Train 5	USA	4.5	1	3.8	844	3.0	100%	3.8	844	2.96

Source: Songhurst, OIES, 2018

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LNG Impact on Global Gas Markets

- LNG trade leads to integration of regional gas markets
- LNG supply chain is more flexible
- LNG helps to develop more remote gas fields
- Diversification helps mitigate the holdup problem

Source: Zweifel / Praktiknjo / Erdmann, 2017

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Vertical Integration or Long-Term Contracts

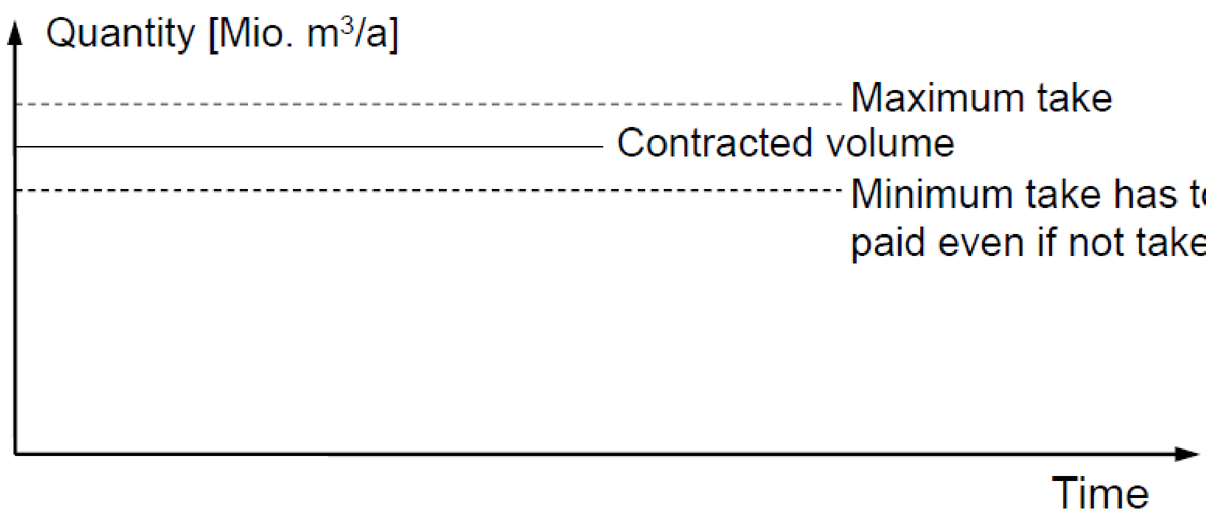
- In a world without vertical integration of (foreign) gas supplier and (domestic) gas importer, long term gas contracts necessary in order to secure cash-flows required for pipeline (and other gas infrastructure) investments

- Selection of Gazprom's long term contracts 2007:
  - „Gaz de France“ – until 2030
  - „E. ON Ruhrgas“ – until 2035, 20 Mrd. m^3/year
  - „Wintershall“ – until 2030
  - „Gazum“ – until 2025 (Finland)
  - „ENI“ – 2035, 3 bn m^3/year (Italy)

- Gazprom as shareholder of European gas companies 2007:
  - „Wingas“ (50% -1 Aktie): 2000 km Gas transmission lines, Natural gas storages in Germany with 2 bn. m^3 gas volume
  - Europolgaz (48%), Eesti Gas (37,2%), Lietuvos Dujos (37,1%), Latvijas Gaze (34%), Gasum (25%), VNG (10,52%), Interconnector (10%)

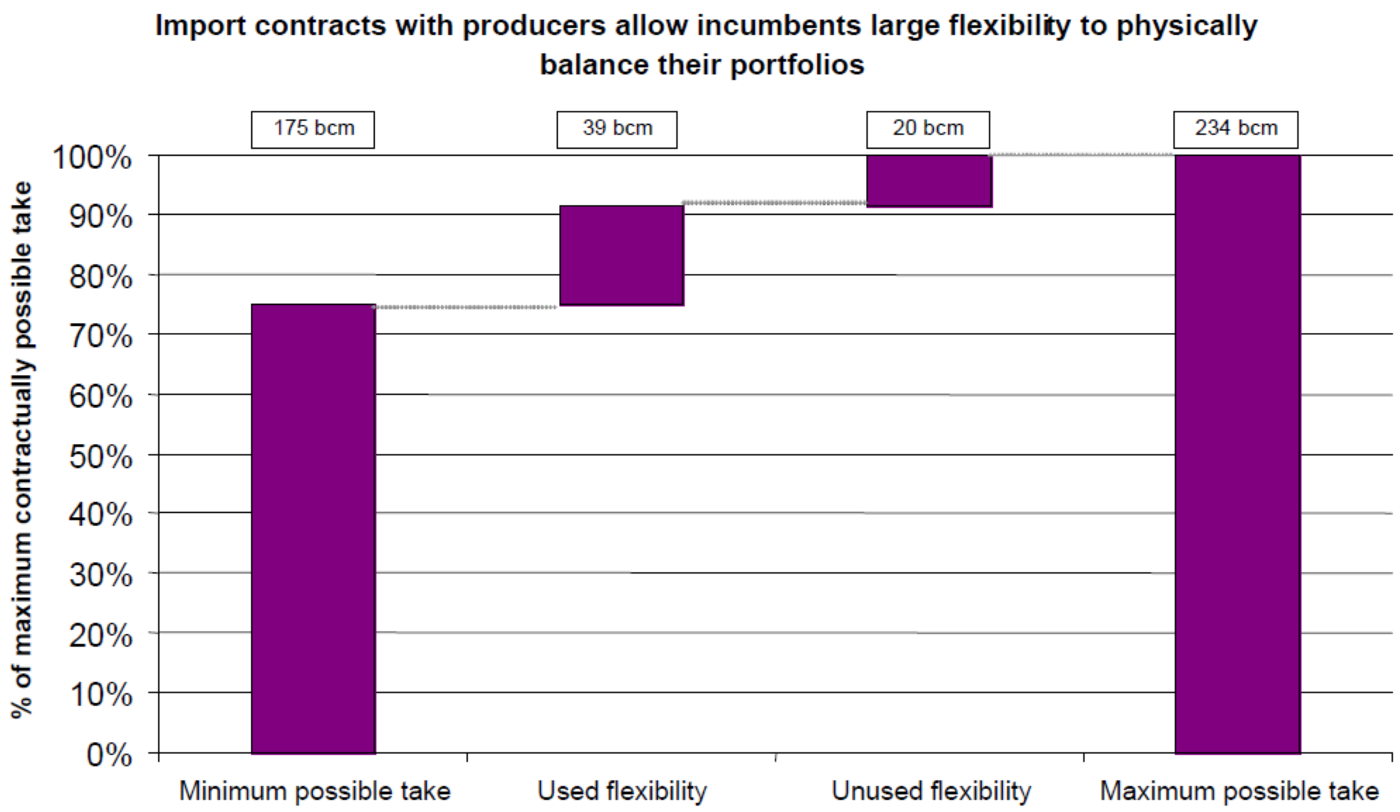
Take-or-Pay Clause in Long Term Contracts

- Volume Risk taken by the importer



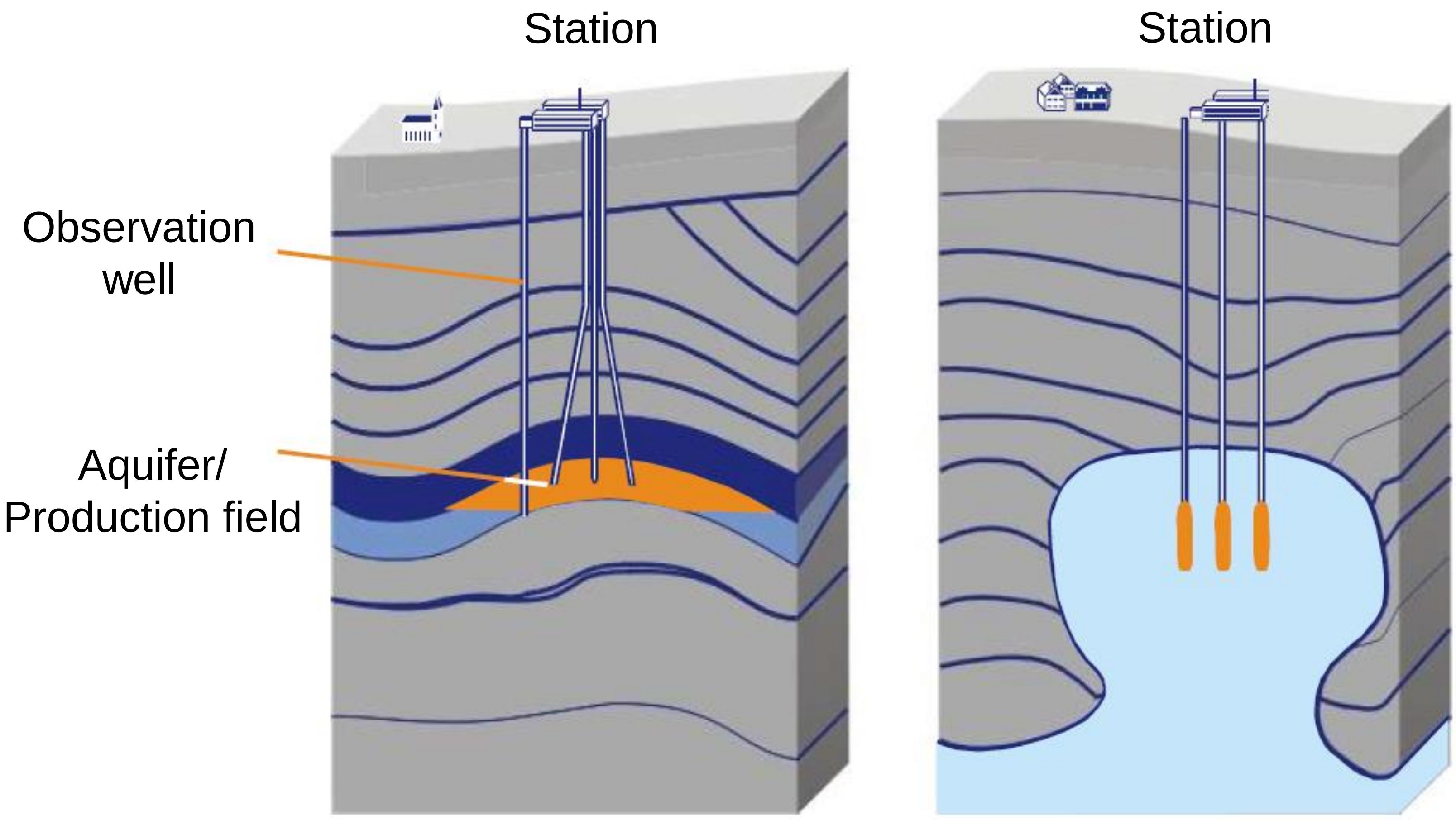
- Price Risk taken by the exporter according to a price formula that depends, among others, on the heating oil price "*Rheinschiene*" published monthly by the German Federal Statistical Office (*Bundesamt für Statistik Destatis*)

Volume Flexibility Under Long Term Contracts (2007)



Souce: European Commission, Energy sector inquiry 2005-2006

Gas storage technologies



Source: E.ON Ruhrgas

Porous rock storage

Cavern storage

Gas storage facilities: Underground

- Porous rock storage
  - uses existing geological underground formations (e.g. depleted oil and gas fields)
  - relatively inexpensive
  - large storage volume
  - more cushion gas required
  - low injection and withdrawal rate
- Cavern storage
  - artificial hollows carved out in underground rock or salt formations
  - higher investment
  - less cushion gas required
  - higher withdrawal rate
  - fast switching between injection and withdrawal mode
  - provide short-term flexibility

Gas storage facilities: Above ground

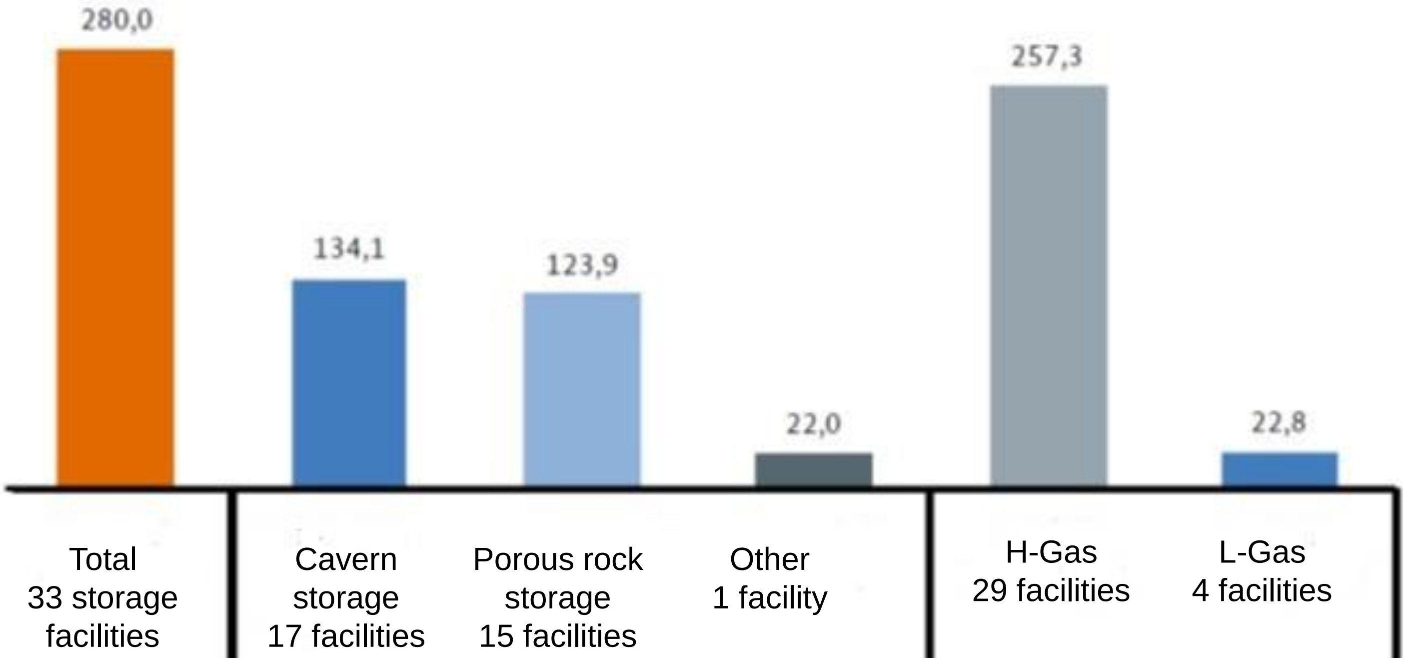
- LNG storage
  - Insulated tanks at LNG terminals
  - No cushion gas needed
  - High injection/withdrawal rates

- Gas tanks
  - Law or high pressure
  - Not economical for high volumes
  - Local storage

- Line pack
  - Gas stored inside pipeline through increased pressure
  - Used to balance daily demand fluctuations

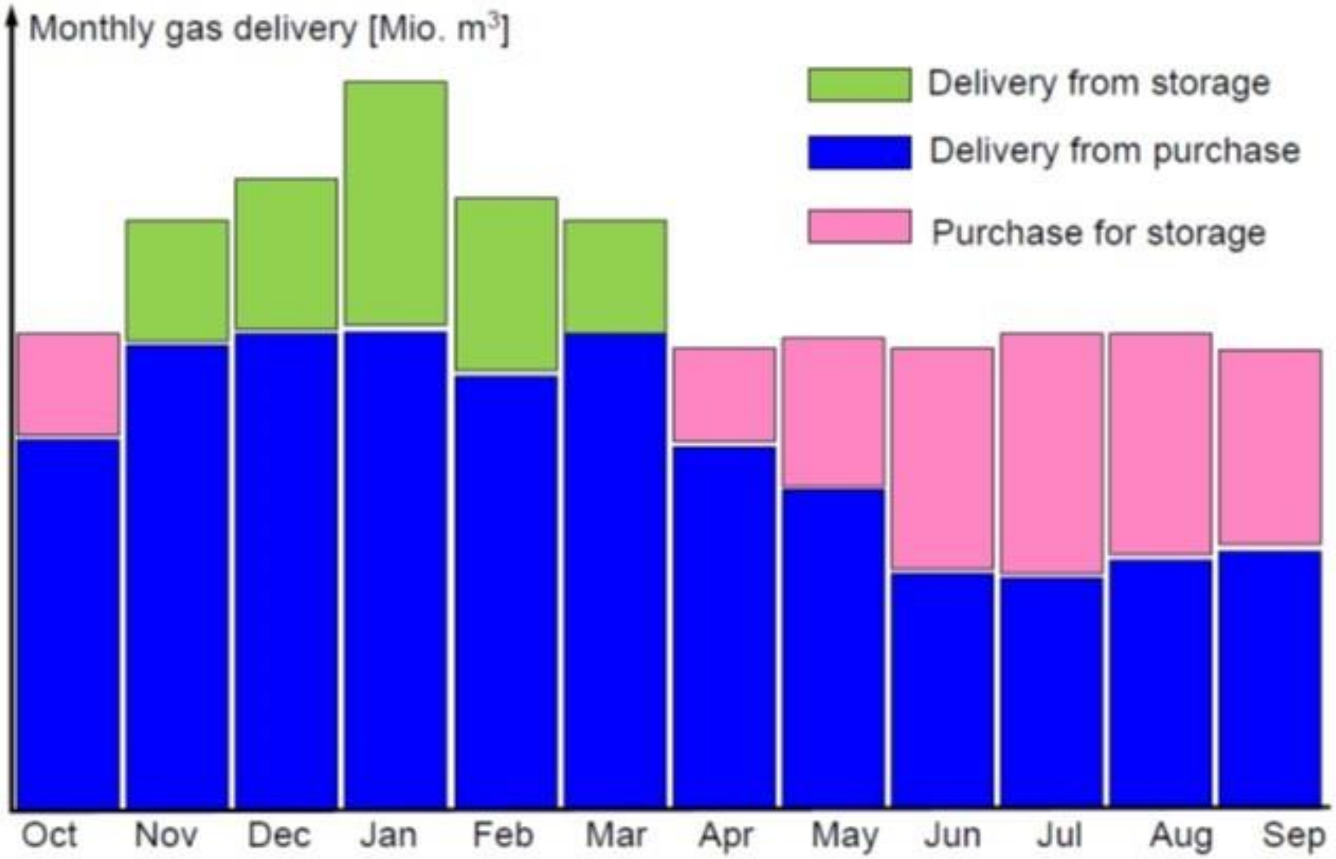
Gas storage facilities in Germany

Max. usable working gas volume as of 31.12.2018, in TWh



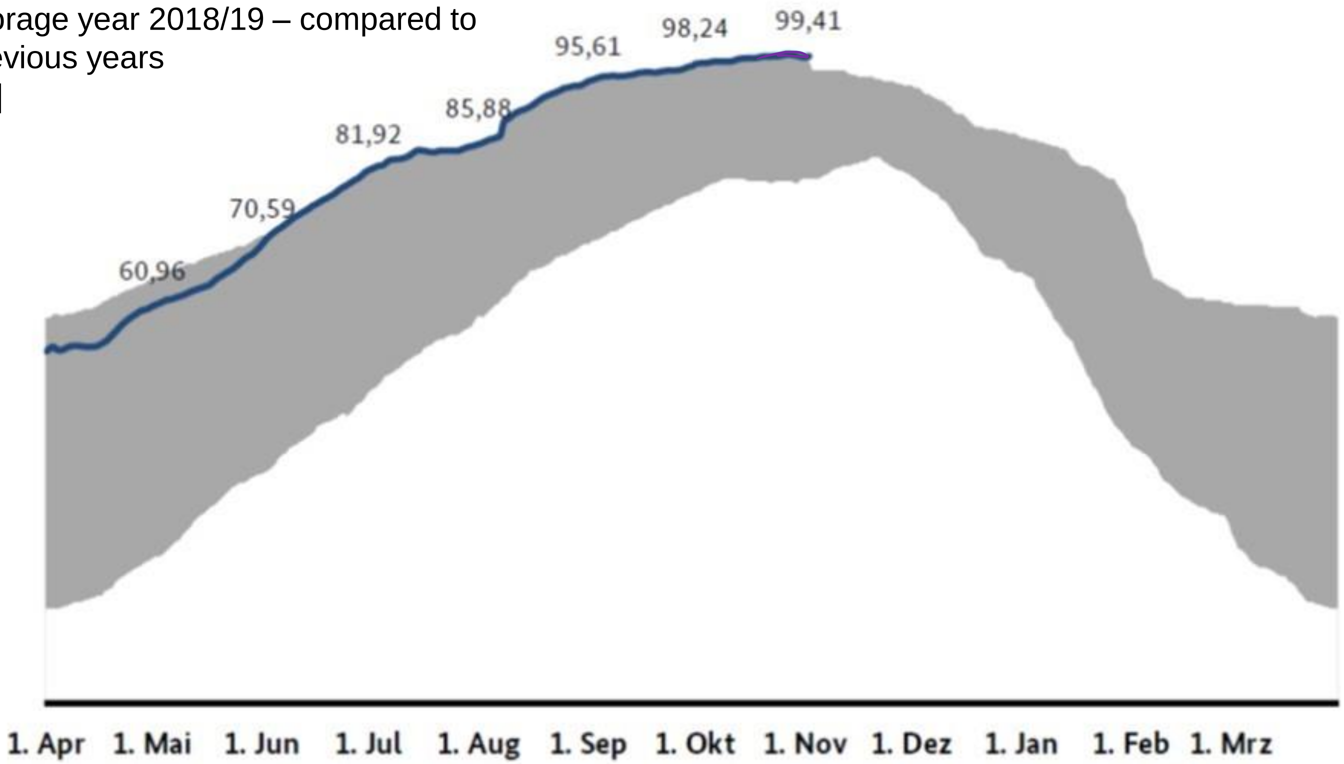
BNetzA, 2019

Merchant Use of a Gas Storage



German gas storage: Filling level development

Storage year 2018/19 – compared to previous years
[%]



Range of storage filling level since 04/2011

Filling level for current storage year – as of 1 Nov 2019

Source: BNetzA, 2019

Value of gas storage

Storage buffers supply and (daily & seasonally fluctuating) demand

Value of storage is determined by the cost of alternative sources of flexibility (transportation and capacity charges):

production swing, take-or-pay, interruptible contracts, spot market

- Intrinsic value
  - ability to inject a certain amount of gas in summer and withdraw it in winter
  - price during withdrawal minus price during injection, i.e. seasonal spread
- Extrinsic value
  - ability to utilise the storage volume more than once (inject and withdraw gas) during the season to profit from short-term price volatility

Gas and Heating Oil Prices

- Energy equivalent: 1 m^3 Methane = 0,89 kg or 1,2 Liter HEL
- Thus a 1:6 long term price relation between gas [USD/Mio. BTU] and crude oil [USD/Barrel] should hold
- Energy efficiencies etc. may justify other price relations
- High gas storage costs and a strong seasonality of gas use on the heating market imply a seasonal gas price pattern
- Extreme temperatures have a high impact on gas prices and not on heating oil prices and cause deviations from the long term price relation
- The same holds for gas (or oil) supply interruptions, deviations from the seasonal gas storage volumes, and the opening of new gas infrastructures
- Gas transport costs justify sustainable price margins between different gas markets

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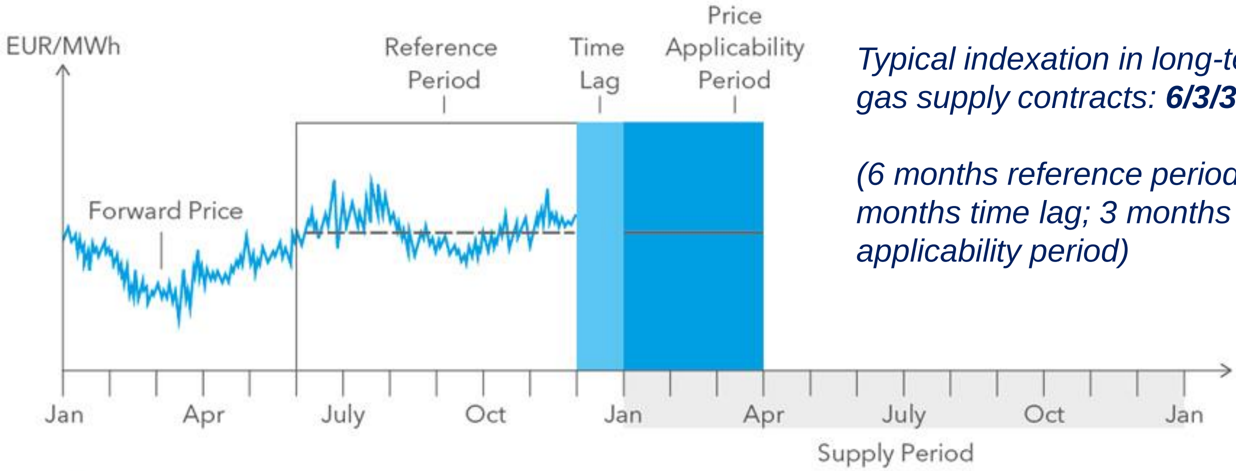
Index-based Gas Price

In this example: 6/1/3 rule

Typical indexation in long-term gas supply contracts: ***6/3/3 rule***

(6 months reference period; 3 months time lag; 3 months price applicability period)



Forward Price (Forward Contract – Quarter)

Arithmetic mean of the daily price quotation

Applicable Commodity Charge

Time period in or for which (depending on the specific index type) the index is published →

The **Reference Period** in this example adds up to six months. The value of the gas indexed commodity charge is the result of the arithmetic average mean of the daily price quotation for the forward contract "Quarter" within this six months (average price).

Time lag between the reference period and price applicability period →

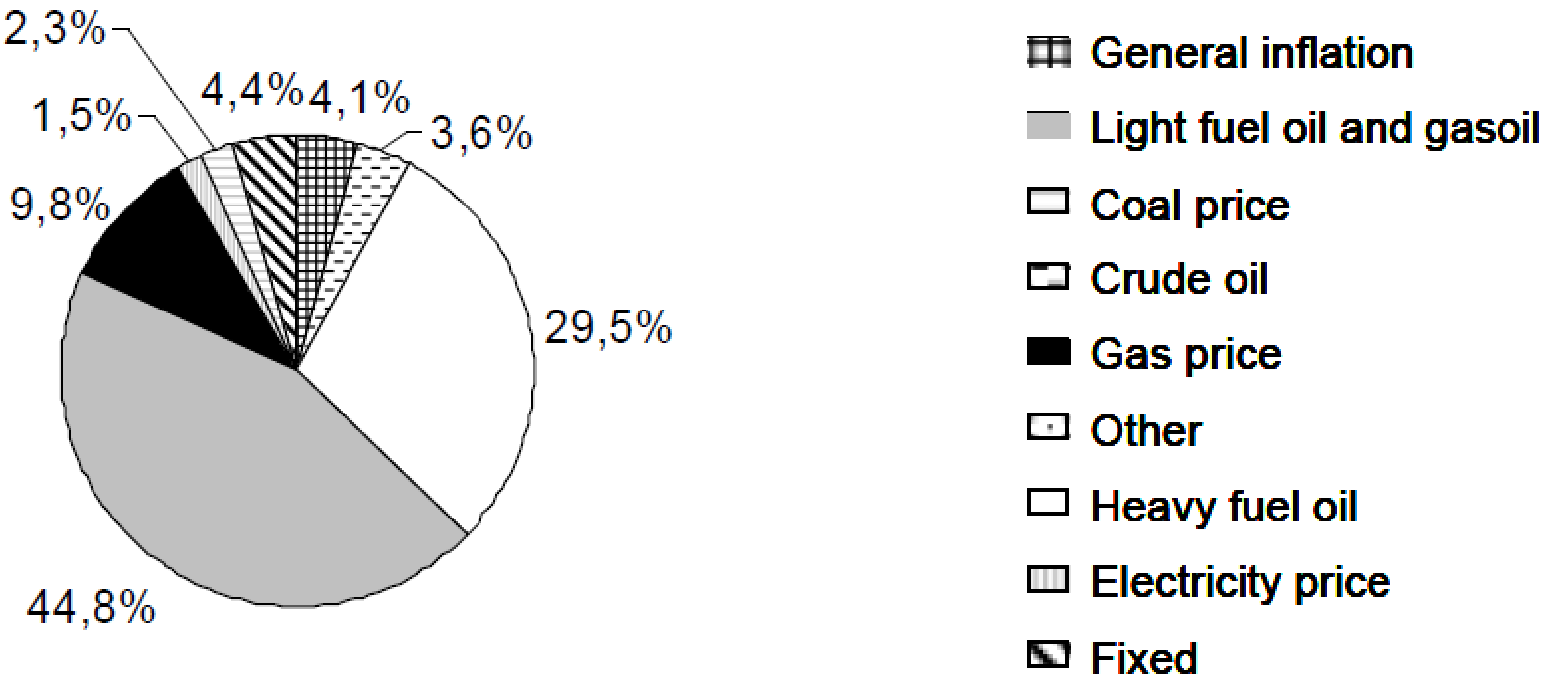
The **Time Lag** in this example is one month.

The **Price Applicability Period** in this example adds up to three months respectively a "Quarter".

Part of the delivery period to the calculated price applies.

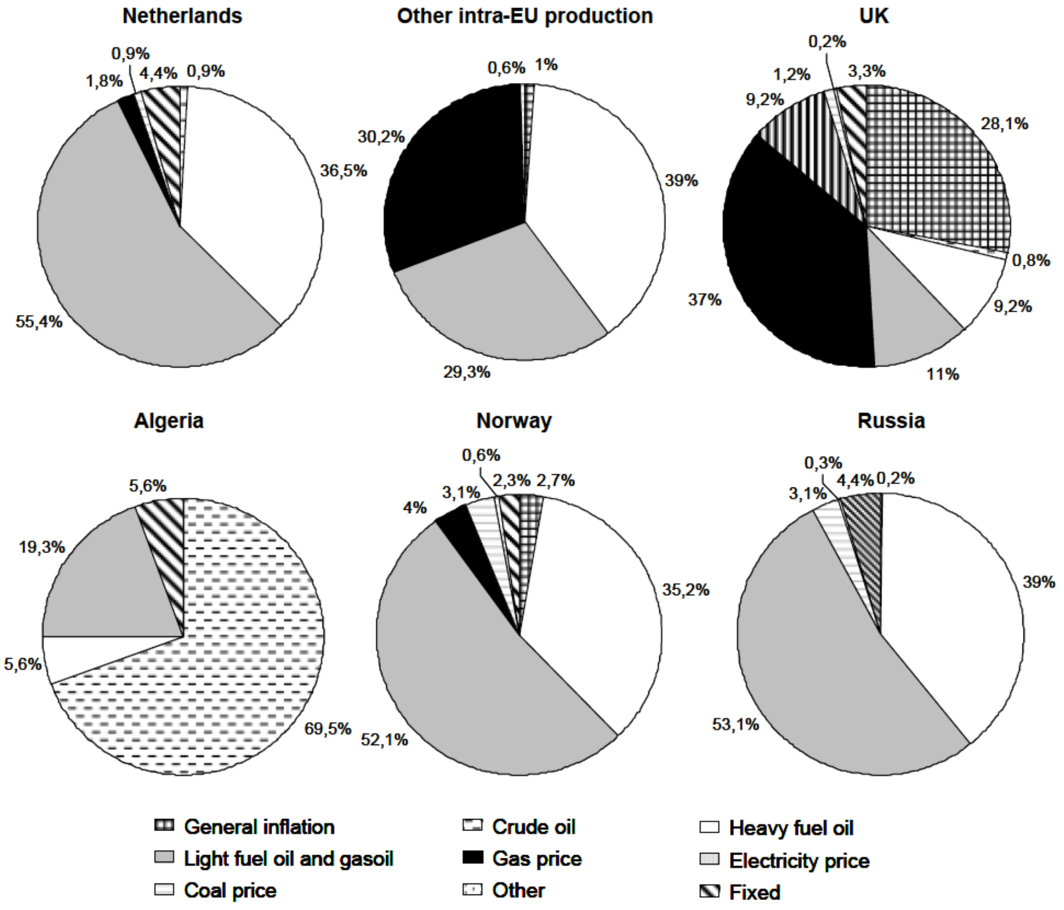
Souce: WINGAS

Price Indexation Under Long Term Contracts (2007)



Souce: European Commission, Energy sector inquiry 2005-2006

Price Indexation by Production Region (2007)



Souce: European Commission, Energy sector inquiry 2005-2006

Oil-product linked gas prices

Initial rationale for oil-based indexation is that users can choose between burning gas and oil products.

Early liberalised gas markets of the US and the UK with a liquid wholesale trading in natural gas resulted into gas-to-gas competition.

Long-term supply contracts for Continental Europe were initially linked to oil prices.

Since late 2000s European gas markets have shifted significantly from oil indexation towards hub-linked prices.

Renegotiation of price formulas in long-term supply contracts followed.

Downside of Long-Term Contracts

- Lacking transparency
- Reduced liquidity on wholesale markets
- Barrier for entry for new competitors

LTC Renegotiation

Driving factors for transition to hub-linked gas prices:

- US shale gas production
- Qatari LNG available in Europe
- Reduction in gas demand

→ new buyer/seller balance

Gas importers stayed bound by LTC at oil-linked prices incurring losses.

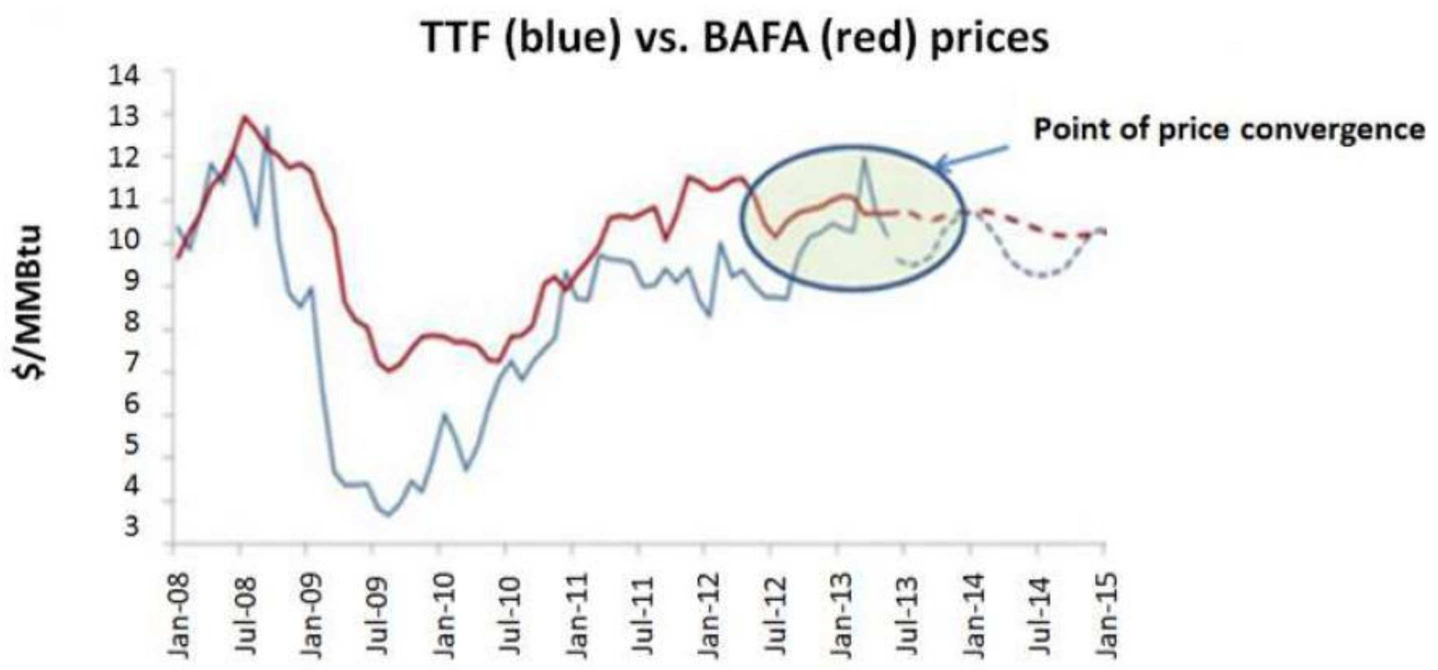
Renegotiation of LTC followed to introduce hub indexation.

Trends in newly signed contracts:

→ shorter duration period (10-15 years)

→ full hub indexation

Evolution of TTF and German Import Contract Prices



TTF (Title Transfer Facility) – Dutch gas hub
BAFA – average German import contract

Source: Franza, CIEP (2014), with reference to DEPA

Third-Party Access to Gas Infrastructure

Non-discriminatory (effective and transparent) access to gas transportation systems is a crucial prerequisite for a liquid market for natural gas.

Unbundling for gas TSOs (see EU Gas Directive 2009/73/EC):

Transmission and distribution activities are separated from the rest of the value chain

- Ownership unbundling
- Independent system operator (ISO)
- Independent transmission operator (ITO)

See lecture 11 on unbundling: equivalent rationale and requirements apply for the gas sector.

Certification to ensure compliance with unbundling requirements for transmission system owner or TSO controlled by person(s) from third country(ies)

„Gazprom clause“

Gas Network Access Models

- **Point-to-point system**
  - gas traders book specific transportation route from an entry to an exit point
  - distance-based capacity pricing

- **Entry-exit system**
  - entry and exit capacities are booked separately
  - entry fee and exit fee – capacity pricing independent of distance
  - traders with entry capacities can sell gas to traders with exit capacities
  - each exit point can be supplied from any entry point

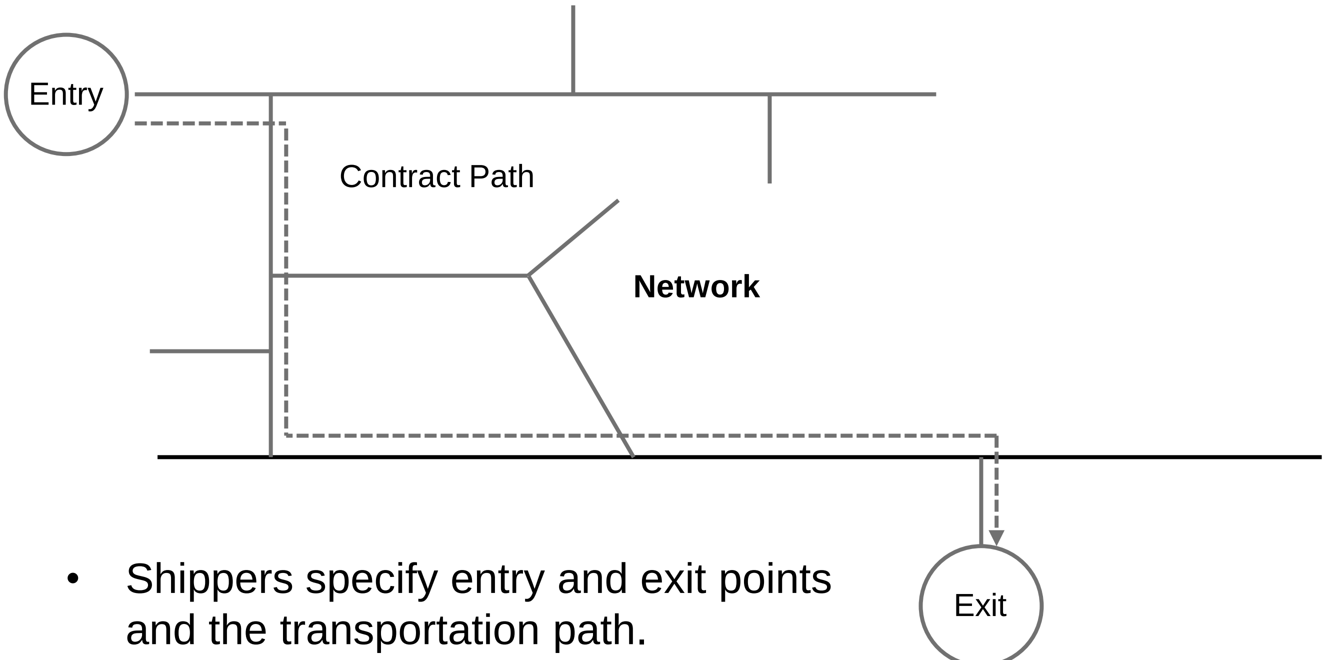
Entry-exit system enables wholegas gas trading on virtual trading point (**virtual hub**) / market area level: gas is traded independently of its location in a market area.

Key Elements of Network Access Model

Overall objective	Non-discriminatory network access to facilitate competition		
Areas of network access	General network access model	Capacity and congestion management	Balancing
Options/ major determinants	• Entry-exit • Point-to-point • Postage stamp	• Allocation principles • Capacity products • Further rules/incentives	• Balancing period • Imbalance pricing • Flexibility market

Source: Hewicker & Kesting, in: Handbook Utility Management, 2009

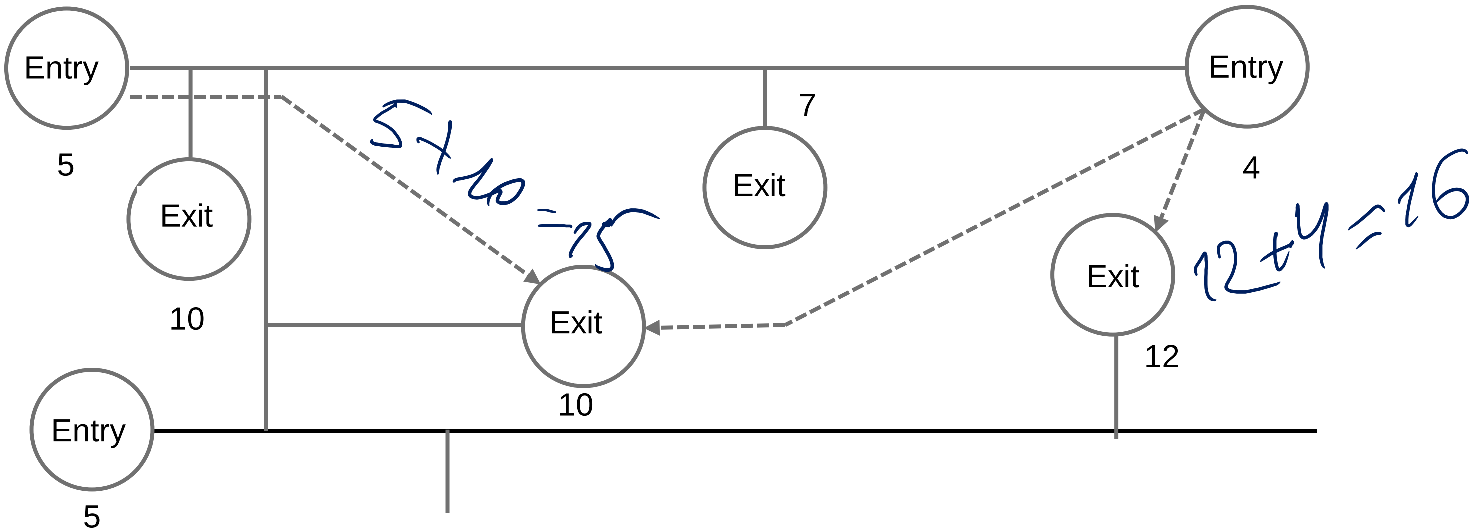
Point-to-point Model



- Shippers specify entry and exit points and the transportation path.
- Actual physical flow may differ from the contracted path.
- Entry and exit capacities cannot be separated from each other and from the gas (commodity) transaction.

Source: Hewicker & Kesting, 2009

Entry-exit Model



- Shippers book entry and exit capacity independently from each other.
- No need to specify transportation path or distance.
- Contracts for entry and exit capacities are independent from each other and from commodity transactions.
- Entry and exit tariffs are set independently for each entry/exit point
- Different tariffs for each point
- All network operators in a network zone cooperate and set tariffs on a cost-reflective basis.

Source: Hewicker & Kesting, 2009

European gas regions, markets and hubs

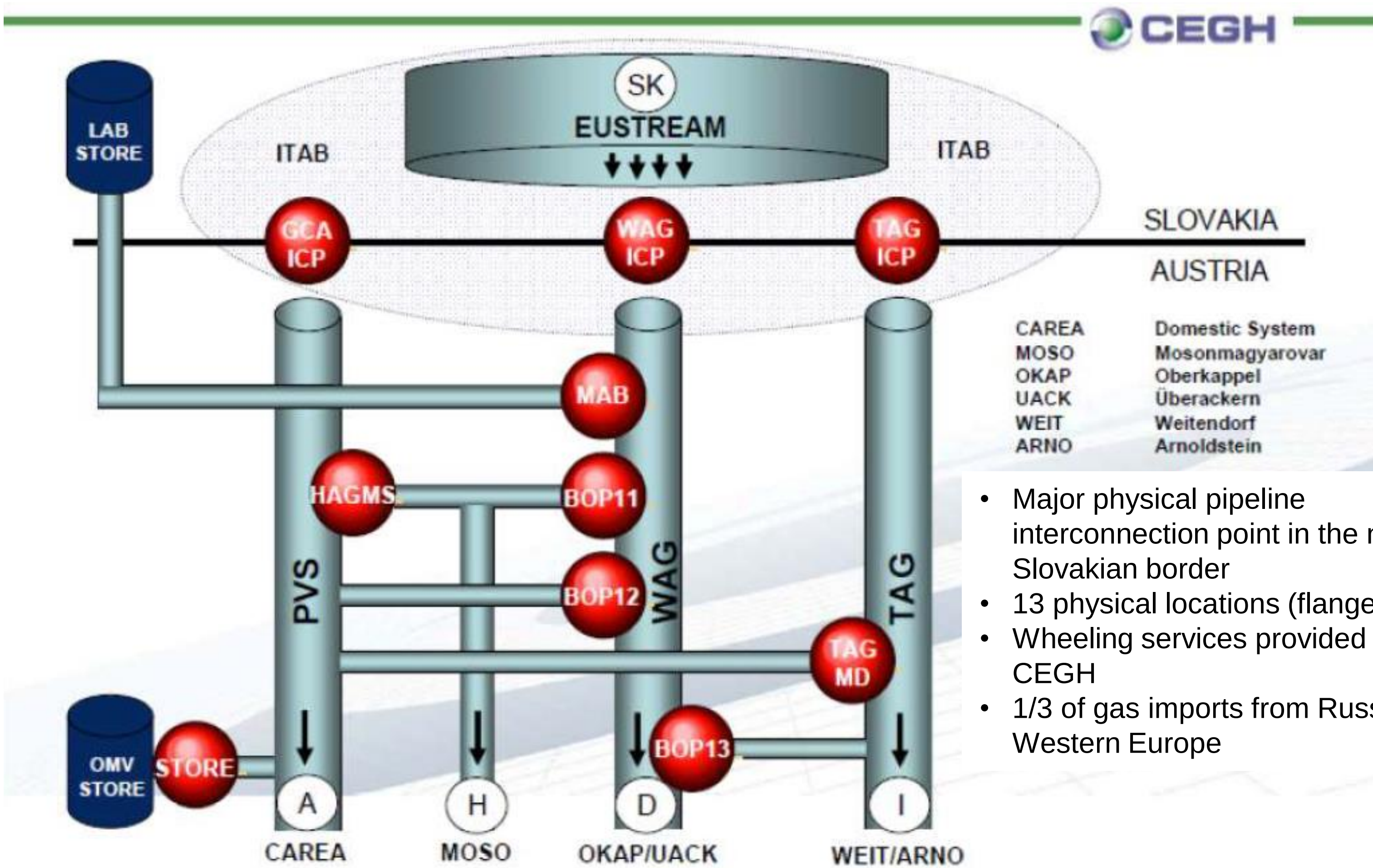
Source: OIES (2017) with reference to www.worldatlasbook.com and P. Heather

Gas Hubs

- Physical gas hub, e.g.
  - Henry Hub (USA) – connecting point of 14 pipelines
  - Zeebrugge (Belgium)
  - Baumgarten (CEGH, Austria)

- Virtual gas hub, e.g.
  - NBP, National Balancing Point (UK)
  - TTF, Title Transfer Facility (Netherlands)

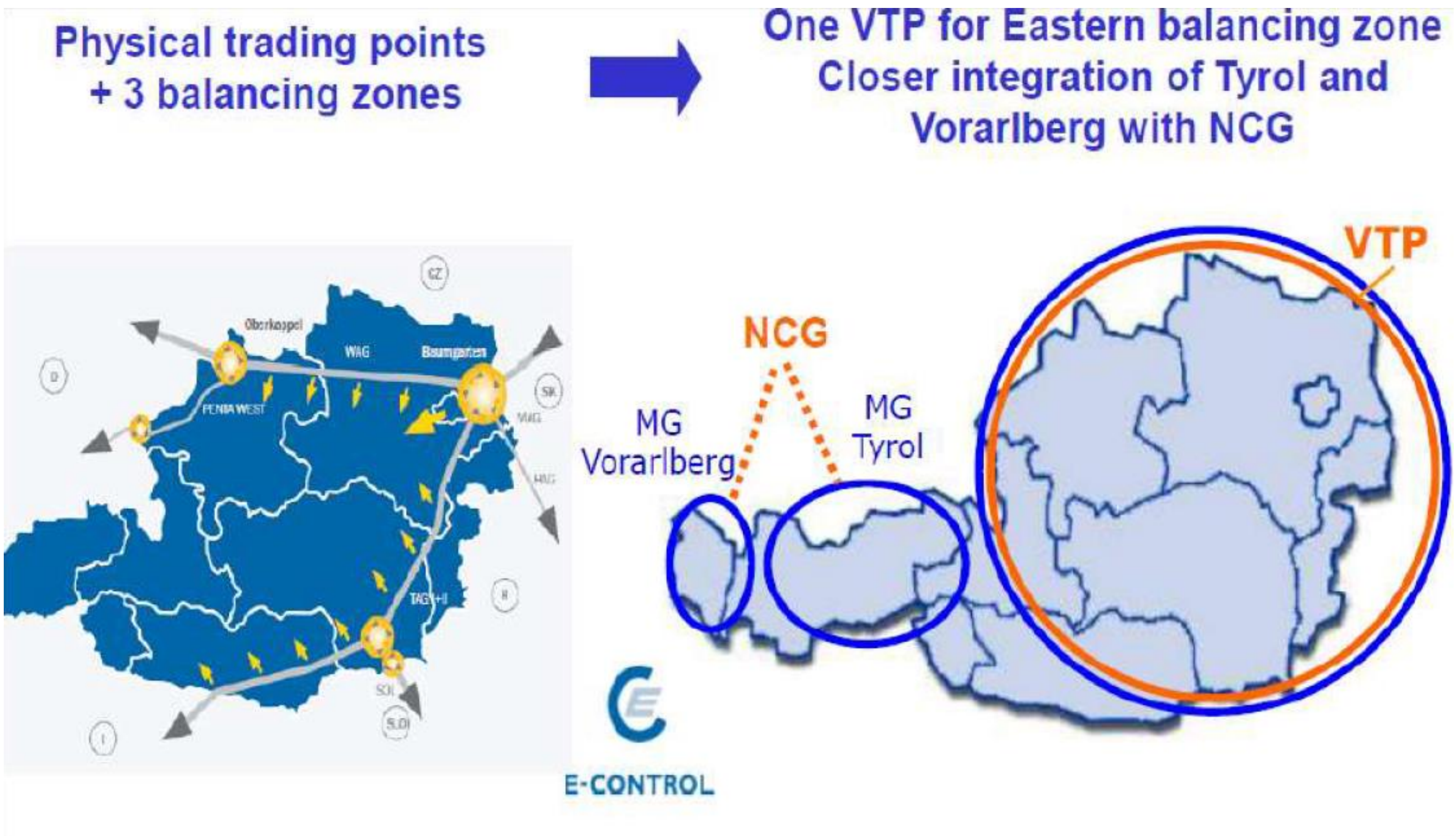
Physical gas hubs: Baumgarten



- Major physical pipeline interconnection point in the near Slovakian border
- 13 physical locations (flanges)
- Wheeling services provided by CEGH
- 1/3 of gas imports from Russia to Western Europe

Source: Heather, OIES (2012) with reference to CEGH Exchange

Virtual Gas Hubs: Austrian Virtual Trading Point (VTP)



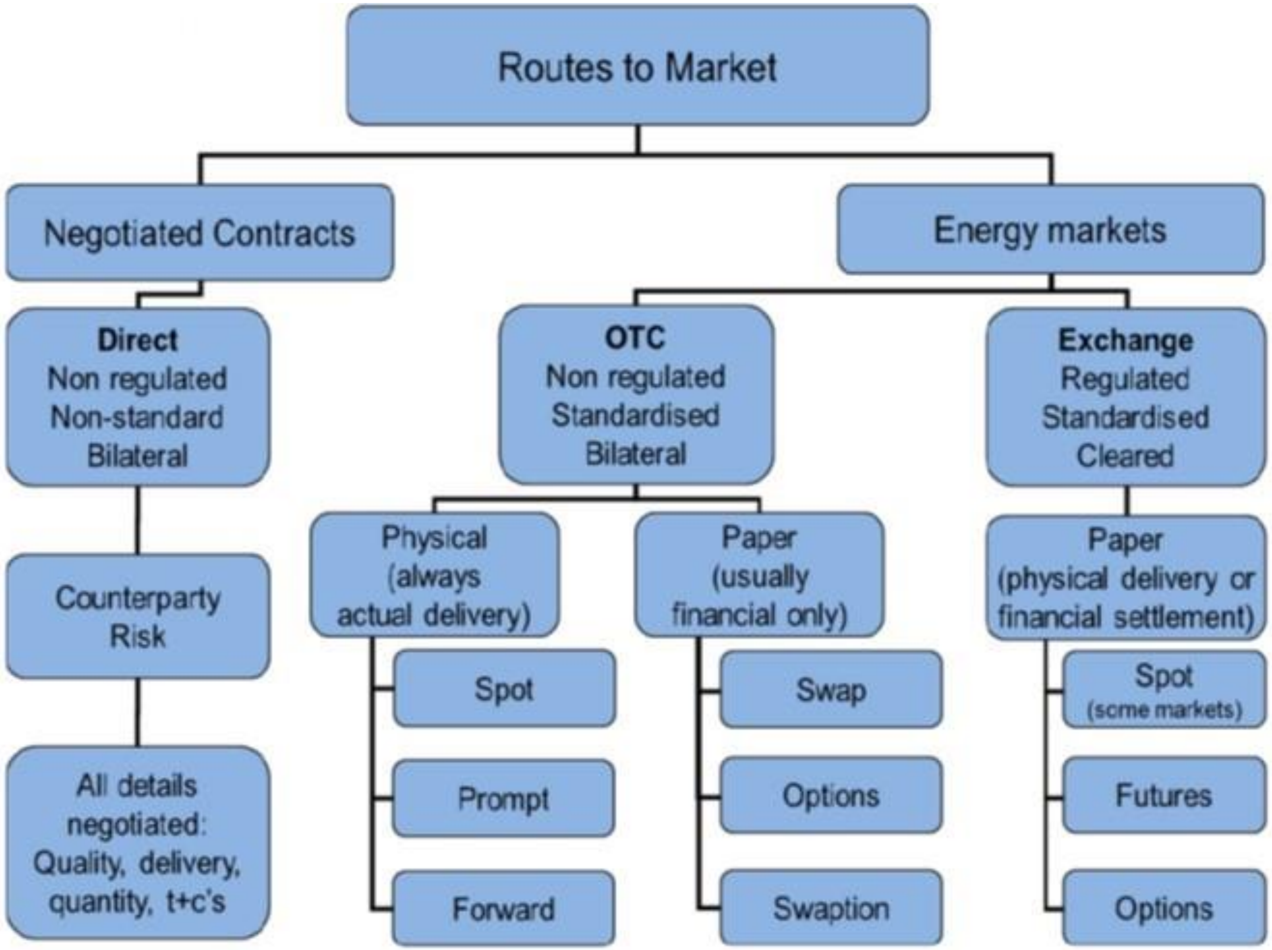
Source: Heather, OIES (2012) with reference to E-Control

Forms of Gas Trading

Motivations to trade:

- Balancing physical portfolio (asset-backed)
- Financial hedge
- Speculation (merchant/proprietary)

Forms of Gas Trading

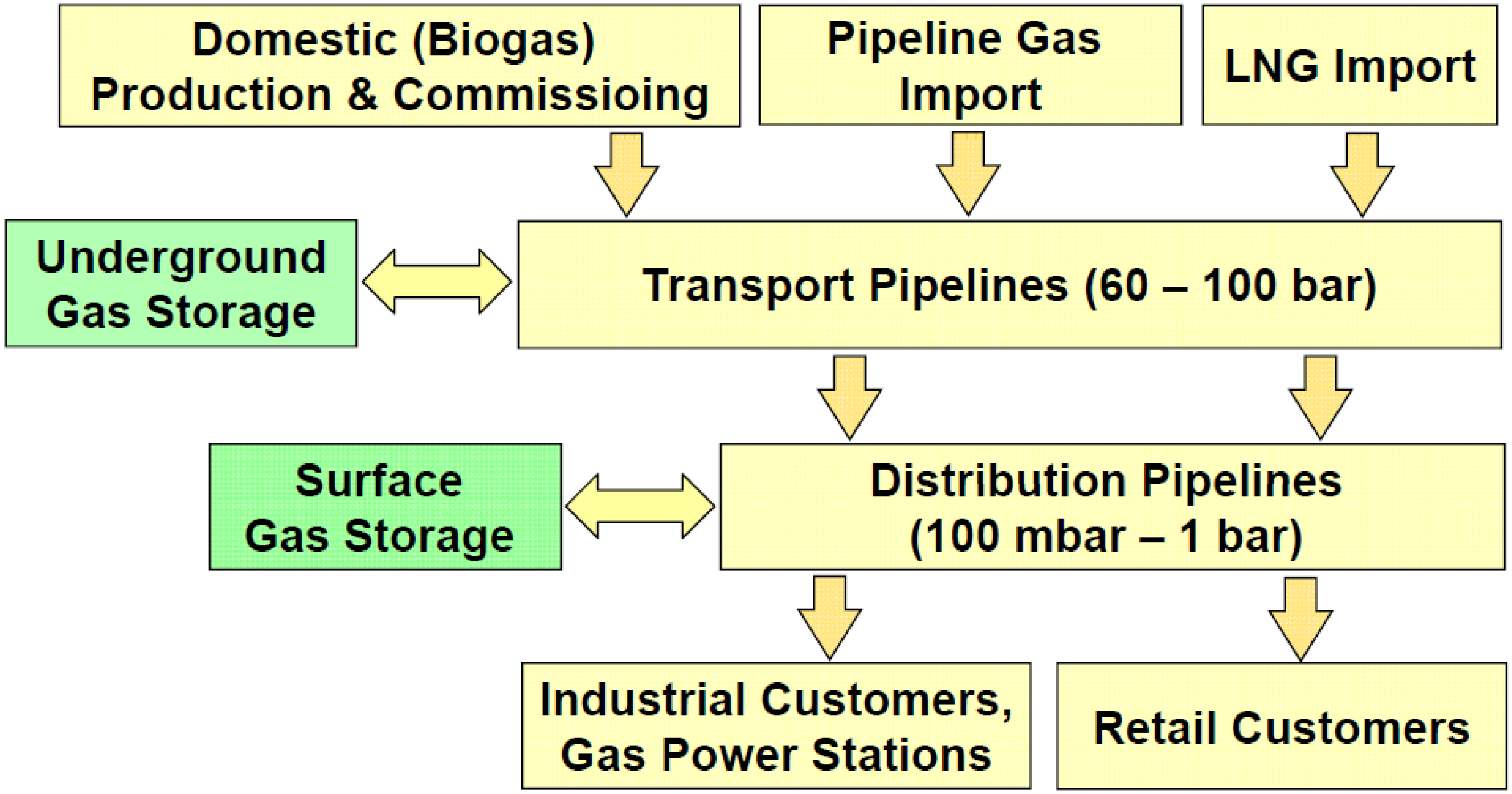


Source: Heather (2010)

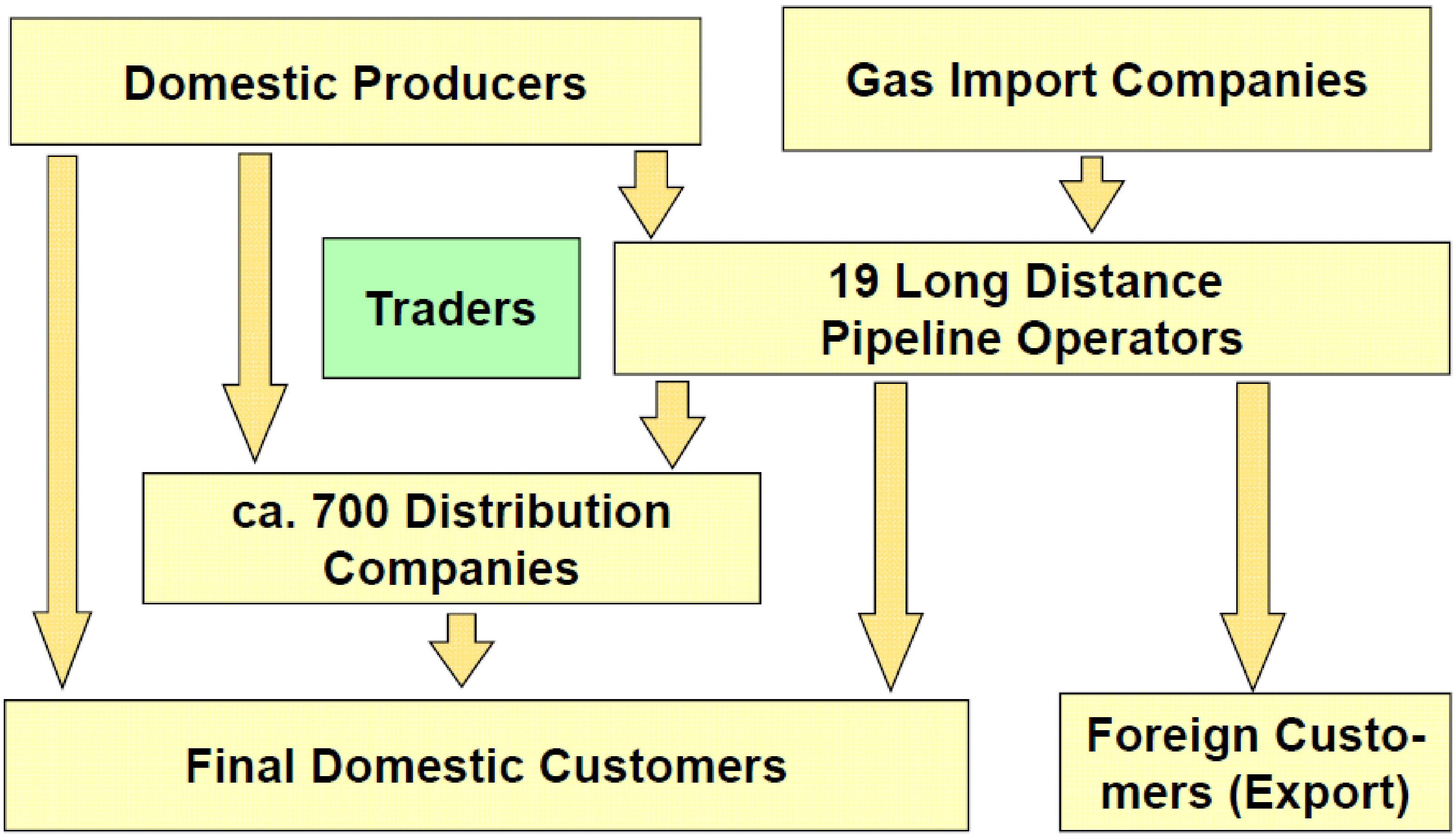
Comparison Electricity – Gas

Electricity Market	Gas Market
Transmission system operator (TSO)	Transmission system operator (TSO)
Balance group coordinator	Market area coordinator (NCG, Gaspool)
Distribution system operator (DSO)	Regional and local system operators (DSO)
Control area BG per control area Balance Responsible Party (BRP)	Market area / Virtual trading point BG per market area Balance Responsible Party (BRP)
SLP and RLM customers	SLP and RLM customers
Symmetrical imbalance price	Positive and negative imbalance price

Structure of the Value Chain

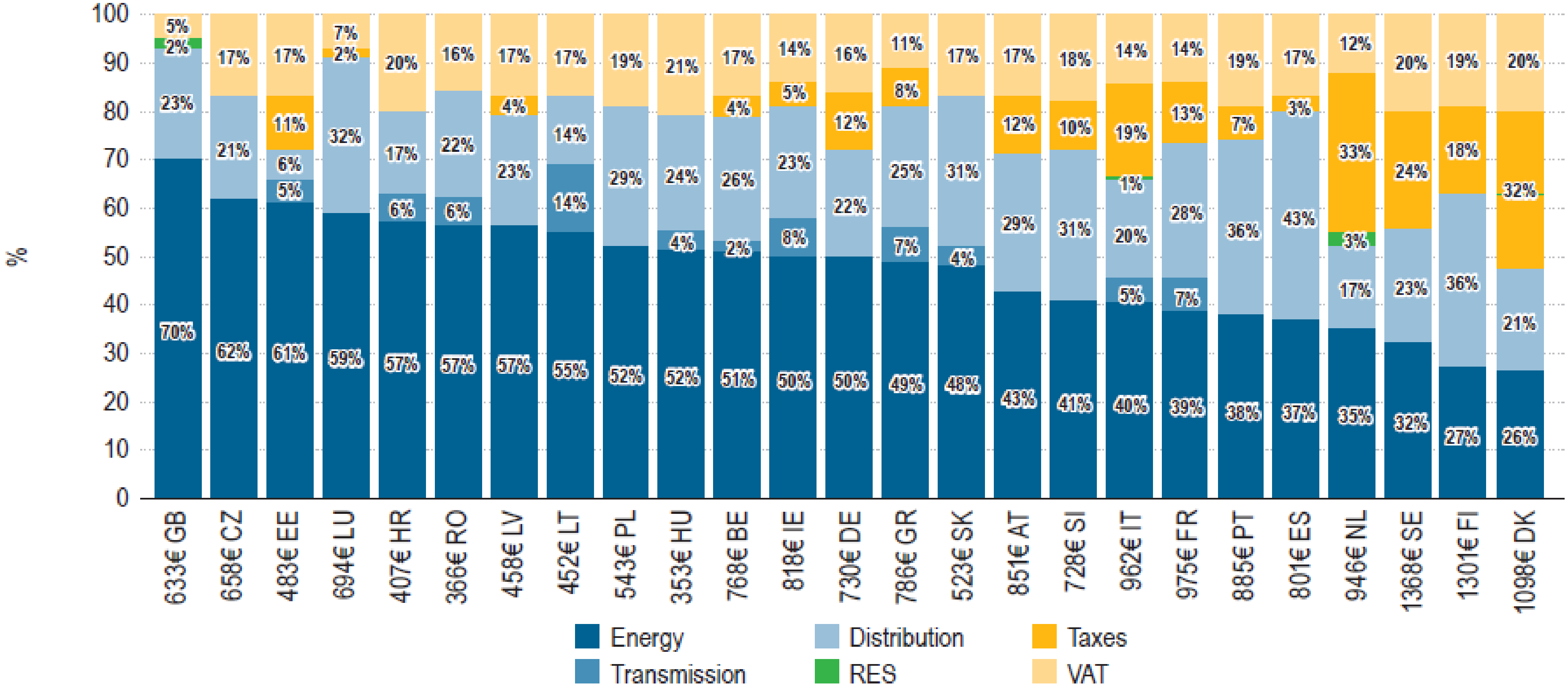


Companies Along the Value Chain



Technische Universität Berlin

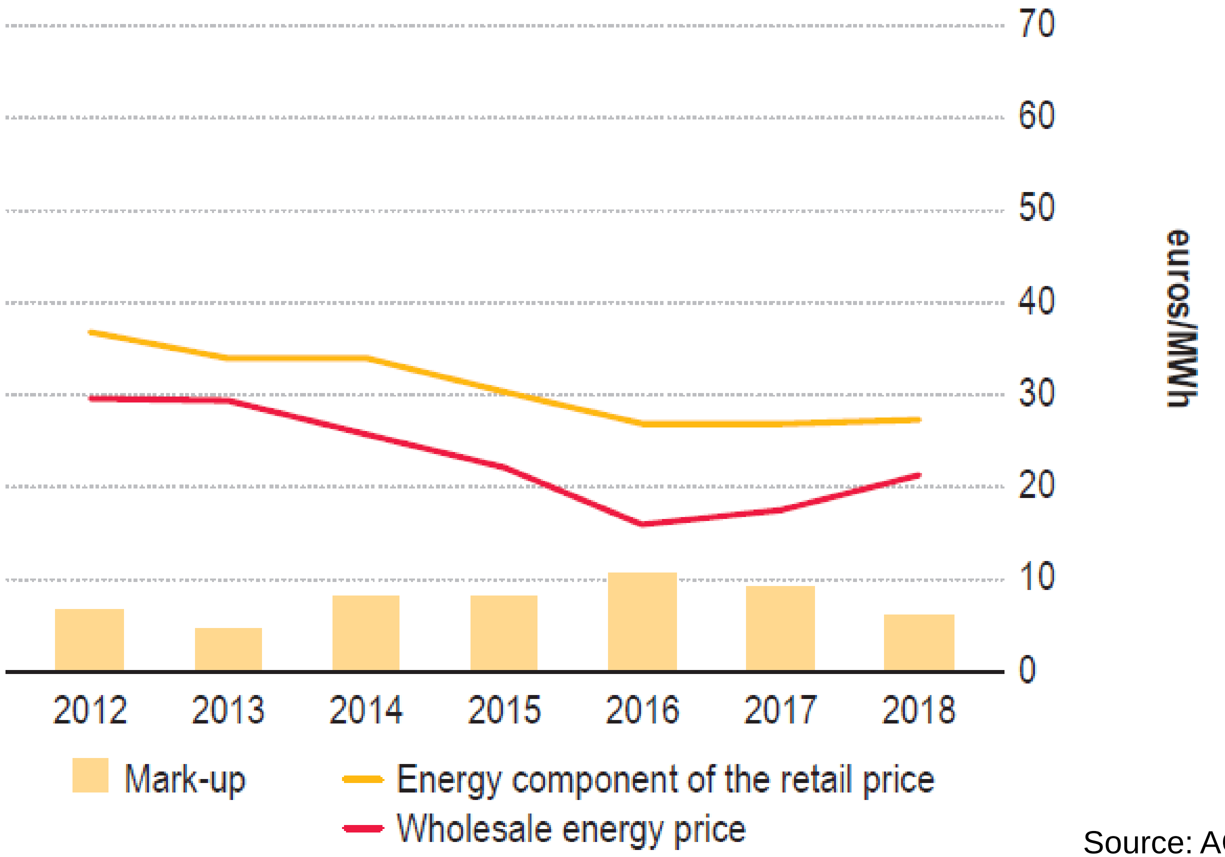
Incumbent's standard gas offers for households in EU capitals – Nov/December 2018 [%]



Source: ACER/CEER, 2018

Pass-through in gas retail market at EU level

Responsiveness of the energy component of the retail prices to changes in wholesale prices and evaluation of mark-ups in the household segments from 2012 to 2018



Source: ACER, 2018