

Module 3: Gas markets

Basics

Gas pricing

EU Gas Markets

US Gas markets & shale gas

Finnish Baltic gas market

Outlook



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This module was also
produced with the assistance
of Dr Kristo Helin



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Reminder: Fundamental differences between oil, gas and coal markets



OPEC and the balance between supply and demand are the key drivers in oil markets



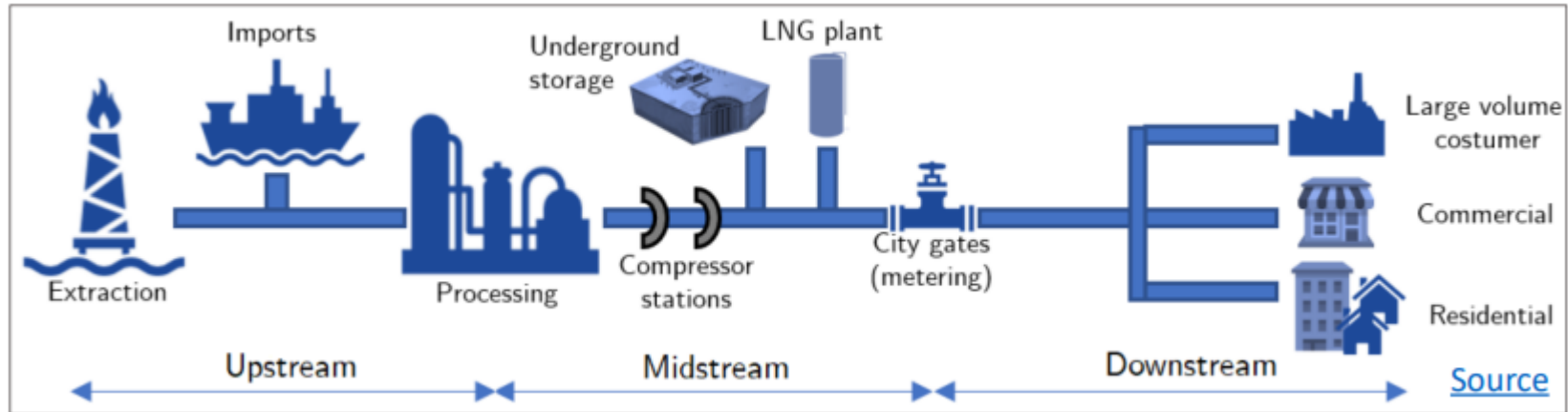
Coal has abundant reserves and it is easily traded



Gas is mostly traded in pipelines and storage near consumption is often difficult

Natural gas basics (1)

- The natural gas (NG) industry is often divided to Upstream, Midstream and Downstream, and the market happens across all of them
- Marketed products include biomethane (refined biogas) and natural gas as delivered by pipeline, compressed in containers (CBG & CNG), or liquefied (LNG & LBG). Synthetic methane made from renewable sources is a promising new entrant



Natural gas basics (2)

- **Global NG consumption in 2020 was 3823 bcm (billion cubic meters (standard))**
- **1 bcm ~ 11.1 TWh → 3823 bcm = 42 500 TWh**
- **European NG consumption was 4200 TWh, Finnish consumption was 28 TWh. Finnish biogas production was ca. 1 TWh.**

Gas markets – key aspects

- **Gas is mostly traded in pipelines and storage near consumption is often difficult. LNG transportation (by ships) has been more expensive but will increase in the future.**
- **In Europe, most of the gas is sold by bilateral long-term agreements. Price is usually indexed at least partly to other indicators, e.g. oil price.**
- **In the EU, large consumers can mostly choose their gas provider**
- **In the USA, there exists a more complex natural gas network, where gas can be traded more like electricity in Europe.**

Liquefied natural gas (LNG)

LNG is natural gas cooled to $-160\text{ }^{\circ}\text{C}$, reducing its volume by a factor of 600

- Transport of LNG happens by ship, truck or train
- Typically, 0.1-0.15 %/day of transport volume is lost to boil-off, often used as energy on the ship
- First LNG plant began operation in 1917 in the United States, first commercial operation in 1941

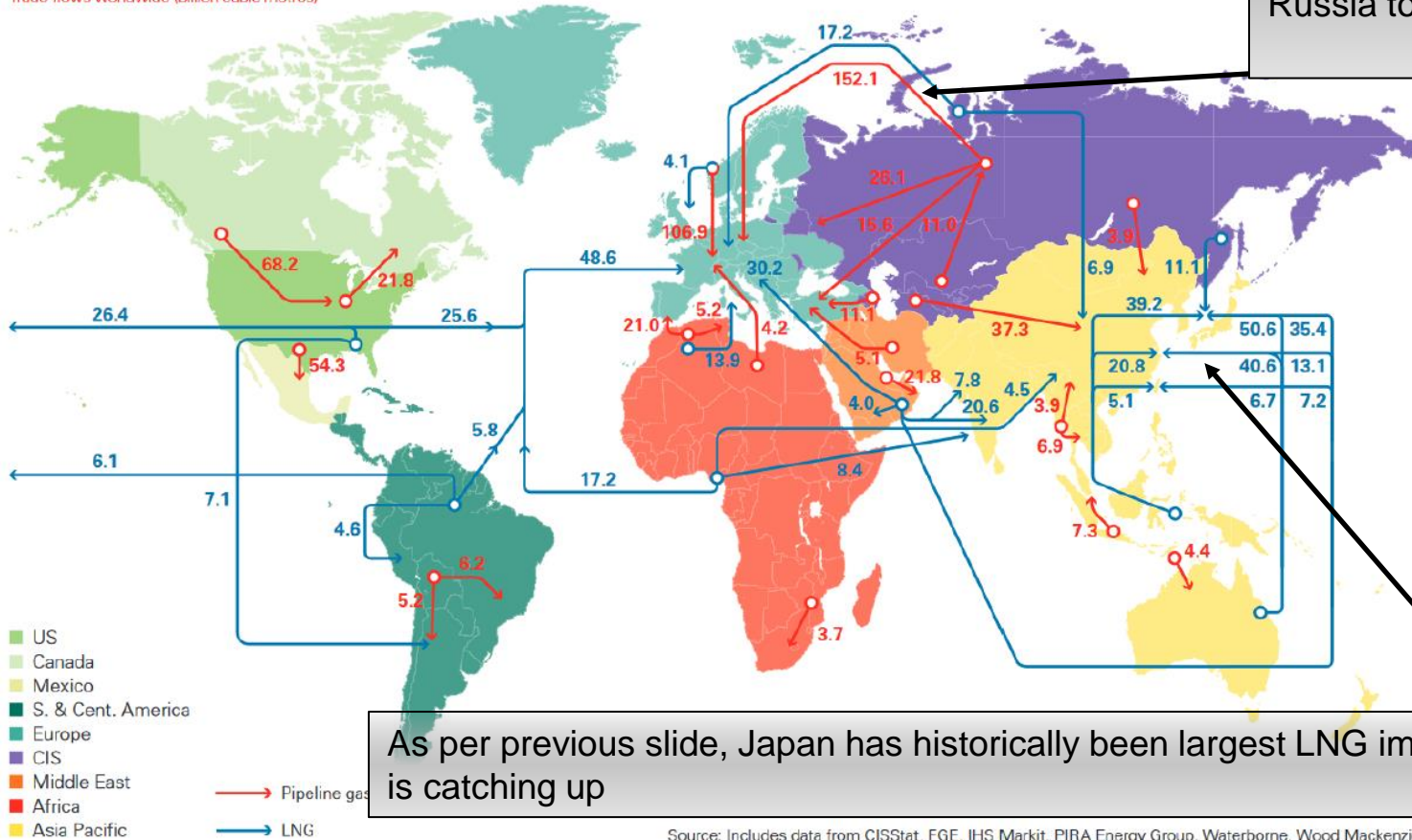
In the early 2000's, LNG was mainly an export method to regions that did not have pipeline access –this is no longer the case, LNG competes with pipeline gas for market share, setting a market price

In 2020, top 5 LNG importer and exporter countries were:

- Import: Japan (102 bcm), China (94), South Korea (55) India (35), Taiwan (25)
- Export: Australia (106), Qatar(106), U.S. (61), Russia (40), Malaysia (33)
- Russia has only recently joined this list, focusing previously on pipeline gas

International gas trade flows

Major trade movements 2020
Trade flows worldwide (billion cubic metres)



Largest global transfer has been by pipelines Russia to EU (pre-2022)

As per previous slide, Japan has historically been largest LNG importer, but China is catching up

Source: Includes data from CISStat, FGE, IHS Markit, PIRA Energy Group, Waterborne, Wood Mackenzie.

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Gas price indexation

Gas price indexation means there is a starting price for the contract (P_0), which is then adjusted based on the value change of some indicator

- The adjustment is often monthly, and there can be a lagging effect, e.g. considering the 6-month rolling average of the indicator
- The indicators are very typically price indices of other energy commodities (oil, gas, coal). Sometimes other indices can be used that reflect the competitive environment of the buyer
- It is also common to have several indices, which are given weight factors to create a suitably balanced total index

Two typical forms of indexation are:

- Oil-indexed: Follows the price change of oil products
- Hub-indexed: Follows the price change of some gas trading hub, such as TTF or NBP

Natural gas pricing methods (1)

Wholesale gas sold in Europe:

- 80 % is priced based on gas on gas competition
- 20 % is priced based on oil price escalation

Oil price escalation means that the price is oil-indexed

- The starting price, adjustment interval, indexed products, and considered lags are purely a matter of contract
- This was the most common contract in Europe still in 2010
- Oil price was used for indexation because it used to be an important competing fuel for NG (in some ways it still is), and no party could impact its world price

Natural gas pricing methods (2)

Gas on gas competition is a much more varied category, and includes all contracts based on the **gas market** in some way, with hub-indexation being only a part of the selection.

- The pricing method is considered fair, because it represents the cost of procuring gas from a competing supplier, which is positive in terms of market integration
- Gas on gas competition is much more volatile than oil indexation was, and it has created some trouble for the markets: Europe saw its lowest ever gas market price in 2020, and highest price ever in 2021

Other pricing methods are bilateral contracts (varied, stable pricing between mainly one big buyer and one big seller), netback (price depends on the price of final product, common in e.g. chemical plants), and different forms of regulated pricing.

Natural gas market areas

The gas market is naturally divided to large and small regions; price convergence depends on the ability of the market to benefit from the price differentials by trading

Depicted are some of the effective gas price areas globally and regionally. Circles represent NG trading hubs

- Hubs with effective markets and no bottlenecks should have close to identical pricing
- If this is not realized, there are likely either natural barriers/distance, or barriers to market entry or participation

The hub price in TTF in the Netherlands is likely the most important NG price benchmark in the world

Natural gas price benchmarks –June 2020 (\$/mmbtu)



Map 1: European gas regions, markets and hubs in 2018



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European regulation and liberalization of gas markets

In the 1990's, the European commission started to aim its market integration agenda at gas and electricity

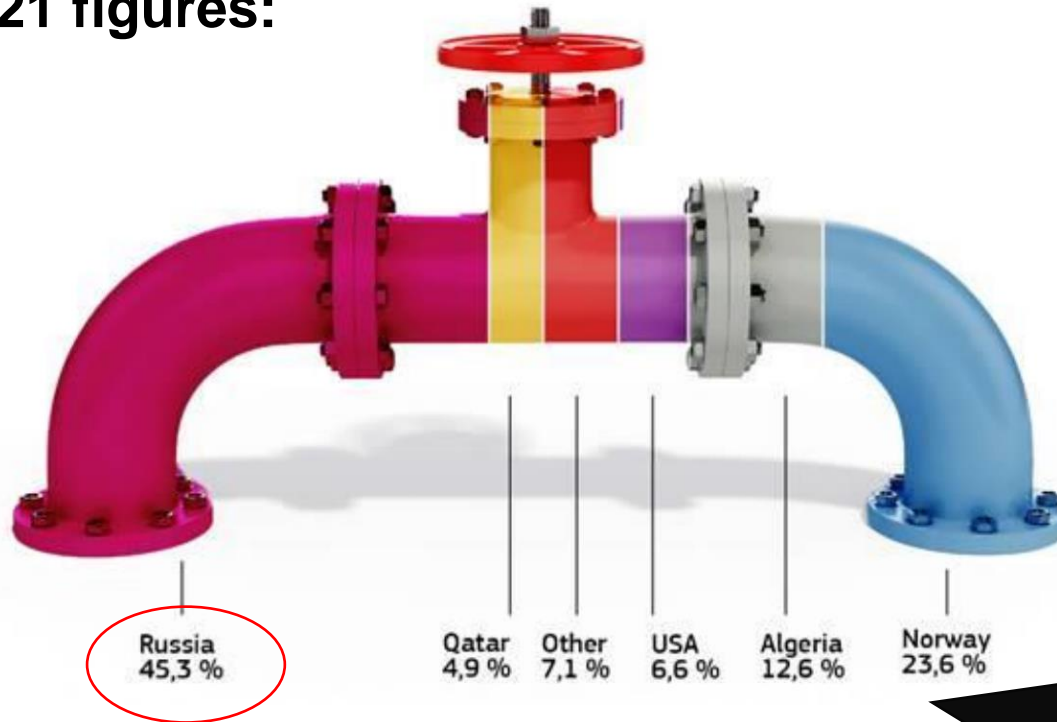
- The oil sector, perhaps due to the ease of transport, was already moving in this direction globally
- Industry and state opposition was significant, and the first concrete results only came a decade later

The bilateral and varyingly taxed and controlled European gas market eventually started to become standardized

- The most significant milestone in gas market integration was in 2009, with the adoption of the Third Energy Package, which included rules for “unbundling”, i.e. the separation of energy trade and transmission
- In energy trading, a significant trend was and is changing contracts from oil-indexation to hub-indexed pricing
- After a gas price drop in 2008, there was a period of arbitration that shifted the pricing and mechanics of long-term contracts

Where do we source our gas in EU? Dependency on Russia has been increasing in recent years...

2021 figures:

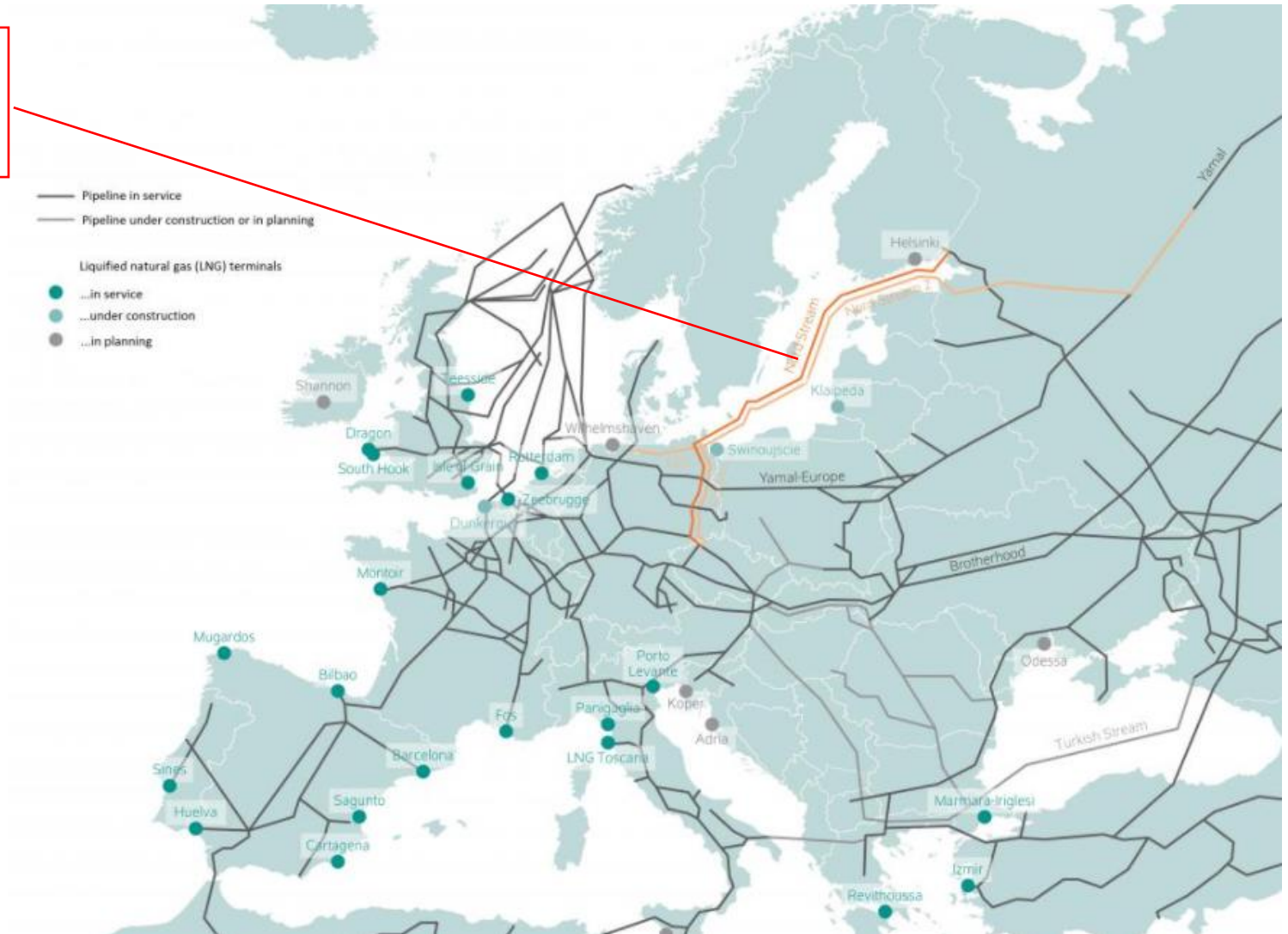


It's been getting worse, data for 2017:



...as facilitated by Nordstream (European gas network)

Nordstream 1&2
Russia > Germany
(Nordstream 2 will likely never begin operation)



Gas and politics; Nordstream

Nordstream was built as a way to transfer gas Russia to Germany bypassing Ukraine and other transit countries, and thus facilitating the weaponization of gas

Nordstream 1 was built after a bilateral agreement between former German chancellor Gerhard Schröder and Vladimir Putin

And what was Schröder's job after leaving office?

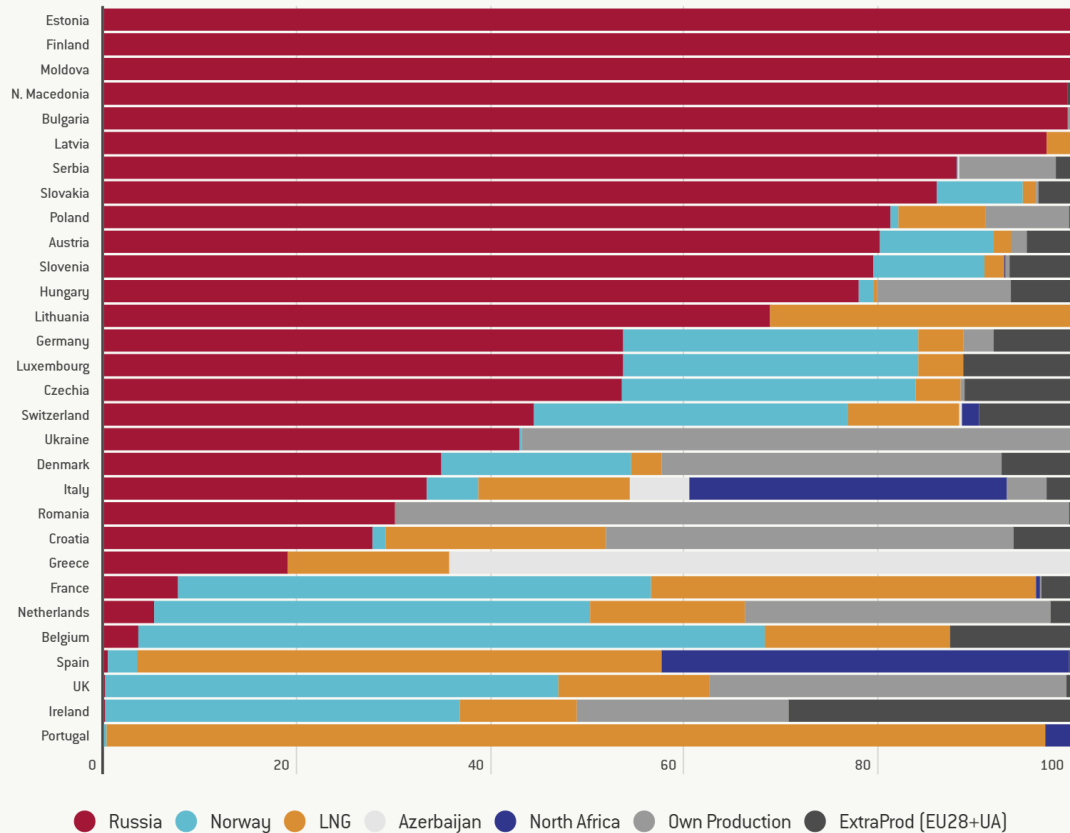


Soon after stepping down as chancellor, Schröder accepted Gazprom's nomination for the post of the head of the shareholders' committee of Nord Stream AG

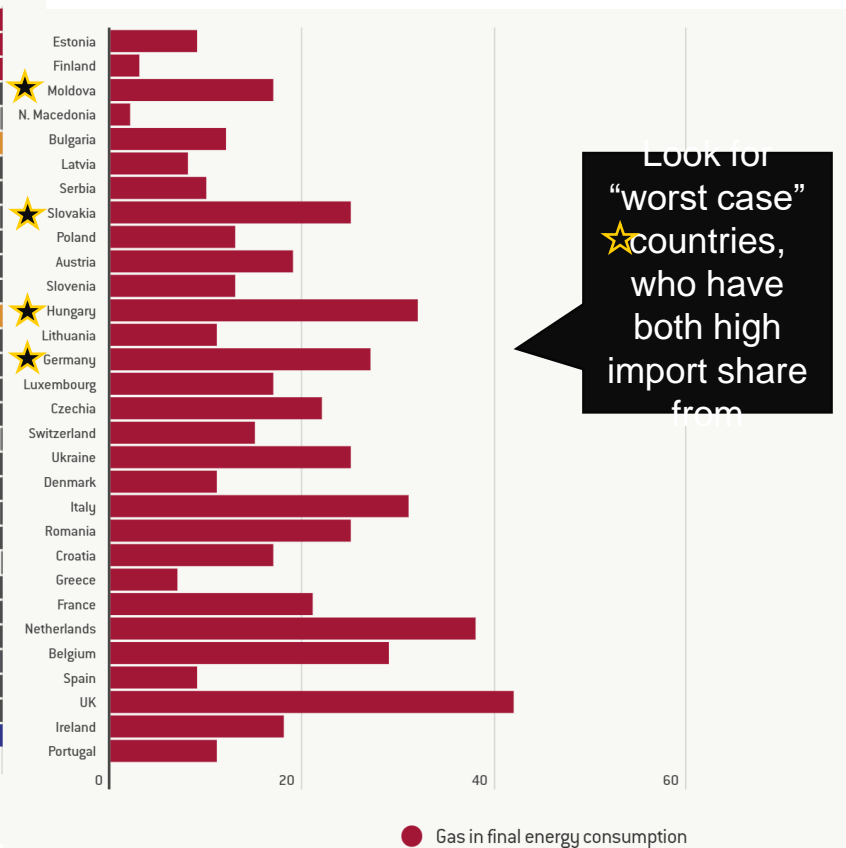


: How is the situation of different European countries? (2020/2021 data)

Gas import share



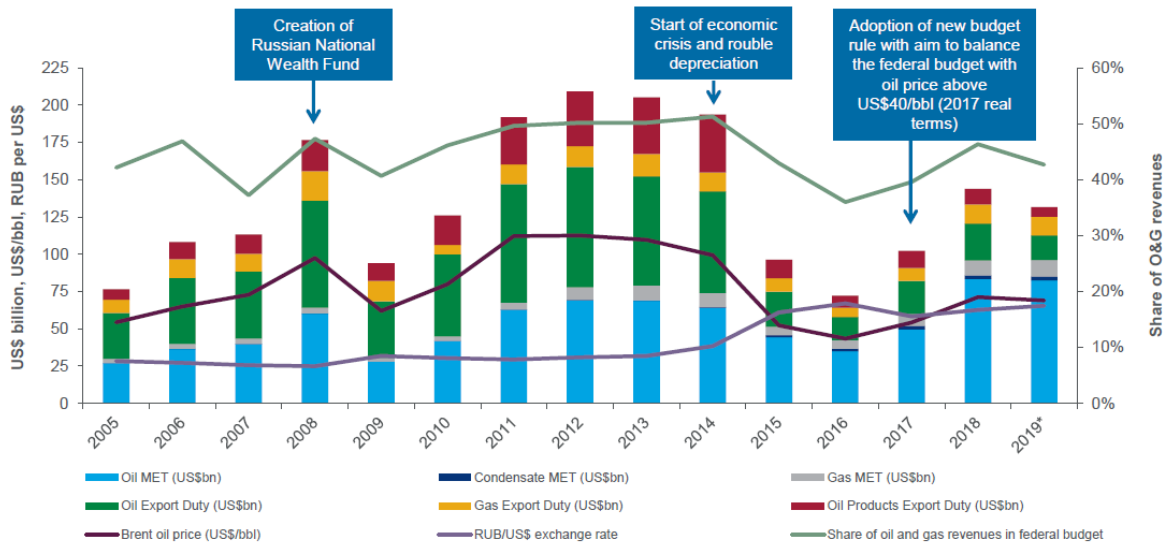
Gas % in energy consumption



LOOK FOR
"worst case"
countries,
who have
both high
import share
from

Oil & Gas sales revenue is critical to the Russian economy

Evolution of federal budget oil and gas revenues



Source: Russian Federal Treasury, Wood Mackenzie (2019 figures estimated)

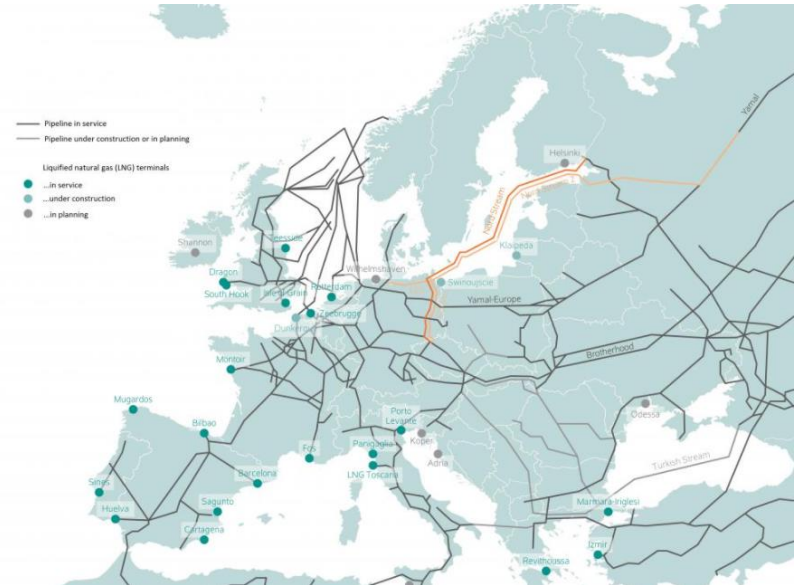
Gas revenues are easier to tackle than oil as Russia cannot simply sell the gas to elsewhere if we don't buy it, movement of gas restricted by pipeline infrastructure (and for LNG, terminal capacity, but Russia exports over 80% of gas by pipeline)

Does LNG facilitate a way out of this crisis?

LNG has opened new flexibility in NG imports, but the volumes of large pipelines are not easily replaced.

But terminals are slow to put in place, and as per the map here (same as in previous slide), observe that LNG are very limited/non-existent in some countries, e.g. Germany

Regions with high shares of LNG production and consumption are less affected by geopolitical concerns because the trading connections are varied and exchangeable



What is the EU planning to alleviate the current gas crisis?

REPower EU communication, 8.3.22: EU Action plan to reduce Russian gas import

Background:

Total Russian gas imports, 155bcm

Existing Fit for 55 measures will reduce gas use by 100 bcm by 2030

Reducing Russian gas import by 100 bcm by end 2022 looks possible but very tough practically and economically

REPOWER EU TRACK	FOCUS	FF55 AMBITION BY 2030	REPOWEREU MEASURE	REPLACED BY THE END OF 2022 (BCM equivalent) estimate	ADDITIONAL TO FF55 BY 2030 (BCM equivalent) estimate
GAS DIVERSIFICATION	NON-RU NATURAL GAS	-	LNG diversification	50	50
		-	Pipeline import diversification	10	10
	MORE RENEWABLE GAS	17 bcm of biomethane production, saving 17 bcm	Boost biomethane production to 35bcm by 2030	3.5	18
5.6 million tonnes of renewable hydrogen, saving 18.5 bcm		Boost hydrogen production and imports to 20mt by 2030	-	25-50	
ELECTRIFY EUROPE	HOMES	Energy efficiency measures, saving 38 bcm	EU-wide energy saving, e.g. by turning down the thermostat for buildings' heating by 1°C, saving 10bcm	14	10
		<i>Counted under overall RES figures below</i>	Solar rooftops front loading – up to 15 TWh within a year	2.5	frontloaded
	30 million newly installed heat pumps installed in 2030, saving 35 bcm in 2030	Heat pump roll out front loading by doubling deployment resulting in a cumulative 10 million units over the next 5 years	1.5	frontloaded	
TRANSFORM INDUSTRY	POWER SECTOR	Deploy 480 GW of wind capacities and 420 GW of solar capacities, saving 170bcm (and producing 5.6 Mt of Green Hydrogen)	Wind and solar front loading, increasing average deployment rate by 20%, saving 3bcm of gas, and additional	20	Gas savings from higher ambition counted under green hydrogen, the rest is frontloaded
			Capacities of 80GW by 2030 to accommodate for higher production of renewable hydrogen.		
	ENERGY-INTENSIVE INDUSTRIES	Front load electrification and renewable hydrogen uptake	Front load Innovation Fund and extend the scope to carbon contracts for difference		Gas savings counted under the renewable hydrogen and renewables targets

Side note on on natural gas concerning price linkages, not just gas<>oil

Gas prices are also linked to power prices since gas plants are the primary marginal power producers. That's the main reason we currently have historical high and volatile prices.

Estimate of article on right, fossil plants* sent power prices in EU power markets 2/3 of the time, but only produce about 1/3 total production

*Mostly Gas, but Coal also sometimes at margin)

Paper currently in journal review, link here:

https://papers.ssrn.com/sol3/papers.cfm?abstract_id=4170906

The Role of Natural Gas in Electricity Prices in Europe

UCL Institute for Sustainable Resources series
Navigating the Energy-Climate Crises - Working Paper #1

Behnam Zakeri and Iain Staffell
with Paul E. Dodds, Michael Grubb, Paul Ekins, Jaakko Jääskeläinen, Samuel Cross, Kristo Helin, Giorgio Castagneto Gisse

This paper quantifies the role of fossil-fuelled vs. low-carbon electricity generation in shaping wholesale electricity prices across European countries, based on historical data. We find that, despite a declining share in electricity generation, fossil fuels are still the main power plants "at the margin": in 2019, they set power prices in Europe about two-thirds of the time, whilst generating only 37% of electricity. Energy transitions in Europe have shifted dependency away from coal toward natural gas as the main electricity price setter, making European electricity prices dependent on natural gas prices more than ever. In four countries (Belgium, Spain, Italy and the UK) gas set the electricity price for more than 80% of the time, well above its share of generation. As most of Europe (including the UK) imports most of its natural gas, this amplifies exposure of electricity prices to the geopolitical risks of gas supply, as well as the economic risks of currency exchange and natural gas price volatility.

Keywords: energy market coupling, energy policy, energy security, electricity market, renewable energy systems, sustainable energy, energy model

Journal of Economic Literature (JEL) Classification Codes: D4, O4

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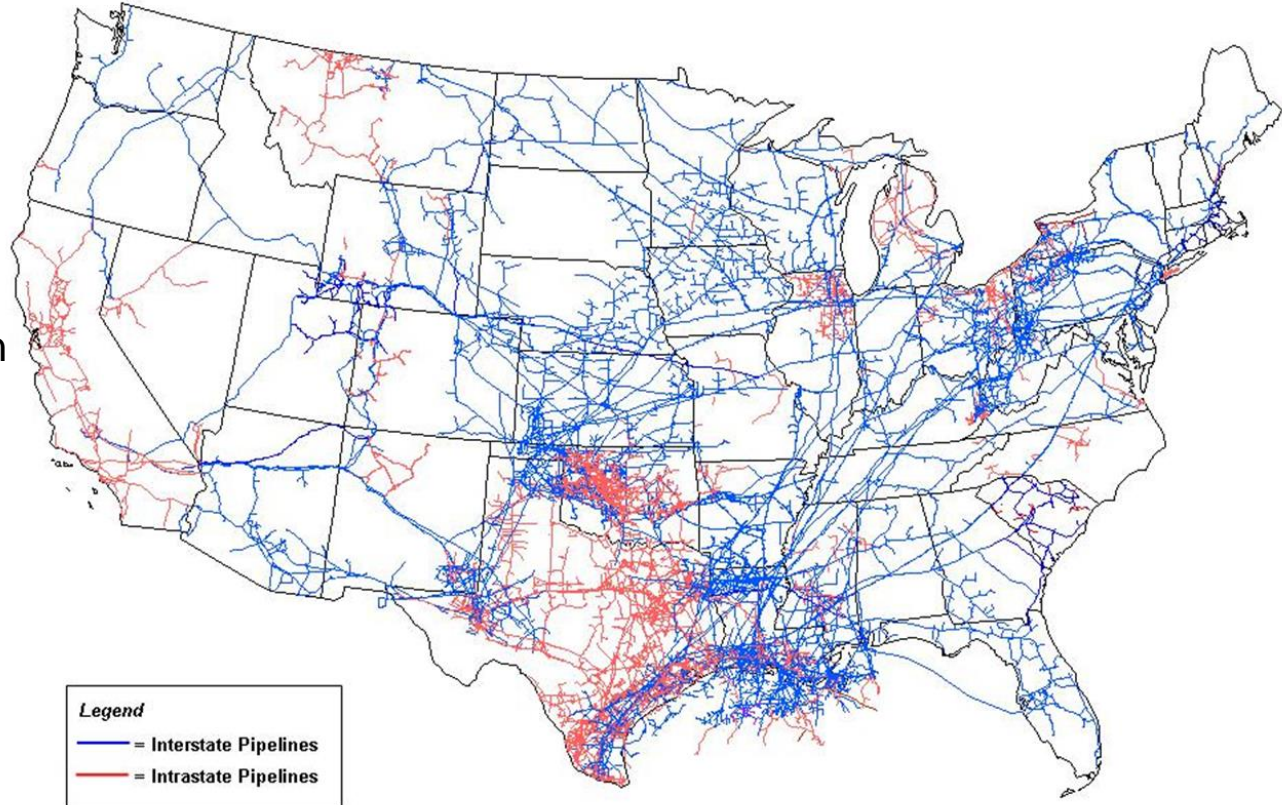


Gas markets in the USA

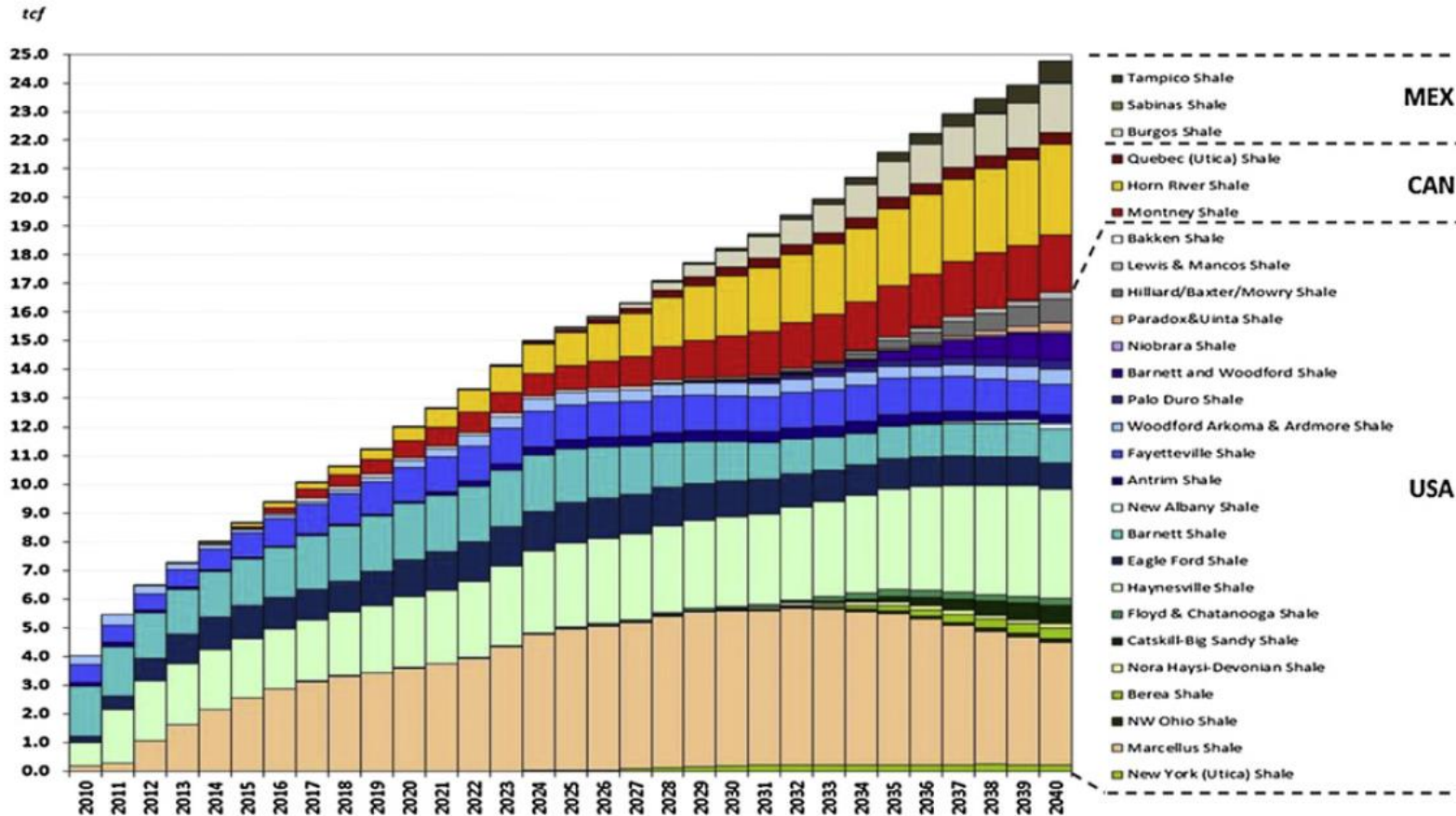
- **Henry Hub: A natural gas pipeline located in Erath, Louisiana that serves as the official delivery location for futures contracts on the NYMEX. The Henry Hub has access to many of the major gas markets in the United States.**
- **New technology of drilling unconventional gas resources in USA and Canada (mainly fracking= särötys) has rapidly increased their reserve estimates and production has affected the gas market: gas prices are low, less import need => reflected in international gas markets, but large differences between global regions in gas prices.**

Natural gas network in USA

- More than 210 natural gas pipeline systems.
- 305 000 miles of interstate and intrastate transmission pipelines
- More than 1400 compressor stations
- 8 LNG (liquefied natural gas) import facilities



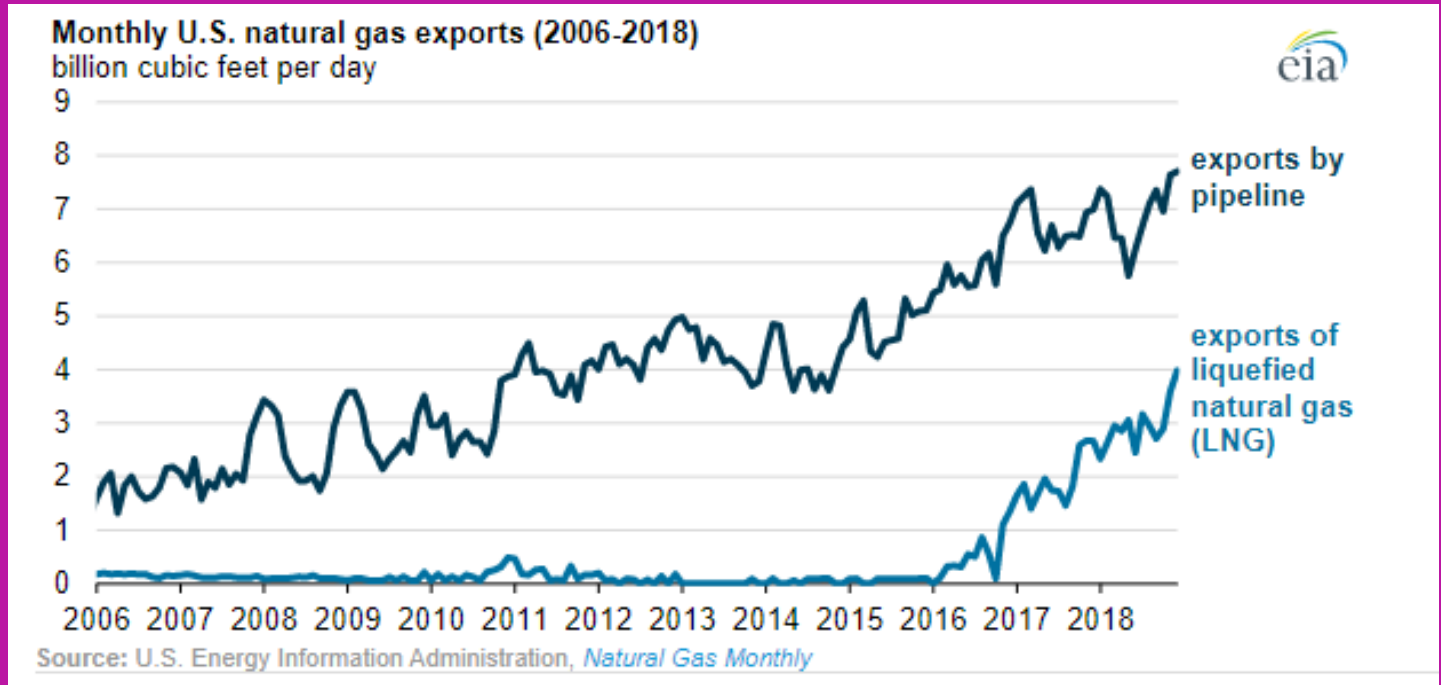
Shale gas boom in the USA



Forecast
production
in North
America to
2040

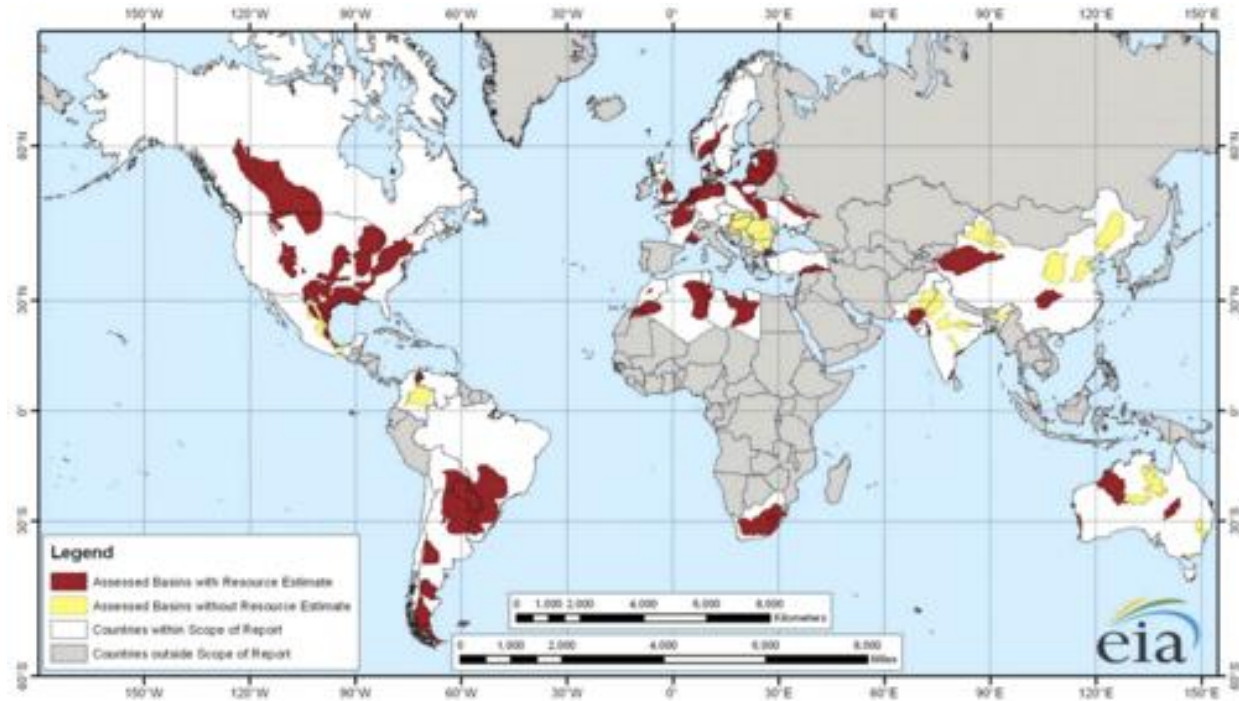
Fig. 9. North American Shale Gas production. Source: Medlock, et al. [6].

US becomes a significant gas exporter (not just re-export of Canadian gas)



Shale gas also has high potential at global level...

Global shale gas resources:



...but there are political barriers across EU

Fracking is banned or suspended in:

- **Austria**
- **Bulgaria**
- **Czech Republic**
- **France**
- **Germany**
- **Ireland**
- **Netherlands**

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The Finnish-Baltic gas market

Finnish gas market development timeline:

- 1974: Natural gas import from Russia begins with a long-term contract indexed to oil
- Pipeline was initially built to Kouvola. During expansions to the current pipeline length, ideas of international expansions were also investigated –in part for energy security reasons –but they did not realize
- 2016: Gasum’s LNG terminal in Pori starts operations
- 2017: Gasum’s “Manga” LNG Terminal in Tornio starts operations
- 2020: Baltic connector pipeline from Finland to Estonia starts operations
- 2020: The Finnish natural gas market is opened for competition, and gas transmission infrastructure is moved from Gasum to Gasgrid Finland (both Finnish state-owned companies)
- 2022: Due to the GIPL pipeline between Lithuania and Poland, the Finnish market is physically fully connected to the European gas market
- 2022: Due to commercial disputes and disagreement, **natural gas flow from Russia to Finland ends**. Same holds at least mostly true for the Baltic countries
- 2022: Hamina LNG’s terminal in Hamina starts operations as the **first transmission grid connected LNG terminal** in Finland
- 2022: Finland and Estonia begin co-operation to lease **a large-scale LNG floating terminal** to Finland with option to locate in Estonia

The Finnish-Baltic gas market

Baltic major gas infrastructure includes:

- A large LNG terminal in Lithuania (Klaipeda)
- An underground gas storage facility in Latvia (Inčukalns)
- Connections to/from Russia, incl. a pipeline connecting Russia to the Russian exclave of Kaliningrad
- Import/export connection of 21-22 TWh/year to/from Poland to Lithuania

With the connections now in place, cross-border trading is now possible from Poland to Finland, connecting the Finnish-Baltic gas market to the European market

- A “price connection” had already existed since 2020, after the opening of the Finnish market



Gas market in Finland

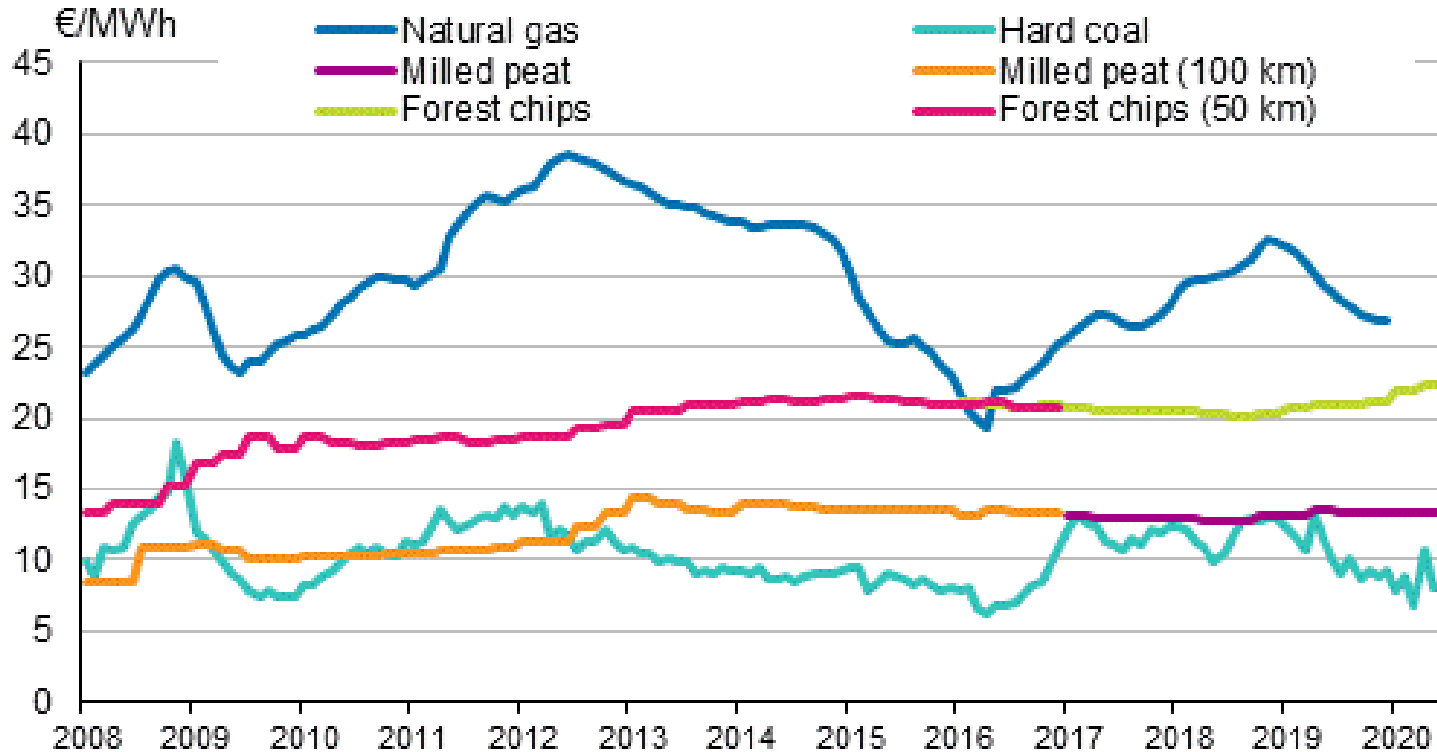
Natural gas is sold with public tariffs, supervised by Energy Authority (Energiavirasto EV)

- The only importer was Gasum Oy, but they lost monopoly as of 1.1.2020
- Transmission network is state-owned, by Gasgrid Finland

Wholesale price is composed of

- Transmission cost
- Energy cost

Gas prices in Finland vs other fuels



Gas market in Finland

- Both the energy and transmission charge contain a fixed component and a variable component
- Customer chooses beforehand a capacity level of consumption => monthly fee (€/MW). If the need is higher than this, customer pays an additional fee.
- **Energy based transmission tariff**
 - Range in winter time has been 1.38-4.15€/MWh and in summer time about half of that
 - Maximal price when volume < 50GWh
 - Minimal price when volume >500 GWh
- **Energy price operates similarly**
 - Winter-time consumption is more expensive
 - Smaller amount of consumption can be chosen for summer time (e.g. CHP customers!)
 - Encourages good planning of consumption beforehand



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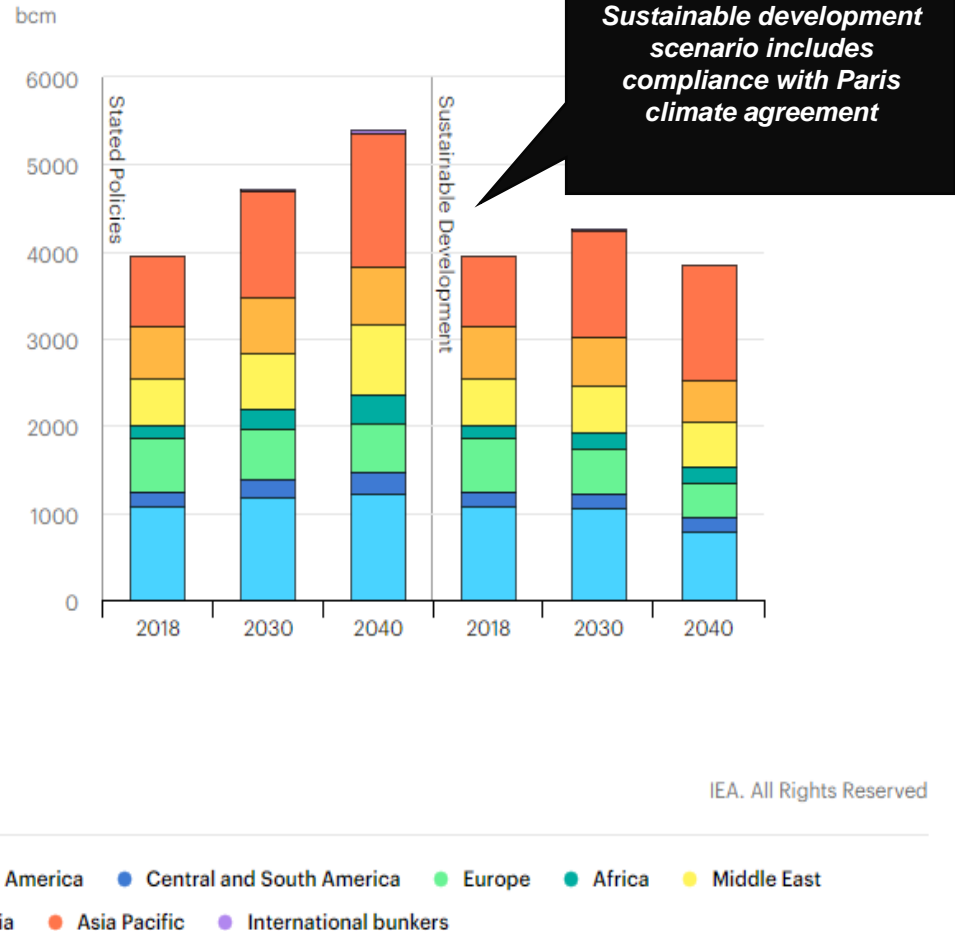
Outlook

To meet climate objectives, growth in gas demand must be curtailed.

In the current crisis, there is also a strong price & security incentive to do this at EU-level

Under these driving factors, alternatives to gas such as hydrogen become more competitive

Gas demand by region and scenario 2018-2040 (IEA WEO, 2019)



Many thanks!

Aalto Networking Platform

MANAGER - ENERGY

Sam Cross

samuel.cross@aalto.fi

+358 50 4096615

energy.aalto.fi



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