

ROLE OF FOSSIL GAS IN THE NORDICS

By Energy Modelling Lab (EML)

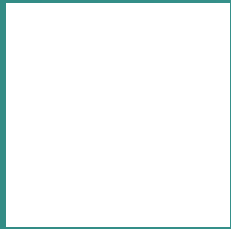
Swedish Environmental Research Institute (IVL)

and Energiforsk

April 2022

FOSSIL GAS DEPENDENCY

- In Europe as a whole – general overview
- In the Nordics – specifics compared to Europe
- Deeper dive into Denmark, Norway, Finland and Sweden

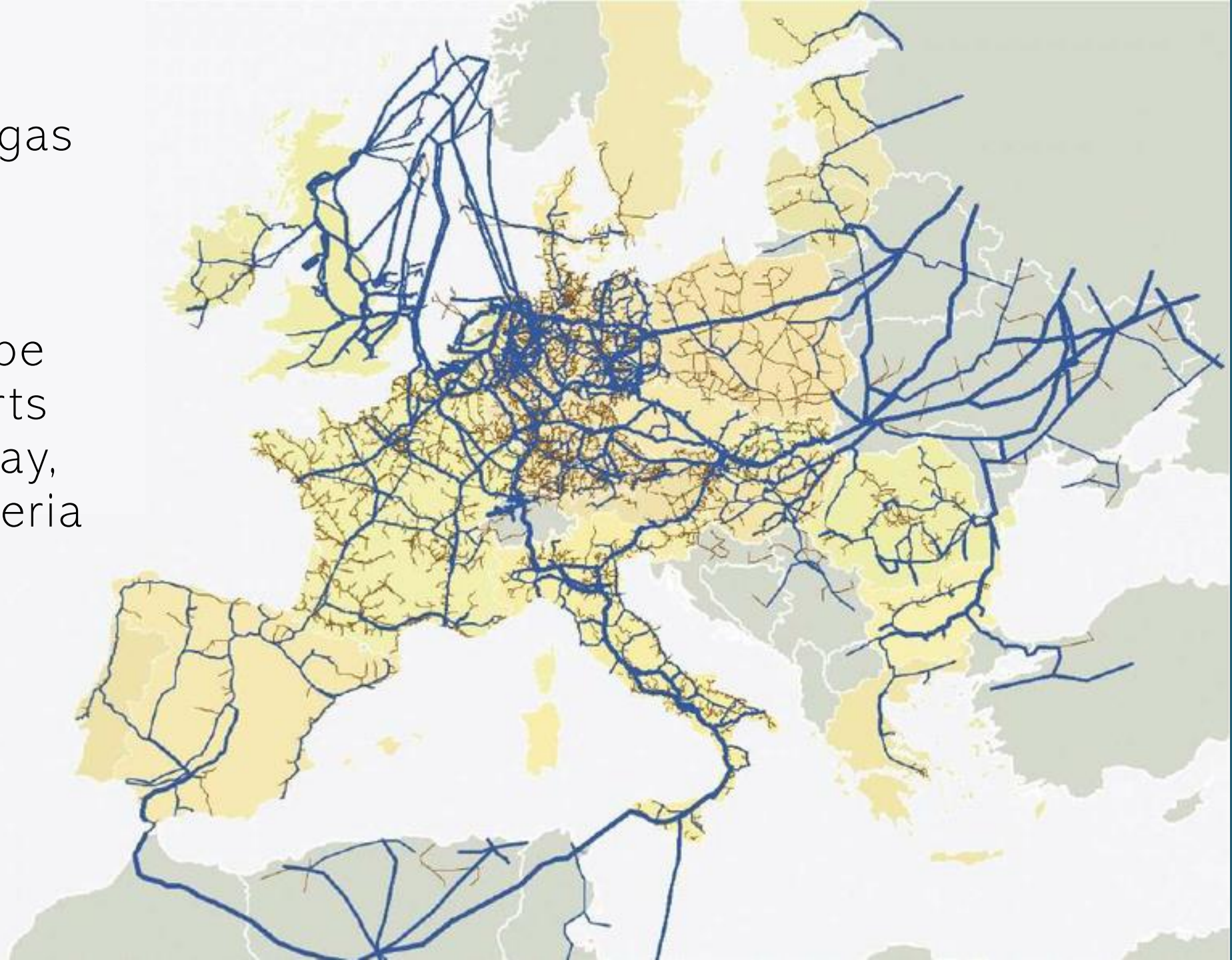


NATURAL GAS PRODUCTION AND TRADE IN EUROPE

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The European gas grid is highly interconnected

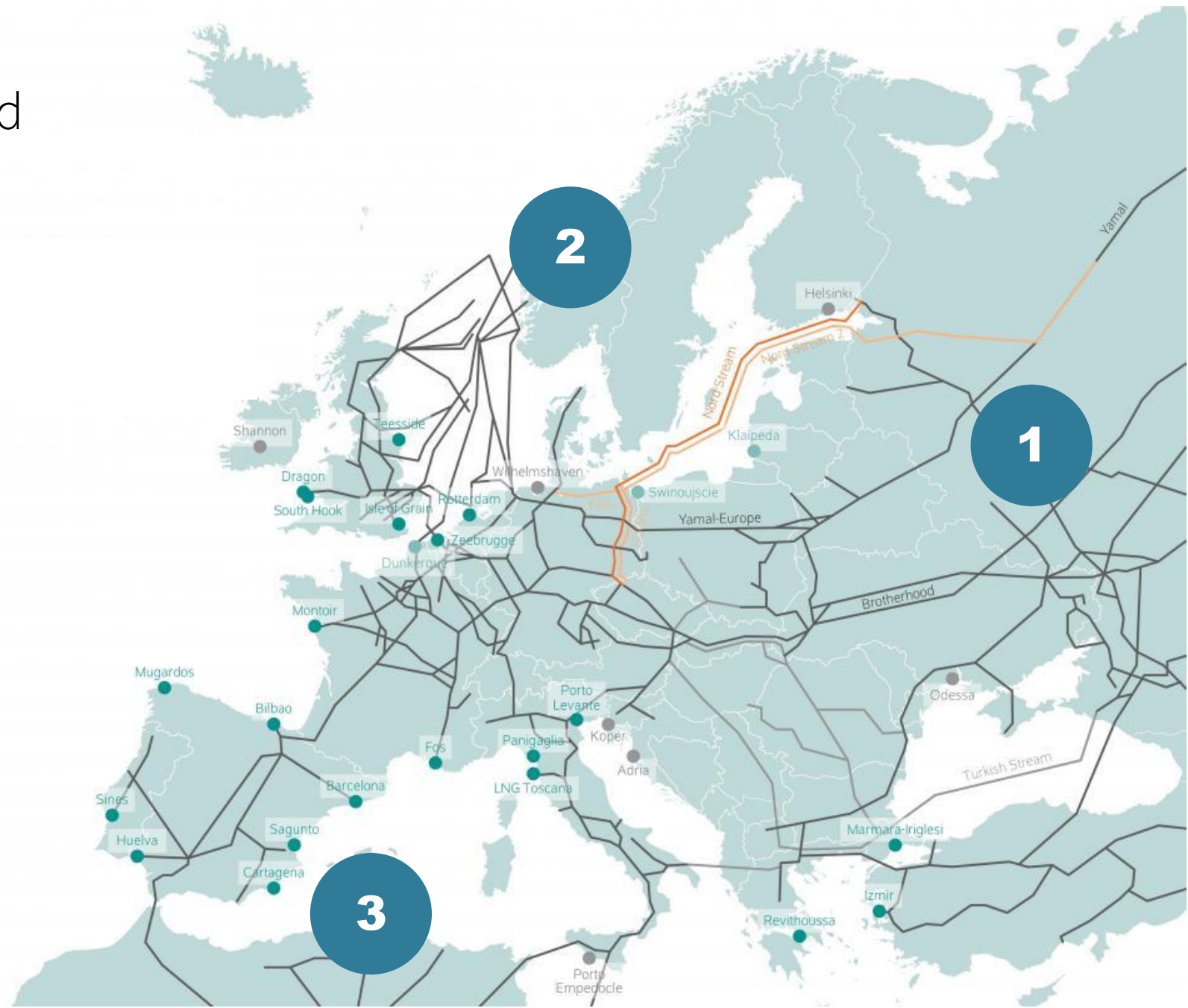
Mainland Europe primarily imports gas from Norway, Russia and Algeria



The European gas grid is highly interconnected.

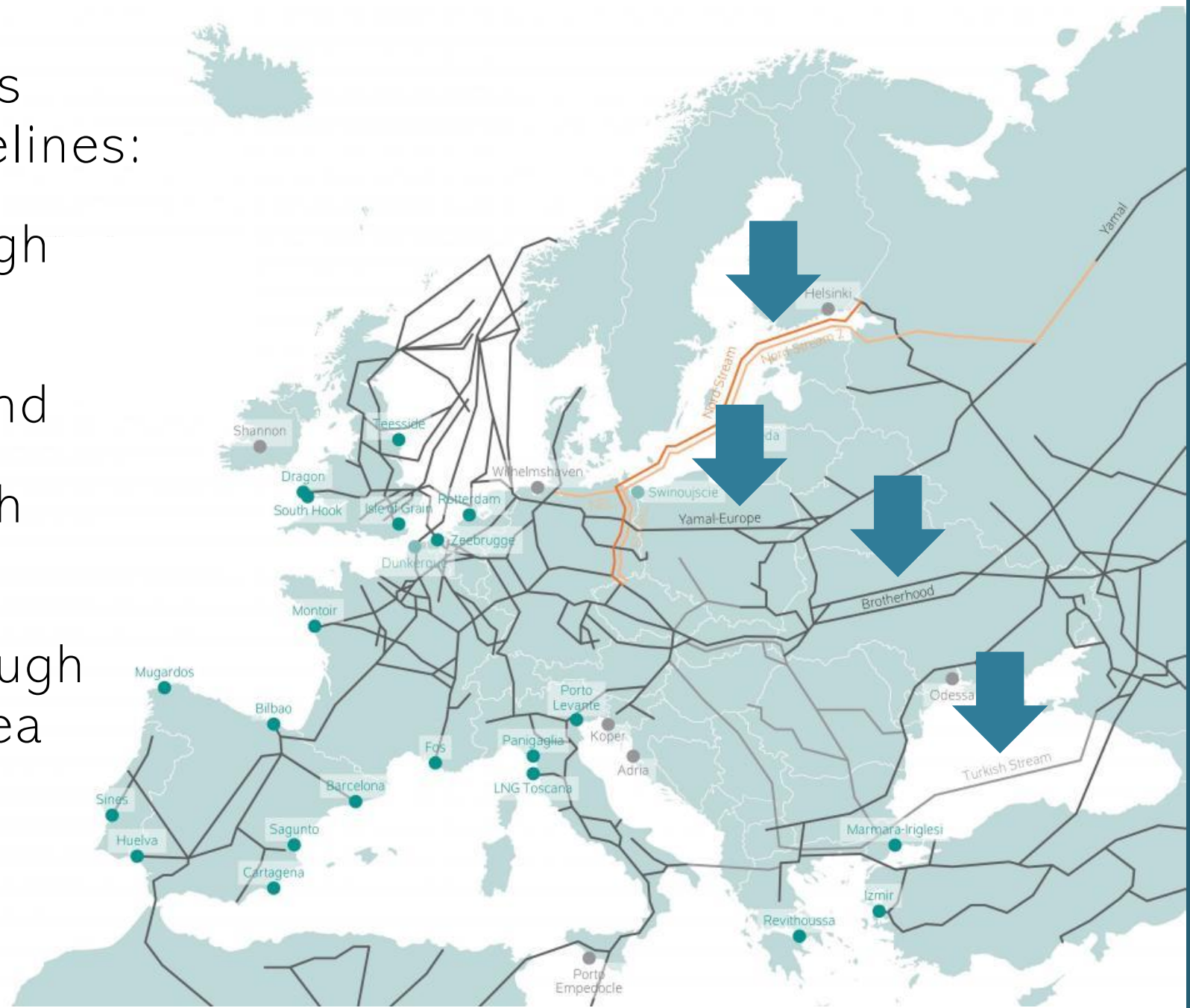
Mainland Europe primarily imports gas from:

1. Russia
2. Norway
3. Algeria/Libya



The Russian gas comes through four main pipelines:

- **North Stream** through Baltic Sea
- **Yamal** through Poland
- **Brotherhood** through Ukraine
- **Turkish Stream** through Turkey and Black Sea



EUROPE CAN THEORETICALLY GAS IMPORT CAPACITY TO EUROPE

The import capacity to Europe is in principle big enough to cover the demand (50% utilisation) without Russian pipes

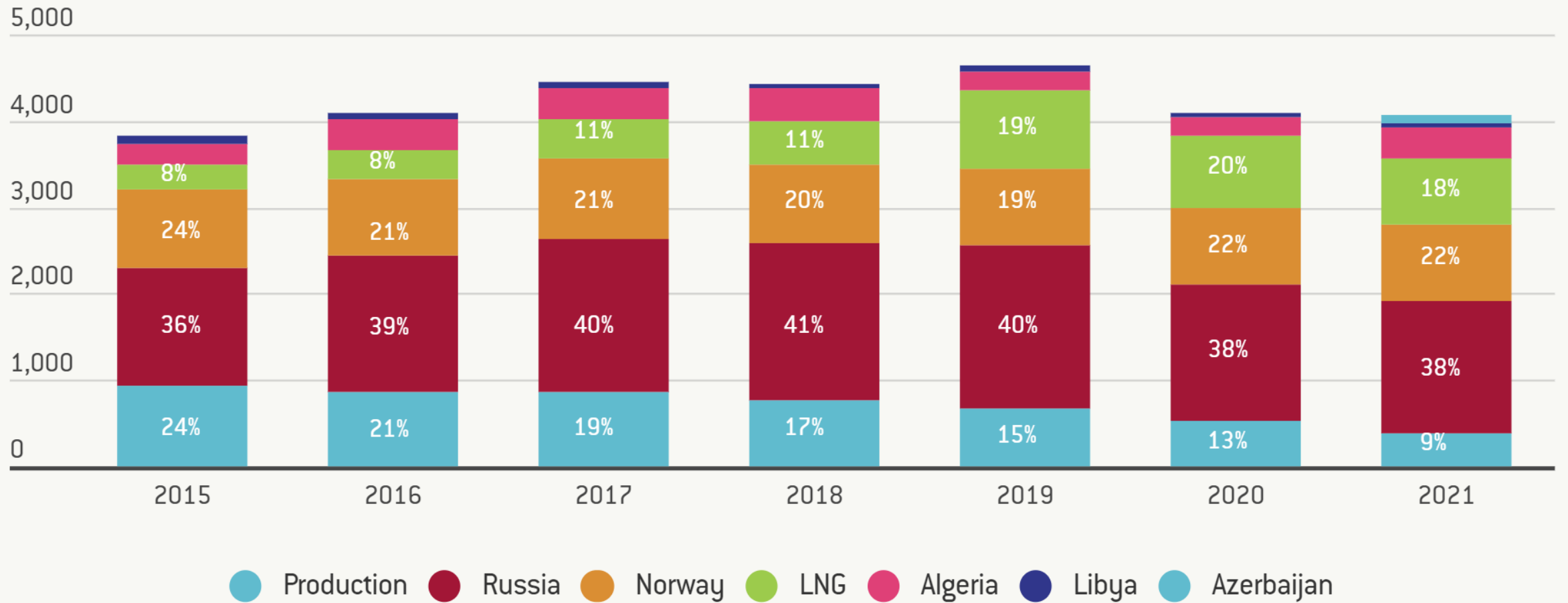
But this means import of LNG should double and Norway, Algeria, Libya should increase their production dramatically – which is not possible short term

And even so, there would be bottlenecks in the gas grid inside Europe.

Supply source	Natural gas import capacity gas per year (PJ)	Share of capacity
Liquefied Natural Gas (LNG)	8.640	29%
Pipelines	21.600	71%
- Russia	12.240	40%
- Norway	6.480	21%
- Algeria, Libya	2.880	10%
Total	30.240	100%
Consumption	14.400	48%

Tesio et al. (2021): Gas prices in Europe

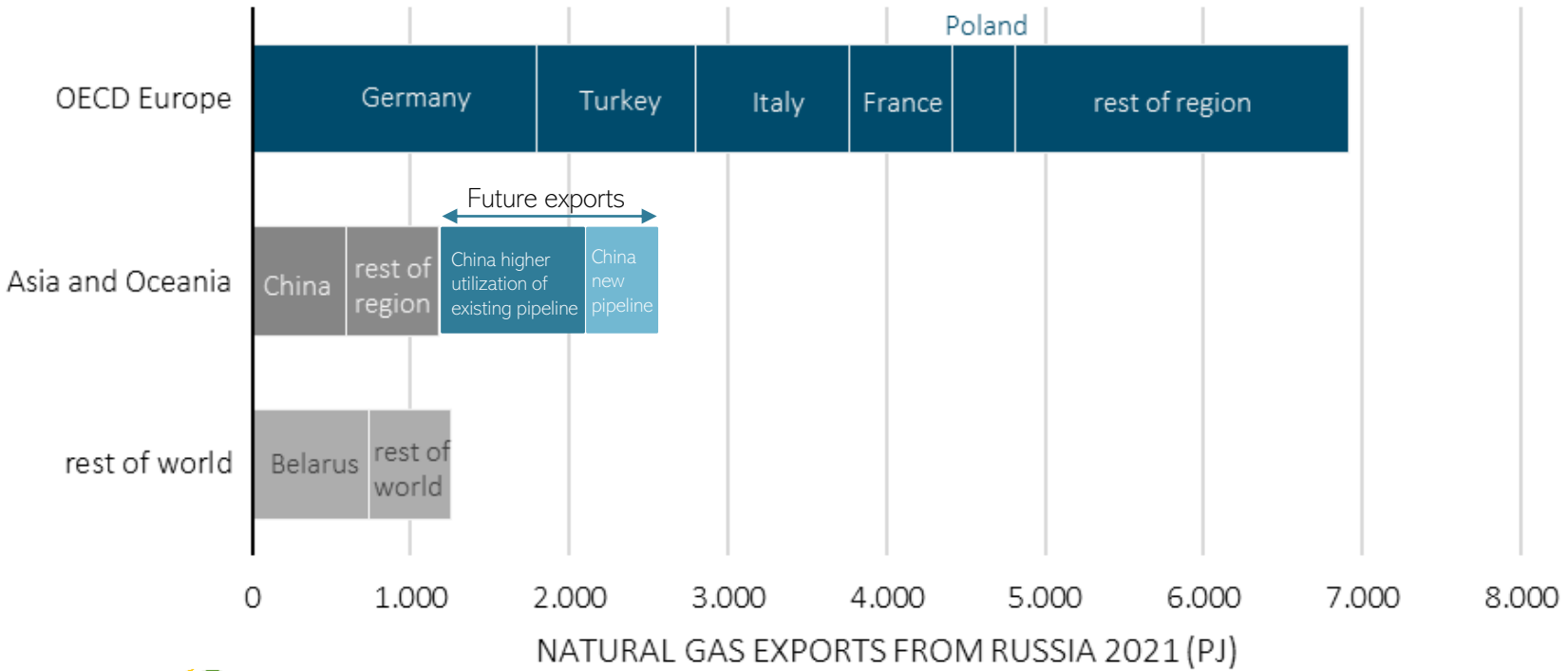
Figure 1: Annual EU27 natural gas domestic production and imports (TWh)



Source: Bruegel based on ENTSOG, GIGGNL, GIE, NPD.

74% OF RUSSIAN GAS EXPORT GOES TO EUROPE, BUT THIS COULD CHANGE

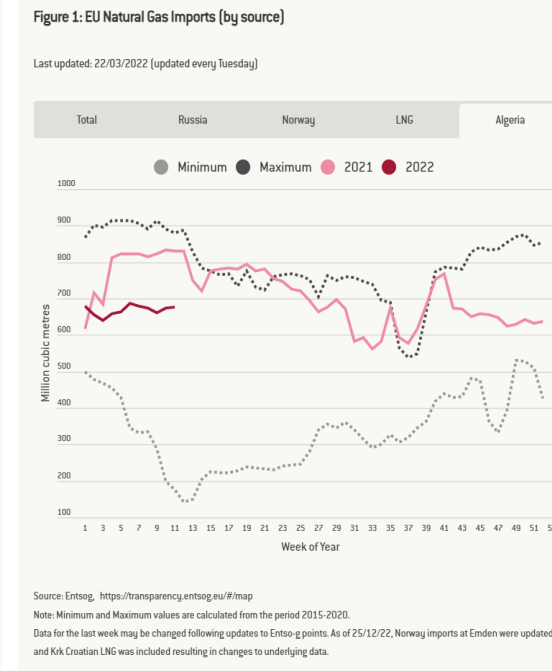
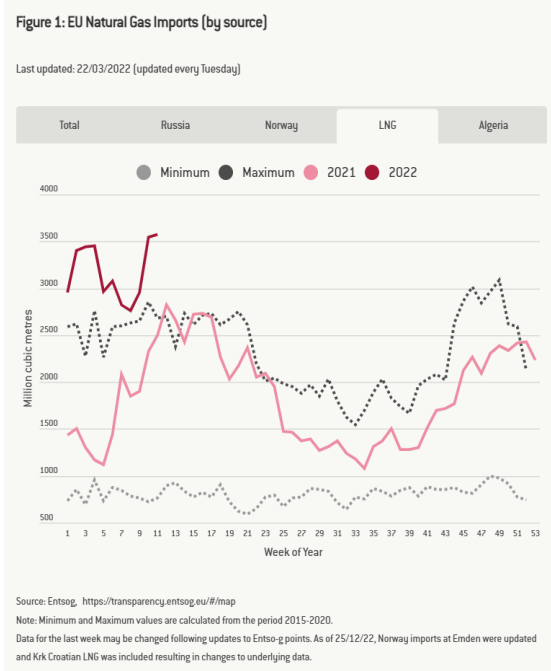
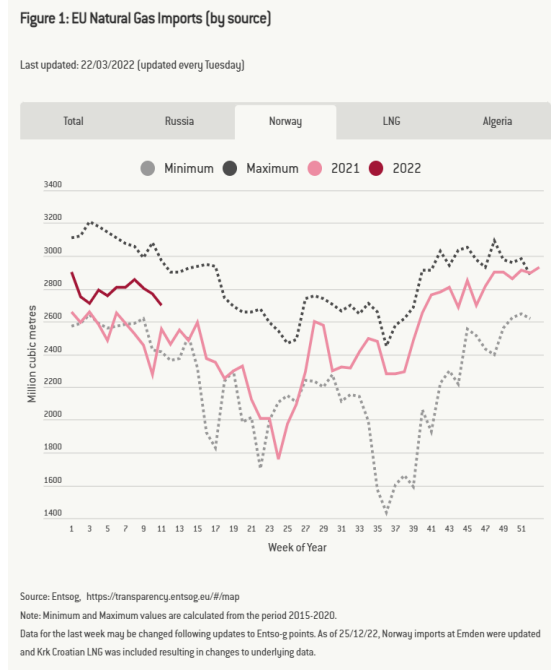
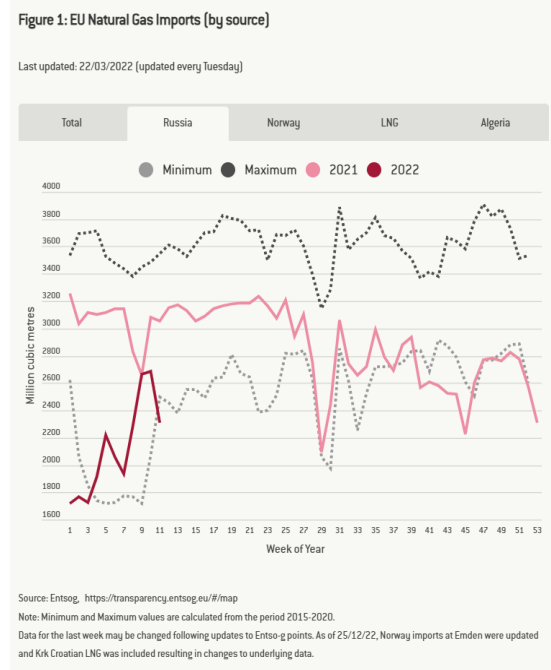
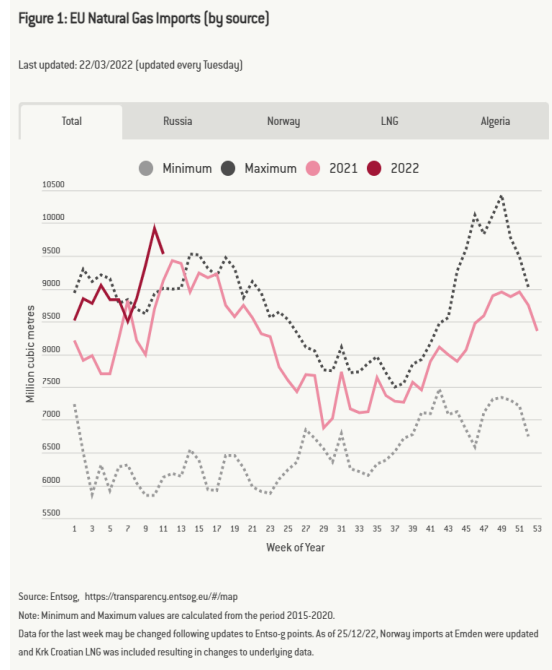
A LARGE REDUCTION IN EUROPEAN IMPORT OF RUSSIAN GAS WILL BE A CHALLENGE FOR RUSSIA



Source: Graph by the U.S. Energy Information Administration, based on Russia's export statistics and partner country import statistics published by Global Trade Tracker

EU NATURAL GAS IMPORTS NOW

- EU total imports in beginning of 2022 are high compared to imports in 2015-2020, especially since the beginning of the war (week 8)
- But with low imports from Russia, close to minimum compared to 2015-2020 period
- Average utilization of Norwegian and Algerian pipelines, potential to increase imports in the short-term
- Significant increase in the utilization of LNG ports, higher than the historical maximum



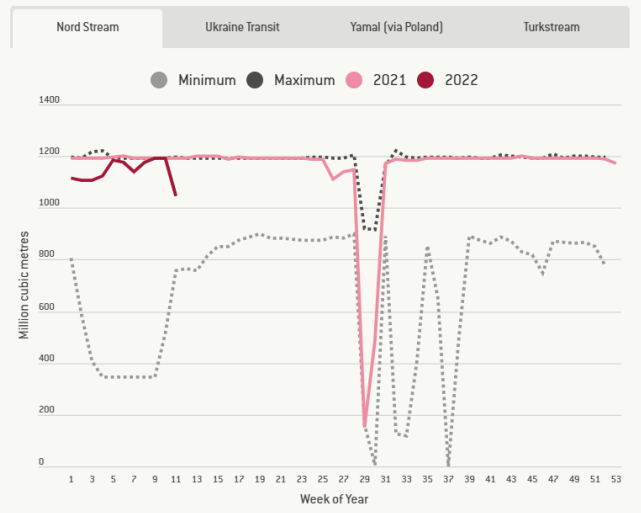
EU NATURAL GAS IMPORTS FROM RUSSIA

- In beginning of 2022 we see low imports from Russia through the Yamal and Ukraine Transit, even below minimums from 2015-2020 period
- While utilization of Nord Stream is at historical maximum in 2022 as in 2021
- There is an increase in the utilization of the Turkstream pipeline, but it is relatively small amounts of gas compared to overall European imports



Figure 3: EU Natural Gas Imports from Russia by exporting route

Last updated: 22/03/2022 (updated every Tuesday)

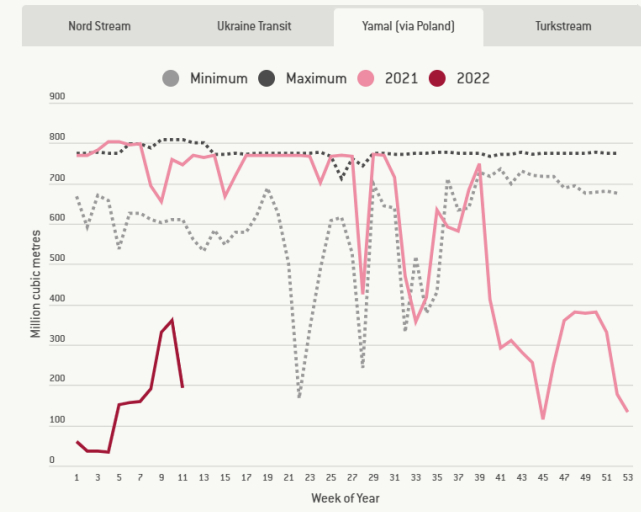


Source: Entso-g, <https://transparency.entso-g.eu/#/map>

Note: Minimum and Maximum values are calculated from the period 2015-2020.

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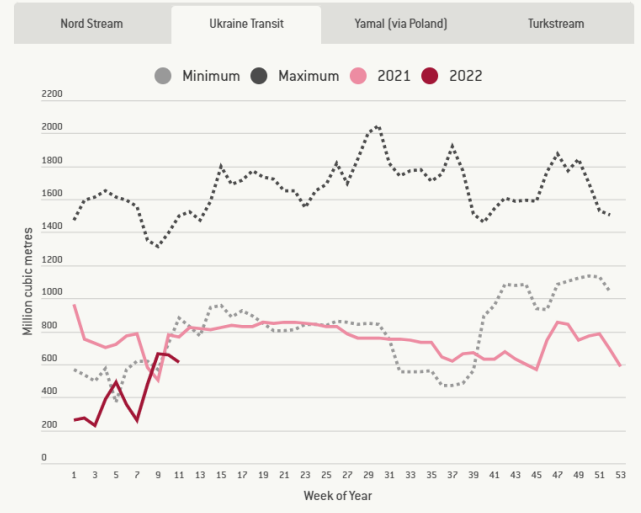


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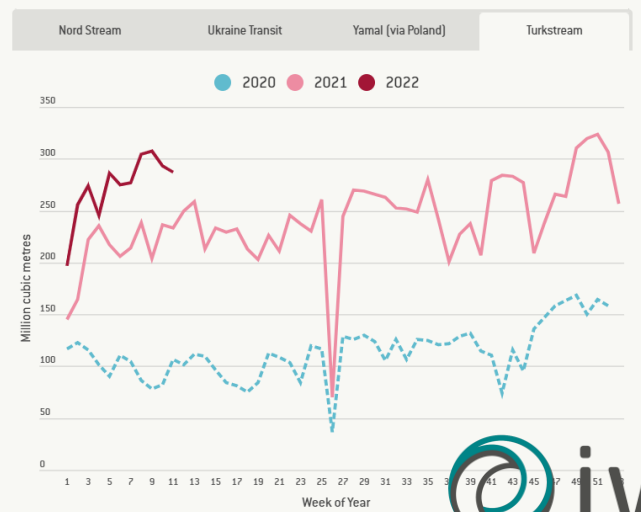


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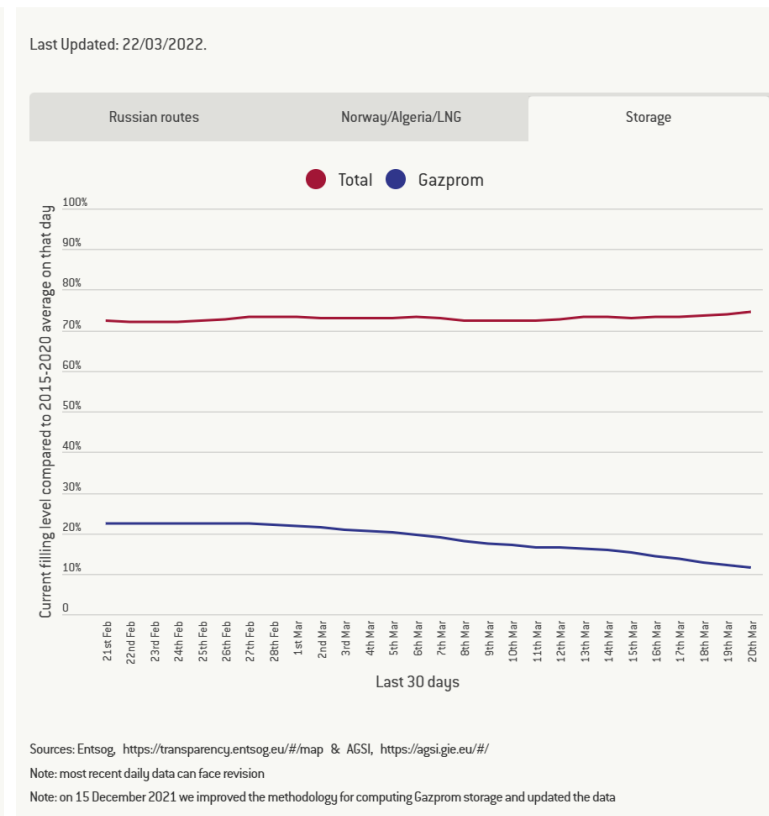
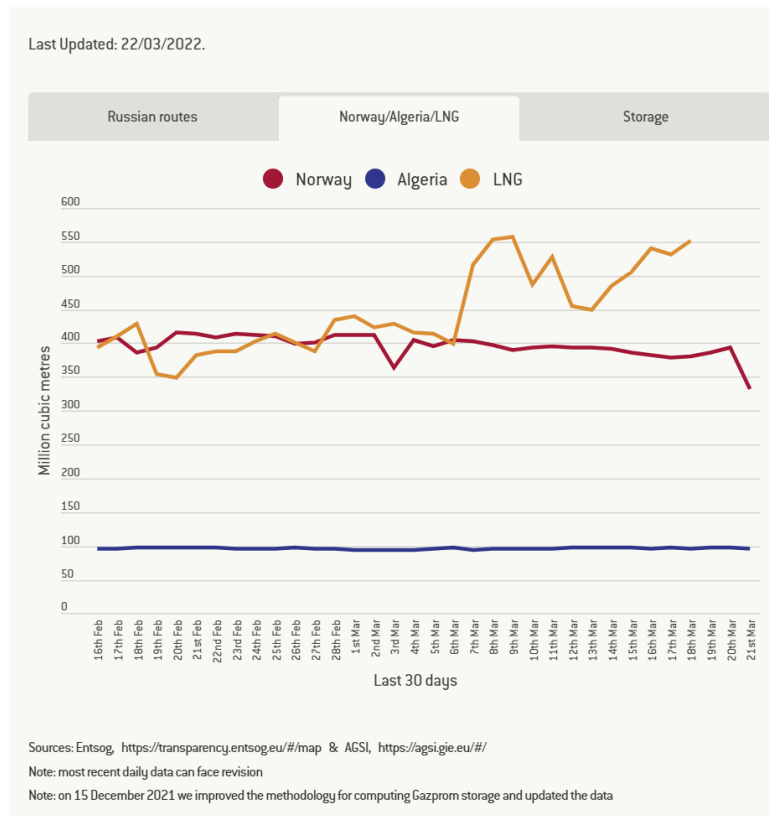
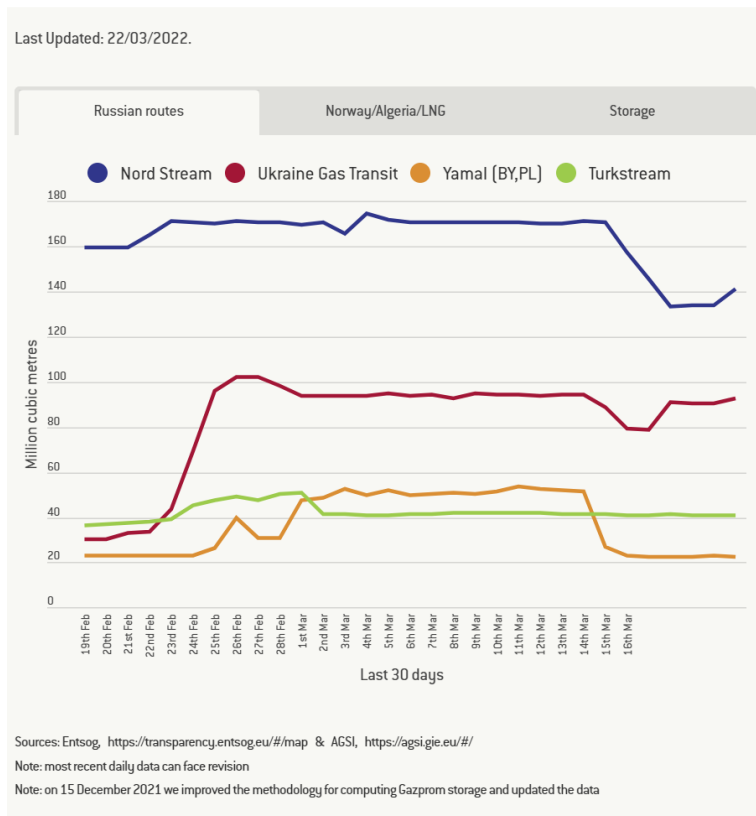
Source: Entso-g, <https://transparency.entso-g.eu/#/map>

Note: Minimum and Maximum values are calculated from the period 2015-2020.



DAILY GAS IMPORTS TO EU – MID FEBRUARY TO MID MARCH

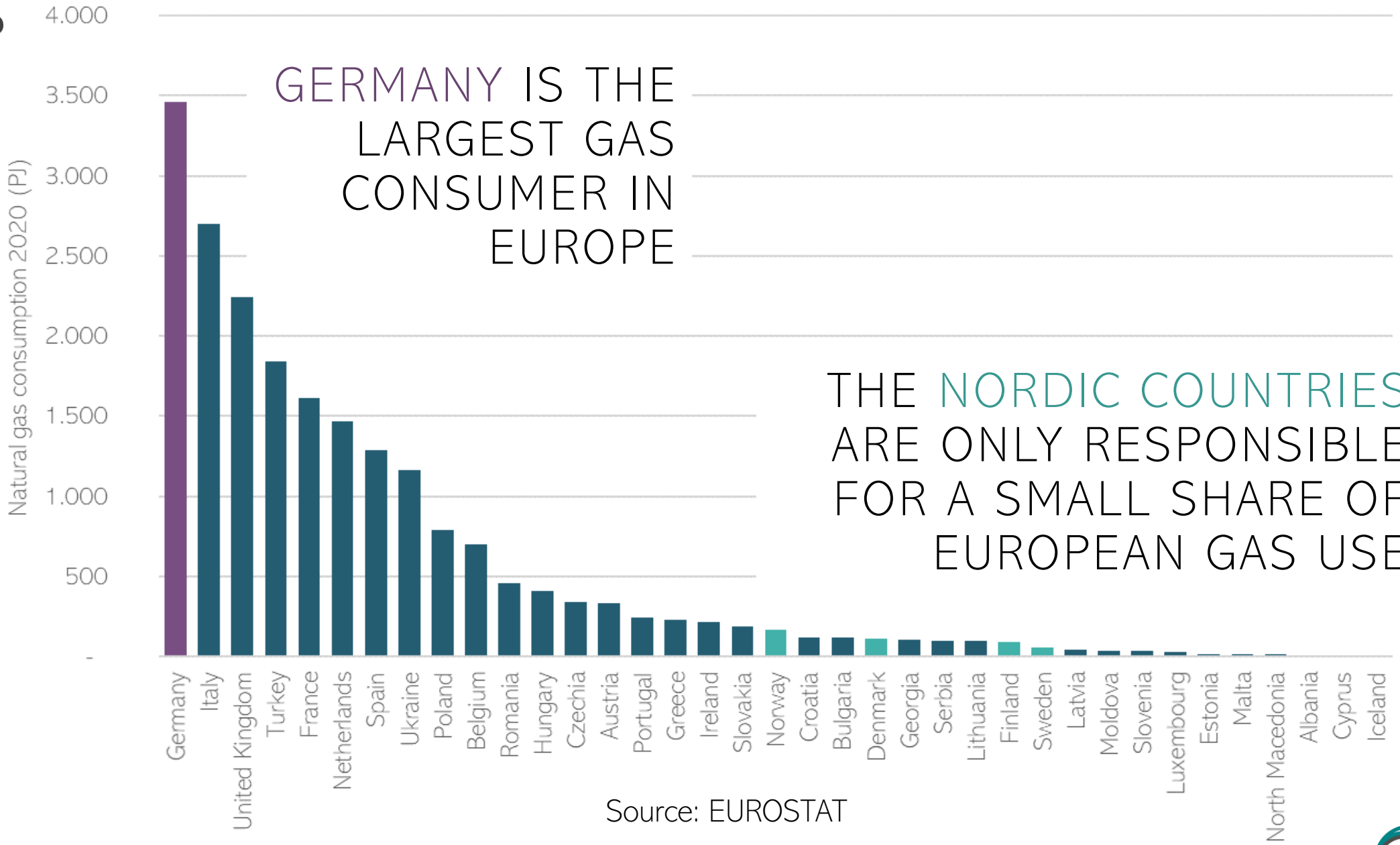
<https://www.bruegel.org/publications/datasets/european-natural-gas-imports/>



- Recent decrease in imports through Nord Stream and Yamal

- Considerable increase in LNG imports (+20%) since early March

- Gazprom keeps lowering storage levels in Europe, something that started already in 2021 and are now at around 10% of “normal”



Source: EUROSTAT

GERMANY IS HIGHLY DEPENDENT OF FOSSIL GAS

The German fossil gas consumption is the same size as total Norwegian gas export!

Space heating: ~450 TWh (50%)

- Includes homes and offices
- Mostly burned on site, smaller amount in district heating plants
- *Half of all homes are heated with gas*

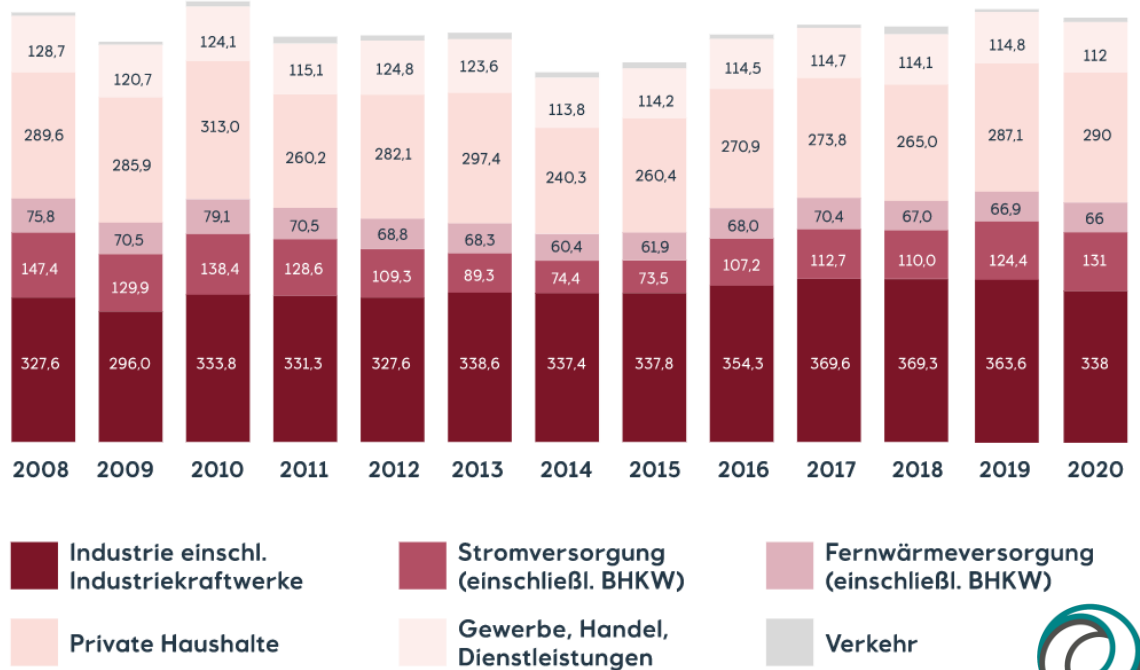
Industry: ~350 TWh (35%)

- Industrial heat-and-power-plants
- High-temperature process heat
- Feedstock to chemical industry, e.g. hydrogen used for fertilizer and in refineries

Electricity generation: ~130 TWh (15%)

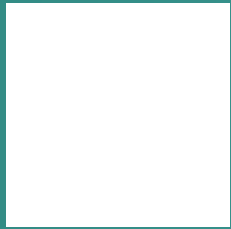
- Around 15% of Germany's electricity is produced on gas-fired plants
- 5-6 GW new gas-fired power plants are in the pipeline

German natural gas consumption, TWh/year



Quelle: Statistisches Bundesamt, Zukunft Gas, bdeu

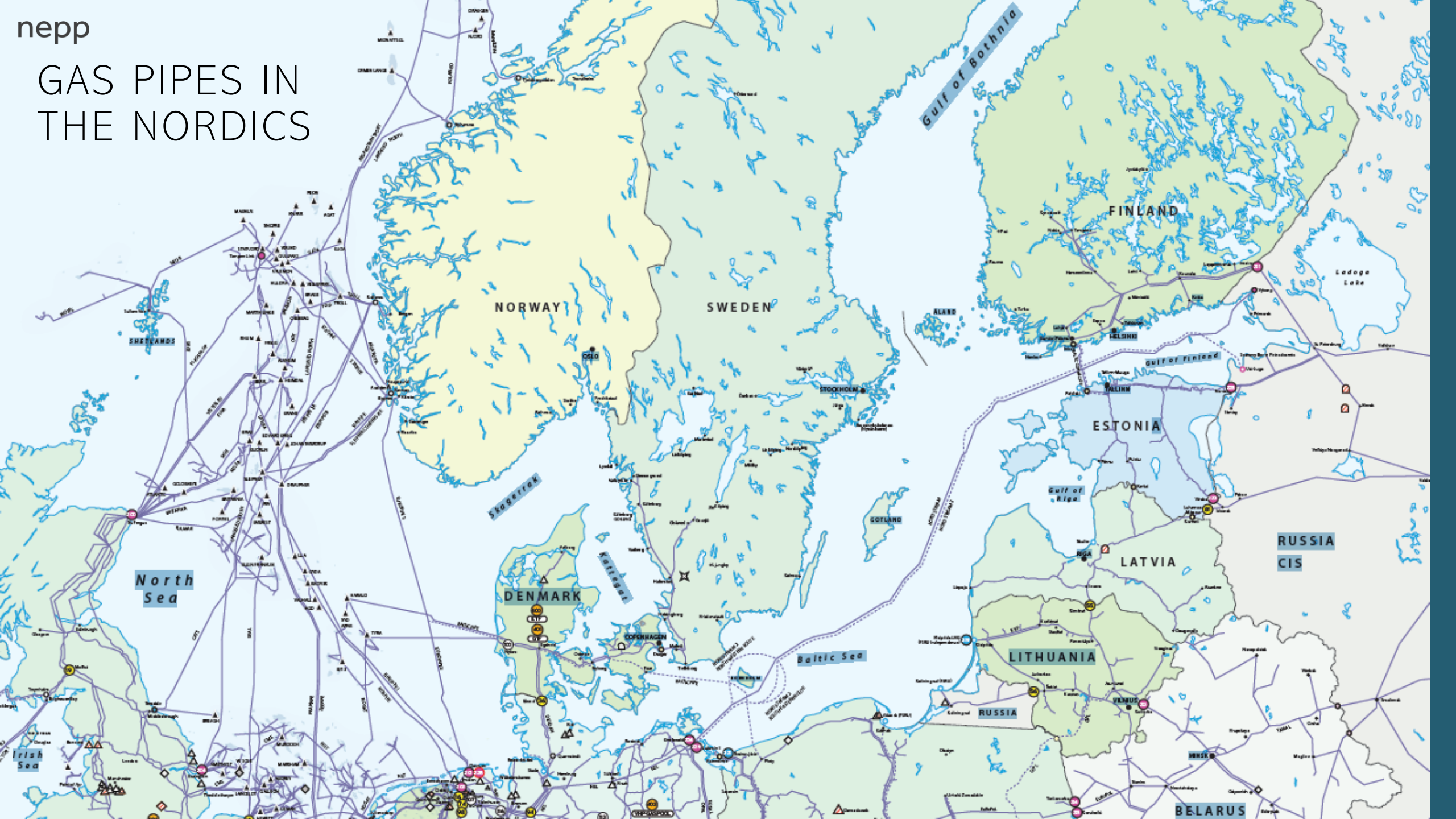
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THE NORDIC COUNTRIES

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GAS PIPES IN THE NORDICS



IMPORTS, EXPORTS OF NATURAL GAS

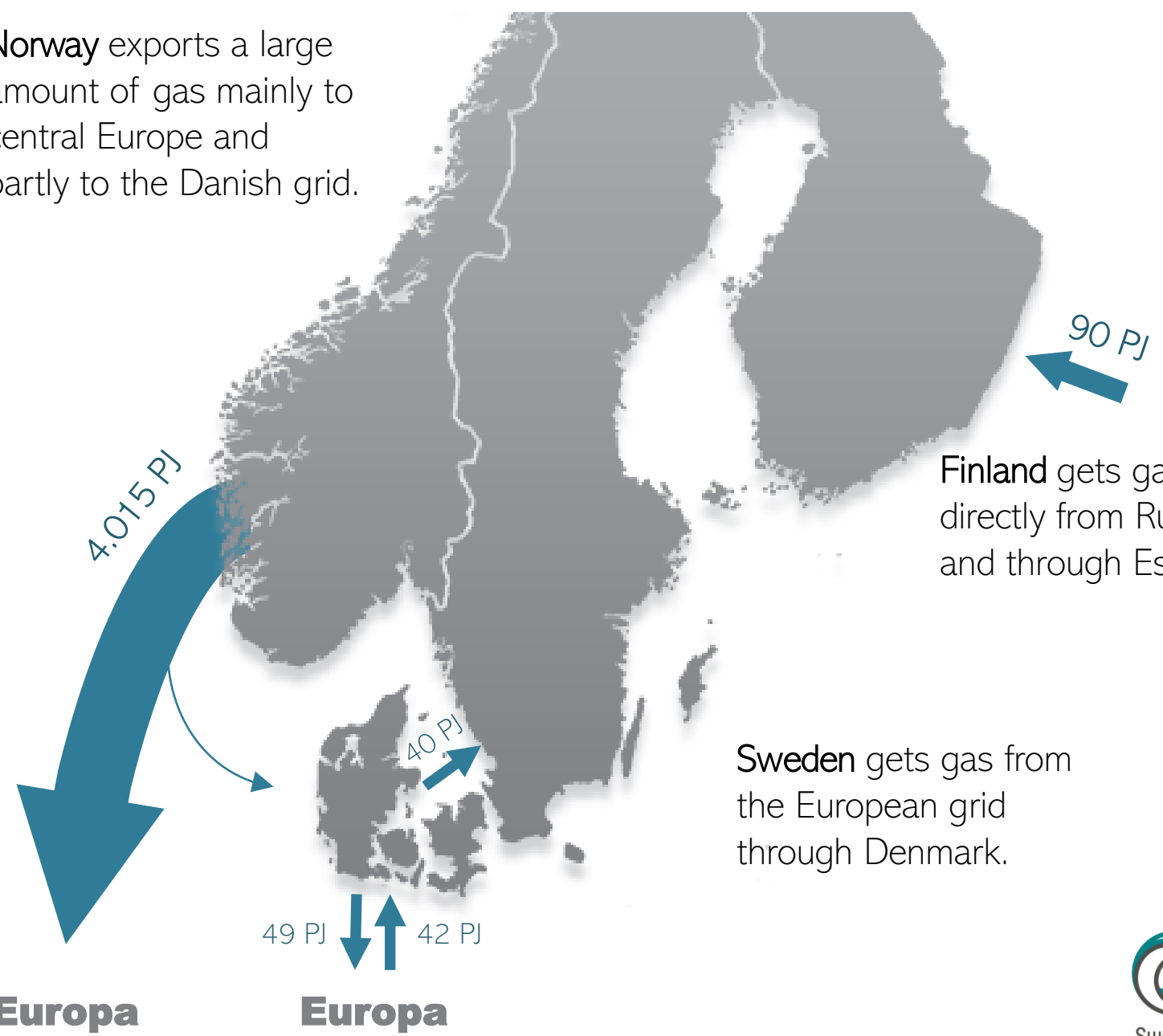
Norway exports a large amount of gas mainly to central Europe and partly to the Danish grid.

Denmark is connected to central Europe and receives the gas mix in the grid from both from Russia and Norway.

(The Danish gas production is temporarily low due to maintenance)

Finland gets gas directly from Russia and through Estonia.

Sweden gets gas from the European grid through Denmark.



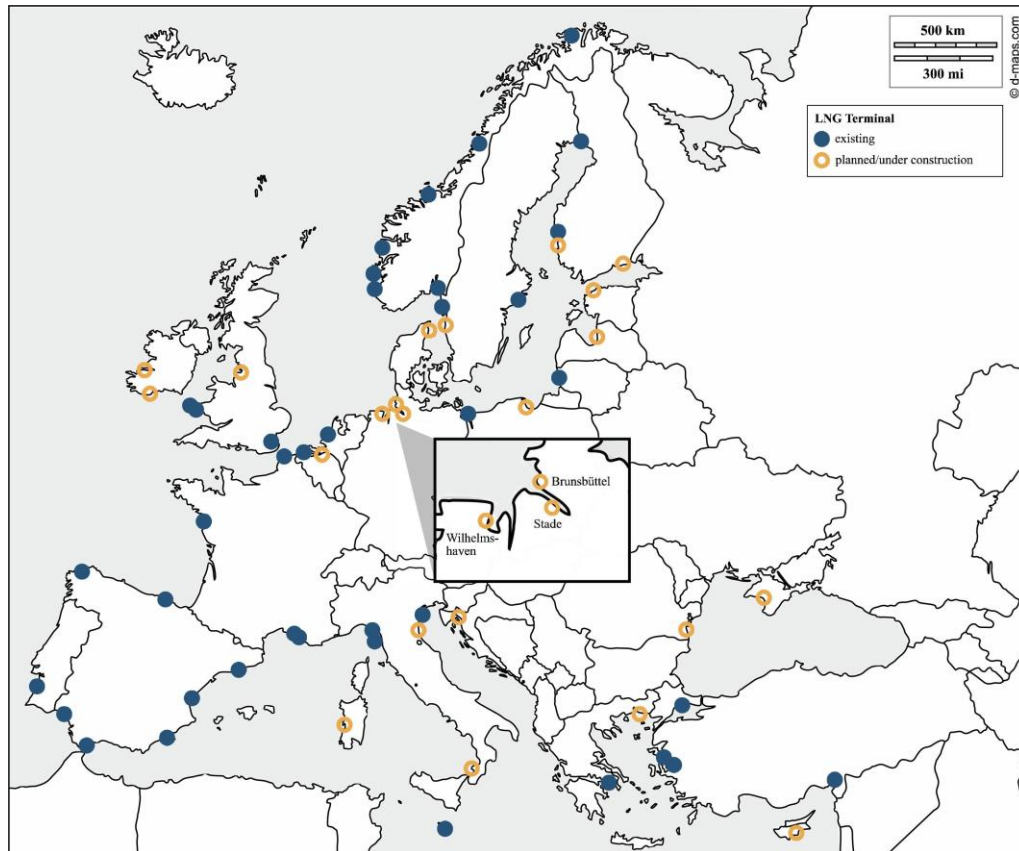


Figure from Hanna Brauers, Isabell Braunger, Jessica Jewell, Liquefied natural gas expansion plans in Germany: The risk of gas lock-in under energy transitions, Energy Research & Social Science, Volume 76, 2021, (<https://www.sciencedirect.com/science/article/pii/S2214629621001523>)

LNG TERMINALS IN EUROPE

- Europe has 29 large-scale LNG import terminals
- The capacity of large-scale LNG terminals in Europe is 237 billion cubic meters = 40% of Europe's gas demand
- Spain was Europe's largest importer of LNG in 2020, followed by the UK, France, Turkey and Italy
- 20 large-scale LNG import terminals are being considered or planned in Europe

IN THE NORDICS

- Finland is expanding its LNG infrastructure and opened the largest LNG-terminal in the Nordics in 2019
- Norway has a large infrastructure for export of LNG

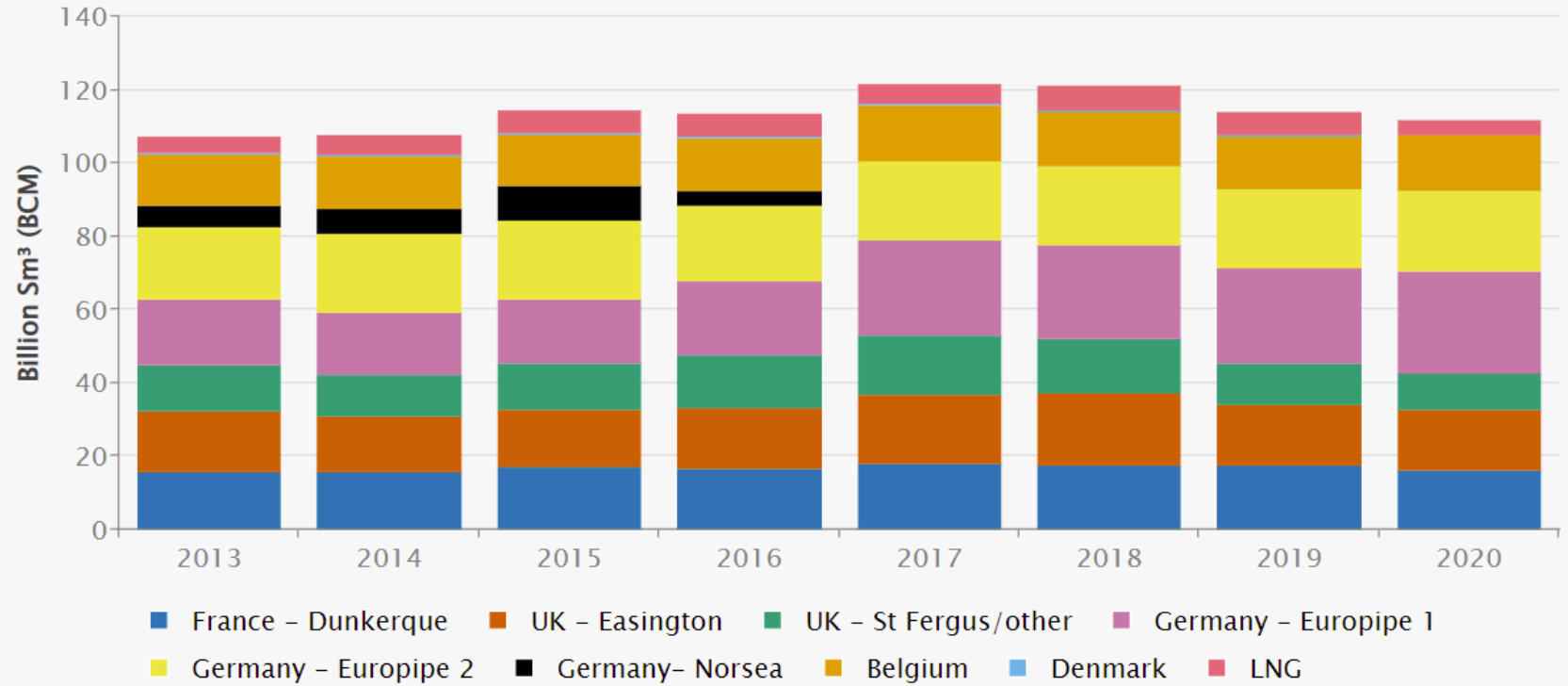
NORWAY DELIVERS
NATURAL GAS TO A
LARGE PART OF
EUROPE THROUGH
PIPELINES

Norwegian natural gas exports in 2013-2019 by first delivery point

Updated: 24.03.2021

Source: Norwegian Petroleum Directorate / Gassco

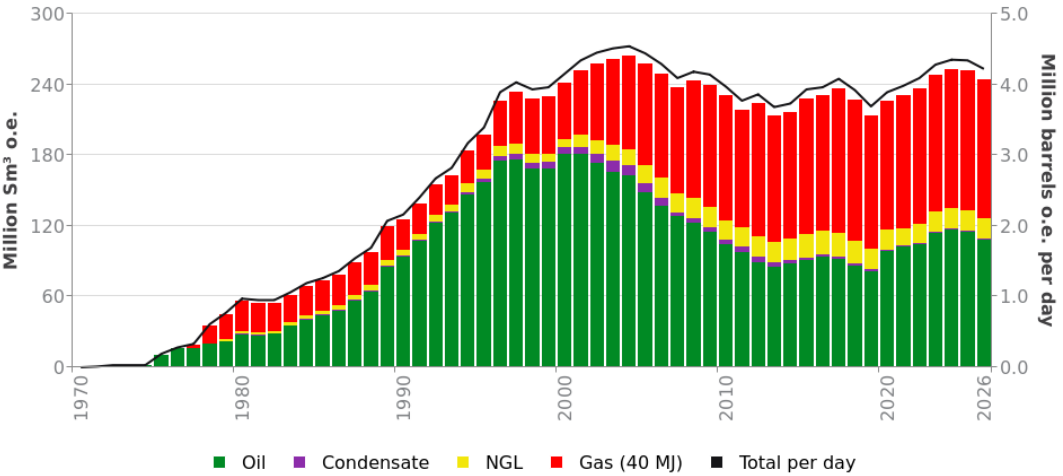
- Print illustration
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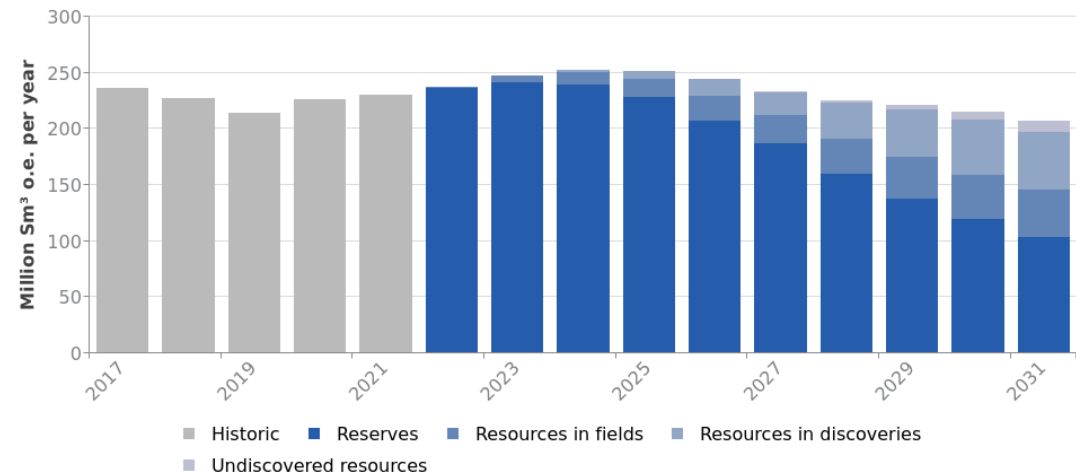
<https://www.norskpetroleum.no/en/production-and-exports/exports-of-oil-and-gas/>

NORWAY EXPECT TO CONTINUE DELIVERING NATURAL GAS AT SAME LEVELS IN THE FUTURE

HISTORICAL AND EXPECTED PRODUCTION IN NORWAY, 1970-2026



PRODUCTION HISTORY AND FORECAST DISTRIBUTED PER RESOURCE CATEGORY, 2017-2031



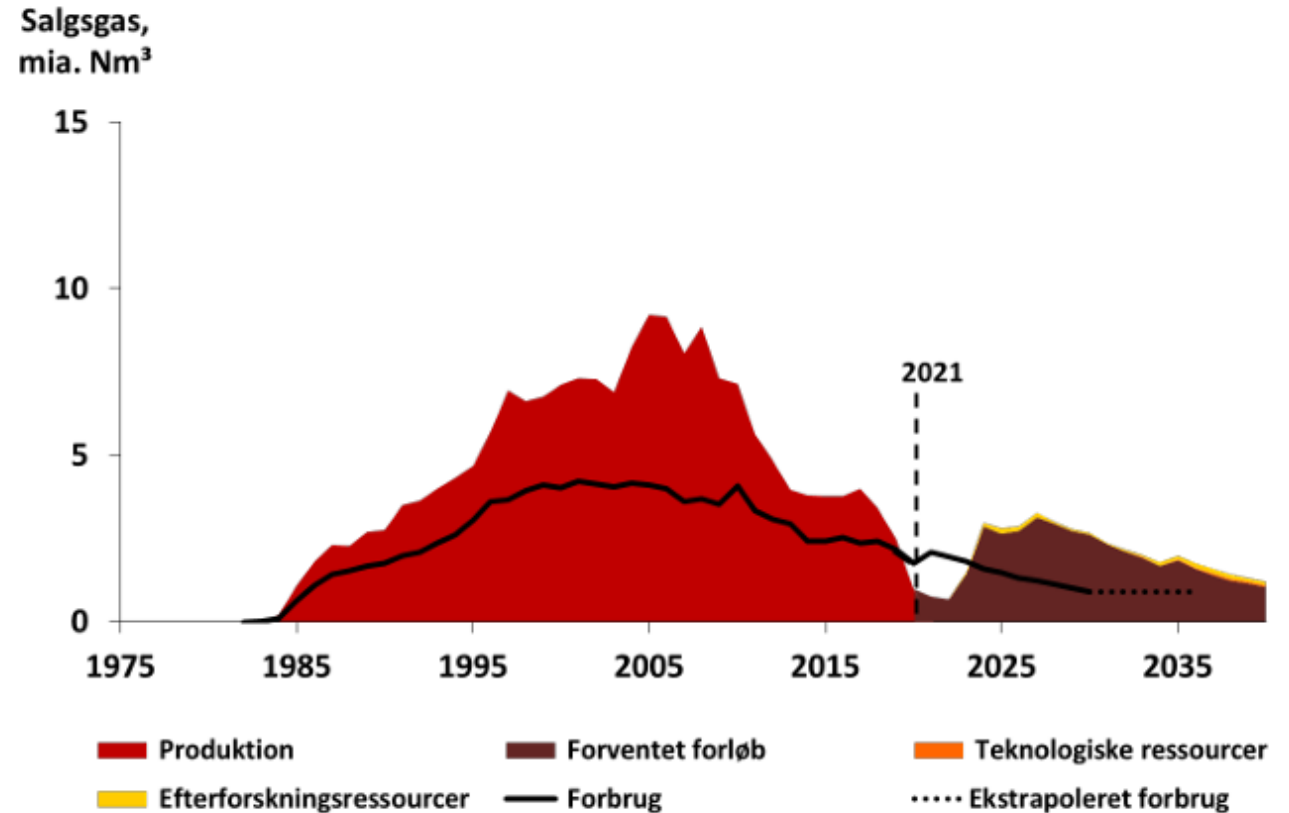
Source: Norwegian Petroleum Directorate

DANISH PRODUCTION OF FOSSIL GAS

The Danish production is currently low due to maintenance of Tyra gas field.

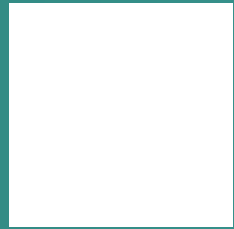
It is expected that the Tyra gas field will reopen in 2023.

The natural gas production in Denmark is projected to gradually decrease from 2026 over the following decades.



FIGUR 4: Produktion og langsigtet prognose for salgsgas

The Danish Energy Agency, 2020

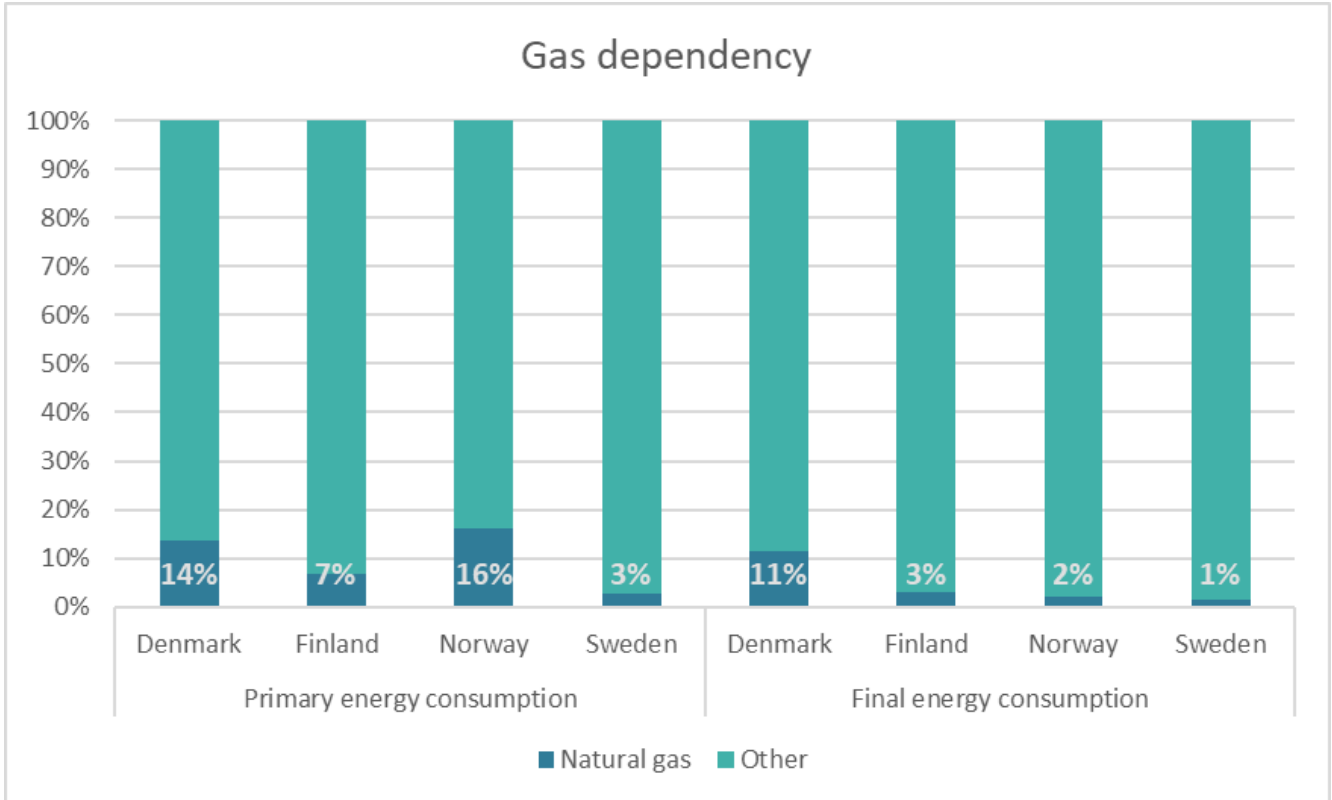


NATURAL GAS CONSUMPTION IN THE NORDICS

DENMARK IS THE MOST DEPENDENT NORDIC COUNTRY ON NATURAL GAS FOR ENERGY USE

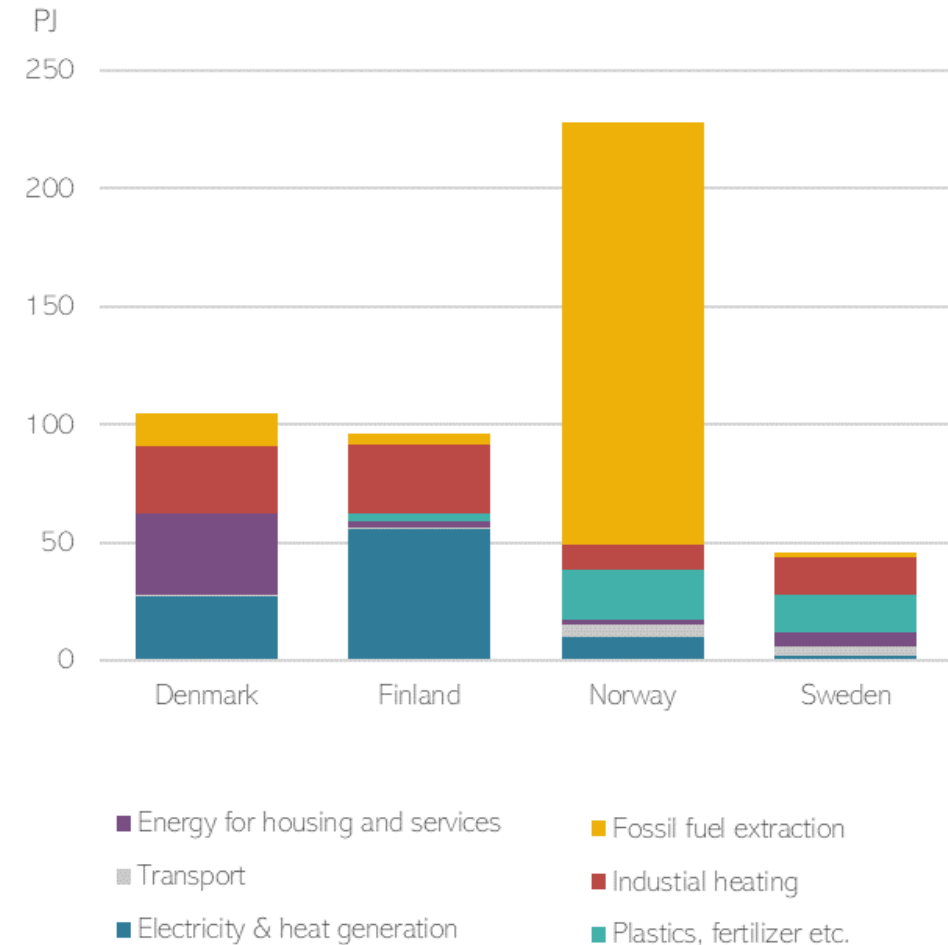
Norway has the highest share of natural gas in primary energy consumption, coming from the extraction sector, while their share in final energy demand is low

Denmark has the highest share of natural gas in final energy consumption and second highest in primary energy consumption



THE NORDIC COUNTRIES USE GAS DIFFERENTLY

- **Denmark** uses gas for residential heating, industrial process heat and for electricity and heat production
- **Finland** primarily uses gas for electricity and heat production and industry
- **Norway and Sweden** mainly use gas for non-energy purposes such as plastics and fertilizer, but also for process heat
- **Norway** use a large amount of gas on their oil and gas extraction facilities



Households and services

Around 350,000 buildings are heated by gas

Solutions

- Short-term – reduce indoor temperature, use supplement heating (e.g. electric panels or existing wood stoves)
- Long-term – role out district heating in dens areas and heat pumps in rural areas

Industrial process heat

Danish companies like Arla, Carlsberg, Danish Crown, Novo Nordisk, and Rockwool use gas for process heat

Solutions

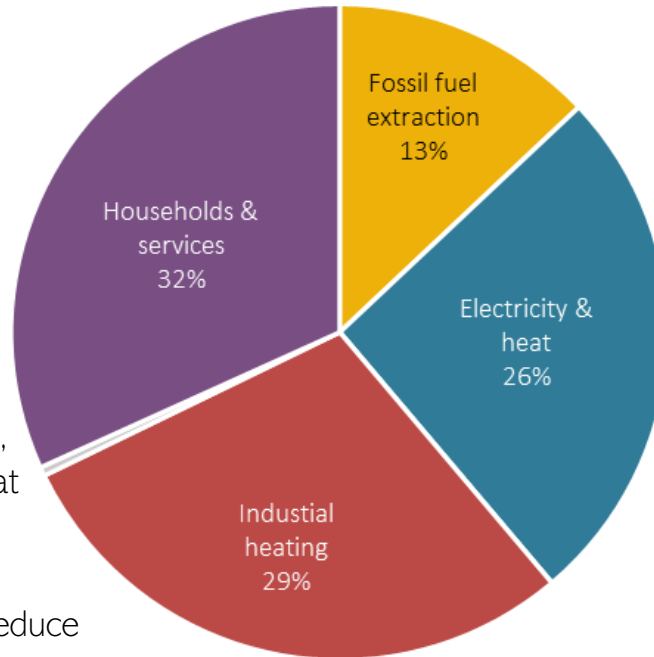
- Short-term – Increase biogas share in the grid, reduce production
- Long-term - Energy Efficiency, Replace gas with high temp. HP and other new process heat sources as CSP, infra-red heating and green gas

Fuel extraction

Gas are used at the production platforms in North Sea for power and heat production

Solutions

- Short-term – Not really any
- Long-term – Supply the platforms with power from shore or wind parks



Electricity and district heat production

110 CHP plants (5.4 GW) and more than 1000 small engines (2.5 GW) and heat only plants are using natural gas

Solutions

- Short-term – Replace production with other existing plants, increase biogas share in the grid
- Long-term – Close down the plants and replace with waste biomass plants, solar, wind and large scale heat pumps

BIOGAS POTENTIALS



Denmark

- 20 PJ/year biogas is produced annually
- If 90% of all manure is utilized, Denmark can produce around 50 PJ/year biogas annually (around half of the Danish natural gas use today).



Sweden

- 6,5 PJ/year biogas is produced today
- The long-term biogas potential is 20 PJ/year (~ 40% of today's natural gas use). Including more agro-biomass, gasification of forest residues etc.



EU

- In 2021 Europe produced 720 PJ biogas.
- Biomethane could cover up to 30-40 % of EU gas consumption in 2050, with a production potentially around 3.600 PJ/year.

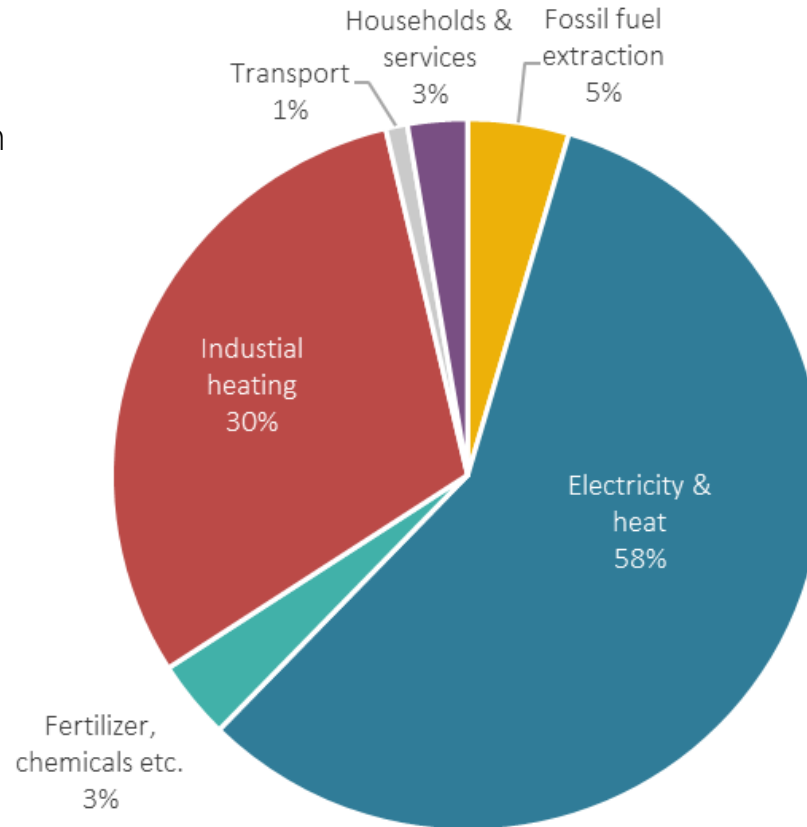
FINLAND

Industrial process heat

The main consumers of natural are iron and steel industry and pulp and paper

Solutions

- Short-term – Increase green gas share, reduce production
- Long-term - Energy Efficiency, electrification of processes, biofuels and green gas



Electricity and district heat production

7% of the energy used for electricity and heat production in comes from gas

Solutions

- Short-term – Replace production with other existing plants. The nuclear reactor Olkiluoto 3 (1600 MW) is expected online summer 2022
- Long-term – Close down the plants and replace with solar, wind, biofuels and large heat pumps

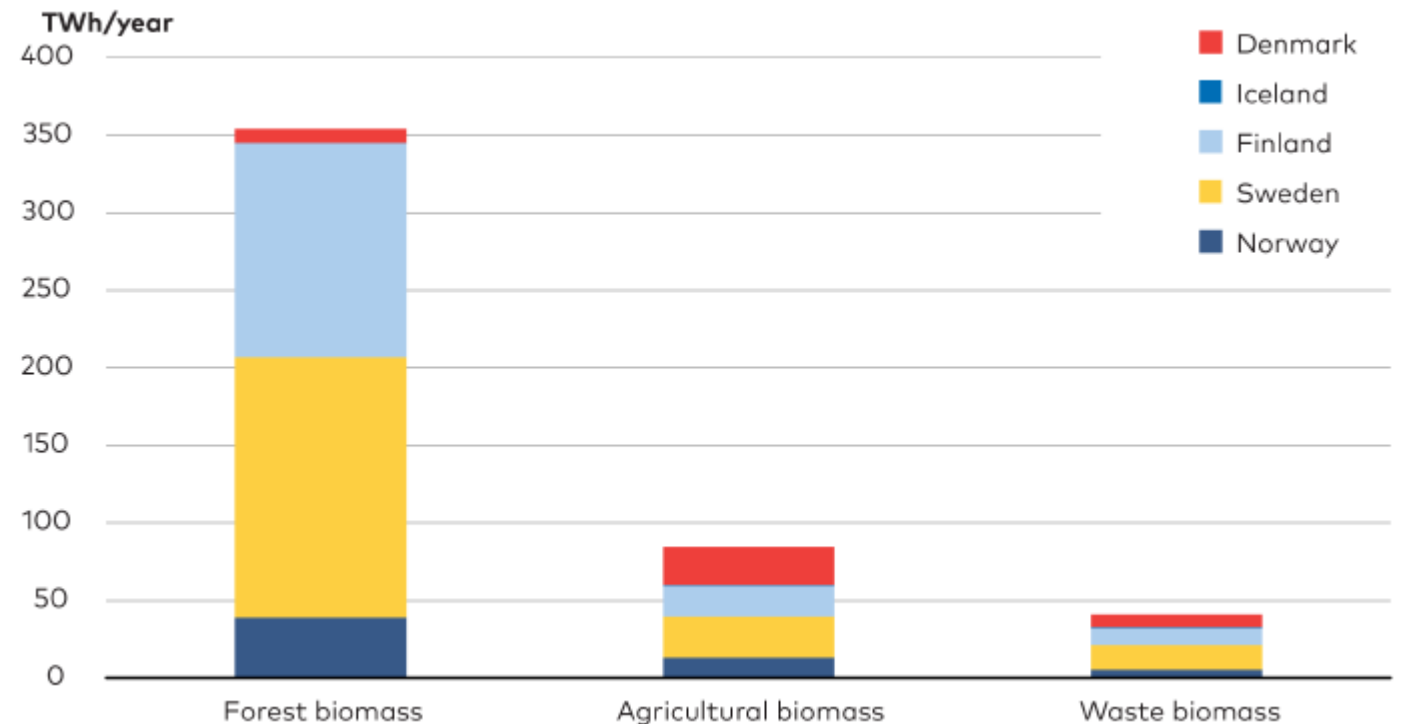
LARGE LOCAL BIOMASS RESOURCES CAN HELP THE NORDIC COUNTRIES REPLACING NATURAL GAS

Can biomass bridge from natural gas?

The Nordic countries are yearly using around 300 TWh of biomass for energy and fuels – while the Nordic potential is more than 450 TWh.

What will be the future role of biomass?

- Earlier the bioenergy resource were expected to be used mainly in transport sector, but due to the ongoing electrification of basically all means of transport – this releases biomass resources to other purposes
- Potentially more biomass can be used for power and heat and process energy



Nordic bioenergy potentials split by source and country. Source: Pöyry & Nordic Energy Research, 2019.

NORWAY

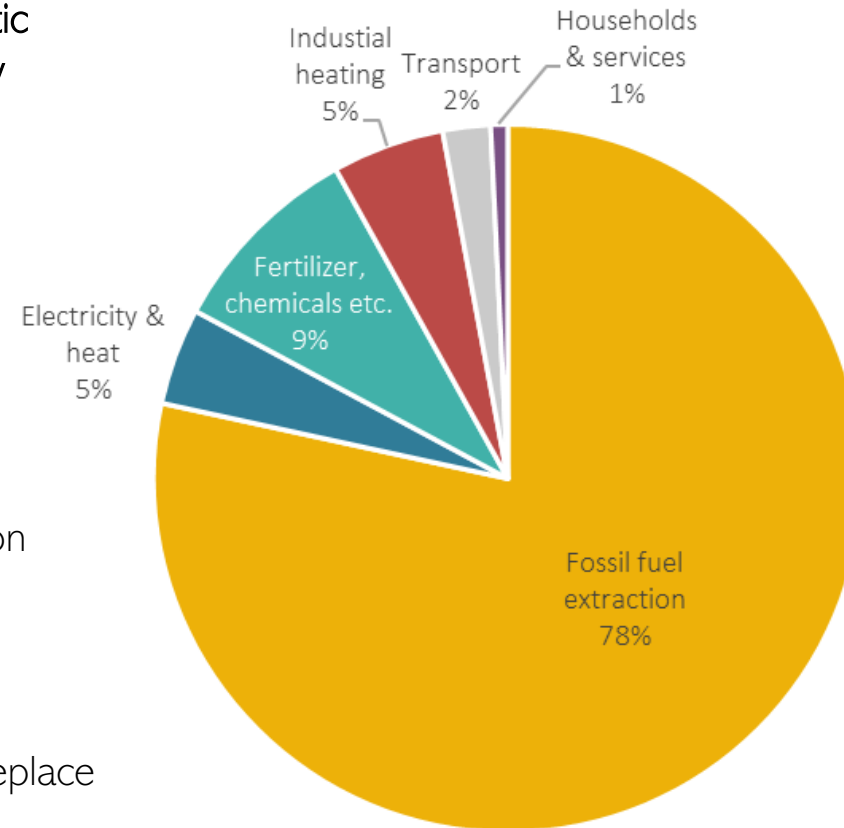
Norway does not have a high domestic gas use, and being self sufficient they will not see an energy shortage, but high prices will occur

Chemical industry

Second largest consumption of natural gas in Norway is chemical industry including fertilizer production

Solutions

- Short-term – Reduce production
- Long-term - Energy Efficiency, replace natural gas by green hydrogen



Fuel extraction

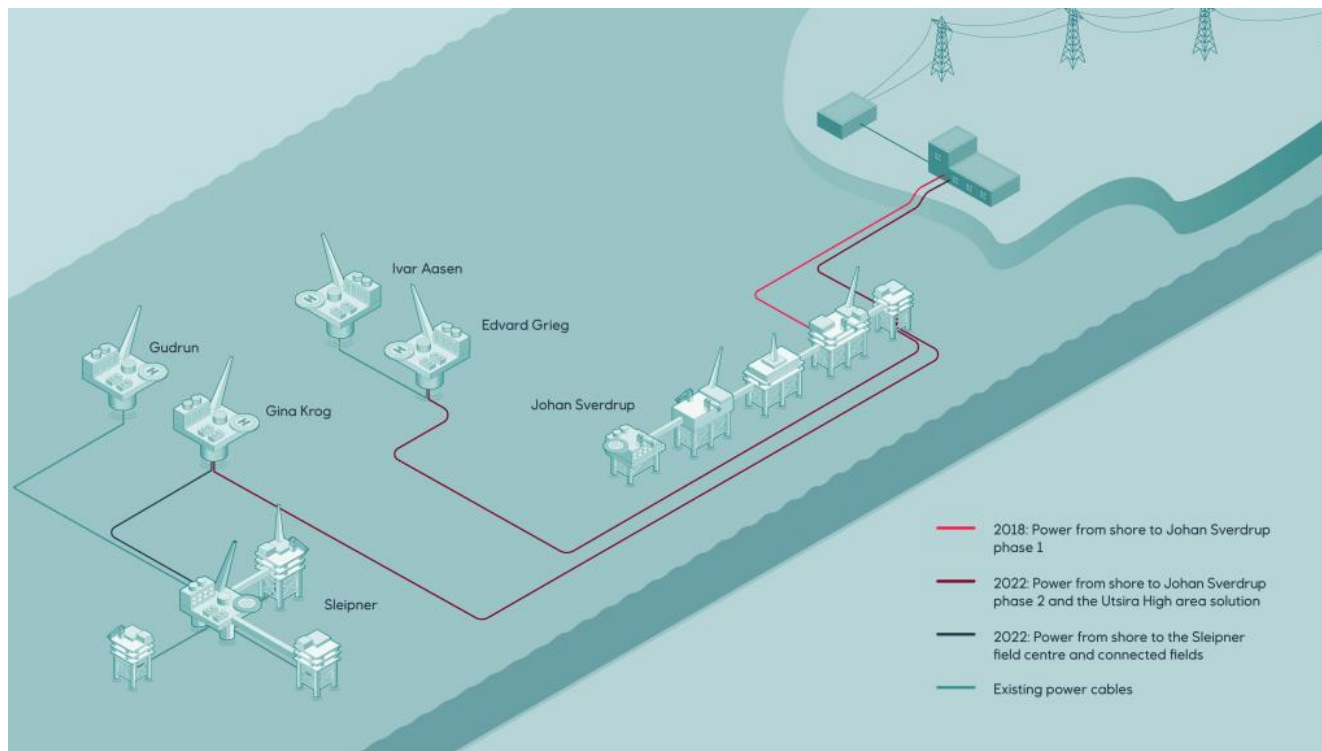
Gas are used at the production platforms in North Sea for power and heat production

Solutions

- Short-term – Not really any
- Long-term – Electrification of production platforms with power from shore

Electrification of the production platforms in Norway can release another +150 PJ natural gas for export

ELECTRIFICATION OF THE NORWEGIAN OIL AND GAS PLATFORMS WILL SIGNIFICANTLY REDUCE THE EMISSIONS AND NORWEGIAN GAS CONSUMPTION



<https://www.equinor.com/en/magazine/electrification-of-oil-and-gas-platforms.html>

The electrification of Johan Sverdrup

By using electricity from land, emissions from Johan Sverdrup are reduced by up to 90 per cent.

Adding a power cable from Sleipner to the Gina Krog platform

The reductions in emissions from the Utsira Heights area (where Sleipner is located) are estimated at 1.15 million tones of CO₂ annually.

New projects

The Norwegian government has approved a plan for the development and operation of the Troll field in the North Sea, which will enable the operator to turn its Troll West electrification plans into reality.

SWEDEN

Households and services

The gas is mainly used for heating of public and commercial buildings

Solution

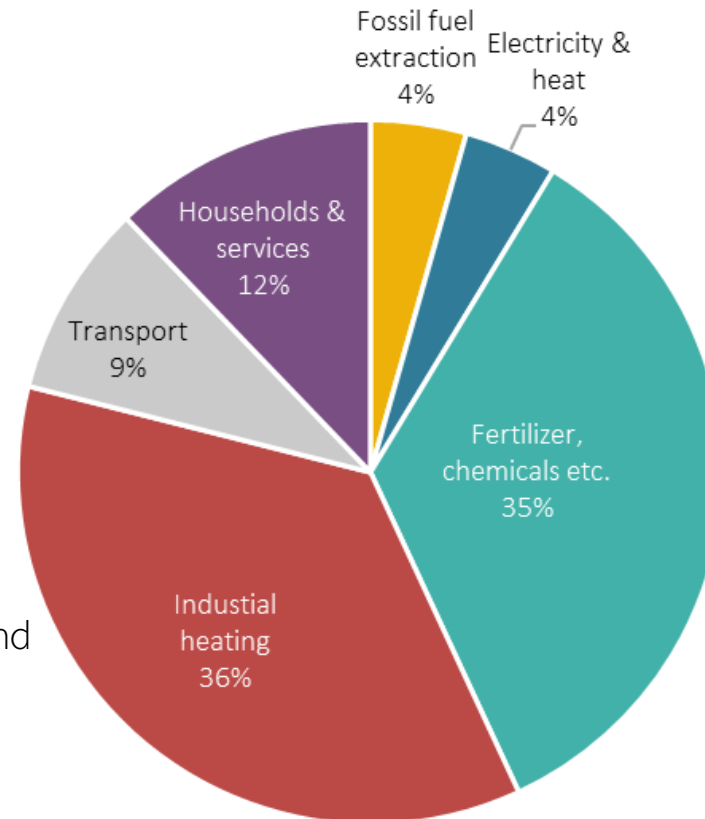
- Short-term – reduce indoor temperature, use supplement heating
- Long-term – role out district heating in dens areas and heat pumps in rural areas

Industrial process heat

The main consumers of natural gas are iron and steel, chemical, pulp and paper, non-metallic, minerals and food industry

Solution

- Short-term – Increase green gas share, reduce production
- Long-term - Energy Efficiency, electrification of processes and green gas



Chemical industry – non-energy

Sweden along with Norway, produces fertilizer, plastic and chemical components based on natural gas

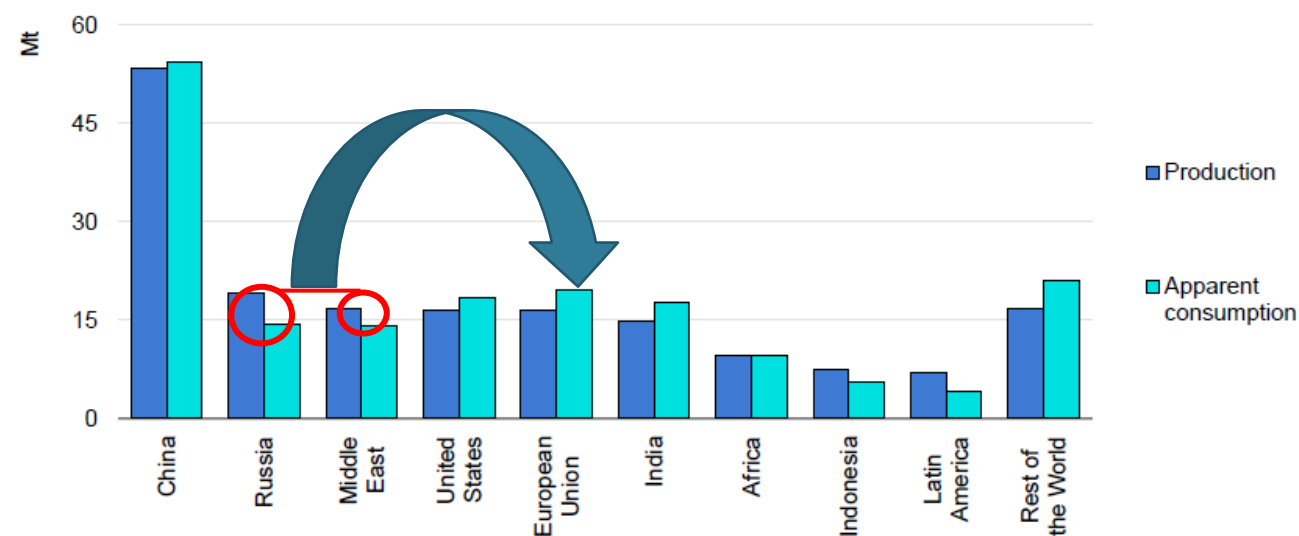
Solutions

- Short-term – reduce production
- Long-term - Energy Efficiency, replace natural gas by green hydrogen

FERTILIZER PRODUCTION IS A HUGE NATURAL GAS CONSUMER GLOBALLY

Russia and Middle East are the main net exporters of fertilizer which means a reduction in import/consumption in Europe, on the margin will hit the Russian and Middle East producers.

Figure 1.3 Apparent consumption and production of ammonia in 2019



IEA, 2021.

Notes: The apparent consumption of a region is equal to its production plus imports minus exports.

Source: Data from [IFA](#).

China is the largest ammonia producer at 53.5 Mt in 2019 (29% of global production), and the largest consumer at 54.3 Mt.

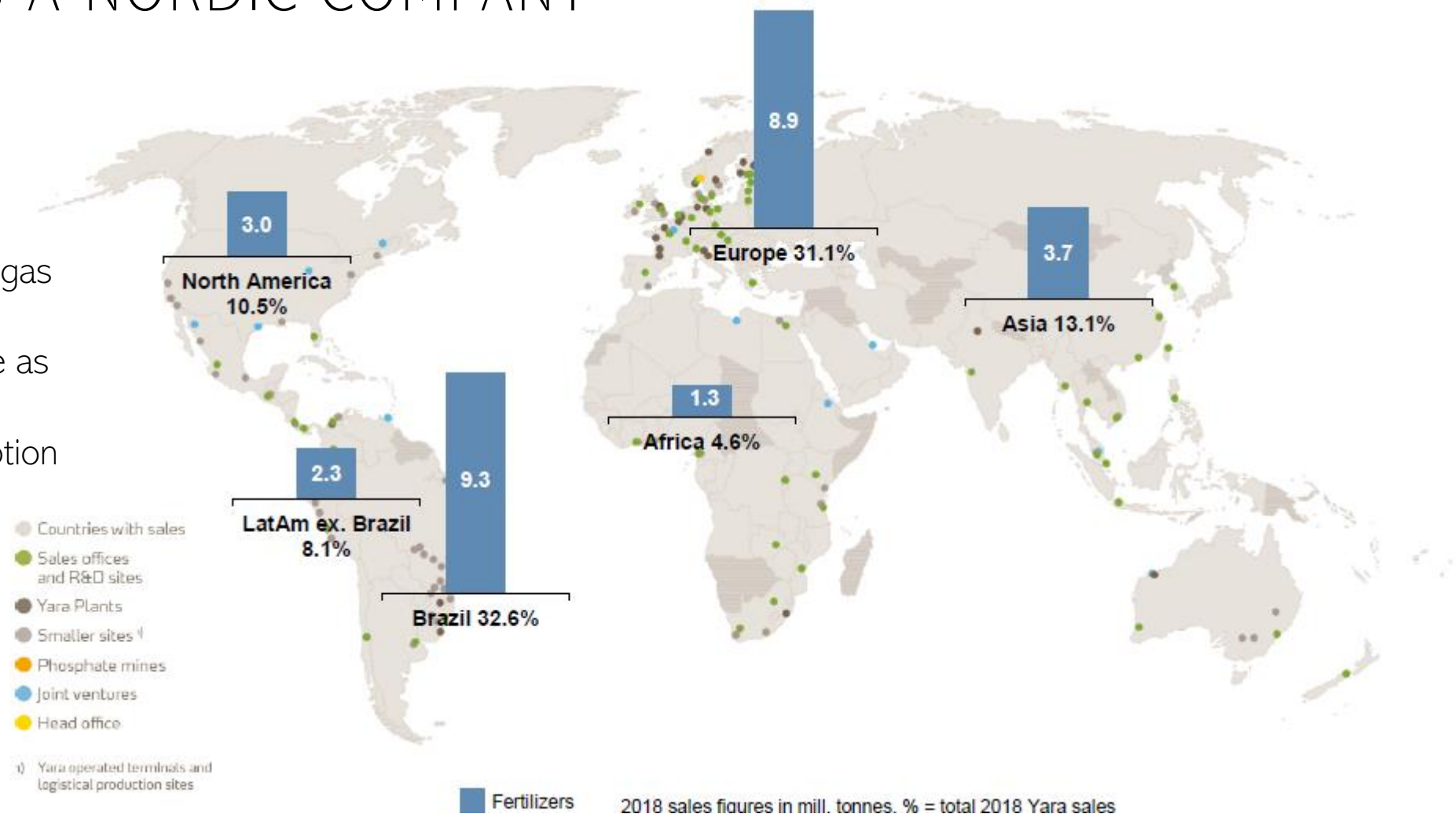
ONE OF THE WORLDS LARGEST PRODUCERS OF FERTILIZER IS A NORDIC COMPANY

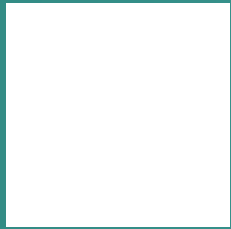
YARA's sales in different regions:

They use 250 PJ natural gas per year in their fertilizer production plants – same as Denmark, Sweden and Finland's yearly consumption of natural gas for energy purposes all together.



Knowledge grows





SOLUTIONS FROM IEA AND THE EU COMMISSION

ACTION POINTS FROM IEA AND EU COMMISSION

HERE AND NOW

- Maximize energy from existing nuclear and biomass plants
- Introduce minimum gas storage obligations
- Temporary thermostat adjustment by consumers
- Economic compensation to vulnerable consumers
- Close selected industries temporarily

SHORT TERM

- Increase LNG and non-Russian gas supply
- Increase biogas and green hydrogen
- Boost district heating, heat pumps and energy efficiency measures in buildings and industry
- Front load wind and solar projects, increase deployment rate

LONG TERM

- Accelerate wind, solar and other renewables build out
- Increase utilization of excess heat for district heating
- Electrification of industry
- Transformation of heavy industries
- Build up green fuel production facilities and infra-structure (PtX)

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