
DTU

# Danish gas from the North Sea in a climate perspective

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# Introduction

Natural gas from the Danish part of the North Sea contributes to the European security of supply with a production that, according to the North Sea Agreement from 2020, will continue until 2050. Danish net exports of natural gas are expected to increase in the coming years as gas is phased out from Danish households. At the same time, the significant drop in European gas imports from Russia after Russia's invasion of Ukraine in 2022 means that LGN, or liquefied natural gas, especially from the US, Africa and the Middle East, has become a very important source of energy for Europe.

The European Commission has a goal of reducing the EU's greenhouse gas emissions by at least 55% by 2030, and here the European phase-out of coal will make a significant contribution to that goal. For this reason, too, it is important to have an objective and reliable assessment of the emissions from the alternatives to coal and how much these can contribute to achieving the European emission reduction targets.

In addition, the world is currently characterized by geopolitical turmoil and is very concerned with energy independence and security of supply. For many countries and politicians, the issue of a stable and reliable energy supply has largely become a security policy issue. It is crucial for political decisions to know where European and Danish energy comes from, in what form and with what climate footprint.

When natural gas produced in Denmark is exported to the European market, imports of LNG or coal are correspondingly reduced. Therefore, it is relevant to look at the greenhouse gas emissions from Danish-produced natural gas compared to LNG and coal.

In order to get an accurate picture of the emissions, Dansk Offshore has asked DTU Offshore to conduct an independent analysis of the total greenhouse gas emissions for gas produced in Denmark and compare this with the main sources of imported LNG (liquefied natural gas) and coal. The analysis includes the entire value chain from production via transport to consumption and focuses on CO2, methane (CH4) and N20.

This is a summary. Many more details can be found in the report "LNG Carbon footprint study – A comparison of GHG emissions of natural gas produced in Denmark and imported LNG and Coal" by Hans Horikx & Ali Akbar Eftekhari, both from DTU.

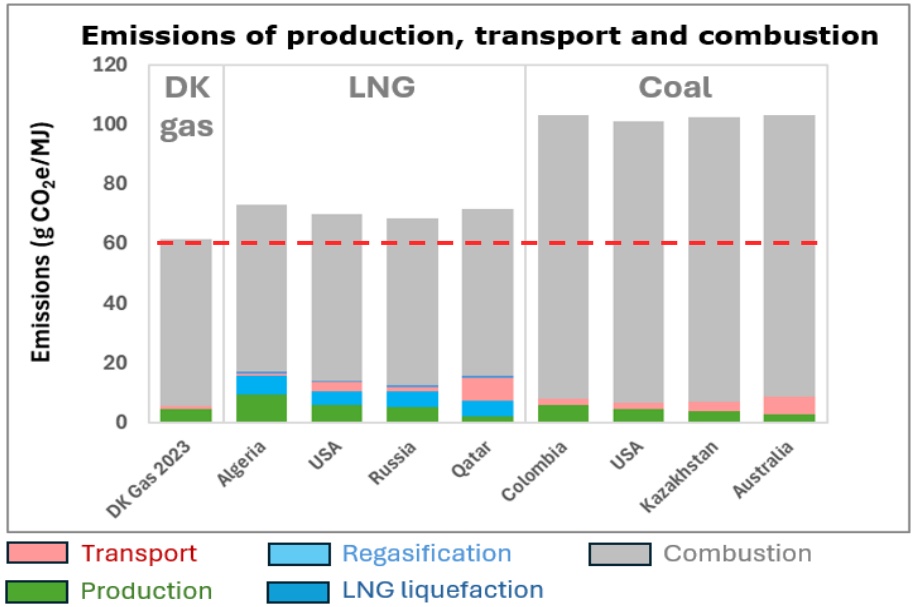
# Main findings

**Total emissions**

- The relative difference between the three fuels varies considerably when looking at total emissions (production, transport and combustion). Coal emits about 66% more and imported LNG about 14% more greenhouse gases compared to natural gas produced in Denmark.
- The forecast for total emissions in 2026 is expected to decrease by approximately 2% compared to 2023 calculations, and the decrease is mainly due to the restart of the modernized Tyra plant.

**Emissions from production and transport**

- Looking exclusively at production and transport, coal emits about 35% more and imported LNG about 159% more greenhouse gases than natural gas from Denmark.
- The effect of the modernized Tyra plant is expected to reduce emissions by approximately 25% in 2026.
- The results of DTU's analysis are in line with another independent study from the North Sea Transition Authority (NSTA) in the UK.




| | Production, transport & combustion (g CO2e/MJ) | Production, transport & combustion (DK Gas 2023 = 100) | Production & transport (g CO2e/MJ) | Production & transport (DK Gas 2023 = 100) |
|---|---|---|---|---|
| **Coal** | 101,9 | 165,9 | 7,21 | 135,4 |
| **LNG** | 69,87 | 113,7 | 13,77 | 258,7 |
| **DK Gas 2023** | 61,42 | **100** | 5,32 | **100** |
| **DK Gas 2026** | 60,11 | 97,7 | 4,01 | 75,3 |

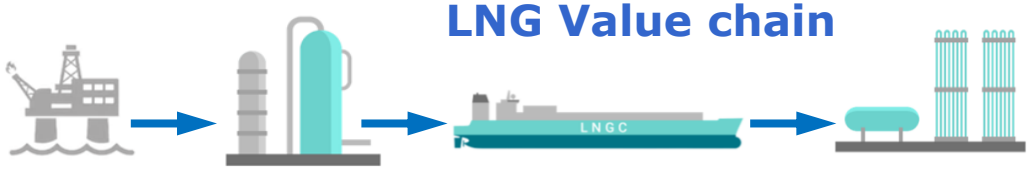
*Values are weighted averages (share x amount of emissions)*

# What we did (1)

## Danish Gas Value chain

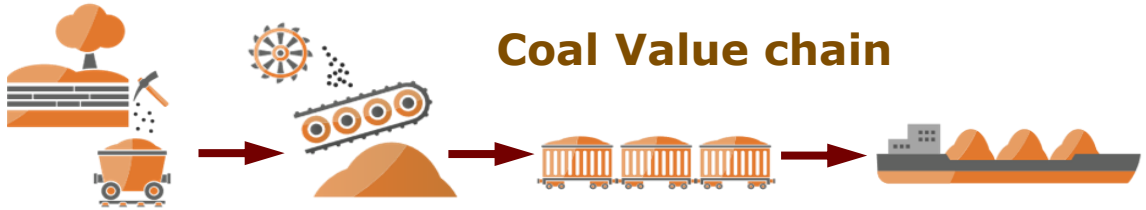
Delivery of DK gas to the Netherlands via NOGAT pipeline

## LNG Value chain

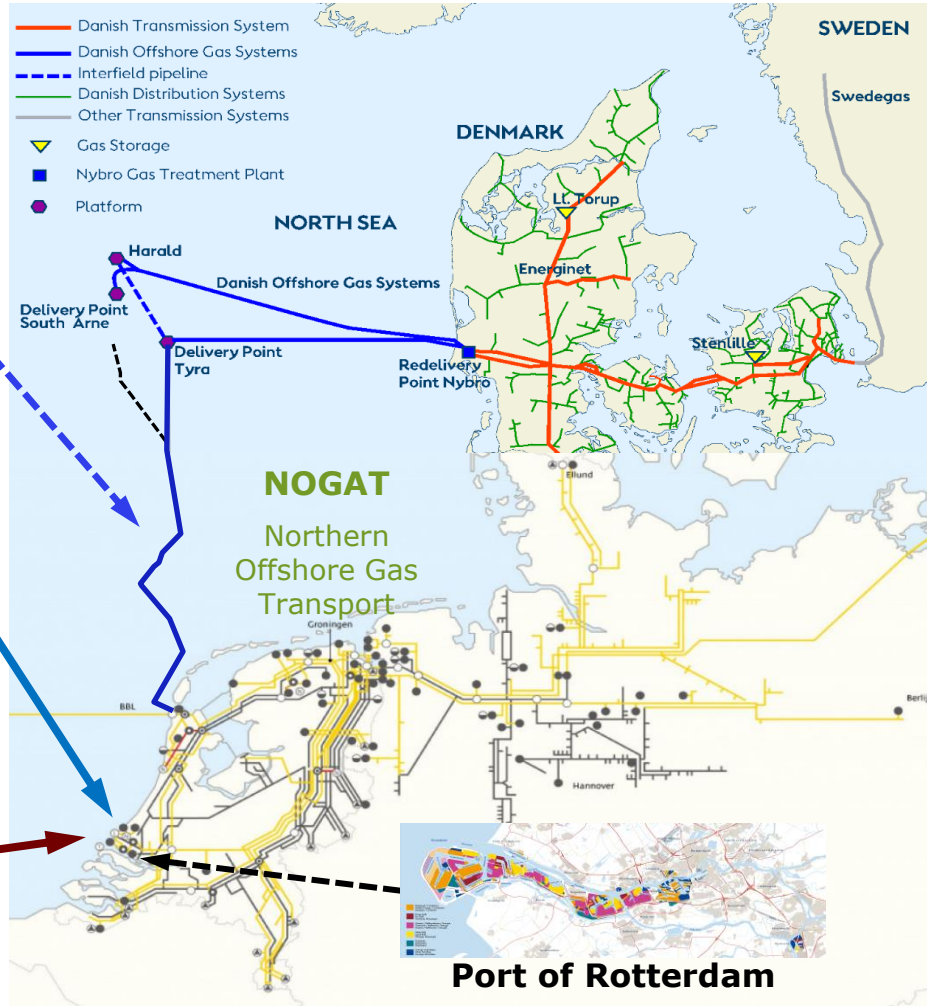



Production Liquefaction Transportation Regasification (in port)

## Coal Value chain

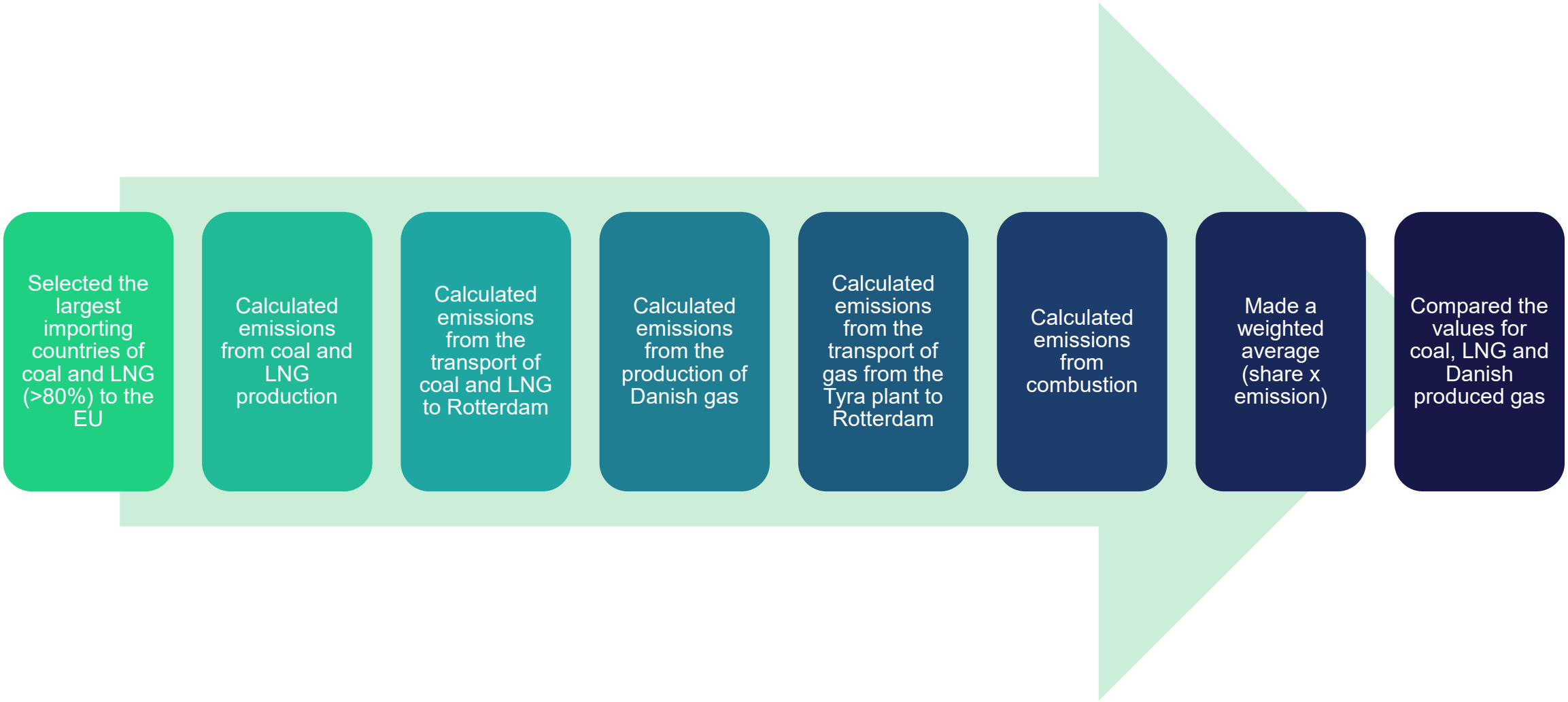


Mining Processing Transportation Transportation



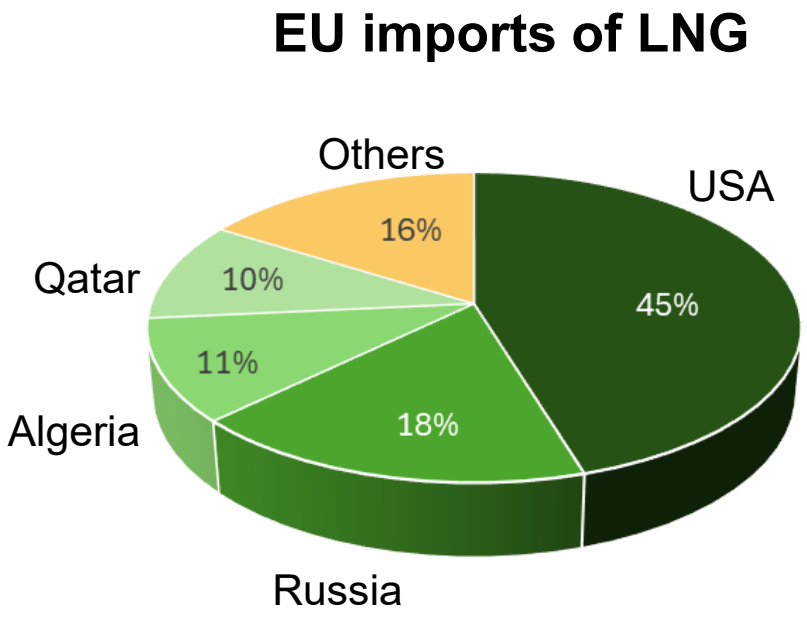

- To have a basis for comparison, we have investigated emissions from the delivery of coal/LNG in Rotterdam, which also receives gas from Danish offshore fields via a gas pipeline, (NOGAT), connecting the Danish Tyra complex to the Netherlands.

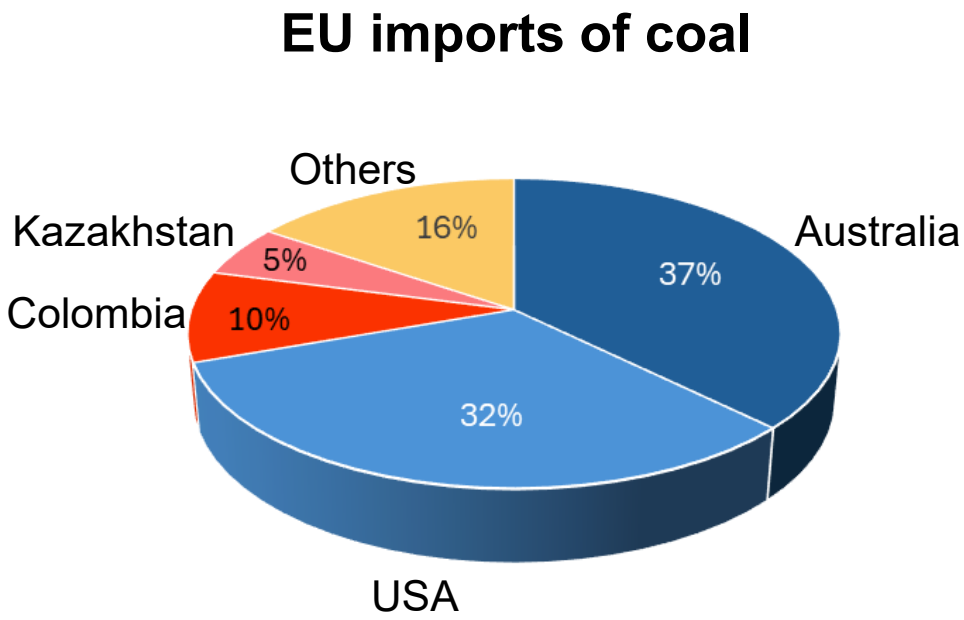
# What we did (2)


Selected the largest importing countries of coal and LNG (>80%) to the EU
Calculated emissions from coal and LNG production
Calculated emissions from the transport of coal and LNG to Rotterdam
Calculated emissions from the production of Danish gas
Calculated emissions from the transport of gas from the Tyra plant to Rotterdam
Calculated emissions from combustion
Made a weighted average (share x emission)
Compared the values for coal, LNG and Danish produced gas

# What we did (3)

- In addition to Denmark, the natural gas and coal-producing countries, which together account for more than 80% of the EU's imports (2024), were included in this survey, according to figures from Eurostat.

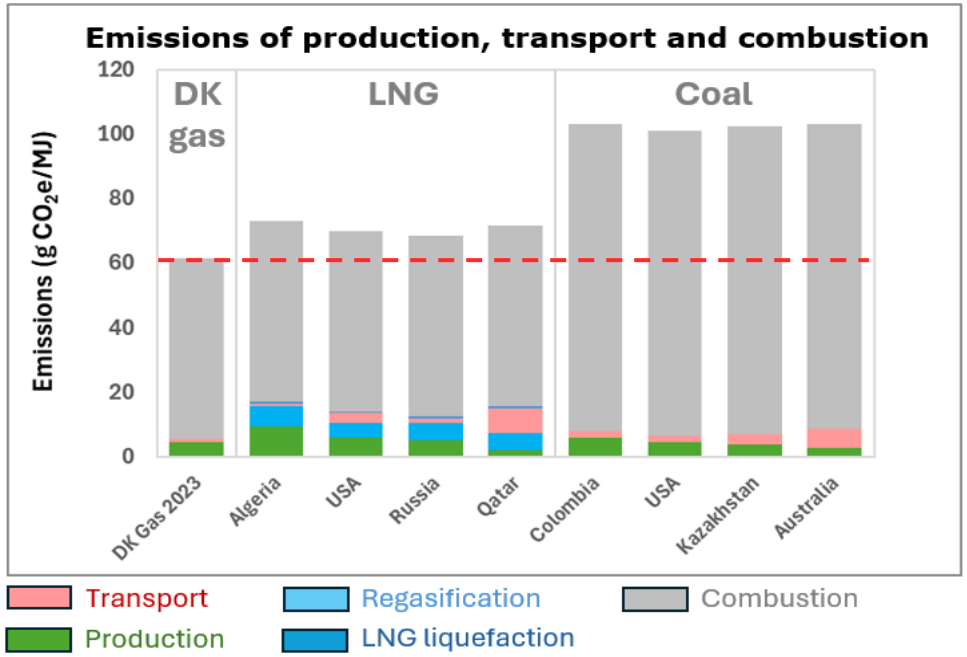


# Results (1) – total emissions (2023)

- From an overall perspective, i.e. greenhouse gas emissions from production, transport and combustion, coal emits about 66% and imported LNG about 14% more greenhouse gases compared to natural gas produced in Denmark.
- The values are calculated as a weighted average (share x emission amount) based on 2023 data.

| | **Production, transport & combustion** (g CO2e/MJ) | **Production, transport & combustion** (DK Gas 2023 = 100) |
|---|---|---|
| **Coal** | 101,9 | 165,9 |
| **LNG** | 69,87 | 113,7 |
| **DK Gas 2023** | 61,42 | **100** |




***LNG liquefaction is the conversion of natural gas in gaseous form into liquefied natural gas through cooling and depressurization.***
***Regasification is the conversion of liquefied natural gas into natural gas in gaseous form by heating.***

# Results (2) – total emissions, forecast for 2026

- The operation of the modernised Tyra plant is expected to result in a reduction of approximately 2% of total greenhouse gas emissions from production, transport and combustion in 2026 compared to the emissions calculated for 2023.
- Seen in isolation, greenhouse gas emissions from the production and transport of Danish natural gas from the North Sea will decrease by 25%, cf. slide 11.
- The values are calculated as a weighted average (share x amount of emissions) based on expected figures.
- If emissions from 2026 are used as a benchmark, LNG emits 16% more than Danish gas, while coal emits 70% as much.

| | **Production, transport and combustion** (g CO2e/MJ) | **Production, transport and combustion** (DK Gas 2026 = 100) |
|---|---|---|
| **Coal** | 101,9 | 169,5 |
| **LNG** | 69,87 | 116,2 |
| **DK Gas 2026** | 60,11 | **100** |

*Transport calculated by short, optimal shipping routes. Values are weighted averages.*

# Results (3) – emissions from production and transport (2023)

- If we only look at production and transport, Danish-produced gas emits less greenhouse gas than imported LNG or coal.
- LNG emits 159% times and coal 35% more greenhouse gas than natural gas produced in Denmark.
- The values are calculated as a weighted average (share x emission amount) based on 2023 data.

| | **Production & transport** (g CO2e/MJ | **Production & transport** (DK Gas 2023= 100) |
|---|---|---|
| **Coal** | 7,21 | 135,4 |
| **LNG** | 13,77 | 258,7 |
| **DK Gas 2023** | 5,32 | **100** |

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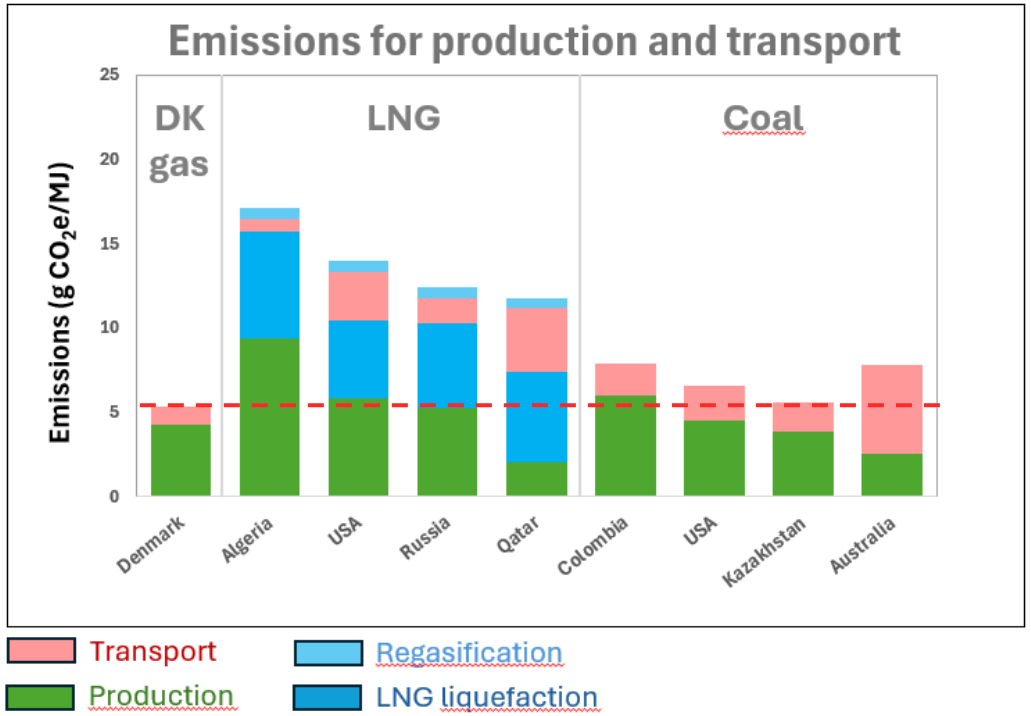



***LNG liquefaction is the conversion of gaseous natural gas into liquefied natural gas through cooling and depressurization.***
***Regasification is the conversion of liquefied natural gas into natural gas in gaseous form by heating.***

# Results (4) – emissions from production and transport, forecast for 2026

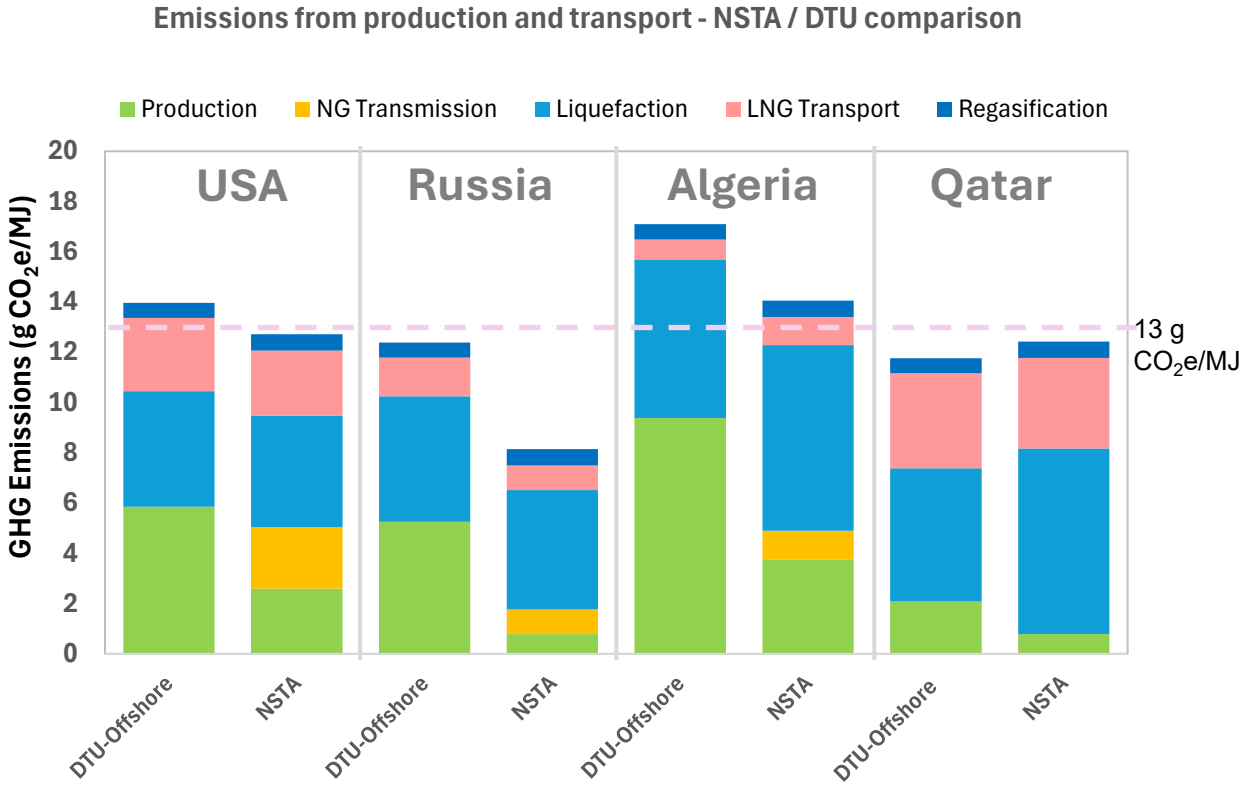
- The start-up of the modernised Tyra plant is expected to result in a reduction of approximately 25% of total emissions from production and transport compared to the emissions calculated for 2023.
- The values are calculated as a weighted average (share x amount of emissions) based on expected figures.
- If emissions from 2026 are used as a benchmark, LNG emits 243% more than Danish gas, while coal emits 80% more.

| | **Production & transport** (g CO2e/MJ) | **Production & transport** (DK Gas 2023 = 100) |
|---|---|---|
| **Coal** | 7,21 | 179,8 |
| **LNG** | 13,77 | 343,4 |
| **DK Gas 2026** | 4,01 | **100** |

*Transport calculated by short, optimal shipping routes. Values are weighted averages.*

# Results (5) – Comparison with NSTA report (greenhouse gas emissions from production and transport)

- The results of this analysis are in line with another independent study conducted for the North Sea Transition Authority (NSTA) in the UK when we look at emissions from production and transport.
- The weighted average for LNG imported into the EU in this study is 13.8 g CO2e/MJ for the four countries analysed.
- NSTA calculates for the same four countries 11.8 g CO2e/MJ and 12.9 g CO2e/MJ for all 10 countries analysed in the NSTA report.
- NSTA is a public institution responsible for regulating the UK oil, gas and CO2 storage industry (Carbon footprint of UK natural gas imports - North Sea Transition Authority, NSTA, 2023.)




*NSTA reports kg CO2e/boe, which is here converted to g CO2e/MJ.*

*The dotted line shows an average of the two studies, which is 13.0 g CO2e/MJ*

*LNG liquefaction is the conversion of natural gas in gaseous form into liquefied natural gas through cooling and depressurization.*

*Regasification is the conversion of liquefied natural gas into natural gas in gaseous form by heating*

# Appendix – methodological considerations

- Two operators in the Danish part of the North Sea, TotalEnergies and INEOS Energy, have provided emissions data for natural gas, which in the analysis has been compared with independent and publicly available data from the EPA (Environmental Protection Agency), IPCC (Intergovernmental Panel on Climate Change) and UNFCCC (United Nations Framework Convention on Climate Change).

- Emissions data covering the entire LNG and coal value chain have been obtained from the same EPA and IPCC databases and from satellite observations quantified by the EU's Emissions Database for Global Atmospheric Research (EDGAR) initiative.

- The use of satellite data to cross-check reported emissions data is innovative for this type of analysis and is based on satellite observations of methane emissions. A number of recent scientific reports have shown that these data can be used as an independent calibration of the emissions data reported to the UN and used by the IPCC.

- The amount of greenhouse gases emitted by imports of coal and LNG is also affected by geopolitical tensions, as these affect transport routes, such as limited access to the Suez Canal (e.g. increased transport around South Africa). These additional transport emissions are very limited.

- Since methane has a shorter lifetime in the atmosphere than CO2, methane's contribution to the warming potential will be different depending on whether a 20-year or 100-year frame of reference is used, and therefore a comparison is calculated as a sensitivity. If a 20-year perspective (GWP20) is used in the calculations, the impact of methane gas on production and transport would increase significantly, so that emissions would increase by approximately 75% for LNG and approximately 78% for coal, while the increase would only be 7% for Danish gas (GWP20/GWP100).

- More information can be found in "LNG Carbon footprint study – A comparison of GHG emissions of natural gas produced in Denmark and imported LNG and Coal" by Hans Horikx & Ali Akbar Eftekhari.