NCGG5

Wuppertal Institute for Climate, Environment and Energy

Future development of the upstream GHG emissions from natural gas industry

Focus on Russian gas fields and export pipelines

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Overview

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  - Focus Russia: Development of NG balance by 2030
- Technology scenarios
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  - Expected GHG emissions of other NG sources
- Results
  - Dynamic representation of natural gas life cycle GHG emissions
  - 2 Scenarios for Germany by 2030

Relevance of the Topic

- Role of Natural Gas
  - Increase of use in the last two decades
  - Direct GHG emissions low compared to other fossil fuels
    - High degree of efficiency + Low level of direct GHG emissions in combustion

- Upstream losses crucial for overall GHG emissions and climate relevance
  - Direct losses are direct emissions of methane (21 - 25 GWP)
  - High use of energy for production, processing and transport lead to GHG emissions
  - Significant potential for mitigation

- Change in gas supply to EU in next decades
  - Decline of European gas fields (DK, NL, UK)
  - Growing distances; more gas import from outside EU (Russia, Norway)
  - Upcoming market for LNG (energy intensive processes)
  - Former study concentrated on current state, dynamic development missing
- Trends might have the potential to significantly increase upstream emissions

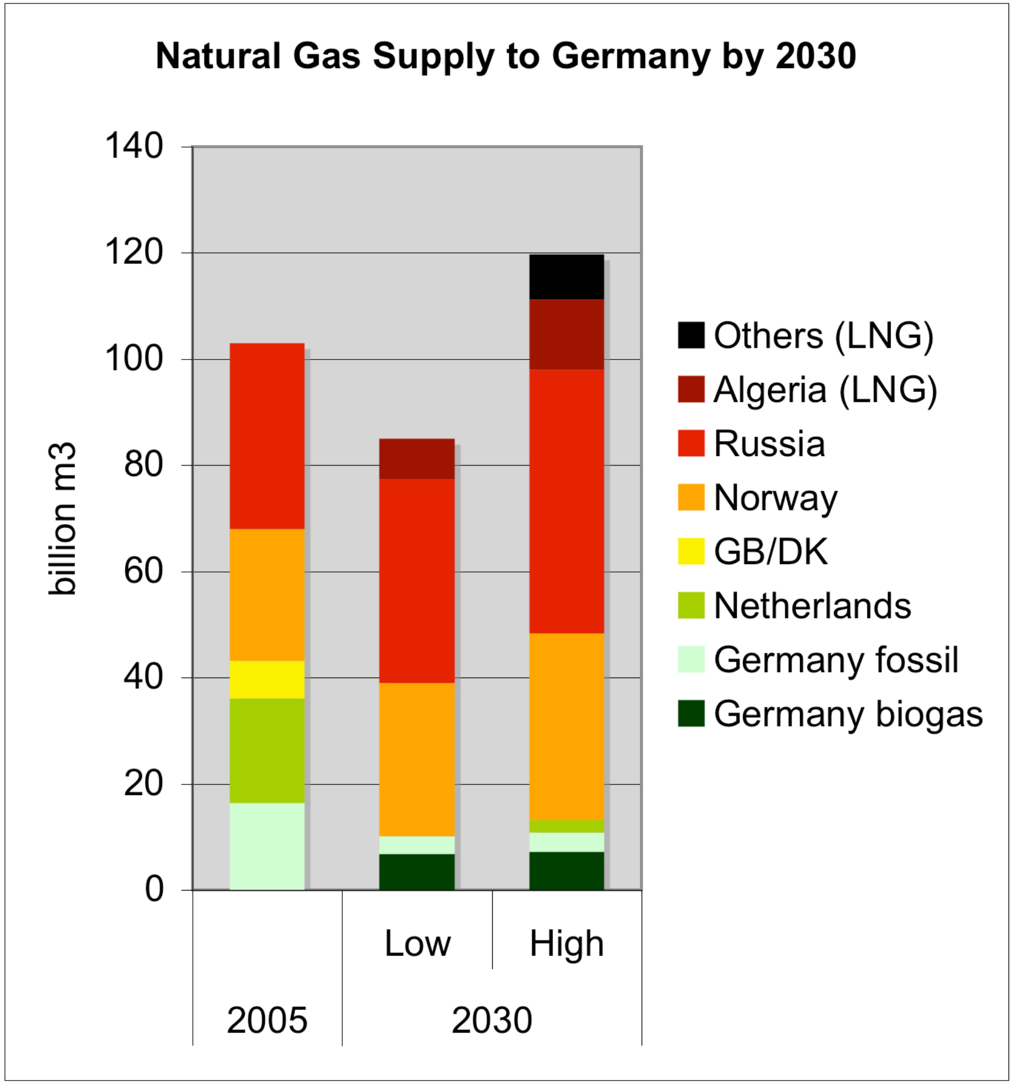
Methodology:
Dynamic LCA

- Combination of
  - scenario analysis
  - and (simplified) life cycle analysis
- Scenarios of the natural gas supply to Germany
  - Focus on Russia
  - Scenarios on demand, supply and technology
  - Matrix of possible scenario combinations
- Selection of two main storylines
  - Coherent pictures of future GHG emissions from natural gas supply
  - „High“ demand, supply, investment versus
  - „Low“ demand, supply, (slightly lower investment)
- Result
  - Probability range of future life cycle emissions of natural gas

Scenario Matrix

	Scenario A	Scenario B
Natural gas demand Germany Assumption	high demand "Business as Usual"	low "Green" or "price constraint"
Natural gas supply	more diverse more distant	as A
Technology	evolutionary development *based on EWI 2005*	as A *based on BMU 2004*
Russia		
Sales	increasing: domestic consumption; new markets; West-EU	slower domestic increases, slower export increases
Production Investment into new fields	fast	slightly slower
Other producers	given access to the grid	given access to the grid
Technology	Best availabe technology very high reinvestments	Low-cost, lower focus on transport route reinvestments

Natural gas demand and supply to the German market by 2030 – two scenarios



- EU gas supply sharply declines
  - By 70 to 77%
  - From 40% to 12%
- Domestic biogas supply (6-8% by 2030)
- Compensation by increased supply
  - Russia (from 34% to 41-45%)
  - Norway (from 24% to 29-34%)
  - LNG from Algeria (9 - 11%)
  - LNG from other producers (7% in high consumption scenario)

➔ Higher transport distance

➔ Production process of LNG

➔ Diversification of supply

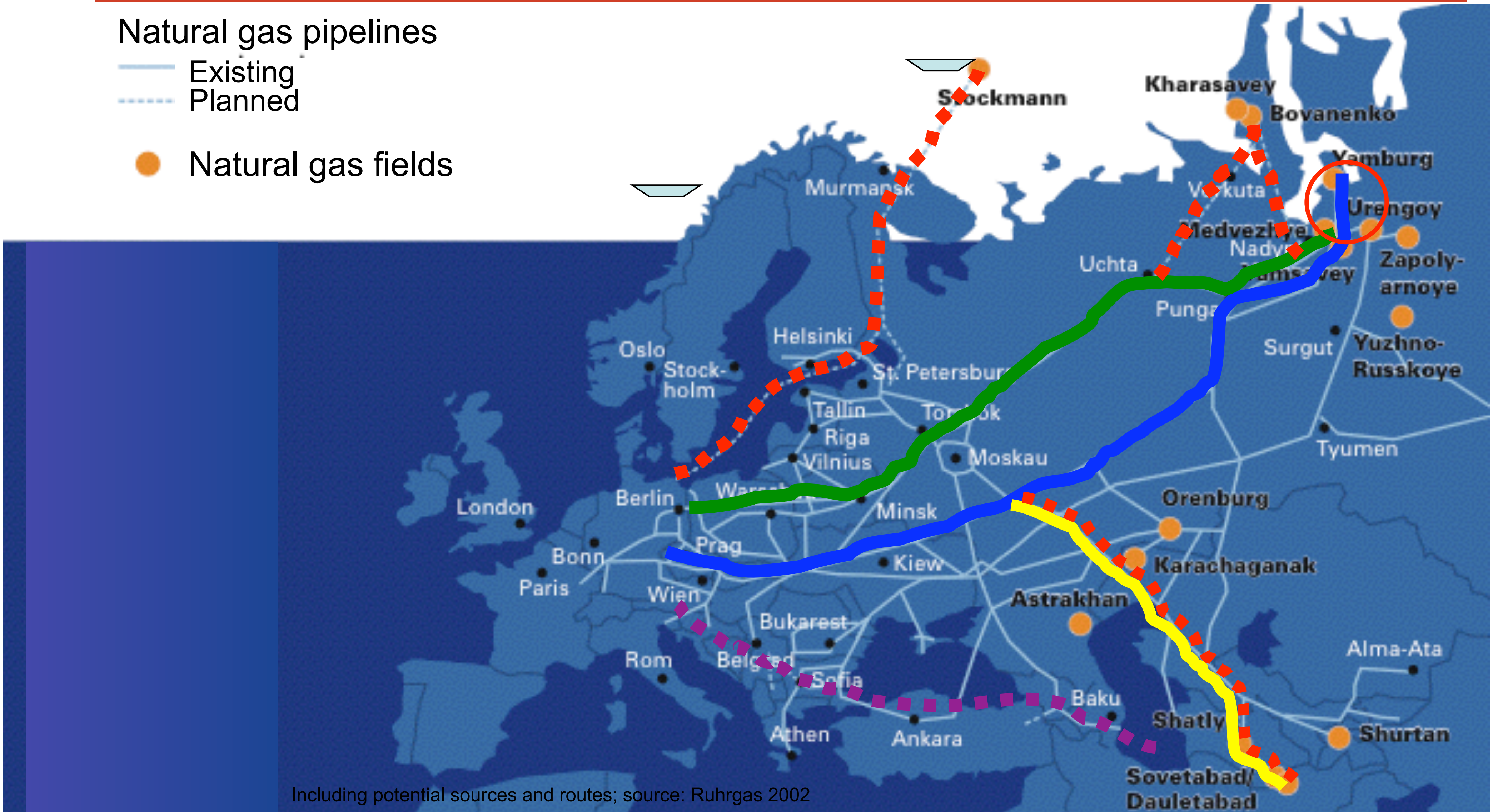
Focus Russia

- Natural gas supply until 2030
- Technical development of Transport
- GHG factors of transport system
- Production and processing

Natural gas fields and transport routes
from Russia/CIS to Germany/Western Europe

Natural gas pipelines
- Existing
- Planned

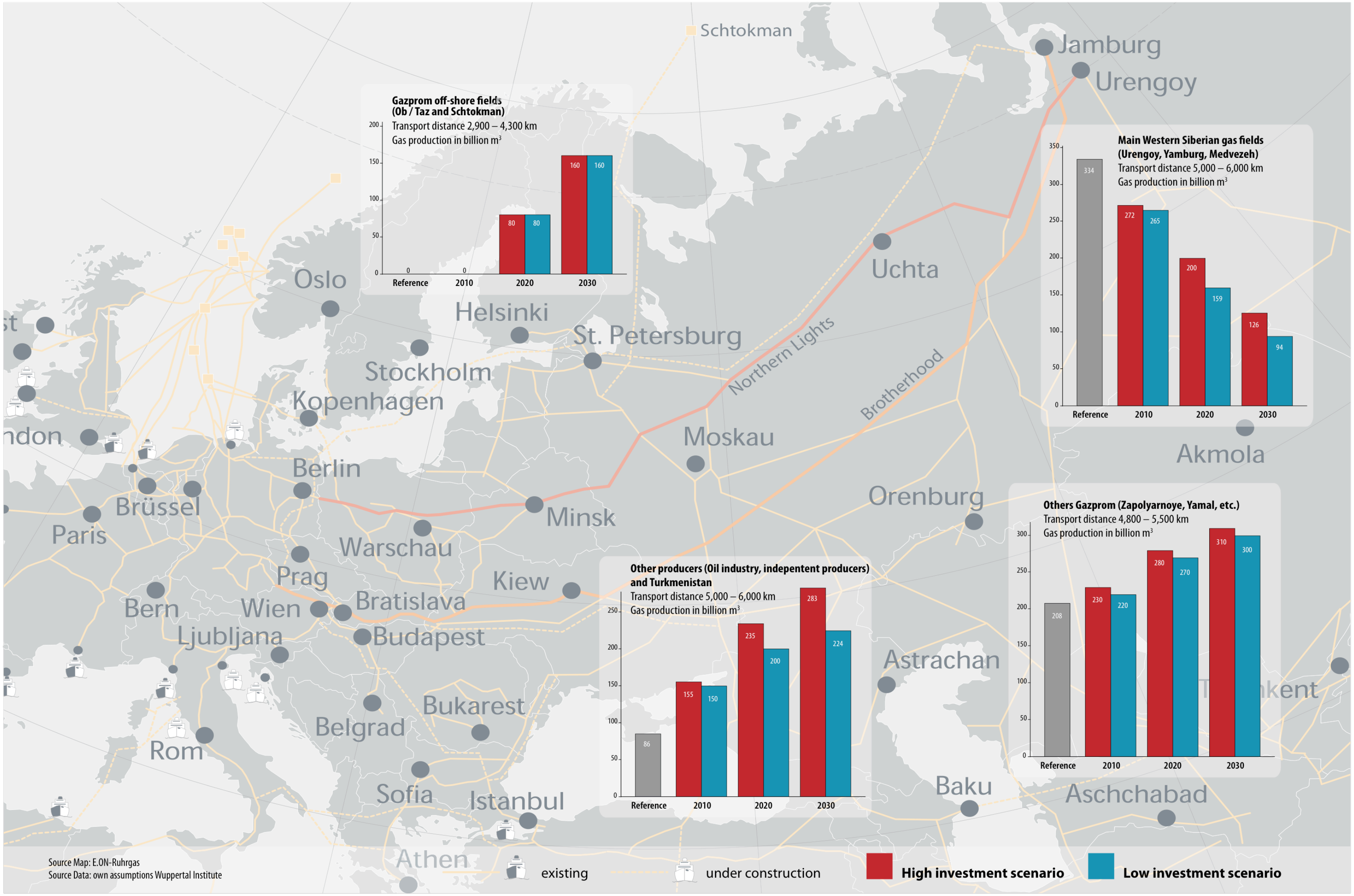
Natural gas fields



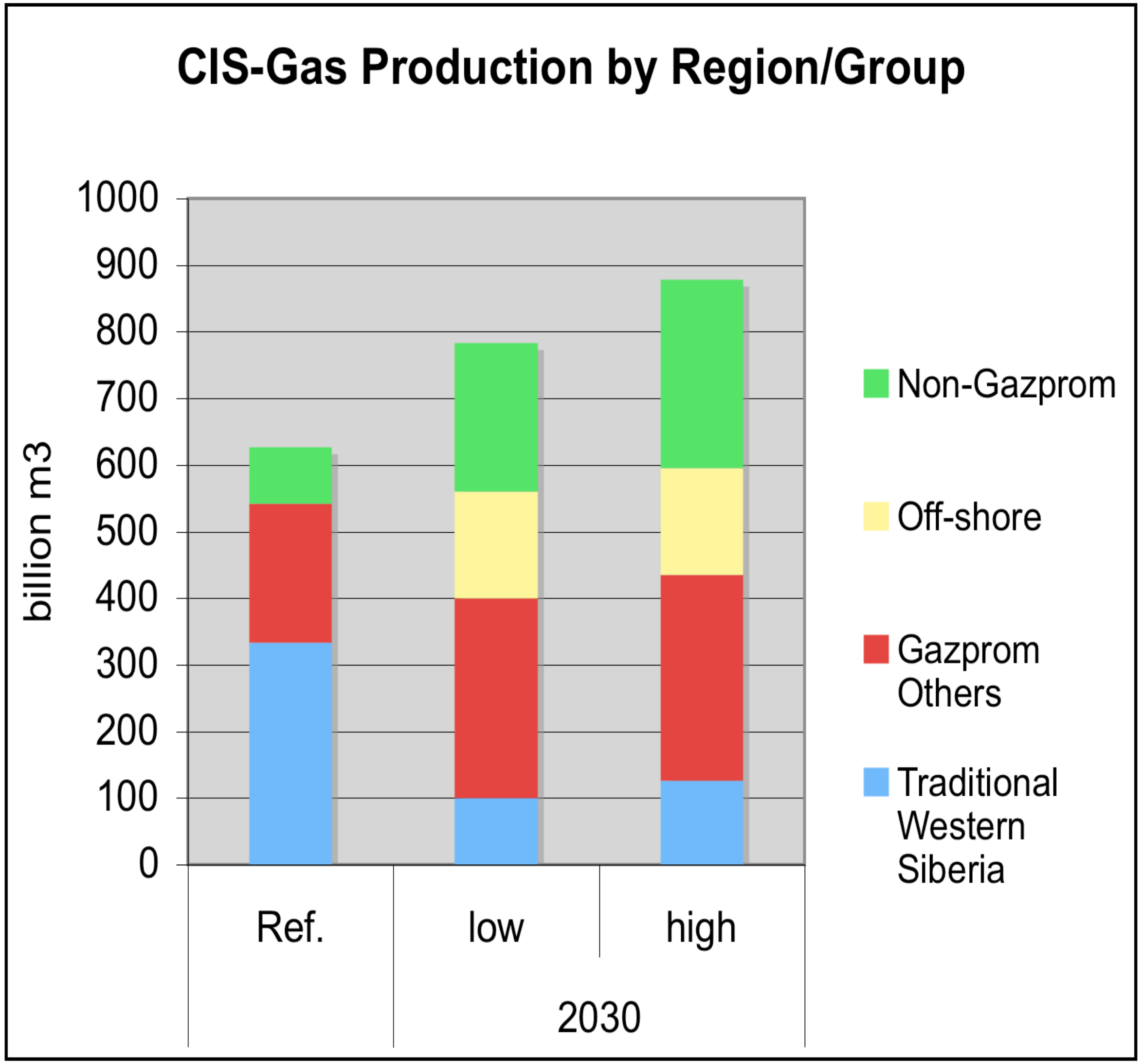
Including potential sources and routes; source: Ruhrgas 2002

Natural Gas supply from Russia (regions)

Reference - 2010 - 2020 - 2030; High/Low consumption scenario



Supply from Russia: The Russian natural gas balance by 2030



- Decline in the three big traditional fields
- Compensation by
  - new (smaller and more northern fields)
  - Off-shore fields (Stockman, Ice Sea and Ob Estuary)
- Additional supplies
  - From Non-Gazprom sources (oil&gas industry, Turkmenistan)
- Most new sources have more difficult conditions

Transport Infrastructure/Pipelines
assumptions of technical development

Current situation

- Main export to D/EU via Central and Northern corridor
- GHG emissions quantified in measurement campaign in 2003:
  - Turbine efficiency: 26.4%;
  - Methane emissions: 0.018%/100km
  - CO_2 for operation power: 0.33%/100km;

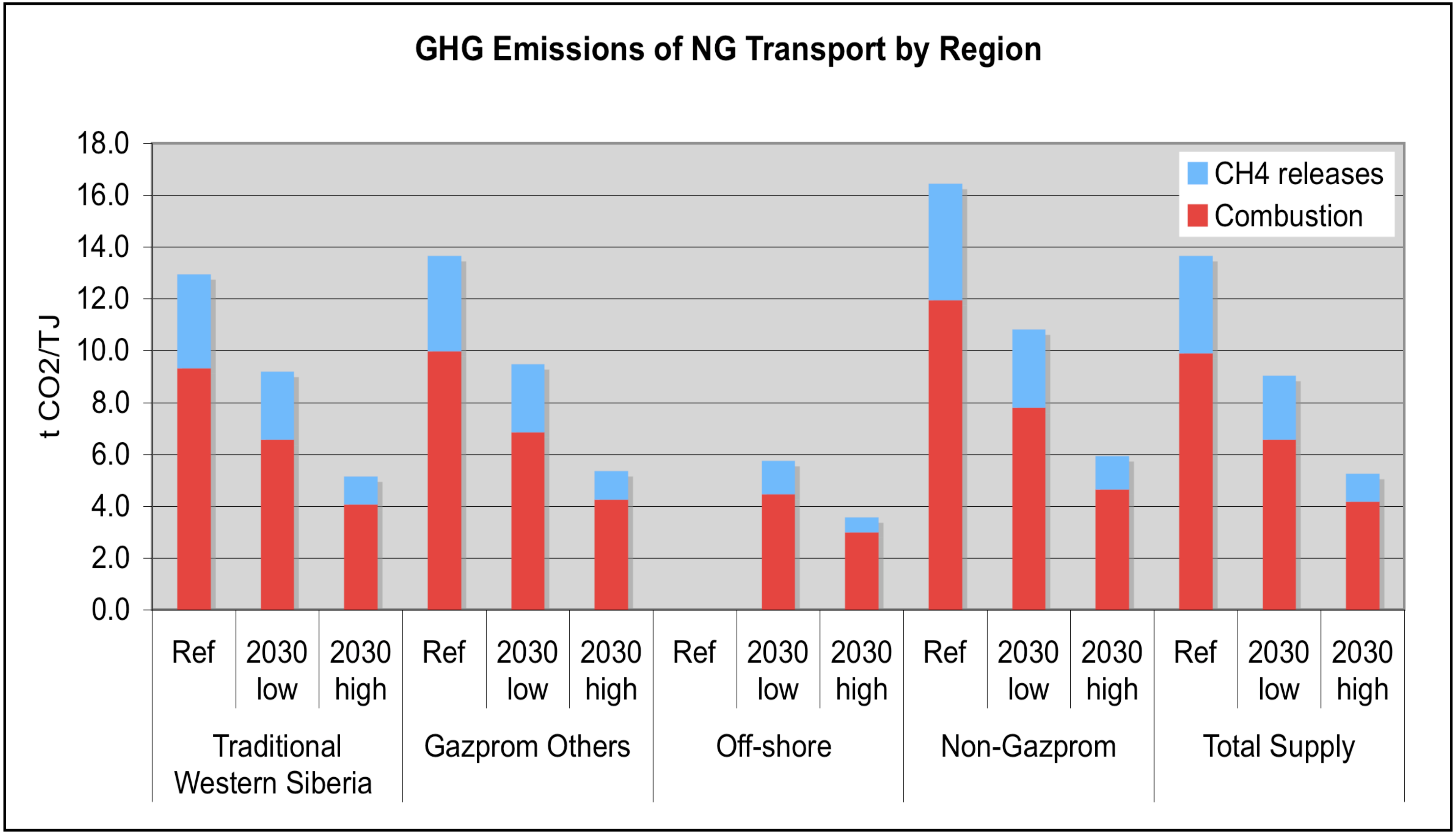
Scenario high production and high investments:

- Improvement of emission by 60%
- Turbine efficiency: 37.5% (BAT);
- Methane emissions: 0.001 - 0.005%/100km
- CO_2 for operation power: 0.12% - 0.15%/100km

Scenario low production and low investments:

- Improvement of emission by 10%
- Turbine efficiency: 31.5%;
- Methane emissions: 0.001 - 0.013%/100km
- CO_2 for operation power: 0.14% - 0.24%/100km

GHG Emissions from Transport (Pipelines and Compressor stations) by Region in CO2-eq/TJ



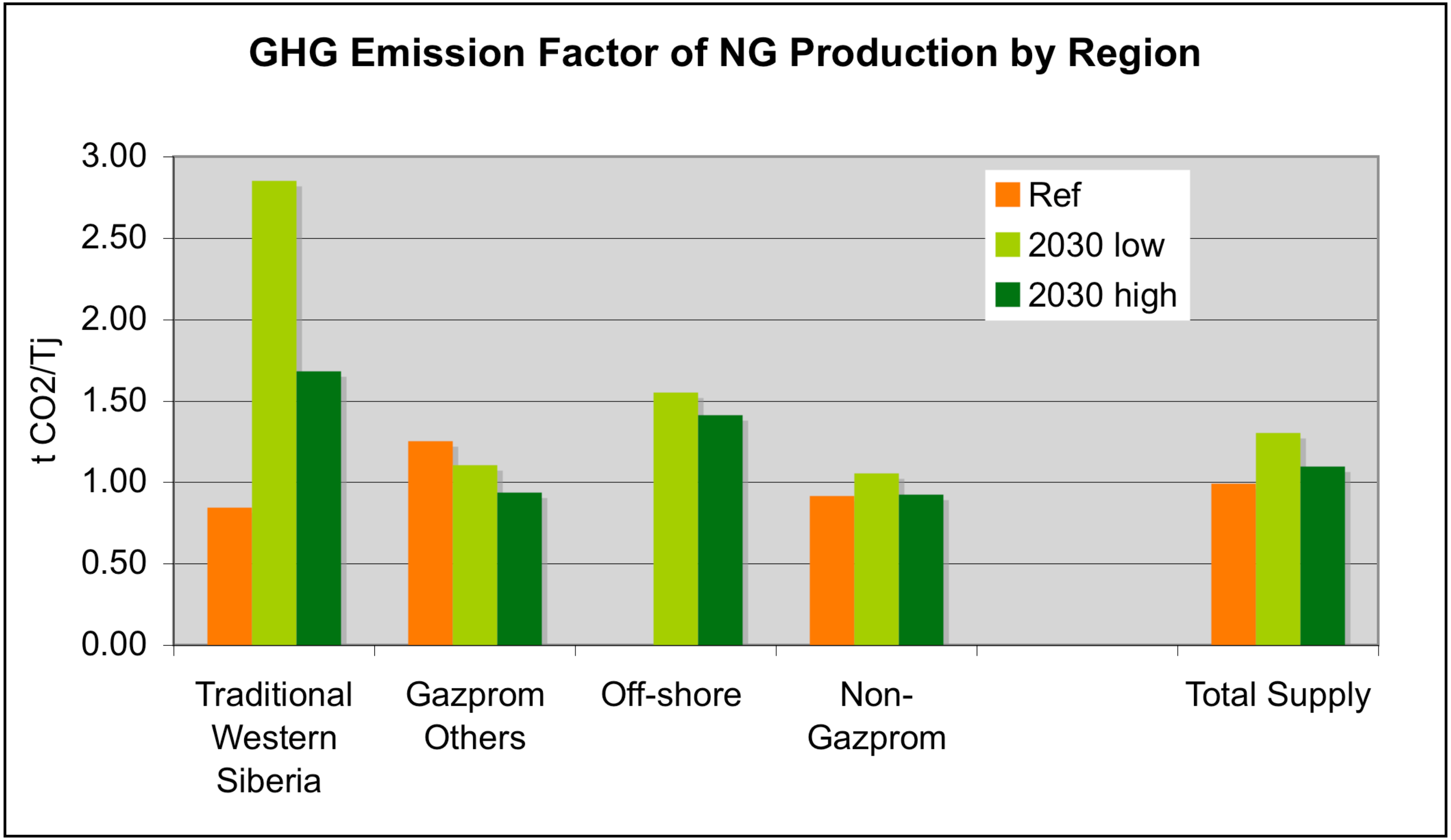
Production and Processing

Technology Assumptions (CH_4 releases only)

- Current situation in Yamburg
  - – Huge field, high production per well
  - – Low processing needs, no compression needed
  - – Very low emission factor
  - – TREND: Emission factor will increase with declining production
- Other (smaller) Russian fields
  - – Western Siberia: Emission factor twice as high as in Yamburg
  - – Other fields: three times
- New fields
  - – 25% improved emission factors vs. existing
  - – Off-shore: +50% vs. Existing fields

CH_4-Emission Factor of Natural Gas Production

(calculated free on German border) in CO2eq/TJ



GHG emission factor for Russia

Production and Transport

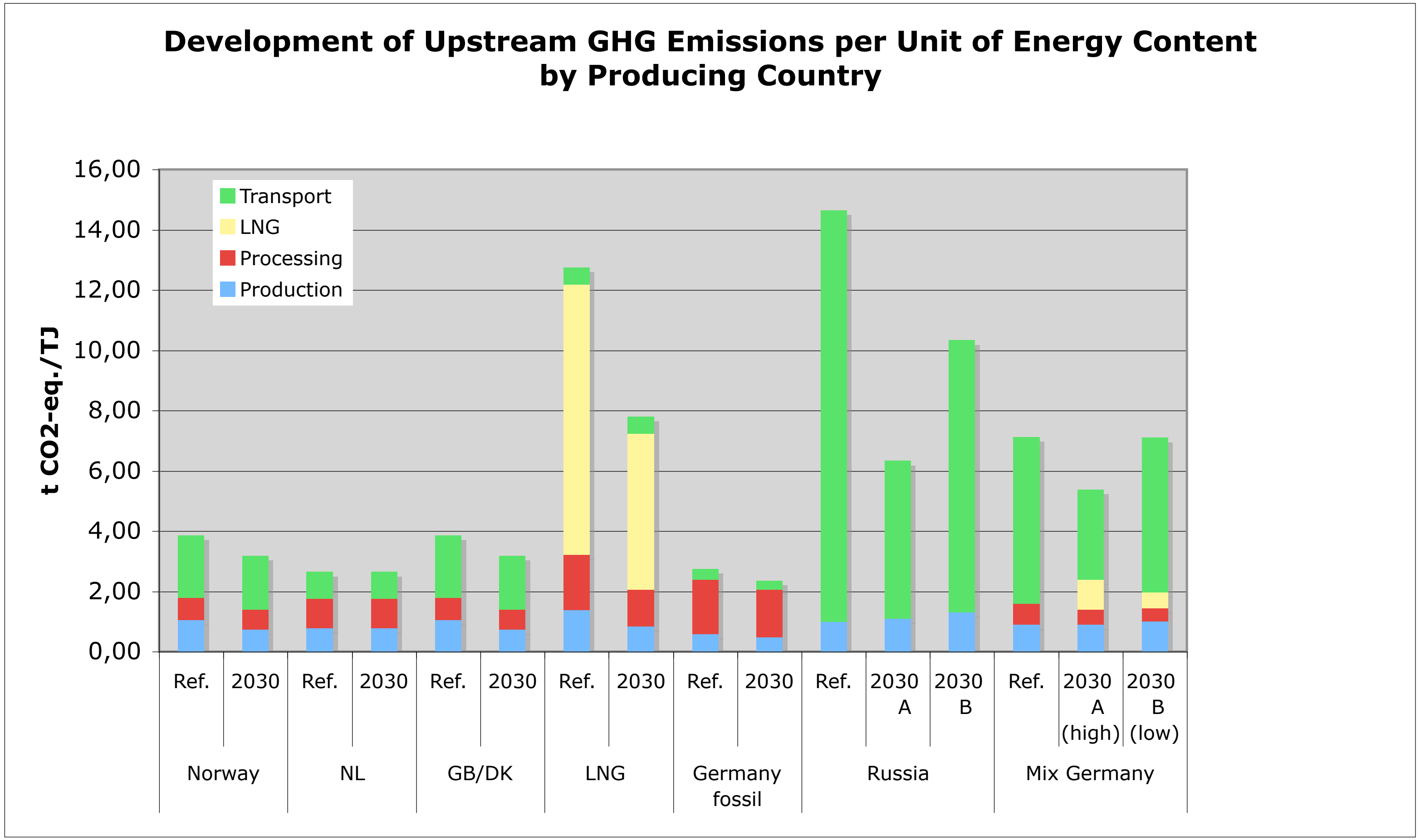
GHG emission factor Russia; 2 Scenarios: "High supply/investment" and "Low supply/investment"			
	Reference (2003)	2030 High	2030 Low
	t CO2eq./TJ		
GHG emissions from production[a]	0,99	1,1	1,3
Methane losses (CH_4) transport	3,76	1,06	2,46
energy related losses Transport	9,9	4,18	6,58
Total GHG emission factor	**14,65**	**6,34**	**10,34**

GHG Emissions from Other Supplies to the German Market

and

Overall Results

Results

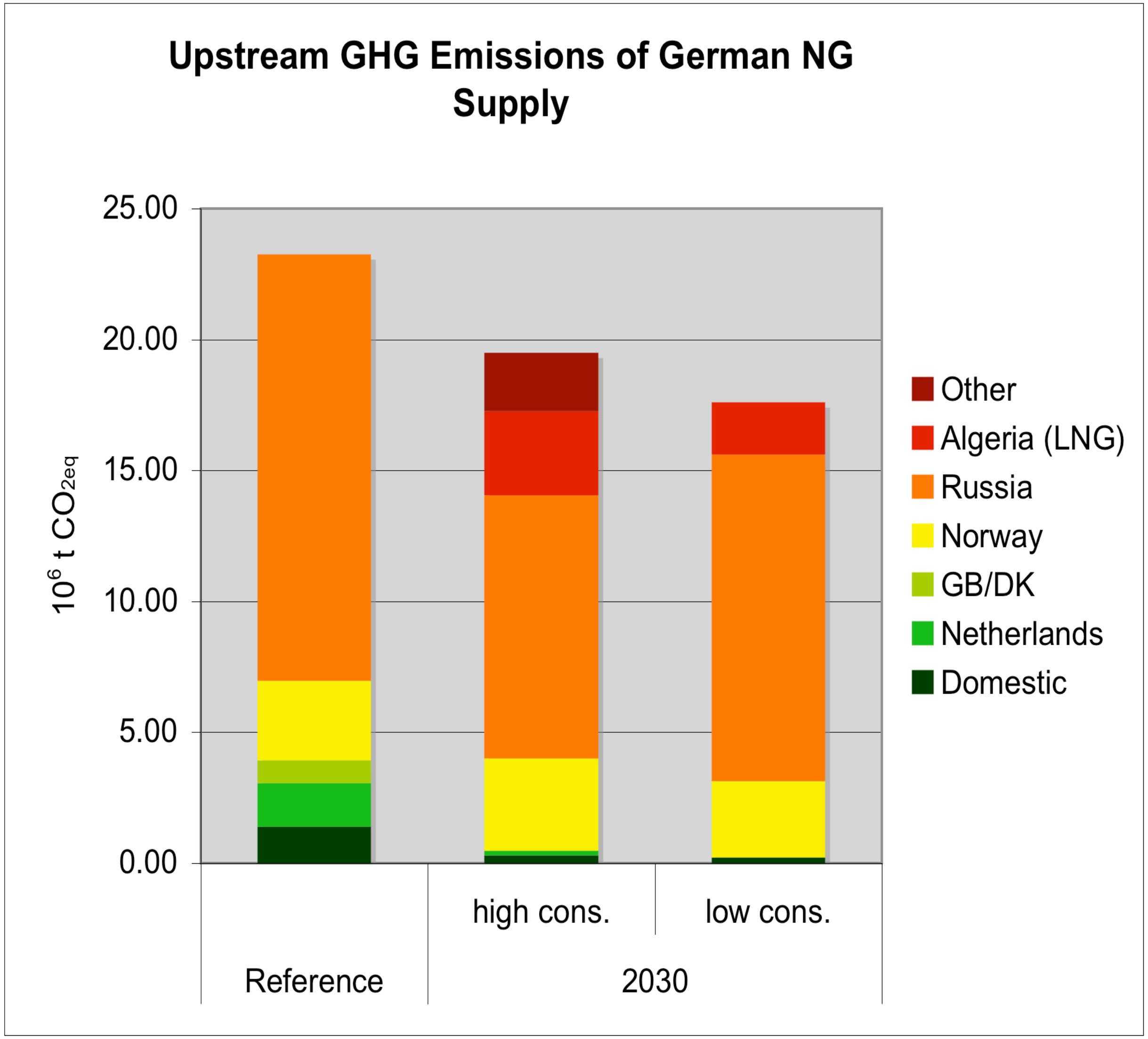


- Depending on scenario for Russia/CIS Ø emission for Mix Germany will be the same or decrease
- Improved technology/investment lead to lower emission factors
- Uncertain data base on LNG, thus conservative assumptions

Source: Own assumptions and Gemis Öko-Institut 2006

Results

Combined emission factors + scenario



- Individual emission factors of exporting countries:
  - will decrease due to improved technology and practise
- Average emission factor for Germany
  - will remain constant or decline (depending on scenario)
  - due to structural effects (higher shares of Russian and LNG)
- Overall emissions will decline due to
  - technical improvements (Scenario A:: high cons./inv.)
  - or demand reduction (Scenario B: low cons./inv.)

Study excluded upstream emissions of Biogas

Conclusion

- Gas mix (German + EU) will change significantly over the next decades
  - Decrease of EU gas; increase of Russian, Norwegian gas + LNG
  - To quantify the related effects and political challenges a combination of traditional (static) LCA with scenario analysis (=dynamic LCA) is an appropriate approach
  - The future gas supply from Russia will diversify; the development of its gas infrastructure is crucial for the future upstream GHG emissions
- Future structural changes in the natural gas supply have the potential to significantly change/increase upstream GHG emissions
- This can be mitigated and even overcompensated by re-investing the existing infrastructure with low emitting technology (BAT)

- Investing in a low emitting NG infrastructure
  - bears a significant potential for GHG mitigation and
  - is crucial to maintain the role of natural gas as an important "bridge" to a 100% renewable energy system.

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Thank you for your attention !

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