DIW BERLIN NTNU NTNU ENERGY TRANSITION

International Workshop at the Chair for the Economics of Gas in Paris

Greenhouse gas emissions in the natural gas value chain and options for their inclusion in the EU-ETS and CBAM

Franziska Holz, based on joint work with Adrián Santonja di Fonzo, Charlotte Baron, Ruud Egging-Bratseth, and others

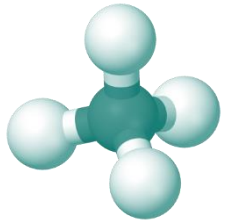
Paris, September 26, 2024

Work in progress – do not quote or cite !

Plan for this presentation

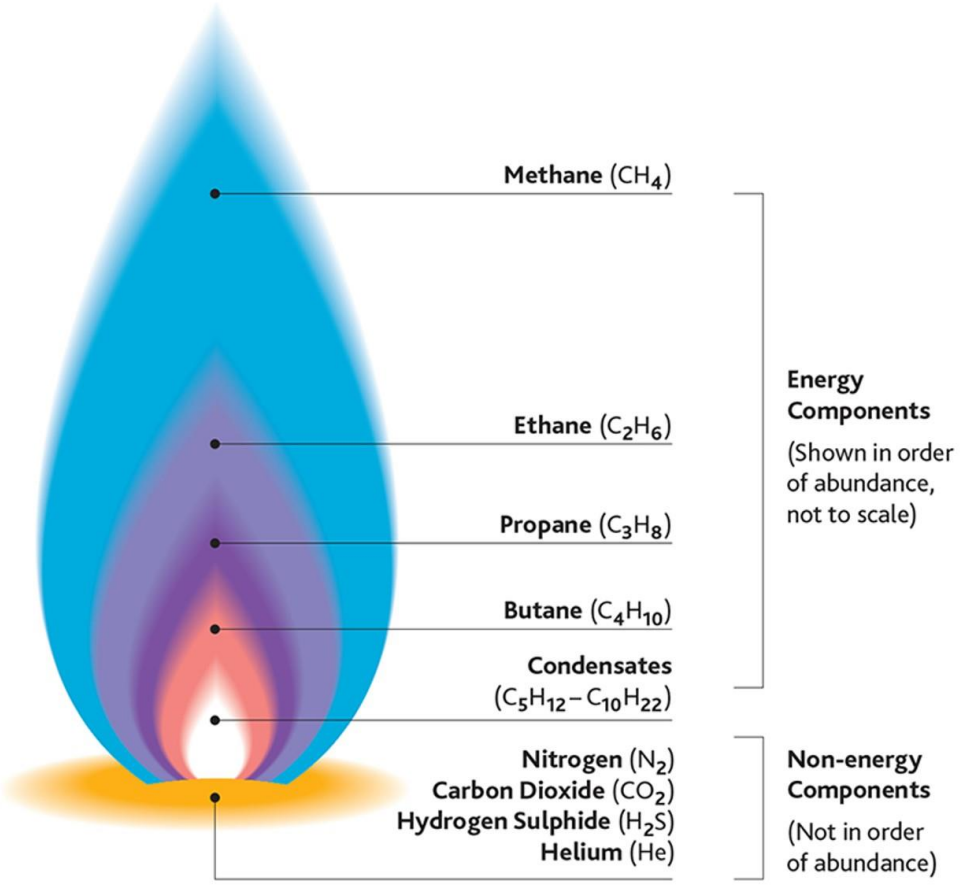
- Background
  - Which GHG emissions? Why are they relevant?
  - GHG emissions in the natural gas value chain
  - GHG emissions from selected exporters to the EU
- Regulation (current and phased in) in the EU and UN
  - Regulation of CO_2 emissions in the natural gas value chain
  - Regulation of CH_4 emissions in the natural gas value chain
- Future regulation?
  - Are there regulatory gaps in the EU-ETS, in CBAM?
- Outlook: GGM model runs for selected CH_4 leak intensity pricing models

What is natural gas?



Natural gas is mostly (95-99%) methane (CH_4)

It often occurs naturally with solid, liquid and/or gaseous impurities (incl. CO_2)



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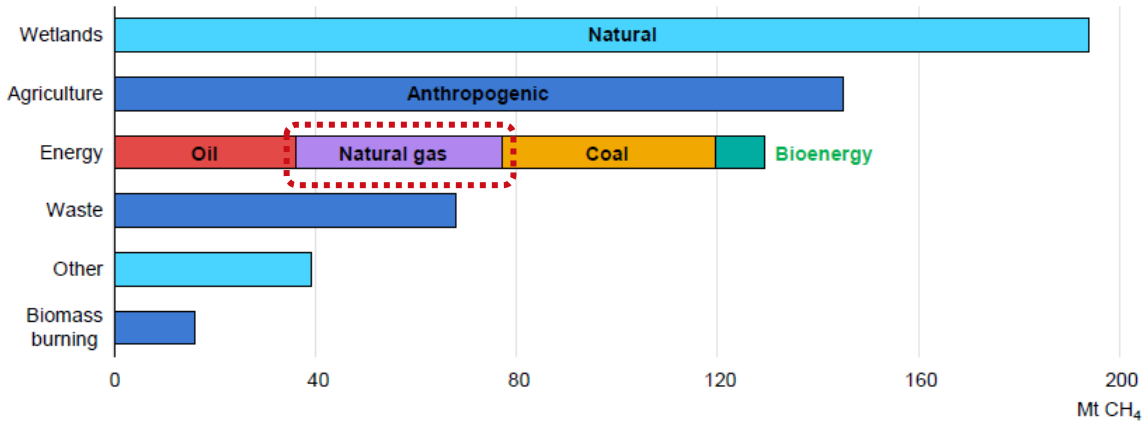
Why are CO_2 and CH_4 relevant?

- CO_2 and CH_4 are the two most important greenhouse gases (~75% and 18%, respectively)
- CH_4 is responsible for about ⅓ of global warming in the last decades
- Natural gas sector alone is responsible for about ⅓ of the energy sector's CH_4 emissions
- CH_4 is a short-lived GHG, so action would quickly result in less temperature increase

Figure 1.1 Sources of methane emissions



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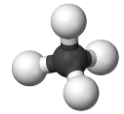
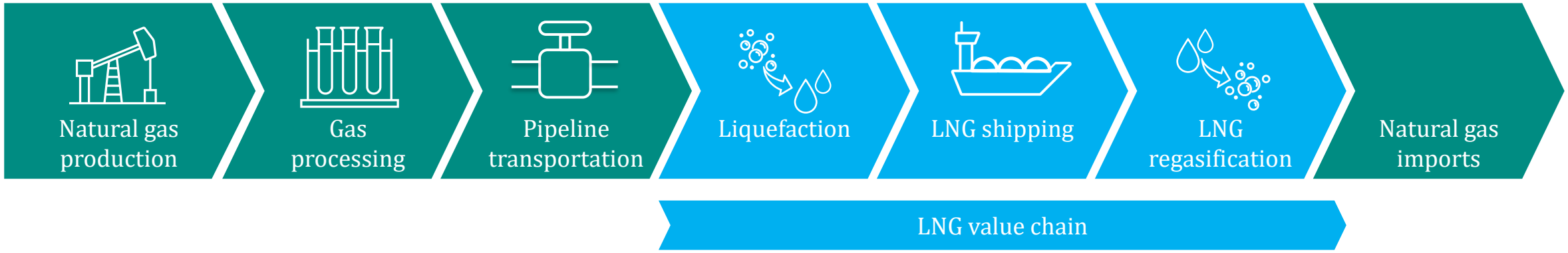
Note: Energy sector emissions are for 2020 and based on the latest estimates from the Methane Tracker and the World Energy Outlook. Non-energy sector emissions are taken from the Global Methane Budget for the year 2017, with natural sources relying on top-down median estimates, and other anthropogenic sources relying on bottom-up median estimates.

The natural gas value chain

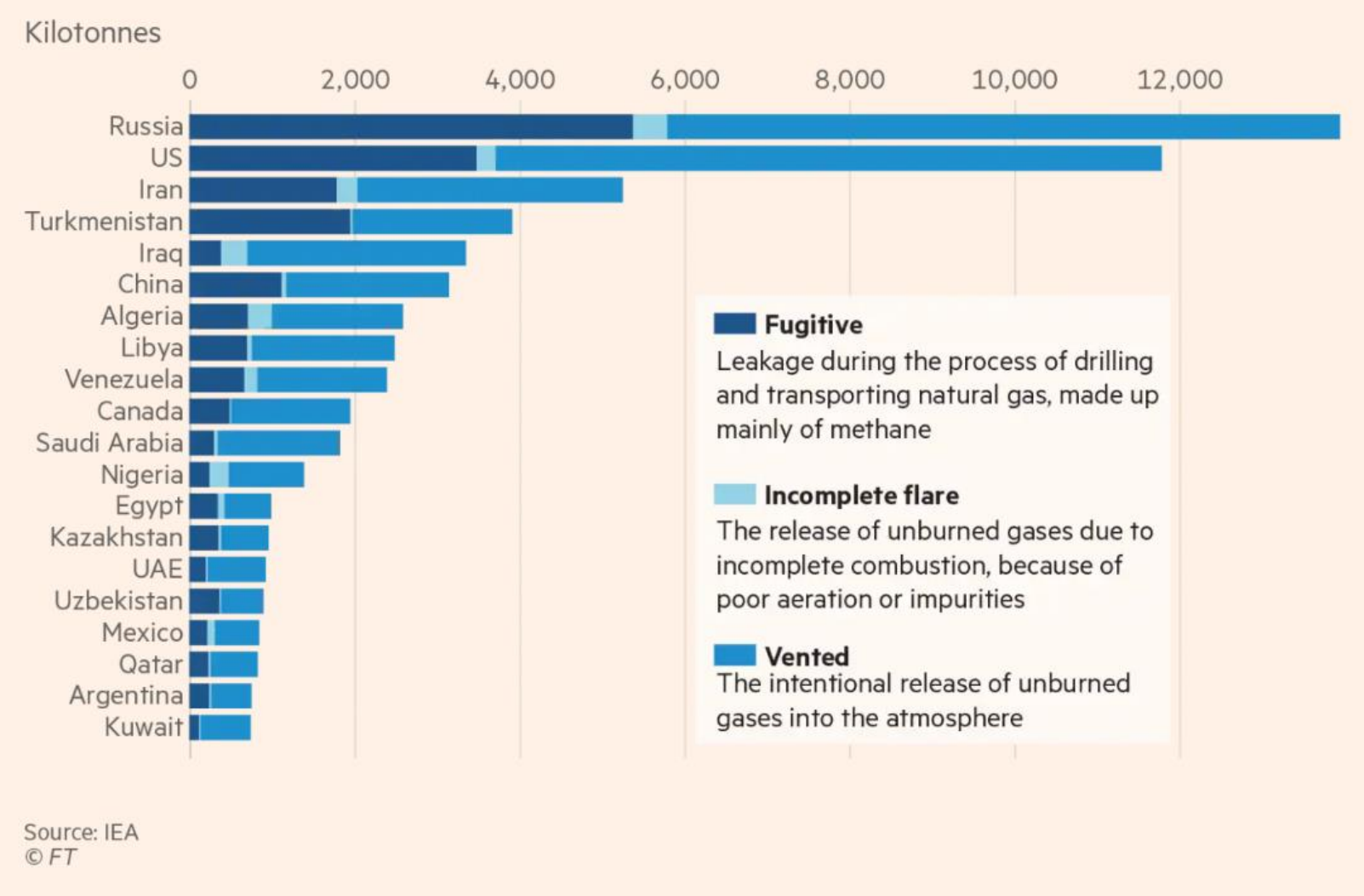
Emissions can occur at every step of the value chain:

- **CO_2** emissions when a fuel is combusted  (and if in the gas field)

  → The more energy-intensive a process, the more CO_2 emissions
- **CH_4** emissions when natural gas is leaking or venting 

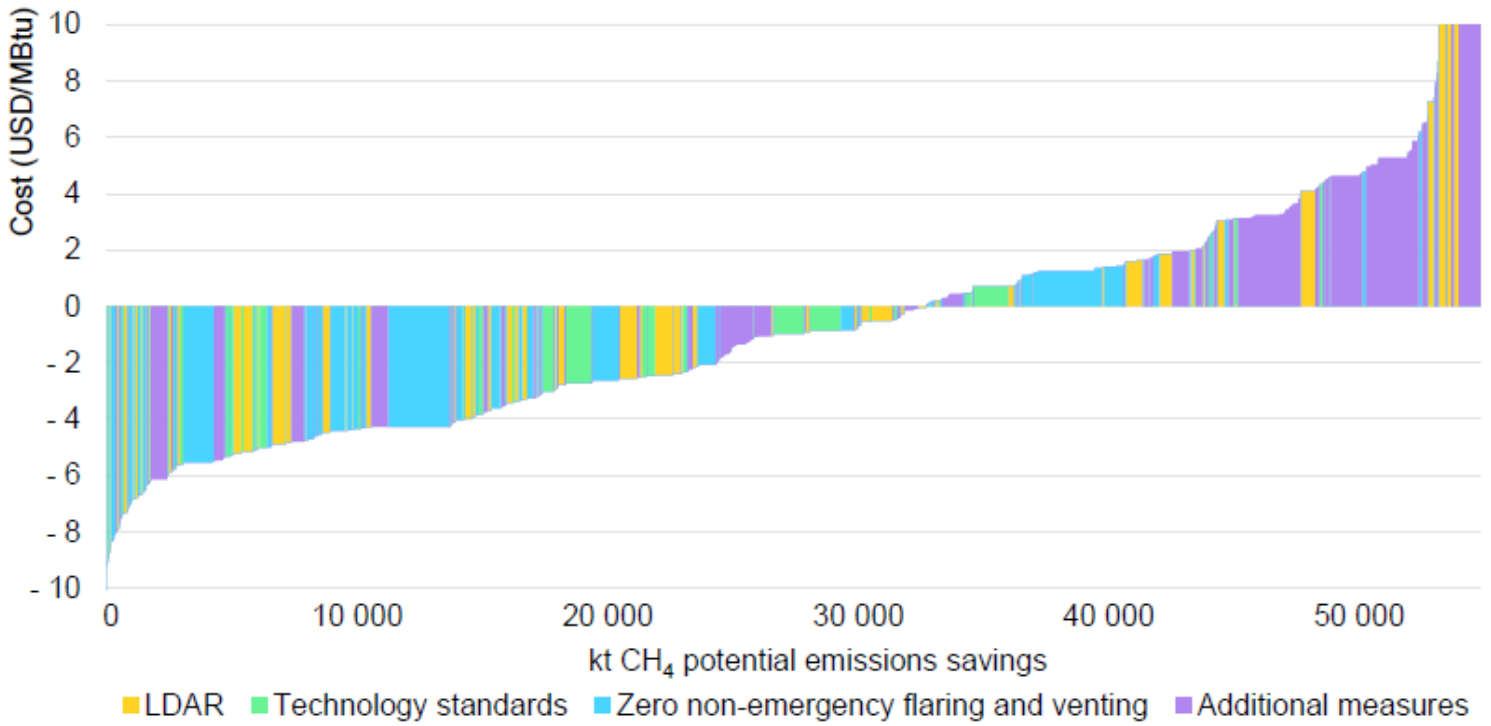


Methane emissions by value chain stage: (intentional) venting is the largest source



Many CH_4 emissions can be avoided at negative / no / low costs

Figure 1.4 Worldwide methane abatement cost curve by policy option, 2020



(Leak Detection and Repair)

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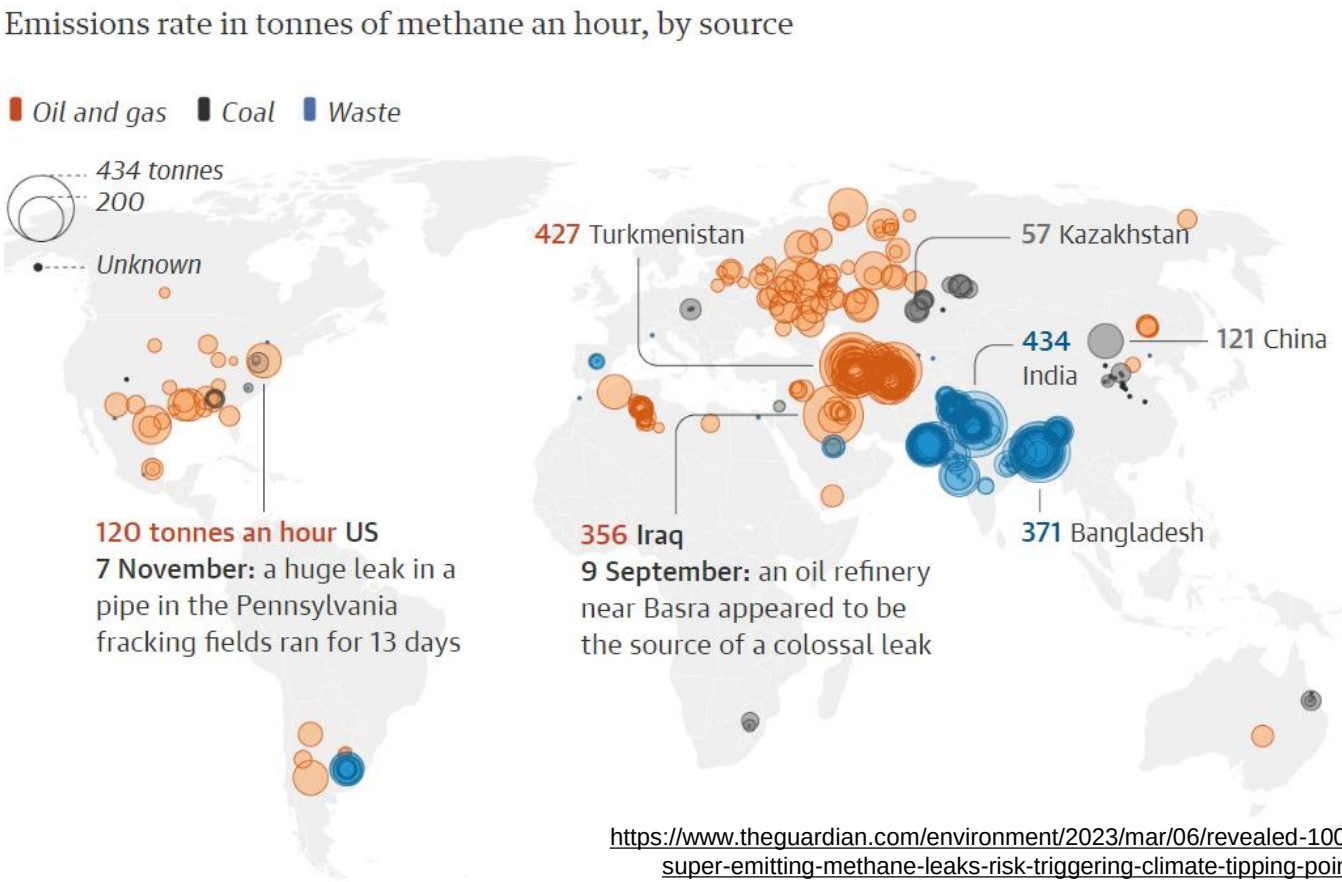
Note: Policies in this marginal abatement cost curve are tied to specific abatement measures in the IEA oil and gas methane emissions model. Gas prices are regional average levels seen from 2017 to 2021.

Geographical distribution of methane leakage intensity

Countries with poor environmental regulation have highest methane leakage rates, including rich countries with modern installations

Table 1: Assumed Methane Emission Intensity Ranges for Gas Production by Supply Country (EDF); descending sorted by quantity of gas volumes supplied to the EU (green = below 1% and red = above 2%)

	Central Baseline Estimates	Lower Bound Baseline Estimates	Upper Bound Baseline Estimates	75% Abatement Below Central Baseline Estimates
Russia	1.3%	0.0%	2.5%	0.3%
Norway	0.01%	0.01%	0.01%	0.0%
Algeria	1.6%	0.0%	3.2%	0.4%
Nigeria	1.2%	0.0%	2.5%	0.3%
Netherlands	0.01%	0.01%	0.02%	0.0%
US	2.2%	1.8%	2.5%	0.5%
Trin. & Tob.	0.3%	0.0%	0.7%	0.1%
Libya	5.1%	0.1%	10.2%	1.3%
UK	0.2%	0.1%	0.3%	0.0%
Romania	0.9%	0.0%	1.8%	0.2%
Eq. Guinea.	1.5%	0.0%	2.9%	0.4%
Egypt	1.1%	0.0%	2.2%	0.3%
Qatar	0.3%	0.0%	0.6%	0.1%
Yemen	5.3%	0.1%	10.5%	1.3%
Angola	6.7%	0.1%	13.4%	1.7%
U. A. E[8]	0.7%	0.0%	1.5%	0.2%
Oman	1.2%	0.0%	2.3%	0.3%



https://www.theguardian.com/environment/2023/mar/06/revealed-1000-super-emitting-methane-leaks-risk-triggering-climate-tipping-points

Kayrros Methane Watch. Note: minimum leak rate is one tonne an hour. Leak rates for some events cannot be calculated and have been assigned a location only. Natural sources not shown

The natural gas value chain

Emissions can occur at every step of the value chain:

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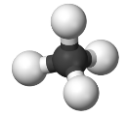
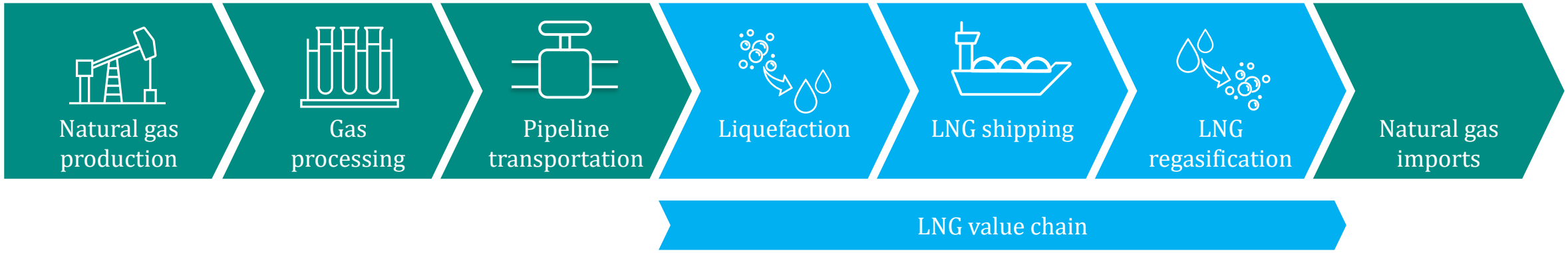
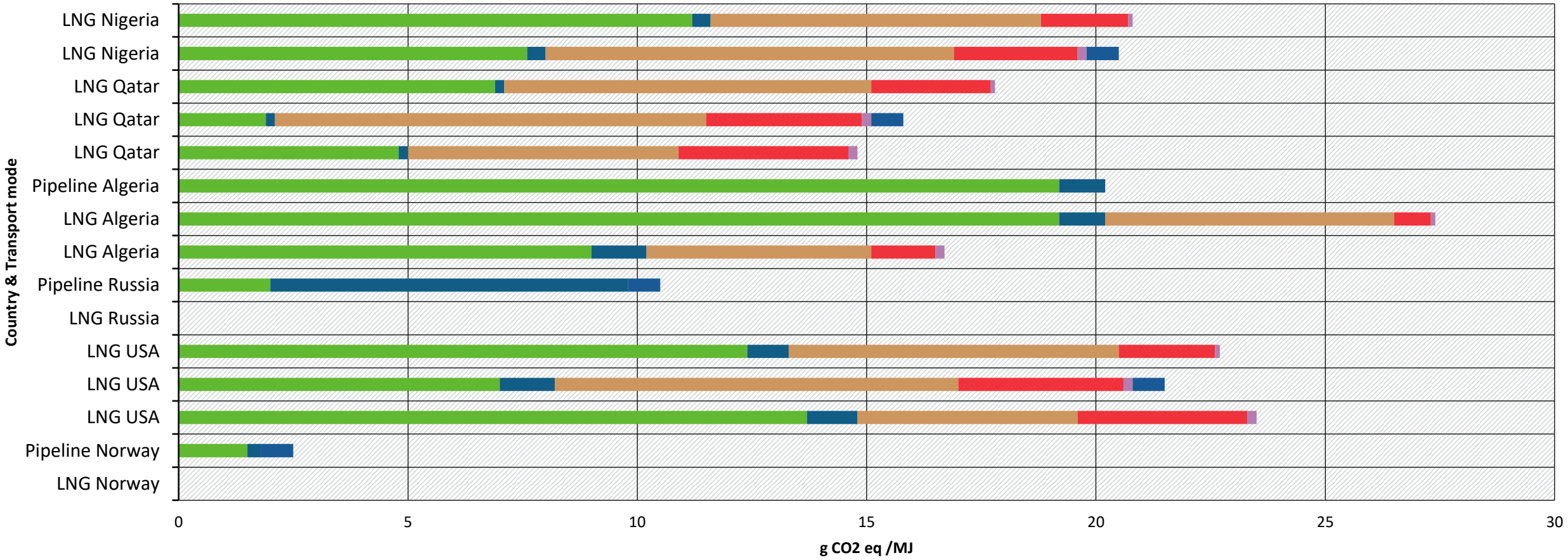
- **CH_4** emissions when natural gas is leaking or venting 



Greenhouse gas emissions (CO_2 & CH_4) of imports to Germany



Regulation of CH_4: recent but ambitious

UN Environmental Programme:

- International Methane Emissions Observatory (IMEO) and more

Oil & Gas Methane Partnership (OGMP):

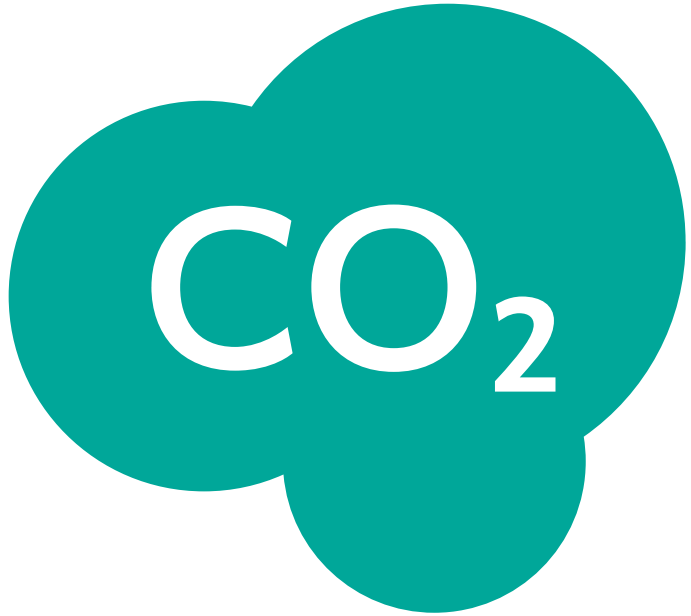
- Voluntary commitment by member companies (almost 100; ~40% of global oil & gas production)
- Sets standards for MRV with phase-in schedule of tightening
- Highest MRV standard (source-level reporting) from 2027 on

EU Methane Regulation

- Regulation 2024/1787, phased in 2025/30
- Covers energy sector, including oil and gas sector (cf. FSR, OIES publications)
- Draws heavily on OGMP2.0 framework for MRV, LDAR, and phase-in timeline of standards
- Main goal: reduce CH_4 emissions (e.g., with LDAR & penalty payments)
- Also addresses imports (from 2026/30)
- Not included: pricing of CH_4 leaks

Regulation of CO_2: established, with pricing, but geographically focused

- EU-ETS (ETS Directive 2003/87): includes the energy sector
- Regulation of CO_2 emissions in the natural gas value chain:
  - Large production equipment with > 20 MW thermal input capacity
  - (Large) Compressors in the pipeline transport grid
  - Liquefaction
  - Regasification (if large and/or energy-intensive)
  - From 2024 on: shipping*
  - From 2026: also on CH_4 and N_2O
- Two elements:
  - MRV (i.e., emissions reporting)
  - CO_2 pricing



* for half of the distance travelled if from outside EU, for full distance for travels within the EU

Are all elements of the value chain covered by regulation?

Value chain segment	Emitted GHG	Regulation of MRV	Emissions cost
Gas production (extraction)	CO_2	MRV Implementation Regul. 2018/2066	ETS Directive*
	CH_4	EU Methane Regulation	-
Gas processing (gas treatment)	CO_2	MRV IR 2018/2066	EU ETS Directive*
	CH_4	EU Methane Regulation	-
Pipeline transport	CO_2	MRV IR 2018/2066	EU ETS Directive*
	CH_4	EU Methane Regulation	-
Liquefaction (LNG)	CO_2	MRV IR 2018/2066	EU ETS Directive*
	CH_4	EU Methane Regulation	-
LNG shipping	CO_2	Maritime MRV Regulation	EU ETS Directive for 100% or 50% of emissions
	CH_4	Maritime MRV Regulation	EU ETS Directive for 100% or 50% of emissions
LNG regasification	CO_2	MRV IR 2018/2066	EU ETS Directive*
	CH_4	EU Methane Regulation	-

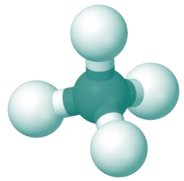
* if >20 MW thermal input capacity

- MRV of both CO_2 and CH_4 will soon be mandatory and (hopefully) enforced
- But: no concrete plans for pricing CH4 (yet)

Four different design options

- Regarding quantification / MRV:
  1. Include CH_4 emissions as a default factor referenced to the mass of natural gas extracted/transported (~ approach on CH_4 emissions from shipping in EU-ETS)
  2. Include emissions as reported under the MRV framework planned in the Methane Regulation
- Regarding scope:
  3. including methane emissions from all value chain stages in Europe (i.e., extraction and processing, transportation, liquefaction and regasification)
  4. Focus only on extraction and processing

Model results of pricing methane intensity of natural gas imports using the Global Gas Model (GGM)



Egging-Bratseth et al. (2022): Global gas market implications of methane emission reduction policies. IEEE EEM Conference Proceedings.

Egging-Bratseth et al. (2024): Global gas market implications of a buyer-side methane emission reduction policy. Mimeo.

Static model runs with «methane price» on imports and domestic production

- Egging-Bratseth et al. (2022)

Egging-Bratseth et al. (2022)

- Still large uncertainty on exact CH_4 emissions

→Two scenarios for methane intensities based on IEA Global Methane Tracker (GMT):

  - 1. Methane emissions reported for upstream gas (production) by the GMT;
  - 4. Methane emissions reported for upstream oil and gas (prod.) by the GMT;

- Two CH_4 price scenarios for the year 2025 :
  - 2800 €/tCH_4 (~ carbon price of 100 €/tCO_2eq considering CH4 GWP of 28, i.e. over a 100 year time)
  - 8400 €/tCH_4 (~ carbon price of 100 €/tCO_2eq considering CH4 GWP of 84, i.e. over a 20 year time period)
  - CH_4 price implemented by a EU or the ~100 GMP countries

The higher the methane intensity of gas production of a country, the more it is affected by a CH_4 price (but the magnitude of the effect is rather insensitive)

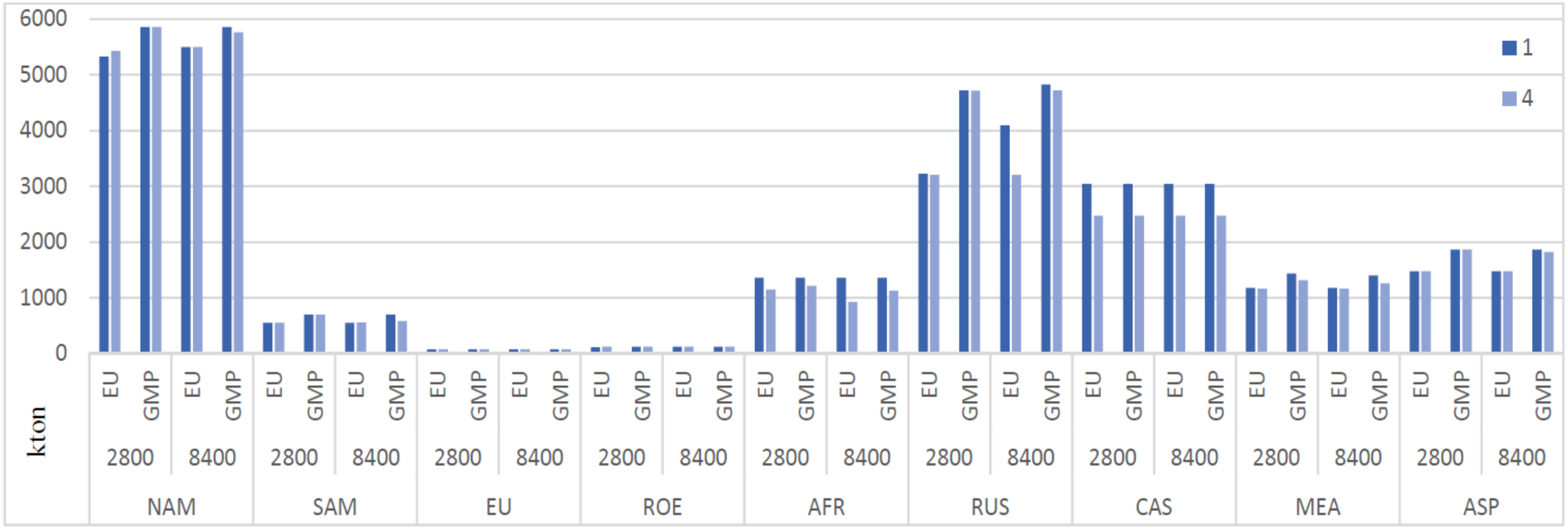


Figure 3. Regional abatement in kton for methane prices 2800 & 8400 €/ton, methane intensity variants: 1: IEA GMT Upstream Gas (the lighter colums) and intensity variant 4: IEA GMT Upstream Oil & Gas (the darker columns), and Clean Buyers Coalitions EU+ vs. Global Methane Pledge (GMP).

Egging-Bratseth et al. (2022)

USA looses, Quatar wins in EU market share, Norway stays stable

Egging-Bratseth et al. (2022)

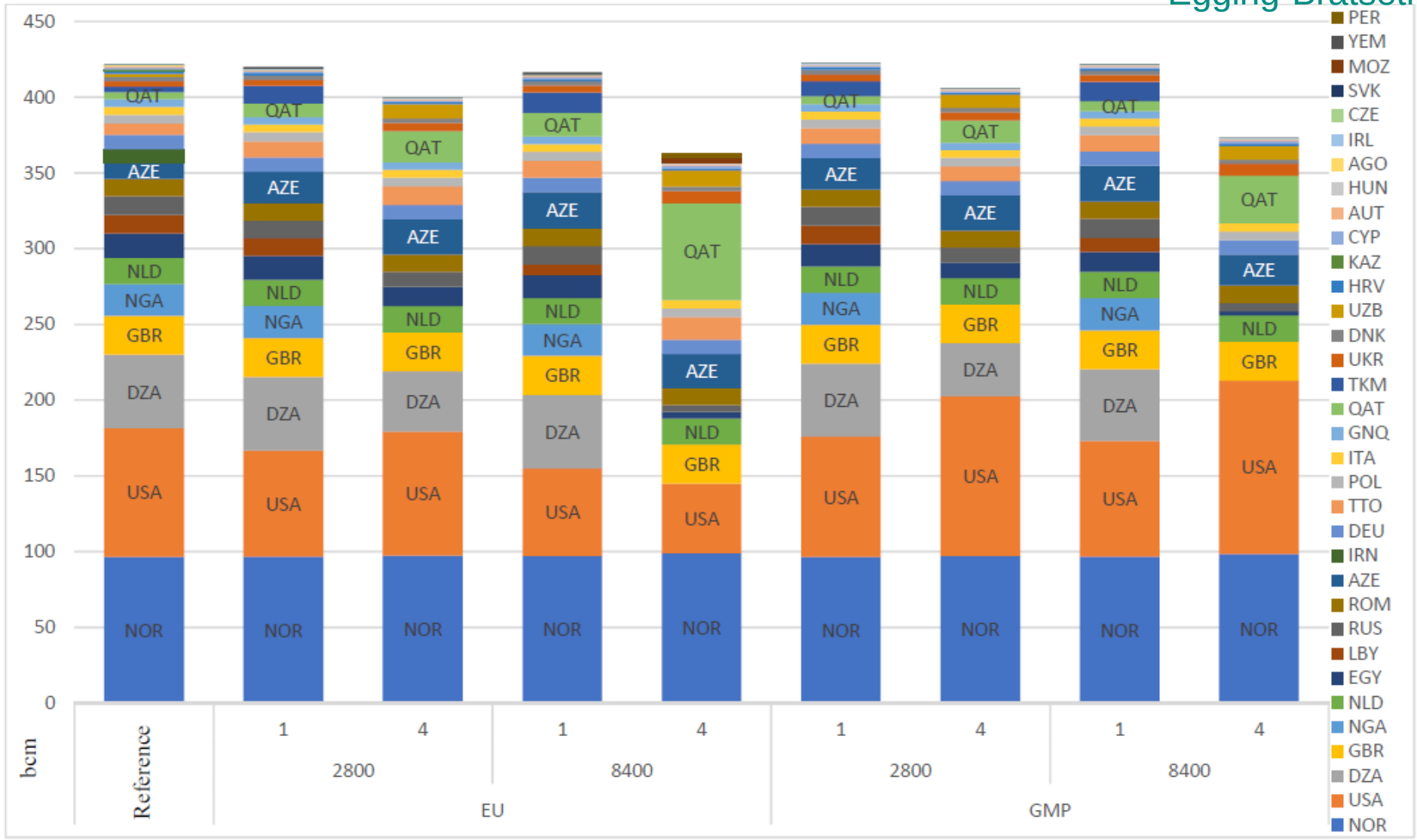
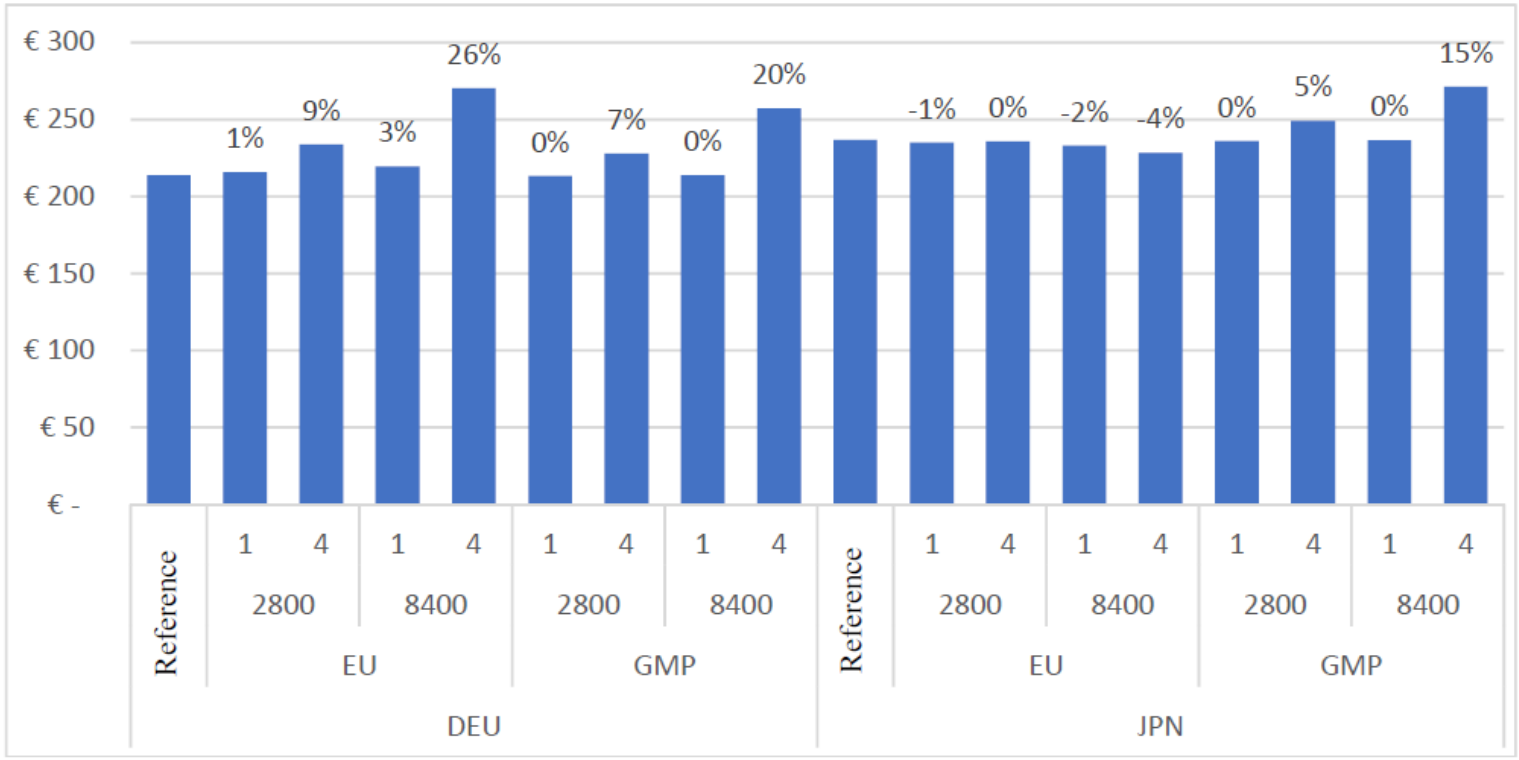


Figure 4. Supply breakdown EU 2025 by supplying country, for the reference projection, and Clean Buyers Coalitions EU+ vs. Global Methane Pledge (GMP), methane prices 2800 & 8400 €/ton, and methane intensity variants: 1: IEA GMT Upstream Gas and 4: IEA GMT Upstream Oil & Gas.

Import prices rise slightly with CH4 prices



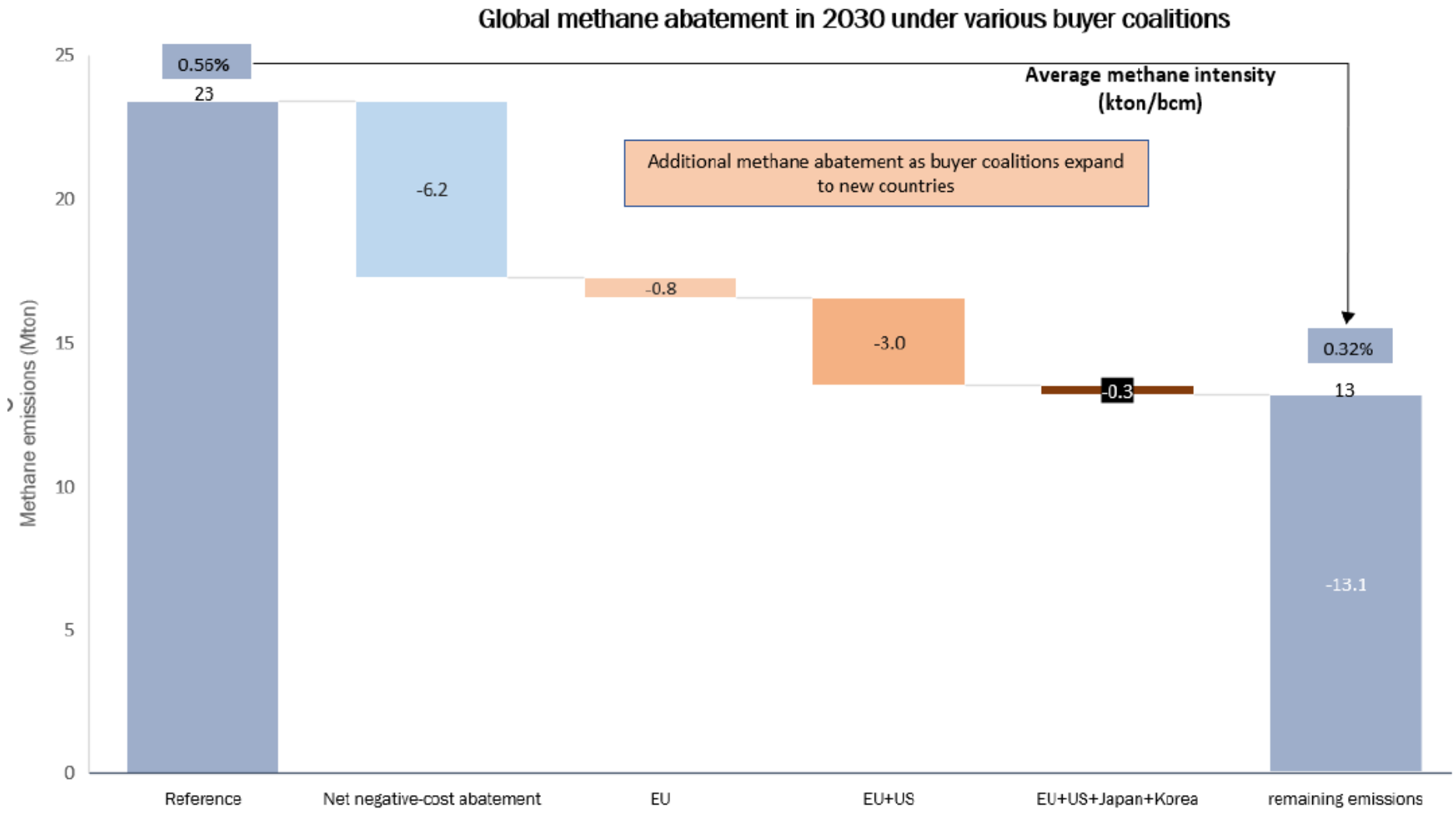
Egging-Bratseth et al. (2022)

Figure 5. Prices ($/kcm) in Germany and Japan, for Clean Buyers Coalitions EU+ vs. Global Methane Pledge (GMP), methane prices 2800 & 8400 €/ton, and methane intensity variants: 1: IEA GMT Upstream Gas and 4: IEA GMT Upstream Oil & Gas (the darker columns).

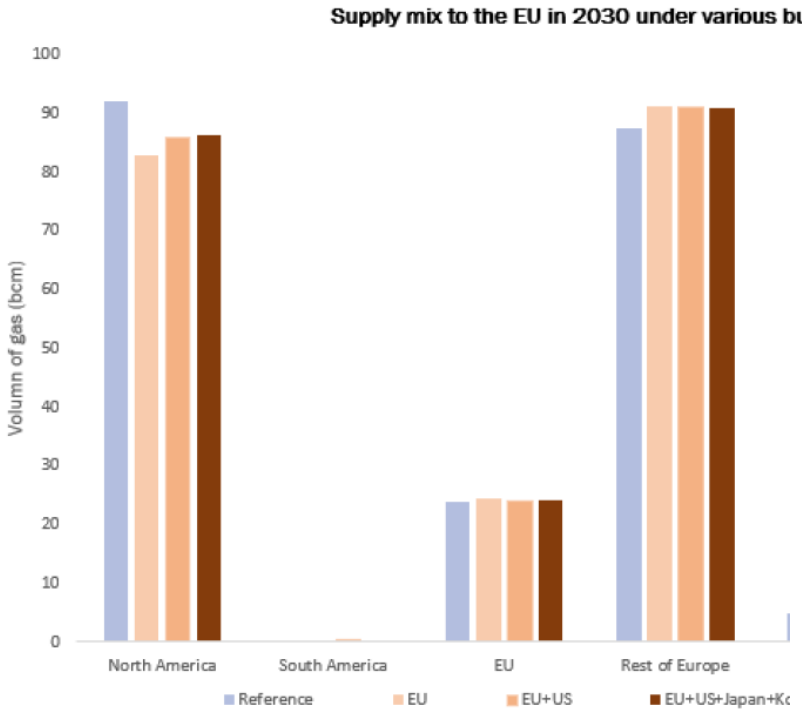
Note: the low / no CH_4 abatement costs are not taken into account here

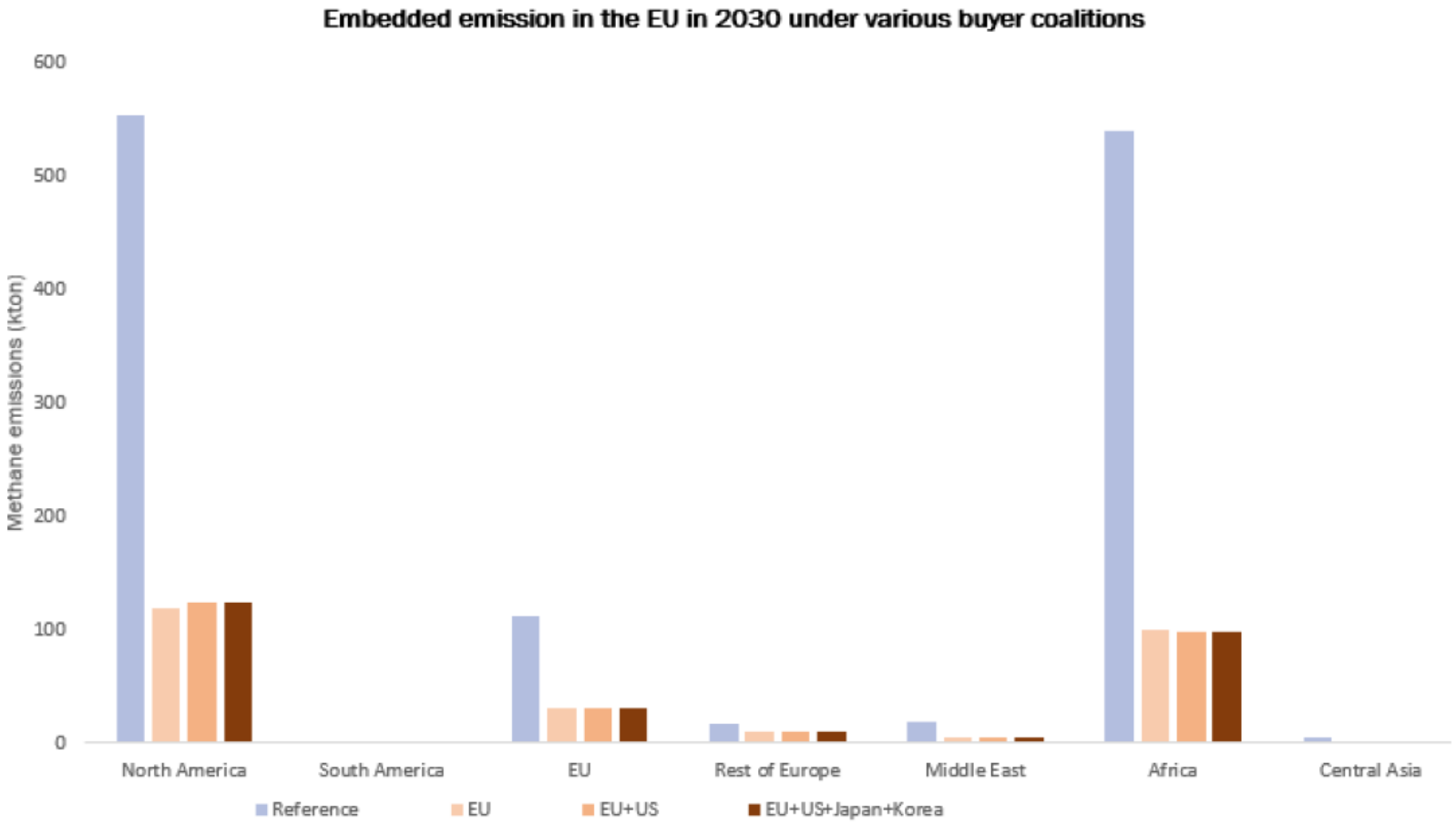
→ It requires dynamic modeling of economic incentives to abate

An importers' policy (emission performance standard) can reduce gas sector methane leakage by almost 50%



Taking into account negative abatement costs, an importers' methane policy would hardly affect imports but considerably reduce the methane content if imports





… with little effect on importers' prices of the methane performance standard

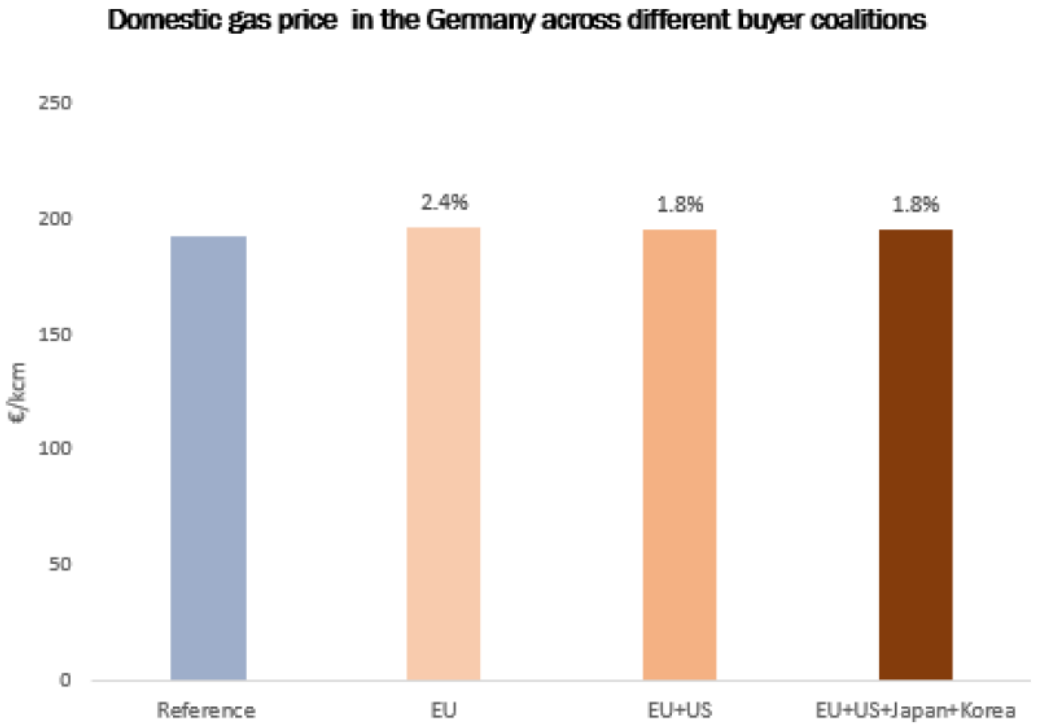


Figure 4: Equilibrium domestic gas price in Germany in 2030 under various clean gas buyer coalitions.

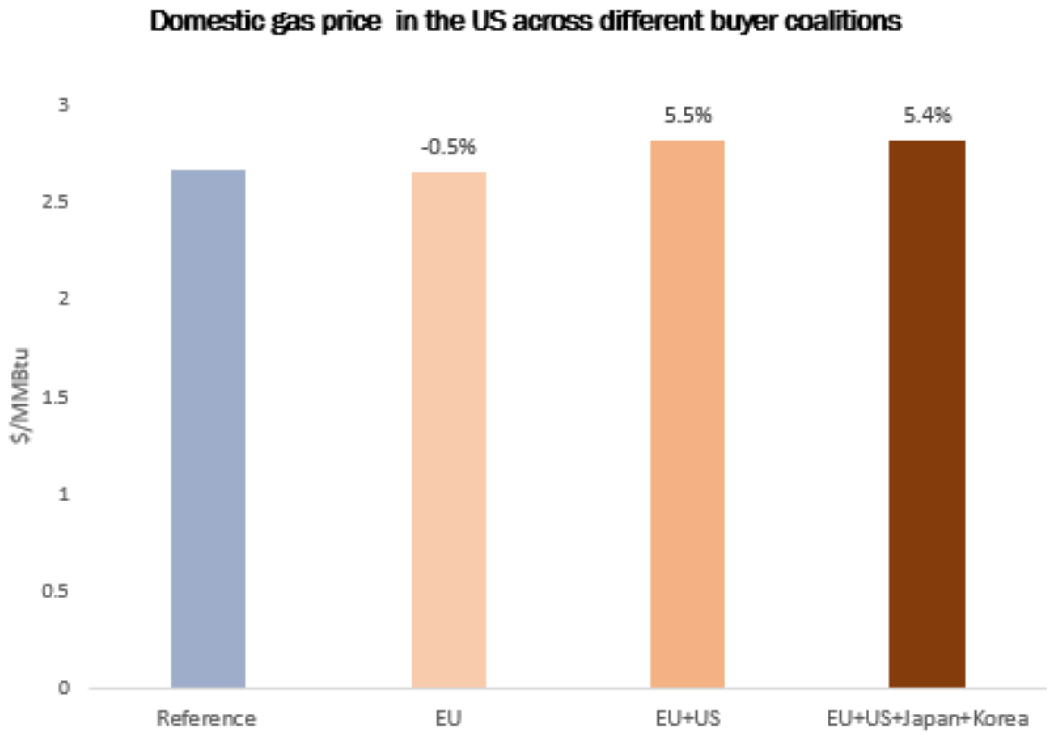


Figure 5: Equilibrium domestic gas price in the US in 2030 under various clean gas buyer coalitions.

Next steps: CBAM and Methane Regulation

- Methane Regulation includes applicability on *imports* from 2026/30 onwards
  - No distinction of value chain segments (i.e., only production?)

- CBAM will, in principle, cover the same emission sources as the EU-ETS

→ Can only be applied on imports if there is no equivalent regulation / pricing in the country of origin

How are CH_4 emissions addressed in other constituencies?

- Norway:
  - ban on routine flaring since the 1970s
  - all combustion of gas, oil, diesel in oil & gas operations has to reported and is taxed as well as releases of CO_2 and CH_4 based on the CO2 Tax Act on Petroleum Activities.
  - tax of NOK 16.89 per standard cubic meter (Sm^3) for vented natural gas offshore (2024)
- USA:
  - Methane Emission Reduction Program in IRA: CH_4 price ("waste emission charge") based on the social cost of methane and administered by the EPA
  - $900/ton of methane in 2024, $1200 in 2025, and $1500 in 2026, on owners / operators of facilities: at production facilities for all methane releases higher than 0.20% of the natural gas delivered from the facility; emissions above 0.11% in transmission, and emissions above 0.05% for other (non-production) facilities
- Other examples?

Conclusions & Outlook

- As of new, EU-ETS and Methane Regulation will complement each other
- CBAM should cover same sectors / installations / emissions as in the EU-ETS:
  - CO_2, relatively large emitters, incl. in natural gas value chain and H_2 production
- CH_4 pricing could become part of the EU-ETS, but several options for quantification and scope exist
- The EC must prepare a *delegated act on low-carbon fuels* until spring 2025 (*Hydrogen and Decarbonised Gas package)* : Which role of this DA for regulating the GHG content of low-carbon gases such as hydrogen?
- Hydrogen is a GHG itself, but not accounted for so far

Work in progress – Feedback welcome (fholz@diw.de)

(Future) EU regulation of emissions outside the EU related to EU imports

Regulation of the gas(es) value chain might change with the DA on low-carbon fuels (part of the gas & H2 package)

Value chain element	GHG	Quantification attempts
Production	CO_2	Low-carbon Gas Delegated Act
	CH_4	Methane Regulation / Low-carbon Gas Delegated Act
Processing	CO_2	Low-carbon Gas Delegated Act
	CH_4	Methane Regulation (potentially) / Low-carbon Gas Delegated Act
Transport (pipeline)	CO_2	Low-carbon Gas Delegated Act
	CH_4	Methane Regulation (indicative values) / Low-carbon Gas DA
Liquefaction	CO_2	Low-carbon Gas Delegated Act
	CH_4	Low-carbon Gas Delegated Act

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Thanks for your attention.

DIW Berlin — German Institute for Economic Research
Mohrenstraße 58, 10117 Berlin
www.diw.de Twitter: @DIW_Berlin_en

Contact
Franziska Holz (fholz@diw.de; franziska.holz@ntnu.no)
Department Energy, Transportation, Environment
DIW Berlin
and
NTNU Energy Transition Initiative (NETI)

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Appendix: EU natural gas imports

Country	LNG exports (bcm)	Pipeline exports (bcm)	Total exports (bcm)
Norway	5	90	95
USA	63	0	63
Russia	18	27	45
Algeria	10	33	43
Qatar	17	0	17
Azerbaijan	0	12	12
Nigeria	9	0	9
Trinidad & Tobago	4	0	4
Angola	3	0	3
Libya	0	3	3
Egypt	2	0	2
Total	**131**	**165**	**296**