Figures and annexes

Biomethane supply potential and its relevance for shipping by 2030

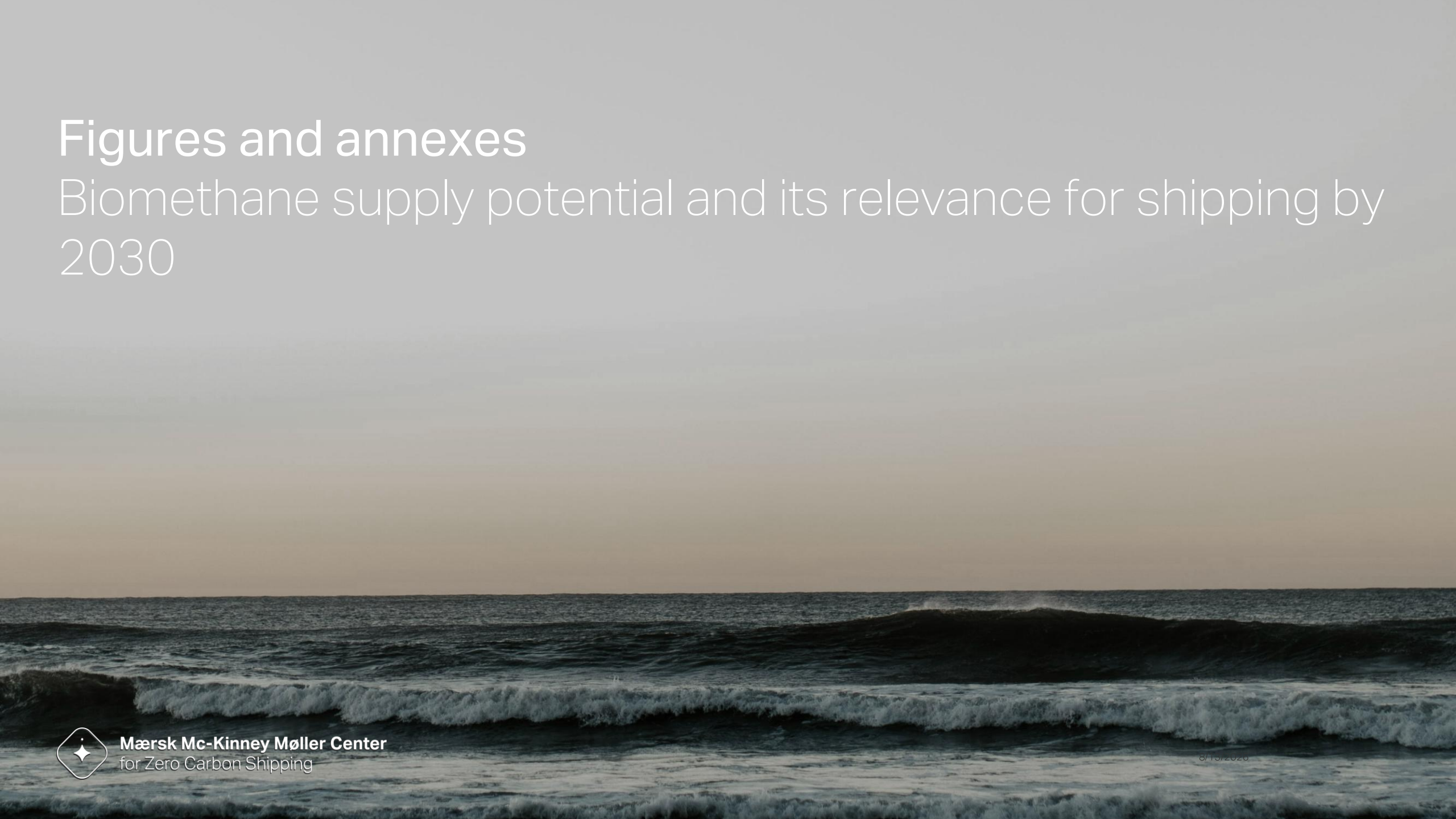


Table 1: Estimated IMO NZF-induced demand for low-emissions fuel under Tier 2* base compliance

Parameter	unit	2030	2035	2040
Energy demand shipping **	EJ	11	11.5	11.5
Reference GHG Fuel Intensity	g CO_2eq/MJ	93.3	93.3	93.3
Tier 2 base reduction required	% vs baseline	8%	30%	65%
Required intensity drop	g CO_2eq/MJ	7.464	27.99	60.645
Abatement required (to reach Tier 2 base compliance)	Mt CO_2eq	82,104	321,885	697,417
Conversion rate***	t CO_2 per tonne fuel	3.114	3.114	3.114
Convert into LSFOeq fuel (Mt)	Mt (LSFOeq) per year	**26.4**	**103.4**	**224.0**

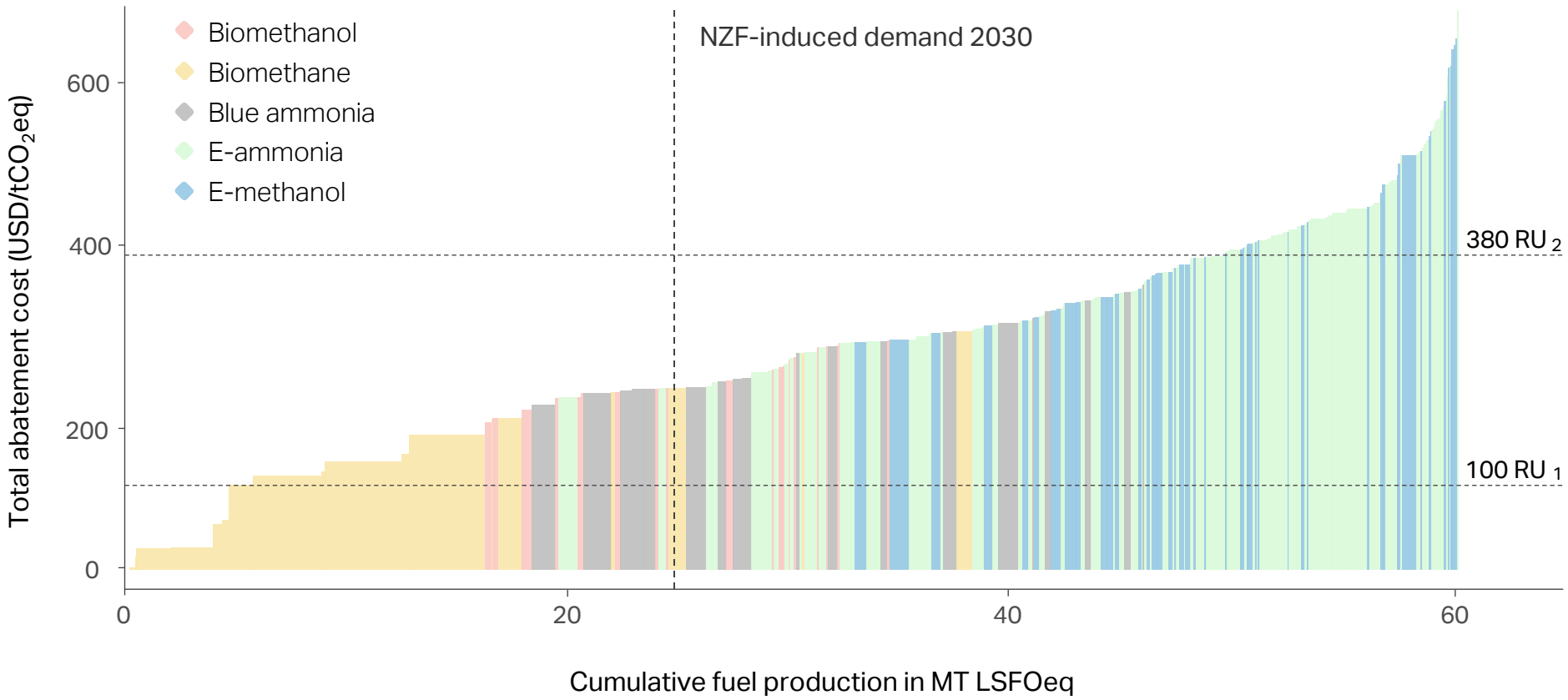
Notes:
* For more information on the two-tiered Global Fuel Standard and structure of the IMO NZF, please see our IMO NZF explainer.
** Source: NavigaTE modeling of the NZF as approved in April 2025, using standard assumptions.
*** We use VLSFO values from MEPC.391 (81) Appendix 2 (pg 49).

Table 2: Current biomethane production and two scenarios for 2030 supply

Region	Actual 2025 biomethane production	"Base" case production by 2030	"Max" case production by 2030
Europe	4.9	9.86	24.52
India	0.3	0.60	1.50
China	1	2.01	5.00
North America	4	8.05	20.02
Southeast Asia	-	-	-
South America	0.36	0.72	1.80
Africa	-	-	-
Global total (bcm)	**10.56**	**21.24**	**52.85**
Global modeled unconstrained low-emissions energy demand from shipping (Mt LSFOeq)		**26.4**	**26.4**
Global modeled low-emissions energy demand from shipping in 2030 (bcm)		**29.7**	**29.7**
Share of 2030 unconstrained low-emissions energy demand potentially addressable by biomethane		**71%**	**178%**

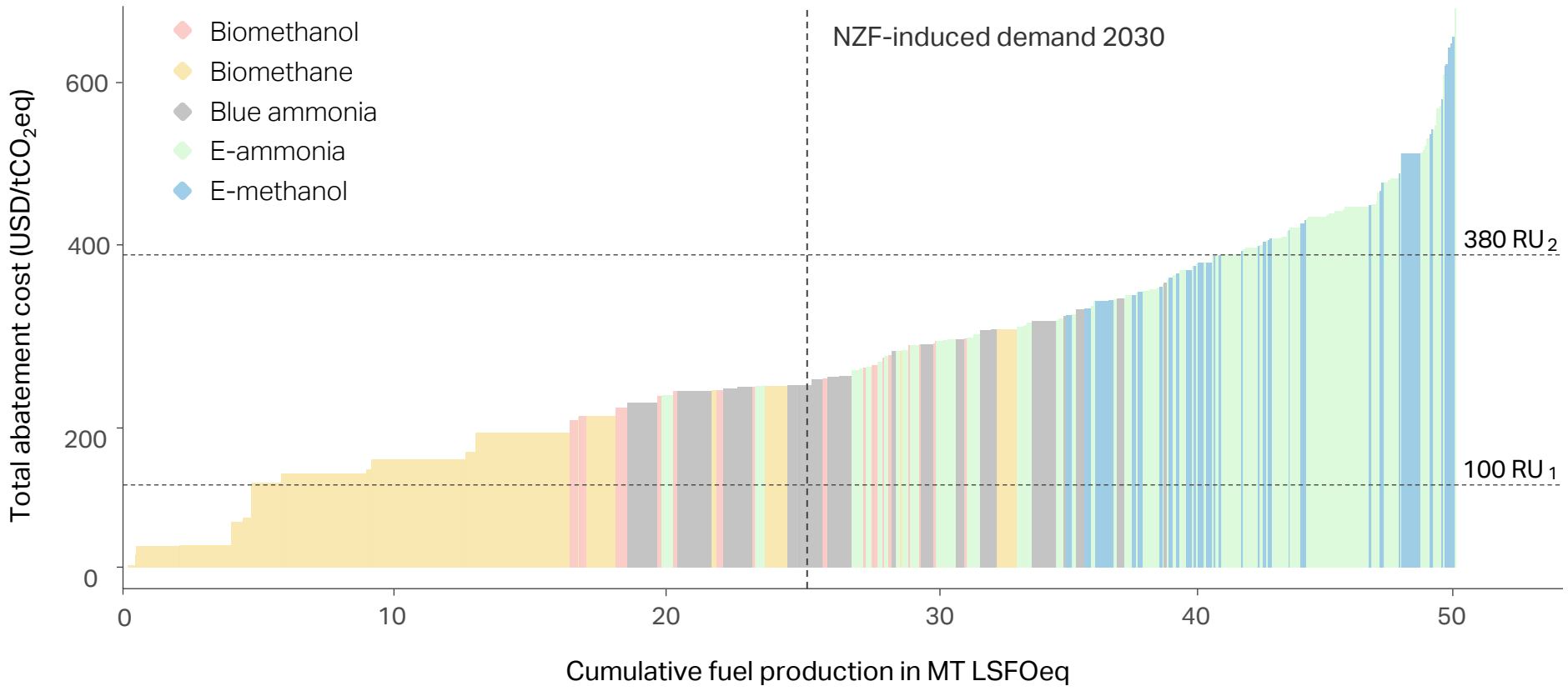
Notes: Current biomethane production and the 2030 base case scenario follow IEA (2025). No separate data were identified for Southeast Asia (excluding India and China), or for Africa, although the dataset captures the majority of current global biomethane production. For South America, we use Brazil as a proxy.

Figure 1: Alternative fuel supply potential (base case, full pre-FID project pipeline)



Notes: Estimated potential supply for biomethanol, blue ammonia, e-ammonia, e-methanol and biomethane. Biomethane potential is based on the base case scenario shown in Table 2 (i.e., 19 Mt LSFOeq biomethane). Each bar represents one fuel production project in pre-FID stages. Projects are ordered by abatement cost (bar height), with the bar width indicating the quantity of annual fuel production. Abatement cost, or cost per tonne of emissions reduced below LSFO, is shown across projects of low-emissions marine fuels. The full and non-risk weighted project-level data from Rystad Energy were combined with transport and storage costs, but we do not include rewards or Surplus Unit revenues from the IMO NZF. The projects included in this figure are taken from a broader dataset of projects filtered based on pre-FID status, with a start-up year or commercial operation date of 2030 or earlier, and production volume of over 100,000 tLSFOeq per year.

Figure 2: Alternative fuel supply potential (base case, pre-FID project pipeline excluding concept and announced phases)



Notes: Estimated potential supply for bio-methanol, blue ammonia, e-ammonia, e-methanol and biomethane. Biomethane potential is based on the base case scenario shown in Table 2 (i.e., 19 Mt LSFOeq biomethane). Each bar represents one fuel production project in pre-FID stages (excluding projects in the 'concept' or 'announced' phase). Projects are ordered by abatement cost (bar height), with the bar width indicating the quantity of annual fuel production. Abatement cost, or cost per tonne of emissions reduced below LSFO, is shown across projects of low-emissions marine fuels. The full and non-risk weighted project-level data from Rystad Energy was combined with transport and storage costs but does not include rewards or Surplus Unit revenues from the IMO NZF. The projects included in this figure are taken from a broader dataset of projects filtered based on pre-FID status, with a start-up year or commercial operation date of 2030 or earlier, and production volume of over 100,000 tonnes LSFOeq per year.

Table 3: Share of feedstock potential per region

	Crop residues	Manure	Biowaste	Woody biomass
Europe	35.0%	39.0%	18.0%	8.0%
India	56.0%	35.0%	9.0%	0.0%
China	23.1%	62.0%	14.8%	0.0%
North America	48.0%	11.0%	26.0%	15.0%
Southeast Asia	48.9%	25.7%	18.4%	6.7%
South America	53.0%	26.0%	9.0%	12.0%
Africa	54.0%	23.0%	14.0%	9.0%

Table 4: "Base" case - 2030 production (bcm) split by feedstock

	Crop residues	Manure	Biowaste	Woody biomass	Total
Europe	3.45	3.84	1.77	0.79	9.86
India	0.34	0.21	0.05	0.00	0.60
China	0.46	1.25	0.30	0.00	2.01
North America	3.86	0.88	2.09	1.21	8.05
Southeast Asia	0.00	0.00	0.00	0.00	0.00
South America	0.38	0.19	0.07	0.09	0.72
Africa	0.00	0.00	0.00	0.00	0.00
Total (bcm)	**8.5**	**6.4**	**4.3**	**2.1**	**21.24**

Table 5: "Max" case - 2030 production (bcm) split by feedstock

	Crop residues	Manure	Biowaste	Woody biomass	Total
Europe	8.58	9.56	4.41	1.96	24.52
India	0.84	0.53	0.14	0.00	1.50
China	1.16	3.10	0.75	0.00	5.00
North America	9.61	2.20	5.21	3.00	20.02
Southeast Asia	0.00	0.00	0.00	0.00	0.00
South America	0.95	0.47	0.16	0.22	1.80
Africa	0.00	0.00	0.00	0.00	0.00
Total (bcm)	**21.15**	**15.86**	**10.66**	**5.18**	**52.85**

Table 6: Announced regional biomethane targets for 2030 and implied annual growth rates

Region	Current production, bcm	Policy driven target by 2030 (bcm)	Growth rate required to meet policy target	Policies
Europe	4.9	35	38%	RePowerEU, Waste Framework Directive, RED II, national blending mandates
India	0.3	5.25	71%	Mandatory blending, GOBAR-Dhan scheme in India
China	1.0	20	83%	14th Five-Year plan target
North America	4	-	-	Renewable Fuel Standard, California Low Carbon Fuel Standard.
South America	0.36	1.6	29%	Fuel of the Future Package

Table 7: WTW emission estimates

Region	Crop residues	Manure	Biowaste	Woody biomass
Europe	17.7	17.0	19.5	20.6
India	30.2	29.5	32.0	20.6
China	24.5	23.8	26.3	20.6
North America	20.3	19.5	22.0	20.6
Southeast Asia	25.7	25.0	27.5	20.6
Africa	29.8	29.1	31.6	20.6
South America	18.3	17.6	20.1	20.6

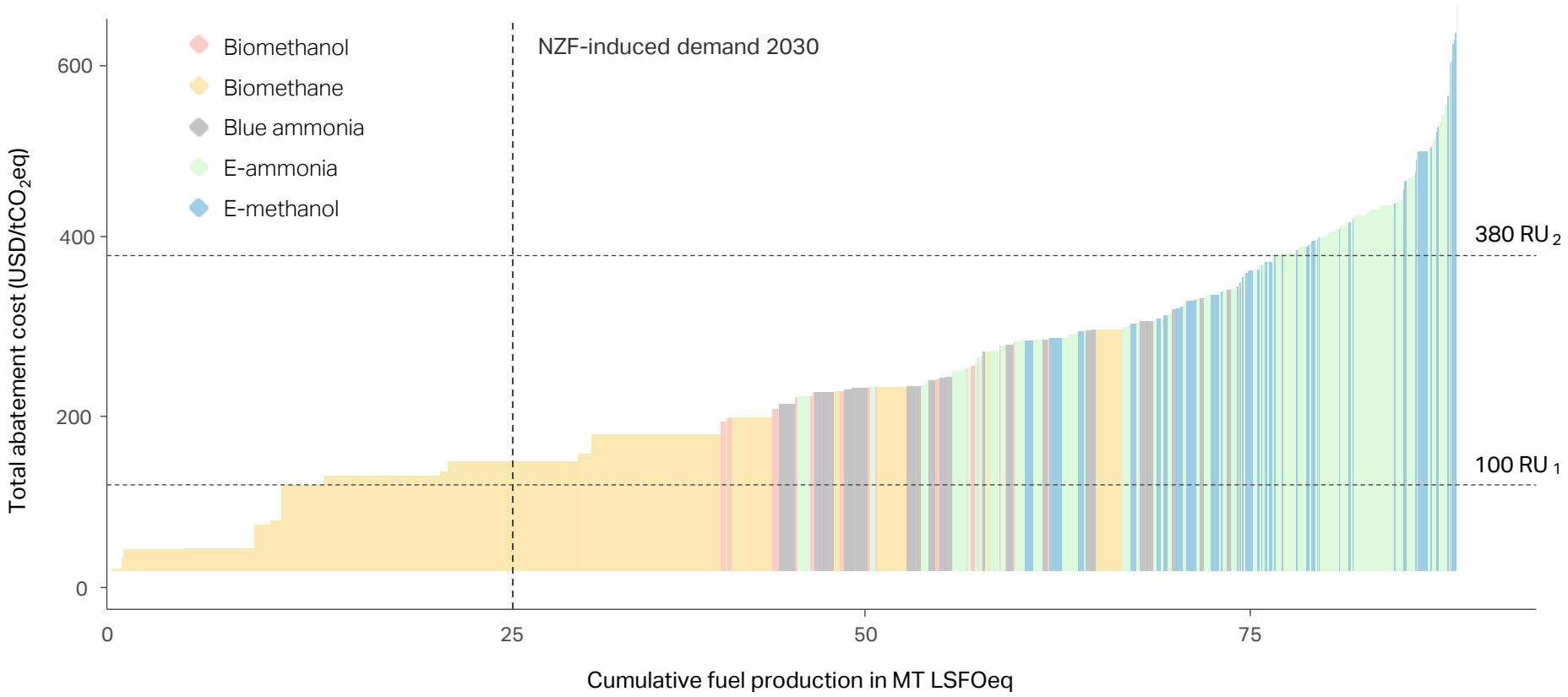
Notes: WTW emissions measured in gCO_2eq / MJ

Table 8: Feedstock-specific biomethane production cost estimates

Region	Crop residues	Manure	Biowaste	Woody biomass
Europe	17	21	10	30
India	12	16	9	20
China	12	15	8	20
North America	14	18	10	23
Southeast Asia	18	25	10	22
Africa	19	25	22	28
South America	24	24	24	24

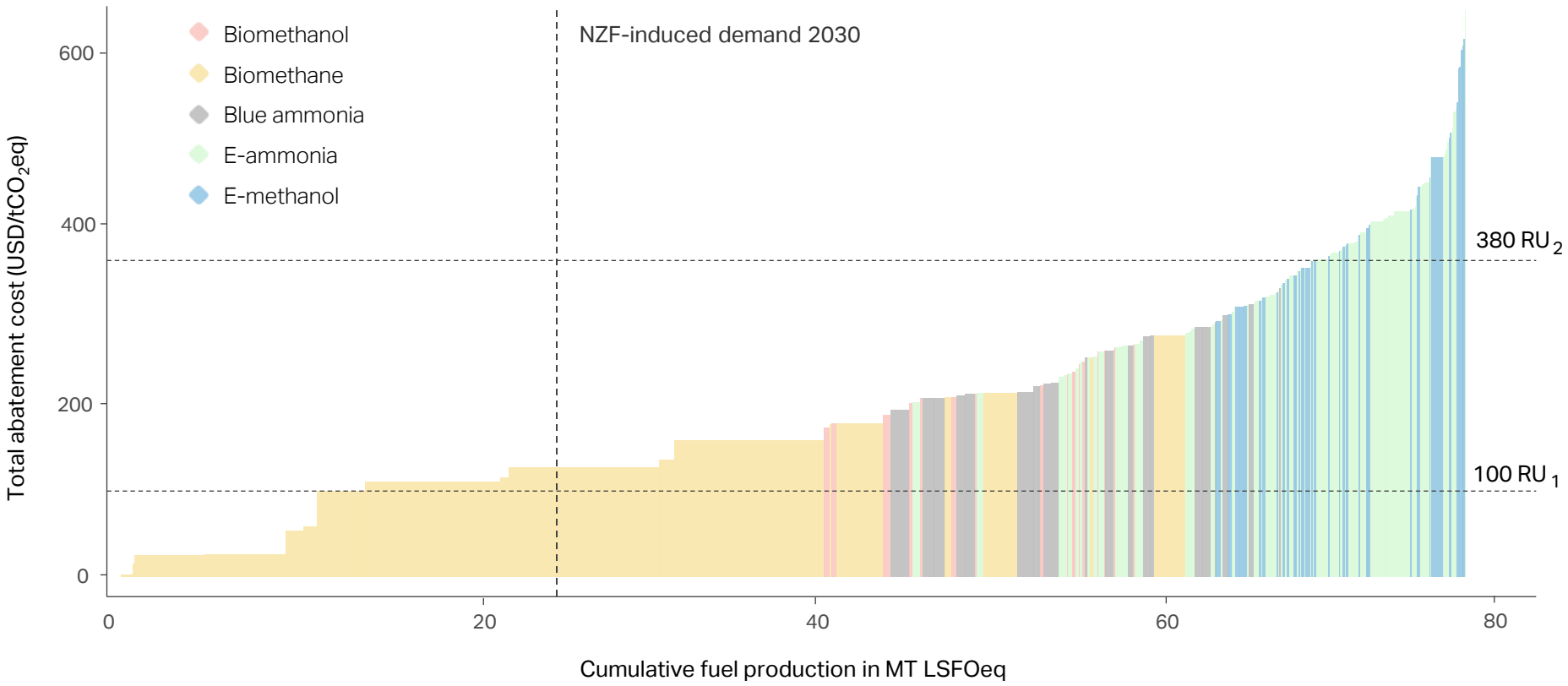
Notes: Cost estimates from IEA (2025) are utilised and measured in USD/GJ

Figure 3: Alternative fuel supply potential ("max" case, full pre-FID project pipeline)



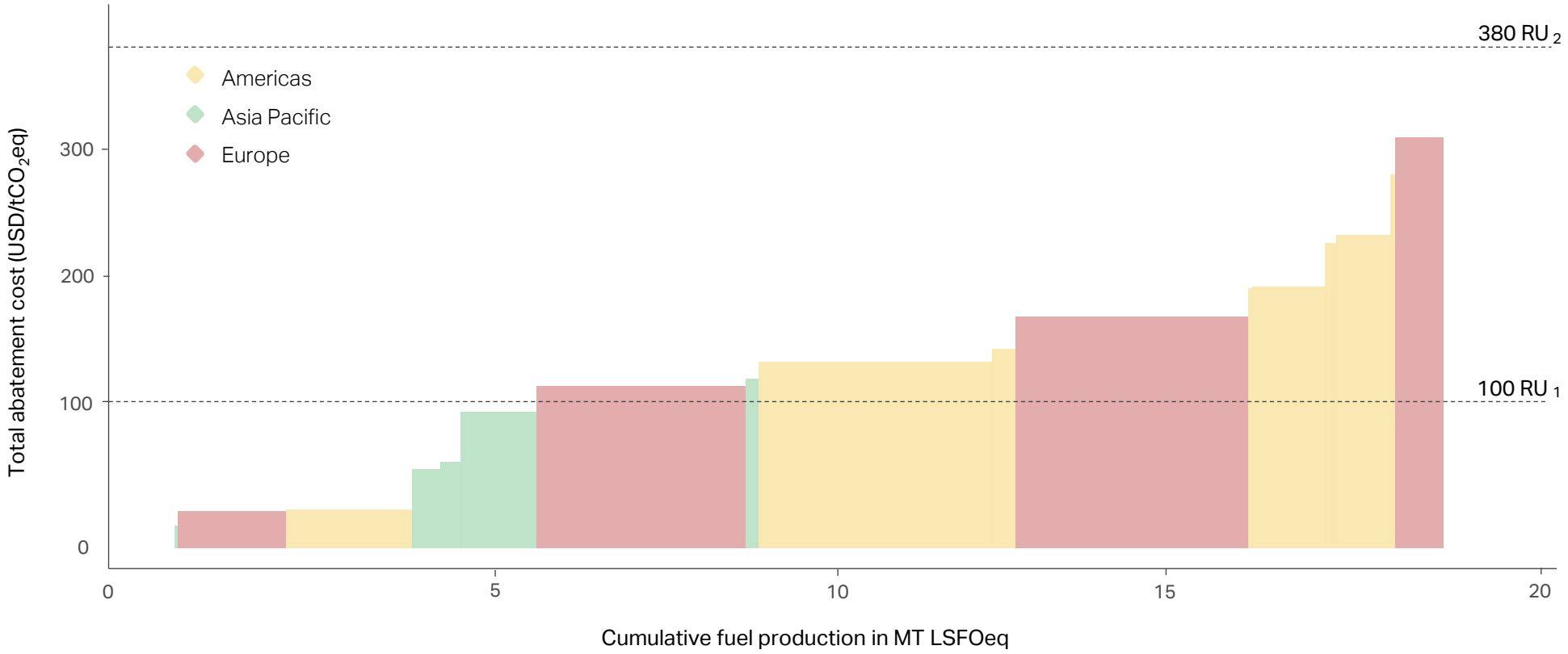
Notes: Estimated potential supply for biomethanol, blue ammonia, e-ammonia, e-methanol and biomethane. Biomethane potential is based on the "max" case scenario. Each bar represents one fuel production project in pre-FID stages. Projects are ordered by abatement cost (bar height), with the bar width indicating the quantity of annual fuel production. Abatement cost, or cost per tonne of emissions reduced below LSFO, is shown across projects for five low-emissions marine fuels. The four pathways besides biomethane use full and non-risk weighted project-level data from Rystad Energy, which was combined with transport and storage costs but does not include rewards or surplus unit revenues from the IMO NZF. The projects included in this figure are taken from a broader dataset of projects filtered based on pre-FID status, with a start-up year or commercial operation date (COD) of 2030 or earlier, and production volume of over 100,000 tonnes LSFOeq per year.

Figure 4: Alternative fuel supply potential ("max" case, pre-FID project pipeline excluding concept and announced phases)



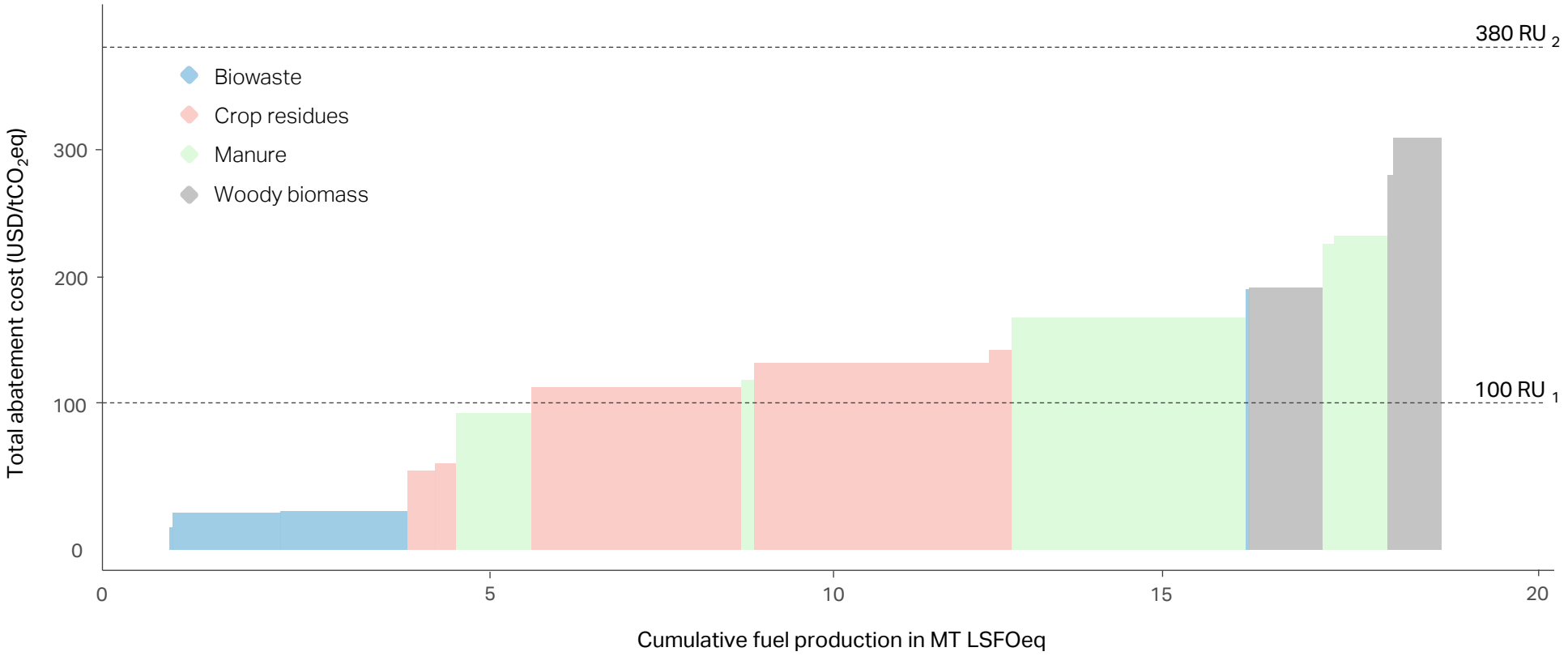
Notes: Estimated potential supply for biomethanol, blue ammonia, e-ammonia, e-methanol and biomethane. Biomethane potential is based on the "max" case scenario. Each bar represents one fuel production project in pre-FID stages (excluding projects in the 'concept' or 'announced' phase). Projects are ordered by abatement cost (bar height), with the bar width indicating the quantity of annual fuel production. Abatement cost, or cost per tonne of emissions reduced below LSFO, is shown across projects for five low-emissions marine fuels. The four pathways besides biomethane use full and non-risk weighted project-level data from Rystad Energy, which was combined with transport and storage costs but does not include rewards or surplus unit revenues from the IMO NZF. The projects included in this figure are taken from a broader dataset of projects filtered based on pre-FID status, with a start-up year or commercial operation date (COD) of 2030 or earlier, and production volume of over 100,000 tonnes LSFOeq per year.

Figure 5: Alternative fuel supply potential ("base" case, full-pre-FID project pipeline)



Notes: This figure decomposes 2030 biomethane production under the base case scenario, split by region. Projects are ordered by abatement cost (bar height), with the bar width indicating the quantity of annual fuel production. Abatement cost, or cost per tonne of emissions reduced below LSFO, is shown. Cost estimates follow IEA (2025), as expressed in Appendix 4. Costs do not include rewards or surplus unit revenues from the IMO NZF.

Figure 6: Alternative fuel supply potential ("base" case, full-pre-FID project pipeline)



Notes: This figure decomposes 2030 biomethane production under the base case scenario, split by feedstock. Projects are ordered by abatement cost (bar height), with the bar width indicating the quantity of annual fuel production. Abatement cost, or cost per tonne of emissions reduced below LSFO, is shown. Cost estimates follow IEA (2025), as expressed in Appendix 4. Costs do not include rewards or surplus unit revenues from the IMO NZF.

Table 9: Feedstock potential less than 20 km away from a natural gas transmission grid

Region	Crop residues	Manure	Biowaste	Woody biomass	Total potential within 20 km from gas grid
Europe	10.7	11.9	5.5	2.4	30.6 (60%)
India	16.1	10.0	2.5	0	28.7 (25%)
China	14.6	30.2	14.5	1.3	60.7 (50%)
North America	40.3	9.2	21.8	12.6	84.0 (60%)
Southeast Asia	7.8	4.1	3.0	1.1	16.1 (20%)
Africa	6.4	2.7	1.6	1.0	12.0 (10%)
South America	10.0	4.9	1.7	2.2	19.0 (10%)

Notes: Biomethane potential less than 20 km away from natural gas transmission grid, denoted in bcm. Parentheses in the last column represent how much this feedstock potential within natural gas grid proximity is as share of total regional feedstock potential. Data source: Outlook for Biogas and Biomethane, IEA, 2025

Note on data source: The fuel pathways (except biomethane) use data from Rystad Energy. Abatement cost modeling and analysis by the Center. Rystad Energy's views on fuel availability and costs may differ.