Clean ammonia pricing mechanisms and willingness to pay

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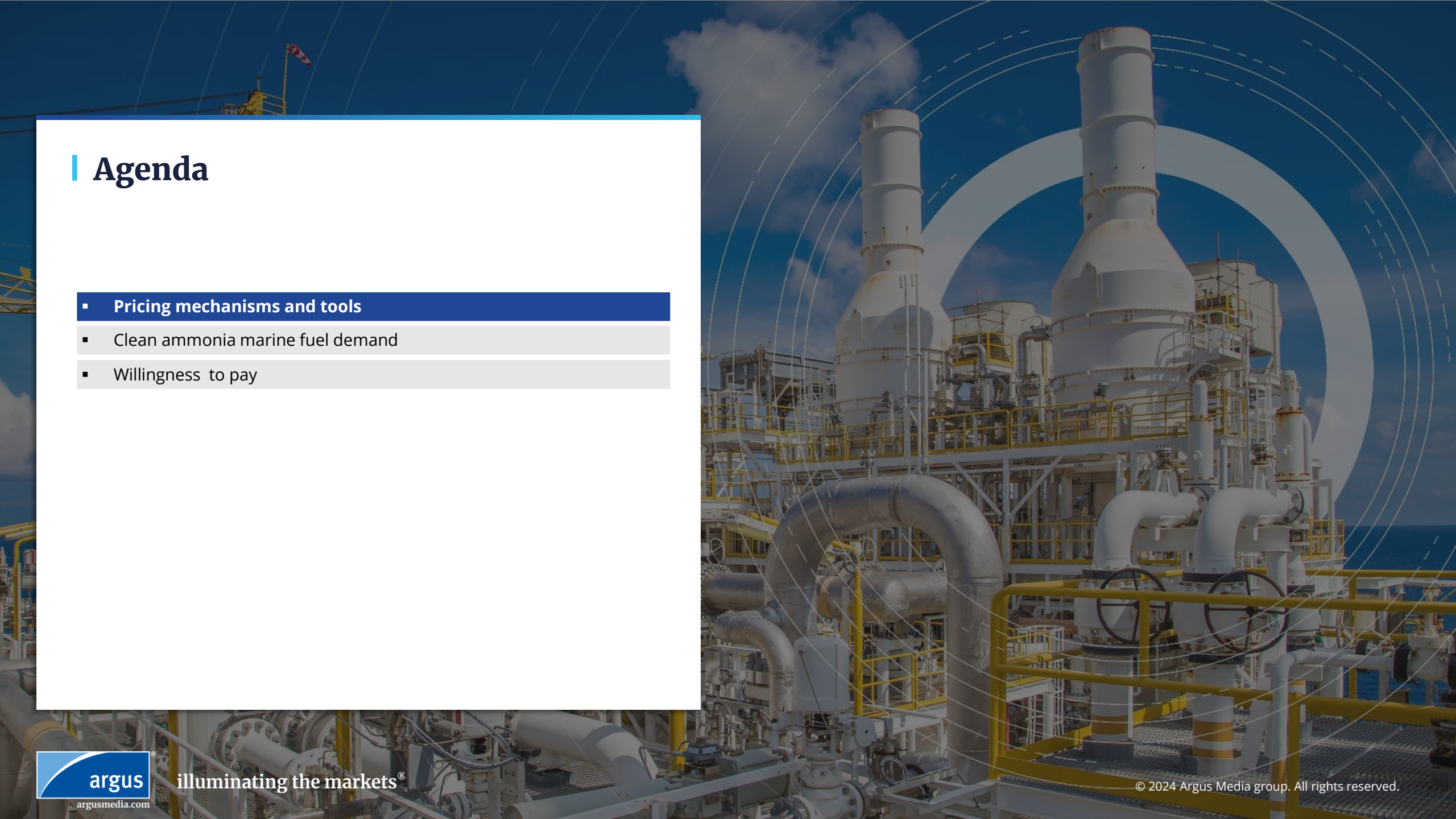
Agenda

- **Pricing mechanisms and tools**
- Clean ammonia marine fuel demand
- Willingness to pay



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Key issues for pricing molecules

Pricing e-fuels beset by challenges

Source: Argus Consulting

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Ways to mitigate e-fuels price risk

Four options to mitigate – and manage – pricing risk

Contracts fix price for a period at a level that services debt

1 **Fixed-price long-term offtake**

2 **Contract for difference**

Governments set a strike price at a level to support demand

Prices capped at high/low range, protecting both sides

3 **Floor/ceiling mechanism**

4 **Spot pricing**

Liquid spot market will form as these contracts end (or to supplement long-term contracts)

Source: Argus Consulting

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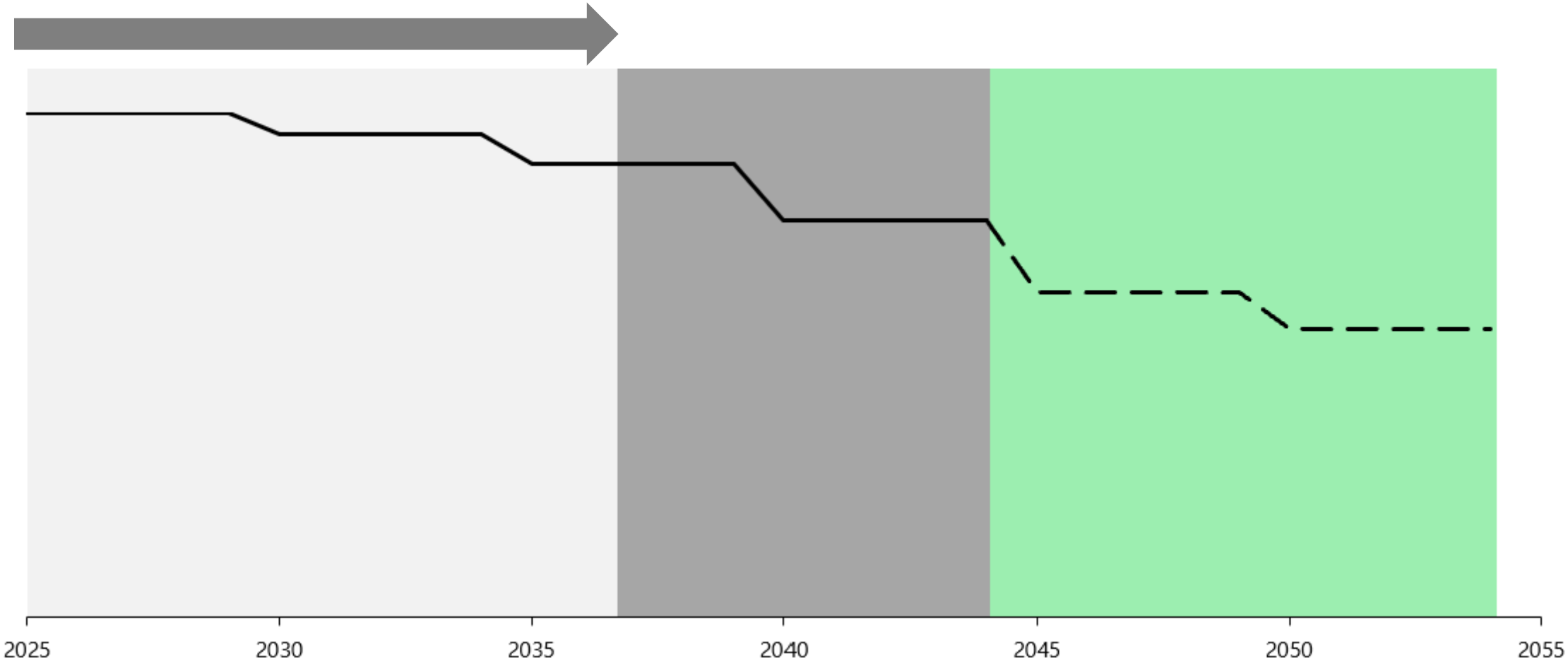
1 Long-term fixed offtake contracts

Hydrogen projects require fixed offtake price for up to 20 years



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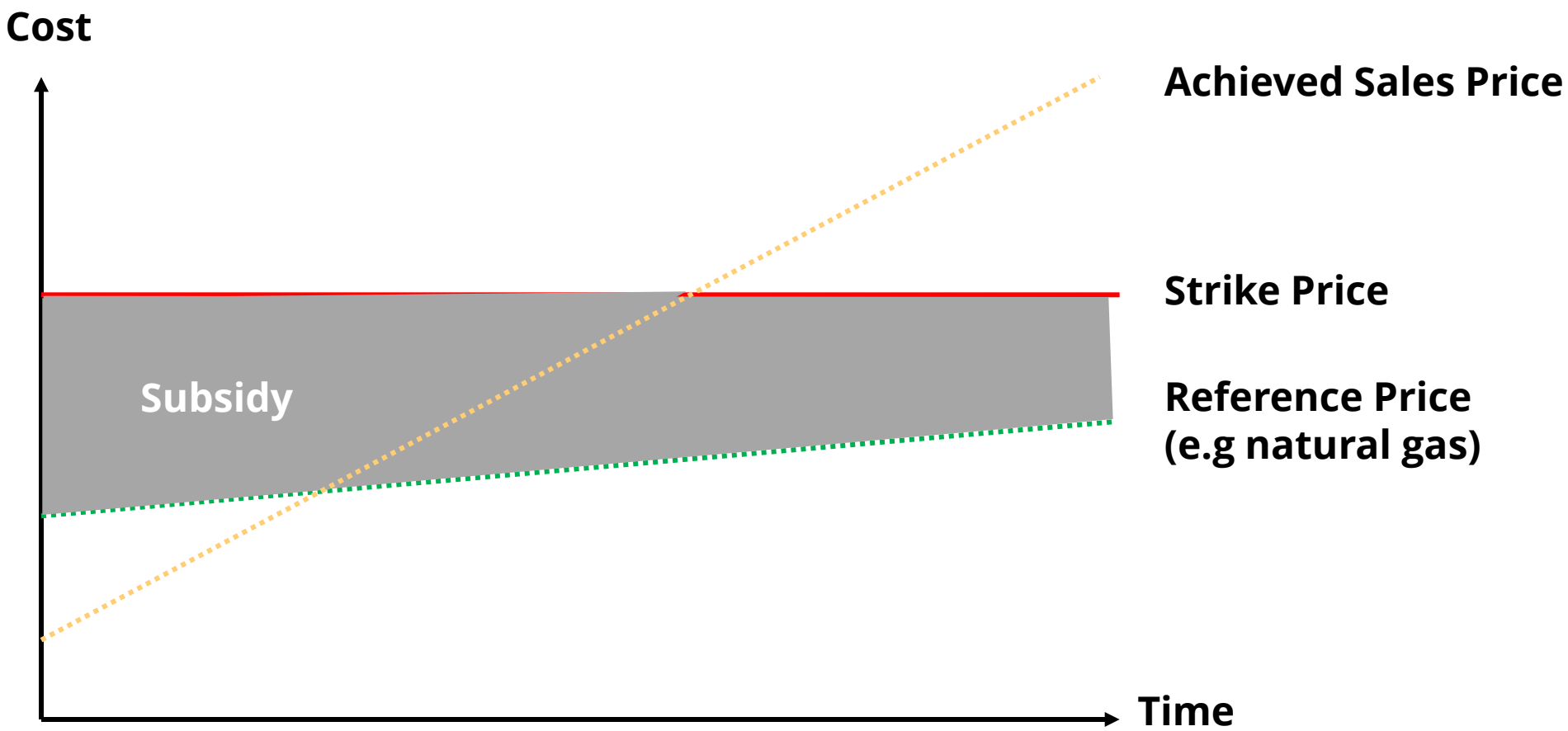
2 Contracts for Difference

CFD covers differential between “strike price” and “reference price”



Source: Argus Consulting

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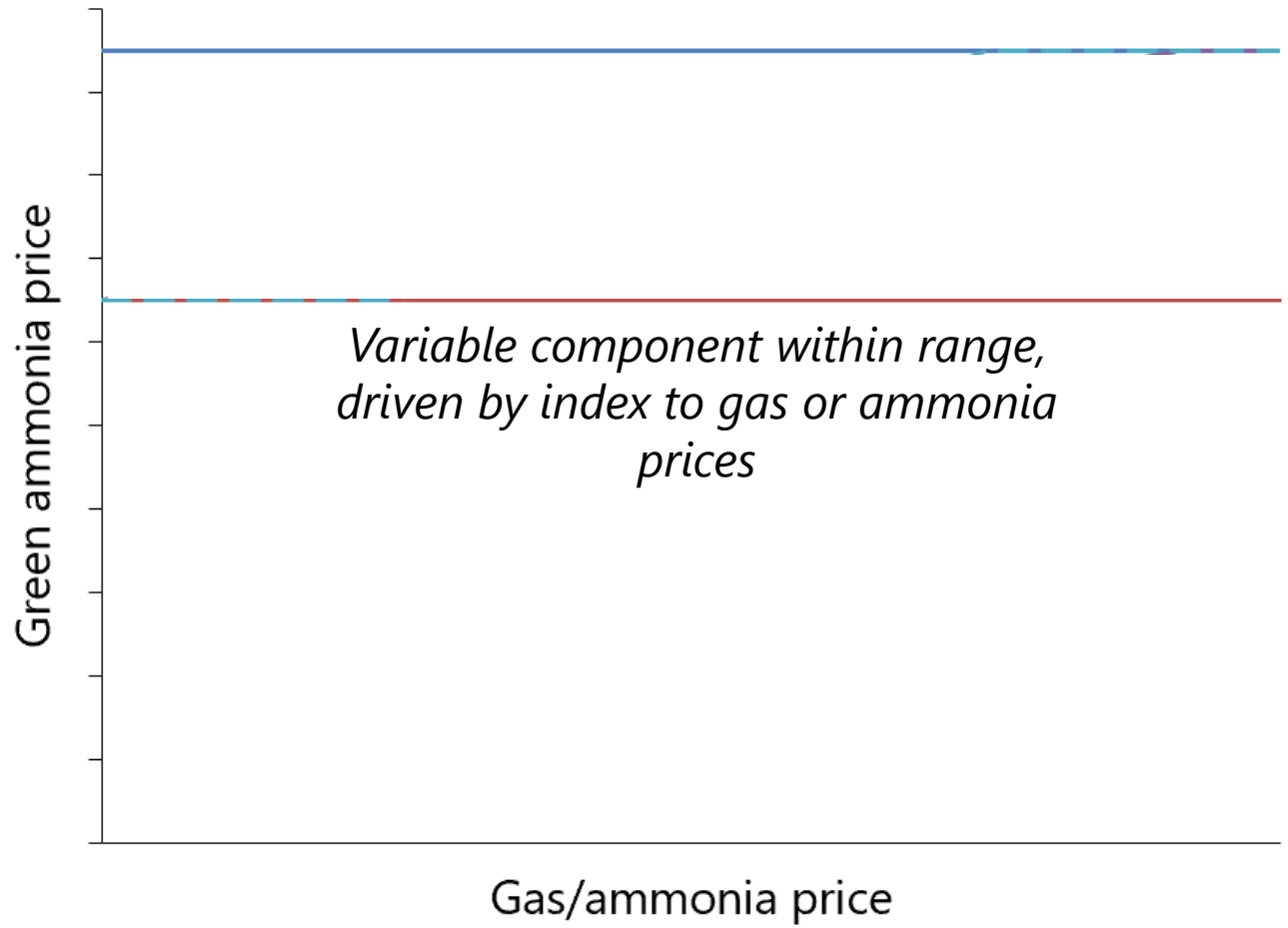
3 Floor/ceiling pricing mechanisms

Protects both parties from extreme prices; ceiling and floor set by IRR



Ceiling price
- E.g. 15% IRR

Floor price
- E.g. 9-10% IRR

Source: Argus Consulting

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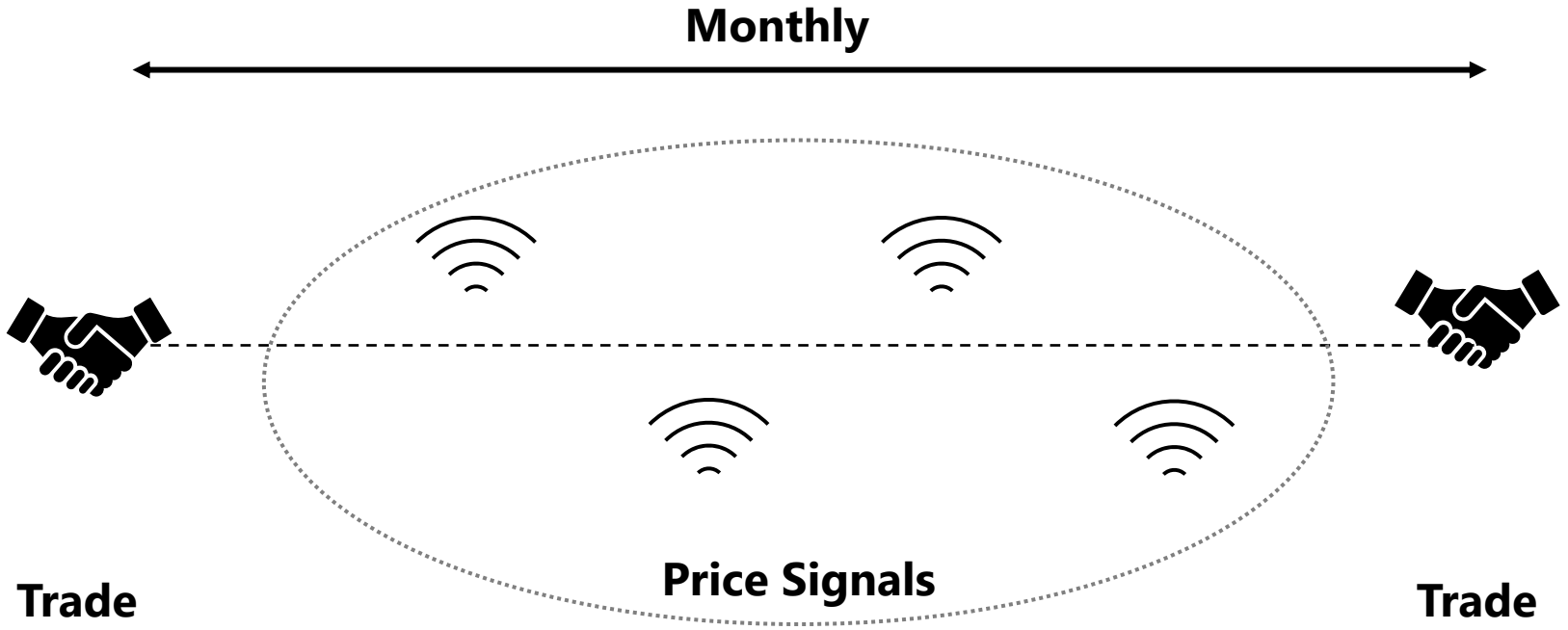
4 Spot price index

Price index anchored by occasional trades + regular price signals



Index Requirements

- ✓ Buying Spot
- ✓ ~1 trade per month
- ✓ Bid + offer ideas

Drivers

- ✓ Spot volumes
- ✓ Sophisticated market
- ✓ Risk management

Source: Argus Consulting

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How Argus' cost-plus clean ammonia index (JKLAB) can help potential offtakers in Japan and South Korea (and beyond)

JKLAB trade routes

Delivery ports:

- Japan: Niihama
- South Korea: Ulsan

i. The cost model is based on a 1.1mn tpy ammonia plant, based in the US Gulf, using **Autothermal Reformation (ATR) with carbon capture and storage (CCS).**

ii. Mass-balanced, all-in cost index, ideal to manage multiple cost inputs

iii. Up-to-date CAPEX and OPEX assumptions

iv. The **gas input is Henry Hub**, and power and CCS assumptions are matching US Gulf coast prevailing costs.

v. Including/excluding 45Q subsidies

vi. Freight rates are for Medium Gas Carrier vessels. We assume the lower of two Medium Gas Carrier routes.

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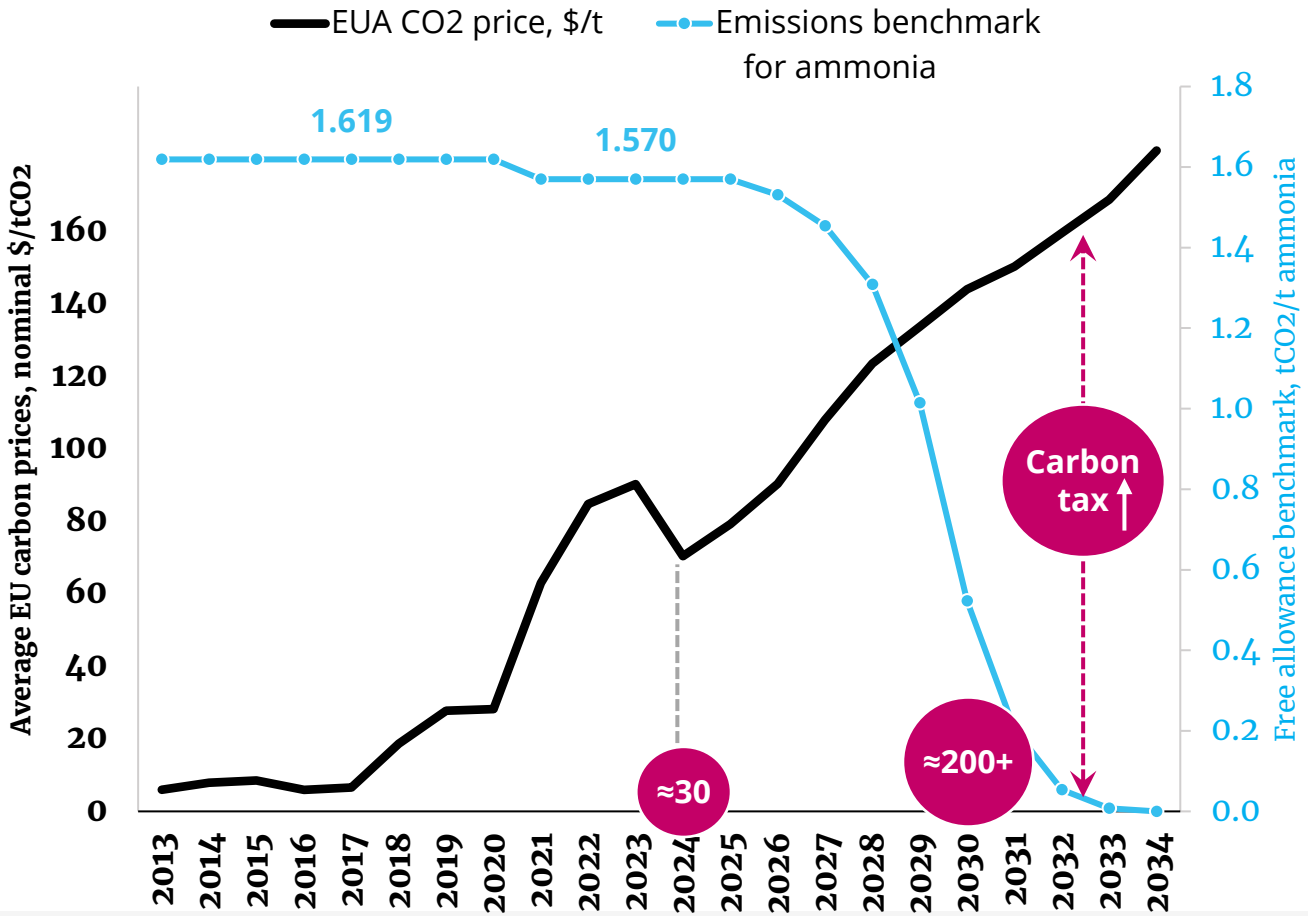
The importance of carbon pricing: ammonia (and hydrogen) will be included in the EU's Carbon Border Adjustment Mechanism (CBAM)

Phasing out of EUA & outlook for CO_2 prices in Europe



- **Progressive removal of free allowances will increase carbon costs (and price) for grey products, with implications beyond EU.**
- **So far the only "mandatory" cross-border carbon scheme.**

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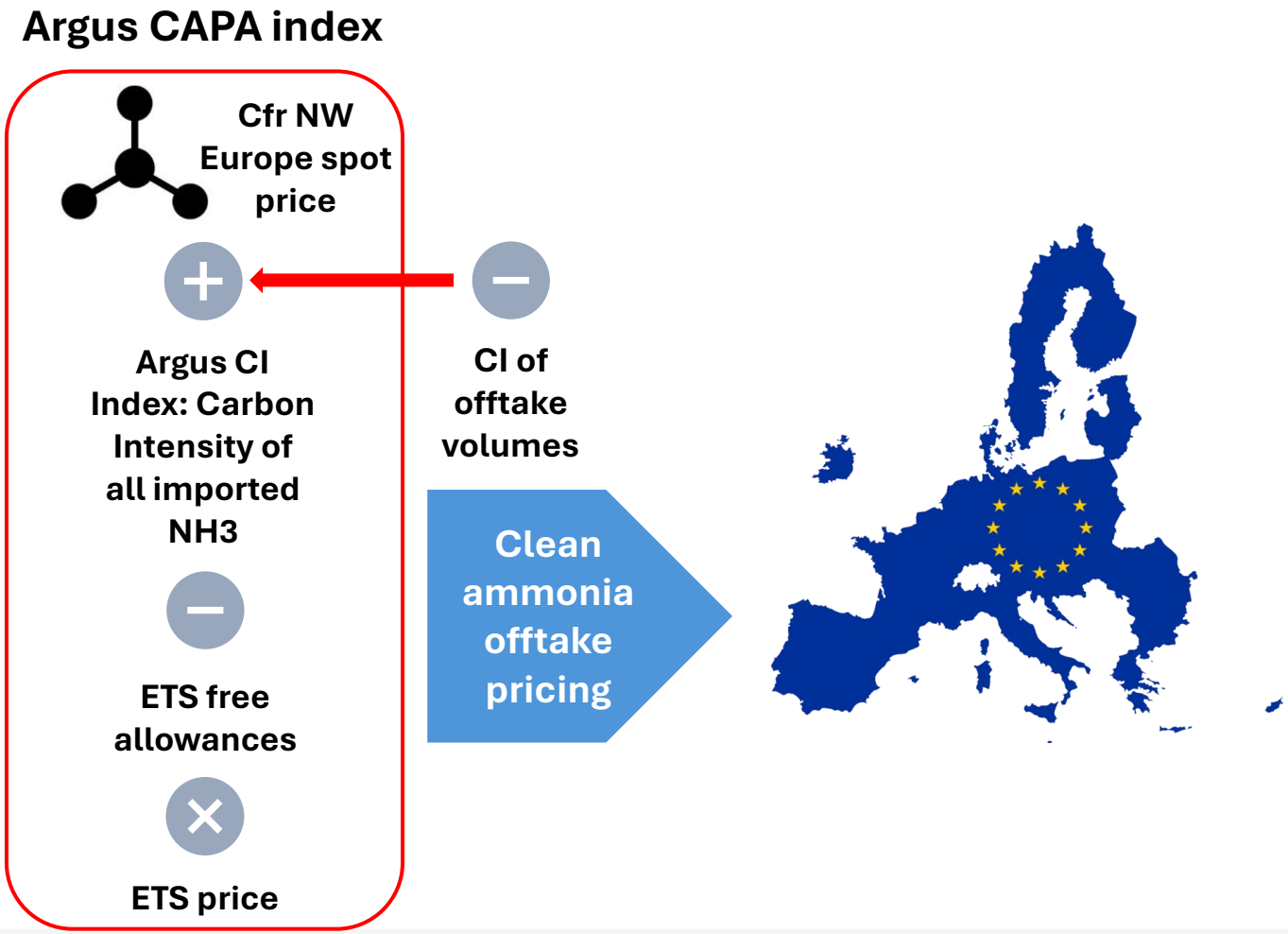
Carbon-Adjusted Price of Ammonia (CAPA) and low-carbon price formation in Europe



- Argus' Carbon-Adjusted Price of Ammonia (CAPA) is a simple mechanism that will allow potential suppliers to lock in a premium for low-carbon ammonia in anticipation of the CBAM implementation.
- This is irrespective of how ammonia is produced and how it will be used (i.e. CBAM allows the market to move beyond "colour" codes).
- CAPA's carbon intensity index (updated quarterly) mirrors the reporting structure required by CBAM.

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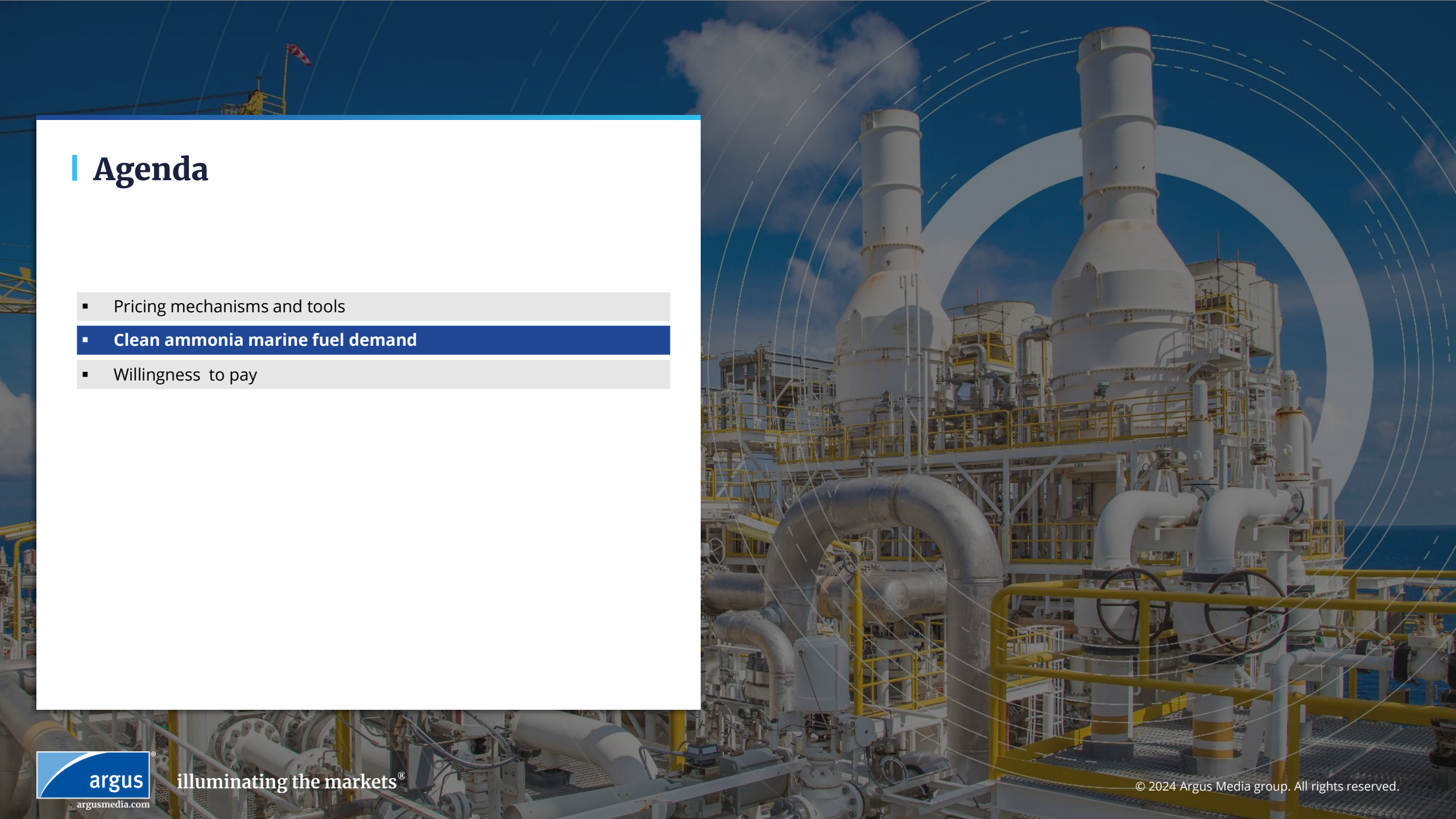

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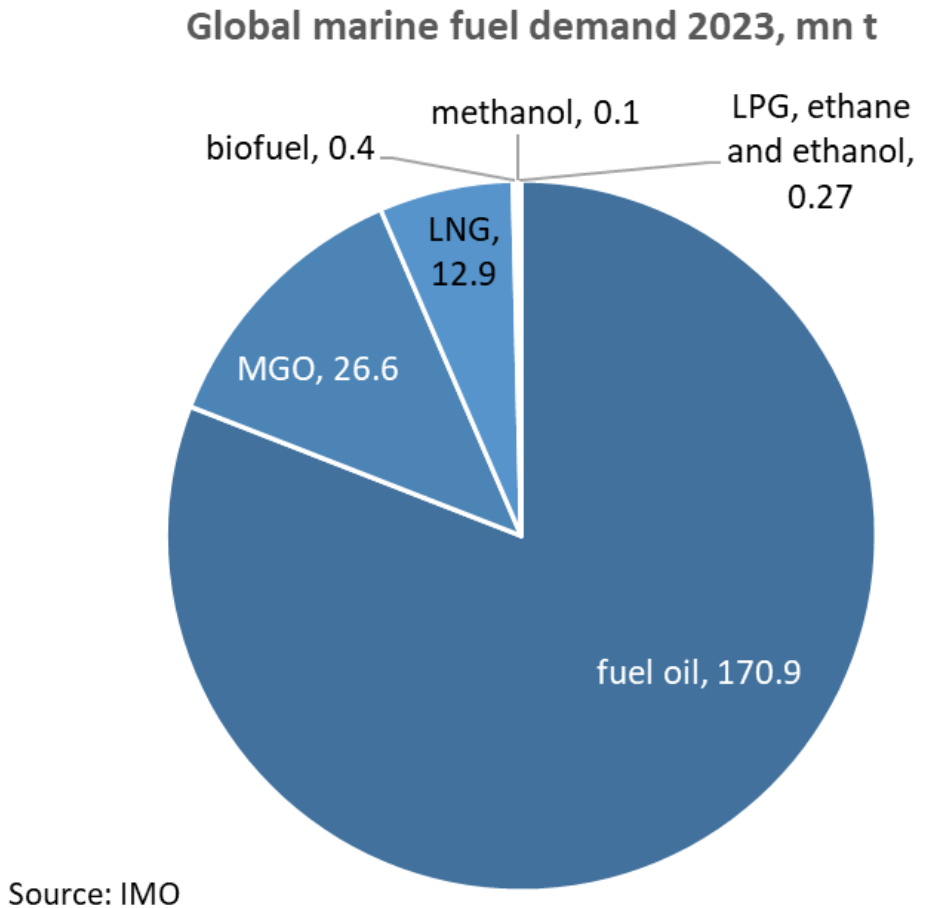
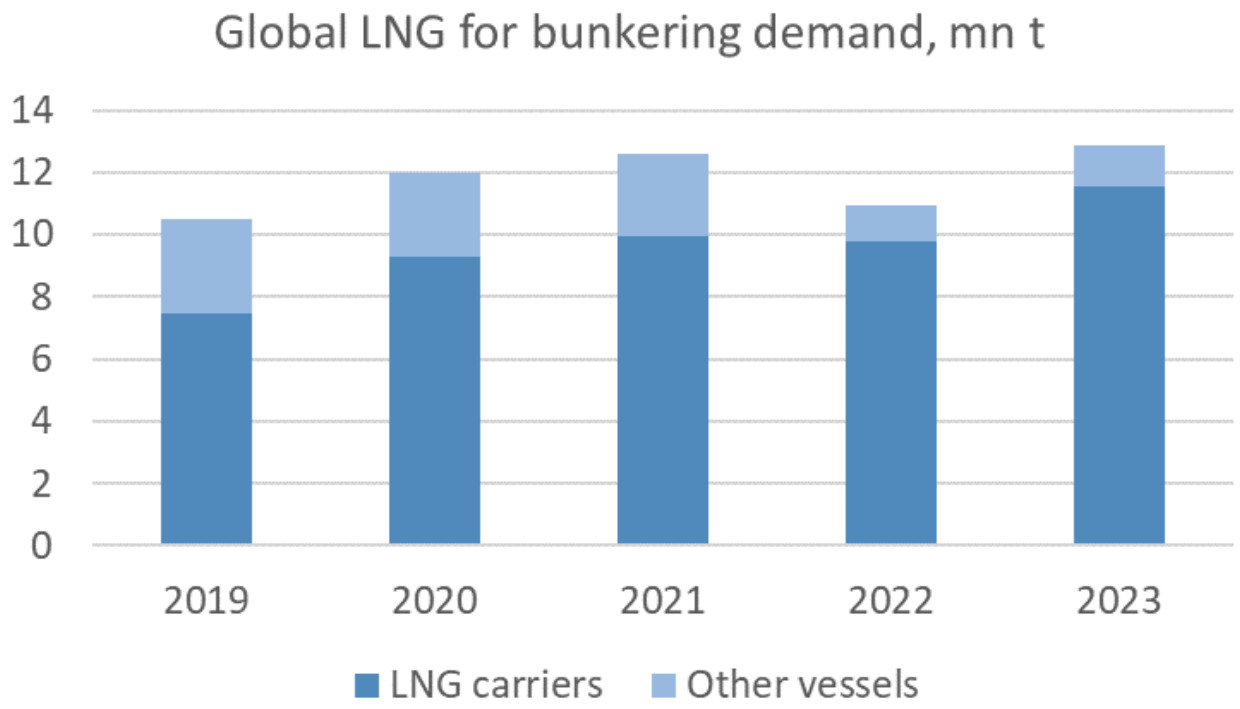
Global bunker demand in 2023 – 211.1mn t (for vessels 5,000 gt and above)



Source: IMO



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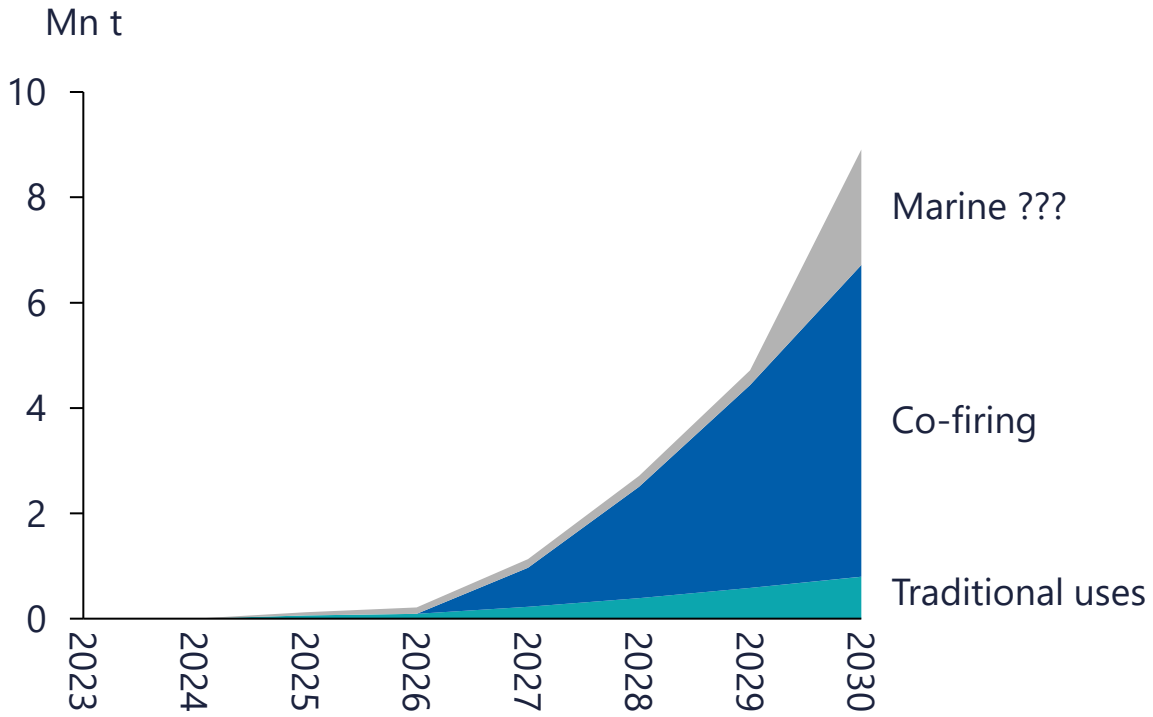
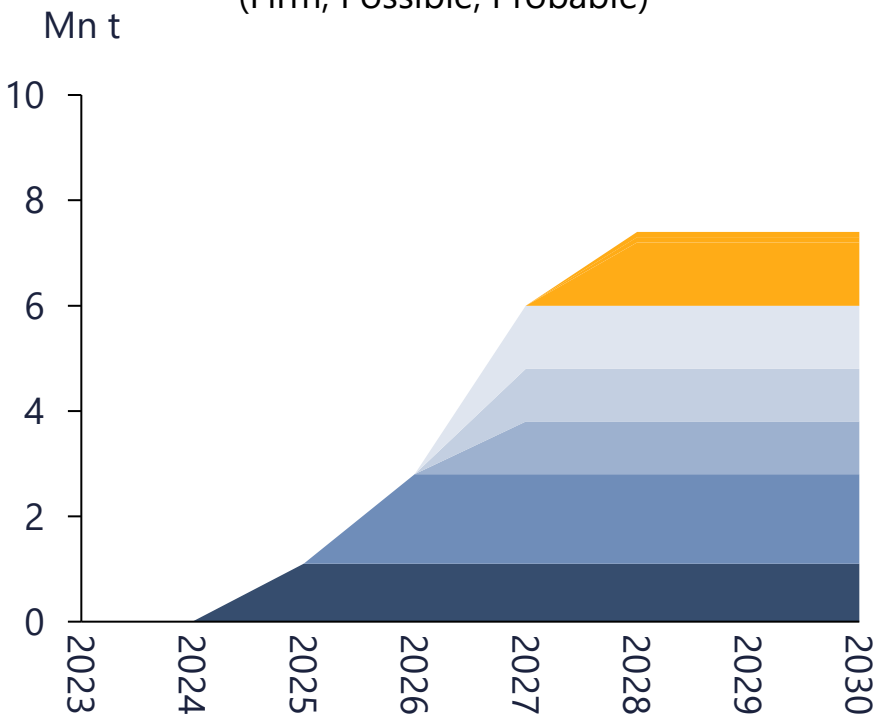
Clean ammonia supply/demand to 2030: Market is balanced to 2030 if we include only the supply projects that Argus ranks as firm/possible/probable

Clean Ammonia Demand Forecast, 2023-2030



Clean Ammonia Supply Forecast, 2023-2030
(Firm, Possible, Probable)



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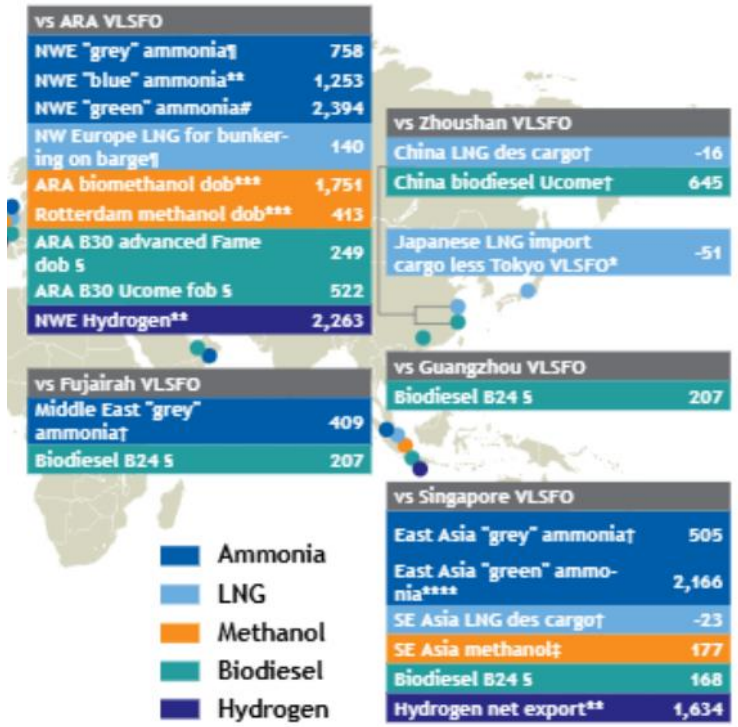
At current prices, ammonia is not a competitive marine fuel

ALTERNATIVE VS CONVENTIONAL MARINE FUEL

Asia-Pacific and Middle East energy equivalent comparisons	$/mn Btu	$/t 0.5%S FOe
Weekly average, week ending 8 Nov		
Grey ammonia East Asia (excl Taiwan) cfr	27.50	1,086.27
Green ammonia East Asia cfr, monthly, Oct	69.16	2,731.64
Methanol Southeast Asia delivered, weekly assessment, 11 Nov	19.19	758.11
LNG des Southeast Asia (ASEA) half-month net calorific value-adjusted	14.12	557.84
Singapore 0.5%S fuel oil delivered	14.72	581.30
Singapore 0.1%S MGO delivered	16.74	-
Singapore 3.5%S fuel oil delivered	12.29	-
Biodiesel B24 (VLSFO blend) Singapore delivered	18.56	733.00
Biodiesel B24 (VLSFO blend) Guangzhou delivered	20.24	796.51
Biodiesel Ucome (used cooking oil) RED bulk China fob	31.30	1,231.97
LNG des China half-month net calorific value-adjusted	14.52	571.59
Biodiesel B24 (VLSFO blend) Fujairah delivered	19.40	766.34
Zhoushan 0.5%S fuel oil delivered	14.92	587.10
Zhoushan 0.1%S MGO delivered	16.39	-
Ammonia Middle East fob spot	24.43	968.20
Fujairah 0.5% fuel oil delivered	14.45	572.75
Fujairah 0.1% MGO delivered	18.45	-

$/t VLSFO-equivalent



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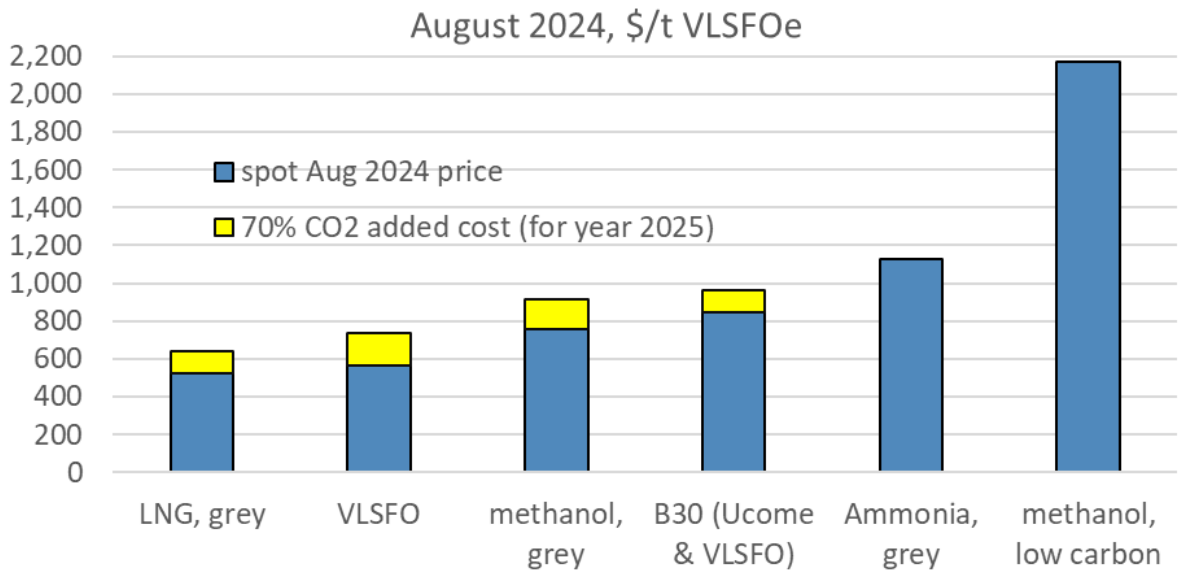
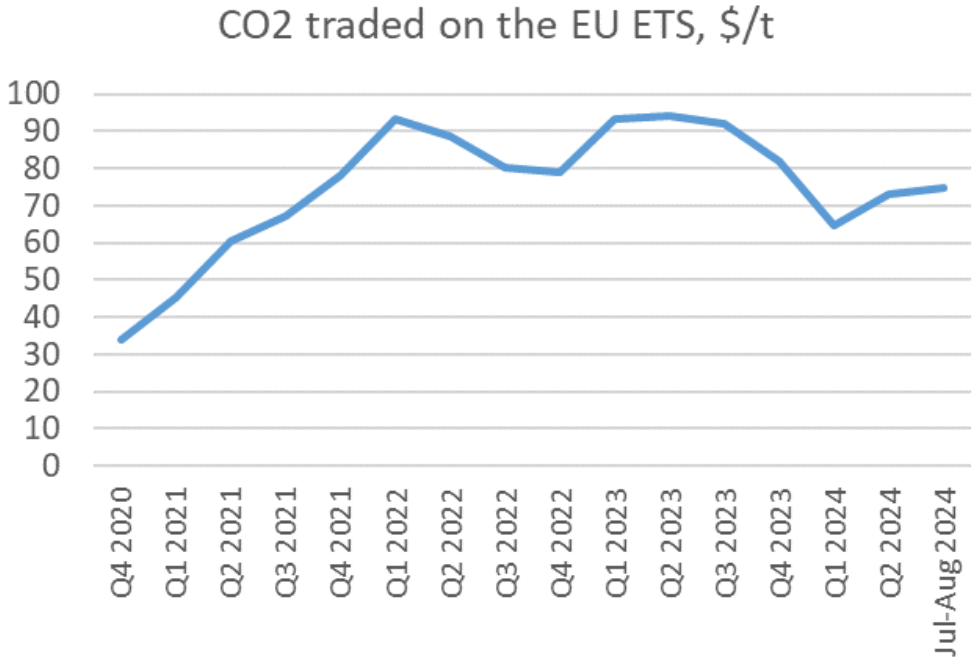
USGC bunker fuels with added CO2* cost

ETS does not have enough impact to bring about switching





Source: Argus Marine Fuels
**CO2 traded on the EU's Emissions Trading System*

- Even with added cost of CO2, VLSFO remains one of the cheapest fuel options in the US Gulf Coast.

Source: Argus Media

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Ammonia vessels are about 10% of all alternative fuel vessels we're tracking

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If you know of a project that is not on this list, let us know at marinefuels@argusmedia.com, and we will add it

Row ID	Shipowner	Charterer	Number of vessels operating on alternat	Option to add more vess (num	Vessel name	IMO vessel num	Vessel size, DWT	Vessel type	Other vessel characteristics	Alternative fuel type	Alternative fuel type more inf	Alternative fuel supplier compar	Vessel: Newbuild or Retrofit	Vessel area of operation	Trial?	Alternative fuel commission year	Alternative fuel commission half yea	Alternative fuel commission quarte	Alternative fuel commission month	Alternative fuel order year	Alternative fuel engine\battery manufacture	Shipyard - alternative fuel installatior	Shipyard location	Year vessel was built
280	Euronav		1					tanker	VLCC	ammonia-ready and LNG-ready			newbuild			2026	2H	4Q				Hyundai Samho		
281	Euronav		1					tanker	VLCC	ammonia-ready and LNG-ready			newbuild			2026	1H	1Q				Hyundai Samho		
282	Euronav		1					tanker	VLCC	ammonia-ready and LNG-ready			newbuild			2026	2H	4Q				Hyundai Samho	Qingdao Beihai, China	
283	Avance Gas		2					gas carrier	VLGC	ammonia-ready and LNG			newbuild			2023	2H					Daewoo Shipbuilding an	South Korea	
289	Hyundai Merchant Marine (HMM)			1				containership		ammonia		POSCO will produce the ammonia; LOTTE Fine will perform the bunkering operation										Korea Shipbuilding & Off	South Korea	
290	Frontline		6					tanker	VLCC	biofuel with option to be retrofitted to burn LNG or ammonia			newbuild			2022-2023						Hyundai Heavy Industries (HHI)		
292	Eneti (formerly Scorpio Bulkers)		1	1				wind turbine installation vessel		ammonia-ready and LNG-ready			newbuild			2024	1H	1Q				Daewoo Shipbuilding & Marine Engineerin		2024
295	Eastern Pacific Shipping (EPS)	OCI	TBA					n/a		methanol and ammonia		OCI N.V., a nitroge	retrofit								MAN				
313	Phoenix Tankers (Mitsui OSK's subsidiary)		2					gas carrier	LPG and ammoni	LPG, possibly to be converted to use ammonia later						2024						Namura Shipbuilding	Japan	
316	Exmar		4					gas carrier	43,000 m3	ammonia		Nutrien	newbuild			2026	1H				WinGD and Wartsila			
327	Fortescue Future Industries (FFI)		1		FFI Green Pioneer (pr	9418743	3,100	offshore supply vessel		ammonia, green			retrofit	Australia		2022								2010
331	Mitsui OSK Lines (MOL)		1					tanker	ammonia carrier	ammonia			newbuild			2026						Mitsui E&S Shipbuilding		2026
332	Aker BP, managed by Eidesvik		1		NS Frøyja	9657650	5,110	offshore supply vessel		fuel cell: ammonia			retrofit											2014
333	Trafigura		6					tanker		ammonia			newbuild			2030								
336	Sumitomo Corp		1				80,000	bulk carrier		ammonia			newbuild									Oshima Shipbuilding	Japan	
371	Hoegh Autoliners		2	4				car carrier		MGO and LNG, but able to transition to a		North Ammonia	newbuild			2024	2H					China Merchants Heavy	China	
372	Hoegh Autoliners		5					car carrier		MGO and LNG, but able to transition to a		North Ammonia	newbuild			2024	2H					China Merchants Heavy	China	
387	AET (subsidiary of MISC Group)	PTT	1					tanker	Aframax	ammonia			newbuild			2025	2H	4Q				Dalian Shipbuilding	China	2025
388	AET (subsidiary of MISC Group)	PTT	1					tanker	Aframax	ammonia			newbuild			2026	1H	1Q				Dalian Shipbuilding	China	2026
398	Geogas		2					tanker	LPG carrier	ammonia-ready			newbuild			2023	1H	2Q	June					2023
413	Ocean Network Express (ONE)		10					containership	13,700 TEU	ammonia-ready or methanol-ready			newbuild			2025/2026					Hyundai Heavy Industries	Nihon Shipyard		2025
433	Pacific International Lines (PIL)		3					containership	8,000 TEU	LNG-fuelled and ammonia-ready			newbuild			2025				2022		Yangzijiang Shipbuilding	China	2025
436	Capital Ship Management Corp.		1		Amore Mio	9326685	299,605	tanker	VLCC	LNG-ready and ammonia-ready			newbuild			2022						Hyundai Samho	South Korea	2022
437	Capital Ship Management Corp.		1		Alkerego	9326697	299,580	tanker	VLCC	LNG-ready and ammonia-ready			newbuild			2022						Hyundai Samho	South Korea	2022
447	Avance Gas		4					gas carrier	VLGC	ammonia-ready and LNG			newbuild			2024						Daewoo Shipbuilding an	South Korea	
472	Grimaldi Group		5					car carrier		ammonia-ready			newbuild	Europe, North Africa and the Fa		2025-2026						China Merchants Heavy	China	
473	Grimaldi Group		5					car carrier		ammonia-ready			newbuild									China Merchants Heavy	China	
475	Southern Devall		1					barge		ammonia			retrofit	US		2023	2H				Amogy			1957
476	Amon Maritime's subsidiary Amor	Offshore	1					service operation vessel		ammonia		Yara	newbuild			2025								
477	Fratelli Cosulich		1					bunker tanker		ammonia			newbuild			2025								
488	K-Line		1					bulk carrier		ammonia			newbuild			2026								2026
511	Vale		2					bulk carrier	coal carriers	methanol (and LNG and ammonia-ready)			newbuild											
541	Hoegh Autoliners		4					car carrier		MGO and LNG, but able to transition to a		Sumitomo	newbuild											
555	Ocean Yield	CMB	8 or 9					bulk carrier	Newcastlemax	ammonia-ready			newbuild			2024-2025								
562	MSC		1					containership	2,800 TEU	ammonia			newbuild			tbd								
575	Grieg Maritime Group		2				82,300	bulk carrier		ammonia-ready			newbuild			2026					CSSC Huangpu Wenchong Longxue		China	
586	NYK Line		1					tanker	gas carrier	LPG, ammonia-ready			newbuild							2023				
587	Faerder Tankers		1					tanker		ammonia			newbuild										China	
588	Faerder Tankers		1					tanker		ammonia			newbuild										China	
613	KSS Line		1					gas carrier		ammonia			newbuild			tbd					WinGD			memorandum of und
618	Eastern Pacific Shipping (EPS)		4				210,000	bulk carrier		ammonia			newbuild			2026					MAN	China State Shipbuilding	China	
624	Bourbon Horizon		2	1				offshore supply vessel		fuel cell: ammonia			newbuild			tbd								
626	Skarv Shipping		1				7,000	multipurpose		ammonia-ready and methanol-ready			newbuild			2025	2H	3Q				Huanghai Shipbuilding	China	
627	Skarv Shipping		3	4			7,000	multipurpose		ammonia-ready and methanol-ready			newbuild			2025-2026						Huanghai Shipbuilding	China	
640	NYK Line		10	5				bulk carrier	copper products,	ammonia		Enaex	newbuild			2028-2029								
647	NorthSea Container Line	NCL Oslofjord	1		Yara Eyde			containership		ammonia			newbuild	North Sea		2026								
654	Maersk		4	6				tanker	ammonia carrier,	ammonia (maybe, tbd)			newbuild			2026	2H	4Q			MAN	Hyundai Samho Heavy I	South Korea	
660	Hoegh Autoliners		1		Hoegh Aurora	9362677	16,250	car carrier		MGO and LNG, but able to transition to a		North Ammonia	newbuild			2024	1H	1Q	January			China Merchants Heavy	China	2024
694	Seaspan Corp		10					car carrier		LNG-burning (but ammonia and methanol-ready)			newbuild			2027						Shanghai Waigaoqiao S	China	
701	Berge Bulk		2				210,000	bulk carrier		ammonia			newbuild			tbd						Qingdao Beihai Shipbuil	China	
702	Wallenius Wilhelmsen		4					car carrier		methanol, ammonia-ready			newbuild			2027			May-November					
703	Wallenius Wilhelmsen		4					car carrier		methanol, ammonia-ready			newbuild			2026	2H					Jingling	China	
708	DFDS		2					ferry		ammonia and battery			newbuild	UK and mainland Europe		2030								
718	Eastern Pacific Shipping (EPS)		6					tanker	ammonia carrier	ammonia			newbuild			tbd							China	
726	BHP		1					bulk carrier		ammonia			newbuild			2026								2026
755	Fortescue Metals Group		1		Fortescue Green Pioneer		3,100	offshore supply vessel	`	ammonia and HVO and diesel			retrofit			2024	1H							2010
756	Trafigura		4					tanker	LPG or ammonia	ammonia			newbuild			2027						Hyundai Mipo Dockyard	South Korea	
772	Amon Maritime's Amon Gas		2					tanker	gas carrier	ammonia			newbuild			2028								
802	Pacific International Lines (PIL)		1		Cota Ocean			containership	8,000 TEU	LNG-fuelled and ammonia-ready			newbuild			2025				2022		Yangzijiang Shipbuilding	China	2025
806	Purus		2					gas carrier	45,000 CBM	ammonia-ready			newbuild			2027				2024		Hyundai Mipo Dockyard	South Korea	
809	Amogy		1		NH3 Kraken			tug		fuel cell: ammonia			newbuild			2024	2H	3Q						

Summary | Alt marine fuel suppliers | Alt fuel vessels excluding LNG | Global LNG-fuelled fleet | LNG bunkering vessels

Ready | Filter Mode | Accessibility: Investigate | Average: 443.4225352 | Count: 71 | Sum: 31483 | Display Settings | 61%

Source: Argus Media

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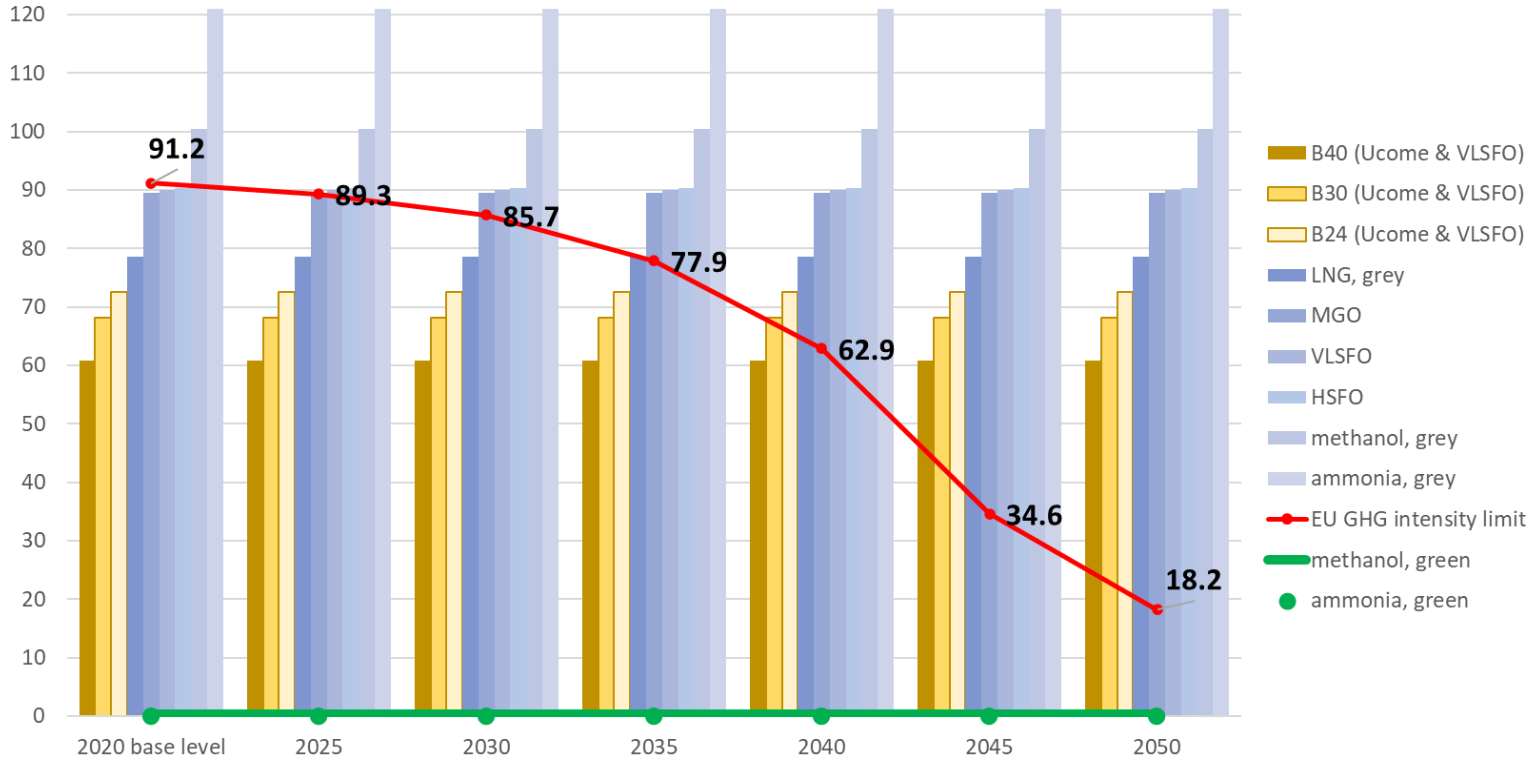
FuelEU – on the face of it, low or zero carbon fuels are not required until 2035

FuelEU GHG intensity limit well-to-wake, gCO2e/MJ



- FuelEU penalty €2,400/t VLFSOe
- Economic fuels that remain compliant longer with the FuelEU GHG intensity limits:
  - "grey" LNG compliant until 2034
  - B24 and B30 compliant through 2039
  - B37 compliant through 2044
- Raising the biofuel blend from 30% to about 40% buys ship owners another 4 years of compliance (from 2040 to 2044).

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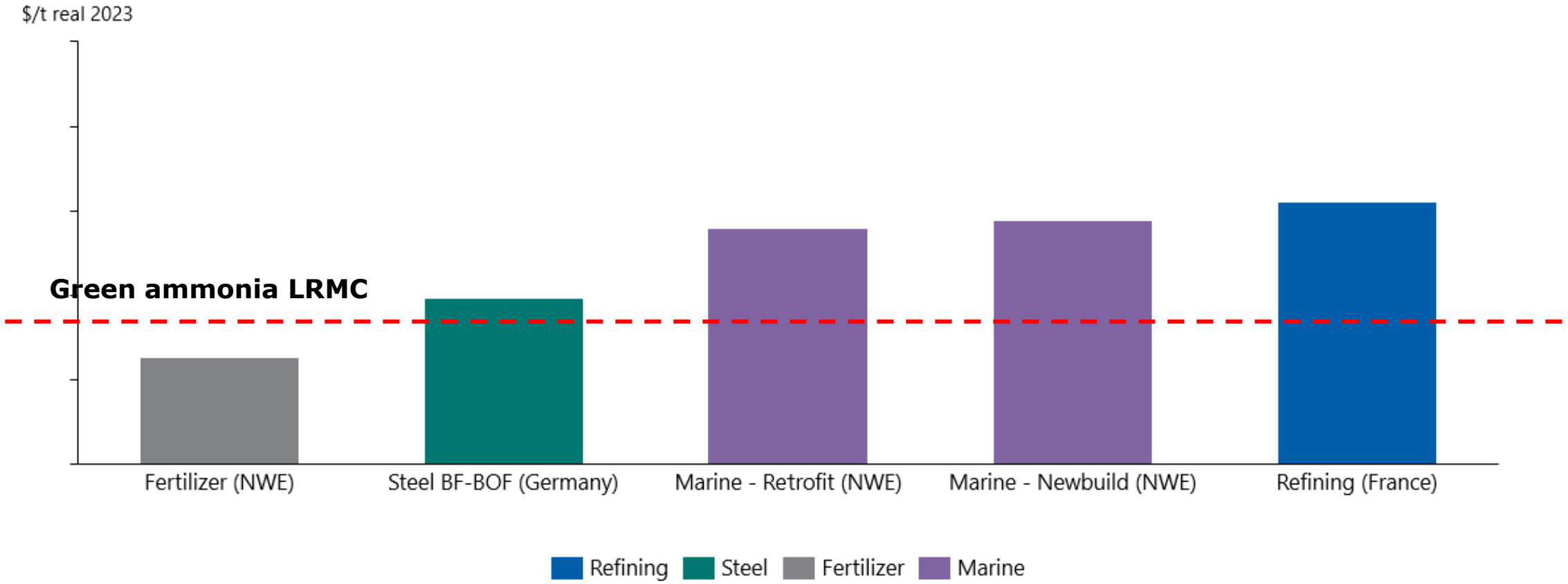
But the pooling mechanism, rewarding over compliance, changes the picture

Price/cost not major barrier to offtake in Europe, particularly for Marine and Refining



Source: Argus Consulting

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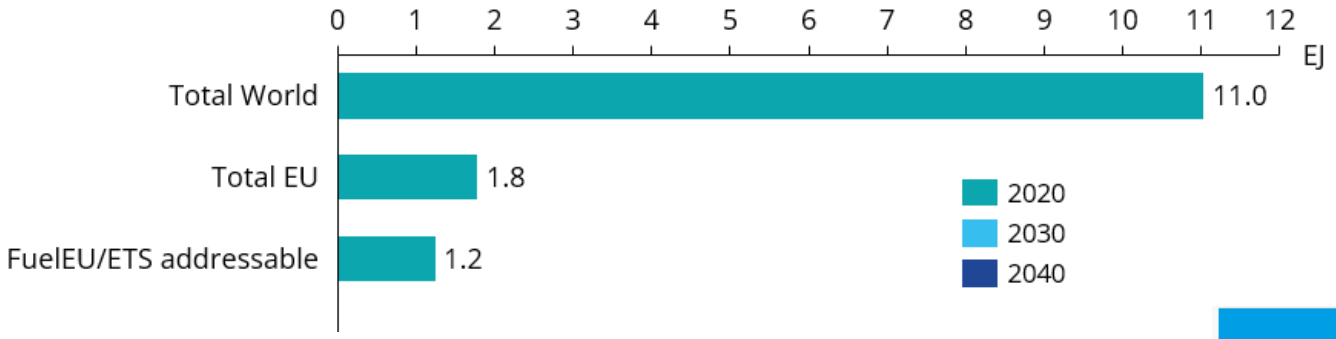
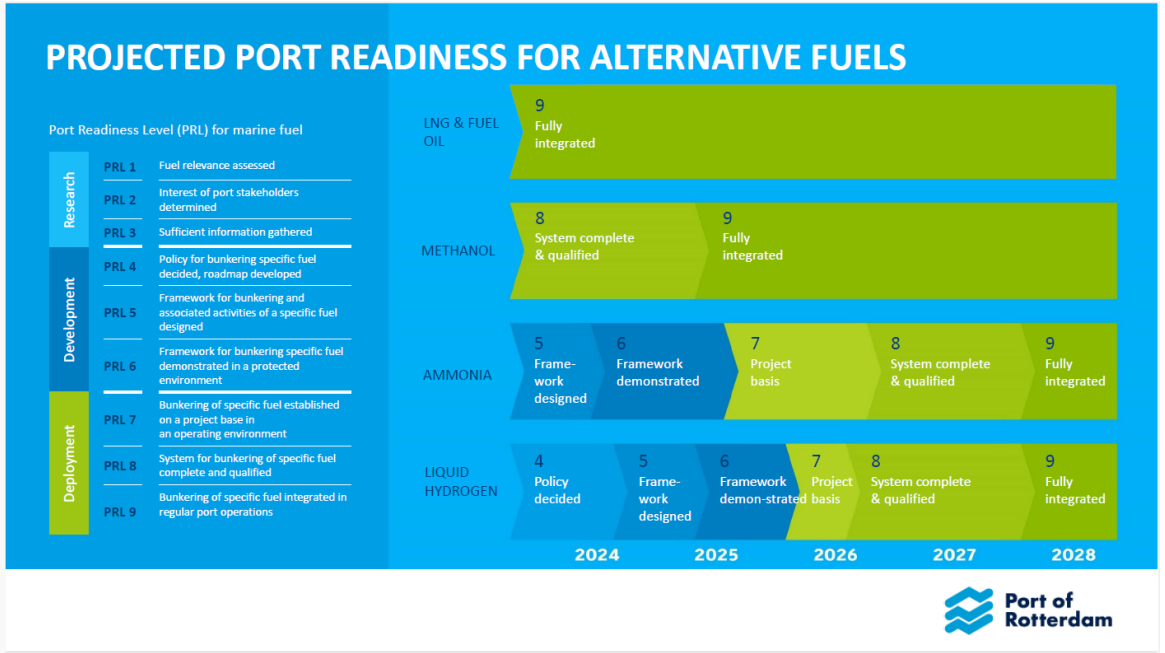
But the EU share of marine fuels is relatively small

So overall, the influence of FuelEU Maritime and EU ETS is limited





Source: Argus analysis

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