

Customized Decarbonization Strategy

■ Pilot Project

Kormarine Conference 2024

Technical Business Development Team / Business Division

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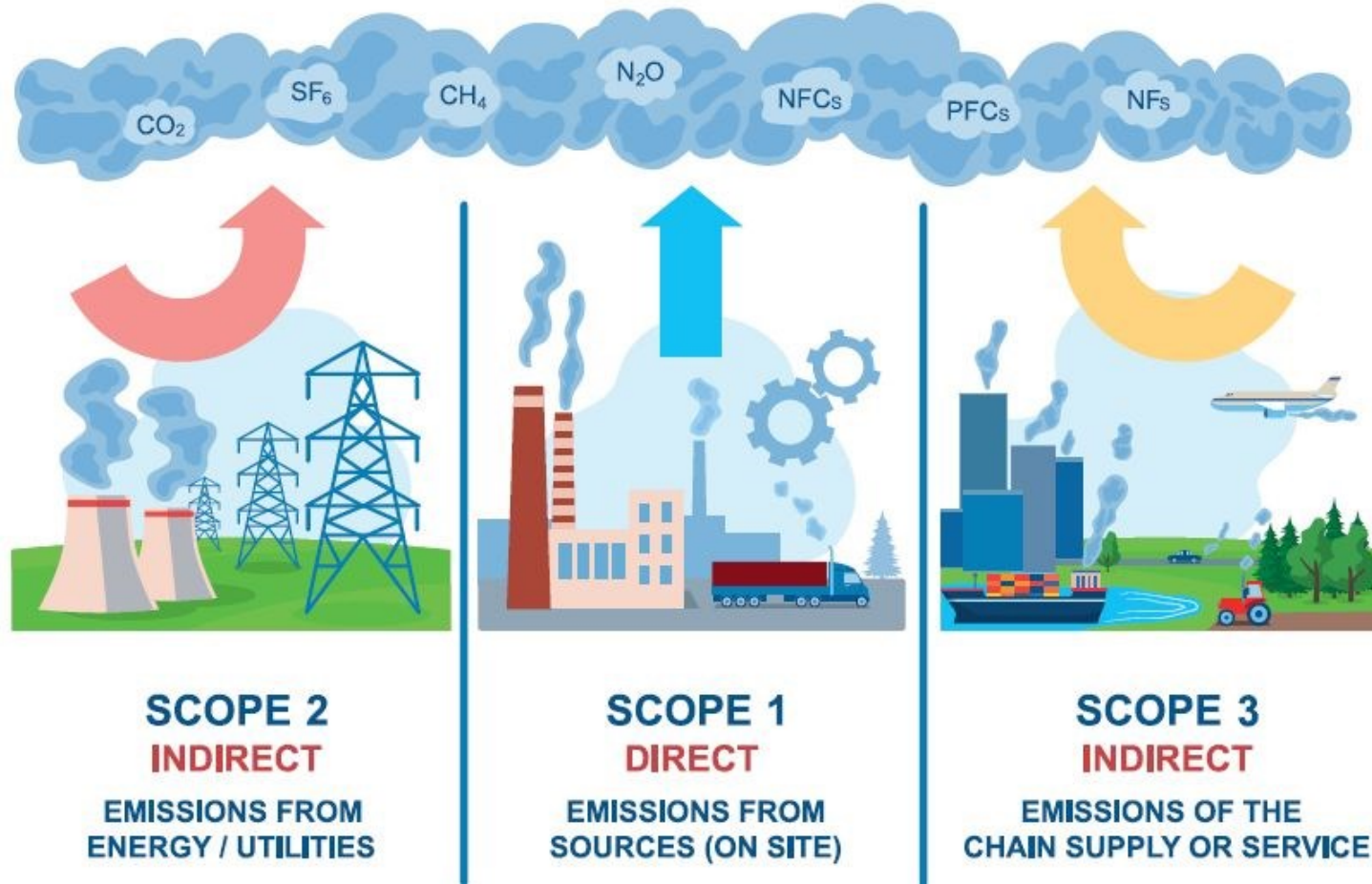


1. Background

Energy Efficiency GHG Reporting Market-based Measure Fuel Standard

	Regulation	Applied to	WtW or TtW	GHG covered	Impacts
IMO	EEDI	≥ 400 GT from 2013	TtW	CO2	Pass or Fail
	EEXI	≥ 400 GT in 2023	TtW	CO2	Pass or Fail
	DCS	≥ 5,000 GT from 2019	TtW	CO2	Monitoring
	CII	≥ 5,000 GT from 2023	TtW	CO2	Corrective Actions
	GHG LEVY <i>(Proposed)</i>	≥ 5,000 GT from 2027	WtW or TtW	CO2, CH4, N2O	Financial
	GFS <i>(Proposed)</i>	≥ 5,000 GT from 2027	WtW or TtW	CO2, CH4, N2O	Financial
EU	MRV	calling EU ports ≥ 5,000 GT from 2018	TtW	CO2 CH4, N2O (from 2024)	Monitoring
	ETS	calling EU ports ≥ 5,000 GT from 2024	TtW	CO2 CH4, N2O (from 2026)	Financial
	FuelEU Maritime	calling EU ports ≥ 5,000 GT from 2025	WtW	CO2, CH4, N2O	Financial
US	IMPA Act of 2023 <i>(Proposed)</i>	calling US ports ≥ 10,000 GT from xxxx	WtW	GHG, NOx, SOx, PM	Financial
	Clean Shipping Act of 2023 <i>(Proposed)</i>	calling US ports ≥ 400 GT from xxxx	WtW	GHG	Financial

SCOPES OF EMISSIONS



Shipping Company
Reduction of Scope 1



Shipper
Reduction of Scope 3

Source : Rudzhan – Stock.adobe.com



- Investment Decision based on the Company's GHG strategy
- 137 Investment Institutions participated on Global
- 7,000 Companies participated on Global



- Finance Loan for Shipping Company considering Climate Variables
- Participation of 11 Global Banks (20% of Shipping Loans)



- Non-profit Organization for Eco-friendly Maritime Transportation under Smart Freight Center
- 25 Shippers and 17 Container Shipping Companies
- Annually Report the Carbon Emissions of Ships belonging to Shipping Companies



2. GHG Emission & Reduction Target

Stage 1

GHG Emission & Reduction Target

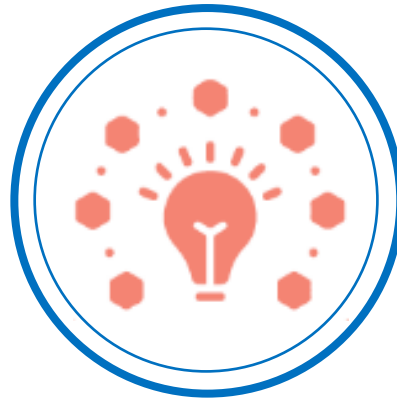


- Fleet GHG Emission
- Regulation Assessment (CII, EU ETS & FuelEU maritime)
- Setting reduction target



Stage 2

GHG Reduction Measures



- Operation Measures
- Energy Saving Technologies
- Alternative Fuels

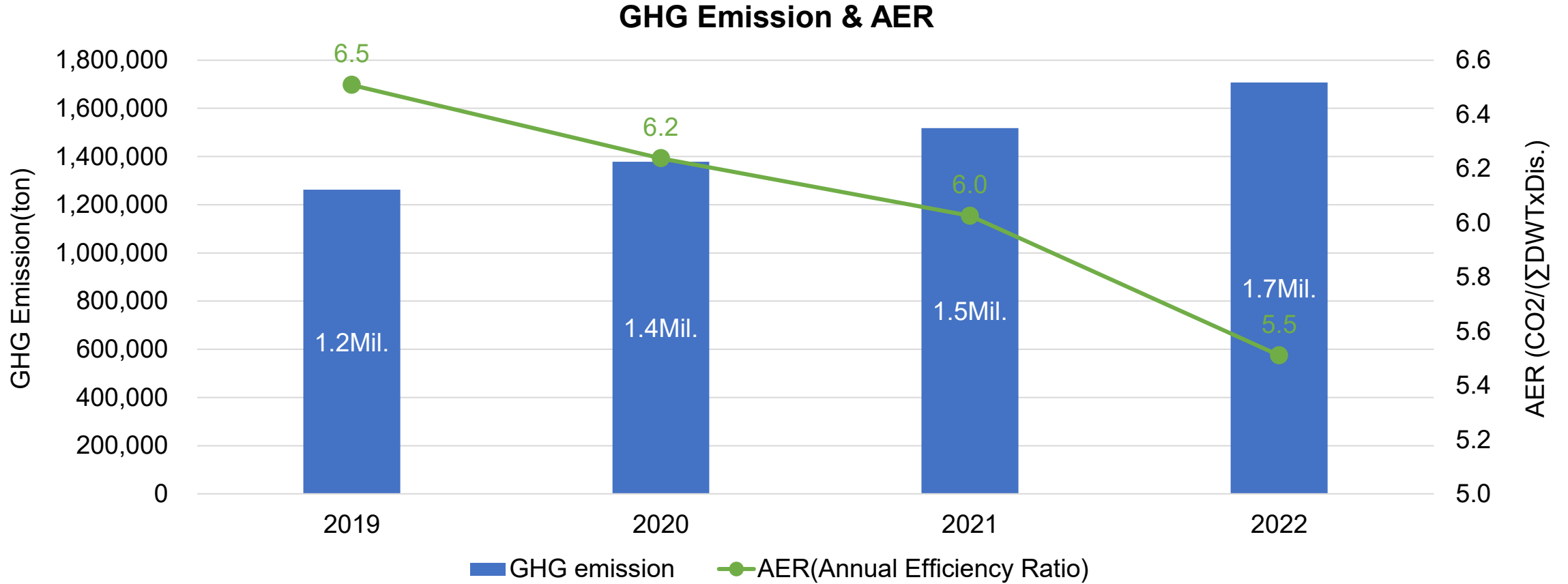


Stage 3

Customized Decarbonization Strategies



- Optimal Pathway

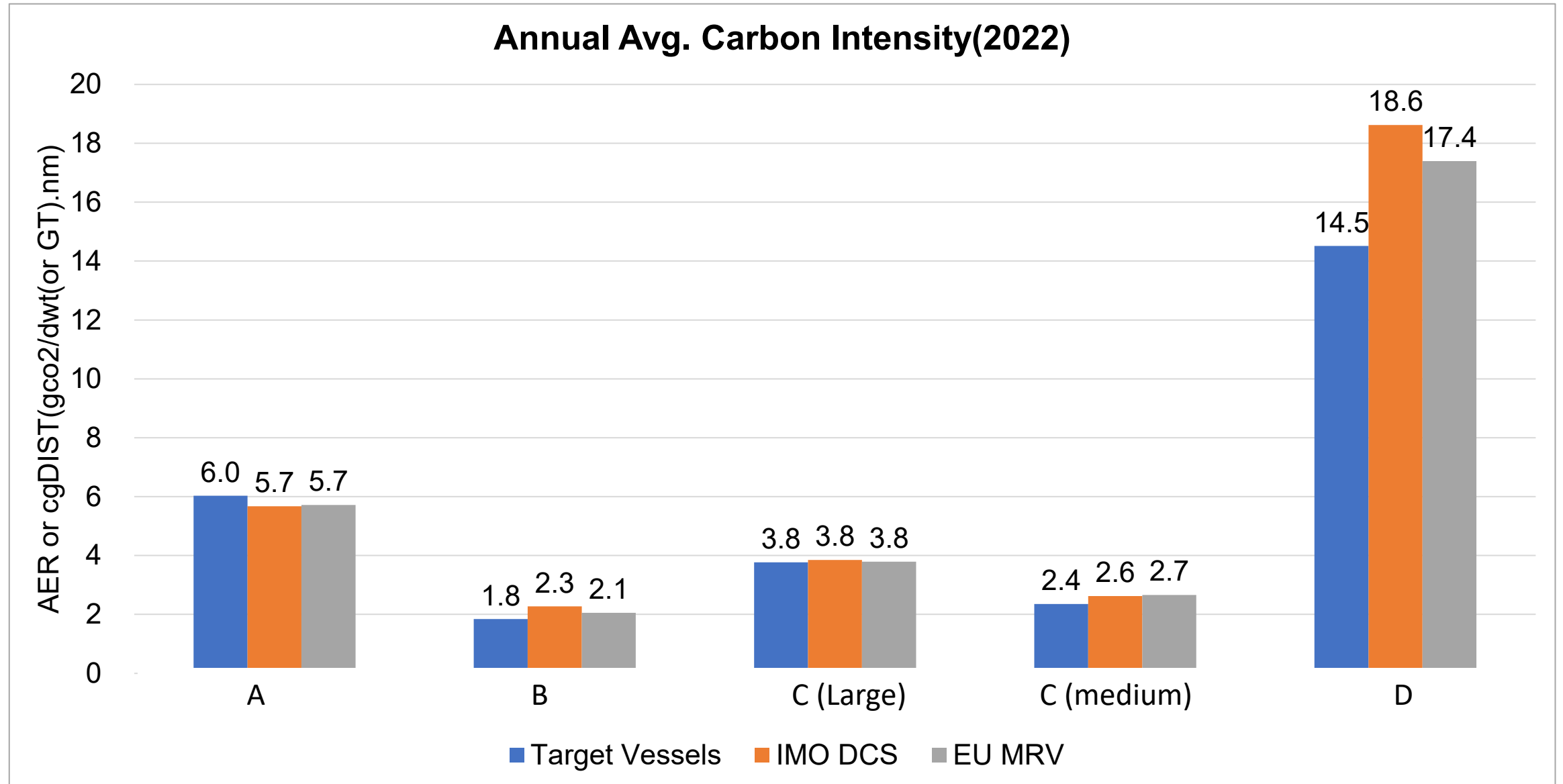


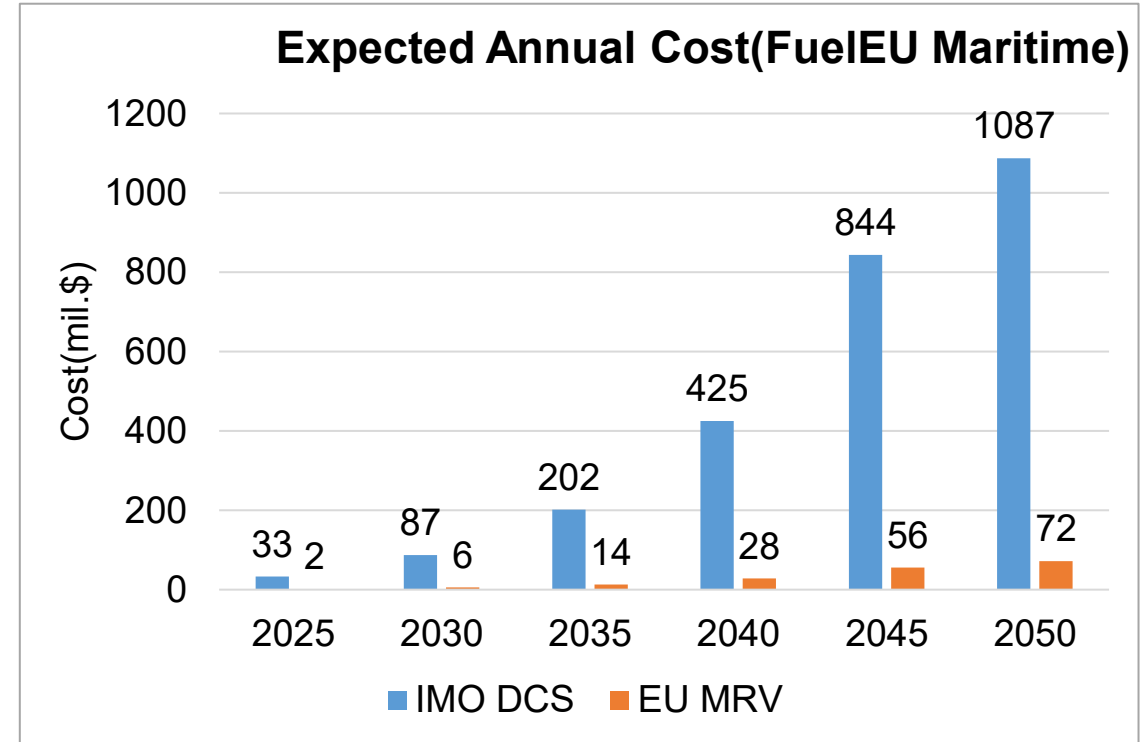
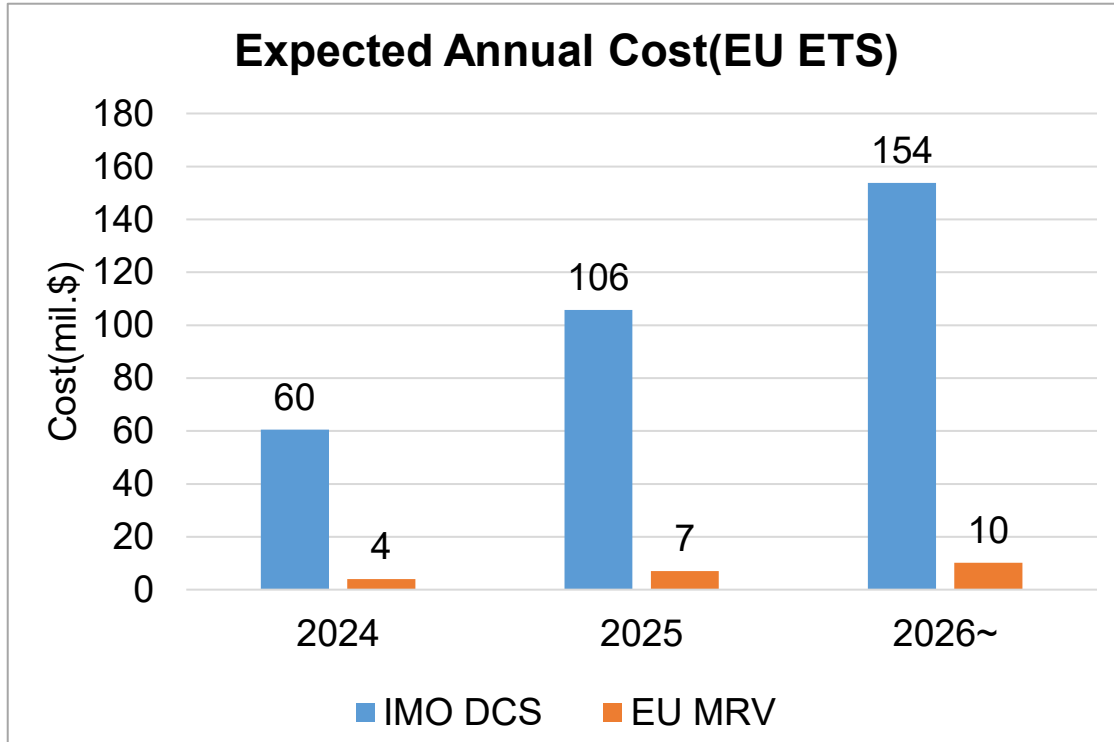
Year	2019	2020	2021	2022
No. of Vessels	36	42	44	46

- GHG Emission: 98% CO2 including CH4 & N2O(GWP CH4: 25, N2O: 298)

Expected CII Rating

No.	Ship type	Name	Delivery	Att. CII				CII Rating				
				2022	2019	2020	2021	2022	2023	2024	2025	2026
1	A	A1	2017	5.27	D	B	B	C	C	C	C	C
2		A2	2017	5.20	A	A	C	C	C	C	C	C
3		A7	2016	5.61	C	B	C	C	C	D	D	D
11		A11	2015	6.30	D	C	C	D	E	E	E	E
12		A12	2015	6.10	D	C	D	D	D	E	E	E
29		A29	2011	6.75	E	E	E	E	E	E	E	E
36	B	B4	2019	1.94	A	A	B	B	B	B	B	B
37		B5	2015	1.90	A	B	B	B	B	B	B	B
41	C	C1	2016	3.75	-	B	C	B	C	C	C	C
42		C2	2015	3.43	-	B	B	A	B	B	B	B
46	D	D1	2016	14.51	C	D	D	B	C	C	C	C





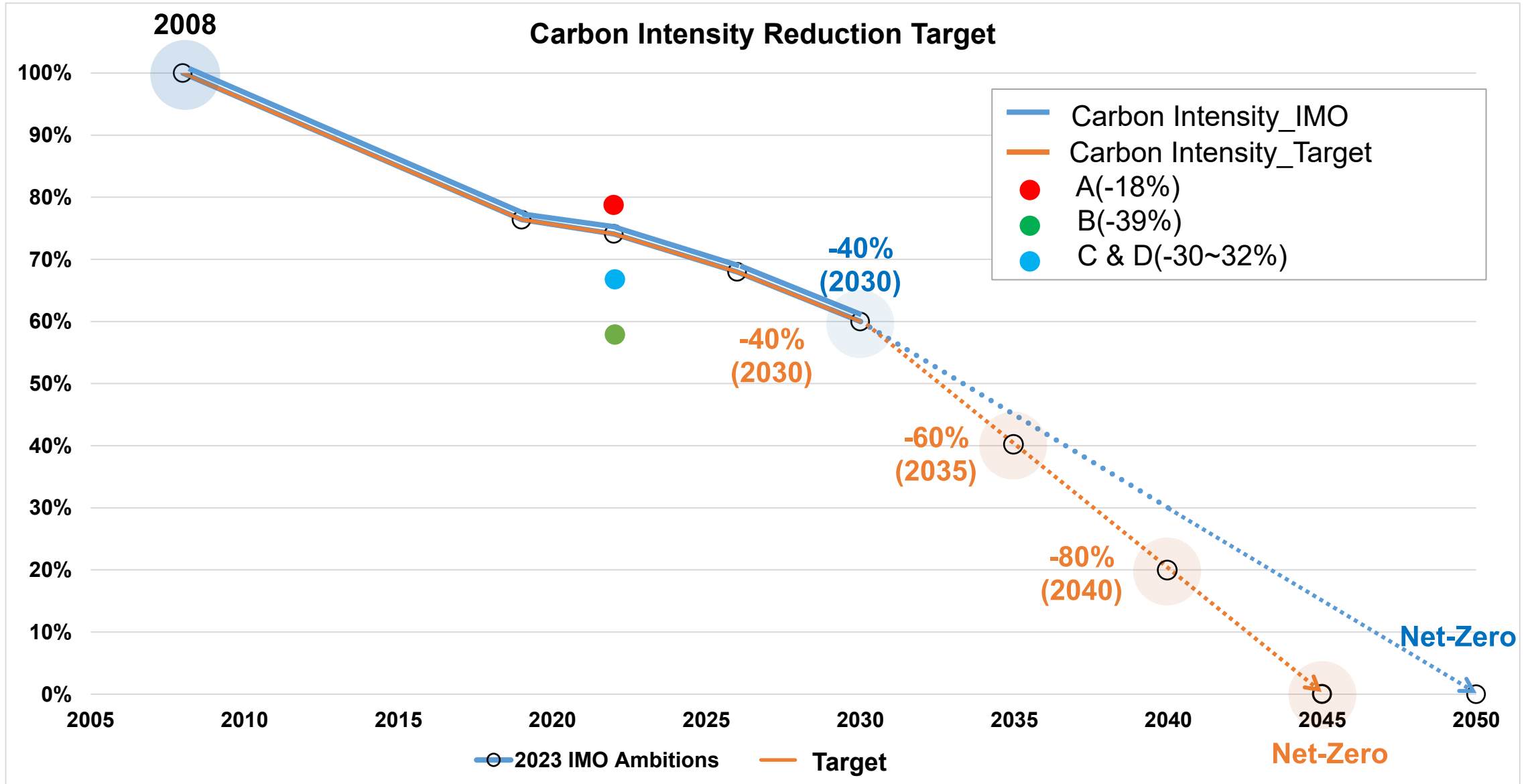
*EUA Price Base : 90 USD/ton CO₂eq

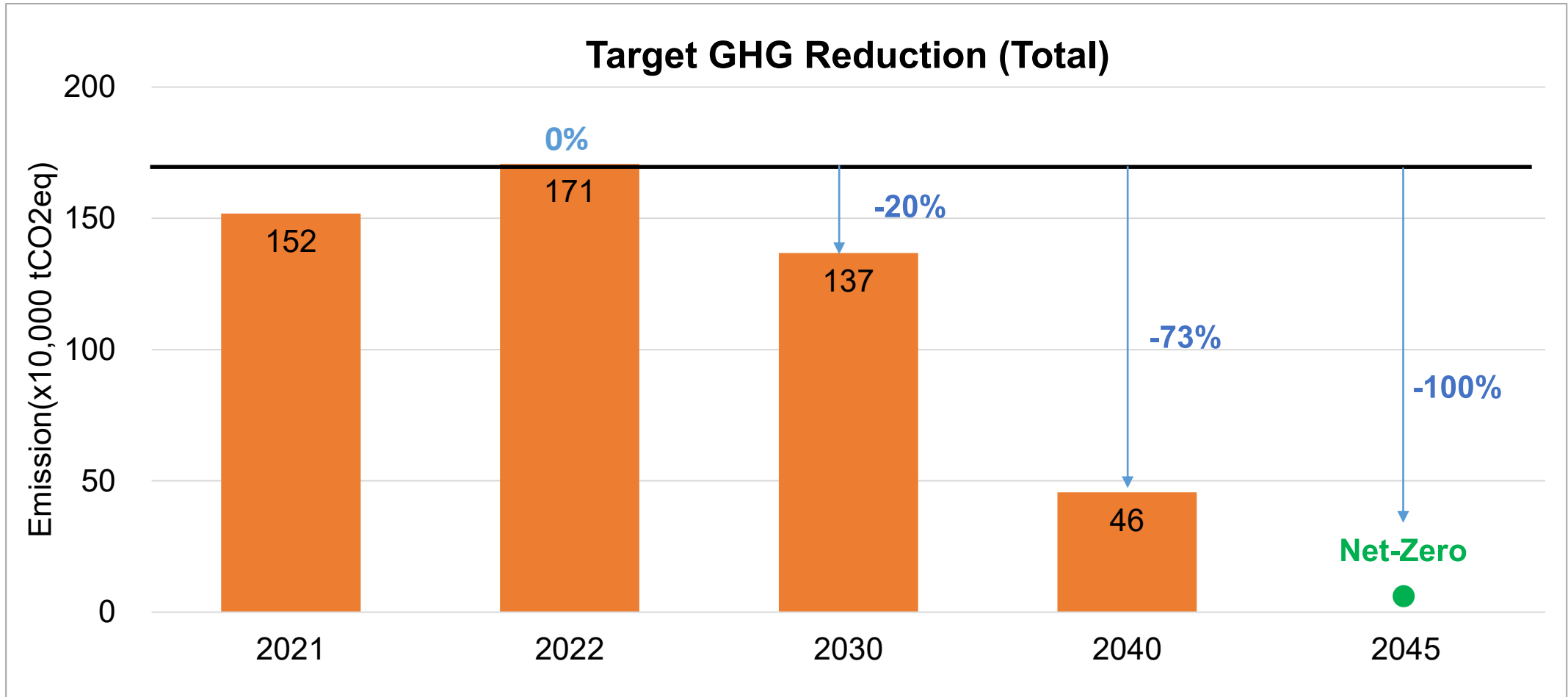
● **IMO 2022 DCS Base(46 ships)**

- Annual Total GHG emission : **1,269,733** ton CO₂eq
- 100% emissions from voyage

● **EU 2022 MRV Base (26 ships)**

- Annual Total GHG emission : **113,523** ton CO₂eq
- Intra EU voyages(100%) / Extra EU voyages(50%)





Year	2022	2030	2040	2045
Target Vessels(46) GHG Reduction(x10,000 tCO ₂ eq)	171	137(20%)	46(73%)	Net-Zero

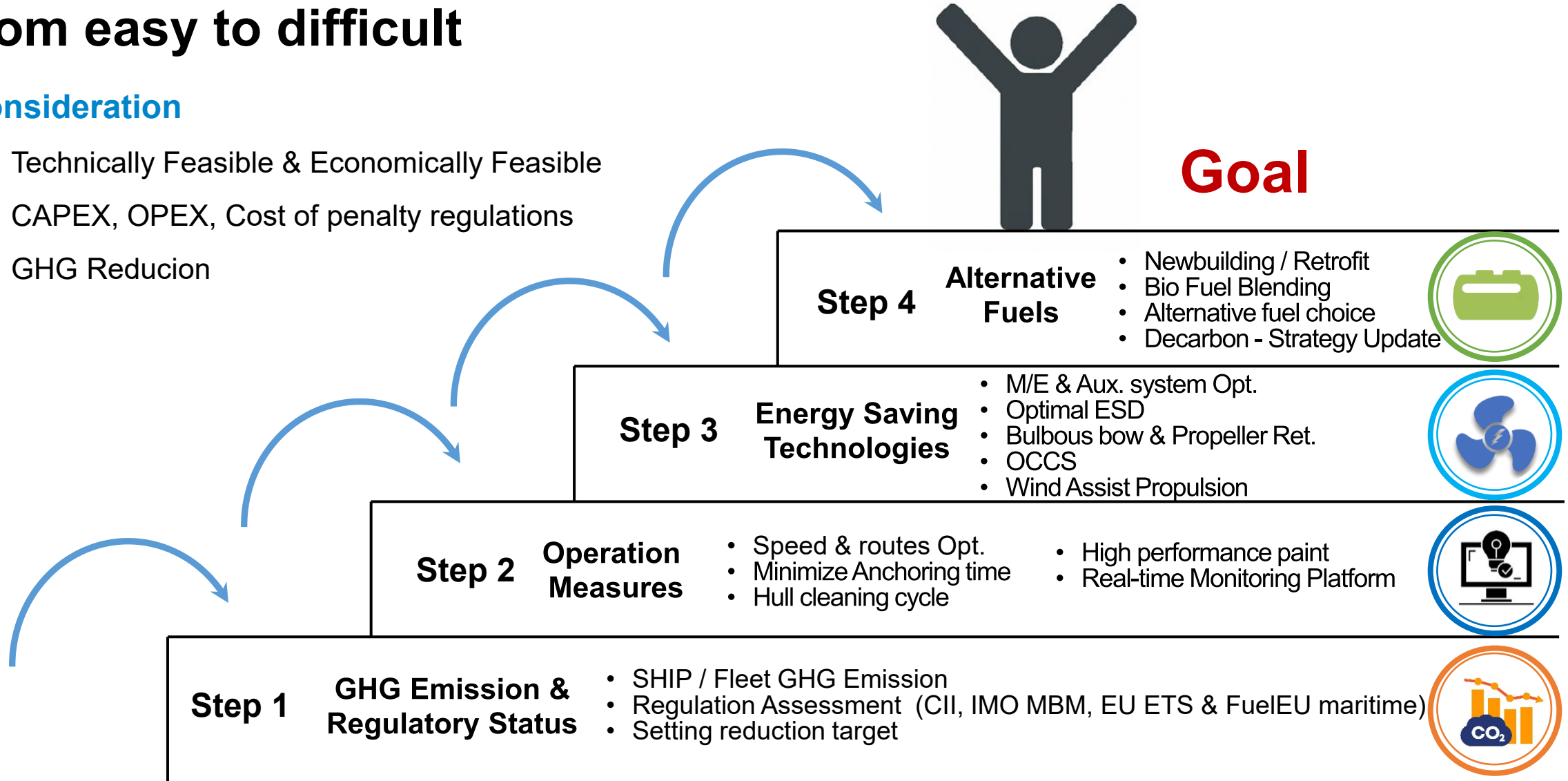


3. GHG Reduction Measures

From easy to difficult

Consideration

- Technically Feasible & Economically Feasible
- CAPEX, OPEX, Cost of penalty regulations
- GHG Reducion



	Option 1	Option 2	Option 3	Option 4	Option 5	Option 6			Option 7
ESD									
	Operating Measure (Speed Down, Digital Platform)	High Performance Antifouling Paint	Bio-Diesel	ESD (EPLO, SAC, VFD, LED, BOILER, PBCF, PSD)	ALS or WAPS	DF Engine (LNG, Methanol, Ammonia)			OCCS
GHG Reduction	6~25% (Vehicle) 4% (Tanker & Bulker)	6.0%	65.0%	1~6% (Vehicle & Tanker) 8~11% (Bulker)	ALS: 3.5% (Vehicle) WAPS: 5~15% (Tanker & Bulker)	Fossil LNG : 17% Bio-LNG : 81%	Bio-Methanol : 85% e-Methanol : 95%	Blue-Ammonia : 87% e-Ammonia : 100%	20.0%
CAPEX (USD)	0.1Mil.	0.5Mil. / 5 years	-	0.8~1.8Mil. (Vehicle & Tanker) 1.8~2.5Mil. (Bulker)	ALS: 3.8Mil. (Vehicle) WAPS: 4.5Mil. (Tanker&Bulker)	45Mil.	36Mil.	41Mil.	30Mil. (Operation Cost : 68/CO2)

ESD: Energy Saving Device
 EPLO: Engine Part Load Optimization
 SAC: Scavenge Air Cooler

VFD: Variable Frequency Drive
 PBCF: Propeller Boss Cap Fin
 PSD: Pre-Swirl Duct

ALS: Air Lubrication System
 WAPS: Wind Assisted Propulsion System
 OCCS: Onboard Carbon Capture System

Ageing & Fouling

- Ageing: Not identified
- Fouling: Depends on Dry-docking year (Better for abt. 2years)

Sea States

- Over 10% Speed Loss: Mostly rough sea routes
- Over 5% Speed Loss: Tidal & Current effects (Identifying current reverse operaton cases)

Design & Reg.

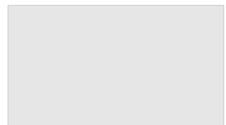
- Design Performance
- Unfair CII Formula (Design Charecterstics)

Anchoring & Berthing

- Normal Case (Non-Propulsion Portion: 10~20%)
- Over 20% vessels identified



Digital Platform



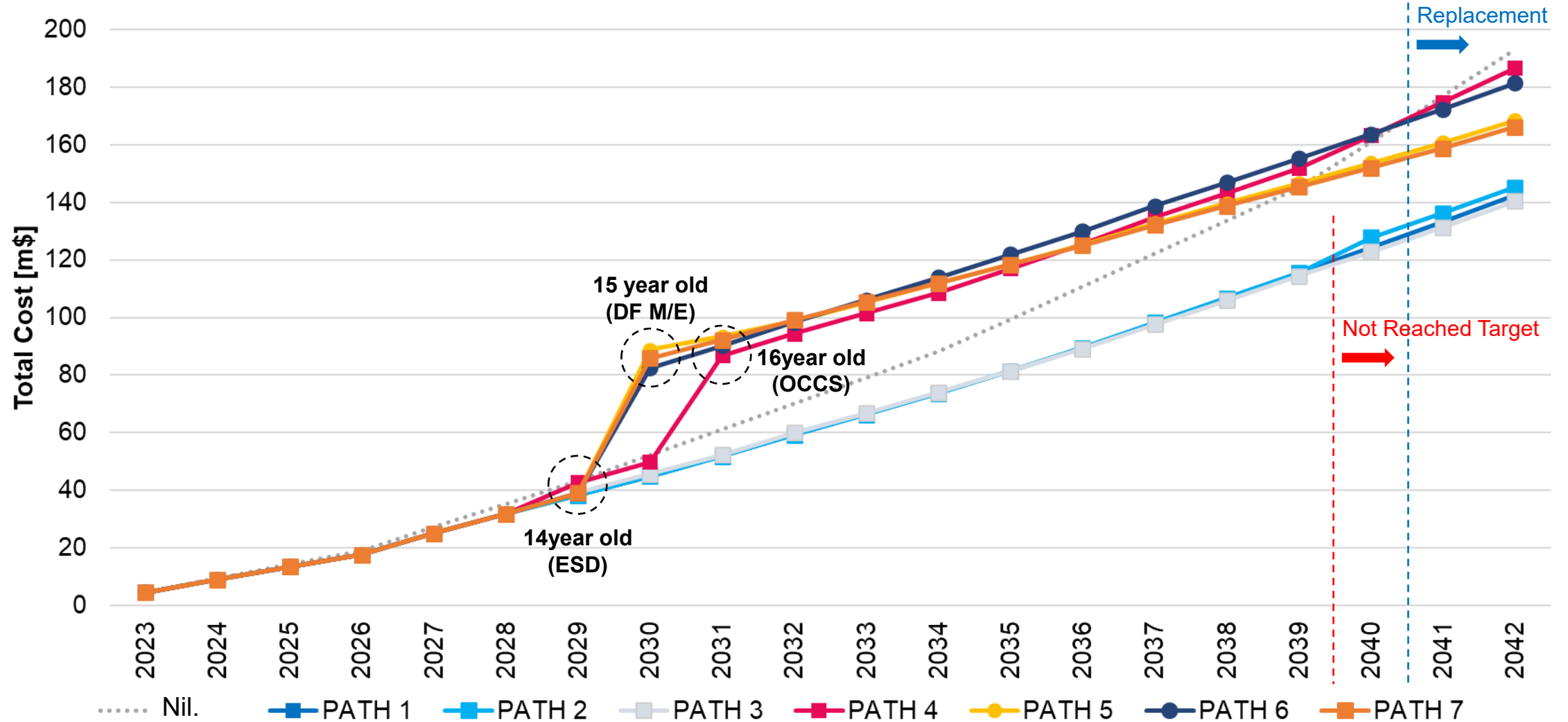
Timing of Each Option by Pathway(Example)

Ship name	PATH	'23	'24	'25	'26	'27	'28	'29	'30	'31	'32	'33	'34	'35	'36	'37	'38	'39	'40	'41	'42	'43	'44	'45	'46	'47	'48	'49	'50	Remark								
Example (A7)	PATH 1	Operational Measure				High Performance Antifouling Paint		Bio-Diesel																														
	PATH 2	Operational Measure				High Performance Antifouling Paint		Bio-Diesel												ALS(Air Lubrication System)																		Satisfying target by 2039
	PATH 3	Operational Measure				High Performance Antifouling Paint	ESD	Bio-Diesel																														
	PATH 4	Operational Measure				High Performance Antifouling Paint	ESD & ALS	OCCS																									Satisfying target by 2033					
	PATH 5	Operational Measure				High Performance Antifouling Paint	ESD	LNG DF (Fossil LNG)	LNG DF (Bio-LNG)																													
	PATH 6	Operational Measure				High Performance Antifouling Paint	ESD	Methanol DF (Bio-Methanol)												Methanol DF (e-Methanol)																		Satisfying target even after 2040
	PATH 7	Operational Measure				High Performance Antifouling Paint	ESD	Ammonia DF (Blue-Ammonia)												Ammonia DF (e-Ammonia)																		

Replacement(25years old) →



Detail Comparison of Cumulative Cost(Example)

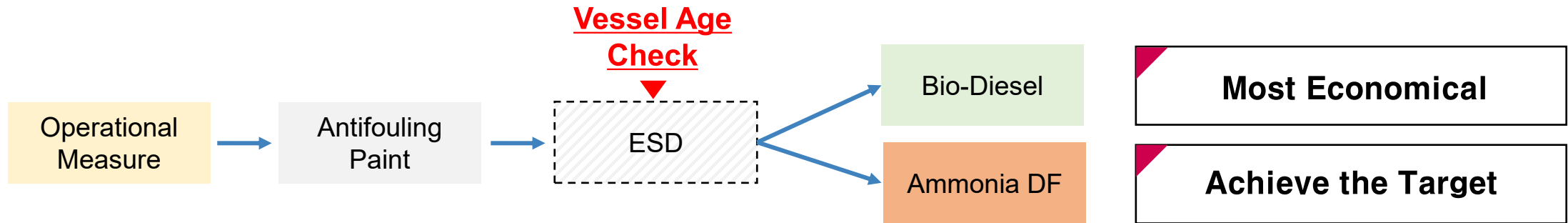


PATH 1: Operational Measure + Antifouling Paint + Bio-Diesel
 PATH 2: Operational Measure + Antifouling Paint + Bio-Diesel + ESD2
PATH 3: Operational Measure + Antifouling Paint + ESD1 + Bio-Diesel
 PATH 4: Operational Measure + Antifouling Paint + ESD1&2 + OCCS

PATH 5: Operational Measure + Antifouling Paint + ESD1 + LNG DF
 PATH 6: Operational Measure + Antifouling Paint + ESD1 + Methanol DF
 PATH 7: Operational Measure + Antifouling Paint + ESD1 + Ammonia DF



4. Customized Decarbonization Strategies




Customized Decarbonization Strategies → Vessel Age, Economic, GHG Target

- 1 **Securing** a Sustainable Biofuel Supply
- 2 **Possibility** of Dual Fuel Engine Conversion
- 3 **Timing** of Applying Optimal Measures for GHG Target

Decarbonization Strategy Plan

No.	Ship type	Ship name	Built year	End year	Satisfying target year	Optimum Pathway																				Total Cost [\\$]				
						Pathway	'23	'24	'25	'26	'27	'28	'29	'30	'31	'32	'33	'34	'35	'36	'37	'38	'39	'40	'41		'42	'43	'44	'45
1	A		2017	2041	2039	PATH 3																								143,905,073
2			2017	2041	2039	PATH 3																								136,123,864
3			2017	2041	2039	PATH 3																								136,076,178
11			2015	2039	2039	PATH 3																								118,520,319
12			2015	2039	2039	PATH 3																								119,450,535
29			2011	2035	2039	PATH 3																								98,275,630
36	B		2019	2043	2050	PATH 7																							243,235,104	
37			2015	2039	2040	PATH 3																							207,060,944	
41	C		2016	2040	2040	PATH 3																							62,438,649	
42			2015	2039	2040	PATH 3																							74,255,767	
46	D		2016	2040	2039	PATH 3																							46,528,237	

 : Operational Measure
 : Antifouling Paint
 : ESD 1
 : Bio-Diesel
 : Ammonia DF(Blue-Ammonia)
 : Ammonia DF(e-Ammonia)
 : Bio-Diesel(Target dissatisfaction)



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