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Supporting Ministry: BAPPENAS

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S-LCA 2026

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Social Life Cycle Hotspot Analysis of using Ammonia as Marine Fuel

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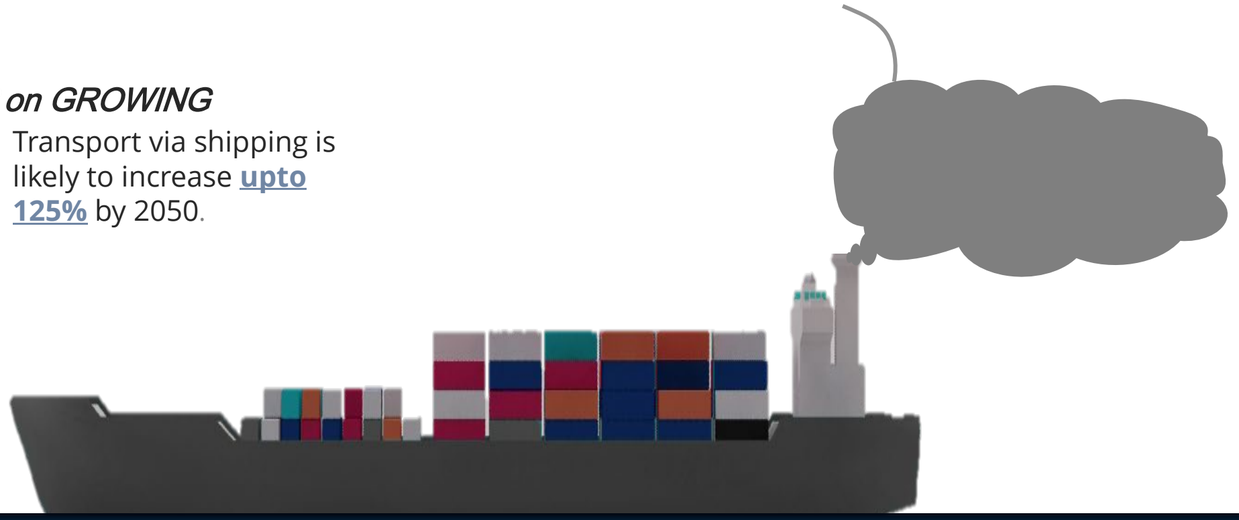
Introduction

SHIPPING and ENVIRONMENT

~ 80% of World trade by volume
~ 3% of total global CO_2 emissions,
> 15% of NOx, SOx, PM, etc..

KEEP on GROWING

Transport via shipping is likely to increase **upto 125%** by 2050.



HARD to ABATE

- **International** nature
- Lock-in with **cheap** fossil fuel, e.g. HFO
- Ship perform **different transport work**
- **Alternative** options are **Immature**
- **Lower energy densities** of alternative fuels

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Introduction

2030

20%
GHG emission
reduction

Striving for 30% reduction

2040

70%
GHG emission
reduction

Striving for 80% reduction

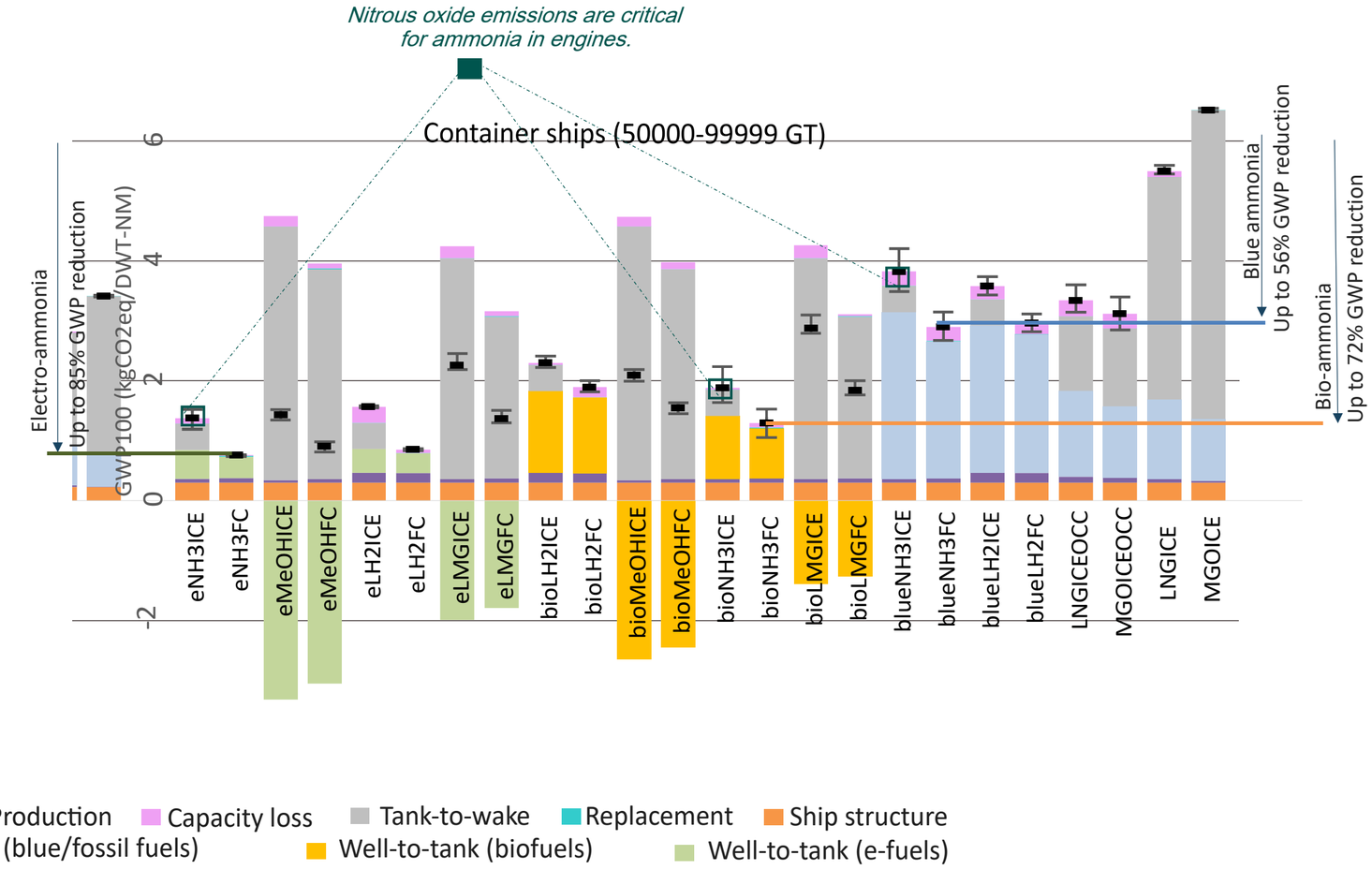
2050

Net zero
GHG emission

Ammonia is anticipated as an important energy carrier for shipping decarbonization.

Ammonia produced via electro -fuel pathway will probably have high role in decarbonization.

Environmental impact



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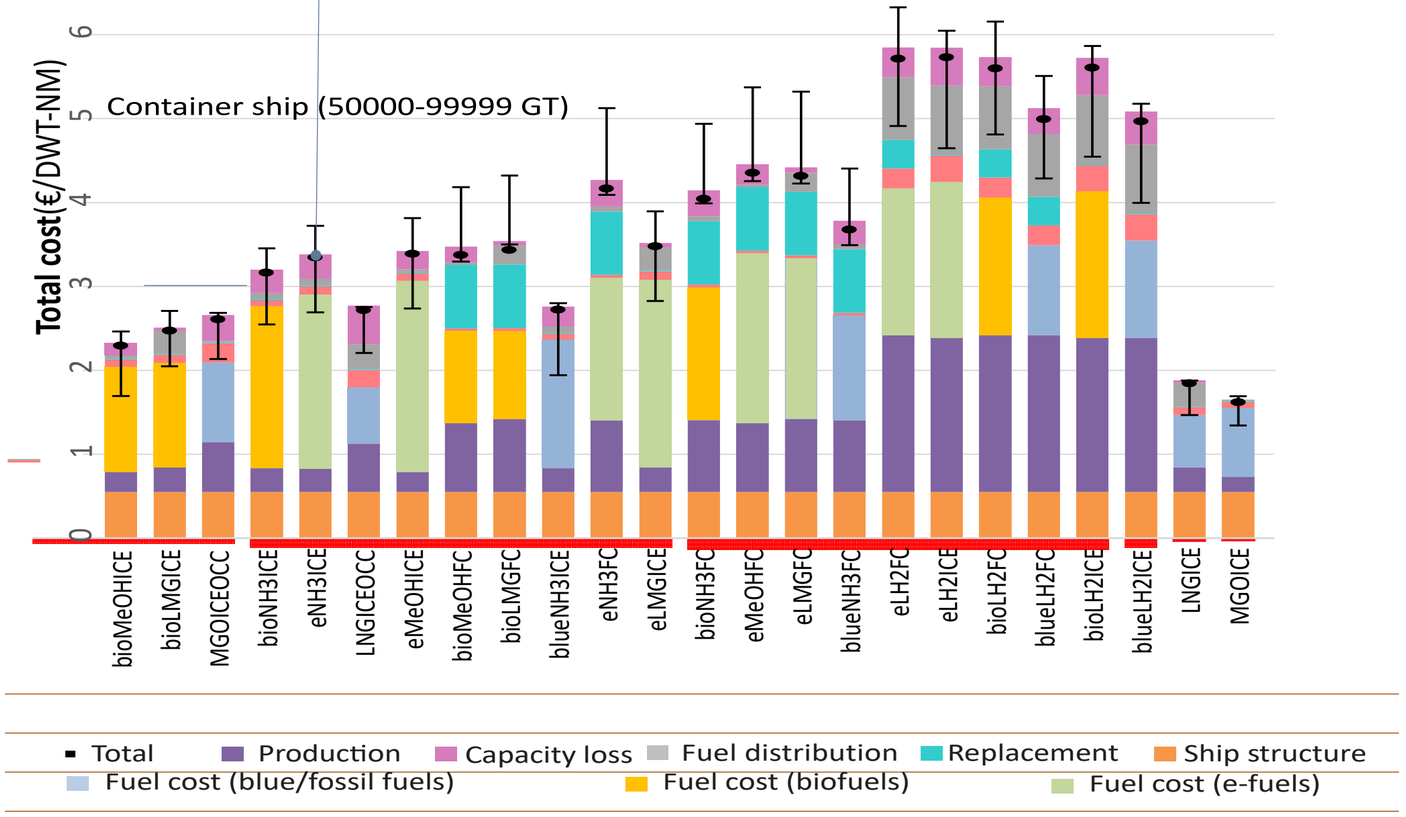
Economic impact

Among electro-fuels, electro-ammonia is one of the cheapest options.



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Method

Goal

The objective is to development of a social hotspot analysis linked to the future deployment of ammonia as marine fuel in EU based on the S-LCA methodology

Scope

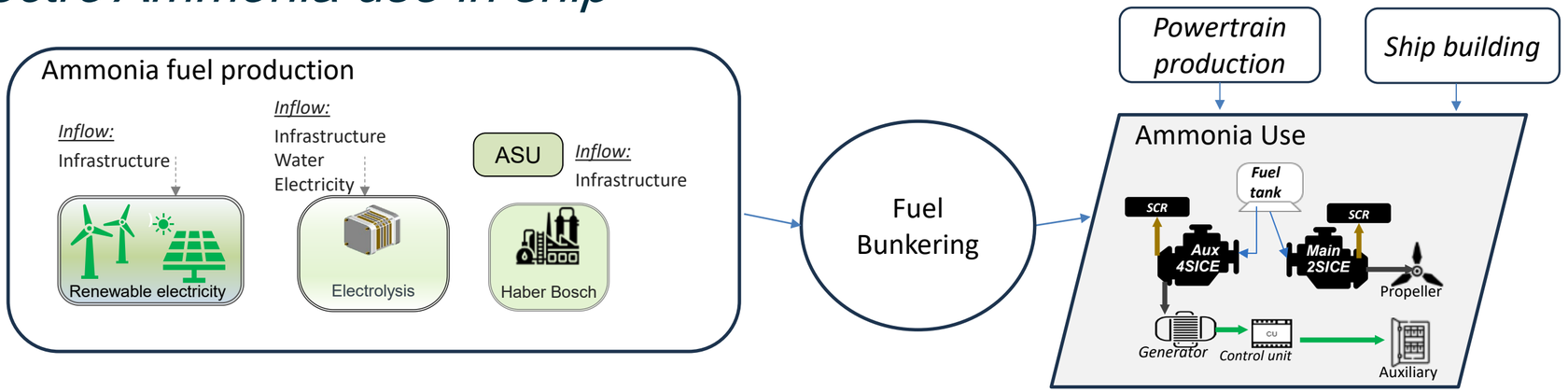
i. Identification of ammonia value chain and key stakeholders	**ii.** Identification of relevant social impact categories and indicators	**iii.** Geographical analysis & modeling emphasizing prospective supply chain	Not performed **iv.** Applying social hotspot analysis using PSILCA to assess the value chains

***Functional unit** : 1 tonne km*

***Time Horizon** : 2030 onwards*

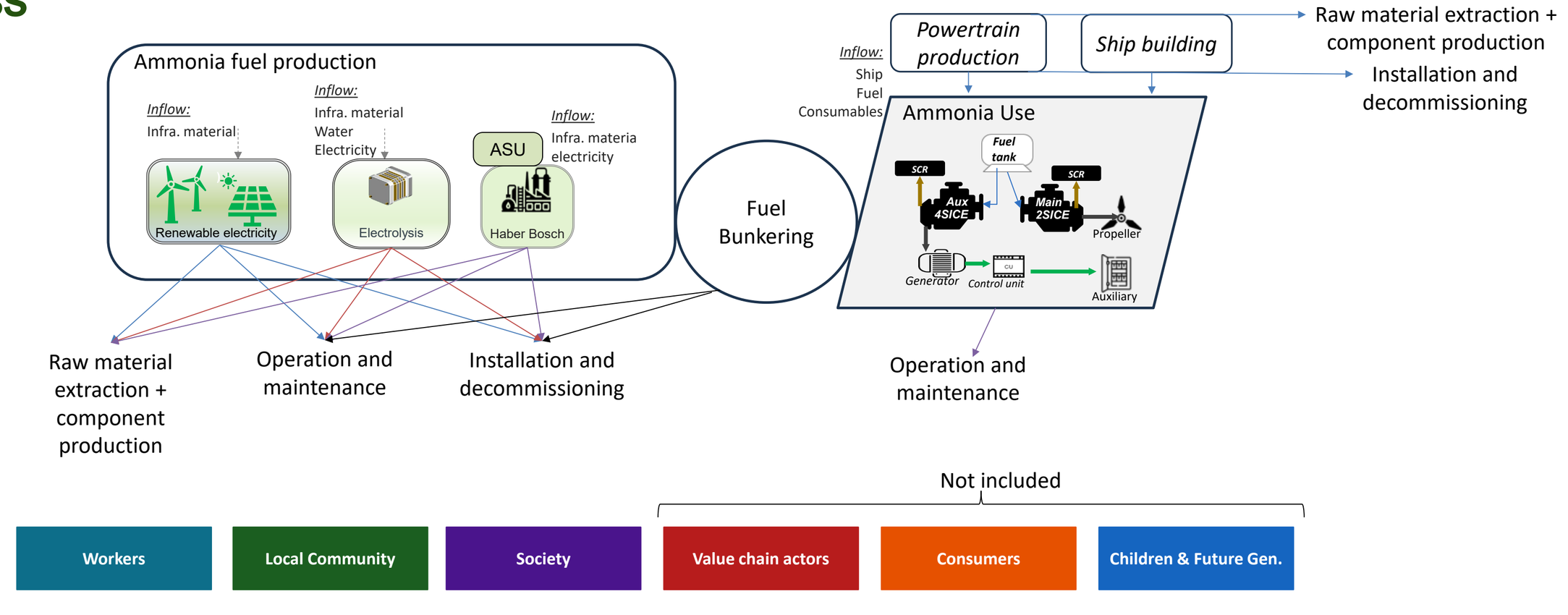
Value chain

Value chain : Electro-Ammonia use in ship



Value chain

Process



Impact category and indicator

Stakeholder: Worker

Relevant PSILCA Indicators	LC Stage	Potential social risks or social opportunity
• Child labor • Health and safety • Freedom of association and collective bargaining • Gender wage gap • Fair salary	**Wind power generation**	Mining of Critical materials including rare earth metals Wind turbine component production locations in China Occupational hazards – electric (installation and operation)
	Solar power generation	Solar panel component production locations in China Occupational hazards – electric (installation and operation)
	Electrolysis	Extraction and processing of electrolyzer materials like iridium, nafion and platinum
	Haber-Bosch / NH_3 Synthesis	Occupational hazard with ammonia inhalation risk, toxic gas exposure Catalyst mining and production
	NH_3 Storage, Transport & Bunkering	Occupational hazard with ammonia inhalation risk, toxic gas exposure Catalyst mining and production
	On-board Operations (Seafarers)	Occupational hazard with ammonia inhalation risk, toxic gas exposure Catalyst mining and production Gender wage gap are salient.

Impact category and indicator

Stakeholder: Society

Relevant PSILCA Indicators	LC Stage	Potential social risks or social opportunity
• Contribution to economic development • Poverty alleviation • Local employment • Safe and Healthy living condition	Wind power generation	New national-scale jobs in wind O&M and supply chains — contribution to GDP in producer nations Poverty alleviation through energy access and industrial wage employment in emerging economies Improved air quality at societal level (displacing fossil combustion)
	Solar power generation	Energy access benefits for communities in producer nations Economic development via large-scale solar manufacturing and export revenues Reduced fossil fuel import dependency improves macroeconomic stability
	Electrolysis	Electrolyser manufacturing scale-up creates high-value industrial employment Improved energy security — reduces national fossil fuel import bills
	Haber-Bosch / NH_3 Synthesis	New high-skill employment in chemical process industries Reduced atmospheric pollution vs. present ammonia production based on SMR
	NH_3 Storage, Transport & Bunkering	Ammonia leakage
	On-board Operations	Nitrogen oxide, nitrous oxide emissions affecting pollution Reduction of SOx and PM emissions if otherwise HFO/MGO is used.

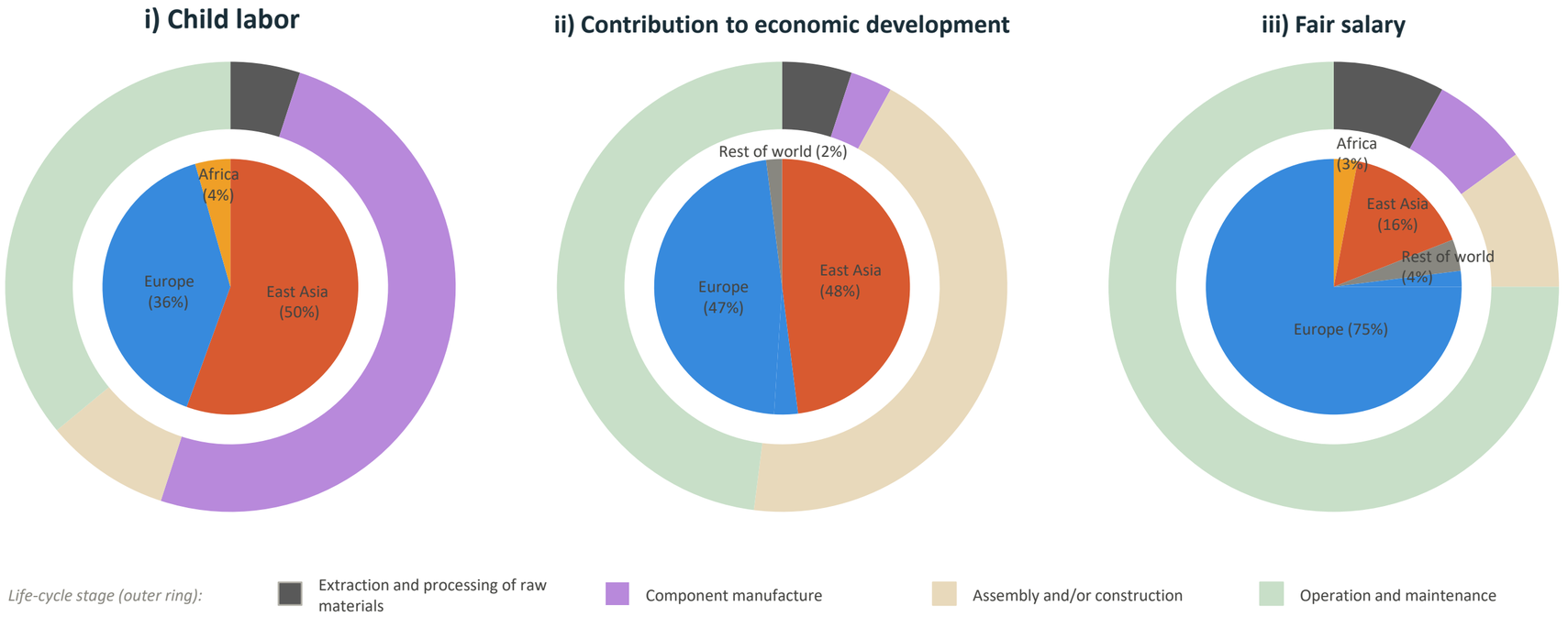
Impact category and indicator

Stakeholder: Local community

Relevant PSILCA Indicators	LC Stage	Potential social risks or social opportunity
• Environmental footprint • GHG footprint • Contribution to public health (DALYs) • Access to material resouces	**Wind power generation**	Mineral extraction depletes finite material resources Land use footprint
	Solar power generation	Toxic release risk during manufacturing (DALYs) Land use footprint
	Electrolysis	Water consumption at scale Mineral extraction depletes finite material resources
	Haber-Bosch / NH_3 Synthesis	Acidification of soils and marine eutrophication from NH_3 leakage. Mineral extraction (catalysts) depletes finite material resources
	NH_3 Storage, Transport & Bunkering	Acidification of soils and marine eutrophication from NH_3 leakage
	On-board Operations	N_2O emission from on-board NH_3 combustion Residual NOx emissions from NH_3 combustion engines Acidification of soils and marine eutrophication from NH_3 leakage

Impact category and indicator

Preliminary Results



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Future Work

- Social Hotspot analysis considering geographical analysis.
- Prospective temporal resolution of the supply chain
- Decommissioning of infrastructure and ship scrapping may be included.
- Evaluate the supply risk and supply performance using a Reference scale approach

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Thank you!

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ADVANCED POWER CONVERSION TECHNOLOGIES BASED ON ONBOARD AMMONIA CRACKING THROUGH NOVEL MEMBRANE REACTORS

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