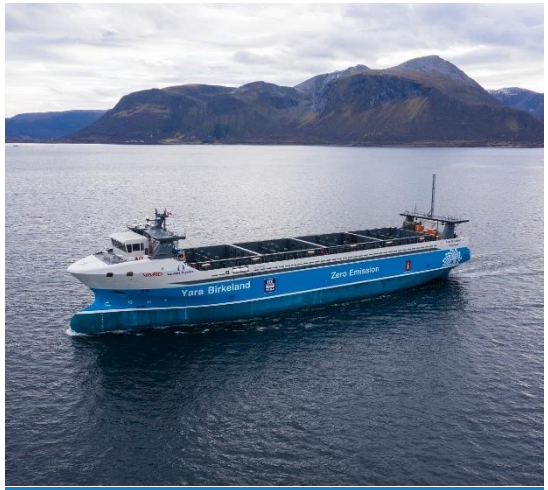
Yara Clean Ammonia

Championing decarbonized shipping

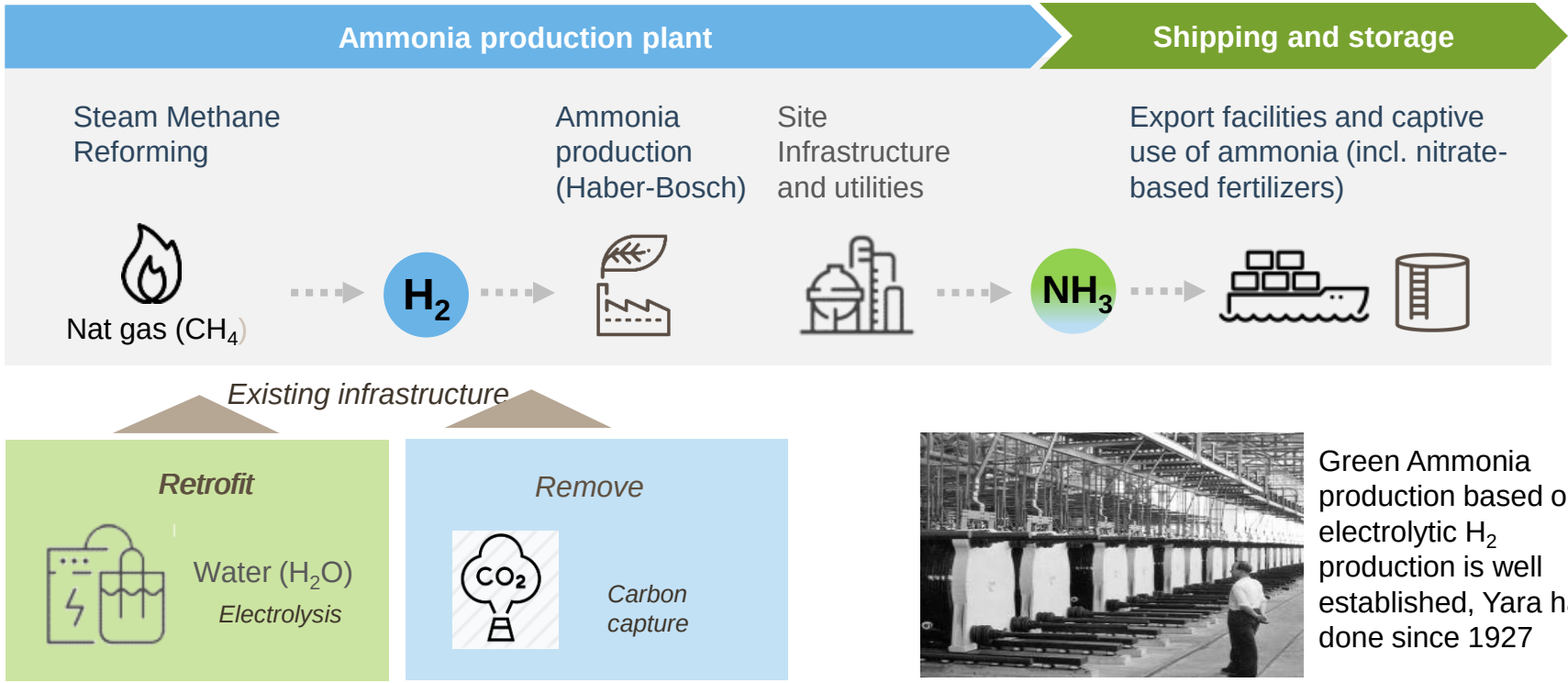
Yara Clean Ammonia

Yara Marine Technology



Yara Birkeland

Existing ammonia infrastructure is the most efficient route to a hydrogen enabled market



Green Ammonia production based on electrolytic H_2 production is well established, Yara have done since 1927

Snapshot of the clean ammonia market opportunity

Grey ammonia
An important input for the agriculture and industrial end-markets

Blue ammonia
Key enabler for decarbonization and new segments as the low-carbon cost leader

Green ammonia
Long-term fully renewable option, but will require significant progress on costs

>USD 220bn
(market by 2050E)

Shipping fuel
USD 87bn
Most competitive clean fuel for deep-sea shipping

Power generation
USD 10bn
Flexible low-carbon fuel for base load power generation

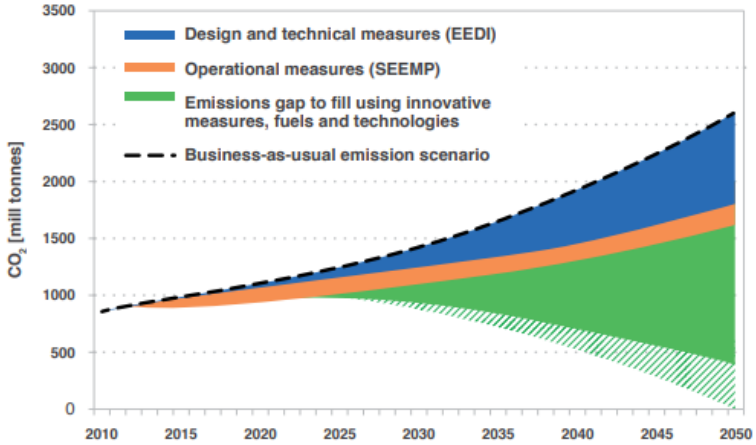
Agriculture/ Industrial
USD 111bn
Robust and large demand served by mix of grey and clean ammonia

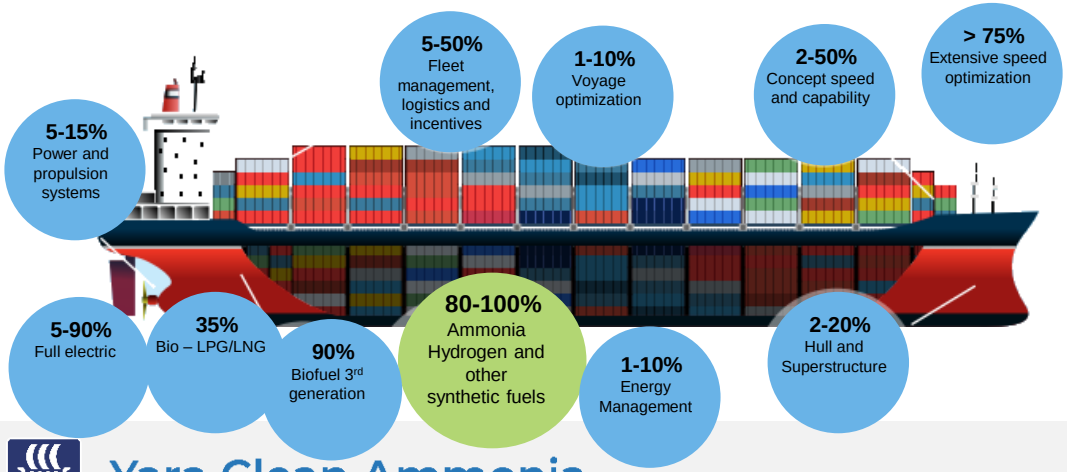
Hydrogen carrier
USD 17bn
Ideal long-distance carrier due to ammonia's superior properties

Source: Arkwright market study 2021
Note: Market value in real 2021 terms, assuming an inflation rate of 2% starting 2021

IMO strategy to reduce GHG emissions from International Shipping

- Maritime transport emits around 940 million tonnes of CO2 annually and is responsible for about 2.5% of global greenhouse gas (GHG) emissions
- According to the 3rd IMO GHG study, shipping emissions could under a business-as-usual scenario increase between 50% and 250% by 2050
- IMO strategy (2018): 50% GHG emission cuts by 2050





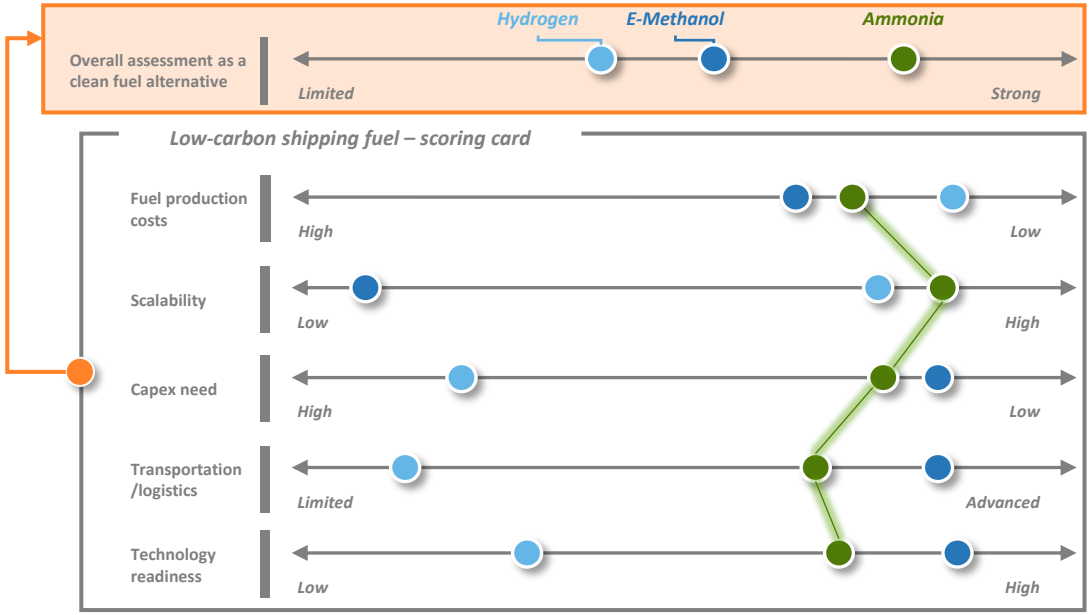
In order to achieve these ambitious goals of GHG emission reduction a mix of technical, operational and innovative solutions is required.

Source : IMO

Yara Clean Ammonia

Ammonia is the most promising solution for clean fuel in deep-sea shipping

Comparison of shipping fuel alternatives



E-Methanol

- **E-Methanol is not a zero-carbon fuel**, as it emits CO2 when combusted
- Methanol will **only be emission-free if the carbon going into e-methanol is captured from a source where it would otherwise be emitted or captured after combustion**; this is very expensive and difficult to scale
- In light of its **low scalability**, there is **limited incentive for large-scale adoption**

Hydrogen

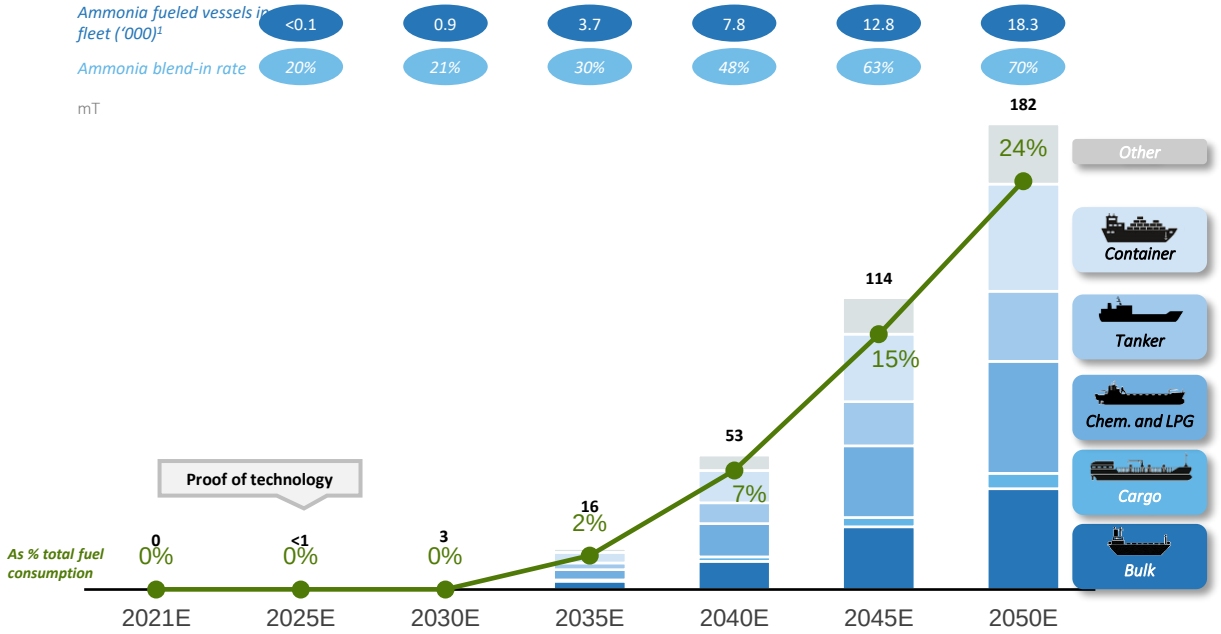
- Lower **energy density** disadvantageous for longer-distance shipping
- **Limited existing infrastructure** vs. ammonia
- **Hydrogen fuel cells are not expected to be available at commercial scale before 2028/2029**, while ammonia engines should be available from 2024/2025

"Ammonia (green and blue) is the most promising carbon-free deep-sea fuel in the long run" – DNV

Source: Arkwright market study 2021

Rapid growth in the use of ammonia as a shipping fuel is expected to create a USD 87bn market by 2050

Ammonia demand outlook in the shipping fuel segment



Key drivers

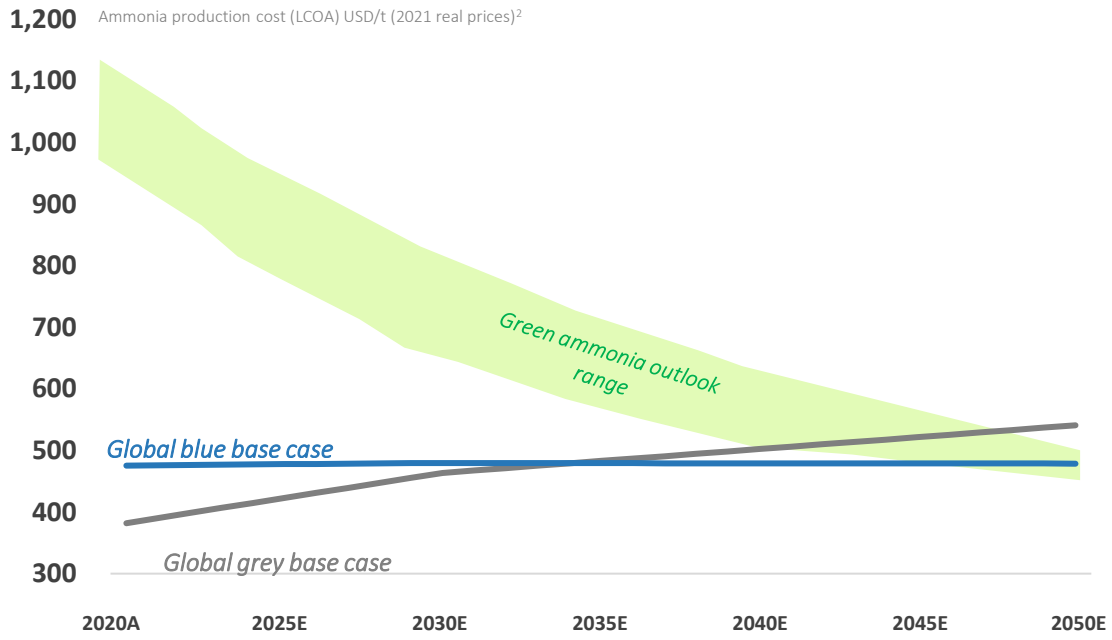
- Current toolbox **insufficient to reach IMO's emission reduction targets – a clean fuel alternative is required**
- Likely inclusion of shipping in the **EU ETS increases price of fossil fuels**
- Ammonia scores best across clean fuel KPIs and will be particularly **important for deep-sea shipping**
- Engine **commercial readiness** and **fuel availability** expected **second half of this decade**
- **Retrofit adoption of c. 10%** gradually from 2028 driven by selected segments
- **Market take-off of newbuilds towards 2040 and 2050** with 50-60% adoption

Source: Arkwright market study 2021

1) All vessels capable of running on ammonia; blend-in rates differ per segment

Blue ammonia to be cost competitive with grey by 2035 and green ammonia becoming cost competitive over time

Ammonia production cost



Key assumptions and trends

- Blue ammonia with high capture rates (90%+) **expected to be cost competitive with grey ammonia with CO2-taxation between 2030-2035**[1]
- **Green ammonia expected to require significant premium and subsidies in order to be competitive short-term** due to high capex, present electrolyzer efficiency rates and competition for renewable electricity in grid-connected locations
- **Green ammonia will prevail in the long-term** as total plant capex comes down and efficiencies and load factors increase as the industry develops, but will take time until it becomes cost competitive without subsidies
- **Blue ammonia is expected to be key to scale up** ammonia application in new segments such as shipping fuel and power generation until green ammonia is mature

Source: Arkwright market study 2021
1) Assuming "global" CO2 prices increasing towards 50 USD/t by 2030
2) Assuming an inflation rate of 2% starting 2021

Global end-to-end position in ammonia enables Yara to unlock future hydrogen economy

Producer

- 8.5 mt ammonia across 17 units
- Front-end (SMR) replaced with electrolyzer – rest of infrastructure in place
- Head-start in commissioning green and blue projects

Trader

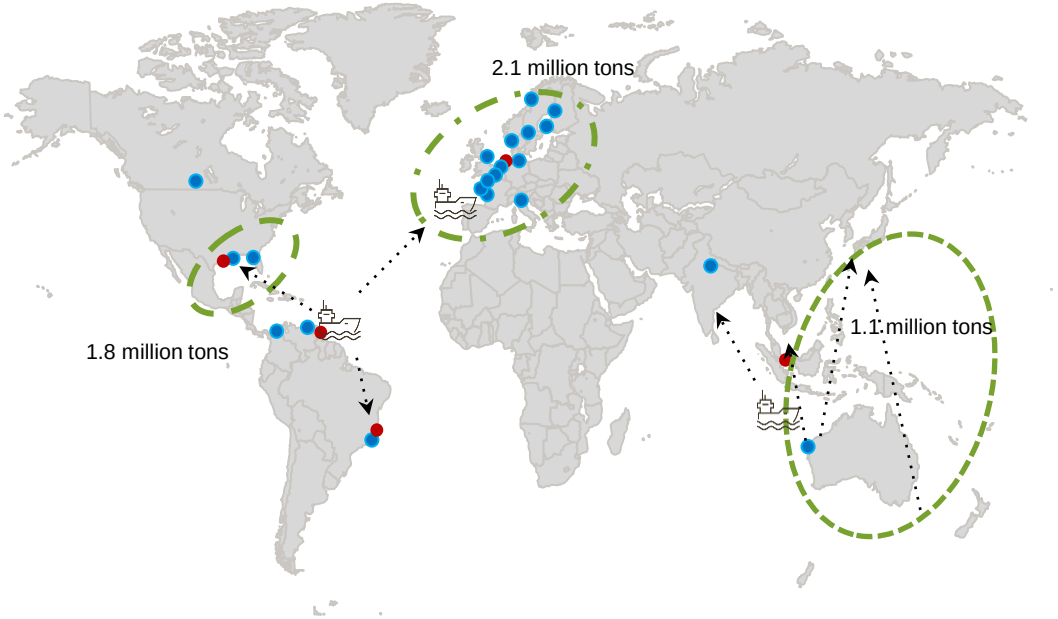
- Global asset-backed trader with > 20% market share
- ~3.7 mt of global export capacity with multiple downstream outlets
- Industrial solutions truck/train logistics expertise

Shipping & Storage

- +200 kt maritime transport
- 580 kt ammonia storage capacity
- 18 marine ammonia terminals
- Ability to connect green supply and demand

End-to-end value chain presence with significant barriers to entry

Yara's is uniquely positioned in ammonia supply chains



- *Yara production plants & infrastructure*
- *Major bunkering hubs[1]*
- *Yara main trade eco-systems*
- *Yara Ammonia Trade & Shipping operations*

YCA partners with First Movers

In order to be able to supply Green Ammonia as a fuel, YCA is involved in several projects to develop and build a bunkering network and the required logistics.

Further YCA is involved in pilot projects within most shipping segments to use Ammonia as fuel either for newbuild or retrofit.

SHIPFC

- Worlds first vessel to use Ammonia FC
- Vessel will start operation in 2024
- YCA shall deliver Green Ammonia

Viridis Bulk Carriers

- Ammonia fueled Short Sea Bulk
- 8 cargo owners as partners incl YML
- YCA shall deliver Green Ammonia

Amon Offshore

- Ammonia fueled PSV's
- New standard for North Sea PSV's
- YCA shall deliver Green Ammonia

Building a Ammonia Bunker network

YCA have pre-ordered 15 Bunker Barges from Azane Fuel Sollutions, the first unit to be operational in 2024 in Norway. Further YCA have teamed up with NorSea Group to operate the units at their logistics bases. The Scandinavian bunker network will be the worlds first and YCA aims to make Ammonia available as a fuel on a global basis.

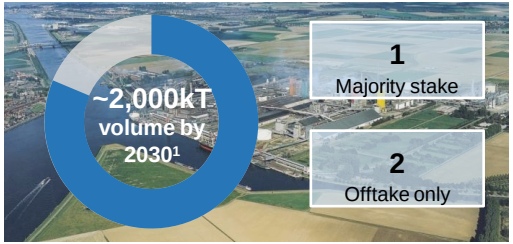
Growth potential from solid upstream projects, building on YCA's leading midstream position

Blue ammonia

Robust pipeline with solid project economics and profitability without need for further subsidies

Key regions

Selected project candidates



Green ammonia

Early mover strategy where government support will be required – lower costs in the future will increase competitiveness

Key regions

Selected project candidates

Well-positioned with a maturing project hopper and additional long-term opportunities

Well-positioned to succeed

- **Access to existing production assets** that can be converted to blue or green at lower costs compared to greenfield investments
- **Knowledge and experience built** through Yara's almost 100 years of ammonia track record and over 8 mT ammonia capacity
- Market leading position makes YCA the **preferred offtaker and partner for Yara and other third-parties**, in turn enabling new projects

Source: Company information
1) Estimated volume for the selected candidate projects

Ambition to shift Herøya to full green production

Full electrification of **500.000 ton ammonia** unit possible with limited infrastructure investments. Commercial startup scheduled for **2026**

Green ammonia will cut **800.000 ton CO2** emissions from Yara's plant in Herøya

Green ammonia production will provide fossil free fuel for **the maritime industry and power production**


The future
will be different…
CARBON FOOTPRINT
CO2
GUARANTEE
YARA