MISSION POSSIBLE PARTNERSHIP

Ammonia Transition Strategy
AEA
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AMMONIA TRANSITION STRATEGY / SEPTEMBER 2022

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RMI

WE MEAN BUSINESS COALITION

WORLD ECONOMIC FORUM

The MPP brings together industry and key sustainability institutions to address this challenge

MPP brings together the most influential global leaders in industrial decarbonization, climate finance and policy development to **trigger transformational change in the world's most carbon-intensive industries.**

Founding Partners

Energy Transitions Commission

RMI ENERGY. TRANSFORMED.

WE MEAN BUSINESS COALITION

WORLD ECONOMIC FORUM

Supporting Partners

BSR

Center for Climate Aligned Finance

CLIMATE GROUP

Ceres

gcca Global Cement and Concrete Association

GLOBAL MARITIME FORUM

iea International Energy Agency

Marrakech Partnership

McKinsey & Company

RACE TO ZERO

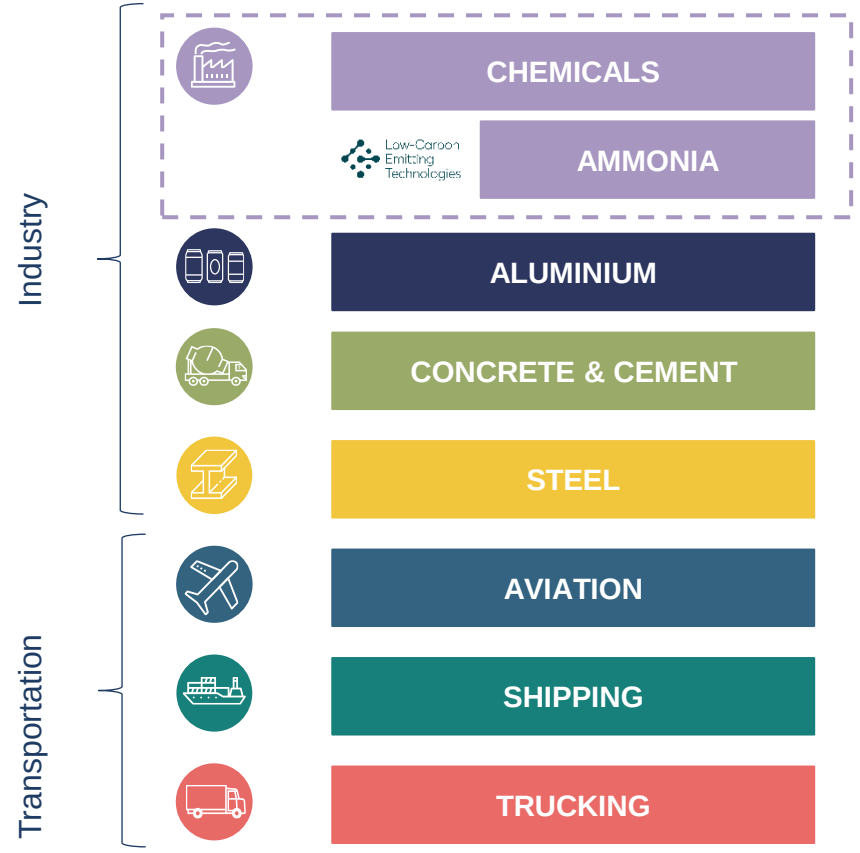
Smart Freight Centre

SYSTEMIQ

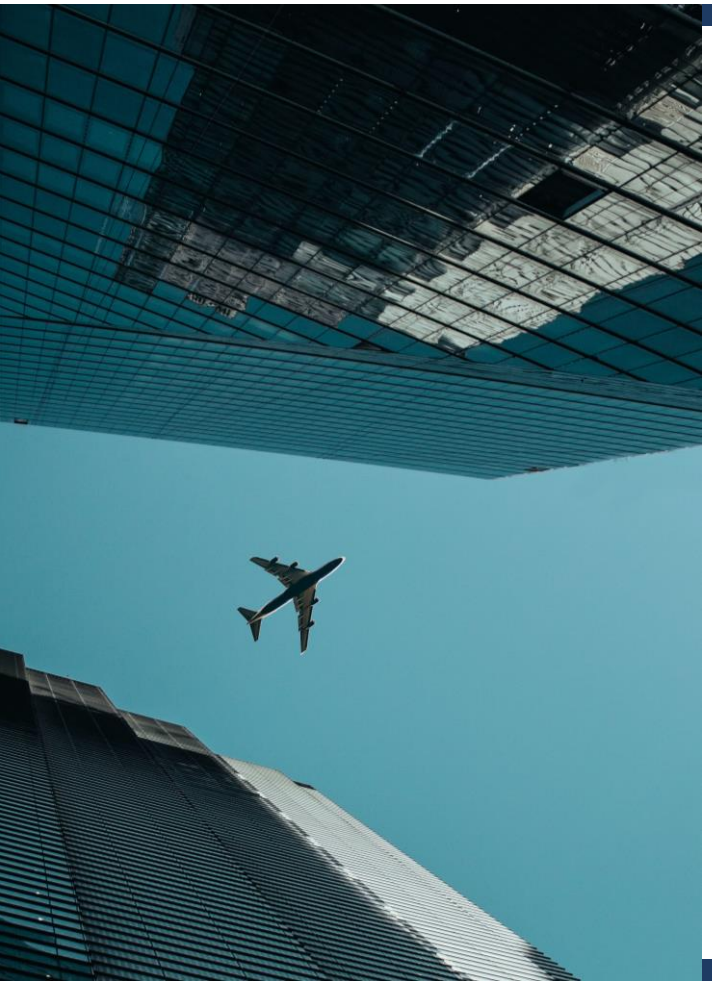
UNEP FINANCE INITIATIVE

wbcsd

Sectors



MPP's 4-step plan to decarbonize the 7 harder-to-abate sectors



1 Convene ambitious stakeholders

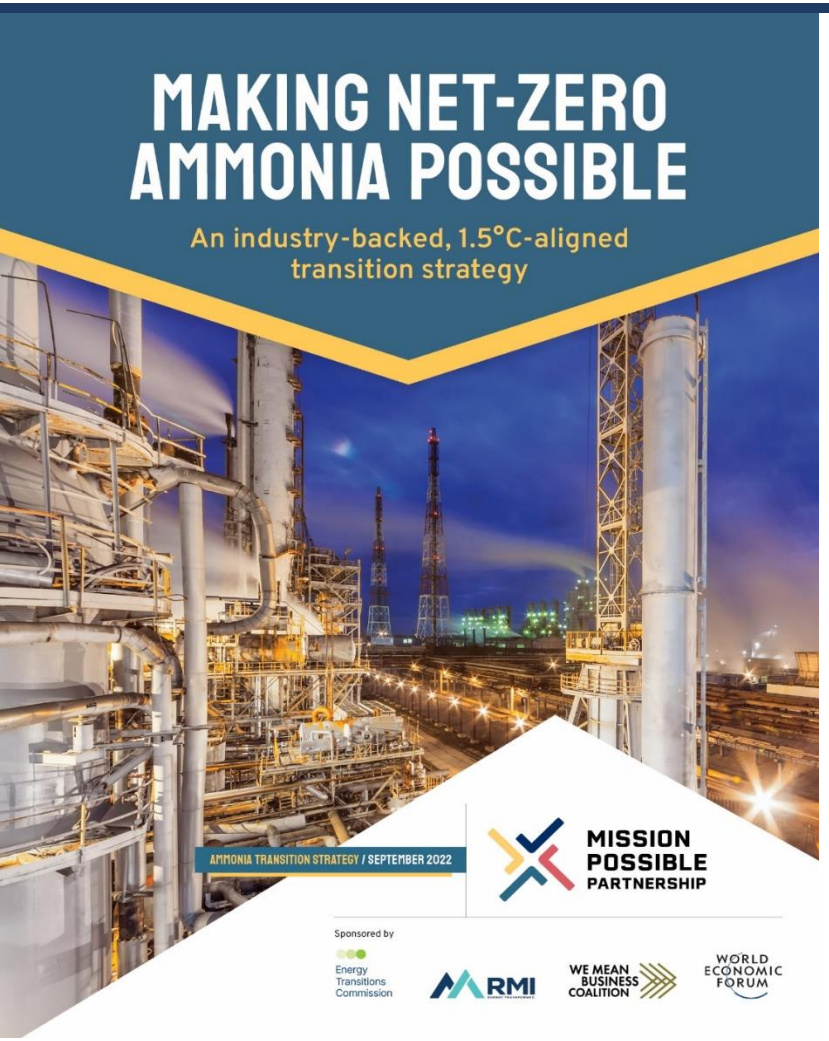
2 Develop a sector transition strategy

3 Commit to action

4 Support implementation

Shape narrative on industry decarbonisation targets, solutions, lighthouse projects

Making Net-Zero Ammonia is Mission Possible



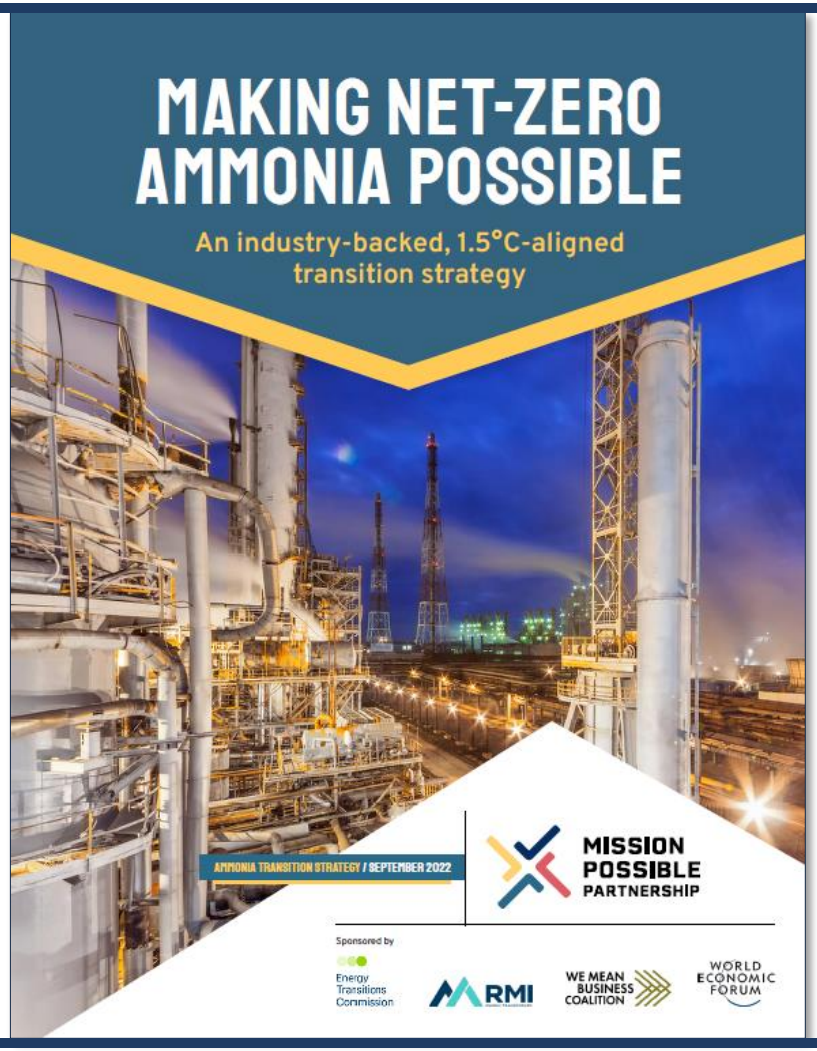
Endorsed by 35 leading companies including representing:

- 15% of total annual global production, with assets on 6 continents (~1/4 of global capacity excluding Russian/Chinese companies)
- Five of the largest ammonia producers globally
- The full current and future ammonia value chain, from upstream energy to downstream buyers

Sources: Ammonia Transition Strategy report; logos from respective company websites (2022)

KEY MESSAGES

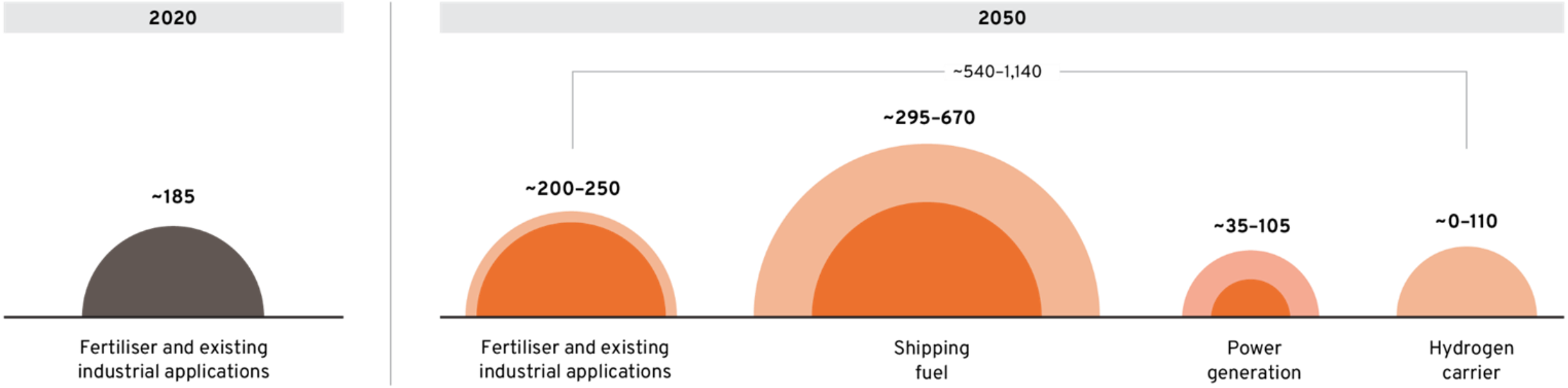
Agenda



- Demand scenarios
- Decarbonisation pathway scenarios & scope 3 emissions
- Production milestones
- Investment milestones
- Priorities for this decade

Ammonia use could grow dramatically in a decarbonized economy

3–6x demand increase for low-emissions ammonia to enable the decarbonisation of other sectors

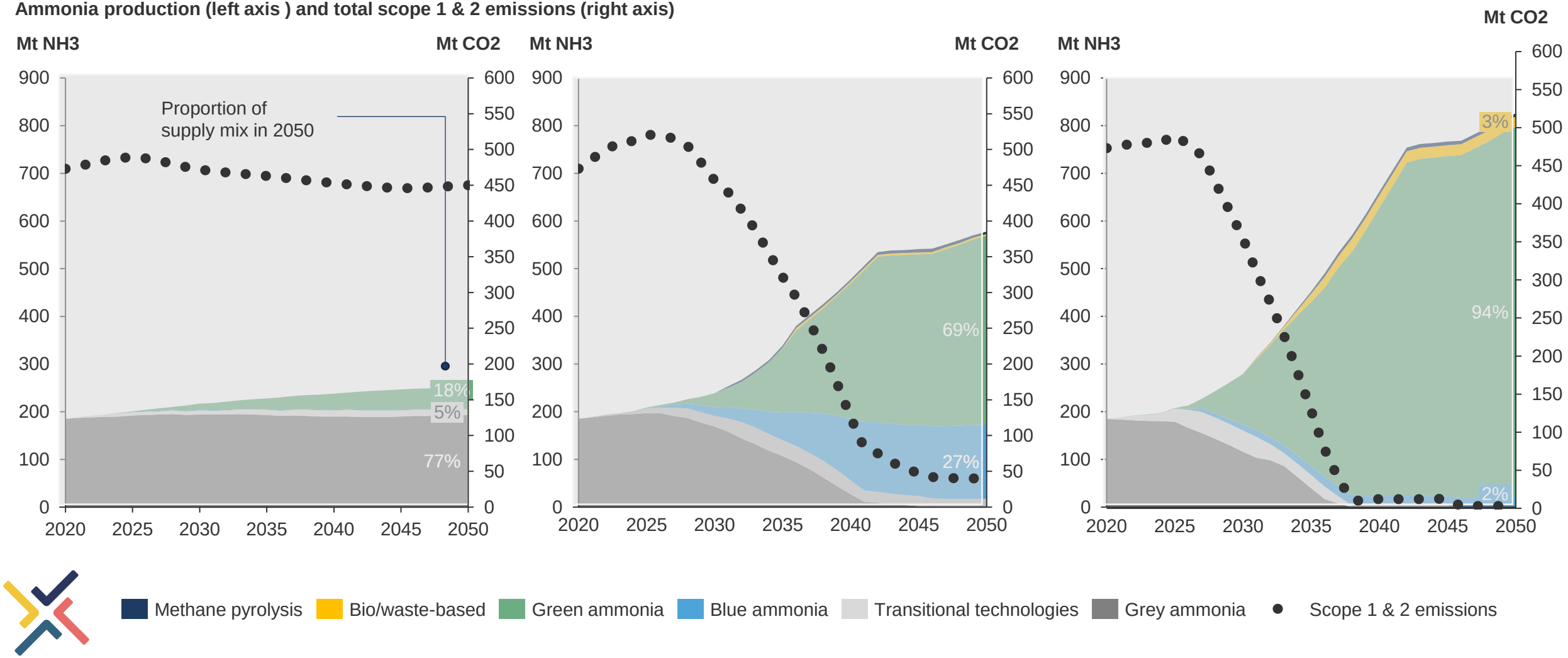


Source: IEA (2021) Ammonia Technology Roadmap; Food and Land Use Coalition (2019) Growing Better; Lloyd's Register and UMAS (2020)
ETC for GMF (2021); DNV-GL (2020); UMAS (forthcoming); JERA (2021) 2050 Road Map; MOTIE (2021) Generate electricity (..); METI (2021) Japan's Road Map for Fuel Ammonia; AFRY Global Hydrogen Trade Model, (2022)

Green ammonia delivers the largest reduction in emissions across all scenarios

BAU scenario | **Lowest cost scenario** | **Fastest abatement scenario**

Ammonia production (left axis) and total scope 1 & 2 emissions (right axis)



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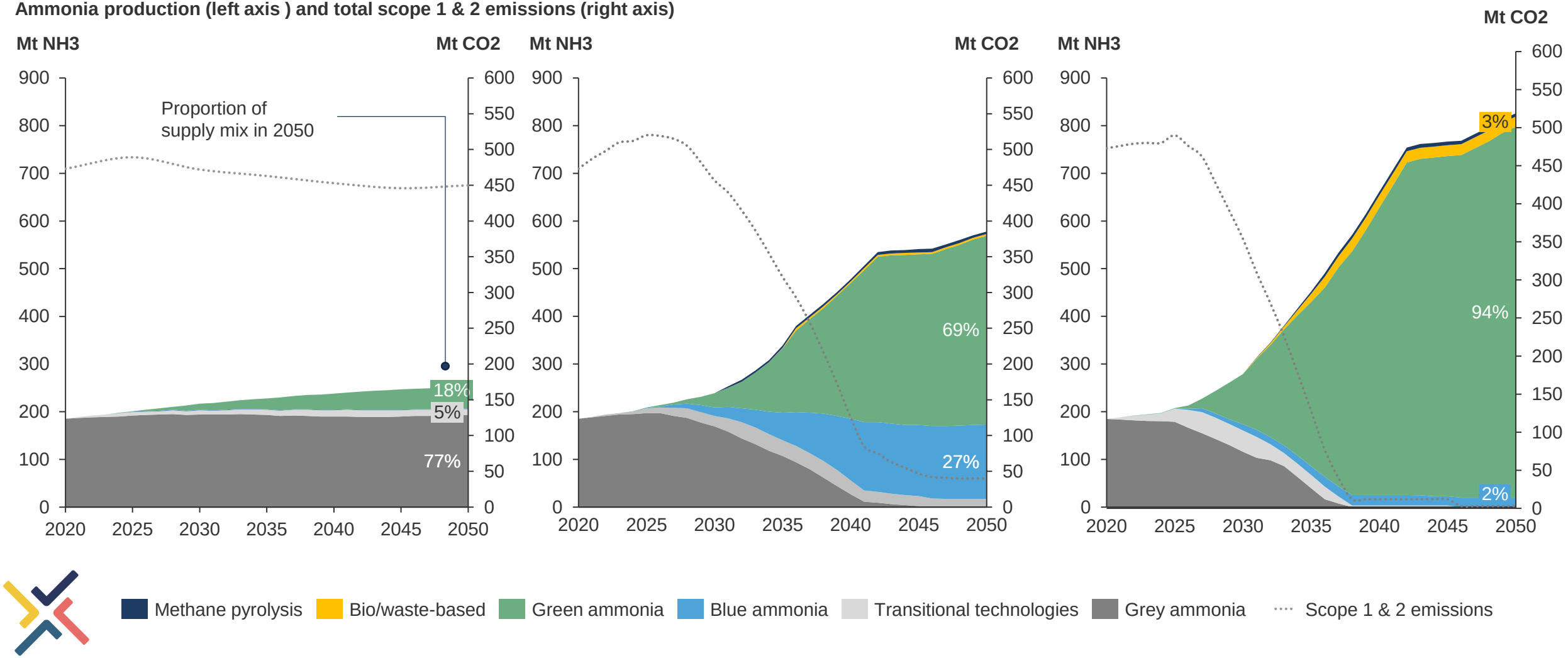
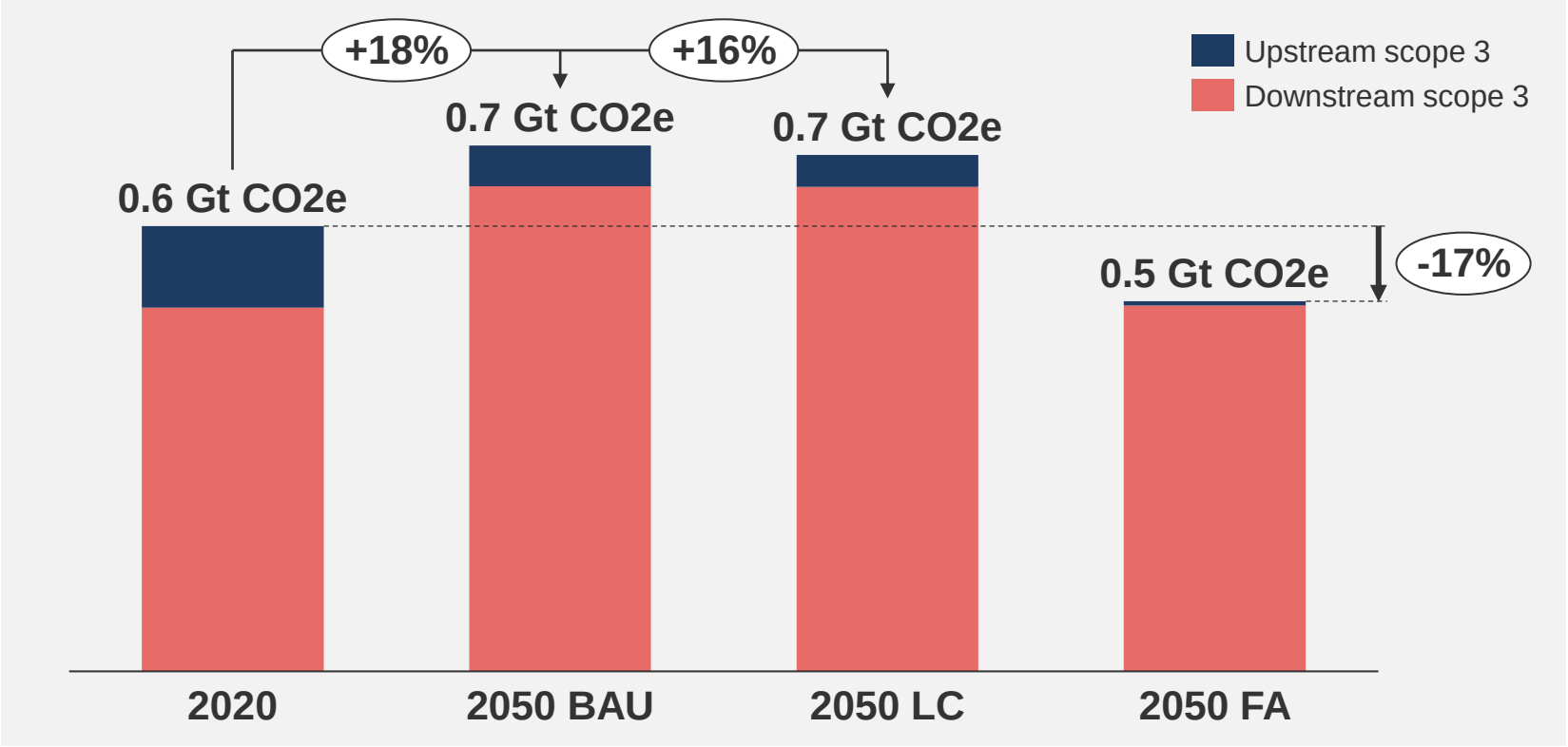


For Scope 3 emissions, measures across full value chain required to keep climate aligned trajectory

Scope 3 GHG emissions, Mt CO2eq per year



Additional measures for climate – aligned trajectory

- Reduce fugitive emissions & end routine flaring
- Improved NUE management
- Shifts in food systems (less waste and less land intensive diets)
- Increased use of nitrogen inhibitors
- Negative emissions solutions up to 0.5Gt-0.8Gt CO_2e by 2050

(1) Thapa et. al (2016), Effect of enhanced efficiency fertilizer of nitrous oxide emissions

Key milestones

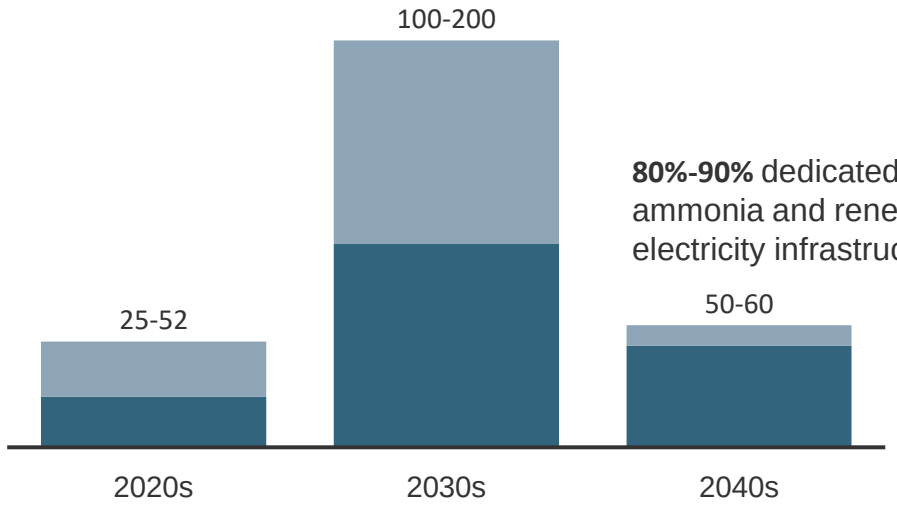
	2025	2030	2040	2050
Supply share of near-zero-emissions ammonia	1%	20%-42%	88%-100%	97%-100%
Near-zero-emissions ammonia produced = 100 Mt	2 MT	50-120 MT	420-660 MT	560-830 MT
Number of green ammonia plants* = 100 plants	1	40-140	400-840	560-1,090
Electrolyser capacity for ammonia production = 100 GW	2-3	70-210	590-1,190	780-1,500
Number of blue ammonia plants* = 100 plants	1	15-25	25-180	25-210

*Assumed daily production capacity of 2000 tNH_3 and 95% capacity utilisation

What it will take for 1.5°C aligned net-zero ammonia

Massive investments culminating in the 2030s

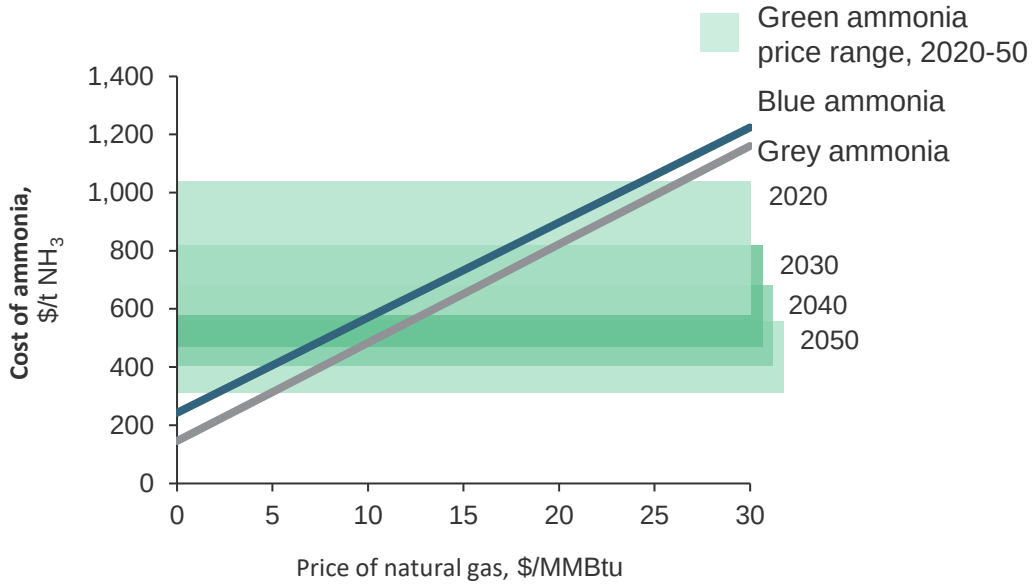
Billion $ annual capital investment



80%-90% dedicated to green ammonia and renewable electricity infrastructure

Large cost reductions in green ammonia compared with alternatives

Levelised cost of ammonia production pathways at different gas prices



By 2030, green ammonia becomes cost competitive with blue ammonia in lowest cost regions and by 2040 in almost all other regions.

Note: Compared with regular investments of $18 billion per year (also required in a Business-as-Usual future)

Priorities for this decade

GOVERNMENT ACTION

- **Certify and regulate use of zero emissions ammonia**
- Mobilise **funds and expand tax credit frameworks**
- Implement **market-based mechanisms** to level the playing field

SUPPLY CHAIN AND INNOVATION

- **Scale renewable energy capacity**
- **Reduce upstream Scope 3 emissions**
- Build with **carbon capture**

AMMONIA DEMAND

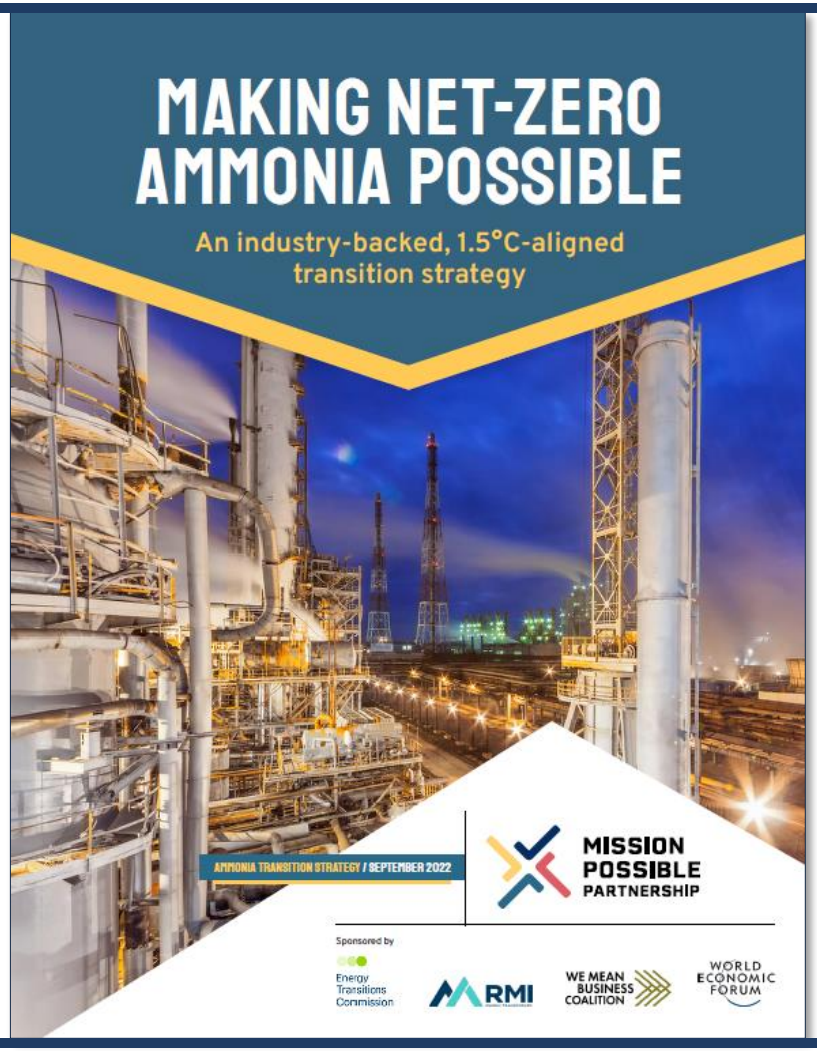
Scale demand for near-zero-emissions ammonia this decade in the following sectors:

- Commit to ambitious emissions reduction plans
- Sign offtake agreements
- Develop zero-emissions corridors
- Scale ammonia transport and storage infrastructure

FINANCE ACTION

- **Mobilise** $25 billion-$52 billion of **capital per annum**
- **Establish climate-aligned investment principles for ammonia**
- **De-risk investments via public-private partnerships**

Key take-home messages



3-6x demand growth of the ammonia sector to enable the decarbonisation of other sectors

50% reduction in emissions by mid-2030's and **92-99% of emissions from ammonia production can be eliminated by 2050**

Both green and blue ammonia have a role to play, but green is likely to dominate over time. (~10-40% of production by 2030 and **~70-90% of production by 2050)**

$59-105 billion average annual direct investments required (compared to ~$18B in BAU) – $20-$30B more across the value chain

Investments should start immediately – current 2030 low-emissions project pipeline needs to scale 2x-4x

3-8% of global **renewable electricity** demand by 2050 (**4,000-7,000 TWh)**

9-28% of global **green hydrogen** demand by 2050 (**70-140Mt)**