

A photograph of an offshore wind farm with several white wind turbines in a row, extending into a blue sea under a clear sky. A ship is visible in the distance. The image is framed by teal and dark blue geometric shapes on the left and right sides.

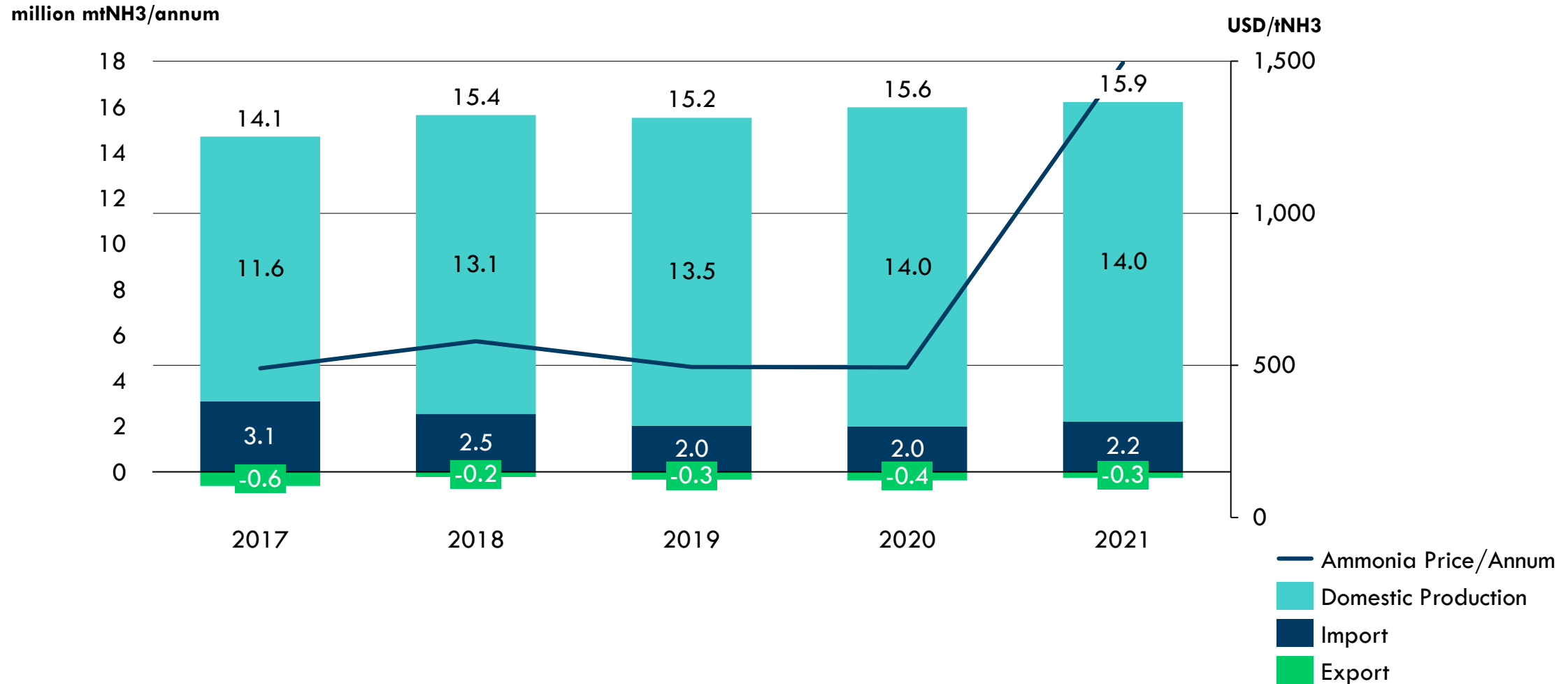
The Potential Future for Ammonia Market Nexus

11/18/2022

 **RMI**
ENERGY. TRANSFORMED.

While ammonia import reliance in the US has dropped from 18% in 2017 to 12% in 2021 (a trend likely to continue), price volatility has nonetheless affected the market

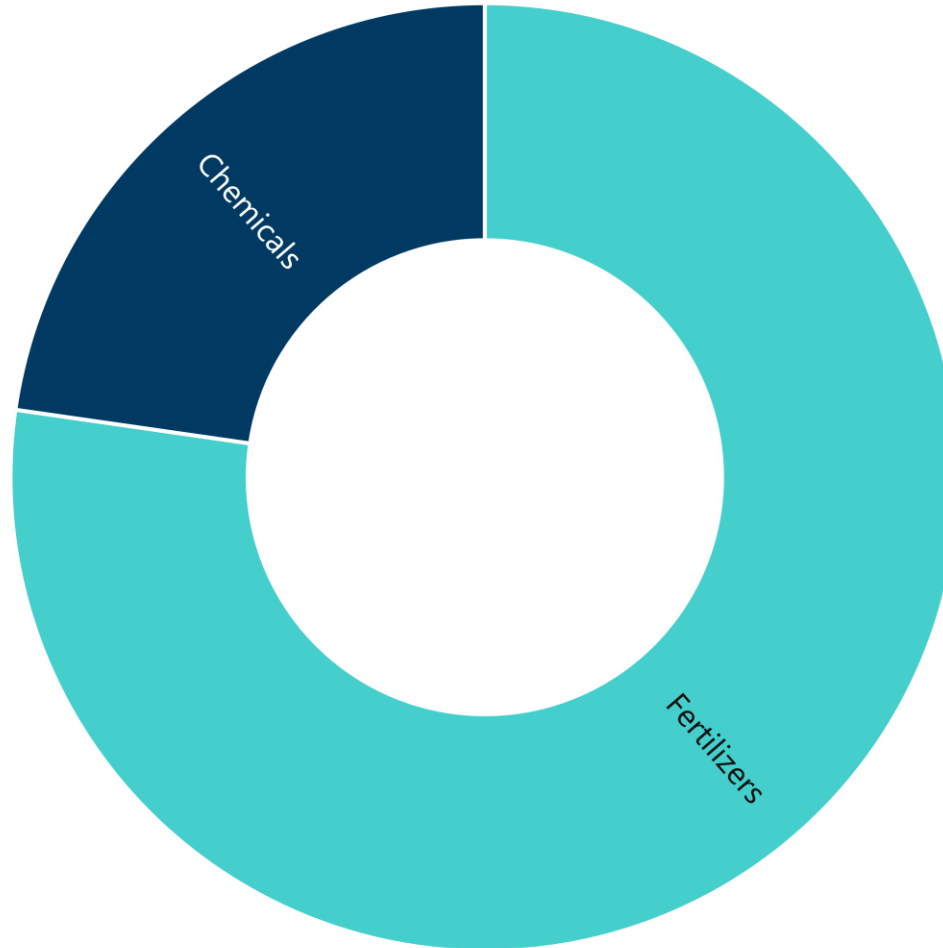
Import sources: Trinidad and Tobago (63%), Canada (34%) and others (3%)



Today US ammonia demand is dominated by the fertilizers space

Demand Today for Ammonia Derived Pathways

million mtNH₃/annum

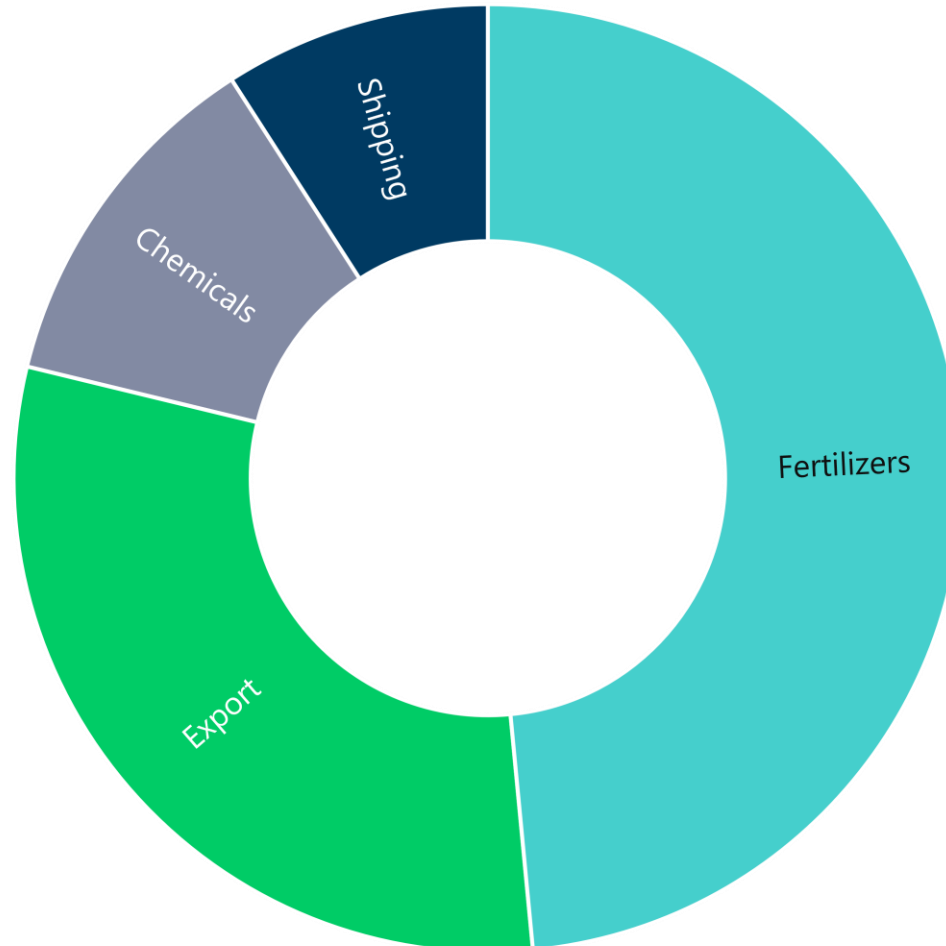


- 16MT total ammonia market
- ~80% fertilizer linked use
- Remainder is linked to chemicals cases (~20%)

As soon as 2030, the ammonia demand pool could be very different

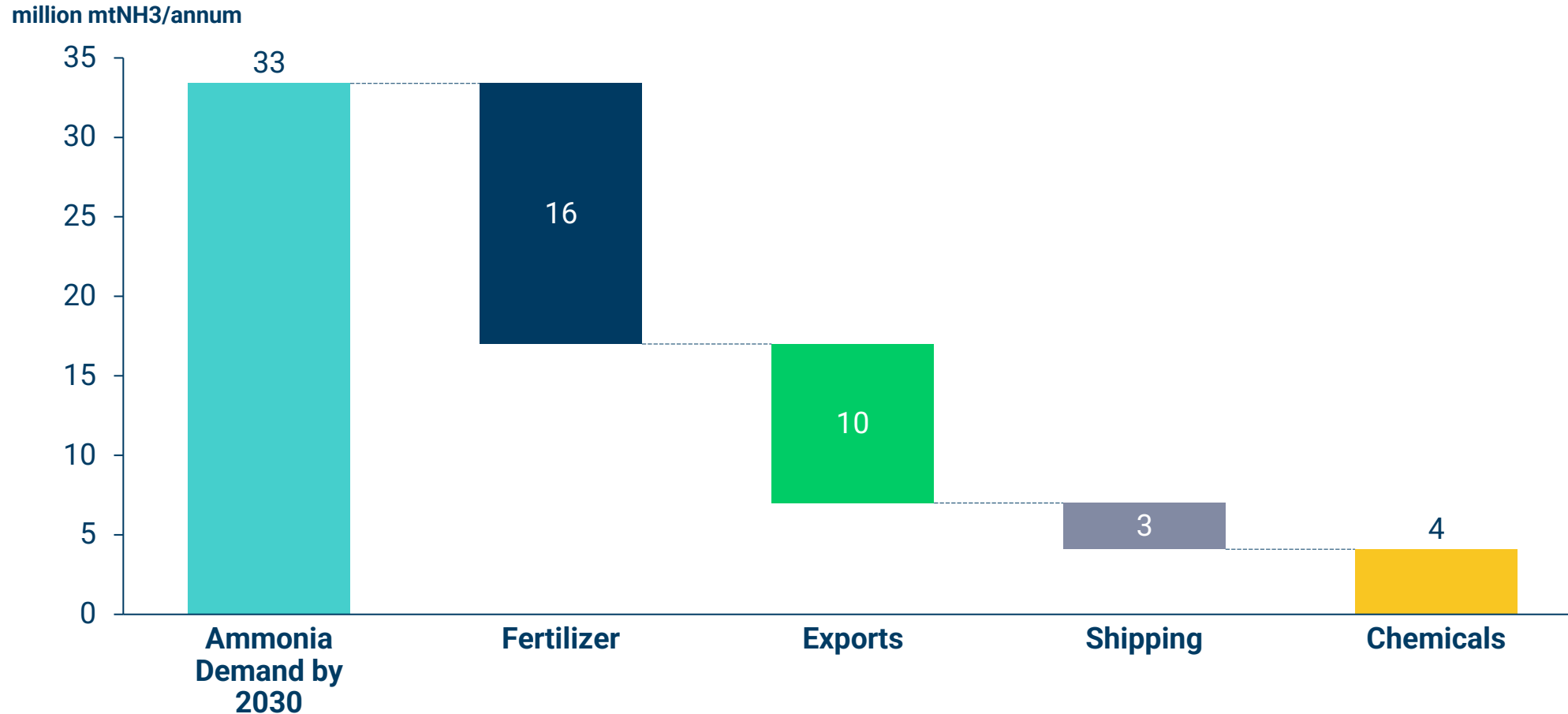
2030 Demand for Ammonia Derived Pathways

million mtNH₃/annum



- Market increases to ~33MT
 - Fertilizers 48% of total demand (16MT, with CAGR of ~3%)
 - Shipping 10% of total demand (~3MT)
 - Exports 30% of total demand (~10MT)
 - Chemicals 12% of total demand (~4MT)

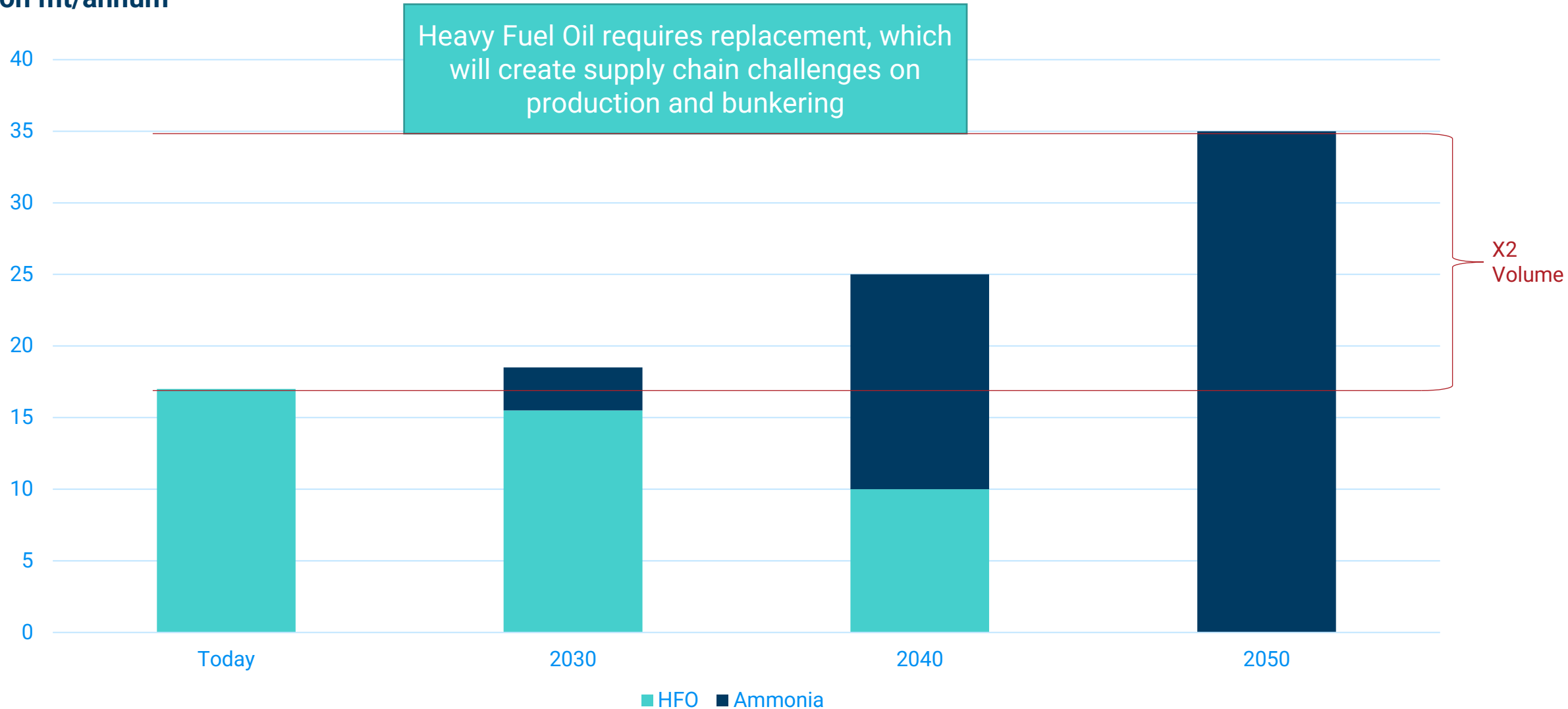
Ammonia Demand in the US by 2030



Note: Demand is based assuming historical ammonia consumption growth to hold. Export estimates are derived from EU projected demand and US supply constraints. Shipping assumes the creation of a corridor with 10 ships coming from the top 10 ports in the world. Potential EU demand estimated in 2030 to US linked production.

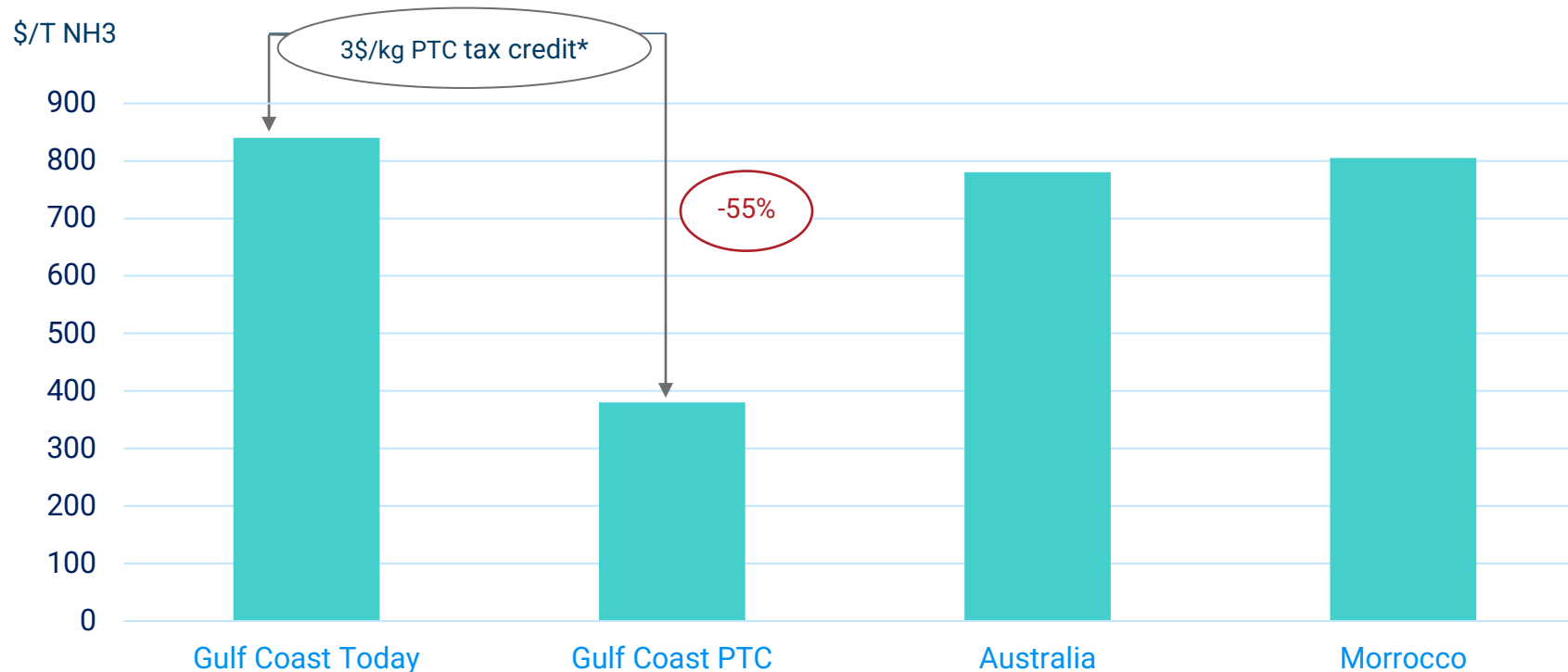
Shipping Market: Transition Challenge

million mt/annum



Indicative impact of IRA: U.S. is now positioned to produce lowest cost zero-emission shipping fuels in the world today

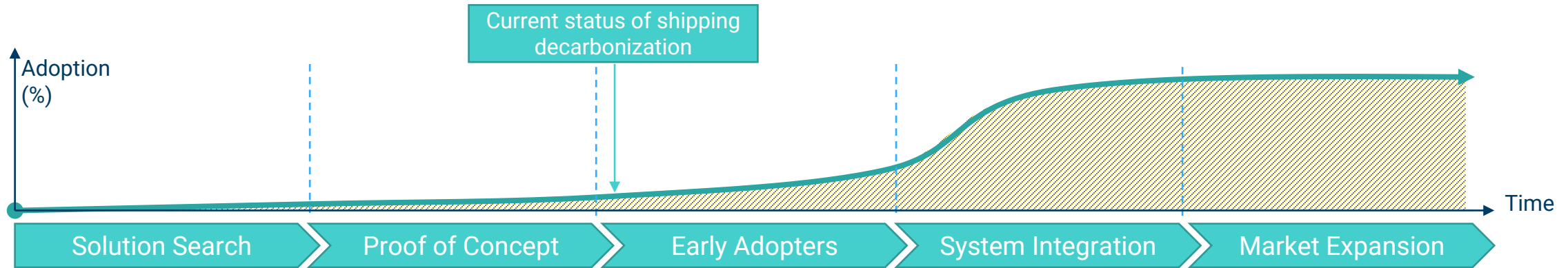
Illustrative green ammonia comparison across different potential hydrogen producing countries
\$/kg H₂, 2030, includes indication for US with PTC tax credit



U.S. green ammonia production already **among most competitive** depending on location




If PTC tax credits is applied, it immediately makes the U.S. the most attractive location to **anchor green shipping corridors**

State of Market: Concrete actions are needed to enable the Early Adoption and System Integration phases



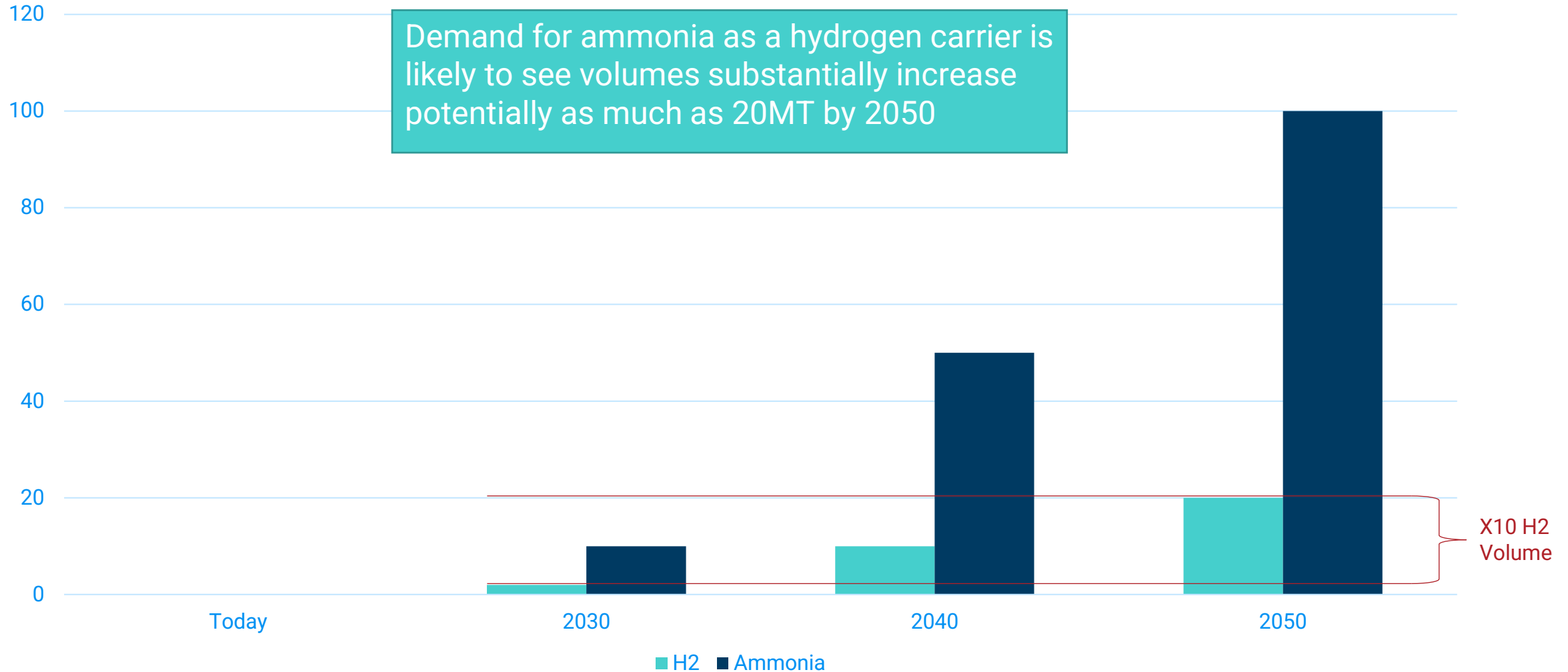
	Solution Search	Proof of Concept	Early Adopters	System Integration	Market Expansion
Description	One or more triggers result in an environment that is conducive for ideation; early-stage research drives development of new solutions	Innovations are being piloted, often through public-private partnerships	Innovations are scaled by frontrunners and extend beyond niche markets	Frontrunners form coalitions to institutionalize change, push to build up the enabling environment	The innovation reaches scale and is widely adopted / met with broad compliance
Potential levers to accelerate towards system integration			<ol style="list-style-type: none"> 1 Implementation of international green shipping corridors 2 Scaling zero-emission fuel supply at ports 		

Role of Green Corridors: ship sub-sectors profiles and challenges in operation are indicators of likely earlier mover market segments

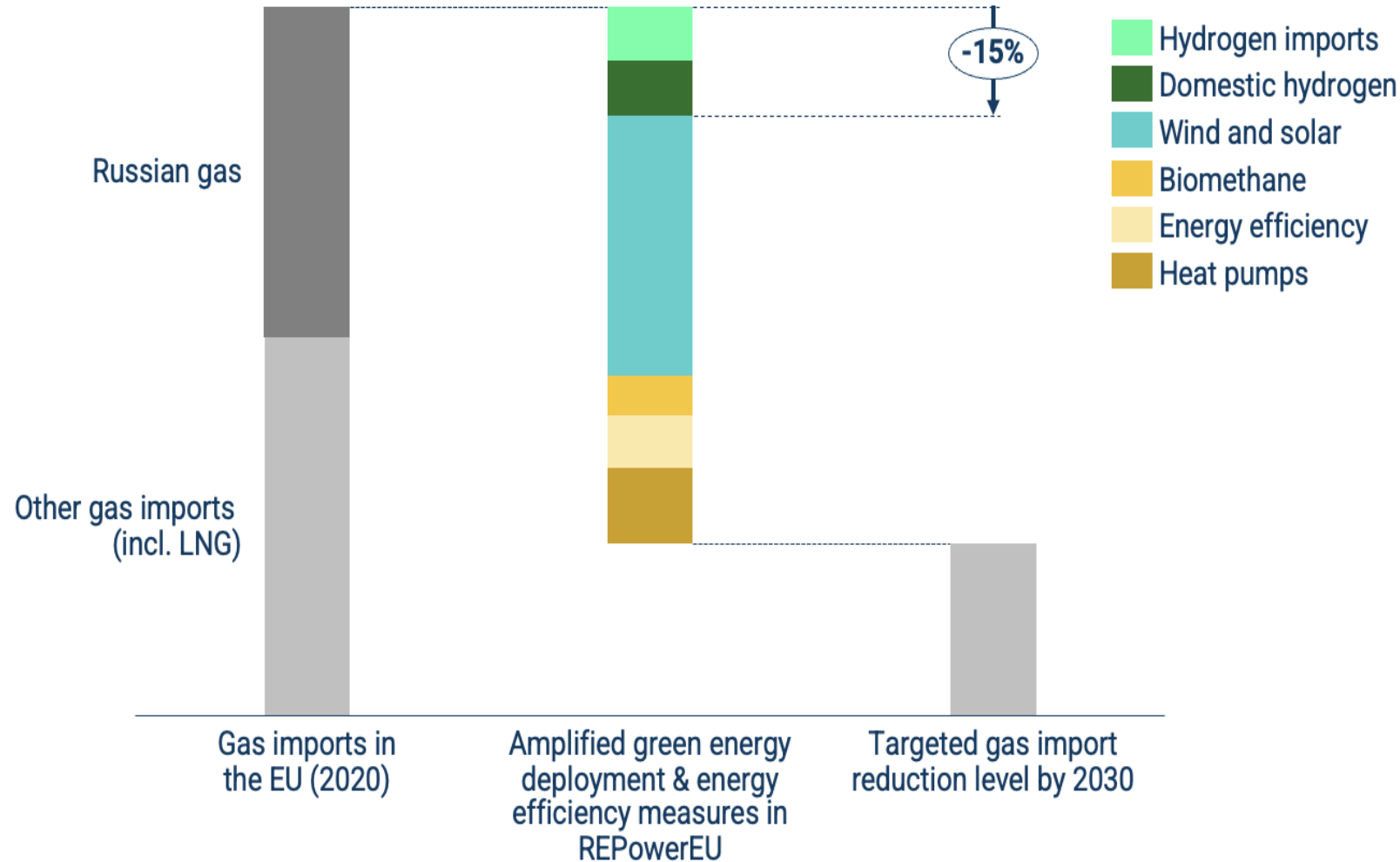
Shipping sub-sector		% of total global major ships fleet	Attention Point
<p>A Containerships</p> 	<p>Ships carry mainly (20ft) containers that can be stacked on the shipping with diversified goods</p>	11%	<p>10-20 companies shipping goods on one containership; difficult to attribute scope 3 emission savings without book and claim system</p>
<p>B Bulk (dry)</p> 	<p>Ships carry major bulk (Iron Ore, Grain and Coal) and minor bulk (Forrest products and steel products)</p>	23%	<p>Significant volumes of iron ore and grain transported; ship routes can be ad hoc which leads to unpredictable logistics planning at times</p>
<p>C Bulk (liquid)</p> 	<p>Consists largely of crude oil (1,860 million t) and other tanker trade (1,320 million t), of which LNG (416 million t)</p>	25%	<p>Largely used to transport fossil fuels; unlikely to be first movers in decarbonization journey unless transporting ammonia or hydrogen</p>

Export Market: Transition Challenge

million mt/annum



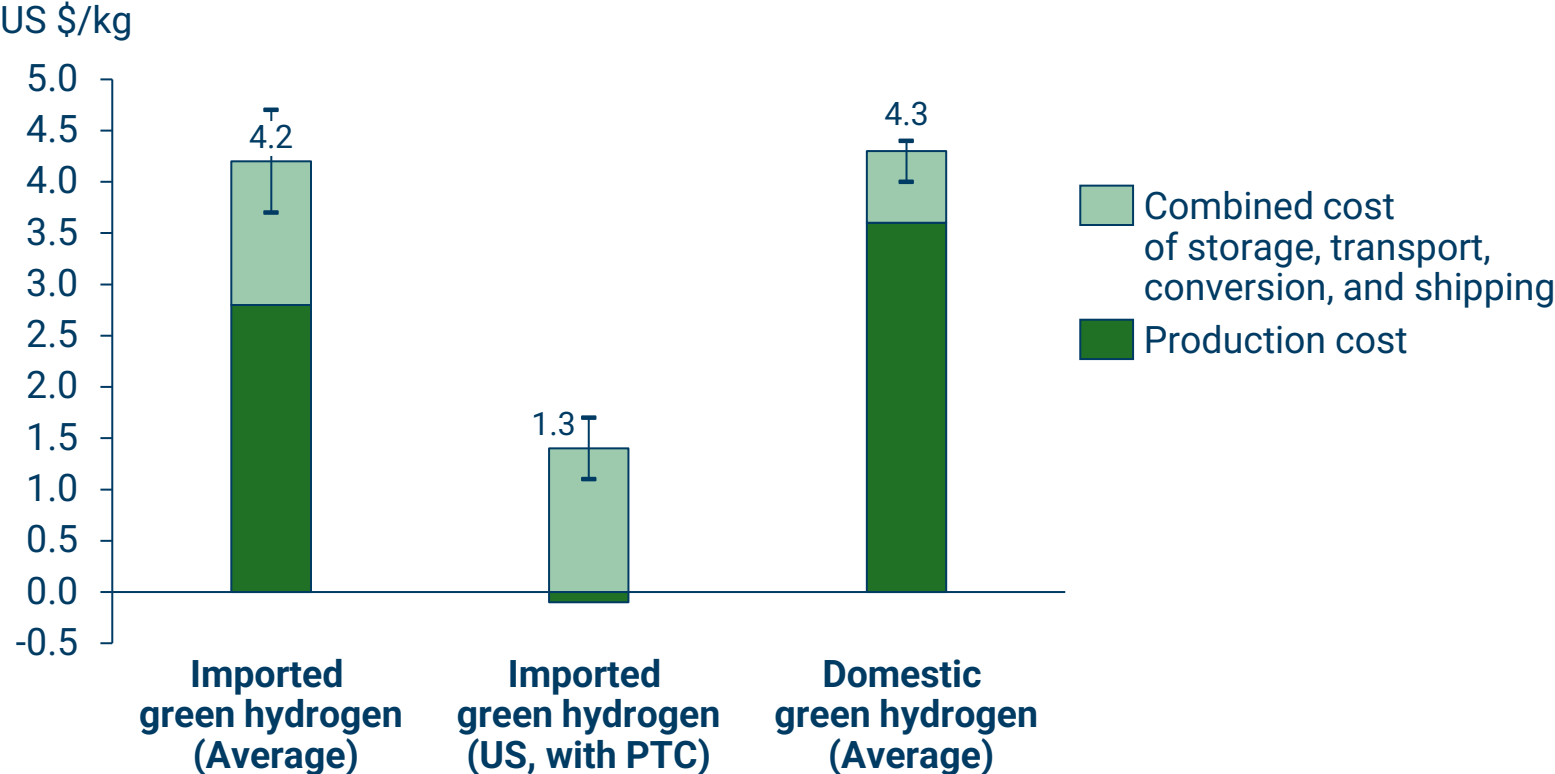
Moving to H2: The transformation of the EU to leverage H2 will require 20MT



- Expected demand of ~10MT of H2 Imports to reach REPowerEU targets
- This equates to ~50MT of ammonia for importation
- Challenges for managing storage and management of supply operations on export side
- Need for stability of trading partners and general operating conditions

The EU can seek out low-cost imports to supply energy-strained industries with early supplies of green hydrogen while domestic production is still scaling up

Landed costs of early imports vs. domestic green hydrogen in the EU, c. 2025

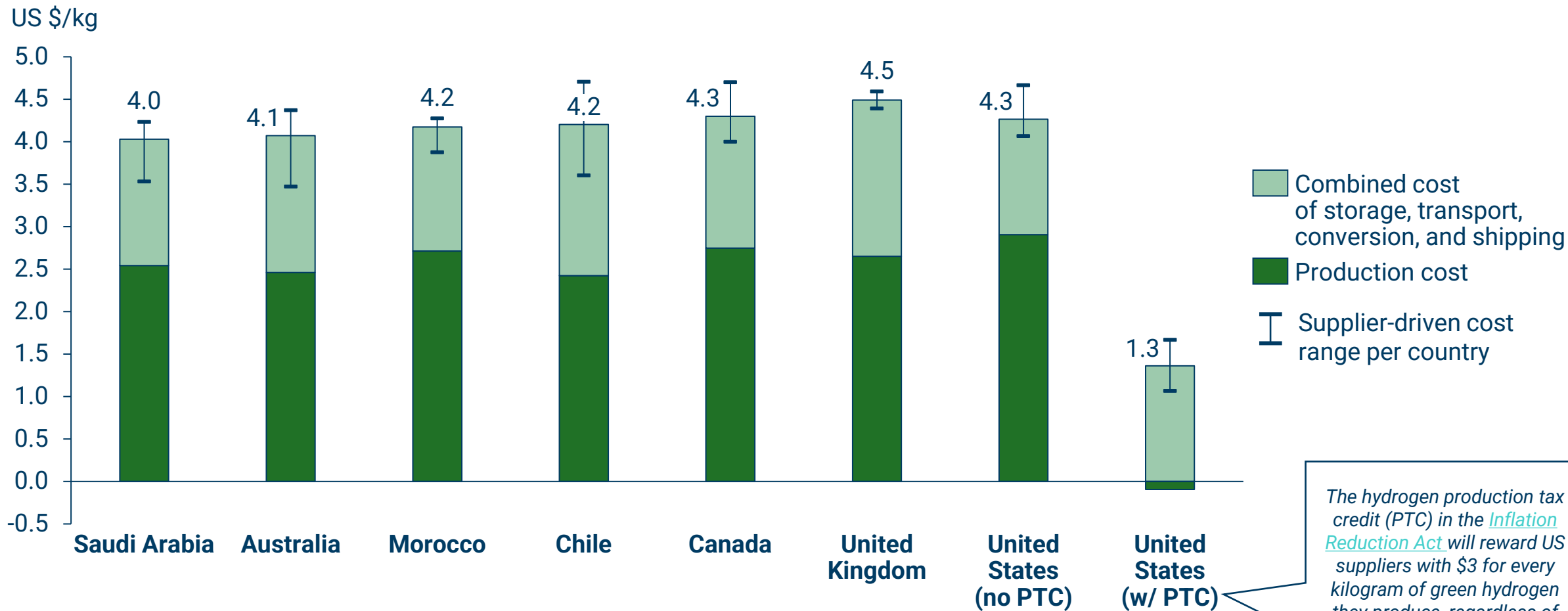


- National subsidies in export countries will impact the delivered cost of green hydrogen, in some cases substantially
- In the United States, recently adopted hydrogen production tax credits (PTC) will reduce costs by \$3/kg, potentially enabling US suppliers to deliver fuel to Europe at an effective cost well below \$2/kg

Sources: RMI Analysis, HySupply State of Play report, The Future of Renewable Hydrogen in the European Union

While several countries with ideal renewable profiles are planning to export green hydrogen to Europe, tax credits will enable US producers to deliver the cheapest supply

Landed costs of early green hydrogen imports in the EU across prospective suppliers, c. 2025



The hydrogen production tax credit (PTC) in the [Inflation Reduction Act](#) will reward US suppliers with \$3 for every kilogram of green hydrogen they produce, regardless of targeted end use

Sources: RMI Analysis, [HySupply State of Play report](#), [The Future of Renewable Hydrogen in the European Union](#)