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MINISTRY OF
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NGHM
NATIONAL GREEN HYDROGEN MISSION

UNLOCKING AN ODISHA, INDIA–NORTHWEST EUROPE GREEN AMMONIA TRADE CORRIDOR

A pre-feasibility study of supply competitiveness, infrastructure readiness, and offtake feasibility

REPORT | NOVEMBER 2026

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Foreword

India has emerged as a global leader in clean energy, with over 300 GW of installed non-fossil-fuel power capacity. The National Green Hydrogen Mission builds on this achievement. Our vision is to position India as a global hub for green hydrogen and its derivatives, strengthen energy security, and create new opportunities for industrial growth and international trade.

India and the European Union share a strong commitment to advancing the global clean energy transition. The conclusion of negotiations on the India-EU Free Trade Agreement and the establishment of the India-EU Task Force on Green Hydrogen mark important milestones in our partnership. Our strengths are complementary. India's renewable energy resources and growing green hydrogen industry, combined with Europe's industrial capabilities and clean energy ambitions, can open new avenues for investment, innovation, and shared growth.

The Odisha, India–Northwest Europe Green Ammonia Trade Corridor brings this shared vision into focus. It seeks to connect India's emerging green ammonia production with European industrial demand. More importantly, it creates a platform for governments, industry, ports, and other stakeholders to work together, strengthen value chain linkages, and unlock opportunities for mutual benefit.

I am confident that this initiative will deepen India–Europe cooperation and set an example for international partnerships in clean energy. By combining our strengths and ambitions, we can accelerate the global energy transition and build a more secure, sustainable, and prosperous future.

(Santosh Sarangi)

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Mission Director
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Ministry of New and Renewable Energy



Foreword

India's green hydrogen ecosystem is making tangible progress. Under the National Green Hydrogen Mission, we are advancing domestic production, strengthening industry participation, and establishing market mechanisms for commercial deployment. The first green ammonia procurement tranche, covering 7.24 lakh tons annually, achieved a price discovery as low as ₹49.75 per kg. The second tranche builds on this milestone and reinforces our commitment to creating a competitive market.

Our next priority is to translate this progress into opportunities at scale. India's growing project pipeline and emerging international offtake agreements reflect increasing market confidence. Innovative business models, long-term demand commitments, and coordinated infrastructure development will be essential to unlock investment and establish reliable trade linkages.

Odisha is emerging as a major centre for green ammonia production. Growing developer participation and substantial announced production capacities reflect the state's potential to serve international markets. The Odisha, India–Northwest Europe Green Ammonia Trade Corridor builds on this momentum. It examines opportunities to connect Odisha's emerging supply ecosystem with industrial demand in Northwest Europe. It also explores the commercial arrangements, infrastructure requirements, and market mechanisms needed to enable this trade.

Realising this opportunity requires producers, buyers, ports, financial institutions, and governments to work together. I believe this assessment provides a foundation for advancing innovative commercial partnerships, aligning investments across the value chain, and strengthening India's position in the global green hydrogen market.

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Executive Summary

Context

In today's world, characterised by geopolitical frictions, trade relationships between countries are tested and scrutinised through the lens of both economic and physical supply security. At the same time, energy and industrial transitions are driven by resilience, security, and affordability, not decarbonisation alone. Against this backdrop, opportunities to create win-win trade formulas between trusted partners that deliver on mutual economic, industrial, and security objectives are rare. This is especially true for the green molecules trade, where competition with established commodities requires public support to close the economic gap, given scarce public resources. Strategic tailwinds are also strengthening, with multiple energy crises over the past five years making a strong case for policymakers to diversify supply by opening new green molecule trade channels and relying on green, homegrown energy.

After spending almost two years convening industrial players from India and Europe, engaging with policymakers, and crunching numbers, the authors of this report believe that green ammonia trade can deliver on both India's and Europe's objectives. These include strengthening security, enhancing industrial competitiveness, and generating economic wealth for both sides. This thesis found confirmation when the EU and India concluded negotiations on a free trade agreement in January 2026 and committed to cooperate on green hydrogen through a joint task force. A green ammonia trade corridor can add a feasible commercial layer to that partnership.

Implementing the complex corridor initiative would require strong public support and collaboration among private players. This prefeasibility study, led by RMI and conducted in partnership with VITO, tests the feasibility of a corridor between the Indian state of Odisha and four industrial clusters in Northwest Europe. It outlines what it would take to implement this initiative and move the first substantial volumes of green ammonia between India and Northwest European countries as early as 2030.

Strategic Rationale for an India–EU Green Ammonia Trade Corridor Approach

Green ammonia trade between India and Europe could provide European industry with a secure, resilient, and affordable way to transition faster and stay competitive in global markets.

This import pathway offers a more affordable route to clean molecules, complementing Europe's push to produce more energy domestically. The EU imports 80% of the natural gas it consumes, and natural gas is the feedstock for most of the hydrogen and ammonia used by its fertiliser, refining, and chemical producers. That dependence leaves European industries exposed to natural gas price shocks.

Domestic electrolysis remains Europe's first choice and will meet part of future demand, but it may not reach the scale, cost, or speed implied by European policy targets. Green ammonia from a diversified set of trusted partners gives policymakers another option to complement domestic supply, allowing each sector in Europe to transition at pace and affordably. European companies are already closely involved in the codevelopment of projects and infrastructure in India. For example, Belgium's John Cockerill partnered with India's AM Green to produce electrolysers in India for a project in which Germany's Uniper is the key off-taker of the molecules produced.

Indian producers pursue a dual-track strategy of domestic and export demand to reach scale.

India is rapidly establishing itself as one of the world's most cost-competitive producers of green hydrogen and green ammonia, leveraging its abundant renewable energy base and increasingly coordinated policy. The country is taking a system-level approach to developing its green ammonia projects. India has designated three emerging hydrogen and ammonia port hubs — Paradip, V.O. Chidambaranar (VOC), and Kandla — as integrated ecosystems, with a meaningful share of their output explicitly intended for international markets. In the near term, exports are not a diversion from domestic priorities but a prerequisite for scale. Early export offtake should allow projects to reach financial close, operate at high utilisation rates, and drive cost reductions that will later benefit domestic demand as it ramps up.

A coordinated corridor initiative can help accelerate the India–EU green ammonia opportunity by de-risking implementation and establishing a clear win-win proposition.

Off-takers, midstream developers, producers, and public institutions must work together to activate the full value chain. This is a complex coordination challenge. On top of that comes a market creation challenge, as green molecule markets are still immature and require policy action and public support mechanisms. Trade corridors offer one way to address this market creation problem by building strategic alignment between private and public players, reducing coordination failures, aligning standards, and creating the demand visibility needed for projects to reach financial close. Trade

corridors are more than logistical routes; they are essential market-making mechanisms that help players across the value chain determine how to share and spread risk within the corridor, and where government interventions through catalytic public capital or regulatory action are needed.

For the Odisha, India–Northwest Europe green ammonia trade corridor, a coordinated, coalition-based approach to developing early green ammonia trade is critical.

This study finds that the conditions for an Odisha–Northwest Europe corridor are emerging, with competitive supply, concentrated demand, and a policy framework that rewards compliant green molecules. Turning this potential into trade would mean aggregating sectoral demand, aligning European terminal and cracker timelines with Odisha's production schedule, and sizing public support to the remaining green premium. It will also require effective risk-sharing mechanisms, win-win business models, and coordinated infrastructure development across multiple projects. After initial convenings with more than 20 organisations interested in this corridor development, RMI and VITO are considering advancing the effort with a full feasibility assessment, partnering across the value chain, and aiming to ship at least 1 million tons (Mt) of green ammonia per year by 2030.



Total Addressable Market in Four Industrial Clusters of Northwest Europe

Unlocking demand in the key European heavy industry and transportation sectors is the main enabler of corridor implementation and the bankability of individual projects.

Without a clear price to beat, most off-takers weigh green supply against continuing to use grey hydrogen and paying EU Emissions Trading System (ETS) costs. With free allowances still cushioning these costs in some sectors, many are choosing to wait. Transposing the EU's Renewable Energy Directive III (RED III)[i] targets with credible penalties, paired with public support sized to the remaining cost gap, would give buyers the certainty they need to sign long-term offtake contracts.

Currently, Europe's refinery sector provides the strongest and most material early demand anchor, as refineries already consume hydrogen and face renewable fuel of non-biological origin (RFNBO) requirements under the RED III transport target. Whether that becomes demand for imported green ammonia depends on how refiners choose to comply, because on-site electrolysis and other domestic sourcing options could suffice. Chemicals and fertilisers could follow, although most products may require additional public funding or stronger demand for lower-emissions products. Shipping could also become a large market as FuelEU Maritime and the EU ETS change the relative economics of conventional and renewable fuels.

Four industrial clusters in Northwest Europe offer the concentrated demand a green ammonia corridor would need.

Antwerp-Bruges, Hamburg, North Rhine-Westphalia, and Rotterdam already consume about 1.8 Mt of hydrogen (H_2) per year, which equates to roughly 12.1 Mt of ammonia (NH_3) once ammonia cracking conversion losses are counted. Almost all of this hydrogen is made from unabated natural gas. Counting three large adjacent assets, the figures rise to 2.4 Mt H_2 (equivalent to 15.6 Mt NH_3). This is the total addressable market (TAM) if every ton were replaced by imported green ammonia. Refining could be an early source of demand because Germany already enforces a quota for RFNBOs in transport fuels, with penalties for noncompliance. Fertiliser and chemical producers that use ammonia directly could follow, as they do not require ammonia cracking. Ammonia bunkering is emerging as an application in the ports of Rotterdam and Antwerp-Bruges.

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i. Renewable Energy Directive III, officially known as Directive (EU) 2023/2413 (RED III), entered into force in November 2023 and raises the EU's binding 2030 renewable energy target to 42.5% and sets RFNBO targets for industry (42% of hydrogen use by 2030, 60% by 2035) and transport (at least 1 percentage point of the combined 5.5% subtarget for advanced biofuels and RFNBOs by 2030). Qualifying RFNBOs must meet the additionality, correlation, and 70% emissions savings rules in Delegated Regulations (EU) 2023/1184 and 2023/1185.

The RED III could turn that potential into firm demand, but only once Member States transpose and enforce its quotas.

RED III sets two RFNBO targets. The industry target requires 42% of the hydrogen used in industry to be RFNBOs by 2030 and 60% by 2035, applicable for industrial processes such as fertiliser production or chemical production. For refineries, this 42% RFNBO industry target covers only hydrogen consumed to produce industrial products. Hydrogen used at refineries to make transport fuels falls outside it. Instead, it counts towards the transport target, which requires RFNBOs to contribute at least 1 percentage point to the combined 5.5% target for advanced biofuels and RFNBOs in 2030.

As of October 2026, more than a year after the May 2025 transposition deadline, none of the three countries hosting the clusters examined in this study has transposed the industry target into national law. Germany and the Netherlands have transposed the transport target, under which refineries can count RFNBO hydrogen, and Germany backs its transport quota with substantial noncompliance penalties. In Germany, the transport quota could drive demand to about 0.8 Mt NH_3 at refining assets in Hamburg and North Rhine-Westphalia by 2030, assuming refinery hydrogen meets half of the RFNBO subquota and refiners source all of it by cracking imported green ammonia. For the upper-bound scenarios, this study applies a uniform 42% share in 2030 and 60% in 2035 to every mapped industrial asset consuming hydrogen. Applying this uniform share to refineries overstates RED III requirements because only refinery hydrogen used to make industrial products counts towards the industry target. If assets met demand entirely with green ammonia imports, the four clusters could require about 5.0 Mt of green ammonia per year by 2030 and 7.3 Mt NH_3 by 2035, or 6.5 Mt NH_3 and 9.4 Mt NH_3 with the adjacent assets. The feasibility stage will calibrate this simplification through a deeper, asset-level assessment of industry and transport obligations.

Economic Case

Green ammonia supplied from Odisha, India, offers a cost-competitive, RFNBO-compliant supply option for European industry and transport.

The state has attracted more than 6.5 Mt per annum (Mtpa) of announced green ammonia capacity across eight developers, with about 0.8 Mtpa NH_3 under construction and 1.6 Mtpa NH_3 already linked to nonbinding offtake, most of it export-oriented. Domestic auctions have discovered prices as low as €502 (US$570) per ton of NH_3. RMI analysis estimates RFNBO-compliant production at about €571–€635 (US$649–US$722) per ton of NH_3 and delivered cost at Northwest European ports at about €665–€774 (US$756–US$880) per ton of NH_3.

RMI analysis also shows that green ammonia from India can compete on cost with supply from the Middle East and North Africa (MENA), a region that has already secured offtake agreements with Northwest European buyers. Green ammonia from the MENA region is projected to land in Northwest Europe at €841–€956 (US$956–US$1,086) per ton of NH_3. Importing green ammonia from India

offers an opportunity to complement domestic EU-based production and diversify energy import partnerships. The India–EU Free Trade Agreement and the Joint Task Force on Green Hydrogen provide a political foundation for this potential corridor.

Indian green ammonia is more cost-competitive than green ammonia produced in Europe and could be more competitive than conventional alternatives in some European end uses; in others, targeted policy approaches will be needed to close the cost gap further.

RMI and VITO analysis suggests that Indian green ammonia fuel could be 24%–29% cheaper than very low sulphur fuel oil (VLSFO) for shipping between EU ports. This is based on fuel and compliance costs under FuelEU Maritime and the EU ETS, assuming ship operators can sell all of their FuelEU surplus. These policies raise VLSFO costs from about €500 to €1,330 (US$568 to US$1,511) per ton, whereas the same policies bring green ammonia costs down to about €940–€1,010 (US$1,068–US$1,148) per ton of VLSFO equivalent. On voyages between India and Europe, where these rules cover only half of the energy consumed under FuelEU Maritime and half of the voyage emissions under the EU ETS, green ammonia would still cost 28%–31% more than VLSFO.

Nitric acid produced from Indian green ammonia would cost 2%–16% more than nitric acid produced using grey ammonia, at a carbon price of €100 (US$114) per ton. In refining, hydrogen cracked from Indian green ammonia would raise external H_2 feedstock and non-oil-related energy costs for refining light liquid fuels from a grey hydrogen baseline of €65 (US$74) per ton to €95–€155 (US$108–US$176) per ton, a 46%–138% premium at the same carbon price. This is potentially below Germany's €14 (US$16) per kilogram penalty for missing RFNBO hydrogen volumes, which equals €88–€210 (US$100–US$239) per ton of fuel at typical refinery hydrogen intensities. Fertilisers face a substantial cost gap, with green urea 38%–47% more expensive than grey, and green urea will need contracts for difference or offtake premiums to move in the near term.

Midstream Infrastructure Readiness Assessment

Odisha has an established ammonia-handling base, with dedicated infrastructure now developing to support green ammonia exports.

Paradip, a port city in Odisha, already has around 110 kilotons (kt) NH_3 of storage and existing pipeline and handling infrastructure serving the fertiliser industry.[ii] A 4 Mtpa dedicated green hydrogen and ammonia jetty is under development at Paradip, whereas Gopalpur, another port city, has 20 kt NH_3 of existing storage with a further 80 kt NH_3 planned. Much of the existing infrastructure is captive, so ensuring access to shared export infrastructure and aligning its development with project commissioning will be important for scaling exports.

European midstream infrastructure is not on track for 2030.

Open-access ammonia storage and cracking projects across the four clusters have not yet reached a final investment decision (FID). Some flagship terminals are still at the prefeasibility stage, with start dates as late as 2032. Ammonia cracking is the least mature step in the value chain and the only way imported green ammonia can supply refiners and most chemical users. Approximately 32 kilotons per annum (ktpa) H_2 of production capacity from ammonia cracking is operational or under construction, representing less than a tenth of what refiners across the four clusters would require by 2030 under the study's upper-bound scenario, assuming all hydrogen is sourced from imported green ammonia. Hydrogen pipelines to carry cracked hydrogen volumes to North Rhine-Westphalia are not expected before the early 2030s.

Aggregating demand across direct-use and cracked ammonia markets can unlock infrastructure investments in Europe.

A standard 50 kt NH_3 tank needs about 1 Mt NH_3 of throughput per year, roughly 20 turnovers, to operate economically. That is about a fifth of the four clusters' demand potential in the 2030 upper-bound scenario. The smallest commercial crackers under construction need at least 0.2 Mt NH_3 per year. Fertiliser and chemical buyers that use ammonia directly would likely need to pool volumes with refiners that would use cracked hydrogen to justify the first terminals.

Midstream costs are higher today because the economies of scale that drive down prices are not present in the early days of market development, but they will fall as throughput grows.

Early terminals will likely run below capacity, and European sites will also face higher construction costs because of ammonia full-containment safety requirements. Ammonia cracking adds further cost because first-of-a-kind crackers are capital-intensive, and only 80% of the hydrogen in ammonia is recovered when hydrogen is used as a process fuel. As these costs fall, landed ammonia or hydrogen in Europe will become cheaper.

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ii. A kiloton (kt) is 1,000 tons. Throughout this report, "ton" refers to the metric ton.

1. Introduction

Energy security, volatile supply chains, industrial competitiveness, and decarbonisation are driving Europe towards adopting clean molecules for both energy and industrial inputs. The region imports about 80% of its natural gas, and more than 85% of its ammonia supply depends on imported ammonia or imported gas feedstock.[1]

A supply base concentrated in a handful of origins leaves fertiliser, refining, and chemical production exposed to the same shocks, making resilience an urgent priority. Europe's industrial clusters face higher energy and feedstock costs than competitors in regions with cheap renewable power, and affordable clean imports can help keep that industry and the jobs it supports in Europe.

In addition, Europe's decarbonisation policy toolbox, including the RED III quotas, the EU ETS, FuelEU Maritime, and the Carbon Border Adjustment Mechanism (CBAM), combines regulatory requirements and economic incentives that encourage commercial stakeholders to adopt more sustainable molecules. These instruments are not yet enough on their own. Slow transposition of RED III into national law and limited public support for closing the green premium are slowing adoption.

Building domestic production remains Europe's first choice, and it will meet part of this emerging demand. Whether it can do so at the scale, cost, and speed that EU policy targets imply is less certain. Green ammonia imports can give policymakers another option. A diversified base of trusted suppliers can deliver secure, affordable clean molecules, strengthen resilience, and let each industrial sector choose its source based on its preferences. For policymakers seeking a rapid, low-carbon industrial transformation, imports offer a clear advantage. The questions then become where to source from, on what terms, and whether the first volumes can arrive in time to keep the assets that need them competitive.

India has emerged as a competitive location for green hydrogen and ammonia production, supported by its rapidly expanding renewable energy base, competitive renewable electricity costs, and strong industrial capabilities. The country has more than 300 GW of installed nonfossil power capacity and substantial untapped renewable resources, including an estimated 748 GW of solar potential and approximately 696–1,164 GW of onshore wind potential.[2] A nationally interconnected electricity grid further enables the transmission of renewable power from resource-rich regions to major production and demand centres.

An enabling policy environment in India is reinforcing these structural advantages. The National Green Hydrogen Mission (NGHM) supports domestic electrolyser manufacturing and green hydrogen production while creating early demand in sectors such as fertilisers and refining. Subnational policies complement these national efforts by providing additional support through measures such as capital subsidies and exemptions from electricity-related charges. This enabling ecosystem is increasingly visible in the market, with green ammonia auctions for the fertiliser industry setting prices as low as €502 (US$570) per ton of NH_3, and refinery-led green hydrogen tenders approaching €2.7 (US$3) per kilogram of H_2.[3] Together with a rapidly expanding project pipeline, these developments provide a strong foundation for India to scale up green ammonia production to serve both domestic and international markets.

In India, Odisha offers a particularly strong case for developing an export-oriented green ammonia industry. The state has attracted more than 6.5 Mtpa of announced green ammonia capacity across eight developers, with approximately 0.8 Mtpa NH_3 already under construction, demonstrating strong developer interest and early progress towards project execution.[4] Odisha also has a substantial industrial base across fertilisers, refining, and steel, creating potential domestic demand for green hydrogen and ammonia. This provides producers with opportunities to serve domestic markets alongside exports as projects scale.

Odisha's emerging production base is concentrated around the coastal clusters of Paradip and Gopalpur, providing access to ports and a pathway for future exports. Some ammonia storage and handling infrastructure already exist across the two clusters, whereas new enabling and export infrastructure is emerging alongside the growing project pipeline. This includes a 4 Mtpa dedicated green hydrogen and ammonia jetty at Paradip Port,[5] which the NGHM has also designated as a Green Hydrogen Hub. Together, the project pipeline's scale, industrial demand base, port access, and emerging infrastructure position Odisha as an excellent India-side anchor for a green ammonia corridor with Northwest Europe.

The deepening India–EU strategic partnership further strengthens the foundation for green ammonia trade between the two regions. The EU and India concluded negotiations on a free trade agreement in January 2026, reinforcing bilateral economic ties and cooperation on resilient and sustainable value chains.[6] Clean technology, energy, and supply chain resilience now sit at the centre of the relationship through the Trade and Technology Council and the Connectivity Partnership. The two sides also agreed to operationalise an India–EU Task Force on Green Hydrogen to strengthen cooperation on hydrogen production, storage, and distribution.[7] Green ammonia corridors can also add a commercial layer to this political partnership, as both sides can meet each other's needs.

In a coordinated corridor (see **Exhibit 1** for an illustration of the Odisha, India–Northwest Europe Green Ammonia Corridor), each stakeholder group can gain something it cannot secure alone. European off-takers in refining, fertilisers, chemicals, and shipping can secure compliant volumes at a delivered cost per ton below that of equivalent volumes from domestic green production and alternative import routes, with enough visibility to plan against RED III, FuelEU Maritime, and the EU ETS. European governments can diversify supply of a strategic input from a partner economy, make measurable progress against policy targets, and retain industry in clusters at risk of relocation. Indian producers can access the demand depth that carries projects to financial close and moves them down the cost curve. Indian public institutions can earn export revenue, drive industrial and employment growth in states such as Odisha, and prove that the NGHM can deliver an internationally traded product. Export scale will also eventually bring green ammonia within reach of India's own fertiliser and refining sectors.

EXHIBIT 1

The Odisha, India–Northwest Europe Green Ammonia Corridor



Note: The exhibit highlights potential Northwest European import ports for supply.
RMI Graphic. **Source:** RMI analysis

This corridor focuses on ammonia because it is an effective vector for clean energy imports, already trades intercontinentally, and has handling infrastructure under development at both ends of the route. Seaborne trade moves about 20 Mt per year today, supported by established vessels, terminals, and handling codes.[8] The molecule presents complexities such as liquefying at −33°C at atmospheric pressure conditions, energy-intensive production and storage, and toxicity. However, ports at both ends of this route have managed these complexities, largely through the fertiliser trade.

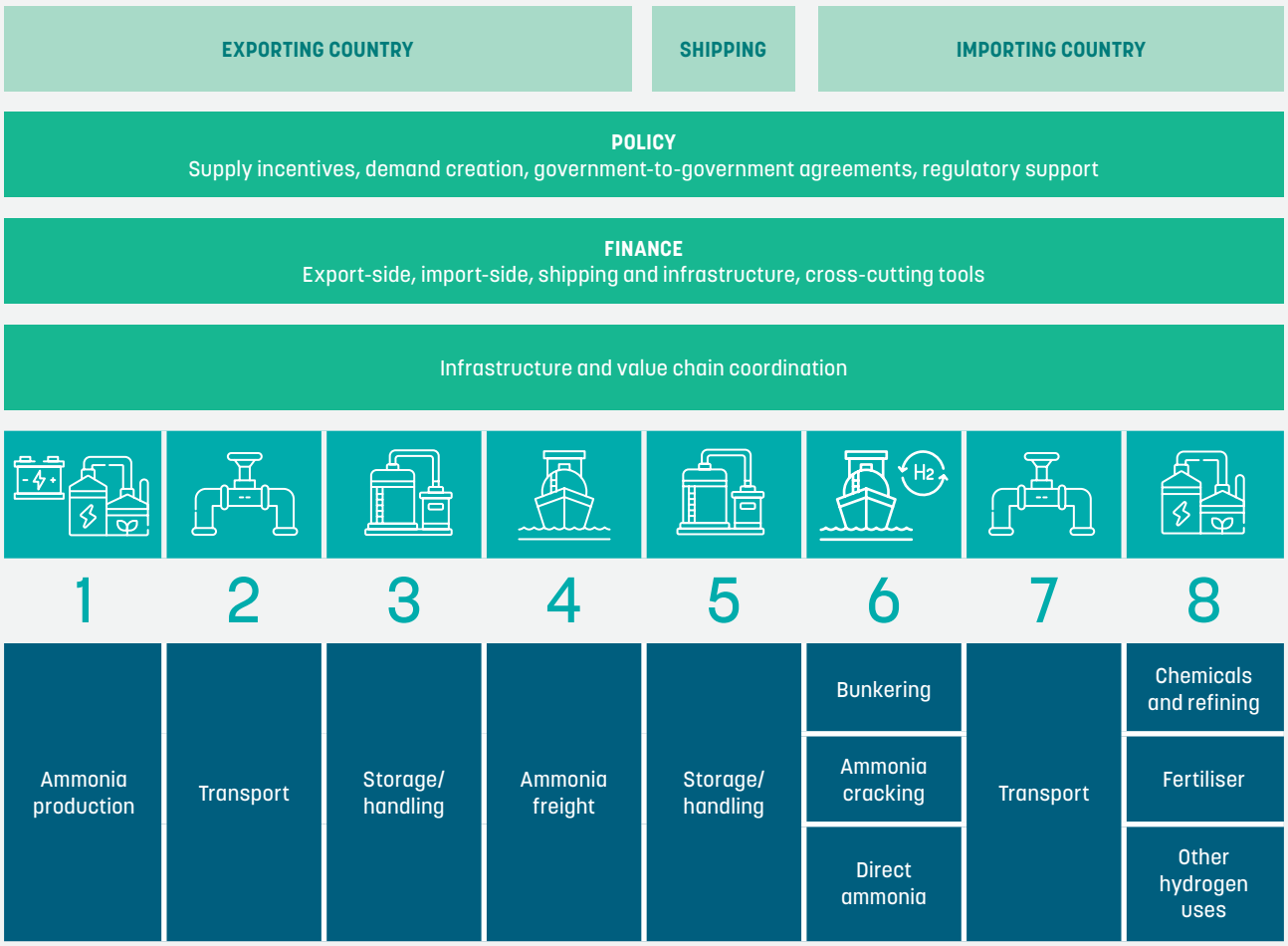
Beyond fertilisers, ammonia is also an important hydrogen carrier for other sectors such as refining and chemicals, and it could be one of the primary solutions for decarbonising the maritime shipping sector. Fertiliser production uses ammonia directly to produce all synthetic nitrogenous fertilisers. Refining and most chemical processes need hydrogen, so imported green ammonia would have to be cracked back to hydrogen at or near the port. Marine bunkering is not established at scale, and methanol is further ahead today as a low-carbon solution, but increasing economic competitiveness and potentially limited access to biogenic carbon dioxide (CO_2) are expected to open a substantial role for ammonia.

Why a Coordinated Value Chain Approach Is Needed

Although bilateral deals are being signed, the overall clean molecule market is not developing at the pace or scale required for meaningful trade. This is largely because every party waits on a signal only another party can send (see **Exhibit 2** for an illustration of the value chain). Off-takers will not commit to long-term volumes without a delivered price they can plan against and infrastructure that can physically serve them. Midstream developers will not take an FID on terminals, storage, and crackers without contracted throughput. Producers will not reach financial close without creditworthy offtake. Public institutions will not size support instruments without a defined volume to size them against. As a result, the market gets stuck collectively.

EXHIBIT 2

Value Chain Illustration



Note: The exhibit shows the chain from renewable power through electrolysis, Haber–Bosch synthesis, port handling, shipping, and midstream infrastructure to the four end uses, with cracking shown as an optional step.
RMI Graphic. **Source:** RMI analysis

A corridor arrangement can provide five benefits:

1. It de-risks the whole value chain, so the same aggregated demand underwrites the plant, the terminal, and the ammonia cracker.
2. It captures synergies for economies of scale, because one import and cracking hub serving several buyers spreads fixed midstream costs in a way no single off-taker could justify.
3. It aligns producers, off-takers, port authorities, midstream developers, and public institutions on one timeline and one set of assumptions.
4. It builds the commercial structures, from offtake contracts through to integrated value chain models, that make the first transactions repeatable.
5. It provides a concrete project for which de-risking levers can be developed.

A cluster-based approach makes this coordination practical. Industrial clusters concentrate large hydrogen and ammonia users around shared ports, pipelines, and storage, so a single import terminal or cracker can serve several buyers. This prefeasibility study focuses on four such clusters in Northwest Europe. Antwerp-Bruges, Hamburg, North Rhine-Westphalia, and Rotterdam can each reach meaningful volume by aggregating demand among their own industrial users. Scale and connectivity still matter. Aggregating offtake across clusters lifts the corridor to a size where large terminals, storage, and cracking capacity become bankable and gives Indian producers a market deep enough to justify bigger plants and lower unit costs. This initiative aims to build that market.

The Initiative and Where It Stands Today

To ensure progress towards creating a precommercial corridor, RMI and VITO have provided independent, neutral coordination among stakeholders, along with deep techno-economic modelling, to support a first-of-a-kind commercial corridor. The effort involved more than 20 major European off-takers across refining, fertilisers, chemicals, and shipping; Indian producers; port authorities in Northwest Europe and India; midstream developers; and demand aggregators. RMI led coordination and execution of the overall corridor coalition and prefeasibility study, with VITO strategically supporting EU demand and infrastructure analysis, as well as engagement with Belgium-based industry.

This prefeasibility study is the first output of a broader initiative. It aims to convene stakeholders around a shared vision and build a collective evidence base to help sequence interdependent decisions.

In the next phase, RMI, with VITO as a key partner, will lead a full feasibility assessment and formally establish an Odisha, India–Northwest Europe corridor coalition that organisations across the value chain are invited to join.

Structure of the Report

The report assesses the corridor's commercial and techno-economic prefeasibility across supply, demand, and midstream infrastructure. The section on ***Supply*** section (**page 20**) covers Odisha's supply position, from the project pipeline and production economics to RFNBO compliance and delivered cost into Northwest Europe. The section on ***Demand*** section (**page 31**) analyses green ammonia and hydrogen demand across the four clusters, explains the policies driving this demand, estimates indicative volumes under current transposition and illustrative upper-bound scenarios, and tests the cost competitiveness of Indian green ammonia for priority end uses. The section on ***Midstream Infrastructure*** (**page 51**) examines midstream infrastructure at both ends of the corridor and estimates the indicative minimum viable scale at which the first assets could become commercially credible. The ***Overall Assessment and Path to Commercialisation*** section (**page 65**) provides an overall assessment of the corridor's status, discusses the business models that could carry the corridor to commercialisation, and outlines the actions to move this effort into implementation.



2. Supply

SCOPE AND REMAINING GAPS

This section assesses Odisha's green ammonia supply potential, including the project pipeline, production economics, RFNBO compliance pathways, and landed costs to Northwest Europe. The analysis establishes the scale and indicative competitiveness of the supply opportunity, while recognising that project-level commercial decisions and regulatory pathways are still evolving. Further feasibility work will need to validate which projects and volumes can materialise within the corridor timeline, confirm RFNBO compliance pathways, and assess the commercial terms and commitments required to advance projects towards FID and long-term supply.

India is among the world's most competitive locations for green ammonia production. Its competitive production cost and readiness advantage stem from abundant renewable energy resources, a nationally interconnected electricity grid, national and subnational policies, strong industry momentum, and a rapidly growing project pipeline. Despite these advantages, barriers remain on both the supply and demand sides of the market. High up-front investment and operating costs continue to affect project economics, whereas limited demand visibility and willingness to pay the green premium constrain long-term offtake.

Policy measures are helping address these barriers on both sides of the market. Incentives under the Ministry of New and Renewable Energy's Strategic Interventions for Green Hydrogen Transition (SIGHT) programme provide direct support for domestic electrolyser manufacturing and green hydrogen production, thereby reducing up-front investment and production costs in the early stages of market development.[iii] On the demand side, interventions such as the green ammonia auctions that the Solar Energy Corporation of India Limited (SECI) runs for the fertiliser sector aggregate demand and provide long-term demand certainty, helping developers progress projects towards FID.

Within India, Odisha is emerging as a major centre for green hydrogen and green ammonia development. The state has prioritised green hydrogen and green ammonia manufacturing under its Industrial Policy Resolution 2022, identifying them as thrust sectors. The policy offers a 30% capital

iii. SIGHT is an incentive programme under the NGHM, with an outlay of ₹17,490 crore (US$1.88 billion), to support domestic manufacturing of electrolysers and the production of green hydrogen, facilitating the growth of the green hydrogen industry value chain in India.

investment subsidy, exemption from applicable electricity-related charges, and reimbursement of ₹3 (US$0.03) per kWh for power purchased from local power distribution companies (DISCOMs) or the Grid Corporation of Odisha.[9] Together, these measures are improving project economics and positioning Odisha as a leading green ammonia production hub.

Odisha's Green Ammonia Project Pipeline

Odisha's enabling policy environment has attracted significant developer interest, with more than 6.5 Mtpa of green ammonia capacity announced across eight developers (see **Exhibit 3**).[10] About 0.8 Mtpa NH_3 of this capacity is already under construction, showing tangible progress from project announcements to execution. Additionally, approximately 1.6 Mtpa NH_3 of announced capacity is linked to nonbinding offtake agreements, providing early commercial signals helping projects progress towards bankability and construction.

International markets are emerging as an important early focus for this pipeline. Of the capacity linked to nonbinding offtake agreements, nearly 75% is export-oriented, indicating strong early interest in international markets. International offtake could provide an initial pathway for projects to reach commercial scale and improve production economics. As costs decline with scale, this could strengthen competitiveness in the domestic market over time, supporting a longer-term dual-market opportunity across exports and domestic demand.

EXHIBIT 3

Odisha's Green Ammonia Pipeline Advances



*RFNBO pre-certification achieved for at least one associated project or phase.

Note: All volumes are in Mtpa NH_3.
RMI Graphic. **Source:** RMI compilation based on the NGHM project database and announcements.

This international orientation is also increasingly reflected in how projects are being developed. As projects progress through different stages, several developers are already incorporating RFNBO and other international market requirements into project development and design. Hygenco and ReNew have secured RFNBO pre-certification under the CertifHy scheme.[11] Meanwhile, the Ocior/Jakson Green Gopalpur project has progressed through front-end engineering design (FEED) and certification activities, with its 600-ton-per-day first phase receiving CertifHy pre-certification in July 2026.[12] ACME's Gopalpur Phase I has similarly progressed through FEED, land acquisition, and establishing a joint venture with Japan's IHI Corporation.[13] Together, these milestones indicate that parts of Odisha's pipeline are advancing towards execution, with international market and compliance requirements increasingly factored into project development.

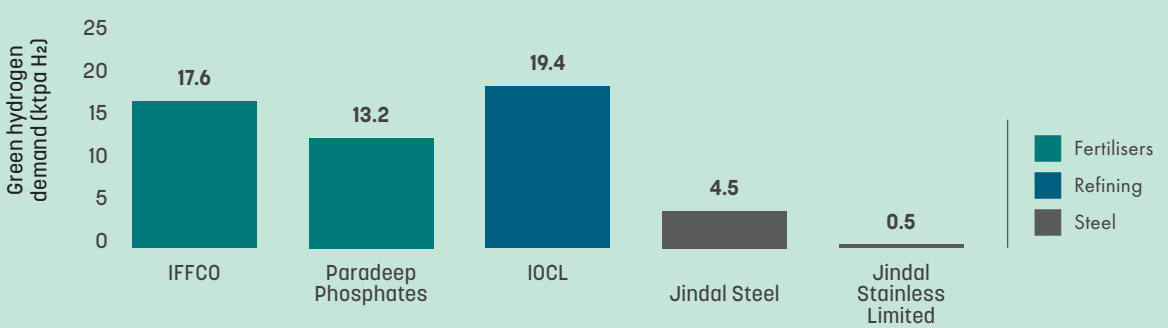
BOX 1

Odisha's Domestic Market Provides a Complementary Demand Opportunity

Odisha has an emerging domestic market for green hydrogen and ammonia. By 2030, identified green hydrogen demand could reach approximately 55 ktpa, led by fertilisers and refining (see **Exhibit 4**). Fertiliser producers Indian Farmers Fertiliser Cooperative Limited (IFFCO) and Paradeep Phosphates Limited have contracted around 31 ktpa of green hydrogen, supported by green ammonia contracted through SECI, and the Paradip refinery of Indian Oil Corporation Limited (IOCL) could contribute approximately 19 ktpa of green hydrogen uptake.[14, iv] Near-term demand from steel remains comparatively limited at around 5 ktpa, although the sector presents a larger opportunity as green steel technologies mature.[15]

EXHIBIT 4

Fertilisers and Refining to Anchor Odisha's Near-Term Domestic Green Hydrogen Demand



RMI Graphic. **Source:** RMI compilation

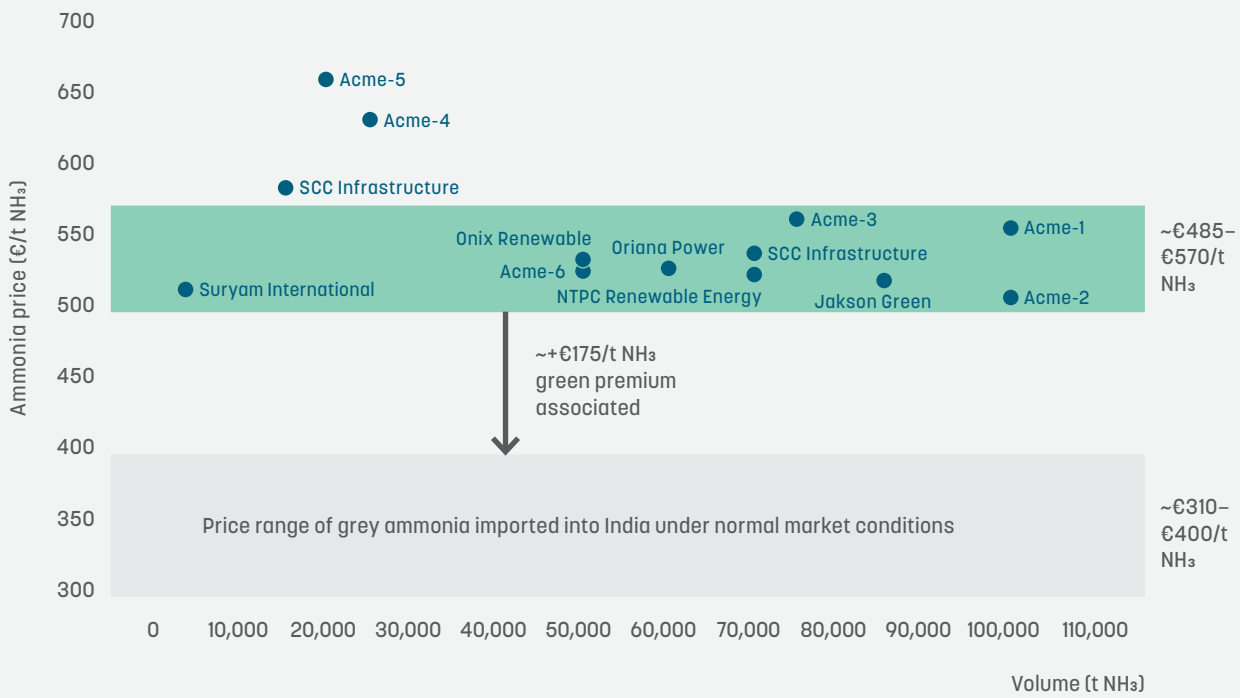
iv. RMI estimate based on IOCL's 80 ktpa green hydrogen deployment target under the NGHM, allocated across its nine refineries based on crude processing capacity and announced expansions.

Green Ammonia Production Economics

Recent auctions have shown India's ability to produce green ammonia at highly competitive prices, with SECI tenders discovering prices as low as €502 (US$570) per ton of NH_3 and awarding capacity of 724 ktpa NH_3 across multiple developers (see **Exhibit 5**).[16] A similar trend is evident in refinery-led green hydrogen tenders, where discovered prices are approaching €2.7 (US$3) per kilogram of H_2.[17] These market-discovered prices from competitive tenders provide real-world benchmarks that complement modelled production cost estimates. Although these prices reflect domestic market conditions and are not directly comparable to the cost of RFNBO-compliant ammonia supplied to Europe, they are an important benchmark for India's underlying production cost advantage.

EXHIBIT 5

Competitive Auctions Show Improving Green Ammonia Production Economics in India



RMI Graphic. **Sources:** SECI, Department of Fertilisers, Argus, FMB Price Data, and RMI analysis

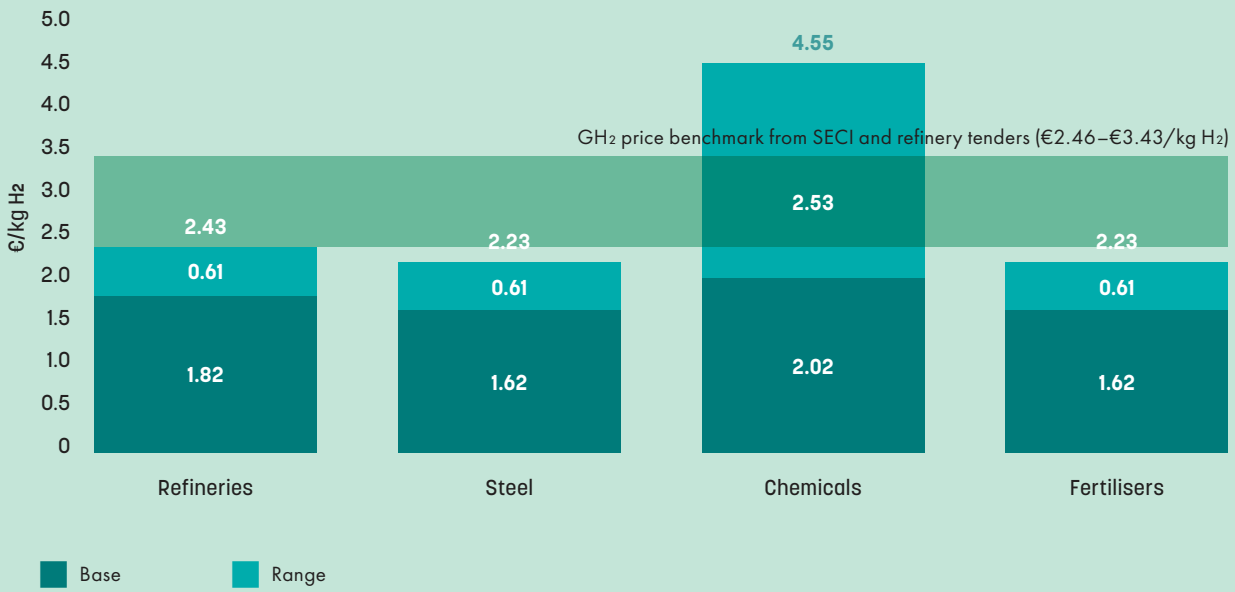
BOX 2

Export-Led Scale Can Support Longer-Term Domestic Competitiveness

Despite increasingly competitive price discoveries, hydrogen and ammonia still carry a green premium over conventional counterparts in India under normal market conditions, and domestic buyers' willingness to absorb it remains limited. Grey hydrogen costs vary across industrial applications, while recent green hydrogen price benchmarks are approximately €2.46–€3.43 (US$2.80–US$3.90) per kilogram of H_2. The gap varies considerably by sector (see **Exhibit 6**). Refining is closest to the lower end of current green hydrogen prices, whereas fertilisers and steel face a wider green premium. Chemicals show a broader price range, suggesting some applications may be better able to absorb higher green hydrogen costs.

EXHIBIT 6

The Green Premium Remains a Key Barrier to Domestic Green Hydrogen Uptake



RMI Graphic. **Source:** RMI analysis of SECI and refinery tenders

This creates a complementary role for export and domestic markets. In the near term, export-oriented projects can deliver larger, more predictable volumes, helping projects achieve scale, improve asset utilisation, and support investment in shared infrastructure. As production scales and costs decline, the same supply ecosystem can increasingly serve domestic industrial demand. A dual-market approach can therefore support early project development through exports while creating the scale and infrastructure needed for deeper domestic decarbonisation over time.

RFNBO Compliance and Renewable Electricity Sourcing Strategy

The domestic auction prices do not reflect the cost of supplying ammonia to Europe. SECI's domestic tenders allow developers greater flexibility to optimise project configurations for the lowest-cost supply, including renewable energy sourcing, energy banking, and access to investment and operational support for the renewable electricity assets. Projects supplying the European market face a more constrained set of optimisation options because they must meet RFNBO requirements for additionality, temporal correlation, and geographic correlation.[18]

BOX 3
RFNBO Requirements Shape Renewable Electricity Sourcing

For an Odisha-based project, RFNBO requirements influence both where renewable electricity can be sourced and how closely renewable generation must be linked to hydrogen production. Three requirements are particularly relevant: geographic correlation, additionality, and temporal correlation.

Geographic correlation can expand renewable energy sourcing beyond Odisha, but with additional conditions. An Odisha-based electrolyser can source renewable electricity either from within its own bidding zone or from eligible interconnected bidding zones. The interconnected zones span several states, including renewable-rich Andhra Pradesh and Karnataka, potentially allowing developers to tap into stronger solar and wind resources.[19, v]

Sourcing from an interconnected bidding zone is subject to an additional day-ahead price correlation test. The electricity price in the renewable generation zone must be at least as high as that in the electrolyser's bidding zone. While more than 99.98% of transacted day-ahead market volume has historically cleared at a uniform national price in India, future congestion or price divergence could affect the RFNBO eligibility of hydrogen produced during those periods. Interconnected-zone sourcing therefore expands the renewable resource base but adds compliance and investment risk compared with sourcing within the same bidding zone.[20]

Additionality rules require hydrogen production to be supported by sufficiently new renewable generation. Renewable generation needs to have come into operation within 36 months of the electrolyser and is subject to restrictions on certain forms of operating and investment aid.[vi] In the Indian context, incentives supporting hydrogen and fuel production facilities, including SIGHT support, plant-level capital expenditure subsidies,

v. The interpretation of the interconnected bidding zone in the Indian context has been cross-checked with industry stakeholders but remains subject to confirmation under the applicable RFNBO certification scheme.

vi. Projects that become operational before January 1, 2028, benefit from a transition phase in which they are exempt from these strict additionality requirements until January 1, 2038.

BOX 3

RFNBO Requirements Shape Renewable Electricity Sourcing (continued)

Inter-State Transmission System (ISTS) and electricity duty waivers, surcharge relief, and land concessions, can be compatible with RFNBO requirements. In contrast, direct capital expenditure or generation-based support for renewable electricity plants is not permitted.[21]

Temporal correlation will require closer alignment between renewable generation and hydrogen production from 2030. Renewable electricity generation and hydrogen production can currently be matched monthly, but from 2030 on, matching will be hourly. This will increase the importance of renewable resource profiles, storage, and electrolyser operating strategies.

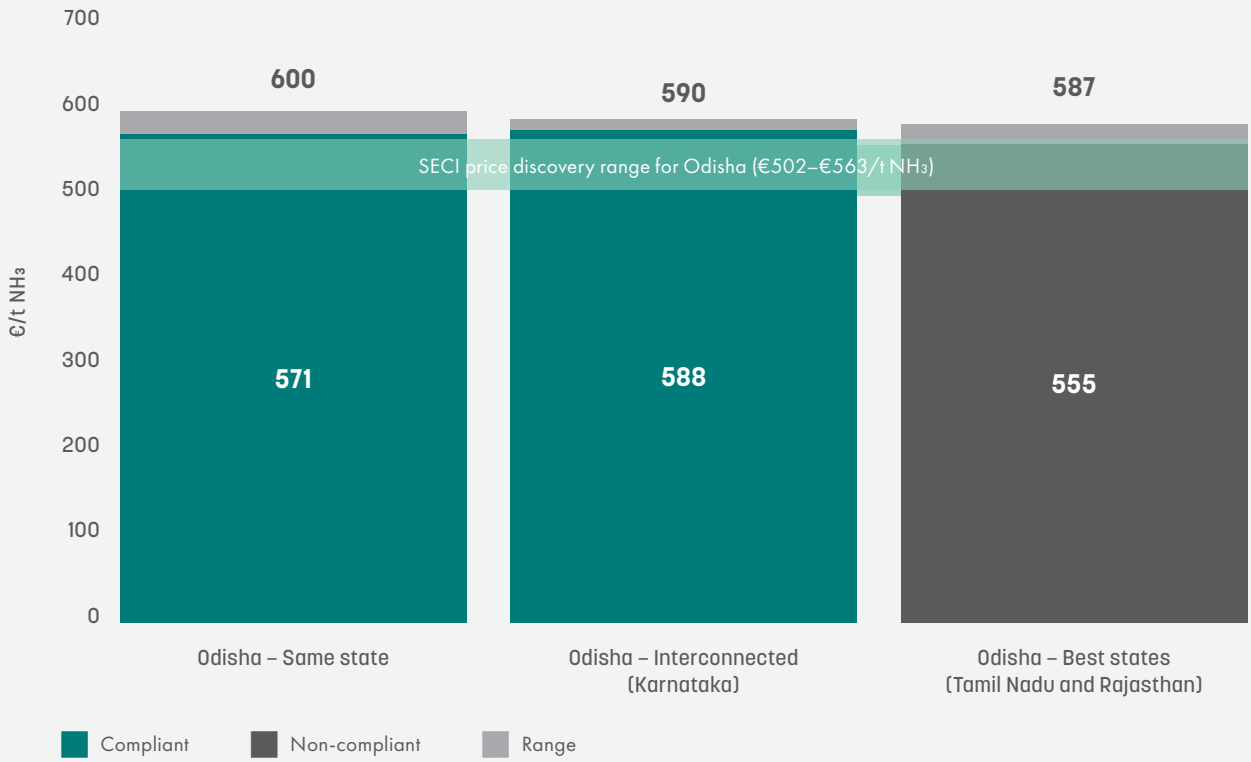
RMI analysis further demonstrates the importance of this sourcing flexibility (see **Exhibit 7**). Across the modelled scenarios, the solid bars represent production using solar power only, whereas the ranges represent a solar-plus-wind hybrid configuration. For an Odisha-based project sourcing renewable electricity within the state, the modelled levelised cost of ammonia ranges from approximately €571 to €600 (US$649 to US$682) per ton of NH_3. This scenario is RFNBO-compliant: it meets geographic-correlation requirements by sourcing renewable electricity within the same state, and it incorporates Odisha's electricity duty exemption, which materially improves production economics.

Access to renewable electricity from interconnected bidding zones can provide additional sourcing options for RFNBO-compliant production. Using Karnataka as an illustrative interconnected bidding zone, modelled costs fall to approximately €588–€590 (US$668–US$671) per ton of NH_3, depending on the renewable electricity configuration.[vii] Although this remains above the €502–€563 (US$570–US$640) per ton of NH_3 range found for Odisha in SECI's domestic green ammonia auctions, the results show that RFNBO compliance can be achieved with a relatively limited premium over domestic auction-discovered prices.

vii. Karnataka is used as a representative interconnected bidding zone for the analysis; other eligible zones, such as Andhra Pradesh, could also be considered.

EXHIBIT 7

RFNBO-Compliant Renewable Energy Sourcing Can Deliver Green Ammonia at Competitive Costs



RMI Graphic. **Source:** RMI analysis

The analysis also highlights the importance of geographic correlation for Odisha's cost competitiveness. If the European Commission relaxed geographic-correlation requirements, or if India were treated as a single bidding zone for RFNBO purposes, projects could access the country's most competitive renewable resources more freely, with modelled green ammonia production costs falling to approximately €555–€587 (US$630–US$667) per ton of NH_3. Greater flexibility in geographic correlation could therefore further strengthen the competitiveness of Indian green ammonia supplied to Europe.

Appendix B provides the detailed modelling methodology, scenario definitions, and assumptions. For subsequent analysis, a broader production cost range of €571–€635 (US$649–US$722) per ton of NH_3 is retained to account for potential variations in project-specific renewable energy sourcing arrangements and associated costs that may not be fully captured in the illustrative configurations modelled above.

Landed Cost of Green Ammonia in Northwest Europe

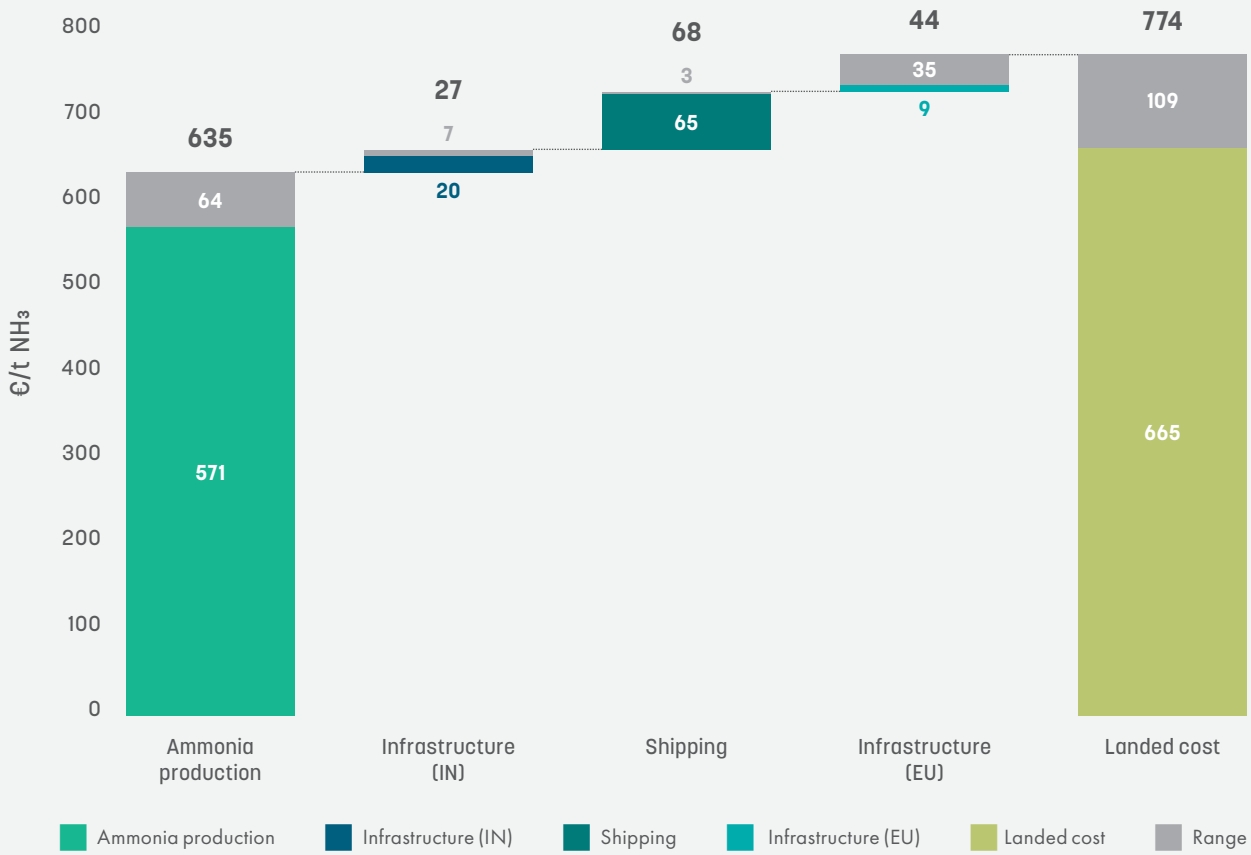
Beyond production costs, transporting green ammonia from Odisha, India, to Northwest Europe adds approximately €94–€139 (US$106–US$157) per ton of NH_3 in logistics costs (see **Exhibit 8**). Shipping is the largest component, at approximately €65–€68 (US$73–US$77) per ton of NH_3, including canal transit and using green ammonia as shipping fuel. However, shipping costs could fall to approximately €35–€44 (US$40–US$50) per ton of NH_3 when accounting for policy measures such as FuelEU Maritime. A more detailed total cost of ownership analysis incorporating these policies will be undertaken during the feasibility stage.

Infrastructure and handling costs are estimated at €20–€27 (US$23–US$30) per ton of NH_3 in India and €9–€44 (US$10–US$50) per ton of NH_3 in Europe. At the lower end, RMI's analysis estimates infrastructure costs based on the assets' expected operating scale. The lower European infrastructure cost reflects economies of scale from shared import infrastructure that handles volumes from multiple supply sources. In contrast, the India-side estimate assumes infrastructure dedicated to a single export-oriented project. However, stakeholder consultations indicate that infrastructure costs could be higher in the corridor's early years, particularly in Europe, when trade volumes are still developing and capital-intensive infrastructure costs are spread over lower throughput. To reflect this early-stage uncertainty, the analysis uses €27 (US$30) per ton of NH_3 for India and €44 (US$50) per ton of NH_3 for Europe as the upper end of the infrastructure cost ranges.



EXHIBIT 8

India's Green Ammonia Retains Most of Its Cost Advantage in Northwest Europe



RMI Graphic. **Source:** RMI analysis

The analysis indicates a delivered cost of approximately €665–€774 (US$755–US$879) per ton of NH_3 at Northwest European ports. The range highlights the importance of infrastructure costs, alongside production and shipping, in determining the corridor's overall economics, particularly during its early years. As trade volumes increase and infrastructure costs benefit from greater scale, delivered costs could move towards the lower end of the range, strengthening the competitiveness of green ammonia delivered from India to Europe.

Overall, Odisha's strong project pipeline, improving production economics, and emerging pathways for RFNBO compliance position it well to supply green ammonia to international markets, while complementing the gradual development of domestic demand. However, turning this supply potential into commercial trade will require infrastructure to develop alongside production, including connectivity,

storage, handling, and export facilities in Odisha, as well as adequate import and distribution infrastructure in Europe. The following section assesses demand drivers, demand scale, and end-use cost competitiveness for green ammonia delivered to Northwest Europe.



3. Demand

SCOPE AND REMAINING GAPS

This section covers refining, fertilisers, chemicals, and maritime shipping across the four clusters. It excludes aviation, steel, and chemical products other than nitric acid, aniline, and hydrogen peroxide. This assessment uses asset capacity as a proxy for consumption.

The feasibility phase will establish in more detail how each host country transposes the industry and transport targets; how much demand will be met through European domestic production of green molecules; what individual buyers are willing to pay, and for how long; the practicalities of blending green ammonia in existing industrial operations; end-use cost comparisons; and the impact of policy on the final product cost, including penalties for missing RFNBO targets.

Northwest Europe offers a potentially sizable, policy-driven market for green ammonia, but how much of it becomes firm demand, and how much is met by imports rather than domestic production, depends on how Member States transpose and enforce RED III and set their fuel-sourcing strategies. This section sizes the market in three layers, from today's consumption to indicative volumes under policy scenarios, and tests the cost competitiveness of Indian green ammonia in each end use. Three findings stand out:

1 **Northwest Europe could offer a large, policy-driven market for imported green ammonia from India.**

Four industrial clusters, Rotterdam, Antwerp-Bruges, North Rhine-Westphalia, and Hamburg, offer a TAM of about 1.8 Mt H_2 per year, equal to 12.1 Mt NH_3 (including conversion losses from ammonia cracking). Additionally, three large assets in the vicinity lift this current consumption to 15.6 Mt NH_3. This TAM assumes every ton is replaced by imported ammonia (the feasibility analysis will estimate the potential domestic production emerging in Europe and its interactions with imports).

2 **Refining could be an early mover because Germany already enforces its transport quota with a penalty of up to €14 (US$16) per kilogram of missing RFNBO hydrogen.**

If refiners in the Hamburg and North Rhine-Westphalia clusters met that quota with cracked imported green ammonia, this could drive up to 0.8 Mt NH_3 of demand by 2030. Fertiliser

and chemical producers that use ammonia directly could follow without cracking, and ammonia bunkering adds a smaller but growing market in Rotterdam and Antwerp-Bruges.

3 Indian green ammonia is competitive in some end uses and needs support in others.

Indian green ammonia could undercut conventional marine fuel by 24%–29% on voyages within the EU once FuelEU Maritime and the EU ETS costs are included. However, it would remain 28%–31% more expensive on voyages between India and Europe, where only half of the energy consumed is in scope. It also comes within 2%–16% of grey production costs in nitric acid at a €100 (US$114) per ton carbon price. Fertilisers face the widest gap, with green urea 38%–47% more expensive than grey.

Turning this potential into contracts will require Germany, the Netherlands, and Belgium to transpose the industry target with credible penalties; it will also require public support sized to the remaining premium, and demand aggregated across assets and clusters.

Policy Drivers

A layered EU policy mix is building a market for clean molecules

A layered set of EU instruments (see **Exhibit 9**) is building a market for low-emissions fuels and feedstocks, pairing sticks that raise the cost of the status quo with carrots that narrow the green premium. The EU ETS prices emissions across refining, chemicals, and fertilisers and now extends to maritime transport.[22] The RED III sets RFNBO quotas for industry and transport.[23] FuelEU Maritime imposes a tightening greenhouse gas (GHG) intensity limit on marine fuel, backed by penalties, a credit market to profit from overcompliance, and an RFNBO multiplier.[24] CBAM, which entered its definitive phase in January 2026, limits the cost advantage of importing grey ammonia and fertilisers.[25] On the support side, the Innovation Fund, the Sustainable Transport Investment Plan, and the Clean Industrial Deal are complemented by national tools such as Germany's carbon contracts for difference and the H2Global import mechanism.[26]

EXHIBIT 9

EU Policies Supporting Low-Emission Fuel and Feedstock Markets



Aviation: Although there is an e-fuel target under ReFuelEU, it is more likely that e-methanol or e-kerosene will be directly shipped to Europe rather than having ammonia being cracked back into hydrogen for sustainable aviation fuel production.

Steel: Steel is extremely price sensitive as a sector and has no direct RFNBO quota. Decarbonisation, in the short-term mostly occurs through carbon capture and storage and lower-carbon industrial heating practices.

RMI Graphic. **Source:** RMI compilation based on European Commission and national government sources

RED III sets separate industry and transport targets

RED III is the main instrument that mandates green hydrogen volumes and drives demand for low-emissions fuel switching. It sets two targets (see **Exhibit 10**). The industry target requires 42% of the hydrogen used in industry, for example in chemicals and fertilisers, to be RFNBOs by 2030 and 60% by 2035.[27] Only refinery hydrogen used to make industrial products falls under the industry target.

Hydrogen used in refineries to produce conventional transport fuels is excluded from the industry target and instead counts towards the transport target, which requires RFNBOs to contribute at least 1 percentage point to the combined 5.5% target for advanced biofuels and RFNBOs by 2030.[28]

More than a year after the May 2025 transposition deadline, none of the three countries has adopted the industry target into national law.[29] Germany and the Netherlands have transposed the transport target, whereas Belgium's transport transposition remains in draft and sets no separate RFNBO obligation (see **Exhibit 10**).[30] The Netherlands has proposed an industry obligation that would apply to individual installations, starting at 0.2% in 2027 and rising to 4% by 2030 and nearly 10% by 2035, well below the EU shares.[31]

EXHIBIT 10

RED III Targets and Member State Transposition Status, October 2026

TARGET	WHAT IT REQUIRES	TRANSPOSITION STATUS AS OF OCTOBER 2026
Industry target (RED III Article 22a)	At least 42% of hydrogen used in industry from RFNBOs by 2030 and 60% by 2035.	Not yet transposed in Germany, the Netherlands, or Belgium. The Netherlands has proposed an installation level obligation of 4% by 2030.
Transport target (RED III Article 25)	Combined share of advanced biofuels and RFNBOs in transport energy of at least 5.5% by 2030, with at least 1 percentage point from RFNBOs. It primarily targets refineries.	Transposed in Germany (1.5% RFNBO subquota by 2030, €120/GJ [US$136/GJ] penalty) and the Netherlands (1.45% of emissions reduction by 2030, up to 1.07 percentage points from refineries). Draft RED III transposition in Belgium presents no RFNBO subtarget.

RMI Graphic. **Source:** RMI compilation based on European Commission and national government sources

Transposition and enforcement will drive firm demand

The transport and industry targets are at different stages of transposition. Germany and the Netherlands have transposed the transport target into law, and Germany imposes penalties. As a result, refineries already face obligations they could meet in part with RFNBO hydrogen, whether produced domestically or cracked from imported ammonia. As of October 2026, none of the three countries under consideration has transposed the industry target into law.

Transposing the industry target into national law is necessary for a bankable business case for RFNBO adoption, and it could drive much greater demand for green ammonia imports. Without transposition, industrial buyers have no obligation to price against, which remains one of the largest sources of uncertainty for European off-takers, and a critical bottleneck for FID for producers and midstream infrastructure developers. Enforcement matters as much as transposition. Outside Germany's transport quota for refineries, governments in Northwest Europe have so far been reluctant to penalise companies that miss RED III targets. Fertiliser and chemical producers already struggle to compete with cheaper producers elsewhere, and policymakers have been more inclined to subsidise the switch than to force it. For most off-takers, the decision comes down to whether staying on grey hydrogen and paying the EU ETS costs is cheaper than switching to a green molecule. Until mandates carry a credible penalty, that comparison will favour waiting, and import infrastructure will lack the contracted demand it needs to reach FID.

Given these transposition delays, 2035 is the more realistic horizon for industry target demand at scale. The industry share is expected to rise from 42% in 2030 to 60% in 2035. Demand in 2030 will therefore come mostly from refineries' transport quota, with fertiliser, chemical, and maritime shipping volumes building towards 2035. It remains uncertain how much of that refinery demand will be met with imported ammonia rather than on-site electrolysis or other options.

Among these sectors, refining could therefore be an early mover and a potential anchor for the corridor. The transport quotas that Germany and the Netherlands have transposed for road fuels, backed in Germany by a penalty of up to €14 (US$16) per kilogram of missing RFNBO hydrogen, make the strongest business case for RFNBO adoption. Refining is already Europe's largest hydrogen consumer, and Northwest Europe hosts some of the continent's biggest refining complexes, with Rotterdam as the leading hub. Fertiliser and some chemical buyers could also follow, because they can avoid ammonia cracking entirely and could blend green ammonia into existing operations.[32]

Northwest Europe Demand Clusters and Green Ammonia Applications

As discussed in previous sections, this prefeasibility assessment considers a cluster-based approach that aggregates demand across select industrial assets in Northwest Europe.

Germany, the Netherlands, and Belgium together account for more than a third of Europe's hydrogen demand, and almost all of it comes from unabated natural gas.[33] Within those countries, Antwerp-Bruges, Hamburg, North Rhine-Westphalia, and Rotterdam hold Europe's highest concentration of hydrogen-consuming assets. RMI and VITO estimate current refining, ammonia, and chemical consumption across the four clusters at about 1.8 Mt H_2 per year, roughly 12.1 Mt NH_3 equivalent once ammonia cracking conversion losses are included, rising to 2.4 Mt H_2 and 15.6 Mt NH_3 when

three large adjacent assets (OCI Chemelot, Yara Sluiskil, and the Total-Lukoil Zeeland Refinery) are counted. Antwerp-Bruges, Hamburg, and Rotterdam are among Europe's largest ports, and all four are among Europe's biggest industrial centres, connected by the Rhine River, existing product pipelines, and planned hydrogen and ammonia connective infrastructure.

Refining, chemicals, fertilisers, and maritime shipping differ in how they would use green ammonia. Refining has the largest existing hydrogen consumption and already faces mandatory national quotas in transportation; green ammonia can be cracked back to hydrogen for hydrotreating and hydrocracking. Some chemicals (though most need hydrogen for production) and fertilisers can use ammonia as is, avoiding cracking losses and making it the most efficient use of the molecule. Maritime shipping opens a new source of demand as ammonia matures into a zero-carbon marine fuel.

Policy shapes demand in three layers

This analysis frames European demand in three layers (see **Exhibit 11**).

1 The first is the demand that obligations already in national law could drive. Germany's transport quota requires RFNBOs to account for at least 1.5% of the fuel energy covered by its fuel supplier quota in 2030, rising to at least 10% by 2040, and suppliers that miss it pay €120 (US$136) per gigajoule, about €14 (US$16) per kilogram of missing RFNBO hydrogen.[34] RMI estimates that this quota could translate into 110 kt of RFNBO hydrogen per year by 2030 at the five German refineries in the North Rhine-Westphalia and Hamburg clusters; supplied as imported green ammonia and cracked back to hydrogen, this would equal roughly 0.8 Mt of green ammonia once hydrogen losses from cracking self-consumption are counted. The Dutch RFNBO subtarget for land transport rises from 0.05% in 2026 to 1.45% in 2030, with refinery hydrogen counting for up to 1.07 percentage points.[viii, 35] It could drive demand at Rotterdam refineries, although its penalties are weaker (see **Exhibit 15**).[36] The two countries measure their targets differently. Germany sets a share of transport energy, whereas the Netherlands sets a share of GHG emissions reduction, so the percentages are not directly comparable.

2 The second layer is an illustrative upper-bound scenario for 2030. If, for simplicity in this prefeasibility study, a uniform 42% RFNBO share (the level of the RED III industry target) is applied to the hydrogen used across refining, fertilisers, and selected chemicals, and is met entirely with imported green ammonia, the four clusters could require about 5.0 Mt of

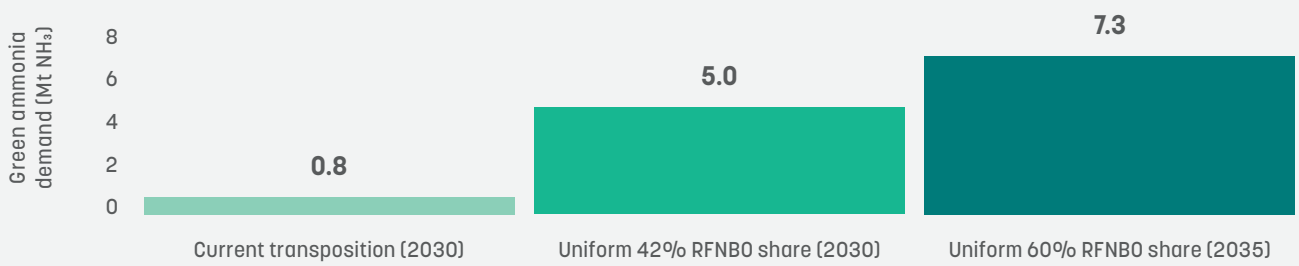
viii. An estimation of equivalent demand will be conducted in the feasibility stage for the transposed Dutch land transport target. This prefeasibility study primarily focuses on the German transposed target as it carries strong penalties.

green ammonia per year by 2030.[ix] These volumes overstate RED III requirements, as only hydrogen used in refineries to produce industrial products falls under the industry quota. About 1 Mt NH_3 of this comes from fertiliser and chemical assets covered by the industry target. The feasibility stage will calibrate this across-the-board assumption by splitting each refinery's hydrogen use between transport fuels and industrial products.

3 The third layer is the 2035 horizon, when a 60% share on the same basis could lift that to about 7.3 Mt NH_3. The second and third layers are illustrative upper bounds. RED III sets the industry target at the national level, leaves Member States to decide how to allocate it, and excludes refinery hydrogen used for transport fuels. Hence, actual obligations, and the share met with imported ammonia, could be much lower.

EXHIBIT 11

Indicative Green Ammonia Demand Scenarios Across the Four Clusters (in Mt NH_3)



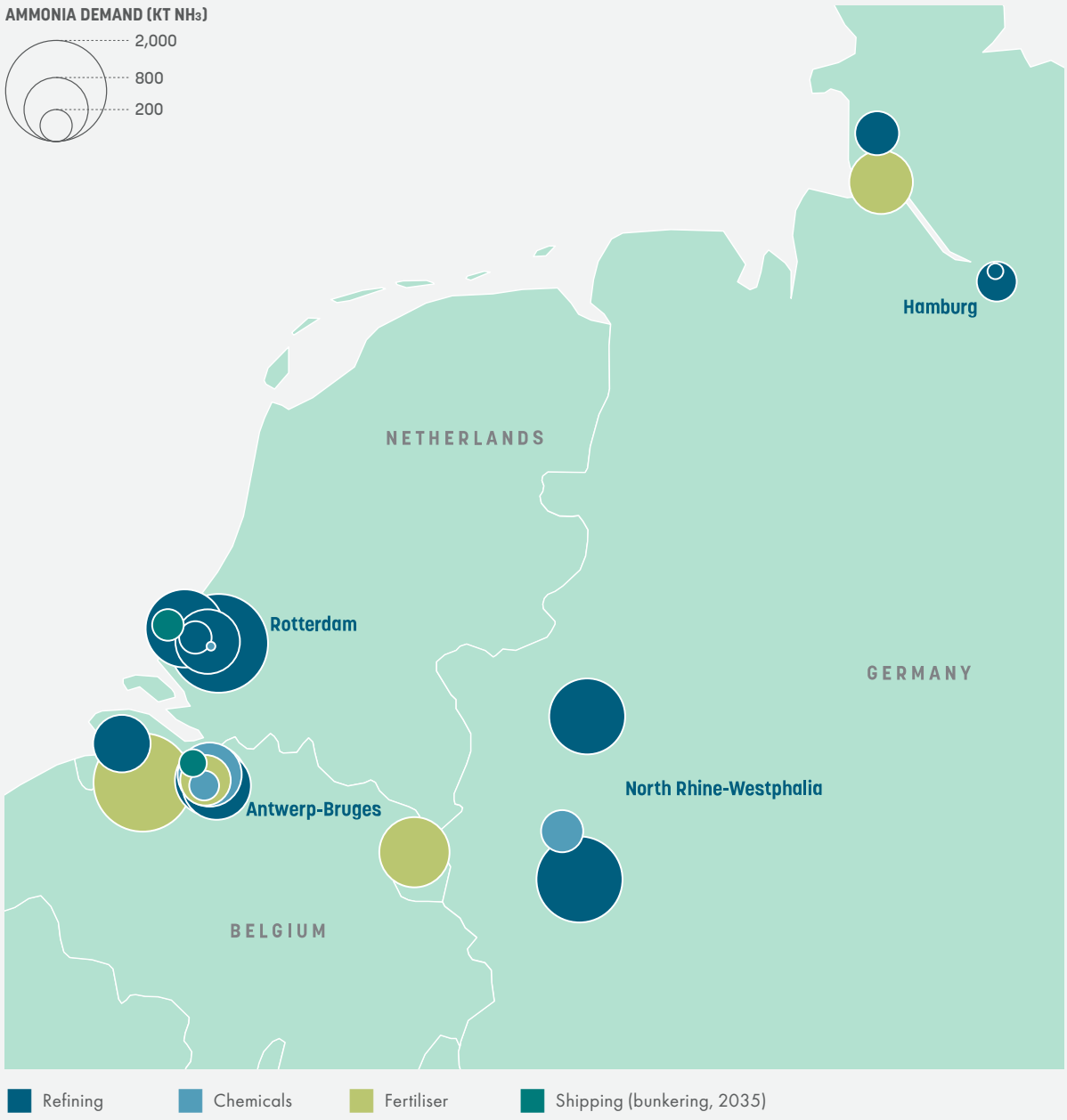
Note: Assumes 50% adoption of the 1.5% energy quota in Germany's transposed transport target across refineries in Hamburg and North Rhine-Westphalia. For 42%, it applies a standard 42% demand across all refining, chemical, and fertiliser assets in each cluster. For 60%, it assumes a 60% demand across all refining, chemical, and fertiliser assets in each cluster. Both are simplifying upper-bound assumptions. Under the RED III, refinery hydrogen used to produce transport fuels falls under the transport target, and only hydrogen used to produce industrial products is covered by the industry target. All volumes assume demand is met with imported green ammonia.
RMI Graphic. **Source:** RMI and VITO analysis

In these assets, green ammonia can be used directly, for example in fertilisers, shipping fuel, or some chemical processes, or cracked back into hydrogen, which is needed for refining and some chemical processes. **Exhibit 12** maps major assets across these clusters.

ix. For this prefeasibility study, chemical demand largely consists of nitric acid, which uses ammonia directly, and intermediate chemicals like hydrogen peroxide and aniline. The feasibility assessment will extend the analysis to the steam cracker base and other intermediate chemical pathways. Conversions assume a cracking yield of 139 kilograms of H_2 per ton of NH_3. Because reconverting ammonia to hydrogen entails losses, buyers requiring hydrogen need more ammonia than buyers able to use ammonia directly.

EXHIBIT 12

Cluster Demand Map by Region and by Sector (kt NH_3)



RMI Graphic. **Source:** RMI compilation based on European Commission and national government sources

BOX 4

Refining — Market Drivers and Green Ammonia Applications

The RED III transport target is the main near-term driver of green hydrogen use in refining. RFNBO hydrogen used in refinery processes to produce transport fuels counts towards the low-emissions fuel share that suppliers must deliver to road transport. Green ammonia could be cracked back into hydrogen to meet ongoing needs in hydrocracking, hydrotreating, and desulphurisation. Hydrogen can also be used as a process fuel, but other options are available to cut those emissions.

Several refiners are moving ahead of regulation. Shell is building the 200 MW Holland Hydrogen 1 electrolyser for its Pernis refinery, and TotalEnergies has contracted Air Liquide for 15 kt of green hydrogen per year at its Antwerp platform from the end of 2027 and up to 30 kt at the Zeeland refinery from 2029, in both cases to serve the European fuel market.[37] Firmer demand would also bring more on-site electrolysis. Holland Hydrogen 1 is sized at up to 60 tons of hydrogen per day, roughly 22 kt per year, against Shell Pernis's estimated 265 ktpa H_2 of demand.[38] Imports can complement domestic production and may offer a cheaper route to closing the cost gap.

BOX 5

Maritime Shipping — Market Drivers and Green Ammonia Applications

In the shipping sector, mandates, penalties, and targeted incentives are driving the adoption of low-carbon fuels. Policy does not favour a single fuel, but it includes measures to support e-fuels such as green methanol and ammonia. From 2025 through 2033, FuelEU Maritime applies a reward factor of 2 to RFNBOs, so each megajoule of certified e-ammonia or e-methanol counts twice in the energy denominator of a ship's GHG intensity calculation. Biofuels receive no such multiplier. This lowers a ship's reported intensity, but it does not double the resulting compliance surplus or pooling revenue. The actual benefit depends on the vessel's overall fuel mix, the RFNBO's certified life-cycle emissions and the target in force that year. If RFNBOs make up less than 1% of ships' in-scope energy use in 2031, a mandatory 2% RFNBO subtarget applies from 2034, turning the incentive into an obligation, with exceptions for insufficient availability, uneven geographical supply, or excessively high prices.[39]

Methanol is emerging as the more popular and easier short-term e-fuel option. Ammonia's economics are more encouraging over time because its synthesis does not require a source of carbon dioxide, which is expected to support its medium-term scale-up. More than 40 ammonia dual-fuel vessels are expected on the water by 2030 across the globe, signalling that the fleet is preparing to use ammonia fuel.[40]

BOX 6

Fertilisers — Market Drivers and Green Ammonia Applications

Ammonia is the building block for all synthetic nitrogen fertilisers, such as urea, ammonium nitrate, and calcium ammonium nitrate. With most of Europe's ammonia exposed to imported gas or imported product, a blend of domestic production and diversified imports could offer a path to resilience at an affordable price. Existing plants could start by blending green ammonia into grey volumes, requiring no process changes.

Once transposed into national law, RED III RFNBO mandates will add to the regulatory requirements facing fertiliser producers. The EU ETS increases the cost of unabated ammonia production within the EU. At the same time, CBAM could reduce the cost advantage of importing grey ammonia and urea from outside the EU. The cheapest compliant option is therefore shifting away from imported grey product and towards low-carbon ammonia.

BOX 7

High Value Chemicals — Market Drivers and Green Ammonia Applications

Green ammonia can either be cracked back into hydrogen for use as a fuel or feedstock in chemical production or used directly in chemical applications that consume ammonia. As in refining, carbon capture and electrified heat can address process energy, but ammonia- and hydrogen-based intermediates such as nitric acid, methylene diphenyl diisocyanate (MDI), aniline, and hydrogen peroxide will keep driving demand at these complexes, as will ongoing demand for hydrogen feedstock at steam crackers.

For high-value chemicals, the EU ETS is the main demand driver today, as none of Germany, the Netherlands, or Belgium has yet transposed the RED III industry target. The Innovation Fund and the Industrial Decarbonisation Bank proposed under the Clean Industrial Deal may channel further support towards bridging the cost premium. Beyond compliance, the shift towards product carbon footprint disclosure and ISO standards will make low-emissions procurement easier to verify, and large consumer brands are pressing suppliers for lower-emissions chemicals to cut Scope 3 emissions, an approach recognised under the Science Based Targets initiative.

The prefeasibility assessment excludes aviation and steel, although some assets in these clusters produce either jet fuel or steel. Although ReFuelEU Aviation creates a binding e-fuel obligation, shipping e-kerosene or e-methanol straight to Europe is likely more efficient than cracking imported ammonia back into hydrogen to make synthetic jet fuel.[41] Steel, primarily concentrated in North Rhine-Westphalia, is acutely price sensitive and, in the near term, may cut emissions more through carbon

capture and lower-carbon heat than through hydrogen-based direct reduction. Green hydrogen in steel also has a weaker demand pull, because no policy mandates its use. When steelmakers adopt hydrogen-based processes, importing green iron produced abroad is likely more efficient than importing ammonia and cracking it.

The total addressable market is sizable

The TAM is the volume of imported green ammonia needed to replace all current hydrogen and ammonia consumption at the mapped assets. It is the most optimistic measure of demand and assumes no constraint from policy, cost, or plant integration. RMI and VITO estimate the TAM across the four clusters at about 12.1 Mt NH_3 per year, equivalent to roughly 1.8 Mt H_2 after ammonia-cracking conversion losses (see **Exhibit 13**). About four-fifths of that volume, 9.6 Mt NH_3, would need to be cracked into hydrogen. This is largely driven by refining's direct hydrogen needs, about 1.3 Mt H_2. At a cracking yield of 139 kilograms of H_2 per ton of NH_3, supplying refineries in those clusters would take about 9.4 Mt NH_3.

The remaining 2.5 Mt NH_3 would be used directly as ammonia, without cracking. Yara Brunsbüttel accounts for about 0.8 Mt NH_3 for fertilisers; BASF Antwerp for 0.8 Mt NH_3 for nitric acid and other chemical intermediates; the Envalior and EuroChem fertiliser plants in Antwerp for 0.5 Mt NH_3; and INEOS Köln for 0.35 Mt NH_3 for acrylonitrile. Green ammonia is chemically identical to grey ammonia, so these plants face no technical limits on blending. Practical limits come from plant integration. Replacing on-site production idles existing ammonia units, and urea plants that take carbon dioxide from their own ammonia process would need another source. The TAM applies no discount for these factors; the feasibility phase will assess them asset by asset.

By cluster, Rotterdam has the highest TAM at about 4.2 Mt NH_3, primarily for ammonia cracked into hydrogen, followed by Antwerp-Bruges at 3.4 Mt NH_3, North Rhine-Westphalia at 2.9 Mt NH_3, and Hamburg at 1.6 Mt NH_3. Additionally, three large assets sit just outside the cluster boundaries: the Zeeland Refinery and Yara Sluiskil near Antwerp-Bruges, and OCI Nitrogen's Chemelot site near North Rhine-Westphalia. They are close enough to share import terminals, and including them raises the TAM to about 15.6 Mt NH_3 or 2.4 Mt H_2 per year.

EXHIBIT 13

Assets Consuming Hydrogen and Ammonia Across Selected Clusters (Mt NH_3)

CLUSTER	DIRECT USE	FOR CRACKING	CURRENT CONSUMPTION (TAM)	UNIFORM 42% RFNBO ADOPTION SHARE (BY 2030)	UNIFORM 60% RFNBO ADOPTION SHARE (BY 2035)
Rotterdam	0	4.2	4.2	1.7	2.5
Antwerp-Bruges	1.3	2.1	3.4	1.4	2.0
North Rhine-Westphalia	0.4	2.6	2.9	1.2	1.8
Hamburg	0.8	0.8	1.6	0.7	1.0
FOUR CLUSTERS	**2.5**	**9.6**	**12.1**	**5.0**	**7.3**
Adjacent assets (Zeeland Refinery, Yara Sluiskil, OCI Chemelot)	2.9	0.7	3.5	1.5	2.1
CORRIDOR TOTAL	**5.4**	**10.2**	**15.6**	**6.5**	**9.4**

Note: Direct use is the ammonia capacity of plants that consume ammonia as a feedstock. Volumes for cracking are calculated by converting refinery and hydrogen peroxide production hydrogen demand using a conversion factor of 139 kilograms of H_2 per ton of NH_3. The 42% and 60% columns apply shares set at the RED III industry target levels uniformly to every asset as an illustrative upper bound, including refinery hydrogen that RED III assigns to the transport target. Totals may not equal sums due to rounding.
RMI Graphic. **Source:** RMI and VITO analysis

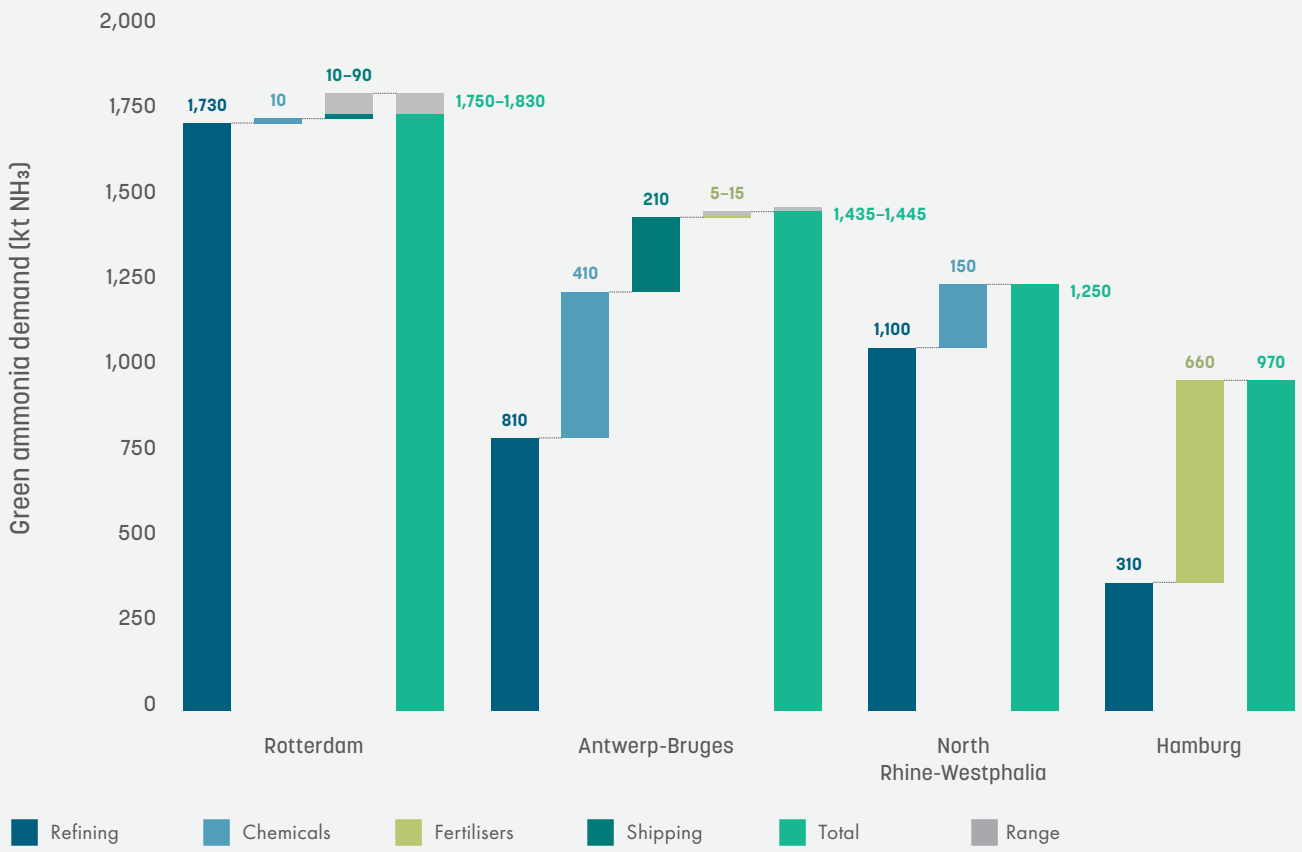
Policy-backed demand represents a fraction of the total addressable market

Applying a uniform share set at the RED III industry target levels to every mapped asset, and assuming all of it is met with imported green ammonia, could motivate up to 5.0 Mt of green ammonia demand per year across the four clusters by 2030, and 6.5 Mt NH_3 with the three adjacent assets counted (see **Exhibit 13**). By 2035, when the share rises to 60%, the same assets could require up to 7.3 Mt NH_3 and 9.4 Mt NH_3. These volumes assume that every mapped asset converts 42%, and then 60%, of its current hydrogen use to RFNBO supply. These volumes, however, overstate the hydrogen demand that refineries must meet under RED III industry obligations. About four-fifths of the ammonia would need cracking, 4.0 Mt NH_3 in 2030 and 5.7 Mt NH_3 in 2035, making ammonia-cracking capacity the central infrastructure limitation (***Midstream Infrastructure*** section on **page 51**). Ammonia

bunkering adds a smaller direct-use market of about 24 kt NH_3 in 2030, rising to about 350 kt NH_3 by 2035 in Rotterdam and Antwerp-Bruges. The transport quota already in German law, backed by noncompliance penalties, could create a smaller, nearer-term demand source of up to about 0.8 Mt NH_3 at five refineries across North Rhine-Westphalia and Hamburg in 2030. How much materialises, and how fast, depends on transposition and the remaining cost gap after public support.

EXHIBIT 14

Illustrative Upper-Bound and Policy-Driven Green Ammonia Demand in 2030



Note: For this prefeasibility study, chemical demand largely consists of nitric acid, which uses ammonia directly, and intermediate chemicals such as hydrogen peroxide and aniline. Shipping demand has been calculated based on national transposition or proposed transposition of the RED III transport target in the Netherlands and Belgium. Totals may not equal sums, or match figures elsewhere in the report, due to rounding.
RMI Graphic. **Source:** RMI and VITO analysis

Rotterdam is a refining-led import and cracking hub

Rotterdam is Northwest Europe's leading refining hub and Europe's largest port, with hydrogen accounting for almost all of the cluster's demand. RMI and VITO analysis puts current hydrogen use at about 575 ktpa, which would require about 4.2 Mt of imported ammonia per year once cracked, the largest volume of any cluster. An illustrative 42% RFNBO upper-bound share would mean about 1.7 Mt NH_3 per year by 2030, all of it for cracking. A 60% share in 2035 would raise this to about 2.5 Mt NH_3. Because demand is largely driven by refining, which primarily falls under the transposed Dutch transport subtarget rather than the pending industry target, actual obligations are likely to be far smaller.

Four refineries process 57.7 Mt of crude oil per year, about 1.16 million barrels per day. RMI and VITO analysis estimates they consume up to 575 ktpa H_2, equivalent to about 4.2 Mt of cracked ammonia. Shell Pernis, with a capacity of 447,000 barrels per day, is Europe's largest refinery and accounts for 265 ktpa H_2 on its own, close to half the cluster total. Applying the illustrative 42% share to Pernis alone would imply about 0.8 Mt NH_3 per year if that hydrogen were supplied as cracked imported green ammonia. BP's Europoort refinery at 400,000 barrels per day adds 166 ktpa H_2, ExxonMobil Botlek at 192,000 barrels per day adds 114 ktpa H_2, and the Vitol-owned VPR hydroskimming site adds a further 29 ktpa H_2. Deep-conversion sites, the most hydrogen-intensive configuration because their hydrocrackers upgrade heavy, low-value streams into diesel, jet fuel, and petrol, account for about two-thirds of that demand.

Rotterdam produces no ammonia of its own, so it serves as an import, cracking, and distribution node in a green ammonia corridor. Shell's Holland Hydrogen 1 electrolyser shows that refiners here are prepared to invest in renewable hydrogen, and imported ammonia offers a route to far larger volumes than on-site electrolysis alone can deliver.[42] Chemical demand inside the port is small. RMI and VITO estimate that Kemira's hydrogen peroxide plant uses about 2 ktpa H_2, or about 16 kt of cracked ammonia.

As Europe's largest bunkering port, Rotterdam is well positioned to lead the uptake of ammonia as a marine fuel. RMI projects ammonia bunkering demand of 9–86 ktpa NH_3 by 2030, rising to 197 ktpa NH_3 by 2035. Bunkering would use ammonia directly, adding a direct-use buyer to a cluster that otherwise depends on cracking.

Antwerp-Bruges is a major chemicals hub

Antwerp-Bruges is Europe's largest integrated chemical cluster, Belgium's largest chemical production region, and the world's second-largest integrated chemical cluster.[43] Unlike Rotterdam, where refining dominates, demand here splits between crude processing and a chemicals base built around the BASF, TotalEnergies, and ExxonMobil complexes. RMI and VITO analysis points to current consumption of 3.4 Mt NH_3 per year, or about 525 kt H_2 per year. About 1.3 Mt NH_3 is used as

delivered, whereas 2.1 Mt NH_3 would have to be cracked. Applying the illustrative upper-bound shares of 42% and 60% to every mapped asset would mean about 1.4 Mt NH_3 per year in 2030 and about 2.0 Mt NH_3 in 2035, if met with imported green ammonia.

Chemicals account for about 980 ktpa NH_3, or about 167 ktpa H_2, driven by the BASF asset. The BASF Antwerp Verbund consumes about 810 ktpa NH_3, equivalent to 143 ktpa H_2, and is the largest chemical asset of its kind in Belgium. That ammonia feeds nitric acid, MDI and polyurethanes, amines, and caprolactam. Hydrogen peroxide production at the Solvay and Evonik facilities adds close to 24 ktpa H_2, requiring about 170 kt of cracked ammonia, and the Total Olefins and Borealis crackers represent further demand that has yet to be quantified.

Fertilisers add a further 0.5 Mt NH_3 used directly. Antwerp-Bruges, with its Envalior and EuroChem facilities, specialises in producing ammonium nitrate and ammonium sulphate solutions.

Refining accounts for 270 ktpa of H_2 demand, equivalent to approximately 1.9 Mt of cracked ammonia, across two medium-conversion refineries. TotalEnergies Antwerp processes 338,000 barrels per day (16.8 Mt of crude oil per annum) to produce 140.7 ktpa H_2 and has already contracted 15 kt of green hydrogen per year from Air Liquide.[44] ExxonMobil Antwerp processes 307,000 barrels per day (15.3 Mt of crude oil per year) to consume 128 ktpa H_2.

Two large assets just beyond the port boundary could extend the cluster's reach. The Zeeland Refinery at Vlissingen, Netherlands, jointly owned by TotalEnergies and Lukoil, has a capacity of 155,000 barrels per day and consumes about 90 ktpa H_2. Yara Sluiskil on the Ghent–Terneuzen Canal is one of Europe's largest nitrogen fertiliser sites, with about 1.9 Mtpa of ammonia capacity, equivalent to roughly 335 ktpa H_2. It is already linked to Dow Terneuzen via the Benelux's first repurposed gas-to-hydrogen pipeline. Counting both, the wider Antwerp-Bruges demand profile approaches 6 Mt NH_3 per year, or about 950 ktpa H_2.

As Europe's second-largest bunkering port, Antwerp-Bruges is also emerging as a major hub for clean marine fuels. RMI estimates ammonia bunkering demand of 4 to 15 ktpa NH_3 by 2030, rising to 152 ktpa NH_3 by 2035.

North Rhine-Westphalia depends on coastal gateways

North Rhine-Westphalia is Germany's industrial heartland and one of Europe's largest industrial regions. RMI and VITO analysis estimates consumption from mapped assets in the cluster at about 420 ktpa H_2, equivalent to about 2.9 Mt NH_3, driven by large refining and chemical complexes. About 2.6 Mt NH_3 of that would need to be cracked, whereas 0.35 Mt NH_3 can be used directly. Applying the illustrative upper-bound 42% share would mean about 1.2 Mt NH_3 per year in 2030, and a 60% share would mean about 1.8 Mt NH_3 in 2035. The state government expects North Rhine-Westphalia to account for as much as 30% of Germany's entire hydrogen demand, and

its import strategy looks to pipelines from the Netherlands and Belgium to meet that need.[45] As a landlocked destination within the corridor, North Rhine-Westphalia could benefit from Indian green ammonia imports that diversify its supply, whether the ammonia is cracked into hydrogen at coastal terminals and piped inland or transported inland by barge along the Rhine or by rail.

Refining accounts for about 360 ktpa H_2 of current consumption, concentrated in two assets. Applying the illustrative 42% upper-bound share would mean about 150 ktpa H_2 of RFNBO hydrogen, or roughly 1.1 Mt of cracked ammonia per year for hydrotreating and hydrocracking. Germany's transport quota, which already applies to these refineries, could translate to about 83 ktpa H_2, or about 0.6 Mt of cracked imported green ammonia, by 2030. Shell Rheinland processes 339,000 barrels per day and consumes up to 201 ktpa H_2. It is already testing green hydrogen through its 10 MW REFHYNE electrolyser.[46] The Klesch Group complex has a capacity of 265,000 barrels per day and consumes up to 157 ktpa H_2. It also produces ammonia and methanol on site, so some of its hydrogen may count towards the industry target rather than the transport target.

Chemicals add about 62 ktpa H_2 of assessed demand. The anchor is INEOS Köln, which operates a 350 ktpa ammonia plant feeding on-site acrylonitrile production, one of the few large European ammonia assets geared to chemical intermediates rather than fertilisers. There, ammonia reacts with propylene and oxygen in the ammoxidation process that makes acrylonitrile, the building block for acrylic fibres and acrylonitrile butadiene styrene (ABS) plastics, so green ammonia could substitute directly with no cracking step. The cluster's chemical footprint is nonetheless larger than these figures suggest. Evonik's Marl chemical park, Covestro's Leverkusen and Dormagen sites, and the LyondellBasell cracker in Cologne all use hydrogen, but their volumes have yet to be quantified. Just across the Dutch border, OCI's Chemelot complex in Geleen adds about 965 ktpa NH_3 for fertiliser production, equivalent to 171 ktpa H_2. It sits at the inland terminus of the proposed Delta Rhine Corridor.

Hamburg, Germany is a fertiliser-led gateway with inland reach

Hamburg, together with the ChemCoast Park at Brunsbüttel, has demand dominated by fertiliser production. RMI and VITO analysis indicates current consumption of about 245 ktpa H_2, equivalent to 1.6 Mt NH_3, of which about 0.8 Mt NH_3 could be used directly and 0.75 Mt NH_3 would need to be cracked. Applying the illustrative 42% RFNBO share would mean about 0.7 Mt NH_3 per year in 2030, and a 60% share would mean about 1.0 Mt NH_3 in 2035. Unlike the other three clusters, its main demand asset is a single nitrogen producer rather than a refining or petrochemical complex.

Fertilisers account for 0.8 Mt NH_3 of consumption. Yara Brunsbüttel has about 0.8 Mtpa of ammonia capacity, along with roughly 0.7 Mtpa of urea capacity and AdBlue production, making it one of Germany's largest nitrogen assets.[47]

Refining adds about 104 ktpa H_2 across three assets. Holborn Europa in Hamburg has capacity of 105,000 barrels per day for 44 ktpa H_2, and Raffinerie Heide at Hemmingstedt has capacity of 90,000 barrels per day, about 4.5 Mt of crude oil per year, for 53 ktpa H_2 while also producing olefins and aromatics. The small Hansen & Rosenthal speciality refinery in Hamburg adds about 7 ktpa H_2. Holborn and Heide also fall under Germany's transport quota, which RMI estimates could require about 27 ktpa H_2 by 2030, or 0.2 Mt of imported and cracked green ammonia.

Hamburg is not a major bunkering hub, so ammonia bunkering demand is expected to remain modest until 2035. This is largely because Germany's bunkering market is relatively small, and the vessels calling there are mostly general cargo, cruise, and container ships. In contrast, most ammonia dual-fuel orders to date have been gas carriers and some bulk vessels.

Nonetheless, Hamburg's catchment reaches well beyond its own cluster. As Europe's largest railway port,[48] the city plans to use its rail network to move imported ammonia to North Rhine-Westphalia, according to stakeholder consultations. MB Energy's permitted import terminal includes loading facilities for rail tank cars,[49] and a city-commissioned study by Fraunhofer CML estimates that Hamburg could supply 10%–18% of Germany's demand for hydrogen-based energy carriers by 2045 after meeting local needs.[50] The cluster figures above therefore understate the demand Hamburg could serve as a gateway, particularly from inland buyers that use ammonia directly (see the ***Midstream Infrastructure*** section **on page 51**).

Green Ammonia Cost Competitiveness

As outlined in the ***Supply*** section, on **page 20**, RMI estimates the landed cost of RFNBO-compliant green ammonia produced in Odisha at €665–€774 (US$755–US$879) per ton of NH_3. In September 2026, domestically produced grey ammonia averaged €569 (US$647) per ton of NH_3.[51] Cracked back to hydrogen, green ammonia from India equates to €6.6–€8.8 (US$7.5–US$10.0) per kilogram of H_2, inclusive of cracking costs. Cost competitiveness varies across end-use applications, many of which could command a cost premium. The section on ***Overall Assessment and Path to Commercialisation*** (**page 65**) discusses strategies to close cost gaps that may persist across these applications.

Maritime shipping

Green ammonia could undercut conventional shipping fuel for journeys within the EU, where operators are exposed to the full suite of decarbonisation policies. This is a fuel and compliance cost comparison, not a total cost of ownership analysis, so it excludes vessel capital costs, engine premiums, and onboard storage. Over a vessel's lifetime, RMI estimates that FuelEU Maritime and the EU ETS could raise the cost of VLSFO from about €500 to €1,330 (US$568 to US$1,511) per ton of VLSFO equivalent, more than two and a half times its cost without these policies. The same rules

would lower the effective cost of green ammonia. Ships that overcomply with FuelEU can sell their surplus units to under-compliant ships, and the 2x multiplier for RFNBOs until 2033 lets e-fuels count double towards the target and earn more surplus units. With that revenue included, green ammonia imported from India could cost about €940–€1,010 (US$1,068–US$1,148) per ton of VLSFO equivalent, compared with €1,420–€1,660 (US$1,614–US$1,886) without these policies, or 24%–29% less than VLSFO. This result assumes that operators sell all of their FuelEU surplus at modelled prices rising from €173 to €354 (US$197 to US$402) per ton of carbon dioxide equivalent (CO_2e), which makes it a favourable scenario. The advantage would narrow if less surplus can be monetised through pooling arrangements or if surplus prices are lower, and it will also vary with vessel type and year of operation. The feasibility stage will test these sensitivities. The advantage does not carry over to the corridor route itself. On voyages between India and Europe, only half of the energy consumed falls within the scope of FuelEU Maritime and the EU ETS, so the cost of VLSFO rises to about €910 (US$1,034) per ton rather than €1,330 (US$1,511) per ton, whereas green ammonia from India would cost about €1,170–€1,200 (US$1,330–US$1,364) per ton of VLSFO equivalent, 28%–31% more than VLSFO.

Fertilisers

RMI and VITO analysis estimates that, at an EU ETS price of €100 (US$114) per ton of CO_2, urea production would cost €470 (US$534) per ton, considering only energy and feedstock operating expenditure. Fully replacing grey ammonia with green ammonia imported from India would raise the production cost to €650–€690 (US$739–US$784) per ton of urea, representing a premium of 38%–47%.

Refining

RMI and VITO analysis shows that, at an EU ETS price of €100 (US$114) per ton of CO_2, the share of external H_2 feedstock and non-oil-related energy costs for refining light liquid fuels are estimated at €65 (US$74) per ton of light liquid fuels. Using hydrogen cracked back from green ammonia imported from India could offer a premium of 46%–138% for the external H_2 feedstock and non-oil-related energy costs for light liquid fuels, with costs of €95–€155 (US$108–US$176) per ton of light liquid fuels. This analysis does not capture Germany's €14 (US$16) per kilogram penalty for missing RFNBO hydrogen for refining light liquid fuels for road transportation, which would create a stronger economic case for fuel switching. RMI analysis estimates that this could be worth €88–€210 (US$100–US$239) per ton of fuel at typical refinery hydrogen intensities to produce diesel and petrol.

Nitric acid

RMI and VITO analysis indicates unabated nitric acid production exposed to an EU ETS price of €100 (US$114) per ton of CO_2 could see a cost of €215 (US$244) per ton of nitric acid (only energy and feedstock operating expenditure). Fully replacing grey ammonia with green ammonia imported from India could raise production costs to €220–€250 (US$250–US$284) per ton of nitric acid, representing a premium of approximately 2%–16%.

This prefeasibility study does not currently assess the impacts of penalties for not adopting RFNBO-compliant fuels. Such penalties would increase baseline operating costs and reduce the perceived premium for adopting RFNBO-compliant fuel. **Exhibit 15** sets out the penalties for non-compliance under consideration or already implemented.

EXHIBIT 15

Penalties for Missing RFNBO Transport Obligations

COUNTRY	TRANSPOSITION STATUS (AS OF OCTOBER 2026)	RFNBO TRANSPORT OBLIGATION	PENALTY FOR NON-COMPLIANCE
Germany	Transposed into law in 2026	RFNBO subquota of 1.5% of transport energy in 2030, rising to 10% by 2040.	€120 (US$136) per GJ of RFNBO missed (equivalent to €14/kg H_2 or US$16/kg H_2), on top of €600/tCO_2e (US$682/$tCO_2e$) for missing the overall GHG quota.
Netherlands	Transposed into law in 2026	RFNBO subtarget for land transport rising from 0.05% in 2026 to 1.45% in 2030, of which refinery hydrogen can count for up to 1.07 percentage points. Expressed as a share of emissions reduction rather than energy.	Fine set case by case, capped at €450,000 (US$511,000) per violation or 10% of annual turnover.
Belgium	Draft legislation; not yet transposed.	No RFNBO subtarget. RFNBOs supplied to road transport count towards an overall renewable share of 13.9% by 2030 with a multiplier of 1.	€1,400 (US$1,591) per 34 GJ of missing renewable energy.

RMI Graphic. **Source:** Bundestag, Dutch Emissions Authority, Dutch Ministry of Infrastructure and Water Management, EUR-Lex

Demand for green ammonia in Northwest Europe has the potential to be large, but it is not yet firm. Its timing depends on how Member States transpose and enforce RED III, on public support for the remaining premium, and on whether buyers can aggregate enough volume to justify shared infrastructure. The following section assesses the readiness of midstream infrastructure required to support trade at scale.

BOX 8

Evolving Geopolitical and Trade Dynamics Could Influence the Corridor Opportunity

The global geopolitical landscape is undergoing significant shifts, prompting countries to reassess their energy security, trade relationships, and supply chains. Europe, in particular, is reshaping its energy and commodity trade policies to balance domestic production, import diversification, and supply security. These developments could influence the scale and competitiveness of the Odisha–Northwest Europe green ammonia corridor.

1. **European policies may favour domestic production while maintaining reliance on imports.**
   RED III and other regulations are expected to drive demand for green hydrogen and ammonia. Future policies may further incentivise domestic production. However, cost and capacity constraints are likely to sustain Europe's reliance on imports. The balance will determine the market opportunity for Indian suppliers.

2. **Europe's import diversification will create competition among supply regions.**
   Europe is expected to diversify green fuel imports to strengthen supply security. Odisha will compete with emerging suppliers in the Middle East, North Africa, Australia, Namibia, and Brazil. Its market share will depend on cost competitiveness, supply reliability, and commercial readiness.

3. **Geopolitical developments could affect trade routes and delivered costs.**
   Disruptions around the Strait of Hormuz and the Red Sea–Suez Canal route could affect shipping costs and supply chains. Rerouting vessels via the Cape of Good Hope would increase voyage distances, transit times, and freight costs, potentially changing the competitiveness of different supply regions.

These developments are not modelled as alternative scenarios in this assessment. They do not change the finding that Odisha, India–Northwest Europe presents a credible green ammonia trade opportunity, but could affect its scale, timing, and competitiveness. These factors should be reassessed as the corridor advances towards commercialisation.



4. Midstream Infrastructure

SCOPE AND REMAINING GAPS

This section covers port storage, handling, power, and water in Odisha, and ammonia storage, cracking, pipelines, barges, and rail in the four European clusters, along with the minimum viable scale of each asset. It does not include detailed cost estimates for individual terminals or an assessment of shipping fleet availability.

Open questions for the feasibility phase include the exact scale at which each midstream asset becomes commercially viable; how midstream costs fall with throughput and deployment; the access terms, tariffs, and capacity booking rules that open-access terminals, crackers, and pipelines would offer; and how much contracted volume each asset needs before it can reach FID.

The development of the Odisha, India–Northwest Europe green ammonia corridor depends not only on the availability of competitive supply and demand, but also on the infrastructure required to connect the two. Infrastructure serves as the physical gateway between production in Odisha and end-users in Europe, requiring coordinated development across storage, pipelines, port terminals, shipping, ammonia cracking, and last-mile distribution. Readiness, therefore, needs to be assessed at both ends of the corridor, including whether infrastructure can be developed at the required scale and within the timelines needed for commercial trade.

India Supply-Side Infrastructure

Paradip

Paradip has an established ammonia storage and handling ecosystem, providing a strong foundation for future green ammonia exports. The port has two dedicated fertiliser berths with a combined ammonia handling capacity of approximately 10.8 Mtpa, comprising 6.6 Mtpa owned and operated by IFFCO and 4.2 Mtpa by Paradeep Phosphates.[53] These berths primarily serve thethe companies' existing operations, limiting their availability as common-user infrastructure for future exporters. IFFCO's facility is connected to the port via an ammonia pipeline with a handling capacity of approximately 800–1,000 tons per hour, and it has 70 kt NH_3 of storage capacity.[52] Similarly, Paradeep Phosphates is connected through a 3 km, 16-inch ammonia pipeline and has an additional 40 kt NH_3 of storage

capacity.[53] Together, the two facilities provide approximately 110 kt NH_3 of storage at Paradip. These assets demonstrate existing ammonia-handling capability at Paradip. However, their current configuration and ownership mean that dedicated or common-user infrastructure will still be important for supporting a broader green ammonia export ecosystem.

Dedicated export infrastructure is also progressing alongside Paradip's existing ammonia-handling base. The Paradip Port Authority (PPA) has initiated the development of a 4 Mtpa NH_3 dedicated jetty and associated facilities for handling green hydrogen, ammonia, and other liquid cargo, including storage systems, pipelines, and handling equipment.[54] The ₹797 crore (US$86 million) project is structured as a 30-year build-operate-and-transfer concession, with the PPA providing 20% capital support of approximately ₹159 crore (US$17 million) during construction.[55] The tender was issued in April 2026 and specifies a two-year (730-day) implementation period following award, indicating potential availability around 2028 and broad alignment with the commissioning timelines of Odisha's early green ammonia projects.[56]

Gopalpur

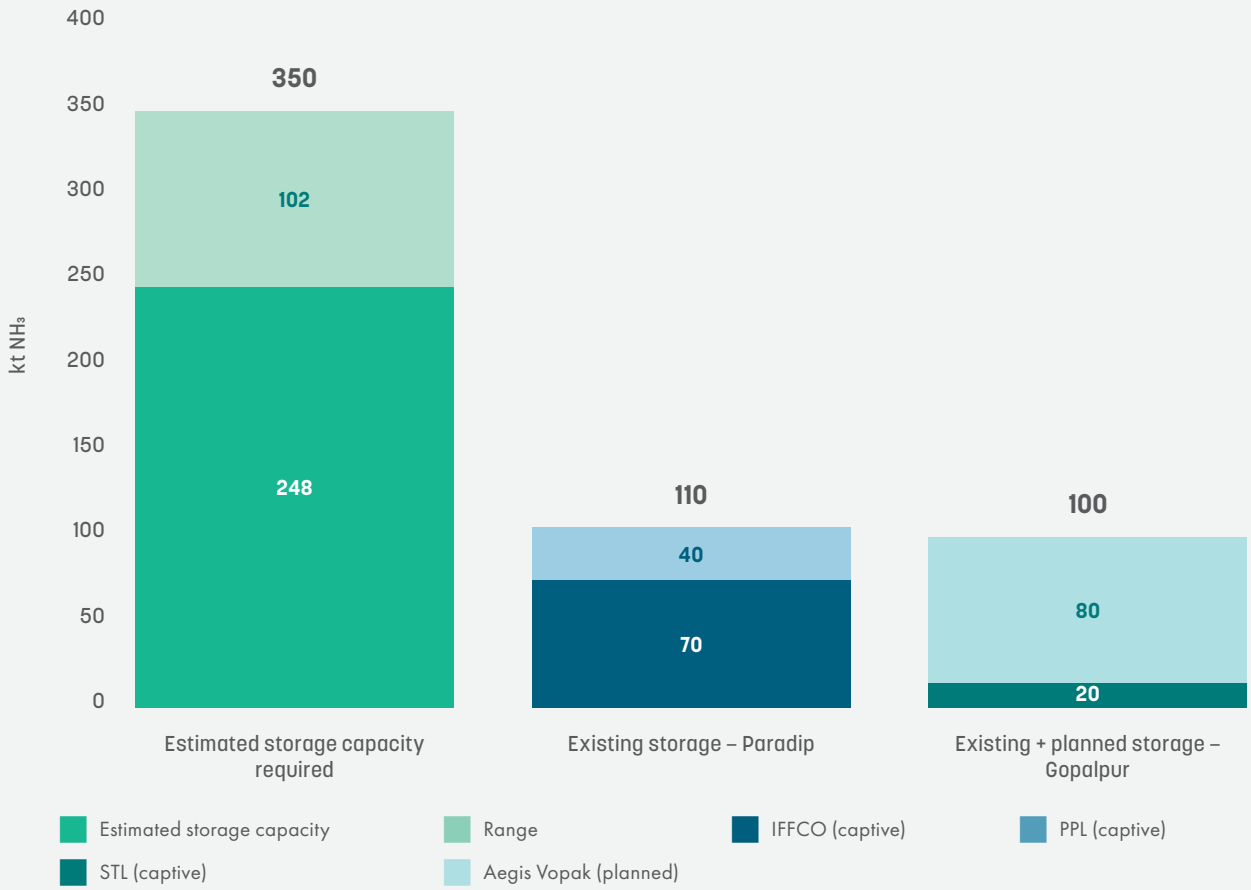
Gopalpur Port currently has limited ammonia infrastructure, but planned investments could significantly expand its ability to support future exports. Smartchem Technologies Limited operates an atmospheric ammonia storage, receipt, and handling facility comprising two 10 kt NH_3 tanks, providing a total storage capacity of 20 kt NH_3.[57] In addition, the Odisha government has approved a ₹1,000 crore (US$107.5 million) ammonia storage project by Aegis Vopak with 80 kt NH_3 of liquid ammonia storage capacity, which would increase the cluster's total storage capacity to approximately 100 kt NH_3 once operational.[58]

Connectivity between the emerging production cluster and Gopalpur Port is also progressing. A dedicated utility corridor between Gopalpur Industrial Park and the port is under construction and is expected to reduce the connection distance to approximately 2.5 km.[59] The corridor provides a dedicated right-of-way for transporting liquid and gaseous products, enabling pipeline connectivity between green ammonia production facilities and port-side storage and handling infrastructure. This pathway is already being utilised for ammonia infrastructure, with an ammonia pipeline connecting the Smartchem/Mahadhan AgriTech facility in the Tata Steel Special Economic Zone (SEZ) to Gopalpur Port, currently under development via the Odisha Industrial Infrastructure Development Corporation (IDCO) common corridor.[60]

Although these developments provide an important foundation, the adequacy of port-side infrastructure ultimately depends on the scale of green ammonia exports it will need to support. The prefeasibility analysis, therefore, estimates the storage, production-to-port connectivity, terminal handling, and marine infrastructure required under projected export volumes and compares these requirements against existing and planned capacity.

EXHIBIT 16

Port-Side Storage Required to Support Odisha's Announced Green Ammonia Capacity



RMI Graphic. **Source:** RMI and VITO analysis

RMI analysis (see **Exhibit 16**) estimates that supporting Odisha's green ammonia export pipeline could require approximately 248–350 kt NH_3 of port-side storage. Odisha already has ammonia storage infrastructure at Paradip and Gopalpur, but this capacity is largely captive and cannot be assumed to be available to emerging exporters. The planned 80 kt NH_3 Aegis Vopak facility at Gopalpur is therefore an important addition, as it could provide third-party storage capacity. However, depending on how much of Odisha's announced project pipeline is commissioned and ultimately targets exports, substantial additional port-side storage capacity may still be required. The precise requirement will depend on export volumes, storage utilisation, and access to existing and planned infrastructure.

Power and water infrastructure

Large-scale green ammonia production will also require substantial power infrastructure. Major ISTS substations are under development at both Paradip and Gopalpur to serve bulk consumers, including green hydrogen and ammonia projects. The initial two 1,500 MVA substations are expected to be commissioned by December 2027 at Paradip and December 2028 at Gopalpur, with provision for expansion to an ultimate six 1,500 MVA (9,000 MVA) at each location.[61] This expansion is being planned to meet an estimated 13.2 GW of combined electricity demand across the Paradip and Gopalpur complexes by 2030, including demand from emerging green hydrogen and ammonia projects.[62]

Water infrastructure will also need to expand to support green ammonia production. At Gopalpur, the Industrial Park currently has access to approximately 7 million litres per day of surface water, with additional supply being explored from nearby perennial sources.[63] Green hydrogen and green ammonia projects are explicitly considered in the assessment of future industrial water demand, with IDCO planning a 100 million litre per day seawater desalination plant under a public–private partnership model to cater to the broader industrial cluster.[64] At Paradip, common water-supply infrastructure has been developed as part of the broader Petroleum, Chemicals and Petrochemicals Investment Region (PCPIR), with water allocated to existing and upcoming industries and additional pipeline and storage infrastructure being developed.[65, x] Although this infrastructure is planned for the broader industrial cluster rather than specifically for green hydrogen and ammonia, it provides a foundation that can be expanded to meet emerging project requirements. As these production clusters develop, planning water infrastructure in parallel with project development and as a common utility could enable multiple producers to access a shared water supply, rather than individual projects developing stand-alone desalination infrastructure.

Taken together, these developments give Odisha a meaningful infrastructure base on which to develop a green ammonia export ecosystem, but readiness varies across infrastructure components and between the two clusters. Paradip benefits from established ammonia handling and connectivity, with dedicated export infrastructure now progressing, whereas Gopalpur will require greater development of export-specific storage, handling and connectivity alongside emerging production. Aligning these investments with the scale and commissioning timelines of green ammonia projects, along with adequate power and water availability, will be critical to translating Odisha's production pipeline into commercial exports.

x. A PCPIR is a large-scale, integrated industrial zone established under the PCPIR Policy announced by the Government of India in April 2007.

EU Demand-Side Infrastructure

Europe's import infrastructure pipeline is large enough for the illustrative 2035 upper-bound demand, but it is too late and too uncommitted for 2030. Under the illustrative upper-bound scenario in the section on ***Demand*** section (**page 31**), which applies uniform 42% and 60% RED III RFNBO shares to all mapped hydrogen use, the four clusters could require about 5.0 Mt of green ammonia per year by 2030 and 7.3 Mt NH_3 by 2035. Of that, about 4.0 Mt NH_3 and 5.7 Mt NH_3, or roughly 560 and 800 ktpa H_2, would need to be cracked. The nearer-term demand that Germany's transport quota could create, up to about 0.8 Mt NH_3 at five refineries if met with imported ammonia, would also need to be cracked.

Exhibit 17 maps every announced storage, cracking, and pipeline project across the four clusters; set against Odisha's supply schedule, it points to a timeline gap. Open-access storage with a disclosed size totals about 165 kt NH_3 in first phases and 445–595 kt NH_3 at full build-out, compared with about 250 kt NH_3 needed in 2030 and 365 kt NH_3 in 2035 in the upper-bound scenario. Cracking is the most critical constraint because it is both the least commercially mature step in the value chain and the only route to serving refining and most chemicals. Capacity with a disclosed size and date reaches about 83 ktpa H_2 by 2030, about 15% of the upper-bound 42% need and about three-quarters of the 110 ktpa H_2 that Germany's transport quota could imply, and only Air Liquide's 30 ktpa H_2 ENHANCE cracker in Antwerp is under construction. That capacity rises to about 360 ktpa H_2 once Vitol Tank Terminals International (VTTI)'s first phases start in 2031–32, well after Odisha's first export volumes arrive in 2030.

Rotterdam and Antwerp-Bruges are the natural gateways because they host nearly all the open-access storage and cracking in development. Hamburg can meet its own fertiliser demand through Yara's Brunsbüttel terminal and MB Energy's permitted 600 ktpa NH_3 terminal. North Rhine-Westphalia depends on those gateways and on pipelines that will not be ready before 2033.

Midstream assets often have to be sized for volumes larger than any single project can provide, and some capacity may need to be built ahead of full use. That makes demand aggregation across assets, along with public support for shared infrastructure that tapers as commercial demand strengthens, a practical way to accelerate midstream infrastructure build-out.

EXHIBIT 17

Infrastructure Readiness Across the Four Clusters

ASSET	OWNER	STATUS	CAPACITY	TIMELINE
ROTTERDAM				
AMMONIA CRACKING				
AmplifHy Rotterdam (Phases 1–3)	VTTI	FEED	140–600 ktpa H_2, phased	N.D.
Air Products crackers (2 units)	Air Products, Gunvor	Permitting	2 × 25.6 ktpa H_2	2030
ACE Terminal cracker	Vopak, Gasunie	Prefeasibility	N.D.	2032
AMMONIA STORAGE				
OCI storage, Phase 1	Agrofert	Operational	30 kt NH_3	In service
OCI storage, Phase 2	Agrofert	Permitting	90 kt NH_3	N.D.
Air Products storage	Air Products, Gunvor	Permitting	55 kt NH_3	2030
AmplifHy Rotterdam storage (Phases 1–3)	VTTI	FEED	40–250 kt NH_3, phased	N.D.
ACE Terminal storage	Vopak, Gasunie	Prefeasibility	N.D.	2032
PIPELINES				
Dutch Hydrogen Network, Phase 1	Hynetwork	Operational	32 km	2026
Dutch Hydrogen Network, Phase 2	Hynetwork	Prefeasibility	N.D.	2030
Delta Rhine Corridor (to North Rhine-Westphalia)	Gasunie	Prefeasibility	N.D.	2031–33

EXHIBIT 17

Infrastructure Readiness Across the Four Clusters (continued)

ASSET	OWNER	STATUS	CAPACITY	TIMELINE
ANTWERP-BRUGES				
AMMONIA CRACKING				
AmplifHy Antwerp (Phases 1–3)	VTTI	Permitting	140–600 ktpa H_2, phased	2031–32
Air Liquide ENHANCE	Air Liquide	Under construction	30 ktpa H_2	2028
Air Liquide ARCAS (pilot)	Air Liquide	Operational	1.9 ktpa H_2	2025
Vopak Energy Park cracker	Vopak	Announced	N.D.	N.D.
Advario–Fluxys cracker	Advario, Fluxys	Announced	N.D.	2029–30
AMMONIA STORAGE				
AmplifHy Antwerp storage (Phases 1–3)	VTTI	Permitting	70–290 kt NH_3, phased	2031-32
BASF tank (captive)	BASF	Operational	50 kt NH_3	2019
Vopak Energy Park storage	Vopak	FEED	N.D.	2029
Advario–Fluxys storage	Advario, Fluxys	FEED	N.D.	2029–30
PIPELINES				
Fluxys Zeebrugge–Ghent–Antwerp link	Fluxys	Under construction	N.D.	2026–27
Fluxys H_2 network to Germany	Fluxys	Prefeasibility	~900 ktpa H_2	2030
Pipelink NH_3 pipeline	Pipelink	Permitting	N.D.	2029
Advario–Fluxys NH_3 pipeline	Advario, Fluxys	FEED	N.D.	2029–30

EXHIBIT 17

Infrastructure Readiness Across the Four Clusters (continued)

ASSET	OWNER	STATUS	CAPACITY	TIMELINE
NORTH RHINE-WESTPHALIA				
AMMONIA STORAGE				
LBC Duisport NH_3 terminal (inland)	LBC, Duisport	Announced	N.D.	2030
PIPELINES				
Fluxys H_2 network to Germany	Fluxys	Prefeasibility	~900 ktpa H_2	2030
Delta Rhine Corridor (from Rotterdam)	Gasunie	Prefeasibility	N.D.	2031–33
GET H2 Nukleus (captive)	RWE, Nowega, OGE, BP, Evonik	Operational	130 km	2026
Air Liquide Rhine-Ruhr (captive)	Air Liquide	Operational	2.9 ktpa H_2	2022
HAMBURG				
AMMONIA CRACKING				
MB Energy cracker	MB Energy	Announced	N.D.	N.D.
AMMONIA STORAGE				
Yara Brunsbüttel terminal (captive)	Yara	Operational	3 Mtpa NH_3 of throughput	2024
MB Energy import terminal	MB Energy	Under construction	600 ktpa NH_3 of throughput	N.D.
PIPELINES				
HH–WIN H_2 pipeline	Gasnetz Hamburg	Under construction	40 km	2026

Note: For phased projects, capacity ranges run from the first phase (lowest capacity) to full build-out (highest capacity). N.D. refers to non disclosed capacity.
RMI Graphic. **Source:** RMI compilation with publicly available information

Ammonia storage project pipeline could cover 2035 needs but falls short for 2030

Beyond incumbents that already operate tanks and have expanded capacity in anticipation of rising ammonia demand, open-access ammonia storage remains pre-FID. Each 1 Mtpa of imported ammonia needs about 50 kt NH_3 of tank capacity, likely turned over about 20 times per year. On that basis, the 5.0 Mt NH_3 implied by the illustrative 42% share across the four clusters in 2030 would need about 250 kt NH_3 of storage, and the 7.3 Mt NH_3 implied by the 60% share in 2035 about 365 kt. Including the three adjacent assets, the requirement rises to about 325 kt NH_3 and 470 kt NH_3. Open-access projects with disclosed tank sizes total about 445–595 kt NH_3, enough for the four clusters' 2035 requirement. Timing is a key constraint. Only Air Products' 55 kt NH_3 tank in Rotterdam, enough for about 1.1 Mtpa NH_3, is scheduled with a disclosed size for 2030, and it has not yet taken FID. VTTI's larger terminals are not expected before 2031–32.[66] For the corridor, this implies that the first 1 Mtpa of Odisha's ammonia exports could land by 2030 if an open-access terminal in Rotterdam or Antwerp-Bruges reaches FID in the next 12–18 months. Still, the full volume implied by the illustrative 42% share could not land before the early 2030s.

Every ton of storage in service today sits behind an already contracted capacity. BASF has held 50 kt NH_3 at Antwerp since 2019, feeding its own site. Agrofert now owns the Europoort terminal in Rotterdam, with 30 kt NH_3 of tank capacity across two tanks, and holds permits to expand to 90 kt NH_3 of tankage and throughput of 2 Mt NH_3 per year.[67] Yara's Brunsbüttel terminal, near Hamburg, has two tanks with a combined capacity of 36 kt NH_3, and the site has likely added capacity since Yara announced in October 2024 that it could handle up to 3 Mtpa NH_3 of low-carbon ammonia in annual throughput.[68]

For the corridor, storage capacity will follow firm offtake. Developers have designed phased terminals that can grow with demand, so the first tranche of contracted volume would trigger the first open-access FIDs. New entrants are building open-access infrastructure that would require multiple tanks, higher throughput, and an attached cracker, aimed at the hydrogen molecule market and merchant customers. VTTI's AmplifHy projects plan phased storage totalling 210–290 kt NH_3 in Antwerp and 180–250 kt NH_3 in Rotterdam at full buildout, each starting with one or two 40–70 kt NH_3 tanks. Air Products and Gunvor plan a single 55 kt NH_3 tank in Rotterdam to feed two cracker lines, with construction set to start in 2026 and operations in 2030.[69] Advario and Fluxys, Vopak Energy Park, and ACE Terminal all follow the same integrated shape of storage plus cracking plus pipeline connection, though none of them has disclosed capacity. MB Energy in Hamburg holds a permit for a terminal with 600 ktpa NH_3 of throughput and undisclosed storage capacity.[70]

Cracking is the key constraint in the midstream value chain

The development of ammonia cracking infrastructure faces four interlinked obstacles: (1) there is no market for cracked hydrogen yet; (2) the infrastructure to deliver it is missing; (3) buyers and sellers have no clarity on price; and (4) timelines for the hydrogen pipelines that would carry it inland remain uncertain. Each of these points back to the same need for aggregated, contracted demand.

For these reasons, a significant gap exists between what is operational or under construction and what is needed to enable imports. Across all four clusters, about 32 ktpa H_2 of ammonia-cracking capacity is operating or under construction, enough to crack about 230 kt NH_3 per year. Air Liquide's ARCAS pilot in Antwerp has been running since 2025 at 30 tons of ammonia per day, about 1.9 ktpa H_2.[71] Its ENHANCE unit, also in Antwerp, is under construction for 2028 at 30 ktpa H_2, and it is the only commercial-scale cracker in Northwest Europe with steel going into the ground. Everything else sits in permitting, FEED, feasibility, or announcement. VTTI holds permits in Antwerp and is in FEED in Rotterdam, with an announced capacity of 300–600 ktpa H_2 in Antwerp (starting at 140 ktpa H_2), with operations expected from 2031–2032.[72] Air Products' two cracker lines in Rotterdam, with combined output of about 51 ktpa H_2, are in permitting for 2030.[73] Advario-Fluxys, Vopak, ACE, and MB Energy have not published any capacity. Even if every cracker with a disclosed size and date were built on schedule, capacity would reach about 83 ktpa H_2 by 2030 and about 360 ktpa H_2 once VTTI's first phases start in 2031–2032. That compares with about 560 ktpa H_2 of cracked hydrogen demand implied by a 42% share in 2030 and about 800 ktpa H_2 at 60% in 2035. Capacity dated for 2030 would cover about 15% of the 2030 need in that scenario, or about three-quarters of the 110 ktpa H_2 that Germany's transport quota could imply. Only VTTI's later phases, at 300–600 ktpa H_2 per site, would bring capacity in line with 2035 demand.

Refining is moving fastest towards green hydrogen in the near term, but slow ammonia cracking development remains a critical obstacle. Refineries already consume hydrogen at scale, operate hydrogen systems, and face the RED III transport obligations, which Germany and the Netherlands have enacted into national law. Once the industry target is transposed, refinery hydrogen used for industrial products will also fall under it. Without a cracker at the port and a dedicated hydrogen line to the refinery gate, refiners cannot consume landed ammonia.

Cracking has not yet reached commercial and economic scale, but its technology readiness level is 8–9. The chemistry is established, catalysts are commercial, and the Antwerp pilot has demonstrated integrated operation. What is missing is proof of performance at scale, particularly sustained availability, the operational energy penalty, and hydrogen purity that meets refinery specifications without expensive downstream clean-up. Developers will not take FID without long-term offtake, and off-takers will not sign long-term offtake without cost-competitive prices and access to dedicated infrastructure. An aggregated offtake commitment tied to cracker infrastructure could also unlock development in other parts of the value chain.

Pipelines to inland Germany will not arrive before the early 2030s

Pipeline infrastructure will not be able to carry corridor volumes inland before the early 2030s. The clusters are building inside their own fence lines faster than they are building links with one another. Fluxys is constructing a hydrogen and CO_2 pipeline connection between Zeebrugge, Ghent, and Antwerp for 2026–2027.[74] Gasnetz Hamburg is constructing 40 kilometres of HH-WIN for 2026, serving the port area.[75] Hynetwork has 32 kilometres of the Dutch hydrogen network in service since 2026.[76]

Cross-border and inland links to North Rhine-Westphalia are still behind schedule. The Delta Rhine Corridor hydrogen pipeline has been delayed to 2031–33, and the project removed ammonia from its scope in December 2024.[77] The Fluxys hydrogen link to Germany, up to 30 terawatt hours or roughly 900 ktpa H_2, remains at prefeasibility for 2030. The German core network is due for completion by 2032, with sections under development now, placing its schedule after the window in which corridor volumes would need to move. Still, it will be the key pipeline link between Hamburg and North Rhine-Westphalia.

As a landlocked region, North Rhine-Westphalia depends on every molecule that arrives through Rotterdam, Antwerp-Bruges, Hamburg, or any other German landing point. Its only operating hydrogen pipelines are captive. GET H2 Nukleus operates a 130-kilometre pipeline from Lingen to Gelsenkirchen, mostly a converted gas line, linking specific supply to specific demand.[78] The Air Liquide Rhine-Ruhr link runs four kilometres to a single Thyssenkrupp facility at 2.9 ktpa H_2.[79]

Ammonia pipelines are also being planned; however, Antwerp-Bruges is the only cluster where planning is in the most advanced phase. Pipelink is in permitting for 2029 to connect Vopak, Advario, and Covestro, and the Advario–Fluxys ammonia line is in FEED for 2029–30.[80]

Rail and barge can bridge the gap for direct-use buyers

Where a pipeline does not exist, ammonia can move to its end-user by barge or rail. Both modes operate at low volumes. An inland ammonia barge has a typical capacity of 900 tons of ammonia. A train wagon can usually carry between 26 and 58 tons of ammonia. A 20-wagon train, an average-sized train, could carry up to 1,000 tons of ammonia per trip.[81] These volumes are unlikely to catalyse large-scale ammonia trade, but they could serve as an initial step to transport the product to off-takers not yet connected to major pipeline infrastructure. Rail is unlikely to be a realistic route for refinery volumes into North Rhine-Westphalia. Moving the 0.6 Mt NH_3 that the region's two refineries could need for Germany's transport quota in 2030 would take about 600 trains of 20 wagons per year, or 12 per week, and the ammonia would still need cracking at the refinery gate. Rail and barge fit direct-use buyers better. INEOS Köln's 42% share, about 150 kt NH_3 per year, equals roughly 165 barge trips on the Rhine, and LBC and Duisport's planned ammonia terminal in Duisburg could receive such volumes from 2030.[82]

This is particularly relevant for North Rhine-Westphalia. Rail from Hamburg would give this region a second inland route that does not depend on the Rhine. Stakeholder consultations indicate that Hamburg plans to use its rail network to move imported ammonia to the region. The port railway already handles about 210 freight trains per day, and rail carried 54% of the port's hinterland transport in 2022, so three ammonia trains per week would add little to existing traffic.[83] However, ammonia needs dedicated pressure tank wagons and dangerous-goods routing. MB Energy plans loading facilities for rail tank cars at its Hamburg terminal, and RWE and VTG have developed a concept to move ammonia from a planned import terminal at Brunsbüttel to industrial customers by rail tank wagon.[84, 85]

Exposure to low water on the Rhine strengthens the case. In late July 2026, low water pushed barge freight rates to Duisburg to record highs and put supply to the Gelsenkirchen refinery at risk, while rail had little spare capacity to absorb the shift.[86] Securing ammonia rail capacity ahead of the first cargoes would let Hamburg serve direct-use buyers in North Rhine-Westphalia before inland pipelines arrive.

Minimum Viable Scale

Minimum viable scale is the smallest volume at which a first-of-a-kind asset could operate commercially. It varies by asset and defines how much demand commercial players need to aggregate before the first projects can be built, regardless of where the ammonia comes from or which off-takers it serves (see **Exhibit 18**). The thresholds in this section are preliminary. They rest on a small number of reference projects and benchmarks. The actual thresholds will depend on public support, contract structures, site conditions, and whether assets are shared or built in phases. The feasibility phase will continue to test them for an accurate representation.

Production can scale in phases

For green ammonia production, scale remains an important consideration for project economics, but it does not translate into a single minimum threshold for the first corridor trade. Electrolyser systems are inherently modular, allowing developers to add capacity in increments and structure projects around a larger ultimate production capacity while bringing partial capacity on line as demand materialises. Odisha's project pipeline already reflects this approach. For example, Hygenco's planned 1.1 Mtpa NH_3 Gopalpur project is being developed in multiple phases,[87] while ACME's 1.2 Mtpa NH_3 Odisha project has similarly been structured for phased development, with its first phase accounting for only part of the ultimate project capacity.[88] Ocior's Gopalpur project follows a similar model, with an initial 0.2 Mtpa NH_3 phase planned before expansion to 1 Mtpa NH_3.[89] Phasing does not reduce the importance of economies of scale and may result in higher unit costs during initial phases, but it allows initial production volumes to remain below the project's eventual capacity.

Storage likely needs about 1 Mtpa NH_3 in throughput

Storage economics depend on tank size and on how often the tank turns over. Standard tanks hold about 50 kt NH_3, and operators size them to the largest vessel expected to call. Tanks of this size likely need around 1 Mtpa NH_3 of throughput to be economic in an early market, or roughly 20 times per year, although the exact figure will vary with tariffs, contract terms, and the terminal's wider business. A terminal with increased need for the molecule, such as a cracker drawing continuously, can empty its tanks more often and push throughput beyond 1 Mtpa NH_3. Smaller tanks, phased construction, or shared use of existing capacity could lower the volume needed for the first cargoes. Even so, the storage threshold is likely to sit above what most single early off-takers would commit, which makes demand aggregation across direct-use and cracked markets an important enabler for the first ammonia terminal.

Economies of scale for crackers need to be proved commercially

Ammonia cracking is the least mature step in the midstream value chain. The smallest commercial-scale units moving forward are about 30 ktpa H_2, which RMI estimates would need 170–215 kt NH_3 of annual feedstock. Air Liquide's ENHANCE unit in Antwerp, at 30 ktpa H_2, is the only cracker under construction in Northwest Europe and currently the best available reference for a first viable unit.[90] The project received public subsidy, which may have allowed a smaller unit than a fully commercial cracker facility would need. Unsubsidised first units may have to be larger to be economic, although modular designs or crackers integrated with an existing hydrogen user could make smaller units viable. With so few reference projects, this threshold remains uncertain.

Hydrogen pipelines hold the highest volume threshold

Hydrogen pipelines likely have the highest volume threshold of the four asset types. The smallest pipeline the European Hydrogen Backbone (EHB) models is 20 inches, about 50 centimetres, in diameter, with a capacity of about 1.2 GW of hydrogen energy. At 5,000 full-load hours per year, the utilisation the EHB assumes, it would carry about 180 ktpa H_2, equal to about 1.3 Mt of cracked ammonia.[91] The threshold is most relevant for North Rhine-Westphalia, where cracked hydrogen demand is about 150 ktpa under the illustrative 42% share in 2030 and about 215 ktpa H_2 under 60% in 2035. On the region's own demand, a dedicated line may become viable only towards 2035. Before then, it would likely need volumes bound for other clusters, and repurposing existing gas pipelines could lower the volume needed to make a first line economic.

Demand aggregation can help unlock a first viable tranche

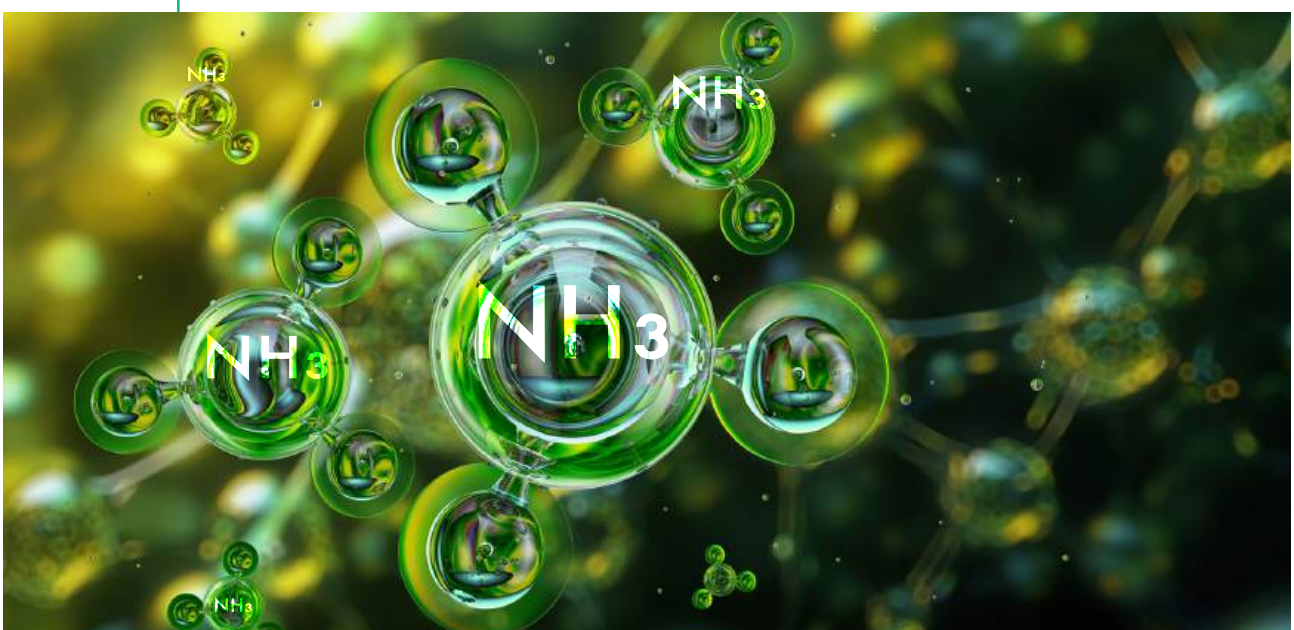
Taken together, these thresholds suggest that a first commercial chain could need on the order of 1 Mt NH_3 of contracted throughput per year. A volume of that size would likely be enough to justify a standard storage tank and to feed a first commercial-scale cracker, and it could combine direct-use buyers, such as a large fertiliser or nitric acid producer, with refiners that need cracked hydrogen. It equals about a fifth of the four clusters' 2030 upper-bound demand, a little above the 0.8 Mt NH_3 that Germany's transport quota could create if all volumes were to be supplied by imported green ammonia.

EXHIBIT 18

Minimum Viable Scale Across Key Assets in the Corridor

VALUE CHAIN STEP	MINIMUM VIABLE SCALE	BASIS FOR MINIMUM VIABLE SCALE	EQUIVALENT DEMAND
Production and export	No fixed minimum threshold identified	Electrolyser capacity is modular, and projects can be developed in phases. This approach is already reflected in Odisha's project pipeline.	N/A
Ammonia storage	About 1 Mtpa NH_3 of throughput for a standard 50 kt NH_3 tank	A standard 50 kt NH_3 tank would likely need about 20 cycles per year (1 Mt NH_3 of throughput) to be economically viable.	At the asset level, based on the demand analysis, 1 Mt NH_3 matches the 60% share of Yara Brunsbüttel and BASF Antwerp combined.
Ammonia cracking	About 0.2 Mtpa NH_3 (30 ktpa H_2)	Air Liquide ENHANCE, Antwerp, produces 30 ktpa H_2 from 170–216 ktpa NH_3, at yields of 177 and 139 kg H_2/t NH_3.	About a third of the potential 2030 German transport obligation of the two North Rhine-Westphalia refineries (about 83 ktpa H_2, or 0.6 Mt NH_3).
Hydrogen pipeline	About 1.3 Mtpa NH_3 (180 ktpa H_2)	Smallest pipeline modelled by the EHB, 20 inches and about 1.2 GW, at 5,000 full-load hours.	North Rhine-Westphalia cracked demand under the 2035 upper bound (about 215 ktpa H_2) or Rotterdam refining under the 2030 upper bound (about 240 ktpa H_2).

Note: Thresholds are indicative, draw on a small set of reference assets, and will vary with public support, contract terms, and asset configuration.
RMI Graphic. **Source:** RMI analysis based on company announcements, the EHB, stakeholder consultations, and Julian Atchison, "Air Liquide's Antwerp Cracker Begins Operations"



5. Overall Assessment and Path to Commercialisation

The prefeasibility assessment finds a credible basis for green ammonia trade between Odisha, India and Northwest Europe. Odisha is developing an export-oriented production base, while Northwest Europe has large concentrations of hydrogen and ammonia demand, established industrial clusters, and growing import infrastructure. European regulation is also beginning to create a clearer market for renewable hydrogen and its derivatives.

These fundamentals do not, on their own, make the projects bankable. A producer considering FID needs confidence in contracted revenues and the route to market. A terminal operator needs sufficient throughput before committing new capacity. Shipping economics depend on cargo size and frequency. European buyers need confidence that a compliant product can be delivered at an acceptable price and on the required schedule. Each decision is commercially rational on its own but depends in part on decisions being taken elsewhere in the chain.

The next stage of corridor development is therefore less about demonstrating the long-term opportunity and more about structuring the first trade flows. This section assesses commercial readiness across the corridor from a 2030–32 perspective, considers how European demand could be concentrated around an initial transaction, and examines the commercial structures and targeted public support needed to address risks within and between projects. It then considers the case for value-chain integration and the priorities for the feasibility stage.

From Prefeasibility to an Investable Trade Flow

The preceding sections establish the supply, infrastructure, and demand fundamentals for the corridor. **Exhibit 19** brings these findings together from a commercial perspective, focusing on the gap between identified potential and the commitments required for investment.

EXHIBIT 19

Commercial Readiness of the Odisha, India–Northwest Europe Corridor

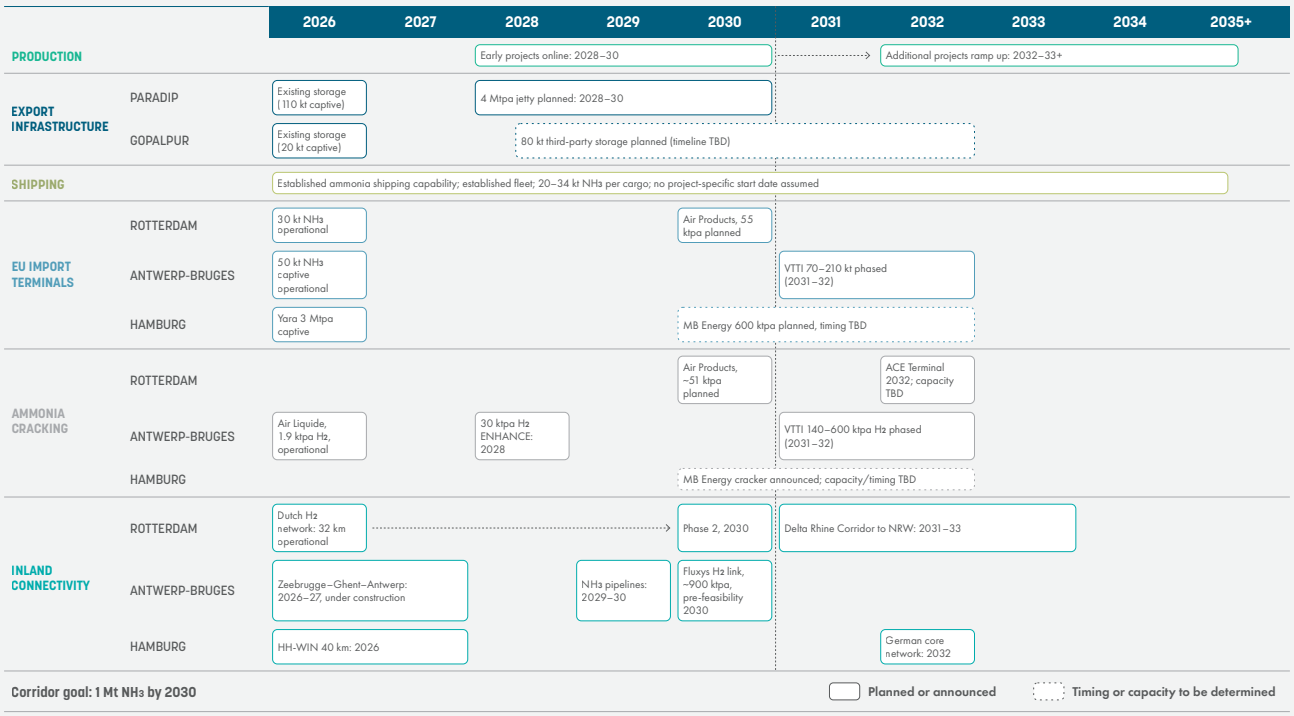
COMPONENT	PREFEASIBILITY FINDING	REMAINING COMMERCIAL GAP	REQUIREMENT FOR COMMERCIALISATION
Odisha supply	Odisha has more than 6.5 Mtpa of announced green ammonia capacity, including 0.8 Mtpa NH_3 under construction, with an indicative delivered cost of €665–€774/t NH_3 (US$755–US$879/t NH_3) into Northwest Europe.	Projects differ in maturity, FID timing, and readiness to meet RFNBO and delivery requirements.	Sufficient contracted revenues and confidence in project execution, compliance, and delivery.
Export infrastructure	Existing port and ammonia-handling capabilities provide a basis for early exports, including ~110 kt NH_3 of storage at Paradip and 20 kt NH_3 at Gopalpur, with a further 80 kt NH_3 planned at Gopalpur. A 4 Mtpa dedicated green hydrogen/ammonia jetty is also being developed at Paradip.	Storage, handling, and loading capacity may not be available when production comes online.	Credible throughput commitments and development schedules aligned with project commissioning.
Shipping	Ammonia shipping is established, with medium gas carriers of 30,000 to 50,000 cubic metres, roughly 20 to 34 kt NH_3 per cargo, carrying most of today's seaborne trade.	Fragmented or irregular volumes can result in inefficient cargo sizes, lower vessel utilisation, and higher freight costs.	Visibility on cargo size, frequency, and duration sufficient to secure shipping capacity and pricing.
European import infrastructure	Planned terminals provide approximately 445–595 kt NH_3 of current and prospective import capacity across relevant Northwest European hubs.	Capacity may not be available at the required location or time, particularly where additional storage or ammonia cracking capacity is required.	Visibility on contracted imports and downstream demand to support capacity reservation or new investment.
European demand	The four clusters and three adjacent assets consume about 2.4 Mt H_2 per year, or 15.6 Mt NH_3 equivalent. Applying uniform 42% and 60% RFNBO shares to every mapped asset, as an illustrative upper bound, gives about 6.5 Mt NH_3 per year by 2030 and 9.4 Mt NH_3 by 2035. German transport obligations could create nearer-term demand of up to 0.8 Mt NH_3 if refiners met them with cracked imported green ammonia.	Buyers differ in volume requirements, willingness to pay, contract tenor, and credit strength.	A sufficiently large and creditworthy portfolio of commitments to support production and the assets serving it.
Certification and regulation	The EU regulatory framework provides a route for RFNBO-compliant hydrogen and derivatives to qualify towards relevant demand obligations.	Project-level compliance, traceability, and regulatory recognition must hold across the transaction.	Clarity on eligibility, verification, and responsibility for noncompliance before long-term commercial terms are fixed.

RMI Graphic. **Source:** RMI compilation

Different elements of the corridor value chain are progressing on different timelines, creating potential gaps between when supply, infrastructure, and connectivity become available (see **Exhibit 20**). For example, early production capacity could come online by 2028–29, while some of the infrastructure required to receive, process, and move these volumes to end users is expected to develop later. Coordinating development and investment decisions across the value chain will therefore be important to ensure that the required assets have compatible capacities and become available on coordinated timelines.

EXHIBIT 20

Different Elements of the Corridor Value Chain Are Progressing on Different Timelines



RMI Graphic. **Source:** RMI compilation

Taken together, the assessment points to a sequencing issue rather than an absence of the components required for trade. The first contracted volume can provide a common reference for project selection, infrastructure requirements, and logistics planning. This makes demand aggregation a practical starting point for commercialisation.

Demand aggregation as the commercial anchor

The addressable European market is considerably larger than the demand that can support investment today. The relevant starting point is bankable demand: buyers with a clear use case, procurement timeline, and ability to commit meaningful volumes. Refining, chemical, fertiliser, and maritime applications will move at different speeds because their compliance obligations, willingness to pay and procurement cycles differ.

Scale adds another constraint. An individual buyer requiring 50–200 ktpa NH_3 may still be too small to support an efficient export transaction. Combining demand into an initial tranche of 1 Mtpa NH_3 could improve terminal and vessel utilisation and reduce dependence on a single buyer. The economics of the first transaction and the volume buyers can credibly contract should determine the appropriate tranche.

Aggregation does not require uniform contracts. An anchor off-taker can combine with smaller buyers, or several buyers can contract independently while sharing common supply and logistics. Intermediation offers another option where contracting horizons differ. H2Global, for example, uses longer-term procurement from suppliers and shorter-term sales to buyers, allowing producer investment requirements and buyer procurement preferences to be accommodated within the same structure.

For this corridor, the objective is a first tranche with sufficient volume, duration, and credit quality to support commercial discussions with Odisha suppliers and the infrastructure and logistics providers required to serve them.

Targeted public support to close early market cost gaps and address risks

Although there is both a commercial basis for and a need for this India–EU green ammonia corridor, early projects are likely to face cost and risk gaps that the private sector cannot efficiently absorb alone. While Indian production is cost-competitive relative to other renewable ammonia supply options, delivered green ammonia may retain a premium over conventional ammonia and other lower-carbon alternatives, as the cost assessments in the sections on **Supply** on **page 20** and **Demand** on **page 30** indicate. Producers will require long-term offtake commitments to finance capital-intensive projects, whereas European buyers may be reluctant to lock in long-term contracts at an uncertain premium. High financing costs for early projects and the need for enabling import infrastructure can further widen the gap.

This creates a coordination challenge across the corridor: producers need demand certainty to reach financial close; buyers need competitive prices and confidence in supply; lenders need predictable revenues; and infrastructure providers need sufficient future throughput. Targeted public support can help break this cycle, particularly for the first wave of projects. Three types of public intervention could be particularly relevant.

1 Bridge the green premium and strengthen revenue certainty.

Public demand-support mechanisms can bridge the difference between the long-term prices required by producers and what European buyers are currently willing to pay. The H2Global model is an effective approach here: its intermediary, Hintco, enters longer-term purchase agreements with producers and resells the product through shorter-term auctions, with public funding covering the resulting price gap. Fertiglobe's renewable ammonia project won the first H2Global pilot auction, backed by a €397 million (US$451 million) contract, with initial deliveries to Europe expected to start in 2027.[92] In September 2026, India's AM Green won the Asian lot of a later H2Global auction, with a 10-year contract worth at least €585 million (US$665 million) and first deliveries of RFNBO ammonia to Germany expected in 2029 from Kakinada in Andhra Pradesh.[93] A similar approach could be particularly relevant to this India–EU corridor because it addresses both the cost gap and contract-duration mismatch without requiring governments to permanently subsidise production. SECI and H2Global have also been discussing a bilateral mechanism for Indian-produced green ammonia and methanol that might deploy about US$600 million of public funding provided by the German and Indian governments. An off-taker-side price backstop could also strengthen buyer willingness to commit to longer-term contracts. This would offer off-takers increased assurance that the premium they pay over fossil-based alternatives is capped, with governments covering a set amount only if a threshold market price is reached.

2 Reduce financing costs and first-mover investment risk.

Green ammonia production is capital-intensive, making financing costs critical to project competitiveness. Concessional finance, blended finance, and credit guarantees can help reduce first-mover risks and mobilise private investment. While project-level concessional financing remains limited in India, opportunities could emerge as larger projects and integrated green fuel hubs develop, particularly for shared infrastructure requiring substantial up-front investment. Targeted capital subsidies and production-linked incentives can further bridge early cost gaps and improve project viability. Combining these instruments with credible long-term offtake commitments could strengthen bankability, lower financing costs, and accelerate investment decisions.

3 **De-risk midstream infrastructure across the corridor.**

As discussed in the section on **Midstream Infrastructure** on **page 51**, midstream infrastructure can face a unique set of risks in a value chain even if supply and offtake can see a bankable business model. Infrastructure must often be developed before sufficient throughput has been contracted, whereas producers and buyers may hesitate to commit to a project without confidence that infrastructure will exist. Targeted grants, concessional finance, or capacity guarantees support shared assets that enable multiple transactions, and any public support can require developing common carrier/open access infrastructure to maximise impact.

Commercial Architecture: From Offtake to Value-Chain Integration

Once a credible demand tranche is identified, participating companies need to determine how far their commercial relationships extend beyond ammonia purchase and sale. Several structures are already emerging in green ammonia markets.

i. **Long-term offtake** provides the most direct link between producer and buyer. A creditworthy buyer committing meaningful volume over an adequate tenor can provide the revenue visibility required for project financing. The agreement between AM Green and Uniper for up to 500 ktpa of green ammonia illustrates the scale at which such a commitment can become material to project development.[94]

   Where the producer contracts to deliver ammonia at the buyer's agreed delivery point, it can remain exposed to infrastructure and logistics that it does not directly control. Revenue risk may be reduced, while execution and delivery risks remain.

ii. **Strategic investment** brings the buyer into the economics of the production project. Energie Baden-Württemberg's investment in the planned Skipavika Green Ammonia project, including a 10% equity interest and associated offtake rights, is an example.[95] The buyer participates in project risk and upside while strengthening its access to future supply.

   This creates deeper alignment around project development, financing, and performance than conventional offtake. Export infrastructure, shipping, and receiving capacity can still depend on separate counterparties and investment decisions.

iii. **Joint development** brings collaboration further upstream in the development process. Partners can shape project design, technology, financing, development responsibilities, market access, and prospective offtake before major investment decisions are fixed. The ACME–IHI partnership in Gopalpur illustrates this approach. IHI is expected to take a 30% interest in the project and offtake approximately 400 ktpa NH_3, alongside its participation in project development.[96] This allows project configuration and risk allocation to reflect the requirements of both sides before FID.

These structures progressively widen the boundary of commercial alignment, but none necessarily covers the complete route between production and consumption (see **Exhibit 21**).

EXHIBIT 21

Progression of Commercial Structures and Their Scope

STRUCTURE	PRIMARY COMMERCIAL FUNCTION	COMMERCIAL ALIGNMENT CREATED	WHAT REMAINS UNRESOLVED
Long-term offtake	Provides revenue visibility for the producer and secures future supply for the buyer.	Volume, tenor, and commercial terms between producer and buyer.	Infrastructure and logistics required to deliver the contracted product.
Strategic investment and offtake	Combines supply access with participation in the production project's economics.	Adds shared exposure to project development, financing, and performance.	Delivery-chain assets and counterparties outside the production project.
Joint development	Allows partners to shape the project before major investment decisions.	Extends alignment to project design, technology, capital, development responsibilities, and market access.	Independently developed infrastructure and logistics outside the project.
Value-chain integration	Coordinates the complete trade flow without requiring common ownership.	Connects production, logistics, infrastructure, and demand around compatible volumes and timelines.	Contractual interfaces and allocation of risks between independently owned assets.

RMI Graphic. **Source:** RMI compilation

For the corridor, the remaining commercial problem sits largely between projects. An investment-ready production asset can still face delays in storage or terminal capacity, whereas logistics and receiving infrastructure may develop to different schedules. This makes coordination across independently owned assets the next layer of commercial architecture.

The case for value-chain integration

Value-chain integration does not require common ownership. Production, ports, shipping, import infrastructure, and industrial consumption can remain independently developed and financed. What matters is whether these investments are based on compatible assumptions about scale, sequencing, and risk.

1 Scale

Production facilities, storage tanks, terminal infrastructure, vessels, and ammonia crackers have different economies of scale and investment thresholds. An initial tranche of 300–1,000 ktpa NH_3 can provide a common planning basis without requiring each asset to have the same capacity. Some infrastructure may need spare capacity for subsequent volumes, while other investment can be phased as throughput increases.

2 Sequencing

Assets do not need to reach FID simultaneously, but their development schedules need to be compatible. Capacity reservation, permitting, contracting, construction, and commissioning can become critical-path items depending on the asset. Working backward from the expected start of trade can identify when each decision needs to be taken.

3 Risk allocation

The broad location of several risks can be identified at this stage, although their contractual allocation will depend on the delivery point and commercial structure. Production performance originates within the production project, while storage, terminal operations, shipping, and downstream infrastructure introduce separate execution risks. For corridor development, the interfaces between them require particular attention.

Production and loading schedules need to align with storage and berth availability at the export terminal. Cargo size and frequency affect both terminal and shipping economics. Vessel arrivals must match unloading and storage capacity at the receiving terminal. Where imported ammonia is cracked back to hydrogen, cracker availability, hydrogen specifications, and downstream delivery add another interface.

Some risks span the entire transaction. RFNBO compliance and traceability must be maintained throughout the delivery chain. Volume and timing affect production, shipping, and infrastructure utilisation simultaneously. Price and green premium influence the commercial position of producer and buyer, whereas regulatory change can alter the value of compliant product.

The feasibility stage can test these interfaces against actual suppliers, buyers, delivery points, and infrastructure configurations. Contractual allocation can then be determined through relevant offtake, terminal, shipping, and other agreements rather than assumed at the corridor level. Coordination can

also broaden the investment relationship between Odisha, India and Northwest Europe. European participation can extend beyond offtake into project capital, technology, equipment, shipping, terminal infrastructure, and finance. The relevant opportunities should emerge from the requirements of the first transactions and the capabilities of participating companies.

Closer coordination should ultimately improve the commercial proposition, whether through lower delivered cost, greater confidence for project financing, better infrastructure utilisation, or reduced schedule mismatch. Constraints that remain after this process form the final part of the commercialisation pathway.

Path to Commercialisation

The corridor's commercial viability will depend on bringing dedicated demand, supply, and infrastructure together, coordinated by the corridor coalition. Participating companies would retain commercial and investment decisions.

1 Concentrate bankable European demand around Antwerp-Bruges, Hamburg, North Rhine-Westphalia, and Rotterdam.

Buyer engagement through port authorities, industrial clusters, and prospective off-takers should establish the parameters required for contracting, including volume, delivery point, start date, specification, certification requirements, tenor, credit quality, and pricing structure. Working with European partners and market-enabling institutions such as H2Global, the corridor can explore demand aggregation mechanisms and translate emerging demand into stronger market signals to inform policymakers on support needed for scaling. The output should be a credible portfolio of anchor and complementary buyers rather than an estimate of the TAM.

2 Shortlist investment-ready Odisha supply.

Buyers will diversify across suppliers, but the first tranche only needs enough Odisha capacity to make one commercial supply chain work. Projects should be assessed against commissioning schedule, delivered cost, certification pathway, port connectivity, financing maturity, and ability to enter long-term commercial arrangements. This should distinguish capacity capable of serving the first tranche from projects better suited to later expansion. In parallel, developing an Odisha green fuels cluster proposition could help suppliers leverage both domestic and export demand, aggregate infrastructure requirements, and achieve the scale needed to support subsequent investments and market expansion.

3 Configure the physical chain around emerging demand and supply commitments.

The corridor coalition will facilitate coordination among ports, terminal operators, shipping companies, infrastructure developers and prospective users to assess viable logistics configurations, whereas commercial actors retain responsibility for infrastructure selection and investment decisions. This includes the export route, storage and terminal requirements, cargo size and frequency, shipping arrangement, receiving terminal, downstream route, and ammonia cracking requirements, where imported ammonia from India and elsewhere will be cracked back to hydrogen. New infrastructure should be linked to identifiable throughput requirements, prioritising existing capacity and phased investments as demand scales.

4 Convert participation into commitments.

The emerging commercial arrangements need to be translated into the contracts and investment decisions required for the corridor to proceed. The corridor coalition can facilitate structured buyer–supplier engagement and coordination with infrastructure providers and financiers, progressing from expressions of interest to commercial negotiations and binding commitments. Depending on the transaction, these may include offtake, strategic equity, joint development, terminal-capacity agreements, shipping contracts, and financing arrangements.

5 Quantify and address the residual gap.

Once potential transactions are sufficiently defined, any remaining barrier can be isolated and assessed with relevant policymakers, financial institutions, and development partners. A price gap may require revenue support; high financing costs may call for guarantees, concessional capital, blended finance or export credit; and shared infrastructure may require targeted support where early throughput is insufficient to justify investment. Regulatory constraints should be addressed through regulatory clarity rather than financial support. Support mechanisms should be tailored to demonstrated commercial barriers, with the aim of mobilising private investment and enabling subsequent transactions at scale.

The objective is not to design the corridor at its eventual scale. It is to take the first trade flow far enough for companies to make investment and contracting decisions on the buyer, supplier, delivery chain, commercial structure, and remaining barriers to investment.

The first transaction can then establish operating experience, commercial precedents, and an infrastructure base for subsequent volumes. This would move the Odisha, India–Northwest Europe corridor from a prefeasibility proposition towards an investable trade flow and provide the commercial foundation for future transactions.

Next Steps

The next phase will move from establishing the corridor opportunity to structuring the first commercial transactions. Intentions are to conduct a full feasibility assessment alongside the creation of a multistakeholder corridor coalition between Odisha, India and Northwest Europe. The assessment will address the questions that the prefeasibility study could only scope, moving from whether the corridor can work to what it takes to implement it.

A key priority will be to deepen engagement with prospective European off-takers and investment-ready suppliers in Odisha. On the demand side, this means moving from broader market potential and expressions of interest to clearer parameters for potential volumes, willingness to pay, contract duration, delivery requirements, and procurement timelines. It also means estimating how much of the clusters' demand domestic production will meet and how much is left for imports. On the supply side, projects will need to be assessed against commissioning schedules, delivered costs, project maturity, and RFNBO certification pathways.

The feasibility phase will also examine the commercial structures and commitments required across the value chain. This includes developing bankable business models, aligning production and infrastructure timelines, progressing project-level RFNBO certification, and determining where long-term offtake, strategic investment, infrastructure agreements or other commercial arrangements can help projects advance towards FID. The objective is to support pre-FID commitments and a pathway towards at least 1 Mt of green ammonia trade by 2030.

RMI and partner organisations, including VITO, will convene the corridor coalition and provide a shared analytical and coordination platform to advance this work. The coalition will bring together producers, European off-takers, ports and terminal operators, shipping and infrastructure providers, financial institutions, and relevant public-sector actors. Initial working sessions will focus on strengthening supply–demand linkages, developing commercial structures, aligning infrastructure and project timelines, and identifying opportunities for coordinated public and private action to advance the first commercial trade flows.

Appendices

Appendix A: Conversion Factors

The appendices set out the methods, assumptions, and sources behind each section. Each appendix lists its assumptions by parameter, value, unit, and source, with numbered sources listed in the endnotes. **Exhibit A1** lists the conversion factors used throughout the report.

EXHIBIT A1
Conversion Factors

PARAMETER	VALUE	UNIT	SOURCE
Hydrogen content of ammonia (stoichiometric)	0.177	t H_2/t NH_3	Stoichiometry, 17.8% hydrogen by mass
Ammonia per ton of hydrogen (stoichiometric)	5.63	t NH_3/t H_2	Stoichiometry
Hydrogen recovered by cracking (cracker yield)	0.139	t H_2/t NH_3	Air Liquide ARCAS demonstrated yield[97]
Ammonia per ton of cracked hydrogen delivered	7.19	t NH_3/t H_2	Derived from cracker yield
Hydrogen lower heating value	33.33	kWh/kg H_2	Standard value (120 MJ/kg)
Hydrogen mass per unit of energy	0.030	t H_2/MWh	Derived from lower heating value
Ammonia lower heating value	18.8	MJ/kg NH_3	Mærsk Mc-Kinney Møller Center[98]
VLSFO lower heating value	41.2	MJ/kg	Mærsk Mc-Kinney Møller Center[99]
Crude oil energy content	6.0	GJ/bbl	US Energy Information Administration[100]
Crude oil volume	7.32	bbl/t	UN Statistics Division[101]
Hydrogen volume	423	scf/kg H_2	Standard value
Liquid ammonia density (refrigerated, −33°C)	0.68	t/m³	Standard value
Exchange rate US$ to €	0.88	€ per US$	RMI assumption, applied to every US dollar to euro conversion
Exchange rate US$ to ₹	93	₹ per US$	RMI assumption, applied to every US dollar to Indian rupee conversion

Appendix B: Green Ammonia Production and Landed Cost Analysis

The landed cost analysis estimates the cost of supplying green ammonia from Odisha to European demand centres across the full supply chain, from hydrogen production through ammonia production, domestic transport and storage, ocean shipping, and handling at the destination port.

Green hydrogen production costs were estimated using RMI's in-house levelised cost of hydrogen (LCOH) optimisation model, which optimises renewable energy, electrolyser, and storage capacities to minimise the cost of hydrogen production. The model incorporates location-specific renewable resource profiles and techno-economic assumptions for renewable generation, electrolysers, and storage.

Hydrogen production was modelled in Odisha with renewable electricity supplied through a Central Transmission Utility/ISTS connection. Accordingly, state transmission, wheeling, cross-subsidy, and additional surcharges were assumed to be zero, with electricity duty applied where relevant. To assess the implications of RFNBO geographic-correlation requirements, renewable electricity sourcing was modelled under different geographic scenarios. Karnataka was used as an illustrative interconnected bidding zone, although other eligible interconnected zones could also be considered. A further scenario assessed access to the most competitive renewable resources across India, using Rajasthan for solar and Tamil Nadu for wind.

The LCOH analysis was subsequently integrated with RMI's port fuel supply (PFS) model to estimate green ammonia production and supply-chain costs. The PFS model captures ammonia conversion, production-site storage, transport to the export port, associated infrastructure at the port, and ocean shipping to the destination port. Terminal handling charges and canal transit costs, where applicable, were calculated separately and added to the modelled costs to estimate the final landed cost.

EXHIBIT B1

Key Assumptions for Green Ammonia Production and Landed-Cost Modelling

CATEGORY	PARAMETER	UNIT	VALUE
Electrolyser	Electrolyser uninstalled CAPEX (stack and balance of plant)	US$/kW	400
	Total system energy requirement	kWh/kg H_2	50
	Electrolyser OPEX	% of electrolyser CAPEX	3
Hydrogen storage	H_2 storage CAPEX	US$/kg	466
	H_2 storage O&M	% CAPEX	0.04
Renewable energy	Solar single axis tracking CAPEX	US$/kW	520
	Onshore wind CAPEX	US$/kW	750
	Solar O&M	US$/kW-year	4.2
	Onshore wind O&M	US$/kW-year	33.5
Financial	Weighted average cost of capital	%	10
Ammonia synthesis	CAPEX air separation unit (ASU) or pressure swing adsorption (PSA), N_2 storage	US$/t N_2	22
	CAPEX ammonia synthesis	US$/t NH_3	500
	ASU and ammonia synthesis O&M	% of CAPEX	4

Note: Abbreviations: capital expenditure (CAPEX); operating expenditure (OPEX); balance of plant (BOP); operation and maintenance (O&M); air separation unit (ASU); pressure swing adsorption (PSA).

Appendix C: European End-Use Cost Analysis

The competitiveness analysis compares the production costs of products that require hydrogen or ammonia as feedstock, namely nitric acid, urea, and refinery products. The assessment evaluates how hydrogen and ammonia supply pathways, including conventional production, domestic renewable production, and imported renewable ammonia with or without ammonia cracking, affect the production costs of these products under different carbon cost scenarios.

Ammonia is used directly in urea, nitric acid, and maritime shipping fuel, so no cracking cost applies in those comparisons. Refining needs hydrogen, so imported ammonia is cracked back to hydrogen at or near the port, and the comparison combines the Indian ammonia landed costs and cracking costs listed below. The cracker yield and other conversion factors are listed in **Exhibit A1**.

EXHIBIT C1

Key Assumptions for Grey Ammonia and Hydrogen Production

To produce ammonia, the following parameters are assumed:

PARAMETER	VALUE	UNIT	SOURCE
CAPEX (annualised)	157	€/t NH_3	Advancing Industrial Decarbonisation by Assessing the Future Use of Renewable Energies in Industrial Processes (AIDRES),[102] corrected for inflation
Fixed OPEX	40	€/t NH_3	Derived assumption (1.5% of upfront CAPEX)
Electricity	0.58	MWh/t NH_3	AIDRES[103]
Natural gas	7.87	MWh/t NH_3	AIDRES[104]
Emissions	1.74	tCO_2/t NH_3	AIDRES[105]

EXHIBIT C1

Key Assumptions for Grey Ammonia and Hydrogen Production (continued)

To produce hydrogen, the following parameters are assumed:

PARAMETER	VALUE	UNIT	SOURCE
CAPEX (annualised)	183	€/t H_2	EnergyVille[106]
Fixed OPEX	127	€/t H_2	EnergyVille[107]
Electricity	0.60	MWh/t H_2	Assumption based on large-scale steam methane reforming (SMR)
Natural gas	45	MWh/t H_2	Assumption based on large-scale SMR
Emissions	10	tCO_2/t H_2	Assumption based on large-scale SMR

Note: For grey hydrogen production, a large steam methane reforming (SMR) plant is assumed.



EXHIBIT C2

Assumed Commodity Prices and Ammonia Supply Costs

The following emissions factor for natural gas is assumed: 0.20196 tCO_2/MWh.[108]

The following prices and costs are assumed. Indian ammonia costs are RMI estimates for first deliveries around 2030:

PARAMETER	VALUE	UNIT	SOURCE
Electricity	129	€/MWh	VITO analysis[109]
Natural gas	37	€/MWh	VITO analysis[110]
CO_2	100	€/t	IMARC[111]
O_2	75	€/t	Estimated based on Arnaiz del Pozo et al. (production cost) and IEAGHG (transport cost), but largely dependent on source and transport.[112]
Crude oil	550	€/t	VITO analysis[113]
Ammonia – landed costs from India, lower bound	665	€/t NH_3	RMI analysis
Ammonia – landed costs from India, upper bound	774	€/t NH_3	RMI analysis
Cracking costs, lower bound	1.2	€/kg H_2	Independent consultation
Cracking costs, upper bound	2.5	€/kg H_2	Independent consultation

Ammonia for maritime shipping

The maritime fuel cost comparison in the section on **Demand** on **page 31** uses RMI's fuel and vessel optimisation model to estimate lifetime fuel and compliance costs for a single vessel on voyages between EU ports. Costs are expressed in euros per ton of VLSFO equivalent so that fuels with different energy densities can be compared directly. The green ammonia range reflects a low and a high delivered price for ammonia from India. The comparison covers fuel and compliance costs only. It excludes vessel capital costs, engine premiums, and onboard storage, so it is not a total cost of ownership analysis, which the feasibility stage will undertake.

Because the modelled voyages run between EU ports, all of the energy the vessel consumes falls within the scope of FuelEU Maritime and the EU ETS. The model assumes that ships comply with FuelEU's GHG intensity limits by trading surplus units rather than paying penalties. Ships that over-comply sell their surplus to under-compliant ships, and the 2x multiplier for RFNBOs until 2033 lets e-fuels earn more surplus units. The EU ETS applies a carbon price to tank-to-wake emissions. The International Maritime Organization (IMO) Net-Zero Framework is not included.

The results are sensitive to the price of FuelEU surplus units and the EU ETS allowances, the vessel type, and the year of operation, so the actual cost advantage will vary across fleets. The assumption that all surplus is sold is particularly favourable, and the feasibility stage will test lower monetisation shares and surplus prices. **Exhibit C3** summarises the major assumptions.

EXHIBIT C3

Major Assumptions for the Maritime Fuel Cost Comparison

PARAMETER	VALUE	UNIT	SOURCE
Vessel type	Liquefied gas carrier with an ammonia dual-fuel engine	–	RMI vessel model[114]
Vessel size	Up to 49,999	m^3	RMI vessel model[115]
Pilot fuel (VLSFO) share	10	% of fuel energy	RMI vessel model, engine specification[116]
Entry into service	2028	year	RMI assumption
Operating life	20	years	RMI assumption
Annual energy use	160,680	GJ/yr (about 3,900 t VLSFO eq.)	RMI vessel model, fleet average for the vessel class[117]
VLSFO price, flat	14.1	US$/GJ (about US$580/t)	RMI vessel model[118]
Green ammonia price from India, low case, flat	40.2	US$/GJ (US$755/t)	RMI analysis, delivered cost in the section on **Supply** on **page 20**
Green ammonia price from India, high case, flat	46.8	US$/GJ (US$879/t)	RMI analysis, delivered cost in the section on **Supply** on **page 20**
Well-to-wake intensity, green ammonia	16.27	gCO_2e/MJ	FuelEU Maritime, default value[119]

EXHIBIT C3

Major Assumptions for the Maritime Fuel Cost Comparison (continued)

PARAMETER	VALUE	UNIT	SOURCE
Well-to-wake intensity, VLSFO	93.3	gCO_2e/MJ	IMO, reference value[120]
Tank-to-wake intensity, VLSFO	76	gCO_2e/MJ	RMI vessel model[121]
Tank-to-wake intensity, green ammonia	0	gCO_2e/MJ	RMI vessel model[122]
FuelEU GHG intensity limit	89.34 (2025–29), 85.69 (2030–34), 77.94 (2035–39)	gCO_2e/MJ	FuelEU Maritime[123]
RFNBO multiplier	2 until 2033, then 1	–	FuelEU Maritime[124]
FuelEU surplus unit price	197 (2028) to 402 (2047)	US/tCO_2e$	RMI vessel model, based on current market values[125]
Share of surplus sold	100	%	RMI assumption
EU ETS allowance price	132 (2028) to 240 (2047)	US/tCO_2e$	BloombergNEF[126]
Energy in scope of FuelEU and EU ETS	100 (EU–EU voyages), 50 (India–EU voyages)	%	RMI assumption, by route
IMO Net-Zero Framework	Not applied	–	RMI assumption

RMI Graphic. **Source:** RMI analysis, RMI fuel and vessel optimisation model[127]

EXHIBIT C4

Key Assumptions for Nitric Acid Production

PARAMETER	VALUE	UNIT	SOURCE
Ammonia/nitric acid	0.288	t/t	AIDRES[128]

Notes:

- For nitric acid production, the cost of producing or purchasing ammonia is included.
- Capital expenditure and fixed operating expenditure for conversion of ammonia to nitric acid are not included.

EXHIBIT C5

Key Assumptions for Urea Production

PARAMETER	VALUE	UNIT	SOURCE
Ammonia/urea	0.57	t/t	Stoichiometry
CO_2/urea	0.73	t/t	Stoichiometry
Electricity/urea	0.08	MWh/t	PBL[129]
Steam/urea	0.61	MWh/t	PBL[130]
Gas to steam efficiency	85	%	Assumption
Electricity to steam efficiency	99	%	Assumption

Notes:

- For urea production, the cost of producing or purchasing ammonia is included.
- Capital expenditure and fixed operating expenditure associated with the conversion of ammonia to urea are not included.
- In the grey ammonia scenarios, the required CO_2 is assumed to be supplied by the ammonia production process, and therefore no additional CO_2 feedstock cost is considered. For all other scenarios, a CO_2 feedstock cost is added.
- In the grey ammonia scenario, natural gas is used for steam generation, whereas in the other scenarios steam is assumed to be generated using electricity.
- The same electricity and steam demand for urea production is assumed in all scenarios, but energy demand may be lower in scenarios with local ammonia production because of process integration.



EXHIBIT C6
Key Assumptions for Refining

PARAMETER	VALUE	UNIT	SOURCE
CAPEX (annualised)	54.52	€/t	AIDRES, corrected for inflation[131]
Fixed OPEX	9.09	€/t	AIDRES, corrected for inflation[132]
Electricity	0.04	MWh/t	AIDRES[133]
Natural gas	0.48	MWh/t	AIDRES[134]
Crude oil	1.57	t/t	AIDRES[135]
Hydrogen	0.0084	t/t	AIDRES[136]
Emissions	0.19	tCO_2/t	AIDRES[137]

Notes:
- For refineries, the cost of producing or purchasing hydrogen is included.
- Capital expenditure and fixed operating expenditure for conversion of crude oil into refinery products are not included, and the cost of crude oil itself is excluded to facilitate comparison between scenarios.
- The refinery output product is assumed to be light liquid fuel. Therefore, 1.57 t of crude oil is required per ton of product, accounting for the full range of refinery products generated during the refining process.

Appendix D: Demand Market Sizing

Approach

The demand assessment maps every refining, fertiliser, and chemical asset with public capacity data in the four clusters of Antwerp-Bruges, Hamburg, North Rhine-Westphalia, and Rotterdam, plus three large assets just outside the cluster boundaries, namely the Zeeland Refinery, Yara Sluiskil, and OCI Nitrogen's Chemelot site. Assets are grouped into refining, fertilisers, chemicals, and maritime shipping. Aviation and steel are excluded for the reasons set out in the section on **Demand** on **page 31**.

Refinery hydrogen demand is estimated bottom-up. Each refinery is classified as hydroskimming, medium conversion, or deep conversion, and each configuration carries its own hydrogen intensity, from low for hydroskimming plants to high for deep-conversion plants with hydrocracking. The intensities draw on Climate TRACE, RMI analysis, and published industry benchmarks and are applied to each refinery's crude capacity. Fertiliser and chemical plants that consume ammonia are assigned their ammonia capacity as reported in Climate TRACE. Chemical demand covers nitric acid, aniline, and hydrogen peroxide, the products VITO identified as the largest ammonia and hydrogen consumers among the chemical assets assessed. Other intermediates and steam crackers are not yet quantified.

Assets that need hydrogen rather than ammonia, mainly refineries and hydrogen peroxide plants, are assumed to receive imported ammonia that is cracked back to hydrogen. Ammonia bunkering demand in Antwerp-Bruges and Rotterdam draws on RMI's maritime fuel demand projections for 2030 and 2035, which already reflect FuelEU Maritime and national transposition of RED III transport targets, so no further policy share is applied.

Demand is reported in three layers. The TAM is current consumption at the mapped assets, expressed as the imported ammonia needed to replace all of it. The firm floor reflects RFNBO obligations already in national law, which today means Germany's transport subquota as it applies to the five refineries in North Rhine-Westphalia and Hamburg. The upper-bound scenarios apply the RED III industry shares of 42% in 2030 and 60% in 2035 uniformly to the hydrogen and ammonia used by every mapped refining, fertiliser, and chemical asset, including refinery hydrogen that RED III assigns to the transport target. None of the layers nets off domestic production in Europe, which the feasibility stage will estimate.

Data sources

Refining and ammonia asset data come from RMI analysis built on Climate TRACE, an emissions inventory to which RMI contributes. Chemical demand comes from VITO's asset-level analysis, and shipping demand from RMI's analysis of maritime fuel demand.

Known limitations

The 42% and 60% scenarios are illustrative upper bounds. RED III sets the industry target at the national level, lets Member States decide how to allocate it across installations, and excludes hydrogen used to produce conventional transport fuels, which falls under the transport target instead. Applying the industry share to refinery hydrogen therefore overstates what the directive requires of refiners. National obligations may also be set well below 42%, as the Dutch proposal of 4% by 2030 shows, and Article 22b of RED III allows a Member State to reduce its industry target by 20% if it meets conditions on its national contribution and fossil hydrogen use.

Limiting chemicals to three products understates the sector's demand, most of all in Germany, where at least half of ammonia goes to chemical uses. Capacity is used as a proxy for consumption, so actual use may be lower where plants run below capacity, as several European ammonia plants have since 2022. Refinery figures are gross hydrogen use and include by-product hydrogen from catalytic reforming, which RED III does not count. Recent ownership and configuration changes are not yet reflected in the asset data.

Key assumptions

The assessment covers 2030, with 2035 as a second horizon. **Exhibit D1** summarises the main assumptions and conversion factors.

EXHIBIT D1

Key Assumptions and Conversion Factors for Demand Sizing

PARAMETER	VALUE	UNIT	SOURCE
RED III industry share, 2030 (upper bound)	42	% of industrial hydrogen	RED III, Article 22a[138]
RED III industry share, 2035 (upper bound)	60	% of industrial hydrogen	RED III, Article 22a[139]
Assets covered by the upper-bound shares	All mapped refining, fertiliser, and chemical assets.	–	RMI assumption
German RFNBO transport subquota, 2030	1.5	% of transport fuel energy	German RED III transposition (see **Exhibit 15**)
Share of the German subquota met by refinery hydrogen	50	%	RMI assumption
German refinery RFNBO demand, 2030 (firm floor)	111	ktpa H_2 (about 0.8 Mt NH_3)	RMI analysis
Consumption proxy	Nameplate capacity	–	Climate TRACE, RMI, and VITO analysis[140]
EU refinery product yields	Diesel 39.8, petrol 19.5, kerosene 8.6, fuel oil 9.1, naphtha 7.5, liquefied petroleum gas (LPG) 2.5, other 13	% of crude by mass	FuelsEurope[141]
Hydrogen for product treating	0–849	scf H_2/bbl of product	*Hydrocarbon processing*, RMI analysis[142]
Hydrogen for hydrocracking	1,400–2,500	scf H_2/bbl	*Hydrocarbon processing*[143]
Ammonia bunkering demand, 2030	9–86 (Rotterdam), 4–15 (Antwerp-Bruges)	ktpa NH_3	RMI analysis
Ammonia bunkering demand, 2035	197 (Rotterdam), 152 (Antwerp-Bruges)	ktpa NH_3	RMI analysis

Appendix E: Infrastructure Assessment

Approach

The infrastructure assessment compiles every announced ammonia storage, cracking, and pipeline project in the four clusters and records each project's owner, status, capacity, and expected start date (see **Exhibit 17**). Capacity is counted only where it has been disclosed. Projects are classified by the most advanced stage they have reached, from announcement through feasibility, FEED, permitting, FID, and construction to operation.

According to RMI analysis and stakeholder consultations, storage needs are based on about 50 kt NH_3 of tank capacity for each 1 Mtpa of imported ammonia, which assumes about 20 tank turnovers per year for EU infrastructure. Cracking needs are derived by converting the cracked share of demand to hydrogen at 139 kg per ton of NH_3. Minimum viable scale thresholds are indicative and draw on a small set of reference assets, namely a standard 50 kt NH_3 storage tank, Air Liquide's 30 ktpa H_2 ENHANCE cracker in Antwerp, and the smallest pipeline modelled by the EHB.

On the India side, RMI sizes the port-side storage needed for Odisha's announced pipeline and compares it with existing and planned capacity at Paradip and Gopalpur, including captive and common-user assets.

Data sources

European project data come from company announcements, permitting records, and trade press. Odisha data come from port authorities, tender documents, transmission planning records, and company disclosures.

Known limitations

Public sources can lag commercial decisions. Most announced capacity has not reached FID, and several developers have not disclosed tank or cracker sizes, so the totals understate the eventual pipeline and overstate what is committed. The thresholds rest on a few reference projects and will vary with public support, contract terms, site conditions, and whether assets are shared or built in phases.

Key assumptions

Exhibit E1 summarises the main assumptions.

EXHIBIT E1

Key Assumptions for Infrastructure Assessment

PARAMETER	VALUE	UNIT	SOURCE
Storage sizing for India and EU	50	kt of tank capacity per 1 Mtpa NH_3 of imports	RMI analysis, stakeholder consultations
Tank turnovers for India and EU	20	per year	RMI analysis, stakeholder consultations
Standard tank size for EU infrastructure	50	kt NH_3	Industry practice, sized to the largest vessel expected to call
Reference cracker output	30	ktpa H_2	Air Liquide ENHANCE, Antwerp[144]
Reference cracker ammonia feed	170–216	ktpa NH_3	Derived at stoichiometric and demonstrated yields (see **Exhibit A1**)
Reference pipeline capacity	1.2	GW (20-inch pipeline)	EHB[145]
Pipeline utilisation	5,000	full-load hours per year	EHB[146]
Reference pipeline throughput	180	ktpa H_2 (about 1.3 Mt NH_3)	Derived
Inland barge capacity	900	t NH_3	Institute for Sustainable Process Technology (ISPT)[147]
Rail tank wagon capacity	26–58	t NH_3	ISPT[148]
Train of 20 wagons	Up to 1,000	t NH_3	ISPT[149]
Project capacity basis	Disclosed capacity only	–	Company and project public announcements[150]

Endnotes

1. *Global Hydrogen Compass 2026*, Hydrogen Council and McKinsey & Company, 2026, https://compass.hydrogencouncil.com/wp-content/uploads/2026/09/Hydrogen-Council-Global-Hydrogen-Compass-2026.pdf.

2. "Wind Overview," Ministry of New and Renewable Energy (MNRE), accessed October 13, 2026, https://mnre.gov.in/en/wind-overview/; and "Solar Overview," MNRE, accessed October 13, 2026, https://mnre.gov.in/en/solar-overview/.

3. "National Green Hydrogen Mission (NGHM)," Solar Energy Corporation of India Limited (SECI), accessed October 13, 2026, https://seci.co.in/nghm; and Vipul Garg, "India's Numaligarh Hydrogen Tender Ends at Record-Low Rupees 279/kg," *S&P Global Commodity Insights*, February 12, 2026, https://www.spglobal.com/energy/en/news-research/latest-news/energy-transition/021226-indias-numaligarh-hydrogen-tender-ends-at-record-low-rupees-279kg.

4. RMI analysis based on the NGHM project database.

5. "Centre Approves ₹797 Crore Green Hydrogen Jetty at Paradip Port," Paradip Port Authority, February 25, 2026, https://paradipport.gov.in/all_news/centre-approves-%E2%82%B9797-crore-green-hydrogen-jetty-at-paradip-port/.

6. "EU and India Conclude Landmark Free Trade Agreement," European Commission, January 27, 2026, https://ec.europa.eu/commission/presscorner/detail/en/ip_26_184.

7. "EU-India Summit, 27 January 2026," Council of the European Union, January 27, 2026, https://www.consilium.europa.eu/en/meetings/international-summit/2026/01/27/; and "Joint Statement EU-India Summit, 27 January 2026," Council of the European Union, January 27, 2026, https://www.consilium.europa.eu/en/press/press-releases/2026/01/27/joint-statement-eu-india-summit-27-january-2026/.

8. "Ammonia Shipborne Trade: Navigating the Bubble for Sustainable Growth," Drewry, 2024, https://www.drewry.co.uk/maritime-research-opinion-browser/maritime-research-opinions/ammonia-shipborne-trade-navigating-the-bubble-for-sustainable-growth.

9. "Renewable Energy Policy 2022," Invest Odisha, accessed October 13, 2026, https://investodisha.gov.in/policy-framework/sectoral-policies/renewable-energy-policy-2022/; and "Incentives Wizard," Invest Odisha, accessed October 13, 2026, https://investodisha.gov.in/incentives-wizard/.

10. RMI analysis based on the NGHM project database.

11. "Hygenco's Green Ammonia Secures RFNBO Pre-Certification from Bureau Veritas under CertifHy Scheme," Hygenco, January 27, 2025, https://www.hygenco.in/press-green-ammonia-secures.html; and "ReNew's Post on CertifHy RFNBO Pre-Certification," ReNew, July 4, 2025, https://www.linkedin.com/posts/renew_greenhydrogen-certifhy-rfnbo-activity-7346757172615094272-z5vE.

12. "Odisha," Ocior Energy, accessed October 13, 2026, https://ociorenergy.com/project-odisha/; "Q&A: Ocior Touts Indian H2 Drive, Urges Rule Tweaks," *Argus Media*, 2025, https://www.argusmedia.com/en/news-and-insights/latest-market-news/2664858-q-a-ocior-touts-indian-h2-drive-urges-rule-tweaks; and "Jakson Green Gopalpur Private Limited's Green Ammonia Project Awarded Precertification under the CertifHy EU Voluntary Scheme," CertifHy, July 31, 2026, https://www.certifhy.eu/news/jakson-green-gopalpur-precertification/.

13. "ACME-IHI Corporation's Green Ammonia JV Achieves Significant Milestones," *Hindu*, September 12, 2025, https://www.thehindu.com/business/Industry/acme-ihi-corporations-green-ammonia-jv-achieves-significant-milestones/article70040750.ece.

14. "National Green Hydrogen Mission (NGHM)," SECI.

15. Namratha A Rai, "Jindal to Develop Green Hydrogen Facility for Use in Its Steelworks," *Mercom India*, September 16, 2024, https://www.mercomindia.com/jindal-to-develop-green-hydrogen-facility-for-use-in-its-steelworks; and "Greenzo bags Jindal Stainless order for 472-tonne green hydrogen plant in Odisha," *ET EnergyWorld*, September 1, 2025, https://energy.economictimes.indiatimes.com/news/renewable/greenzo-energy-partners-with-jindal-stainless-for-major-green-hydrogen-plant-in-odisha/123627909.

16. "National Green Hydrogen Mission (NGHM)," SECI.

17. Garg, "India's Numaligarh Hydrogen Tender Ends at Record-Low Rupees 279/kg," 2026.

18. Commission Delegated Regulation (EU) 2023/1184 of 10 February 2023 Supplementing Directive (EU) 2018/2001 of the European Parliament and of the Council by Establishing a Union Methodology Setting Out Detailed Rules for the Production of Renewable Liquid and Gaseous Transport Fuels of Non-Biological Origin, European Commission, June 20, 2023, https://eur-lex.europa.eu/eli/reg_del/2023/1184/oj/eng.

19. Sonal Gupta, Deepankar Chakrabarti, and Hiranmoy Roy, "Indian Energy Exchange Day Ahead Market: Effects of Volatility on Profitability," *Journal of Emerging Technologies and Innovative Research 5*, no. 9 (September 2018); and Simon Byrtus, *Green Hydrogen Certification for Export to Europe: Compatibility Gap Analysis of European Sustainability Criteria for Renewable Hydrogen Production with the Indian Electricity System*, Indo-German Energy Forum, 2023, https://energyforum.in/fileadmin/india/media_elements/publications/20230515_GH2_Certification_Byrtus/20230605_mn_dj_GapAnalysis.pdf.

20. Pankaj Bindlish, Shiv Mohan Sharma, and Aditya Sharma, *Regulatory Enablers for Accelerating Green Methanol: Policy Roadmap for Export-Oriented Projects with Domestic Integration*, Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), 2025, https://energyforum.in/fileadmin/india/media_elements/publications/Green_Methanol_Whitepaper/Green_Methanol_Whitepaper.pdf; and Anjan Dasgupta and Yashaswini Basu, "RFNBO Certification – Leveling Dissonances between EU and Indian Scenarios," DSK Legal, accessed October 13, 2026, https://dsklegal.com/rfnbo-certification-leveling-dissonances-between-eu-and-indian-scenarios/.

21. *Navigating EU-India Renewable Hydrogen Trade: Certification Challenges and Strategic Pathways*, Industrial Transition Accelerator, 2026, https://irp.cdn-website.com/7f2e400a/files/uploaded/ITA_Technical+Briefing_EU-India+RFNBO+Certification_DIGITAL.pdf.

22. "Reducing Emissions from the Shipping Sector," European Commission, last modified May 6, 2026, https://climate.ec.europa.eu/areas-action/transport-decarbonisation/reducing-emissions-shipping-sector_en.

23. Directive (EU) 2023/2413 of the European Parliament and of the Council of 18 October 2023 Amending Directive (EU) 2018/2001, Regulation (EU) 2018/1999 and Directive 98/70/EC as Regards the Promotion of Energy from Renewable Sources, and Repealing Council Directive (EU) 2015/652, European Parliament and Council of the European Union, October 31, 2023, https://eur-lex.europa.eu/eli/dir/2023/2413/oj.

24. "Decarbonising Maritime Transport – FuelEU Maritime," European Commission, accessed September 28, 2026, https://transport.ec.europa.eu/transport-modes/maritime/decarbonising-maritime-transport-fueleu-maritime_en.

25. "CBAM Successfully Entered into Force on 1 January 2026," European Commission, January 14, 2026, https://taxation-customs.ec.europa.eu/news/cbam-successfully-entered-force-1-january-2026-2026-01-14_en.

26. "IF25 Hydrogen Auction," European Commission, last modified June 19, 2026, https://climate.ec.europa.eu/areas-action/eu-funding-climate-action/innovation-fund/calls-proposals/if25-hydrogen-auction_en; "Sustainable Transport Investment Plan," European Commission, accessed September 28, 2026, https://transport.ec.europa.eu/transport-themes/clean-transport/sustainable-transport-investment-plan_en; "Clean Industrial Deal," European Commission, last modified March 5, 2026, https://commission.europa.eu/topics/competitiveness/clean-industrial-deal_en; and "Important Step for Global Hydrogen Ramp-Up – Germany Will Work with H2Global to Import Green Hydrogen Products on a Large Scale from 2027," Federal Ministry for Economic Affairs and Climate Action, July 11, 2024, https://www.bundeswirtschaftsministerium.de/Redaktion/EN/Pressemitteilungen/2024/07/20240711-h2global.html.

27. Directive (EU) 2023/2413 of the European Parliament and of the Council of 18 October 2023 Amending Directive (EU) 2018/2001, Regulation (EU) 2018/1999 and Directive 98/70/EC as Regards the Promotion of Energy from Renewable Sources, and Repealing Council Directive (EU) 2015/652, 2023; and C/2025/2983, "Communication from the Commission: Guidance on the Targets for the Consumption of Renewable Fuels of Non-Biological Origin in the Industry and Transport Sectors Laid Down in Articles 22a, 22b and 25 of Directive (EU) 2018/2001 on the Promotion of Energy from Renewable Sources, as Amended by Directive (EU) 2023/2413," European Commission, May 27, 2025, https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52025XC02983.

28. "How Is RFNBO-H_2 Consumed at a Refinery Allocated between the Transport and Industry Sub-Targets under RED III?" ISCC System, last modified August 7, 2025, https://contact.iscc-system.org/support/solutions/articles/103000361279; and Joanna Damerell, "Why RED III Implementation Matters?" Hydrogen Council, May 3, 2026, https://hydrogencouncil.com/en/why-red-iii-implementation-matters/.

29. *REDIII Industry Target: Implementation Options for Member States*, Hydrogen Europe, 2026, https://hydrogeneurope.eu/wp-content/uploads/2026/06/June-2026_HE-REDIII_Industry_Target_Implementation-options.pdf.

30. Monica Trilho and Greig Boulstridge, "Enforcement and Investment: How RED III Is Shaping the Hydrogen Market in the EU," Wood Mackenzie, August 29, 2025, https://www.woodmac.com/news/opinion/enforcement-and-investment-how-red-iii-is-shaping-the-hydrogen-market-in-the-eu/.

31. Kamerstuk 36 936, nr. 3, "Memorie van toelichting: Wet jaarverplichting hernieuwbare brandstoffen van niet-biologische oorsprong in de industrie," Tweede Kamer der Staten-Generaal, 2026, https://www.tweedekamer.nl/kamerstukken/kamervragen/detail?id=2026D20447&did=2026D20447; and Hyung-Ja de Zeeuw, "Will Renewable Hydrogen Ever Gain Traction in the Netherlands?" Rabobank, September 10, 2026, https://www.rabobank.com/knowledge/d011544960-will-renewable-hydrogen-ever-gain-traction-in-the-netherlands.

32. Kevin Tu, Matthias Deutsch, and Gniewomir Flis, "Industrial Clusters Using Green Hydrogen Can Drive Clean Energy Transition in Europe and China," *World Economic Forum*, May 6, 2021, https://www.weforum.org/stories/energy-transition/industrial-clusters-green-hydrogen-europe-china/.

33. *The European Hydrogen Market Landscape*, Clean Hydrogen Partnership, 2025, https://observatory.clean-hydrogen.europa.eu/sites/default/files/2025-11/The%20European%20hydrogen%20market%20landscape_November%202025.pdf.

34. "Klimafreundlicher tanken: Neue THG-Quote stärkt Nachfrage für grünen Wasserstoff und Ladestrom," Federal Ministry for the Environment, Climate Action, Nature Conservation and Nuclear Safety, April 23, 2026, https://www.bundesumweltministerium.de/pressemitteilung/klimafreundlicher-tanken-neue-thg-quote-staerkt-nachfrage-fuer-gruenen-wasserstoff-und-ladestrom; Sophia Jenke, "GHG Quota: Bundestag Approves Mandatory Minimum Quota for Green Hydrogen," *H2-news.de*, April 27, 2026, https://h2-news.de/en/politik/thg-quote-bundestag-beschliesst-verbindliche-mindestquote-fuer-gruenen-wasserstoff/; and "German Cabinet Passes EU RED III," *Argus Media*, December 10, 2025, https://www.argusmedia.com/en/news-and-insights/latest-market-news/2764078-german-cabinet-passes-eu-red-iii.

35. Kamerstuk 32 813, nr. 1546, "Kabinetsaanpak Klimaatbeleid: Brief van de staatssecretaris van Infrastructuur en Waterstaat," Tweede Kamer der Staten-Generaal, December 10, 2025, https://zoek.officielebekendmakingen.nl/kst-1227963.pdf.

36. "Netherlands Publishes RED III Biofuels Draft," *Argus Media*, June 24, 2025, https://www.argusmedia.com/en/news-and-insights/latest-market-news/2702749-netherlands-publishes-red-iii-biofuels-draft.

37. "Shell to Start Building Europe's Biggest Green Hydrogen Plant," Port of Rotterdam, July 6, 2022, https://www.portofrotterdam.com/en/news-and-press-releases/shell-to-start-building-europes-biggest-green-hydrogen-plant; "TotalEnergies Joins Forces with Air Liquide to Decarbonize Its Refineries in Northern Europe with Green Hydrogen," TotalEnergies, February 18, 2025, https://totalenergies.com/newsroom/totalenergies-joins-forces-air-liquide-decarbonize-its-refineries-northern/?lang=eng.

38. "Shell to Start Building Europe's Biggest Green Hydrogen Plant," Port of Rotterdam.

39. "Decarbonising Maritime Transport – FuelEU Maritime," European Commission.

40. Linda Sigrid Hammer, "Ammonia as a Marine Fuel: Prospects and Challenges," *Maritime Impact*, September 30, 2025, https://www.dnv.com/expert-story/maritime-impact/ammonia-as-a-marine-fuel-prospects-and-challenges/.

41. "ReFuelEU Aviation," European Commission, accessed September 28, 2026, https://transport.ec.europa.eu/transport-modes/air/environment/refueleu-aviation_en.

42. "Shell to Start Building Europe's Biggest Green Hydrogen Plant," Port of Rotterdam.

43. "Europe's Largest Integrated Chemical Cluster Is a Hub of Innovation and Sustainability," Business in Antwerp, accessed September 28, 2026, https://www.businessinantwerp.eu/en/europes-largest-integrated-chemical-cluster-hub-innovation-and-sustainability.

44. "TotalEnergies Joins Forces with Air Liquide to Decarbonize Its Refineries in Northern Europe with Green Hydrogen," TotalEnergies.

45. *Hydrogen Import Strategy North Rhine-Westphalia*, Ministry of Economic Affairs, Industry, Climate Action and Energy of the State of North Rhine-Westphalia, 2024, https://www.wirtschaft.nrw/system/files/media/document/file/mwike_br_wasserstoff-importkonzept_gb_rz_bf.pdf.

46. Anders Ødegård, "REFHYNE – 10 MW PEM Electrolyser," Clean Hydrogen Partnership, November 24, 2025, https://www.clean-hydrogen.europa.eu/document/download/4d0c2927-da90-43ce-bba0-c528c0f474b0_en?filename=05_Day1_Session_1_H2Production_AndersOdegard_public.pdf; and "REFHYNE 2," REFHYNE, accessed September 28, 2026, https://www.refhyne.eu/refhyne-2/.

47. "Yara Drives Hydrogen Economy with New Ammonia Import Terminal," Yara International, October 2, 2024, https://www.yara.com/corporate-releases/yara-drives-hydrogen-economy-with-new-ammonia-import-terminal/.

48. "Tracks with Tradition," Port of Hamburg, accessed October 8, 2026, https://www.hafen-hamburg.de/en/hinterland/tracks-with-tradition/.

49. "Permit Granted: MB Energy Can Build Ammonia Import Terminal in Hamburg," MB Energy, April 15, 2026, https://www.mbenergy.com/en/press-releases/permit-granted-mb-energy-can-build-ammonia-import-terminal-in-hamburg.

50. "Studie: Hamburg kann Deutschlands Wasserstoff-Drehkreuz sein," Hamburg Business, December 9, 2024, https://hamburg-business.com/de/news/studie-hamburg-kann-deutschlands-wasserstoff-drehkreuz-werden.

51. "Ammonia CFR NWE," Cbonds, accessed October 13, 2026, https://cbonds.com/indexes/194203/.

52.

53. "Annexure to Amendment-2: Detailed Site Matrix," SECI, accessed October 13, 2026, https://www.seci.co.in/Upload/Tender/SECI000157-1348110-AnnexuretoAmendment-2(DetailedSiteMatrix).pdf.

54. "Annexure to Amendment-2: Detailed Site Matrix," SECI.

55. "Centre Clears Rs 797 Crore Jetty for Handling Green Hydrogen, Ammonia, Other Liquid Cargo in Odisha Port," *New Indian Express*, February 26, 2026, https://www.newindianexpress.com/states/odisha/2026/Feb/26/centre-clears-rs-797-crore-jetty-for-handling-green-hydrogen-ammonia-other-liquid-cargo-in-odisha-port.

56. "Centre Approves ₹797 Crore Green Hydrogen Jetty at Paradip Port," Paradip Port Authority.

57. "Tender Notice," Central Public Procurement Portal, Government of India, accessed October 13, 2026, https://eprocure.gov.in/eprocure/app?component=%24DirectLink&page=-FrontEndLatestActiveTenders&service=direct&sp=S4SraN5T10ny0z%2B1KUFpgM-Q%3D%3D.

58. "Toyo-India Awarded EPC Contract for Ammonia Tanks at Gopalpur, Odisha," Toyo

Engineering India, January 3, 2024, https://www.toyo-eng.com/in/en/company/news/?n=4938.

59. Priya Jestin, "India's Odisha State Approves Green Hydrogen, Ammonia, Methanol Projects," ICIS, November 30, 2023, https://www.icis.com/explore/resources/news/2023/11/30/10949434/india-s-odisha-state-approves-green-hydrogen-ammonia-methanol-projects/.

60. "Industrial Infrastructure," Gopalpur Industrial Park, accessed October 13, 2026, https://gip.city/industrial-infrastructure/.

61. "Combined Reply to Essential Details Sought (EDS)," Ministry of Environment, Forest and Climate Change, accessed October 13, 2026, https://environmentclearance.nic.in/writereaddata/Online/EDS/0_0_31_Mar_2021_1712270871CombinedReply_compressed.pdf; and "Intimation under Regulation 30 of the SEBI (Listing Obligations and Disclosure Requirements) Regulations, 2015," Deepak Fertilisers and Petrochemicals Corporation Limited, July 28, 2025, https://nsearchives.nseindia.com/corporate/DEEPAKFERT_28072025231939_Intimation.pdf.

62. "Meeting Notice & Agenda: 55th CMETS-ER," Central Transmission Utility of India Limited (CTUIL), accessed October 13, 2026, https://ctuil.in/uploads/ists_consultation_meeting/agenda/177945241519Meeting%20Notice%20%26%20Agenda_55th%20CMETS-ER.pdf; and "Details of ISTS Sub-stations Planned for Bulk Consumers (including Green Hydrogen / Green Ammonia)," CTUIL, August 31, 2025, https://ctuil.in/uploads/assets/1764157726022025_08_Location%20and%20margin%20for%20bulk%20consumers_approved.pdf.

63. "Minutes of 30th CMETS-ER," CTUIL, 2024, https://www.ctuil.in/uploads/ists_consultation_meeting/minutes/171576475439Minutes%20of%2030th%20CMETS-ER_final.pdf.

64. "Industrial Infrastructure," Gopalpur Industrial Park.

65. "RFP: Consultant for Technical Advisory Services for Gopalpur Desalination PPP Project in Odisha," International Finance Corporation (IFC), June 30, 2026, https://wbgeprocure-rfx-now.worldbank.org/rfxnow/public/advertisement/7066/view.html.

66. "Petroleum, Chemicals and Petrochemicals Investment Region (PCPIR), Paradip, Odisha," Invest Odisha, accessed October 13, 2026, https://investodisha.gov.in/Application/uploadDocuments/Content/PCPIR_Brochure_1.pdf.

67. "Project Amplifhy Europe," VTTI, last modified April 8, 2026, https://www.vtti.com/

our-business/hydrogen/amplifhy/; and Erik Verheggen, "Air Products Aims to Start Construction of the Ammonia Crackers in Rotterdam before the End of This Year," *Industrylinqs*, August 10, 2026, https://www.industrylinqs.com/hydrogen/2026/08/air-products-aims-to-start-construction-of-the-ammonia-crackers-at-rotterdam-europoort-before-the-end-of-this-year/.

68. Geofrey Njovu, "Port of Rotterdam on the Cusp of Commercial Ammonia Bunkering Operations," Ammonia Energy Association, November 5, 2025, https://ammoniaenergy.org/articles/port-of-rotterdam-on-the-cusp-of-commercial-ammonia-bunkering-operations/.

69. "Ammonia Terminals - A Global View," Argus Media, 2024, https://futurefuels.imo.org/wp-content/uploads/2024/03/WorldAmmoniaMap2024.pdf; and "Yara Drives Hydrogen Economy with New Ammonia Import Terminal," Yara International.

70. Verheggen, "Air Products Aims to Start Construction of the Ammonia Crackers in Rotterdam before the End of This Year," 2026.

71. "Permit Granted: MB Energy Can Build Ammonia Import Terminal in Hamburg," MB Energy.

72. "World First: Air Liquide's Innovative Technology Converts Ammonia into Hydrogen at Industrial Scale, Paving the Way for New Low-Carbon Supply Chains," Air Liquide, November 13, 2025, https://www.airliquide.com/group/press-releases-news/2025-11-13/world-first-air-liquides-innovative-technology-converts-ammonia-hydrogen-industrial-scale-paving-way.

73. "Project Amplifhy Europe," VTTI.

74. Verheggen, "Air Products Aims to Start Construction of the Ammonia Crackers in Rotterdam before the End of This Year," 2026.

75. "The SDR Region Is Becoming a Strategic CO_2 and Hydrogen Corridor: Fluxys Is Building a Belgian Backbone for Tomorrow's Industry," Smart Delta Resources, accessed September 28, 2026, https://www.smartdeltaresources.com/en/Fluxys-multipurpose-backbone.

76. "Hamburg Energy Networks Construct Tunnel for Hydrogen Industry Network HH-WIN," *FuelCellsWorks*, May 8, 2026, https://fuelcellsworks.com/2026/05/08/energy-innovation/hamburg-energy-networks-construct-tunnel-for-hydrogen-industry-network-hh-win; and "Hydrogen in Hamburg," Hamburg Business, accessed September 28, 2026, https://hamburg-business.com/en/future-hamburg/green-hydrogen.

77. "First Major Hydrogen Plant Connected to Dutch Hydrogen Network," Hydrogen Eu-

rope, accessed September 28, 2026, https://hydrogeneurope.eu/first-major-hydrogen-plant-connected-to-dutch-hydrogen-network/.

78. "Delta Rhine Corridor Decision Provides Foothold on Way to Making Industry More Sustainable," Hynetwork, December 5, 2024, https://www.hynetwork.nl/en/knowledge-base/article/delta-rhine-corridor-decision-provides-foothold-on-way-to-making-industry-more-sustainable.

79. "GET H2 Nukleus Gains Momentum: First Hydrogen from Lingen Reaches Marl," RWE Generation, August 4, 2026, https://www.rwe.com/en/press/rwe-generation/2026-08-04-get-h2-nukleus-gains-momentum/.

80. "Creating Facts for the Transformation: Air Liquide Completes Hydrogen Pipeline to thyssenkrupp Steel in Duisburg," thyssenkrupp Steel, December 22, 2022, https://www.thyssenkrupp-steel.com/en/newsroom/press-releases/air-liquide-completes-hydrogen-pipeline-to-thyssenkrupp-steel-in-duisburg.html.

81. Erik Verheggen, "Pipelink Is Developing an Ammonia Pipeline Linking Vopak, Advario and Covestro in Antwerp," *Industrylinqs*, August 6, 2026, https://www.industrylinqs.com/chemicals/2026/08/pipelink-is-developing-an-ammonia-pipeline-linking-vopak-advario-and-covestro-in-antwerp/.

82. Hans van 't Noordende et al., *Clean Ammonia Roadmap*, Institute for Sustainable Process Technology (ISPT), 2024, https://ispt.eu/media/2024-ISPT-Clean-Ammonia-Roadmap-report_online-versie.pdf.

83. Geofrey Njovu, "LBC and duisport: Development of New Ammonia Terminal in the Ruhr Industrial Region," Ammonia Energy Association, January 13, 2026, https://ammoniaenergy.org/articles/lbc-duisport-development-of-new-ammonia-terminal-in-the-ruhr-industrial-region/.

84. "Tracks with Tradition," Port of Hamburg.

85. "Permit Granted: MB Energy Can Build Ammonia Import Terminal in Hamburg," MB Energy.

86. "RWE and VTG develop logistics concept for ammonia: from import terminal to customer by rail," VTG, February 13, 2023, https://www.rwe.com/en/press/rwe-supply-and-trading/2023-02-13-rwe-and-vtg-develop-logistics-concept-for-ammonia/.

87. "Rhine Oil Barge Rates at Record on Near-Impassable Kaub," *Argus Media*, July 30, 2026,

https://www.argusmedia.com/en/news-and-insights/latest-market-news/2858829-rhine-oil-barge-rates-at-record-on-near-impassable-kaub.

88. "Hygenco and Ameropa Ink Cooperation for Supply of Green Ammonia," Hygenco, June 20, 2024, https://hygenco.in/press-releases-ameropa.html.

89. "Indian Renewable Energy Company - ACME and Japanese Heavy Industry Major IHI Sign One of the Largest Pacts to Supply Green Ammonia from India to Japan," Press Information Bureau, January 23, 2024, https://www.pib.gov.in/Pressreleaseshare.aspx?PRID=1998871&lang=2&reg=48.

90. "Odisha," Ocior Energy.

91. Julian Atchison, "Air Liquide's Antwerp Cracker Begins Operations," Ammonia Energy Association, November 23, 2025, https://ammoniaenergy.org/articles/air-liquides-antwerp-cracker-begins-operations/.

92. Jaro Jens et al., *Extending the European Hydrogen Backbone: A European Hydrogen Infrastructure Vision Covering 21 Countries*, European Hydrogen Backbone, 2021, https://ehb.eu/files/downloads/European-Hydrogen-Backbone-April-2021-V3.pdf.

93. "Fertiglobe Chosen as Winning Bidder in H2Global Pilot Auction for Supply of Renewable Ammonia at a Delivered Price of €1,000 per ton into Europe," Fertiglobe, July 11, 2024, https://fertiglobe.com/fertiglobe-chosen-as-winning-bidder-in-h2global-pilot-auction-for-supply-of-renewable-ammonia-at-a-delivered-price-of-e1000-per-ton-into-europe/.

94. "AM Green Secures €585M Renewable Ammonia Deal with Germany's H2Global," *Times of India*, September 30, 2026, https://timesofindia.indiatimes.com/city/hyderabad/am-green-secures-585m-renewable-ammonia-deal-with-germanys-h2global/articleshow/134593746.cms.

95. "Uniper and AM Green Sign Long-Term Offtake Agreement for Up to 500,000 Tons per Year of Renewable Ammonia from India," Uniper, January 12, 2026, https://www.uniper.energy/news/uniper-and-am-green-sign-long-term-offtake-agreement-for-up-to-500000-tons-per-year-of-renewable-ammonia-from-india.

96. "EnBW Buys into Norwegian Green Ammonia Project," *Offshore Energy*, August 30, 2023, https://www.offshore-energy.biz/2023/08/30/enbw-buys-into-norwegian-green-ammonia-project.

97. Rachel Parks, "Japanese Conglomerate Takes 30% Stake in Large-Scale Indian Green

Ammonia Project: Reports," *Hydrogen Insight*, September 11, 2025, https://www.hydrogeninsight.com/industrial/japanese-conglomerate-takes-30-stake-in-large-scale-indian-green-ammonia-project-reports/2-1-1870904.

98. Atchison, "Air Liquide's Antwerp Cracker Begins Operations," Ammonia Energy Association.

99. RMI analysis using Mærsk Mc-Kinney Møller Center for Zero Carbon Shipping's Fuel Pathway Maturity Map.

100. RMI analysis using Mærsk Mc-Kinney Møller Center for Zero Carbon Shipping's Fuel Pathway Maturity Map.

101. "Energy Conversion Calculators," US Energy Information Administration, accessed October 13, 2026, https://www.eia.gov/energyexplained/units-and-calculators/energy-conversion-calculators.php.

102. *2023 Energy Statistics Yearbook*, United Nations Statistics Division, 2025, https://unstats.un.org/unsd/energystats/pubs/yearbook/2023/09ii.pdf.

103. Luc Girardin, Juan Correa Laguna, and Joris Valee, *Advancing Industrial Decarbonization by Assessing the Future Use of Renewable Energies in Industrial Processes (AIDRES): Assessment and Geo-Mapping of Renewable Energy Demand for Technological Paths towards Carbon Neutrality of EU Energy-Intensive Industries*, European Commission, 2023, https://data.europa.eu/doi/10.2833/696697.

104. Luc Girardin, *Advancing Industrial Decarbonization by Assessing the Future Use of Renewable Energies in Industrial Processes (AIDRES)*, 2023.

105. Luc Girardin, *Advancing Industrial Decarbonization by Assessing the Future Use of Renewable Energies in Industrial Processes (AIDRES)*, 2023.

106. Luc Girardin, *Advancing Industrial Decarbonization by Assessing the Future Use of Renewable Energies in Industrial Processes (AIDRES)*, 2023.

107. "Assumptions," EnergyVille, accessed October 13, 2026, https://perspective2050.energyville.be/results/main-edition-2025/assumptions.

108. "Assumptions," EnergyVille.

109. "Emission Factor: Natural Gas," Climatiq, accessed October 13, 2026, https://www.

climatiq.io/data/emission-factor/dfbffa96-f127-4121-90e4-a912e590f71b.

110. Alexandra Göbel et al., *The 3C-VaCS Project: Competitive Chemical Value Chains in the Netherlands-Flanders-North Rhine-Westphalia Chemical Cluster*, VITO and DECHEMA, 2026, https://vito.be/sites/vito/files/upload/3c-vacs-final-report.pdf.

111. Göbel, *The 3C-VaCS Project*, 2026.

112. "Carbon Dioxide Prices, Trend, Chart, Demand, Market Analysis, News, Historical and Forecast Data Report 2026 Edition," IMARC Group, last modified September 23, 2026, https://www.imarcgroup.com/carbon-dioxide-pricing-report.

113. Carlos Arnaiz del Pozo et al., "Exergoeconomic Assessment of Air Separation Units for Pressurized O_2 Production Incorporating Two-Phase Expanders," *Cryogenics* 124 (2022): 103477, https://www.sciencedirect.com/science/article/abs/pii/S0011227522000595; and *Comparative Analysis of Electrolytic Hydrogen Production Technologies with Low-Carbon (CCS-Abated) Hydrogen Pathways*, IEA Greenhouse Gas R&D Programme, 2024, https://ieaghg.org/publications/2024-08%20Analysis%20of%20electrolytic%20hydrogen.pdf.

114. Göbel, *The 3C-VaCS Project*, 2026.

115. RMI analysis.

116. RMI analysis.

117. RMI analysis.

118. RMI analysis.

119. RMI analysis.

120. Regulation (EU) 2023/1805 of the European Parliament and of the Council of 13 September 2023 on the Use of Renewable and Low-Carbon Fuels in Maritime Transport, and Amending Directive 2009/16/EC, European Parliament and Council of the European Union, September 22, 2023, https://eur-lex.europa.eu/eli/reg/2023/1805/oj.

121. Circular Letter No. 5005, "Draft Revised MARPOL Annex VI," International Maritime Organ-

ization, 2025, https://wwwcdn.imo.org/localresources/en/MediaCentre/HotTopics/Documents/Circular%20Letter%20No.5005%20-%20Draft%20Revised%20Marpol%20Annex%20Vi%20%28Secretariat%29.pdf.

122. RMI analysis.

123. RMI analysis.

124. Regulation (EU) 2023/1805 of the European Parliament and of the Council of 13 September 2023 on the Use of Renewable and Low-Carbon Fuels in Maritime Transport, and Amending Directive 2009/16/EC, 2023.

125. Regulation (EU) 2023/1805 of the European Parliament and of the Council of 13 September 2023 on the Use of Renewable and Low-Carbon Fuels in Maritime Transport, and Amending Directive 2009/16/EC, 2023.

126. RMI analysis.

127. *EU ETS II Pricing Scenarios: Balancing Cuts and Costs*, Bloomberg New Energy Finance, Bloomberg Philanthropies, and European Climate Foundation, 2025, https://assets.bbhub.io/promo/sites/16/EU_ETS_II_Pricing_Scenarios_Balancing_Cuts_and_Costs.pdf.

128. RMI analysis.

129. *Advancing Industrial Decarbonization by Assessing the Future Use of Renewable Energies in Industrial Processes (AIDRES)*, 2023.

130. M. Batool and W. Wetzels, *Decarbonisation Options for the Dutch Fertiliser Industry*, PBL Netherlands Environmental Assessment Agency, and ECN part of TNO, 2019, https://www.pbl.nl/sites/default/files/downloads/pbl-2019-decarbonisation-options-for-the-dutch-fertiliser-industry_3657.pdf.

131. Batool, Decarbonisation Options for the Dutch Fertiliser Industry, 2019.

132. *Advancing Industrial Decarbonization by Assessing the Future Use of Renewable Energies in Industrial Processes (AIDRES)*, 2023.

133. *Advancing Industrial Decarbonization by Assessing the Future Use of Renewable Energies in Industrial Processes (AIDRES)*, 2023.

134. *Advancing Industrial Decarbonization by Assessing the Future Use of Renewable Energies in*

Industrial Processes (AIDRES), 2023.

135. *Advancing Industrial Decarbonization by Assessing the Future Use of Renewable Energies in Industrial Processes (AIDRES)*, 2023.

136. *Advancing Industrial Decarbonization by Assessing the Future Use of Renewable Energies in Industrial Processes (AIDRES)*, 2023.

137. *Advancing Industrial Decarbonization by Assessing the Future Use of Renewable Energies in Industrial Processes (AIDRES)*, 2023.

138. *Advancing Industrial Decarbonization by Assessing the Future Use of Renewable Energies in Industrial Processes (AIDRES)*, 2023.

139. Directive (EU) 2023/2413 of the European Parliament and of the Council of 18 October 2023 Amending Directive (EU) 2018/2001, Regulation (EU) 2018/1999 and Directive 98/70/EC as Regards the Promotion of Energy from Renewable Sources, and Repealing Council Directive (EU) 2015/652, 2023.

140. Directive (EU) 2023/2413 of the European Parliament and of the Council of 18 October 2023 Amending Directive (EU) 2018/2001, Regulation (EU) 2018/1999 and Directive 98/70/EC as Regards the Promotion of Energy from Renewable Sources, and Repealing Council Directive (EU) 2015/652, 2023.

141. "Climate TRACE," Climate TRACE, accessed October 13, 2026, **https://climatetrace.org**.

142. *Statistical Report 2026*, FuelsEurope, 2026, **https://www.fuelseurope.eu/uploads/files/modules/documents/file/1782999250_xliepQAIq8mlR4GvWMCoNu48bBFhp7YfFt7g-SORt.pdf**.

143. Marco Márquez and Brian Bumgarner, "2020 AFPM Summit: Optimum Use of H_2 in the Production of Drop-In Green Fuels," *Hydrocarbon Processing*, August 24, 2020, **https://www.hydrocarbonprocessing.com/conference-news/2020/08/2020-afpm-summit-optimum-use-of-h2-in-the-production-of-drop-in-green-fuels/**.

144. Márquez, "2020 AFPM Summit: Optimum Use of H_2 in the Production of Drop-In Green Fuels," 2020.

145. Atchison, "Air Liquide's Antwerp Cracker Begins Operations," Ammonia Energy Association.

146. Jens, *Extending the European Hydrogen Backbone*, 2021.

147. Jens, *Extending the European Hydrogen Backbone*, 2021.

148. van 't Noordende, *Clean Ammonia Roadmap*, 2024.

149. van 't Noordende, *Clean Ammonia Roadmap*, 2024.

150. van 't Noordende, *Clean Ammonia Roadmap*, 2024.

151. "Delta Rhine Corridor Project Procedure Preparations Started," Hynetwork, March 26, 2025, https://www.hynetwork.nl/en/knowledge-base/article/delta-rhine-corridor-project-procedure-preparations-started; "Delta Rhine Corridor Decision Provides Foothold on Way to Making Industry More Sustainable," Hynetwork; "The Hydrogen System Is Taking Shape," Port of Rotterdam, May 7, 2025, https://www.portofrotterdam.com/en/news-and-press-releases/hydrogen-system-taking-shape; Verheggen, "Air Products Aims to Start Construction of the Ammonia Crackers in Rotterdam before the End of This Year," 2026; "Project Amplifhy Europe," VTTI; "ACE Terminal," ACE Terminal, accessed October 13, 2026, https://www.aceterminal.com; Njovu, "Port of Rotterdam on the Cusp of Commercial Ammonia Bunkering Operations," Ammonia Energy Association; Thomas Butler et al., *Gaps and Developments: Ammonia Supply Chain for Future Demand*, MAGPIE, 2023, https://www.magpie-ports.eu/wp-content/uploads/2023/05/Deliverable-D3.6-Ammonia-Supply-Chain.pdf; "NH3 Antwerp Terminal," Fluxys, last modified June 8, 2026, https://www.fluxys.com/en/projects/ammonia-antwerp-terminal; "World First: Air Liquide's Innovative Technology Converts Ammonia into Hydrogen at Industrial Scale, Paving the Way for New Low-Carbon Supply Chains," Air Liquide; Verheggen, "Pipelink Is Developing an Ammonia Pipeline Linking Vopak, Advario and Covestro in Antwerp," 2026; "Vopak Energy Park Antwerp Starts Market Consultation for Ammonia Storage," Vopak, October 24, 2024, https://www.vopak.com/newsroom/news/news-vopak-energy-park-antwerp-starts-market-consultation-ammonia-storage; Atchison, "Air Liquide's Antwerp Cracker Begins Operations," Ammonia Energy Association; "Yara Drives Hydrogen Economy with New Ammonia Import Terminal," Yara International; "Permit Granted: MB Energy Can Build Ammonia Import Terminal in Hamburg," MB Energy; "Tracks with Tradition," Port of Hamburg; "RWE and VTG Develop Logistics Concept for Ammonia: From Import Terminal to Customer by Rail," VTG; "GET H2 Nukleus Gains Momentum: First Hydrogen from Lingen Reaches Marl," RWE Generation; "Studie: Hamburg kann Deutschlands Wasserstoff-Drehkreuz sein," Hamburg Business; and Njovu, "LBC and duisport: Development of New Ammonia Terminal in the Ruhr Industrial Region," Ammonia Energy Association.

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Parimal Kogekar et al., *Unlocking an Odisha, India–Northwest Europe Green Ammonia Trade Corridor: A Pre-Feasibility Study of Supply Competitiveness, Infrastructure Readiness, and Offtake Feasibility,* RMI and VITO, 2026, https://rmi.org/insight/odisha-northwest-europe-green-ammonia-trade-corridor/.

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