



Policy Brief

# A pragmatic path to scaling clean ammonia trade

The case for destination-based, weighted-average carbon intensity compliance enabled by portfolio supply blending

# Introduction

As countries pursue net-zero commitments, hydrogen and ammonia are emerging as critical enablers of power sector decarbonisation. However, a gap remains between national decarbonisation ambitions and the commercial realities of affordability and supply security.

For countries seeking to decarbonise power sectors through ammonia co-firing, the near-term cross-border clean hydrogen market will effectively take the form of ammonia trade. Nevertheless, in most cases, the cost of green<sup>1</sup> ammonia remains significantly higher than that of blue<sup>2</sup> or grey<sup>3</sup> ammonia, often exceeding the price thresholds of current procurement frameworks. This creates structural challenges for early offtake. At the same time, some regulatory frameworks apply strict, cargo-by-cargo carbon intensity rules that can further constrain market entry.

While designed to ensure environmental integrity, such approaches may unintentionally limit the ability of markets to sell during the early stages of development.

To establish a pragmatic and cost-effective pathway for scaling clean ammonia trade, this paper proposes a transition towards **a destination-based, annual weighted-average carbon intensity compliance framework**. By assessing compliance based on aggregated performance over a defined period, this approach provides operational flexibility while maintaining environmental integrity. Importantly, it supports the market's need for stable, reliable and affordable supply, thereby strengthening regional energy security.

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<sup>1</sup> Green hydrogen or green ammonia is produced using renewable electricity (e.g. solar, wind, hydro) through electrolysis, with near-zero direct emissions and no fossil fuel feedstock.

<sup>2</sup> Blue hydrogen or blue ammonia is produced from fossil fuels (e.g. natural gas via Steam Methane Reforming [SMR] or Auto-Thermal Reforming [ATR]) with carbon capture and storage (CCS) applied to a portion of process emissions. Carbon intensity depends on capture rate, methane leakage and upstream supply-chain emissions.

<sup>3</sup> Grey hydrogen or grey ammonia is produced from fossil fuels without carbon capture (e.g. SMR or ATR without CCS), resulting in full carbon dioxide emissions to the atmosphere.

# Portfolio supply blending as the operational enabler

The transition from source-based verification to destination-based compliance can be operationalised through a portfolio supply blending model.

Two complementary implementation mechanisms underpin this model:

**A) System blending** occurs upstream at the ammonia production facility, where carbon intensity is averaged across multiple hydrogen production sources at the ammonia production facility.

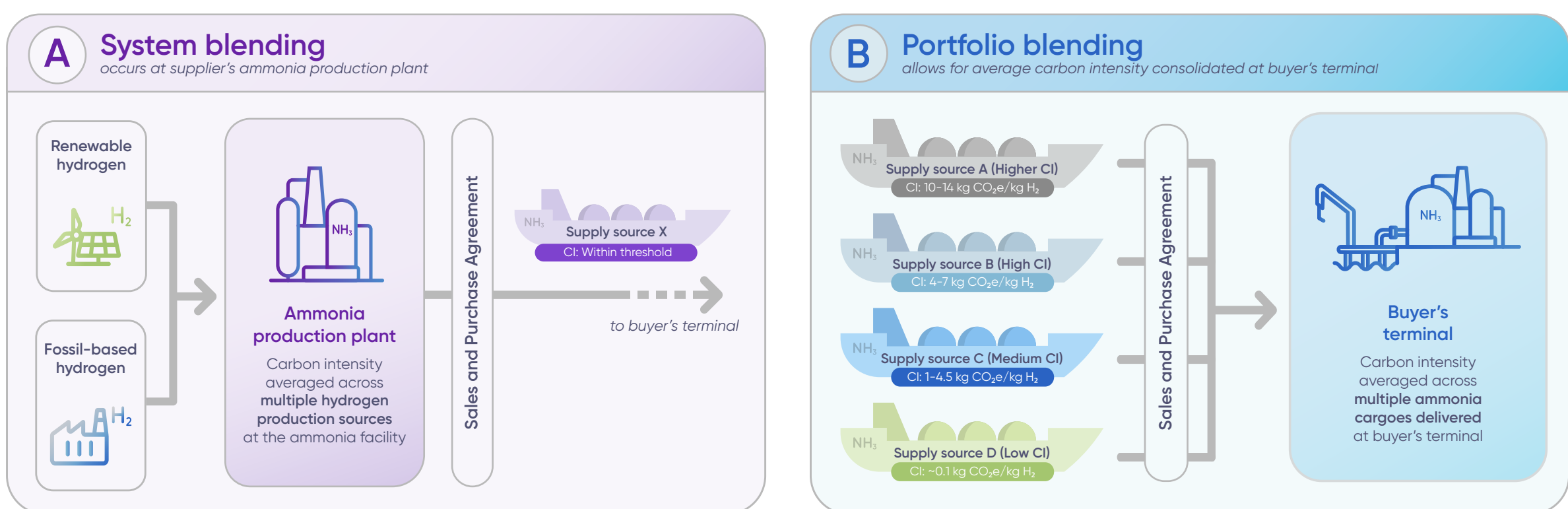
This allows producers to optimise feedstock inputs – for example, by balancing renewable electricity inputs with fossil-based hydrogen, while remaining within defined carbon intensity thresholds.

**B) Portfolio blending**, by contrast, occurs downstream at the point of delivery. In this model, carbon intensity is averaged across multiple ammonia production sources based on actual cargoes delivered at the buyer's terminal.

This approach allows for diversified supply portfolios for the buyer and reduces exposure to geographic or price volatility. It also allows for a structured and gradual increase in the share of green ammonia without requiring exclusive reliance on a single-source supply contract.

## Destination-based, annual weighted-average carbon intensity

Aggregated performance over a defined period determines compliance at the destination



### BENEFITS AND IMPACT

**Pragmatic**  
Supports transition with flexibility for producers and buyers

**Credible**  
Maintains environmental integrity through transparent auditable averaging

**Scalable**  
Enables reliable, affordable and sustainable trade to strengthen energy security

Abbreviations: CI (carbon intensity) | CO<sub>2</sub>e (carbon dioxide equivalent) | H<sub>2</sub> (hydrogen) | kg (kilogram) | NH<sub>3</sub> (ammonia)

Diagram 1: Simplified illustration of the portfolio supply blending model

Having established the models (system blending and portfolio blending), the next illustration contrasts the current single-source mechanism against the proposed portfolio-level mechanism.

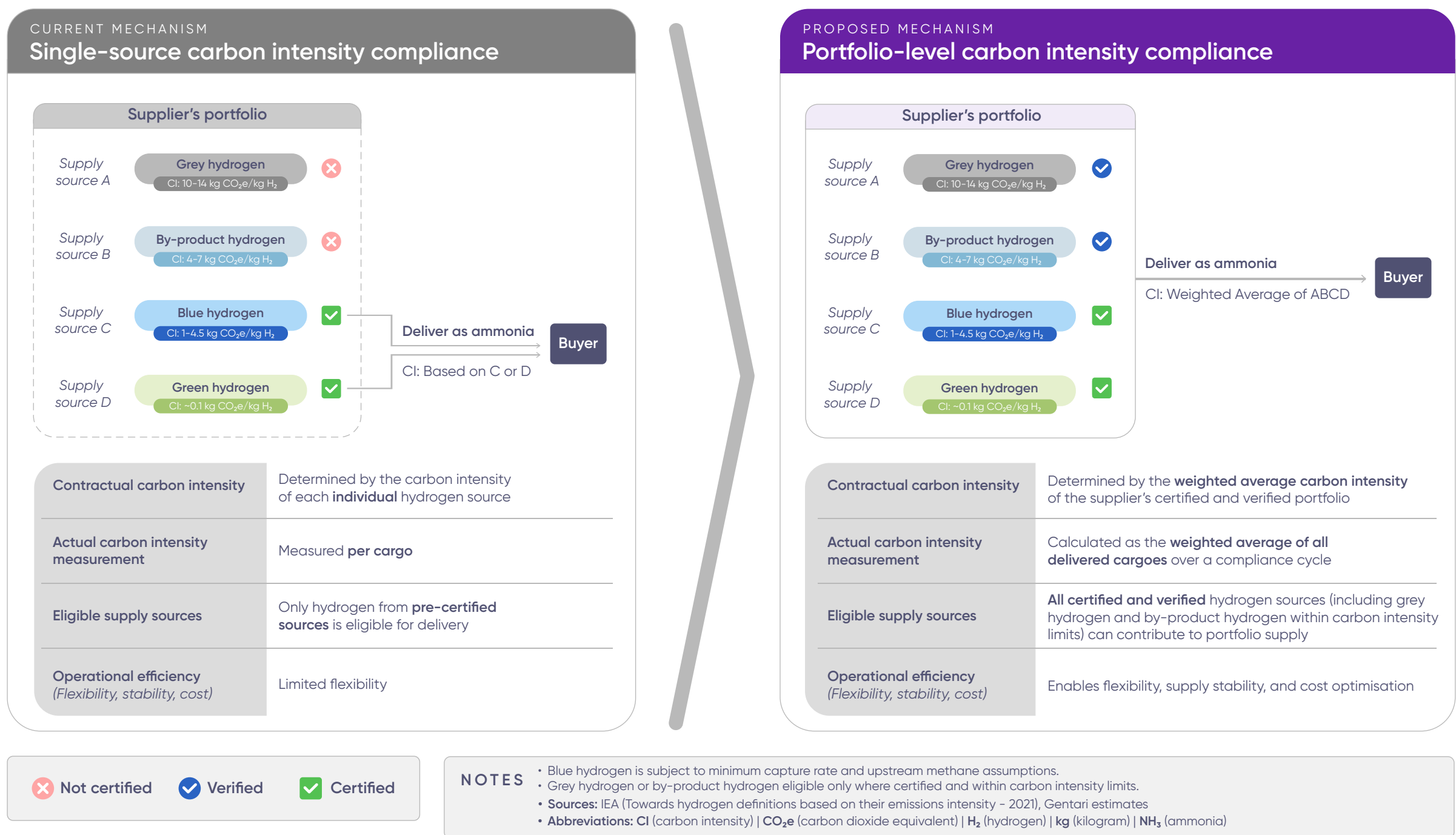


Diagram 2: Simplified illustration of portfolio supply blending as the operational enabler

## Governance, certification and compliance integrity

The credibility of this framework depends on a robust governance and verification structure. While the portfolio supply blending model introduces operational flexibility, it must be supported by clear contractual mechanisms to ensure credibility, transparency and accountability. Certification and verification protocols should therefore be embedded within sales and purchase agreements.



**For clean molecules such as green ammonia,** carbon intensity values should be accredited by designated third-party bodies using clearly defined life-cycle assessment system boundaries.



**For fossil-based molecules,** verification ensures accurate emissions reporting and compliance within the blended volumes.

This dual-track approach enhances transparency in emissions accounting and reporting, while mitigating the risk of unverified environmental claims. It establishes the regulatory certainty to unlock long-term project investments in hydrogen and ammonia supply chains.

# Compliance cycle and weighted-average carbon intensity methodology

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A fundamental component of this framework is the clear definition of the compliance cycle and the methodology used to calculate weighted-average carbon intensity.

Rather than assessing carbon intensity on a per-cargo basis, compliance would be measured over a defined period, such as a 12-month compliance cycle, reflecting how blended portfolios are managed in practice. Within this framework, the sales and purchase agreements should explicitly set out how weighted-average carbon intensity is calculated across all delivered volumes during the compliance period.

Where a carbon intensity shortfall arises at the end of the cycle, contractual remedy provisions may apply. These could include a defined grace period e.g. three months, to allow for settlement through remedy mechanisms such as the delivery of additional green cargoes, the transfer of verified carbon intensity certificates, or agreed financial adjustments. Such provisions enable compliance to be achieved without disrupting physical supply.

## Policy precedent: Lessons from FuelEU Maritime

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The proposed weighted-average carbon intensity compliance approach aligns with the EU's FuelEU Maritime Regulation, in force since January 2025. Under this framework, compliance is assessed at the fleet level rather than on a vessel-by-vessel basis. Shipping companies can pool compliance surpluses and deficits across multiple vessels, provided performance is verified against defined criteria. The core principle is clear: compliance is determined by aggregated performance over a defined period, not point-in-time conformity at the individual asset level.

The same principle underlies destination-based, weighted-average carbon intensity compliance for ammonia imports. Instead of requiring each cargo to meet a fixed carbon intensity threshold, compliance is measured across total delivered volumes over time, based on verified, aggregated performance.

This aggregation can occur at different points in the supply chain. Upstream, the carbon intensity may be averaged across multiple hydrogen feedstocks at the ammonia production facility, commonly referred to as system blending. Downstream, it may be averaged across multiple ammonia supply sources at the buyer's terminal, referred to as portfolio blending. Both approaches apply the same weighted-average compliance logic, differing only in where the averaging takes place.

Environmental integrity is maintained through transparent calculation methodologies, third-party certification, clearly defined life cycle assessment system boundaries and contractual enforcement mechanisms embedded in sales and purchase agreements. This structure provides the operational flexibility market participants need to manage supply variability and cost, while ensuring that compliance remains credible, verifiable and enforceable.

## Broader market benefits and implications for energy security

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From a market perspective, the blending model offers several strategic benefits that can enhance regional energy security:

- 1 Improves affordability of clean energy molecules** through portfolio-level optimisation and contractual flexibility.
- 2 Enables diversified geographic sourcing,** reducing exposures to geopolitical supply risks.
- 3 Facilitates earlier decarbonisation impact**  
Introducing blended ammonia volumes to enter the power mix today enables immediate emissions reductions, rather than deferring action until full green supply chains are in place.
- 4 Supports technology deployment and infrastructure scaling,** accelerating long-term cost convergence for green molecules.

These considerations are particularly relevant for high-volume import markets such as Japan, South Korea, and Singapore, where energy resilience, affordability and decarbonisation must be pursued simultaneously.

## A pragmatic evolution in policy design

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Institutionalising destination-based, weighted-average carbon intensity compliance represents a pragmatic evolution in policy design.

Many current auction-based procurement frameworks prioritise price while applying rigid carbon intensity thresholds that may limit early market participation. By adopting a flexible yet verifiable portfolio-based compliance model, policymakers can create a more balanced framework that supports both cost competitiveness and emissions reduction. **Gentari seeks to collaborate with industry stakeholders, regulators, and utilities to co-develop market mechanisms that are credible, bankable, and scalable.** Such approaches recognise that the transition to net-zero will occur through structured phases. Policy frameworks must therefore support a trajectory that maintains energy system stability while steadily advancing toward a low-carbon energy future.



## AUTHORS

**Siti Fairuz Khan**  
Head, Policy Research

**'Awadh Asyraf Supri**  
Head, Marketing and Sales - Far East,  
Hydrogen

**M Azamuddin Hassan**  
Analyst, Policy Research

## CONTRIBUTORS

**Sriram Narayanan**  
Global Head, Business Development,  
Hydrogen

**Alex Bower**  
Global Head, Marketing and Sales,  
Hydrogen

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**Gentari Sdn. Bhd.**

199301005062 (259799-X)

Level 30,  
Permata Sapura,  
Kuala Lumpur City Centre,  
50088 Kuala Lumpur

[enquiries@gentari.com](mailto:enquiries@gentari.com)

[gentari.com](https://www.gentari.com) | follow us



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