



**AMMONIA ENERGY**  
ASSOCIATION

# Nuclear Ammonia

Non-Electric Applications of Nuclear Heat Workshop  
Generation IV International Forum  
Toronto, Canada — October 3, 2022

**John Kutsch**

Director, Ammonia Energy Association  
&  
Thorium Energy Alliance

# Ammonia Energy Association



## Who we are

The **Ammonia Energy Association (AEA)** is a global industry association that promotes the responsible use of ammonia in a sustainable energy economy.

**Members:** 180+ global and cross-sectoral

## Our mission

**Supply:** decarbonize ammonia production

**Demand:** adopt ammonia in energy markets

## Our strategy

**Strategic Pillars:** knowledge stewardship, program development, collaboration, advocacy

# AEA Members: October 2022

\* indicates representation on Board of Directors

**PLATINUM:** bp, CF Industries\*, CWP Global\*, Denbury Inc., The Hydrogen Utility\*, Hy Stor Energy, InterContinental Energy\*, KBR\*, LSB Industries\*, Mitsui & Co., Monolith Materials\*, Nutrien\*, OCI\*, Reliance Industries, Starfire Energy\*, Yara\*. **GOLD:** AFC Energy, Airgas, Aker Clean Hydrogen, Casale\*, Enaex, Engie, Equinor, Fortescue Future Industries, FuelPositive, Green Hydrogen & Chemicals (UK), Hamilton Locke, Horisont Energi\*, Marnco\*, Mitsubishi Heavy Industries, Origin Energy\*, Proton Ventures\*, S&P Global, Syzygy Plasmonics, thyssenkrupp Industrial Solutions\*, Topsoe\*, Trammo, Trigon, Tri-State Generation & Transmission. **SILVER:** AES Gener, Air Products, Ambient Fuels, Ammonigy, AmmPower, Amogy, Argus Media, BASF, Black & Veatch, Bureau Veritas, Burns & McDonnell, Casa dos Ventos, Christof Group, Consorcio Eólico, ControlRooms.ai\*, Copenhagen Atomics\*, Copernic Catalysts, CRU Group, CS Combustion Solutions, Cummins, Eastman Chemical, EIFER, Enterprize Energy, Envision Group, Fertiberia, First Ammonia, Fujitsu Research of America, GenCell Energy, GTI Energy, Gunvor Group\*, H2Site, Heraeus, HyFuels Holdings, IHI Americas, Inherent Solutions Consult, inodú, Intecsa Industrial, JGC Corporation, Johnson Matthey, Koch Fertilizer, Linde, Lotte Fine Chemical, Mabanaft, Maersk\*, Mercuria, MineARC Systems, Mitsui OSK Lines, Nel Hydrogen\*, Oldendorff Carriers, Pacific Green Technologies\*, SagaPure\*, Shell, Skeiron, Stamicarbon, Starbulk, Talos Energy, Technip Energies, Tecnicas Reunidas, Terrestrial Energy, Thorium Energy Alliance\*, TotalEnergies\*, Tsubame BHB, Universal H2, Vesta Terminals B.V., Wonik Materials, Woodside Energy. **MEMBERS:** 8 Rivers Capital, AB Achema, ACEN Australia, Advanced Ionics, Advanced Thermal Devices, AHMON, Air Liquide, Alfanar, Apex Clean Energy, Arizona Public Service, Ark Energy, AustriaEnergy, Avaada Energy, Axetris, BLG, Brittany Ferries, C-Job Naval Architects, Carbon-Neutral Consulting\*, CHZ Technology, Cozairo, Cura IT, CyaNH<sub>3</sub>, Danaos Shipping, Duiker Combustion Engineers, EDF Renewables, EIH<sub>2</sub>, Energy Estate, Eneus Energy, ESNA, Evergy, EVOS, Greenfield Nitrogen, GTT North America, Idemitsu Kosan, Incitec Pivot, Ingenostrum, Inpex Corporation, Interlock Consulting, IT Power Australia, John Cockerill, Jupiter Ionics, Karachaganak Green Energy Corporation, Keppel Infrastructure\*, Koole Terminals, Mainspring Energy, MAN Energy Solutions, MicroEra Power\*, Moda, Nebraska Public Power District, Neology, Netsco, New Energy Technology, Next Hydrogen, NGLStrategy, Nikki-Universal, Nordex, Northern Nitrogen, NovoHy, NYK Energy Transport (USA), Oceanic Vessels, Oiltanking, Osaka Gas USA, ReMo Energy, Renewable Hydrogen Corporation Canada, RES, Scatec, Shrieve Chemical Company, Suzlon Energy Australia, TasRex, Tokyo Gas, Umicore, Unconventional Gas Solutions, Vahterus, Varo Energy, Vopak.



# Ammonia Sector Transition



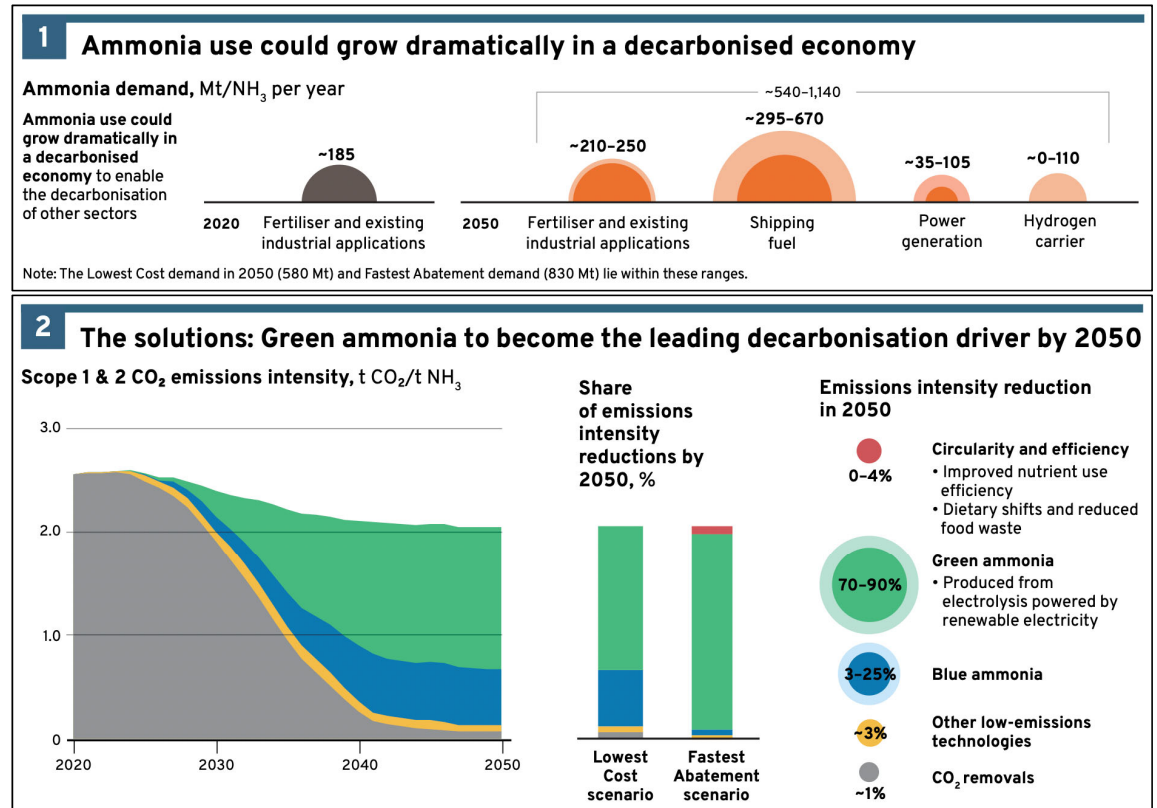
Mission Possible Partnership published its *Ammonia Sector Transition Strategy* in Sept 2022.

Ammonia is unlike other commodities:

- We need to decarbonize ammonia for existing market applications
- But decarbonized ammonia can be used to displace fossil fuels in new applications.

So while existing markets will see growth, bigger, new opportunities are on the horizon: shipping fuel, power generation, H<sub>2</sub> carrier.

The transition is feasible with renewables and CCS. Nuclear is not yet considered despite potential to accelerate the



*Making Net-Zero Ammonia Possible*, Mission Possible Partnership, September 2022. <https://missionpossiblepartnership.org/our-approach/sector-transition-strategies/>

# Ammonia Certification



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The AEA is developing a certification scheme for ammonia, to account for the GHG emissions associated with production.

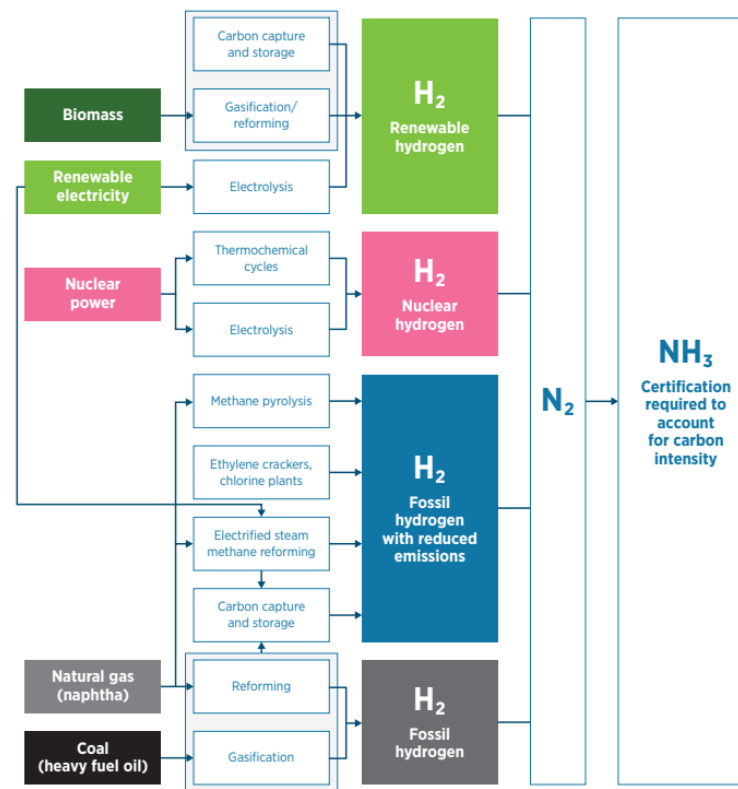
Our strategic objectives include:

- Global harmonization, across multiple regions and sectors
- Technology neutrality, including fossil, renewable, bio, nuclear
- Absolute GHG emissions, site-specific, measured not modelled
- Well-to-gate, including upstream Scope 3
- Tradable, enabling the low-carbon ammonia commodity market

Not colors (green/blue) or labels (clean/low-carbon) but credible and transparent absolute GHG intensity (tCO<sub>2</sub>e/tNH<sub>3</sub>).

AEA Member-led working groups, including international partners, are currently developing the design principles and methodologies.

- Design phase is underway.
- Implementation phase begins in 2023.



Ammonia pathways. IRENA and AEA (2022), Innovation Outlook: Renewable Ammonia, <https://www.irena.org/publications/2022/May/Innovation-Outlook-Renewable-Ammonia>

# Closing thoughts



The ammonia sector has already started the transition, driven by:

- decarbonization efforts in existing industry
- new markets for low-carbon energy.

Nuclear needs to become a clearer part of this picture, to

- support the necessary speed and scale of deployment, and
- diversify the technology / sustainability portfolio.

To get involved in the AEA's work on nuclear ammonia:

- Contact Trevor Brown, Executive Director  
[tbrown@ammoniaenergy.org](mailto:tbrown@ammoniaenergy.org)
- Learn more at <https://www.ammoniaenergy.org/certification>

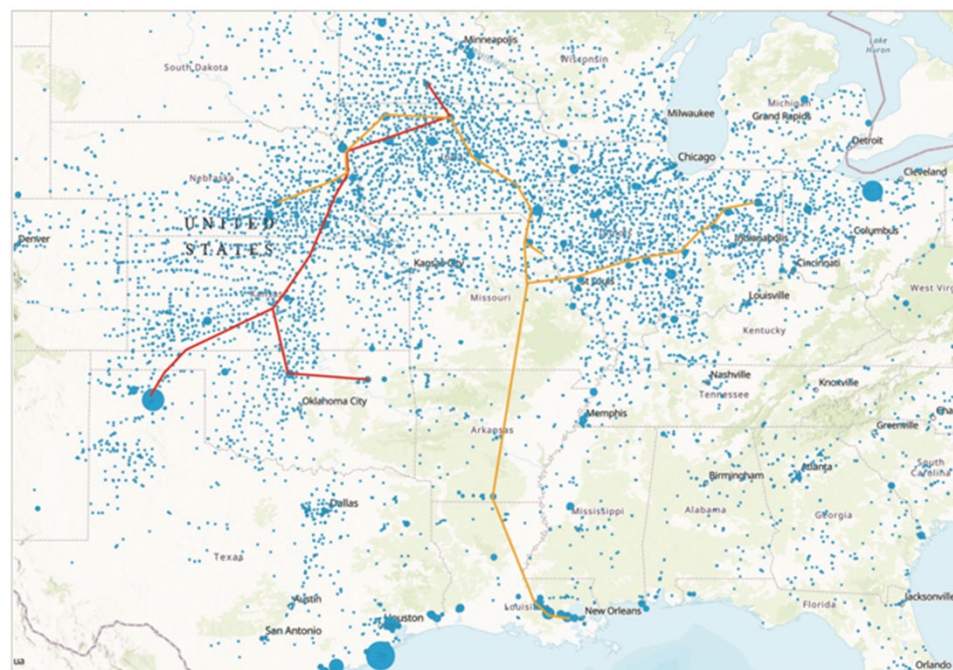
# Existing Ammonia Market



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Ammonia is  $\text{NH}_3$ : 82.2%wt nitrogen (ie, 17.8%wt  $\text{H}_2$ )

- Ammonia is everywhere (>10,000 regulated ammonia storage sites in USA)
- ~90% of ammonia is upgraded immediately on-site to downstream molecules: urea, ammonium nitrate, nitric acid, etc
- 80% of market is fertilizers
- 20% of market is industrial:  $\text{deNO}_x$ , chemicals and plastics (eg, melamine, acrylonitrile), wastewater treatment, explosives, metals refining, refrigeration, pharmaceutical, electronics.



Ammonia storage and distribution networks in the U.S., Royal Society policy briefing, "Ammonia: zero-carbon fertiliser, fuel and energy store," February 2020, <http://royalsociety.org/green-ammonia>

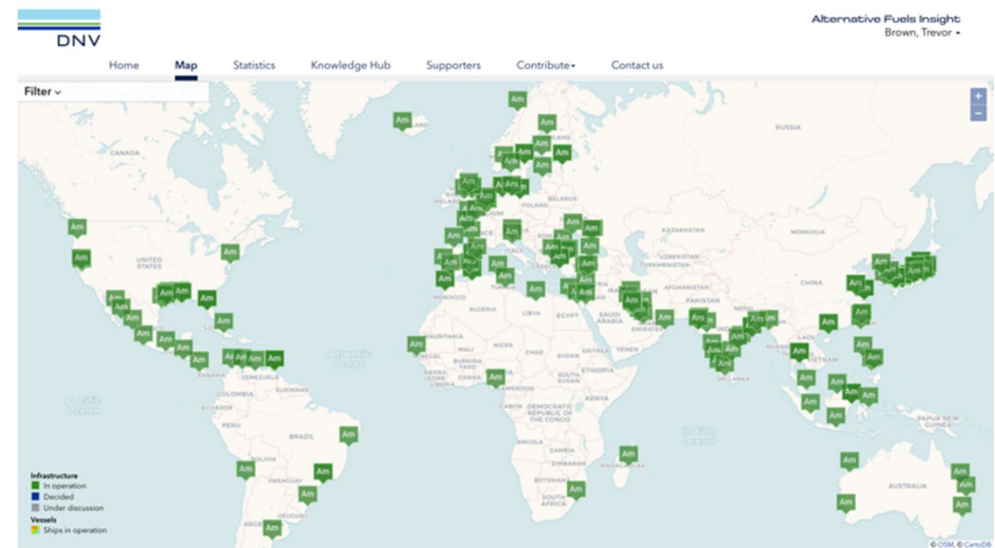
# Existing Ammonia Market



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Ammonia is the 2<sup>nd</sup> most produced chemical worldwide

- Global production: 180 Mt
- International trade: 18 Mt
- 196 ports with infrastructure for bunkering (import/export terminals)
- 150 years of safety knowhow, codes and standards, regulations, technologies, training.
- Significant anchor markets and existing infrastructure enable expansion into new markets.



Global operational ammonia terminals (import/export tanks and infrastructure), DNV GL's Alternative Fuel Insight platform, <https://afi.dnvgl.com/Map>