

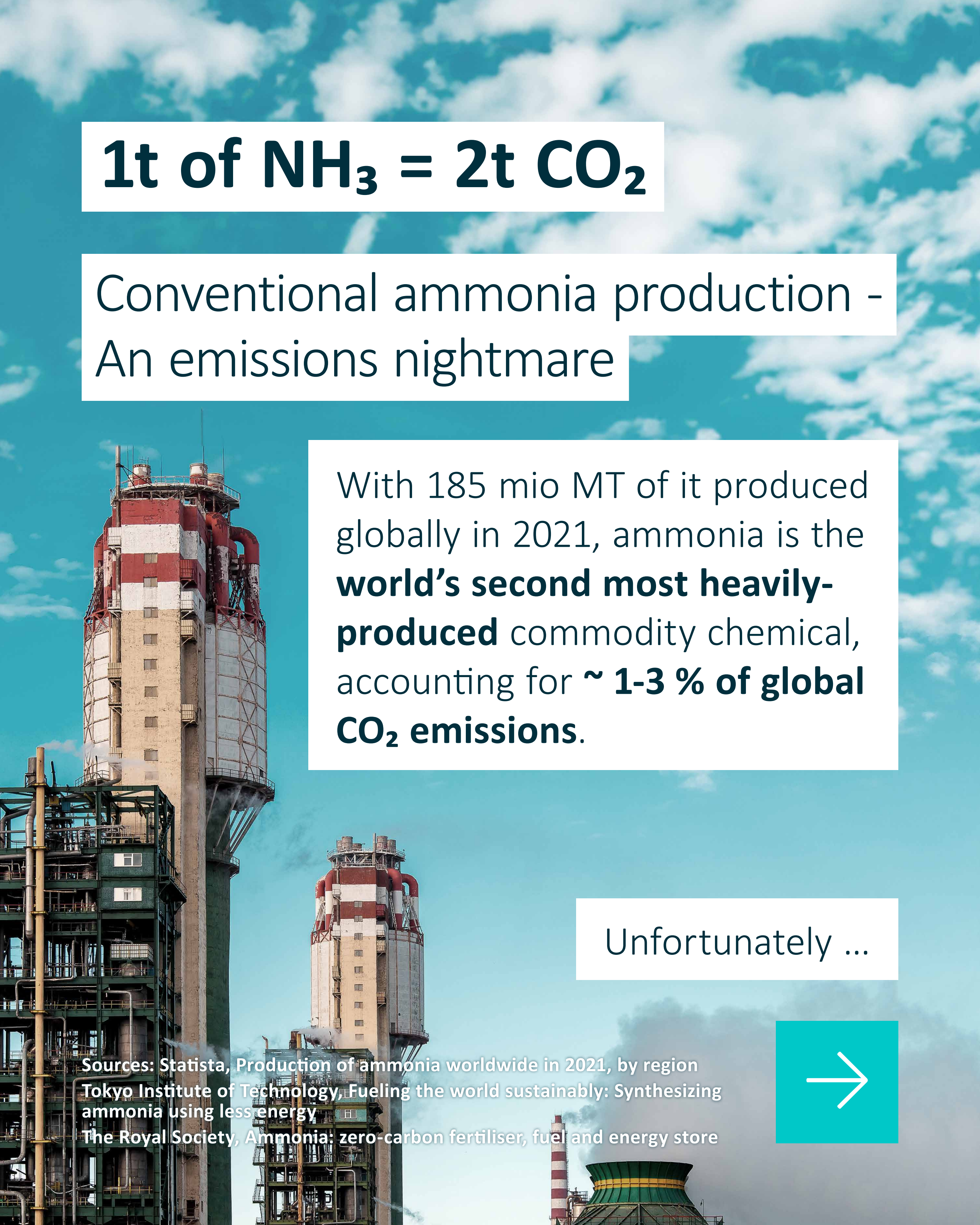
Green Ammonia

Unlocking its potential
to become H₂'s energy
transition partner

Many people
associate ammonia
with cleaning agents,
fertilisers or dirty
industrial processes.

The truth is ...





1t of NH_3 = 2t CO_2

Conventional ammonia production - An emissions nightmare

With 185 mio MT of it produced globally in 2021, ammonia is the **world's second most heavily-produced** commodity chemical, accounting for ~ **1-3 % of global CO_2 emissions.**

Unfortunately ...

Sources: Statista, Production of ammonia worldwide in 2021, by region
Tokyo Institute of Technology, Fueling the world sustainably: Synthesizing ammonia using less energy
The Royal Society, Ammonia: zero-carbon fertiliser, fuel and energy store



Green Ammonia = NH_3

Most of today's production of the colourless gas runs on **fossil fuels** such as natural gas and coal.

But ...

Sources: Statista, Production of ammonia worldwide in 2021, by region
Tokyo Institute of Technology, Fueling the world sustainably: Synthesizing ammonia using less energy
The Royal Society, Ammonia: zero-carbon fertiliser, fuel and energy store





Starfire Energy

MAKING SUSTAINABLE ENERGY A REALITY

Luckily, companies like our partner **Starfire Energy** already scale the production of green ammonia with only three clean ingredients:

- ≡ Fresh air
- ≡ Water
- ≡ Renewable electricity

Here's how it works:



The green ammonia process

Capture nitrogen from air
(78 % of the atmosphere)

+

Produce green hydrogen
via **AEM electrolysis**

=

Get clean NH_3 via Starfire's
Rapid Ramp system

Green ammonia presents a
multi-trillion-dollar opportunity ...

Sources: Starfire Energy, Scalable Ammonia Technology That Doesn't Rely on Fossil Fuels, <https://starfireenergy.com/>

UMAS, Aggregate investment for the decarbonisation of the shipping industry



Green ammonia's vast potential

Demand for clean maritime fuel alone opens up a massive market:

≡ **670 – 946 mio t/year**

≡ **~ 5 trillion USD market**

But why the buzz?

Source: UMAS, Aggregate investment for the decarbonisation of the shipping industry



Green ammonia is an incredibly hydrogen-dense material



It's one of the most energy-dense substances we can create from renewable electricity.

Fun fact ...



Source: ecuity, Ammonia to Green Hydrogen Project, Feasibility Study

Ammonia's hydrogen boost



There's **1.5 × more hydrogen** in a gallon of ammonia compared to a gallon of only hydrogen.

Plus ...

Source: Blain, New Atlas, Green ammonia: The rocky pathway to a new clean fuel





Advantages in storage and transport

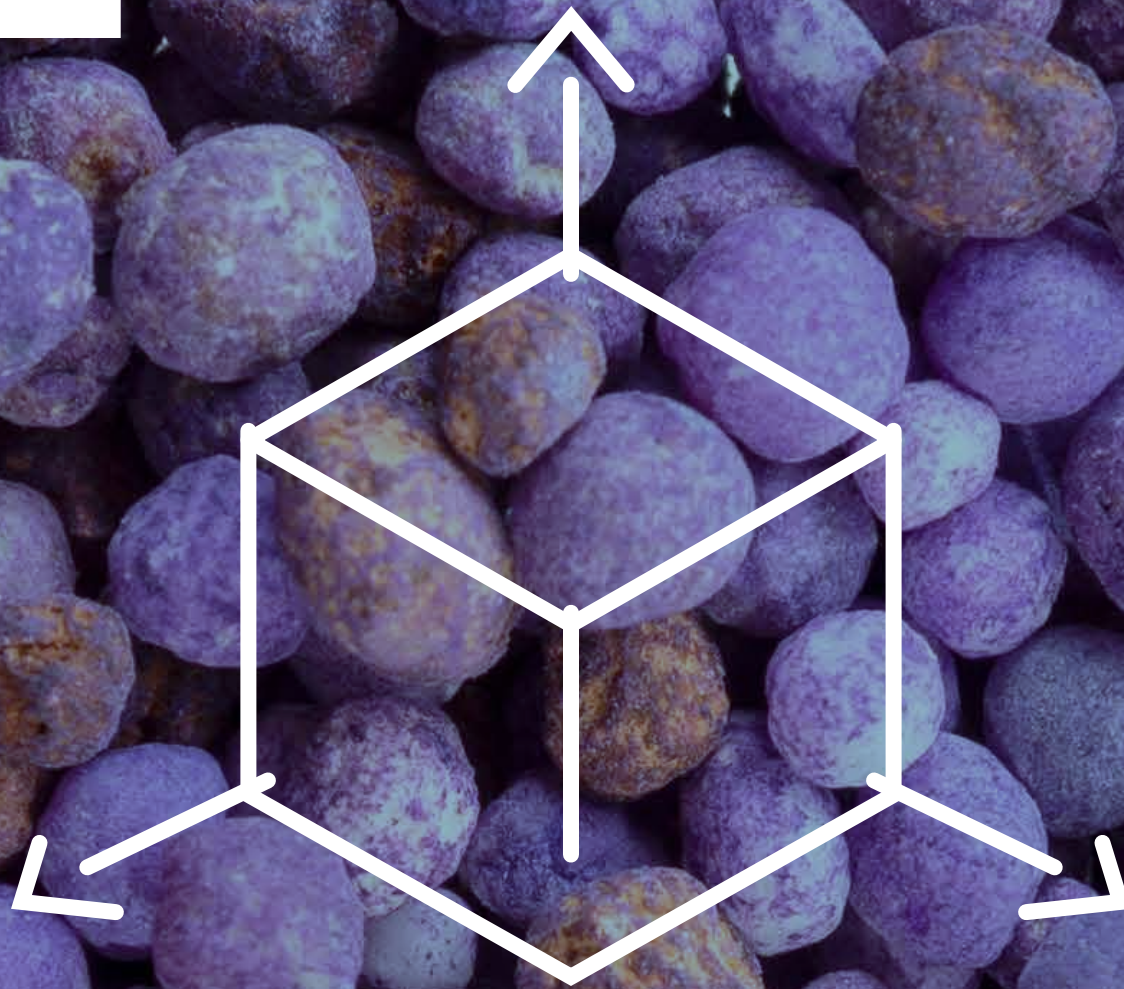
Ammonia liquefies at -33°C
(H_2 at -253°C)

This feature makes it ...

Source: Blain, New Atlas, Green ammonia: The rocky pathway to a new clean fuel



Energy Packed by Volume



Ammonia outshines hydrogen by volume:

≡ **+ 70 % more energy** than liquefied H₂

≡ **3 × more energy** than compressed H₂ gas

And ...



Source: Blain, New Atlas, Green ammonia: The rocky pathway to a new clean fuel

Energy Boost by Weight

Union BATTERY

> 20 × more specific energy than
today's lithium batteries

That's why it's ...

Source: Blain, New Atlas, Green ammonia: The rocky pathway to a
new clean fuel



Shipping Industry's Green Solution

This makes it extremely interesting as a clean alternative fuel for the shipping industry, which currently uses dirty bunker fuel, accounting for:

**2 % of global CO₂ emissions
in 2022**

The good news is ...



Source: iea, international shipping

Partners in Crime

H₂ and NH₃ build on each others' strengths to enable the energy transition.

Certainly, the world needs massive **green ammonia plants**.

Nevertheless, ...



Modular systems,
like **Starfire Energy's**,
leverage **AEM tech** for:

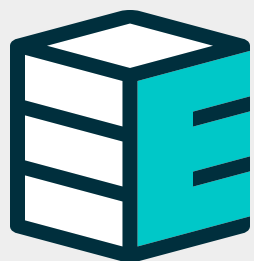
- ≡ Easy transportability
- ≡ On-site production
- ≡ Tailored NH_3 supply
- ≡ Shorter construction lead times



Ready for Your Green Hydrogen Project?

Request your quote
for our scalable **AEM
Electrolysers** now and
benefit from short
lead times:

go.enapter.com/quote



Enapter

