Knowledge grows

# Decarbonized Ammonia for Food and Energy

Rob Stevens
VP Decarbonize Scouting
Climate Neutral Solutions

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# Yara - the Crop Nutrition Company for the Future

**220 million**
people our products help to feed

**+60**
The number of countries we operate in

**20 million**
The number of farmers we collaborate with

**5 million**
Tonnes of ammonia traded – Global leader

**9,000**
Fully branded retail outlets[1]

**3 units**
3 Industrial Nitrogen Business Units

**870**
Agronomists on the ground

**No. 10**
Ranked no. 10 on FORTUNES' prestigious Changing the World List[2]

[1]Owned and operated by external parties
[2] Fortune List rating dates back to 2017

# The agricultural sector is facing several fundamental changes

| | | |
|---|---|---|
| **Climate Change** | CC impacts how and where crops can be grown, and demands agricultural efficiency improvements | *Yara's premium products, knowledge and solutions reduce emissions, preserve resources and address specific challenges like water stress* |
| **Circular Economy** | Increased awareness and need for nutrient recycling | *Yara is contributing its knowledge and experience in partnerships to develop new crop nutrition business models, e.g. based on urban waste streams* |
| **Technology in agriculture** | Digital solutions change how farmers operate | *Innovative digital technology and solutions combine ideally with Yara's unrivalled global on-field presence and crop nutrition knowledge* |
| **Food value chain integration** | Increasing consumer demands: quality, environmental impact, traceability | *Yara's global on-field presence and crop nutrition knowledge make it an ideal partner for food producers and retailers* |

## The Crop Nutrition Company *for* the Future

# Our Ambition: towards climate neutrality

Yara's total greenhouse gas emissions halved by almost eliminating $N_2O$

**Past 15 years**

Further improving on world leading performance by $CO_2$ reduction target

**Present**

Ambition to become climate neutral by 2050

**Future**

# Scope 1, 2 and 3 GHG emissions from fertilizers produced by Yara amounted to 70 million tonne $CO_2e$ in 2018*

REDUCE

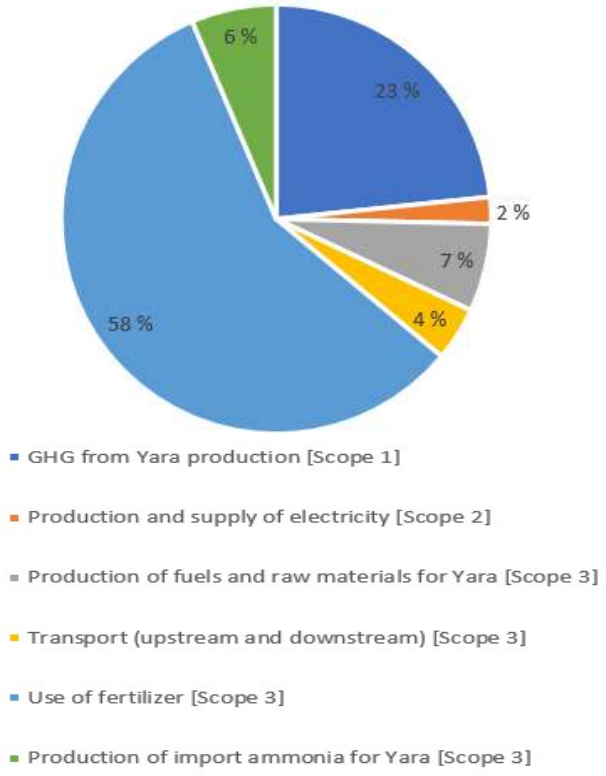
carbon footprint in Yara's own assets & electricity usage

REFRAME

low-carbon solutions in the supply chain & emissions in the field through fertilizer application

REIMAGINE

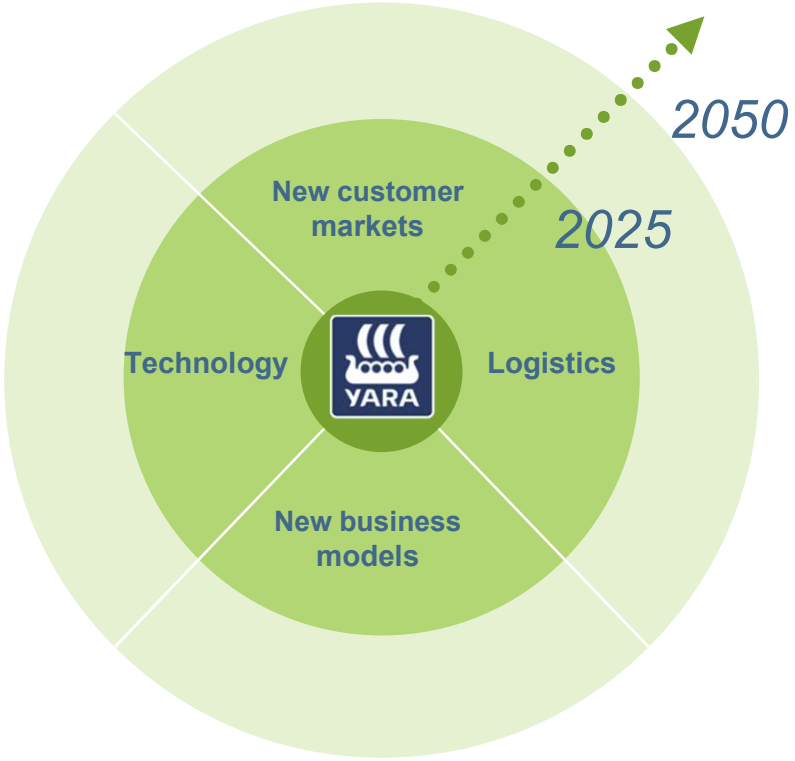
the fertilizer value chain with innovations in production processes, logistics and energy



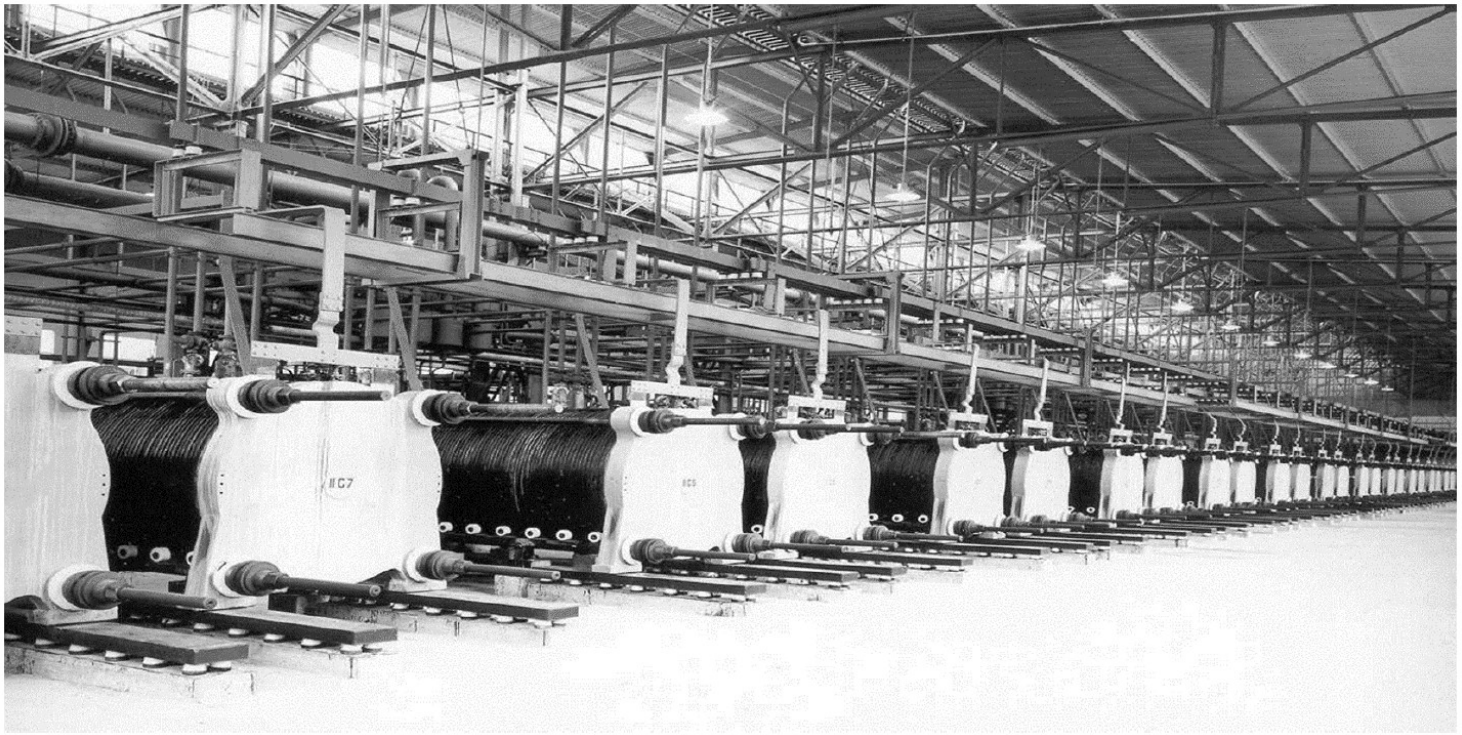

* 2018 Yara GRI report
**Compared to nitrates the in-field direct nitrogen loss is higher.

# Drive Innovative growth by decarbonizing Yara by 2050

## Reduce-Reframe-Reimagine



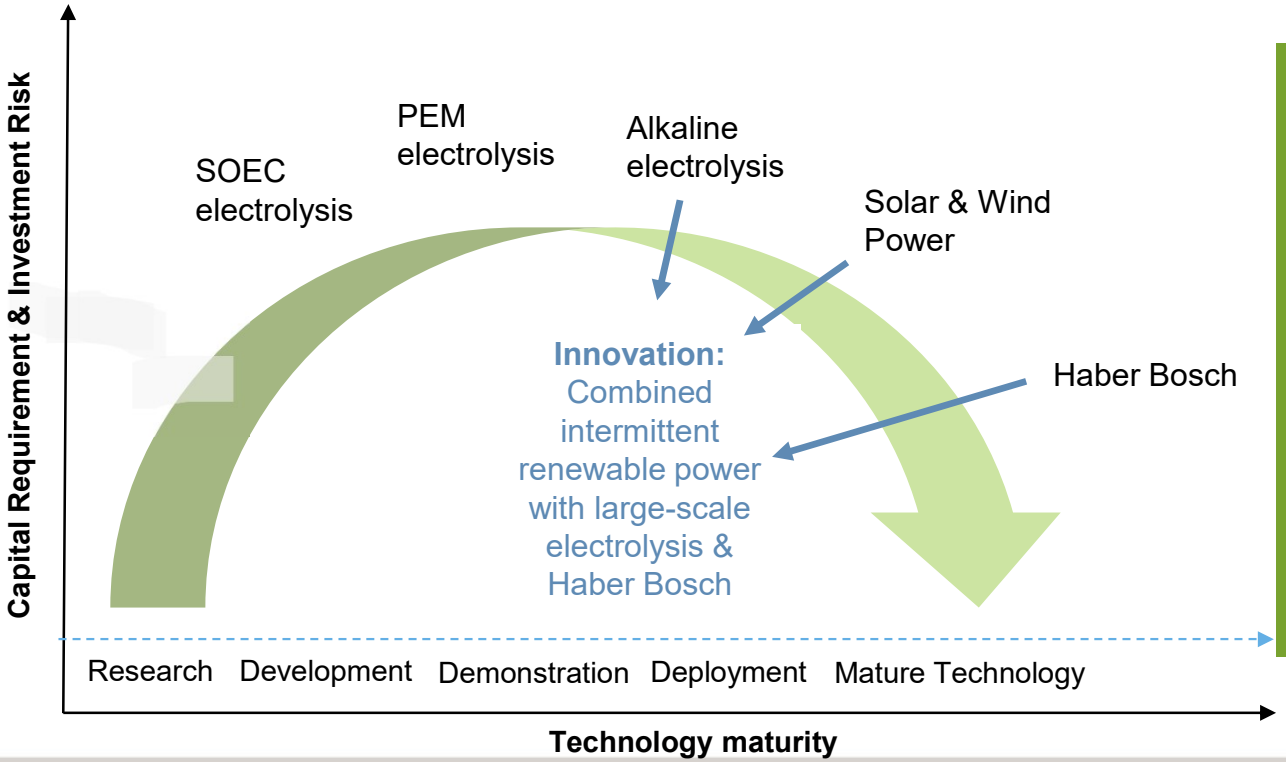
# Yara Glomfjord, Norway until 1991
# 155MW electrolysis based ‘green’ ammonia production



Picture: courtesy of Nel Hydrogen ASA

Notodden: 1927 – 1968; Rjukan: 1929 – 1971; Glomfjord: 1953 - 1991

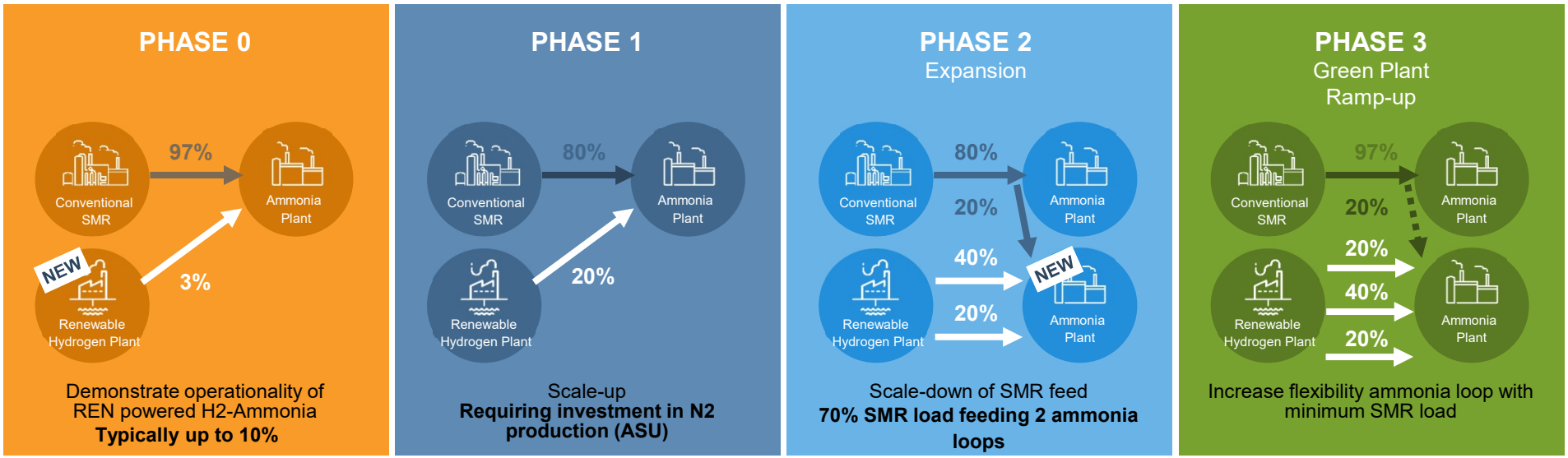
# Green Ammonia: High TRL components, never been combined at large-scale in an intermittent renewable power context




- ✓ **Building blocks are at high TRL, yet the combination & integration of the building blocks needs to be developed and deployed at scale**
- ✓ **All alternative technologies to electrolysis + HaberBosch are at low TRL level***

# Hybridization scale-up of green ammonia production

## New Business models



# Decarbonize Yara – Partnerships and R&D initiatives
## Technology

Next generation low-carbon fertilizer technology

Green ammonia partnership

Cost reduction of electrolysers
- Integrated battery-electrolyser (kW size)
- Gigawatt electrolyser design
- Open Innovation electrolyser test center (PEM and alkaline)

Front-running in-house R&D on in-field agricultural emissions

# Yara and Lantmännen lead the way towards world's first fossil free food chain

## New Customer markets

From field to fork: A joint effort to reduce the carbon footprint of food production

- A fossil free food chain is only possible with mineral fertilizers produced with renewable energy – collaboration
- Pilot project that aims to enable consumers to mitigate their climate impact by making low-carbon food choices.

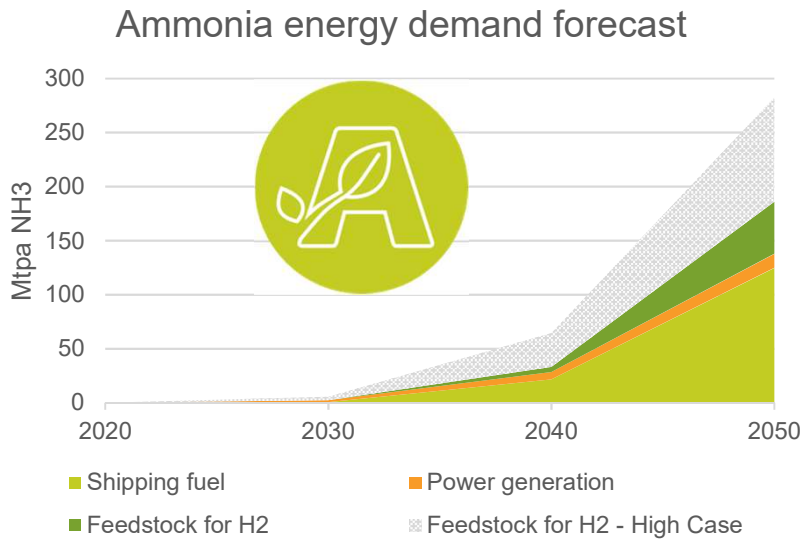
# Clean Energy could double the global demand for ammonia Logistics

- Ammonia Energy is receiving increasing attention and can shift the ammonia market

AMMONIA ENERGY ASSOCIATION

- **Power generation**
  - Ammonia for direct power generation
- **Shipping fuel**
  - Ammonia as marine fuel

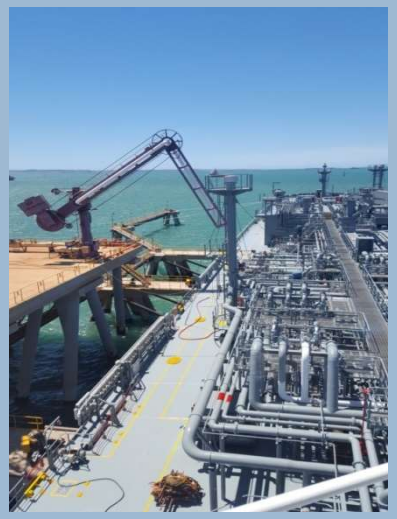
    *(DNVGL 25% of 2050 shipping fuel can be ammonia*
- **H2 carrier**
  - Ammonia as energy storage and transport vector (H2 economy) can emerge as deep decarbonization begins




* Lloyd's/Umas/IMO/DNVGL/IEA etc

# Yara Ammonia logistics

- 25% market volume (of 20mt trade)
- 12 ammonia carriers
- 10-25kt ~15-38000m$^3$
- Base Chemicals unit
- Safe rail-truck-barge logistics
- LPG like handling
- Ammonia is liquid at either -33°C or 10 bar



# Yara is developing partnerships to explore and remove barriers for ammonia as shipping fuel

| | Bunkering infrastructure | Fuel cost | Perception Safety | Regulatory | Technology |
|---|---|---|---|---|---|
| **Barrier description** | **Security of supply** and **scalability** of infrastructure | Ammonia fuel will need long term high carbon price. Today **beyond 250 USD/tn CO2** to compete with LNG IC | Perceived ammonia **safety risks can be a barrier for uptake** of NH3 fuel | **Currently no rules for use ammonia as fuel**; an IMO process for NH3 fuel is expected to take 10 years. | **No proven technologies at marine full scale** yet. |
| **How to close the gap?** | **Starting point** is **decent** with 20 Mtn/ yr global trade. Industry collaboration required to gradually develop infrastucture to match demand | Access to **low cost** renewable **energy** and/or large scale development of CCS will be the key to bring fuel costs down. | **Demonstration projects** must be handled with utmost caution, building on global best practice and competence. | Establish first projects based on the **IGF code** for alternative design must be applied (as for LNG until recently). | Both SOFC and ICE technologies are being developed, and should be demonstrated whithin 3-5 years |

- The key to overcoming the barriers is to identify the viable demonstration concepts
- Yara aims to participate in 1-2 strong consortia to establish viable demonstration cases
- Yara can offer a fuel value chain perspective as well as expertise in ammonia handling and safety


The future
will be different…
CARBON FOOTPRINT
CO2
GUARANTEE
YARA