Ammonia Project Features

(Wednesday 23 November, 3PM CEST, online via Zoom Webinar)

Renewable ammonia projects in Sub-Saharan Africa

Ralph Koekkoek
Project Development Manager, MET Development

Marcel Jacobs
Representative African Hydrogen Partnership, owner Jacob Lawren Ltd.

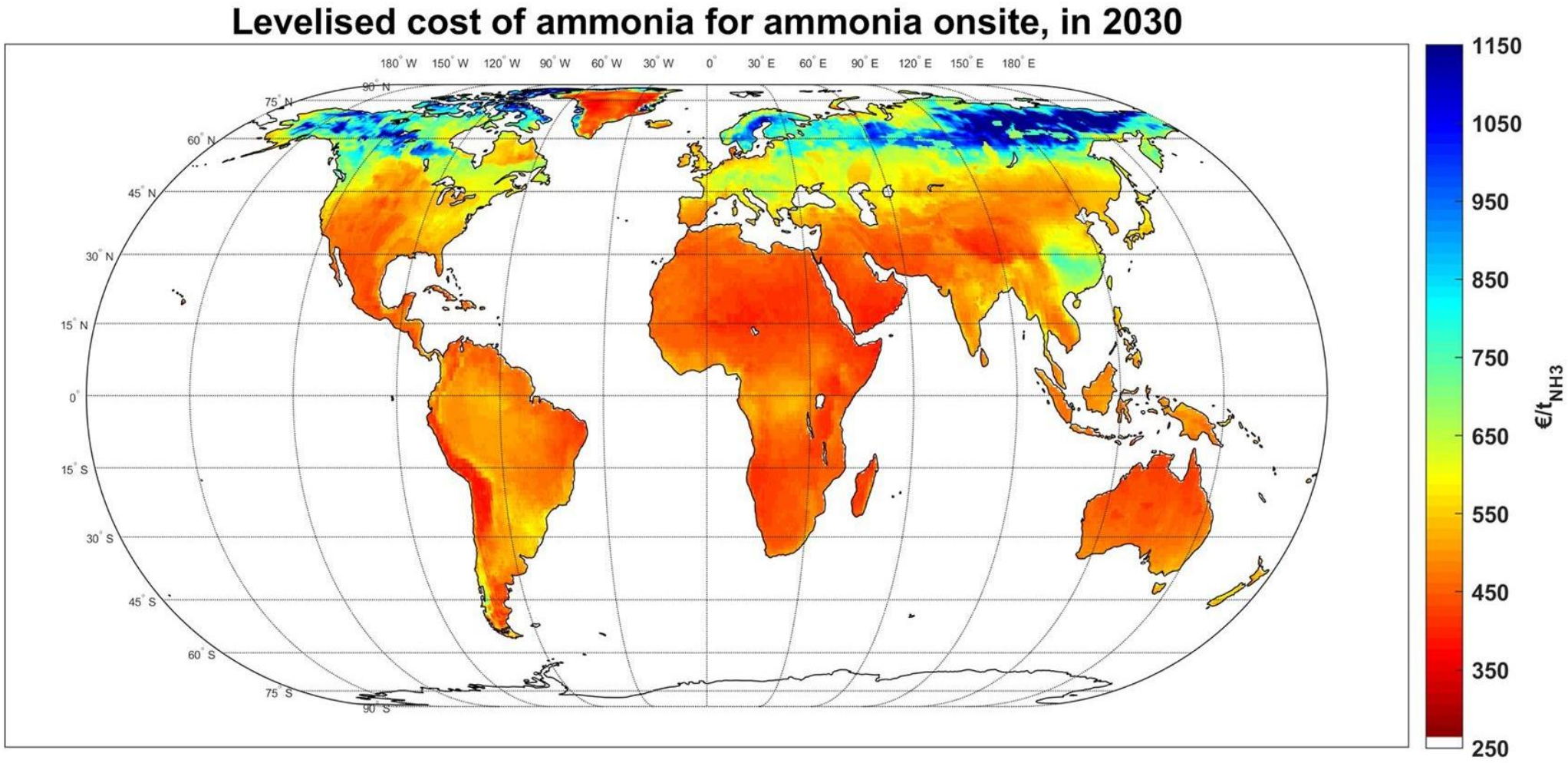
Allan Manhanga
Senior Executive Manager - Special Projects, Sable Chemicals

In conversation with:

Kevin Rouwenhorst (Technology Manager, AEA)

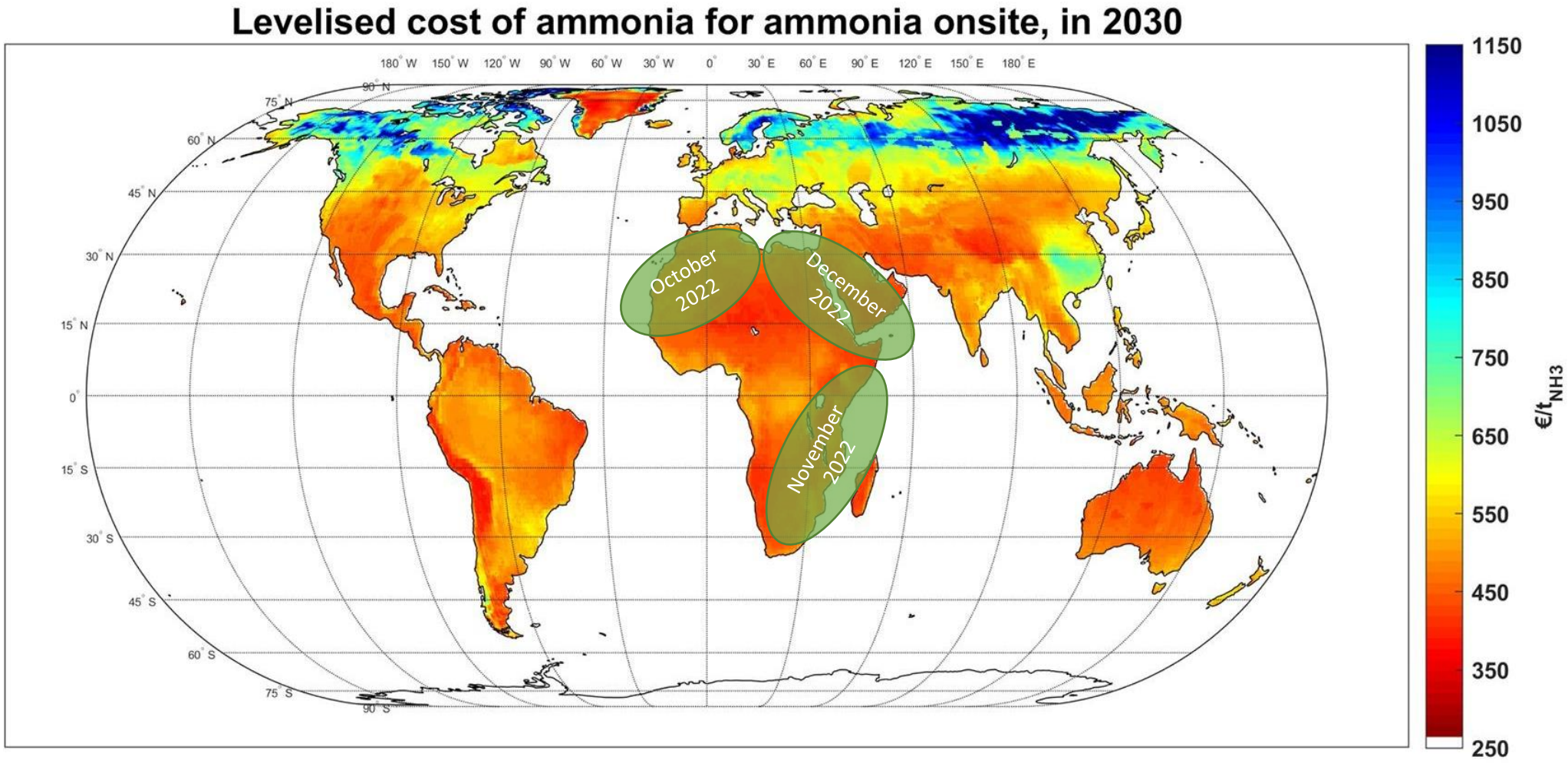
AMMONIA ENERGY ASSOCIATION

Projects in Africa



Source: Fasihi et al. (2021) https://www.sciencedirect.com/science/article/pii/S0306261920315750

Projects in Africa



Source: Fasihi et al. (2021) https://www.sciencedirect.com/science/article/pii/S0306261920315750

Ammonia Project Features

(Thursday 1 December, 5 PM EET, online via Zoom Webinar)

Ammonia opportunities in Egypt

Alzbeta Klein
CEO & Director General, International Fertilizer Association

Tarek Hosny
Head of Investments and Projects, Fertiglobe

In conversation with:

Kevin Rouwenhorst (Technology Manager, AEA)

ifa INTERNATIONAL FERTILIZER ASSOCIATION

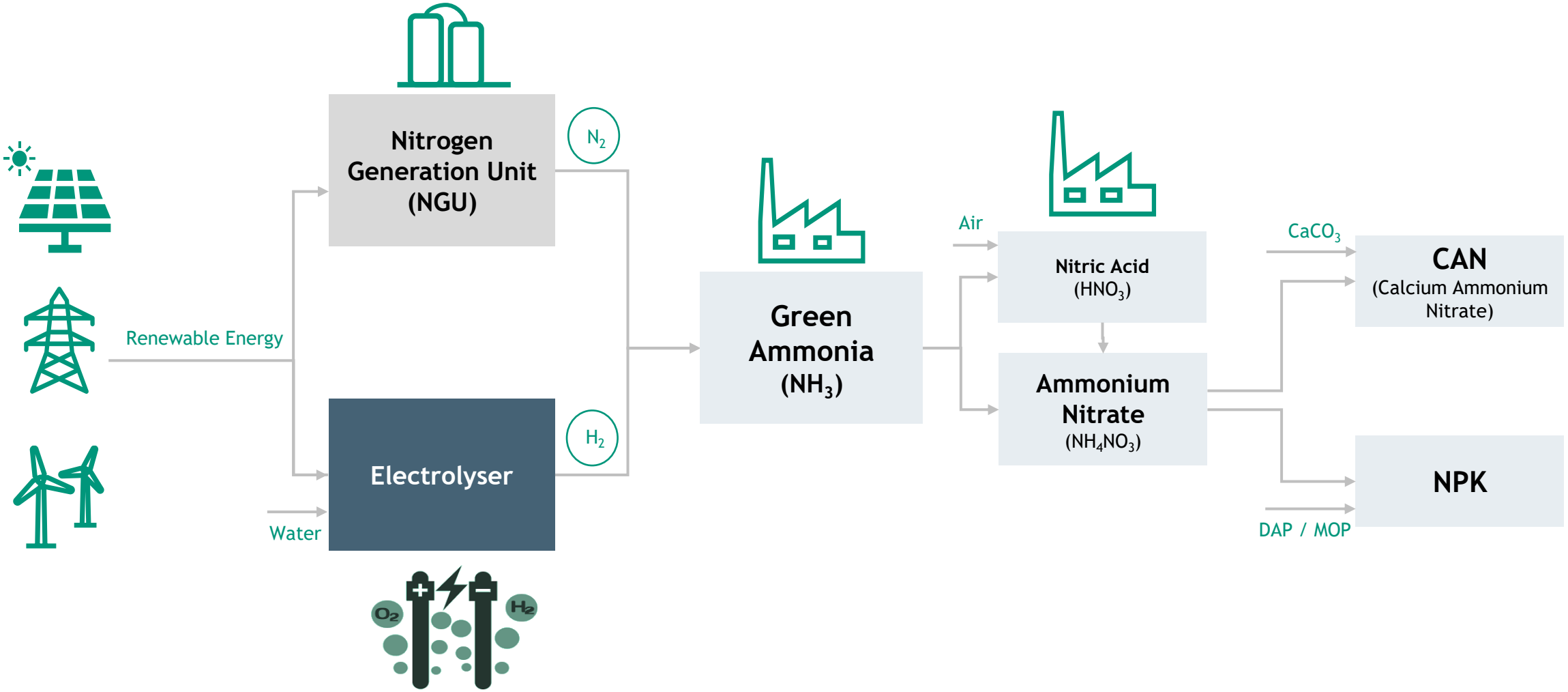
Fertiglobe

AMMONIA ENERGY ASSOCIATION

Renewable fertilizers for Sub-Saharan Africa

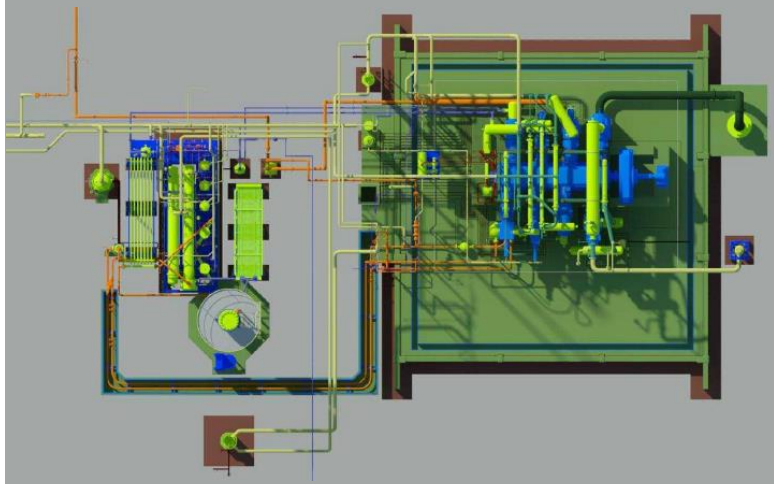
Met Development

SUSTAINABLE NITROGEN FERTILIZER - THE PROCESS



STAMICARBON GREEN AMMONIA TECHNOLOGY

- **Stamicarbon Green Ammonia** technology key features:
  - Design optimized for **low CAPEX** expenditure
  - Strong reference base in small-scale plants with **4 plants in operation**
  - Full modularization
  - High reliability, thanks to a multi-service reciprocating compressor
  - Dedicated operator training simulator available
  - Access to digital solutions, such as a process monitoring tool and OTS



Stamicarbon

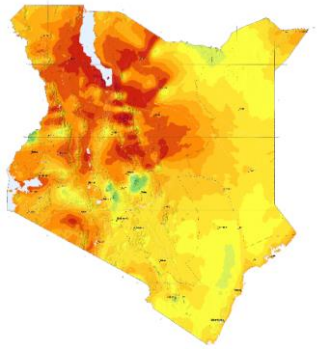
PROJECT INTRODUCTION GREEN FERTILIZER KENYA

- Green Fertilizer plant for the production of 200,000 tons of the most **locally** consumed fertilizers: **CAN-26 and NPK 26-5-5**.
- The production will be based on renewable electricity and water as feedstock
- Strong consortium with partners over the value chain

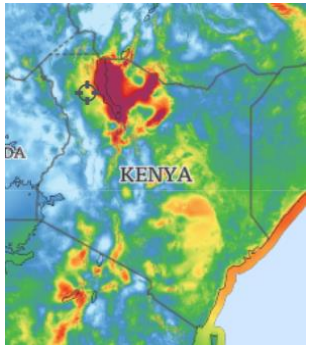
Value chain approach

- Electricity grid is for 90% renewable in Kenya
- Kenya has an overcapacity of electricity (~500 MW installed capacity)

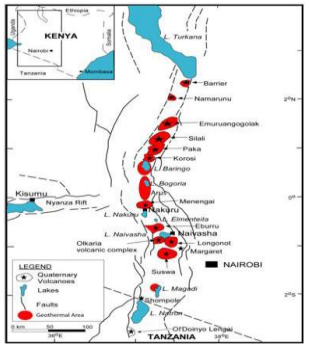
Solar



Wind



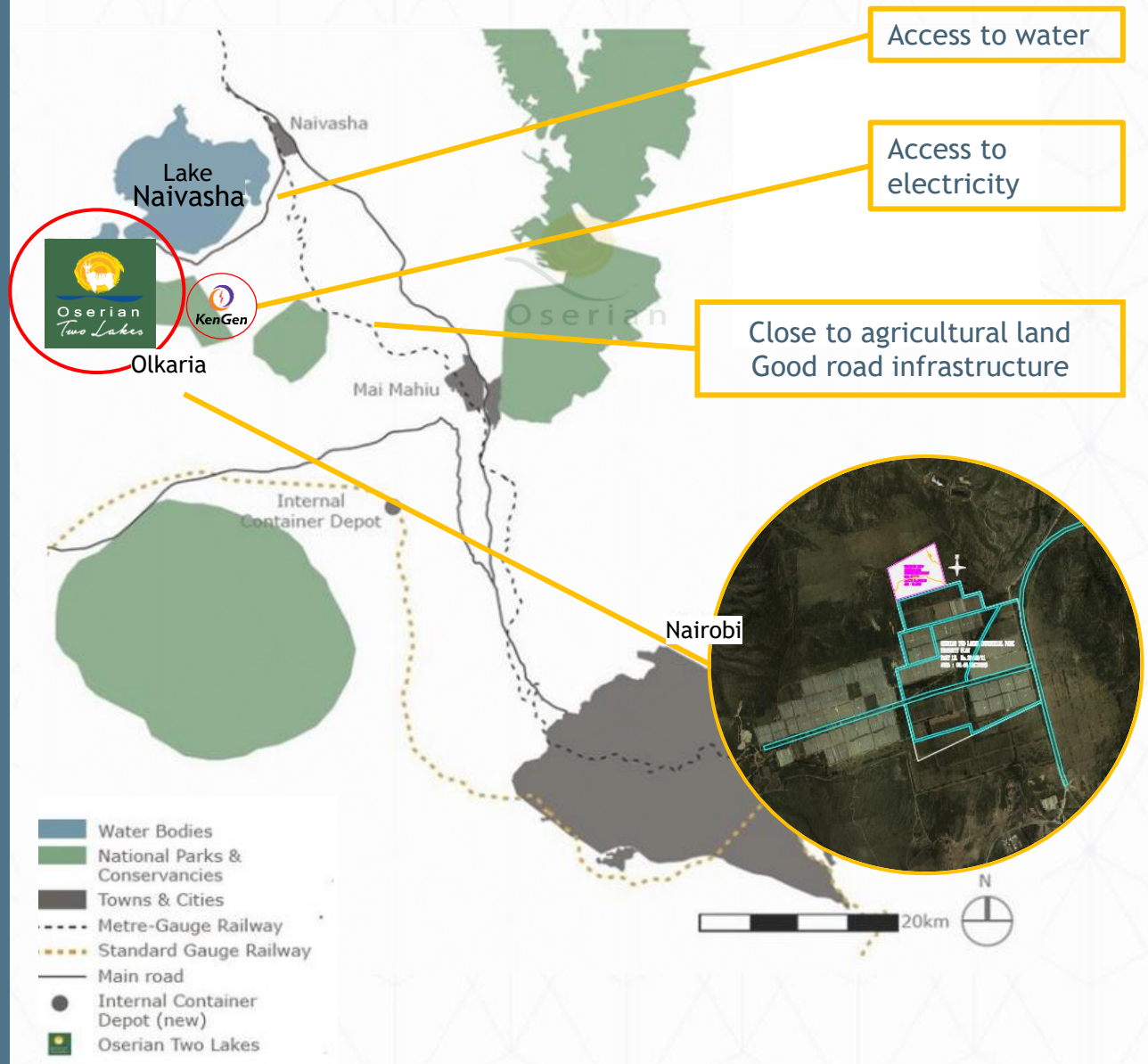
Geothermal



MAIN PROJECT DELIVERABLES

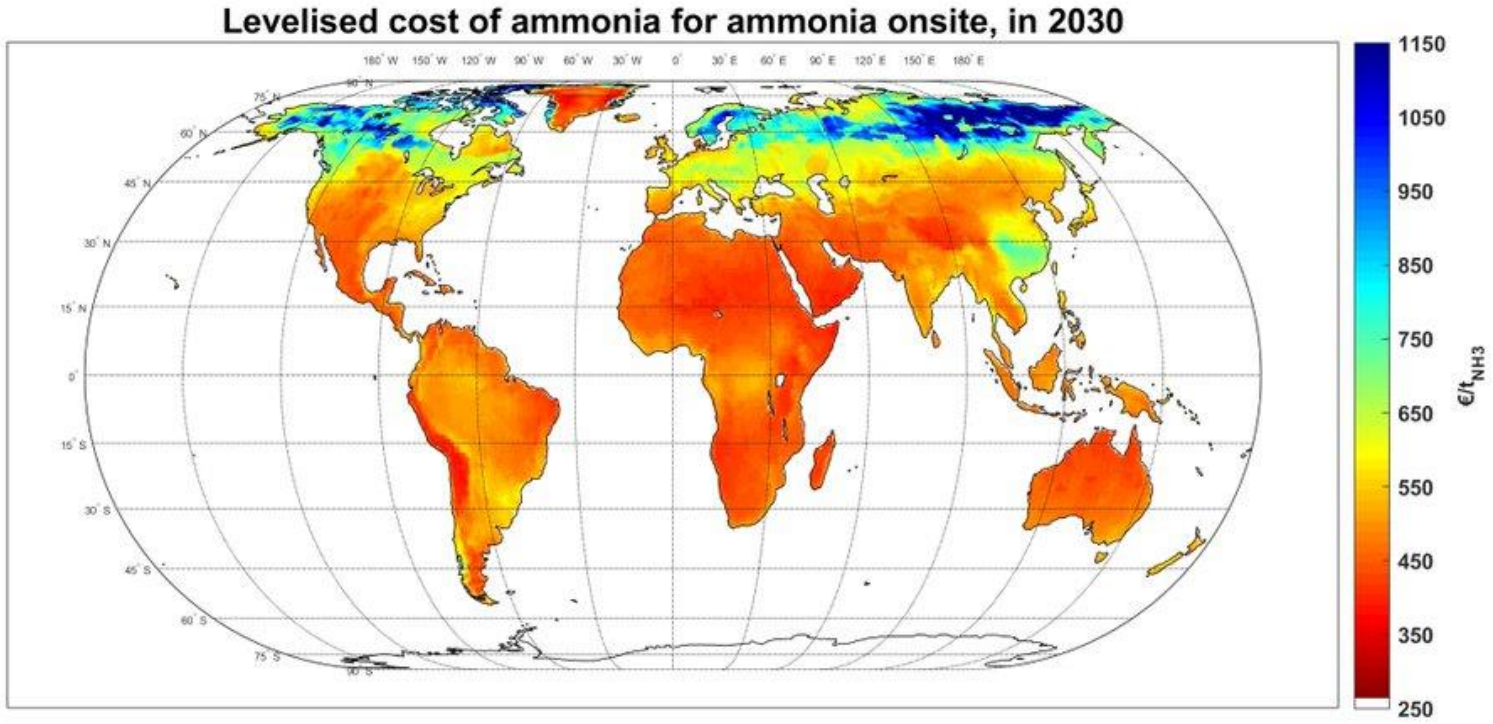
- Food Security
- Import substitution
- Affordable fertilizer
- Sustainable process
- Export potential

LOCATION – OSERIAN INDUSTRIAL PARK



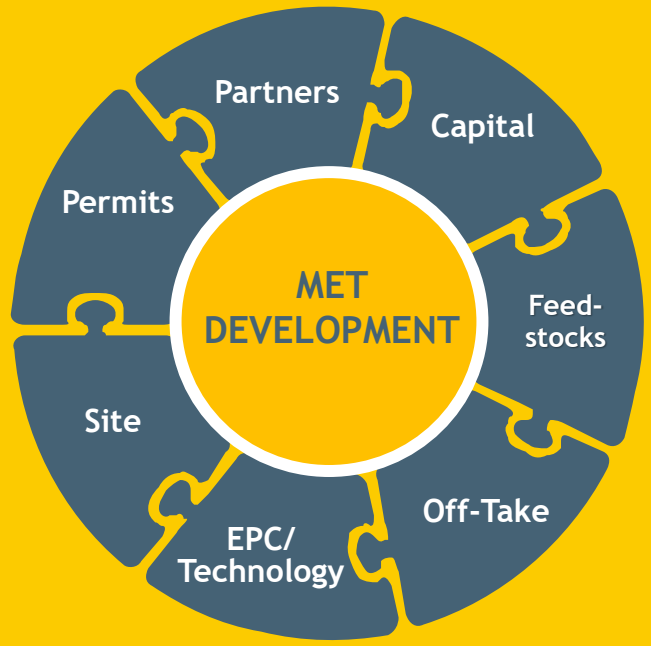
- Privately owned Industrial Park operated by Oserian Development Company
- The Industrial Park has the structure required for the project such as water access, grid connection and main infrastructure (roads etc.).

GREEN FERTILIZER, A PROMISING FUTURE FOR AFRICA



Source:M. Fasihi, R. Weiss, J. Savolainen, C. Breyer, Global potential of green ammonia based on hybrid PV-wind power plants (2021)

How we support our partners



- Attract sponsors & partners
- Coordinate capital funding & debt financing
- Secure long-term feedstock & off-take
- Access to best-in-class technologies and EPC capabilities
- Identify locations for the project
- Support in permit applications

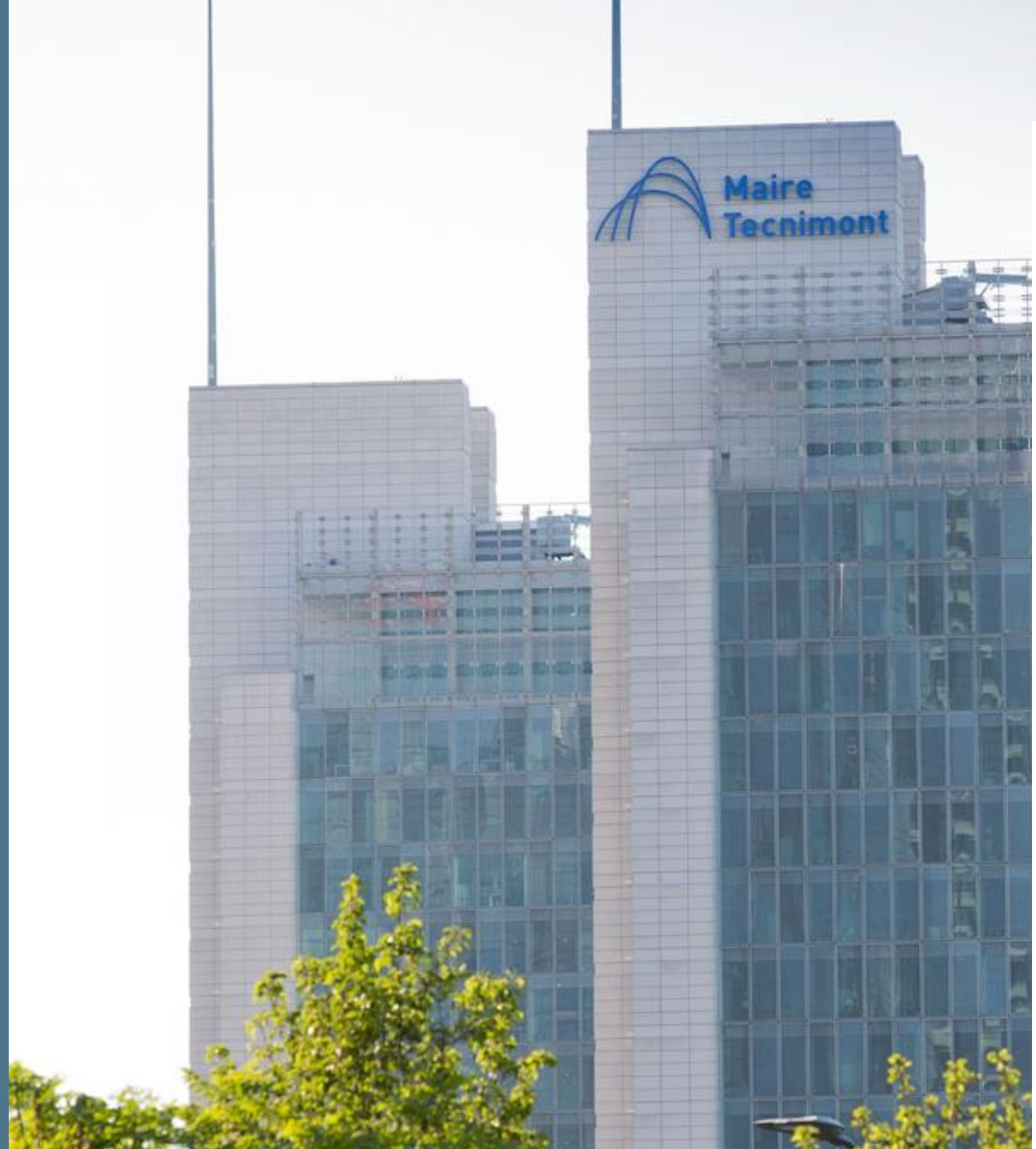
CONTACT DETAILS

Ralph Koekkoek

MET Development S.p.A.
Project Development Manager
Via Gaetano De Castillia 6A
20124 Milan, Italy
Ralph.koekkoek@external.met-development.com
www.mairetecnimont.com

Responsible areas:

- Power-to-ammonia
- Power-to-fertilizer



Maire Tecnimont Group's Headquarters

Via Gaetano De Castillia, 6A
20124 Milan

MET Development | Maire Tecnimont

Met
Development

Renewable ammonia projects in Sub-Saharan Africa

Drs. Ing. Marcel Jacobs, Executive Director at Jacob Lawren Ltd. Ghana, a Pioneer Member of the African Hydrogen Partnership

Fossil Fuels, Green Hydrogen - Energy Transition

Fossil Fuels:

Markets (Finance and Supplies) will become less liquid.

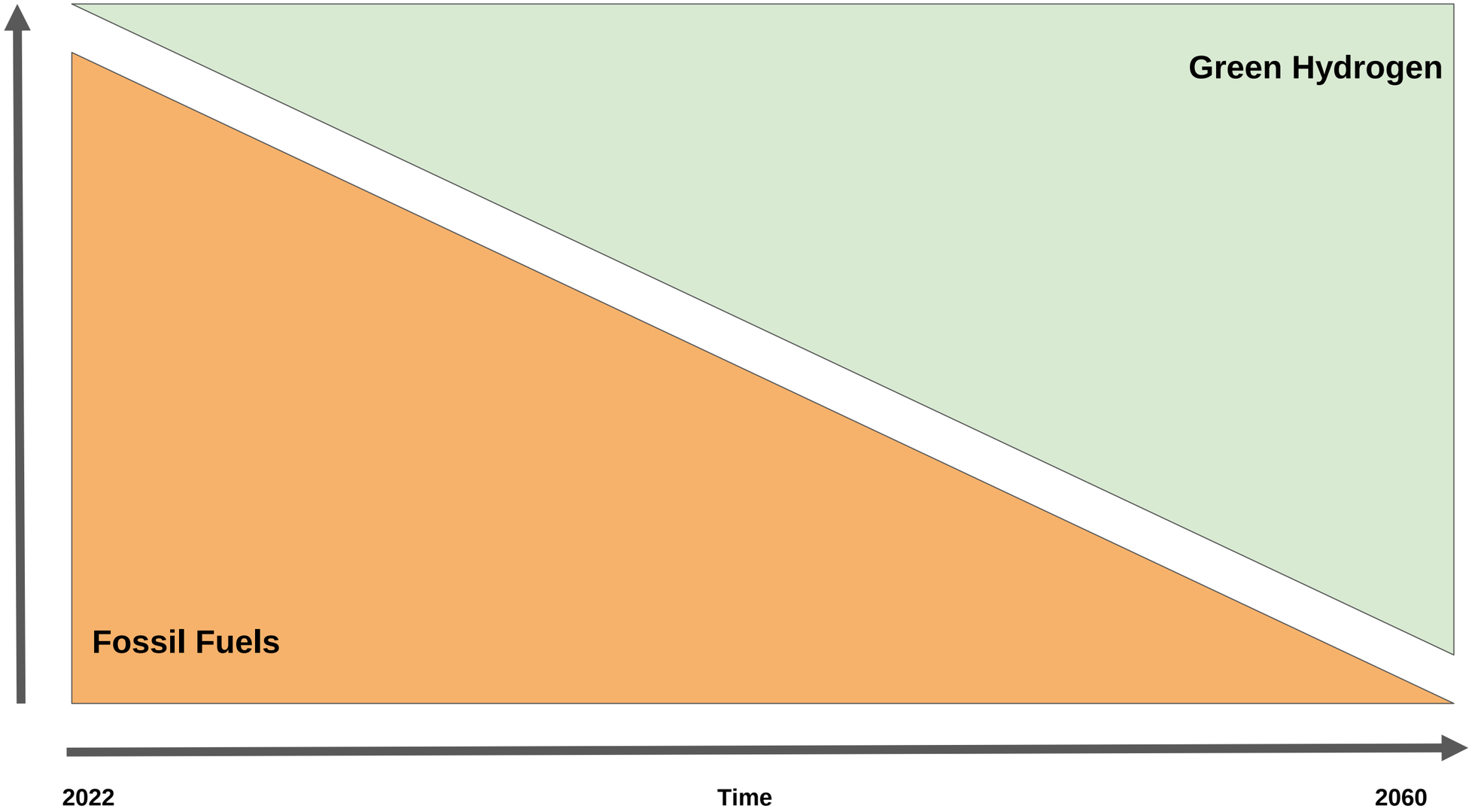
Less lenders and suppliers.

Shrinking liquidity will increase Cost of Capital.

Projects will become less and less profitable. Default risks increase.

Risk of stranded assets.

Declining Market Share



Green Hydrogen:

Growing market and more competition.

Markets (Finance and Supplies) will become more liquid.

Cost of Capital will decrease.

Projects will become more and more profitable.

Growing market share

East African Green Hydrogen and Fertilizer Corridor

Green Hydrogen and Green Ammonia

Green hydrogen is hydrogen produced by electrolysis whereby water is split into hydrogen and oxygen through the application of electrical energy from renewable energy sources, such as wind or solar. Green Hydrogen is the only universally applicable clean, sustainable and renewable energy carrier. Green hydrogen and its derivatives (e.g. **green ammonia** or synthetic hydrocarbons) can facilitate the management of the intermittent character of renewable energy sources by virtue of hydrogen's superior ability to store large amounts of energy, and to efficiently use this energy by coupling or connecting the power sector to the residential/commercial, transport and industry sectors.

Green Ammonia is produced by combining green hydrogen and nitrogen extracted from the air. It's a clean, green, sustainable and carbon-free process which can be safely transported using pipelines, tankers or other means of transport.

Process Flow

- Renewable Electricity
- Nitrogen Gas
- Hydrogen Gas
- Green Ammonia

Renewable Electricity Sources

1. Geothermal Energy
2. Hydropower Energy
3. Wind Energy
4. Solar Energy

Gas Production

5. Air separation unit for Nitrogen gas production
6. Water electrolysis for Hydrogen gas production

Green Ammonia Production

7. Green Ammonia produced from Nitrogen and Hydrogen

Green Ammonia: Applications, Usage

8. Fertilizer for farms
9. Feedstock for many industrial processes, including the production of green fertilisers
10. Fuel for independent power supply of residential buildings
11. Fuel for independent power supply of commercial buildings
12. Shipping fuel
13. Energy to be exported to other regions

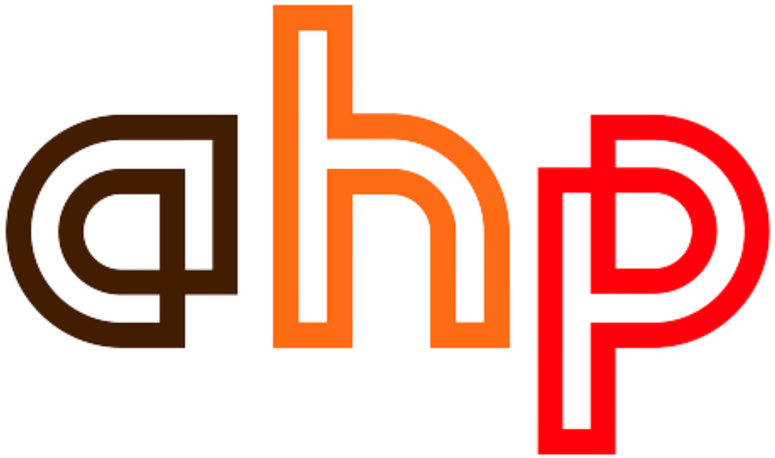
Green Hydrogen: Applications, Usage

14. Hydrogen trucks, buses, cars and many other applications

Hydrogen Ecosystem

- Baseload Renewable Power using Hydrogen
- Green Fertilizer Production
- Grid Independent Power Supply
- Waste-to-(Hydrogen)Power
- Maritime Sector, Shipping Fuel
- Mining, Land Transport, Industry

The African Hydrogen Partnership (AHP)



- The only the **only continent-wide African umbrella association** dedicated to the development of **green and natural (native) hydrogen**, hydrogen based chemicals, fuel cell technology and related business opportunities in Africa; The AHP represents the **whole African continent and all African nations**.
- Promotes **fair business practice** and provides the necessary support to facilitate the establishment of African hydrogen value chains; Supports and strives to achieve the **climate targets of the Paris Agreement** as well as the **UN Sustainable Development Goals.**

Thank you

Authors: Siggi Huegemann

Design: TenSevenNine.com

Date: 2022_11_18

Version: 001

Contact: info@afr-h2-p.com

Internet: www.afr-h2-p.com

Twitter: https://twitter.com/afr_h2_p

LinkedIn: https://www.linkedin.com/company/african-hydrogen-partnership/

Sable's Legacy on Green Ammonia

Presentation on Green Hydrogen (and Ammonia)

23/11/2022

LOCATION OF SABLE

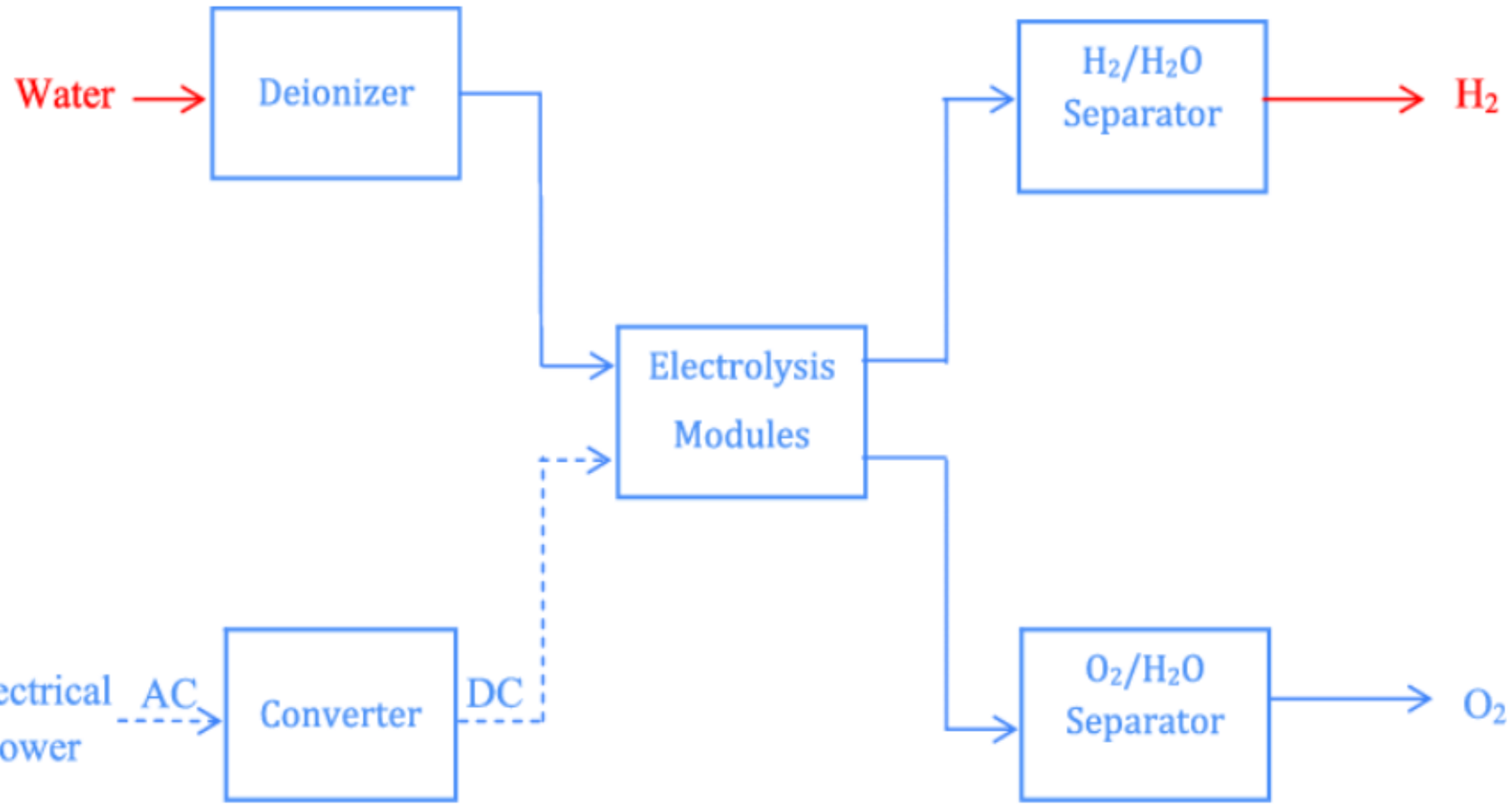
More Than Just A Fertiliser Company

Sable Chemicals @ A Glance

- Sole Ammonium Nitrate (AN) manufacturer in Zimbabwe
- Started operations in 1969 based on 100% imported ammonia
- Added Ammonia making section in 1972, including Electrolysis
- Required 115 MW of power at full capacity
- Based on hydro power from Kariba - "Green" ammonia till 2015
- Sable plant was the largest of 10 in the world = (70% of NH_3 requirements)
- Full capacity – 240 000 tonnes of Ammonium Nitrate (AN) annually.
- Employed 480 people

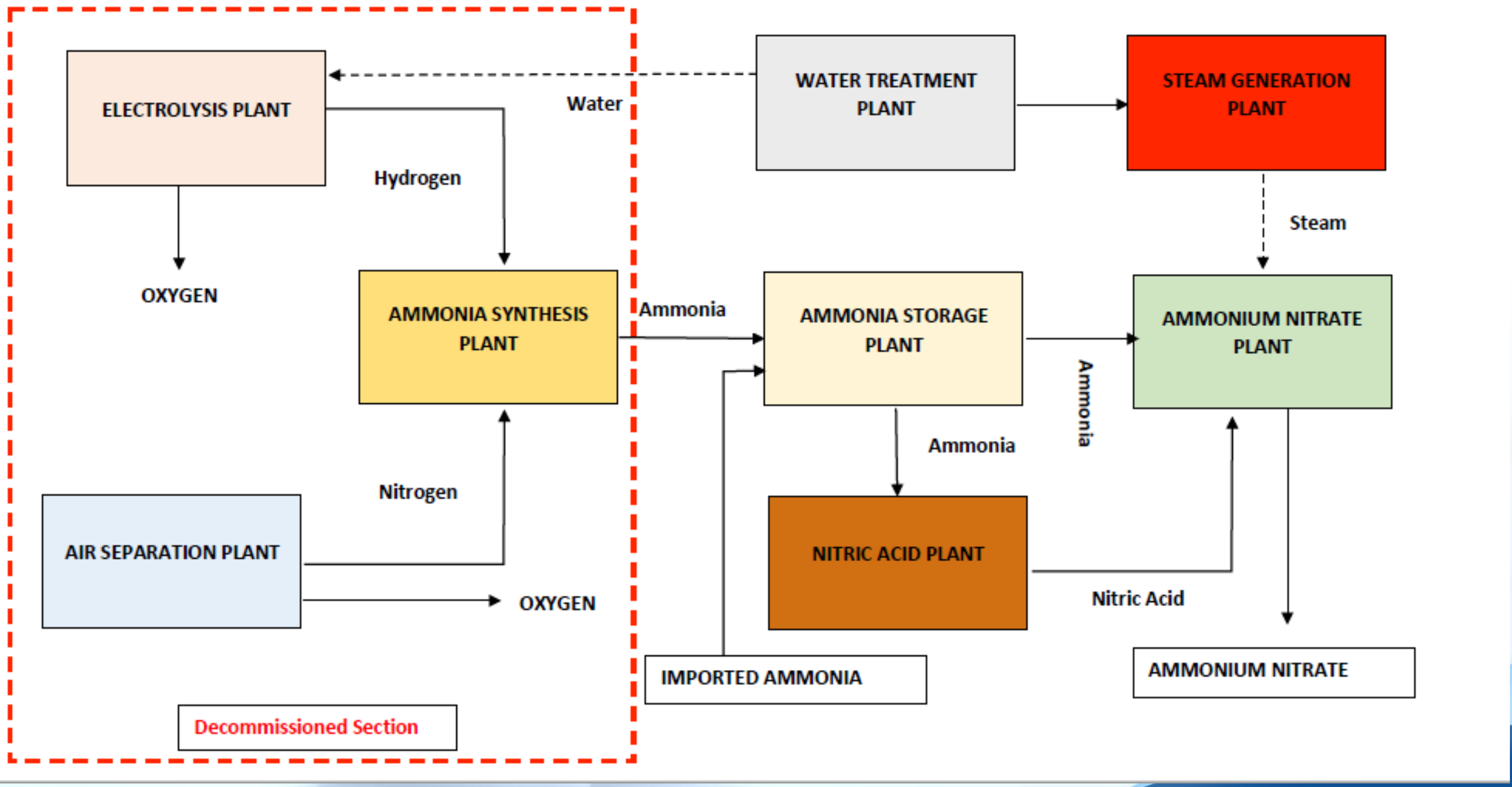
More Than Just A Fertiliser Company

TYPICAL ELECTROLYSIS PROCESS



More Than Just A Fertiliser Company

Sable "Green" Process Flow: 1972~2015



More Than Just A Fertiliser Company

CHALLENGES WITH THE MODEL

- Cost of Power
- Availability of power
- Energy Intensive Technology, >12.5MWh/mt (NH_3)

PRODUCTION FACTSHEET

1990

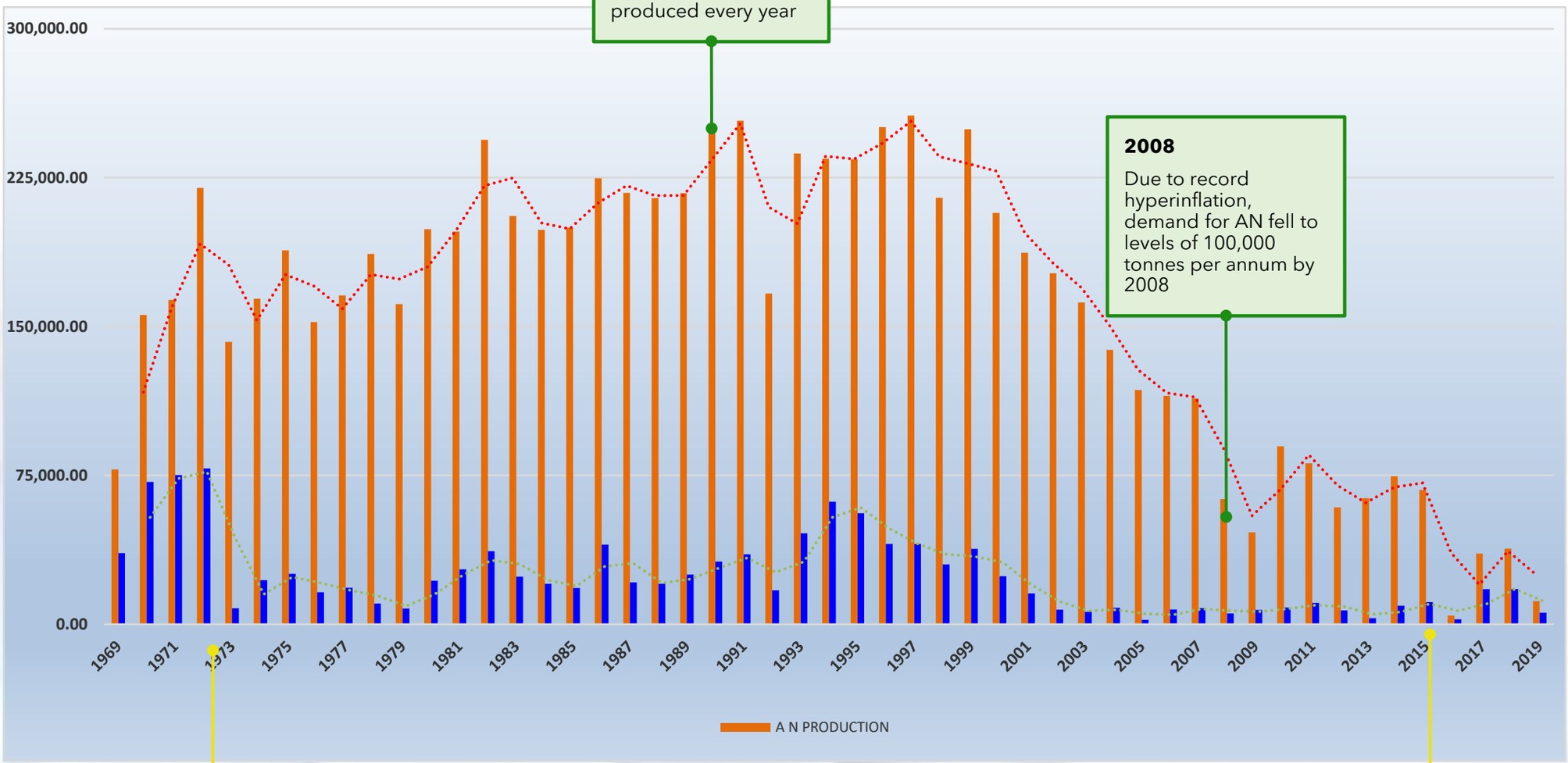
100% market share

Production peaked at 250,000 tonnes

The market absorbed all of the AN Sable produced every year

2008

Due to record hyperinflation, demand for AN fell to levels of 100,000 tonnes per annum by 2008



1972

Phase 2: Ammonia Gas Manufacturing Section commissioned

Production based 100% on electrolysis

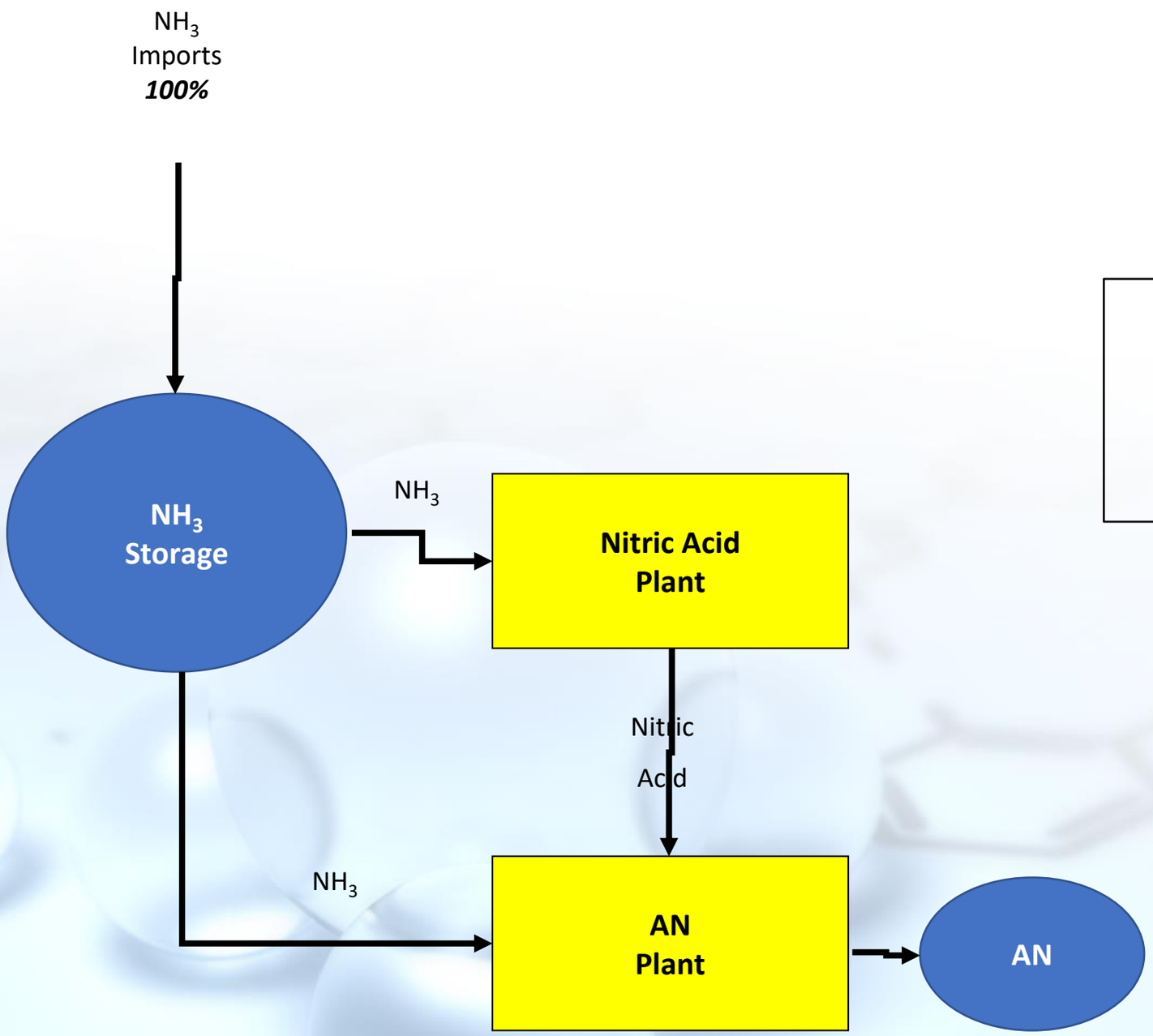
2015

Ammonia Gas Manufacturing Section decommissioned

Revert back to 100% importation of anhydrous ammonia

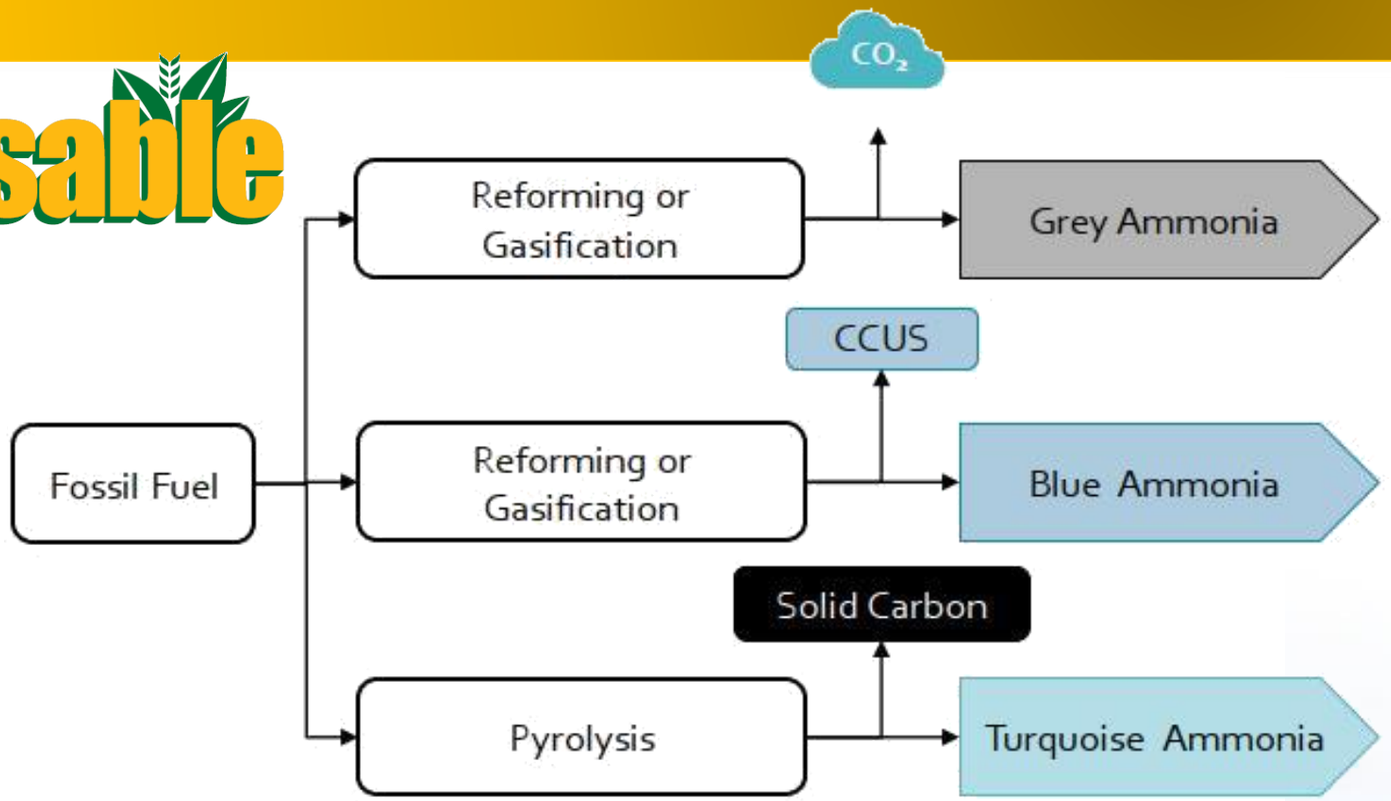
More Than Just A Fertiliser Company

Current Sable Process Flow



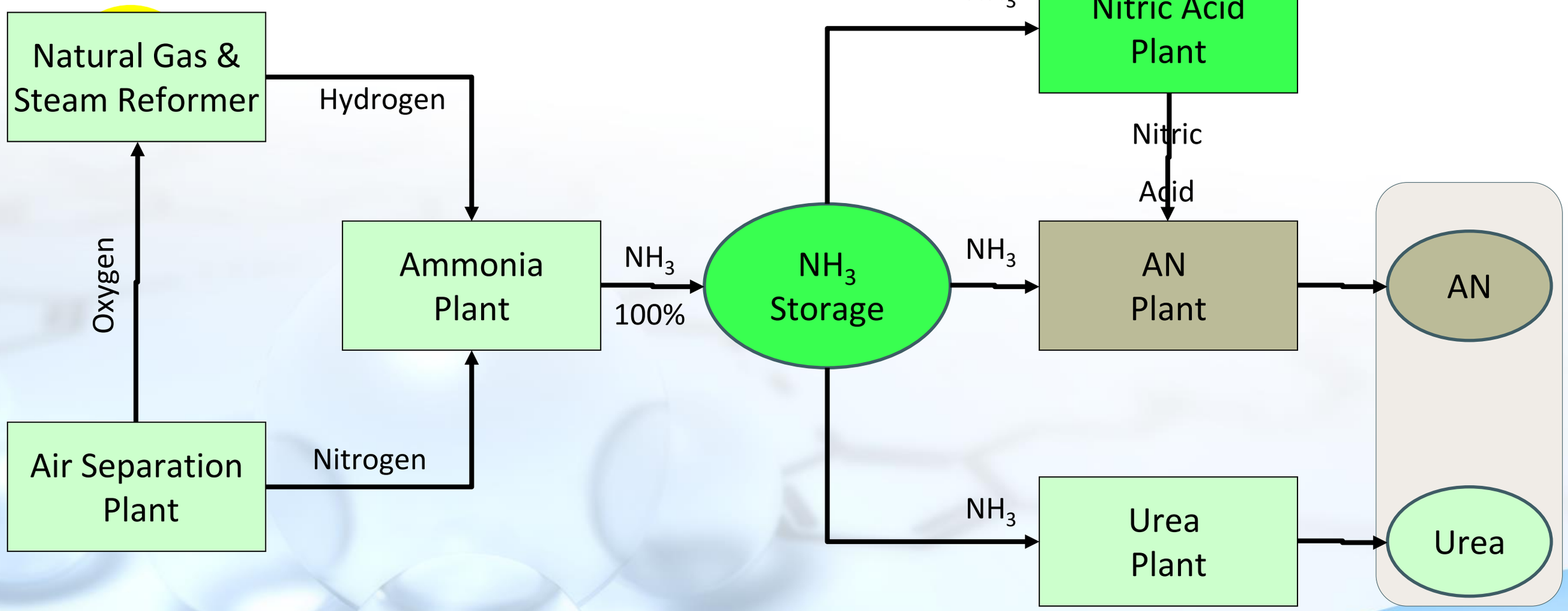
Post decommissioning of ammonia making plants in 2015, Total Power Requirement: 10MW

TYPES OF AMMONIA BY SOURCE

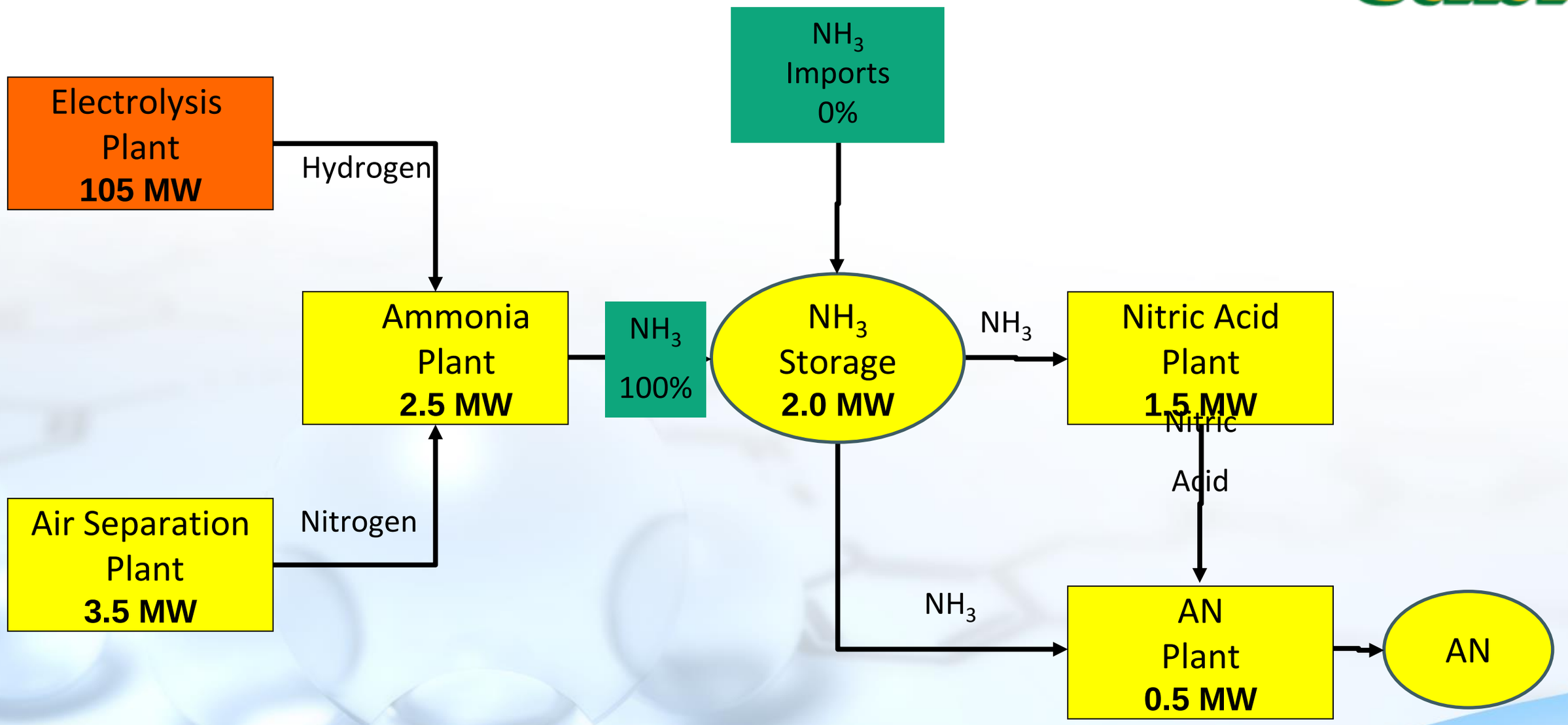


- **Sable c**ommissioned its **green ammonia hydrogen plant based on Alkaline Water Electrolysis (AWE)** and hydropower from Kariba dam in 1972
- **Sable** ammonia section unfortunately decommissioned in 2015 **on account of increasing power tariffs and shortage of electricity**
- Sable ammonia was one among about 10 same technology (LURGI) plants of which **top 3 were the Sable one, the Peru one and one in Aswan, Egypt,** with most decommissioned due to lack of competitiveness against natural gas based plants in face of rising power tariffs

Process Flow – "Grey"



Rescusitated Sable "Green" Process Flow



PROJECTED PATHWAY

Renewable power availability

Technology Readiness

Infrastructure

Government Support

Offtake Agreement

More Than Just A Fertiliser Company

SABLE GREEN ASSETS

More Than Just A Fertiliser Company

WAY FORWARD FOR SABLE

	Sable Solar Energy
Production Type/ Capacity	• 400MW Solar Park • 50MW Phased development
Key Markets	• Sable “Green” ammonia plant • Zimbabwe (ZETDC) • Mining firms around Kwekwe
Feedstock	• N//A
Key Infrastructure	• The good road and rail access for development requirements • Cost efficient evacuation as the ZETDC Sherwood Sub-station is within 5km • High irradiation
Key Developments	• Power generation license issued

More Than Just A Fertiliser Company

PROJECTED PATHWAY

Sable Chemicals looks into current and future green ammonia and hydrogen economy with keen interest as it has the potential to reshape the organization and the nation at large in as far as Nitrogenous fertilisers are concerned.

In Sable's case, we already have the Ammonia Synthesis and ASU plants- what is required in a Renewable Energy Source and a New Generation Electrolysis plant

Going this direction is critical to remove the temptation to implement a fossil fuel based solution for Sable that would lead to Carbon lock-up for next couple of decades

Project currently at Pre-Feasibility study stage where we may need assistance in completing same prior to launching full feasibility study

Thank You

More Than Just A Fertiliser Company