Ammonia Project Features

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

Renewable ammonia projects in Sub-Saharan Africa

In conversation with:

Kevin Rouwenhorst
(Technology Manager, AEA)

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
Projects in Africa

Projects in Africa

Levelised cost of ammonia for ammonia onsite, in 2030

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

Ammonia opportunities in Egypt

In conversation with:
Kevin Rouwenhorst
(Technology Manager, AEA)

Alzbeta Klein
CEO & Director
General, International Fertilizer Association

Tarek Hosny
Head of Investments and Projects, Fertiglobe

AMMONIA ENERGY
ASSOCIATION
Renewable fertilizers for Sub-Saharan Africa
SUSTAINABLE NITROGEN FERTILIZER - THE PROCESS

Nitrogen Generation Unit (NGU)

Nitrogen ($N_2$) generation using renewable energy.

Electrolyser

Green Ammonia ($NH_3$) production through electrolysis of water ($H_2O$).

Nitric Acid ($HNO_3$)

Ammonium Nitrate ($NH_4NO_3$)

Calcium Ammonium Nitrate (CAN)

DAP / MOP

NPK

Renewable Energy

Water

Air

CaCO$_3$
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
- 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

- Electricity grid is for 90% renewable in Kenya

- Kenya has an overcapacity of electricity (~500 MW installed capacity)
MAIN PROJECT DELIVERABLES

- Food Security
- Import substitution
- Affordable fertilizer
- Sustainable process
- Export potential
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 Castilla, 6A
20124 Milan

MET Development | Maire Tecnimont
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

2022
Time
2060
East African Green Hydrogen and Fertilizer Corridor

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

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 is 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 fertilizers
10. Fuel for independent power supply of residential buildings
11. Fuel for independent power supply of commercial buildings
12. Shaping fuel
13. Energy to be exported to other regions

Green Hydrogen: Applications, Usage
14. Hydrogen trucks, buses, cars and many other applications

18 November 2022
The African Hydrogen Partnership (AHP)

- 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
Sable’s Legacy on Green Ammonia

Presentation on Green Hydrogen (and Ammonia)
LOCATION OF SABLE

ZIMBABWE

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 NH₃ requirements)
- Full capacity – 240 000 tonnes of Ammonium Nitrate (AN) annually.
- Employed 480 people
TYPICAL ELECTROLYSIS PROCESS

Water → Deionizer → Electrolysis Modules → H₂/H₂O Separator → H₂

Electrical Power → AC Converter → DC → O₂/H₂O Separator → O₂

More Than Just A Fertiliser Company

- **ELECTROLYSIS PLANT**
  - Water
  - Hydrogen
  - Oxygen

- **AMMONIA SYNTHESIS PLANT**
  - Ammonia
  - Nitrogen

- **AIR SEPARATION PLANT**
  - Nitrogen
  - Oxygen

- **WATER TREATMENT PLANT**
  - Water

- **STEAM GENERATION PLANT**
  - Steam

- **AMMONIA STORAGE PLANT**
  - Ammonia

- **NITRIC ACID PLANT**
  - Ammonia
  - Nitric Acid

- **IMPORTED AMMONIA**

- **AMMONIUM NITRATE PLANT**
  - Ammonia

**Decommissioned Section**

**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

1972
Phase 2: Ammonia Gas Manufacturing Section commissioned
Production based 100% on electrolysis

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

2015
Ammonia Gas Manufacturing Section decommissioned
Revert back to 100% importation of anhydrous ammonia
Current Sable Process Flow

Post decommissioning of ammonia making plants in 2015, Total Power Requirement: 10MW
Sable commissioned 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.
Rescuscitated Sable “**Green**” Process Flow

- **Electrolysis Plant** 105 MW
  - Hydrogen

- **Ammonia Plant** 2.5 MW
  - NH₃ 100%
  - NH₃ Storage 2.0 MW

- **Air Separation Plant** 3.5 MW
  - Nitrogen

- **Nitric Acid Plant** 1.5 MW
  - Nitric Acid

- **AN Plant** 0.5 MW
  - AN

**Imports**
- NH₃: 0%
- NH₃: 100%

**More Than Just A Fertiliser Company**
PROJECTED PATHWAY

1. **Renewable power availability**
2. **Technology Readiness**
3. **Infrastructure**
4. **Government Support**
5. **Offtake Agreement**

More Than Just A Fertiliser Company
SABLE GREEN ASSETS

Loop

ASU

More Than Just A Fertiliser Company
### Sable Solar Energy

| Production Type/Capacity | • 400MW Solar Park  
<table>
<thead>
<tr>
<th>• 50MW Phased development</th>
</tr>
</thead>
</table>
| 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 |
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