

STAMI GREEN AMMONIA

STAMI GREEN AMMONIA

Green Ammonia in Process
Industry

Deepak Shetty
Global Business Manager
25th June 2022



Stamicarbon



STAMICARBON- PART OF MAIRE TECNIMONT GROUP



Maire Tecnimont's main business activities



Technology Licensing



EPC Services



Project Development



Joint Ventures & Cooperation Agreements

Key sustainable industries presence:



BIO-BASED

Use of biological components as feedstock



CIRCULAR ECONOMY

Recycle of wastes

FOCUS ON GREEN AMMONIA



CARBON AND EMISSION REDUCTION

Industry decarbonization

FY 2021 RESULTS

€2.8 BLN

REVENUES

€174 MLN

EBITDA

€9.5 BLN

BACKLOG



~45 countries



50 Operating companies
& **~9000** employees



~1,500 Delivered Projects

The innovation & license company
of Maire Tecnimont





A TECHNOLOGICAL APPROACH TO GREEN ENERGY

* Data are based on corporate analysis
** Completed

HYDROCARBONS

PETROCHEMICALS

WELL ROOTED TECHNOLOGY
ORIENTATION: MARKET LEADER (#1) FOR
INSTALLED CAPACITY (last 10ys)

30% MARKET SHARE IN
POLYOLEFIN PLANTS

50% MARKET SHARE IN
LDPE PLANTS

Since 1970 MORE THAN

210
POLYETHYLENE AND
POLYPROPYLENE
PLANTS **

FERTILIZERS

52% MARKET SHARE IN
LICENSING UREA PLANTS
TECHNOLOGY
(#1 worldwide)*

33% MARKET SHARE IN
LICENSING UREA
GRANULATION TECHNOLOGY
(#2 worldwide)*

Since 1924

175
AMMONIA AND UREA
PLANTS**

OIL & GAS REFINING



WELL RECOGNIZED
LEADERSHIP IN LICENSING
HYDROGEN TECHNOLOGY
AND IN LICENSING SULPHUR
RECOVERY AND TAIL GAS TREATMENT
TECHNOLOGY



WORLD CLASS TRACK
RECORD IN LARGE GAS
TREATMENT PLANTS AND
REFINERY PROCESS UNITS

Since 1971 MORE THAN

250
HYDROGEN AND
SULPHUR RECOVERY
UNIT PROJECTS**

ENERGETIC & NEW POWER



21GW
INSTALLED WORLDWIDE

7th

RANK ENR WORLD
TOP-10 POWER MARKET
ENGINEERING
COMPANIES 2016

Since 1962 MORE THAN

280
POWER GENERATION
PROJECTS

GREEN ENERGY

- PLASTIC UPCYCLING
- PLASTIC CHEMICAL RECYCLING
- WASTE TO CHEMICALS
- GREEN CIRCULAR DISTRICT
- BIO-POLYMERS

- GREEN AMMONIA
- UREA AND NITRIC ACID BASED ON SUSTAINABLE FEEDSTOCK

- RENEWABLE DIESEL (HVO)
- SUSTAINABLE AVIATION FUEL FROM HVO
- 2G BIO-ETHANOL
- CO₂ CAPTURE AND VALORIZATION

- RENEWABLE ENERGY
- GREEN HYDROGEN (ELECTROLYSIS)
- ELECTRIC BLUE HYDROGEN (ELECTRICAL SMR)
- ELECTROCHEMISTRY/POWER TO X
- WASTE TO ENERGY



TECHNOLOGIES FOR
ENERGY TRANSITION:

5

PROPRIETARY

6

UNDER PARTNERSHIP
FOR EXCLUSIVE
LICENSING

OVER

20

WITH A ROLE OF
INTEGRATOR &
EPC

OVER

12

RESEARCH PROJECTS WITH
A ROLE OF PARTNER
/ COORDINATOR



1,725

Cumulated Patents

STRONG COMMITMENT
TO TECHNOLOGY DEVELOPMENT

€56MN INVESTED IN
INNOVATION

70 R&D
PROJECTS

IN GREEN
ACCELERATION
(LAST 5ys)

ABOUT US: STAMICARBON

- We are world leaders in the design and licensing of **urea plants, nitric acid plants** and related services, including the supply of proprietary equipment.
- We now provide **commercial & proven Green Ammonia technology, which is** suitable for small-scale plants <350~400 mtpd.
- Active in the licensing of various technologies and in **project development** for the fertilizer and petrochemical industry.
- A **pioneering company** with a vision to help enable the world to feed itself and improve quality of life focused to **reduce the carbon footprint from the fertilizer industry, including carbon recycling.**



SYNLOOP – HISTORY & ECONOMIES OF SCALE

1913-1959

Haber-Bosch (HB) Process

High Pressure (>300 barg)

Large Capacity, Single Train

- Centrifugal Compressor
- Medium, Low Pressure (< 220 barg)

1960s

1980-2020

Catalysis

- New Generation Catalyst
- Smaller Catalyst Size (≤ 3.0 mm)

Optimize CAPEX-OPEX

- Converter Internals
- Steam Turbine for Compressor

2020+

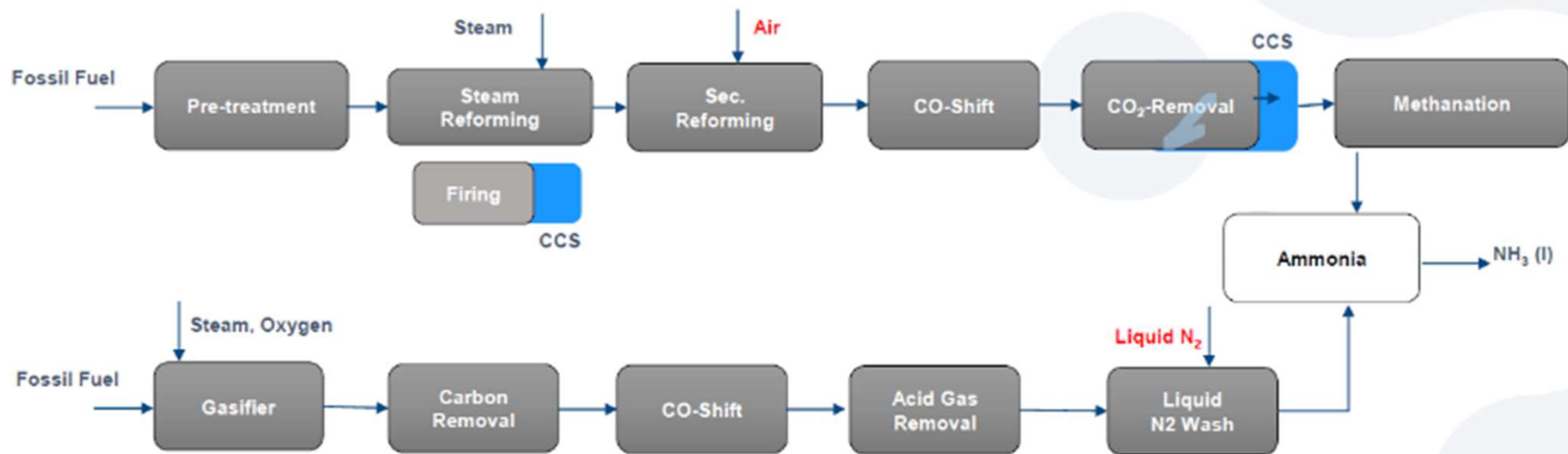
Green Ammonia

- Renewables

The innovation & license company
of Maire Tecnimont



COLORS OF AMMONIA – GREY/BLUE

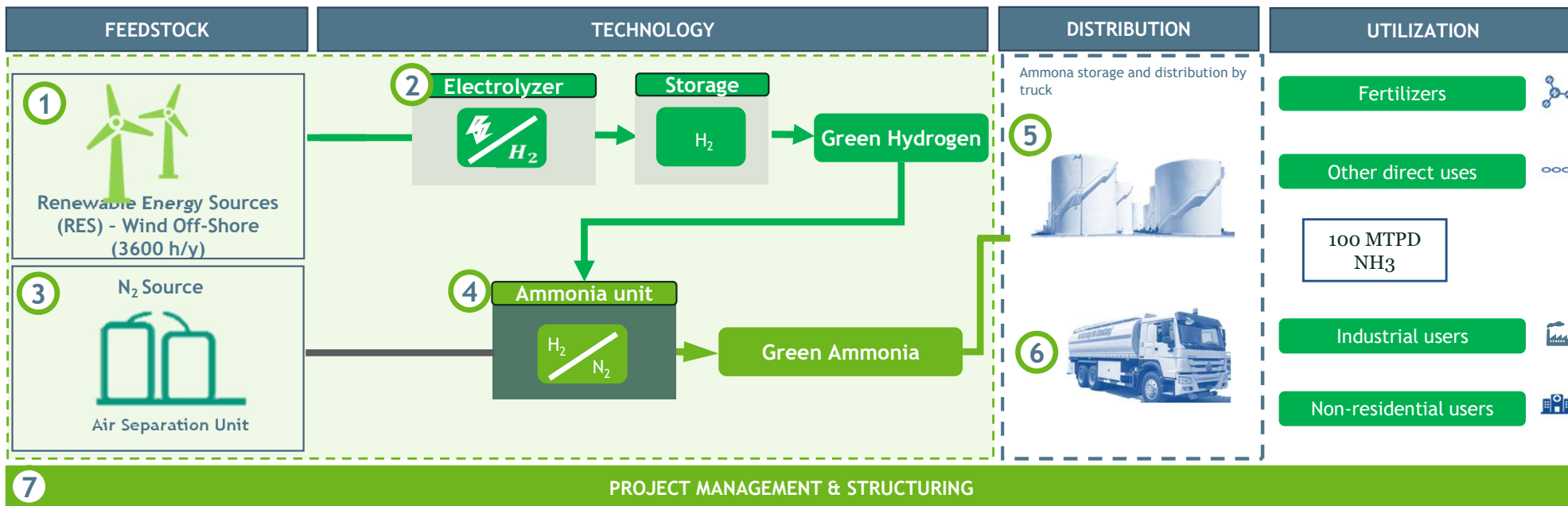


- Grey Ammonia → Blue Ammonia possible with CO₂ capture and sequestration (CCS)
- Difficult to fully decarbonize existing facility - a challenge!

POWER-TO-AMMONIA

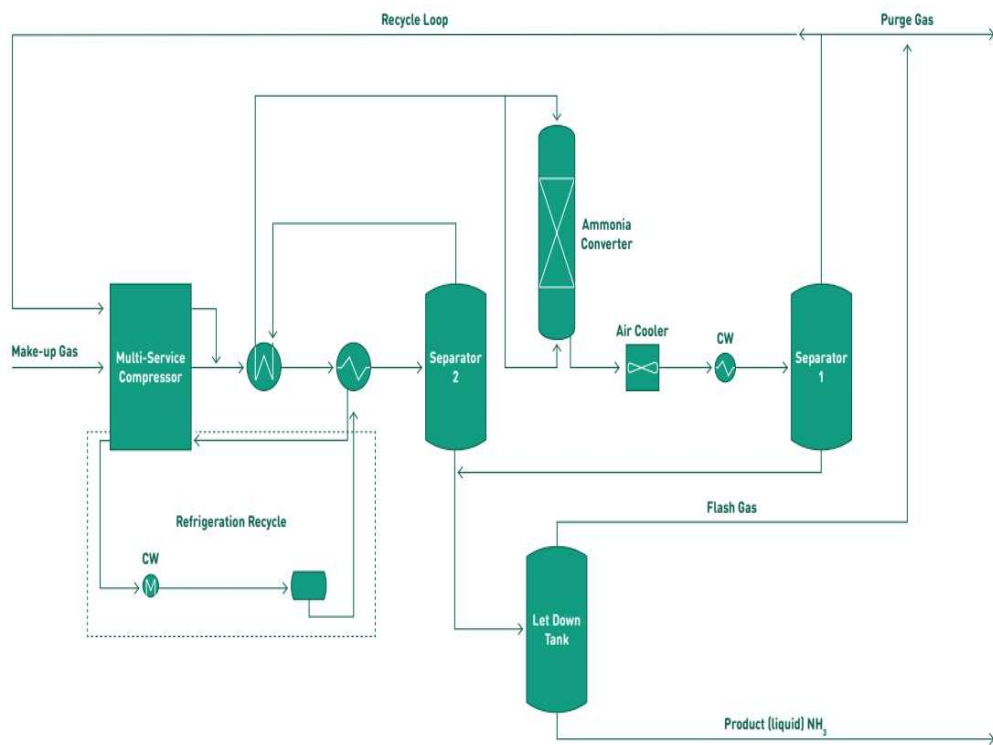
Project :

- 1) Produce low carbon Ammonia
- 2) Use of Renewable Energy Source to produce chemicals




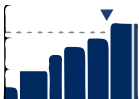
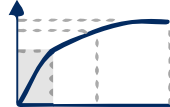



- 1** Dedicated RES Field
- 2** Green H₂ Production via Electrolyzer (Power-to-H₂)
- 3** N₂ Source from Air Separation Unit
- 4** Ammonia Production: N₂ e Green H₂ Reaction
- 5** Ammonia Storage
- 6** Ammonia distribution

STAMI GREEN AMMONIA TECHNOLOGY



- Proven Haber-Bosh process.
- Lean design - minimum number of equipment items.
- Simple Hex and separator vessels.
- State-of-the-art multiservice reciprocating compressor.
- High conversion rate with low catalyst volume.
- Majority of NH_3 is condensed by means of CW.
- Small NH_3 refrigeration circuit included in the compressor.
- Dedicated OTS & Process Monitoring tool
- Minimum utility requirement:
 - CW, instrument air & no steam/condensate is produced or required.

GREEN AMMONIA TECHNOLOGY- HIGHLIGHTS

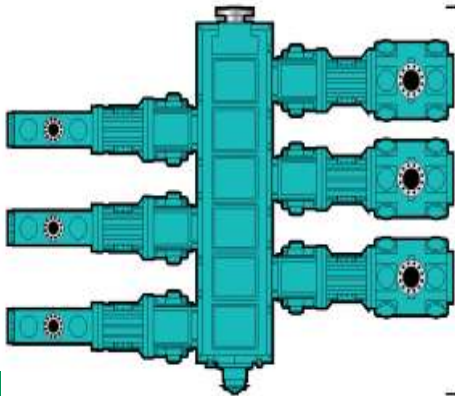
- ✓  Strongest technology reference (NG based) in small scale with proven capacities (scalable upwards/ downwards) < 400 mtpd
- ✓  Operates at higher pressure >300 bar
- ✓  Higher Nitrogen conversion > 30%
- ✓  Lower catalyst volume (lowering OPEX) & highly competitive CAPEX due to lean design & minimum number of equipment items.
- ✓  Operates on single proven reciprocating multi-service compressor which is electrically driven.
- ✓  Small footprint – 15m x 30m (100 mtpd plant) including compressor building. Highly modularized thereby reducing erection times and site works.

STAMI GREEN AMMONIA TYPICAL RECIPROCATING COMPRESSOR



Courtesy: Burckhardt Compression AG

* Compressor illustrations courtesy of Siemens Energy



- Typical configuration of a multiservice compressor.
- State-of-the-art reciprocating Compressor
- Wide range of operations is possible.
- Operational points to be defined in anticipation.
- All services included in a single compressor:
 - Syngas & make up
 - Recycle
 - Refrigeration
- Electrically driven motor.

QUALITATIVE COMPARISON (TECHNOLOGY)

	Stami Green Ammonia
Compression Energy	
Make-up Gas	-
Recycle Gas	o
Refrigeration Loop	++
Net Electricity Consumption	o
Catalyst Volume (m ³)	++
Cost (\$)	++
Equipment Size	+
Wall thickness	-
Weight of equipment → Cost (\$)	o
Nr. of Equipment	++
Plot Space	++
By-product (Utility)	No Steam Generation

++ Clear Advantage
 + Advantage
 o Neutral
 - Disadvantage

QUANTITATIVE COMPARISON (CAPEX-OPEX)

200 MTPD	Stami Green Ammonia	Other (Green) Ammonia Technologies
Electricity (Electrolyzer)	Similar	
Electricity (NGU)	Similar	
Electricity (Ammonia ISBL)	0.61 – 0.67 MW/t NH ₃	Similar
Relative Catalyst Volume (%)	30%-40%	100%
Specific Feed Consumption H ₂ (Nm ³ /t NH ₃)	Similar	
N ₂ (Nm ³ /t NH ₃)	Similar	
200 MTPD	Stami Green Ammonia	Other (Green) Ammonia Technologies
CAPEX (%) Ammonia ISBL Only	55%-65% <ul style="list-style-type: none"> Lean design Compact equipment sizing Smaller foot-print 	100%

CAPEX AND OPEX BREAKDOWN

Modular small-scale Green Ammonia technology CAPEX & OPEX impact on the overall Green Ammonia complex for 100/ 200/ 300 mtpd capacity plant.

<i>Block</i>	<i>CAPEX</i>	<i>OPEX</i>
<i>ASU (N2)</i>	<i>5-8%</i>	<i>2%</i>
<i>Electrolyzers (H2)</i>	<i>50-55%</i>	<i>91%</i>
<i>Stami Green Ammonia (NH3)</i>	<i>18-22%</i>	<i>5%</i>
<i>OSBL & Utilities</i>	<i>20-25%</i>	<i>2%</i>
<i>Total</i>	<i>100%</i>	

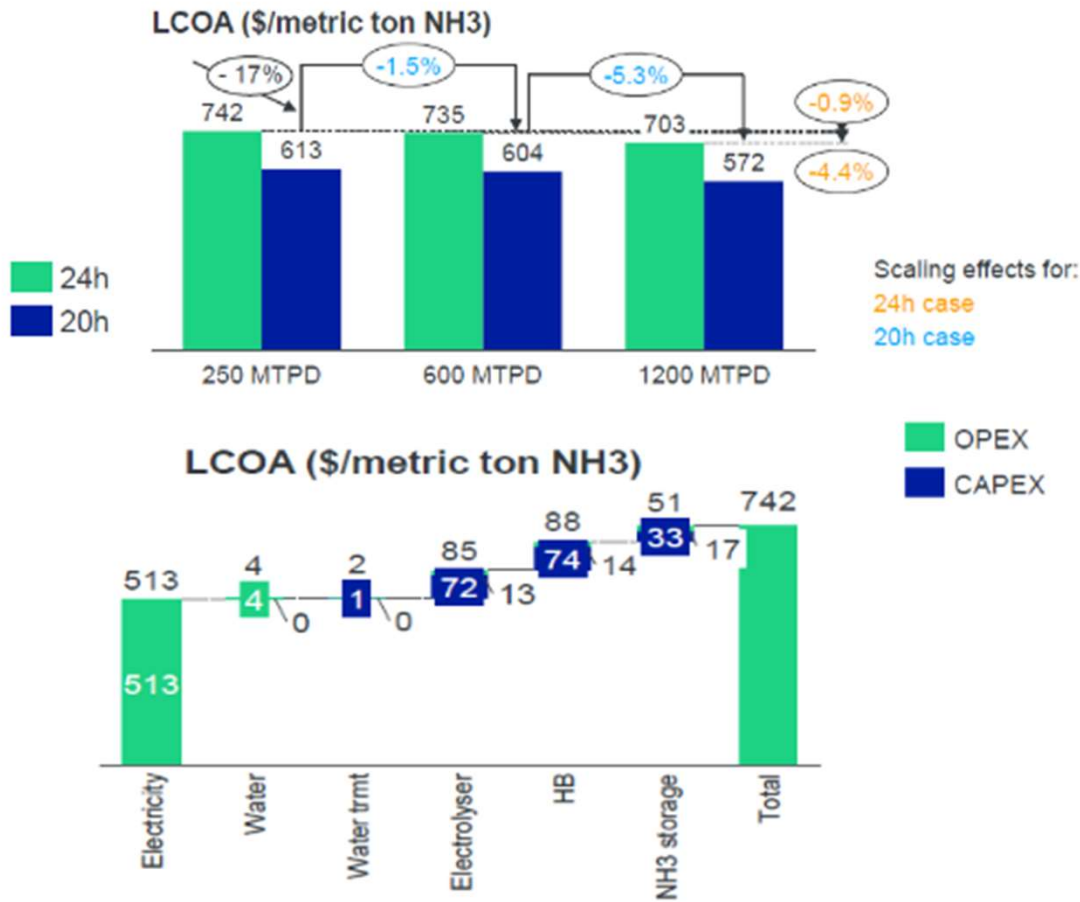
OPEX:

- Referred to as EE consumption only

The innovation & license company
of Maire Tecnimont

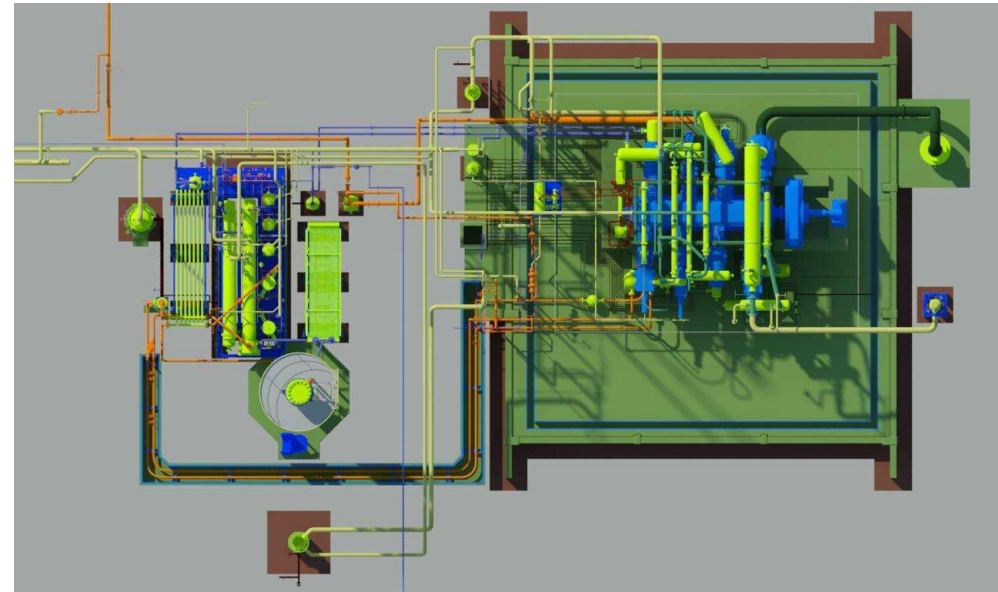


LEVELIZED COST OF AMMONIA



- Graphs are shown for 250 MTPD
- Other drivers of the Levelised cost include Electrolyser Capex
- Approximately 75% of the total LCOA is driven by H₂ production activities.

300 MTPD MODULARIZED STAMI GREEN AMMONIA TECHNOLOGY

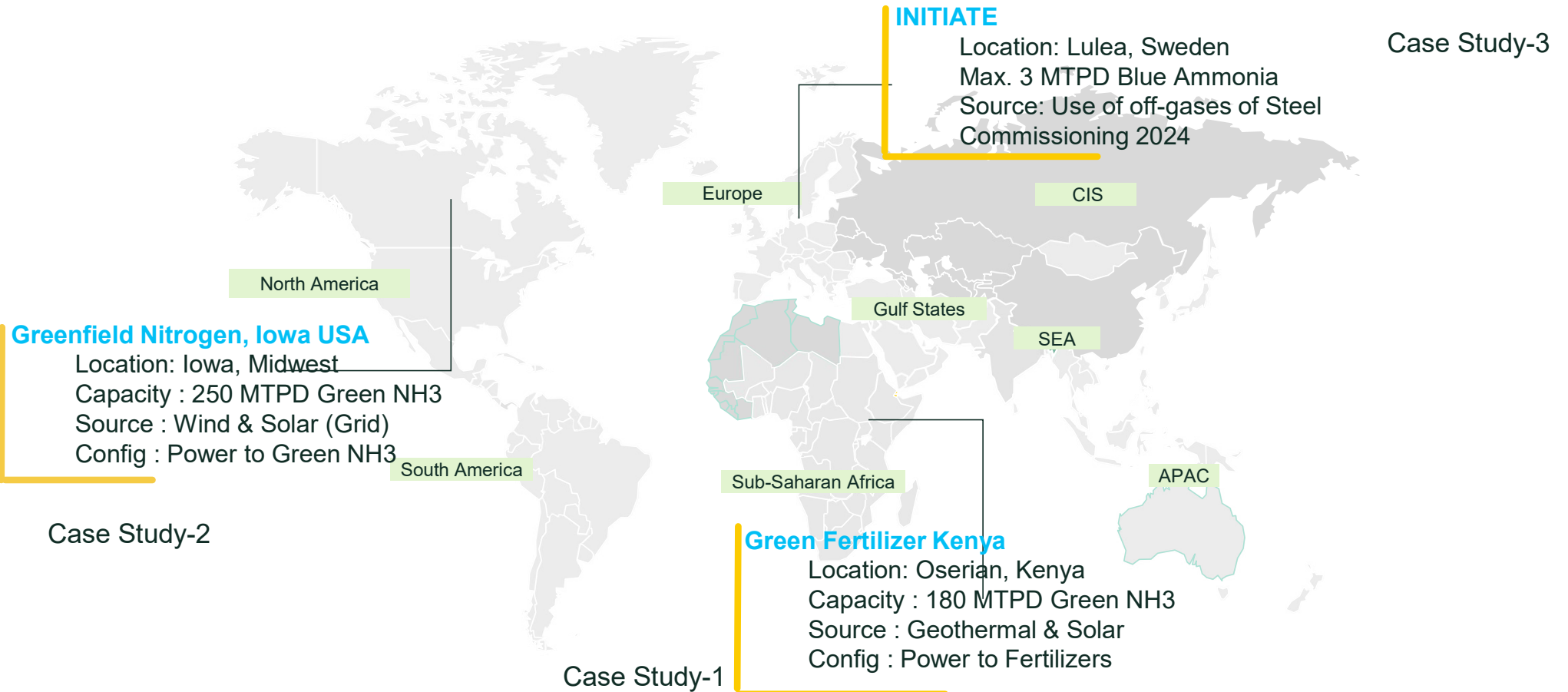


Nov 2021

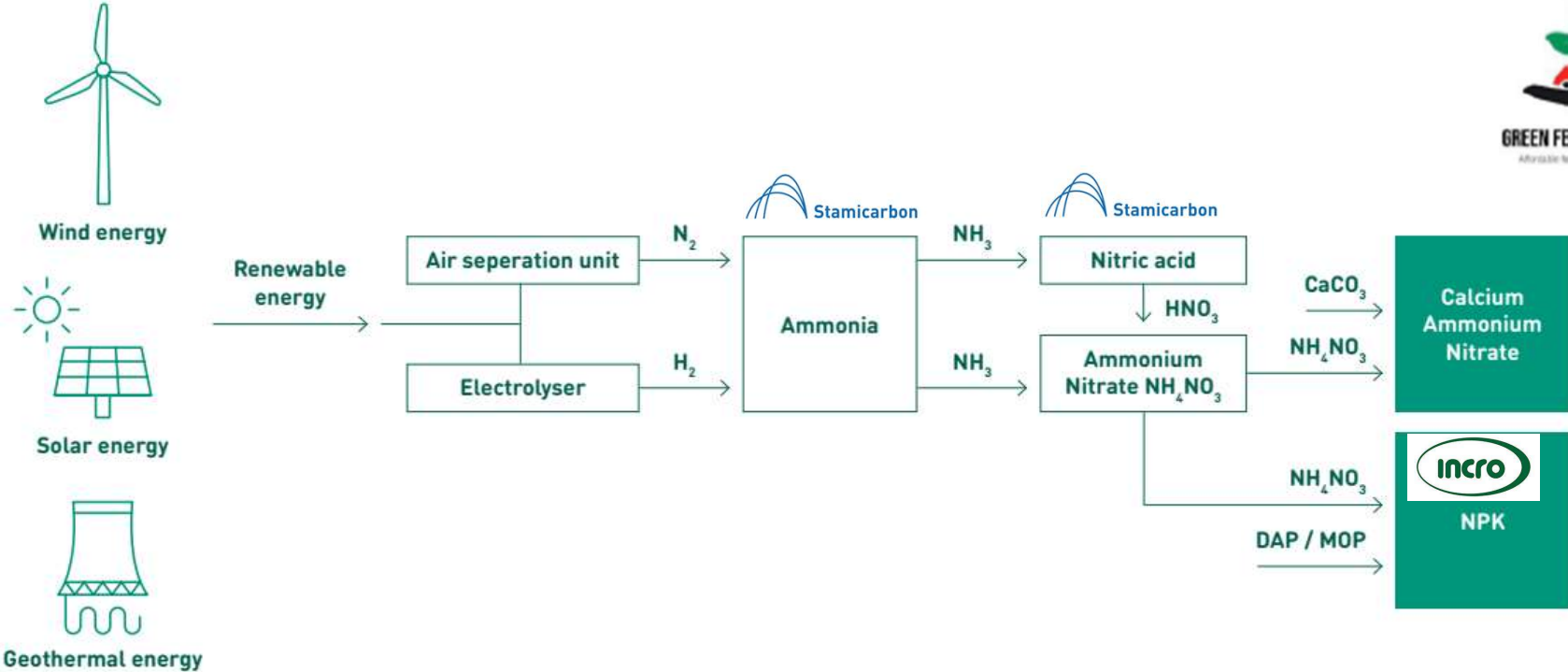
The innovation & license company
of Maire Tecnimont



GREEN AMMONIA / FERTILIZERS DEVELOPMENT – CASE STUDIES



CASE STUDY 1: KENYA GREEN FERTILIZER PROJECT



CASE STUDY-1 : FINANCIALS

- Unique business case due to higher inland logistics of fertilizer.
Logistics advantage due to:
 - the proximity to local farms/end-users,
 - local price will compete with imported products
- **Local government support**
- Showcase for local fertilizer production.
- Kenya has an **abundance of renewable energy** (solar, wind and geothermal energy), making it a prime location for green projects.
- The project shows an **attractive and solid Industrial IRR.**



Imported products are higher priced due to the related expensive logistics costs (shipping, uploading, storage, inland transport,...)

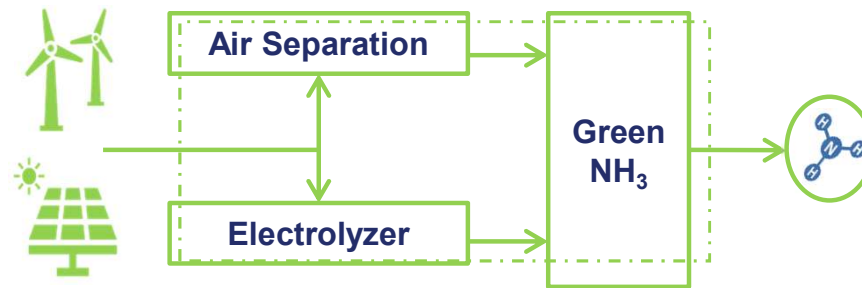
CASE STUDY 1: PLANT DESIGN

The plant will:

- be powered by energy from the grid (geothermal)/ solar
- generate over 300 jobs in the region
- reduce carbon emission by $\pm 100,000$ tons of CO₂ per annum → **first green fertilizer plant**
- reduce the dependency on imported nitrogen fertilizers and substitute around 25% of fertilizer imports which accounts for around 800 kt/a.
- increase fertilizer **affordability** and ensure the **availability** of fertilizers at the right time in the season for fertilizer application



250 tpd Green Ammonia, IOWA USA



Project Highlights:

- 100% renewable electricity supply
- Grid connected assuring 24/7 operation of NH₃ plant
- **Capacity: 250mtpd NH₃ plant**
- Location: the heart of the US Corn Belt with high NH₃ demand
- The business case is perfectly viable

CASE STUDY 3: DECARBONISATION OF STEEL INDUSTRY (INITIATE PROJECT)

€ 23 M European Union-funded project to demonstrate industrial symbiosis



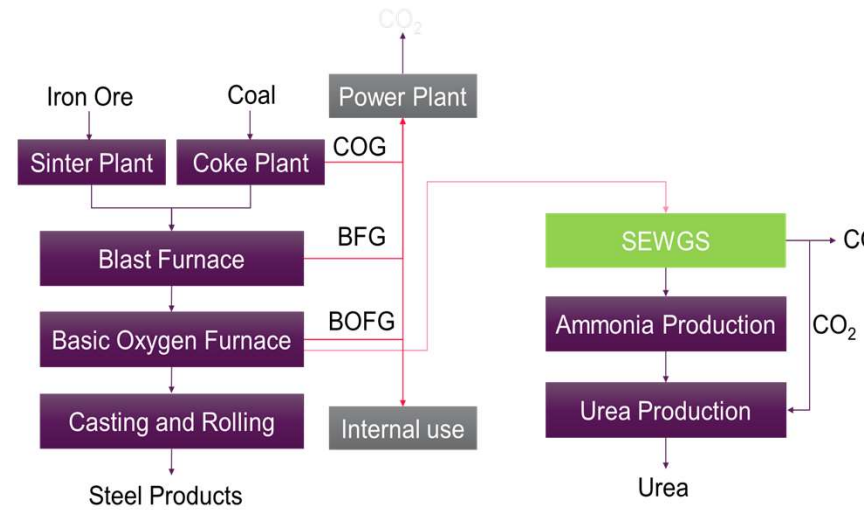
Demonstrate operational reliability for commercialization



Demonstrate continuous production of 5 t/d of NH₃ from steel gases



Confirm positive business case (target IRR > 15%)



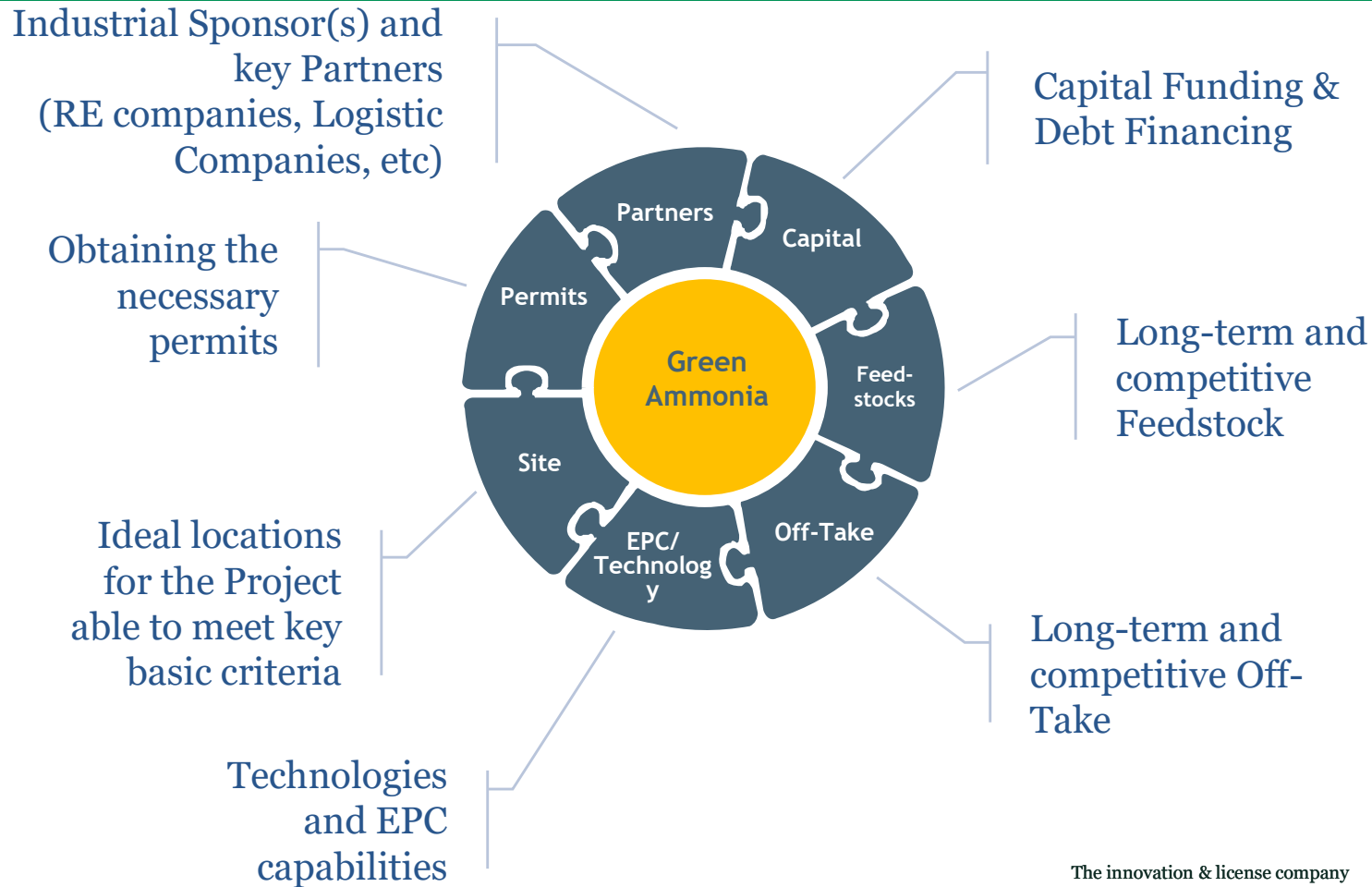
The Consortium



The innovation & license company of Maire Tecnimont



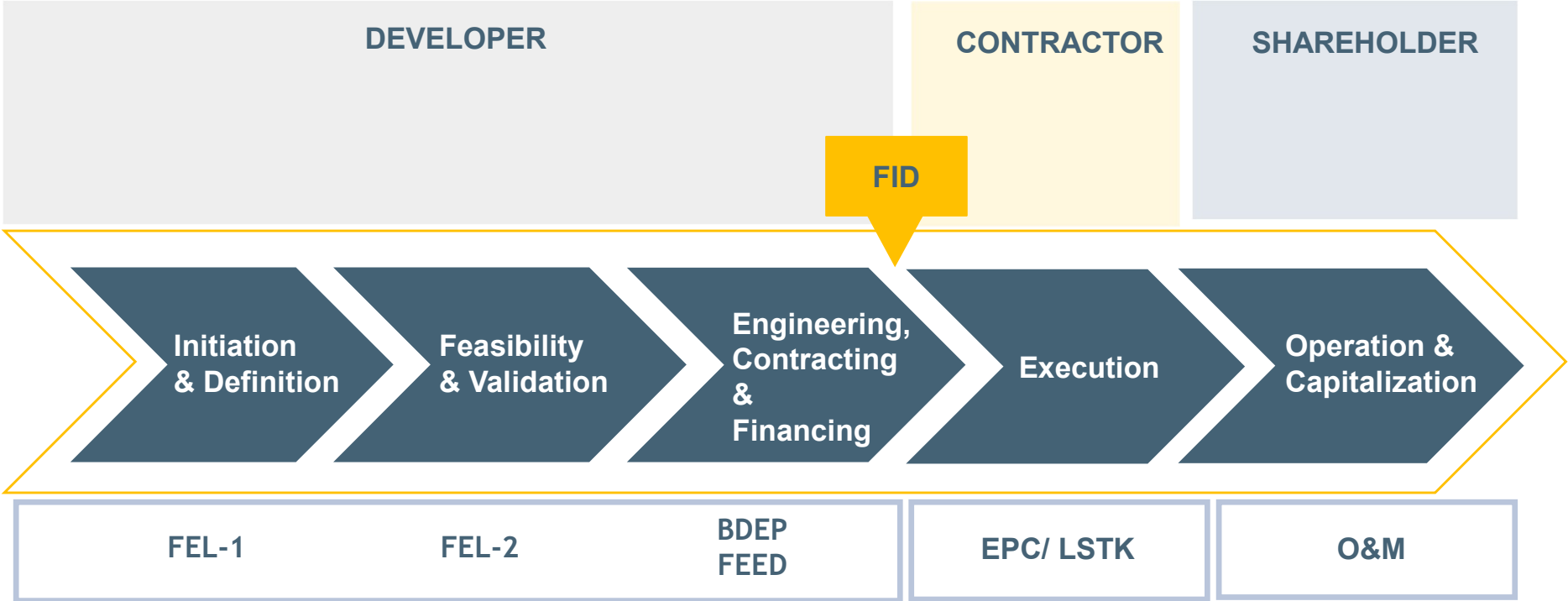
GREEN AMMONIA – KEY DRIVERS



The innovation & license company
of Maire Tecnimont



GREEN AMMONIA PROJECT DEVELOPMENT – PHASES AND TIMELINE



CONCLUSIONS

1. Small and medium-size plants play a crucial role in bridging the technological gap and accelerating the Green Ammonia transition to decarbonize the industry.
2. Stami Green Ammonia technology is a lean, robust and reliable design.
3. Wide portfolio of applications of green ammonia (Fuel, Energy carrier, Chemicals)
4. Green nitrate fertilizer plants are available today based on proven technologies, with various projects at the FS stage.
5. Stami Green Ammonia is the “most competitive technology design” for green small-scale applications both in OPEX and CAPEX.

NOW IS THE TIME!! THANK YOU

“If we wait for the meek to inherit the earth, ‘there wont be anything left to inherit ’”

~Bob Hunter
Environmentalist



Think Green