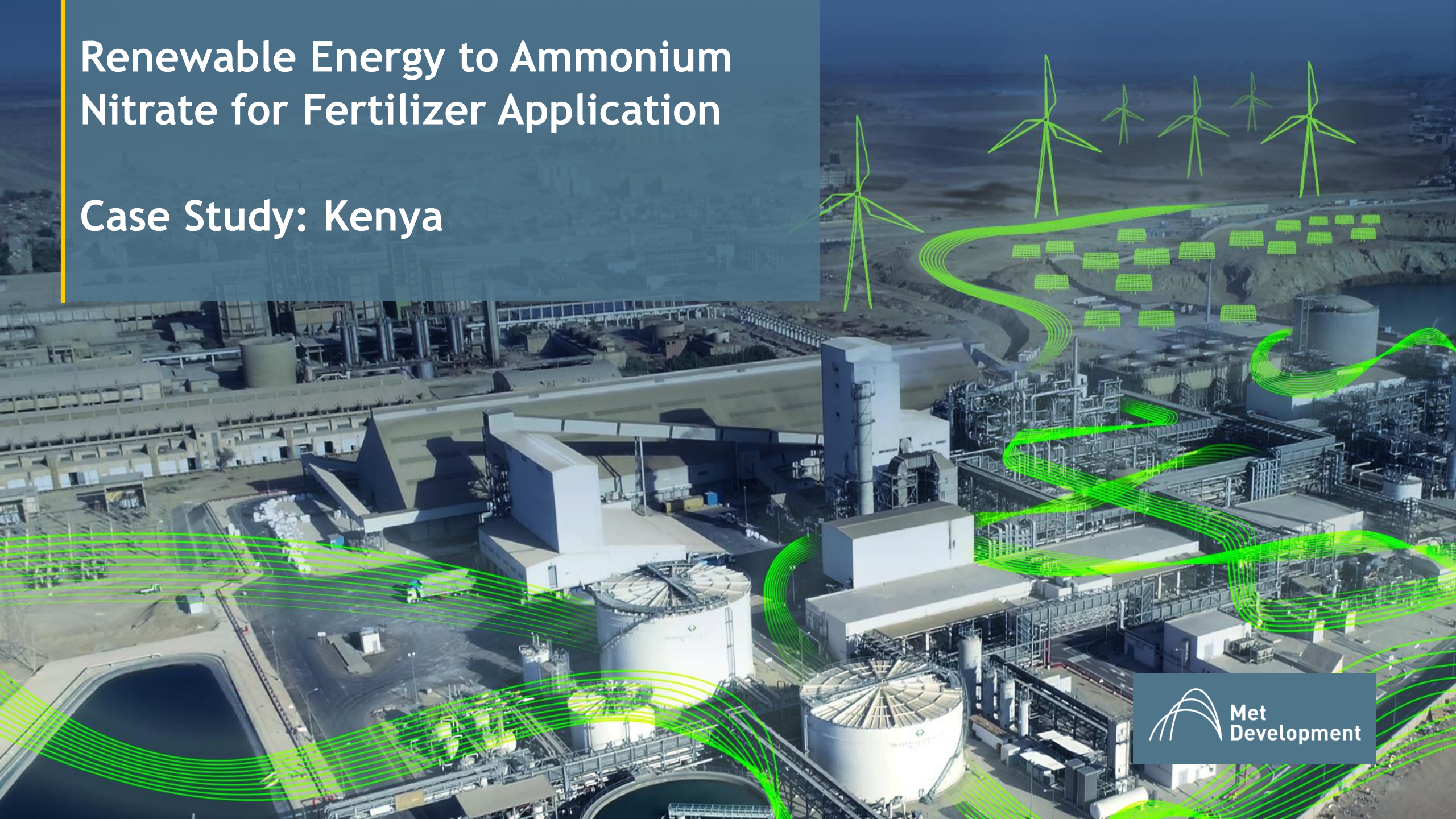


# Renewable Energy to Ammonium Nitrate for Fertilizer Application

## Case Study: Kenya





# CONTENT

- THE NEED FOR CHANGE
- SUSTAINABLE FERTILIZER PRODUCTION
- THE KENYA PROJECT



# THE NEED FOR CHANGE - FERTILIZER EMISSIONS

137 . 311 . 650

ton CO<sub>2</sub> emitted from  
fertilizer production  
in 2022

Fertilizer production alone accounts for roughly **1%** of all greenhouse gases annually. Ammonia manufacturing makes up approximately **90%** of this energy use.

IFA



Scale/Modern NG

Subscale NG

Per MT NH<sub>3</sub>

1.8 - 2.0 MT CO<sub>2</sub>

2.0 - 2.2 MT CO<sub>2</sub>



Thermal Coal

Anthracite

Anthracite Lump

2.5 - 4.6 MT CO<sub>2</sub>

3.0 - 5.5 MT CO<sub>2</sub>

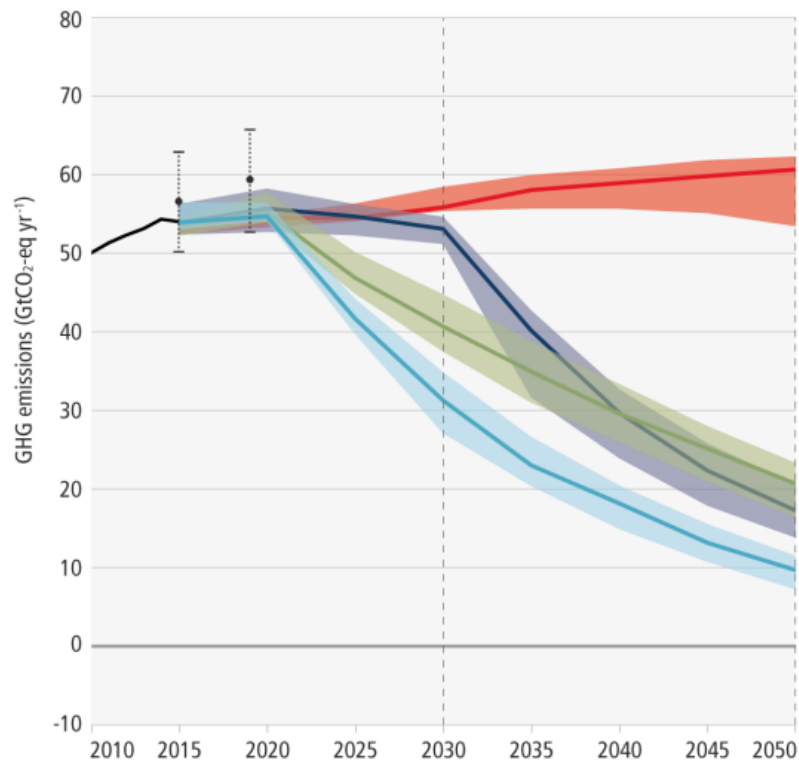
5.2 - 5.9 MT CO<sub>2</sub>

CFIndustries, 2015



# THE NEED FOR CHANGE - LATEST IPCC FINDINGS

The extent and magnitude of climate change impacts are larger than estimated in previous assessments



Modelled pathways:

- Trend from implemented policies
- Limit warming to 2°C (>67%) or return warming to 1.5°C (>50%) after a high overshoot, NDCs until 2030
- Limit warming to 2°C (>67%)
- Limit warming to 1.5°C (>50%) with no or limited overshoot

- - - - - Past GHG emissions and uncertainty for 2015 and 2019 (dot indicates the median)

For limiting global warming to 2°C (>67%):

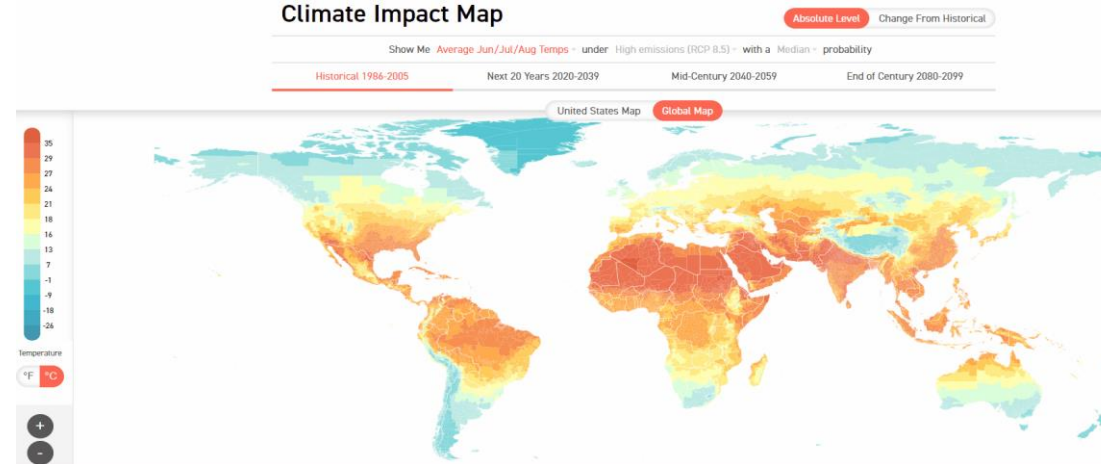
- 0-0.7 GtCO<sub>2</sub>-eq per year during 2020-2030
- 1.4-2.0 GtCO<sub>2</sub>-eq per year during 2030-2050

average global GHG emissions reduction rates are required.

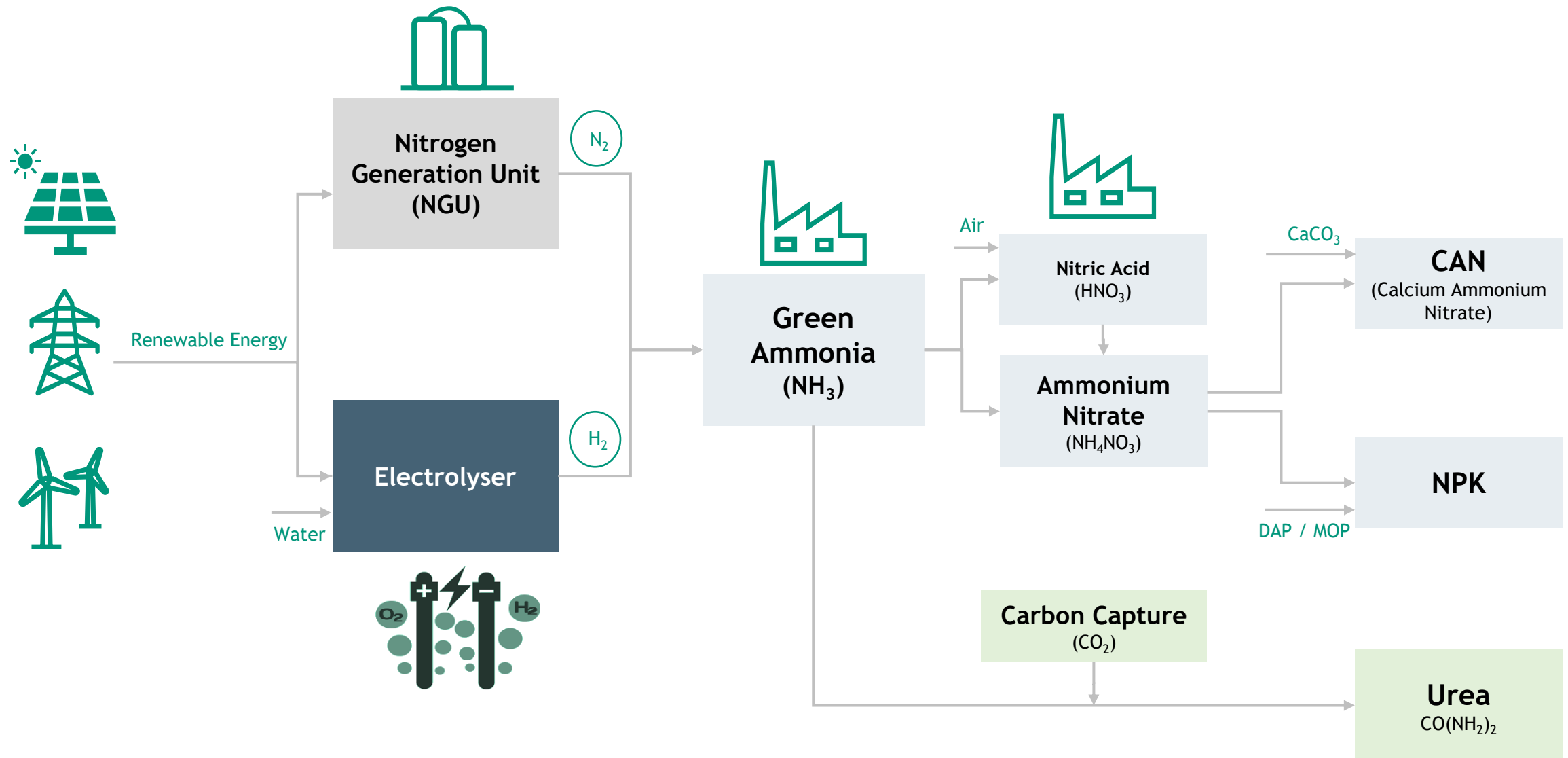
Global warming will impact 3.3-3.6 billion people:

Global hotspots of high human vulnerability are found particularly in West-, Central- and East Africa, South Asia, Central and South America, Small Island Developing States and the Arctic.

## Climate Impact Map



# SUSTAINABLE NITROGEN FERTILIZER - THE PROCESS

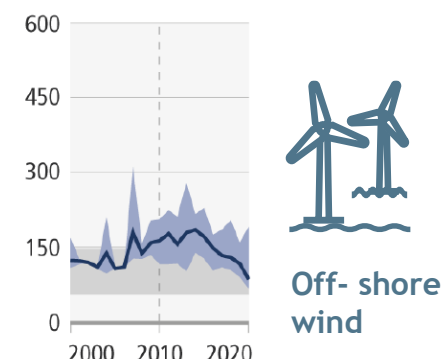
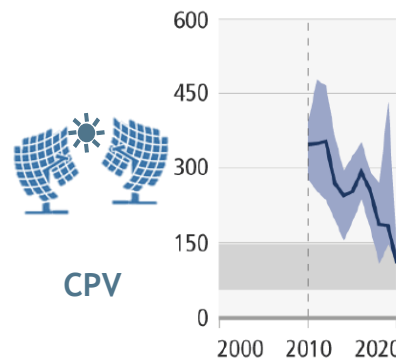
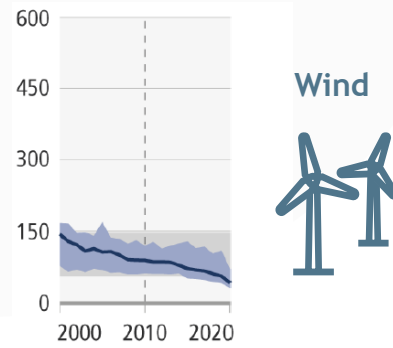
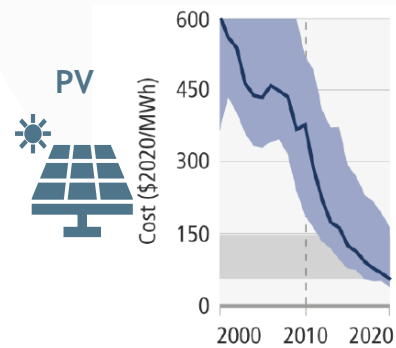






# RENEWABLE ENERGY AS A FEEDSTOCK FOR FERTILIZER PRODUCTION

IPCC report show that the renewable energy production costs decreased significantly in last decades. This leads to feasible Power-to-X projects.



## Saudi Arabia's second PV tender draws world record low bid of \$0.0104/kWh

The record low price was offered for the 600 MW Al Shuaiba PV IP project, which competed in the second round of the country's procurement scheme for renewable energy.

### APRIL 12, 2021 **Dubai's 900 MW solar tender sees lowest bid of \$0.0169/kWh**

The offer was apparently submitted by Saudi energy giant ACWA Power, which refused to confirm the bid when asked by **pV magazine**. The second lowest bid – \$0.0175/kWh – was reportedly submitted by a consortium formed by Emirati developer Masdar, French utility EDF and Chinese PV panel maker Jinko Power.

OCTOBER 10, 2019 **EMILIANO BELLINI**

## Portugal's second PV auction draws world record low bid of \$0.0132/kWh

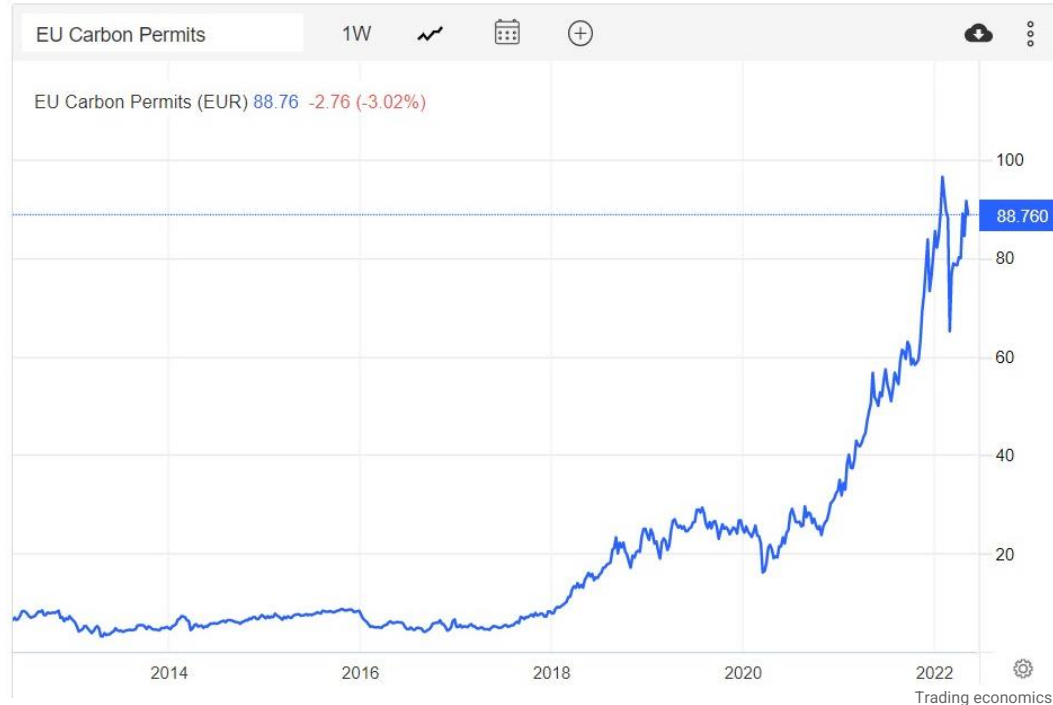
According to financial newspaper *Expresso*, the lowest bid in the exercise was €0.0112/kWh, slightly lower than the \$0.0135/kWh submitted by French energy group EDF and China's JinkoPower in a 2 GW tender held in Abu Dhabi, a price which was confirmed last month.

The projects were proposed to serve southern New Mexico and west Texas customers, and start service in the summer of 2022. One project will add 100 MW of solar for \$0.015 per kWh while the second will add 100 MW of solar and 50 MW of storage for \$0.021 per kWh, record-low prices for solar and storage in New Mexico.



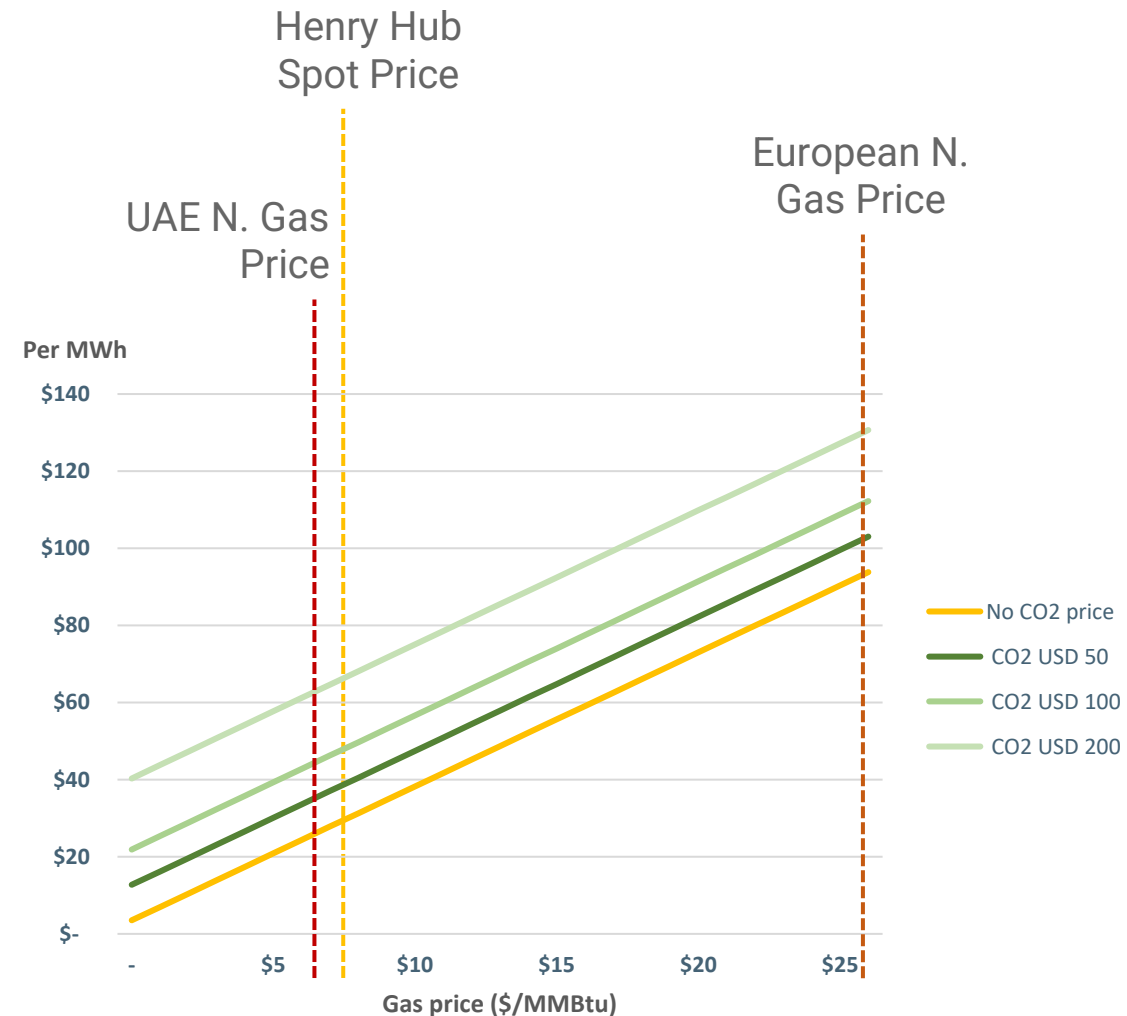
# CO<sub>2</sub> PRICES AND SUSTAINABILITY TARGETS ARE DRIVING DEVELOPMENTS

## ETS Prices



The price of emissions allowances traded on the EU **ETS** have increased from €7 per ton of CO<sub>2</sub> equivalent to approximately €90 recently.

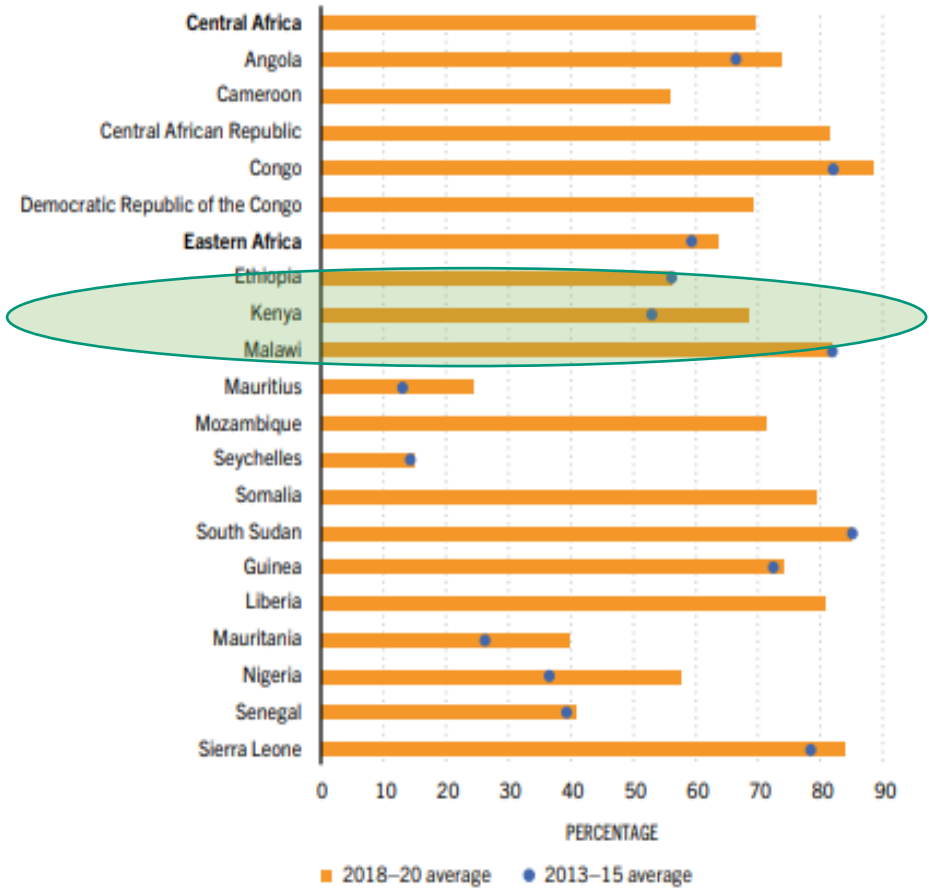
## Corresponding cost of electricity





# IN AFRICA ALSO FOOD SECURITY IS DRIVING LOCAL POWER-TO-FERTILIZER PROJECTS

Prevalence of moderate or severe food insecurity in Africa by country



The Kenyan Wall Street  
THE THINKING BEHIND THE INVESTOR

## KTDA suspends fertilizer importation for 2020

by Business Reporter — June 15, 2020 in Agriculture, Kenyan News, Press Releases Reading Time: 2 mins read

### BUSINESS DAILY

#### COUNTIES

## Subsidise fertiliser prices, North Rift farmers ask State

FRIDAY APRIL 01 2022







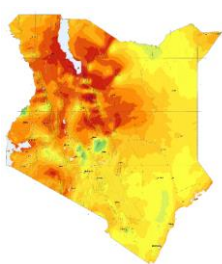
# PROJECT INTRODUCTION

Green Fertilizer Kenya Project is a sustainable fertilizer production facility in Naivasha developed by Maire Tecnimont.

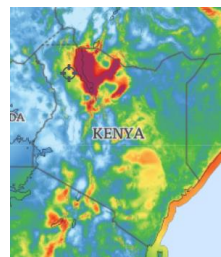
- Green Fertilizer Kenya Project aims to produce 200,000 tons of the most locally consumed fertilizers: CAN-26 and NPK 26-5-5.
- The production will be based on renewable electricity and water which will be fed to electrolyser to produce Green Hydrogen in order to produce fertilizer.

Electricity on grid is 90% renewable in Kenya with solar, wind and geothermal sources.

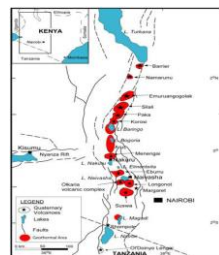
Solar



Wind



Geothermal



## Food Security

Fertilizer production boosts the food security by securing certainty of supply and increasing crop productivity.



## Import Substitution

Local fertilizer substitutes the imported fertilizers, eliminating the dependency on foreign countries.



## Affordable Fertilizer

Fertilizer price will be correlated to the local electricity price and will be independent from global commodity prices.

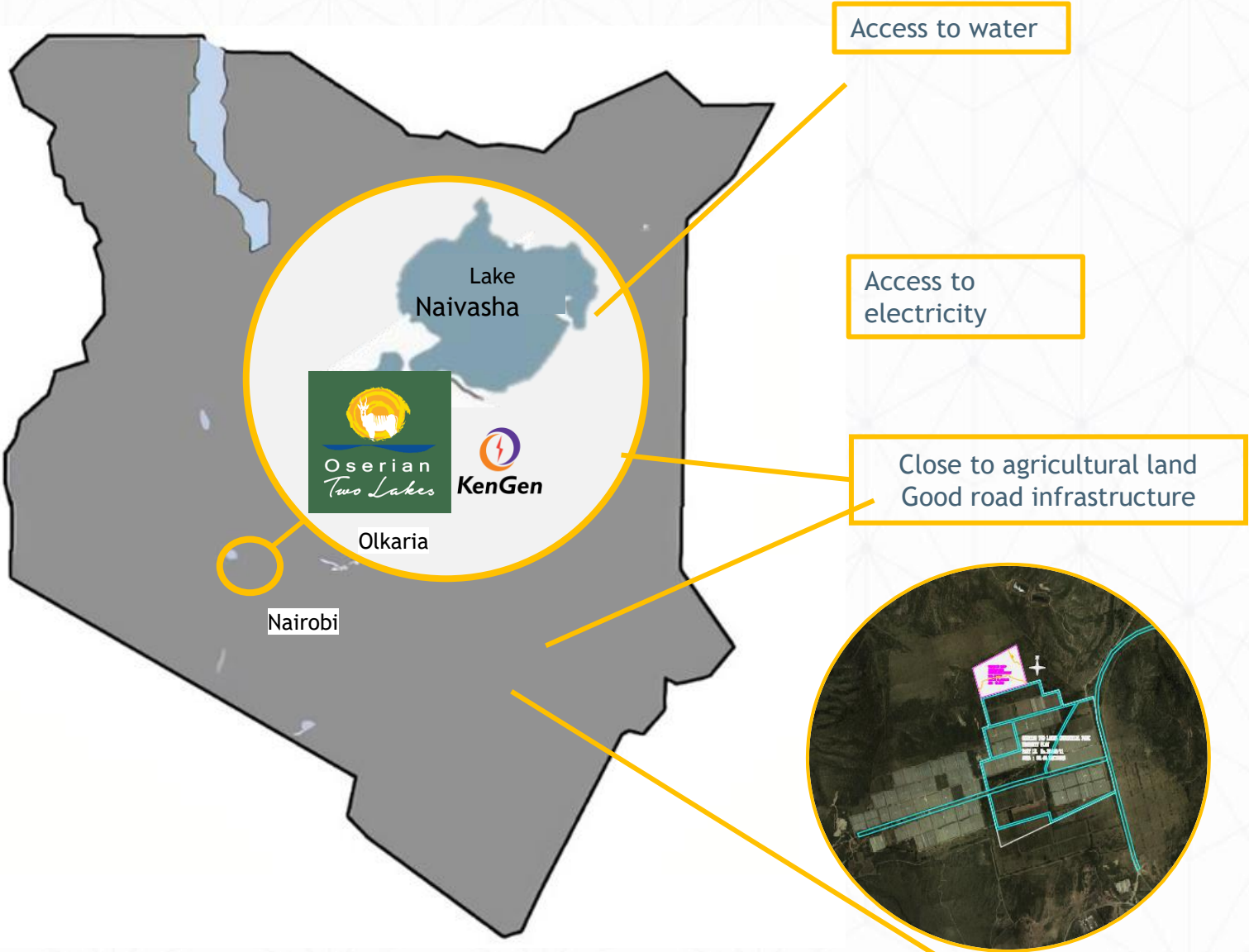


## Sustainable Process

Fertilizer will be produced starting from renewable energy and the project saves 217,000 tons/annum CO<sub>2</sub>. Green aspect allows for green financing schemes.




# LOCATION



  
Power from Geothermal & Solar

  
Electrolyser &  Ammonia-ANNA

  
N - from the plant  
P - external  
K - external

Farmer



# THE FEEDSTOCK: ELECTRICITY

## Renewable Energy Development in Kenya

1

overcapacity in  
the grid

2

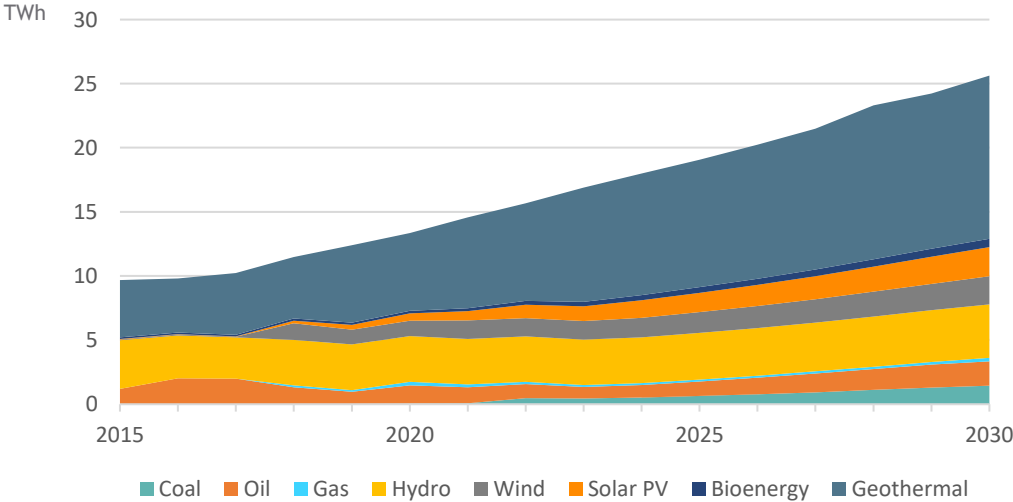
>90% of grid is  
renewable

3

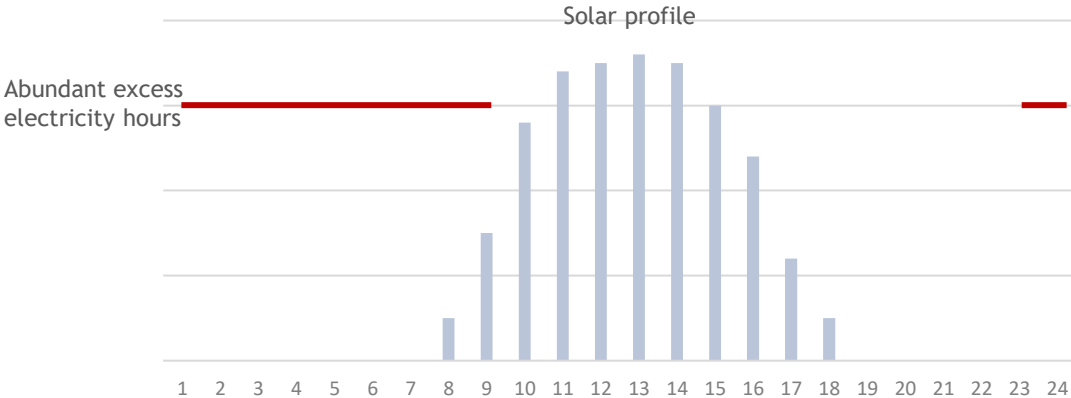
continuous  
power



Electricity Generation Sources



Solar PV Profile & Excess Energy



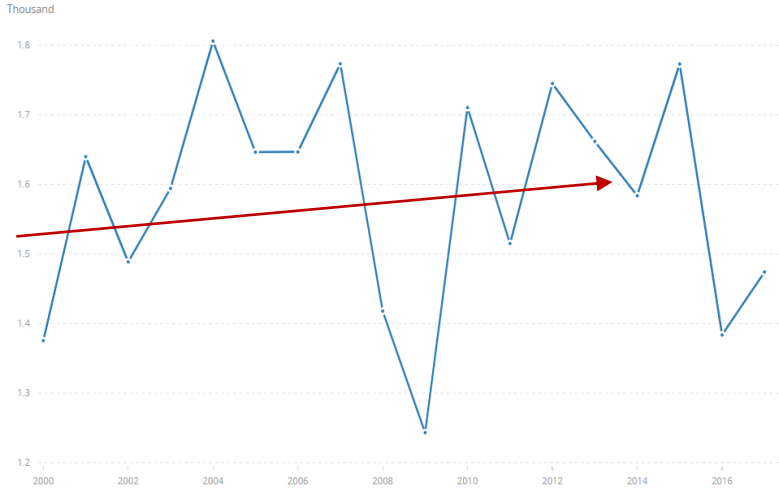
Indicative profile



# KENYA AND FERTILIZERS

## Kenya

Cereal yield (kg per hectare)



The maximum cereal yield in **Europe** has been reached in **2014** with **5.5** tons per hectare while in **Kenya**, maximum yield was **1.8** tons per hectare in **2004** and dropped 1.5 tons per hectare in 2017.

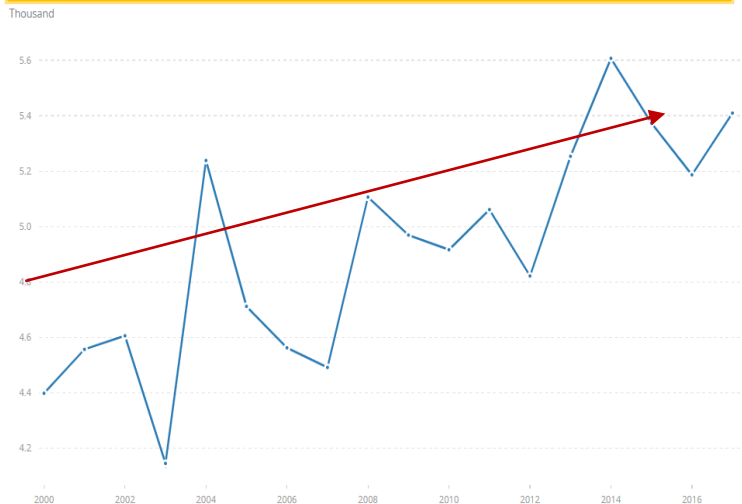
The average fertilizer use in last 20 years:

- Europe: 150 kg/arable hectare
- Kenya : 30 kg/arable hectare

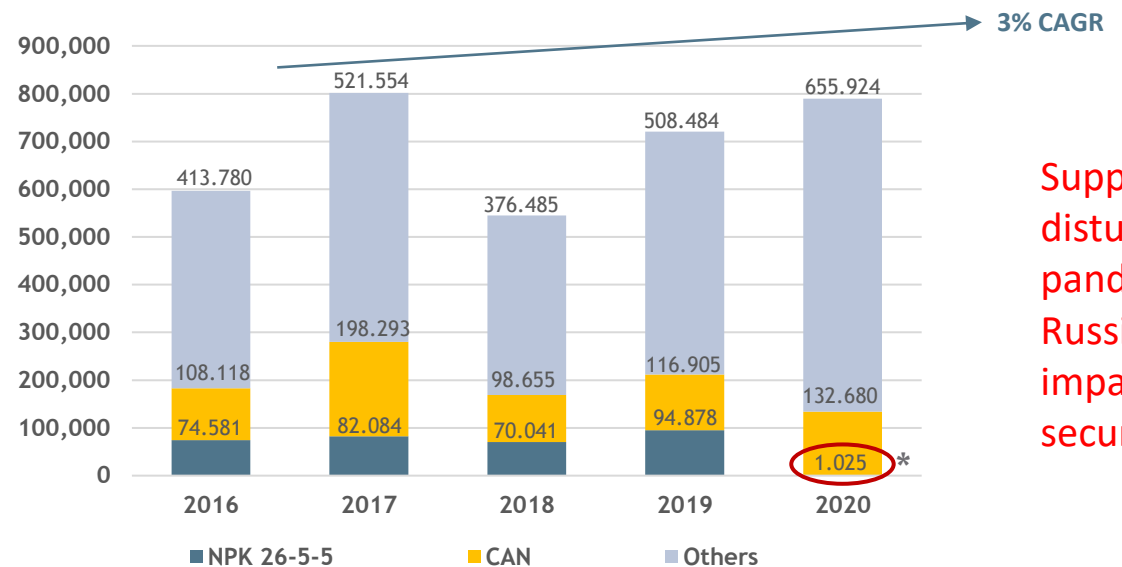
World Bank

Crop yield must be improved in Kenya by steady fertilizer application.

## Europe



## Apparent Fertilizer Consumption



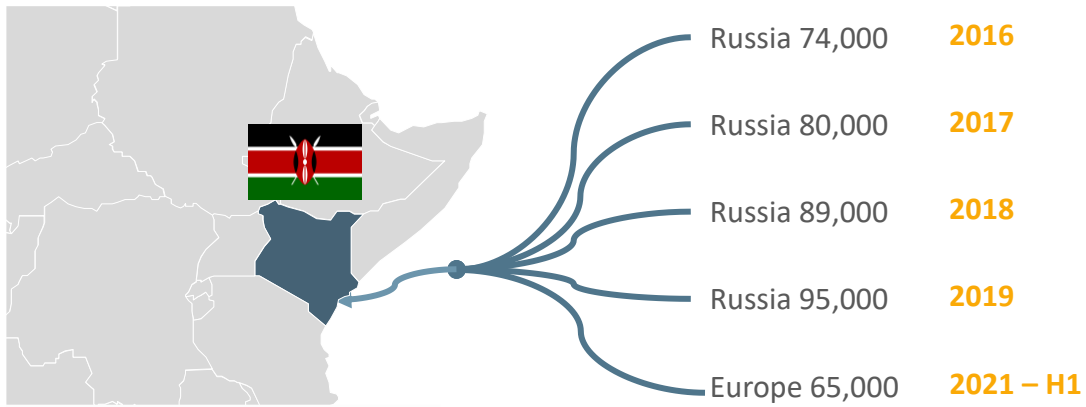
Supply chain disturbance by pandemic and Russia crisis and impact on food security

Source: AfricaFertilizer.org and AFAP (2017)

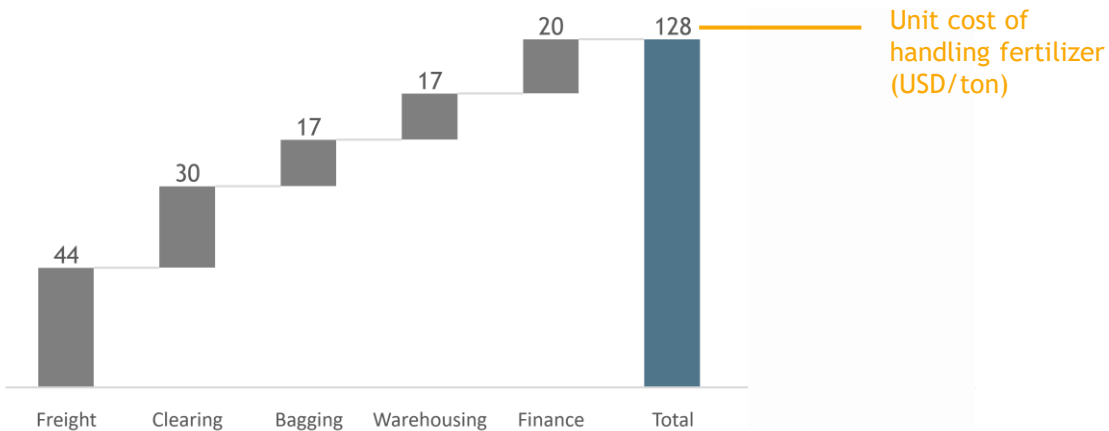
# REDUCING LOGISTICAL COSTS

Long supply chain covers premium required for green fertilizer

## NPK 26-5-5 Import Route



## Fertilizer Cost Build-Up for Imports



Production close to agricultural zone saves:

- 1. Sea freight cost**  
-Import from Russia, M. East etc.
- 2. Inland freight cost**  
-Freight cost from port to the agricultural areas
- 3. Handling costs**  
-Clearing, bagging, port warehouses etc.

## CAPEX optimized set-up

- Minimizing number of equipment
- Optimizing footprint

## Competitive Electricity

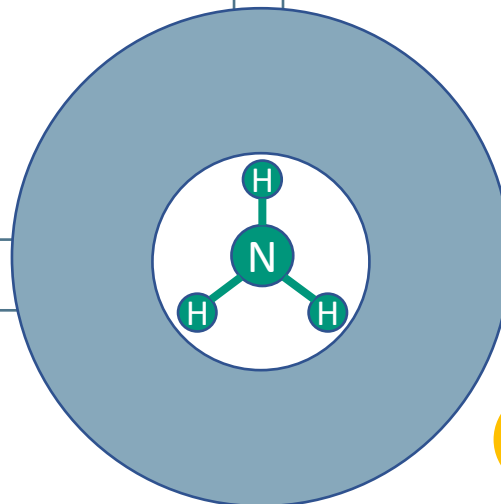
- Competitive renewable electricity price decreases OPEX drastically and a requisite for feasible business case.

## Logistics

- High logistics and handling costs may be avoided by having plants in demanding regions.

## Green Premium

- CO<sub>2</sub> credits
- Voluntary schemes
- CO<sub>2</sub> reduction of energy crops





# STRONG LOCAL PARTNERSHIP



- Project initiator
- Co-developer



- Equity sponsor
- Co-developer



- Equity sponsor
- Co-developer



- Solar plant development
- Co-developer



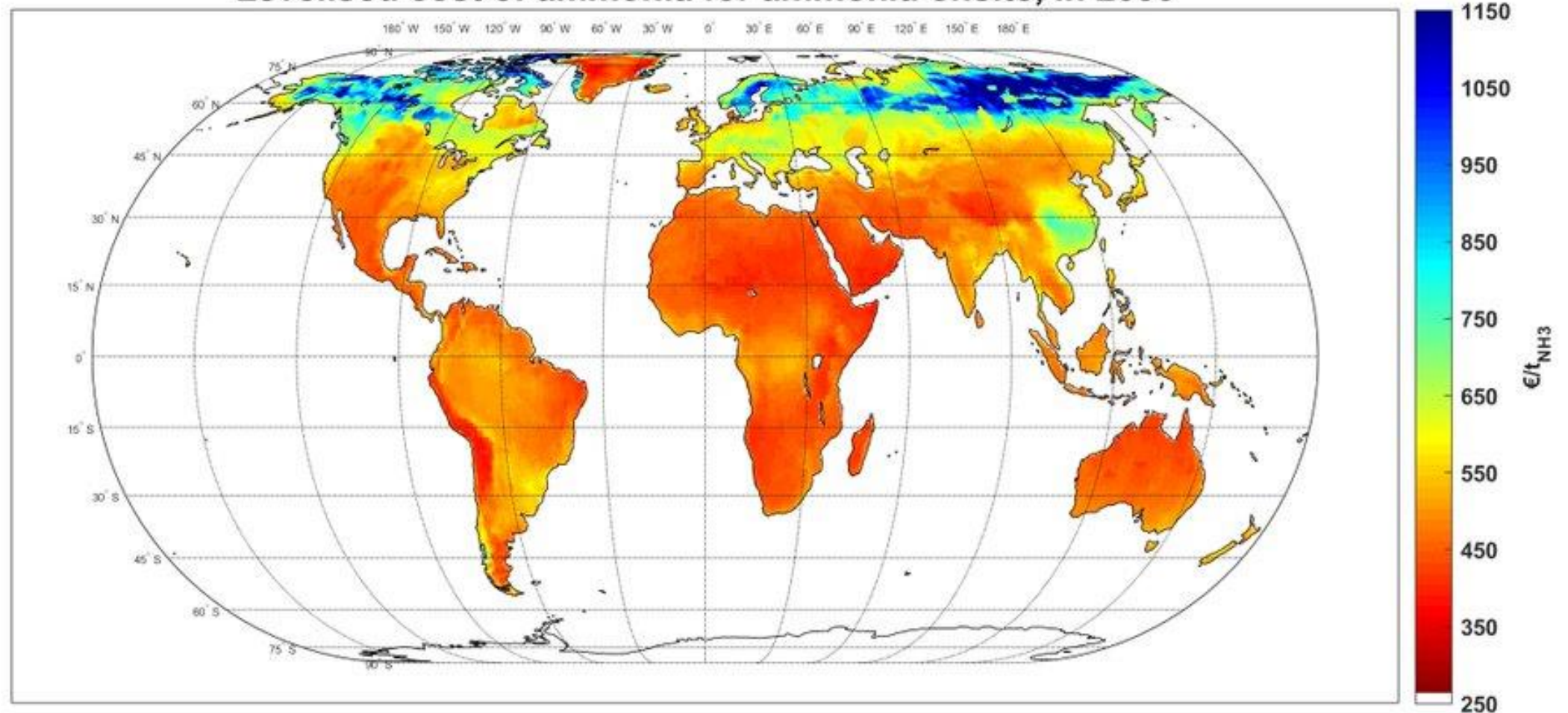
- Technology provider



- EPC contractor

## New Geographies for Hydrogen & Ammonia Production

### Levelised cost of ammonia for ammonia onsite, in 2030



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



## SIMILAR DEVELOPMENT IN DIFFERENT LOCATIONS

### Iowa Green Ammonia Plant



<b>Product:</b>	Green Ammonia
<b>Partnership:</b>	Greenfield Nitrogen
<b>Capacity:</b>	250 mtpd
<b>Year:</b>	2026
<b>Energy source:</b>	Grid (Solar, wind combined)
<b>Premium:</b>	Logistics, Hydrogen bill

### Paraguay Green Fertilizer Plant



<b>Product:</b>	Green Ammonium Nitrate
<b>Partnership:</b>	FerSam
<b>Capacity:</b>	1400 mtpd
<b>Year:</b>	2026
<b>Energy source:</b>	Hydropower
<b>Premium:</b>	Logistics



# THANK YOU



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