AFRICA 20 WORKS! 22
Innovation for Resilient Growth

HYDROGEN PRODUCTION AND APPLICATIONS

TNO innovation for life

XiNTC ELECTROLYSERS

TNO innovation for life

NL.IN. BUSINESS

NABC
Confidence in African Business

Government of the Netherlands

MODERATOR

AFRICA WORKS! 2022
Innovation for Resilient Growth

MR. SVEN BAX

Sector Head Sustainable Manufacturing

Invest International

PRESENTATION 1

MR. THOMAS HAJONIDES VAN DER MEULEN

Research Consultant

TNO

AFRICA WORKS! 2022
Innovation for Resilient Growth

NABC
Energy - Hydrogen Production and Applications

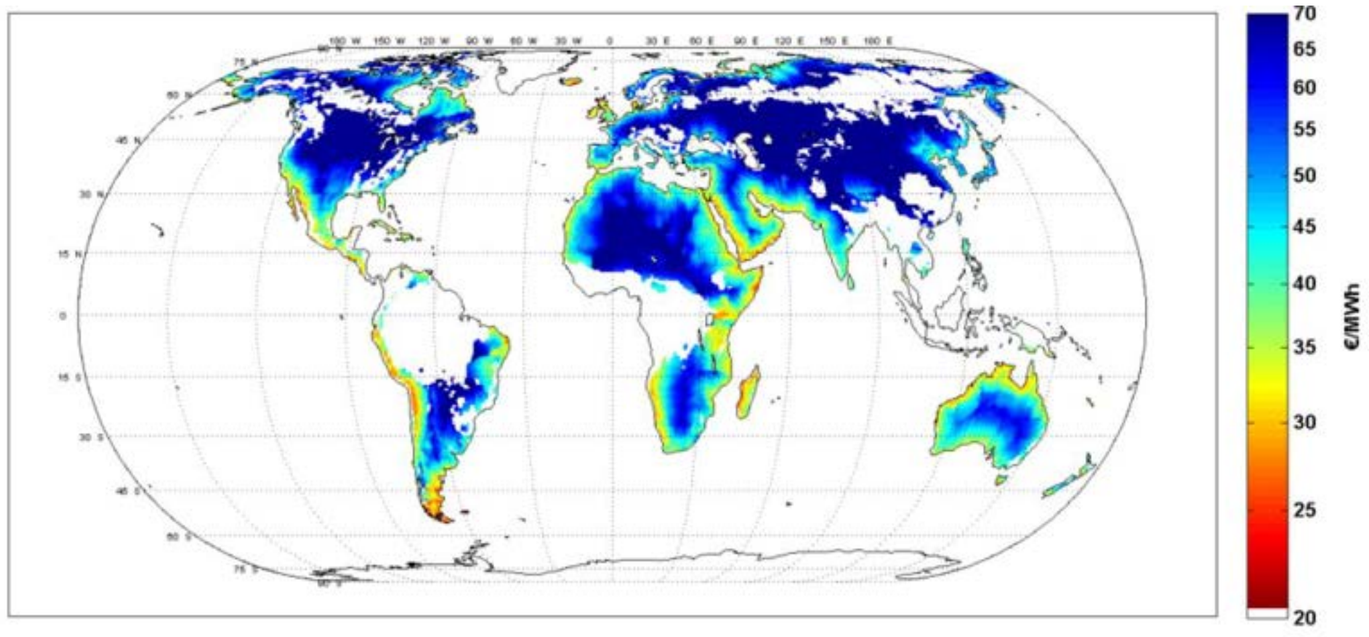
HYDROGEN IMPORT: CONNECTING PRODUCTION & APPLICATIONS

CONTACT: T.C. (THOMAS) HAJONIDES VAN DER MEULEN (RESEARCH CONSULTANT)

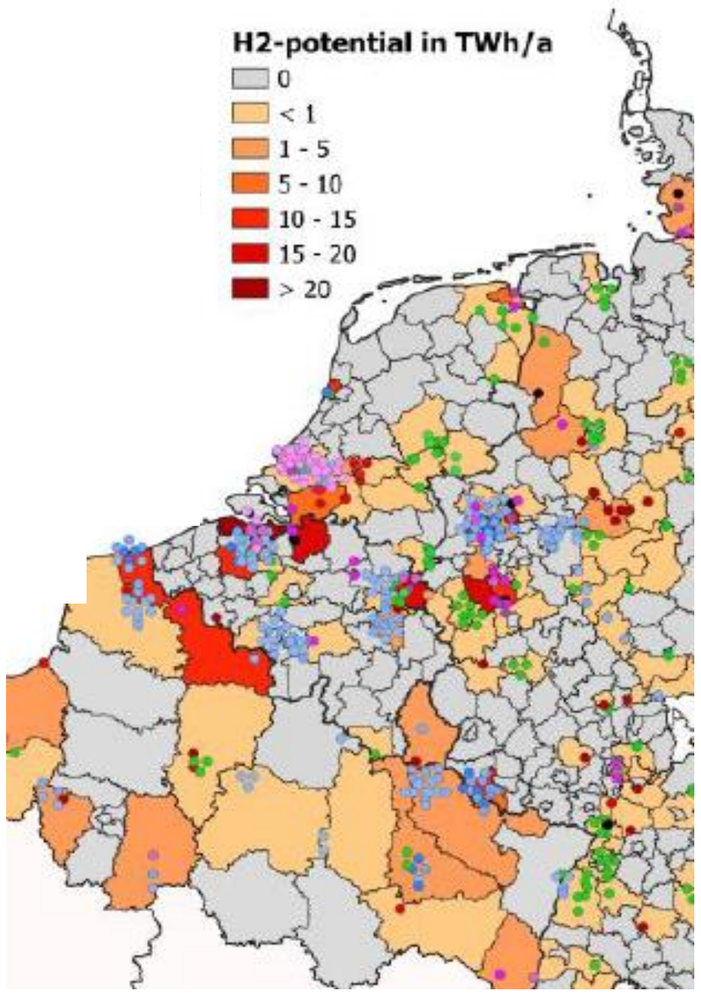
28 JUNE 2022

MAJOR ROLE FOR IMPORTED SUSTAINABLE MOLECULES IN EUROPE IS ENVISIONED BY MANY

- EU targets 2030 include major renewable hydrogen volumes
- Currently, less than <2% of energy consumption is hydrogen
- Many future worldviews and scenarios envision hydrogen trade from Africa towards Europe



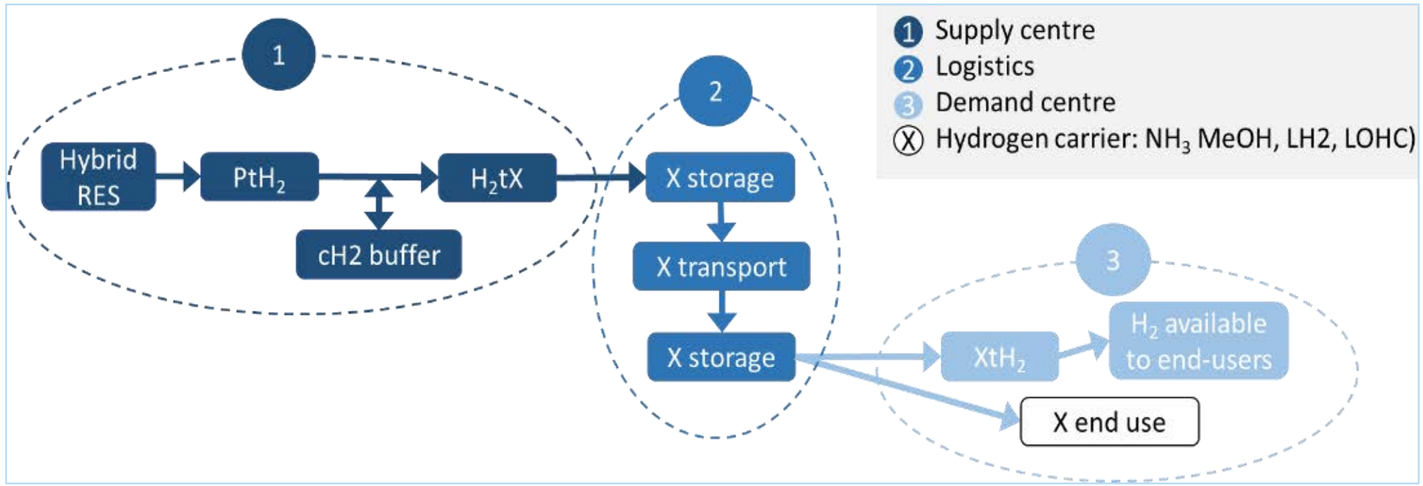
Levelized cost of delivered electricity for PtG in 2030
Source: Fasihi & Breyer (2020)



Bottom-up assessment of hydrogen demand potential for industry
Source: TNO Fraunhofer (2022) Future hydrogen demands from industry transition towards 2030 - a site-specific bottom-up assessment for North-Western Europe

WHAT MATTERS FROM AN EU OFFTAKER PERSPECTIVE?

KEY QUESTION: WHICH MOLECULE IS DEMANDED, IN WHICH QUANTITY, AND WHEN?



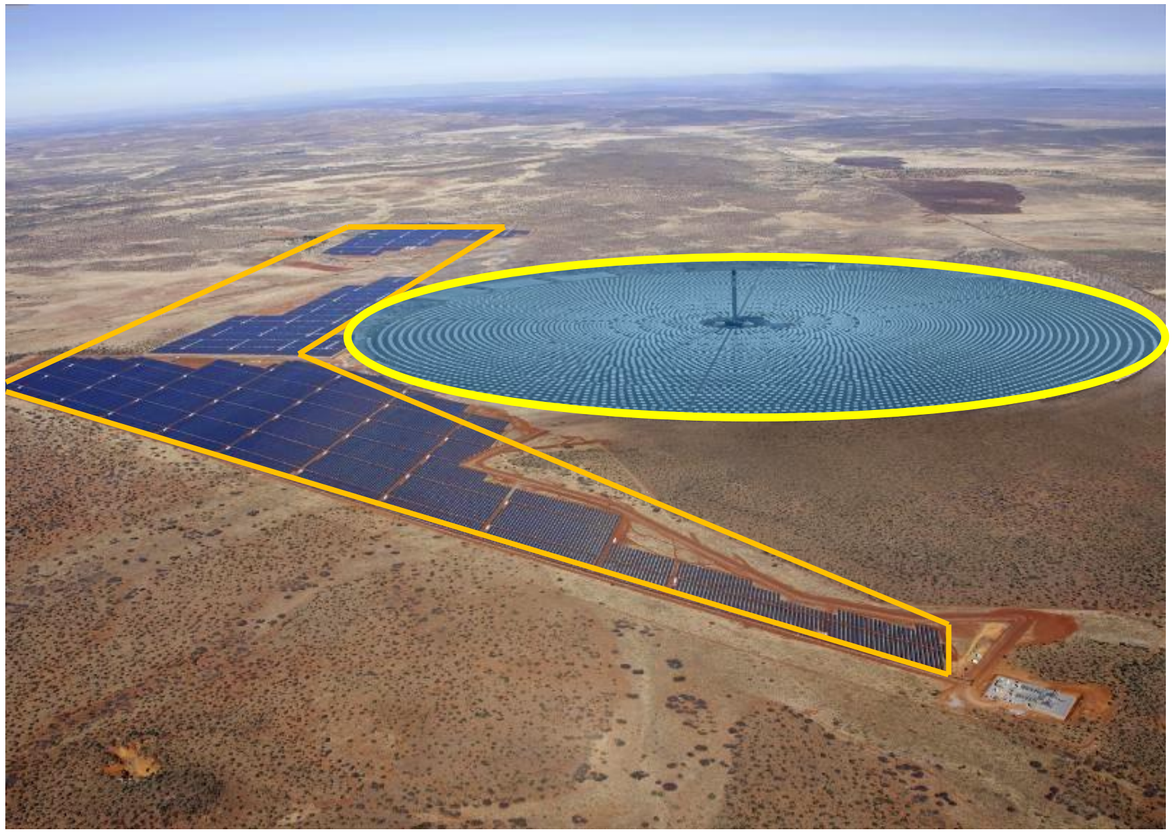
1. Security of supply
2. Carbon intensity
3. Cost

Building hydrogen(derivative) value chains:

- Wide range of molecules: ammonia (NH_3), methanol (CH_3OH, ethanol (C_2H_6O), kerosine ($C_{12\text{-}15}H_{26\text{-}25}$)
- Many configurations possible
- Increasing scale over time

WHAT MATTERS FROM AN EU OFFTAKER PERSPECTIVE?

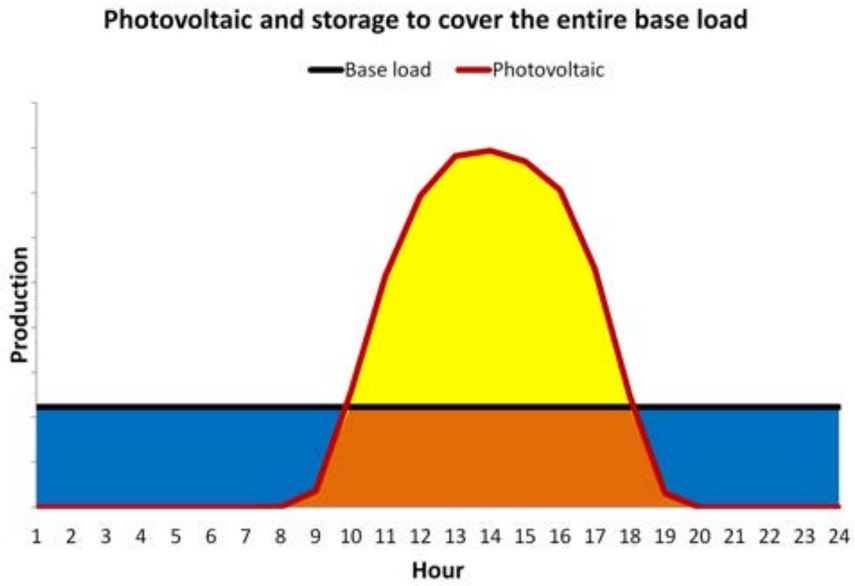
SECURITY OF SUPPLY, CARBON INTENSITY AND COST



Source: www.helioscsp.com

Complementory drivers are:

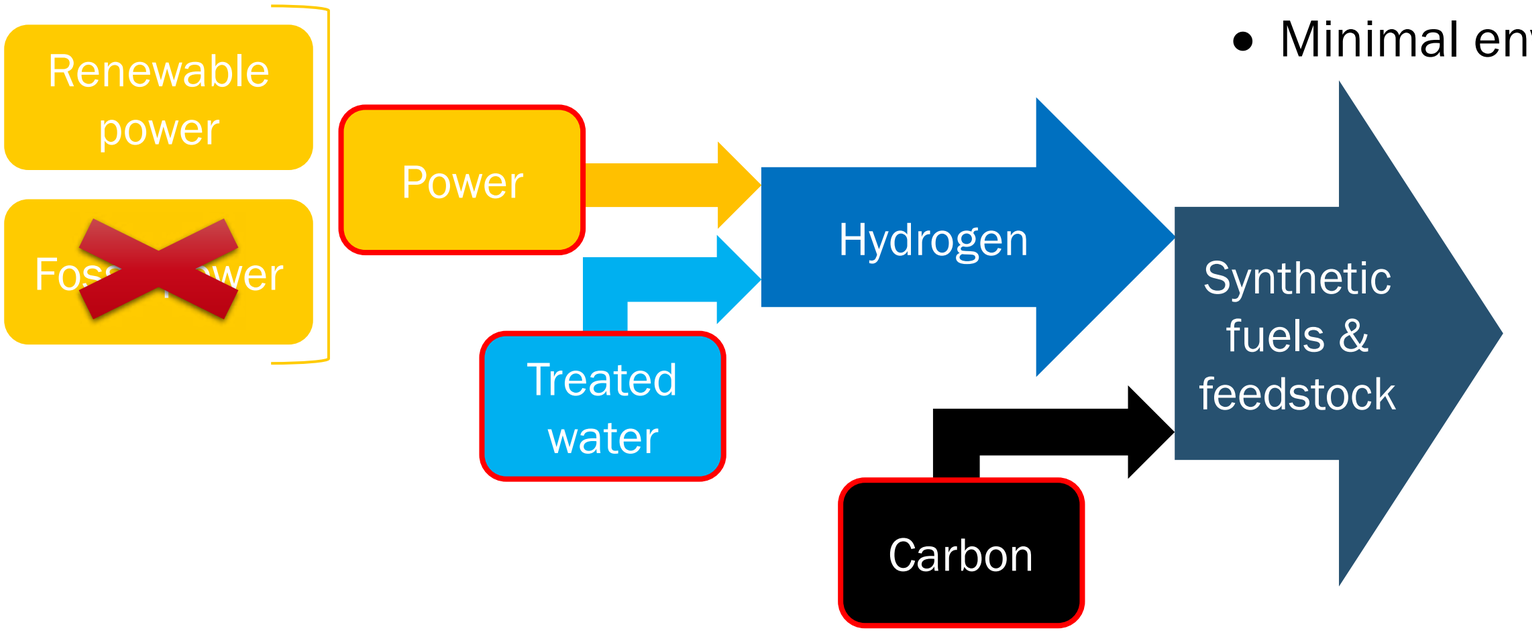
- Operational hours
- Availability of land for upscaling



WHAT MATTERS FROM AN EU OFFTAKER PERSPECTIVE?
SECURITY OF SUPPLY, CARBON INTENSITY AND COST

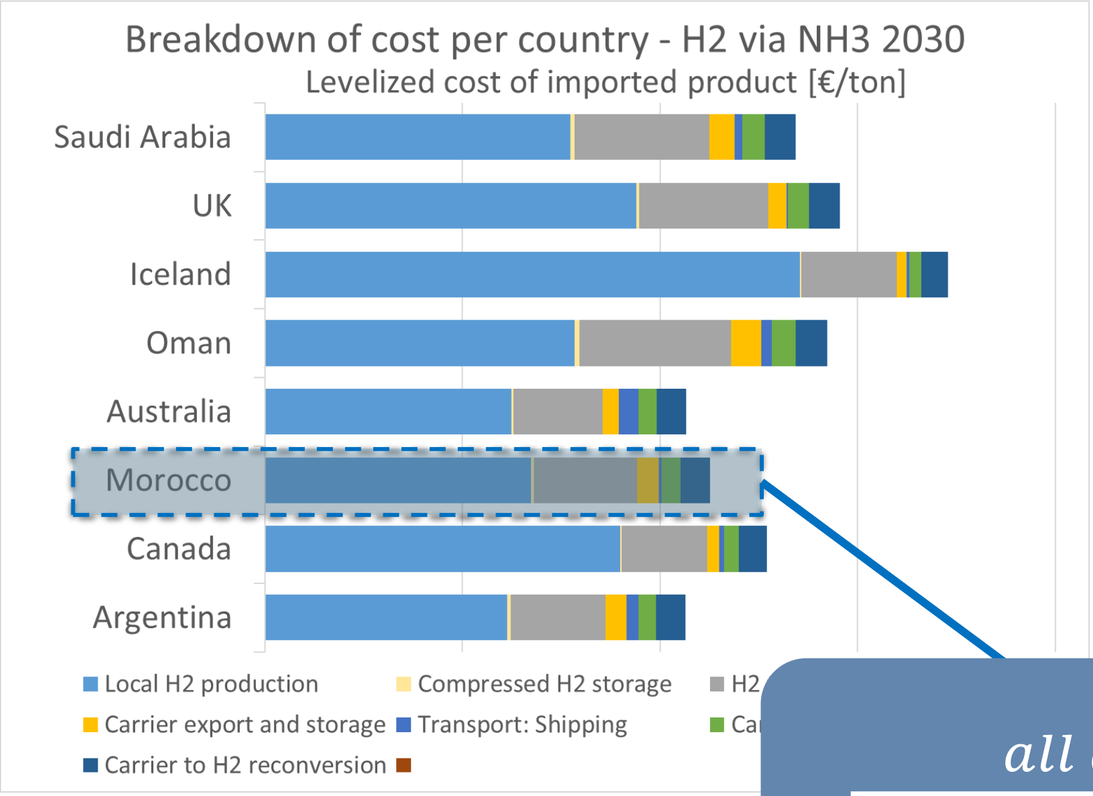
Complementory drivers are:

- Operational hours
- Availability of land for upscaling
- Availability of feedstock (H_2O, C or CO_2, N_2)
- Minimal environmental footprint



Carbon sources:
- Fossil hydrocarbons
- (Domestic) waste
- Biomass
- Point capture of CO_2
- Direct air capture

WHAT MATTERS FROM AN EU OFFTAKER PERSPECTIVE?
SECURITY OF SUPPLY, CARBON INTENSITY, **COST**



Cost drivers are:

- The local cost of renewable electricity
- Operational hours
- Economies of scale of H_2tX and logistics
- Distance of country for shipping LOHC and LH_2

$$\frac{all\ annual\ costs}{annual\ hydrogen\ delivered} = \frac{736\ M€}{163\ kton} = 4{,}5\ €/kg$$

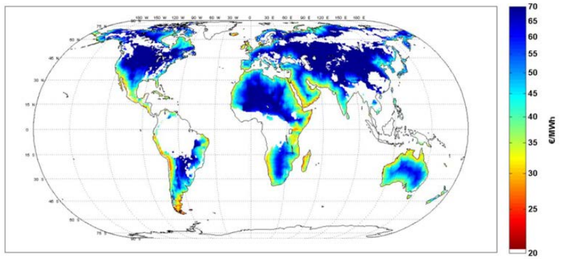
Assumptions

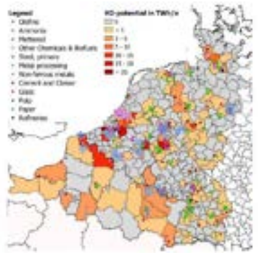
2 GW PV+onshore wind, 1.7 GW AEL, PtH_2 load-following

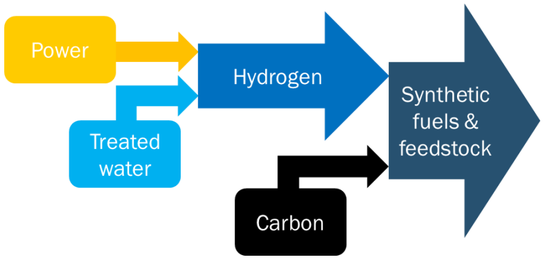
Source: TNO (2022) Cost analysis and comparison of different hydrogen carrier import chains and expected cost development, HyDelta 1.0 program

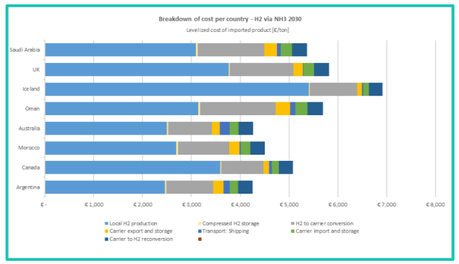
TNO innovation for life

KEY TAKE-AWAYS & DISCUSSION STARTERS:









- EU targets 2030 include major renewable hydrogen volumes
- Hydrogen trade between Africa and Europe is envisioned by many
- Many possible value chain designs

Focus on five major drivers can increase competitiveness of Africa-EU value chains:

1. Levelized cost of renewable electricity
2. Operational hours of processes
3. Economies of scale benefits
4. Feedstock availability
5. Minimal environmental footprint

We look forward to think along, and independently assess, the feasibility of novel value chain options.

Contact: T.C. (Thomas) Hajonides van der Meulen, thomas.hajonides@tno.nl

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PRESENTATION 2

MR. SAM LAMBOO

Medior Scientist Energy Transition Studies

TNO

AFRICA WORKS! 2022
Innovation for Resilient Growth

ENERGY SCENARIOS MODELLING FOR AFRICA

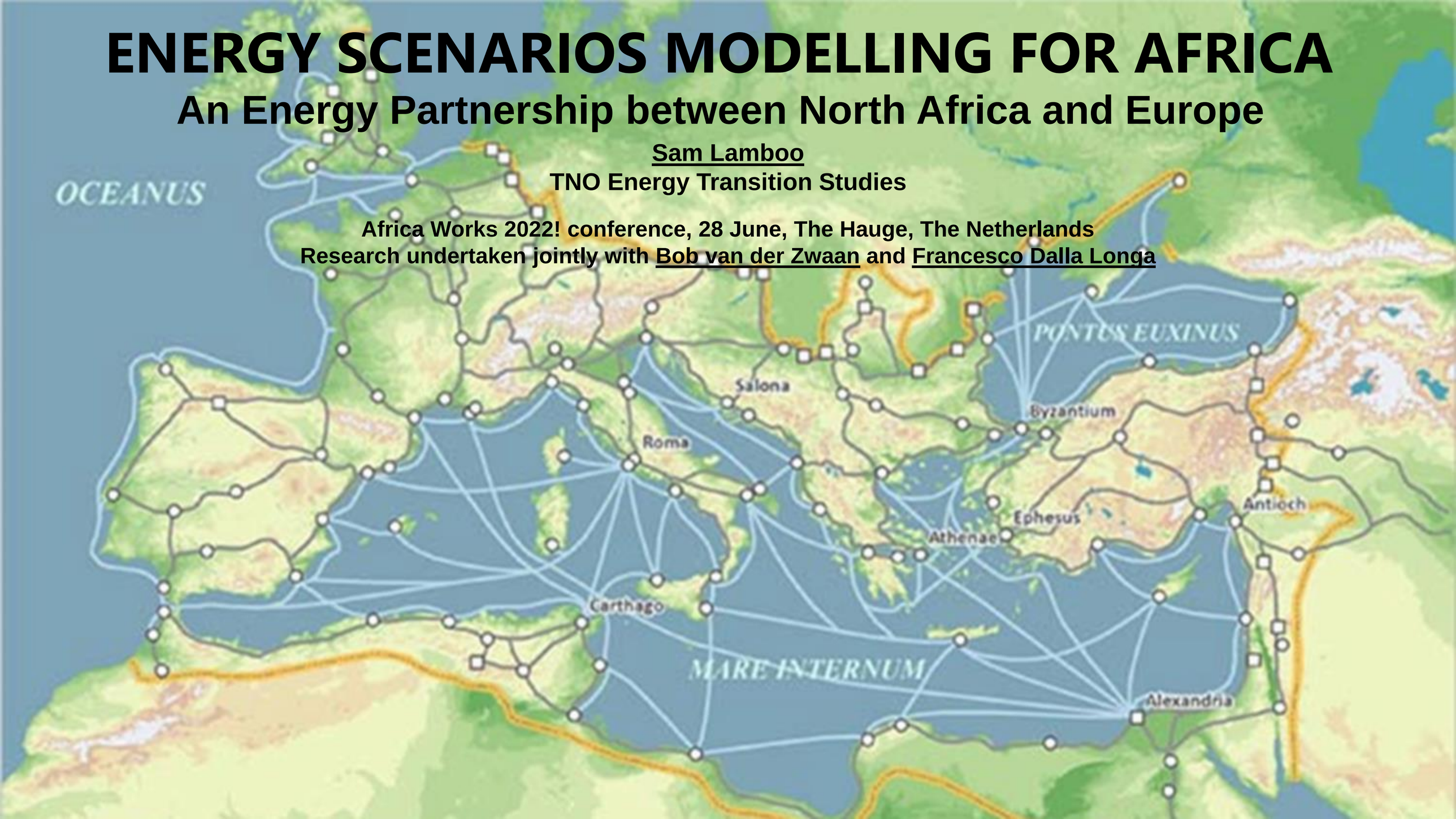
An Energy Partnership between North Africa and Europe

Sam Lamboo

TNO Energy Transition Studies

Africa Works 2022! conference, 28 June, The Hauge, The Netherlands

Research undertaken jointly with Bob van der Zwaan and Francesco Dalla Longa



OUR RESEARCH ON AFRICA

- Dalla Longa, F., B.C.C. van der Zwaan, “Do **Kenya’s Climate Change Mitigation Ambitions** Necessitate Large-Scale Renewable Energy Deployment?”, *Renewable Energy*, 113, 2017, 1559-1568.
- van der Zwaan, B.C.C., A. Boccalon, F. Dalla Longa, “Prospects for **Hydropower in Ethiopia**: An Energy-Water Nexus Analysis”, *Energy Strategy Reviews*, 19, 2018, 19-30
- van der Zwaan, B.C.C., T. Kober, F. Dalla Longa, A.J. van der Laan, G.J. Kramer, “An Integrated Assessment of Pathways for **Low-Carbon Development in Africa**”, *Energy Policy*, 117, 2018, 387-395.
- Dalla Longa, F., T. Strikkers, T. Kober, B.C.C. van der Zwaan, “Advancing **Energy Access** Modelling with Geographic Information System Data”, *Environmental Modeling and Assessment*, 23, 6, 2018, 627-637.
- Sweerts, B.R.N., F. Dalla Longa, B.C.C. van der Zwaan, “**Financial de-risking** to unlock Africa's renewable energy potential”, *Renewable and Sustainable Energy Reviews*, 102, 2019, 75-82.
- van der Zwaan, B.C.C., F. Dalla Longa, H. de Boer, F. Johnson, O. Johnson, M. van Klaveren, J. Mastop, M. Ogeya, M. Rietkerk, K. Straver, H. Wanjiru, “An Expert Elicitation of **Public Acceptance** of Renewable Energy in Kenya”, *Challenges in Sustainability*, 7, 1, 2019, 30-39.
- Nogueira, L.P., F. Dalla Longa, B.C.C. van der Zwaan, “A Cross-sectoral Integrated Assessment of Alternatives for **Climate Mitigation in Madagascar**”, *Climate Policy*, 20, 10, 2020, 1257-1273.
- Dalla Longa, F. and B.C.C. van der Zwaan, “Heart of Light: An Assessment of Enhanced **Electricity Access in Africa**”, *Renewable and Sustainable Energy Reviews*, 136, 2021, 110399
- van der Zwaan, B.C.C., S. Lamboo, F Dalla Longa, “Timmermans’ dream: An electricity and hydrogen **partnership between Europe and North Africa**”, *Energy Policy*, 159, 2021, 112613.

TIMMERMANS' DREAM

"In my dreams, we would create a partnership with Africa, especially North Africa, and we would help install a huge capacity of solar energy in Africa and transform that energy into hydrogen. Then we would transport that hydrogen to other parts of the world and Europe,..."

Frans Timmermans (Executive Vice-President, European Commission, 2019)

"…if we don't incorporate a perspective for North Africa…, we will be weakened…"

INTRODUCTION

- The main driver for the **energy transition** is, of course, **climate change**.
- Traditionally, energy **security**, **partnerships**, **dependencies** and **prices** were the main determinants for shaping our energy system and infrastructure.
- We here ask ourselves whether in the context of global climate mitigation (i.e. when fulfilling the goals of the Paris Agreement), *old energy partnerships and dependencies are perhaps going to be replaced by new ones*.

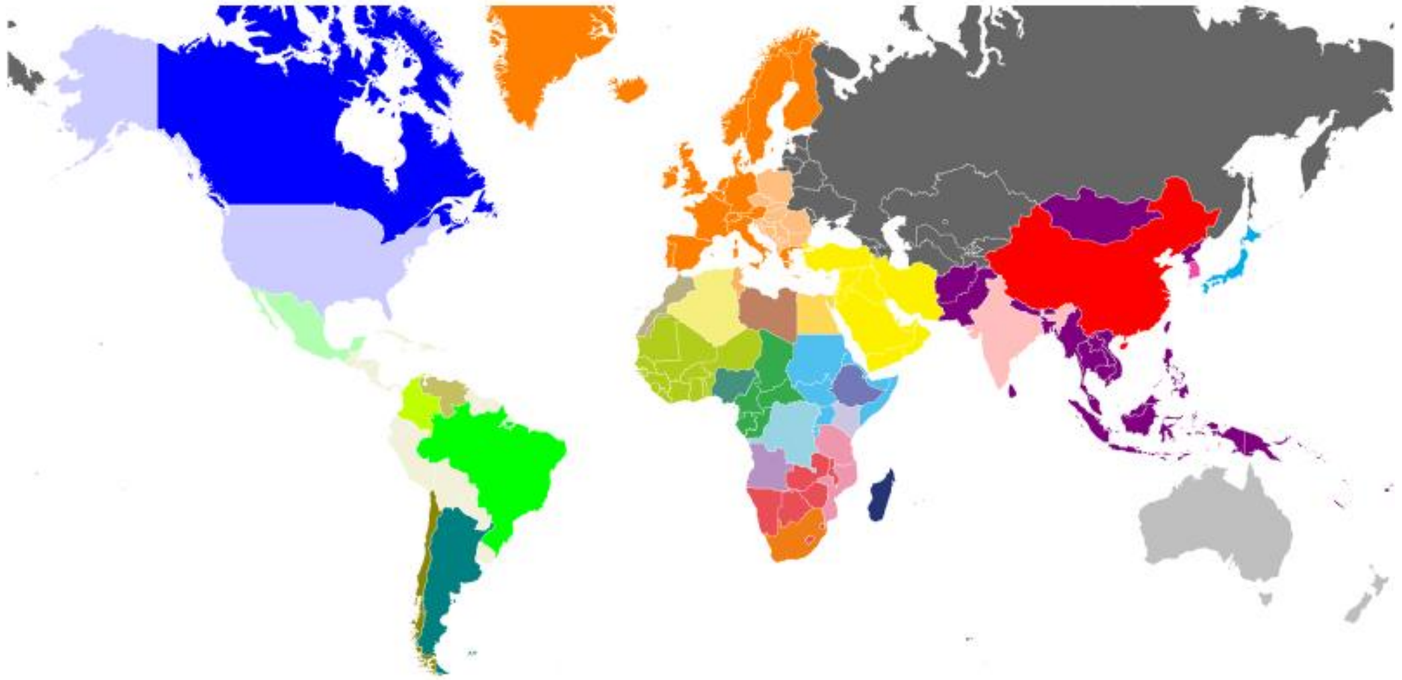
- Our focus has been Europe (EU) and North Africa (NA, 5 Maghreb countries), and the role that **renewable electricity** and **renewable hydrogen** could play in an energy partnership between these two regions.

GLOBAL SCENARIOS MODEL: TIAM-ECN

TIAM-ECN: TNO's integrated assessment model of the global energy system that allows for analyzing how to reach the 2.0 or even 1.5°C target of the Paris Agreement; it is particularly suitable for researching energy trade and new energy dependencies.

TIAM-ECN analysis:

- Model adaptations
- Scenario design
- Scenario runs
- Scenario analysis
- Policy interpretation



ENERGY TRADE SCENARIOS

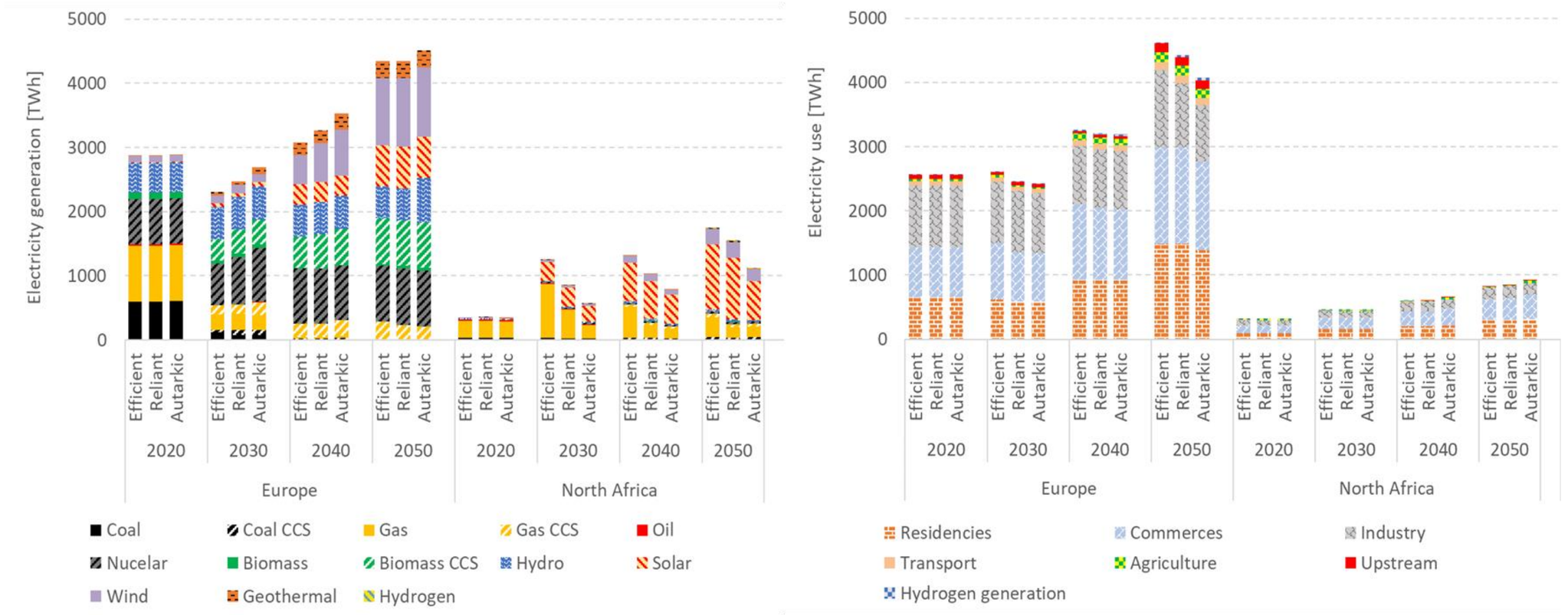
Scenario	Electricity import (2030-2050)	Hydrogen import (2030-2050)	2°C policy
Efficient	High *(no limit)*	High *(max 250-3750 PJ/yr)*	Yes
Reliant	Medium *(max 35-85 GW)*	Medium *(max 125-1750 PJ/yr)*	Yes
Autarkic	Low *(6 GW)*	None *(0 PJ/yr)*	Yes

Scenario runs with TIAM-ECN for trade between Europe and North Africa.

TIAM-ECN RESULTS

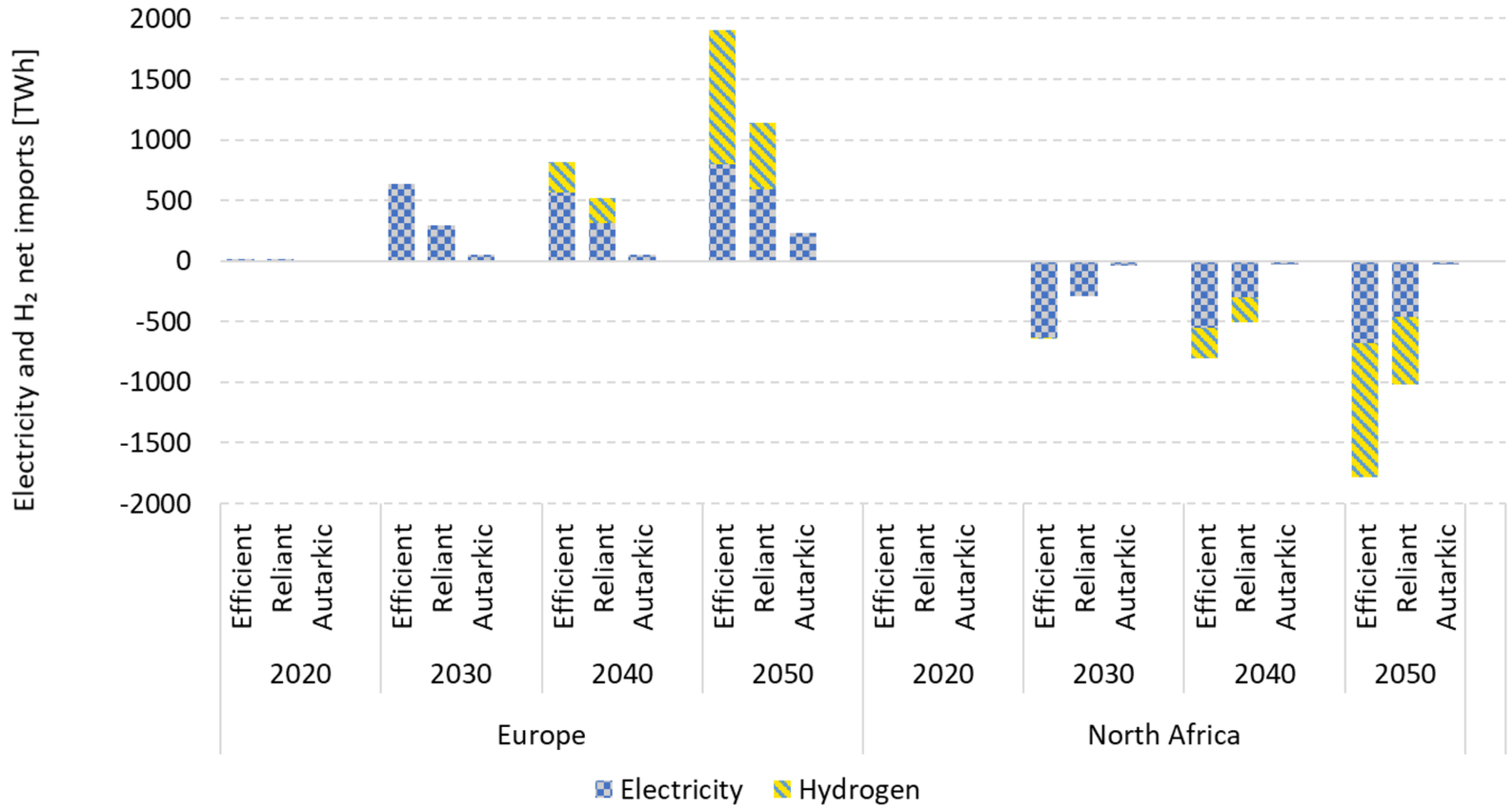
- Individual scenario runs generate a wealth of information.
- The art of integrated assessment modeling, as undertaken for IPCC Reports, is to extract the relevant insights.
- We here show some examples of our central results.

ELECTRICITY SECTOR



Projections with TIAM-ECN for the electricity sector: generation (left) and use (right).

ENERGY TRADE BETWEEN EU AND NA



Projections with TIAM-ECN for trade of EL and H_2 between Europe and North Africa.

KEY MESSAGES

- Timmermans' dream on an NA-EU partnership may (need to) become reality.
- It could become optimal to establish extensive NA-EU energy trade (EL & H_2).
- Net gains for North Africa may grow to 50 billion €/yr in 2050.
- But, Europe may have to pay a net price for an NA-EU energy partnership.
- Despite fears over costs and security, the EU could benefit from this partnership in many ways, indirectly: stimulating economic growth in North Africa, increasing income, employment and stability in the region, and thereby perhaps even averting future large-scale (climate-induced) migration.
- Trade reduces domestic renewable investments required for EU's Green Deal.
- EU can reduce intricacies with locating renewable energy projects.

PRESENTATION 3

DR. AHMADREZA RAHBARI

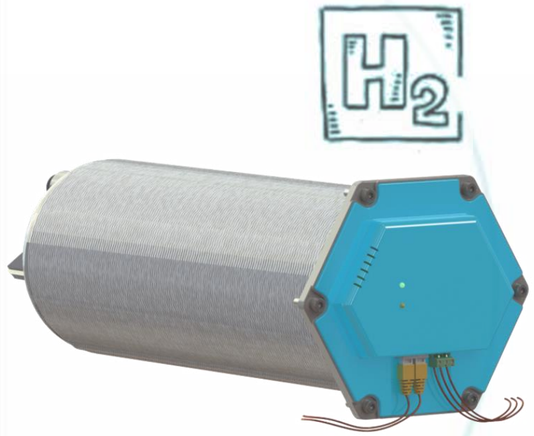
Lead Scientist

XINTC Global

AFRICA WORKS! 2022
Innovation for Resilient Growth

Africa Works! 2022

The global race to net zero by 2050 is accelerating!



Dr. Ahmadreza Rahbari

Email: ara@XINTC.global

Lead Scientist

Energy Access – Backbone of the Economy

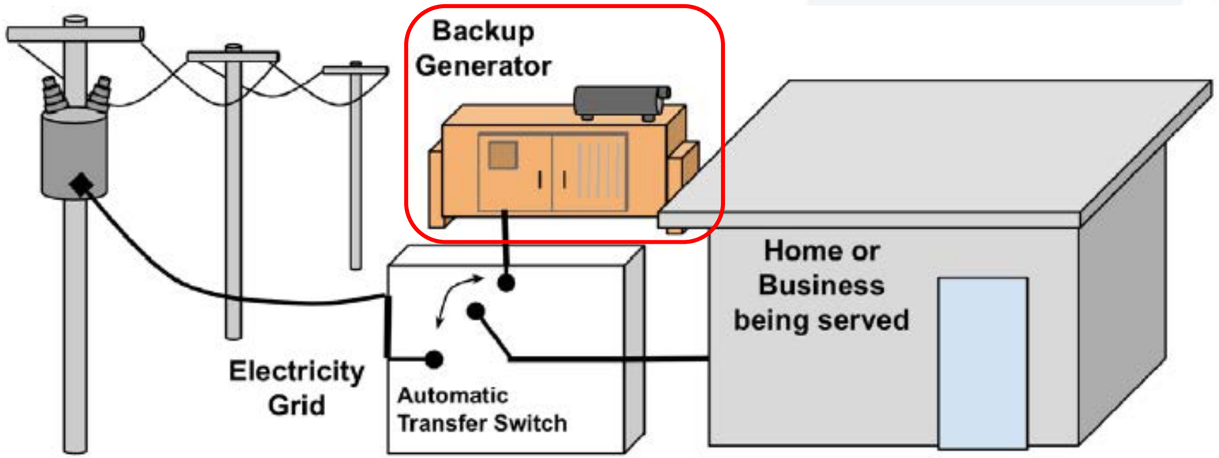
Two-thirds of African grids are considered unreliable

69% of African households are unelectrified

Gensets are generally used for **thousands of hours** instead of intermittent use

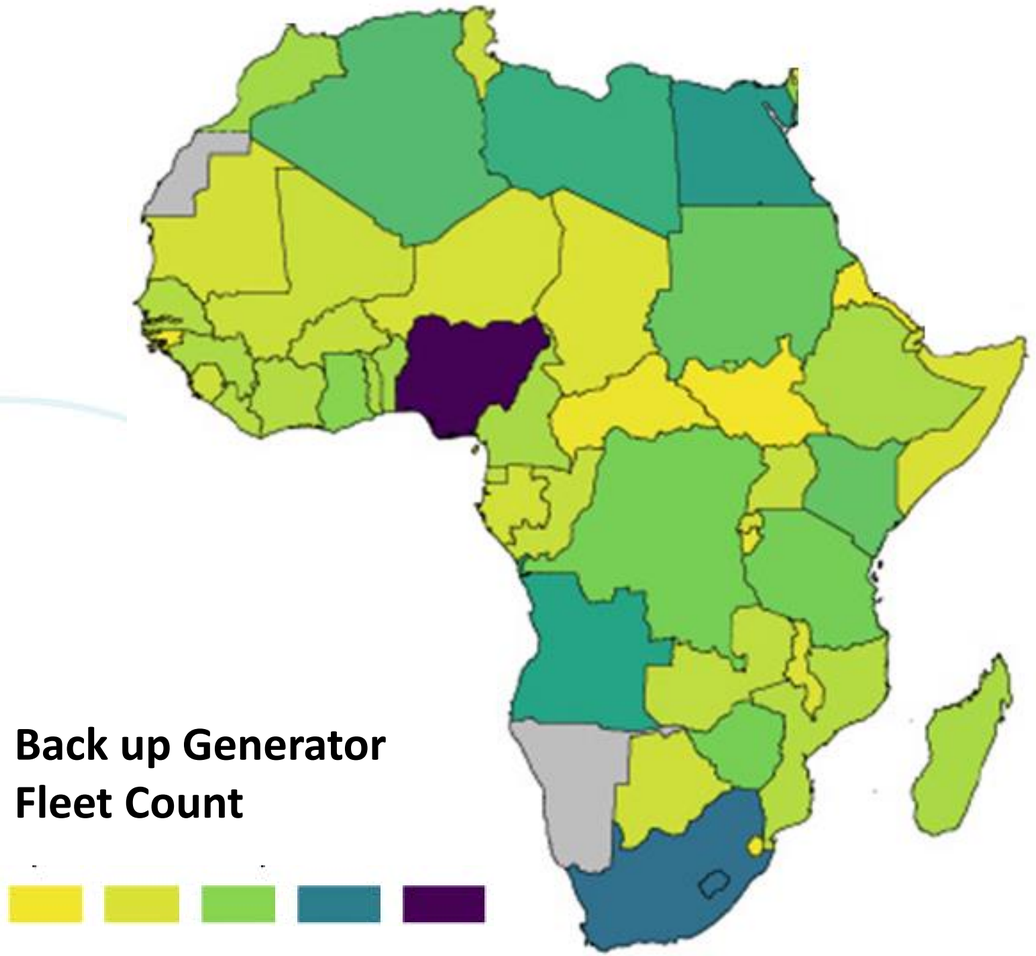
Continued reliance on gensets brings financial, environmental, and health **challenges**.

Significant opportunity to reduce costs and negative health and environmental impacts by replacing gensets.



Source: The Dirty Footprint of the Broken Grid, The Impacts of Fossil Fuel Back-up Generators in Developing Countries, 2019

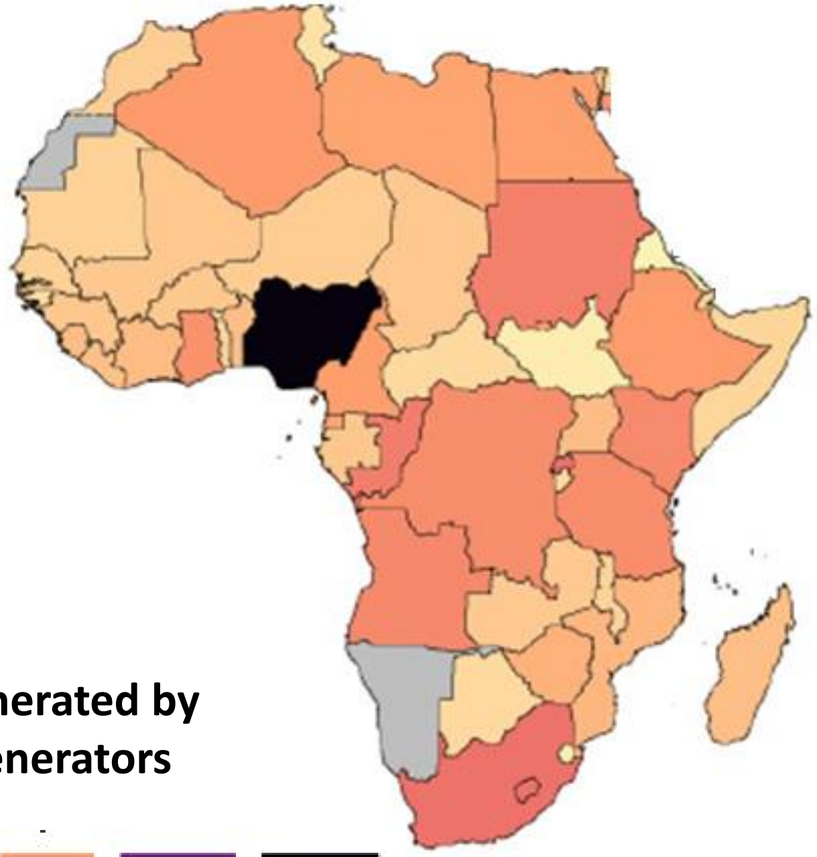
Gensets & Grid Energy Generation



- **7 million**
  Backup genset sites in Sub-Saharan Africa
- **120 coal-fired power stations**
  Equivalent to using gensets
- **13 billion USDs**
  Per year spent on fuel for gensets

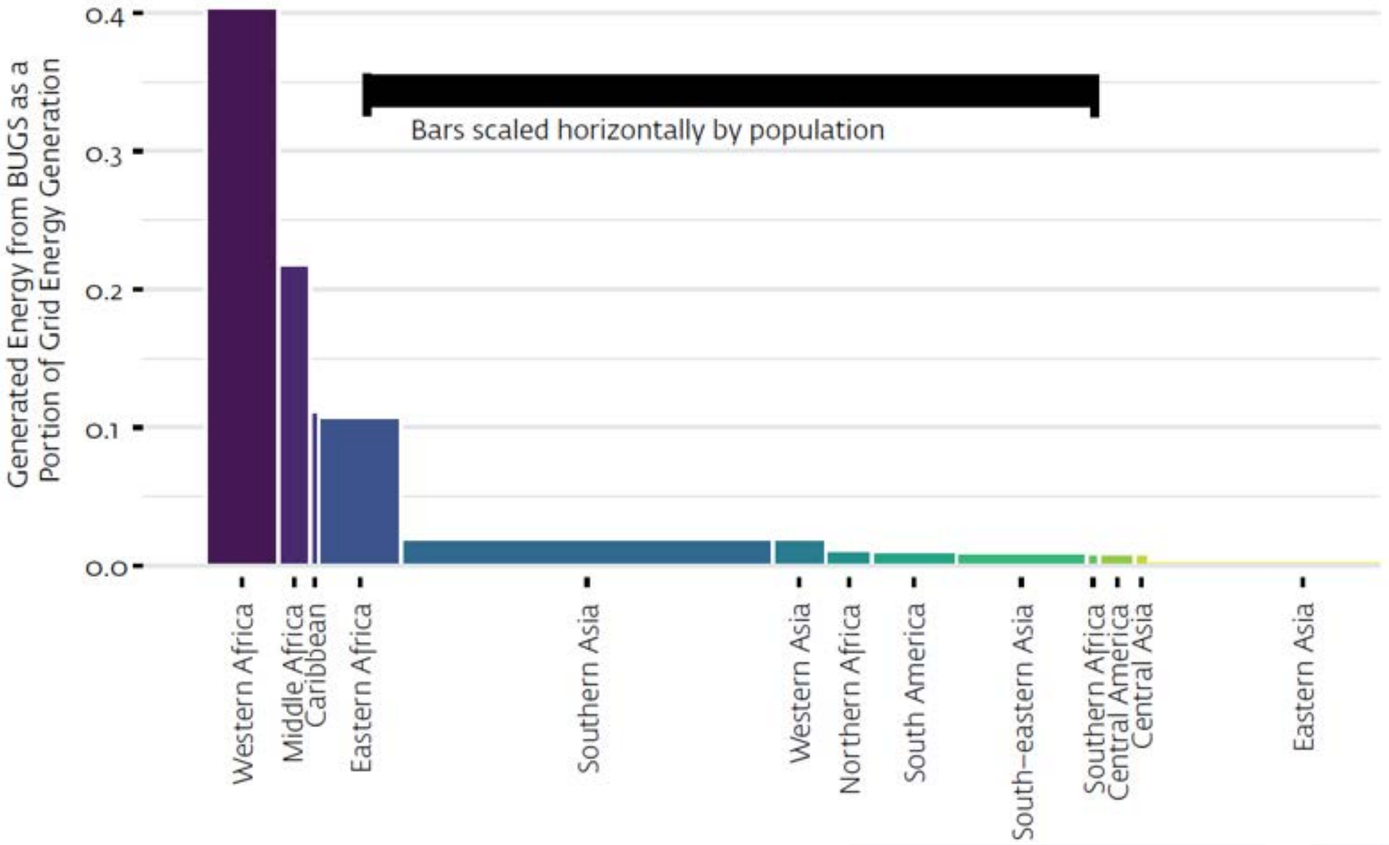
Source: The Dirty Footprint of the Broken Grid, The Impacts of Fossil Fuel Back-up Generators in Developing Countries, 2019

Gensets & Grid Energy Generation



Energy generated by back up generators

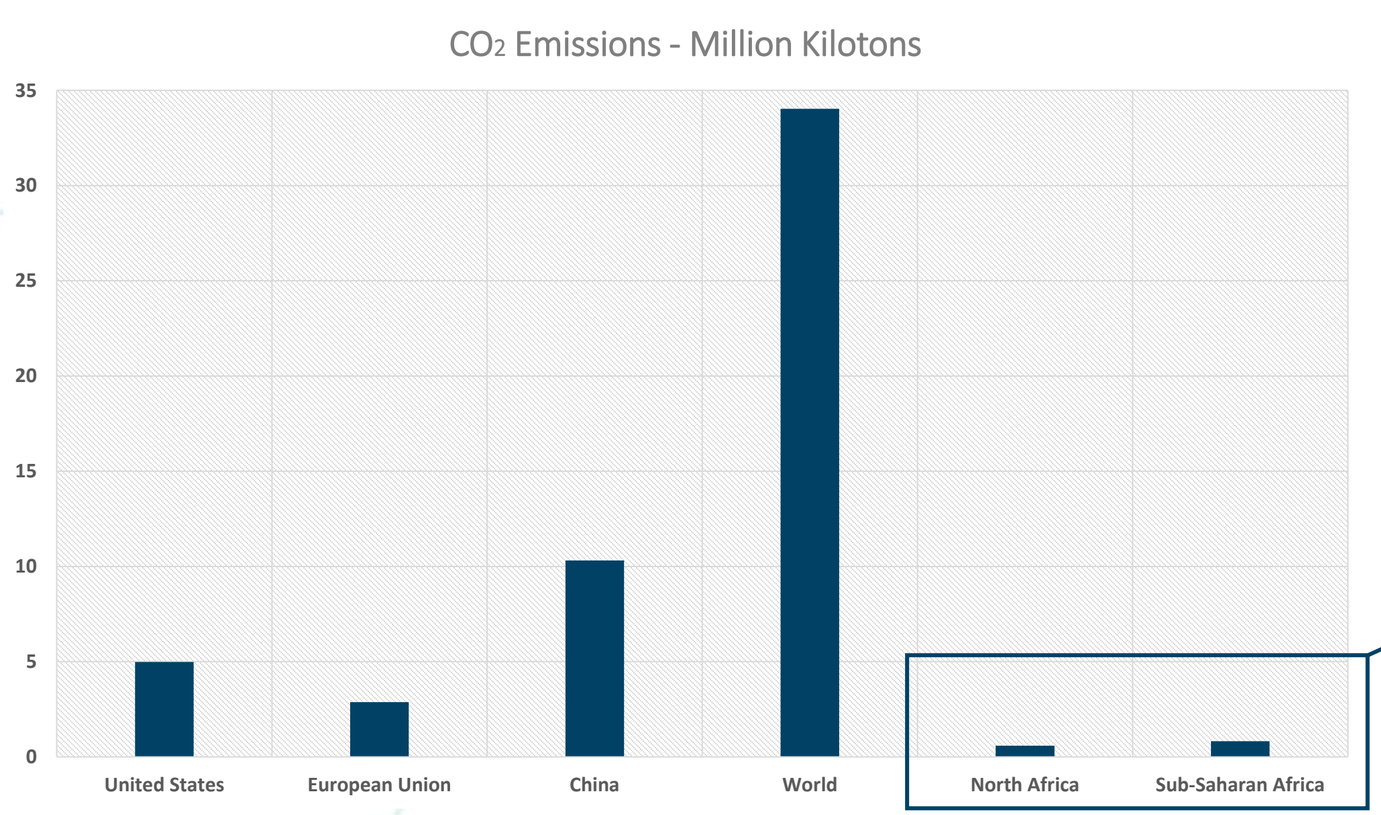
10 100 1000 10000 20000 (Gwh/Year)

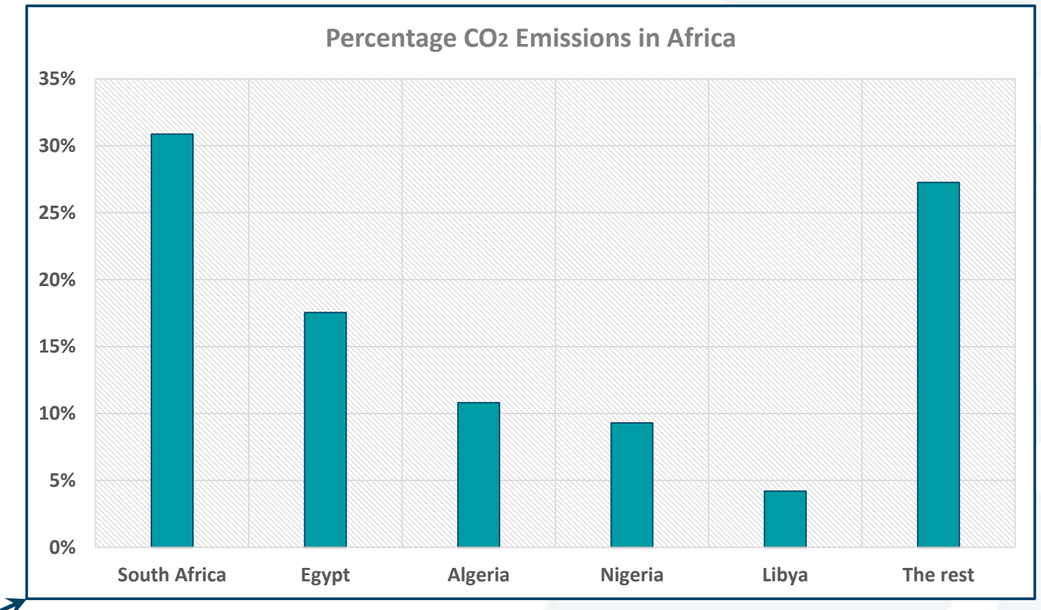


Source: The Dirty Footprint of the Broken Grid, The Impacts of Fossil Fuel Back-up Generators in Developing Countries, 2019

CO_2 emissions

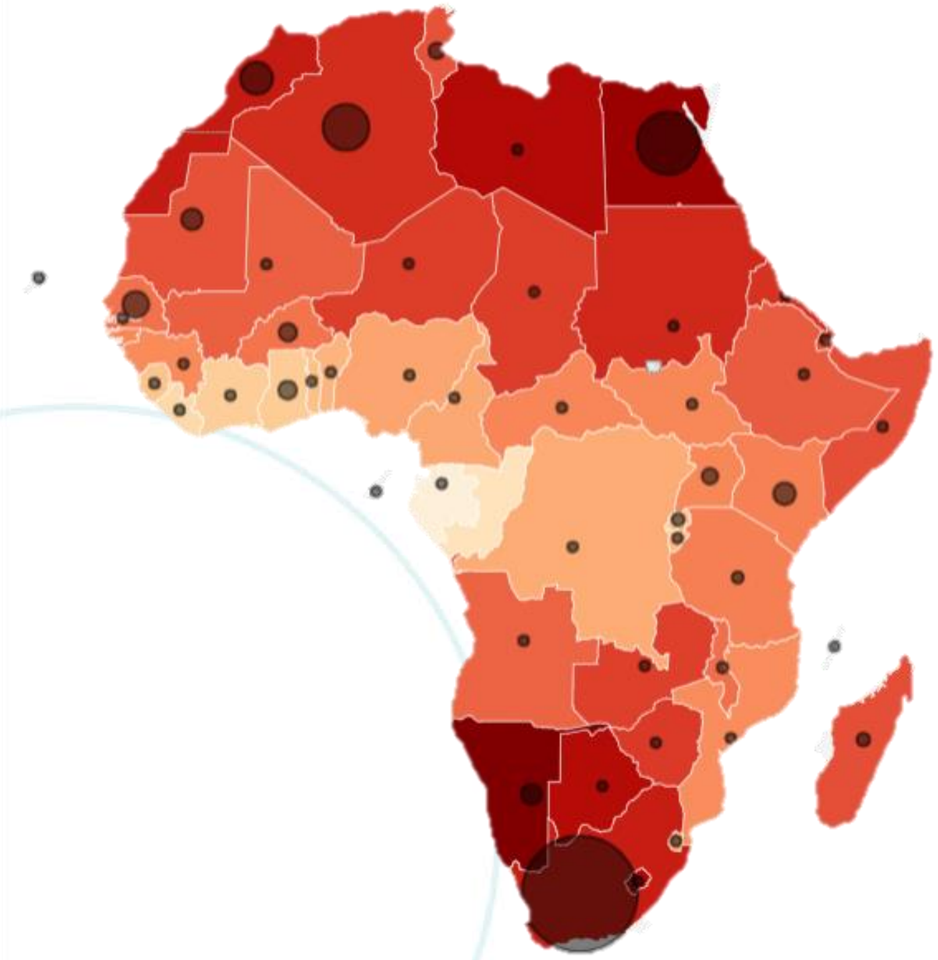
- A one-size-fits-all approach cannot be adopted!



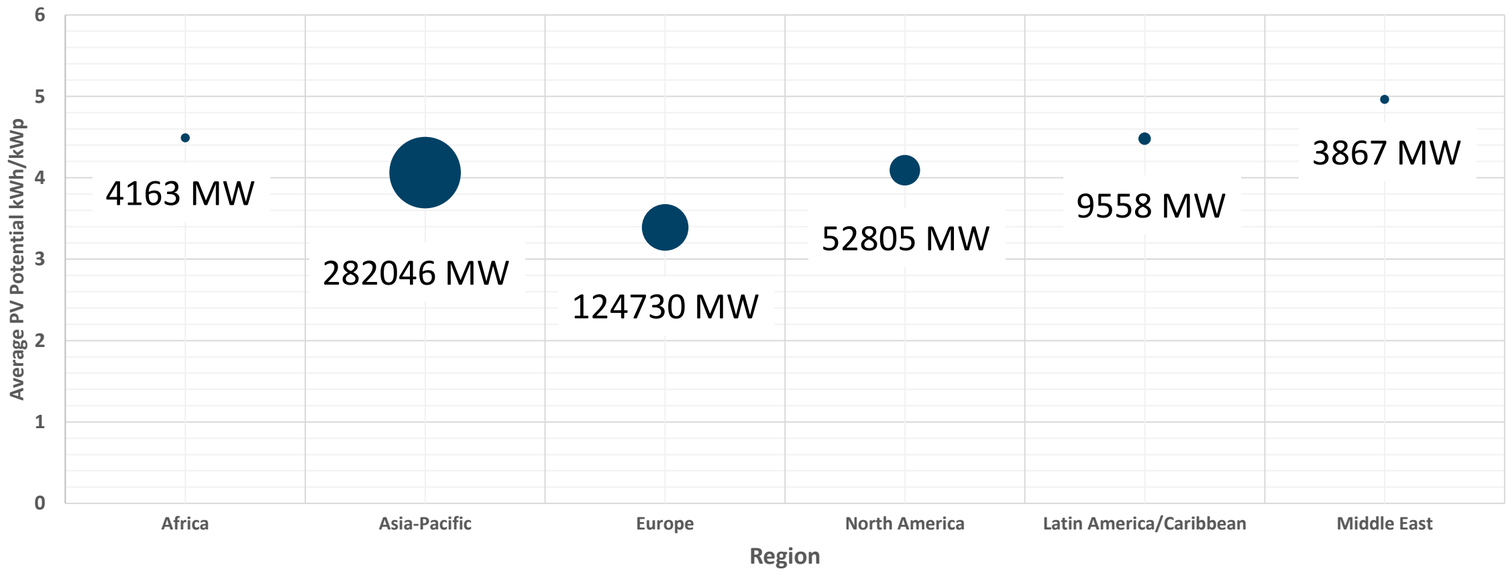


Source: https://data.worldbank.org/

Africa's Solar Energy Potential Remains mainly Untapped!



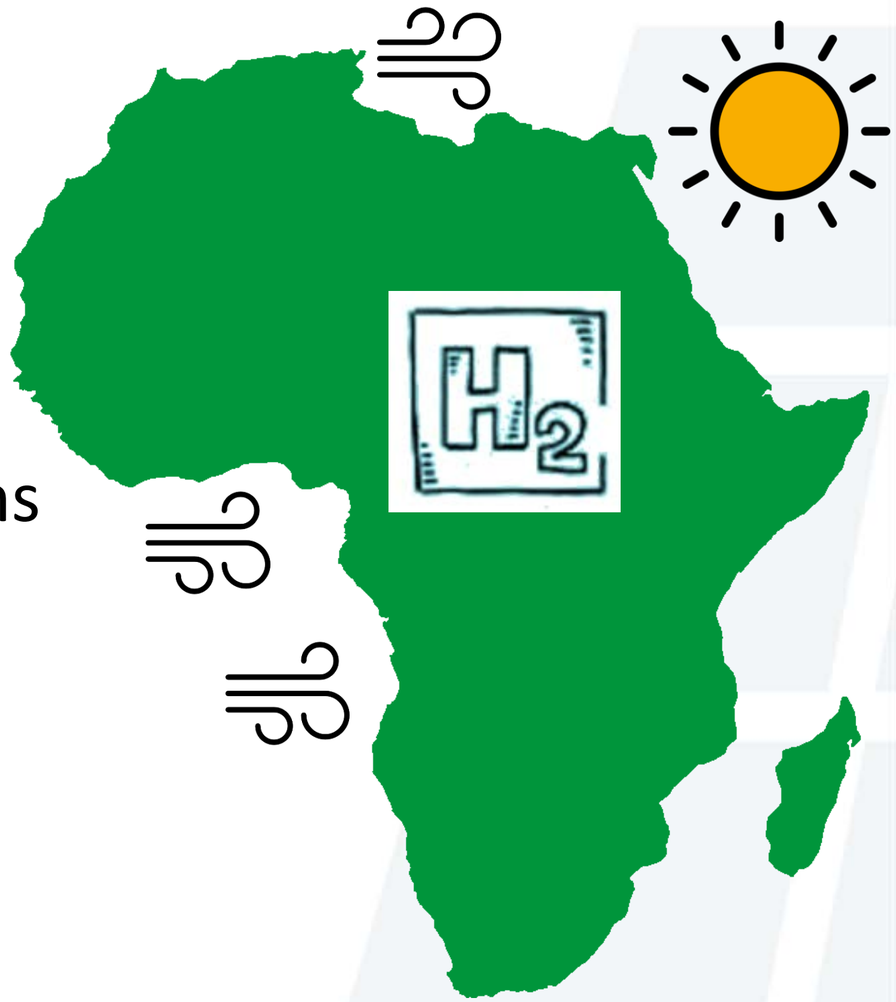
Installed Photovoltaic Potential by Region. Size mirrors installed Capacity



Source: https://www.fdiintelligence.com/content/data-trends/africa-is-missing-out-on-solar-energy-potential-79823

Why Green hydrogen?

- Hydrogen produced using renewable energy sources
- Green alternative for backup generator sets
- Production mainly in rural (and offshore) regions
- Reduce economic burden
- Electrical transport problems
- Africa, exporter of hydrogen to the rest of the world



Other Derived Benefits in Africa

Potential job gains per renewable energy technology per MW in Africa by 2030 (FTE jobs/MW)

		Potential CIM Jobs in Africa (short term)	Potential O&M Jobs in Africa (medium to long term)
Renewable Technology	Solar PV	37,999,13	335,286
	Wind	284,076	16,233
	Hydro	571,950	3,050
	Bioenergy	131,128	17,030
Total		4,787,067	371,599

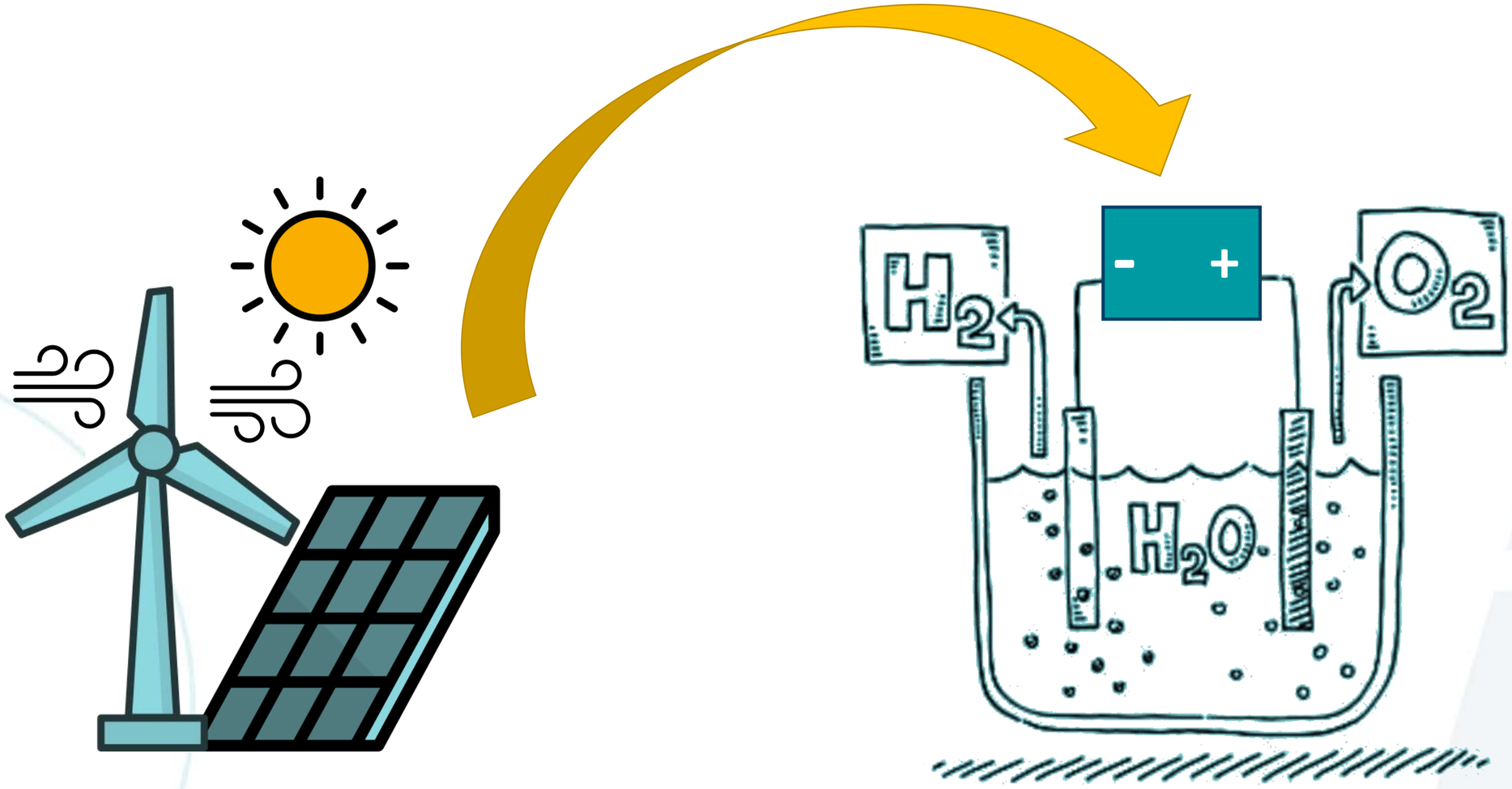
Source: PwC Analysis

Transition to green hydrogen & other renewable technologies:

- Capturing the (global) market share in time
- Transition for workers previously employed by the fossil fuels industry
- Metals mining for battery production, including vanadium, manganese, nickel, etc.

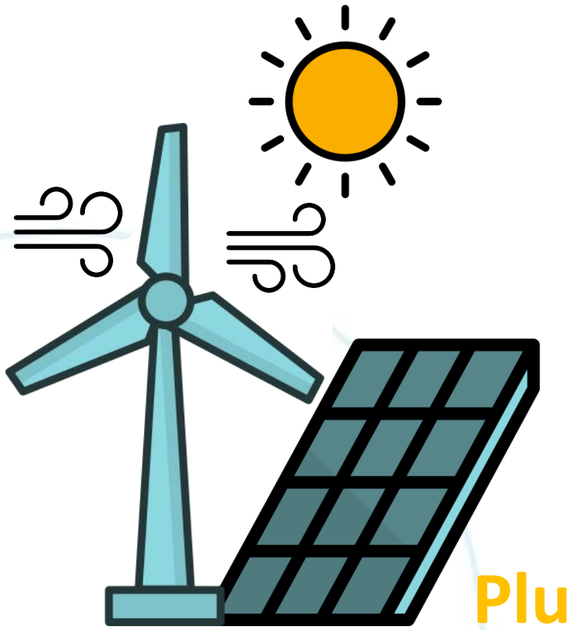
XiNTC ELECTROLYSERS

Producing Hydrogen Using Electrolysis



XiNTC ELECTROLYSERS

Original Equipment Manufacturer

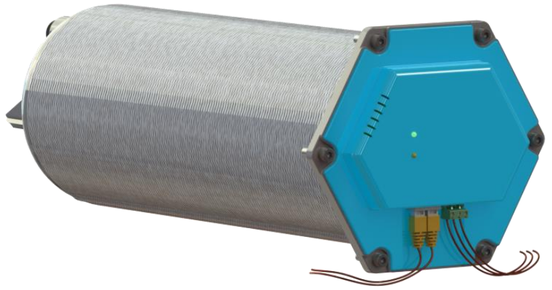


Plug & Play

50+MW

Middel Market

150kW



Green H2

A Unique product – No Engineering Solution

- No membranes
- No rare metals
- Plastic housing
- Captures dynamic loads
- Recyclable

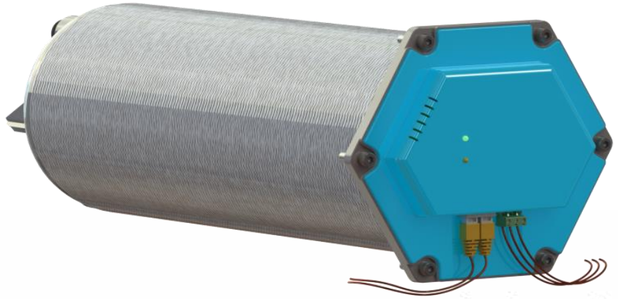
Smart
Robust
Modular
Scalable
Sustainable
Low maintenance

Power electronics

Process control & PM

Water treatment & electrolyte

Gas conditioning

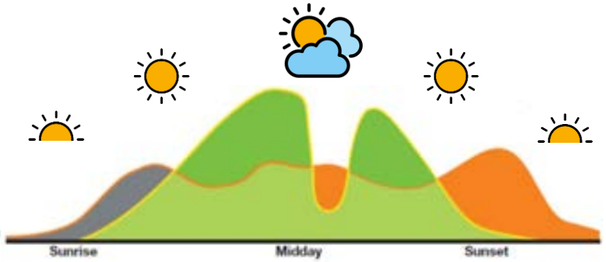


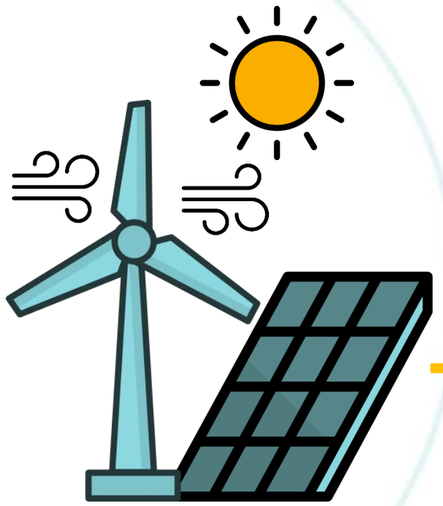
PATENT

Service station

Production Container

Utilizing Full Capacity using Containerized Solutions





Plug & Play

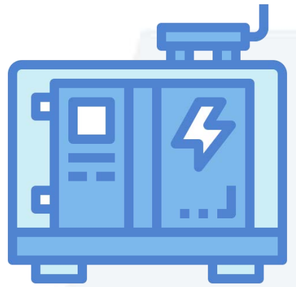
AC/DC Source

Heating

Storage

cooking

Hydrogen gensets



Synergy

XiNTC ELECTROLYSERS

Economies of Numbers

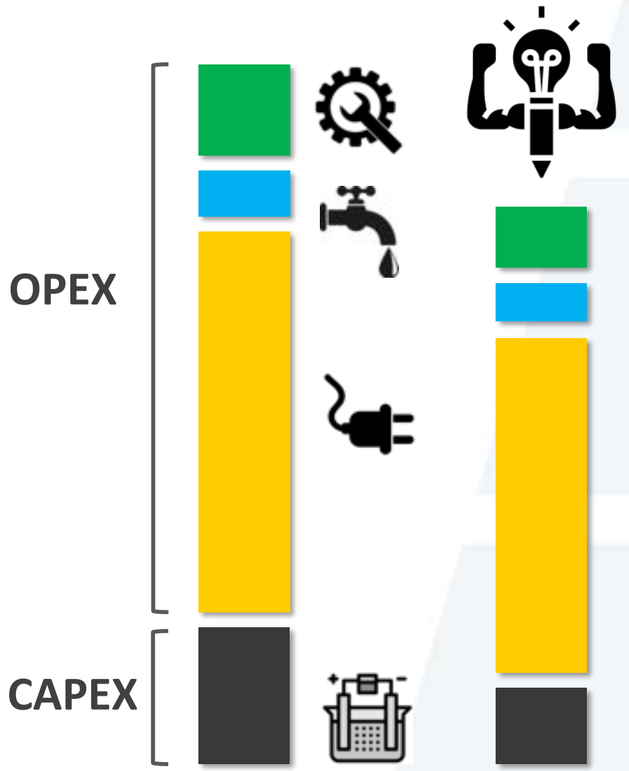
+

+

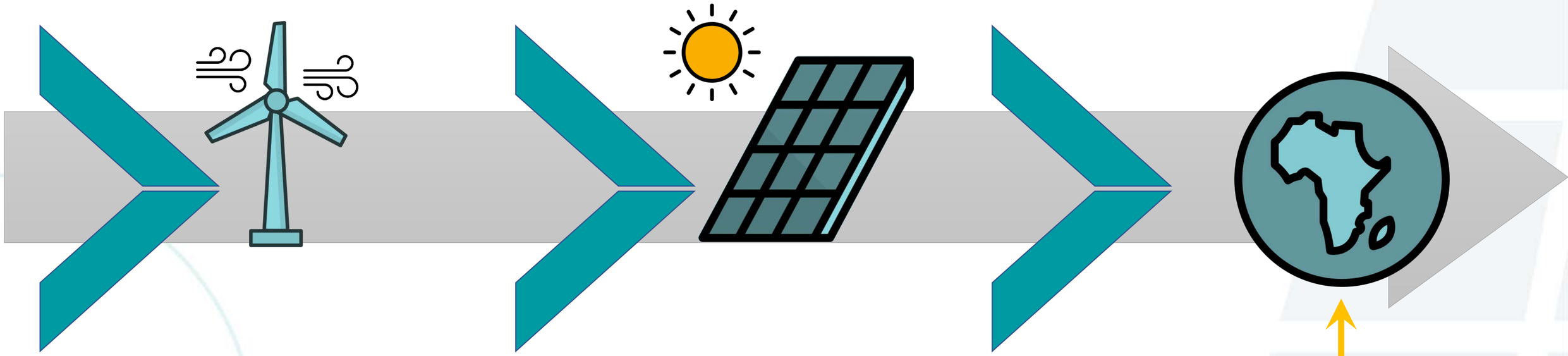
=

Mass production of electrolyzers
“Economies of numbers approach”

- Standardize, standardize, standardize
- Avoid long-lead specialist supply parts
- Automated manufacturing techniques
- Supply chain
- Pre-fab modules and sub-parts
- Local assembling partners



Closing Africa's Future Energy Demand gap



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THANK YOU FOR YOUR ATTENTION

DO YOU HAVE ANY QUESTIONS?

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