Green Hydrogen for Africa- Potentials, opportunities and challenges

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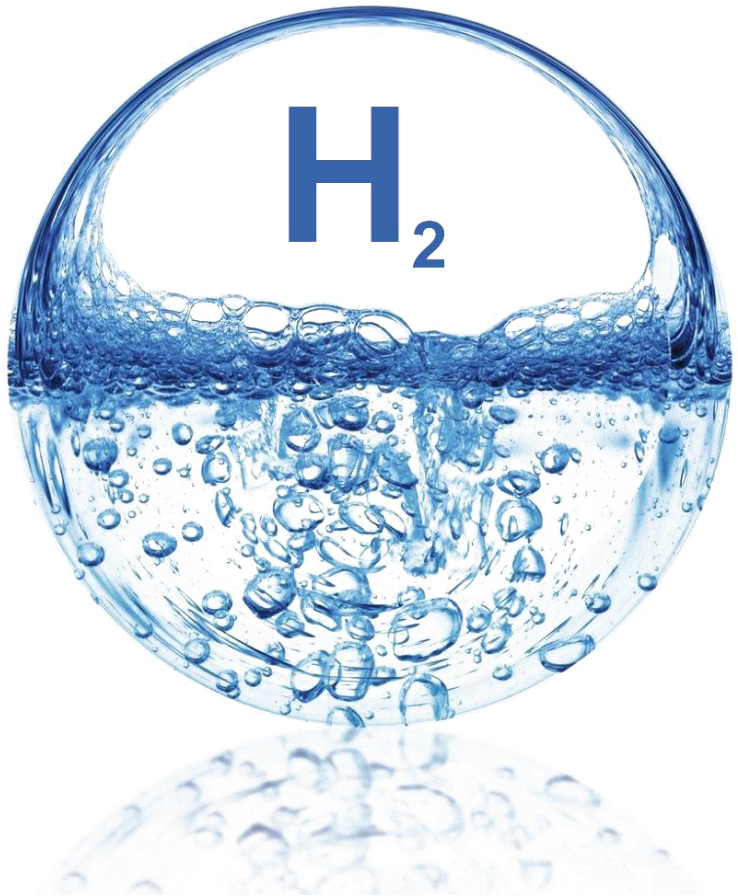
Basic facts about hydrogen



- Most prevalent element in the whole universe
- Gaseous at room temperature and atmospheric pressure
- Burns with oxygen to produce water
- Produced from a variety of sources (water, fossil fuels, or biomass)
- Highest energy content of any common fuel by weight (about three times more than gasoline)

➔Produces water on combustion, hence no carbon emissions

https://medium.com/@KOR_Water

Why hydrogen?

- Can be produced and used green
- Broad applications in the industries, transport sector, residential and for electrification
- Opportunity to store energy
  - Grid stability
  - Deal with intermittent sources
- Can produce synthetic fuels (methanol, methane, ammonia etc) for transport sector

➔Many possibilities in direct or indirect use

How is hydrogen produced?

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Green hydrogen

Technology: Electrolyser
Input: RE electricity
Process: Splitting water into hydrogen and oxygen

Blue hydrogen

Technology: (1) Steam Methane Reforming (SMR) plant with carbon capture and storage (CCS); (2) Coal gasification plant with CCS
Input: (1) Natural Gas; (2) Coal
Process: Converting (1) natural gas / (2) coal into hydrogen and CO_2, CO_2 stored and/or reused

Grey hydrogen

Technology: (1) Steam Methan Reforming (SMR) plant; (2) Coal gasification plant
Input: (1) Natural Gas; (2) Coal
Process: Converting (1) natural gas / (2) coal into hydrogen and CO_2

Turquoise hydrogen

Technology: Methane pyrolysis plant wit carbon capture and utilisation (CCU)
Input: Mainly natural gas
Process: Splitting methane into hydrogen and solid carbon

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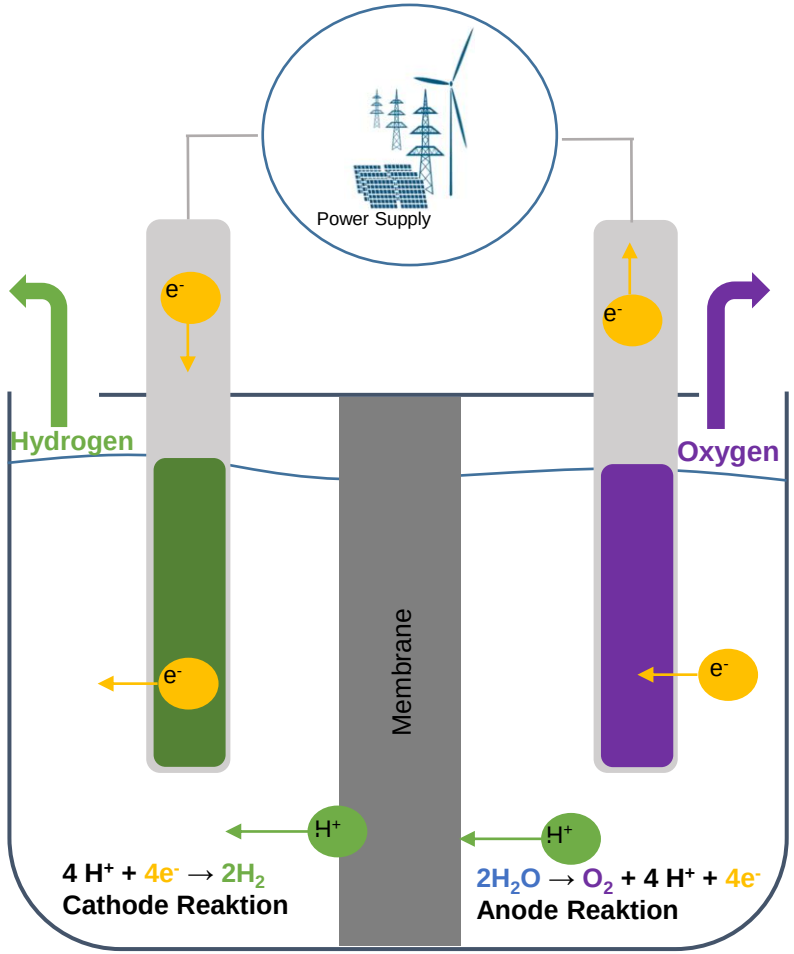
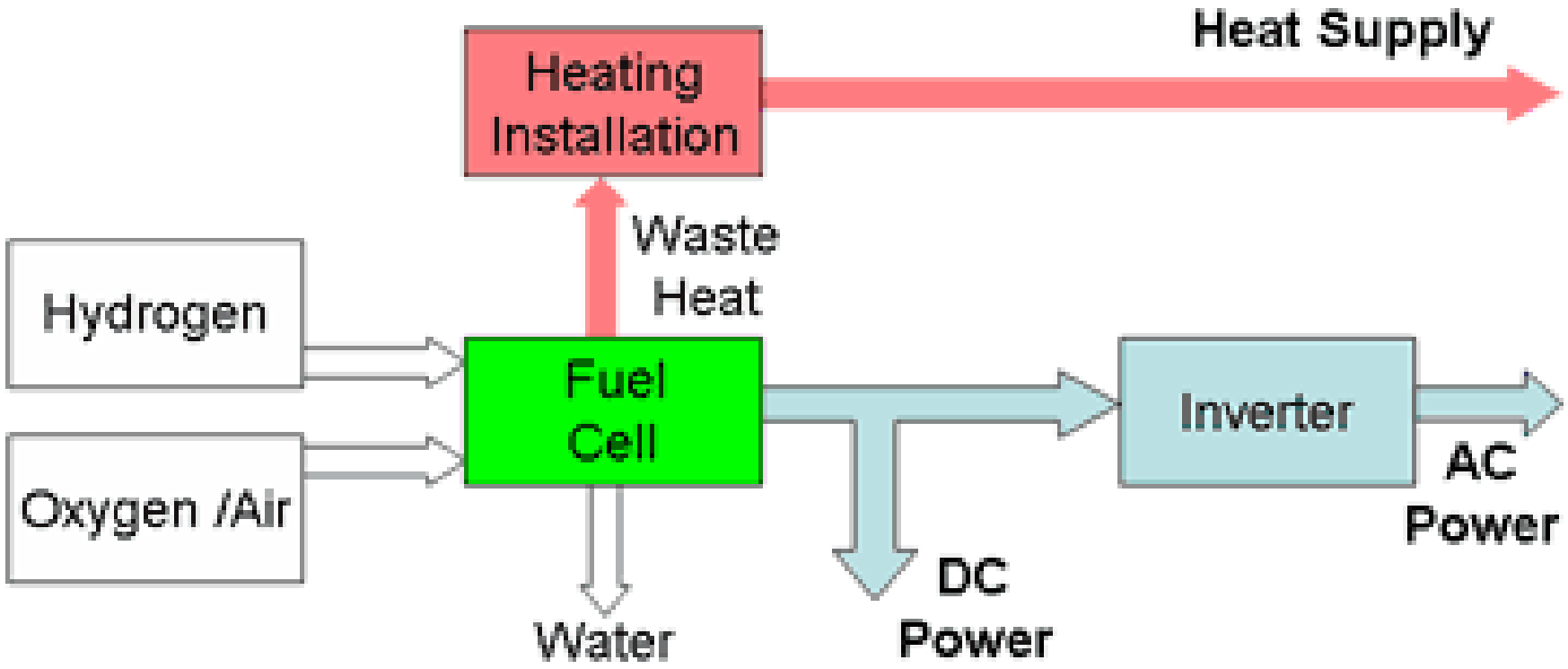
How is green hydrogen produced?

Electrolysis is a key technology

for green hydrogen production

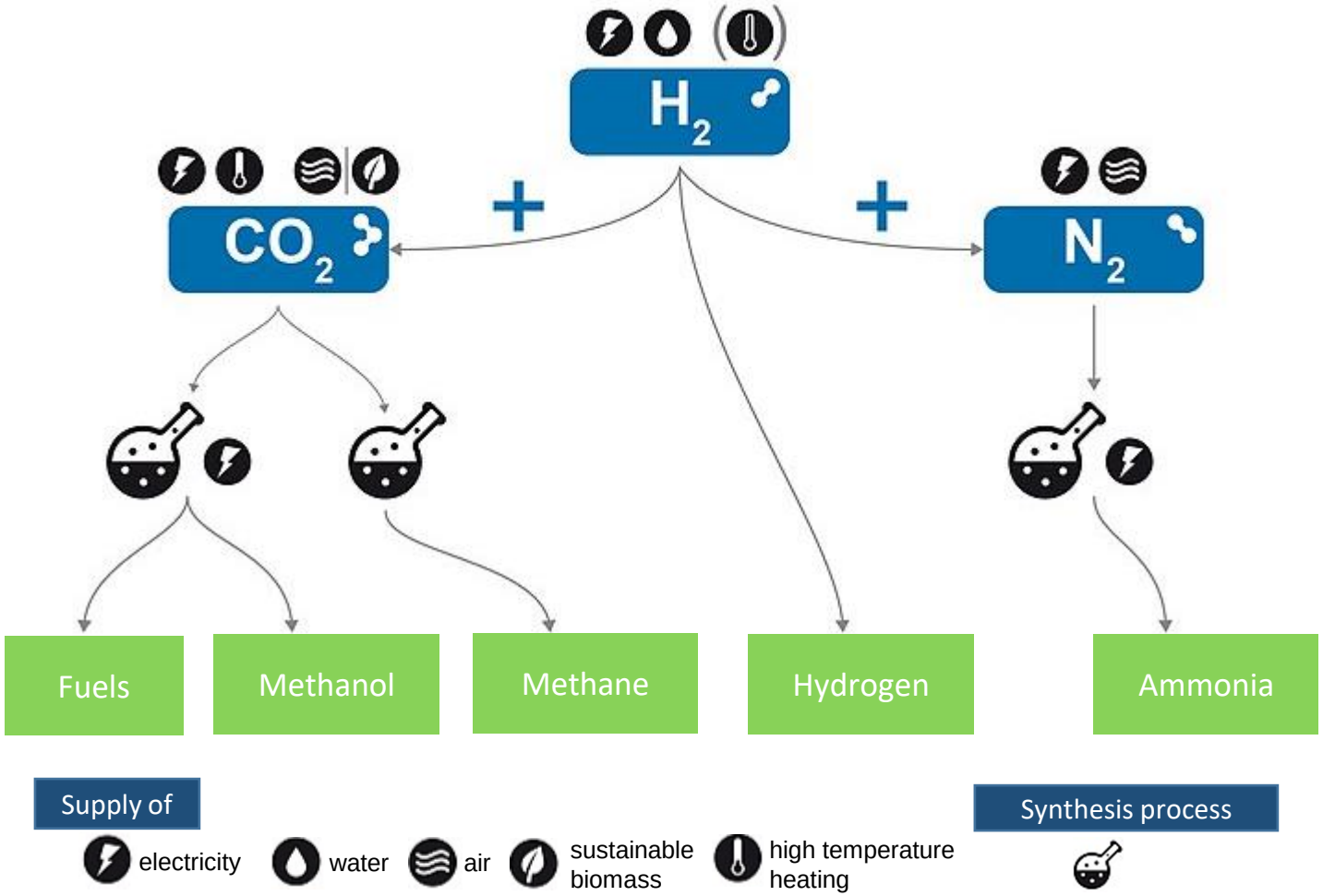


Green hydrogen and energy access

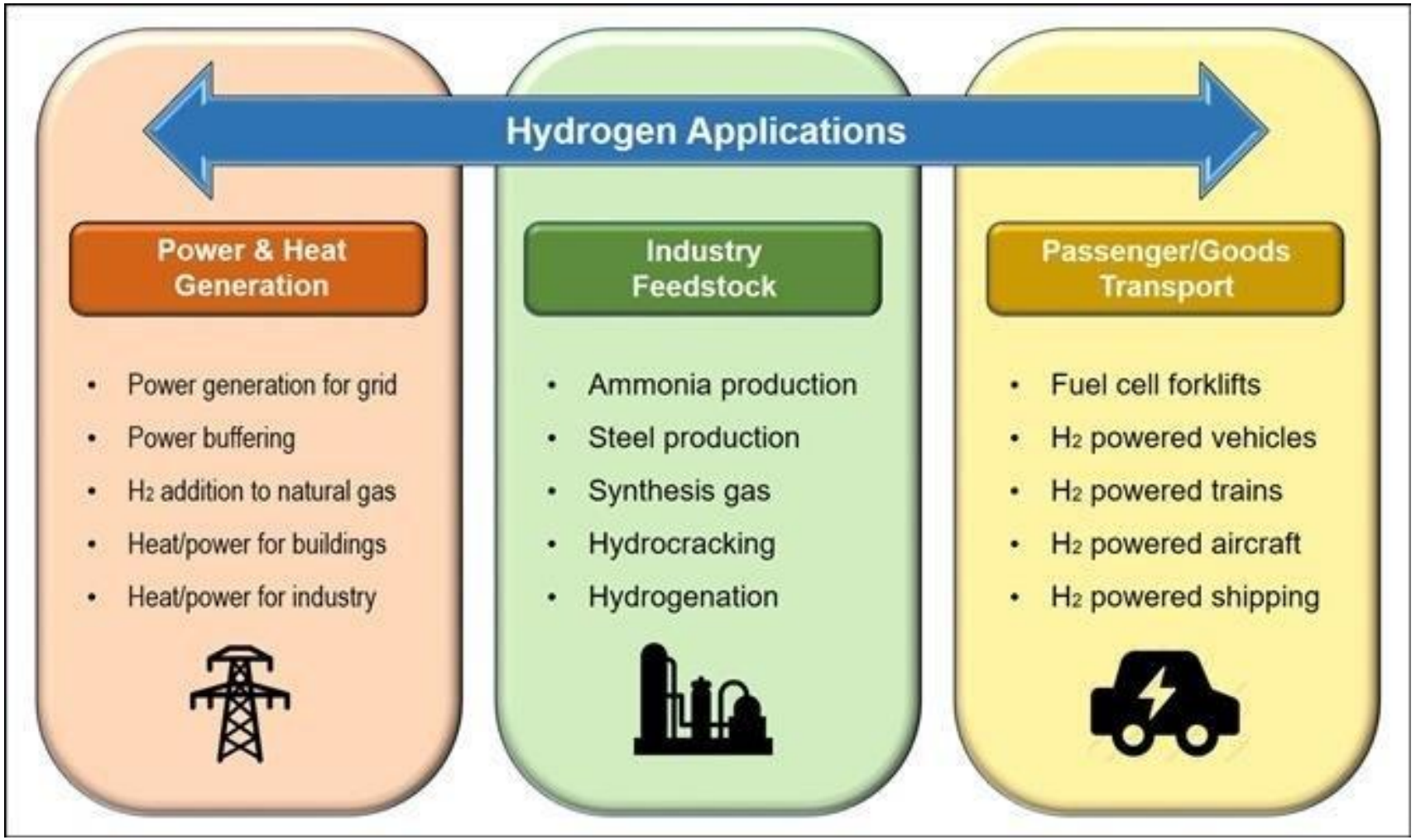


Source: Z. Salameh, Renev

Uses and application of hydrogen

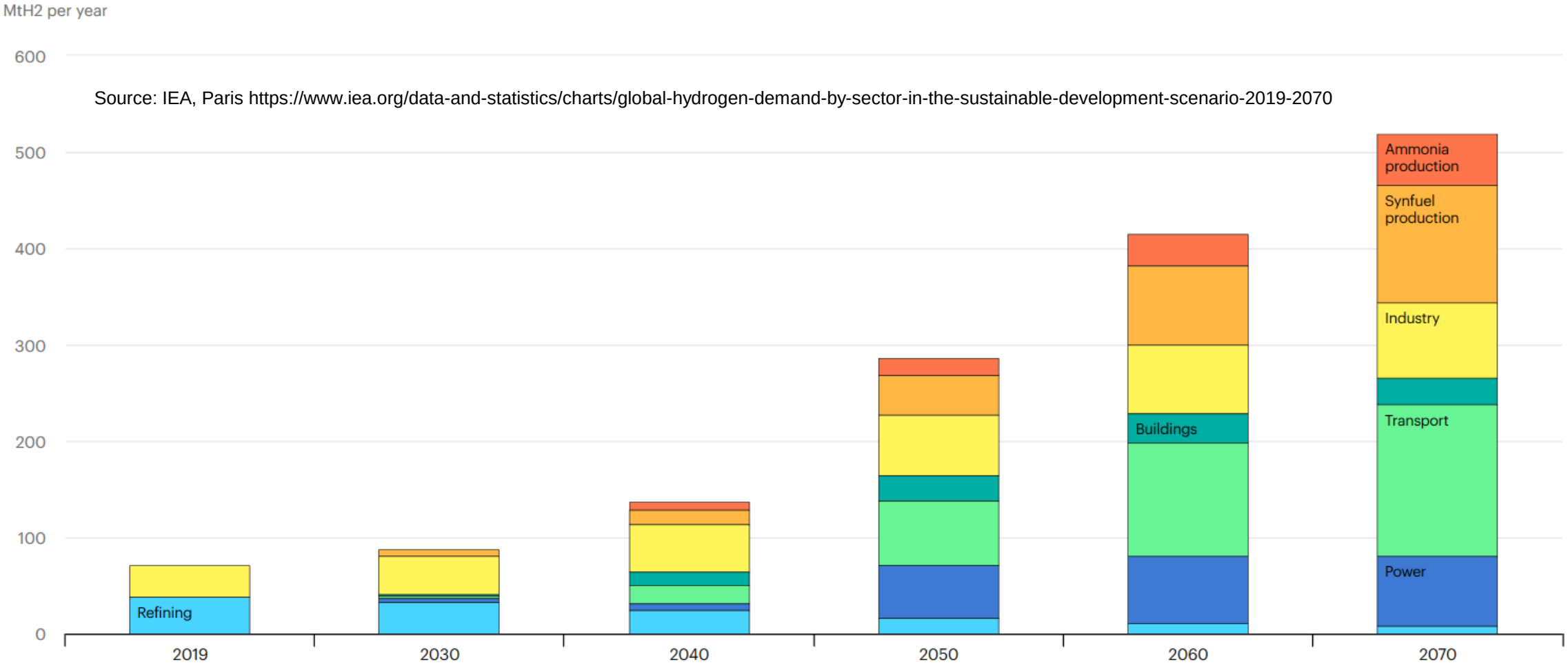


Uses and application of hydrogen



Steyne et al 2020

Long term use and application of hydrogen



Source: IEA, Paris https://www.iea.org/data-and-statistics/charts/global-hydrogen-demand-by-sector-in-the-sustainable-development-scenario-2019-2070

Hydrogen potentials for AFRICA

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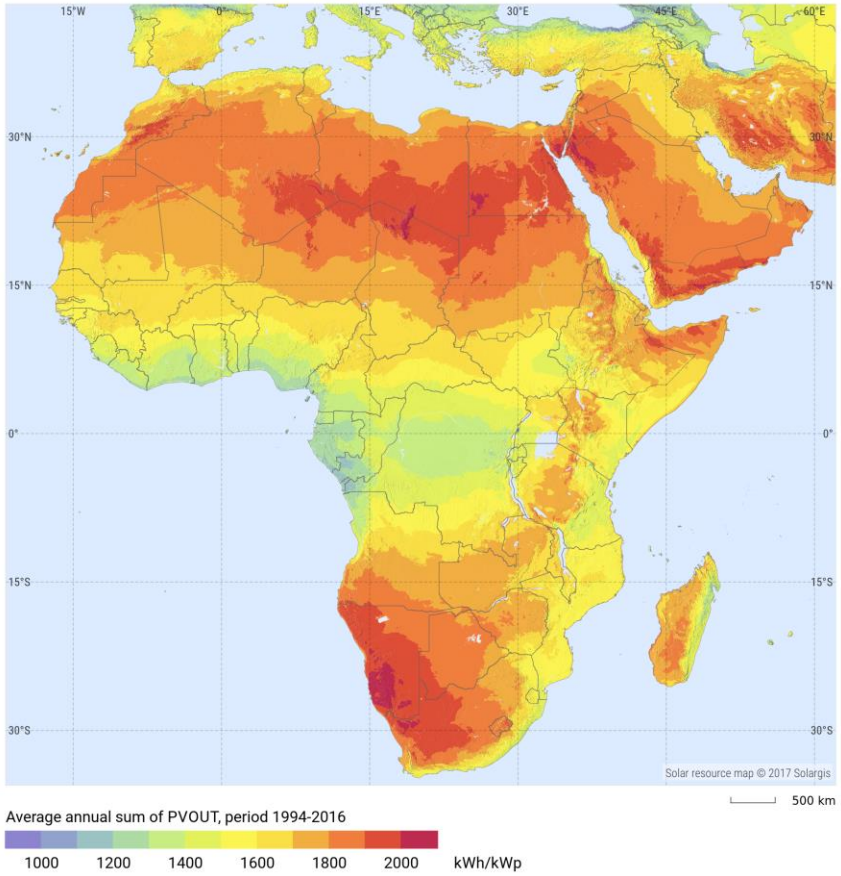
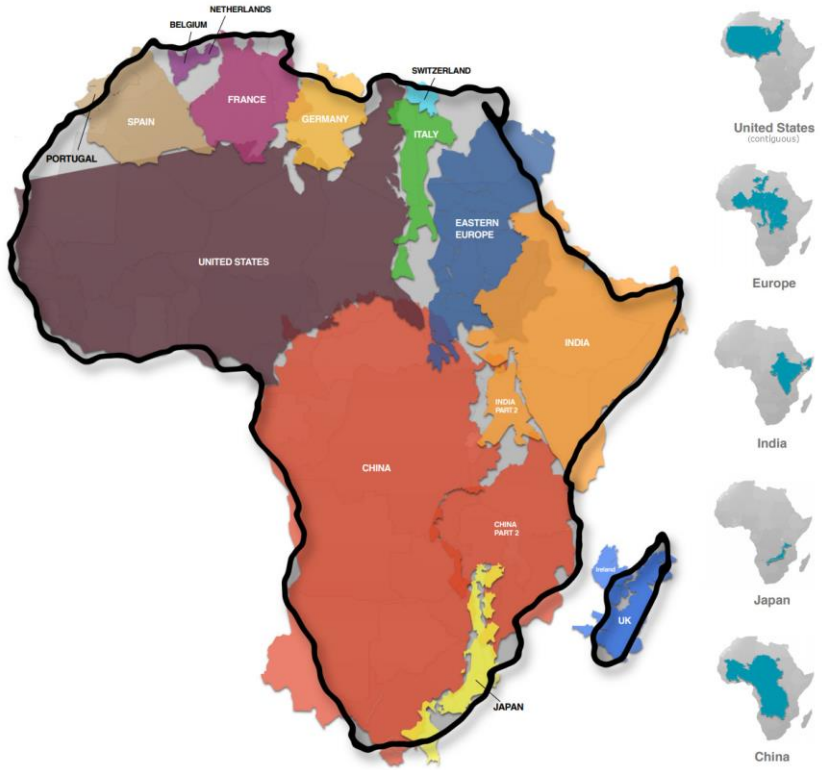
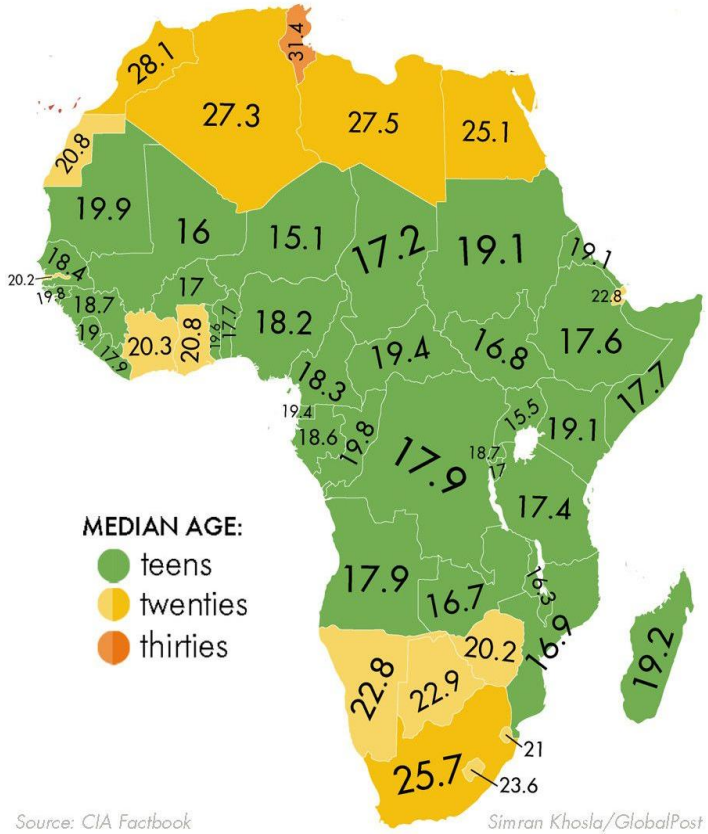
Resources

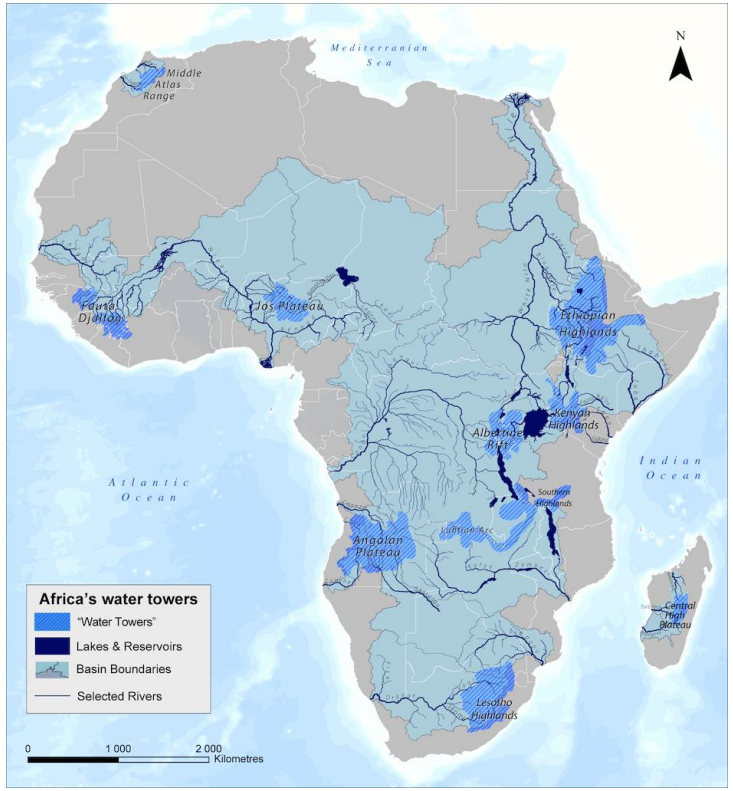




- Huge renewable enrgy potentials
- Vast land area -**30.37 million sq km**

Resources





UNEP 2010

17 rivers with catchments areas greater than 100 000 kM2
160 lakes larger than 27 kM2
one-third of the world's major international**water**basins (basins >100,000kM2

- Abundance of human (young people) resources

Resources in numbers

According to the ADB (2017):

- 1000GW potential from Solar
- 110 GW from wind
- 350 GW from hydropower
- 15GW from geothermal

➔Enough to generate 1000 times more electricity than the region would need in 2040

Benefits of green hydrogen for the region

- Opportunity to tap more of the exisiting renewable energy sources (address energy access, meet green target, combat climate change)

- Resource diversification (opportunity for more countries)

- African can be a key play in the international energy market

- Revenue source (local use, export)

H_2ATLAS-AFRICA PROJECT

Atlas of green hydrogen generation potentials in Africa: A technological, environmental and socio-economic feasibility assessment

Funded by Federal Ministry of Education and Research (BMBF)

Main partners:

- Forschungszentrum Jülich
- West African Science Service Centre on Climate change and Adapted Land use (WASCAL), Accra, Ghana
- Southern Africa Science Service Centre for Climate change and Adaptive Land Management (SASSCAL), Windhoek, Namibia.

Main aim: Create a database to develop a green hydrogen-driven economy to support sustainable development and contribute to fight against climate change in both Africa and Germany.

Underlying principle: Climate change and the need for sustainable development are global challenges that must be addressed relying on cross-border partnership based on trust, understanding and fairness.

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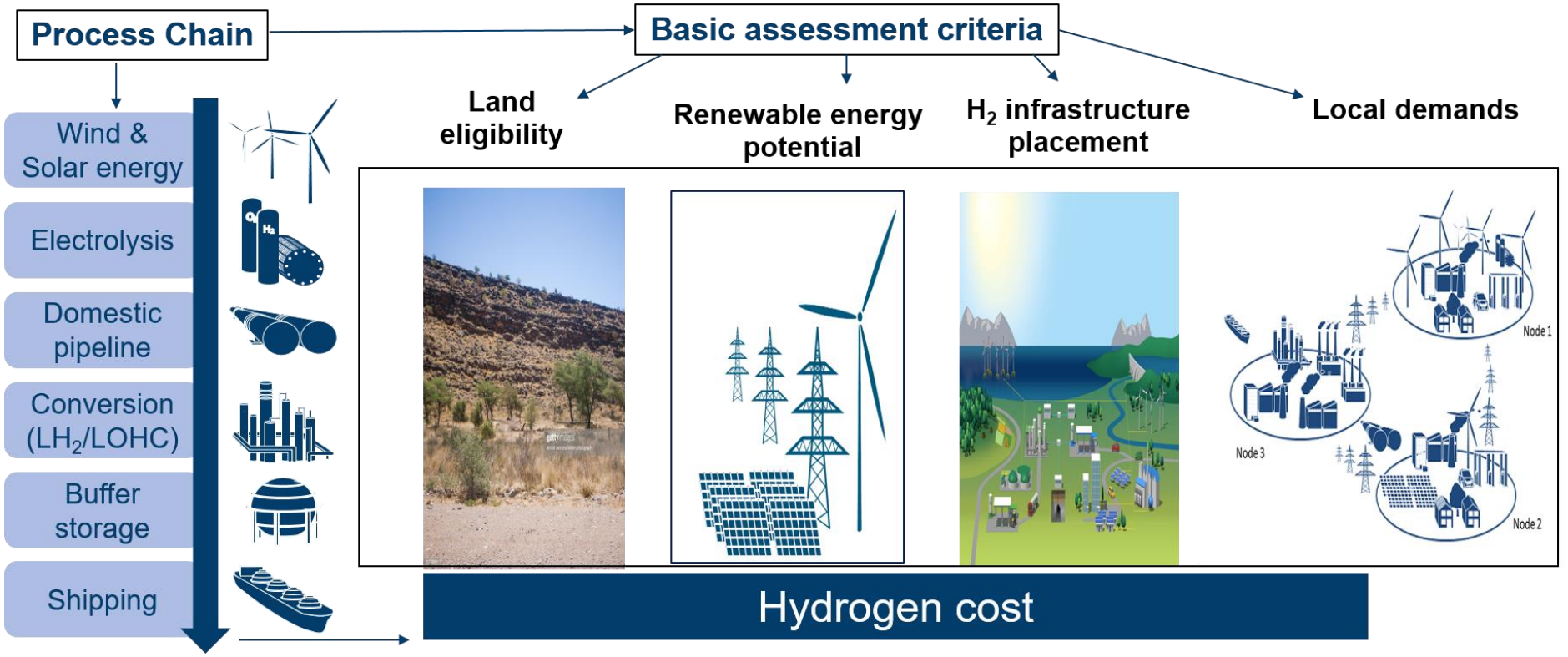
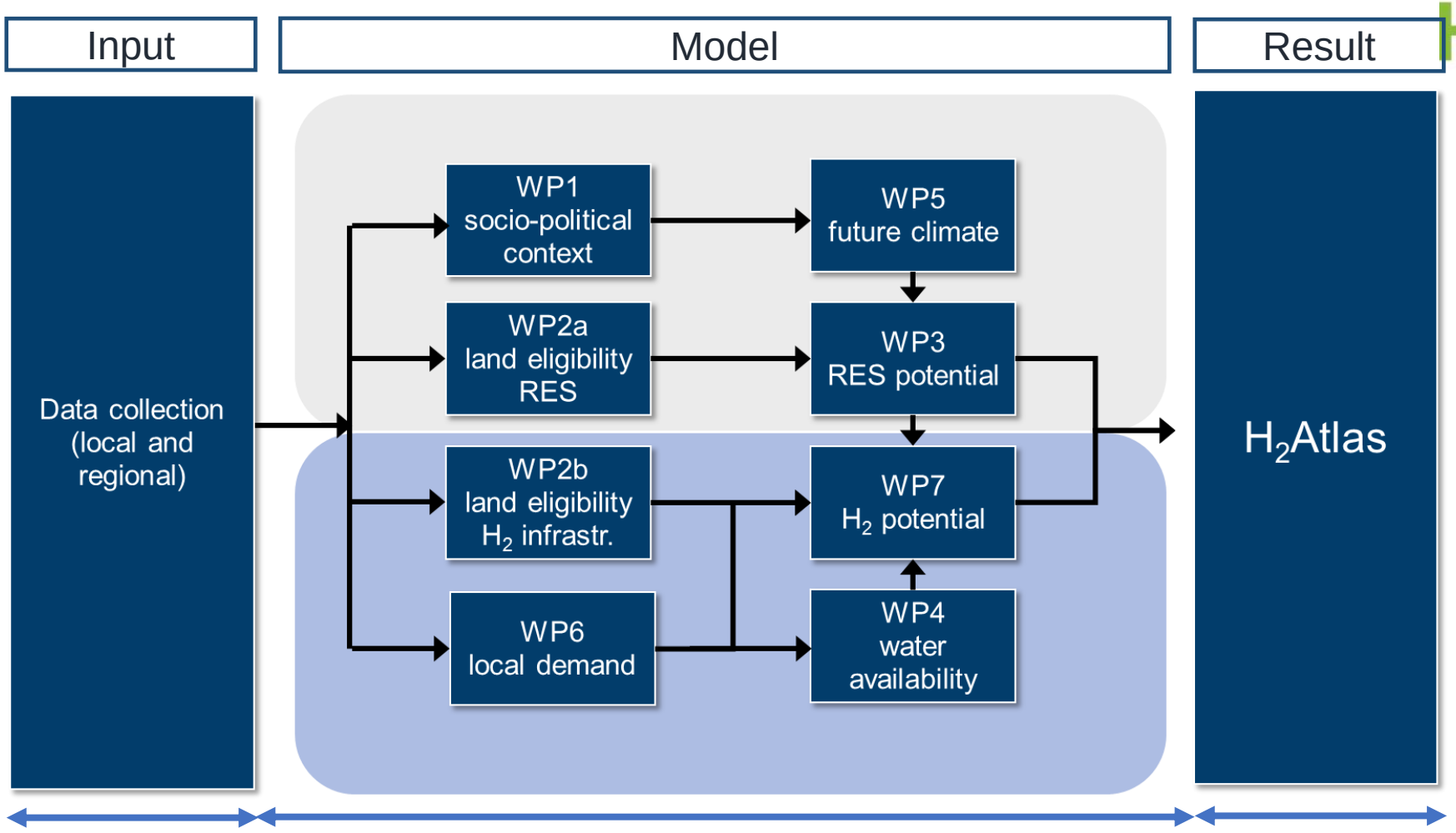
H_2ATLAS guiding criteria



Local interests are considered.

Work packages

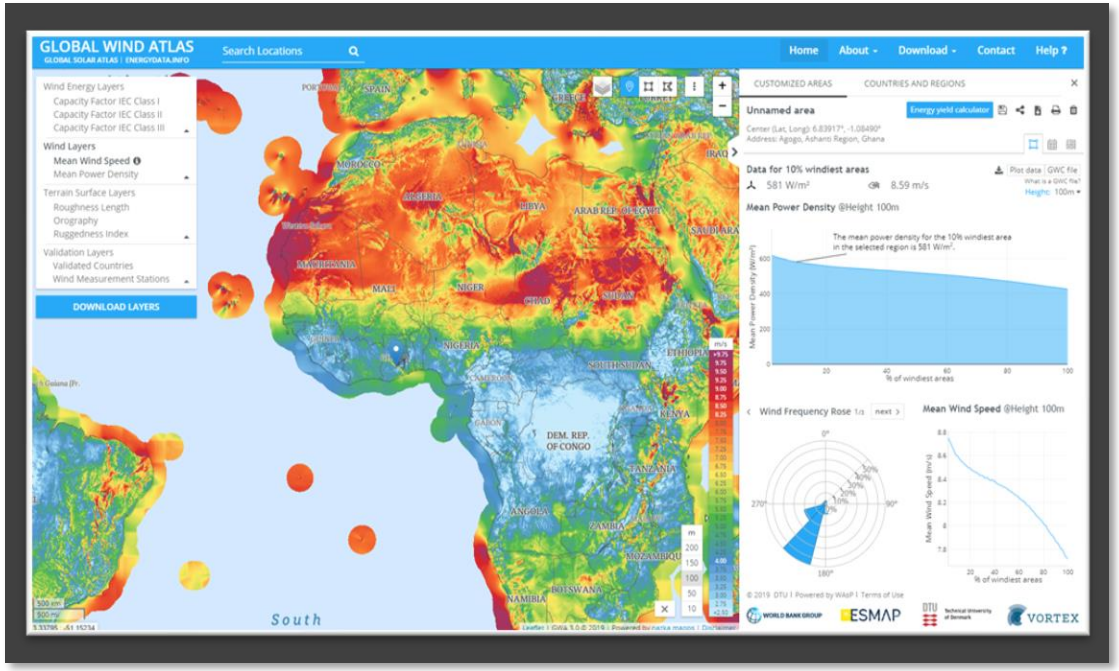


H_2ATLAS guiding criteria- Details

- Geography, environment and resources
  (e.g. availability of land and water [identification and avoidance of conflicts of use])
- Influence of future climatic developments on the availability of resources
- Generation potential from renewable sources (e.g. sun, wind, hydropower)
- Infrastructures and logistics (e.g. deep-sea ports, gas and electricity networks, transport/traffic routes)
- Investment security
- Local energy situation and future needs; possible export quantities

Main deliverables

- Techno-economic green H_2 production and supply potential
  - What is the **optimal system design** to satisfy local demands and H_2 export?
  - Quantity and cost of H_2



- Interactive user display interface- Atlas

- Potential sites and concept for pilot project

- **[1]** Welder, L., et al., *Spatio-temporal optimization of a future energy system for power-to-hydrogen applications in Germany.* Energy, 2018

H2Atlas project Results

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Result 1: Plenty of Land for Renewable Energies and Local Development

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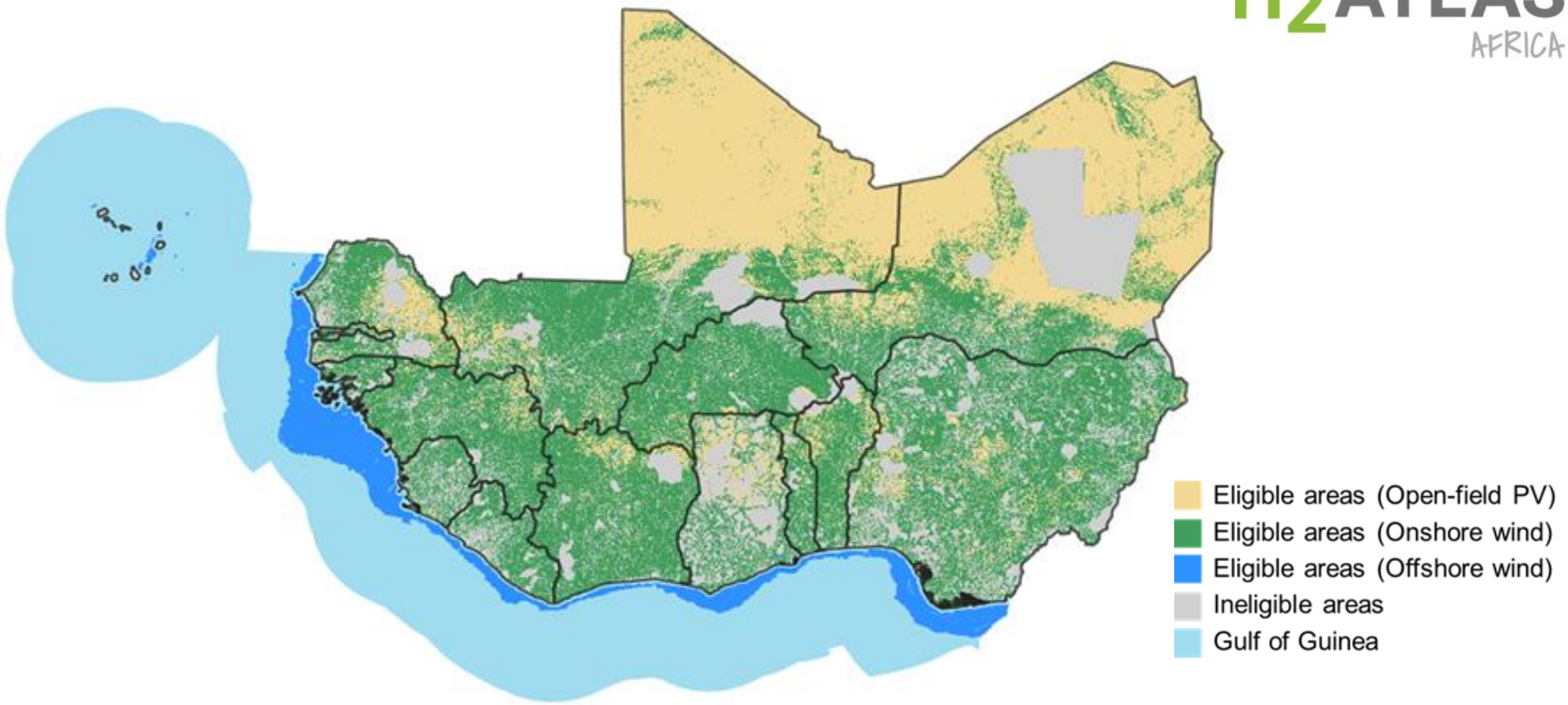

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Result 2: Abundant & Cheap RE Potential

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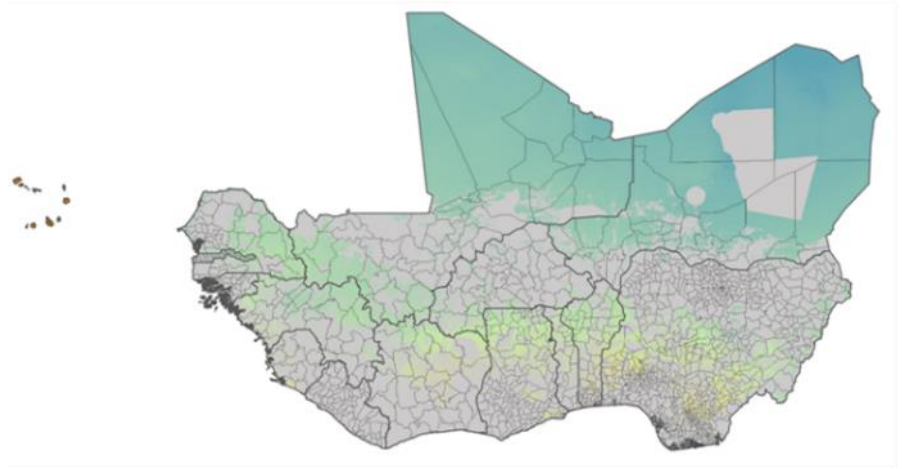
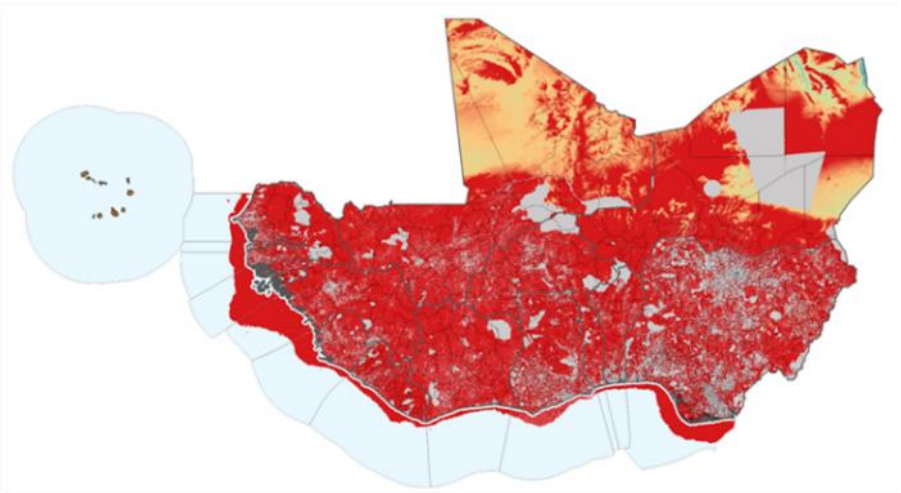
Open-field PV



Onshore and Offshore Wind



Average LCOE [€ct/kWh]

2.10 3.07 4.03 5.00

- Preference should be given to expanding open-field photovoltaic in West Africa

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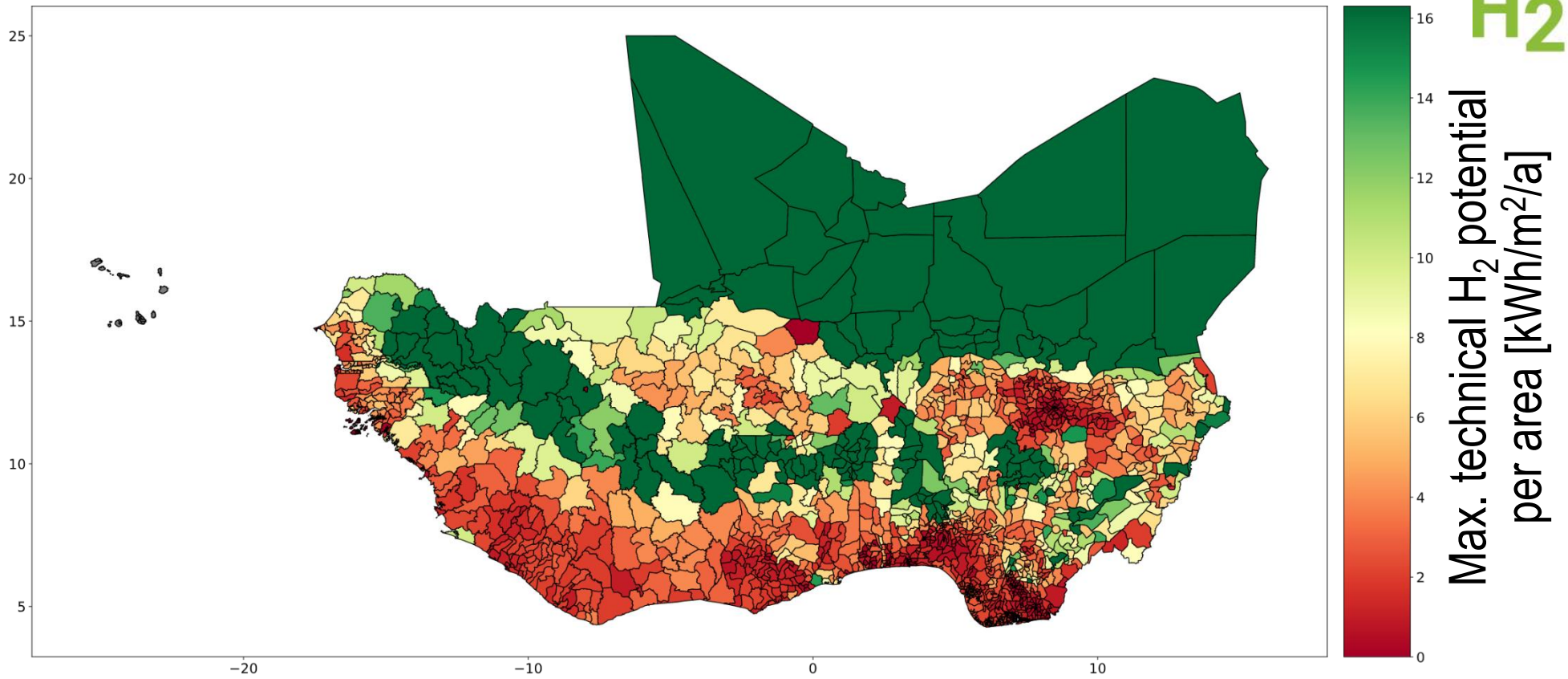
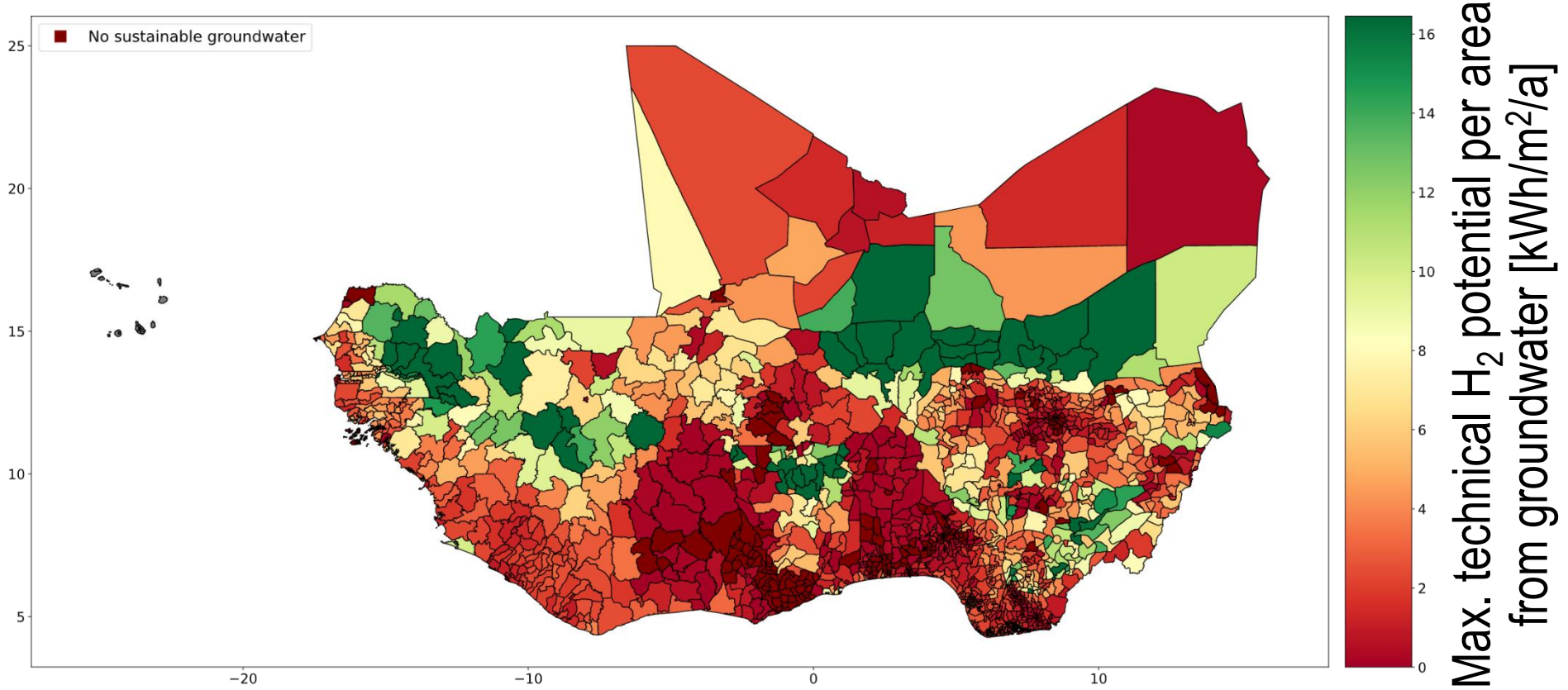
Result 3: Huge Technical Green Hydrogen Potential



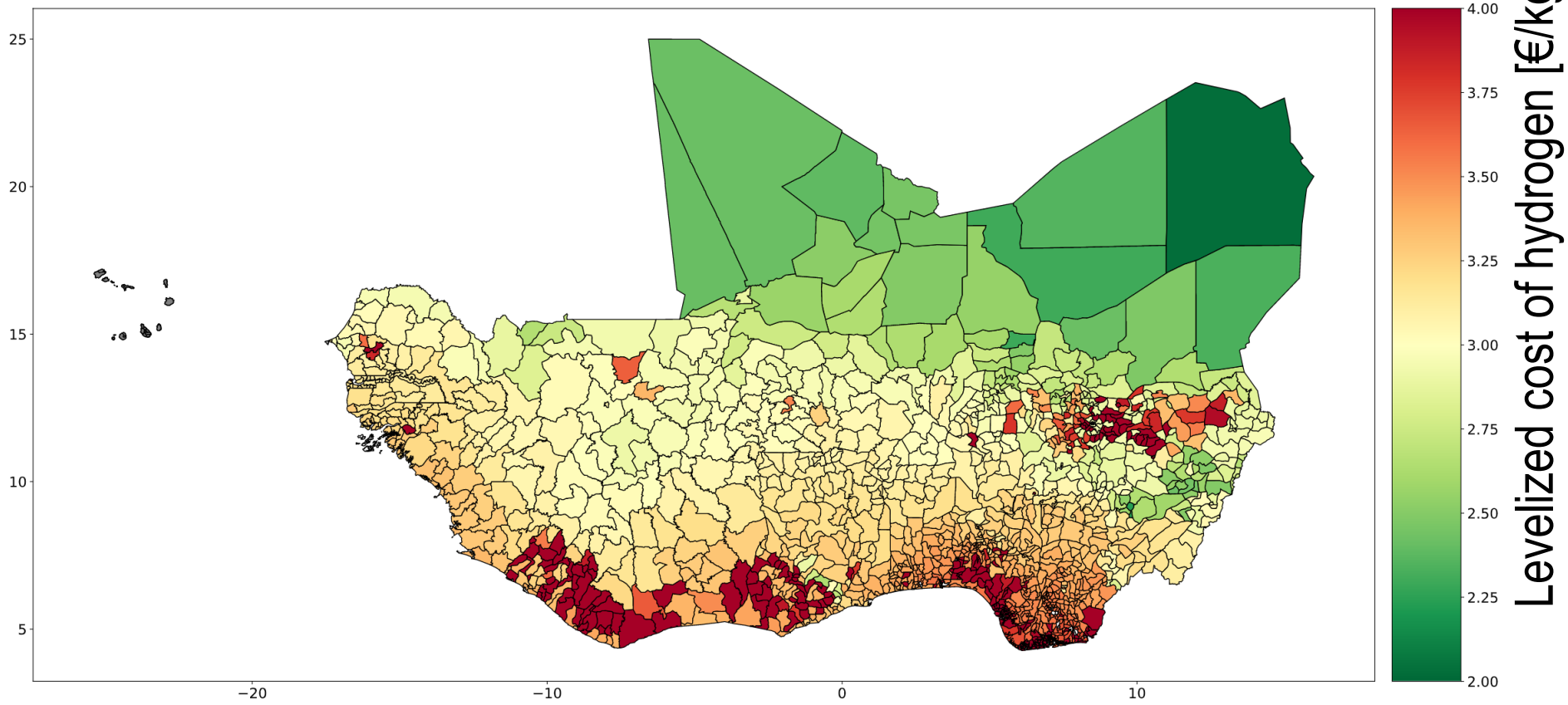
- Technical green hydrogen production potential over 160 PWh; without local demand/water constraint

Result 4: Local groundwater Availability-Strong Constraint

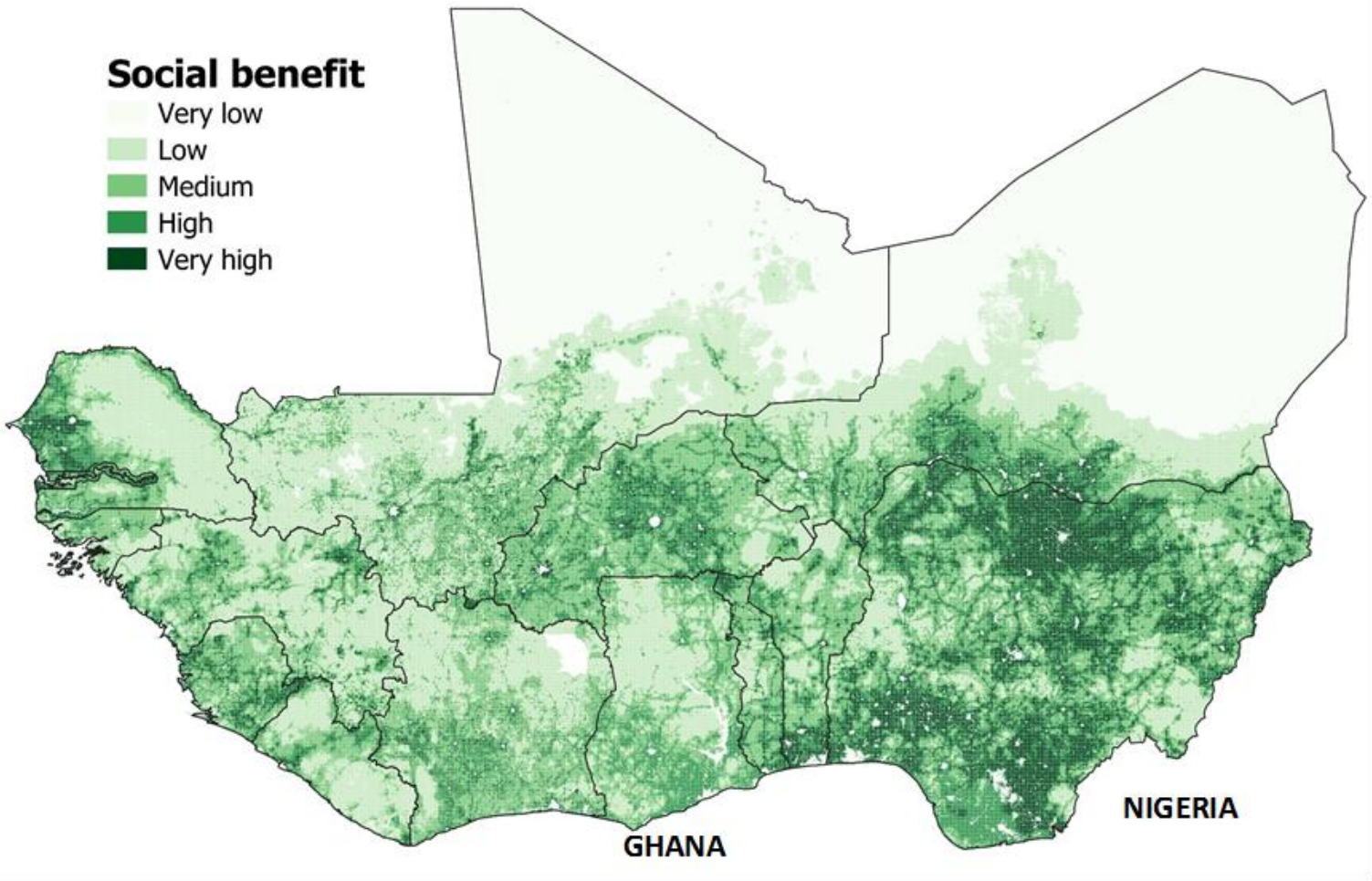


- Local ground water availability constraint the technical green hydrogen potential by roughly 80%
- Cheap desalination of sea water (ca. +0.5-0.7% of LCOH) required to explore the full potential

Result 5: Hydrogen Cost Starts at ~2 €/kgH2 assuming no water constraint



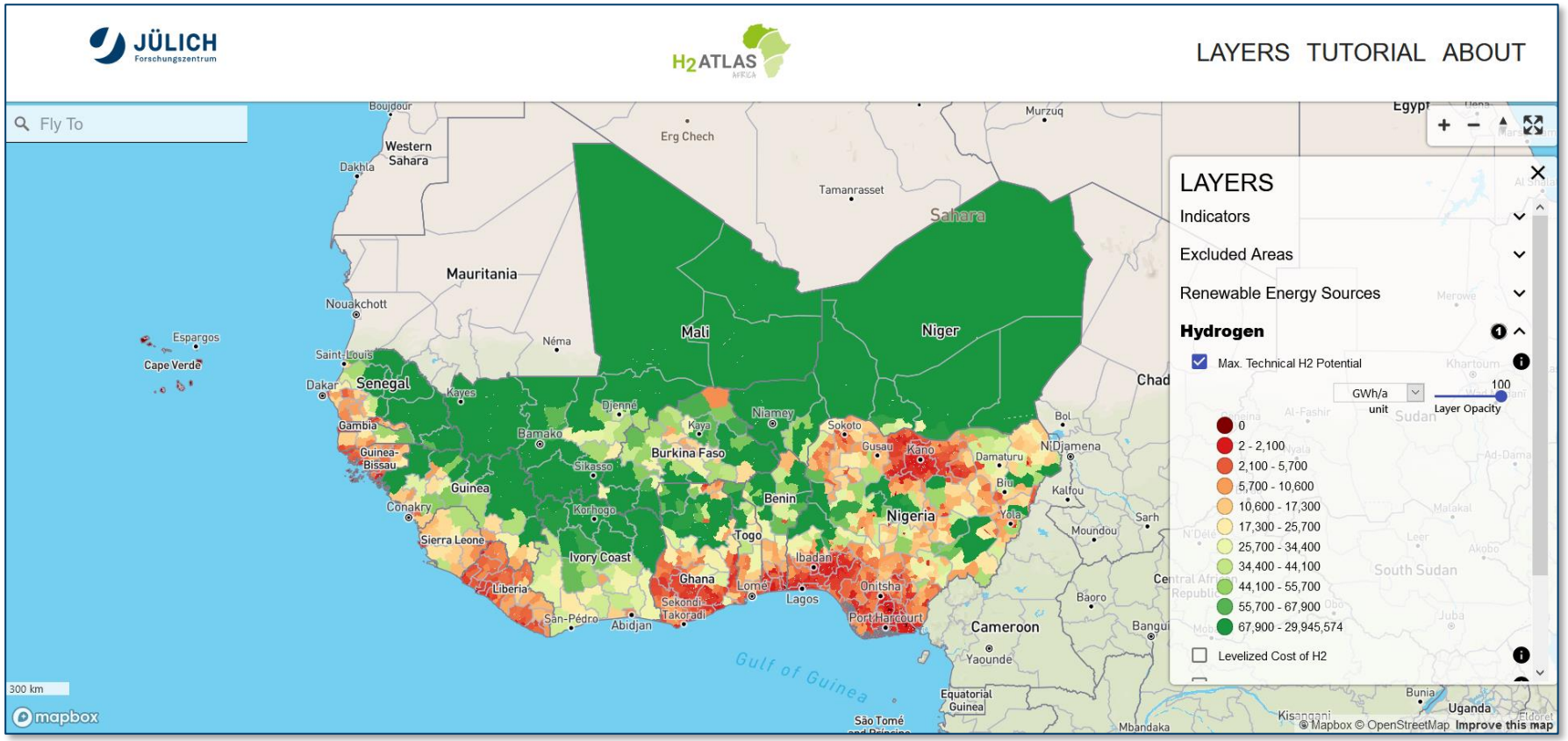
Result 6: Increased Social impact



- Based on increased energy access, stimulation of economic activities and population distribution

For more information on H2Atlas:

https://www.h2atlas.de/en/



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H2Atas for other sub-regions

To follow soon!

Main challenges

- Dealing with the status-quo (e.g. dependence on crude oil)
- Limited supporting infrastructure
- Insecurity and investment climate
- Regional concept for infrastructure and logistics (e.g. deep-sea ports, gas and electricity networks, transport/traffic routes)
- Enabling framework (policies, regulations, legal etc)

For immediate action

Recommendation 1

- **All stakeholders** involvement
- **Deployment of demonstration/pilot projects** based on state-of-the-art technologies (e.g. electrolyzer, PV and wind turbine)
- P**ublic-private partnerships** and ensure mutual benefit

Recommendation 2

- **Capacity building (academic and non-academic)**
  - Establish international Master/PhD programmes on energy and green hydrogen
  - Development of international training activities for technicians and technologists

- **Research and innovation**
  - Establish transnational research and innovation hubs focused on green hydrogen technologies (thematic clusters in participating countries: electrolyzers, membranes, fuel cells, hydrogen production, storage and transport, energy system analysis & modeling)
  - Adapt innovation to specific local conditions to address local needs to create direct local benefit

Recommendation 3

- **Science-based policy for a green hydrogen economy**
  - Organize an agenda process with industry, science, policy, stakeholders
  - Development of national hydrogen strategy (*to align with regional strategy*)
  - Develop a **Green Hydrogen Action Plan** for the region

Recommendation 4

- **Development of strategic international cooperation/partnership**
  - Strengthen long-term relationships for mutual benefit
  - Create and enhance cooperation with partners around the world

Recommendation 5

- **Short- and Long-term investment plan on energy infrastructure**
  - Grid network
  - Off-takers
  - Consider regional pool

Conclusion

- Let us start now not tomorrow
- Be part of the global green hydrogen movement

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Thank you for your attention!

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