Low-cost, circular, plug-and-play, off-grid energy for remote locations including Hydrogen

Co-funded by the European Union

LoCEL-H2 objectives and impact

Project goal: development and demonstration of affordable and clean off-grid energy solutions

- 24/7 access to electricity for basic needs (light, communication, refrigeration, local business uptake)
- Green hydrogen for safe cooking (the use of open wood and coal fires for cooking is causing the loss of over 3 million lives per year, women and children being most of the victims of such practices)
- Market uptake supported by a sustainable business model based on results from SSH studies

Sustainable business model

48V Smart grid for renewable energy sharing (PV, wind, etc.)

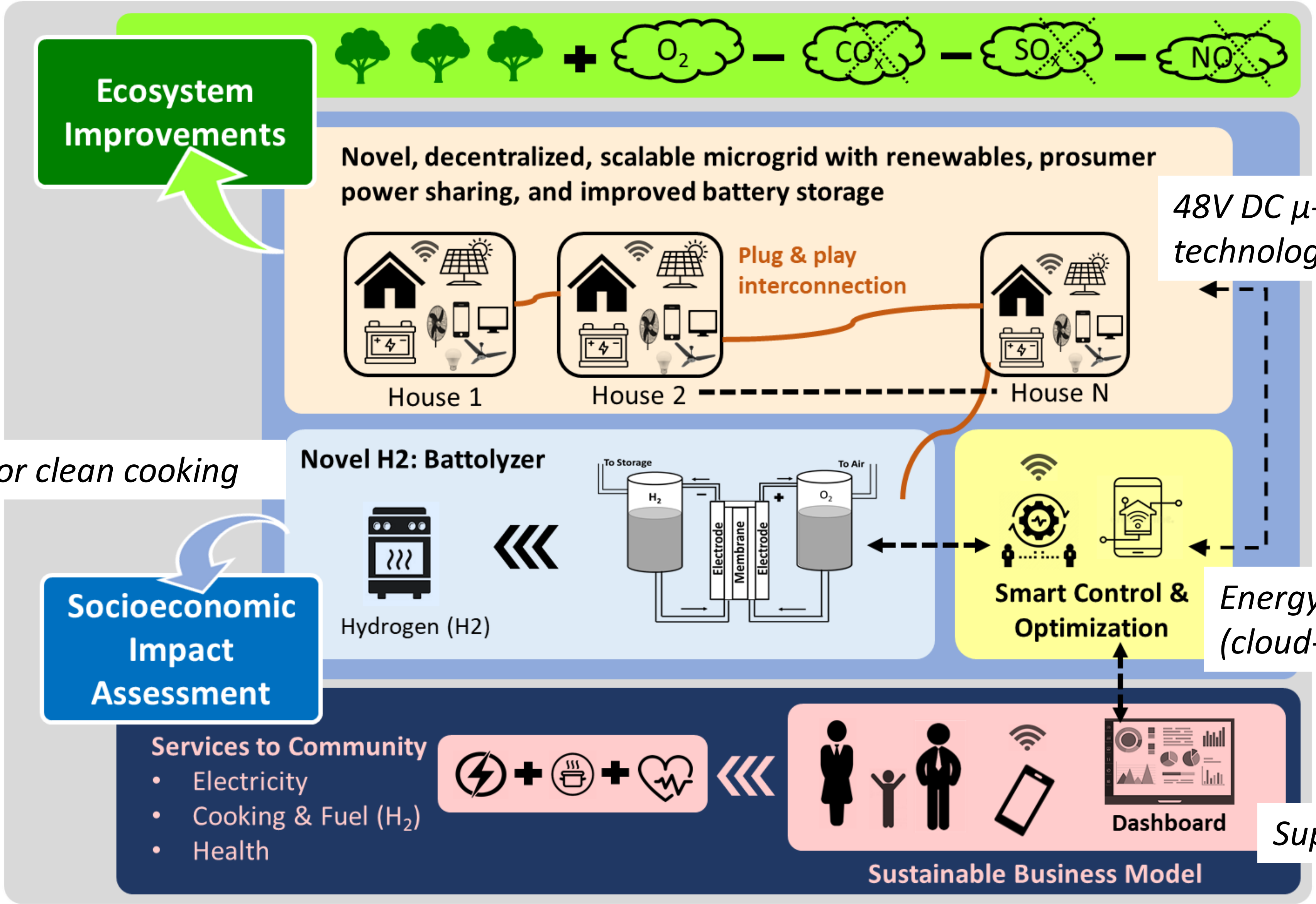
Advanced & Affordable Energy Storage (HPPL battery)

Combined Green Hydrogen production and energy storage (Battolyzer)

Project consortium and timing

- Engineers and scientists from 9 industrial and academy organisations started working together in 2023 with the ambition to demonstrate market-ready prototypes in the end of 2026

Project approach at a glance



48V DC μ-grid using HPPL battery technology for PV energy storage

Hydrogen for clean cooking

Energy Management System (cloud-based)

Supported by SSH studies

Sustainable Electricity and Hydrogen for Remote Communities

Webinar “Energy for Africa”:
Work Package 1 aims and purposes

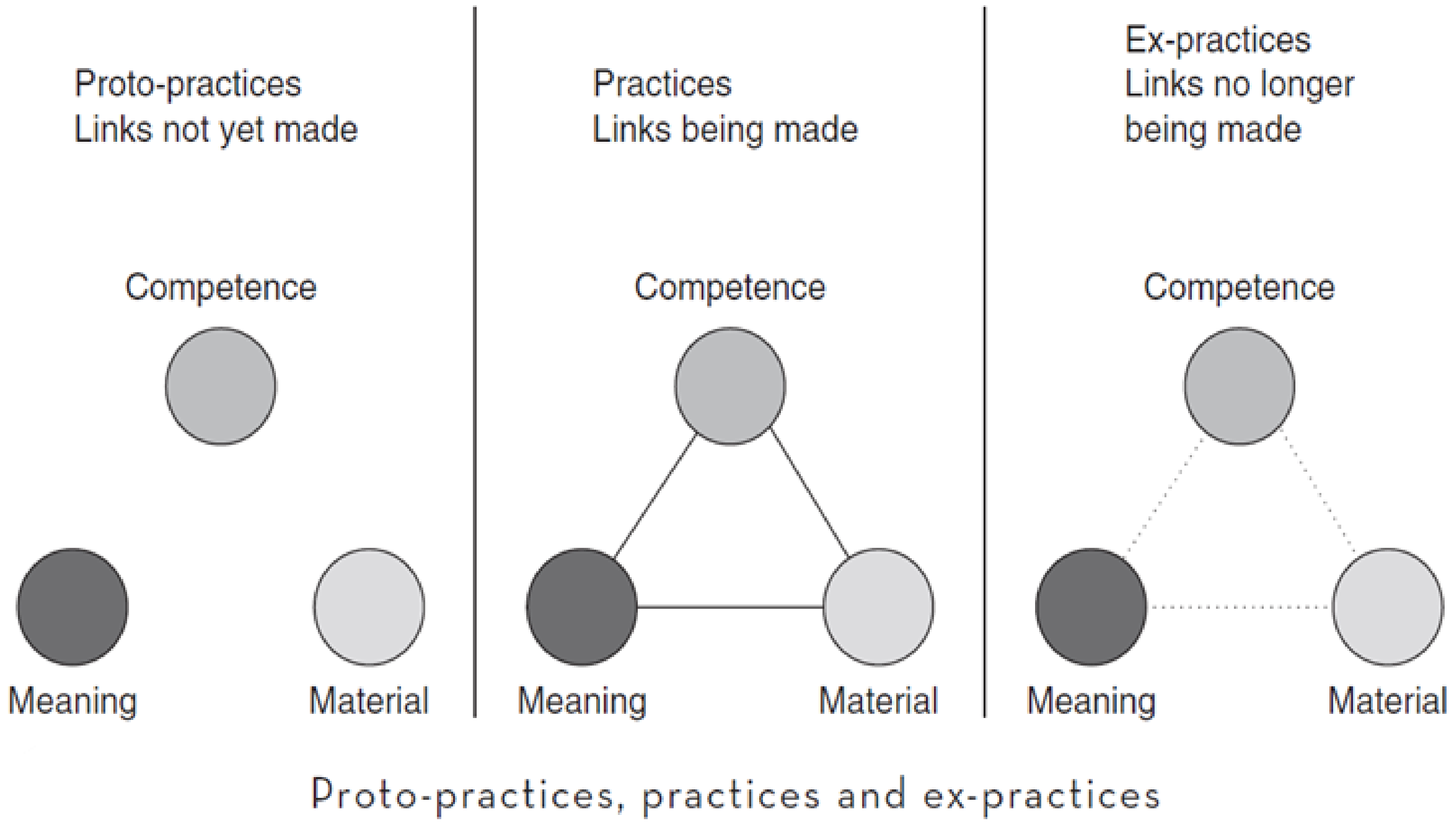
04-June-2024

UNINA Team (WP1) coordinators

Rosanna De Rosa

Ivano Scotti

Methodology: the approach of social (energy) practices



Research actions

- Reconstruction of the “ecosystem of actors” with on-desk data analysis & interviews/meetings online and on-site.
- Focus group with the consortium partners to detect they needs for WPs and expectations.
- Fieldwork on sites (*Pakistan as pre-pilot, Ivory Coast and Zambia as pilots*) using semi-structured interviews and site activities (*pics, spontaneiuse dialogies, etc*.).

Source: Shove E., et al. (2012), p. 25

Fieldwork activities outcomes in Pakistan (*pre-pilot*) and Ivory Coast (*pilot*)

Insights from the pre-pilot

<u>Competences and values:</u> they manage in unpredictable way the system, they take care of it in traditional way as valuable home staffs, combine new skills and traditional practices.

<u>Expectation and woman:</u> increasing their wish to electrified tools for economic and social reasons; signs of female awareness and forms of ‘‘emancipation’’ in a patriarcal context throught energy.

<u>The social context:</u> rural context socially homogeneous, a constant control, training and collaboration appear pivotal for a successful technological implementation.

<u>Business & prosumer model:</u> it matched & fitted the local conditions, decentralized system means responsibility and autonomy to users, they need to be trained and monitored.

Insights from the pilot

Power, authority and gender issues: patriarchal & traditional community, women collect water (strenuous activity), cook (time-consuming activity) and work in the cocoa field; woman manage family resources but not “political-public” power.

Labor, economic and financial aspects: only manual labor for poor cacao agriculture (no idea od chocolate production), periodically they collect money for community needs, issue concerns the land property, possible jealousy conflict with neighbor villages.

Energy needs: some households rent small solar panels to power the light bulbs (inside and outside the houses), fans (to “sleep better”), televisions, and recharge mobiles phones. Kerosene is used for preparing the breakfast and fueling a power generator (music and celebrations).

Expectations: energy for water, outdoor illumination, for cooking as soon as possible that they will adapt (es., H2 chicken).

Closing remarks

- In pre-pilot and pilots, electricity consumption will **initially be low**, but power availability **will tend to increase** the consumption (*e.g., due to increased time of use of light bulbs, fans, and not necessarily the purchase of new devices*).
- It seems useful to **foster local culture** of solidarity/reciprocity practices for collective uses of the energy good (*e.g., use of the kitchen for a collective purpose*).
- Solidarity/reciprocity local practices can be **analyzed & translated** for a sustainable business model (*i.e., Friday money collection for community expenses in Abacouadriokro*).
- The energy system proposed by LoCEL-H2 could be **joined by villagers** with the technologies they have for other purposes (*context adaptive capacity for purposes not included in the project*).
- A constant **"social maintenance" or negotiation** appears pivotal for the success of project in its social and technical points (*as Pakistan example suggests*).

Closing remarks: engagement as site-specific process

The success of our project, as it emerged in Pakistan example, is related to **a very specific engagement process** that need to be **site-specific & constantly managed** during and after the implementation.

It calls the need to plan this task in a **very accurate way** for Zambia and Ivory Coast (*and the pre-pilot cite in Pakistan*). **Gatekeepers are crucial**.

Closing remarks: property & owneship

Questioning property: ownership of what comes from a possessed land?

- Customary rules (livelihood and dwelling)
- How community property rights and rules are intertwined (land, house)?
- How microgrid can be “translated” in this (informal) system of rights?
- Who owns the technologies & who takes care of the infrastructure?
- What prosumerism means in terms of ownership (of technology, of energy)?
- What is the relationship between responsibility and ownership (possession) of the technologies?
- How does the property/technological arrangement cope with the “domestication” of devices and uses of energy?
- How to “package” this complexity in a business model?

WP5 - Design and development of a plug and play prosumer microgrid and system integration

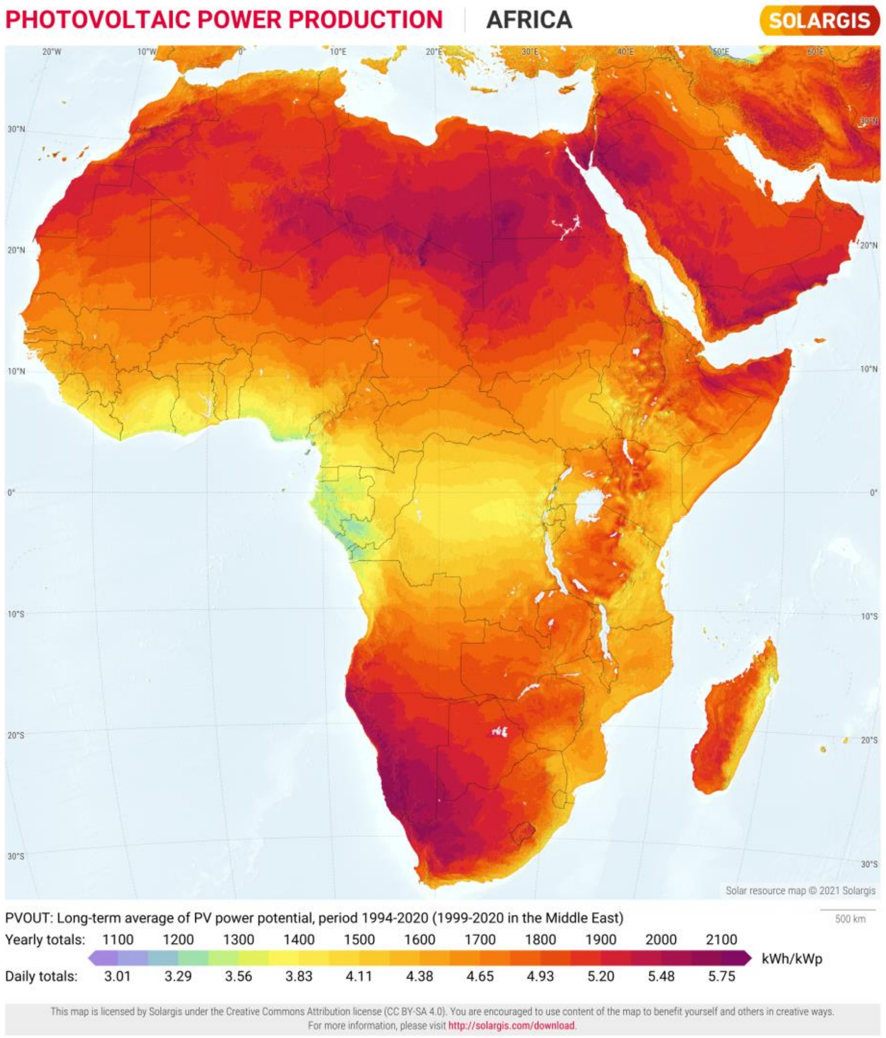
04-June-2024

Presenter: Reesha Arshad, LUMS

Co-funded by the European Union

Need for Off-grid Electrification

- Globally, **770 million people**[1] lack access to electricity, mostly in rural areas
- South Asia and Africa have “**excellent conditions for solar PV**”
- Large central microgrids are largely unviable due high upfront cost
- SHS installations are on the rise
  - Community owned or PAYG Models
- Consumers can benefit from **prosumer** (producer + consumer) power sharing.



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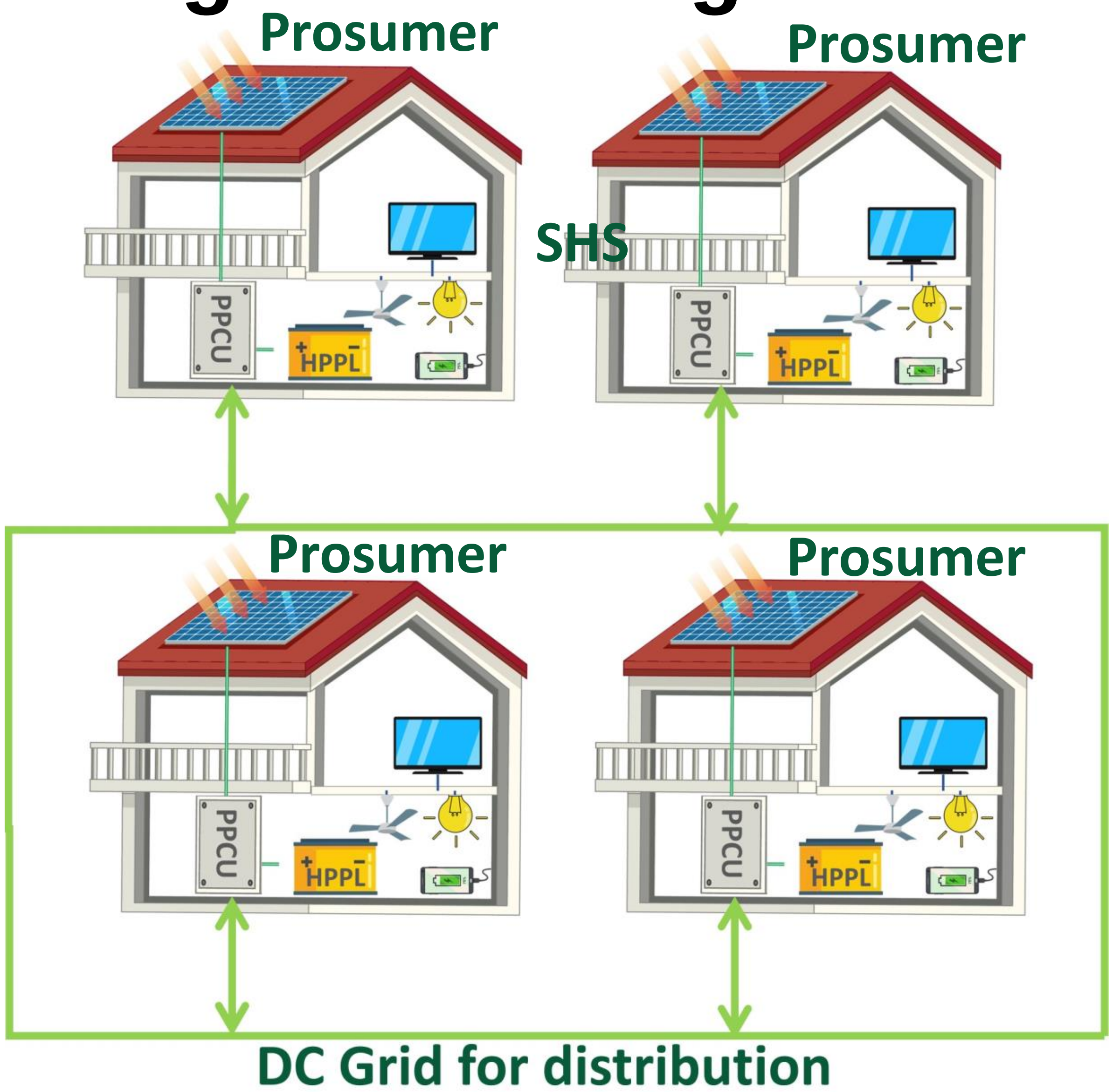
1. IEA (2022), World Energy Outlook 2022, IEA, Paris https://www.iea.org/reports/world-energy-outlook-2022
   Solar resource map © 2021 Solargis, available: *https://solargis.com*

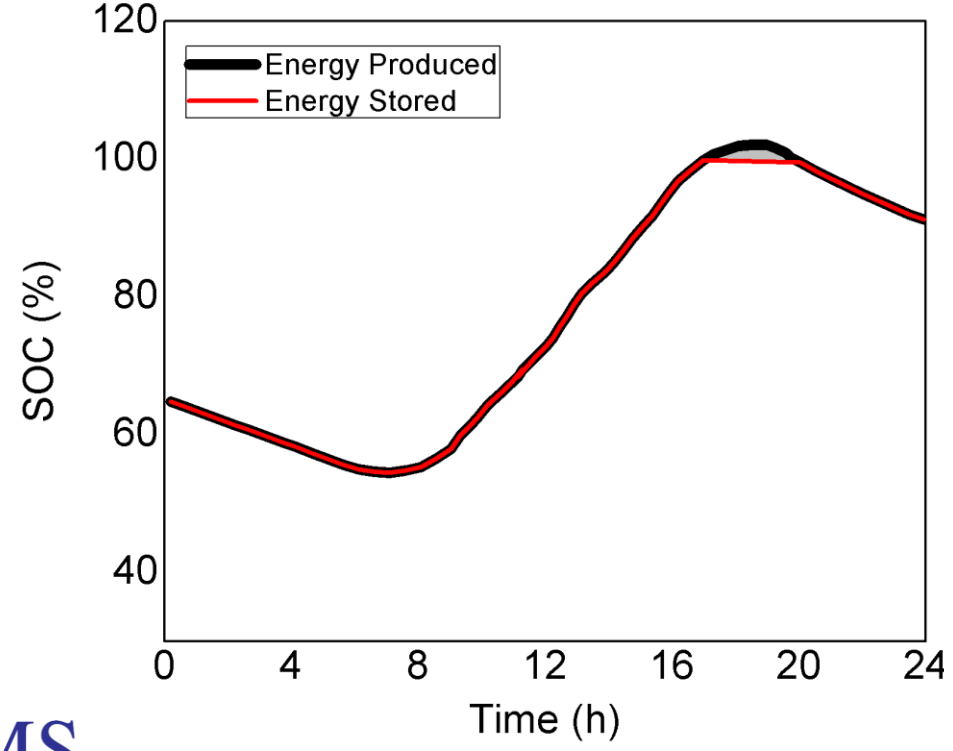
Common Electrification Strategies for Off-grid

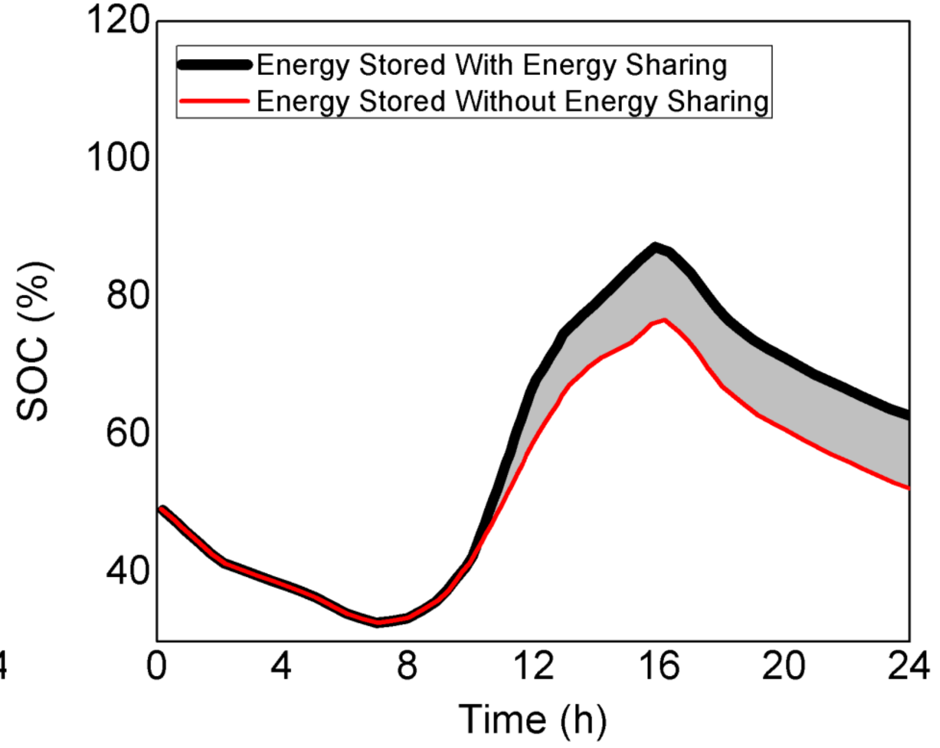
- **Solar Home System (SHS)**
  - A solution for remote communities that are left out of national electrification projects.
  - **High energy wastage**: up to 50% of the generated energy is wasted.
- **LoCEL-H2: Decentralized microgrid with prosumer power sharing**
  - Potential for excess energy provision through power sharing.
  - Each SHS may become a **prosumer (producer + consumer).**



Benefits of Prosumer Power Sharing

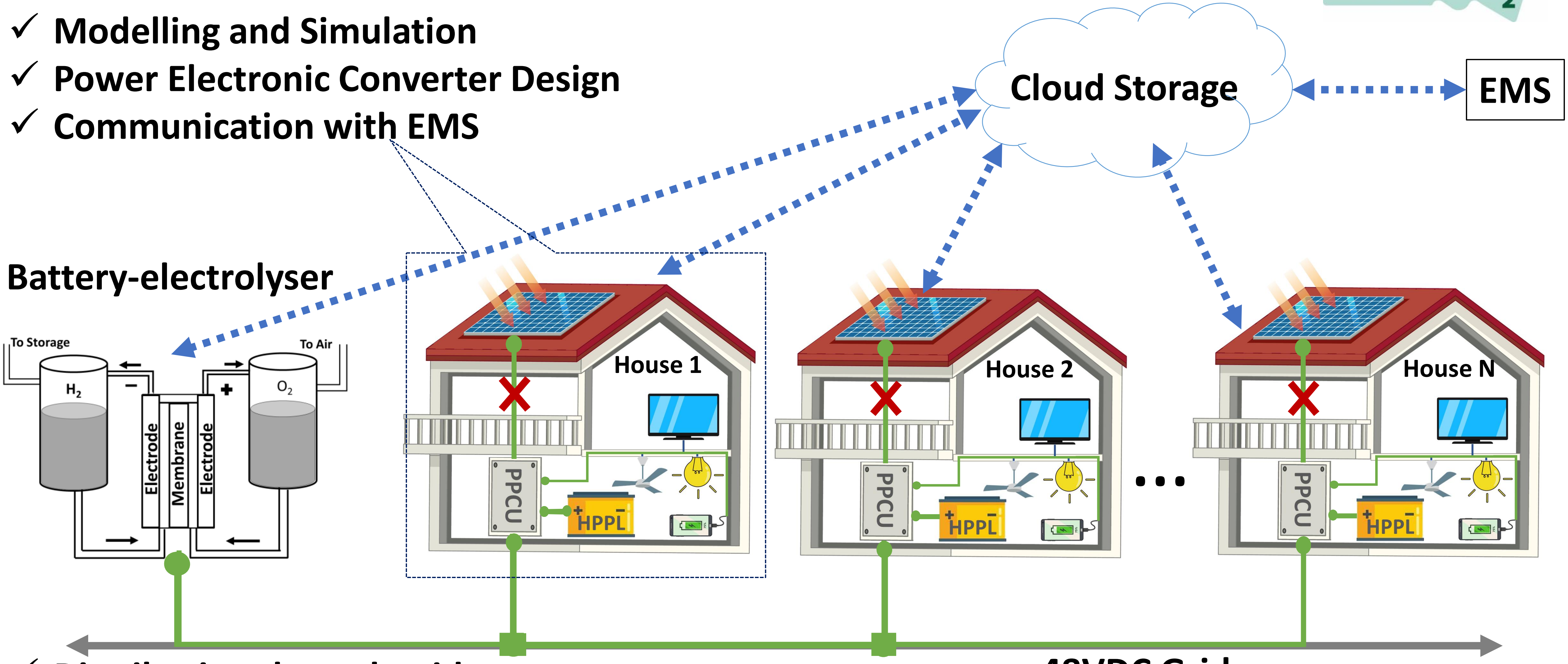
20-50% improvement in energy utilization





How LoCEL-H2 works?

- ✓ Modelling and Simulation
- ✓ Power Electronic Converter Design
- ✓ Communication with EMS



- ✓ Distribution through grid

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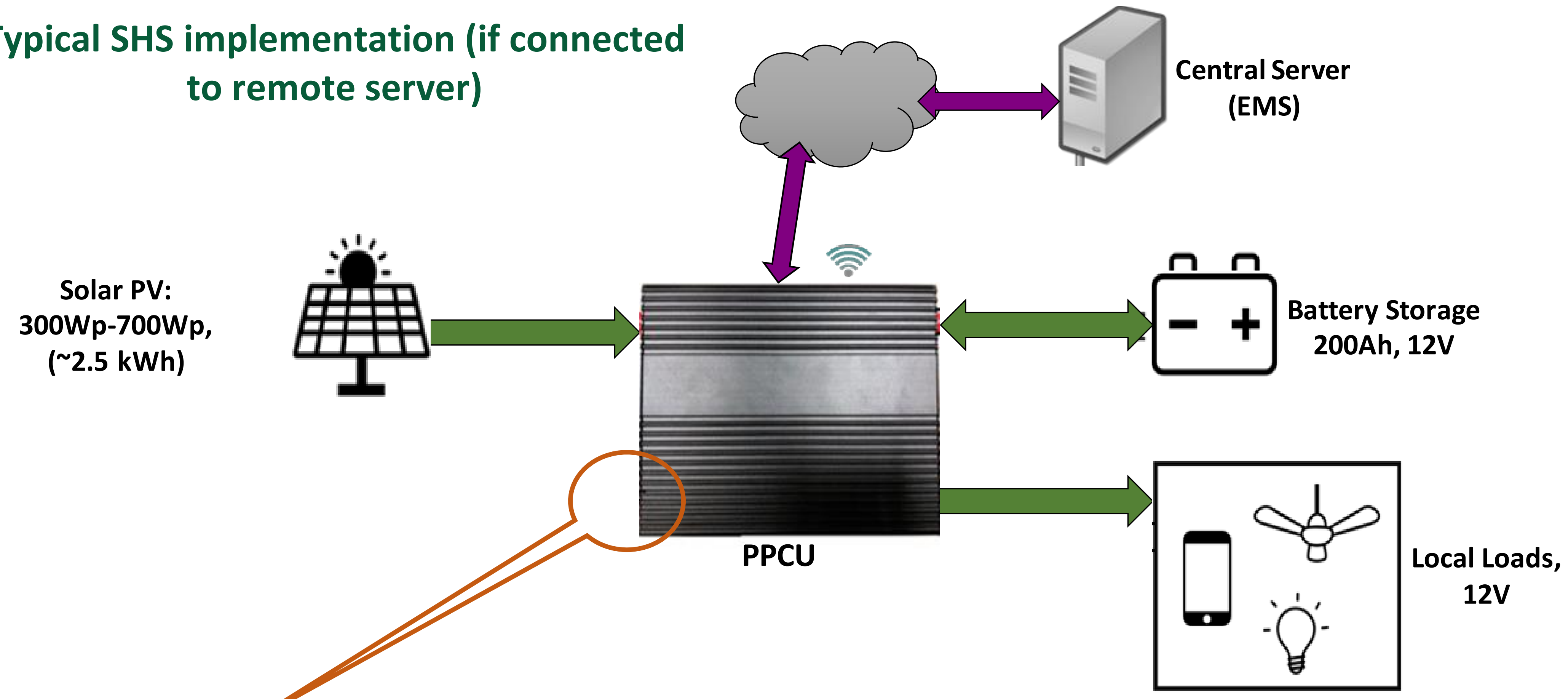
Power Processing and Control Unit (PPCU)

Typical SHS implementation (if connected to remote server)



Grid port for scalable and flexible extension of atomic unit to form a “grid”

Not drawn to scale

Key Advantages of Prosumer Power Sharing

LoCEL-H2

Improved Access To Energy also leads to Climate Change Adaptation!

Energy-driven socio-economic improvements and Climate Change Adaptation

AGRICULTURE

- Use of ICTs to inform about pests, drought-resistant seed varieties, crop shifting etc.
- Space cooling for animals.

LIVELIHOOD

- Task lighting for cottage industries/small shops.
- Mobile phones enable use of microfinance services.
- Electric machines for food processing for sale in cities.

EDUCATION

- Lights for schools and for houses to enable students to study at night.

HEALTH

- Use of ICTs to raise awareness about viral diseases, reproductive health and childcare.
- Refrigeration enables cold storage for vaccines.

Conclusion

- Access to clean energy is linked to improved socio-economic conditions of people.
- Remote off-grid communities use SHSs, which typically provide low levels of electrification, and power very simple appliances such as lights and fans.
- Decentralized microgrids with prosumer power sharing are scalable and allow households to utilize up to 50% extra energy compared to SHSs.
- LoCEL-H2 provides a decentralized microgrid solution with battolyser and optimized lead-based storage to provide a clean and sustainable solution to remote communities in Africa.

LoCEL-H_2

Sustainable Electricity and Hydrogen for Remote Communities

Webinar Work package 4 (WP 4)

04-June-2024

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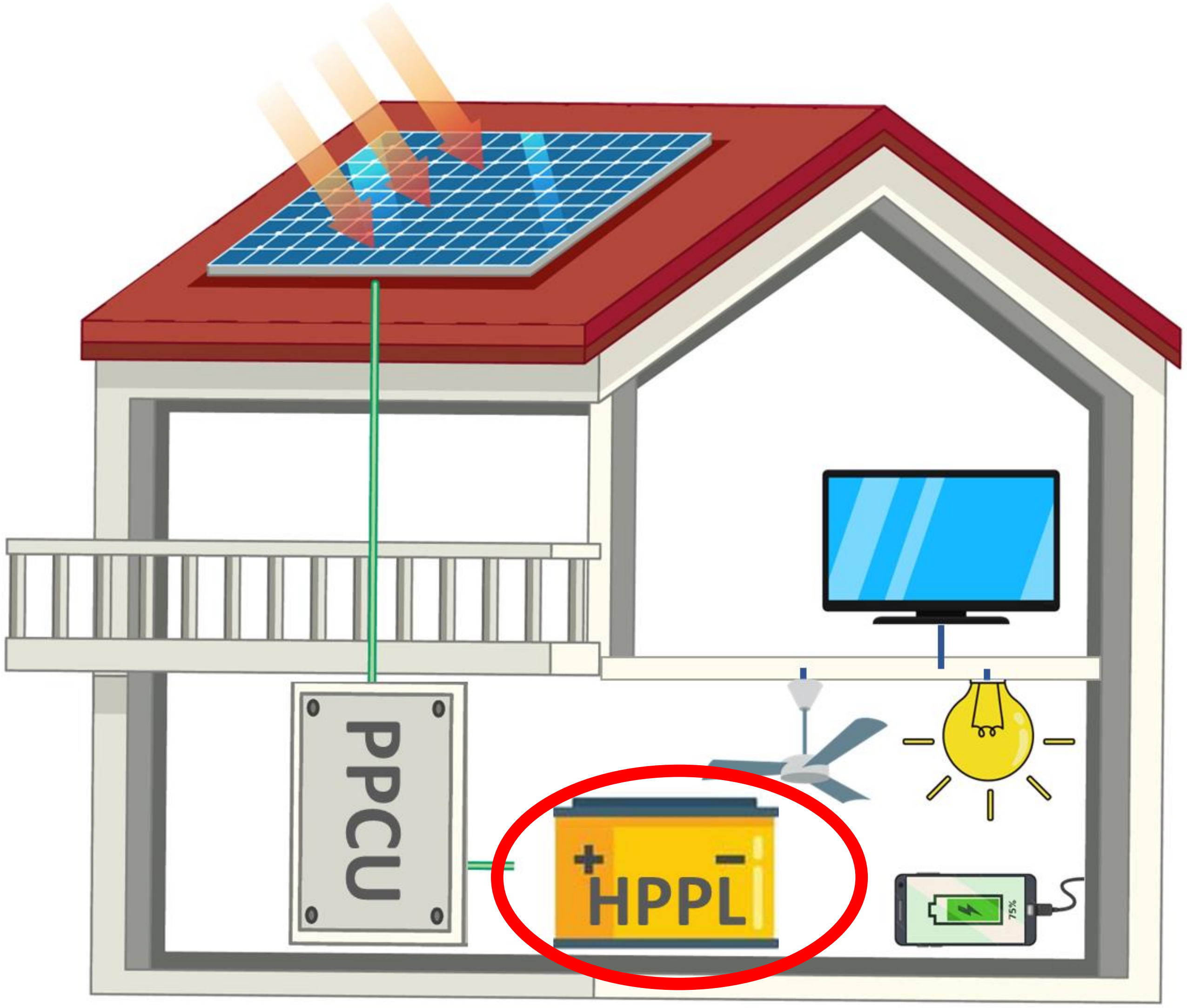

PPCU
HPPL

Requirements for the battery

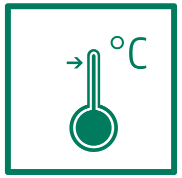
<u>Application requirements</u>

- maintenance free
- safe technology
- efficient charging
- partial state of charge
- high availability
- low cost

Requirements for the battery

<u>Environmental requirements</u>

- temperature



- humidity

- theft

Advantages HPPL

Temperature

- Higher **operational temperatures**
- Reduced **battery aging**

CO_2-Footprint

- Less energy for **aircon** in battery room
- Longer **battery lifetime**

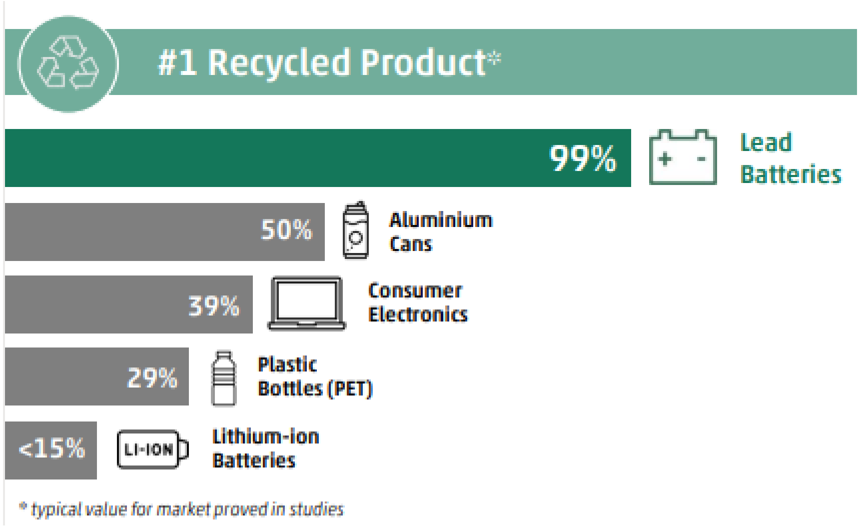
Operating Expenses

- Less costs for **climatisation**
- Prolonged intervals for **maintenance & replacement**

Requirements for the battery

Circularity requirements

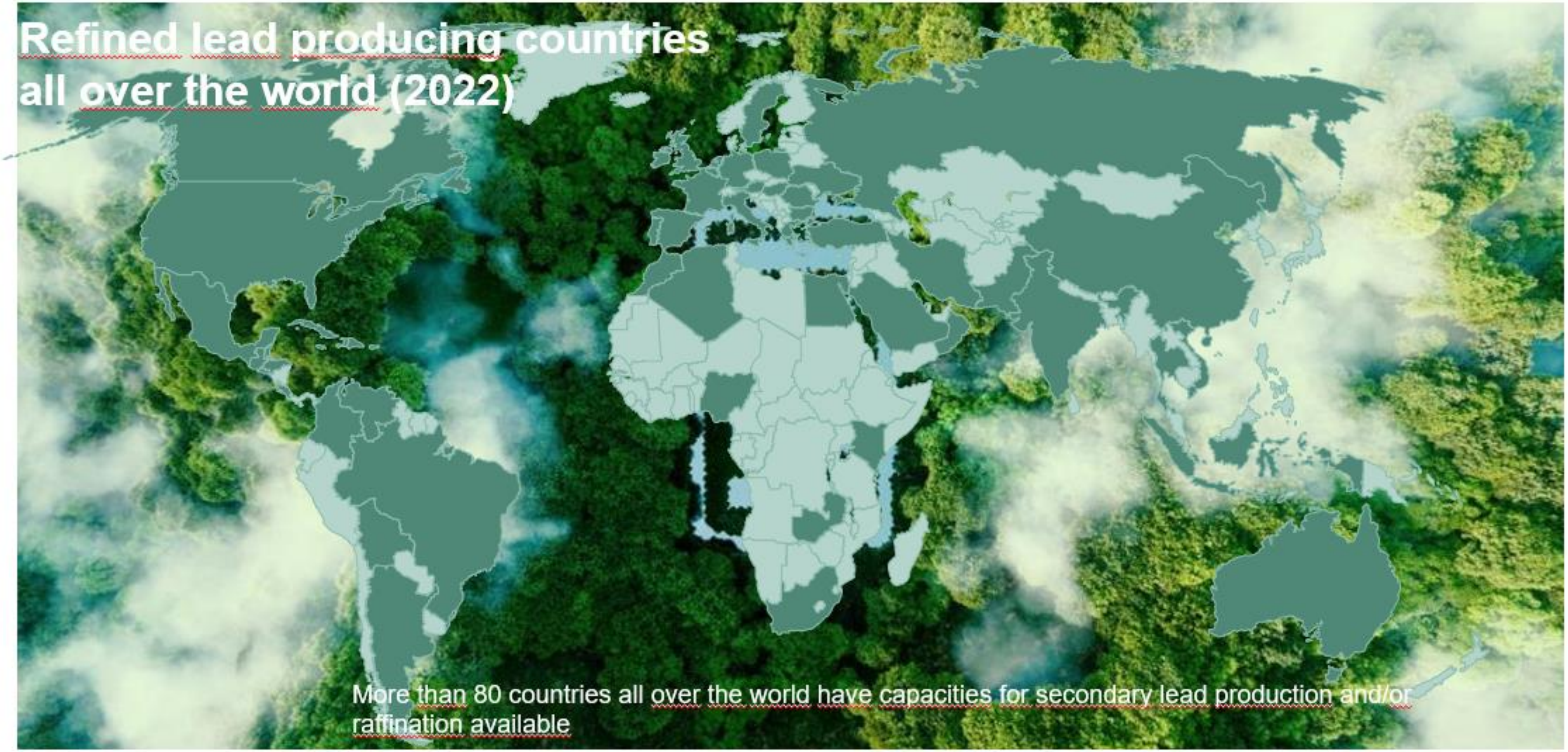
- easy to recycle



- sustainable

CO_2-Footprint

Lead acid battery, circularity



Requirements for the battery

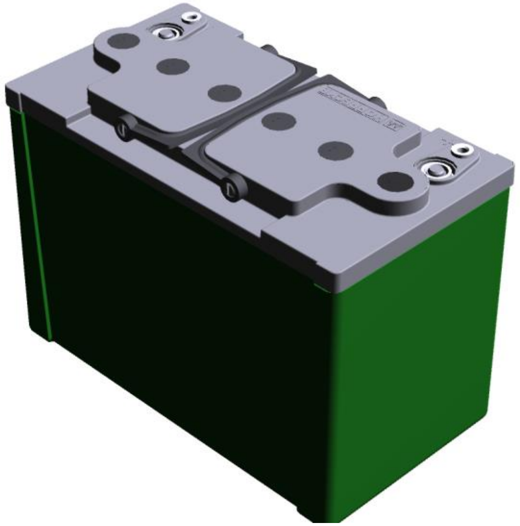
Remote management requirement

- BMS with connection to EMS

and the world

Battery testing

Laboratory tests on prototyping batteries
(I. Generation, w/o optimized electrode recipe)



Test of prototyping batteries

	cut-off	TT100 -MP	
	Vpc	**current [A]**	**capacity [Ah]**
C120	1.85	**1**	**120**
C10	[illegible]	[illegible]	**[illegible]00**
C5	[illegible]	[illegible]	**[illegible]3**
C3	1,7	**29,3**	**88**
C2	1,8	**41**	**82**
C15min	1,6	**224**	**56**

Performance tests done ✓

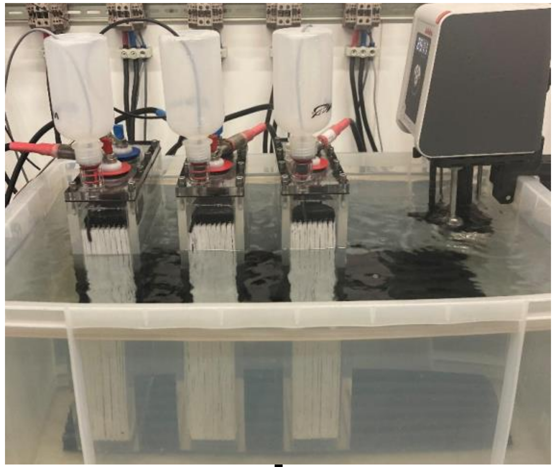
Real life simulating laboratory tests in doing

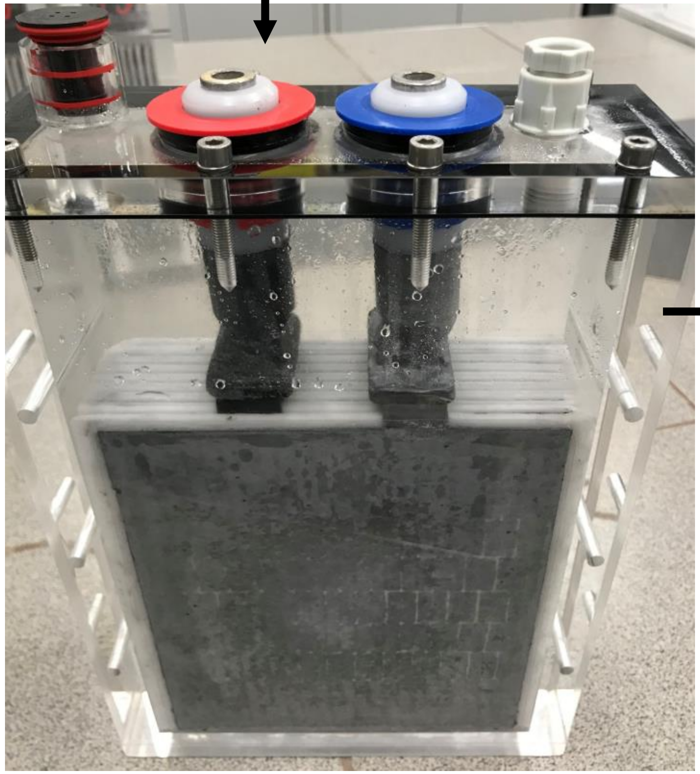
to simulate	cyclability	PSOC	life time	storage behaviour
special test	**70% DOD DIN 60254-1 cycling**	**renewable PSOC cycles**	**corrosion acc to IEC 60896-21 6.16**	**self discharge, acc to IEC60896-21 (6.12)**
status	TDA after 150 cycles	3 simulated years	4. unit C3 ~ 104%	**1% /month**
progress	**stopped** 2./3. Gen	**running**	**running**	**done**

Extract out of whole testing matrix

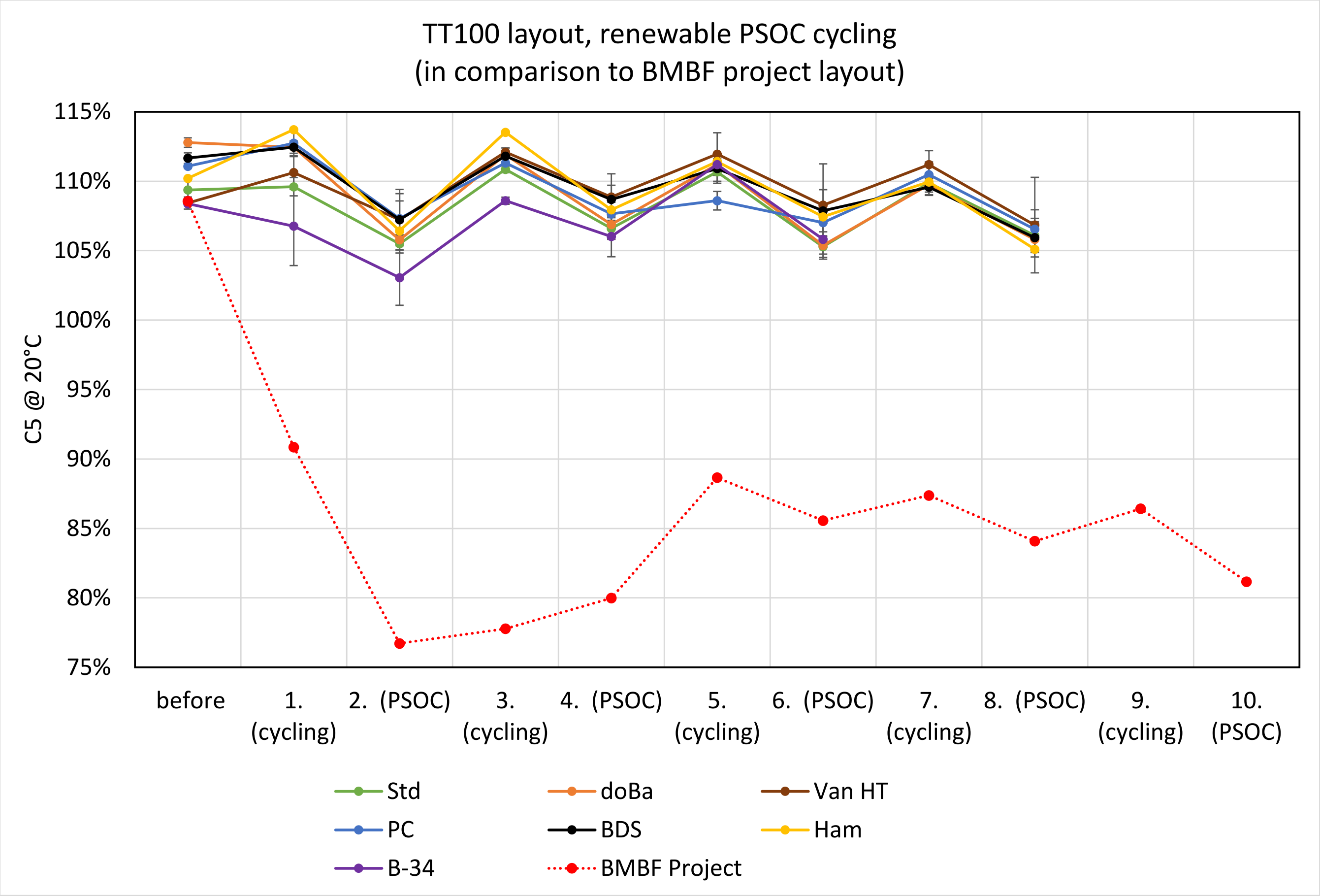
Single cell testing

For optimization of single battery components (NAM, PAM, AGM)





(4 simulated years, ~1500 cycles)



LoCEL-H_2

Sustainable Electricity and Hydrogen for Remote Communities

Webinar Work package 3 (WP 3)

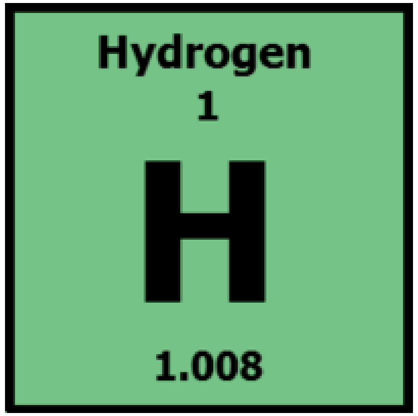
04-June-2024

Co-funded by the European Union

Combined – Battery Electrolyser

E. Ashton, J. G. Wilson, M. Brenton, R.Wilson, J. Barton, D. Strickland.

Hydrogen as a Fuel



$$2H_2 + O_2 \leftrightarrow 2H_2O$$

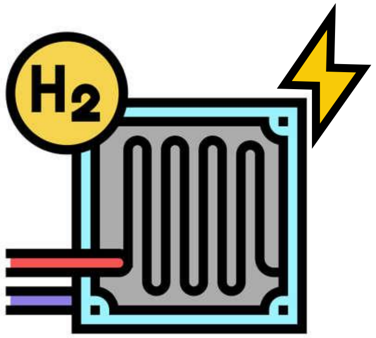
Hydrogen is a gas that can be reacted with oxygen to release energy in the form of electricity (via a **fuel cell**) or heat (**combustion**).

Combusting hydrogen can replace fossil fuels for high energy applications:

- Steel production
- Transport / freight
- Cooking

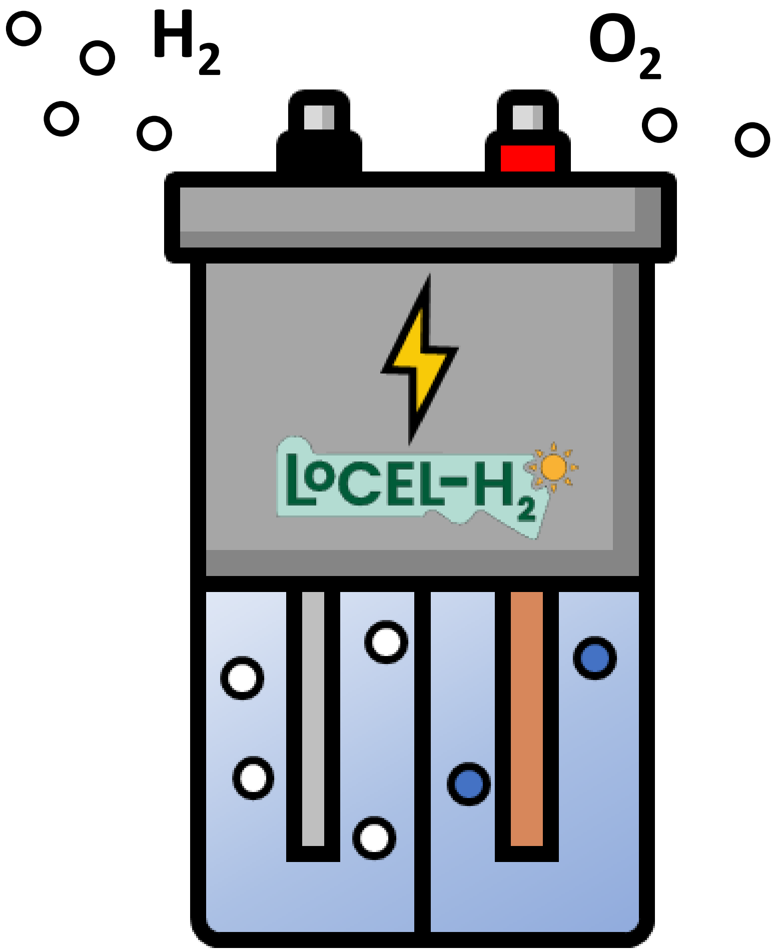
Fuel cells can be used for:

- Transport / freight
- Electrical backup
- Portable power



Combined battery-electrolyser

Lead acid battery technology allows the cell to charge and discharge as a battery

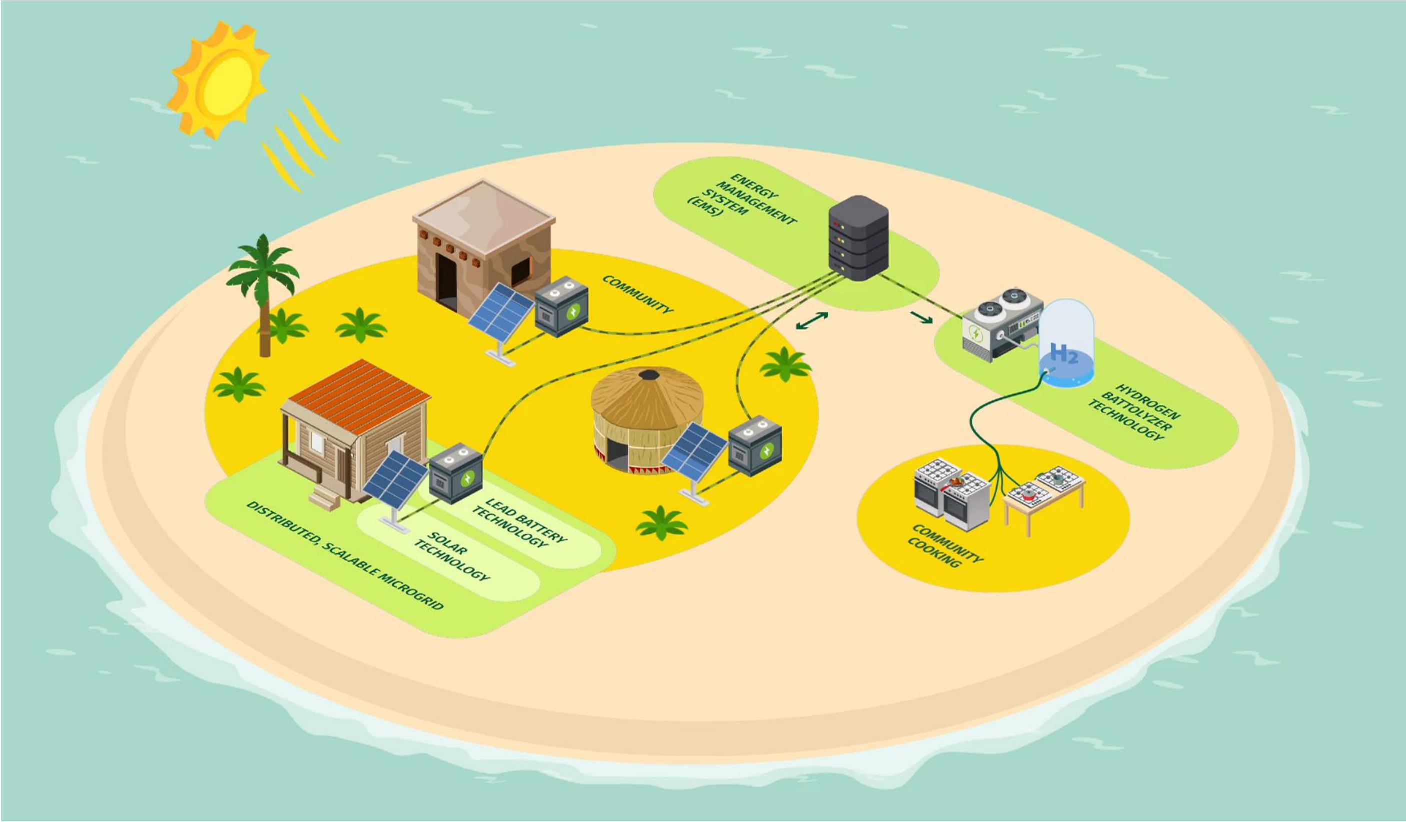


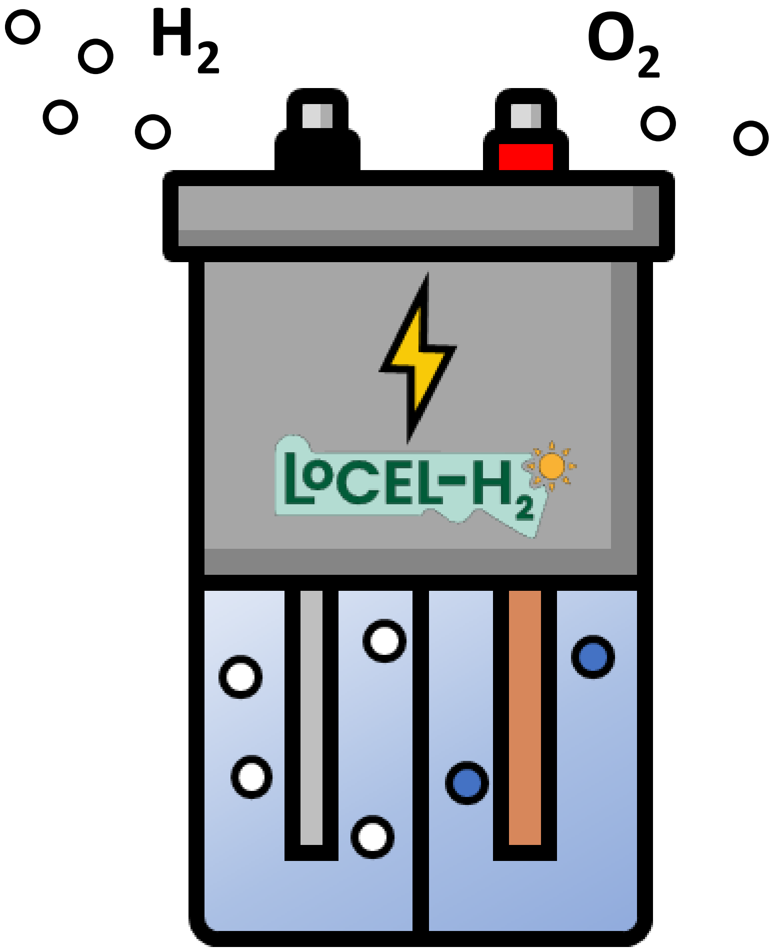
Hydrogen gas is collected at the negative electrode as a method of chemical energy storage during excess renewable energy production

Electrolysis occurs when the cell is over charged – splitting water from the electrolyte into H_2 and O_2 gas.

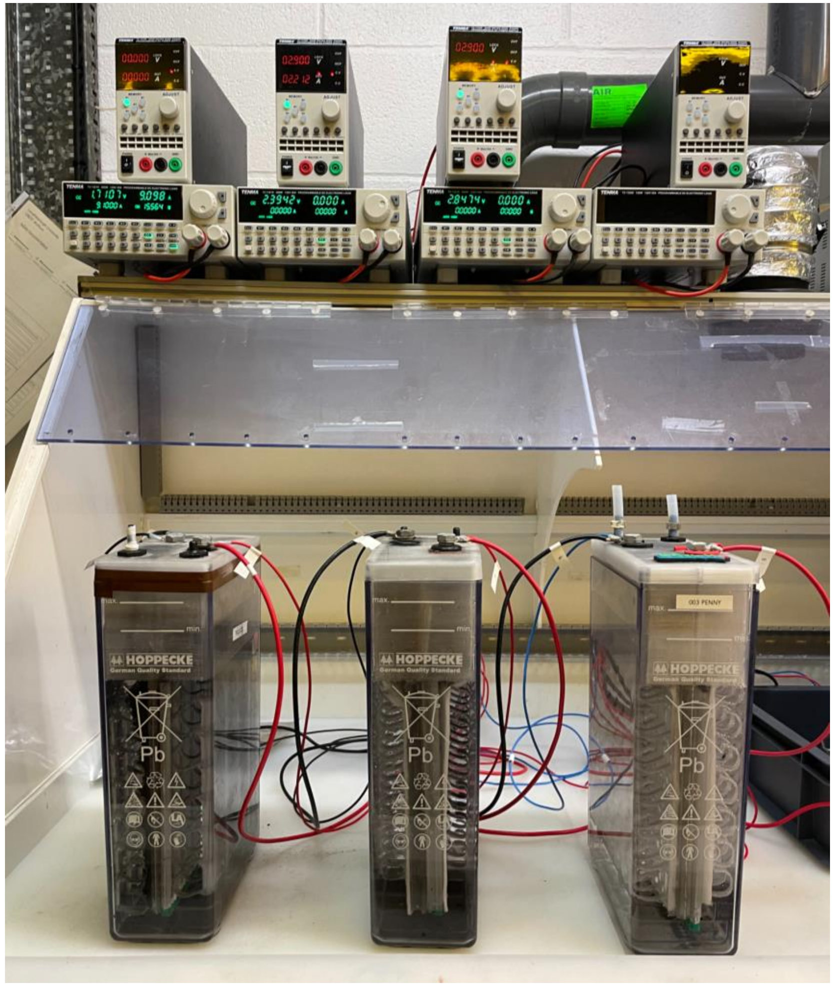
Renewable energy is stored either as electrical energy in the battery or chemical energy as hydrogen gas

LoCEL-H2 battery electrolyser

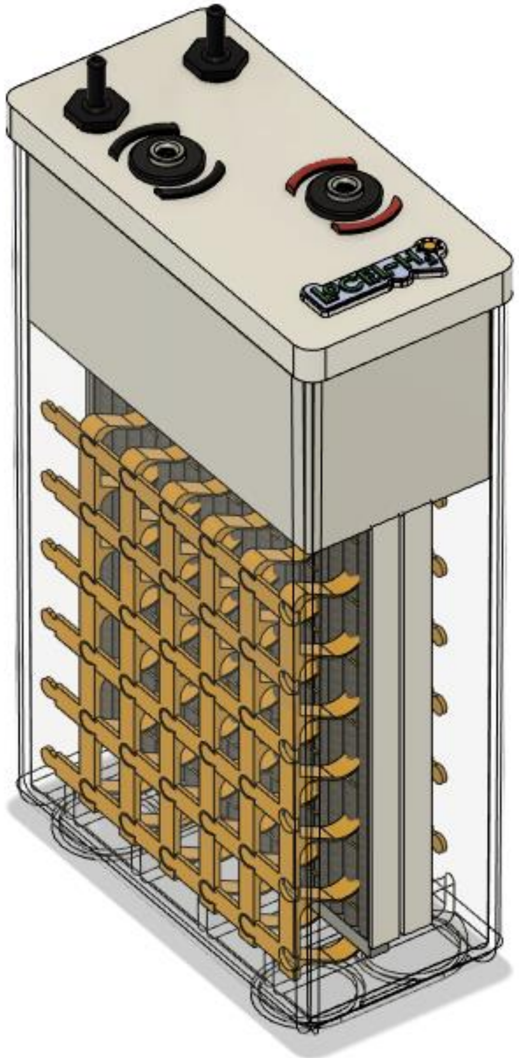




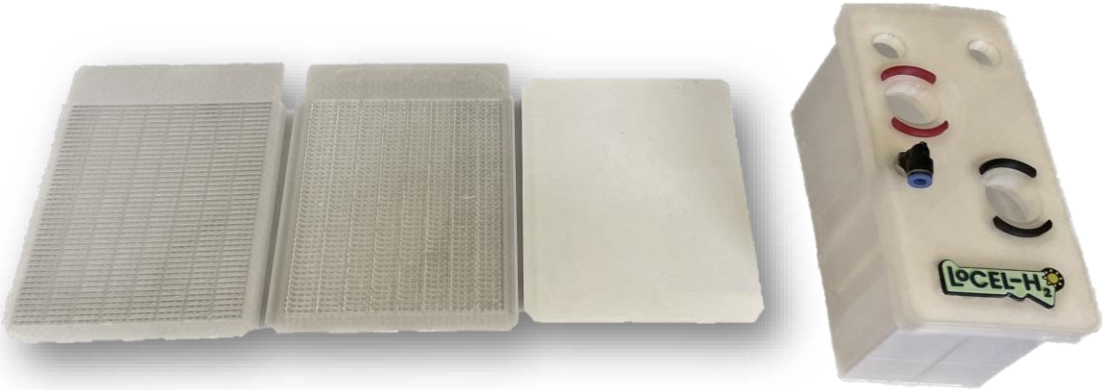
Setup for operating 20 cells

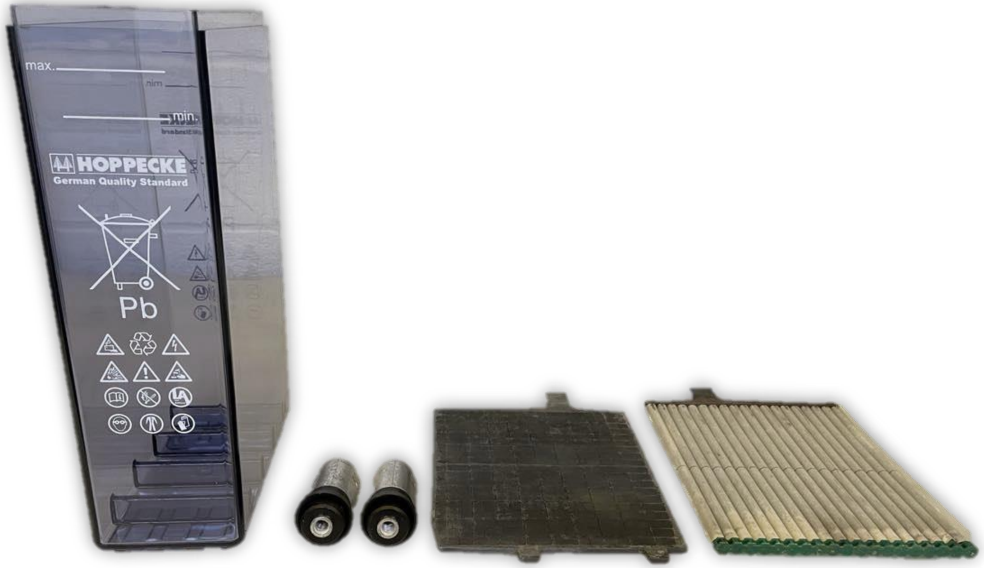


Off the shelve and 3D printed parts



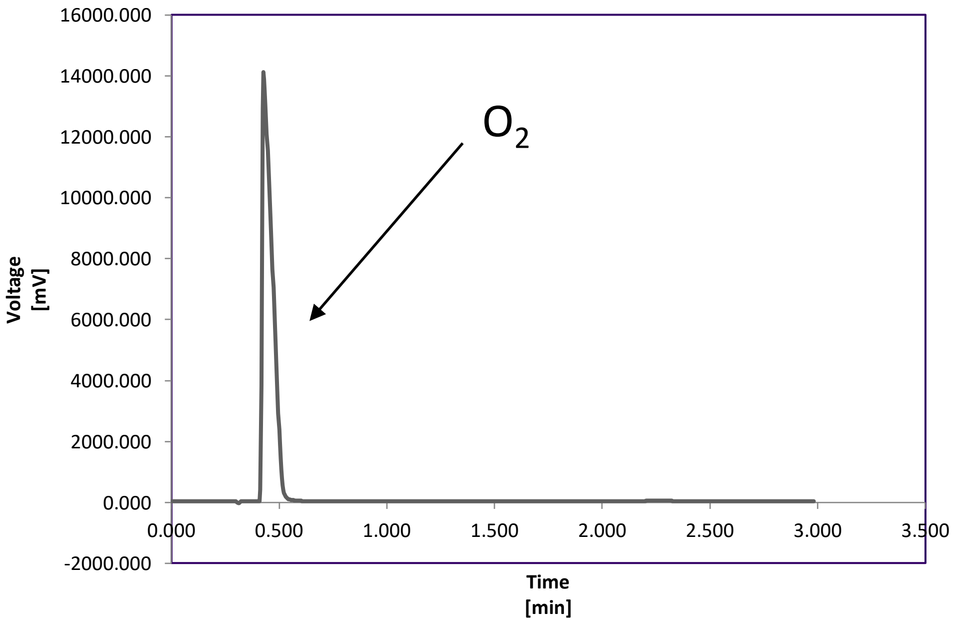
99 %



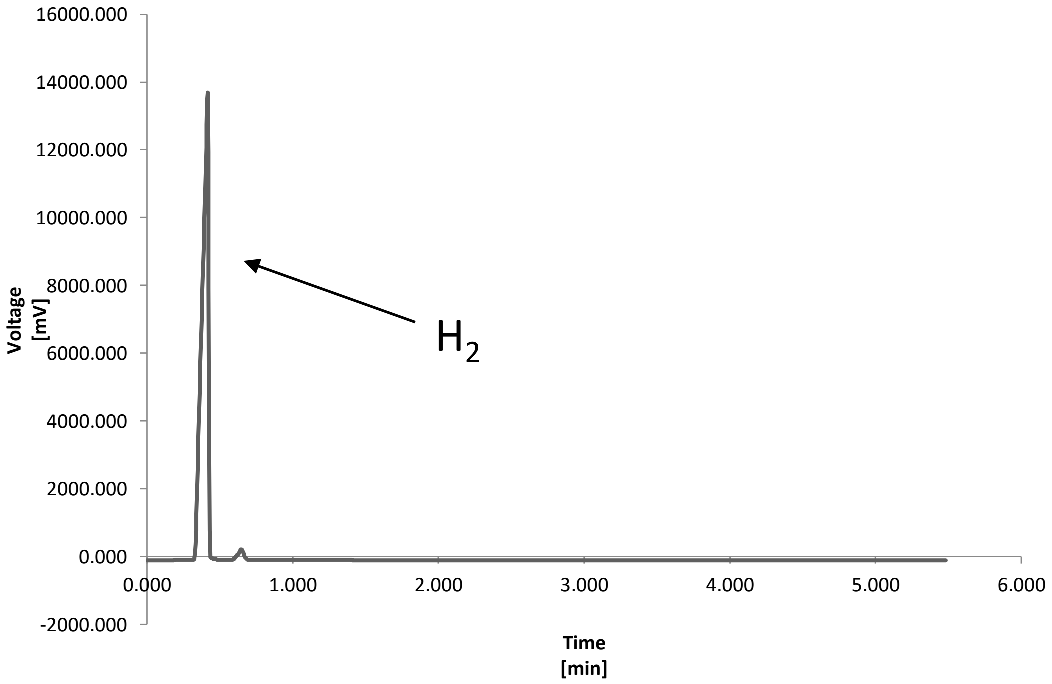


GC analysis– with gas separation

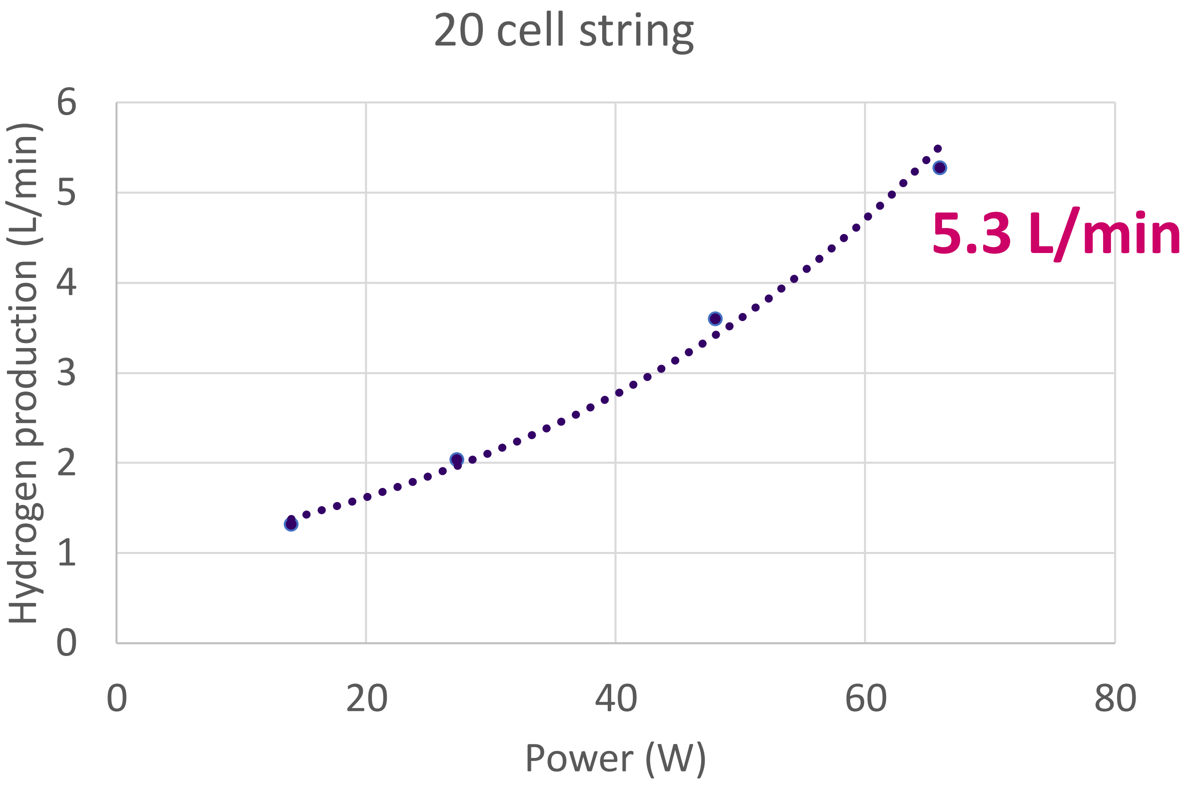
GC analysis of oxygen



GC analysis of hydrogen

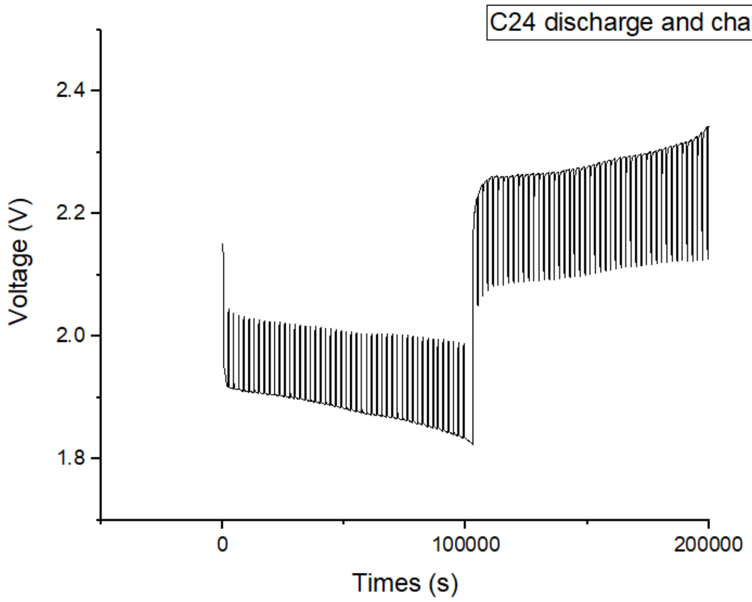


Electrolysis of 20 cell string

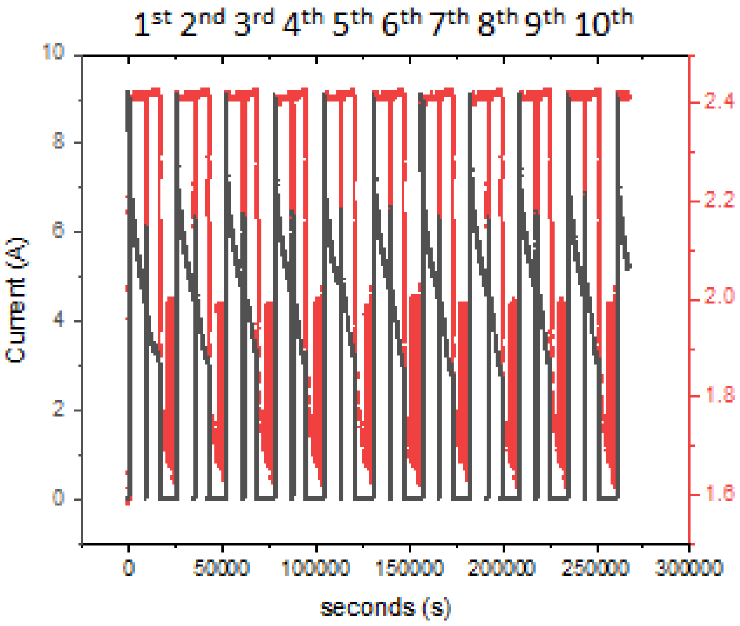


Durability and performance testing

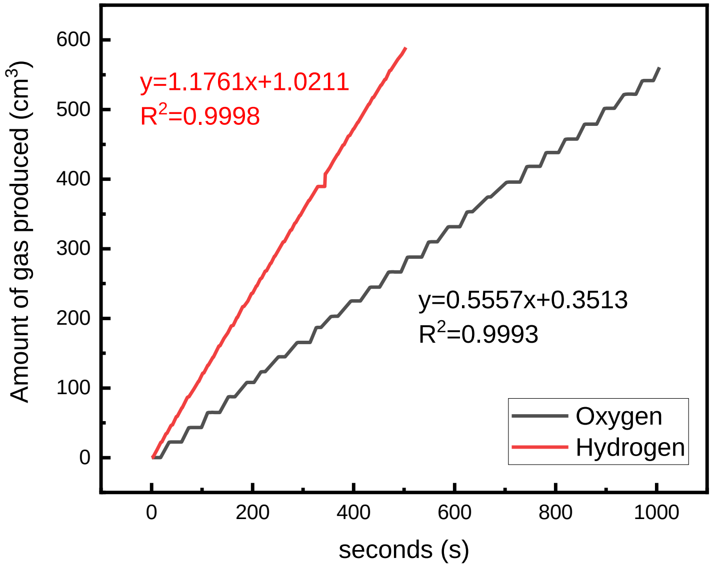
- Performance testing is key to durability and business case costings.
- Long term testing underway



Cell 3 capacity discharge test



Cell 1 cycling



Cell 3 electrolysis test

Arrival of 20 ft containers

Conclusions on Technology

1 Battery technology

2 Green H_2

3 Manufacture

4 Pilot scale

- **Battery technology:** Using lead acid battery technology we have successfully developed a combined battery and electrolyser.
- **Green H_2:** excess renewable energy can be used to generate water via electrolysis when over charging the battery cell.
- **Manufacture**: We have developed the combine battery and electrolyser cell design from lab scale to full scale, using off the shelf and bespoke 3D printed parts.
- **Pilot scale:** We are now in the process of testing the next 20 cells for testing, before deploying 160 cells in Zambia and the Ivory Coast.

Co-funded by the European Union

Co-funded by the European Union

Serena Scotton (RINA Consulting spa)

ONEPlanET

Open source Nexus modelling tools for Planning sustainable Energy Transition in Africa

This project has been funded by the European Union, Grant Agreement n. 101084127

ONEPlanET Project Overview

ONEPlanET is a Horizon Europe funded project, started on the 1st of November 2022

12 partners, 8 European and 4 African partners

This project has been funded by the European Union, Grant Agreement n. 101084127

Project Goal

ONEPlanET project aims **at empowering African policy makers, research & academia**, investors and **citizens** with the necessary tools and know-how **to increase clean energy generation** and sustainable **use of resources in Africa** while **reducing inequalities and cultural/socio-economic gaps**.

This project has been funded by the European Union, Grant Agreement n. 101084127

Mission

- ONEPlanET will **co-design** and test a **Toolkit**, built upon existing WEF Nexus models and methodologies, that allows to simulate scenarios optimizing existing resources with the most appropriate policies considering social, climate, economic and biophysical constrains.
- User engagement and co-design methodologies.
- Creation of a **Knowledge Hub** including a set of capacity building materials will be developed.

ONEPlanET aims to become **the Toolkit supporting decision-makers** in their day-to-day work. It will provide **open-source tools**, models and materials to help them to make informed decisions, considering social, economic and environmental parameters.

This project has been funded by the European Union, Grant Agreement n. 101084127

CASE STUDIES

The ONEPLanET concept, based on **3 diverse African case studies**, spans various river basins, and social, economic, and energy scenarios. These representative cases ensure broad project applicability, **advancing a just energy transition** in Africa, and **granting energy access** to communities while conserving resources and the environment.

- **West Africa** - Bani River (Niger Basin)
- **Malawi & Tanzania** - Songwe River Basin
- **South Africa** - Inkomati-Usunthu water management Area

participatory approach building local communities in three African case studies

This project has been funded by the European Union, Grant Agreement n. 101084127

Why Nexus in Africa

"African leaders have made clear their commitment to attaining **inclusive and sustainable economic growth** and development in **the Agenda 2063**, still it is necessary to support them in the definition of effective energy policy choices and to provide them with the scientific knowledge for de-risking investments in RES projects"

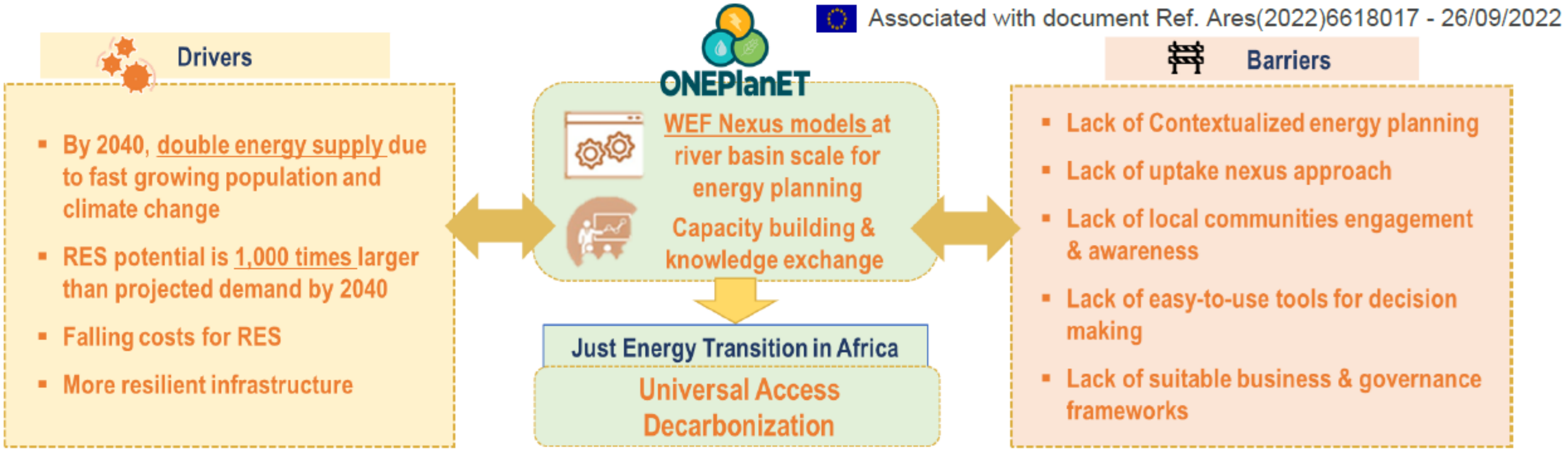


Figure 1 - ONEPlanET vision

This project has been funded by the European Union, Grant Agreement n. 101084127

Project Pillars

ONEPlanET aims at **becoming the Toolkit supporting decision-makers in the energy** field in their day-to-day work. It will provide open-source tools, models and materials helping them to take informed decisions, considering social, economic and environmental parameters.

❖ ONEPlanET ambition lies in these 4 main pillars:

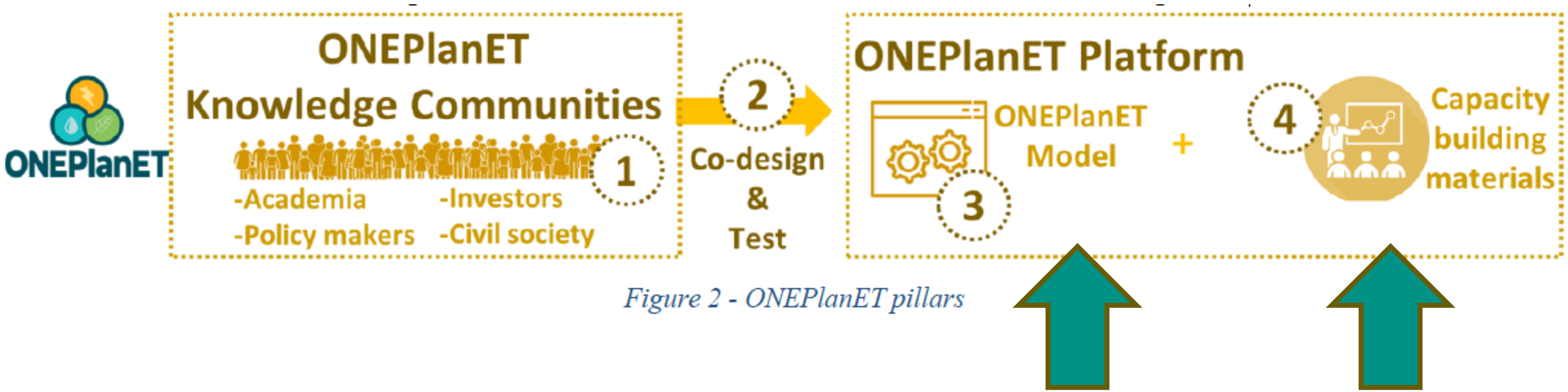


Figure 2 - ONEPlanET pillars

This project has been funded by the European Union, Grant Agreement n. 101084127

1: Community and stakeholders

ONEPlanET aims at building knowledge communities around the Nexus initiative mixing experts and future users of the platform from the EU and AU. The project will not build a network from scratch in the AU, but will use of the African partners, particularly the network of members in Mali, South Africa and Malawi/Tanzania.

The knowledge communities will also build on the existing networks of the EU and AU partners, particularly linked to the UNESCO institutions and collaborations,

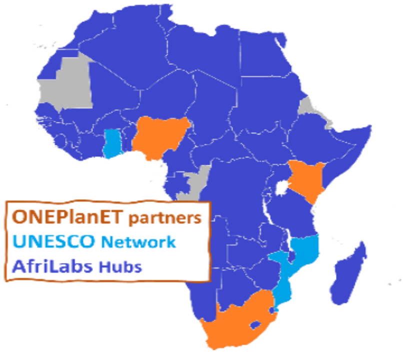


Figure 3 - ONEPlanET Network

This project has been funded by the European Union, Grant Agreement n. 101084127

2: User engagement and co-design methodologies to build the ONEPlanET Toolkit

Building the ONEPlanET Toolkit with knowledge from Local Communities, will allow to design the user experience of the whole **Toolkit adapted to real problems and challenges.**

The Toolkit development process encompasses:

1) **User research** that will be carried out in each basin and its region, to map current problems for these stakeholders → stakeholders engagement

2) **Co-creation of the user experience and the capacity building materials**. The main pains and challenges of policy makers, utilities and investors will be used to build the most adapted user experience of the Toolkit

3) **Creation of the model, user interface, training materials** and testing process. Everything will be exchanged/shared with users through different loops to ensure that it is still addressing the needs and challenges identified

4) **Final validation.** The Toolkit will get feedback from the four target audiences

This project has been funded by the European Union, Grant Agreement n. 101084127

3. Novel Nexus model for African continent

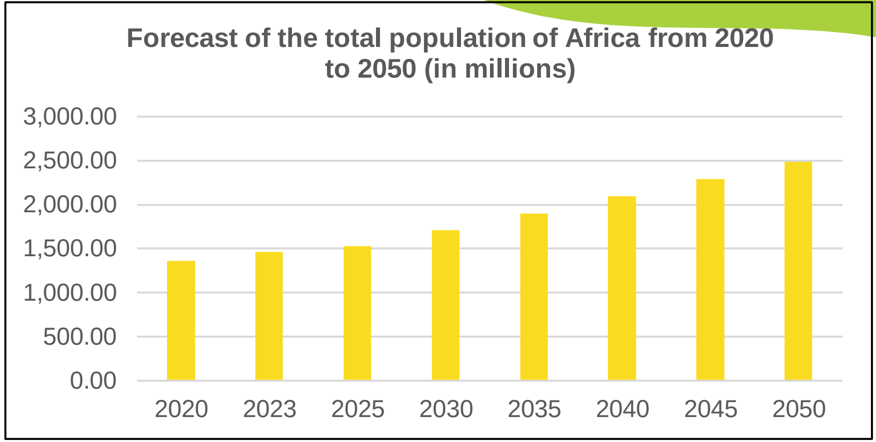
Most of the existing models simulate the WEF Nexus in a one-way direction rather than fully investigating the feedbacks and interconnections of each element.

The major missing aspects in existing models, and covered by ONEPlanET are:

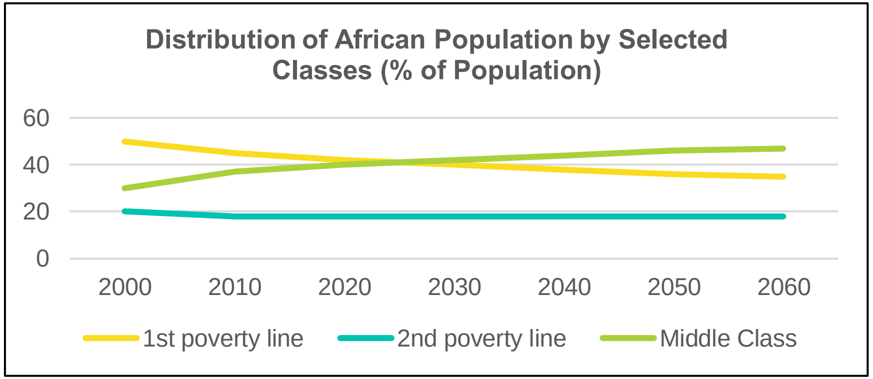
This project has been funded by the European Union, Grant Agreement n. 101084127

Context

- Challenges: Rapid population growth, accelerated urbanization, and climate change threaten water, energy, and food security.
- WEF Nexus Approach: Essential for understanding and managing the interdependencies between water, energy, and food systems.
- Model Objective: Provide a basis for strategic decision-making and promote sustainable development.



Source: UNDESA



Source: AfDB

This project has been funded by the European Union, Grant Agreement n. 101084127

Context

- **WP3 partners:**

- **Modelers:**
- Uva, IHE Delft, UKZN
- **Collaborators:**
- CARTIF, ECREEE, RINA, SU, SEI and Cyprus Institute

- **Study cases:**
- Bani River as part of Niger basin
- Songwe River Basin East Africa
- Inkomati-Usunthu Water Management Area

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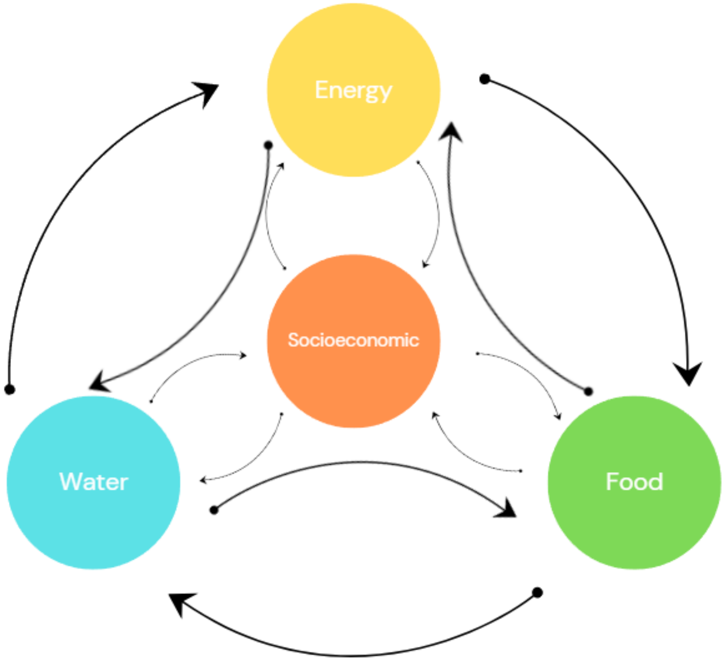
Model structure



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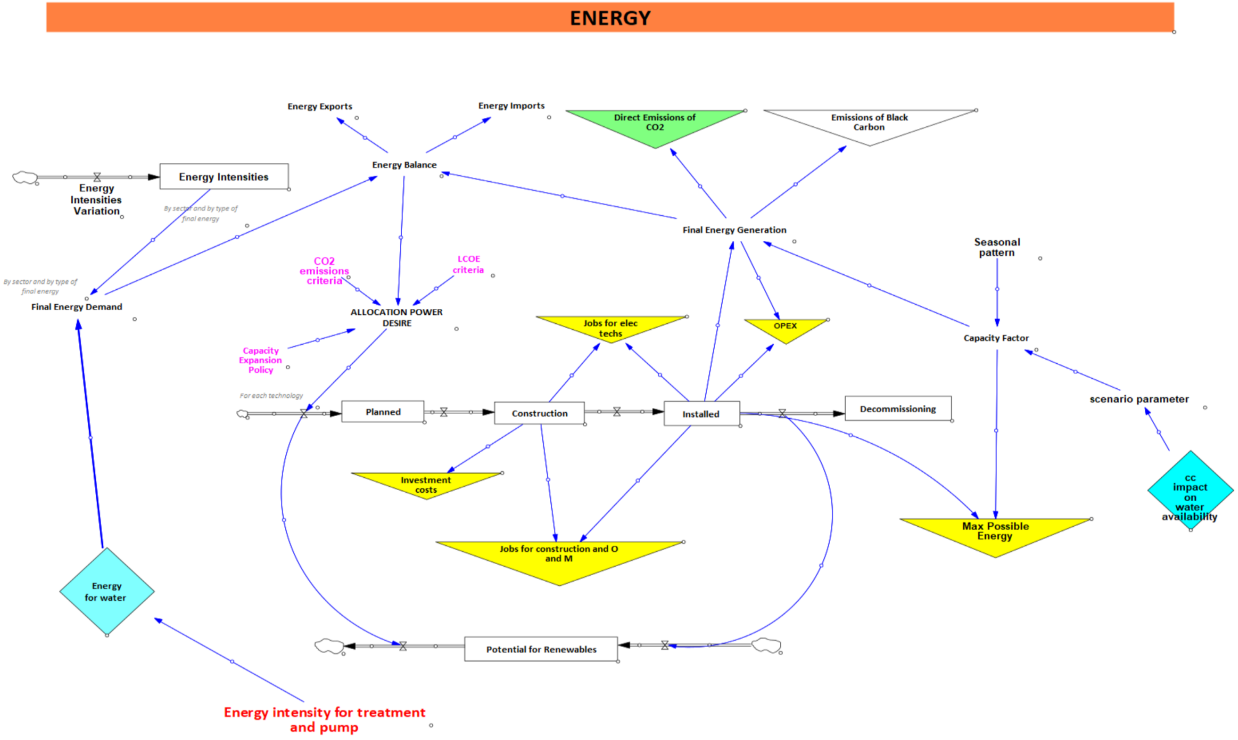
Model structure

- **Methodology:**
- System Dynamics

- **Software:**
- Vensim DSS



Energy module draft

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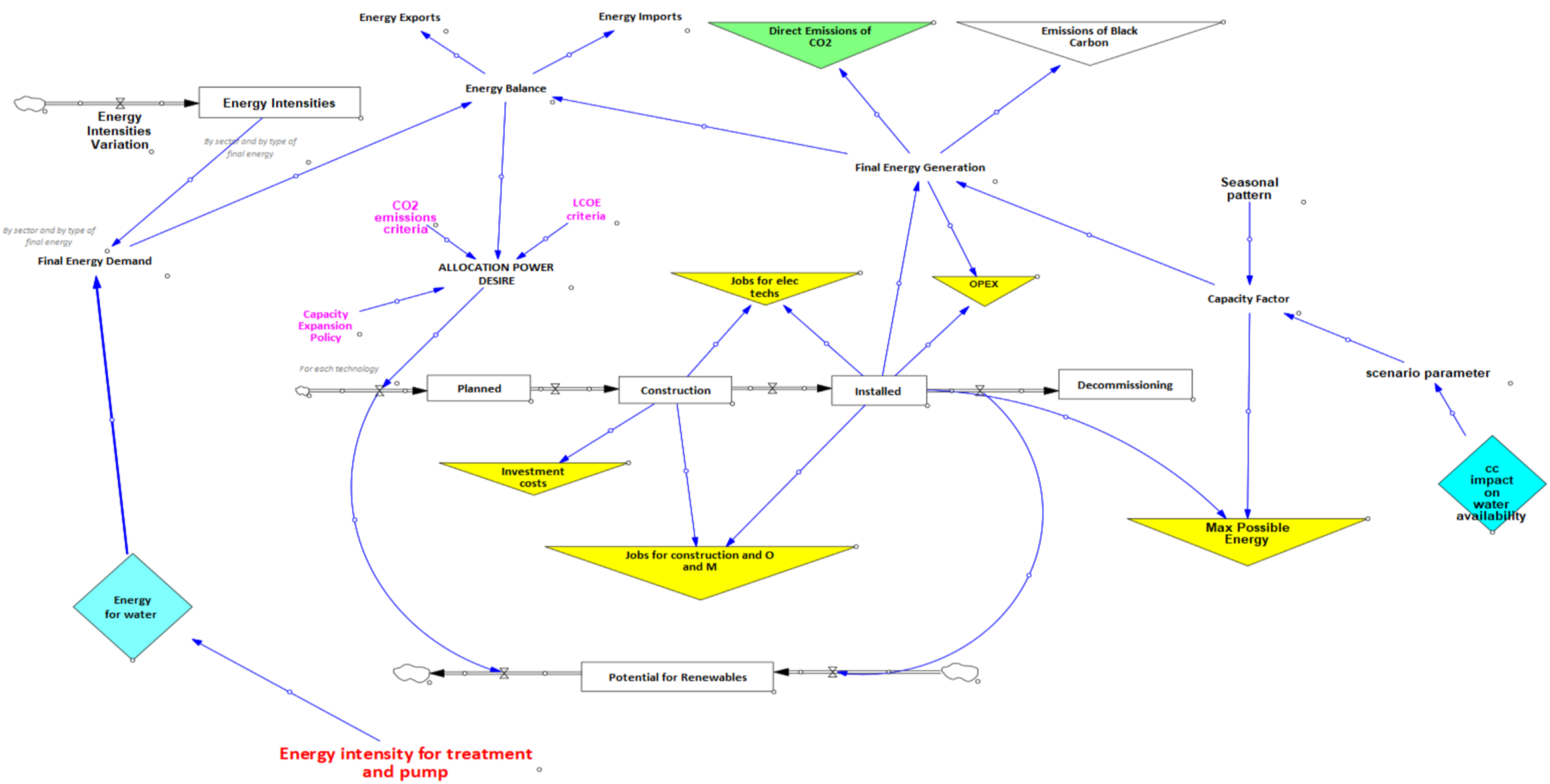
ENERGY



Energy Exports
Energy Imports
Direct Emissions of CO2
Emissions of Black Carbon
Energy Intensities
Energy Intensities Variation
Energy Balance
By sector and by type of final energy
Final Energy Generation
Seasonal pattern
By sector and by type of final energy
Final Energy Demand
CO2 emissions criteria
LCOE criteria
ALLOCATION POWER DESIRE
Jobs for elec techs
OPEX
Capacity Factor
Capacity Expansion Policy
scenario parameter
For each technology
Planned
Construction
Installed
Decommissioning
Investment costs
Jobs for construction and O and M
Max Possible Energy
cc impact on water availability
Energy for water
Potential for Renewables
Energy intensity for treatment and pump

Water Module

01

Key Variables:

- Water availability (surface and groundwater);
- Demand by sector (agriculture, industry, domestic);
- Water quality;

02

Interconnections:

- **Food:** Impact of irrigation on water availability.
- **Energy:** Water demand for hydropower and thermal power generation.
- **Socioeconomic:** Population growth and urbanization increasing water demand.

03

Expected Outcomes:

- Assess water security under different climate change, land-ueses and population growth scenarios.
- Identify areas at higher risk of water scarcity and conflict over water resources.
- Evaluate the impact of different water management policies on water security.

This project has been funded by the European Union, Grant Agreement n. 101084127

Energy Module

01

Key Variables:

- Energy technologies for electricity production (renewable and non-renewable);
- Energy demand by sector;
- Greenhouse gas emissions;
- Electricity generation;

02

Interconnections:

- **Food:** Energy consumption for food production and processing, land requirements for energy production.
- **Water:** Water availability for hydropower generation, energy intensity for treatment and pumping.
- **Socioeconomic:** Economic growth driving the energy demand.

03

Expected Outcomes:

- Assess the energy production capacity necessary to satisfy energy demand, for different scenarios.
- Analyze the impact of energy transition on GHG emissions.
- Analyze labour market changes and investment needs to develop new energy facilities.

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Food Module

01

Key Variables:

- Land-uses;
- Crop yields and food production;
- CO_2 emissions and GHG balance;
- Food demand and diets;

02

Interconnections:

- **Water:** Availability and quality of water for irrigation.
- **Energy:** The agriculture sector relies heavily on energy for various processes, impacting overall energy demand.
- **Socioeconomic:** Food demand driven by population growth and income.

03

Expected Outcomes:

- Assess the resilience of food production to climate and economic shocks.
- Identify strategies and policies to increase agricultural productivity sustainably and food security.
- Evaluate the impact and trade-offs of land use policies on WEF systems.

This project has been funded by the European Union, Grant Agreement n. 101084127

Socioeconomic Module

ONEPlanET

01

Key Variables:

- Population growth,
- GDP,
- Employment,
- Investment;
- Consumption;

02

Interconnections:

- **Food:** Dietary shifts and consumption patterns impacting food demand.
- **Energy:** Increased energy demand due to economic development and rising living standards.
- **Water:** Population and economic growth driving water demand.

03

Expected Outcomes:

- Analyze the impact of population growth and urbanization on resource demand and environmental pressures.
- Evaluate the economic impacts of water scarcity and energy constraints.
- Assess the effects of different socioeconomic development pathways on the WEF nexus.
- Identify policy options to promote sustainable and inclusive economic growth while ensuring resources security.

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Module development

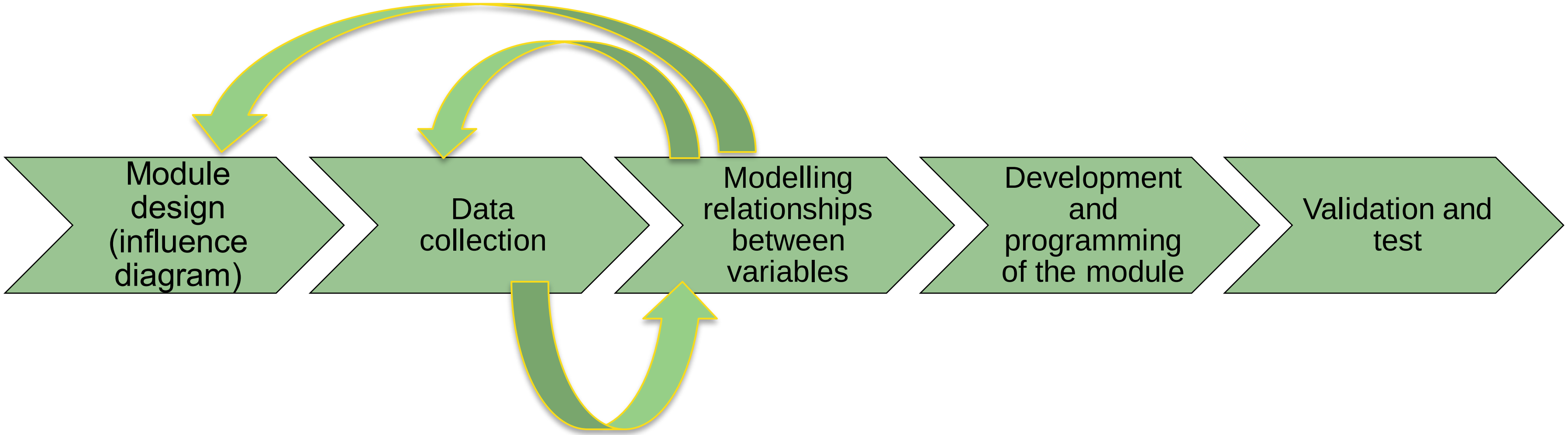


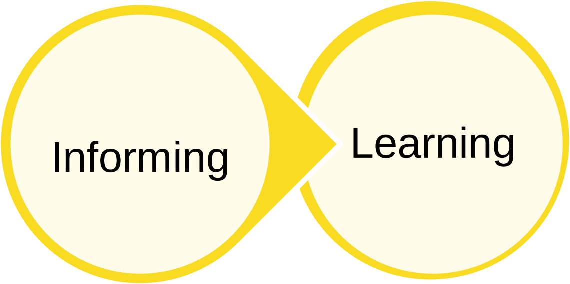
Figure 1: Planned stages in the development of each OnePlanet module.

This project has been funded by the European Union, Grant Agreement n. 101084127
The project has received funding from the European Union, grant agreement number 101084127.

4. A comprehensive capacity building approach to build skills and knowledge on the Nexus

- **Capacity building** enables organizations and more in general actors involved in the Nexus to develop competencies and skills that can make them more effective and sustainable in the use of resources.
- It helps to fosters a sense of ownership and empowerment

- ONEPlanET capacity building strategy has been conceived at two main levels:



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Breakthroughs

- When it comes to developing **new decision-making models** and tools, one of the **biggest challenges is getting decision-makers and final users to actually use** them. This is especially difficult when it comes to government agencies and public authorities.
- These tools are developed using a **techno-push strategy** that doesn't actually solve the real problems of final users. This leads to **low adoption rates** of the tools themselves.
- ONEPlanET Project aims to enhance the usability, relevance, and acceptance of WEF Nexus decision-support models and tools in Africa. This will be achieved through the use **participatory approaches, co-design techniques and interdisciplinary knowledge exchange**.

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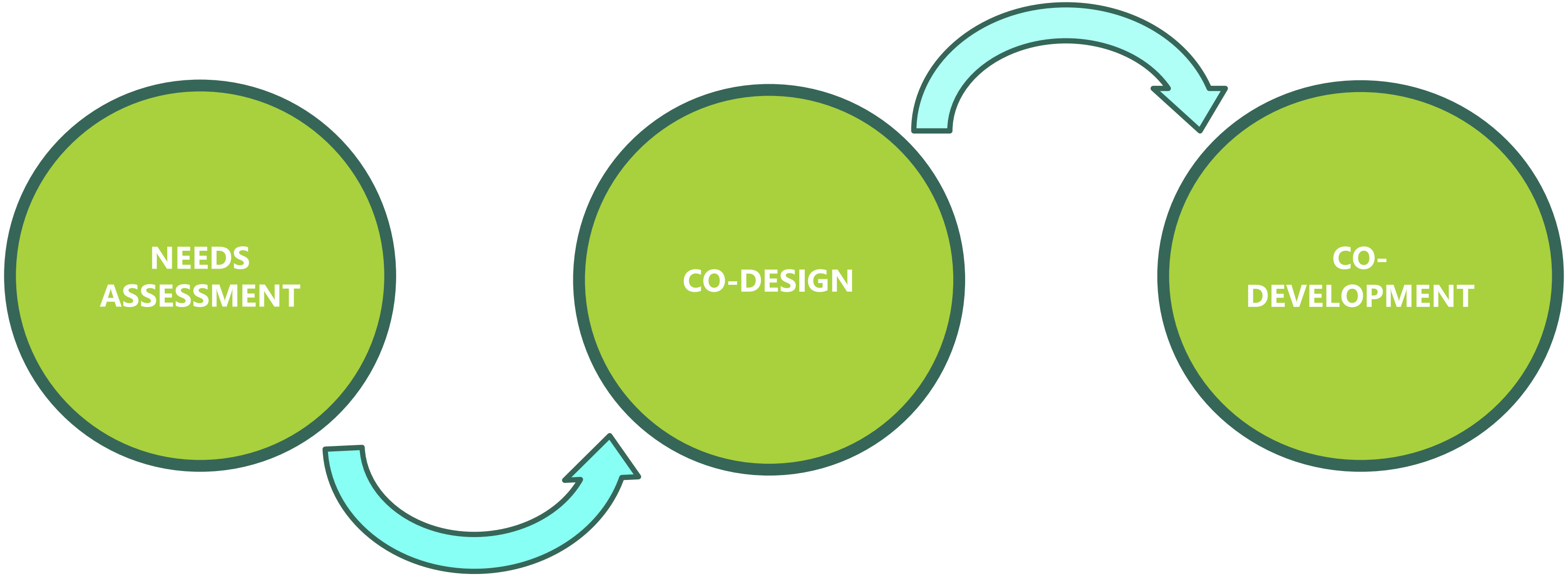
OUR PARTICIPATORY FRAMEWORK



STAKEHOLDERS INVOLVED THROUGHTOUT THE WHOLE DESIGN PROCESS

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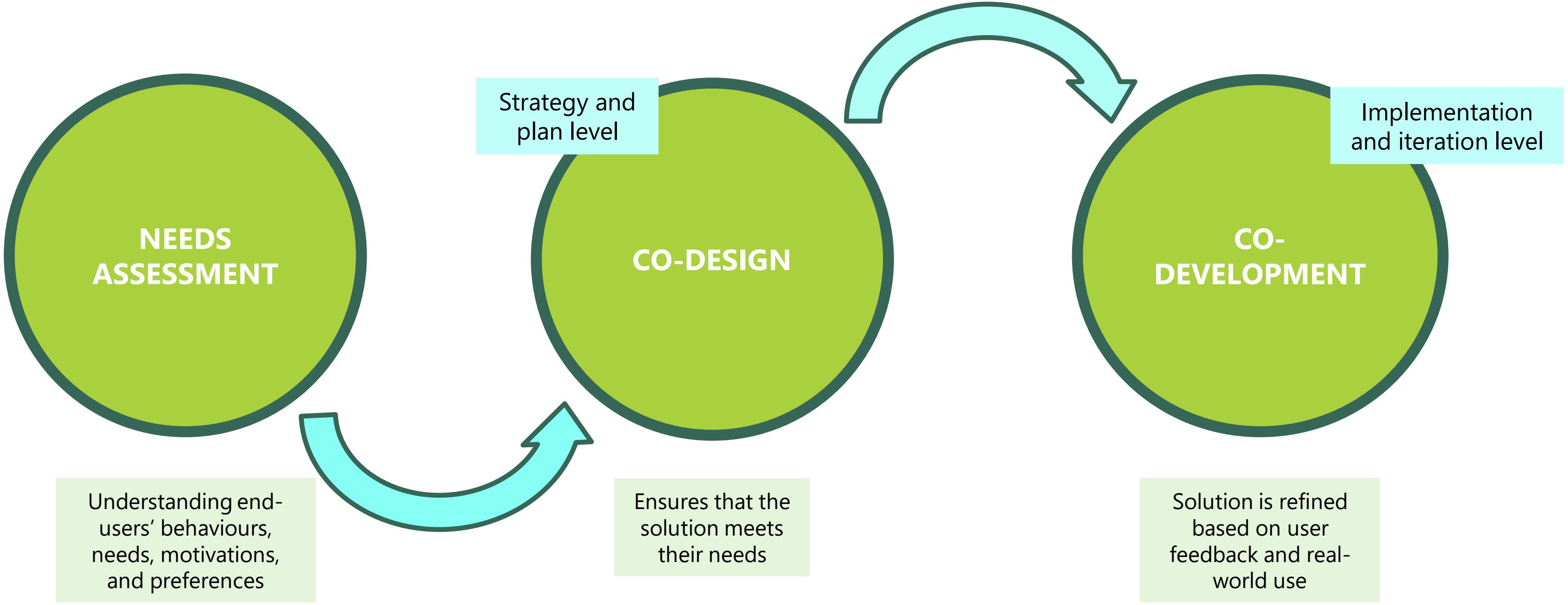
OUR PARTICIPATORY FRAMEWORK



STAKEHOLDERS INVOLVED THROUGHTOUT THE WHOLE DESIGN PROCESS

This project has been funded by the European Union, Grant Agreement n. 101084127

ONEPLANET TARGET GROUPS

TG1
ACADEMIA, RESEARCH INSTITUTIONS on climate science & climate change

TG2
POLICY AND DECISION MAKERS for WEF Nexus policy

TG3 INDUSTRY PROFESSIONALS AND INVESTORS for renewable energies

TG4
CIVIL SOCIETY GROUP

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Balancing the level of engagement

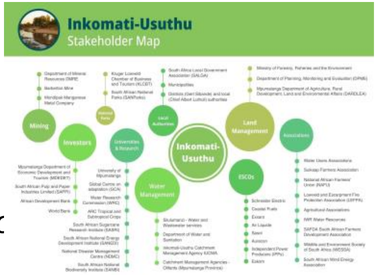
- To provide stakeholders with balanced and objective information to assist in understanding the problem, alternatives, opportunities, and/or solutions.
- To obtain public feedback on analysis, alternatives, and/or decisions.
- To work directly with stakeholders throughout the process to ensure that their concerns are consistently understood and considered.
- To partner with stakeholders in each aspect of the decision, including the development of alternatives and the identification of the preferred solution.
- To place final decision making in the hands of the stakeholders.

Public Participation Spectrum - Nabatchi, T. (2012). Putting the public back in public values research: Designing participation to identify and respond to values. Public Administration Review, 72(5), 699–708.

NEEDS ASSESSMENT

A mixed methods approach to achieve a better understanding of local challenges to the implementation of the WEF Nexus approach and its acceptance

- **Context analysis and stakeholder mapping** in each case study
- **Face-to-face semi-structured interviews (23)** with researchers, policymakers, industry professionals, and representatives from non-profit organizations.
- **An online user needs survey** was deployed between January 2024 and mid-march 2024 2024, through the ONEPlanET stakeholder network and at local workshops in the case studies. **223 responses** from **29 African countries**.
- **Focus Groups** to have an in depth understanding of findings, common challenges and pressing needs.



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ONEPlanET

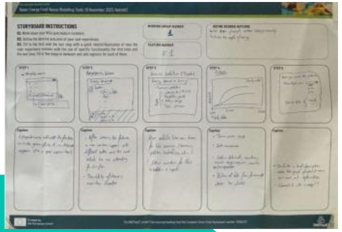
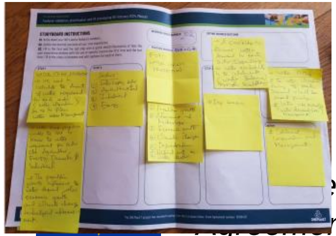
CO DESIGN WORKSHOPS

4 workshops in Nairobi and in the 3 case studies with local stakeholders to validate and prioritise the most relevant features for operational purposes and ensure effective UX design from the end-user perspective.

The 4 workshops followed the same structure:

- **Co-design Exercise 1:** Validation & prioritization of features


- **Co-design Exercise 2:** Prototyping user experience

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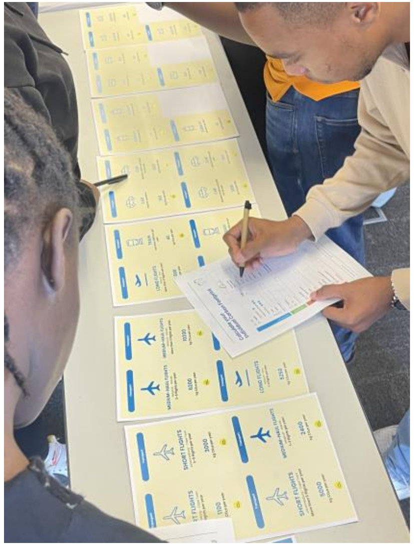
AWARENESS RAISING

Interactive and fun activities to raise awareness among the civil society

2 **Climate Sprints were organised in Kenya and South Africa** engaging more than 50 postgraduate students majoring in agriculture and water 🌱 💧



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MAIN OUTPUTS

From the first stage of the co creation process in OneplANET

- **Main local challenges and areas of capacity building identified:**
  - Lack of know-how to implement sustainable technologies
  - More reliable data to make decisions on investments and the distribution of resources
  - Need for realistic and actionable policy advice,
  - Difficulties involving community stakeholders in sustainability actions.
  - Developing long-term visions for sustainability projects

- **A list of 13 socio-technical requirements and recommendations for the ONEPlanET ICT Toolkit**

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MAIN CONCLUSIONS

From the first stage of the co creation process in OneplANET

- **Enhanced stakeholder engagement:** Given the success of stakeholder involvement in the co-design exercises, it's imperative to maintain and enhance this engagement throughout the project lifecycle. Regular consultations with stakeholders from diverse sectors—academia, policy, civil society, and industry—should be integrated into the project's methodology.

- **Iterative tool development:** Building on the iterative nature of the co-design exercises, the project team should adopt an agile approach to tool development. Rather than following a linear trajectory, where requirements are defined upfront and implemented in a single phase, the development process should be flexible and adaptable.

- **Capacity building and training:** it's essential to invest in capacity building and training initiatives. Targeted training programmes will be designed to equip end-users with the knowledge and skills required to leverage the toolkit's full potential. These training sessions will cover various aspects, including tool functionalities, data interpretation, scenario analysis, and decision-making support. By empowering end-users with the necessary competencies, the project can maximize the toolkit's impact and promote its widespread adoption across different stakeholder groups.

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And Where are we Now?

ONEPlanET
Knowledge Hub

ONEPlanET Academy

The WEF Nexus Modellling Drawer

ONEPlanET Toolkit

Online Directory

This project has been funded by the European Union, Grant Agreement n. 101084127

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ENERGY CATALYST

Innovate UK

aftrak

AFRICA TRACTOR

Loughborough University

Tiyeni

CONSORTIUM FOR BATTERY INNOVATION

THE BACKGROUND

ENERGY CATALYST

Only 8.9% of population grid connected

No mechanised agriculture

89% without electricity

Many smallholders do not grow enough to eat

Microgrids have a high failure rate due to insufficient income

Rock hard soil prevents crop root growth and drought protection

aftrak

Innovate UK

AFTRAK: THE SOLUTION

ENERGY CATALYST

Innovate UK

AFTRAK: THE TECHNOLOGY

ENERGY CATALYST

UKRI Innovate UK

AFTRAK: THE FEATURES

Walk behind: self-propelled for all physical abilities

AC sockets to take power home with you

Powered from our microgrid

Earth saw for
Deep Bed
Farming

Innovate UK

AFTRAK: ENABLING DEEP BED FARMING

Approved agricultural methodology in Malawi

Scale for any community size

Significantly increases crop yield

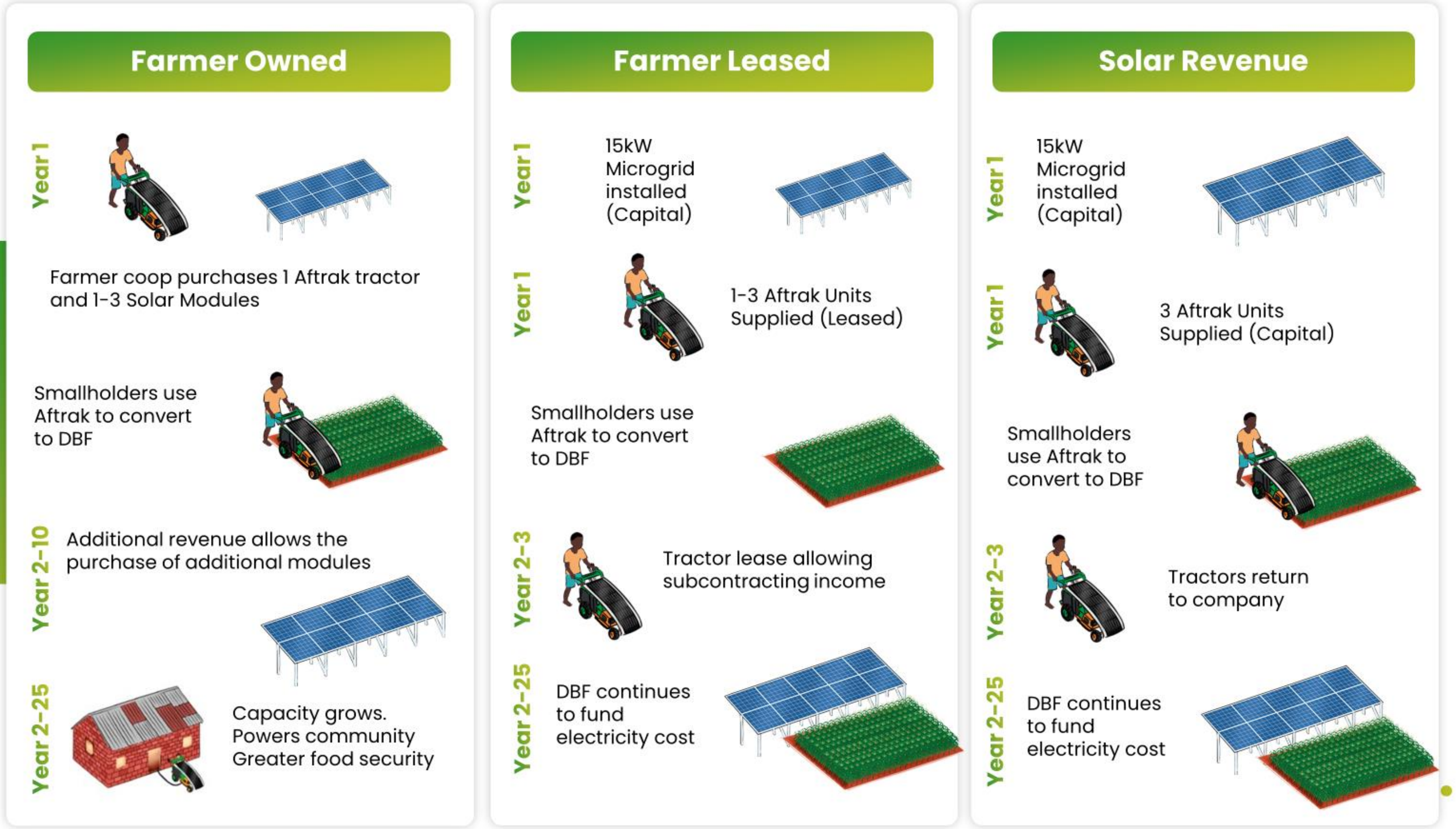
DBF IMPACT

ENERGY CATALYST

Innovate UK

BUSINESS MODELS: AFTRAK

ENERGY CATALYST



THE BUSINESS: AFTRAK

ENERGY CATALYST

ORGANISATION OVERVIEW

Organisational status: • Consortium (Aftrak website) • Supported by VARTA • Pre-commercial team	**Geographic focus**: • Sub-Saharan Africa (starting in Malawi)
Commercial next steps: • Commercial entity (in prog) • Enter pre-revenue stage • Plan extended demos	**Technical Status**: • Prototypes x 2 • Field trials in progress • Business & financial research

FUNDING WILL BE USED FOR.

- ✓ Design Improvements
- ✓ Design for production (cost down)
- ✓ Tooling provision
- ✓ Beta-run (20-30 systems)
- ✓ Trial business model
- ✓ Commercial entity
- ✓ Production scaleup

Loughborough University

Tiyeni

CONSORTIUM FOR BATTERY INNOVATION

aftrak

WINNERS OF MILKEN-MOTSEPE PRIZE IN GREEN ENERGY 2024!!!!!

ENERGY CATALYST

aftrak AFRICA TRACTOR

Aftrak, an initiative based out of the UK and Malawi, was awarded the $1 million Grand Prize for their innovative system involving solar microgrids to power custom-designed tractors for deep-bed farming.

Team Leader: Jonathan Wilson

aftrak AFRICA TRACTOR

UKRI Innovate UK

Watch on YouTube

Loughborough University

Tiyeni

CONSORTIUM FOR BATTERY INNOVATION

Dr Jonathan Wilson
Dr Toby Williams
Prof Dani Strickland

Alex Gerard
Ian Kerr

Isaac Chavula
France Gondwe
Chance Mwenitete
Thokozani Kamphata

Dr Carl Telford

"ENERGY FOR AFRICA" WEBINAR AGENDA

Tuesday, 04 June 2024 | 10:00-15:00 CEST

CASASOL PROJECT 2019 - 2024

Olivier WISS
Alexandre PLISSONNIER

INSTITUT NATIONAL
DE L'ENERGIE SOLAIRE

Born in 2005

22 000 sqm

120 M€ Equipment

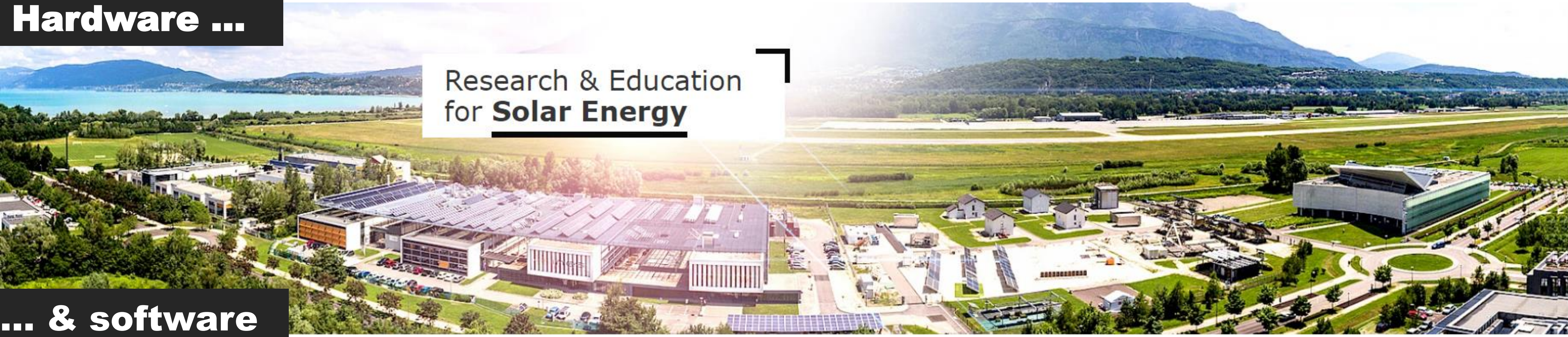
500 employees

50 M€ Annual Budget

> 60 patents a year

Premium PV Cells and modules I Process & equipment I X-IPV I Power electronics I Plants Architectures

Hardware ...



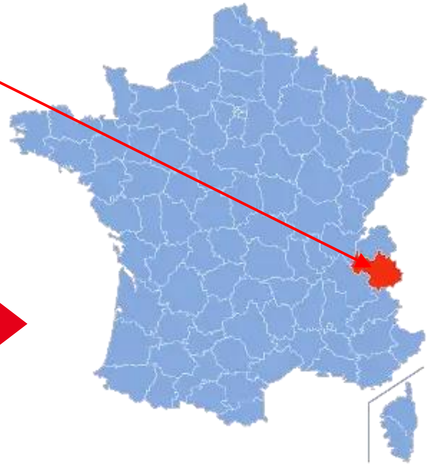
... & software

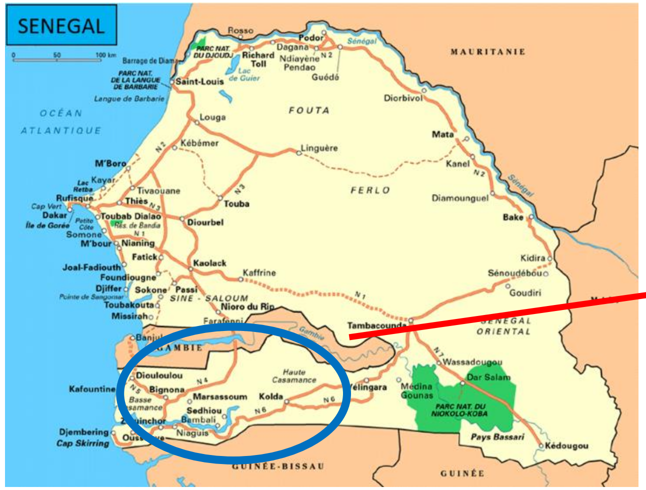
Grid integration I Diagnosis & Data I Energy management systems I Storage I Smart grids & Smart cities

CASASOL Project Genesis

- Strong partnership between Savoie Department, and Bignona Department, since 25 years, lead by PSS
- Bignona :
  - Needs for reliable electricity
  - Strong needs for rural electrification
  - Environmental issues

- Decision for a diagnostic mission
  - Bignona city (30 000p) and surrounds
  - 3 weeks on July 2019
  - Analysis of the needs and of the local context
  - Consortium building:
    - PSS / K2DS / ESF / INES /





Pays de Savoie solidaires
KASSOFOR - DEVELOPPEMENT DURABLE - SOLIDAIRE
K2DS
Electriciens sans frontières
l'energie du développement
ines
INSTITUT NATIONAL DE L'ENERGIE SOLAIRE

cea

Diagnostic mission achievements

- Meetings with national institutions in Dakar
- Meetings with PV systems and products importers and distributors in Dakar
- Meetings with national (Dakar) and local (Bignona) vocational training centers (CFP)
- Meetings with local authorities and local grid operator
- Meeting with local electrical and photovoltaic equipment dealers and other stakeholders
- Visits of Bignona and surrounding villages and meetings with peoples
- Diagnostics of several PV installations functional, or not.

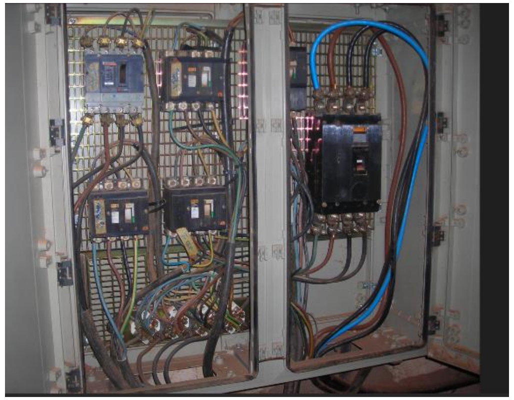






Diagnostic mission conclusions:

- **Bignona city connected to the Ziguinchor grid via SENELEC operator**
  - Huge grid stability issues. Black out up to several days (36h blackout during the exploratory mission)
- **Surrounding villages not connected to the grid**
- **Many existing PV systems but many not operational**
- **Existing qualified manpower for electricity but lack of PV specialists**
  - Electrical competencies to be reinforced (safety)
  - “Groupement d’ Intérêt économique” (GIE) or “Business Interest Group” typical organization
- **Existing PV and electricity equipments resellers but products are often from bad quality and sometimes counterfeit !**
- **High agricultural and tourism potential**
  - Populations have resources
- **Need for a specialized photovoltaic structure in Bignona !**



CASASOL concept:
A Solar Energy Resource Center (SERC)

National and international institutions /PSS/INES/ESF/Others

development assistance

Team:

- PV specialists
- Electrical engineering specialists
- Administration specialists

Resources:

- Premises
  - Office equipments
  - PV Expert software
- Laboratory
  - Handheld equipments
  - Stationary equipments

Knowledges, trainees, students, equipments

Vocational Training Centers / ISEP / University

Missions

- Consulting services
- PV systems design
- PV systems diagnostic
- PV equipments testing
- Project management
- Assistance in finding funding
- Energy education
- Regulatory compliance ?

Business Interest Groups

Local institutions

Private customers

Villages committees

Companies Public / private

Populations

CASASOL Project building

AFD
AGENCE FRANÇAISE DE DÉVELOPPEMENT

RÉPUBLIQUE FRANÇAISE
Liberté
Égalité
Fraternité

ADEME
AGENCE DE LA TRANSITION ÉCOLOGIQUE

Funding:
180 k€

SAVOIE
LE DÉPARTEMENT

Funding

KASSOFOR SOLIDAIRE DÉVELOPPEMENT DURABLE
K2DS

Manpower
+ Assistance

cea

Manpower
+ Equipments

ines
INSTITUT NATIONAL DE L'ENERGIE SOLAIRE

Pays de Savoie solidaires

Electriciens sans frontières
l'energie du développement

Global budget: ~ 350 k€

AFD funding signed: October 2020

- **Project Aims:**
  - Help to develop the local photovoltaic sector
  - Help set up a local corporate governance for CASASOL
  - Support to build CASASOL center and supplying equipments
  - Transfer PV skills and provide medium-term assistance
  - Communication & capitalization
- **Financial autonomy target: 5 years**

CASASOL
CENTRE DE RESSOURCES SOLAIRES

Team:	**Resources:**

• PV specialists
• Electrical engineering specialists
• Administration specialists
• secretary
	• Premises
	  • Office equipments
	  • PV Expert software
	• Laboratory
	  • Handheld equipments
	  • Stationary equipments

cea

CASASOL achievements

2021

2022

2023

End 2023

CASASOL official inauguration : 8th December 2023

CASASOL Governance building

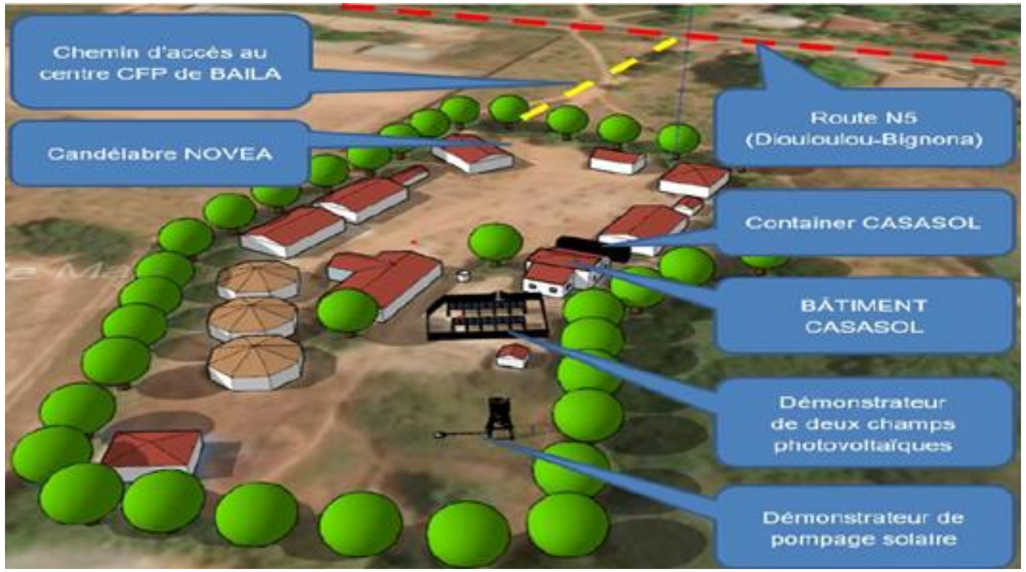
- Regional support mobilization
- Legal founding of the SERC
- Raising awareness among local stakeholders
- First PV diagnostics

Technical studies

- Identification of a location for CASASOL
- Definition of the demonstrators and equipments with local team
- Equipments purchasing, manufacturing
- Preparing for container shipment

CASASOL building

- Delivery of the container (19Th January)
- Students task force for the installation
- Recruitments of 2 technicians
- Training for the CASASOL team
- First quotations and other activities



CASASOL

CASASOL CENTRE DE RESSOURCES SOLAIRES

CASASOL CENTRE D'EXPERTISE SOLAIRE

CASASOL achievements

Building of the SERC with a students task force with teachers and CASASOL team management

- 10 days onsite for the structural work
- Cooperation between project team, teachers and students
- 80 Students from ISEP (technicians students)
- 30 students from CFP (Workers students)
- Gender mix


Eelectrical wiring workshop


Student briefing


PV module installation

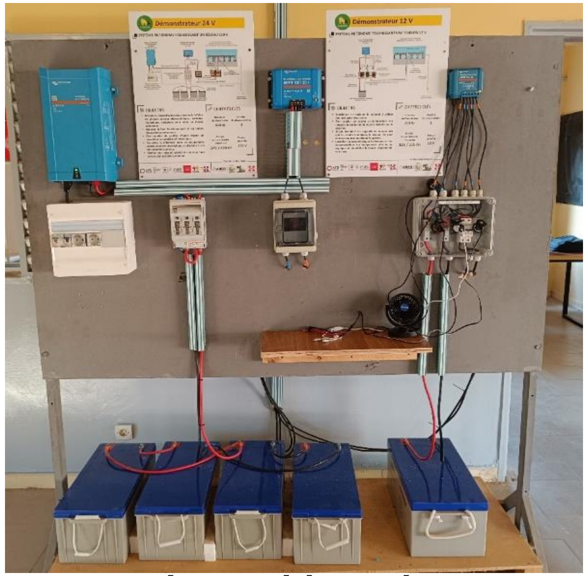

trench digging


CASASOL electric network wiring


Water tank frame assembly

CASASOL demonstrators and equipment

48V Micro grid mockup



24V Micro grid mockup

CASASOL main PV field

Operational pumping station

Solar streetlights

Solar home systems demonstrators

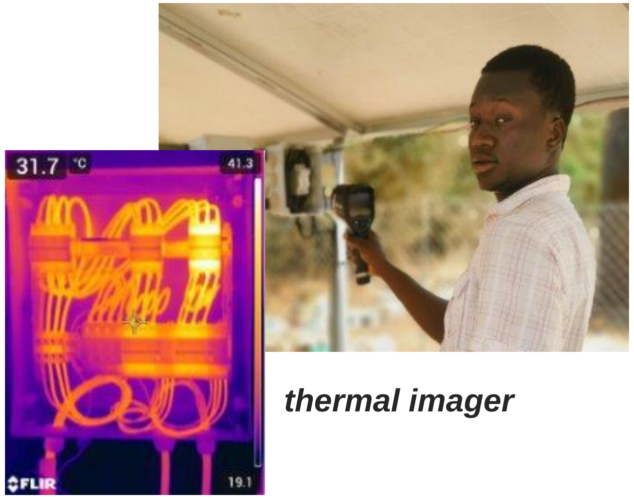
Educational mockup « Use of Energy”

CASASOL Laboratory equipment

- PV module I/V tracer
- Programmable power supply
- Electronic load
- Resistive autonomous load bank
- Irradiation monitoring (pyranometer + reference cell + acquisition)
- Thermal imager
- Multimeters
- Electrician tool boxes
- Lead acid battery maintenance kit
- Safety equipments (helmets, gloves, facial protection…)

Electronic load and power supply (battery tests in laboratory)

PV module tracer



thermal imager

Stock of electrical devices

Handheld load bank (battery tests in the field)

CASASOL team training

PV engineering and design

- PVsyst expert software (islanded, hybrid, pumping systems)
- In the field inspection, customer consulting & reporting
- CASASOL center use case application

PV installations diagnostic

- Knowledge and mastery of experts tools (I/V PV module tracer, thermal imager, battery testing load bank)
- Data analysis and debriefing
- Diagnostic reporting

CASASOL activities

First PV systems diagnostics for the CASASOL team

Municipal pumping station facility of Baila (10 km from Bignona)

In the field inspection

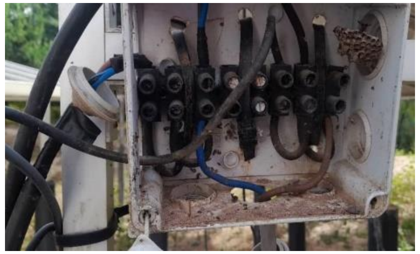
- Customer contact Needs & context identification
- Verification of suitability
- Equipments inspection (use of expert tools)

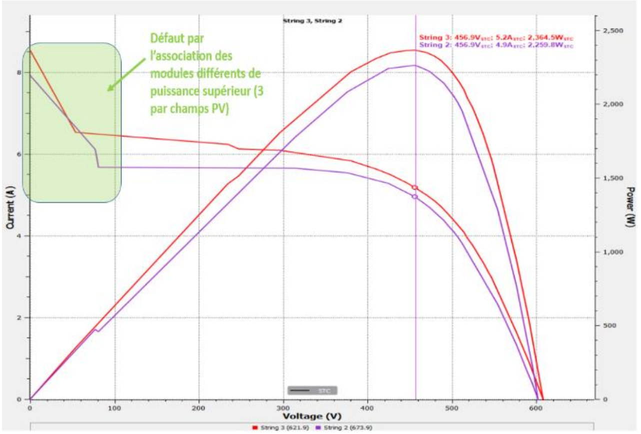
Data analysis at CASASOL

- PV simulation with Pvsyst tool
- Malfunctions analysis
- Search for technical solutions

Customer reporting

- Detailed diagnostic report
- Financial estimation for identified solutions
- Quotation for the work





CASASOL
CENTRE D'EXPERTISE SOLAIRE

Rapport Technique CASASOL/RT/2023/001

RAPPORT DE DIAGNOSTIC – STATION DE POMPAGE COMMUNALE DE BAÏLA

Auteur(s) : Equipe Technique CASASOL

TABLE DES MATIERES

CASOL Soiling tests on site

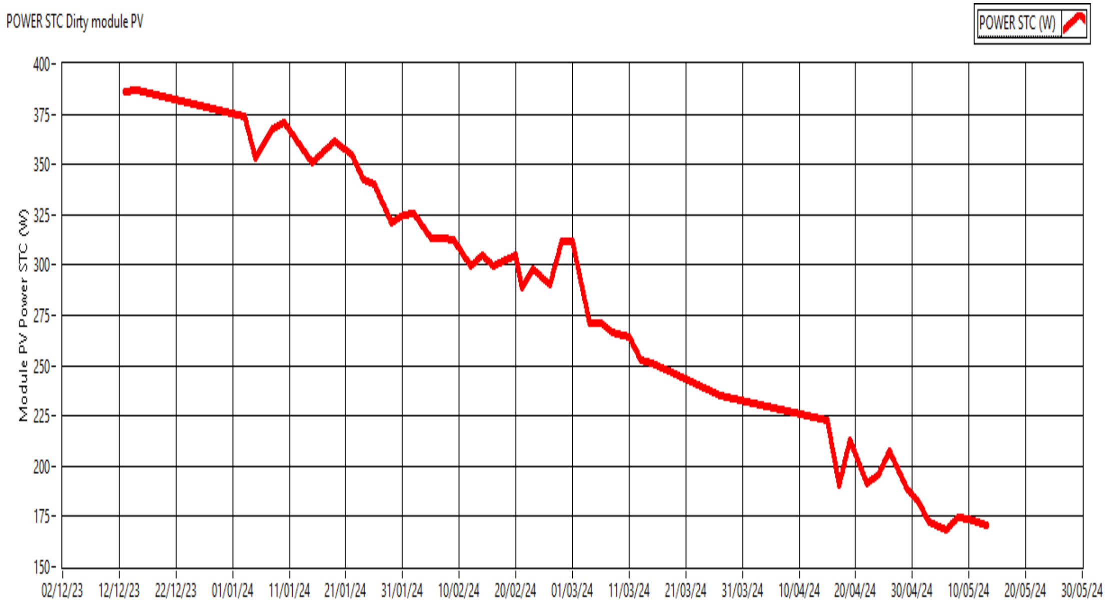
Impact assessment of local soiling to the performance of PV modules

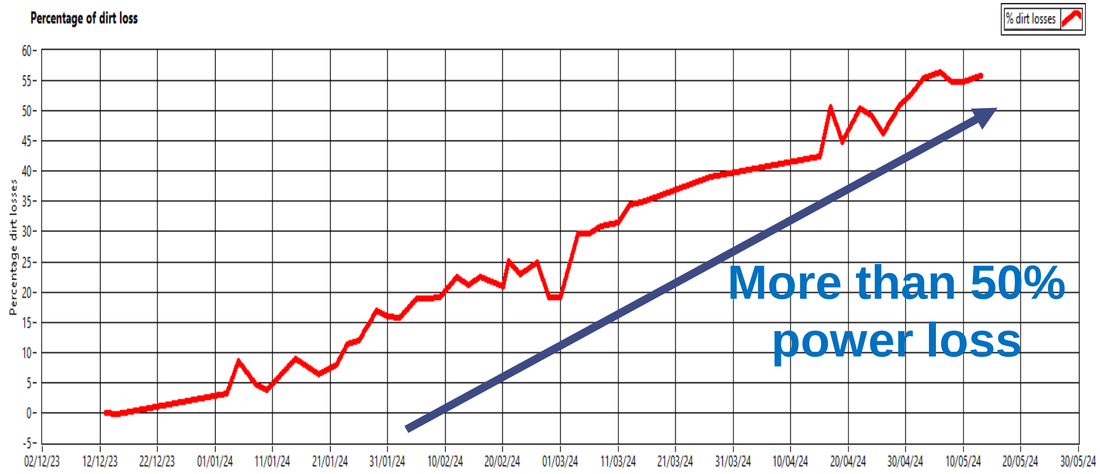
Methodology of the test protocol:

- Relative comparison between 2 PV modules TRINA Vertex 405W (One cleaned every day, the other, no)
- Regular measurements of I/V characteristics with a certified device BENNING PV2 → estimation of Pmax STC
- Measurements performed throughout the year to take account of Senegalese seasons

Measurement results:

- 6 months of measurements from december 2023 to now
- Approximately 55% loss of PV module power
- Measurements are still ongoing until the end of the rainy season.



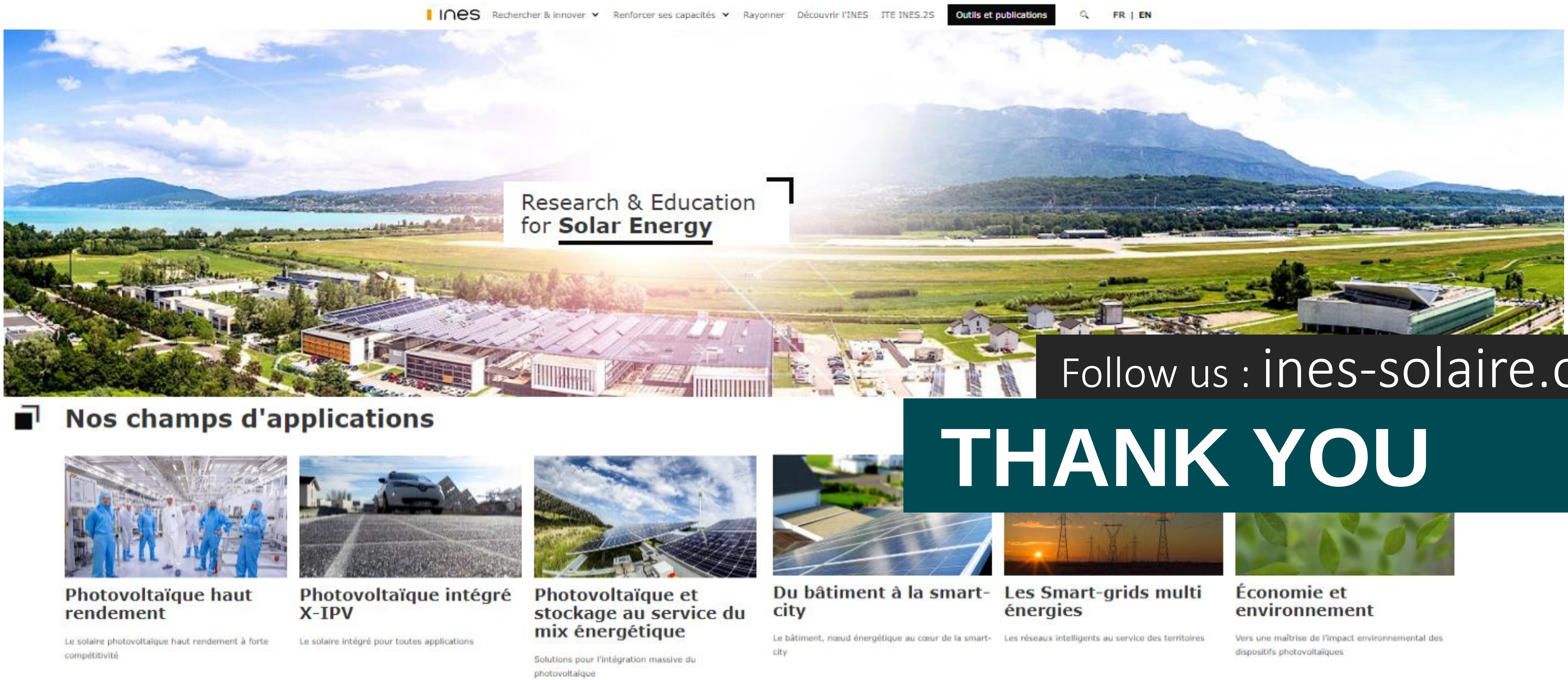


CASASOL project conclusions

- Solar Energy Resource Center installed equipped and operational
- Activities started and rising
  - Ability to diagnostic PV systems and equipments
  - Ability to design new installations
  - Ability to detect bad or counterfeit PV equipments
  - 4 quotations realized (waiting for answers from customers)
  - 5 diagnostics realized

- Next steps:
  - New projects in the pipe with the support of PSS
  - CASASOL – INES cooperation ongoing
  - Financial autonomy expected within 5 years
  - Reinforcement of the team
  - Hope for replication of the concept

CASASOL FaceBook page:
https://www.facebook.com/profile.php?id=61550910041688



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INSTITUT NATIONAL
DE L'ENERGIE SOLAIRE

EMERGE: ENERGY SYSTEM MODELLING FOR GREEN DEVELOPMENT OF AFRICA

Toolbox to advance clean energy production and responsible resource use

Presenter: Nikola Matak, PhD

4th June, 2024

Funded by the European Union under Grant number 101118278 . Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union. Neither the European Union nor the granting authority can be held responsible for them.

ENERGY SYSTEM MODELLING FOR GREEN DEVELOPMENT OF AFRICA

Emerge is a verb meaning move out of or away from something and become visible, apparent or prominent.
This verb has a Latin origin - *emergere* means to "bring forth, bring to light"

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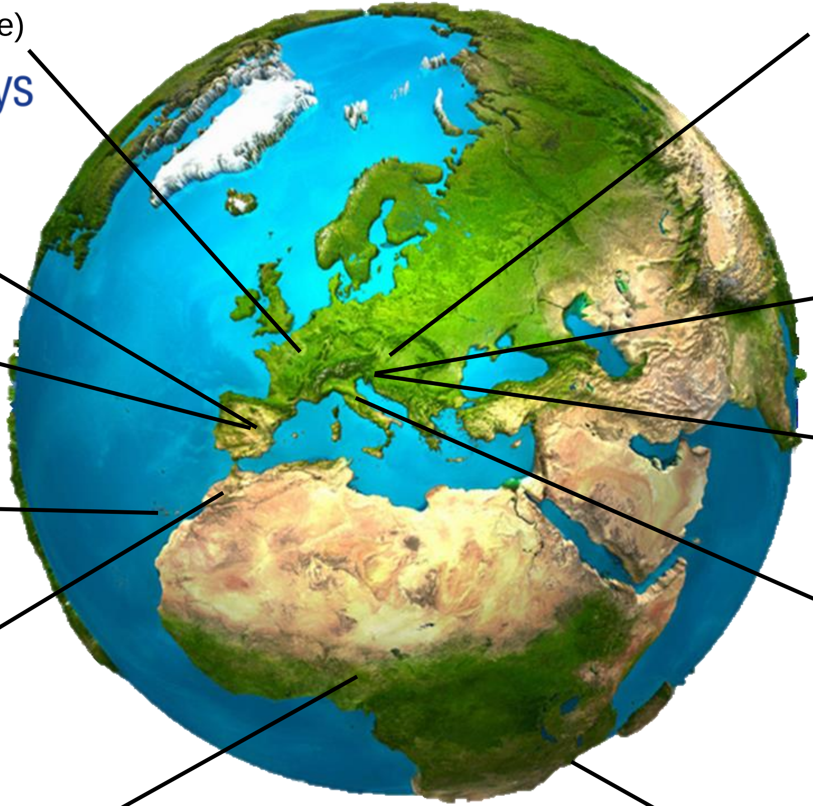
Consortium



Artelys
(France)

ESEIA
(Austria)

CIRCE
(Spain)

Cartif
(Spain)

UNIZAG FSB
(Croatia)

ECREEE
(Cabo Verde)

BrainIT
(Croatia)

EnGreen Srl
(Italy)

UMP
(Morocco)

AfriLabs
(Nigeria)

UEM
(Mozambique)

Key numbers and figures

11 partners from 9 countries

Start: December 1st, 2023

End: November 30th, 2026

Duration: 36 months

Coordinator: UNIZAG FSB

Grant: 2.49M €

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EMERGE project goal

- The EMERGE project is dedicated to advancing sustainability in Africa by providing key stakeholders with essential tools and knowledge.
- Focused on clean energy production and responsible resource use, EMERGE aims to bridge cultural and socioeconomic gaps for a united approach to development.

Key challenges

DRIVERS

- RES CAPEX decrease
- Energy infrastructure improvement
- Significant RES potential
- Doubling the RES production by 2040
- Climate change

EMERGE GREEN AFRICA

STAKEHOLDERS ENGAGEMENT

TOOLBOX

EXPERT NETWORK

COMMON MODELLING APPROACH

POLICY CREATION

BARRIERS

- Lack of transnational energy policies
- Lack of support for authoroties and policy makers
- Lack of multilateral AU-EU cooperation
- Lack of easy-to-use tools

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Key objectives

- Establish a network of African experts in energy system analysis through value-based design methodology
- Connect with other AU-EU cooperation activities
- Demonstrate innovative EMERGE Toolbox based on a cross-sectoral CSA for energy system analysis and planning as a support mechanism for the policy and decision-makers
- Identify and evaluate regulatory frameworks, EMs and potential opportunities for clean energy technologies integration in African countries
- Promote, raise awareness and facilitate the adoption of the solutions in EMERGE Toolbox to support the wide-scale energy transition of African countries

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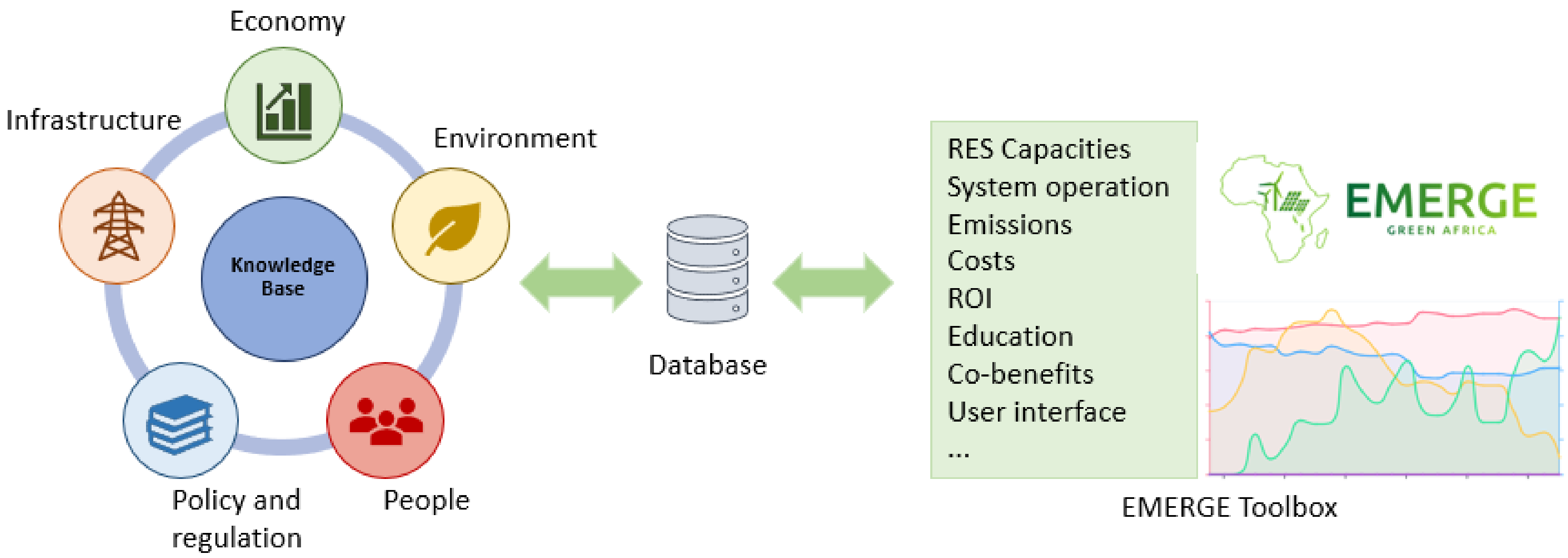
EMERGE approach



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EMERGE approach

EMERGE Toolbox

- CEPIA
- Hosting Capacity
- Optimal Storage Placement Tool
- Calliope
- PowSyBl
- GREENADVISE

Stakeholders inclusion

- Social inclusion via co-design workshops
- Stakeholders engagement via consultation and feedback
- Education and investment advisor through gamification
- Study visits AU-AU
- Knowledge exchange and training AU-EU
- Stakeholder Group
- Webpage and capacity building materials

Policy and regulations

- Policy analysis
- Public consultation
- Scenario identification – use cases
- R&I and Policy Labs
- Steering policy recommendations
- Action plans
- Roadmap

EMERGE GREEN AFRICA

Universal Energy Access & Decarbonization Energy Transition in EU/AU

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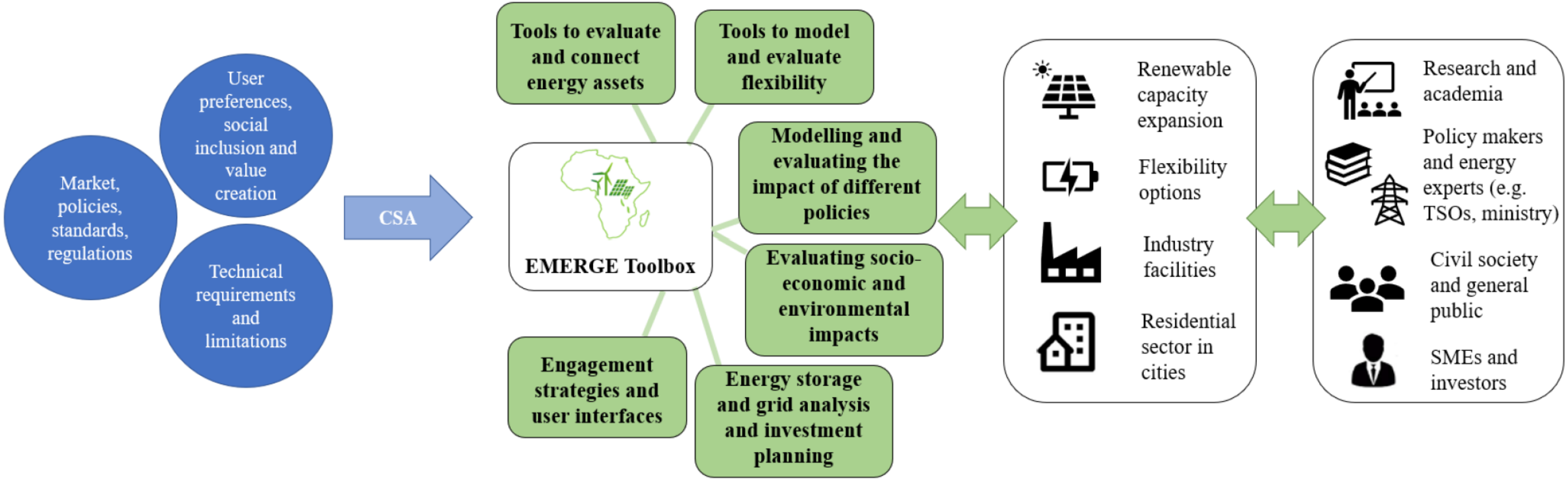
EMERGE toolbox

- Key partners: Artelys, CIRCE, UNIZAG, Cartif



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Toolbox development

Successfully transition to a clean energy system and preserve resources

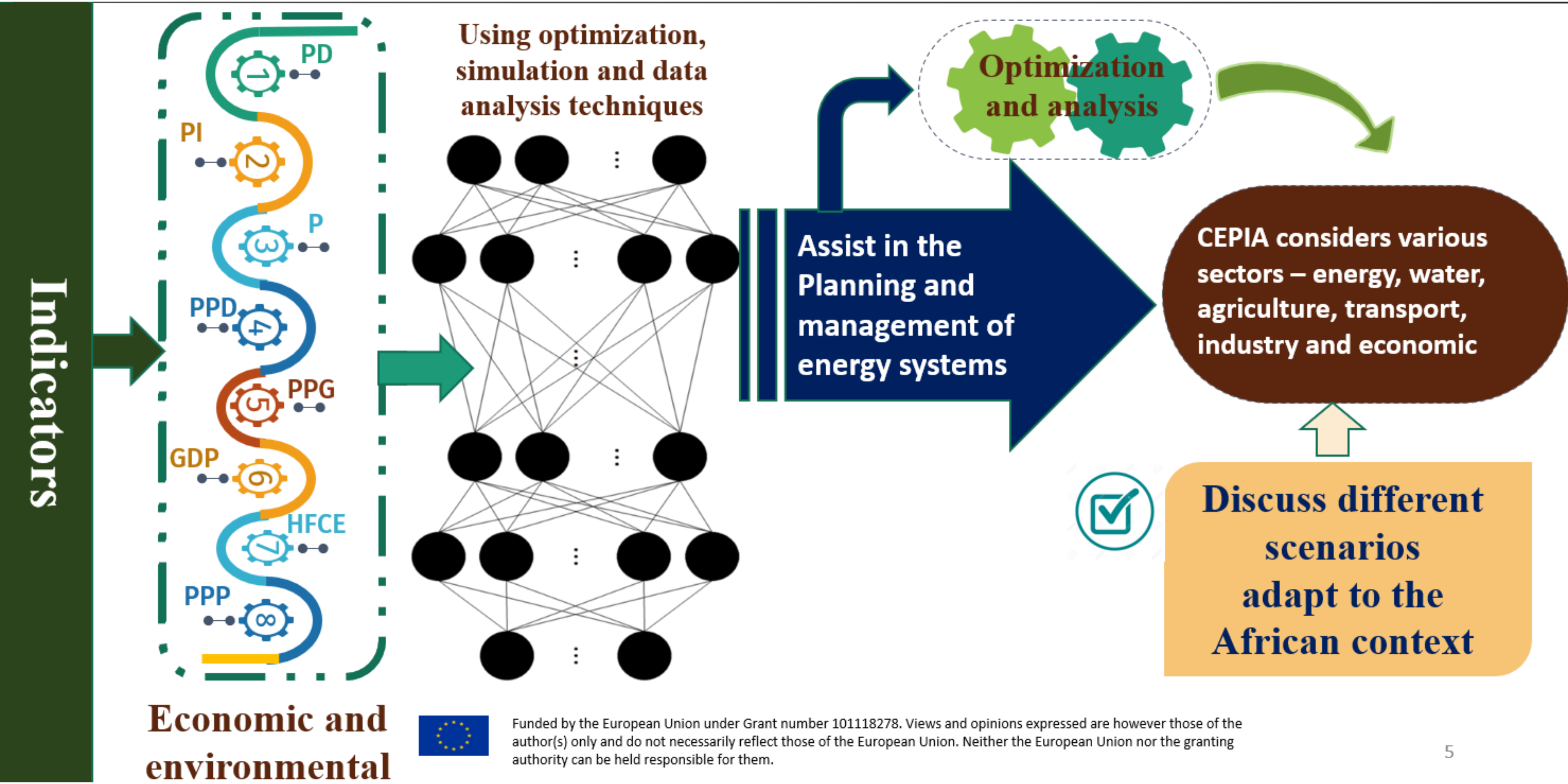
Provide a comprehensive toolbox

Modeling African energy systems

Economical
Social
Environmental

Assist with energy planning

CEPIA - Artelys



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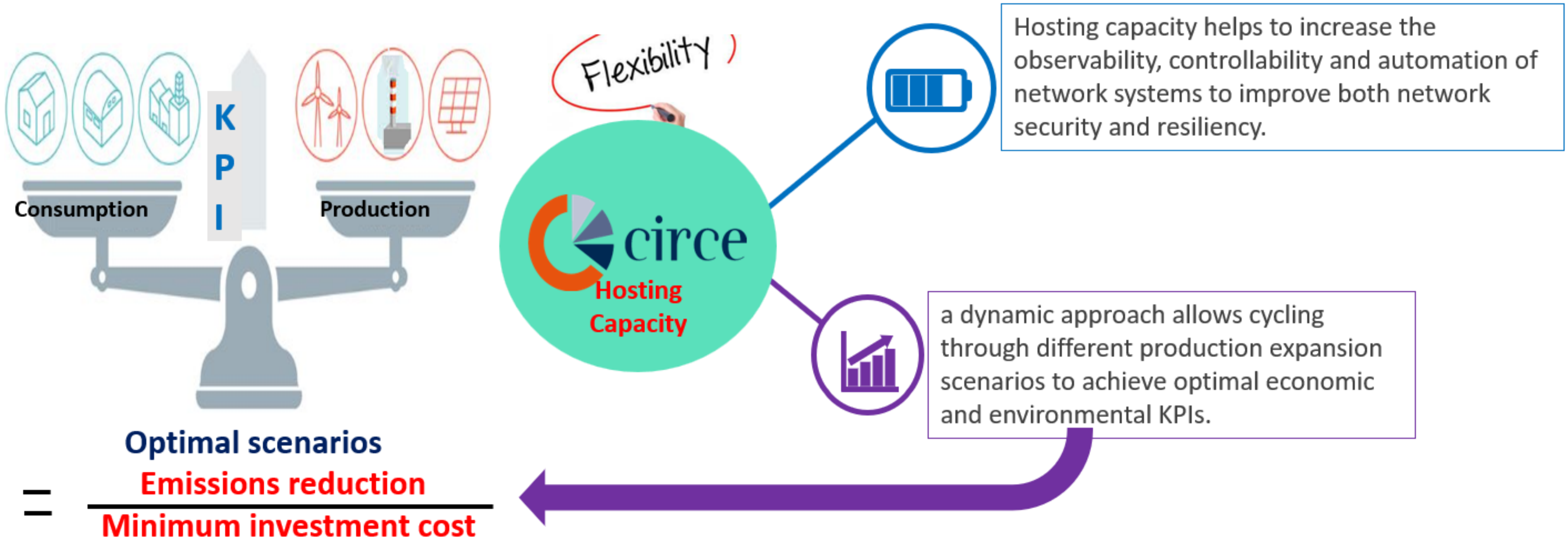
Hosting Capacity – CIRCE



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Optimal Storage Placement Tool – CIRCE

The Tool will provide

a visualization dashboard, showing energy and flows as well as power network parameters such as voltage.

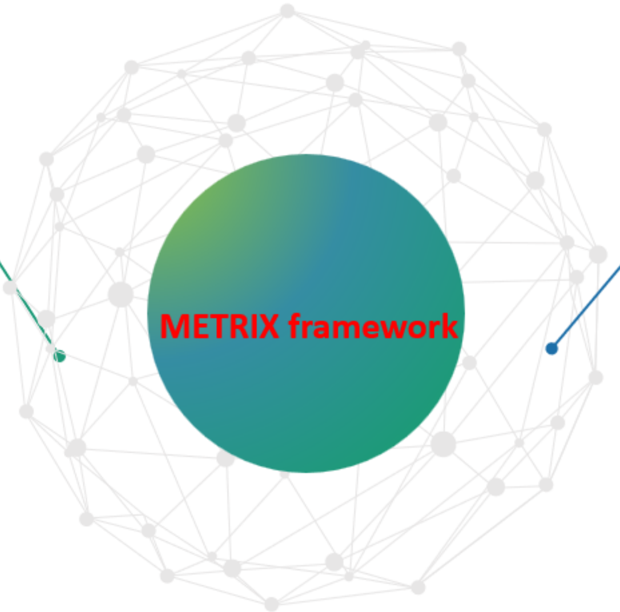
the tool will establish

the link between the storage location and environmental and economic KPIs in addition to existing economic parameters

By connecting to the database and knowledge base, energy modeling experts will be able to compare different scenarios and find an optimal storage location to maximize benefits in terms of additional environmental, technical and economic parameters.

PowSybl – Artelys

will use the PowSyBl tool to improve the METRIX software to include it in the modeling of grid flexibility solutions, such as battery storage.



will develop an additional module to integrate temporal coupling into the evaluation of flexibility solutions on network flows.

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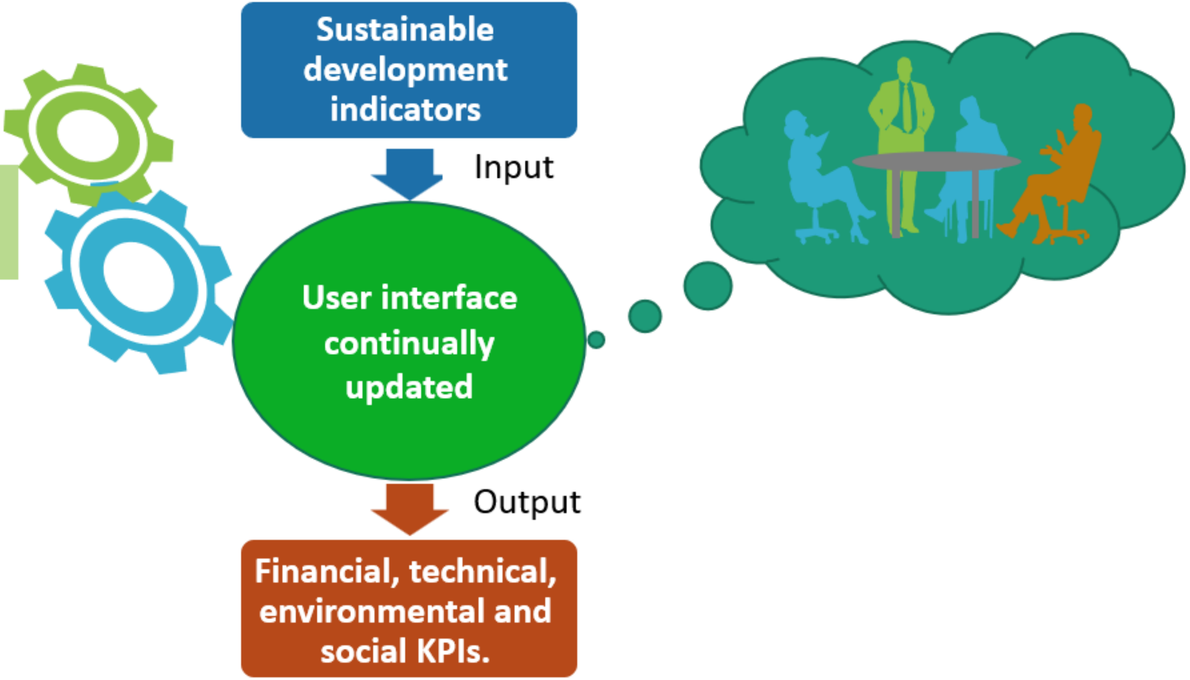
GREENADVISE – UNIZAG FSB

GREENADVISE

With robust and stochastic algorithms **UNIZAG will develop**



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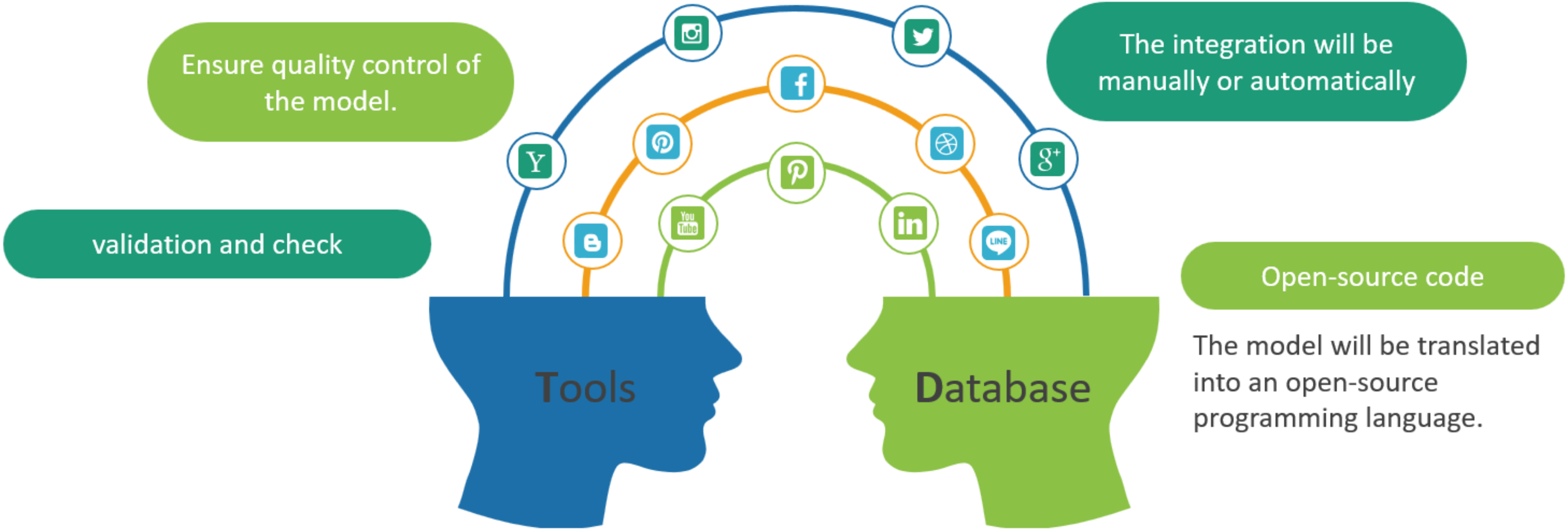
Integration of the EMERGE Toolbox and database



The model will be translated into an open-source programming language.

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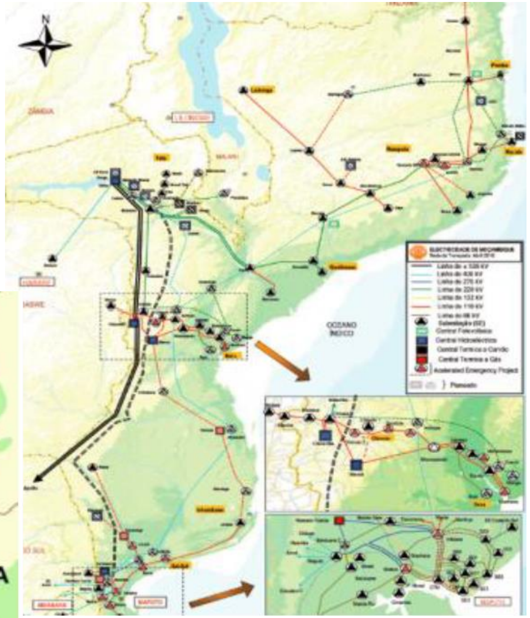
EMERGE demo sites



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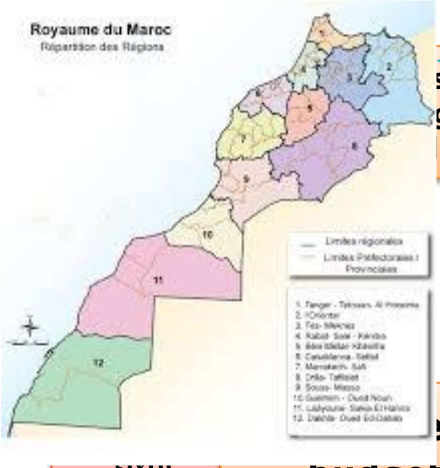
North Western Africa (Morocco)

Eastern Morocco Case

8	Prefecture + 7 provinces



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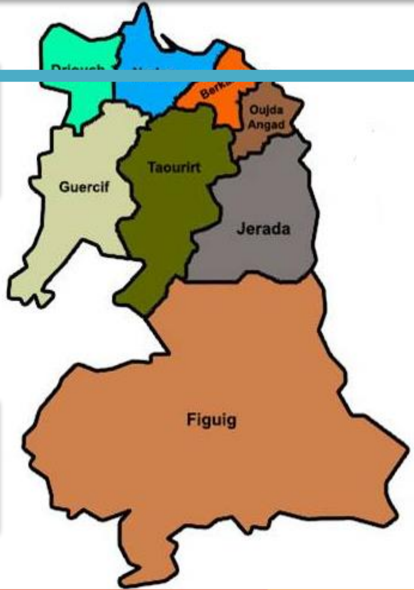

2.314.346 (6.8%)	Population

65,4 % 60,4 % Nationally	Urbanization rate

17,9 % 9,9 % Nationally	Unemployment rate

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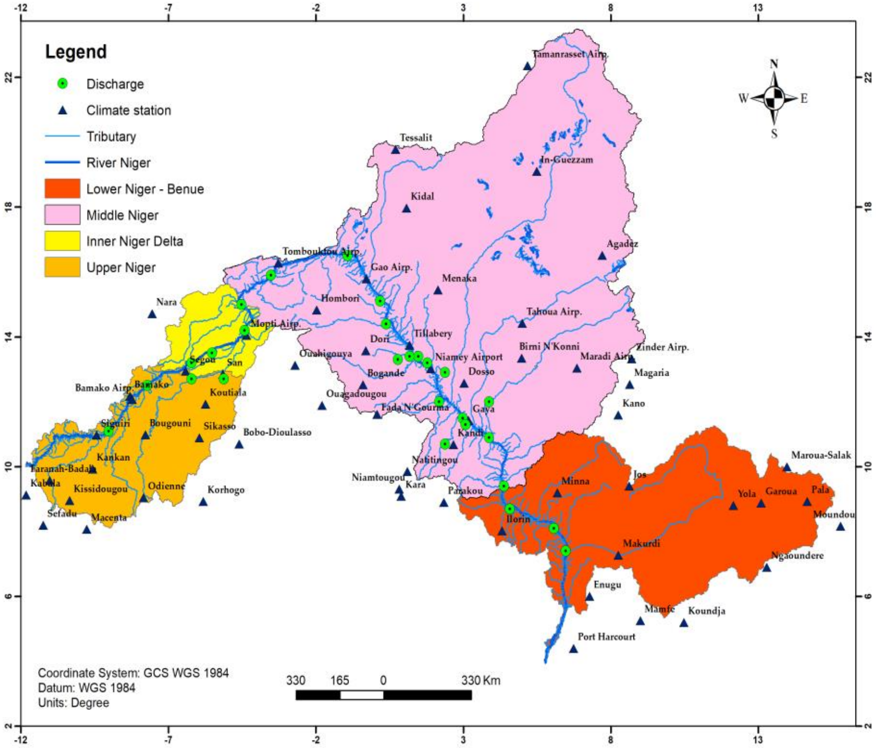
Niger river region



- Niger River Basin is the third longest river in Africa in terms of its drainage basin (2,170,500 km2).
- Its active watershed covers an area of approximately 1,500,000 km2 shared by the nine (9) countries: Benin (2%), Burkina Faso (4%), Cameroon (4%), Ivory Coast (1%), Guinea (6%), Mali (26%), Niger (23%), Nigeria (33%) and Chad (1%).
- The Niger River basin is subdivided into 4 sub-basins: the Upper Niger, the Inner Delta, the Middle Niger and the Lower Niger.
- Major tributaries: Bani (Bani River), Sokoto – Rima (delta midstream & downstream), and Benue (Benue river)

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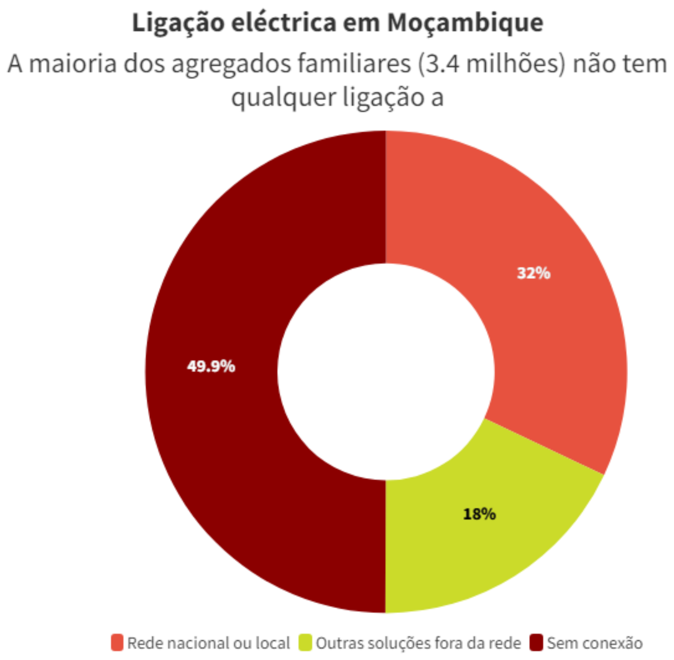
East Africa (Mozambique)



The majority of Mozambican households (3.4 million) are not connected to the national grid.

Electricity Access in Mozambique - the Case of Nampula

- Nampula is amongst the poorest provinces of Mozambique, according to the most recent National poverty assessment.

- Electricity access in province is amongst the lowest in the country - in 2020 was estimate to be 27.4% (EDM, 2020)

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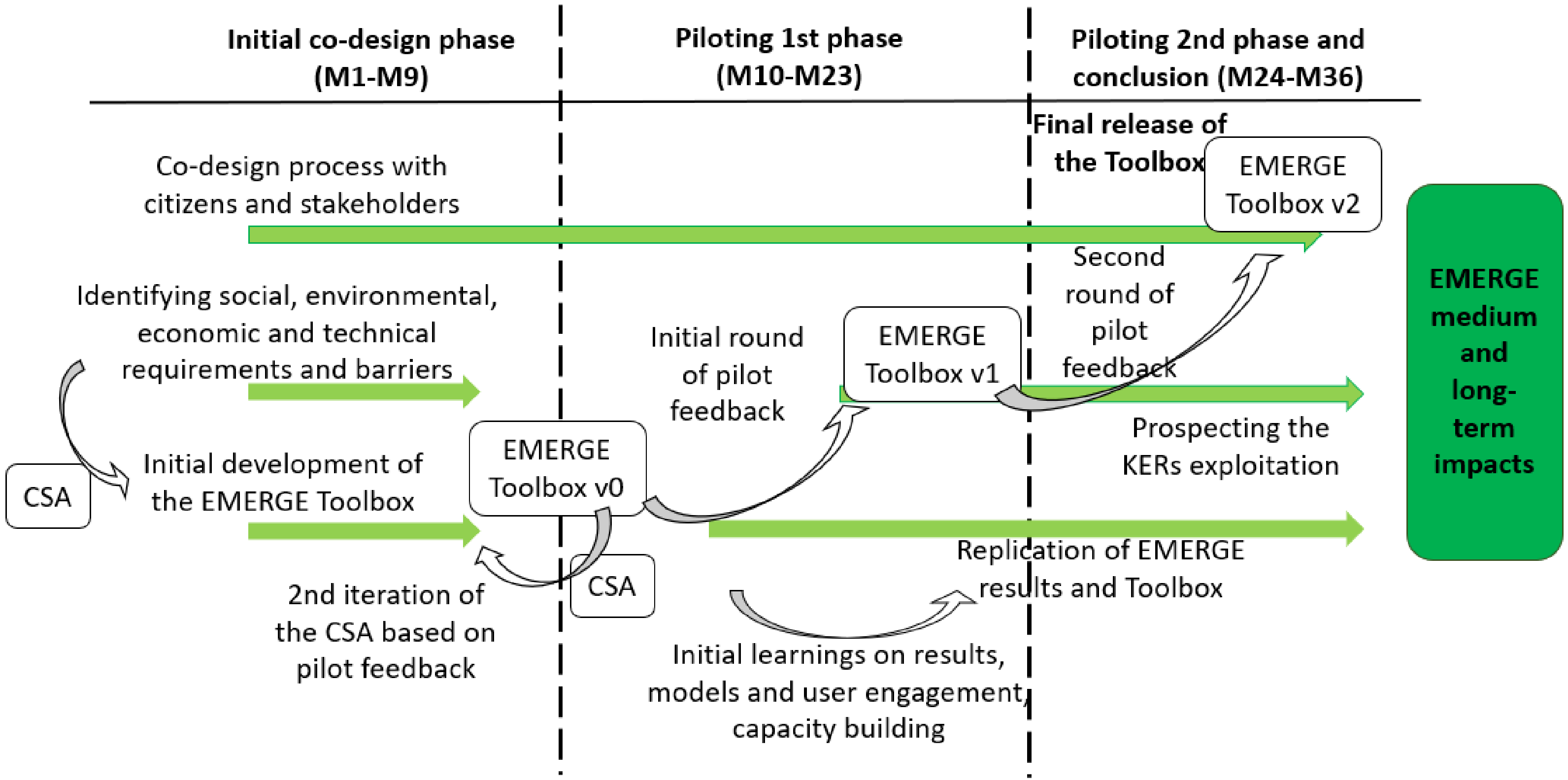

The phases of EMERGE project

Social sciences and humanities role

- identifying and including in the modelling the key social forces that lead to behavioural changes, changes in collective action, policy and institutions, and feedbacks between climate change and human society

- considering the viewpoints and considerations of individual as well as collective actors who deal and/or affected by climate change and clean energy transition

- social innovation measures, social factors (drivers and barriers), and their connections to socioeconomic indicators and climate change

- stakeholders and citizens will engage with modelling activities

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Expected outcomes

- Reinforce the activities in the long term the AU-EU HLPD CCSE Partnership

- Provide knowledge and scientific energy system modelling as evidence base including the environmental, social and economic trade-offs to contribute to R&I strategy and policy making

- Increase clean energy generation in the African energy systems

- A permanent network of African experts and expertise in this area

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EMERGE GREEN AFRICA

Impacts

- Availability of disruptive renewable energy and renewable fuel technologies and systems in 2050 in order to accelerate the replacement of fossil-based energy technologies
- Reduced cost and improved efficiency of renewable energy and renewable fuel technologies and their value chains
- De-risking of renewable energy and fuel technologies with a view to their commercial exploitation and net zero greenhouse gas emissions by 2050
- Better integration of renewable energy and renewable fuel-based solutions in energy consuming sectors
- Reinforced European scientific basis and European export potential for renewable energy technologies through international collaboration (notably with Africa in renewable energy technologies and renewable fuels and enhanced collaboration with Mission Innovation countries)
- Enhanced sustainability of renewable energy and renewable fuels value chains, taking fully into account social, economic and environmental aspects in line with the European Green Deal priorities
- More effective market uptake of renewable energy and fuel technologies

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Contacts:
info@emerge4green-africa.eu

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HYAFRICA PROJECT
LEAP-RE
HORIZON 2020

Assessing the resources of natural hydrogen in Africa

Júlio Carneiro[1], P. Mesquita[1], A. Barkaoui[2], A. Bumby[3], R. Christiansen[4], R. Ennabbabi[2], G. Gabriel[4], N. Hammond[5], S. Masango[5], B. Noureddine[2], A. Smit[3], S. Mondlane[6], G. Bauque[7], E. Pérez[8]

[1] CONVERGE!, Lda, Portugal; [2] Université Mohammed Premier, Morocco, [3] University of Pretoria, South Africa, [4] Leibniz Institute for Applied Geophysics, Germany, [5]University of Limpopo, South Africa, [6] Universidade Eduardo Mondlane, Mozambique, [7]Direcção Geral de Geologia e Minas, Mozambique, [8] Fraunhofer IEE, Germany

LoCEL-H2, Energy for Africa Webinar, 4 June 2024

LEAP-RE
Long-Term Joint EU-AU Research and Innovation Partnership on Renewable Energy

HyAfrica

fct Fundação para a Ciência e a Tecnologia

JÜLICH Forschungszentrum

sanedi South African National Energy Development Institute

Royaume du Maroc
Ministère de l'Education Nationale, de la Formation Professionnelle de l'Enseignement Supérieur & de la Recherche Scientifique

The LEAP-RE project has received funding from the European Union's Horizon 2020 Research and Innovation Program under Grant Agreement 963530.

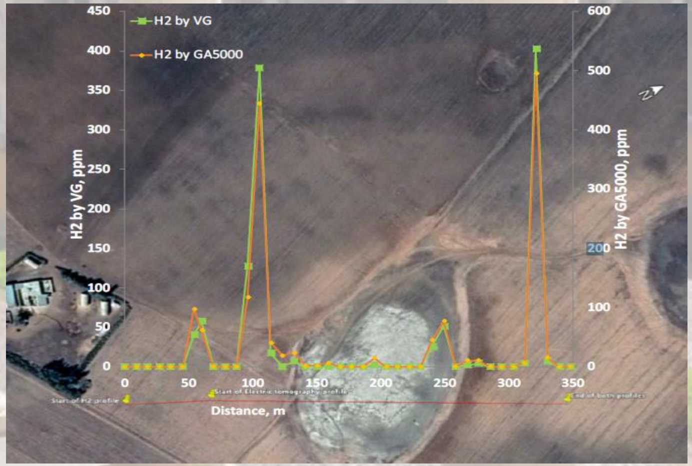
About CONVERGE!

Spin-off UÉVORA

GEO-ENERGY AND GEOPHYSICS FOR ENERGY TRANSITION:

- **CCUS**
- **Energy storage in geological formations**
- Geothermal studies
- Applied geophysics (archaeology, hydrogeology, geotechnics)
- **Natural Hydrogen**

Morocco country-scale assessment of Natural Hydrogen (2018-2020)



Natural Hydrogen

HyAfrica LEAP-RE

Natural hydrogen is formed by geologic processes in the interior of the earth

Some formation hypothesis:

- **Serpentinization** - the reaction of water with ultrabasic rocks,
- natural **radiolysis** of water due to radioactive decay of U, Th, K rich minerals
- mantle degassing;
- biological activity,
- primordial origin
- ...

In any case natural H_2:

- **constantly** being replenished;
- renewable (at human time-scale) resource;
- clean energy source;
- free of intermittency.

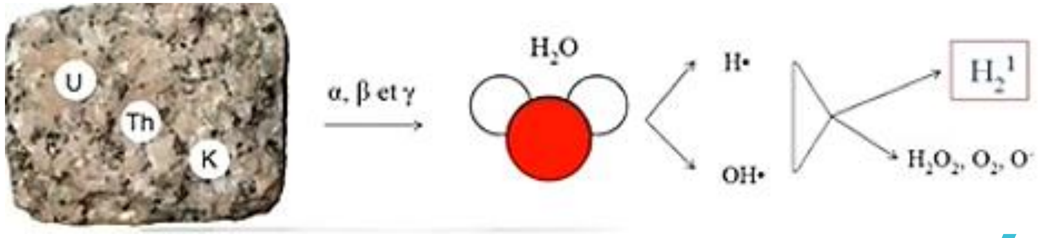
Serpentinization

$$3Fe_2SiO_4 + 2H_2O \rightarrow 2Fe_3O_4 + 3SiO_2 + 2H_2$$

Olivine + Water → Serpentine + Magnetite + Hydrogen

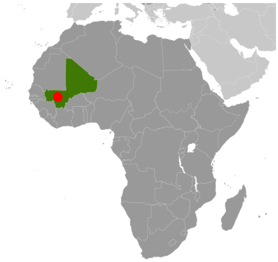
Radiolysis

$$2H_2O \rightarrow O_2 + 2H_2$$



Natural Hydrogen, Mali case

Source: Omar Maiga (2022)



- In 1987, groundwater well 110 m deep hits 98% pure hydrogen.
- Well re-opened in 2012 – pilot H_2 project.
- H_2 concentration 96%-98%. Pressure of 68 psi - not declining.
- Generates electricity for the local village.
- Recently 24 new wells confirmed five hydrogen reservoirs. Depths from 105 m to 500 m, one well 1800 m.

Major Known Natural Hydrogen Occurrences

HyAfrica LEAP-RE

Key challenges for Natural Hydrogen

HyAfrica LEAP-RE

Technical capacity and awareness is very low, even in the geosciences community

No established exploration methodologies

No regulatory and licensing framework in place

Lack of studies on social-economic impact or business model

HyAfrica project - LEAP-RE

HyAfrica LEAP-RE

Towards a next-generation renewable energy source – a natural hydrogen solution for power supply in Africa (HyAfrica)

Implemented in the framework of the Long-term **Europe Africa Partnership on Renewable Energy (LEAP-RE)**

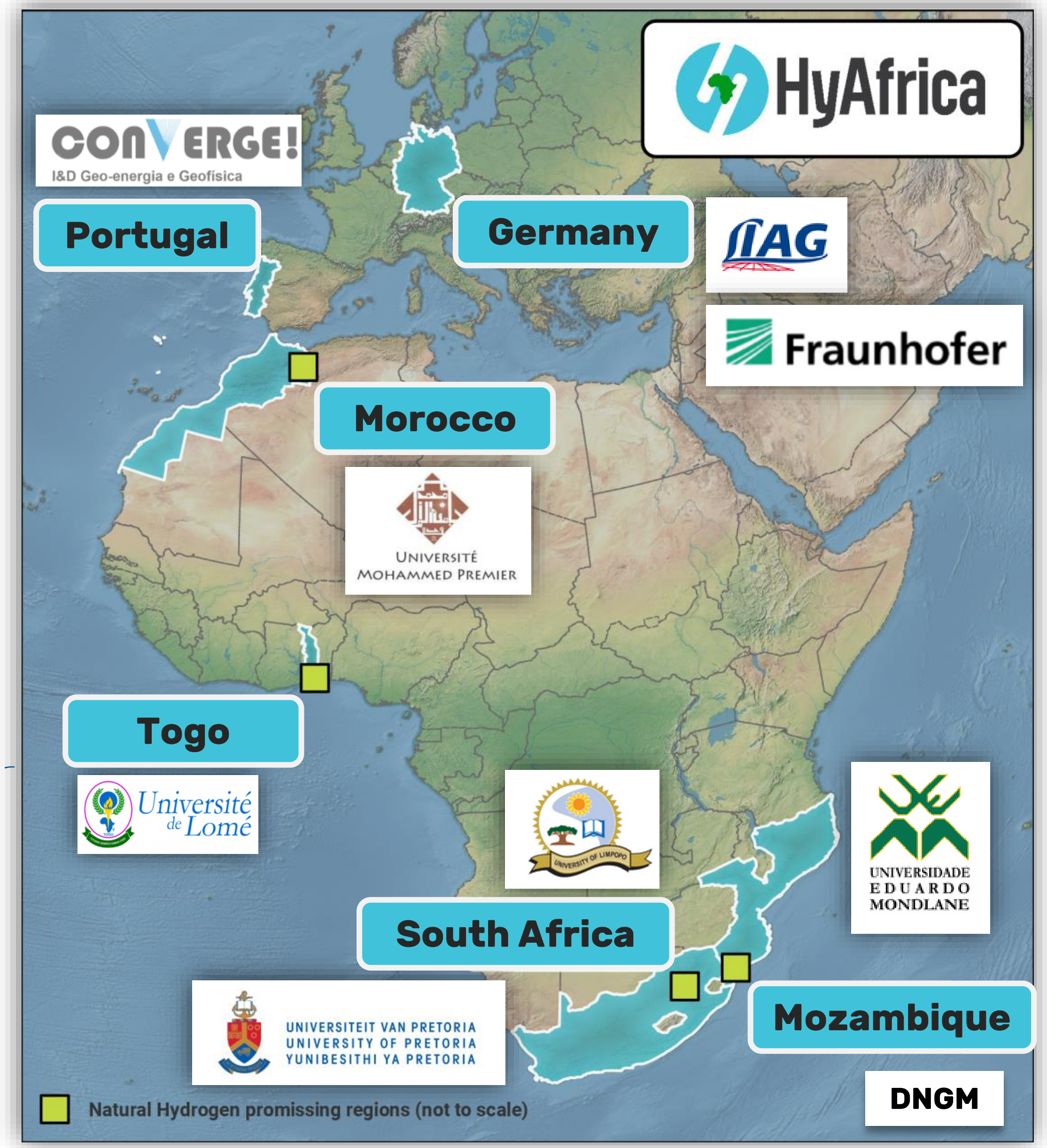
- Pillar 1, first call - research, innovation and capacity building.
- Multi-Annual Roadmaps 3 (Smart standalone systems) and 4 (Off-grid applications).

Project duration: 3 years (August 2022 – August 2025)

OBJECTIVES

- **Map the natural H_2 resources** in target regions of **Morocco, Mozambique, South Africa, Togo.**
- Socio-economic impact assessment and business models in **standalone and mini-grid systems.**
- **Regulatory and roadmap actions** for target countries to engage on natural hydrogen.
- **Building capacity** and **raising awareness about natural H_2**.

HyAfrica Consortium



- Converge! — **1** SME [coordinator]
- Direcção Geral de Geologia e Minas — **1** Governmental regulatory body
- Fraunhofer IEE
- Leibniz Institute for Applied Geophysics

  — **2** Research institutes
- Universidade Eduardo Mondlane
- University of Limpopo
- Université of Lomé
- Université Mohammed Premier
- University of Pretoria

  — **5** Universities

Expected Outcomes

HyAfrica LEAP-RE

Regional scale

At least 2 regions implement natural H_2 exploration and utilisation programmes;

At least 2 regions increase the share of RES and promote sustainability by using natural H_2;

Business models for standalone systems with H_2 (natural and/or green) are validated in the target regions;

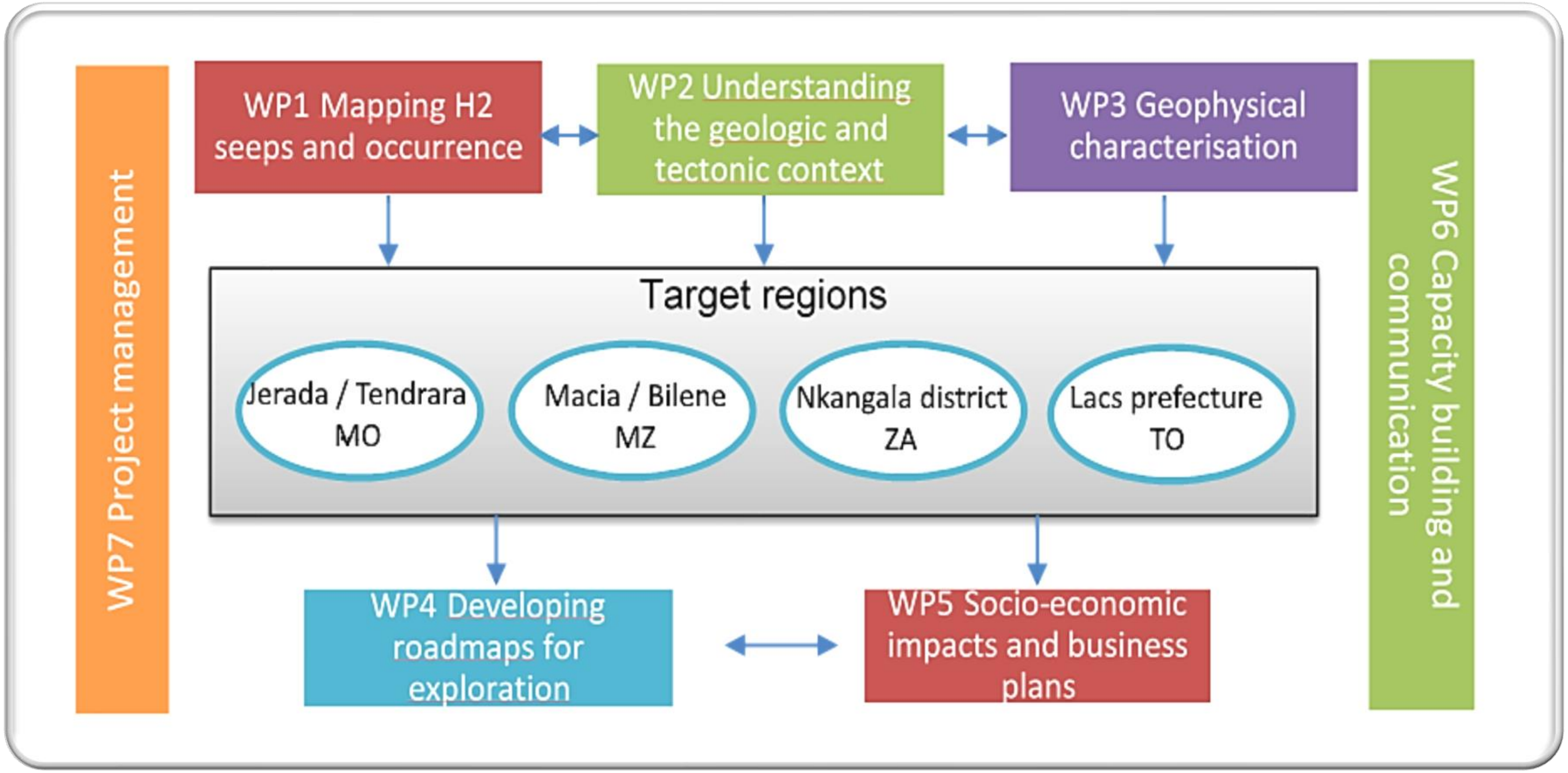
Communication at local and regional level increase local populations engagements.

National scale

At least 2 countries include natural H_2 in the national mining and energy laws;

At least 2 countries implement programs for characterisation of national resources in natural H_2.

Methodological approach



Mapping, Geological and Geophysical research.

WP1, WP2, WP3

Policy and regulatory analysis.

WP4

Evaluation of local energy systems and their economics.
WP5

Capacity-building and communication strategy.

WP6

Region characterisation and engagement with stakeholders conducted by local teams.

Target Regions and Resources (WP1, WP2, WP3)

WP1
Identification and mapping of resources
Leader: Converge!

WP2
Geologic and tectonic context
Leader: University of Pretoria

WP3
Geophysical characterization
Leader: LIAG

Satellite imagery remote sensing, Geochemical field studies and Lab Analysis, ranking criteria

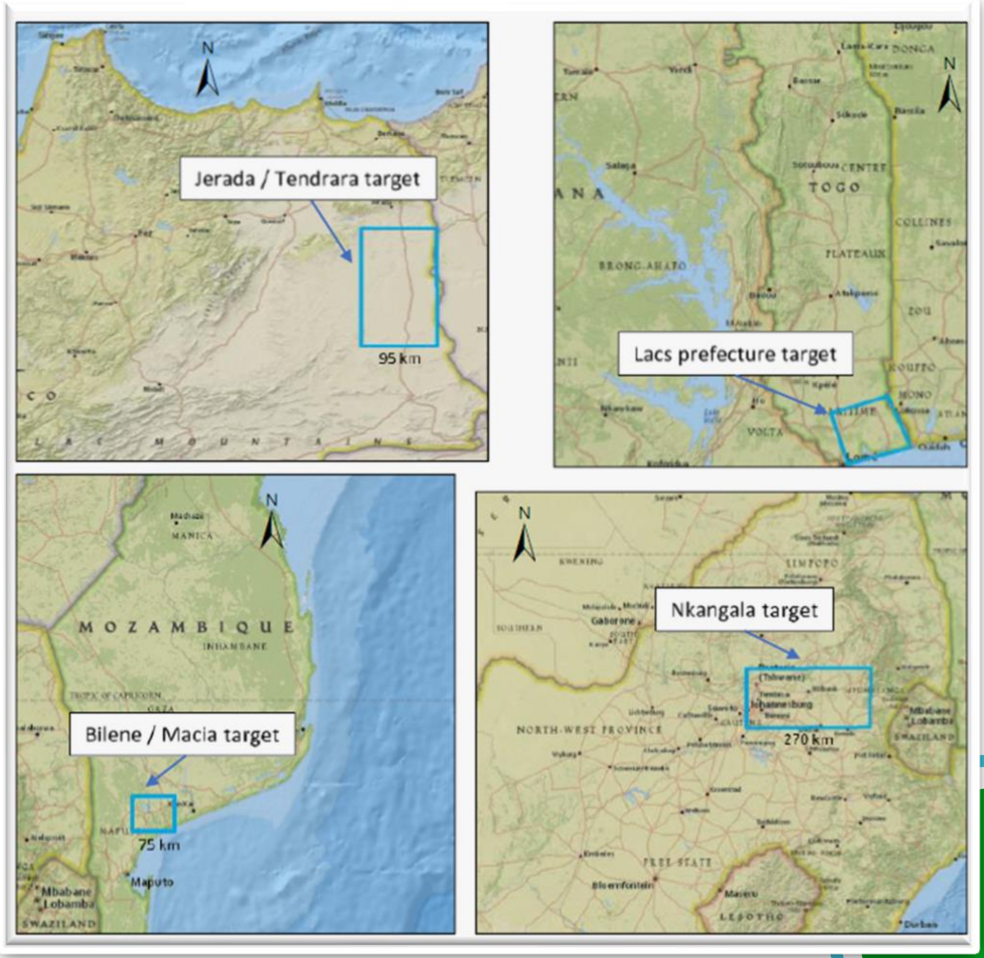
Geologic, Seismicity and Tectonic conditions. Geothermal and Hydrogeologic components

Magnetic and Gravimetric data, geophysical exploration strategies

Conceptual modelling and ranking of areas

Selection of areas based on:

- Previous record of H_2 occurrence in wells or mines
- Topographic depressions as proxies
- Accessibility



Regulations and Roadmaps – WP4

Leader: University Eduardo Mondlane

Engages the Mozambican Mining and Geology National (DNGM) **regulatory and licensing body**

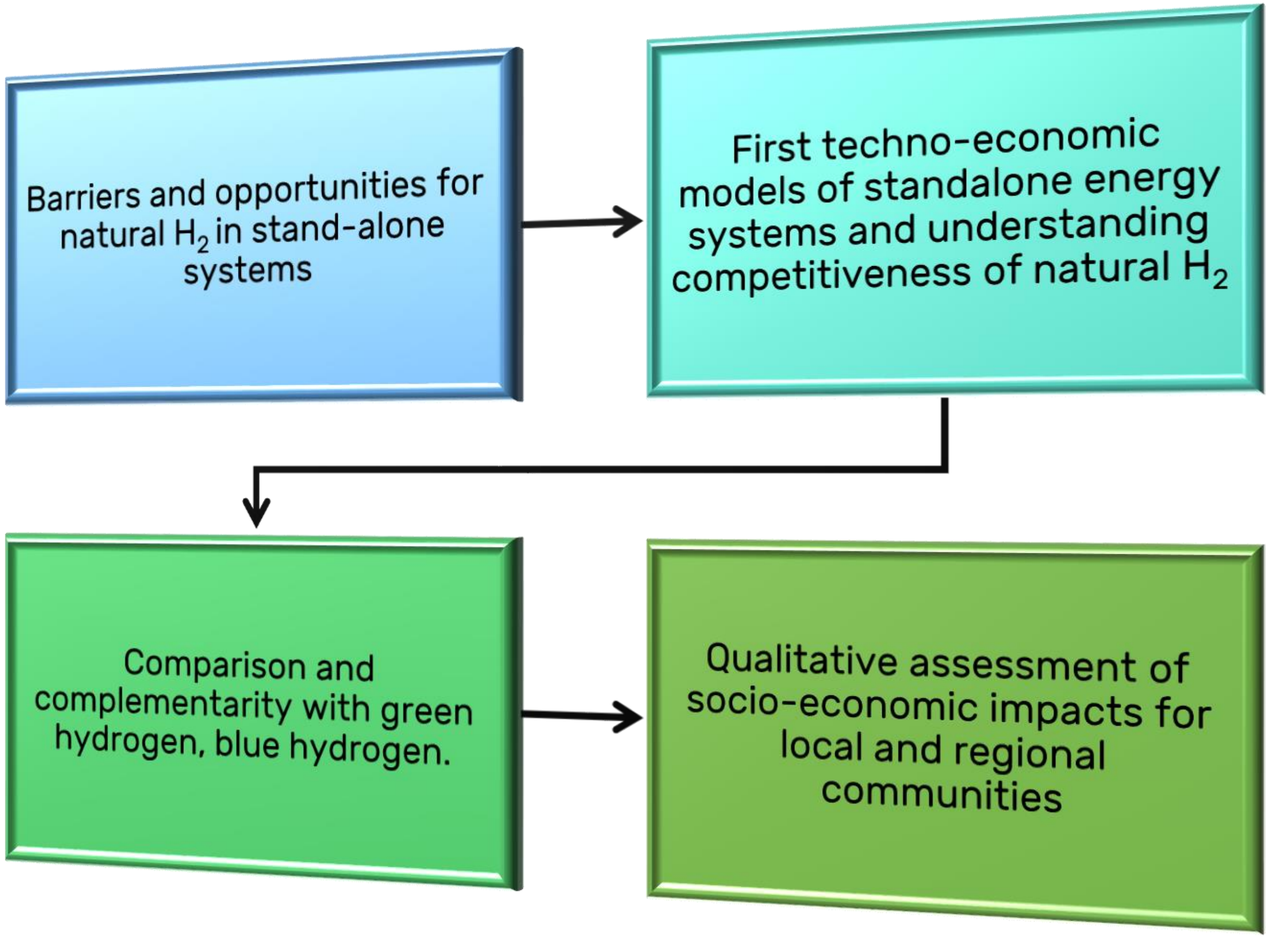
- Assess legislation and regulatory gaps in target countries
- Engage with local policy makers
- Develop mechanisms to include natural H_2 in the Energy or Mining Laws of target countries
- Develop roadmaps in target countries for for natural H_2 strategies

Current work: Stakeholders mapping and regulatory and legislative gap analysis

Socio-Economic Relevance - WP5

Leader: Fraunhofer IEE

Focusing on the two **highest ranking regions**. Consider local **socio-economic conditions**.



WP5 Workflow

D5.1	• Use-case Description	Collection and description of the possible applications for the local communities
D5.2	• Business model - qualitative	Assessment and consultation of the magnitude and impact of business model for the two locations
D5.2	• Techno-economic Analysis	Financial feasibility analysis, e.g. net present value method
D5.2	• Business model – quantitative	Selection of the best cases/models, including funding mechanisms
D5.3	• Socio-economic Analysis	(To be determined)

D5.1: Description of use-case for the exploitation of natural hydrogen in local communities

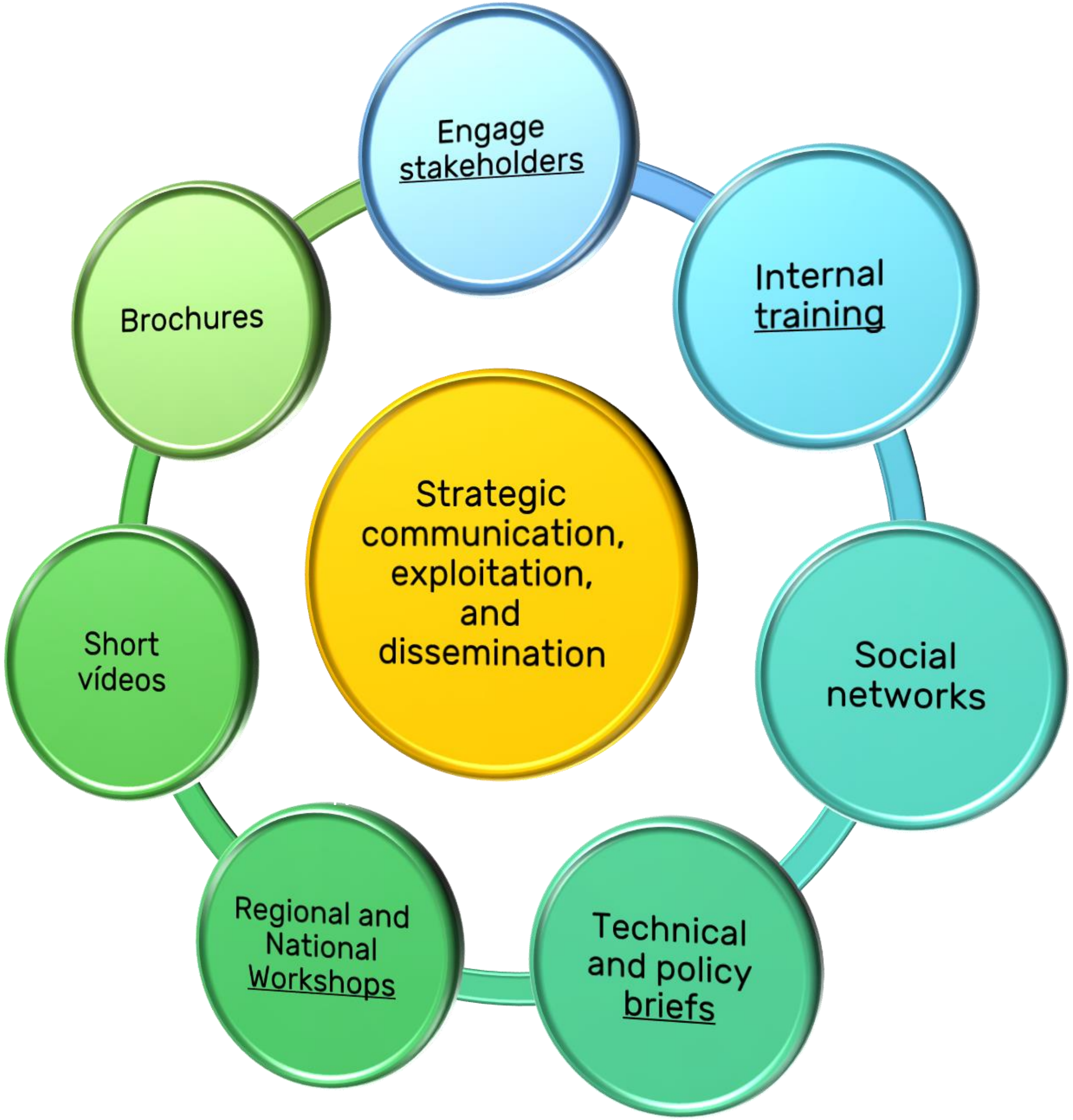
Upstream

- Definition of current energy system boundaries
- Possible off-takers (industry, households,...)
- Local energy needs (electricity, heat, cooling, ...)
- Existing infrastructure (local grid, pv panels, ...)

Downstream

- Timeframe of implementation (2025, 2030, ..., 2050)
- Potential amounts for extraction [kg/a]
- Extraction cost ranges / H2 costs [$/kg_h2]
- Socio-economical limitations/requirement s

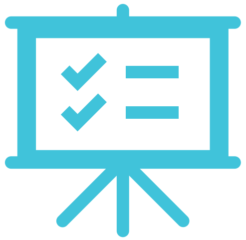
Building capacity and raising awareness – WP6



Leader: University Mohammed Premier

Aims to address major gap:

Poor knowledge about natural H_2 !



Building capacity and raising awareness

- Building capacity workshop for African partners (September 2022), Casablanca. Specialists in Natural H_2 from **Air Liquide, USGS, Université Grenoble Alpes, the European Federation of Geologists and NH2E.**

- Technical building capacity workshops on field exploration for natural H_2 seeps - Morocco (February 2023), South Africa (June 2023), Mozambique (November 2023).

- Workshop "Raising Awareness About Natural Hydrogen" for South African stakeholders , 14 of September 2023, Pretoria, South Africa. Attendees from public and private institutions and sectors including academia, research, mining and energy.

- Future Worshop "Raising Awareness About Natural Hydrogen" for Mozambican stakeholders , September 2024, Maputo.

WP1 to WP3 Mapping Workflow

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Remote sensing: Depressions / pans as proxies for seeps;

Surface geochemistry: *in situ* H_2 measurements (and radon)

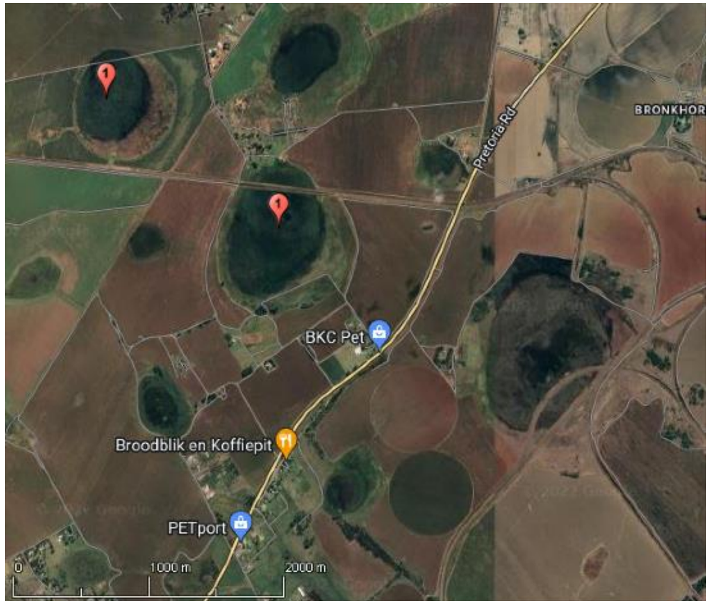
Geophysics: gamma spect. and existing magnetic/ gravimetric / seismics

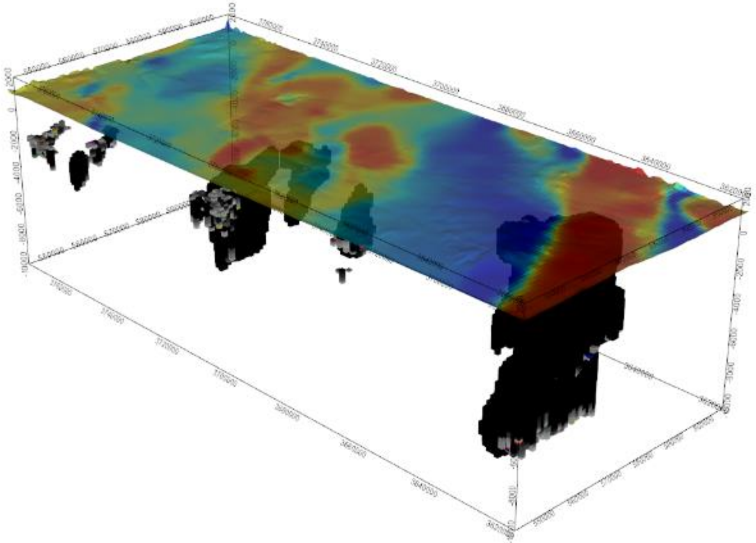
Laboratory analysis: soil gas composition

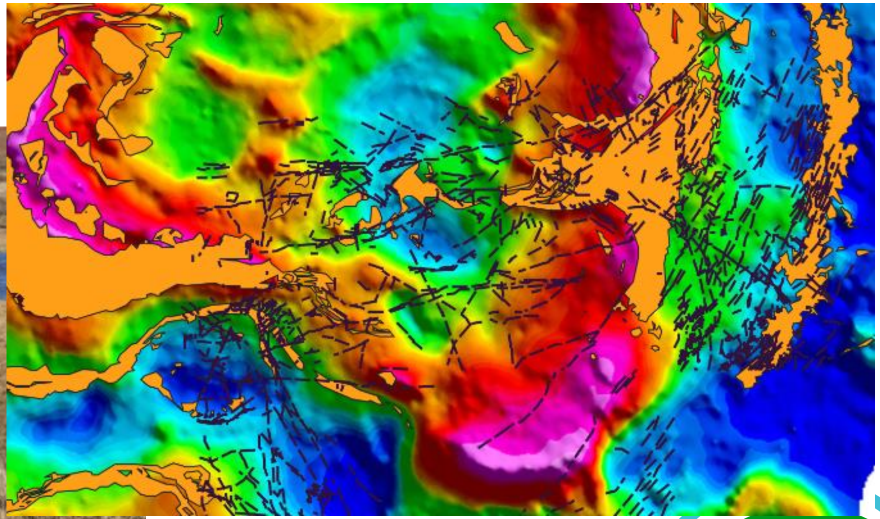
Structural geology: regional discontinuities and deep faults

Magnetic / gravimetric anomalies: 3D modelling and H_2 origin

Definition of hydrogen system







South Africa study area

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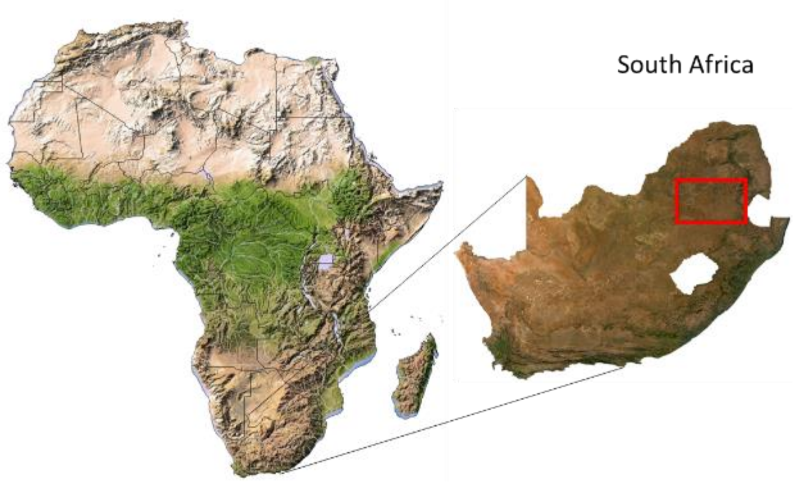

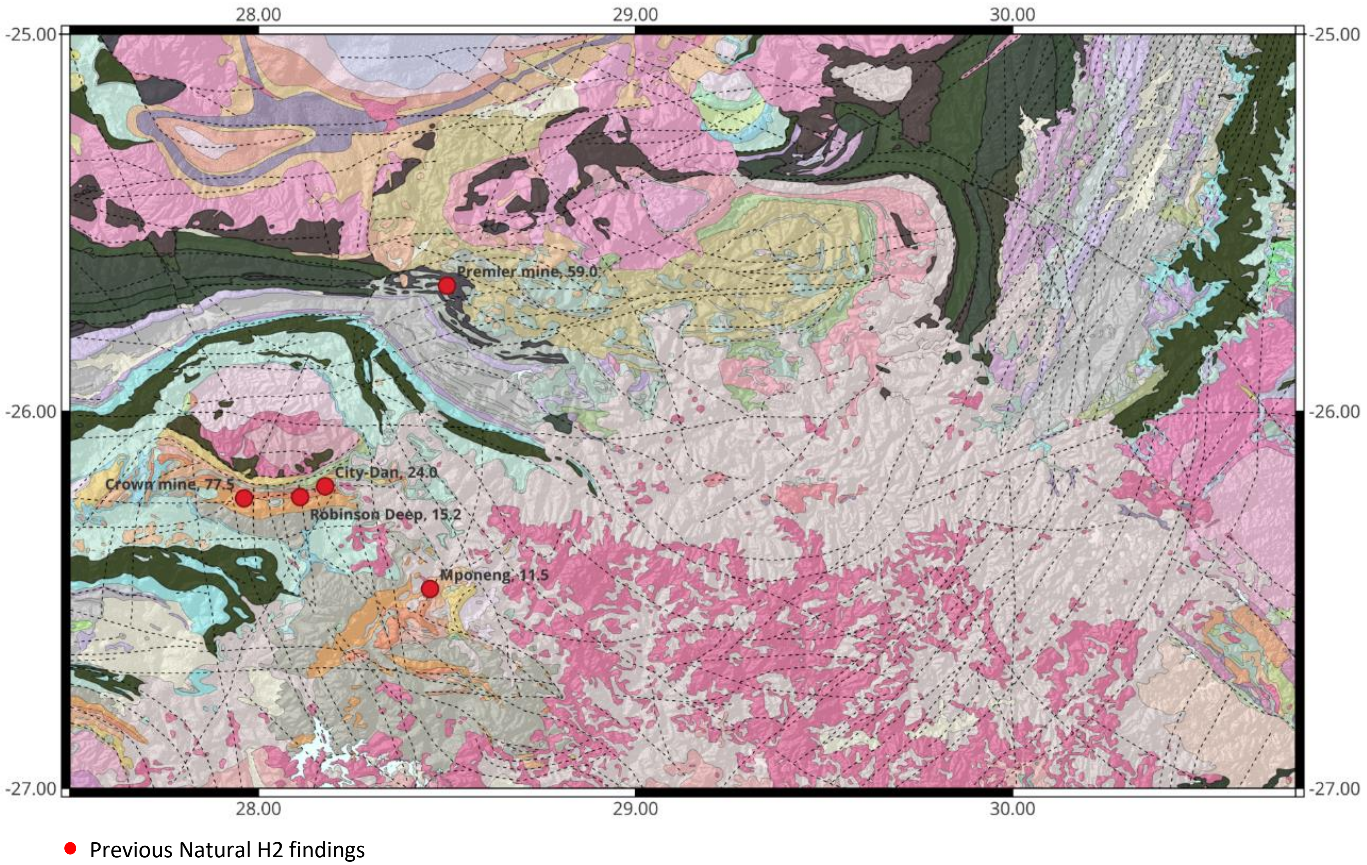

South Africa (Zgonnik, 2020)

Crown Mine - 77.5% H_2

Robinson Deep - 15.2% H_2

City Dan - 24% H_2

St. Helena Gold mine – 50%

Kimberly mine - 43.1% H_2

Driefontein – 10% H_2

Mponeng - 11.5% H_2

High H_2 concentrations were found in ground water samples from fractured rock in 24 South African wells.

Iron rich and serpentinized units

Pyramid subsuite: Gabbro and norite

Timeball Hill and Rooihoogte Fms.: Magnetic ironstone

Roossenekal subsuite: Olivine, magnetite gabbro

Muldersrif, Roodekrans, etc: Ultramafic

Djsate Subsuite: Black magnetite gabbro

Bierkraal Subsuite: Magnetite

Rashoop Granophyre suite: Pyroxene hornfels

First Measurements - South Africa

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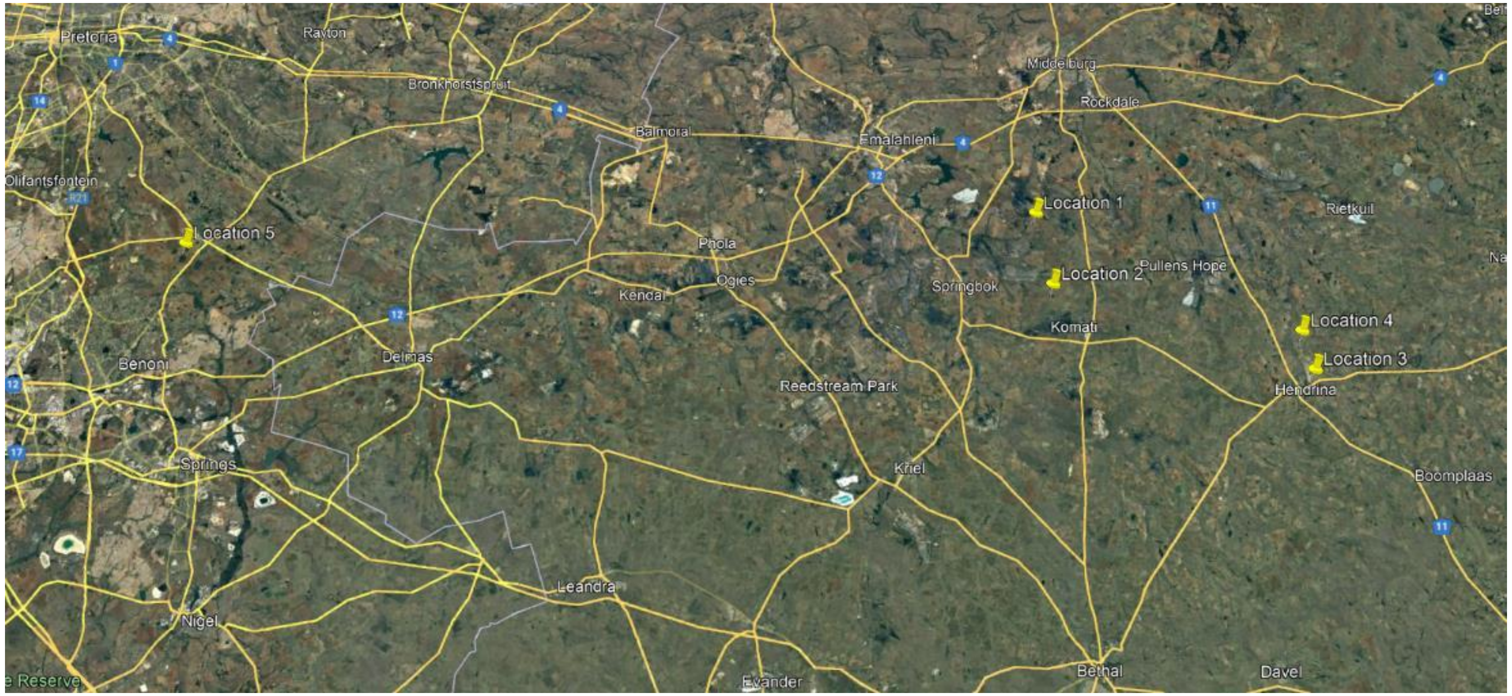
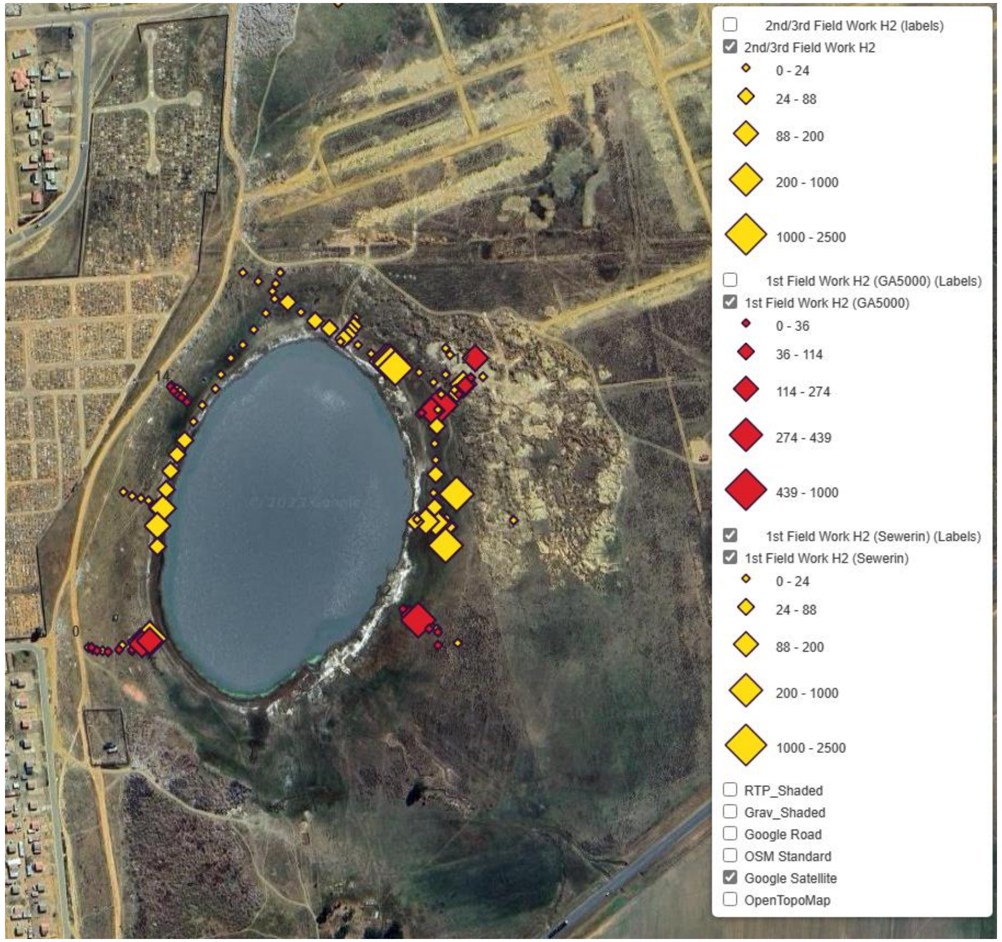


In eastern Highveld region 4628 depressions (pans).

First Results - South Africa

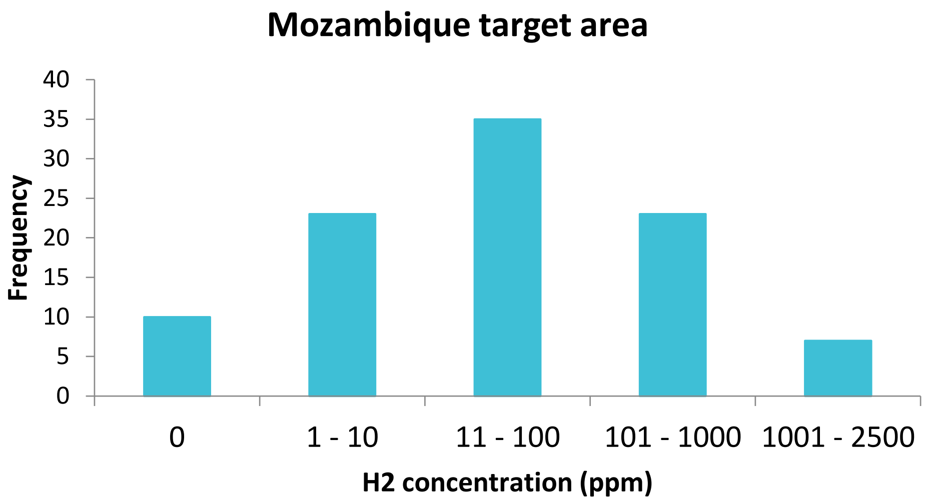


First field survey, June 2023
Second field survey, Sept. 2023
Third field survey, March 2024

Currently around **900** points have been sampled

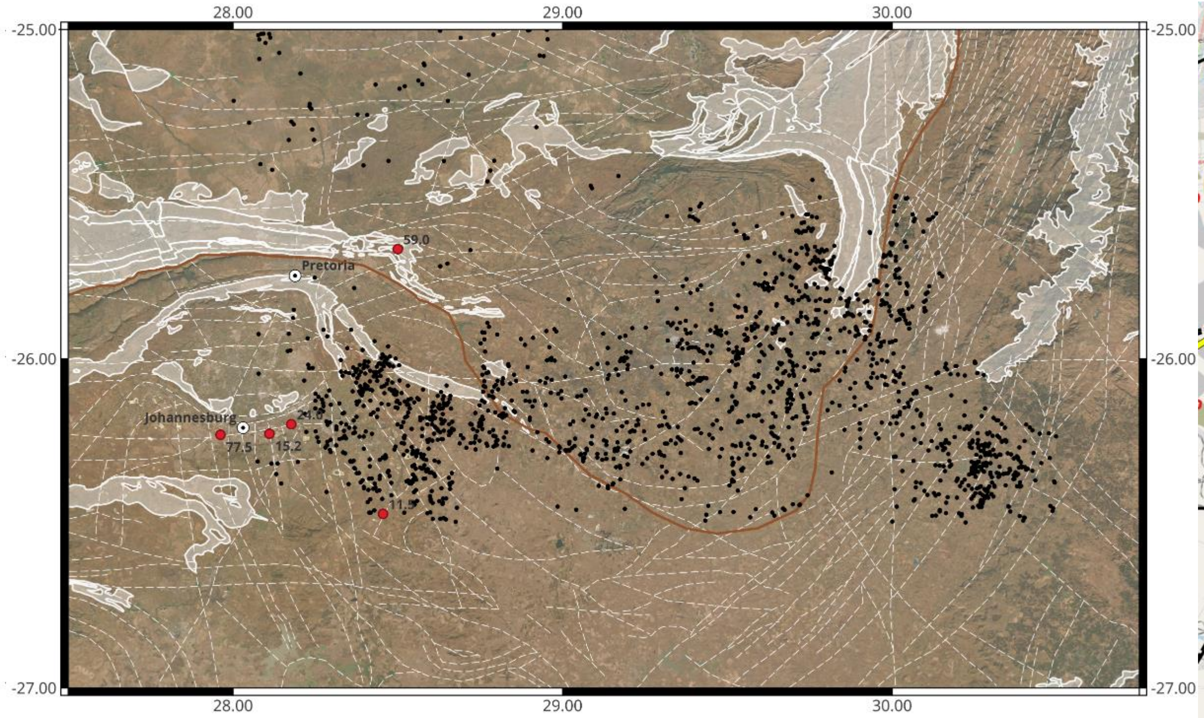
H_2 max concentration > 4% vol

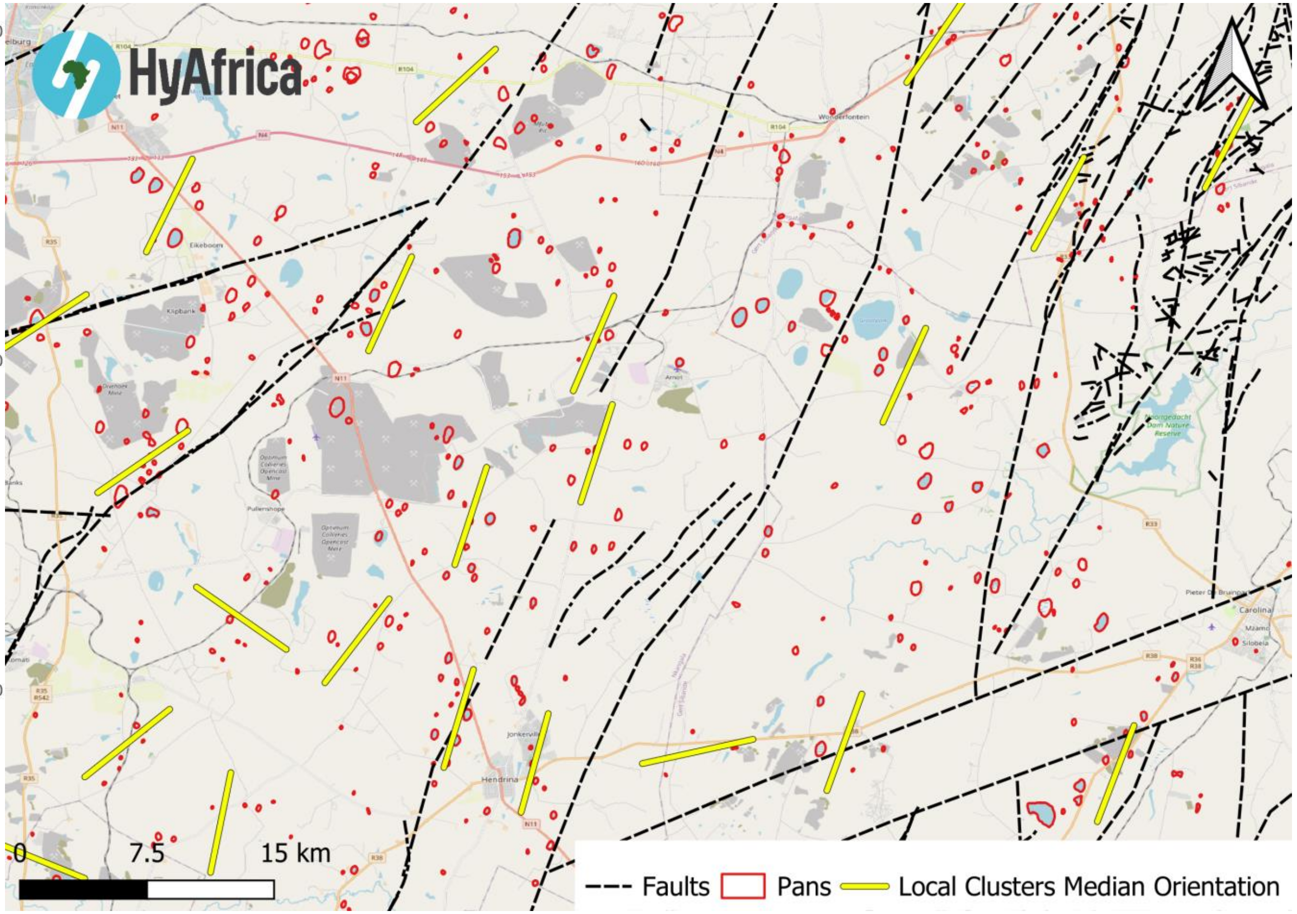
First Results - Mozambique



Targets	6 depressions
Measurements	98
Concentration H_2 (ppm)	
Mean	225
Median	56
Std. Dev.	466
Minimum	0
Maximum	2500

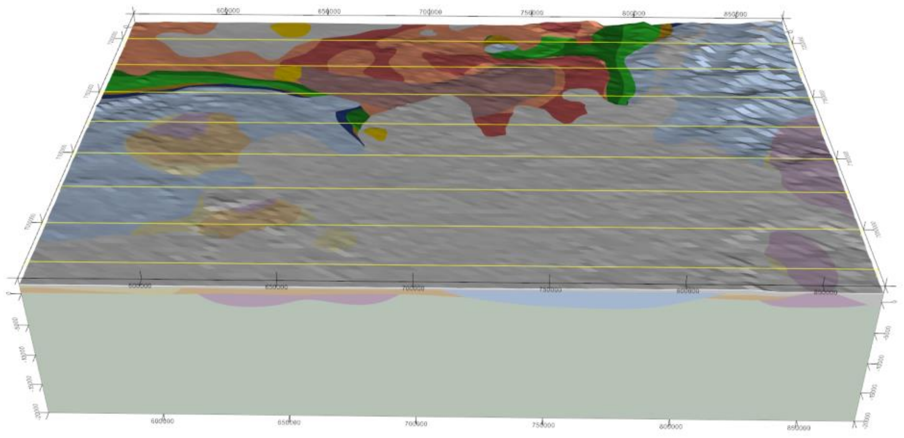
Faults and structural controls of depressions – South Africa

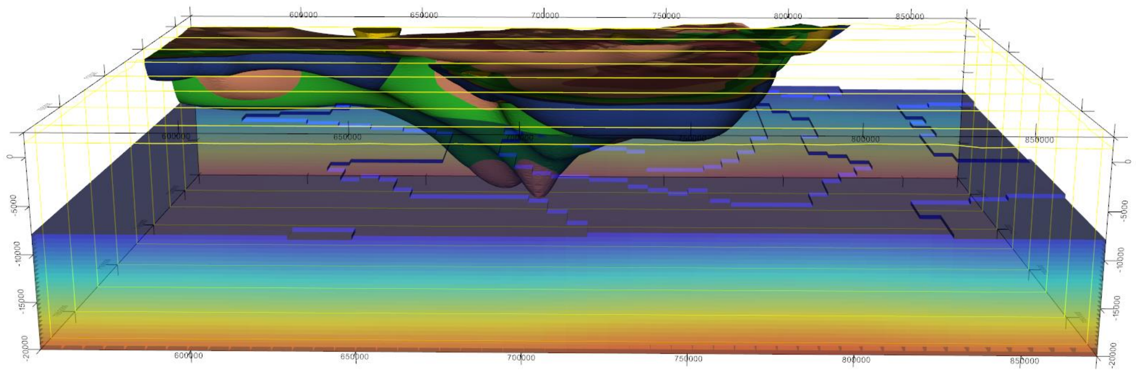




Note the sub-parallel arrangements between elliptical depressions and faults determined from geophysics

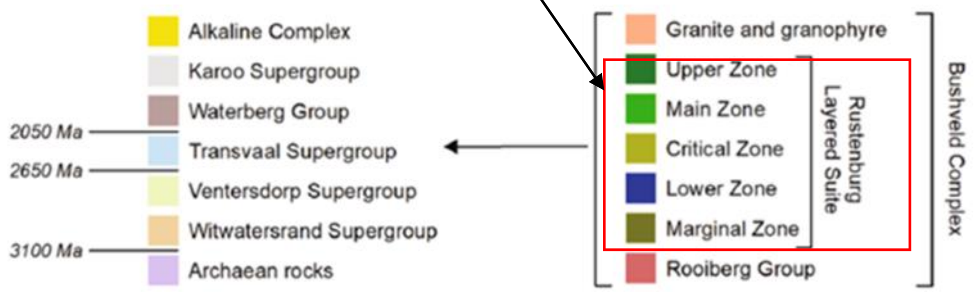
3D model of anomalies and H_2 sources

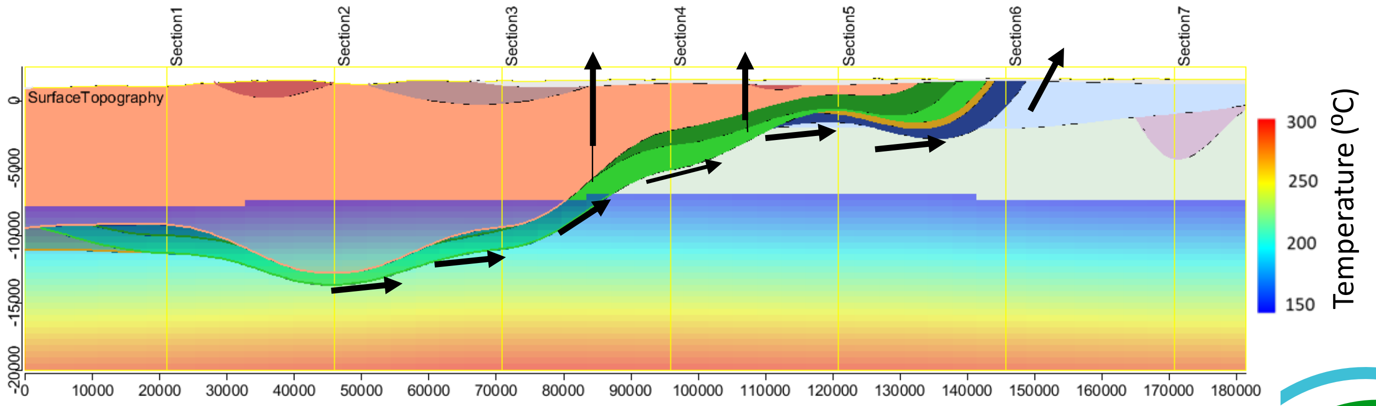




Temperature window deeper 6 km

Rocks with high content of iron





Hydrogen migration to shallower sectors??

Natural Hydrogen Challenges

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- What are the trapping mechanisms?
- Can it trully accumulate or is it a continuous flow along faults?
- What is the generation and destruction (by reaction with rocks) rates?
- How to model its geochemical and transport behaviour in depth?
- Can we develop reliable exploration protocols?
- Are conventional wells from O&G industry adequate for production?
- What technologies to purify it (there won't be many cases of 98% as in Mali)?
- What are the regulations requirements (mining law? O&G regulations?)

Conclusions

- High anomalous **concentration of hydrogen** at shallow depth demonstrated in target areas in **South Africa and Mozambique**.
- **3D models** of the iron-rich mafic rocks at depth, identify potential **sources of hydrogen**;
- **South Africa** target **highly promising** - faults and lineaments providing structural control;
- **Building capacity** and **raising awareness** are essential to engage **local authorities** – 2024/25
- Essential to understand the **socio-economic context** and feasibility for H2 in **standalone systems**– 2024/25

HyAfrica

THANK YOU

LEAP-RE

Long-Term Joint EU-AU Research and Innovation Partnership on Renewable Energy

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