LEAP-RE STAKEHOLDE FORUM

WP10: PURAMS

LEAP-RE

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

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

WP No: 10

WP title : Productive Use in Rural Africa Markets using Standalone Solar (**PURAMS**)

LEAP-RE

PARTNERS:

- Strathmore University (SU) – **Kenya**
- Rural Electrification and Renewable Energy Corporation (REREC) – **Kenya**
- Africa Energy Services Group (AESG) - **Rwanda**
- Universidade Eduardo Mondlane (UEM) - **Mozambique**
- Laboratório Nacional de Energie e Geologia (LNEG) – **Portugal**
- University of Cordoba (UCO) – **Spain**

WP 10 – Objectives and tasks

WP 10 objectives:

This project aims to develop a standalone solar cooking appliance (cooker), to address the challenges caused by traditional cooking methods and faced by rural communities in Africa. The specific objectives of the project can be summarized as follows:

- To do an off-grid market assessment for solar cooking, a solar resource assessment to enable cooker design and capacity assessment to support piloting of systems.
- To develop a standalone solar cooker and pilot it.
- To identify business models and engage policy makers to create an enabling environment.
- To develop or improve solar photovoltaic module technology for use in the cooker design.

MARs addressed.

MARs 2: Smart Stand Alone Systems (SAS)

Promote the development of RE-SAS demonstrators (s) considering the diversity of potential local RE sources and the local effective environment.

MARs 6: Innovative solutions for priority domestic uses (clean cooking and cold chain)

Improving, managing and maintaing solar photovoltaic systems, cookstoves and cold chain components for clean cooking and food storage. Supporting interactions with policymaking to foster fast market uptake considering the macro socio economic and gender impacts.

INNOVATIONS UNDER WP10

1. **Questionnaire Methodology**
2. **Solar-powered Cooker**
3. **Solar Resource Assessment**
4. **Power system design.**

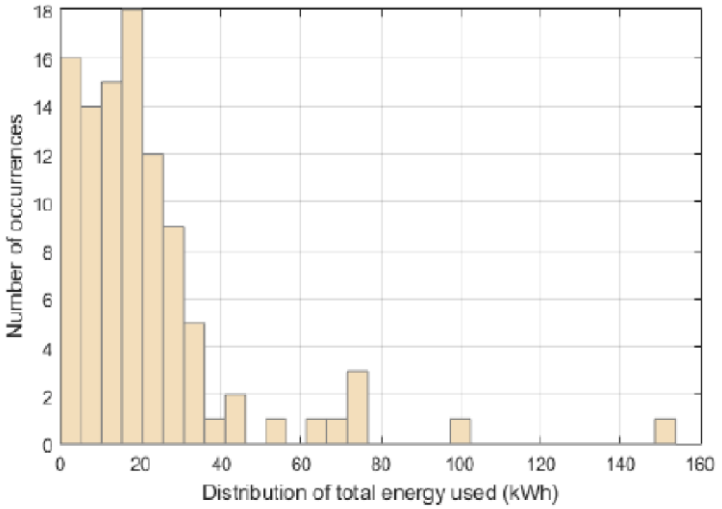
1: Data Collection Methodology

- Methodology approach for the electric cooking study to fix the gaps:
  - Kenya – Study the adoption of electric cooking in a newly electrified households and market.
  - Rwanda – Study the adoption of electric cooking in households powered by mini grids.
  - Mozambique – Study the business aspect of cooking by households and businesses.
- The in-depth data collection involved the following activities;
  - Pre-Screening Survey that involved a number of households in rural areas to participate in the study
  - A baseline study of the households shortlisted from the households above before issuing them the Electric pressure Cookers
  - A 6-month study of households selected on the usage of issued electric pressure cookers
  - An exit study of the selected households to compare data from the baseline study with the data post EPC adoption

Most significant project results

Cooking habits and design metrics:

- Analysis of cooking habits: three questionnaires were conducted in the target countries
  - Information on socio-economic aspects that shall contribute for the business models on solar electric cookers
  - Improved knowledge on cooking habits and fuel demand of the users
- Analysis of cooking habits: Experimental campaign using EPCs with electric needs measurements + cooking habits
- Design metrics for PV cookers were proposed (D10.2)



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7	Charcoal st	0	0	Year(s)		Cooking hard foods Grilling	1	0	0	1	0	0	0		More expensive than regular cooking	0	1
8	Fogao a car	7000	8	Month(s)		Cooking hard foods Grilling	1	0	0	1	0	0	0		Cooks food faster	0	0
9	Lenha embu	0	1	Year(s)		Cooking hard foods	1	0	0	0	0	0	0		More expensive than regular cooking	0	1
10	Fogao a car	750	20	Day(s)		Cooking hard foods	1	0	0	0	0	0	0		Cheaper than regular cooking	1	0
11	Não aplicáv	750	20	Day(s)		Baking	0	0	0	0	0	1	0		Cheaper than regular cooking	1	0
12	Lenha embu	4500	10	Year(s)		Boiling Water Grilling Warming Food	0	0	1	1	1	1	0		Cheaper than regular cooking	1	0
13	Fogao a car	4500	10	Year(s)		Grilling Warming Food Baking	0	0	0	1	1	1	0		Cheaper than regular cooking	1	0
14	Fogao a car	150	2	Year(s)		Cooking hard foods Cooking soft fo	1	1	1	1	1	1	0		Cooks food faster	0	0
15	Fogao a car	150	2	Year(s)		Baking	0	0	0	0	0	1	0		Cooks food faster	0	0
16	Fogao a car	150	2	Year(s)		Cooking hard foods Cooking soft fo	1	1	0	1	0	0	0		Cheaper than regular cooking Cooks	1	0
17	Outro espe	390	1	Month(s)		Boiling Water Warming Food	0	0	1	0	1	0	0		Cooks food faster	0	0
18	Fogao a car	0	5	Year(s)		Cooking hard foods Cooking soft fo	1	1	0	0	0	0	0		Cheaper than regular cooking Cooks	1	0
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Launch Mozambique | cookstoves_grp | fuels

Ready

100%

2: Solar Powered Cooker

First design of a standalone solar cooker:

Research gap:

1. Developing an energy efficient DC EPC cooker for rural markets.
2. Off-grid solar powered cooker for deep fat frying

Deep frying cooker

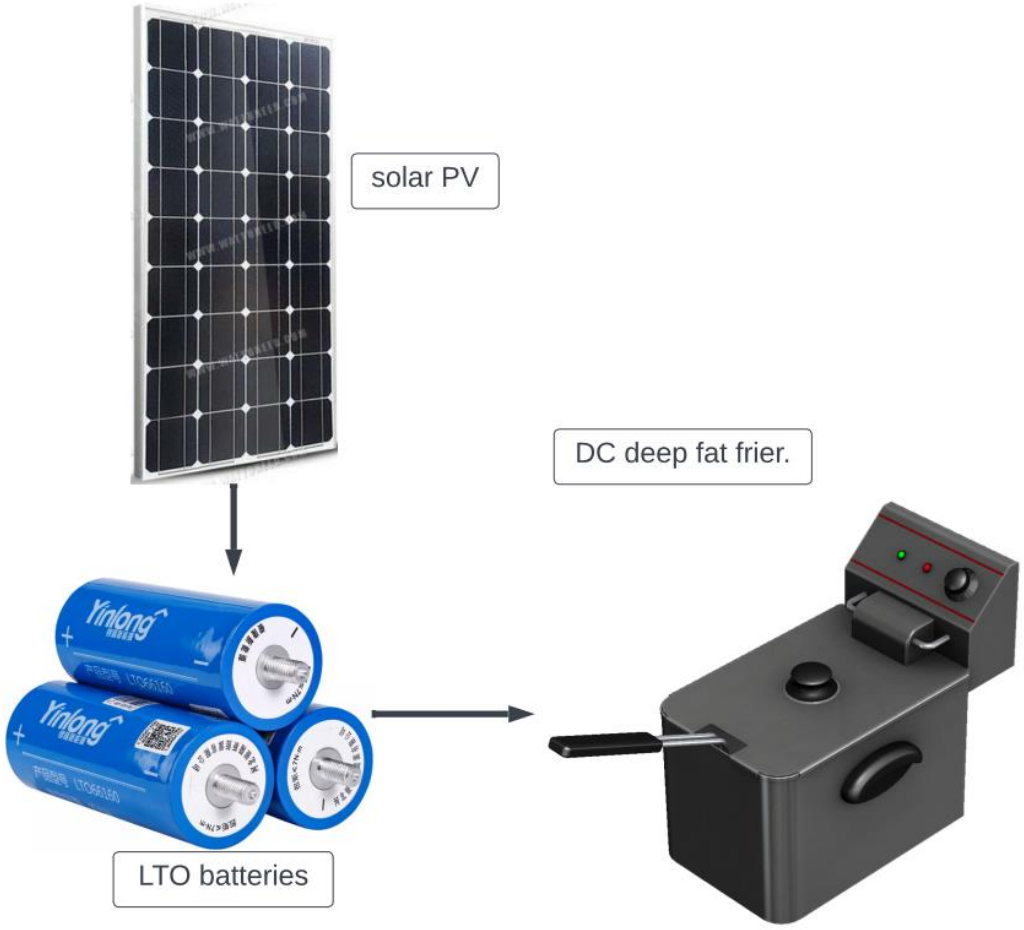
- Targeted to road-side vendors.
- Most energy consuming form of cooking.
- Deep fried meals include: chicken, chips, sausage, kebab etc.

DC EPC

- Targeted for households and small cooking business owners/road-side vendors.
- Boiling, Sauté, Frying considered as main cooking methods
- Boiled street foods include; rice, eggs, maize, sweet potatoes, legumes, arrowroots, githeri etc

2 a)Deep fryer cooker.

Off-grid Deep Fat Fryer:

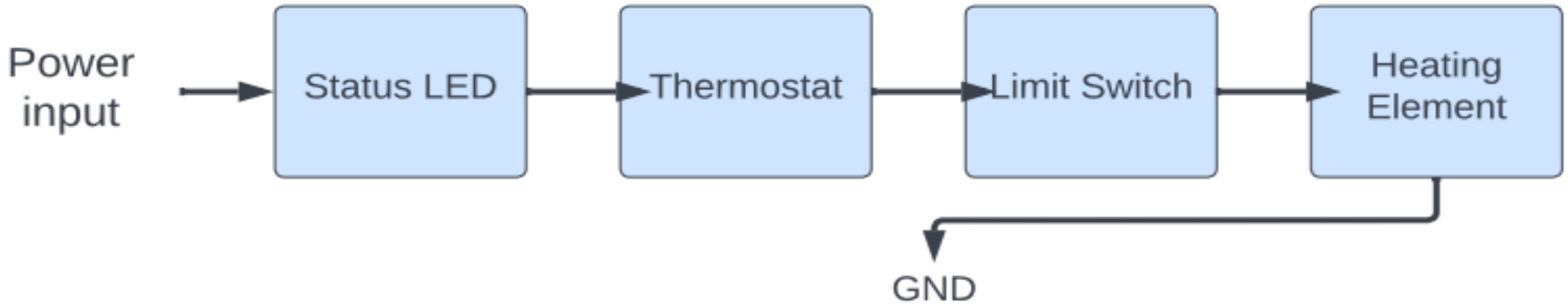


Design specifications:

- Capacity of 5 liters to accommodate liters of oil frying at least 2 kg of potatoes per cycle.
- Layered stainless steel shell material to provide insulation
- Power switching element, temperature control element, timer, LED status indicator and heating element ie. PTC.

2 a)Deep fryer cooker.

Block diagram for electrical components.



- The device is set to have a power switching element, a temperature control element, a timer, an LED status indicator and a heating element.

2 a)Deep fryer cooker.

First Iteration design

400W PTC/Cast iron solar chips fryer

- Prototype built using a combination of PTC heating elements and resistive heating elements with 500W startup power.
- Voltage range (21-25V).
- Startup power 500W
- Power (250W power above 100 degrees celsius.
- Peak frying power (above 100W) to maintain temperature close to 150 degrees.
- Cooks close to 0.5 kg per session.

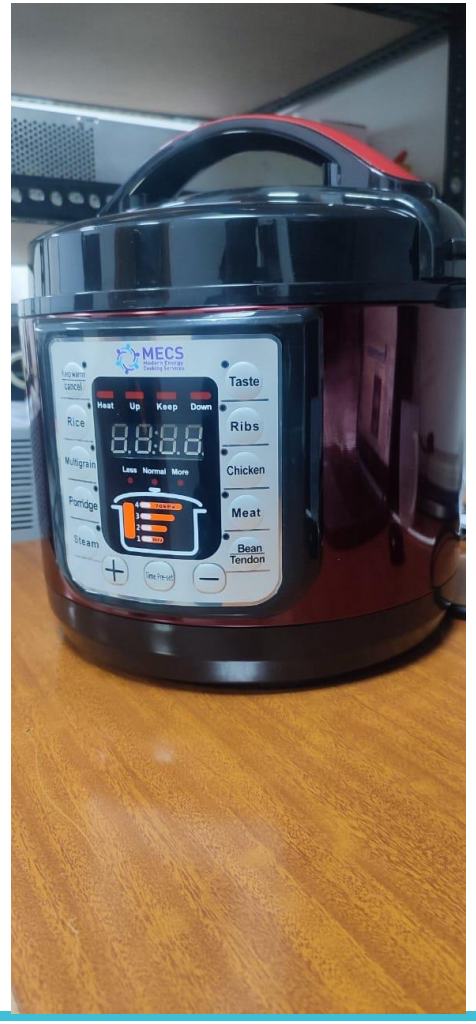
2 b)Electric Pressure Cooker (EPC).

Innovation (s) (Include Images):

Testing out DC EPC with MECS:

- MECS eWant DC cooker manufactured by Foshan Shunde Ewant Electrical Technology Co Ltd
- The DC EPC is best for boiling, frying or sauteing foods.
- Specifications: 24VDC, 500 W with 5L capacity
- EPC will be evaluated for its safety, performance, and quality

Testing the EPCs.



- Quality; packaging, warranty, user manual, warranty and ingress protection.
- Workmanship and material; lid seal design, durability, lifting grips, functionality of handles, coating compliance, concavity test to check the deviation of the pot shape under different heating cycles and plastic deformation.
- Energy Performance Test; power consumption and thermal efficiency.

Solar Power System.

- 24V monocrystalline solar panels with a maximum nominal power output of about 450W.
- These PV panels are the best choice for isolated self-consumption installations.
- The average price for these PV panels oscillates between 180-220 €.
- The supplier normally offers a 25-year power guarantee

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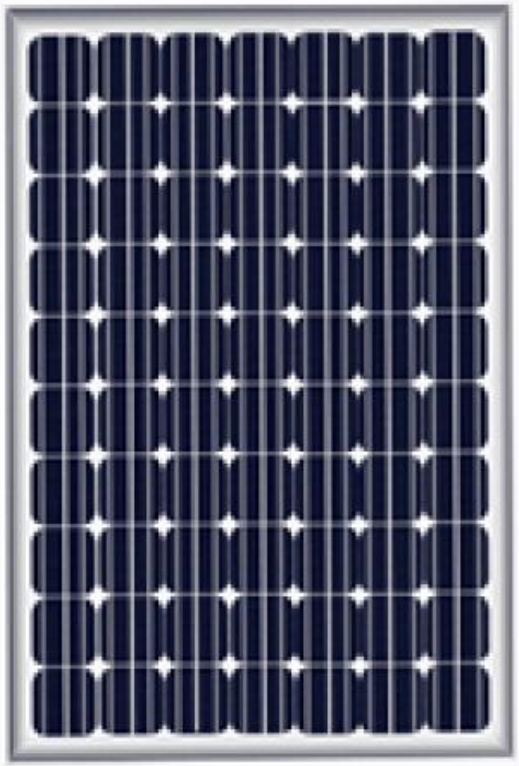


Solar Power System.

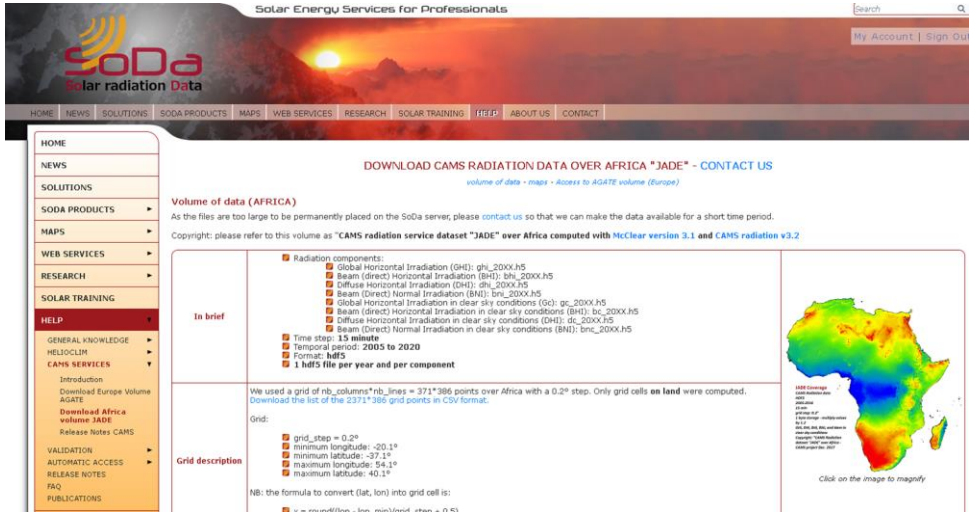
The previous type of PV panel is selected due a combination of the distinctive characteristics:

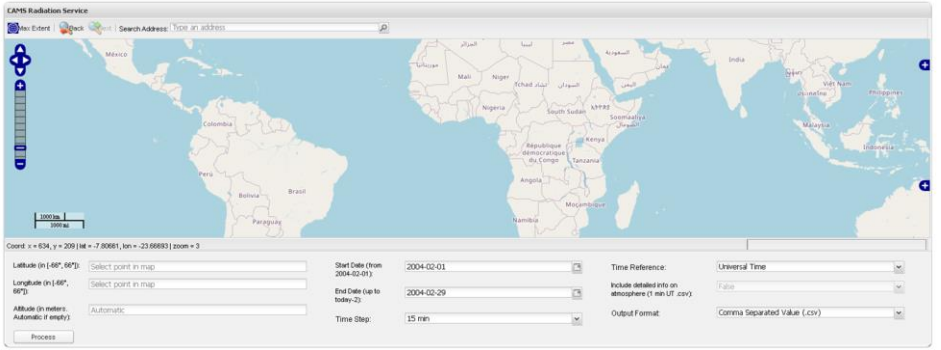
- Ease of cleaning, the silicon cells are covered with a glass that can be simply washed with water.
- Moderate cost with respect to the flexible solar panels
- Simplicity in the installation and connection with the electrical components as inverters or charge controllers.
- PV panels with the highest performance
- This type of solar panels are the best sellers, so they are easily accessible in the locations of piloting

Solar Resource Methodology and Validation Assessment

for Kenya, Mozambique and Rwanda

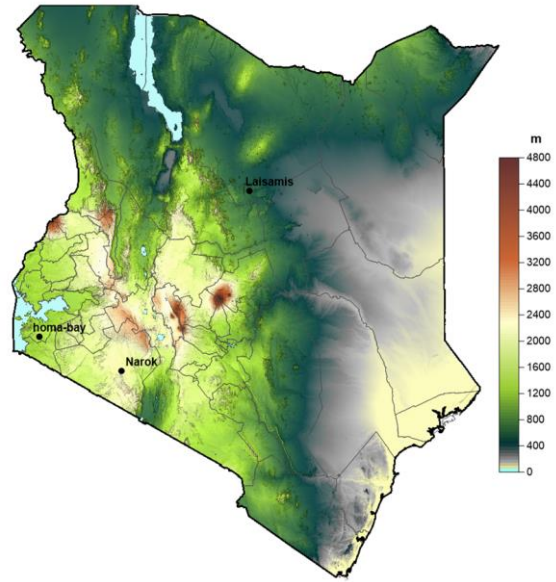
- Solar resource assessment was performed – in a broader scale – using satellite-based public databases (e.g. CAMS and PVGIS).
- Methodology was divided into two stages:
    1. **Mapping GHI** – Global Horizontal Irradiance from the satellite-based databases;
    2. **Validation**/calibration with measuring stations (correlation, BIAS, RMSE, BIAS – Daily profile, BIAS – Monthly profile)
- Enables to understand the accuracy of the data from existing public databases in African countries and can be used in several other countries in the absence of experimental data
- Validation performed for Kenya with 3 locations with measurements, but there is the need to gather more experimental data in other African countries to confirm these outcomes.



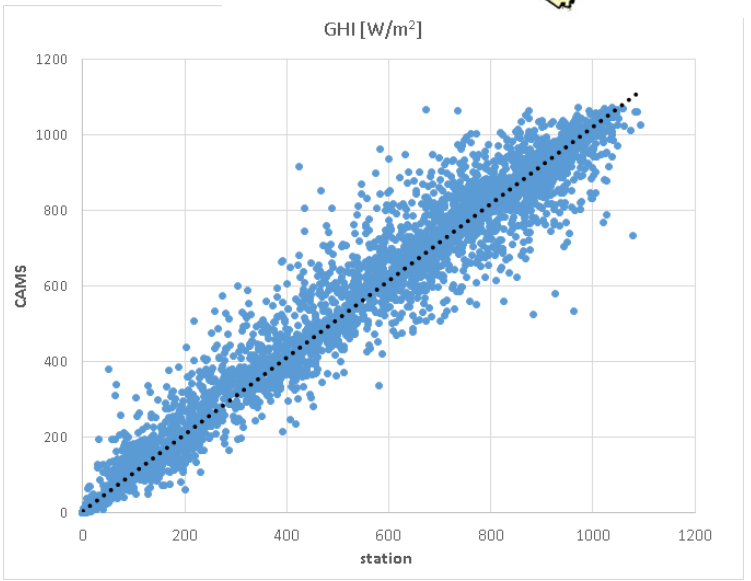


Most significant project results

- **Validation in Kenya (so far)** : 3 publicly ground-based stations
- Time-series of satellite-based databases show **correlation** values **above 0.96**);
- Maximum normalized BIAS and RMSE values between **5% and 22%**.
  - These values are in line with publicly global validation studies - SolarGIS and CAMS for African Countries.
- Mean daily and monthly profiles with BIAS are between **1% and 9%**
- **CAMS** provided highest correlation values with minimum BIAS and RMSE.
- CAMS will probably be the default database to provide solar data.



Laisamis	Correlation	BIAS [%]	RMSE [%]	BIAS Daily Profile [%]	BIAS Monthly Profile [%]
CAMS	0.990	3.67	11.86	4.90	3.68
PVGIS	0.977	3.96	17.75	13.30	14.23
POWER	0.977	-2.02	15.76	1.42	0.17



Most significant project results:

Publications/Dissemination of project results:

- SU is working on a perspective article on the 'State of solar photovoltaics technology' to be published in *Nature Journal* in 2023
- Solar resource assessment using the developed methodology was validated. The validation makes the use of solar public databases for African countries more effective as it was done using Kenyan data
- The most critical comments regarded the test of only one cookstove technology. This led the WP10 team to consider more options to meet the energy needs of the communities
- The project was invited to present the developments at an International Conference that will take place in April 2023.

Publications/Dissemination of project results:

- Participation in CIES2022 in Palma de Maiorca – Spain
  - Conference Paper:Title (Published in Portuguese): Projecto LEAP-RE/PURAMS – Fogões Solares autónomos para áreas rurais
  - Title (in English): LEAP-RE/PURAMS Project - Autonomous Solar Stoves for Rural Areas
  - Authors: Couto A., Cardoso J.P., Costa P.A., Facão J., Loureiro D., Rodrigues C., Wambugu A., Banda S., Simões T.
  - Summary: Presentation of the solar resource assessment methodology and validation results; business plan methodology and questionnaires results presented at D10.2

- LNEG published a short news article about its participation in LEAP-RE on its website. Link: https://www.lneg.pt/en/lneg-is-part-of-the-leap-re-consortium-on-two-projects-dealing-with-energy-sustainability-and-development-in-africa/

- UCO published two newspaper articles in 2022 about their participation in the LEAP-RE project and the highlight the goals they intend to achieve in WP10
  - El Confidencial: https://www.elconfidencial.com/medioambiente/energia/2022-01-13/hornos-solares-cocinar-africa-subsahariana_3357108
  - SolarNews: https://es.calameo.com/read/000884165725a4a8223fd

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Impact of Project Results:

- Solar resource assessment using the developed methodology was validated and makes the use of public databases in African countries more effective due to validation performed so far for Kenya;
- The socioeconomic component processed so far has enable to understand the future use of these technologies – advantages for the communities and what can be improved – and gave a valuable contribution for the development of the business plan;
- Understanding the cooking habits in different countries. Identification i) of the energy needs and ii) if the same cooking solutions can be used in different countries or the specific solutions are needed according each context.
- The most critical comments so far where the test of only one cookstove technology – More options are being developed at this moment to meet the energy needs;
- In the sequence of the presentation of the first project results in the CIES 2022 congress, the project was invited to present the developments in a paper on an MDPI journal - "Solar" (Open Access) that will be issued in the beginning of 2023

Next steps and ongoing work

Resource Assessment:

- Correlation between cooking hours and resource availability (in the final stage)
- Comparison with experimental measurements if available (performed with three met masts and reported in D10.2, but more data are needed to improve results

Prototype development, testing and analysis (ongoing)

Business Model

- Profile analysis for the business plan (ongoing)
- Analysis of the data being collected in the surveys, especially in what concerns socio-economic aspects (currently finishing final stage of Rwanda and starting Mozambique data processing)
- Improvement of the results and making the developed routines available to the partners, if needed
- Analyse information related with the developed studies with the EPCs (external to the project), and consider more possibilities in the business plan (e.g. hot plate or other) towards final version (ongoing)
- Costs breakdown (starting)

Next steps and ongoing work

What is to be done to contribute to the innovation or collaboration efforts within the WP:

- More experimental data are needed
  - Public data sources are being used, but more experimental data are needed to validate their suitability on African countries and to contribute for the resource vs cooking hours analysis
  - Information on socio-economic aspects that shall contribute for the business models on solar electric cookers
- Cooperation in identifying strategies to contribute for the “user ability to pay” component
  - Questionnaires are a very good help but the samples in some cases are limited – Local Partners intervention is needed to complement the outcomes of the questionnaires
- Stakeholder Engagement

THANK YOU

CONTACT US FOR MORE INFORMATION

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