# Solar Ecooking

Virtual eCooking Dialogue, 8th October 2022

*Christina Kiwiri,* Kenya Power

*Stewart Craine*, Village Infrastructure Angels
*Anastacia Kamau*, SCODE
*Omina Wandera*, Athel Technology
*Sandra Banda*, Strathmore University

**eCooking Community of Practice**

MECS
Modern Energy Cooking Services

## *SESSION OVERVIEW*

- *Stewart Craine*, Village Infrastructure Angels
- *Anastacia Kamau*, SCODE
- *Omina Wandera*, Athel Technology
- *Sandra Banda*, Strathmore University
- Roundtable Discussion and Q&A

# Solar Electric Cooking Solutions

## Village Infrastructure Angels (VIA)

November 2022

# Why cook with solar?

CleanTechnica  Clean Energy  EVs  Tesla News  Exclusives  About


CLEAN POWER

## Solar Power = "Cheapest Electricity In History"

The fossil-friendly International Energy Agency indicates that solar power is now the "cheapest electricity in history."

By Zachary Shahan Published October 26, 2020    117 Comments

# Cost comparisons - charcoal, LPG, bioethanol

| Fuel source | Stove type | Capital cost | Stove life, years | Daily fuel consumption | Fuel unit | Fuel cost per unit | Fuel cost per day | 20 year fuel cost | 20 year total cost | Total cost per day | Example market |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Charcoal | Improved cookstove, urban | $20 | 5 | 0.75 | kg | $0.10 | $0.08 | $548 | $628 | $0.09 | |
| | | $20 | 5 | 0.75 | kg | $0.20 | $0.15 | $1,095 | $1,175 | $0.16 | |
| | | $20 | 5 | 0.75 | kg | $0.30 | $0.23 | $1,643 | $1,723 | $0.24 | |
| | | $20 | 5 | 0.75 | kg | $0.60 | $0.45 | $3,285 | $3,365 | $0.46 | |
| LPG | 2-burner gas stove | $30 | 10 | 0.30 | kg | $0.90 | $0.27 | $1,965 | $2,025 | $0.28 | India |
| | | $30 | 10 | 0.30 | kg | $2.00 | $0.60 | $4,380 | $4,440 | $0.61 | Kenya |
| | | $30 | 10 | 0.30 | kg | $3.50 | $1.05 | $7,666 | $7,726 | $1.06 | Vanuatu |
| Ethanol | 2-burner gas stove | $21 | 10 | 0.60 | kg | $0.82 | $0.49 | $3,589 | $3,631 | $0.50 | Kenya |

# Cost comparisons - wood

| Fuel source | Stove type | Capital cost | Stove life, years | Daily fuel consumption | Fuel unit | Fuel cost per unit | Fuel cost per day | 20 year fuel cost | 20 year total cost | Total cost per day | Example market |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Wood | 3-stone open fire, rural | $0 | 20 | 3 | kg | $0.00 | $0.00 | $0 | $0 | $0.00 | |
| | 3-stone open fire, urban | $0 | 20 | 3 | kg | $0.05 | $0.15 | $1,095 | $1,095 | $0.15 | India |
| | | $0 | 20 | 3 | kg | $0.10 | $0.30 | $2,190 | $2,190 | $0.30 | Ghana |
| | | $0 | 20 | 3 | kg | $0.15 | $0.45 | $3,285 | $3,285 | $0.45 | Kenya |
| | | $0 | 20 | 3 | kg | $0.30 | $0.90 | $6,570 | $6,570 | $0.90 | Vanuatu |
| Wood | Improved cookstove, rural | $20 | 5 | 1.5 | kg | $0.00 | $0.00 | $0 | $80 | $0.01 | |
| | Improved cookstove, urban | $20 | 5 | 1.5 | kg | $0.05 | $0.08 | $548 | $628 | $0.09 | |
| | | $20 | 5 | 1.5 | kg | $0.10 | $0.15 | $1,095 | $1,175 | $0.16 | |
| | | $20 | 5 | 1.5 | kg | $0.15 | $0.23 | $1,643 | $1,723 | $0.24 | |
| | | $20 | 5 | 1.5 | kg | $0.30 | $0.45 | $3,285 | $3,365 | $0.46 | |

# Cost comparisons - Dalberg study in Kenya

## Fuel consumption and expenditure at the household level: calculation and key assumptions

**B: Potential of Bio-ethanol for Cooking in Kenya**

Annual cost of cooking = Annual HH fuel consumption x unit price to consumer

Annual HH fuel consumption = 3500MJ / (net calorific value x stove efficiency)

| Fuel | Net calorific value (MJ/kg) * | Range of stove efficiencies from literature | | Stove efficiency used for analysis | Average annual household fuel consumption (assuming 3,500MJ / HH annual consumption) | Price to consumer (USD) | Average annual cost of cooking (USD) (assuming 3,500MJ / HH annual consumption) |
|---|---|---|---|---|---|---|---|
| LPG | 46.6 | 50% | 60% | 55% | 137kg | 1.70 / kg | 233 |
| Kerosene | 43.1 | 25% | 40% | 35% | 284L | 0.79 / L | 224 |
| Charcoal | 28.2 | 12% | 43% | 21.9% | 569kg | 0.40 / kg | 228 |
| Bio-ethanol | 27.0 | 58% | 62% | 60% | 275L | 0.82 / L | 226 |

Source: https://dalberg.com/wp-content/uploads/2018/06/Dalberg_Long-form-report_FINAL_PDF_0.pdf

**3500MJ = 2.7kWh/day at 100% efficiency**

**Can this be reduced to 1-2kWh/day via insulated cooking pots?**

**1-2 kWh/day can be generated from 250-500Wp of solar panel**

**Can the cost of solar cooking be less than $3000-$4500?**

**↑ = $4500 over 20 years**

# Cost comparisons - electricity

| Fuel source | Stove type | Capital cost | Stove life, years | Daily fuel consumption | Fuel unit | Fuel cost per unit | Fuel cost per day | 20 year fuel cost | 20 year total cost | Total cost per day | Example markets |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Electricity | Normal cooking pots | $40 | 10 | 2.5 | kWh | $0.05 | $0.13 | $913 | $993 | $0.14 | India (rural), Serbia |
| | | $40 | 10 | 2.5 | kWh | $0.10 | $0.25 | $1,825 | $1,905 | $0.26 | India (urban) |
| | | $40 | 10 | 2.5 | kWh | $0.15 | $0.38 | $2,738 | $2,818 | $0.39 | Kenya |
| | | $40 | 10 | 2.5 | kWh | $0.20 | $0.50 | $3,650 | $3,730 | $0.51 | Uganda |
| | | $40 | 10 | 2.5 | kWh | $0.30 | $0.75 | $5,475 | **$5,555** | $0.76 | Denmark |
| | | $40 | 10 | 2.5 | kWh | $0.50 | $1.25 | $9,125 | $9,205 | $1.26 | Vanuatu, solar minigrids |
| | Efficient cooking pots | $100 | 10 | 1.8 | kWh | $0.05 | $0.09 | $652 | $852 | $0.12 | |
| | | $100 | 10 | 1.8 | kWh | $0.10 | $0.18 | $1,304 | $1,504 | $0.21 | |
| | | $100 | 10 | 1.8 | kWh | $0.15 | $0.27 | $1,955 | $2,155 | $0.30 | |
| | | $100 | 10 | 1.8 | kWh | $0.20 | $0.36 | $2,607 | $2,807 | $0.38 | |
| | | $100 | 10 | 1.8 | kWh | $0.30 | $0.54 | $3,911 | $4,111 | $0.56 | |
| | | $100 | 10 | 1.8 | kWh | $0.50 | $0.89 | $6,518 | $6,718 | $0.92 | |

# Cost comparisons - solar

| Fuel source | Stove type | Capital cost | Stove life, years | Daily fuel consumption | Fuel unit | Fuel cost per unit | Fuel cost per day | 20 year fuel cost | 20 year total cost | Total cost per day |
|---|---|---|---|---|---|---|---|---|---|---|
| Solar DC | No battery | $150 | 10 | 1.8 | kWh | $0.023 | $0.04 | $300 | $600 | $0.08 |
| | Lead-acid battery, 1.8kWh storage | $150 | 10 | 1.8 | kWh | $0.112 | $0.20 | $1,458 | $1,758 | $0.24 |
| | LFP battery, 0.5kWh storage | $150 | 10 | 1.8 | kWh | $0.052 | $0.09 | $683 | $983 | $0.13 |
| | LFP battery, 1.8kWh storage | $150 | 10 | 1.8 | kWh | $0.119 | $0.21 | $1,550 | $1,850 | $0.25 |
| | LTO battery, 0.5kWh storage | $150 | 10 | 1.8 | kWh | $0.048 | $0.09 | $628 | $928 | $0.13 |
| | LTO battery, 1.8kWh storage | $150 | 10 | 1.8 | kWh | $0.104 | $0.18 | $1,350 | $1,650 | $0.23 |
| Solar AC | No battery | $100 | 10 | 1.8 | kWh | $0.038 | $0.07 | $500 | $700 | $0.10 |
| | Lead-acid battery, 1.8kWh storage | $100 | 10 | 1.8 | kWh | $0.127 | $0.23 | $1,658 | $1,858 | $0.25 |
| | LFP battery, 0.5kWh storage | $100 | 10 | 1.8 | kWh | $0.068 | $0.12 | $883 | $1,083 | $0.15 |
| | LFP battery, 1.8kWh storage | $100 | 10 | 1.8 | kWh | $0.134 | $0.24 | $1,750 | $1,950 | $0.27 |
| | LTO battery, 0.5kWh storage | $100 | 10 | 1.8 | kWh | $0.064 | $0.11 | $828 | $1,028 | $0.14 |
| | LTO battery, 1.8kWh storage | $100 | 10 | 1.8 | kWh | $0.119 | $0.21 | $1,550 | $1,750 | $0.24 |

# Solar thermal cookers


SunFire 18 1600W Parabolic Solar Cooker

GoSun Fusion

SunFire Sunstove

**$100-500, but can they cook ugali...?!?! Disrupts daily life, poor heat control, need attention**

# Solar DC electric cooker designs


**"Direct drive"**
- 500-1000Wp, no battery
- voltage regulator required
- input power may vary
- cooking time may vary
- can automate switch on/off


**Solar + battery**
- 500Wp with 1-4 hr battery
- solar regulator required
- input power unlikely to vary
- cooking time unlikely to vary
- can automate switch on/off

## Battery options

**Lead-acid**
5 year life, low initial cost, only 65% of capacity usable to best life, maximum input 0.25C means 2kWh battery needed per 500Wp solar panel input......means not portable.

**Lithium**
Various chemistries available, LFP is safest option, 10 year likely life, maximum input 1C means a smaller 0.5kWh battery can be used, offsetting higher initial cost per kWh and can be portable.

Lithium titanate worth a special mention, as has 20-30 year life. Very high intial cost per kWh but can have up to 5-10C maximum input, so could use a very small battery for non-cooking uses.

AC cookers would need a 1000W inverter added

# Solar cookers will run the whole house

A solar cook with battery storage can run many non-cooking loads too

| | |
|---|---|
| Lights | 5-10W of LED lights, 30-60Wh/day |
| Phone charger, radio | 5-10W each, 20-50Wh/day |
| TV, fan | 10-20W each, 50-100Wh/day |

- Normally needs a 40-50Wp 150-250Wh solar home system
- Yields additional savings of kerosene lamp and candle elimination and reduced battery use for radios.
- Only 10-20% of the cooking system's energy required

# Experience to date

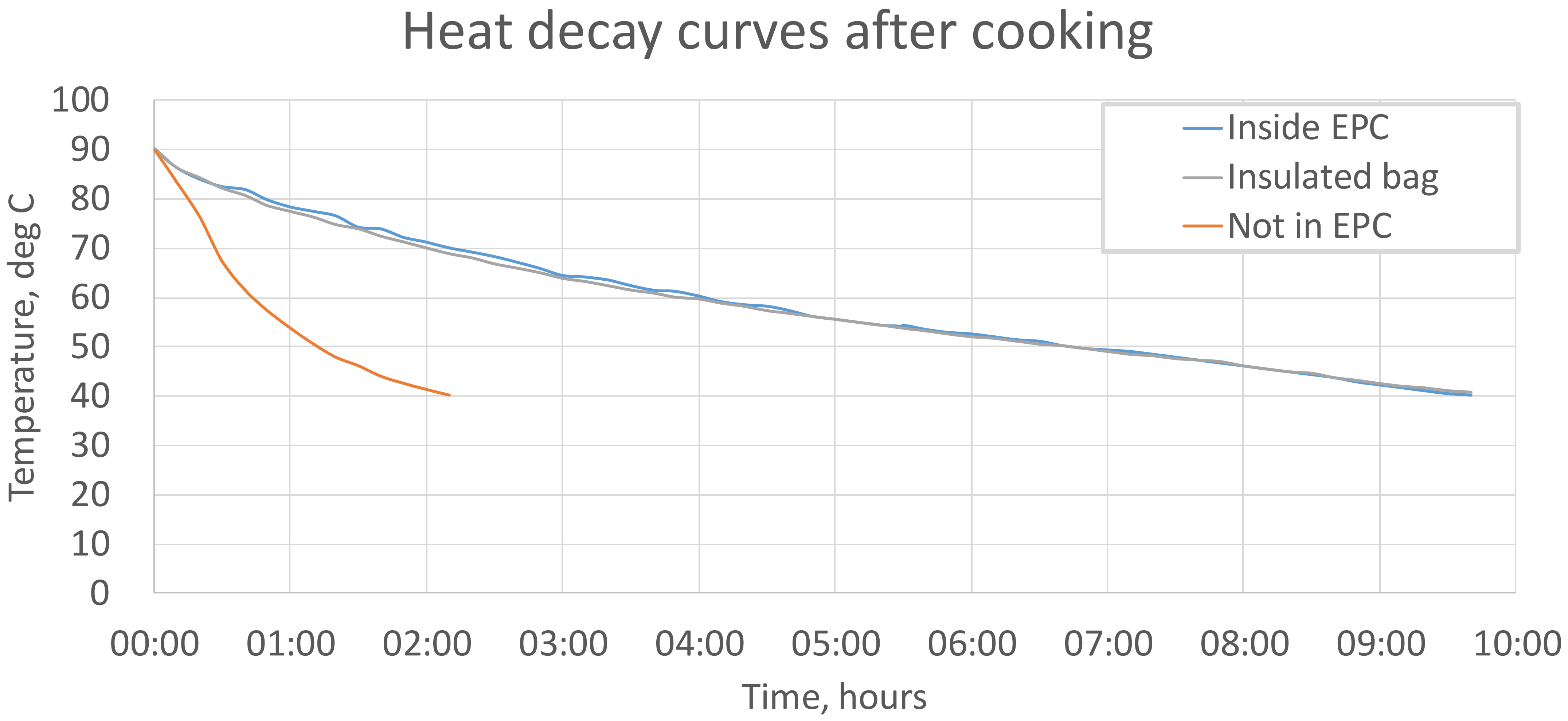
Various foods need 150-250 Wh/kg to cook in insulated pots
People need 1-2 kg/day of food to survive - 6-8 kg per household
Implies 1-2kWh/day of energy needed
At 4 hours of sun per day, 250-500Wp solar panel required

3-4 kg cooked per meal, or more if all cooked at once
6-8L pot probably required
Multiple cookers or pots needed for meat/rice/veg
First Chinese products tested probably too small at 3-5L, but confirmed Wh/kg
Automation allows unattended cooking, but programming could confuse users
Pot insulation kept food warm enough to serve for 4-6 hours
Have added spare inner pot, steamer basket and insulation bag

Difficult to get 1000W into a 24V DC pot, very thick wires needed
Pay-as-you-go at higher voltages (eg. 48V) not yet available (will be next year)



# Heat retention



# Conclusions

Solar electric cooking is likely cheaper than any other form of cooking,
but needs financing, and the cost of that financing could double the cost.

The cheapest cooking is daytime cooking without batteries, but would need behaviour change - automation may help make this easier, as does the heat retention capability of the insulated pot or bag for many hours after cooking.

Electrical energy storage adds cost 50-200% extra cost
Thermal energy storage might be cheaper, not yet explored

Emission reductions could be 1-5 tonnes/year, depending on baseline fuel
Carbon credit income at $10-25/tonne could be $10-100/year - very important.
Good microfinance partners will be needed, but few can lend for enough years.
Best markets will be where households pay $0.50-$1/day on fuel, so $150-300/year can result in 2-4 year payback periods without battery or 4-8 year paybacks with battery.

# Solar Electric cooking system pilots in Rural Areas

Anastacia Kamau, SCODE

Sustainable Community
Development services
www.scode.co.ke

# Ecooking CoP Monthly dialogue: solar ecooking
# Date: 8/11/2022


Presented by: Anastacia Kamau-Scode

Sustainable Community Development services www.scode.co.ke

# About SCODE

SCODE is a Kenyan grassroots community development organization registered in 1996 as a national NGO. The organization has offices and a community-training and resource centre in Nakuru County, Kenya.

## Mission:

*SCODE exists to facilitate adoption of cleaner energy technology and sustainable land use approaches through capacity building and applied research for enhanced livelihoods for men and women.*

**SCODE works through two main programmes:-**

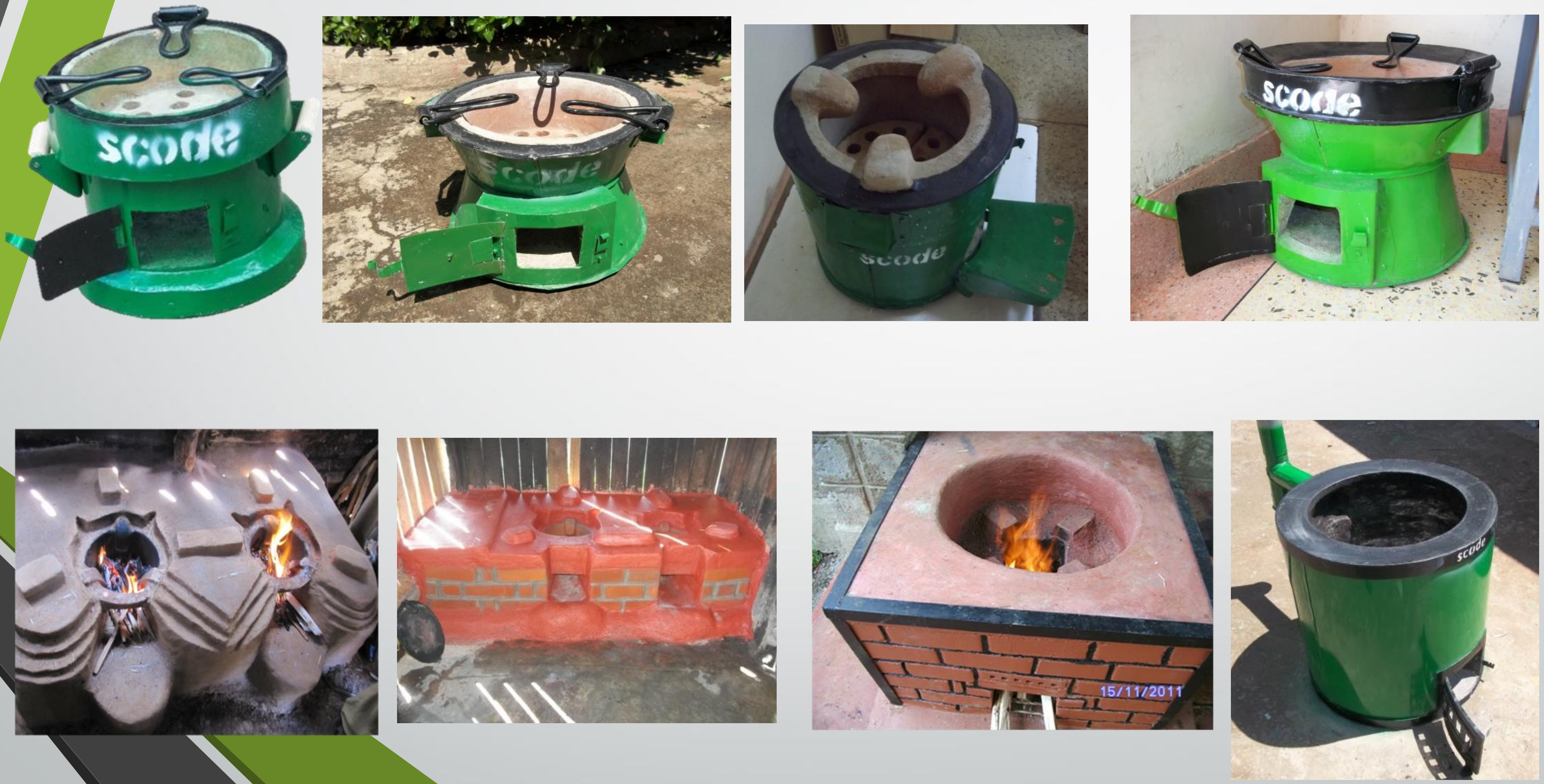
### 1. RENEWABLE ENERGY TECHNOLOGIES (RET'S)PROGRAMME:

This programme focuses on the conservation & sustainable utilization of renewable energy resources to reduce indoor air pollution, enhance food security and improve income of both men and women.

### 2. SUSTAINABLE LAND USE MANAGEMENT (SLUM)

This programme aims at improving food security and income levels of small scale men and women farmers through the adoption of low external input environment friendly technologies and approaches.

# Biomass Stove products




**Clockwise: HEC stove, Kunimbili (Multipurpose), KCJ, Mazingira, Maendeleo stove, Brick Maendeleo, Rocket stove, Institutional stove**

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## SOLAR ECOOKING


Packed solar dried fruits

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**September 2014-April 2017:The Solar Home Systems for Rural Off-Grid Households and Small Businesses project** aimed at developing a scalable business model for enhancing/accelerating adoption of clean energy technologies through use of a rare combination of power consumption metering to increase affordability of Solar Home Systems (SHS) through either rent-to-own or leasing models and integration with a micro gasifier. This addressed both cooking and lighting challenges in addition to protecting the environment by reducing deforestation and indoor air pollution/reduced $CO_2$ emission.

**Action area:** Nakuru, Meru, Embu, Uasingishu, Kakamega, Busia counties

**Achievement**: over 157 HH acquired solar home lighting systems coupled with a gasifier stoves

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## Solar Nano grids-Mbaruk, Mogotio

**2019-2020: Development and evaluation of a direct current solar electric pressure cooker unit.** The aim of the study was to test and evaluate the performance of the d.c solar pressure cooker in the workshop, evaluate potential for adoption of d.c unit within the communities and asses the economic viability of d.c units

Action areas: Nakuru County

Achievement: over 50 HH acquired d.c Ac ecooking kits

Baseline:

Stacking

HH energy costs per month 1,600-2,000/month

PAYGO- flexible daily, weekly, monthly payments

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**November 2020-to date:MECS: Piloting eCooking Power stations project in Nakuru, Kenya.** The study is exploring the potential for electric cooking appliances to meet the cooking needs of East African households. This will be done by testing the viability of energy storage (power stations) to enable households in off-grid and weak-grid areas to cook with electricity. It specifically targets households who currently don't have access to electricity (off-grid) and people who have access to an unreliable grid (weak-grid) with frequent blackouts and/or brownouts (voltage dips) that prevent them from using electricity when they want to cook.

**Action area:** Nakuru counties

**Achievement**: 20 HH with access to weak grid have already completed an 8 months testing phase. A further 20 HH with no grid access will participate in the trial as from November



MECS
Modern Energy
Cooking Services

## Scode Information Resource center and Ecooking Hub

SCODE's information resource centre provides information to women and men end users and technicians on renewable energy. It has a training hall, a modest library and a range of energy devices for demonstration.
It's founded on the premise that access to right information at the right time by the right person (man or woman) can result to an improved quality of life and better management of natural resources among poor men and women. Lack of the right information deprives the poor of opportunities to exploit their potential thereby consigning them to perpetual poverty.

Scode Ecooking hub was launched in April, 2022 to create awareness and stimulate demand for e-cooking. Its supported by ACTS through the Modern Energy Cooking Services program (MECS) in partnership with the relevant County Governments, the e-cooking Hub Hosts, the Clean Cooking Alliance Kenya, the Kenya Power and Lighting Company, Gamos East Africa, and suppliers in the e-cooking sector

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# Thank you.

SCODE

8 km from Nakuru town, Along Nakuru—Subukia—Nyahururu highway, Behind Heshima Centre (400Meters from the highway)

P.O Box 13177—20100, Nakuru, Kenya

Cell: 0723767265

Email: scode@scode.co.ke

Website: www.scode.co.ke

# Demand for Solar Ecooking Facilities

Omina Wandera, Athel Technology Limited

# ECOMPISHI SOLAR COOKERS

POWERED BY

## ATHEL TECHNOLOGY LIMITED

ATHEL TECHNOLOGY
Reuse . Reliable . Efficient

# ABOUT US

Athel Technology Limited was founded in 2019 by our founder Robert Nguma. This was after he was awarded a World Bank grant after participating in a competition funded by the World Bank in collaboration with Kwale county.

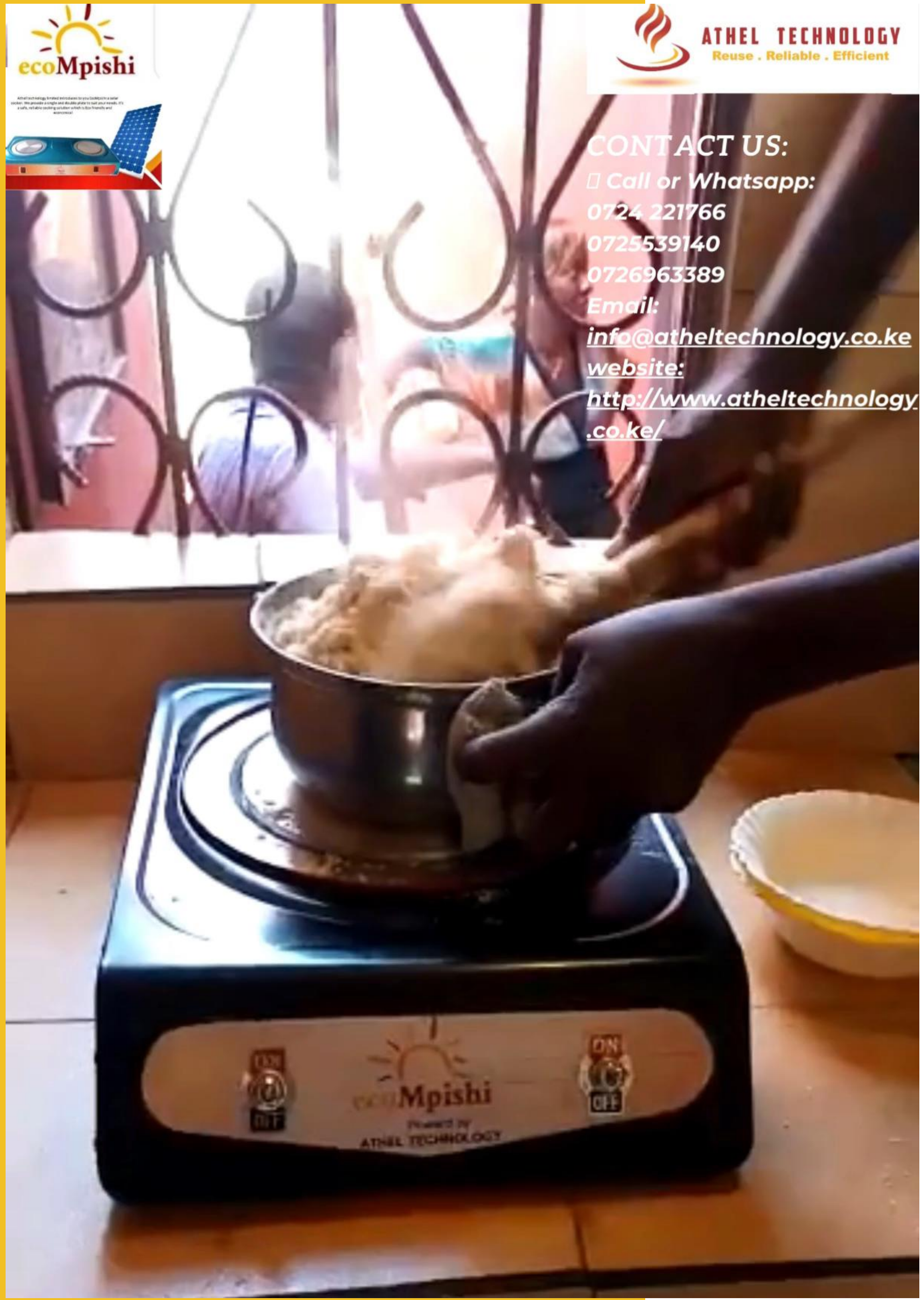
Driven by the need to reduce the use of firewood for cooking, as it is common with many communities in the country, we did endless research and managed to come up with a new environmentally friendly cooking solution known as the EcoMpishi Solar Cookers.

# THE MARKET

- Cooking in Sub-Saharan Africa (SSA) provides a strategic entry point towards catalyzing the adoption of clean, affordable and sustainable cooking energy.

- Kenya is one of many Sub-Saharan African countries facing a formidable clean cooking challenge.

- Firewood is the most popular cooking fuel in Kenya with a usage of 55 percent countrywide and 84 percent in the rural setup..




# MARKET OPPORTUNITY

- Firewood usage is primarily driven by ease in accessibility.
- Based on the Kenya National Bureau of Statistic data; the usage of cooking gas is highest in urban areas at 52 percent while only 5 percent of rural households use cooking gas.
- Current increased prices of cooking gas in Kenya, are now making more households to opt using firewood and charcoal which produce emissions.


The EcoMpishi Double Burner Solar Cooker.


The EcoMpishi Single Burner Solar Cooker.

# THE ECOMPISHI SOLAR COOKERS

- EcoMpishi Solar Cookers do not produce emissions.
- Our Solar cooking technology is one way of reducing deforestation.
- The EcoMpishi is an innovation that allows families to cook for free.
- EcoMpishi Solar Cookers work both during the day and at night.

# UPTAKE OF SOLAR ECOOKING ACROSS OUR TARGET MARKETS

- We have done EcoMpishi Solar Cooker installations in various counties in Kenya.
- The perception that solar energy can only be used for lighting, for pumping water and for warming water through solar water heaters.
- Creating awareness on the importance of utilizing solar energy for cooking, will educate more people that solar energy can actually be used for cooking.
- Working with different women groups in Kwale county has created awareness and increased demand for EcoMpishi Solar Cookers.
- We have also partnered with 2 NGOs in Isiolo County. This has also helped create awareness on the importance of solar ecooking solutions and has also helped increase demand for the EcoMpishi Solar Cooker.
- Using our social media pages has helped create awareness to the youth and promoted the EcoMpishi Solar Cookers.


# PRICE COMPARISON BETWEEN THE COST OF CHARCOAL AND THE ECOMPISHI SOLAR COOKERS.

- Price plays a big significant in the market as many customers will always look for a cheaper way of purchasing cooking energy.

Based on a study we did on the expenditure families in Mombasa use in purchasing charcoal.

Our findings:

- 1kg charcoal is Ksh.80 ($0.66).
- A family needs 3kg of charcoal to be able to cook 3 meals each day. Therefore, a family needs Ksh.240 ($1.98) each day.
- In a month, a family will spend a monthly cost of Ksh. 7200 ($59).
- This will bring the yearly cost of purchasing charcoal for a family to Ksh. 86,400 ($711) and a 5-year cost of Ksh. 432,000 ($3557).

When you compare the total yearly cost of purchasing charcoal, that is, Ksh. 86,400 ($711) to the total cost of purchasing the EcoMpishi Solar Cooker full kit package, that is, Ksh. 65,000 ($535)... There is a difference of Ksh. 21,400 ($176).

- Based on this data, the EcoMpishi Solar Cooker will enable a family to save a significant amount of money each year.

# CHALLENGES AROUND PROMOTING THE USE OF SOLAR ELECTRIC COOKING APPLIANCES.

Our customers are both low-income and high-income citizens.

Challenges:

- One of the challenges we have faced, is making the EcoMpishi Solar Cooker full kit package even more affordable for our customers.

Mitigation measures:

- Working on raising funds to be able to purchase equipments in bulk to bring down full kit prices.
- We recently partnered with a Sacco in Kwale county which allows different women groups to purchase the EcoMpishi Solar Cookers and pay for them through an installments plan.
- We are also engaging different Saccos and Banks to allow installments plan for our customers.

# OPPORTUNITIES AND FUTURE OUTLOOK

- Apart from the obvious advantage of money saved, solar ecooking solutions do not produce emissions and thus are eco-friendly and sustainable.

- Solar ecooking solutions are the future. More effort should be put in promoting the solar ecooking technologies through both mainstream media and on social media platforms. This will help create more awareness and increase the demand for solar ecooking facilities.

# OUR TEAM

ROBERT NGUMA

EVERN GARI

OMINA WANDERA

GERTSEN KAI

ecoMpishi

THANK YOU!

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# Productive use in Rural African Markets using Solar

Sandra Banda, Strathmore University

# Productive Use in Rural African Markets using Stand Alone Solar

**Sandra Banda**

**Project Manager**

UNESCO Chair on Climate Change Resilience and Sustainability

Strathmore University

*Energy Research Centre*

LEAP-RE

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

# Electricity Outlook

- Approximately 600 million Africans do not have access to electricity.
- Only 40% of the African population have access to reliable electricity.
- Electrification of the continent will not only provide millions with job opportunities but also aid in preserving our environment by decarbonizing our industries.

# Productive Use Outlook

In developing and growing nations, rural electrification is essential for the socioeconomic growth of non-urban areas.

Since there is a strong link between having access to energy and economic growth, energy use should also be coordinated to promote economic growth by boosting local residents' ability to generate money. The social wellbeing would be further enhanced by this economic progress. We need to electrify as a continent

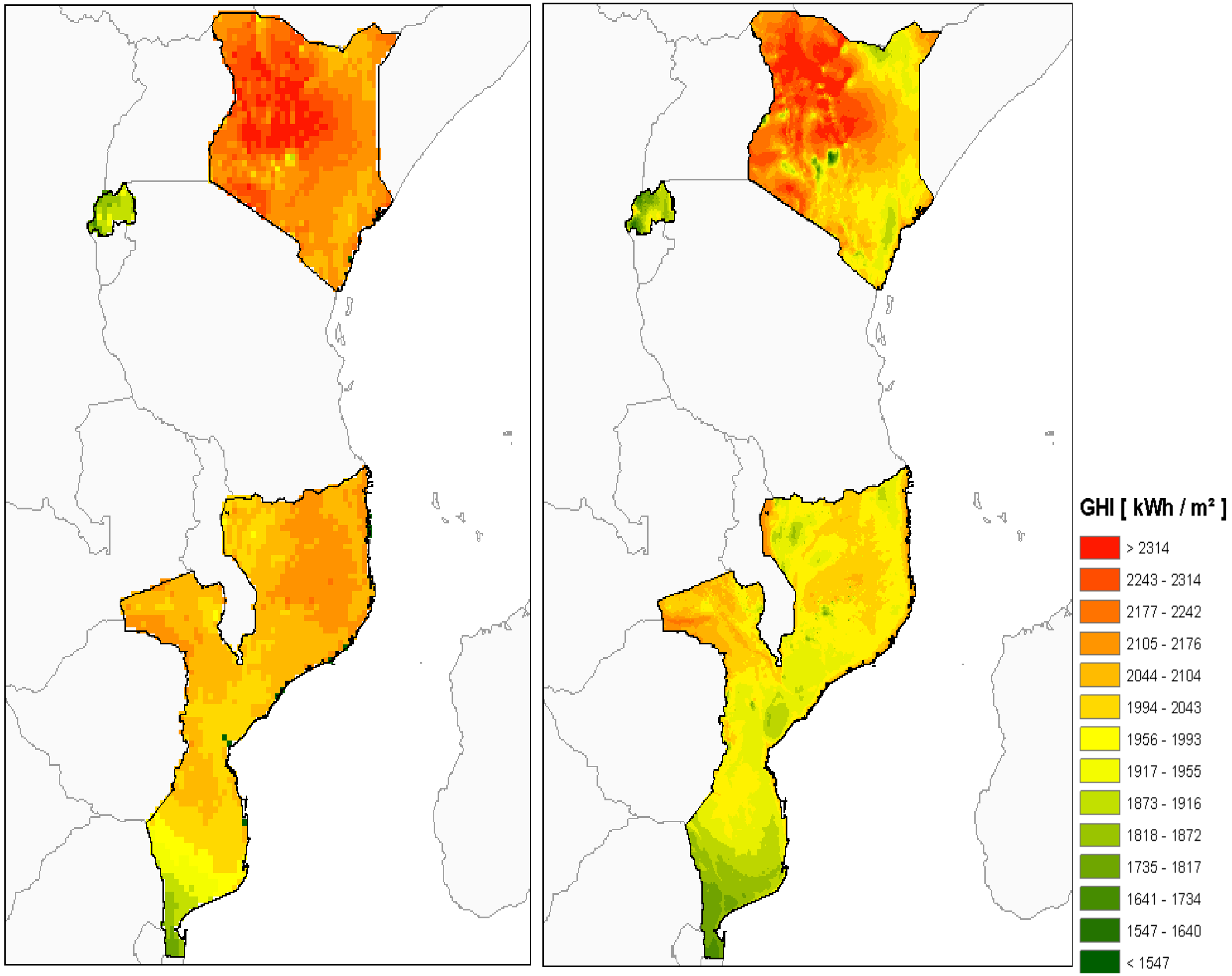
# Clean Cooking at Glance:

- 82% of Africans use solid fuels like wood, charcoal, dung, crop waste and coal for primary cooking. A figure that will keep rising by the of the decade.
- 600 Africans die annually from household air pollutions (HAP) caused by solid fuel cooking emissions.
- 11% of Africans use clean stoves. 6% use electric stoves, 5% use LPG.

*Local foods cooked in an EPC. Source: Strathmore Researchers.*

# Research: PURAMS (WP10)

- PURAMS: Productive Use in Rural Markets using Standalone Solar.
- The project aims to address the challenges caused by traditional cooking methods and face rural African communities.
- Study is being implemented in Kenya, Rwanda and Mozambique to develop a solar power clean cooking solution for these areas.




*Map showing solar resource assessment in the 3 countries. Source: CAMS (left) and SolarGIS (right) databases*

# Data Collection Methodology

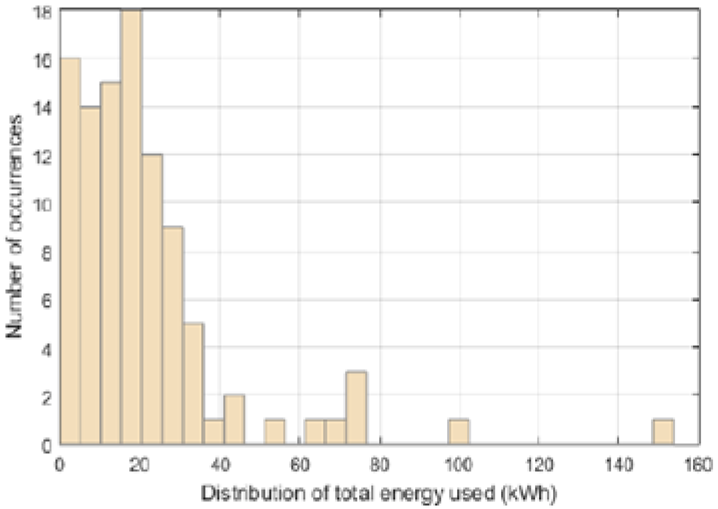
- Methodology approach for the electric cooking study to fix the gaps:
  - Kenya – Study the adoption of electric cooking in a newly electrified households and market.
  - Rwanda – Study the adoption of electric cooking in households powered by mini grids.
  - Mozambique – Study the business aspect of 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

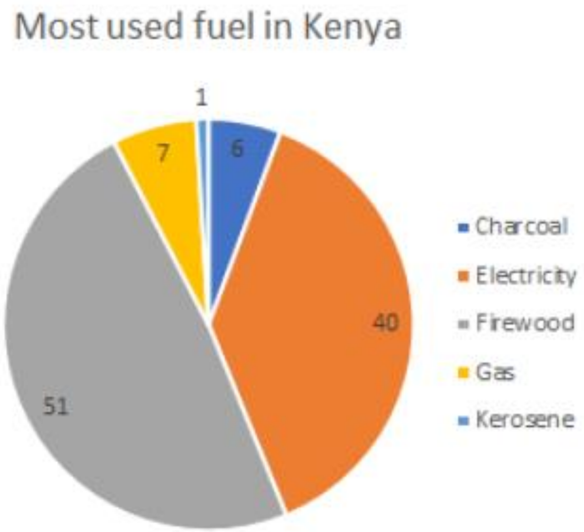
*Data collection in Rwanda. Source: Strathmore Researchers*

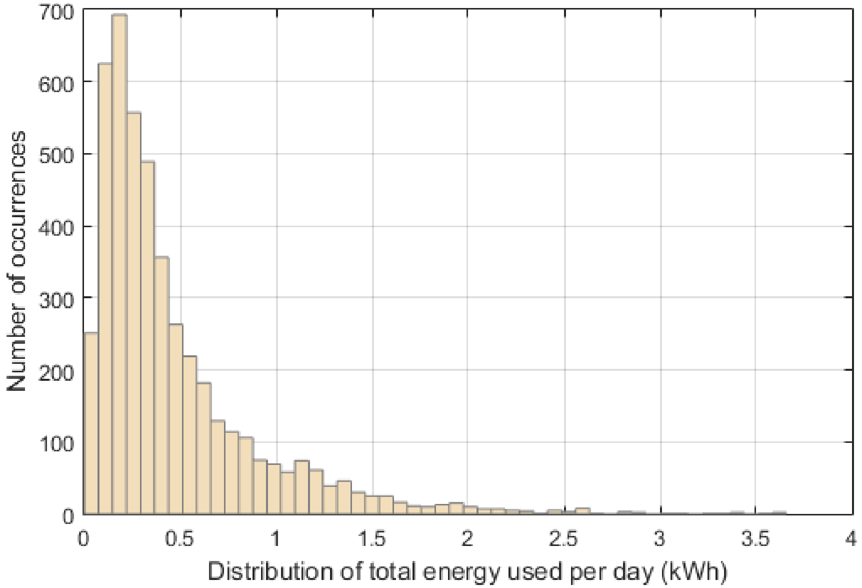
# Most significant project results

## Cooking habits and design metrics:

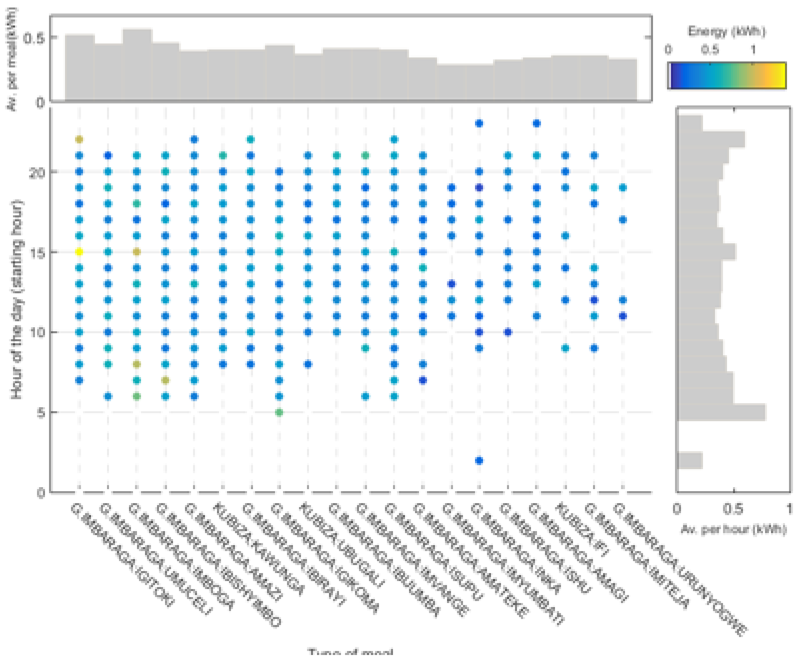
- Analysis of cooking habits: three questionnaires were conducted in the target countries
  - Information on socio-economic aspects that shall contribute for the business models on solar electric cookers
  - Improved knowledge on cooking habits and fuel demand of the users
- Analysis of cooking habits: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



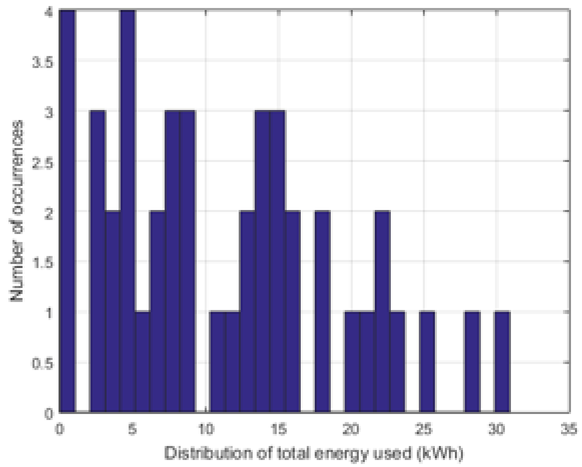



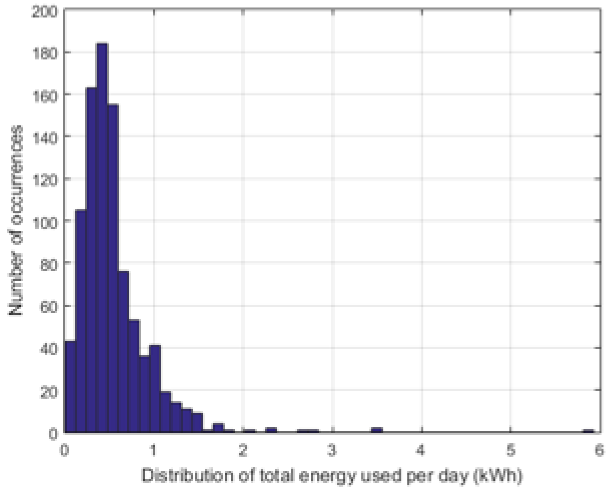
# Most significant project results




Average energy time per meal and hour. Right and top bar plots represent the average values per hour and meal, respectively.




Distribution of the total energy used during the experimental campaign per device.




Distribution of total energy consumed per day.

Quantitative analysis for initial cooker design parameters. The analysis is based on electricity demand and cooking habits as per data collected in the three countries.

# Most significant project results

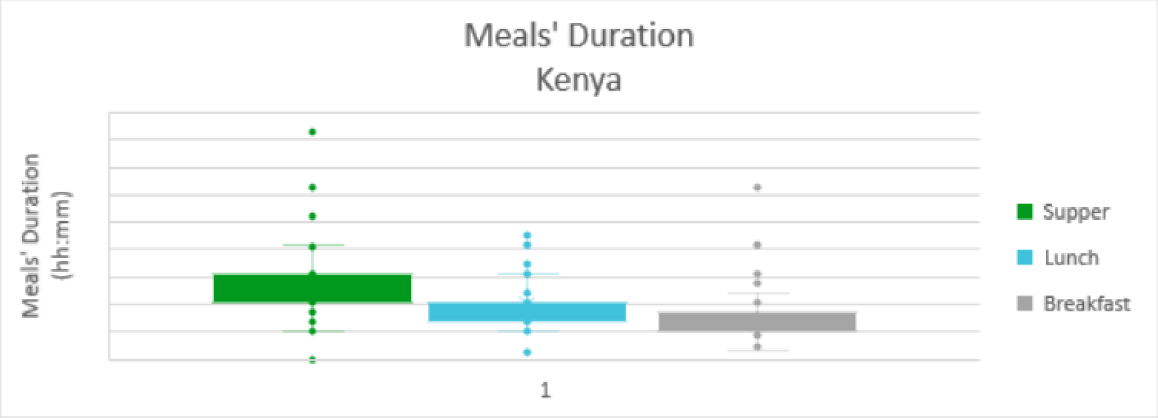
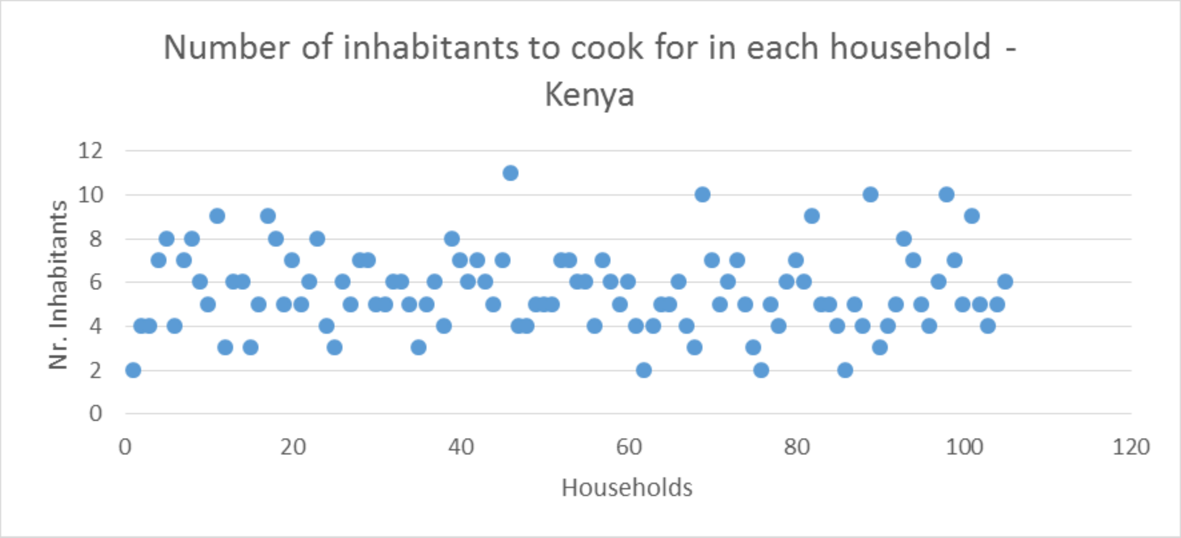
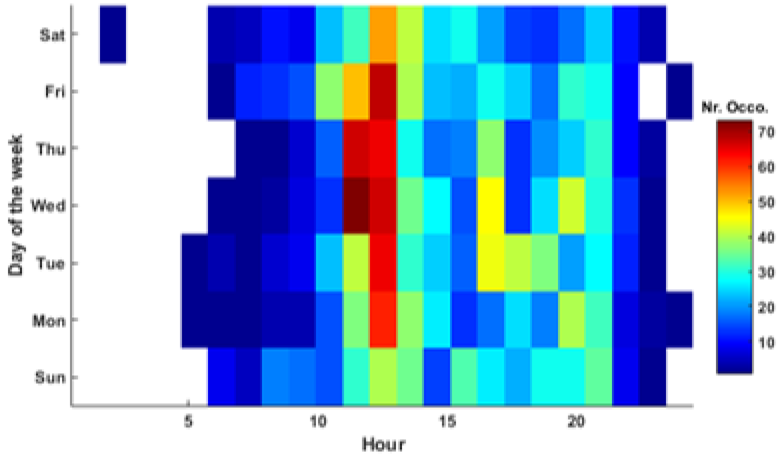



**Figure 37 - Meals' duration according to the responses in the inquired households in Kenya.**




Distribution of the number of cooking uses according to the hour and day of the week.

# Solar Powered Cookers

**Research gap:**

1. An energy efficient DC EPC cooker for rural markets.
2. Off-grid solar powered cooker for commercial use.

## DC Fryer

- 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

# 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.

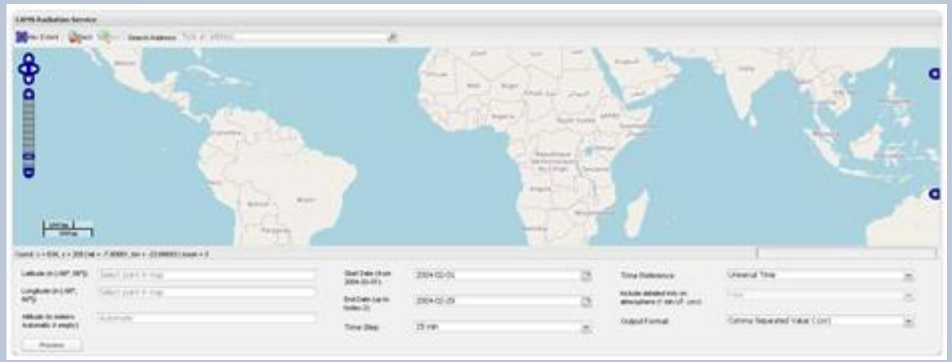
# Testing out DC EPC with MECS

- 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
- The EPC will be subjected to various tests: quality, workmanship, energy performance test.

# 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:

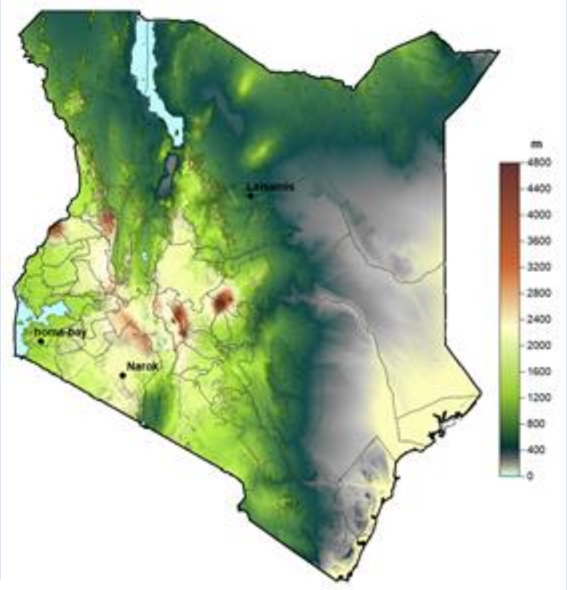
  1. **Mapping GHI** – Global Horizontal Irradiance from the satellite-based databases;
  2. **Validation**/calibration with measuring stations (correlation, BIAS, RMSE, BIAS – Daily profile, BIAS – Monthly profile)



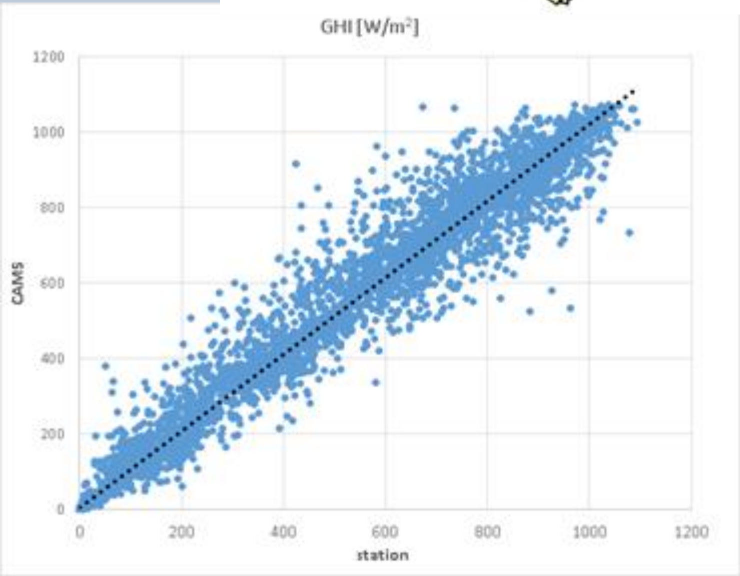
- Enables to understand the accuracy of the data from existing public databases in African countries and can be used in several other countries in the absence of experimental data
- Validation performed for Kenya with 3 locations with measurements, but there is the need to gather more experimental data in other African countries to confirm these outcomes.

# Solar Resource Assessment 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 |



# 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;

# Thank You

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Nairobi

MECS
Modern Energy Cooking Services

# Roundtable discussion

MECS
Modern Energy
Cooking Services

# 1. What is the future outlook for solar ecooking?

CCAK
CLEAN COOKING ASSOCIATION OF KENYA
ACTS
Knowledge for Better Livelihoods
UKaid
from the British people
Kenya Power

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## 2. Comment on the general durability of solar cooking components and what this means for affordability and accessibility at the household level.

CCAK CLEAN COOKING ASSOCIATION OF KENYA
ACTS Knowledge for Better Livelihoods
UKaid from the British people
Kenya Power

MECS
Modern Energy Cooking Services

3. What appliance financing mechanisms hold the most promise for unlocking the potential of solar eCooking?

CCAK CLEAN COOKING ASSOCIATION OF KENYA
ACTS Knowledge for Better Livelihoods
UKaid from the British people
Kenya Power

# Thank you for listening!

Visit www.MECS.org.uk

Sign up for the eCooking Community of Practice:

- Mailing list for future events
- WhatsApp group for ongoing dialogue

Post your email/phone number in the chat
or contact beryl@gamoseastafrica.org

*This material has been funded by UKAid from the UK government; however, the views expressed do not necessarily reflect the UK government's official policies.*