-MOVING IMPACT-

Integrated Means to Power, Agriculture, Clean Cooking & Transportation -Whole systems approach to household energy access

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The project examines how renewable energy can support agriculture, clean cooking, and e-mobility. Within this, our team is dedicated to understanding how solar mini-grids and biogas systems can enable clean, modern cooking solutions for households that currently rely on solid biomass. By reducing dependence on wood and charcoal, these systems have the potential to improve health outcomes, lower environmental pressures, and enhance daily life for millions.

INTRODUCTION

Access to clean, reliable energy is fundamental to improving health, education, and overall quality of life [1]. Yet many communities in Sub Saharan Africa still face significant gaps in access to energy for essential activities such as cooking [2]. Solar power offers a promising pathway to close this divide.

In particular, solar mini grids can deliver the higher power levels needed for productive uses while also integrating with existing distribution networks to create more resilient and flexible energy systems [3]. Other clean cooking options include gas stoves which can use biogas made from agricultural waste which is readily available [4].

Our study focuses on identifying suitable clean cooking energy vectors in case study sites located in Ghana, Rwanda, and Kenya where these opportunities can be explored in depth.

Figure 1: *Countries studied in Moving Impact Project in orange.*

OBJECTIVE

The aim is to provide a framework to enable access to clean cooking for households in rural areas. The proposed technologies are electric cookers powered by solar power and gas stoves that use biogas.

The selection of the best performing technology will be based on technical performance, accessibility, flexibility, climate change impact, indoor air quality effect and land use associated.

Figure 3: *Example of a solar mini-grid in Africa [5].*

Figure 4: *Example of household-evel biogas production in Africa [6].*

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REFERENCES

METHODOLOGY

To incorporate and design a comprehensive methodology, it was important to understand what the necessary concepts are and the resulting outcomes. See Figure 2. The methodology is being developed based on the framework developed with country project partners. At the moment, existing literature is being reviewed to gain insights, understanding of the context and identify suitable sites. This will allow to determine what data is available in the literature and which has to be collected from relevant stakeholders in the study are. The data is on the following topics: demand and usage, solar mini-grids, small-scale biogas production from available feedstocks and associated land use, climate change impact and indoor air quality. Additionally, the literature has determined the energy transition levers and land and resource constraints. All this data will be modelled with the objective of:

I. Cross-vector comparison.
II. Prioritization of technologies and sites.
III. Opportunities for carbon and circularity pathways.
IV. Policy and investment recommendations.

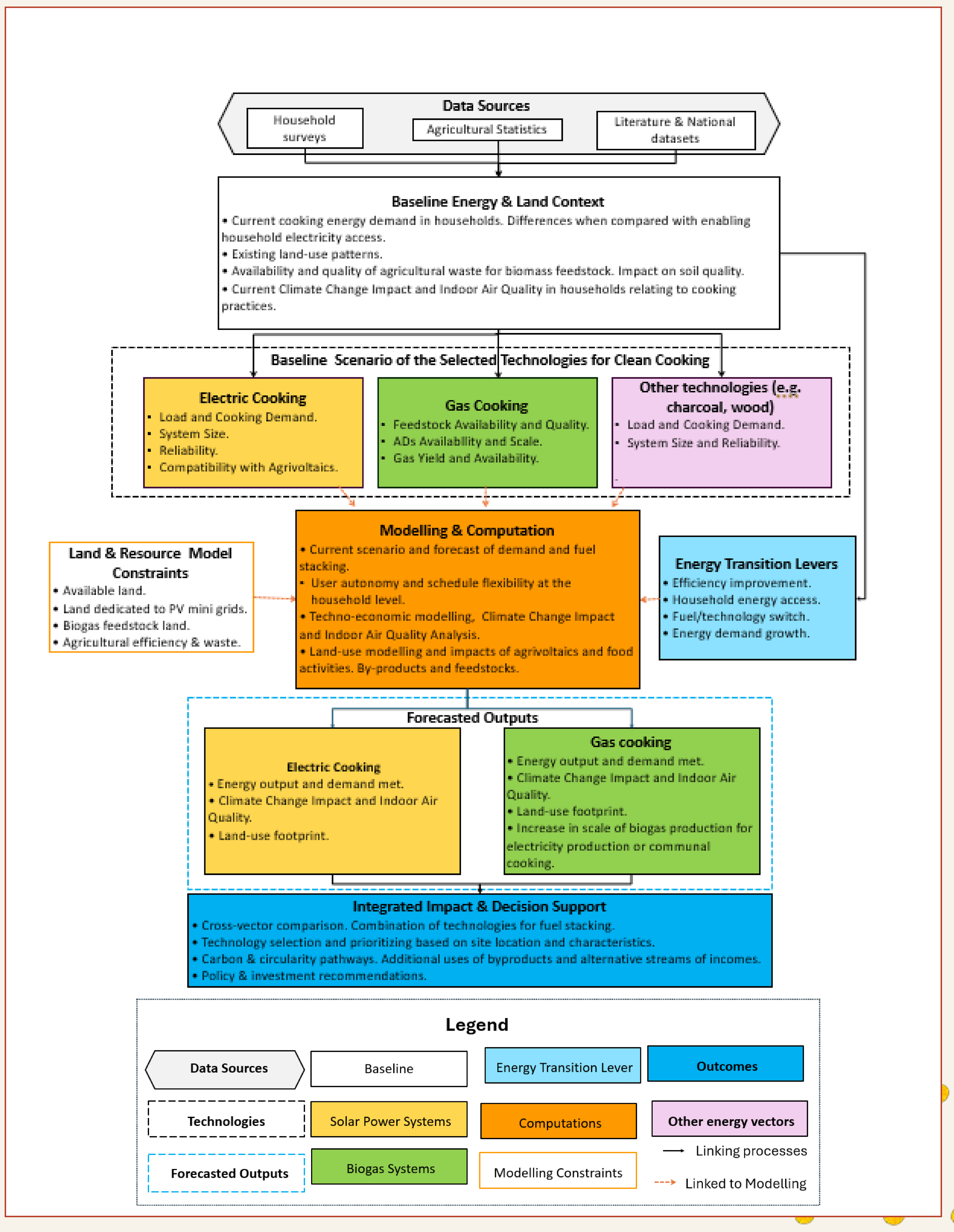

Figure 2: *Framework for the comparison of energy vectors for clean cooking in the study area.*

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Moving Impact: Linking PV generation with agricultural production and socio-economic modelling

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Introduction

Moving Impact is a three-year, UKRI Aytron fund–funded project focusing on rural electrification in sub-Saharan Africa (SSA). The project is divided into six work packages (WPs): 0. Socio-economic development (which underpins all other work packages), 1. Agrivoltaics, 2. Clean cooking, 3. Sensors and networks, 4. Electrification of transport, and 5. Capacity building (which will be an outcome of all work packages).

Over 80% of the world's population who lack access to electricity live in sub-Saharan Africa (SSA), with the majority living in rural areas[1]. Based at research institutions (universities and companies) across the UK and sub-Saharan Africa (SSA), the project focuses on mini-grid systems for sustainable rural electrification and development.

By 2035, populations in SSA are predicted to grow (both in rural and urban environments), increasing the number of people who will need access to electricity. Figure 1 shows, for a set level of access and carbon price, a lowest-cost pathway to rural electrification, featuring **solar PV mini-grid** systems.

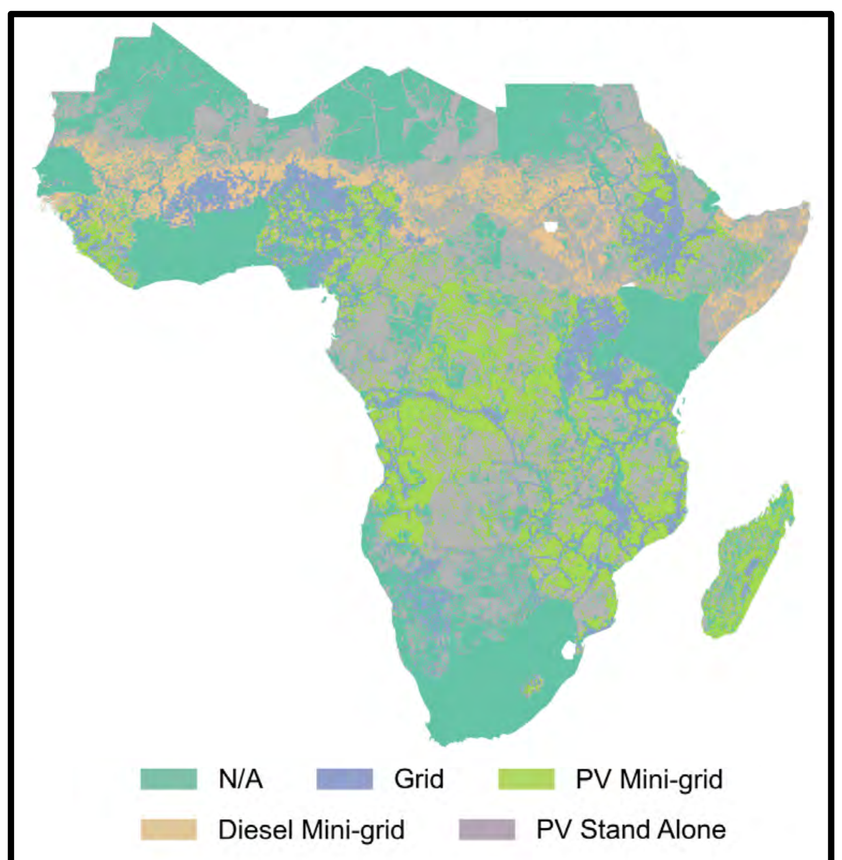

Figure 1. Choropleth map showing the lowest-cost modes of rural electrification. Shown are the modes for rural electrification (solar or otherwise) that we expect to be least cost for universal electrification in sub-Saharan Africa (SSA) by 2035 with a multi-tier framework "Tier 2" level of demand[2].

Novel mini-grids

Mini-grids are decentralised energy systems which generate electricity and distribute this for local consumption[1]. Often independent of national-grid networks, they have the potential to provide electricity to off-grid communities currently either without power or with an unreliable grid connection in line with SDG 7, affordable and clean energy[3].

Moving Impact

Moving Impact considers novel mini-grid systems for rural electrification:

1. Incorporates **techno- and socio-economic assessments** of mini-grids integrated with productive uses of energy (PUEs): ways of utilising electricity to generate income. The goal is to investigate ways to increase mini-grid economic sustainability and community benefits;
2. Focuses on **agrivoltaics**: co-locating solar PV modules with agriculture. This can range from mounting modules atop buildings to semi-transparent or opeque modules above crops or pasture or alongisde as vertical bi-facial modules (Figure 2).

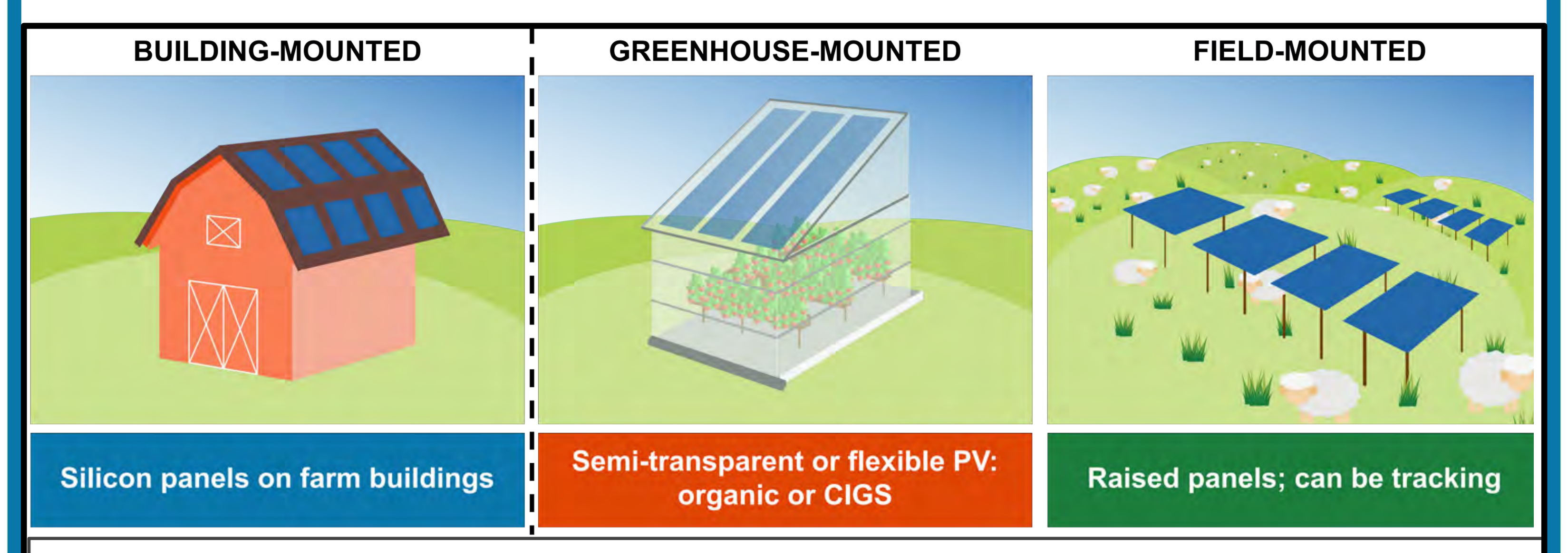

Figure 2. Classification of agrivoltaic systems[4]. Systems co-locating agriculture and electrictity generation with solar PV panels are termed "agrivoltaic": greenhouse-mounted can split intensity and wavelength; field-mounted systems share light via intensity.

0. Socio-economic modelling

Improved **economic viability** of mini-grids, supported by integrated design, increased energy demand and socio-economic development, is critical for addressing energy access needs in across SSA. Within WP0, through a **techno-economic analysis,** we will assess how integration with additional loads from **productive uses of energy (PUE)**, community services and electric cooking can 1. reduce the levelised cost of used electricity (LCUE), 2. stimulate demand and 3. enhance the overall economic well-being of end-users, reducing non-payment risks.

Using **CLOVER**[5], we will optimize mini-grid system design to lower cost (LCOE/LCUE) and reduce emissions. Demand will be modelled stochastically (based on appliance ownership, usage patterns) or monitored hourly load profiles will be used. Our modelling in CLOVER allows for growing demand over time.

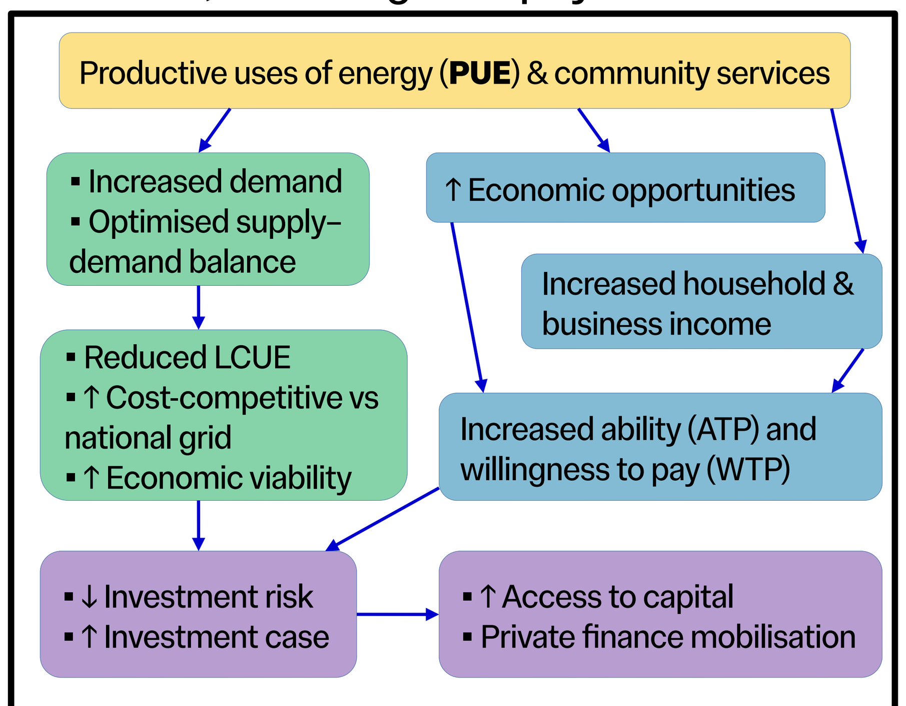

Figure 3. Pathways and linkages between integrating productive uses of energy (PUEs) and serving community loads. These include increased demand, economic opportunities and improved access to capital.

We also assess the **socio-economic impact** of mini-grids to support community development; *e.g.,* through jobs, income, local business revenues, improved gender issues, education, health.

1. Agrivoltaic potential

Not all sunlight incident on leaves is used for photosynthesis. Light with the right wavelength is called **photosynthetically active radiation (PAR).** The point at which no more light increases photosynthesis is called the **light saturation point (LSP).** (Figure 4.)

Within WP1, we are working to identify regions across SSA where agrivoltaic-integrated mini-grid systems would be a suitable choice for achieving rural electrification alongside other SDGs (clean water, food security, *etc.*). Regions preliminarily identified as suitable based on the crops grown are shown in Figure 5.

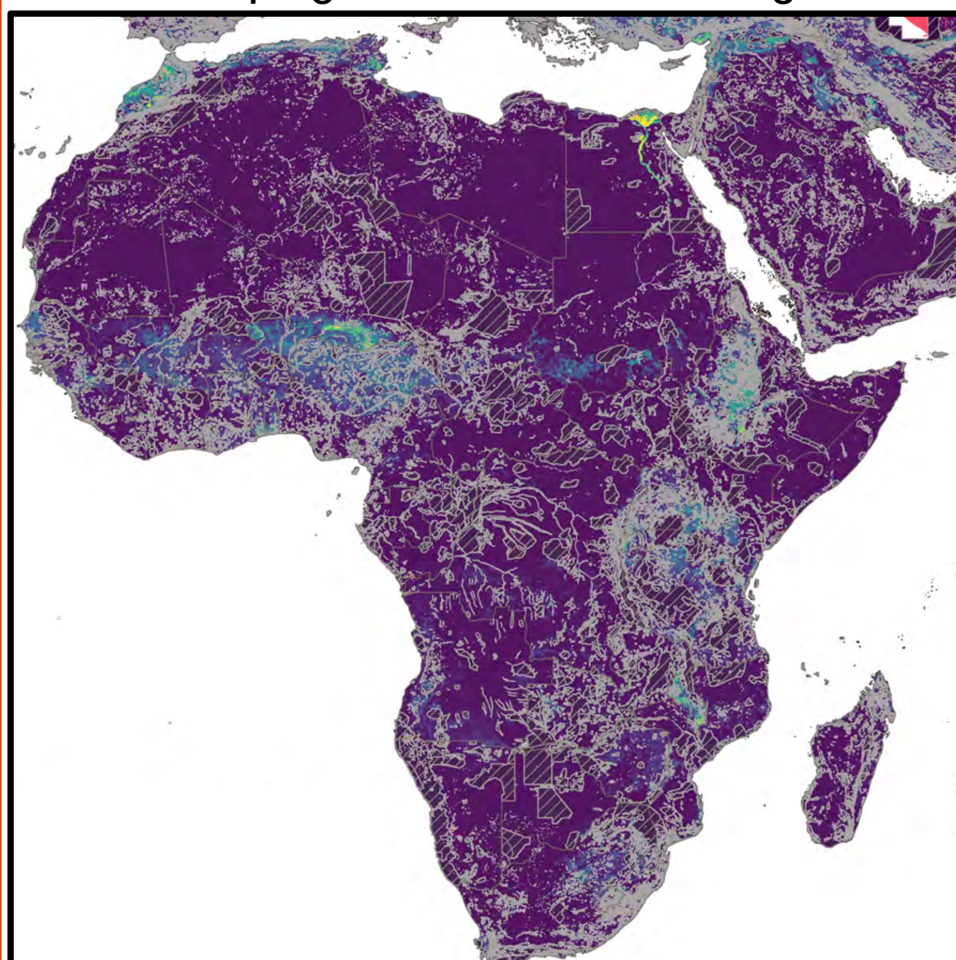

Figure 5. Baseline agrivoltaic potential. Shown are regions across SSA where crops with low enough PARs to be suitable for agrivoltaics are grown.

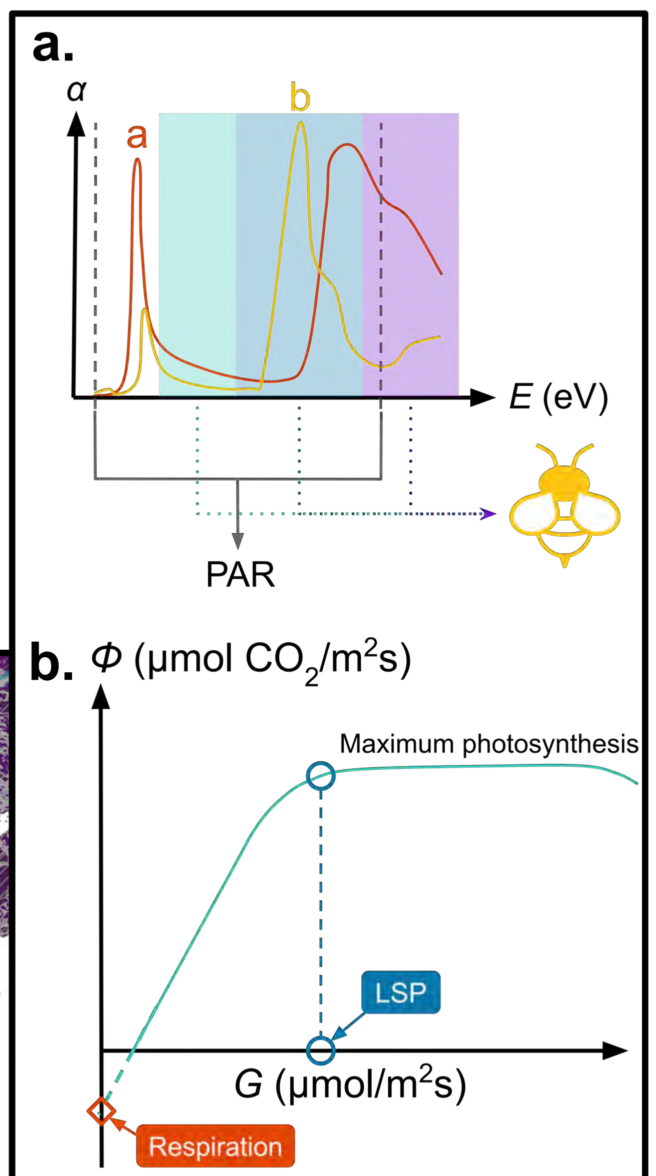

Figure 4. PAR bands[6] and LSP. a. Wavelengths 400–700 nm are used in photosynthesis in chlorophyl and are called photosynthetically-active radiation (PAR) whilst other wavelengths are used by bees for polination; **b.** The point at which no additional light increases photosynthesis is called the light saturation point (LSP) and is indicated in blue.

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