SESA
Smart Energy Solutions for Africa

PRACTICAL OPERATION AND MAINTENANCE MANUAL FOR CLEAN COOKING STOVES

A Comprehensive Guide to Efficient Management and Maintenance

Cover Image: SESA project, clean cooking in Malawi

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Contents

List of Figures

List of Tables

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Disclaimer

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The information provided in this guide is for general informational purposes only and should not replace professional advice. Always consult and hire qualified professionals to ensure your solar cooking set up is installed and maintained safely and in compliance with local regulations.

All images included in this document are created by Make it Green Solutions AB and Econexus Ventures Limited (except figure 6f) to be either as original drawings, in-house designs, or photographs taken by the team.

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Introduction

The SESA project Smart Energy Solutions for Africa (SESA) project, funded by the Research & Innovation programme of the European Union is working to accelerate the uptake of clean cooking solutions by testing and scaling innovations in Africa. As part of this effort, this capacity-building manual has been developed to equip technicians, small and medium-sized enterprise (SME) owners, and everyday users with practical knowledge and skills that go beyond "how-to" instructions - helping communities unlock the full potential of clean cooking technologies.

The following are the core objectives of the manual:

- **To provide comprehensive user guidance** on the two cookstove models featured in the manual. This includes detailed information on stove components, step-by-step assembly instructions, and safety precautions for proper use.
- **To equip owners and users**, including households and small business proprietors, with a deeper understanding of clean cooking technologies and practical insights into the operational efficiency of clean cooking stoves. This involves learning how the stoves function, how to monitor their performance, optimize fuel consumption, manage costs, and ensure long-term durability.
- **To emphasize safety protocols** that safeguard users and help prevent accidents during stove use, installation, and maintenance.
- **To offer practical guidance** on routine maintenance and recognizing when professional assistance is needed to maintain safe and efficient stove operation.

This manual also supports users in reducing costs and avoiding unnecessary expenses (such as repairs or fuel waste) by promoting best practices for independent operation and maintenance of clean cooking stoves. In doing so, it contributes to broader goals of sustainable energy use, helps reduce indoor air pollution, and supports climate resilience.

1. Overview of clean cooking

Clean cooking refers to the practice of using cooking technologies and fuels that reduce pollution and harmful emissions of greenhouse gases and improve efficiency. It is about shifting away from traditional methods like open fires and inefficient stoves that burn wood, cow dung, or other solid polluting fuels towards modern and cleaner alternatives.

In fact, more 950 million people in Sub-Saharan Africa are still dependent on wood or charcoal (United Nations Climate Change, 2021) with severe consequences especially for women, children, and other vulnerable groups who spend hours collecting firewood and facing significant health risks from indoor air pollution (Health Effects Institute, 2024).

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In this context, testing and rolling out clean cooking alternatives is critical. Not only for achieving the Sustainable Development Goals, but also for improving health by reducing premature deaths linked to smoke exposure. By minimizing harmful smoke, modern and clean cooking technologies help prevent respiratory diseases and enhance the quality of life within households. Importantly. Women and children can reclaim several hours each day that would otherwise be spent gathering fuel and starting fires, opening up greater opportunities for education, personal development and economic participation.

The benefits extend beyond health. Shifting to modern cooking solutions reduces reliance on inefficient use of traditional biomass and contributes to protecting forests and curbs greenhouse gas emissions, reinforcing climate action efforts and preserving local ecosystems. At the same time, clean cooking initiatives open new economic opportunities, from the production and distribution of stoves to the creation of supportive services, stimulating local employment and strengthening livelihoods (IEA, 2023a; IEA, 2023b).

Cooking requires heat, commonly produced by combustion. New technologies are now exploring alternative ways to generate the increase in temperature needed for food to be cooked, thanks to electricity and solar irradiation. At the same time, different fuels and cookstoves are tested to minimise the environmental and health risks, in fact, not all combustion generates the same amount of carbon dioxide (CO2), particulate matter (PM) and other types of pollutants, and a great number of harmful emissions can be avoided by using more efficient equipment and fuels.

Examples of clean cooking solutions include:

- Modern stoves designed to burn traditional fuels such as charcoal, wood and dung, more efficiently and less smoke and pollutants.
- Modern fuels like liquid petroleum gas (LPG), natural gas, biogas, and electricity.
- Solar cookers that use solar energy to heat food, reducing the need for traditional and modern fuels.

To compare the many stoves that are on the market, the **International Organization for Standardisation (ISO)** published in 2018 the first international standard for laboratory testing of cookstoves. Stoves can be categorised in "tiers" on a scale that goes from 0 (baseline) to 5 (high level of performance across all indicators). Indicators are rated individually, and it is possible the same cookstove has different tiers depending on the category. A tier is essentially a performance level:

- **Tier 0–2:** Traditional open fires or basic biomass stoves that are highly polluting, inefficient and expose users to harmful pollutants.
- **Tier 3:** Transitional options such as improved biomass cookstoves (ICS), which burn solid fuels more efficiently and produce less smoke but still rely on biomass.
- **Tier 4–5:** Clean cooking solutions such as LPG, biogas, ethanol, electricity, and advanced stoves that meet international standards for efficiency, safety, and very low emissions.

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The World Bank looked at these technologies from a more comprehensive perspective and developed a **Multi-Tier Framework (MTF)** that includes in the assessment factors such as fuel availability and affordability.

According to the International Energy Agency (IEA), while technologies under Tier 4 and above are classified as clean cooking solutions, Tier 3 ICS remain an important transitional technology. They can deliver significant health benefits, decrease household fuel use, and reduce reliance on traditional biomass, being particularly important in rural contexts where clean fuels and infrastructure remain limited or financially inaccessible in the near future (IEA, 2023a).

The two innovations that were initiated, demonstrated, and replicated through the SESA project in Ghana and Malawi Living Labs are:

1. The Econexus Ventures Limited (Econexus) Bio-Ethanol Cooker (Ghana)
2. The Make it Green (MiG) BioCooker (Malawi)

Both incorporate elements from the first and the second type of clean cooking solutions listed above, seeking to improve efficiency with new types of fuels such as gel and briquettes, both using byproducts as a source.

2. Overview of the Econexus Bio-Ethanol Cooker

Figure 1: Bio-Ethanol Cooker, Econexus Ventures Limited

The Econexus Bio-Ethanol Cooker uses clean burning fuels, such as the EcoGel (a bio-ethanol gel fuel). Produced from organic waste, this fuel is safer for the environment, has no threat to food security, and unlike other type of fuels is smokeless, burns cleaner, and offers a more efficient and sustainable alternative to charcoal, kerosene and other biomass fuels. The Econexus Bio-Ethanol Cookstove is specifically designed and fabricated for commercial and institutional use. Through its stove regulators, the cookstove heat control is improved, increasing its efficiency when cooking. Its stability and durability are enhanced to be suitable for heavy pots, ensuring the overall safety in the school kitchen environment.

Within SESA, the demonstration actions comprised waste-to-energy bioethanol and stoves for cooking in three boarding secondary schools in Ghana.

While the ethanol cookstove offers significant health and environmental benefits, the experience within the SESA project highlighted areas for improvements, particularly with regards to the EcoGel. These include the need to stabilise the supply chain and increasing the efficiency of the final products. Tackling these two aspects will allow the availability of this type

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of fuel at a more affordable price, overcoming concrete pitfalls that slow down the technology uptake.

2.1. Components of Econexus Bio-Ethanol Cooker

Stove components and functions:

1. **Stove opening**: it allows for flames of fire to reach the surface
2. **Pan support:** it holds the utensil in place on the stove
3. **Canister:** it keeps the fuel used in the cooking process
4. **Stove regulator**: it is used to either increase or decrease the fire intensity

Figure 2: Components of Bio-Ethanol Cooker, Econexus Ventures Limited

As mentioned, a key component of the cookstove is Econexus's bioethanol-gel fuel, marketed under the trademark "EcoGel". The fuel is locally produced from fruit waste, including pineapple peels, cashew apples, mango puree, and expired fruit juice. It contains citronella, a natural mosquito repellent, which helps keep mosquitoes away while cooking. EcoGel provides a sustainable way to convert food waste into a climate-smart cooking fuel. It is safe for the environment and does not pose any risk to food security.

Figure 3a, 3b: EcoGel, Econexus Ventures Limited

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2.2. Operation

Operation of the stove:

1. Start the fire:
    - Put the required amount of EcoGel into the canister
    - Insert the canister into the cookstove
    - Ignite the fire
2. Regulating the fire:
    - The intensity of the fire is regulated by moving both regulator switches
    - Move the stove regulator switch up to reduce or stop the fire

Figure 4: Bio-Ethanol Cooker in use, Econexus Ventures Limited

2.3. Safety Precautions

- Placement: make sure it is on safe ground and installed correctly.
- Fuel handling: use only "EcoGel" as fuel and store it safely far from any heat sources.
- Operation and fire safety:
    - Surfaces of the stove, especially the metal body, become extremely hot. Use the appropriate protective equipment such as gloves, when handling the stove
    - Keep children far from the stove to prevent accidents
    - Never overload or leave it running unattended
- Keep a first-aid kit nearby
- In case of fire outbreak, consider the following tips:
    - Close the stove with the lid or regulator
    - Do not pour water into it to stop the fire
    - Use Fire Extinguishers if available or use sand or a wet blanket/fire blanket as certified fire management personnel directed.

3. Overview of MiG BioCooker (Malawi)

The MiG BioCooker is a clean and efficient cookstove designed to use biomass briquettes instead of wood, thereby promoting healthier cooking practices and reducing deforestation. It was developed through a collaboration between Going Green, a Malawian female-led social impact company, and the Swedish company Make it Green. The stove primarily targets contracted farmers in Malawi who supply sunflower seeds to Going Green for cooking oil production. From the sunflower, biomass residues such as stalks can be transformed into fuel briquettes, creating a new value chain and business model for local entrepreneurs.

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The MiG BioCooker is a highly efficient Tier 4 stove designed to use a variety of dry solid biomass fuels. Its controlled combustion provides a cleaner and more environmentally friendly alternative to open burning. Moreover, the ash produced can be returned to the fields as a valuable plant nutrient, supporting circular practices. The stove integrates advanced features such as a built-in power bank, solar PV support, improved combustion chamber materials, and compatibility with clean fuels like briquettes. These innovations allow the Mig BioCooker to achieve higher efficiency and reduce emissions by 80–90%. However, in order to meet the high-performance requirements of ISO standards, the stove is priced higher compared to simple stoves, thus limiting its affordability for rural households in Malawi.

Figure 5: MiG BioCooker, Make it Green Solutions AB

3.1. Components of MiG BioCooker

a. Stove body: it is supported by 4 legs, and it can be moved by 2 handles
b. Built-in fan on the bottom of the stove: it improves the combustion as it allows the pellets to ignite more easily and quickly.
c. Inner burner chamber unit: core compartment where fuel combusts, generating heat within the stove structure
d. Power bank: charged by the solar panel, it is responsible for powering the fan. It can also be used to recharge a mobile phone or for lighting
e. USB cable: it connects the power bank with the stove body
f. Portable solar panel: generate electricity to charge the power bank.

a 

b 

c 

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Figure 6: Components of MiG BioCooker. Images a–e from Make it Green Solutions AB; image f from ©Albert Lozano | Dreamstime

The stove utilizes locally sourced dry biomass from wood residues and agro waste, such as sunflower briquettes and bagasse pellets, for their high efficiency and low emissions, providing a sustainable cooking solution. The living lab also developed a local fuel supply chain based on manufacturing of briquettes from locally available biomass residues as sunflower stalks and saw dust to reduce deforestation. Briquetting technology was chosen because it focuses on a wider range of biomass material and is less expensive to operate and maintain and usually demand less power than pellets technology (SESA Project, 2025).

Figure 7a, 7b: Types of fuel, Make it Green Solutions AB

3.2. Configuration and operation

1. **Assemble the BioCooker**: connect the charged power bank to the fan. Put the power bank into the power bank holder

Figure 8: MiG BioCooker assembled, Make it Green Solutions AB

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2. **Fill the BioCooker with fuel**. Do not overload. 2-3 cm below the secondary airflow holes is the limit.

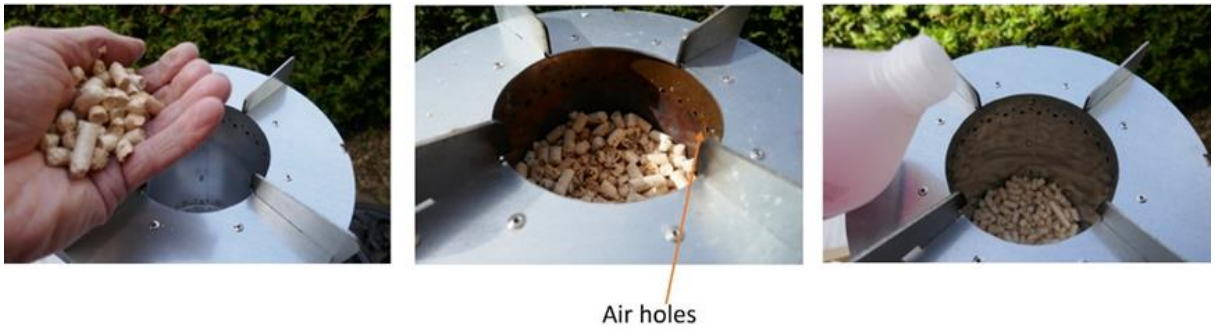

Figure 9: How to fill the fuel, Make it Green Solutions AB

3. **Ignite the fire**. Use a lighter, a fire starter or similar to ignite
   - After ignition, wait a minute before set the fan on L=Low
   - When the fire is stable set fan to M=Medium
   - Depending on the feedstock and what is cooking sometimes you must set the fan H=High or switch between them

Figure 10: How to ignite MiG BioCooker, Make it Green Solutions AB

4. **Cook**. When the fire is stable start the cooking

5. **Stop the fire**.
   - To stop the fire, just let it burn until you cannot see any fire, only the glow
   - Leave the fan on and grasp the handles and turn the stove upside down. Place the ash in a tin bucket or similar
   - Leave the fan on for another 5-10 min to cool down the stove

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Figure 11: How to stop fire on MiG BioCooker, Make it Green Solutions AB

3.3. Safety Precautions

- **Placement:**
  - Always use the stove outdoors or in a well-ventilated area to prevent indoor air pollution and carbon monoxide poisoning.
  - Make sure it is on safe ground and installed correctly.

- **Fuel handling:**
  - Use only dry, approved pellets and briquettes.
  - Do not overfill the fuel chamber, as it can warp components, shorten lifespan, and cause failures.
  - Store any fuel used in the stove or flammable materials safely far from any heat sources and in a dry place to avoid moisture, which can cause incomplete combustion and smoke.

- **Operation and fire safety:**
  - Surfaces of the stove, especially metal body, become extremely hot. Use the appropriate protective equipment such as gloves, when handling the stove.
  - Keep children far from the stove to prevent accidents.
  - Never overload or leave it running unattended.
  - Keep an ABC extinguisher, a smoke detector, and a first-aid kit nearby.
  - Only trained personnel may handle the stove.

3.4. Maintenance and troubleshooting

- **After each use**
  - Empty ash and residue from the combustion chamber once the stove is completely cool.
  - Wipe down surfaces to remove dirt, grease and build-up of ash. Ash buildup and neglected servicing reduce efficiency and reliability.

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- **Storage:**
  - Store the stove indoors when not in use and out of reach of unauthorized people
  - Do not expose the stove to moisture. Moisture intrusion can damage sensitive electronics and solar hardware, while corrosion or worn parts increase the chance of leakage, malfunctions, or fire.
  - Keep all electronics (including the solar components) dry. Pay extra attention to the solar panel and wiring.

- **Regular checks:**
  - Inspect he stove routinely for signs of damage, wear, or rust, and replace faulty parts promptly (the power bank, the inner burner chamber is user-replaceable via your dealer).
  - Under the BioCooker leasing plan, users are provided with a stove, fuel and a yearly inspection from a technician, who can assess and replace components if needed.

- **When to contact the distributor or manufacturer**:
  - If stove performance drops.
  - Whenever the cookstove breaks down or poses health and safety risks
  - For repair or replacements of damaged or worn-out parts.

- **Components care:**
  - Repair and replace any damaged or worn-out parts immediately to prevent accidents.
  - Handles:
    - Maintenance: Keep clean and dry. Periodically check that screws/nuts are tight.
    - Replacement: A handy user can replace them.
  - Fan:
    - Replacement should be done by a technician, though skilled. Users may replace it at their own responsibility.
    - Expected lifespan**:** About 8-10 years (under the normal usage assumption below.)
  - Power bank:
    - Replacement: Users can normally replace the power bank themselves (disconnect old/plug in new).
    - Lifespan: About 8–10 years under proper usage assumptions
    - Compatibility: Most standard power banks work with the stove. Use a power bank with the same voltage/connector as the fan (typically USB 5

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V) and sufficient current output. Check the fan/stove label or manual if unsure.
        - Solar fallback: If the power bank fails, the fan can run directly from the solar panel in sunlight. Fan speed may drop when cloudy.
    - Solar panel
        - Lifespan: Over 10 years with typical use and care.
        - Maintenance: Keep the panel clean and unshaded for best performance.
    - Inner burner:
        - Replacement: user-replaceable via dealer
        - Lifespan: about 6–7 years under the normal usage assumption below; shorter with more aggressive fuels such as sunflower briquettes compared to regular wood fuels.

- **End of life**: When the stove has reached the end of the life cycle, dispose of it through a local metal recycling company

Note: the lifespans assumption above are based on typical family use: three cooking sessions per day (morning, midday, and evening). Actual life may vary with fuel type, environment, and maintenance.

Table 1: Common issues and suggested actions

Issue category	Symptoms	Suggested Actions
Fan	Fan does not start	• Check the power bank is charged and the cable is firmly connected. • Try another USB port/power bank if available. • Try running from the solar panel (if available). • If none of this helps stop using and book service/fan replacement.
	Fan is blocked (a small object passes through the protective guard)	• Switch off the fan/power bank. • Remove the object without bending the guard. Don't insert fingers or tools into spinning blades. • Check the blades spin freely. Restart.
	Fan stops from age/fault	Combustion quality drops. The flame continues, but emissions increase. We do not recommend cooking until the fan works again.
	Unusual fan noise or vibration	• Power off, check that nothing is rubbing. Restart. • If the noise continues, schedule service.

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Stove body	Significant amount of smoke	• Check air paths are clear and that the fan spins normally. • Do not use the stove in a poorly ventilated space if the fan isn't working
	Handled shows cracks, heat damage or loose mounts	• Stop using the stove and replace the part or contact a technician.

Conclusion

This manual has outlined the core objectives, functions, and safe use of two innovative clean cooking technologies: the Econexus Bio-Ethanol Cooker in Ghana and the MiG BioCooker in Malawi. By providing step-by-step assembly instructions, safety protocols, operational guidance, and maintenance practices, it equips households, schools, and small businesses with the knowledge needed to use these stoves effectively and sustainably.
The clean cooking transition is more than just adopting new stoves and fuels; it is about improving health outcomes, reducing time spent on fuel collection, protecting forests, and lowering harmful emissions that drive climate change. Both technologies demonstrated through the SESA project highlight how waste-to-energy solutions and biomass innovations can create new value chains, reduce reliance on polluting fuels, and stimulate local entrepreneurship.

With proper use and regular maintenance, these cookstoves can provide long-term benefits - ensuring efficiency, durability, and safety while reducing costs and improving household well-being. By adopting clean cooking practices, communities can advance sustainable development goals, safeguard the environment, and unlock new opportunities for health, education, and economic growth.

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About SESA

SESA is a collaborative project between the European Union and nine African countries (Kenya, Ghana, South Africa, Malawi, Morocco, Namibia, Tanzania, Rwanda, and Nigeria) that aims at providing energy access technologies and business models that are easily replicable and generate local opportunities for economic development and social cohesion in Africa.

Through a series of local living labs, the project facilitates the co-development of scalable and replicable energy access innovations tested, validated, and later replicated throughout the African continent. These solutions included decentralised renewables (solar photovoltaics), innovative energy storage systems including the use of second-life electric vehicle batteries, smart microgrids, waste-to-energy systems (biomass to biogas), climate-proofing, resilience and adaptation, and rural internet access.

SESA Partners