FACTSHEET 8

Clean Cooking Solutions

SESA
Smart Energy Solutions for Africa

Figure 1: **Cooking with an improved biomass cookstove** (Emerging Cooking Solutions/SupaMoto, 2022)

About the Sustainable Energy Solutions Catalogue

The Sustainable Energy Solutions Catalogue provides an introduction to the solutions deployed during the SESA project. The catalogue targets energy practitioners, policy makers and civil society, especially at local level. In the catalogue, readers can find key facts about specific sustainable energy solutions (technologies, business models, impact areas), and learn about approaches and concepts that help ensure the viability and long-term success of sustainable energy in the African context.

AUTHORS:

Sophia Schneider, Madeleine Raabe, María Yetano Roche (WI)

Contributors: Kent Davidsson (RISE), Elisabeth Biber (Siemens Foundation), Elena Turienzo López (TEC)

1 Introduction

Around 970 million Africans – almost three quarters of Africa's population – lacked access to clean cooking fuels and technologies in 2021, relying instead on solid biomass, kerosene or charcoal as their primary cooking fuel (IEA, 2022). The lack of access is particularly pronounced in rural regions (Figure 2). The collection and use of biomass for cooking dramatically damages health and impairs productivity. In Africa, around 500,000 premature deaths per year are linked to indoor household air pollution and the lack of access to clean cooking solutions. The cost of premature mortality from air pollution, measured by loss of productivity, is estimated at almost 9% of Africa's GDP (IEA, 2022). Depending on how solid biomass fuels are collected, the lack of access to clean cooking also contributes to deforestation. Therefore, clean cooking fuels and technologies are critical to Africa's energy transition. This factsheet reviews the potential of clean cooking solutions, including key technological aspects, business models and impacts, as well as examples of the use of the solutions across the continent and within the SESA project.

2 The technology

Clean cooking technologies come in various shapes and sizes and may use different fuels and different approaches to reducing polluting emissions. The World Health Organization (WHO) defines clean cooking technologies as those that are safe for the health of users at the point of use. In other words, cooking fuels and cooking devices that attain the fine particulate matter (PM2.5) and carbon monoxide (CO) levels recommended in the WHO global air quality guidelines (WHO, 2022). Only a few technologies meet the cleanest standards, such as electricity, biogas, liquefied petroleum gas (LPG), and alcohol fuels including ethanol. However, there also are different transitional technologies that oftentimes are easier to access and afford compared to the cleanest ones. These include improved cookstoves which burn biomass more efficiently and provide some health benefits over open "3-stone" fires or inefficient stoves. Figure 3 shows the variety of cooking fuels, classified in polluting and clean fuels, whereas Figure 4 delves into how different technologies are classified under the Multi-Tier Framework for energy access.

It is important to note that ICT and IoT technologies play an important role in clean cooking solutions. They enable businesses to track real-time usage data on fuel consumption and to offer consumers Pay-as-you-Go (PAYGO) solutions. This can help to overcome customer affordability barriers (CCA, 2022a).

Figure 2: **Main fuels used by households for cooking in selected African countries, 2018** (IEA, 2019)

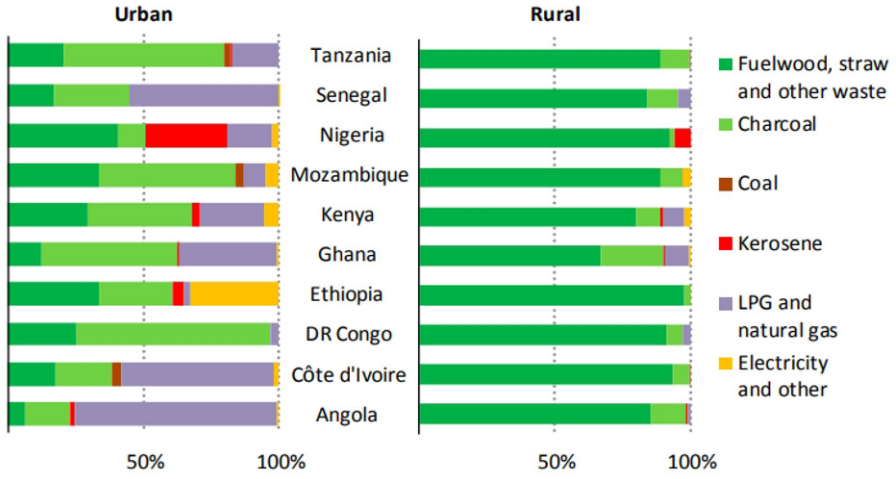
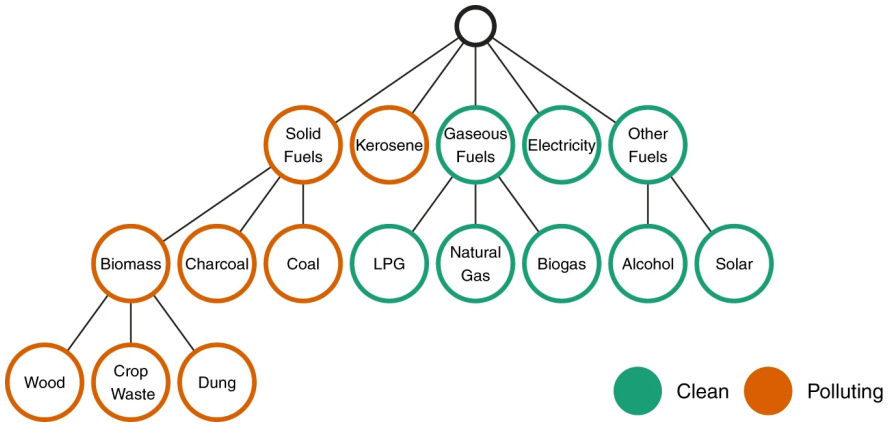


Figure 3: **Cooking fuel categorization** (Stoner et al., 2021)



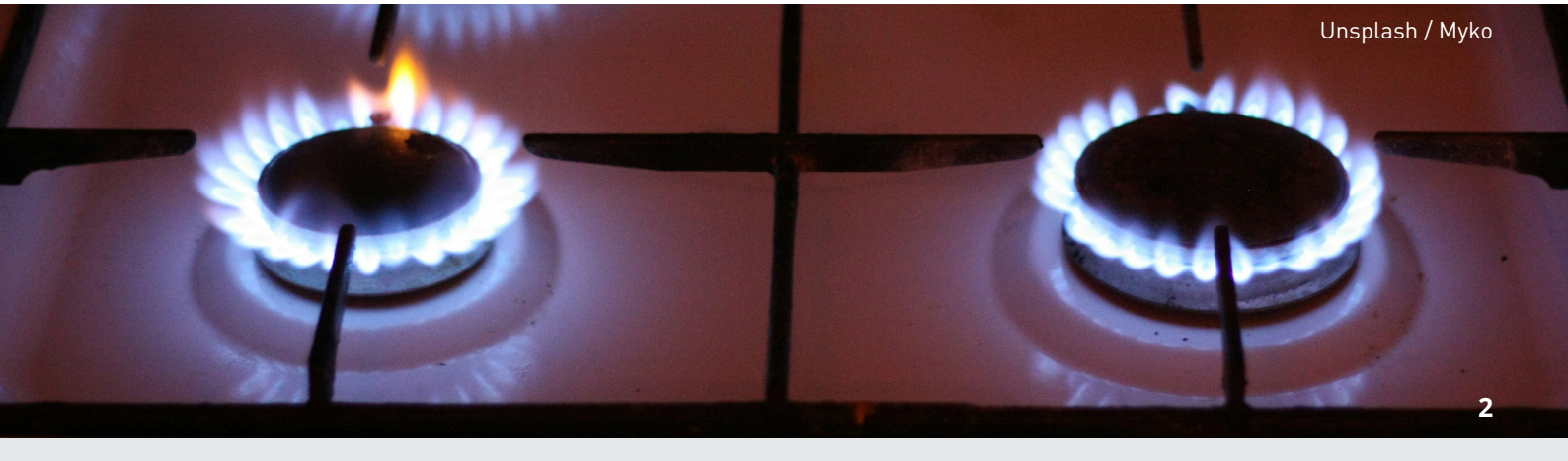
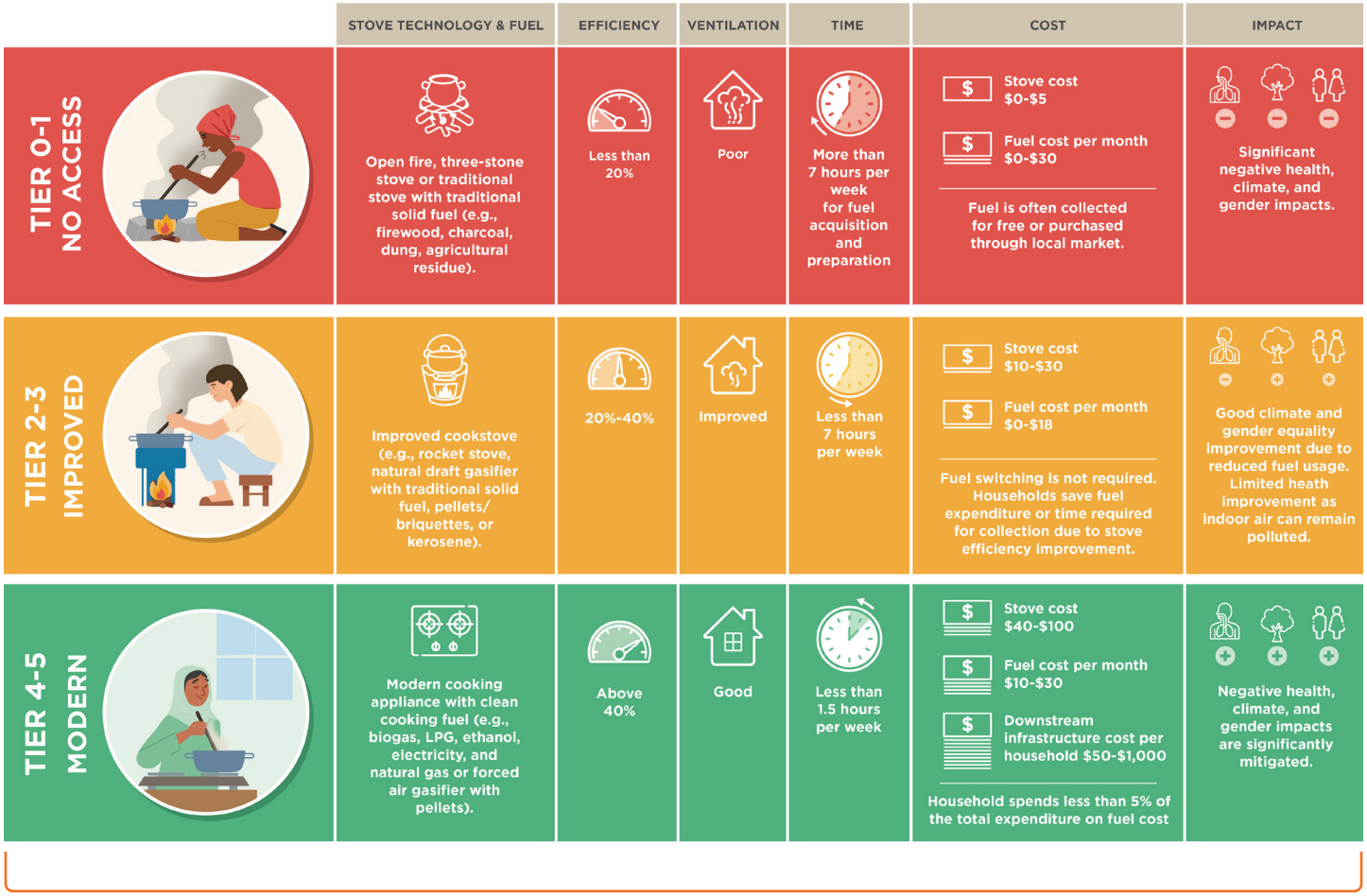

Unsplash / Myko

Figure 4: **Framework for classifying degree of access to modern cooking fuels and appliances** (WB/ESMAP and MECS, 2022)



3 Business and financing models

The clean cooking sector in Africa is characterised by various challenges such as underdeveloped markets with a small number of sizable players, a lack of ability of customers to pay, as well as poor access to finance for businesses and consumers (MECS, 2021). A key barrier for low-income households to replace traditional fuels with clean cooking solutions oftentimes is often not only the cost, but the cost structure. For example, in the case of LPG, fuel costs can often be lower than solid biomass, but the financial outlay required to pay upfront for pre-set units of gas (e.g., 6 kg-15 kg cylinders) is prohibitive for many households (Shupler et al., 2021). Price fluctuations and supply unreliability can also act as a barrier. However, business and financing models are being developed to counter these barriers.

Consumer financing models are key for the viability of clean cooking companies. In such models, suppliers offer payment plans, potentially with PAYGo technology, to align customer's ability to pay with the businesses' revenue needs. Businesses also often partner with financial institutions to implement consumer financing (CCA, 2022a). The PAYGo model can be used for both financing the purchase or lease of clean cookstoves as well as purchasing the fuel. In lease-to-own models, customers can make periodic payments until they reach an unlock price that allows them to own the device outright (Junio, 2021). PAYGo for fuels enables consumers to only purchase the amount of fuel that they need (rather than a whole LPG gas cylinder, for example). Businesses that apply this model in the LPG sector are, for example, KOPAGAS (see Examples section).

Another key area in business models relates to the companies' approach to the value chain. Businesses can either manufacture and distribute cooking appliances, or only the fuels, or both. Integrated clean cooking models that provide the appliance and fuel currently dominate the sector with 45% of companies accounting for 71% of overall capital raised in the clean cooking sector (CCA, 2022a).

4 Socio-economic and sustainability impacts

The use of traditional cookstoves with solid fuels like wood and charcoal is predominant in Africa and has severe impacts on health, ecosystems, climate and livelihoods:

- An estimated 500,000 premature deaths per year are linked to household air pollution from the lack of access to clean cooking in Africa (IEA, 2022).
- Up to 34% of woodfuel harvested is unsustainable, contributing to forest degradation and deforestation. More than 275 million people live in "hot spots" where over 50% of woodfuel harvest is unsustainable (CCA, 2022b).
- Although Africa is responsible for a minimal share of global greenhouse gas emissions, it is estimated that emissions from non-renewable woodfuel for cooking amount to 1 $GtCO_2e$ per year - about 2% of global emissions and roughly on a par with emissions from aviation (CCA, 2022b).
- Approximately 30% of global greenhouse gas (GHG) emissions from forest degradation are derived from woodfuel harvest (CCA, 2022b).
- Cooking with biomass contributes greatly to global black carbon emissions, which has a warming impact on climate that is up to 1,500 times as strong as that of CO_2. This makes cooking energy the largest controllable source of black carbon emissions.
- Significant time is spent collecting fuel, especially in locations where firewood value chains do not exist.

While the most climate-friendly cooking fuels are those relying on renewable energy (e.g., solar-powered electricity, biogas), the use of fossil fuels in clean cooking solutions can have a lower climate footprint than traditional biomass fuels, depending on how the biomass is sourced and how much this leads to deforestation and land degradation. For example, LPG has a lower climate impact than traditional biomass fuels, even when a large fraction of the biomass is renewable (Kypridemos et al., 2020).

Women and children stand to benefit drastically from a transition to clean cooking. Apart from avoiding the health risks described above, some of the gender-specific benefits of clean cooking are time savings and safety. Household fuel collectors (who are often women and children) can spend up to 10 hours a week gathering fuel and might be limited in attending school or generating an income to do that work (CCA, 2021b). In conflict settings, fuel wood collection involves an increased vulnerability to physical attack when leaving the communities or refugee camps (CCA, 2021b).

Strengthening the clean cooking sector also has economic benefits in terms of creation of new value chains (for fuels, stoves, cylinders, etc.), increased opportunities for local manufacturers and distribution companies, new employment and skills. Electric cooking solutions can also increase the economic viability of solar mini grids, by increasing the array of energy services offered to customers and balancing the electrical loads (MECS, 2021).

Examples of application in the African context 1

KOPAGAS, Tanzania

The idea: Through smart meters and PAYG technology, KOPAGAS distributes LPG to last-mile areas in Tanzania.

The technology:
- LPG
- A smart meter solution that enables PAYG

The business model:
- PAYG with a mobile money account

The impact:
- Increased accessibility and affordability of clean cooking solutions due to removal of high up-front costs and a large distribution network for LPG in Tanzania

For further information visit:
➔ www.kopagas.com

Unsplash / Omotayo Tajudeen

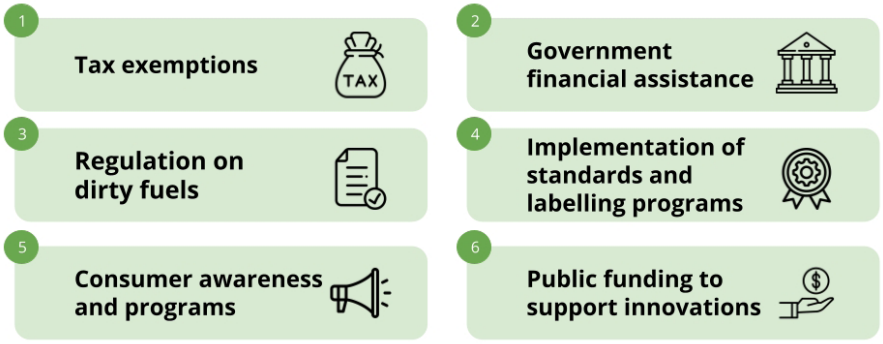
5 Scaling-up

There is an urgent need to scale up the use of clean cooking solutions in Africa. The number of people who rely on wood and charcoal for cooking is currently 970 million. Under current policies and investment landscapes, many African countries are not expected to reach full clean cooking access even into the 2050s (IEA, 2023). Affordability, accessibility of liquid petroleum gas (LPG), lack of electricity access, or the lack of suitable cooking appliances all act as barriers to scaling up the use of clean cooking solutions. Perceptions and customs can also be part of the barriers to adoption. Firewood may be preferred due to its deep cultural meaning (Tamire et al., 2018), and households may perceive other benefits of open-fire cooking, like keeping mosquitos away or the provision of light. Programmes and projects to replace traditional unsustainable fuels are likely to succeed only if they can take multiple barriers to adoption into account in their design.

Grants, loans and financing incentives such as tax exemptions or import duty waivers (for imported stoves) have a critical role to play in de-risking businesses and developing the market. Beyond project-specific financing, financial instruments can be used to support the growth of clean cooking companies (CCA, 2022a). Incentivising local manufacturing of clean cookstoves and of local fuel value chains and improving the enabling environment for businesses via policy changes (e.g., removal of subsidies on dirty fuels, adoption and enforcement of technical standards), all have a role to play. Figure 5 shows the top policy areas that were prioritised by 37 clean cooking companies surveyed by the Clean Cooking Alliance in 2020.

A further challenge to scaling clean cooking solutions up the required level is the relatively small number of sizable players in each segment of the market (MECS, 2021). This is accompanied by a lack of country-level data on the market (e.g., consumption patterns, competing fuel prices), technologies (e.g., unit economics), companies (e.g., business models, distribution strategies, payment plans), and customers (cooking behaviours in different cultural settings) as well as the lack of standardised impact metrics.

Figure 5: **Top priority policies for surveyed clean cooking companies** (own illustration, based on CCA, 2022a)



Examples of application in the African context 2

Powerstove, Abuja, Nigeria
(Company selected in the SESA Call for Entrepreneurs 2023)

The idea: Powerstove displaces traditional firewood and charcoal stoves with affordable fuel-efficient biomass stoves.

The technology:
- Bio-pellets made from agricultural and wood waste as fuel for the stoves
- Built-in IoT technology to monitor and monetize the carbon offsets generated

The business model:
- Outright purchase or PAYGO (lease-to-own) models

The impact:
- Significantly reduced indoor air pollution and expenditure on fuel for cooking

For further information visit:
➔ https://powerstove.africa

6 Clean cooking solutions in SESA

Implemented in nine African countries, the EU-funded SESA project is developing and testing solutions to accelerate the energy transition in Africa. The focus of the project is on the exploration of innovative technologies and services in urban and rural contexts. SESA partners in various countries are working on clean cooking solutions. Their activities are briefly outlined below.

6.1 Malawi Living Lab

Within SESA, a local supply chain will be developed by testing new biomass alternatives for selected regions in Malawi. Furthermore, the BioCooker developed by the company Make It Green (MIG), will be developed and validated by customers. The BioCooker can use locally available biomass residues, and can produce biochar and power small electric appliacnes through a thermoelectric generation function.

6.2 Ghana Living Lab

The Ghanaian Living Lab will explore clean cooking through waste-to-energy solutions. The company Econexus Ventures, in cooperation with SESA partner AAMUSTED (Akenten Appiah-Menka University), will test and validate a business model for clean cooking solutions suitable for both urban and rural communities. This validation will involve local manufacturing and testing of a locally-produced industrial cookstove fueled with bioethanol made from agricultural waste. The testing is conducted by Econexus in public schools in the Accra and Kumasi regions, with the goal of developing a growth and replication strategy for waste-to-energy ventures in this new customer segment. The Ghana Living Lab will help provide clean and reliable energy for cooking as well as ensure adequate availability of electricity for productive uses.

6.3 Nigeria Replication Action

This SESA replication action is implemented by the local venture Powerstove and aims to support the replication and scale-up of locally manufactured biodigesters and biogas cookstoves in Nigeria. This replication will particularly focus on enhancing the affordability and accessibility of biodigesters to rural communities and female-led households through an optimized business model (PAYGO), expanding local production with a circular economy approach, and addressing the barrier of financial sustainability for local cookstove ventures.

6.4 Rwanda Replication Action

The SESA replication action is implemented in close cooperation with the local venture Ecogreen Solutions and addresses the immense challenge in Rwanda where only 1% of the population has access to clean cooking fuels and technologies. It will support the replication and scale-up of an innovative business model for local production and sales of improved cook stoves and waste-to-energy solutions through local production of pellets made of agricultural waste. Moreover, there will be an analysis of local supply chains and the development of a circular economy strategy that decreases production costs and maximises local procurement in Rwanda.

Examples of application in the African context 3

Econexus Ventures Limited, Accra, Ghana
(Company selected in the SESA Call for Entrepreneurs 2022)

The idea: Commercialising bioethanol produced from locally sourced water hyacinth and sugarcane molasses.

The technology:
- Clean-burning stoves adapted to bio-ethanol gel fuel

The business model:
- Sale of bio-ethanol cooking fuels and stoves

The impact:
- Fuel is smokeless and cost-competitive against current traditional cooking fuels

For further information visit:
→ https://www.econexusventures.net

7 Climate-proofing

Climate proofing is a term that refers to the process of mainstreaming climate change into mitigation and/or adaptation strategies and programmes (Climate Policy Info Hub, 2022). The goal of climate proofing is to ensure that climate-related risks and opportunities are integrated into the design, operation, and management of products and infrastructure. To achieve that, projects must be screened for climate risks, vulnerabilities and opportunities early in the design stages.

As well as the multiple benefits described in section 4, a transition to clean cooking solutions can also deliver cost-effective resilience to climate change. However, the clean cooking solutions themselves (fuels, stoves, infrastructure) can also be affected by climate change. Some of the risks to clean cooking value chains include:

- Biofuel supply chains can be disrupted by climate variability that affects production.
- Physical fuel supply and storage infrastructure can be disrupted by climate change-induced physical damage (floods, landslides, storms, or sea level rise).
- Solar-powered electricity generation for clean cooking (for example via solar PV mini grids) can also be physically damaged or its efficiency reduced due to extreme events or changes in radiation and ambient temperature.

The exact approach to climate proofing clean cooking solutions will depend on the location and context, but in general it should integrate the design of robust fuel supply and storage infrastructure that considers climate variability and risk. To extend infrastructure lifetime hazard exposure should be minimised by taking future climate projections into account in the selection of infrastructure locations.

8 Relevant tools and capacity building materials

Clean Cooking Catalog

The Clean Cooking Catalog is a global database of cookstoves, fuels, fuel products, and performance data and includes information on features, specifications, emissions, efficiency and safety based on laboratory and field-testing. The catalog helps to drive the development of international clean cookstove standards, and provides monitoring and evaluation information. It was launched in 2013 by the Clean Cooking Alliance and is continuously updated.
➔ http://catalog.cleancookstoves.org

Improved Cooking Energy Portal (Energypedia)

The improved cooking energy portal collects and structures all information on clean cooking energy that is available on Energypedia. The portal covers various sections, including: cooking fuels, cooking energy technologies, impacts or case studies. The portal is continuously updated.
➔ https://energypedia.info/wiki/Portal:Improved_Cooking

Global Market Assessment for electric cooking – country factsheets (2021)

Modern Energy Cooking Services (MECS) developed country factsheets for Morocco and Tanzania on the market assessment for electric cooking, covering many African countries. Each factsheet provides background information, key statistics, policies, opportunities and challenges in the electric cooking sector as well as an assessment on the viability to scale up.
➔ https://mecs.org.uk/resources/factsheets

Clean cooking planning tool

The World Bank's Energy Sector Management Assistance Program (ESMAP) has developed a scenario-based, integrated Clean Cooking Planning Tool (CCPT) that helps decision makers and planners to explore and identify transition pathways for achieving universal access to clean cooking solutions. It adopts the World Bank's established Multi-Tier Framework (MTF) to classify cooking energy services.
➔ https://energydata.info/cleancooking/planningtool

9 Bibliography

CCA, 2021a. Circle Gas Now Supplying Clean Cooking Gas to over 100,000 Households. Clean Cooking Alliance. (Accessed Oct 08, 2023). https://cleancooking.org/news/circle-gas-now-supplying-clean-cooking-gas-to-over-100000-households

CCA, 2021b. Gender and Clean Cooking. Clean Cooking Alliance. (Accessed Oct 08, 2023). https://cleancooking.org/wp-content/uploads/2021/07/CCA-gender-sheet-ENGLISH.pdf

CCA, 2022a. 2022 Clean Cooking Industry Snapshot. Clean Cooking Alliance. (Accessed Oct 08, 2023). https://cleancooking.org/wp-content/uploads/2022/05/CCA-2022-Clean-Cooking-Industry-Snapshot.pdf

CCA, 2022b. A call to action - Accelerating clean cooking as a nature-based climate solution. Global Alliance for Clean Cookstoves. (Accessed Oct 08, 2023). https://cleancooking.org/wp-content/uploads/2022/08/Accelerating-Clean-Cooking-as-a-Nature-Based-Climate-Solution.pdf

Climate Policy Info Hub, 2022. Climate proofing (Accessed Oct 08, 2023). https://climatepolicyinfohub.eu/glossary/climate-proofing

World Bank/ESMAP and MECS, 2022. Clean Cooking Planning Tool. (Accessed Oct 08, 2023). https://energydata.info/cleancooking/planningtool/about

IEA, 2019. Africa Energy Outlook 2019. International Energy Agency. (Accessed Oct 08, 2023). https://www.iea.org/reports/africa-energy-outlook-2019

IEA, 2022. Africa Energy Outlook. International Energy Agency. (Accessed Oct 08, 2023). www.iea.org/reports/africa-energy-outlook-2022

IEA, 2023. A Vision for Clean Cooking Access for All. World Energy Outlook Special Report. (Accessed Oct 08, 2023). www.iea.org/reports/a-vision-for-clean-cooking-access-for-all

Junio, E., 2021. Bringing Clean Cooking Technology to Last-Mile Markets. Angaza. (Accessed Oct 08, 2023). www.angaza.com/2021/03/31/bringing-clean-cooking-technology-to-last-mile-markets

Kypridemos, C., Puzzolo, E., Aamaas, B., Hyseni, L., Shupler, M., Aunan, K., Pope, D., 2020. Health and Climate Impacts of Scaling Adoption of Liquefied Petroleum Gas (LPG) for Clean Household Cooking in Cameroon: A Modeling Study. Environmental Health Perspectives, 128(4):47001. DOI: 10.1289/EHP4899

MECS, 2021. Clean cooking: Results-based financing as a potential scale-up tool for the sector. (Accessed Oct 08, 2023). https://mecs.org.uk/wp-content/uploads/2021/10/Clean-cooking-results-based-financing-as-a-potential-scale-up-tool-for-the-sector.pdf

Shupler, M., O'Keefe, M., Puzzolo, E., Nix, E., Anderson de Cuevas, R., Mwitari, J., Gohole, A., Sang, E., Čukić, I., Menya, D., Pope, D., 2021. Pay-as-you-go liquefied petroleum gas supports sustainable clean cooking in Kenyan informal urban settlement during COVID-19 lockdown. Applied Energy, 292. https://doi.org/10.1016/j.apenergy.2021.116769

Stoner, O., Lewis, J., Martínez, I. L., Gumy, S., Economou, T., Adair-Rohani, H., 2021. Household cooking fuel estimates at global and country level for 1990 to 2030. Nature Communications, 12, 5793 (2021). https://doi.org/10.1038/s41467-021-26036-x

Tamire, M., Addissie, A., Skovbjerg, S., Andersson, R., and Lärstad, M., 2018. Socio-Cultural Reasons and Community Perceptions Regarding Indoor Cooking Using Biomass Fuel and Traditional Stoves in Rural Ethiopia: A Qualitative Study. International Journal of Environmental Research and Public Health, 15(9). www.mdpi.com/1660-4601/15/9/2035

UN Habitat, 2021. Climate Proofing Toolkit: For Basic Urban Infrastructure with a Focus on Water and Sanitation. (Accessed Oct 08, 2023). https://unhabitat.org/climate-proofing-toolkit-for-basic-urban-infrastructure-with-a-focus-on-water-and-sanitation#:~:text=The%20Climate%20Proofing%20Toolkit%20is,current%20and%20future%20basic%20urban

WHO, 2022. Defining clean fuels and technologies. World Health Organization. (Accessed Oct 08, 2023). www.who.int/tools/clean-household-energy-solutions-toolkit/module-7-defining-clean

FACTSHEET 8

Clean Cooking Solutions

SESA
Smart Energy Solutions for Africa

Contact:

https://sesa-euafrica.eu https://twitter.com/sesa_project https://sesa-euafrica.eu/contact-us

www.facebook.com/sesaproject www.linkedin.com/company/sesa-project

Partners:

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 101037141. This material reflects only the views of the Consortium, and the EC cannot be held responsible for any use that may be made of the information in it.

Dreamstime / Lucian Milasan