



Clean Energy to Nourish a Continent: Unlocking renewable power for Africa's food systems

November 2025



Executive summary

This study on energy efficiency and renewable energy in food processing was commissioned by Partners in Food Solutions (PFS), SNV, and the Global Alliance for Improved Nutrition (GAIN). With a focus on Nigeria and Uganda, the study examines energy use, efficiency gaps, and opportunities for clean energy adoption across Africa's food-processing sector with a nutrition lens.

It also provides actionable recommendations for governments, development partners, and the private sector to support small and medium-sized enterprises' (SMEs) transition to affordable, reliable, and sustainable energy systems - delivering a triple win for nutrition, climate, and economic growth.

The study reveals **high energy costs, uncompetitively high energy intensity, and limitations in current energy mixes**. It addresses a key research gap, providing a multi-country perspective across diverse food value chains. Drawing on a comprehensive literature review, an online survey of 48 processors across more than seven African countries, and six on-site energy audits in Nigeria and Uganda, the analysis combines global-to-African benchmarking with processor-level data and real-world operational insights.

Findings confirm that food processing is the most energy-intensive stage in African agri-food systems, yet it remains inefficient and heavily reliant on diesel generators and biomass. With the right policies, incentives, awareness campaigns, and targeted programmes, modern energy efficiency (EE) and renewable energy (RE) solutions can cut costs, improve reliability, and deliver climate and nutrition co-benefits. The study also highlights gender and inclusion, recognising the specific barriers and opportunities for women-led enterprises in adopting clean energy.

Key messages

- Africa must align clean energy transition with nutrition gains. Food and energy prices are closely linked. Energy inefficiencies in processing raise costs, waste food, and undermine food and nutrition security. Urgent, energy-efficient, and clean energy interventions are needed to improve the availability of nutritious foods and reduce spoilage.
- African food processors are up to two times more energy intensive than their global peers. Outdated equipment, inefficient thermal systems, poor maintenance, and inadequate waste and heat recovery mean that processing one kilogram of produce can require nearly double the energy, reducing competitiveness. Most of the energy

demand comes from thermal processes such as drying, frying, pasteurisation, roasting, and boiling, while electricity use peaks in milling, refrigeration, and pumping. Cold chain and refrigeration remain significantly underpowered.

- The processing and post-harvest stages offer a strong renewable energy opportunity. Processing consumes 42% of total energy in food systems and presents the strongest business case. Using RE at this stage provides greater co-benefits, especially in terms of nutritious, perishable foods such as fruits, vegetables, eggs, and dairy, where solar photovoltaic (PV) adoption is already on the rise.
- Energy costs are a major business risk for small and medium-sized enterprise (SME) processors, accounting for 15%-22% of operating expenses. For small processors, even modest bills take a high share of revenue, threatening viability. Thin margins make them highly vulnerable to energy price shocks.
- Grid instability is disruptive and costly. Frequent outages, voltage fluctuations, and poor power quality cause equipment damage, downtime, and significant financial losses. Some processors pay USD 4,800 per year in penalties for poor power factor, while others lose USD 10,000 per year due to harmonics-related trips.

The triple win

Reducing energy intensity and adopting renewable energy in food processing delivers **three interconnected benefits**:

1. **Nutrition:** Minimises post-harvest losses and enhances the affordability and availability of nutritious foods, thereby reducing the risk of malnutrition.
2. **Climate:** Cuts greenhouse gas emissions from diesel and biomass use with clean energy sources. It also strengthens climate resilience by ensuring reliable, low-carbon energy access for rural and peri-urban food systems.
3. **Economic growth:** Boosts the profitability and competitiveness of SMEs, driving inclusive growth and job creation across the agri-food value chain.

- Fossil fuel lock-in undermines Africa's agro-industrialisation and climate mitigation goals. Diesel dominates off-grid processing operations, while unreliable power drives greater diesel dependence. Biomass and firewood account for 18%-48% of fuel use in rural dairy plants and 70%-90% in fish processing, adding to emissions, deforestation, and health risks.

The way forward

- Reducing energy intensity alongside renewable adoption is crucial. Retrofitting with high-efficiency motors, insulated dryers, improved burners, and waste heat recovery could cut specific energy consumption by 25%-40%, reducing both the size and cost of clean energy systems.
- Renewable energy is increasingly viable, with hybrid systems (e.g. solar-diesel, solar-biomass) already achieving 30%–80% diesel displacement in pilot sites. However, return on investment, willingness to pay, and payback periods remain sensitive to seasonality, utilisation rates, and processor size. Whether through standalone solar, hybrid, or grid-optimised efficiency solutions, consistent use also depends on stronger value chains such as market access for processed goods, reliable offtake to ensure steady demand, and improved storage, handling, and operations. Crucially, consistent renewable energy supply supports nutrient-preserving processing and reliable cold storage, enhancing the availability and quality of perishable, nutrient-rich foods such as dairy, fruits, and vegetables.

Barriers to overcome

- Access to finance, technical skills, and awareness remain the main barriers. Over 70% of surveyed processors reported little or no knowledge of energy-saving or renewable options. Most SMEs cannot self-finance upgrades, and maintenance capacity is limited, especially in rural areas.
- Business viability is another major barrier. SMEs need holistic business support that goes beyond energy solutions. Targeted policy action, blended finance, fiscal incentives, and public-private demonstration projects can accelerate the adoption of clean energy solutions.
- Women-led enterprises face greater barriers to energy transition. They often lack access to finance, information, training, and networks despite dominating certain value chains. Without targeted support, they risk exclusion from clean energy benefits.

Priority intervention opportunities

1. **Energy management and EE retrofits:** Target high-impact processes such as drying, frying, milling, and refrigeration for immediate upgrades using high-efficiency motors, VFD controls, heat recovery units, and insulation to rapidly cut energy costs and prepare for renewable integration. Prioritise nutrient-preserving technologies, including low-temperature drying, controlled frying, and efficient cold chains, to reduce post-harvest nutrient loss while improving food quality and safety.
2. **Hybrid RE systems for reliability:** Promote solar-diesel, solar-grid, and biomass-biofuel solar hybrids, which combine renewables with backup power. In addition, selection of energy efficient, nutrition sensitive technology with operational resilience requirements.
3. **Value-chain aggregation and shared infrastructure:** Cooperatives and processor clusters can pool demand for bulk procurement of EE and RE equipment, share pilot facilities for demonstration, and spread operations and maintenance (O&M) costs to overcome scale barriers.
4. **Gender-responsive interventions:** Tailoring finance (micro-leasing, concessional loans, grants), training, and technical support to women-led enterprises could unlock substantial untapped potential in spice, cereal, and small-scale dairy value chains.
5. **Nutrition-sensitive energy interventions:** Integrate nutrition as a performance indicator across all energy initiatives. Promote technologies and business models that enhance nutrient retention, food safety, and access to perishable, nutrient-dense foods. Establish simple nutrition metrics - such as reduction in nutrient loss (%), improved dietary diversity, or increased market availability of fortified or fresh foods—to track the broader health and food security benefits of renewable and energy-efficient systems.



Actionable recommendations

Policy makers

- Embed agro-processing energy needs in national agriculture, nutrition, and energy strategies.
- Introduce fiscal incentives such as Value Added Tax and duty waivers, and accelerated depreciation for EE and RE equipment.
- Establish Nutrition Energy performance indicators within agro-industrial policy (e.g., post-harvest loss rates, nutrient retention in processed foods, and affordability of nutrient-rich foods).
- Introduce super energy service companies (Super ESCOs) and leverage the energy efficiency networks of agro-processing industries.

Development partners

- Fund RE demonstration hubs, technical training programmes, and subsidised energy audits.
- Integrate renewable energy into programmes targeting agricultural value addition and nutrition-sensitive food systems, such as fortified or perishable food value chains.
- Support blended finance facilities and guarantees to de-risk SME investment, prioritising nutrition-impact enterprises (cold storage, drying of fruits/vegetables, dairy).
- Promote gender-inclusive access to clean energy financing and training.

Private sector and processors

- Conduct regular energy audits and track specific energy consumption (SEC) alongside nutrition-relevant KPIs, such as nutrient retention.

- Invest in efficient processing systems, VFD-driven or efficient motors, and waste-heat recovery.
- Adopt hybrid RE systems to reduce diesel dependence and improve reliability.
- Participate in peer learning networks and demonstration clusters.

Financial institutions and funders

- Launch dedicated SME energy credit lines and equipment-leasing programmes for EE and RE investments.
- Support aggregation and bulk procurement to reduce unit equipment costs.
- Leverage climate finance for projects delivering measurable emissions reductions (carbon-credit revenues into agribusiness energy upgrades).
- Partner with governments to underwrite risk via credit guarantees.

Mobilising coordinated action

By pursuing these targeted interventions, Africa's food-processing sector can cut energy costs, strengthen climate resilience, and enhance both food security and nutrition outcomes.

Embedding nutrition metrics - such as reductions in post-harvest nutrient loss, improved availability of nutrient-dense foods, and higher dietary diversity scores - within renewable energy and efficiency initiatives ensures that economic and climate gains also translate into better health and well-being.

Major outcome: Specific energy consumption benchmarks

A summary of specific energy consumption by food value chains in Africa is shown in the table below. To ensure comparability across different energy sources (electricity, biomass, biogas), all reported quantities were converted into common units of measurement, expressed in megajoules (MJ). Standard conversion factors were applied: electricity was converted from kilowatt-hours at a factor of 3.6 MJ/kWh, diesel from litres at 38.6 MJ/litre, and firewood from kilogrammes at 16 MJ/kg. This allowed for the aggregation of diverse fuel types into a single total energy use figure for each processor.

Table 1: SEC in Africa vs. verified global benchmarks (MJ/kg product)

Food value chain	Sub-product	Africa SEC (MJ/kg)	Global SEC (MJ/kg)
Cereals and cereal products	Wheat flour	0.07–0.10	0.05–0.07
	Maize flour	0.12–0.18	0.08–0.12
	Breakfast cereal	11.27	~5.0
	Grain products (general)	4.32–10.8	3.6–7.2
Nuts and seeds	Groundnuts and oilseeds	5.4–9.0	3.6–6.48
	Cashew nuts	13.8	~8–10
Roots and tubers	Cassava <i>garri</i>	0.65–1.04	0.43–0.9
	Potato products	~15–20	12–15
Legumes and pulses	Split pulses (<i>dal</i>)	0.1–0.3	0.05–0.15
	Canned legumes	2–4	1.5–2.5
Dairy	Liquid milk	0.66–0.70 MJ/L	0.5–0.6 MJ/L
	Yogurt	2.5–3.0	~2.2
	Cheese	~7.7	~8
	Milk powder	2.5	1.3
Fruits	Fruit juice	1–4	1–3
	Fruit concentrate	6–10	5–8
	Jam	5–10	4–8
	Dried fruit	5–12	3–7
Vegetables	Tomato paste	0.34	~0.4
	Mixed vegetables	5–10	4–8
	Frozen vegetables	0.6	0.3–0.5
	Dried vegetables	5–10	3–7
Animal meat, poultry, and eggs	Meat products	3–5	2–4
	Poultry products	0.06–0.17	0.05–0.10
	Dried meat	3–5	2–4
Honey and spices	Honey	3–6	2–4
	Spices	0.5–1.0	0.3–0.6

Source: author generated (Best available post-2019 data; African ranges drawn from surveys, audits, and literature)

About the partners

SNV is a mission-driven global development partner working in more than 20 countries across Africa and Asia. Building on 60 years of experience and together with our team of over 1,600 people, we strengthen capacities and catalyse partnerships that transform the agri-food, energy, and water systems, which enable sustainable and more equitable lives for all.

The Global Alliance for Improved Nutrition (GAIN) is a Swiss-based foundation launched at the United Nations in 2002 to tackle the human suffering caused by malnutrition. Working with governments, businesses and civil society, we aim to transform food systems so that they deliver healthier diets for all people, especially the most vulnerable. GAIN's mission is to advance nutrition outcomes by improving the consumption of nutritious and safe food for all people, especially the most vulnerable to malnutrition.

Partners in Food Solutions, a consortium of leading global food companies – General Mills, Cargill, Bühler, The Hershey Company, Ardent Mills and The J.M. Smucker Company – works to strengthen food security, improve nutrition and increase economic development across Africa by expanding and increasing the competitiveness of the food processing sector. We link corporate volunteers from our world-class corporate partners, who share their expertise virtually with promising entrepreneurs across Africa to help them improve and grow their food businesses.