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UGANDA

FEASIBILITY STUDY ON THE USE OF SUSTAINABLE AVIATION FUELS

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FOREWORD

In June 2022, on the 50-year anniversary of the Stockholm Convention, the International Civil Aviation Organization (ICAO) launched the Assistance, Capacity-building, and Training for Sustainable Aviation Fuels (ACT-SAF) programme to aid developing states in their transition to cleaner energy for aviation.

Later in 2022, the 41st ICAO Assembly adopted a long-term global aspirational goal (LTAG) for international civil aviation: collectively targeting net-zero carbon emissions by 2050, as a contribution to global climate action in line with the objectives of the UNFCCC Paris Agreement. The ICAO Assembly, through Resolution A41-21, emphasized the need for targeted support to developing states, including enhanced access to financial resources, technology transfer, and capacity-building initiatives.

With the adoption at the 3rd ICAO Conference on Aviation Alternative Fuels (CAAF/3) in November 2023 of the ICAO Global Framework for Sustainable Aviation Fuels (SAF), Lower Carbon Aviation Fuels (LCAF) and other Aviation Cleaner Energies, ICAO and its Member States have agreed to strive to achieve a collective global aspirational Vision to reduce CO_2 emissions in international aviation by 5 per cent by 2030 through the use of SAF, LCAF and other aviation cleaner energies (compared to zero cleaner energy use).

The Vision has four building blocks, the third of which is implementation support. It expresses the importance of support for developing countries and States with particular needs, to be addressed through the ACT-SAF programme. This should be a robust and substantial capacity-building and implementation support programme designed to assist States, to foster partnerships and collaboration on SAF initiatives under ICAO's coordination and to serve as a global platform for knowledge exchange. In Resolution A42-21 the 42nd ICAO Assembly resolves to achieve this Vision and requests the ICAO Council to continue to implement the ACT-SAF Programme to support the global scale-up in development and deployment of SAF, LCAF and other aviation cleaner energies.

In 2024, the United Kingdom made a voluntary financial contribution to the ICAO Environment Fund to fund at least three feasibility studies on sustainable aviation fuels for states including Uganda. The same year, the Uganda Civil Aviation Authority accepted to be the project beneficiary through an interchange of letters and designed national focal points in charge of supporting the project.

This feasibility study assesses the potential for producing and utilizing sustainable drop-in Sustainable Aviation Fuel (SAF) in Uganda, ensuring alignment with the environmental and socio-economic sustainability criteria in ICAO's Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA). It follows the guidelines set out in the ICAO *Template for Feasibility Studies on Sustainable Aviation Fuels* and *Guide for Feasibility Studies on Sustainable Aviation Fuels* (Version 1, July 2023).[1]

[1] https://www.icao.int/act-saf

ACKNOWLEDGEMENTS

This feasibility study would not have been possible without the invaluable engagement and leadership of the Uganda Civil Aviation Authority and in particular to Mr Khalid Muwembe, the national SAF Focal Point, who has supported it through its implementation.

We acknowledge the instrumental role of the many national stakeholders who contributed to the development of this work by providing valuable information and guidance to identify SAF potential in the country.

The authors express their gratitude to all stakeholders listed in APPENDIX A.

EXECUTIVE SUMMARY

BACKGROUND AND CONTEXT

Uganda has a unique combination of biomass abundance, agricultural productivity, and strategic location that makes it well suited for Sustainable Aviation Fuel (SAF) development. The country generates significant quantities of sugarcane, maize, cassava, and agricultural residues, while its rapidly growing urban centres produce an increasing volume of municipal solid waste (MSW). With the aviation sector expanding through Entebbe International Airport and new domestic routes, the opportunity to decarbonize air transport and strengthen national energy security is substantial.

The Government of Uganda's infrastructure priorities—particularly the Hoima Oil Refinery and Kabalega Industrial Park— create the foundation for co-developing petroleum and biofuel value chains. This study, developed under ICAO's ACT-SAF framework, evaluates the technical and economic feasibility of SAF production in Uganda, identifies key enabling factors, and provides a roadmap for implementation aligned with ICAO's CORSIA and Uganda Vision 2040.

OBJECTIVES AND METHODOLOGY

The study applies the ICAO ACT-SAF methodology, which includes:

- Assessing feedstock availability and logistics using national production statistics and residue ratios.
- Evaluating certified ASTM D7566 pathways (ATJ-SPK, HEFA-SPK, and FT-SPK).
- Estimating conversion yields, technology readiness levels (TRLs), and indicative costs.
- Mapping infrastructure readiness and logistics compatibility.
- Reviewing policy, financing, and institutional mechanisms for SAF deployment.

KEY PATHWAYS

Alcohol-to-Jet (ATJ-SPK, ASTM Annex A5/A7)

TRL 8–9, up to 50% blend. Estimated cost USD 1.0–1.8 per L. Best aligned with Uganda's sugarcane and cassava sectors, where bagasse can supply heat and power.

Hydroprocessed Esters and Fatty Acids (HEFA-SPK, Annex A2) and co-processing (ASTM D1655 Annex A1)

TRL 9, up to 50% blend for HEFA and up to 5% of refinery capacity for co-processing. Cost USD 0.9–1.6 per L. Viable with used cooking oil (UCO) and limited corn or palm oil; low technical risk and fastest time to market. The Hoima refinery under construction provides a near-term opportunity for co-processing of esters and fatty acids or Fischer-Tropsch hydrocarbons in a traditional petroleum refinery, with a potential production capacity of 3 000 barrels per day (5% of its capacity) if sufficient feedstock is available.

Gasification–Fischer-Tropsch (FT-SPK, Annex A1)

TRL 7–9, cost USD 1.2–2.0 per L. Applicable for MSW and agricultural residues once syngas quality management is proven.

FEEDSTOCK AVAILABILITY AND SAF PRODUCTION POTENTIAL

Aggregate technical potential, depending on the recoverable fraction, feedstock prioritization and final product yield: approximately 310–858 million L of SAF per year, equivalent to 3–8 times Uganda's current yearly Jet A-1 consumption[2] (see Table ES). This could create export and inter-regional partnership opportunities.

Table ES. Uganda's feedstock availability and SAF output (annual)

Feedstock	Annual supply (million t)	Recoverable fraction	SAF yield (L/t)	Potential SAF output (million L/year)
Sugarcane	6.0–6.4	10–30% diverted	80–120	15–70
Maize residues	3.5–4.7 (1.4–1.9 recoverable)	40%	90–120	125–225
Cassava	1.7–2.8	10–20% diverted	100–120	10–35
Palm oil	0.04–0.06	20–50%	200–250	7–28
Agricultural waste (mixed)	1–3	30–50%	90–120	90–360
MSW (biogenic fraction)	7.2 total (0.8–1.2 recoverable)	50–60%	90–120	70–140

INFRASTRUCTURE AND LOGISTICS READINESS

Uganda's aviation fuel system is well developed:

- **Entebbe International Airport (Tristar):** 12 million L of underground Jet A-1 storage (expandable to 22 million L), 7 km hydrant system, 43 hydrant points built to JIG/IATA standards. The system can accommodate low-blend SAF without major modification.
- **Hoima refinery and industrial zone:** A planned 60 000 barrel-per-day refinery provides opportunity for HEFA co-processing and future ATJ/FT integration, supported by a regional pipeline network.
- **Regional SAF hubs:** Potential production clusters include Jinja–Kamuli (sugarcane/cassava), Masaka–Rakai (cassava/banana), Mbale–Sironko (maize residues), Lira–Apac (oilseeds), and Hoima–Kikuube (refinery integration).

FINANCE LANDSCAPE

SAF implementation requires blended finance combining concessional, public, and private capital.

- Development finance institutions (DFIs): The African Development Bank (SEFA), Green Climate Fund (GCF), ICAO Finvest Hub, and Uganda Energy Credit Capitalisation Company (UECCC) offer early-stage grant and loan support.
- Private sector: Agribusiness and energy investors seek clear policy frameworks and offtake security.

[2] 116 million L per day in 2023, Based on aggregated datasets in 2025 obtained from MEMD Sector Performance, BP Statistical Review of World Energy, U.S. Energy Information Administration (EIA), World Bank, and national government sources.

- Carbon finance: CORSIA and voluntary carbon markets could generate USD 50–80 per t CO_2 in additional revenue.

Public guarantees, VAT and excise exemptions, and offtake-linked incentives will be vital to attract initial investment.

POLICY IMPLICATIONS

Uganda should adopt a national SAF policy framework that harmonizes roles across ministries (Energy, Transport, Agriculture, NEMA, URA, and Civil Aviation Authority).

Short-term (0–2 years)
- VAT/excise exemptions, time-bound carbon-intensity credits, feasibility grants.
- SAF blending pilot at Entebbe with ASTM D7566-aligned monitoring and reporting.
- Establishment of a SAF Council chaired by MEMD.

Medium-term (2–5 years)
- Progressive SAF blending mandate (1 → 3 → 5%).
- Revenue-certainty mechanism (Contracts-for-Difference).
- Public procurement for government travel and national airlines.

Long-term (5–10 years)
- Regional policy harmonization under EAC.
- Green bond and climate-finance vehicles for large-scale production.
- Export eligibility under ICAO CORSIA and EU/UK SAF markets.

OPPORTUNITIES AND CHALLENGES

Opportunities
- Abundant feedstocks and residues.
- Ready infrastructure at Entebbe and Hoima.
- Emerging airline and cargo markets.
- Climate finance and carbon-credit potential.
- Job creation and circular-economy co-benefits.

Challenges
- Limited residue collection and waste segregation.
- Food security concerns for sugarcane and cassava.
- High CAPEX and financing hurdles.
- Nascent technical capacity for advanced bio-refining.
- Need for coordinated policy across agencies.

RECOMMENDED ROADMAP

1. Form the Uganda SAF Council (MEMD/OPM lead).
2. Publish a National SAF Roadmap with quantitative targets and MRV standards.

3. Launch pilot projects: Entebbe SAF blending and two pre-FEEDs (ATJ and FT).
4. Secure airline offtakes (Uganda Airlines, Kenya Airways, Ethiopian Airlines).
5. Mobilize finance from AfDB, GCF, and private developers; target first FID by 2027.
6. Scale up production to 100–200 million L/year by 2032 via integrated ATJ/HEFA/FT capacity.

CONCLUSION

Uganda's combination of biomass availability, waste management needs, and strategic infrastructure provides a strong foundation for SAF deployment. With quantified technical potential exceeding 300–850 million L per year, certified pathways, and airport readiness, Uganda is positioned to progress from feasibility to first-generation production within this decade. A robust policy framework, blended-finance support, and coordinated leadership through a national SAF Council will enable Uganda to become a regional SAF pioneer, advancing energy security, economic diversification, and climate-aligned growth in East Africa.

CONTENTS

ABBREVIATIONS AND ACRONYMS

ACCF	Africa Climate Change Fund
AfCFTA	African Continental Free Trade Area
AfDB	African Development Bank
ATJ	Alcohol to Jet
BOOT	Build-Own-Operate-Transfer
BOT	Build-Operate-Transfer
BoU	Bank of Uganda
CFA	Climate Finance Accelerator
CIF	Climate Investment Funds
COMESA	Common Market for Eastern and Southern Africa
DBOT	Design-Build-Operate-Transfer
DESNZ	Department for Energy Security and Net Zero (UK)
DRC	Democratic Republic of the Congo
EAC	East African Community
EIA	Entebbe International Airport
EJAF	Entebbe Joint Aviation Fuel
ERA	Electricity Regulatory Authority
ETS	Emissions Trading System
FCDO	Foreign, Commonwealth & Development Office (UK)
FEI	Facility for Energy Inclusion
FT	Fischer–Tropsch
FT-SPK	Fischer-Tropsch Synthetic Paraffinic Kerosene
GCF	Green Climate Fund
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
HEFA	Hydroprocessed Esters and Fatty Acids
ICAO	International Civil Aviation Organization
ICF	International Climate Finance
IGG	Inspectorate of Government
IISD	International Institute for Sustainable Development
IPCC	Intergovernmental Panel on Climate Change
KPCIP	Kabalega Petrochemical Industrial Park
MAAIF	Ministry of Agriculture, Animal Industry and Fisheries
MEMD	Ministry of Energy and Mineral Development
MJ	Megajoule
MoFPED	Ministry of Finance, Planning and Economic Development
MoGLSD	Ministry of Gender, Labour and Social Development
MoH	Ministry of Health
MoLG	Ministry of Local Government
MoWT	Ministry of Works and Transport
MRV	Monitoring, Reporting and Verification
MWE	Ministry of Water and Environment
NEMA	National Environment Management Authority
NPA	National Planning Authority

NSSF	National Social Security Fund
NWSC	National Water and Sewerage Corporation
PPDA	Public Procurement and Disposal of Public Assets Authority
PPP	Public-Private Partnership
RBF	Results-Based Financing
REA	Rural Electrification Agency
SAF	Sustainable Aviation Fuel
SARPs	Standards and Recommended Practices
SEFA	Sustainable Energy Fund for Africa
UBC	Uganda Broadcasting Corporation
UCAA	Uganda Civil Aviation Authority
UCC	Uganda Communications Commission
UDB	Uganda Development Bank
UECCC	Uganda Energy Credit Capitalisation Company
UETCL	Uganda Electricity Transmission Company Ltd.
UGX	Ugandan Shilling
UHRC	Uganda Human Rights Commission
UIA	Uganda Investment Authority
UK PACT	UK Partnering for Accelerated Climate Transitions
UNBS	Uganda National Bureau of Standards
UNFCCC	United Nations Framework Convention on Climate Change
UNOC	Uganda National Oil Company
UNRA	Uganda National Roads Authority
URA	Uganda Revenue Authority
USD	United States Dollar
VCM	Voluntary Carbon Markets

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SECTION 1. STATE-SPECIFIC INFORMATION

1.1 GEOGRAPHY AND CLIMATE

Uganda is a landlocked country in East Africa that boasts remarkable geographic diversity and a predominantly tropical climate. Its varied landscapes, equatorial location, abundant water bodies, and elevated plateaus make Uganda a unique environmental mosaic in the African Great Lakes region. Understanding Uganda's geography and climate provides insight into its rich biodiversity, agricultural potential, and socio-economic development.

Uganda is situated on the East African Plateau, lying between latitudes 1°S and 4°N, and longitudes 29°E and 35°E. Covering an area of approximately 241 038 km^2, Uganda is similar in size to the United Kingdom or Ghana. It shares its borders with five countries: Kenya to the east, South Sudan to the north, the Democratic Republic of the Congo (DRC) to the west, Rwanda to the southwest, and Tanzania to the south. Lake Victoria, the world's second-largest freshwater lake by surface area, forms part of Uganda's southern border and is shared with Kenya and Tanzania (see Figure 1).

Figure 1. Map of Uganda highlighting major cities and neighbouring countries.

1.1.1 Physical features and landforms

Uganda's topography is characterized by extensive plateaus, mountain ranges, vast lakes, rolling hills, and wetlands. The central part of the country is dominated by a plateau that averages about 1 000 to 1 500 m above sea level, contributing to its moderate tropical climate.

Uganda is home to several significant mountain ranges and volcanic features. The most prominent is the Rwenzori Mountain Range, often called the "Mountains of the Moon", which lies on the western border with the DRC. The Rwenzoris include Uganda's highest point, Margherita Peak on Mount Stanley, standing at 5 109 m. These snow-capped peaks are among the few places in Africa where permanent glaciers exist, despite being near the equator.

In the east, Mount Elgon, an extinct shield volcano, rises to 4 321 m and straddles the Uganda-Kenya border. Its caldera, one of the world's largest, feeds numerous rivers and supports a rich variety of flora and fauna.

Uganda is part of the African Great Lakes system and is endowed with numerous freshwater bodies. Besides Lake Victoria, it includes Lakes Albert, Edward, George, Kyoga, and several crater lakes scattered mainly in the western regions. The Nile River, the world's longest river, originates from Lake Victoria at Jinja. From here, the Victoria Nile flows northward through Lake Kyoga and Lake Albert, eventually continuing its journey toward South Sudan and beyond.

The western rift valley, part of the Albertine Rift, forms Uganda's western border and is characterized by deep valleys and escarpments. The Albertine Rift is a biodiversity hotspot, supporting montane forests and rare species such as the mountain gorilla. Wetlands cover about 13% of Uganda's surface area, providing critical ecological services such as water filtration, flood control, and habitat for fish and birdlife.

1.1.2 Climate

Uganda's climate is predominantly tropical, tempered by altitude. The equatorial location means that Uganda experiences relatively uniform temperatures year-round, with two primary rainfall seasons.

Average temperatures vary with altitude but generally range from 21 °C to 27 °C in most lowland areas. Higher elevations, like the Rwenzori Mountains and Mount Elgon, experience much cooler temperatures, often dropping below freezing at the highest peaks, as shown in Figure 2.

Uganda receives moderate to heavy rainfall, with annual precipitation ranging from 1 000 mm to 2 000 mm in most areas. The country experiences two distinct rainy seasons: the "long rains" from March to May and the "short rains" from September to December. However, rainfall patterns vary considerably across the country. The Lake Victoria basin receives some of the highest rainfall due to the lake's influence on convectional rain formation. The northern regions tend to be drier and can experience more pronounced dry seasons, especially in the semi-arid Karamoja region.

Uganda's diverse geography gives rise to various microclimates. The Albertine Rift region is cooler and wetter due to orographic rainfall and forest cover, while the northeastern Karamoja region lies in a rain shadow, making it semi-arid and prone to droughts. The Lake Victoria basin benefits from a humid equatorial climate that supports dense vegetation and extensive agriculture.

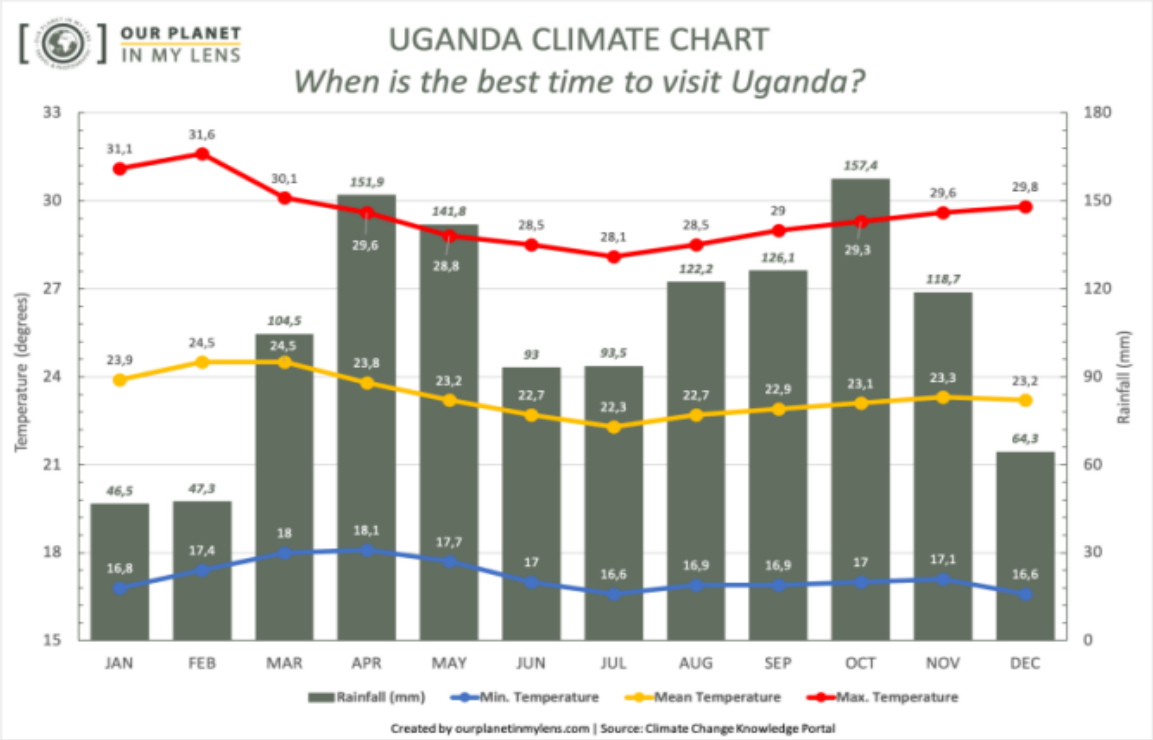

Figure 2. Variation of temperature and rainfall in Uganda by month.[3]

At the heart of Uganda lie lush central plateaus where the equatorial sun is tempered into warm, pleasant days averaging between 22 °C and 28 °C, with nights cooling gently to 16 °C. Kampala, for instance, typically swings from 24 °C by day to around 17 °C at night, buffered by Lake Victoria's stabilizing presence. In contrast, the northern regions — such as Karamoja or around Koboko — experience sharper heat, often with daytime highs reaching the mid-30s and significantly reduced rainfall.[4]

Rainfall in Uganda may seem generous, with annual totals averaging about 1 200 mm, but this moisture is unevenly shared. Most of the country enjoys a dual rainfall system: the long rains between March and May and shorter showers from September to November. Yet as Figure 3 shows these rhythms are not uniform. The western highlands around Mount Elgon and the Rwenzori regularly receive over 1 500 mm, while the northeast drifts below 800 mm annually.

Seasonal variation is also part of the rhythm. The dry months — December to February and June to August — bring respite from the rains, especially in central and southern districts. In Kampala, afternoons stay mild at around 27 °C, but mornings dip to a fresher 16 °C. Yet in the north, the dry season endures longer, extending from March through November in some areas, reinforcing semi-arid conditions and grazing challenges.

[3] Source: Climate Change Knowledge Portal

[4] Source: Blue Green Atlas

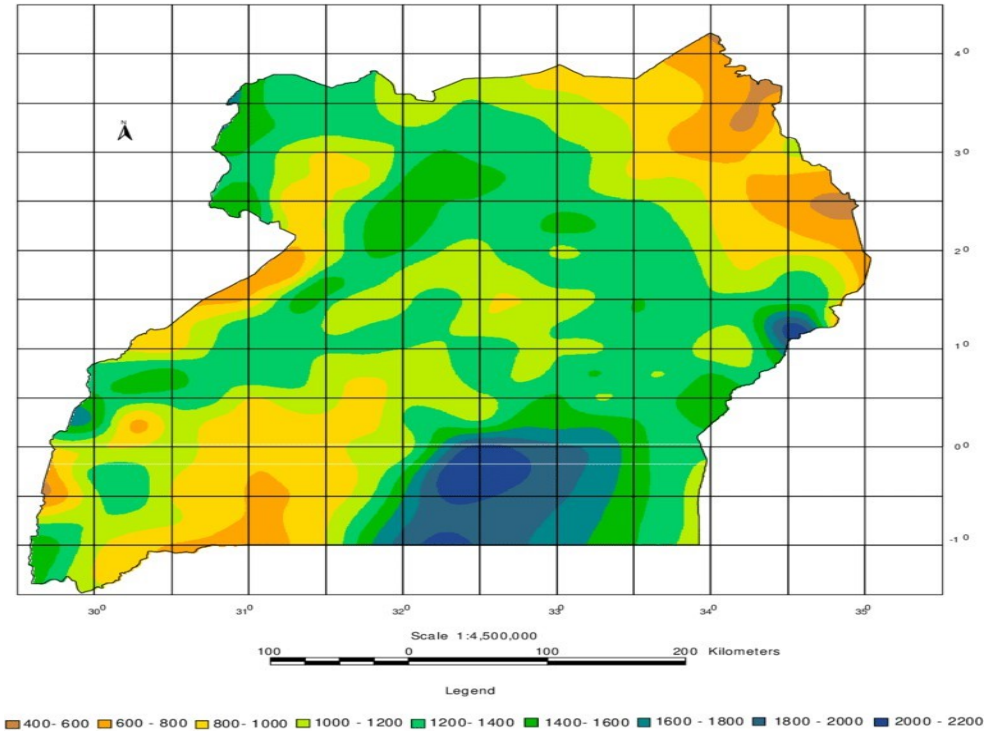

Figure 3. Mean annual rainfall in Uganda.[5]

Topography plays a commanding role. Uganda's western highlands, enlivened by orographic lifting, are rich in precipitation. The towering Rwenzori and Elgon ranges capture moisture-laden winds, which condense into frequent rainfall and contribute to glacial runoff. Sadly, glacier retreat here has accelerated in recent decades, and climate change continues to expose the land to floods and landslides.[6]

Climatic influences from global systems are also evident. Uganda's rainfall is shaped by the shifting Inter-Tropical Convergence Zone and local lake-convection — notably around Lake Victoria. During El Niño or positive Indian Ocean Dipole events, rainfall surges, leading to intensified wet seasons and flood risks.

Indeed, Uganda's climate is in flux. Temperatures have already risen by some 1.3 °C over six decades, with nights warming even faster. Meanwhile, rainfall patterns have grown erratic: Down by roughly 12% since the 1980s in key agricultural belts, especially across central and western Uganda. These shifts heighten vulnerability to crop failures, soil erosion, and freshwater scarcity.[7]

The climatic tapestry of Uganda spans fertile wetlands and savanna plains, rugged mountains, and semi-arid northlands. These conditions nourish a rich agricultural diversity — from banana groves and coffee estates to grazing plains. But they also amplify challenges ahead: shifting seasons threaten rain-fed farming; rising floods and heatwaves fracture infrastructure; and melting glaciers destabilize river systems and water supply.

[5] Source: Department of Meteorology, Kampala
[6] World Bank - Uganda: Climate Risk Country Profile
[7] Ssentongo et al - Changes in Ugandan Climate Rainfall at the Village and Forest Level

1.1.3 Environmental significance

Uganda's favourable climate and varied geography make it one of Africa's most biodiverse nations. The country's ecosystems range from tropical rainforests to savannas, montane forests, wetlands, and freshwater systems. This ecological diversity supports an array of wildlife, including iconic species like chimpanzees, mountain gorillas, elephants, and over 1 000 bird species. National parks such as Bwindi Impenetrable Forest, Queen Elizabeth, and Murchison Falls showcase this natural wealth.

Additionally, the moderate climate and fertile soils make agriculture the backbone of Uganda's economy, employing the majority of the population. Crops such as coffee, tea, bananas, maize, and beans thrive under these conditions.

1.1.4 Challenges and climate change

Despite its natural abundance, Uganda faces significant environmental challenges. Deforestation, wetland degradation, soil erosion, and climate change pose threats to the country's delicate ecosystems and livelihoods. Rising temperatures, shifting rainfall patterns, and extreme weather events have begun to affect agricultural productivity and water availability. In response, Uganda has developed climate adaptation strategies to safeguard its environment and build resilience.

Uganda's geography and climate form the foundation of its rich biodiversity, vibrant cultures, and economic activities. From the snow-capped Rwenzoris and misty rainforests to the vast savannas and fertile wetlands, Uganda's landscapes are a testament to the country's natural beauty and environmental diversity. Preserving this remarkable geography while adapting to the challenges of climate change will be key to ensuring that the "Pearl of Africa" continues to shine for generations to come.

1.2 TRADE AND GOVERNANCE

Uganda is strategically positioned in East Africa, bordering Kenya, Tanzania, Rwanda, South Sudan, and the Democratic Republic of Congo (DRC). Though landlocked, it leverages major regional corridors — especially through Mombasa (Kenya) and Dar es Salaam (Tanzania) — for sea access. The Northern Corridor and Central Corridor are the country's key international trade routes.

Uganda's trade strategy emphasizes:

- Regional integration
- Agricultural and industrial export diversification
- Import substitution for selected manufactured goods
- Infrastructure development to improve trade logistics

Uganda's exports are diverse but largely based on its primary sector, with agriculture dominating the landscape. Coffee, long the hallmark of Uganda's export identity, continues to be the country's most important traditional cash crop. Uganda is the leading exporter of Robusta coffee in Africa and a notable player in global Arabica markets. This industry supports millions of smallholder farmers and contributes significantly to foreign exchange earnings. Alongside coffee, other traditional exports such as tea, tobacco, and cotton remain important, especially in the western and southern parts of the country.

In recent years, however, non-traditional exports have surged in importance. Gold, for instance, has become Uganda's single largest export commodity. While much of it is re-exported after being refined following import from neighbouring countries, its role in the national trade profile cannot be overstated. Fish, particularly Nile perch from Lake Victoria, represents another crucial export, especially to the European Union and Asia. Additionally, Uganda exports a range of regional food staples, including maize, beans, sesame seeds, and sugar — much of which is destined for regional markets in South Sudan, the Democratic Republic of Congo, and Rwanda.

Uganda's import profile tells another story, one of industrial ambition and structural dependency. The country imports vast quantities of petroleum products, refined abroad and transported primarily via Kenya. This dependency on external energy supplies has a significant impact on the trade balance. Moreover, Uganda imports machinery, vehicles, construction equipment, pharmaceuticals, and textiles — reflecting its ongoing efforts to modernize its infrastructure and meet growing domestic demand for manufactured goods. These imports come largely from China, India, the United Arab Emirates, Kenya, and several European Union nations.

Despite the diversity of Uganda's trade, the country runs a persistent trade deficit. While annual exports hover around USD 5.5 billion, imports typically exceed USD 9 billion, creating a deficit of nearly USD 3.5 billion. This imbalance places pressure on foreign reserves and necessitates careful economic management. The top export, gold, brings in over USD 2 billion annually, while the leading import — refined petroleum products — costs Uganda more than USD 1 billion each year.

Uganda's trade relationships are deeply rooted in regional integration. As a founding member of the East African Community (EAC), Uganda benefits from reduced tariffs and a common customs union with neighbouring countries. The EAC facilitates intra-regional trade and promotes large-scale infrastructure development. Through COMESA (Common Market for Eastern and Southern Africa), Uganda accesses broader markets across the continent. Additionally, the African Continental Free Trade Area (AfCFTA), which Uganda ratified in 2018, promises to unlock new trade opportunities and reduce dependence on overseas markets.
South Sudan has emerged as Uganda's top regional export destination, with trade driven by demand for food products, beverages, and building materials. The DRC is another major market, absorbing vast quantities of Ugandan maize flour, sugar, and consumer goods. Kenya, while also a competitor in some sectors, remains a critical trade partner and transit country. India, China, and the United Arab Emirates are among Uganda's most significant global trade partners, supplying industrial inputs and consumer goods (see Table 1 and Table 2).

Table 1. Uganda's key trading partners and their roles.

Country/region	Role in trade
Kenya	Gateway via Mombasa port; top source of imports
South Sudan	Top regional export destination (maize, sugar, cement)
DR Congo	Major market for Ugandan food, cement, and beverages
United Arab Emirates (UAE)	Key gold and fuel trading partner
India & China	Top suppliers of machinery, textiles, chemicals
EU (especially Germany, Italy)	Destination for coffee, fish, and tea

Table 2. Noteworthy statistics on Uganda's recent trading activity. Note figures are approximations and vary annually depending on commodity prices and border conditions.

Indicator	2023-2024 estimate
Total exports (FOB)	~USD 5.5 billion
Total imports (CIF)	~USD 9.0 billion
Trade balance	~USD -3.5 billion (deficit)
Top export	Gold (~USD 2.2 billion)
Top import	Petroleum products (~USD 1.3 billion)

Uganda is a member of:

- **East African Community (EAC)**: Allows duty-free trade within the bloc; supports infrastructure and customs harmonization.
- **COMESA (Common Market for Eastern and Southern Africa)**: Expands regional trade opportunities.
- **AfCFTA (African Continental Free Trade Area)**: Uganda ratified this agreement in 2018, aiming to increase intra-African trade.

These frameworks offer Uganda tariff preferences, dispute resolution mechanisms, and platforms for infrastructure cooperation.

Trade challenges and opportunities

Uganda's landlocked status adds considerable logistical costs, often 20–30% higher than coastal nations. Poor rural infrastructure and bottlenecks at border crossings delay goods and increase operational expenses. Non-tariff barriers such as cumbersome customs procedures, inconsistent product standards, and informal trade practices further constrain competitiveness. The dominance of raw commodities in Uganda's export mix exposes the economy to volatile global prices and limits value addition. Compounding these issues, many small and medium-sized enterprises face difficulties accessing trade finance, with limited availability of credit guarantees, insurance, and export working capital.

Despite these hurdles, the future of Uganda's trade is bright with promise. Efforts to diversify the export base are gaining momentum. The government has prioritized agro-processing industries, encouraging value addition in coffee, fruits, cereals, and dairy. Export diversification has also begun to include avocados, hot peppers, and floriculture — products with growing demand in European and Middle Eastern markets.

Strategic investments in infrastructure are reshaping the trade landscape. Projects such as the Kampala–Jinja expressway, the planned standard gauge railway, and the oil pipeline from Hoima to Tanga are poised to enhance Uganda's logistics capacity. Industrial parks and Special Economic Zones (SEZs), such as those in Namanve and Mbale, are attracting investment and bolstering manufacturing for export. Digital trade platforms and customs automation have started reducing bureaucracy and enhancing transparency, making trade more efficient and accessible.

Trade in Uganda is, therefore, a story of transformation. From a colonial-era exporter of cash crops to an increasingly diversified and regionally integrated economy, Uganda's trade sector reflects both the country's resilience and its aspirations. While the challenges are real and often structural, the opportunities—fuelled by youth entrepreneurship, expanding infrastructure, regional cooperation, and resource endowment—offer a path forward.

In conclusion, Uganda's trade is not merely a transactional activity; it is a vital thread that weaves through the nation's development goals, regional ambitions, and global integration. With sustained reforms, strategic investment, and a commitment to industrial growth, Uganda has the potential to evolve from a primary commodity exporter into a dynamic trade hub at the heart of Africa.

Government stakeholders in SAF deployment

Uganda's governance ecosystem consists of a wide array of ministries, regulatory bodies, state-owned enterprises, and local governments, each playing a distinct role in delivering services, enforcing laws, and managing public resources (see Figure 4). While the architecture is robust and expansive, ongoing reforms in transparency, decentralization, and performance monitoring are vital to ensure that these institutions meet the growing needs of the Ugandan population.

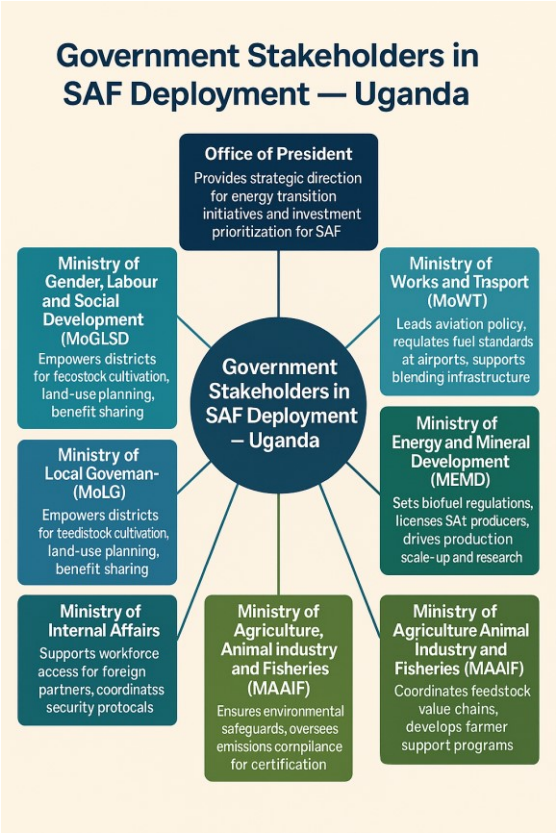

Figure 4. Key ministries in Uganda and their mandates.[8]

SAF success in Uganda requires coordination across multiple government entities (see figure above) because it spans through sectors such as energy security, agricultural growth, aviation competitiveness, rural job creation and climate transition mandates. By clearly defining these ministry roles early, Uganda can streamline governance, attract investors faster, and signal readiness to international aviation partners.

In addition to the above, Figure 5 shows the key agencies that operate with technical or regulatory independence but report to specific ministries or Parliament.

[8] Source: Constitution of the Republic of Uganda (1995, amended version)

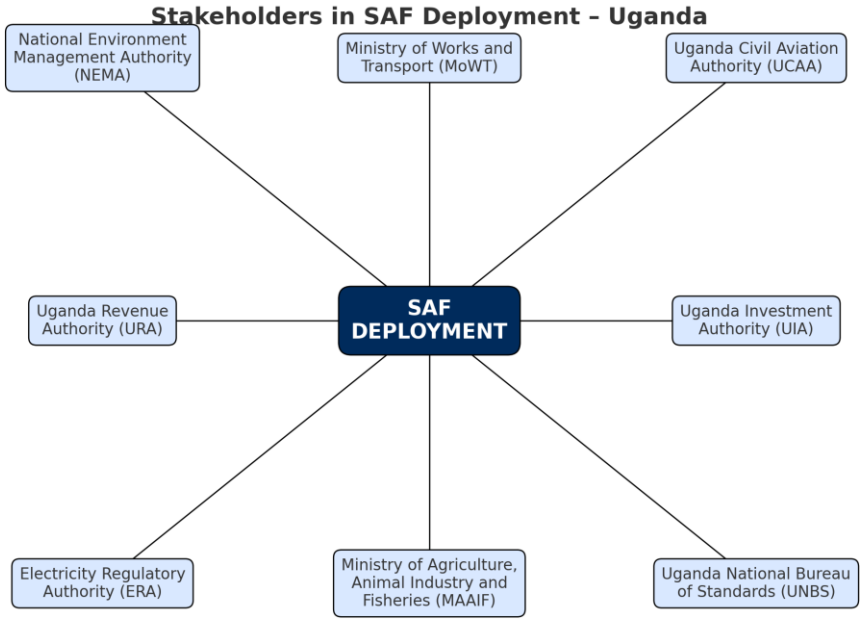

Figure 5. Key stakeholders in SAF deployment, including public bodies other than ministries.[9]

1.3 DEMOGRAPHICS

According to the 2024 census report (Uganda Bureau of Statistics), Uganda has a population of 45.9 million people (see Table 3). The population density is highest in Kampala, as illustrated in Figure 6.

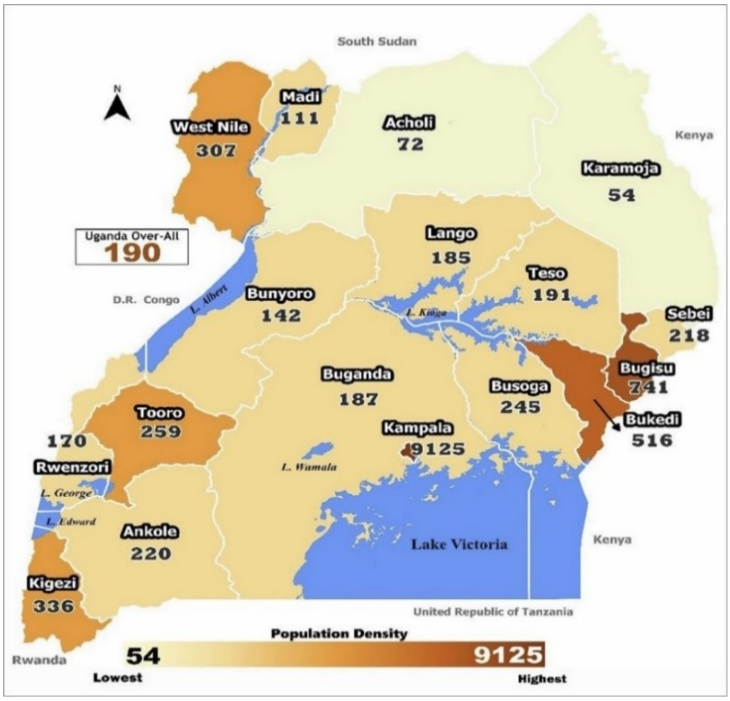

Figure 6. Population density in Uganda by sub-region.[10]

[9] Source: Ministry of Works and Transport https://www.works.go.ug as referenced in Uganda's Civil Aviation Policy and MoWT mandate documents

[10] Source: Uganda Bureau of Statistics (UBOS), National Population and Housing Census 2024 – Final Report Volume 1

Table 3. Population of major municipalities in Uganda based upon the 2024 census.[11]

Municipality	Population
Kampala	1 797 722
Nansana	692 478
Kira	459 827
Makindye-Ssabagabo	439 605
Arua	384 656
Kyengera	311 112
Mukono	305 945
Masaka	294 166
Mbale	290 414

1.4 VULNERABILITY TO CLIMATE CHANGE

1.4.1 Rising temperatures & changing weather patterns

Since the 1960s, Uganda's average temperature has risen by approximately 1.3 °C, with minimum and maximum temperatures increasing by ~0.5–1.2 °C and 0.6–0.9 °C respectively — about 0.28 °C per decade. This shift has led to more frequent and intense heatwaves and hot nights.

Rainfall has become more erratic—overall decreasing by around 12% over the past 34 years in key agricultural zones, with less predictable onset and duration of rainy seasons. Figure 7 illustrates the potential impact of temperature variations on coffee production.

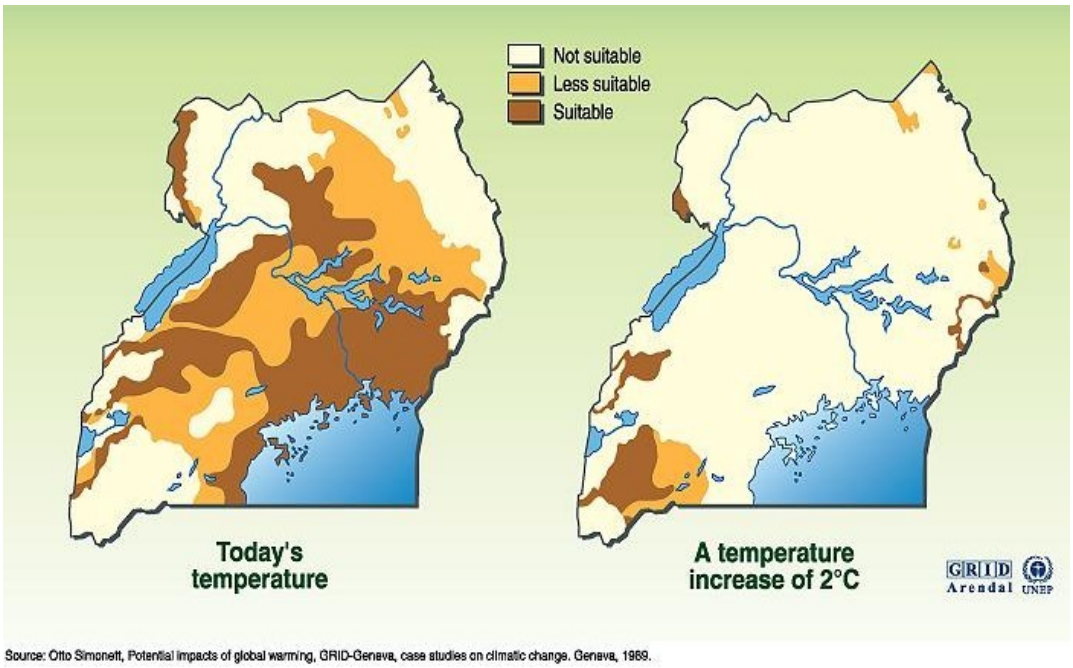

Figure 7. Impact of temperature on robusta coffee in Uganda.[12]

[11] Source: Uganda Bureau of Statistics (UBOS), National Population and Housing Census 2024 – Final Report Volume 1

[12] Source: GRID-Arendal / United Nations Environment Programme; S. Naddamba, "The potential impact of temperature variations on coffee production in Mityana district, Uganda" (2021, Busitema University)

1.4.2 Extreme weather: floods, droughts & landslides

Uganda experiences frequent flash flooding and drought events, largely influenced by the country's topography (see Figure 8). Between 1900 and 2018, it recorded approximately 20 floods, 9 droughts, and 5 landslides, which together caused at least 200 000 deaths and an estimated USD 80 million in economic losses.[13] Recent deadly landslides include the December 2024 Mt Elgon incident, which killed 28 people, and the 2022 Kasese landslides, which resulted in around 15 fatalities. Flooding—particularly during El Niño years, typically from September to December—regularly inundates infrastructure, displacing communities and damaging transport networks, homes, and communication systems.

1.4.3 Agriculture & food security

With more than 80% of Uganda's workforce dependent on rain-fed agriculture—which accounts for about 40 per cent of the country's GDP—erratic rainfall patterns and heat stress significantly disrupt crop yields and overall food availability.[14] Declining rainfall and prolonged dry spells increasingly threaten staple crops such as maize, sorghum, millet, and coffee, raising the risk of higher food prices, malnutrition, and hunger across vulnerable communities.

1.4.4 Water resources & ecosystem loss

Melting glaciers in the Rwenzori Mountains are reducing seasonal water flow and contributing to worsening river flooding, soil erosion, landslides, and ecosystem disruption. Water bodies across the country face both scarcity during dry seasons and contamination during floods, and more than seven million people lack access to safe drinking water, with poor sanitation further compounding public health risks.

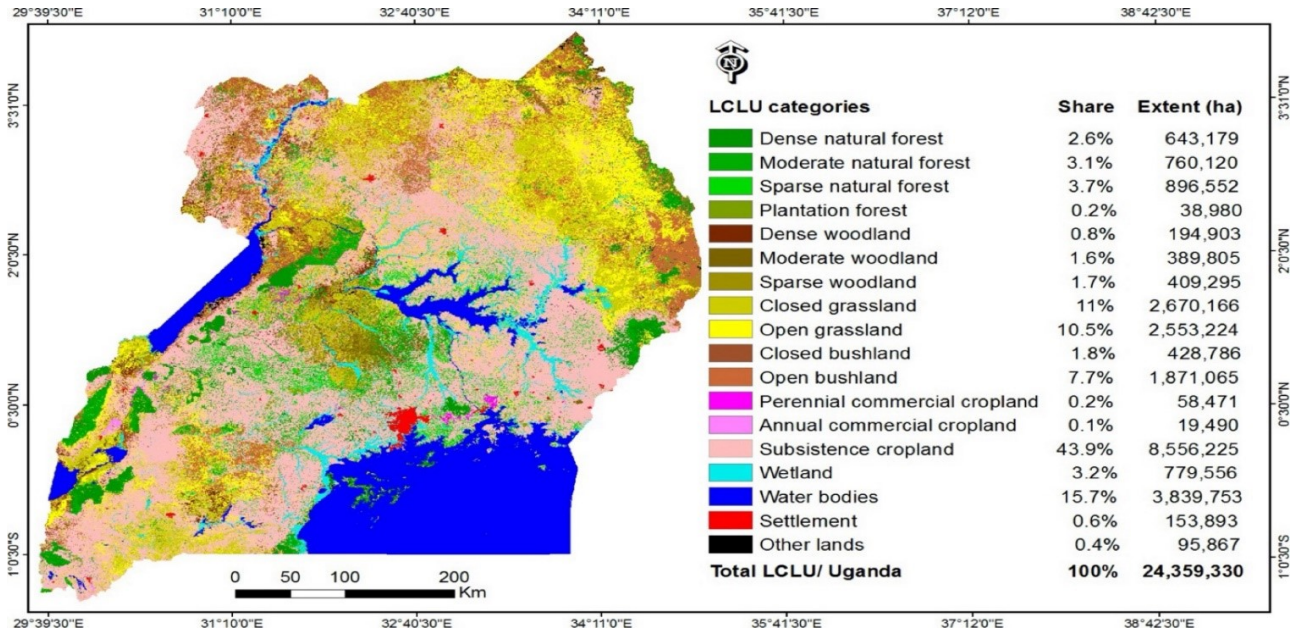

Figure 8. Topographical distribution in Uganda.[15]

[13] Source: Climate Knowledge Portal

[14] UNFCC: Enabling Farmers to Adapt to Climate Change

[15] Source: FloodMap.net — Interactive elevation map of Uganda generated from NASA SRTM, 2025

1.4.5 Human health risks

- Climate-driven floods and droughts fuel disease outbreaks: cholera, diarrheal illnesses, malaria, dengue, and respiratory infections.[16]
- Warming temperatures and higher humidity have expanded mosquito habitats, pushing malaria into highlands and intensifying vector-borne disease transmission.
- In response, Uganda launched a National Health Adaptation Plan (2024), focusing on climate-resilient infrastructure and healthcare training, supported by the Rockefeller Foundation.

1.4.6 Infrastructure & economic loss

- Roads, bridges, airports, and energy systems are increasingly vulnerable to destructive floods, eroding economic resilience. The 2010 Bududa landslide killed over 100 and demolished significant infrastructure.
- Economically, without adaptation, climate damages could cost Uganda 2–4% of GDP annually between 2010 and 2050 (~ USD 3.2–5.9 billion/year), especially in agriculture, water, energy, and infrastructure sectors.[17]

1.4.7 Ecosystems & biodiversity

- Deforestation and land degradation are accelerated by changing climate, triggering bush encroachment, loss of biodiversity, and increased invasive species.
- Ecosystem shifts damage wildlife habitats in forests and mountainous zones, with cascading effects on tourism and ecosystem services.

Table 4. Summary of climate-change driven risks.[18]

Risk type	Hotspot areas	Impacts
Flood/landslide	Mt Elgon slopes, Nile basin, Lake Victoria fringes	Infrastructure loss, displacement, fatalities
Drought	Karamoja & cattle corridor	Crop failure, food insecurity, pastoral distress
Soil erosion	Upslope croplands, rangelands	Land degradation, sedimentation, flood amplitudes
Crop suitability	Central, eastern belt	Reduced yields for staples (banana, coffee)
Overall vulnerability	Karamoja, central east	Compound exposure across sectors (agriculture, water etc.)

1.5 AGRICULTURE

Agriculture is the cornerstone of Uganda's economy and society. It supports the livelihoods of the majority of Ugandans, contributes significantly to the country's GDP, and plays a central role in food security, employment, and exports. Uganda's fertile soils, favourable climate, and abundant water resources make it well-suited for a wide range of agricultural activities, from subsistence farming to large-scale commercial enterprises. Despite its potential, the sector faces persistent challenges, including limited access to technology, land fragmentation, climate change, and market volatility. Figure 9 illustrates the link between annual rainfall and agricultural output in Uganda.

[16] Health Effects of Climate Change in Africa - National Library of Medicine

[17] Economic Assessment of the Impacts of Climate Change in Uganda - Ministry of Water and Environment

[18] Source: United Nations Development Programme (UNDP), "Climate Risk Management: Uganda", 2025

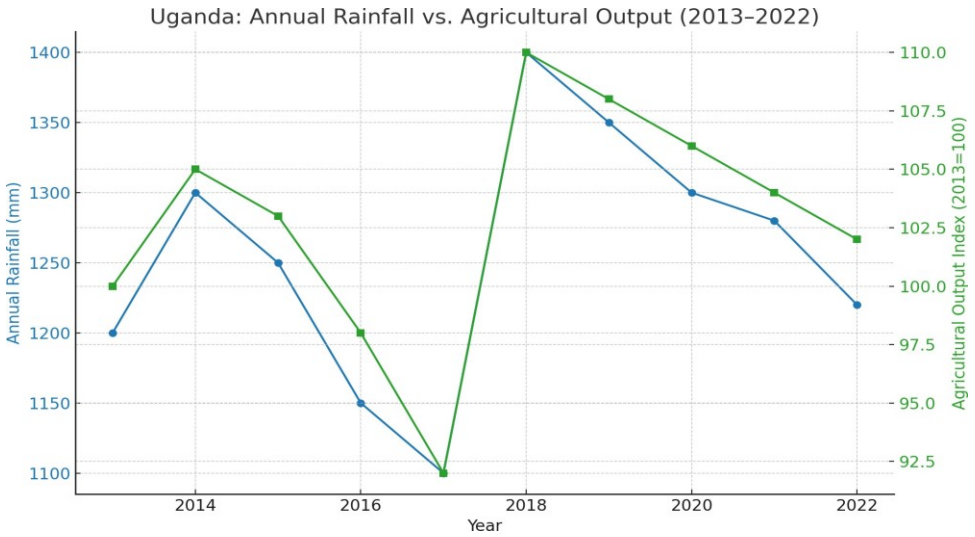

Figure 9. Trend of annual rainfall and agricultural output in Uganda.[19]

1.5.1 Importance of agriculture in Uganda

Agriculture remains the largest employer in Uganda, with over 70% of the population engaged in the sector, particularly in rural areas. It contributes about 24% of GDP (as of recent estimates) and over 50% of export earnings, particularly through coffee, tea, and fish. The sector is central to national development goals, including poverty reduction, food security, and economic transformation.

1.5.2 Types of agriculture

Uganda practices both subsistence and commercial agriculture (see Figure 10).

- Subsistence farming dominates, with smallholder farmers using traditional methods to grow food for their families and selling any surplus in local markets.
- Commercial agriculture is expanding, particularly in export-oriented crops and livestock. Some investors are also engaging in large-scale agribusiness, though land acquisition and equity remain sensitive issues.

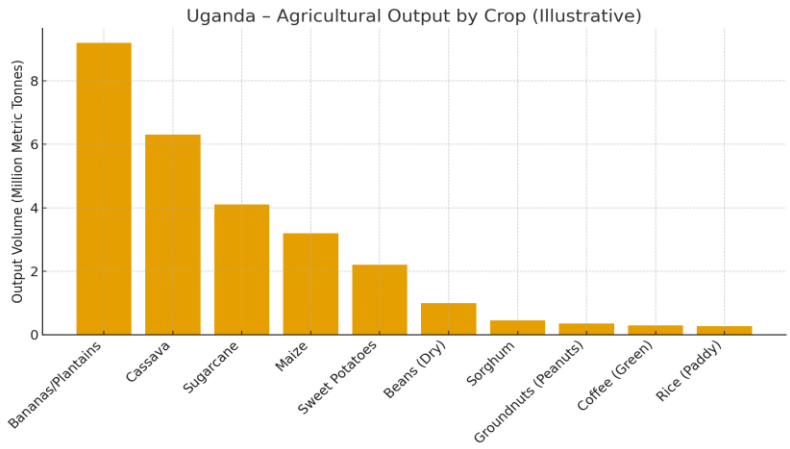

Figure 10. Total agricultural output by crop in Uganda in 2024.[20]

[19] Source: Annual Agricultural Survey and crop-production data: Uganda Bureau of Statistics (UBOS), AAS 2023

[20] Source: The Uganda Bureau of Statistics (UBOS) Annual Agricultural Survey 2024

1.5.3 Major crops

Uganda has diverse agro-ecological zones that support a wide range of crops, as shown above. Key categories include:

1. Food crops

- Bananas (Matooke): A staple food, especially in central and western Uganda.
- Cassava and sweet potatoes: Grown widely as food security crops.
- Maize: A staple and cash crop in eastern and northern regions.
- Beans, groundnuts, and sorghum: Important protein and carbohydrate sources.

2. Cash crops

- Coffee: Uganda is Africa's second-largest coffee producer after Ethiopia. Robusta and Arabica are grown, primarily for export.
- Tea: Grown in the highlands of southwestern Uganda.
- Cotton: Once a major export crop, now less dominant but still grown in the east and north.
- Sugarcane: Grown around Lake Victoria, especially in Busoga and Buganda.

3. Horticultural crops

- Includes pineapples, mangoes, avocados, onions, tomatoes, and passion fruit. An emerging export sector, particularly to Europe and the Middle East.

1.5.4 Livestock farming

Livestock is a vital component of Ugandan agriculture, particularly in the semi-arid and pastoral regions of the north and northeast.

- Cattle: Both indigenous breeds and improved dairy cattle are reared. Ankole longhorn cattle are common in the west.
- Goats and sheep: Raised widely, especially in drier regions.
- Poultry: Smallholder chickens and commercial poultry are significant for both meat and eggs.
- Pigs: Pork is popular in Uganda, and piggery is expanding rapidly.

1.5.5 Fisheries and aquaculture

With many lakes and rivers, Uganda has a thriving fisheries sector, especially in:

- Lake Victoria, Lake Albert, and Lake Kyoga.
- Nile Perch and Tilapia are the most commercially important species.
- Aquaculture (fish farming) is growing due to overfishing and demand for protein-rich food.

1.5.6 Regional patterns of agriculture

Uganda's agricultural production varies by region due to climate, soils, and culture:

- Central Uganda: Dominated by bananas, coffee, and poultry.
- Eastern Uganda: Major maize and rice production area.
- Northern Uganda: Groundnuts, sorghum, millet, and cotton are common.
- Western Uganda: Known for dairy farming, tea estates, bananas, and coffee.

1.5.7 Agricultural exports

Coffee alone accounts for 20–30% of Uganda's export earnings and supports millions of smallholder farmers (see Table 5).

Table 5. Uganda's leading agricultural exports and destination markets, by value of commodity.[21]

Rank	Commodity	Estimated export value	Key destination markets
1	Coffee	~USD 877 million (2022)	EU (Germany, Italy), USA, Sudan, India
2	Fish & fish products	~USD 160–180 million	EU, UAE, regional markets
3	Dairy products	~USD 150 million	Kenya, DR Congo, South Sudan
4	Maize & other cereals	~USD 120 million	Kenya, South Sudan, Rwanda, DRC
5	Cut flowers & horticulture	~USD 110 million	Netherlands, EU, UAE
6	Tea	~USD 95–100 million	Pakistan, UK, UAE
7	Tobacco (leaf)	~USD 70–80 million	European/Asian buyers
8	Oilseeds / groundnuts / sesame	~USD 55–70 million	Middle East & Asian markets
9	Cocoa beans	~USD 40 million	Netherlands, Belgium
10	Sugar & sugarcane products	~USD 30–40 million	Regional (South Sudan, DRC)

1.5.8 Challenges facing agriculture

Despite its promise, agriculture in Uganda is hindered by multiple structural and environmental challenges:

- Low productivity due to limited mechanization and poor inputs.
- Land fragmentation, especially from inheritance systems.
- Climate change, with erratic rainfall and increased droughts.
- Post-harvest losses due to poor storage and transport.
- Limited access to credit, extension services, and markets.
- Pest and disease outbreaks, such as the banana bacterial wilt and armyworm infestations.

1.5.9 Government and development initiatives

Uganda's government, along with international partners, has implemented several policies and programs to support agriculture:

- National Agricultural Policy (2013): Focuses on productivity, commercialization, and sustainability.
- Operation Wealth Creation (OWC): A government initiative distributing seeds, animals, and farm tools.
- Uganda Coffee Development Authority (UCDA): Promotes quality coffee production and marketing.
- Irrigation schemes and climate-smart agriculture projects funded by the World Bank and FAO.

1.6 ENERGY

Uganda's energy industry plays a crucial role in its socio-economic development. As the country industrializes and urbanizes, access to reliable, affordable, and sustainable energy is becoming increasingly vital. Uganda is endowed with a variety of energy resources — including hydro, solar, biomass, and fossil fuels — but still faces major gaps in generation, transmission, distribution, and access, especially in rural areas.

[21] Source: Uganda Bureau of Statistics (UBOS) International Merchandise Trade Statistics and Agricultural Export Data https://www.ubos.org (Trade tables by commodity value and destination markets)

1.6.1 Overview of the energy sector

The energy sector in Uganda is divided into three main sub-sectors:

- Electricity
- Petroleum (oil and gas)
- Renewables and Biomass

The sector is regulated by the Ministry of Energy and Mineral Development (MEMD) and the Electricity Regulatory Authority (ERA), with support from institutions like the Rural Electrification Agency (REA), the Uganda National Oil Company (UNOC), and the Uganda Electricity Transmission Company Limited (UETCL).

Electricity generation

Uganda's electricity generation is dominated by hydropower, accounting for over 80% of total capacity. As of 2024, Uganda had an installed generation capacity of over 1 400 MW, which far exceeds the current peak demand (about 800–850 MW), creating a generation surplus.

Key hydropower plants include:

- Karuma Hydropower Station (600 MW) – commissioned in 2022 (see Figure 11)
- Isimba (183 MW)
- Nalubaale and Kiira (combined 380 MW) on the Nile River

In addition to hydro, Uganda has small contributions from:

- Solar energy (e.g., Soroti and Tororo plants)
- Thermal (diesel) power plants
- Bagasse and biomass co-generation in sugar factories

Figure 11. Karuma Hydro Power Station.[22]

[22] Source: Uganda Electricity Generation Company Limited (UEGCL)

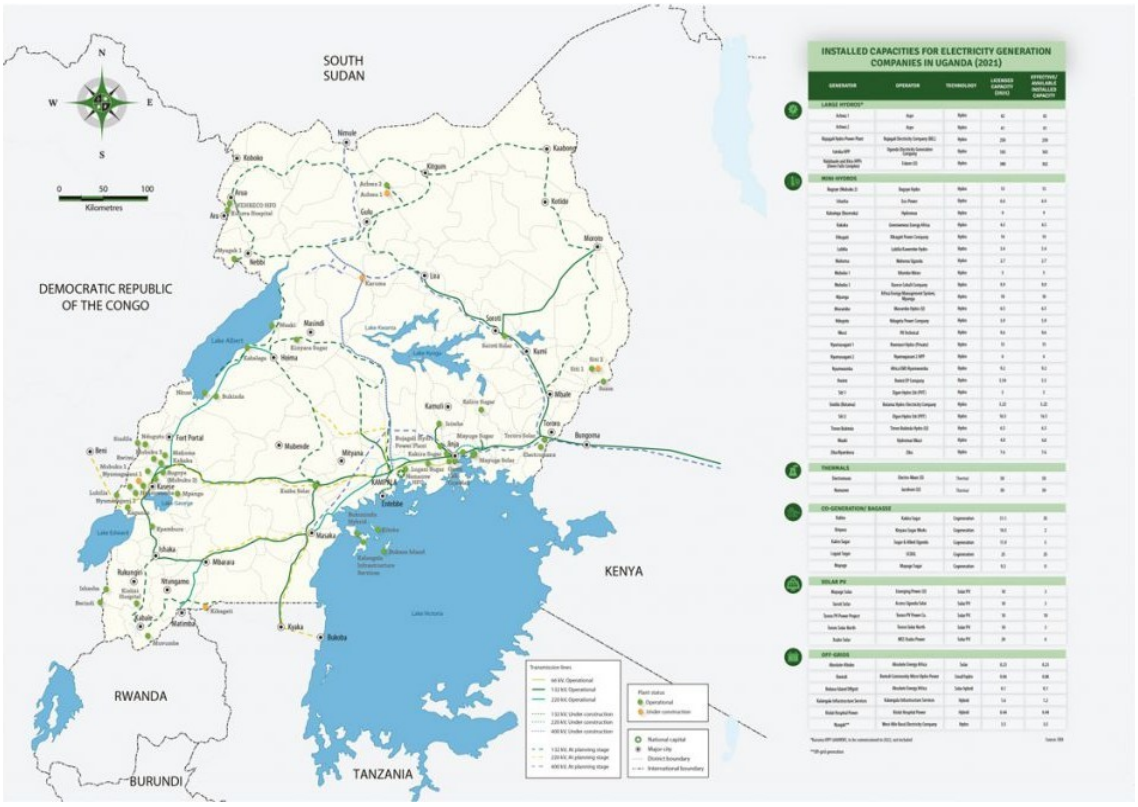

Figure 12. Power infrastructure in Uganda.[23]

1.6.2 Transmission and distribution

Power infrastructure is shown in Figure 12. While generation is increasing, transmission and distribution infrastructure remains underdeveloped. Grid losses, outages, and limited rural reach hamper access and reliability.

- The national grid is managed by UETCL.
- Distribution is largely handled by Umeme Limited, Uganda's main electricity distributor.
- Electrification rates (2024):
    - Urban areas: ~60–70%
    - Rural areas: ~25%
    - National average: ~40%

1.6.3 Petroleum and oil industry

Uganda discovered commercially viable oil reserves in the Albertine Graben region in 2006. The proven reserves are estimated at 6.5 billion barrels, with about 1.4 billion recoverable.

Key developments:

- Tilenga and Kingfisher oil fields are being developed by TotalEnergies, CNOOC, and UNOC.
- The East African Crude Oil Pipeline (EACOP) will transport crude oil from Hoima (Uganda) to the port of Tanga (Tanzania).
- Oil refinery: Uganda plans to build a refinery with a capacity of 60 000 barrels/day in Hoima.

[23] Source: Ministry of Energy

Once operational, oil production is expected to transform Uganda's energy landscape and economy, creating jobs and boosting revenues. However, concerns exist around:

- Environmental and social impacts
- Delays in infrastructure development
- Financing and global shift toward renewables

1.6.4 Renewable energy and biomass

1. Biomass

- Biomass (firewood, charcoal, crop residues) accounts for over 85% of Uganda's total energy consumption, while electricity accounts for the remainder
- Widely used in households for cooking, especially in rural areas.
- Inefficient use and unsustainable harvesting contribute to deforestation and indoor air pollution.

2. Solar energy

- Abundant solar radiation (average of 5.1 kWh/m²/day).
- Growth of solar home systems and mini-grids, especially in off-grid rural areas.
- Government and development partners support solar initiatives (e.g., GET-FiT, SolarNow).

3. Wind and geothermal

- Wind energy potential is limited but being studied in certain highland areas.
- Geothermal exploration is ongoing in western Uganda (e.g., Katwe, Kibiro, Panyimur), though still in early stages.

1.6.5 Energy access and policy goals

Uganda's energy policy aims to achieve universal access by 2040 under the Electricity Connections Policy (ECP) and Vision 2040 strategy.

Key targets include:

- Expanding grid and off-grid electrification
- Reducing dependency on biomass
- Improving energy efficiency
- Transitioning to clean cooking technologies

1.6.6 Challenges facing Uganda's energy sector

Uganda's energy sector continues to evolve, but significant structural and operational challenges impact its ability to support emerging industrial opportunities such as Sustainable Aviation Fuel (SAF) production. While the country has expanded electricity generation in recent years — particularly through multiple large hydropower projects — reliability, affordability, and limited national coverage remain barriers to scalable clean-energy-driven industrialization.

A central constraint is Uganda's heavy reliance on hydropower, which supplies over 90% of transmitted electricity (78.8% large hydro + 14.5% small hydro in 2023)[24]. This dependence makes national energy security increasingly vulnerable to climate variability, including prolonged droughts and reduced river flows that diminish the generation capacity of Nile-based dams. For energy-intensive industries such as SAF production, this introduces supply-stability risks and motivates the need for broader energy mix diversification into solar, biomass cogeneration, and battery-backed systems.

Access to grid electricity also remains uneven. Uganda's national electrification rate is estimated around 57%, while rural connectivity hovers near 30%, leaving most agricultural production zones without reliable grid service[25]. Because the majority of SAF-relevant feedstocks — such as cassava, sugarcane, and oilseeds — originate from rural regions, the lack of power access hinders local feedstock pre-processing and drives up logistics costs when raw materials must be transported before value addition.

Even where power is available, electricity pricing presents competitiveness challenges. Industrial tariffs stand at approximately UGX 351.5 per kWh (~USD 0.09) for large manufacturers and UGX 417.8 per kWh (~USD 0.11) for medium-scale industries as of early 2025. According to the Uganda Manufacturers Association, cost structures need to approach USD 0.05 per kWh to compete with peer economies.[26] For SAF producers, which face high operating cost pressures relative to fossil jet fuel, Uganda's elevated industrial tariffs represent an economic hurdle requiring government incentives or dedicated energy-pricing frameworks.

Infrastructure inefficiencies further compound cost and reliability issues. Distribution losses remain high at 17.3% in 2023, while transmission losses are around 4.8%, contributing to tariff inflation and reducing supply dependability[27]. Frequent outages due to grid instability can cause downtime in refinery-style operations, leading to production delays and higher capital-recovery costs for SAF plants.

Uganda's incomplete downstream petroleum infrastructure also presents logistical challenges. The country currently imports nearly all refined fuels, and although investments continue at the Hoima refinery and associated storage facilities, there is no nationally operational jet fuel blending network. SAF deployment will require dedicated dispensing, certification, and handling infrastructure at key airports — beginning with Entebbe — and integration into national fuel distribution.

Project financing remains a further challenge. Large-scale energy and fuel facilities often require blended finance involving concessional capital, climate funds, and private equity, but slow procurement processes and regulatory uncertainty have historically discouraged investors. This can delay the development of SAF production plants that must demonstrate bankable certainty in policy, energy supply, and offtake agreements. Finally, Uganda retains a skills and equipment dependency on international technology providers in sectors such as refining, power transmission, and advanced biofuel processing. Without a skilled domestic workforce and local manufacturing capacity, SAF projects may face higher O&M costs and slower operational ramp-up, especially when located in rural agro-industrial zones that lack experienced technicians.

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[24] Source: Electricity Regulatory Authority (ERA): Industrial tariffs, energy mix, transmission & distribution loss data (2023–2025)

[25] Source: Ministry of Energy & Mineral Development (MEMD): Energy & Mineral Sector Performance Reports)

[26] Source: Electricity Regulatory Authority (ERA): Industrial tariffs, energy mix, transmission & distribution loss data (2023–2025)

[27] Source: Uganda Manufacturers Association (UMA): Industrial energy pricing competitiveness reports

In summary, Uganda's energy sector constraints—including high tariffs, uneven grid access, climate-vulnerable hydropower dependence, infrastructure inefficiencies, and limited downstream fuel assets—significantly influence the feasibility and strategic siting of SAF facilities. Addressing these challenges through energy diversification, targeted incentives for green industries, accelerated grid expansion, and improved industrial energy governance will help ensure that SAF development supports—and benefits from—Uganda's broader economic and environmental transformation goals.

1.7 AVIATION SECTOR IN UGANDA

Uganda is a landlocked country in the East African region; therefore, air transport is of strategic importance to the nation as it guarantees an alternative gateway to the rest of the world. Air transport services in Uganda started with the flying boats that landed at Port Bell, Luzira at the shores of Lake Victoria, to deliver mail in the early 1930s. This was an extension of the Wilson Airways that started air operations in neighbouring Kenya in 1929. In 1946 the Directorate of Civil Aviation (DCA) was formed, followed by the construction of the country's main airport at Entebbe in 1947, however, the International Airport was commissioned in 1952. Travel by air provides the most efficient and quickest transport means to Uganda and from the country to the rest of the world.

Uganda's aviation industry is the nucleus of the country's development and is a pivotal link between Uganda and other countries. The country's perishable high value commodities are also exported by air as well as much of the sensitive drugs and vaccines. Uganda also boasts of great natural tourism sites and a great deal of tourists are transported by air into the country especially by foreign registered international carriers and internally by private charters. The development of a safe, efficient, reliable and environmentally sustainable air transport industry is thus among the government's priority programmes. The Civil aviation services were later taken on by several Government Departments, leading to segmentation. The need to harmonize and efficiently run civil aviation services in the country led to the establishment of the Civil Aviation Authority in 1991.

Uganda currently operates one International Airport at Entebbe which is under expansion and upgrade to accommodate the demand of increasing passengers and cargo traffic. Additionally, the government is constructing a new international airport, the Kabalega International Airport in Hoima district, to serve the demands of the oil industry.

In 2019 the Entebbe International Airport (EIA) handled 2 008 238 passengers (International, Domestic and Transit passengers) and 64 731 t of cargo (Imports and Exports). However, due to the effects of travel restrictions caused by the Covid-19 pandemic, in 2020, EIA handled 622 643 passengers and 58 898 t of cargo. Reports from ICAO had estimated that air traffic would get back to the pre-pandemic levels (where it was in 2019) by 2023.[28]

[28] Source: Uganda Civil Aviation Authority (UCAA), *Traffic Results 2020 & 2021* https://caa.go.ug/passenger-and-cargo-traffic-statistics/

Figure 13. Aerial view of Entebbe International Airport.[29]

In regard to regional and local transport, there are thirteen (13) regional aerodromes under management of the Uganda Civil Aviation Authority (UCAA). These include Arua, Gulu, Soroti, Kasese, Kisoro, Jinja, Kidepo, Lira, Pakuba, Tororo, Masindi, Mbarara and Moroto. Government intends to upgrade five (Arua, Gulu, Pakuba, Kidepo and Kasese) regional aerodromes to promote trade and tourism. Furthermore, there are 20 airports and airstrips that are privately managed.

Historically, Uganda's aviation fuel consumption has remained relatively low due to limited air traffic volumes, infrastructure constraints, and the small size of its domestic and regional airline market. From 2010 to 2015, jet fuel demand increased from approximately 222 600 to 349 800 L per day (equivalent to 58 800 to 92 400 US gallons per day), driven by a gradual rise in international passenger movements through Entebbe International Airport. This growth period coincided with infrastructure investments at the airport, expansion of cargo traffic, and more regional airline activity.[30]

Between 2015 and 2020, demand fluctuated slightly, stabilizing around 318 000 to 365 400 L per day (83 980 to 96 500 US gallons), reflecting a maturing market constrained by both structural and global shocks—including the impact of the COVID-19 pandemic in 2020, which caused a noticeable dip in consumption. In the subsequent years (2021–2023), a rebound emerged as regional travel resumed and national airline operations, including Uganda Airlines, expanded their footprint.[31]

By 2023, jet fuel consumption stood at 319 500 L per day (84 350 US gallons). While this remains modest in global terms, it signifies a renewed momentum, reinforced by rising passenger numbers, air cargo growth, and government commitment to aviation infrastructure. Entebbe International Airport's enhanced facilities—including new fuel storage capacity, upgraded terminal buildings, and a planned cargo village—have strengthened Uganda's potential as a regional air hub.[32]

[29] Source: Uganda CAA
[30] Source: MEMD Sector Performance Reports (2012–2016 editions) https://www.energyandminerals.go.ug/
[31] Source: MEMD Sector Performance Reports (2015–2023 editions) https://www.energyandminerals.go.ug/
[32] Source: MEMD Sector Performance Reports (2015–2023 editions) https://www.energyandminerals.go.ug/

Looking ahead, the projection from 2024 to 2030 anticipates a 5% annual growth rate in aviation fuel demand. This forecast is grounded in several strategic assumptions: an expanding route network for Uganda Airlines, increased connectivity to key regional and international destinations, continued GDP growth, and improved airport throughput. By 2030, demand could reach approximately 441 000 to 477 000 L per day (116 500 to 126 000 US gallons), signalling a 40–50% increase over 2023 levels.[33]

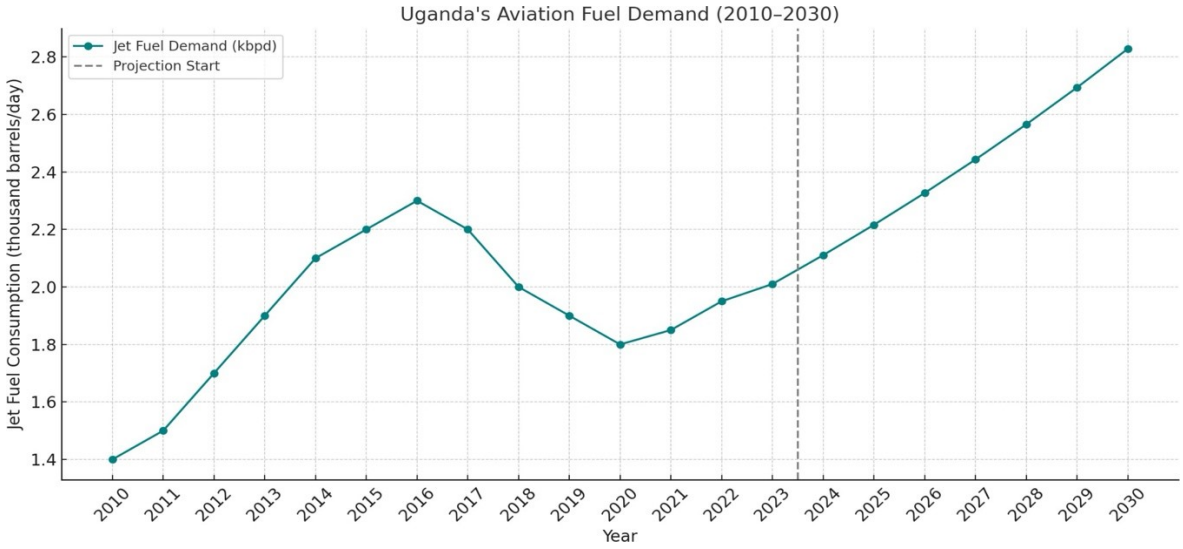

Figure 14. Aviation fuel demand in Uganda (historical data and projections).[34]

Several external and internal factors will influence the pace and scale of this growth. First, Uganda's regional trade ambitions and participation in cross-border infrastructure initiatives, such as the East African Single African Air Transport Market (SAATM), could accelerate aviation activity. Second, domestic oil production and refinery developments in Hoima are expected to support localized jet fuel supply, reducing reliance on imports and potentially lowering cost volatility.

Third, the global and regional push toward Sustainable Aviation Fuel (SAF) introduces both an opportunity and a challenge. As ICAO and IATA push for cleaner fuels, Uganda's aviation sector will need to balance growth in conventional jet fuel demand with SAF adoption, possibly beginning with small-scale blending mandates or voluntary offset programs.

The chart encapsulates a cautiously optimistic vision for Uganda's aviation fuel future. It charts the historical journey from recovery to resilience and sketches a forward-looking pathway informed by infrastructure readiness, policy direction, and market potential. For stakeholders—including fuel suppliers, regulators, airlines, and development partners—this trajectory provides a data-driven foundation to align investment, policy, and sustainability strategies with the realities of Uganda's evolving aviation ecosystem.

[33] Source: United States Energy Information Administration. https://www.eia.gov/international/data/world/petroleum-and-other-liquids/more-petroleum-and-other-liquids-data

[34] Source: United States Energy Information Administration https://www.eia.gov/international/data/world/petroleum-and-other-liquids/more-petroleum-and-other-liquids-data

1.7.1 Fuel supply Chain

In order to establish an optimal supply chain, whilst leveraging existing infrastructure, Uganda will need to rely on key fuel suppliers, follow the framework created by the environmental protection plan and undertake additional tasks to improve the SAF supply chain. Aviation fuel at Entebbe International Airport is supplied by the Entebbe Joint Aviation Fuel (EJAF), a consortium of fuel companies including Vivo Energy Uganda, Total Energies and Tristar Energies.

Total Energies Aviation Solutions

Total Energies has specialized in supplying, marketing jet fuels and aviation gasoline for over 50 years. Total Energies has the largest market share in the aviation business in Uganda, which has been consistently above 50% since 2013 (Uganda CAA data within "aviation fuel market study 2023").

Vivo Energy Uganda

Vivo Energy Uganda runs the Solus into plane fuelling activities and a joint venture storage and hydrant fixed facility, playing a vital role in the growth of the industry.

1.7.2 Aviation Environment Protection Plan

Uganda Civil Aviation Authority (UCAA) has joined other States in setting development policy and standards to limit and reduce the impact of aviation carbon emissions on the global climate and to take action and advance initiatives on environmental protection, through the ICAO State Action Plan initiative launched in 2010 as a means for States to develop national strategies for reducing aviation carbon emissions.

Uganda submitted its initial State Action Plan (SAP) to ICAO in 2017 and it is due for updating. In the updated SAP, Uganda is expected to define a quantified baseline scenario on carbon emission, select appropriate emissions mitigation measures and estimate the expected results of implementing those measures. The process of updating the State Action Plan is in progress, the strategic measures in the plan reflect the national capacities and circumstances, including quantified information on the expected environmental benefits from the implementation of the measures.

The action plan also establishes medium term and long-term strategy on climate change for the aviation sector in the country and these strategies are derived with involvement of all stakeholders at national level such as airline operators, aerodrome management, air navigation service providers, handling services, fuel farms, Ministry of Works and Transport and the National Environment Authorities among others.

Uganda is also participating in the ICAO initiative of Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA), following the 27 June 2018, ICAO Council decision to adopt the First Edition of Annex 16, Volume IV on the Standards and Recommended Practices (SARPs) for Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA).

Following the UCAA decision to join and participate in the voluntary phase of CORSIA, Uganda CAA has taken steps in implementation of CORSIA activities and these include:

- Nomination of CORSIA Focal Point
- Participated in the initial ICAO organized CORSIA capacity building.
- Joined to participate in the voluntary Pilot and First phases of CORSIA
- Commenced the process of updating the initial SAP
- Registered Uganda Airlines under CORSIA Monitoring, Reporting and Verification (MRV) system in 2023

- Started the process of developing the Civil Aviation Regulation for CORSIA

1.7.3 Requirements for a SAF supply chain

Before SAF can be produced, a feedstock must go through several steps, as shown in the following steps (see diagram below):

- The feedstock must be produced and collected. In the case of agricultural biomass, this means growing and harvesting. Non-biological feedstocks as MSW and captured carbon dioxide have their own logistical processes.
- Once collected, the feedstock must be sorted, treated, processed, and transported to a production facility.
- At the production facility, the feedstock is converted into SAF by one of the approved conversion pathways. The feedstock may undergo transformation into an intermediate product beforehand. For example, sugar-containing feedstock may be processed into ethanol before conversion to SAF. In this way, it may be possible for a SAF facility to use inputs from multiple feedstocks in the same category.
- Once produced, the neat (pure) SAF must be blended with fossil jet fuel and distributed to the airports. This process is shown in Figure 15.

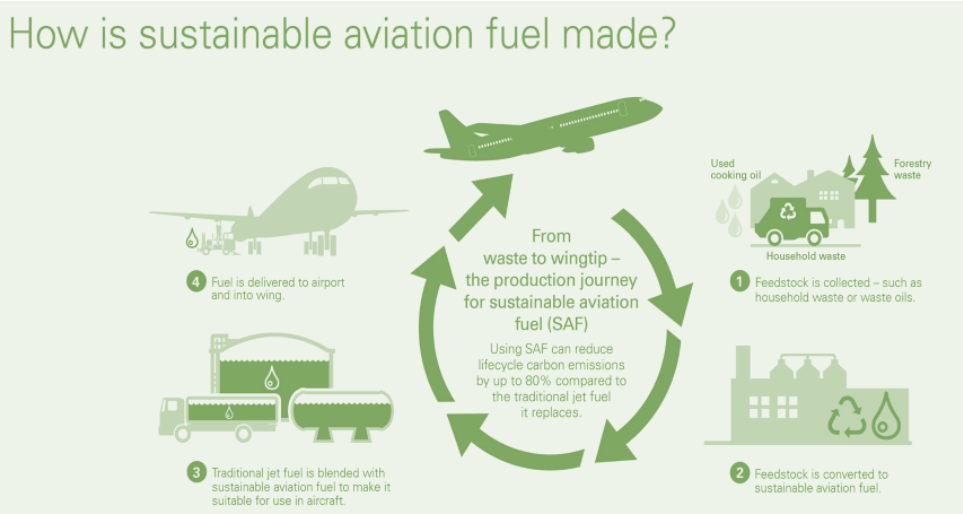

Figure 15. SAF integrated aviation fuel ecosystem process flow.[35]

Blending

Current regulations stipulate that SAF must be blended with jet fuel before being uploaded into an aircraft. Blending levels vary by production pathway and can go up to a level of 50%. Therefore, blending is a critical part of the SAF delivery chain.

If the SAF feedstock is co-processed at a refinery, the resulting blend is equivalent to jet fuel, and the current supply chain would be used. This is expected to be done at existing fuel terminals and then delivered to airports by pipeline, rail, or truck. Since the blending would occur upstream to the airport, no operational changes or investments would be needed at the airports. In addition, due to the space restraints, the need for additional staff and equipment, and quality standards it makes more sense to certify SAF as ASTM D1655 upstream of an airport.

[35] Source: Effectual Services https://www.effectualservices.com/article/sustainable-aviation-fuel

Uganda's highly developed petroleum infrastructure that includes the future Hoima Refinery makes it an ideal location to blend SAF produced from various pathways not only domestically but also for the region.

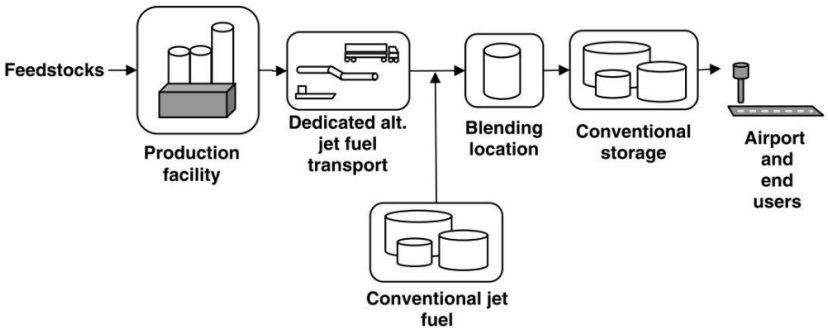

Figure 16. SAF Supply Chain with blending and delivery to airport.[36]

[36] Source: Airport Cooperative Research Program, 2012

SECTION 2. EVALUATION OF FEEDSTOCKS AND PATHWAYS FOR SAF PRODUCTION

2.1 PRODUCTION PATHWAYS

2.1.1 Alcohol to Jet (AtJ) Pathway

The alcohol to jet pathway combines two established commercial processes:

(i) the conversion of starch or sugar to ethanol, and

(ii) the dehydration and oligomerization of ethanol to produce jet-range alkanes.

The processes could be conducted independently, e.g., with sugarcane ethanol produced at one location and shipped to a second facility that converts the ethanol into sustainable aviation fuel. Alternatively, the two processes could be co-located, with sharing of utilities and process integration that reduces overall capital costs and reduces the carbon intensity of the fuel. Sugarcane bagasse could, for example, potentially provide the heat and electricity required for both processes.

AtJ is commercially approved under ASTM D7566 for blending into Jet A/A-1 fuel (Source: ASTM International — D7566 Standard Specification for Aviation Turbine Fuel Containing Synthesized Hydrocarbons):

- ATJ–SPK from isobutanol (GEVO / Annex A5)
- ATJ–SPK from ethanol (LanzaJet / Annex A7)

Approved maximum blend limits are currently up to 50% with fossil jet fuel, pending demonstration of fully drop-in performance at higher percentages. The AtJ process can be deployed in a distributed configuration, where ethanol is produced at one site and transported to a centralized SAF conversion facility. Alternatively, the process can be co-located with a distillery to reduce logistics costs, improve heat integration, and lower lifecycle carbon intensity. Bagasse or other residues can supply renewable steam and electricity, helping AtJ achieve a 40–80% GHG reduction depending on feedstock sourcing and land-use practices.[37]

From a technology readiness perspective, AtJ is considered TRL 8–9 — commercial demonstration is ongoing (e.g., LanzaJet Freedom Pines Fuels in the USA), but large-scale deployment is still emerging globally, and SAF costs remain above conventional jet fuel. Current modelled production costs often fall between USD ~1.00–1.80 per L of SAF (depending on financing, feedstock costs, country energy pricing, and credit incentives). Full co-location with sugar or starch ethanol plants can reduce CAPEX by 10–20% and lower OPEX tied to hydrogen, heat, and transport.

[37] Source: ICAO CORSIA LCA Database https://www.icao.int/environmental-protection/CORSIA/Pages/SAF_LCA.aspx

Advantages of AtJ for Uganda include:

- Compatible with existing ethanol industry structure (sugarcane mills, distilleries)
- Strong sustainability profile when bagasse or biogas provides process energy
- Flexible feedstocks: sugarcane, maize, cassava, and molasses streams
- Leveraging export expertise in ethanol if not fully absorbed locally

Challenges include:

- Feedstock competition with food security and sugar markets — careful prioritization needed
- Logistics for ethanol aggregation if plants are decentralized
- Higher costs than fossil jet fuel absent policy support (mandates, tax incentives)
- ASTM blend-limit means fossil jet supply chains remain required
- Land-use governance must avoid emissions from expansion into natural ecosystems

In the context of Uganda, sugarcane, maize, and cassava all provide viable ethanol streams for ATJ-SAF production, particularly where processing can occur near established sugar estates or industrial zones such as Jinja and Hoima. Integration with bagasse- or biogas-powered utilities can further enhance competitiveness and deliver a robust low-carbon pathway aligned with ICAO CORSIA requirements.[38]

2.1.2 Hydrogenated Esters and Fatty Acids (HEFA) and co-processing

The hydrogenated esters and fatty acids pathway is a well-established means to produce SAF. The technology involves hydrodeoxygenation of renewable and/or waste fats and oils to produce a mixture of renewable diesel and sustainable aviation fuel. The renewable diesel could be subjected to an additional isomerization step to increase the yield of SAF, at the expense of a lower renewable diesel yield.

HEFA-SPK is fully certified under ASTM D7566 Annex A2 for commercial aviation and can be blended at up to 50% with conventional Jet-A/A-1 fuel to meet all aviation turbine fuel specifications (no aircraft or engine modifications required). The pathway has achieved TRL 9, indicating widespread commercial operation at scale[39].

The HEFA process can take place in a stand-alone bio-refinery, or renewable lipids can be co-processed with crude oil in existing hydrotreating units at conventional refineries. ASTM D1655 allows for the co-processing of renewable feedstocks, such as esters, FT hydrocarbons or HEFA intermediates, within traditional petroleum refineries. These routes provide an attractive short- and medium-term solution for SAF scale-up, as they leverage existing refinery infrastructure and require relatively lower capital investment. Co-processing at blend levels up to ~5% renewable feedstock is currently practiced commercially, and higher percentages are undergoing qualification for certification.

Co-processing represents one of the lowest-CAPEX options for SAF deployment because it leverages existing refinery infrastructure, utilities, distribution, and workforce, although the SAF yield is lower than in a fully dedicated HEFA facility.

[38] Source: FAOSTAT – Uganda crop output https://www.fao.org/faostat/en/#data/QCL

[39] Source: ASTM International — D7566 Specification https://www.astm.org/Standards/D7566.htm

The 60 000 barrel-per-day Hoima refinery under construction in Uganda, provides a near-term opportunity for co-processing. Its potential production capacity could enable the replacement of 3 000 barrels per day of crude oil by bio-based feedstock (5% of its capacity). Future ASTM developments could increase such potential to higher volumes. The UK (Def Stan 91-091) has increased the % of allowed bio-based feedstock input up to 30%, what would enable the replacement of 18 000 barrels per day of crude by bio-based feedstock.

Cost and performance considerations:

- Commercial HEFA SAF production costs typically range USD ~0.90–1.60 per L, depending on feedstock price, plant scale, and hydrogen supply[40].
- Fuel yield and carbon intensity are highly dependent on feedstock characteristics → waste oils typically have better GHG profiles but higher impurity-removal costs.
- HEFA delivers 60–85% lifecycle GHG reduction vs fossil Jet-A when using waste oils and renewable hydrogen.[41]

Key advantages:

- Most proven SAF pathway (commercial at scale)
- ASTM-certified and drop-in performance
- Flexible deployment (stand-alone or co-processing)
- Strong GHG performance from waste feedstocks
- Fastest time-to-market, lowest technological risk

Key challenges:

- Feedstock availability limits scale globally — lipid oils are in high demand
- Potential food vs fuel competition if using virgin vegetable oils
- Impurity management and logistics for UCO collection
- Fossil-derived hydrogen can reduce GHG benefit without investment in green H_2

In the Ugandan context, crude corn oil from maize milling could serve as a domestic HEFA feedstock, although current volumes are relatively small. Used cooking oil (UCO) collection from hotels, restaurants, and institutional kitchens presents a higher-sustainability alternative, particularly as municipal waste systems develop. Both feedstocks require pre-treatment (dewatering, degumming, removal of metals and sulfur) to meet refinery input specifications.

When available, esters and fatty acids could be integrated at a future Hoima refinery facility or processed through a small, modular hydrogenation unit co-located with a UCO aggregation centre — offering a fast-deployment SAF opportunity while other pathways scale.[42]

[40] Source: IEA Bioenergy — Biojet technology cost analysis https://task39.ieabioenergy.com/publications/

[41] Source: ICAO CORSIA LCA Default Values for HEFA-SPK https://www.icao.int/environmental-protection/CORSIA/Pages/SAF_LCA.aspx

[42] Source: FAOSTAT crops dataset https://www.fao.org/faostat/en/#data/QCL

2.1.3 Fischer–Tropsch (FT)

The gasification Fischer–Tropsch process involves conversion of biomass such as crop residues or municipal solid waste into syngas, followed by catalytic conversion of the cleaned syngas into hydrocarbons, usually comprising a mixture of naphtha, renewable diesel and SAF.

Fischer–Tropsch Synthetic Paraffinic Kerosene (FT-SPK) is certified under ASTM D7566 Annex A1 for use in commercial aviation at blend levels up to 50%. This pathway has a high Technology Readiness Level (TRL 7–9) depending on configuration: gasification and FT are commercial individually, but integrated biomass/MSW-to-liquids plants remain at demonstration scale globally.[43]

The main challenge with biomass and especially MSW is feedstock heterogeneity. Variations in moisture, ash, plastics, metals, and contaminants lead to inconsistent syngas quality, requiring robust pre-treatment and syngas cleaning (tar cracking, sulfur removal, ammonia management, and chloride scrubbing). Stable syngas purity is essential to avoid catalyst poisoning and ensure high conversion efficiency.

Cost considerations remain significant. Biomass/MSW gasification-FT projects typically require large-scale CAPEX investments to achieve economies of scale (often USD 300–600 million for commercial facilities). When well-optimized and scaled, FT-SAF can achieve strong carbon intensity performance (up to 80–95% GHG reductions).[44]

Advantages

- Can utilize low-value or waste feedstocks (crop residues + MSW)
- Strong GHG reduction potential (major methane avoidance)
- No food-versus-fuel conflict
- Produces multiple valuable refinery products
- Large potential feedstock pools in Uganda (residues, Kampala MSW)

Challenges

- High CAPEX and long development timelines
- Feedstock variability complicates gasification performance
- Intensive syngas cleanup requirements
- Need for large supply-chain coordination and permitting
- Limited track record of long-term commercial uptime for MSW-to-jet

For Uganda, the gasification-FT pathway offers a strategic waste management + SAF synergy. Significant quantities of crop residues (maize stover, sugarcane trash) and expanding urban MSW streams in Kampala and secondary cities could form a sustainable, non-food-competitive feedstock base. Early deployment may

[43] Source: ASTM International — D7566 Specification https://www.astm.org/Standards/D7566.htm

[44] Source: ICAO CORSIA LCA Default Values for SAF Pathways https://www.icao.int/environmental-protection/CORSIA/Pages/SAF_LCA.aspx), particularly when biogenic carbon and renewable power/hydrogen are used. MSW-based FT is attractive for landfill diversion and methane avoidance, but high capital cost and complex waste-management logistics influence economic feasibility (Source: IEA Bioenergy Task 39 — Biojet techno-economic analyses https://task39.ieabioenergy.com/publications/

focus on agricultural residues due to more uniform composition, while MSW conversion improves as collection and segregation systems mature.[45]

2.2 ANALYSIS OF FEEDSTOCKS

2.2.1 Sugarcane

Feedstock-related information

Sugarcane production in Uganda totalled 5.8 million t in 2020, increasing to about 6.2 million t in 2023, primarily produced in the sub-regions of Buganda, Bunyoyo, and Busoga. Land allocated to sugarcane production has increased by about 20% over the period from 2020 to 2023. Yields have averaged about 60 t/ha[46].

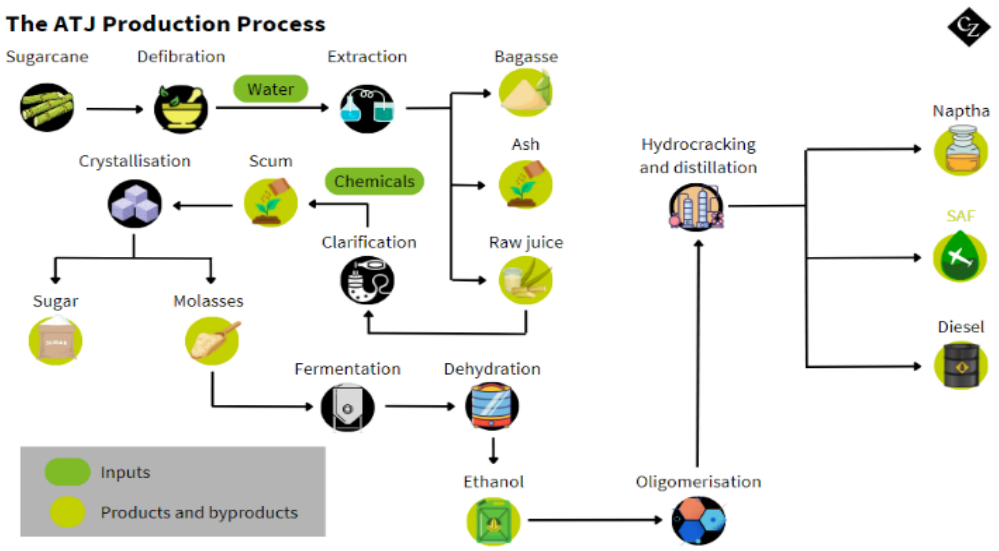

Figure 17. Process of producing SAF using sugarcane.[47]

Large sugar manufacturers in Uganda include:

- GM Sugar Uganda Limited
- Kakira Sugar Works
- Kinyara Sugar Works Limited
- Sango Bay Estates Limited
- Sugar Corporation of Uganda Limited

Kakira accounts for about 30-40% of Uganda's sugarcane processing and sugar production. Kakira uses the sugarcane bagasse to produce about 370 GWh of power at its cogeneration facility; about 60% of the power generated is sold to Uganda's power grid. Kakira also has an ethanol distillery to produce about 20 million L/year of ethanol from molasses.

[45] Source: Kampala MSW growth and biogenic proportion documented in Uganda waste management studies (Baguma et al., 2023; Osman et al., 2023)

[46] Source: USDA FAS Sugar Annual (2023) https://www.fas.usda.gov/data/uganda-sugar-annual-2

[47] Source: CZ https://www.czapp.com/explainers/the-sugar-to-saf-production-process/

The majority of the sugar produced in Uganda is used domestically. When there is a surplus, it is allocated into strategic reserves or exported to the Democratic Republic of Congo, Kenya, Ethiopia, and South Sudan.

Although sugarcane production continues to increase, the demand for sugar for food use limits the use of this feedstock for SAF production. Furthermore, the extensive use of bagasse for power generation limits opportunities to use this crop residual for SAF production.

Sustainability-related issues, including greenhouse gas emissions

Sugarcane is a water-intensive crop, and processing of sugarcane is also water intensive. In areas with a lack of rainfall, irrigation may be required. Currently, only 0.5% of Uganda's land with the capacity for irrigation is actually under irrigation, mainly due to the high cost of implementation. Although sugarcane is one of the crops where irrigation is used (second only to rice), the relatively low deployment of irrigation overall suggests that there is room to further expand irrigation, which would increase crop yields and mitigate the need for land expansion.

Processing of sugarcane to produce sugar can be water intensive, as water is used during the cane crushing process to extract the sugar. However, use of advanced technologies like diffusers can reduce water consumption during processing, and mineral-rich process wastewater can also be field applied to support crop growth.

SAF produced from sugarcane via the ATJ process (either ethanol or isobutanol) generates 24 g/MJ of CO2 equivalent (gCO_2e) emissions, excluding induced land use change, which adds another $9gCO_2e$/MJ of emissions. Overall, sugarcane can be produced and used sustainably, and the use of bagasse to produce steam and electricity during biofuel production contributes to the materially lower GHG emissions profile compared to other feedstocks. Nonetheless, clearing of land to expand sugarcane production can contribute to GHG emissions. As biofuel production expands, strategies will be needed to manage land-use conversion. Existing production of sugarcane could yield 12 million to 20 million L/year of SAF using the ATJ conversion pathway.[48]

Economic/market-related issues

Sugarcane represents a comparatively low-cost pathway to produce biofuels. The sugar extraction technology and sugar conversion to ethanol technology are well established. Further use of the bagasse creates an additional opportunity, as a bagasse processing facility (e.g., to make power or lignocellulosic ethanol) can be co-located with the sugar/ethanol biorefinery, enhancing efficiency and capital utilization.

Overall assessment

Although sugarcane is suitable for SAF production, competing uses are expected to limit its availability for biofuel production. Nonetheless, if sugarcane yields can be improved there may be an opportunity to use sugarcane for SAF production (see Table 6).

[48] Source: Direct conversion from sugarcane production to fuel volume using ICAO (2023) — CORSIA Sustainability & LCA Methodology: sugarcane CI values https://www.icao.int/environmental-protection/CORSIA/Pages/SAF_LCA.aspx

Table 6. Overall assessment of sugarcane production

Feedstock	Indicative collection / preprocessing cost [USD/t]	Approximate amount available in Uganda [million t/year]	Estimated SAF potential [million L/year]	Key sources
Sugarcane	10–25 (field harvest & short-haul to mill; ethanol plant costs separate)	6.0–6.4	If 10–30% of cane diverted: 15–70	FAOSTAT crops (sugarcane); IEA Bioenergy Task 39 (ATJ yields); ICAO CORSIA (pathway)

2.2.2 Maize

Feedstock-related information

Maize is a staple food crop widely produced by farmers in Uganda. Most of the maize grown in Uganda is by smallholder farmers that grow the crop for their own use, with some sales for commercial use. Maize production in Uganda was quite variable from 2020 through 2023, ranging from 2.8 to 4.7 million t, and averaging 3.6 million t. Although there has been a trend towards increasing yields (2.2 to 2.5 t/Ha), the area planted has varied significantly, leading to the wide range in production volumes. By comparison, maize yields at Uganda research stations have been reported to be about 5 t/ha - suggesting an opportunity to improve productivity and close the gap between current farm yields and those observed at the research stations that employ enhanced farming practises (Source: East African Grain Council (EAGC): Uganda Maize Market Report 2023). According to the Uganda Bureau of Statistics (UBOS), the majority of the maize is grown in the Mukono, Bulindi, and Buginyanya regions.

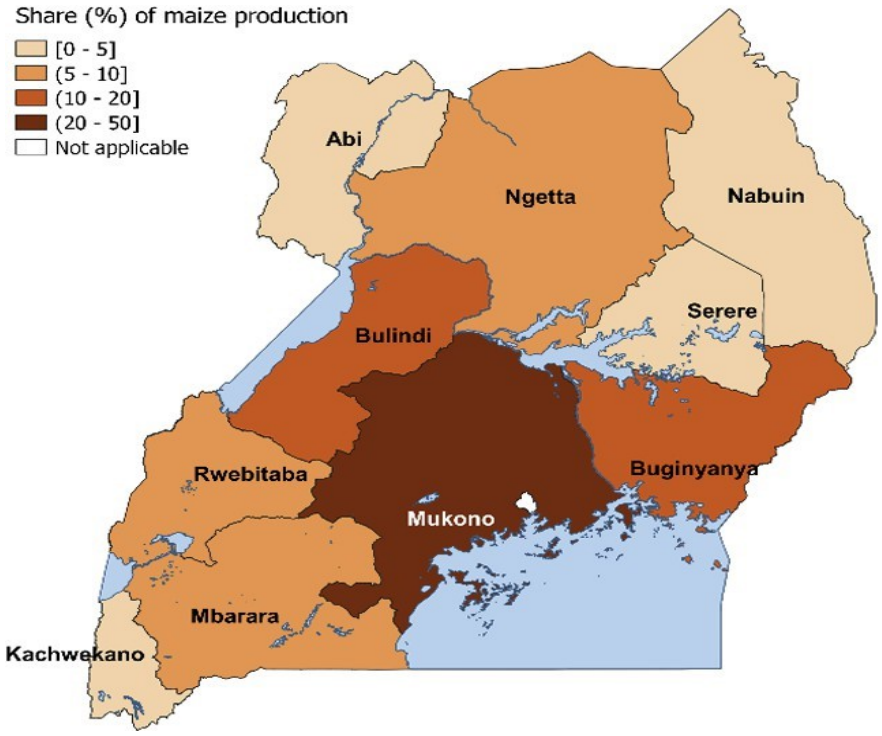

Figure 18. Share of maize production by region in Uganda.

Sustainability-related issues, including greenhouse gas emissions

The main environmental impacts of maize production and maize-related biofuels are usually associated with use of nitrogen-based fertilizers, water requirements, and emissions associated with the biofuel production process. Compared to the United States, maize production in Uganda uses substantially less fertilizer per hectare. However, owing to the lower crop yield in Uganda, fertilizer consumption and emissions per tonne of maize are higher in Uganda. Ethanol production from maize in Uganda is projected to reduce GHG emissions by ~60% compared to gasoline, excluding land-use impacts. Prioritizing productivity improvements over land expansion would mitigate the risk of land use change and related GHG emissions. Water use from irrigation is estimated at 10 L per L of ethanol produced from maize.[49]

Economic/market-related issues

Beyond its use as a food crop, maize is an important component of poultry and livestock feeds. This contributes to Uganda's role as a leading poultry producer. Uganda has primarily exported maize to the Democratic Republic of Congo, Kenya, Rwanda, South Africa, and Tanzania. Over the period from 2016 to 2020, Uganda exported 70 to 110 thousand t of maize.[50] Variations (and strong growth) in maize production in neighbouring countries, especially Kenya, have contributed to volatility in farm-gate prices. Challenges with grain storage infrastructure (and capital resources to sustain year-over-year storage) further contribute to price volatility.

Overall assessment

Maize itself may not be a suitable feedstock due to competing demands, although this could be alleviated (in part) by enhanced productivity and crop yields. Nonetheless, the additional maize arising from enhanced crop yields would have priority use for food (either direct food consumption or as animal feed). The more significant biofuel opportunity could arise from collecting and using the stover as a feedstock. This is further discussed later in this section of the report.

Table 7. Overall assessment of maize production.

Feedstock	Indicative collection / preprocessing cost [USD/t]	Approximate amount available in Uganda [million t/year]	Estimated SAF potential [million L/year]	Key sources
Maize	20–40 (raking, baling, stacking, farm-gate haul)	Grain ≈ 3.5–4.7 ⇒ residues (RPR ~1.0) ≈ 3.5–4.7; recoverable ~40% ⇒ **1.4–1.9**	125–225	FAOSTAT (maize); IEA Bioenergy / Scarlat et al. (residue RPR); ASTM D7566 A1 (FT-SPK)

2.2.3 Jatropha

Feedstock-related information

Jatropha is an oilseed plant that has the potential to grow under arid and semi-arid conditions, and in marginal soils. However, quality soils and irrigation materially improve jatropha productivity. Following oilseed processing, jatropha oil may be used as a feedstock in a HEFA process to produce SAF and renewable diesel. Although there were test plots of jatropha in Uganda about 10–15 years ago, there is no evidence that these crops have continued to be grown.

[49] Source: The Committee on Sustainability Assessment (COSA) (2024) report on fertilizer application rates in Uganda

[50] Source: FAOSTAT – Trade Data (Maize: Commodity Code 56 or 1005) https://www.fao.org/faostat/en/#data/TM

Figure 19. Process of producing SAF using Jatropha.[51]

Sustainability-related issues, including greenhouse gas emissions

In spite of potential for jatropha growth in water-limited regions, annual precipitation of 900–1 500 mm is expected to be needed for profitable cultivation. In sub-Saharan Africa, in most locations, this requires irrigation. Farmers in Mozambique had to supplement 5–7 L of water per day per plant just to meet basic profitable yields, and around 40 % of farmers in Kenya utilized expensive irrigation systems.

Consequently, absent development of varieties that require materially less water, jatropha production will be a challenge.

Overall assessment

Jatropha is not currently available in quantities suitable for SAF production (see Table 8).

Table 8. Overall assessment of Jatropha production

Feedstock	Indicative collection / preprocessing cost [USD/t]	Approximate amount available in Uganda [million t/year]	Estimated SAF potential [million L/year]	Key sources
Jatropha	60–120 /t seeds (smallholder collection/dehulling); pre-treat oil	Current very limited planted area; pilot-scale only (<< 0.1)	< 1 (pilot only)	IEA Bioenergy Task 39 (HEFA); literature on oil yields; ASTM D7566 A2 (HEFA)

2.2.4 Cassava (tapioca)

Feedstock-related information

Cassava is a major staple food in Uganda, producing tubers/roots rich in starch. The stem, leaf, and bagasse from the cassava plant and processing provide additional pathways to produce renewable fuels such as ethanol, biogas, and SAF. Approximately 600 kg of residues are produced per tonne of cassava. Furthermore, the stems are rich in starch, which is readily extractable.

[51] Source: Science Direct https://www.sciencedirect.com/science/article/pii/S0196890420311894

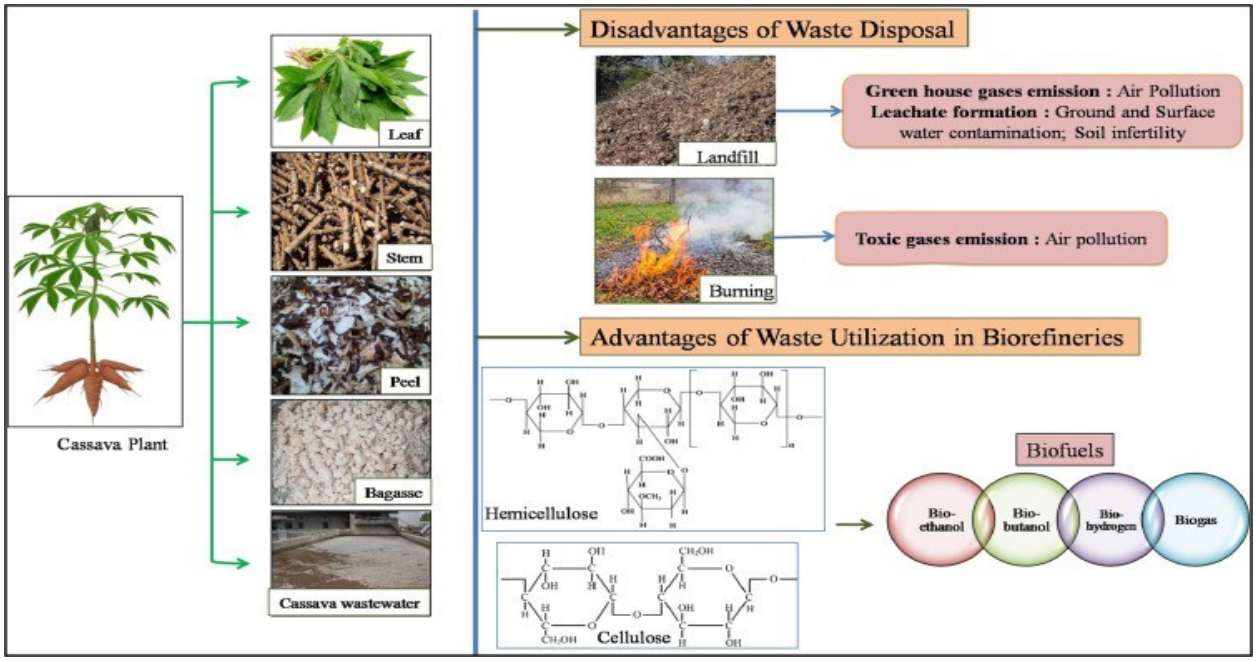

Figure 20. Cassava plant processing into biofuels flowchart.[52]

Cassava is widely used to produce food products such as flour and noodles, and to produce industrial products such as starches, paperboard, and alcohol. In sub-Saharan Africa, the average daily per-capita consumption of cassava is 0.8 kg. An ethanol production facility in the Lira region commenced production in 2015, utilizing cassava as the feedstock. Cassava production in Uganda averaged 2.1 million t annually from 2020 through 2023.[53] Most cassava production is in the eastern and northern regions of the country. In the past year, additional cassava processing facilities were proposed in Nakasongola and in the Amuria district.

There is a mix of smallholder farms for personal consumption and commercially focused production. The average yield is about 2 t/Ha - far below the continental average of ~9 t/Ha. Improvements to agricultural practices, infrastructure, and use of mechanization could help to improve productivity. Cassava is highly perishable, and the lack of drying infrastructure reduces output and product quality. Uganda imports cassava, mainly from Tanzania, and exports cassava, mainly to Rwanda. Overall, Uganda is a net exporter of cassava.

Sustainability-related issues, including greenhouse gas emissions

There are no validated data for SAF production from cassava. However, there are publications that evaluate the GHG emissions for ethanol production from Cassava in China, Thailand, and Vietnam. These publications indicate a 30% reduction in GHG emissions for cassava ethanol in China, with coal as the thermal energy source. Lower GHG emissions were predicted for cassava ethanol in Thailand, mainly attributable to use of biomass and biogas for thermal and electrical energy during ethanol production. Similarly, an assessment of GHG emissions for cassava ethanol in Vietnam predicted a 50% reduction compared to gasoline, including land-use change impacts. Owing to conversion yields and energy inputs associated with conversion of ethanol

[52] Source: https://www.sciencedirect.com/science/article/pii/B9780443217470000102

[53] Source: The Uganda Bureau of Statistics (UBOS) Annual Agricultural Surveys 2020-2023

into SAF, the emissions for cassava-derived SAF will be higher than emissions for ethanol, i.e., the emissions reductions will be less than the reductions cited above.

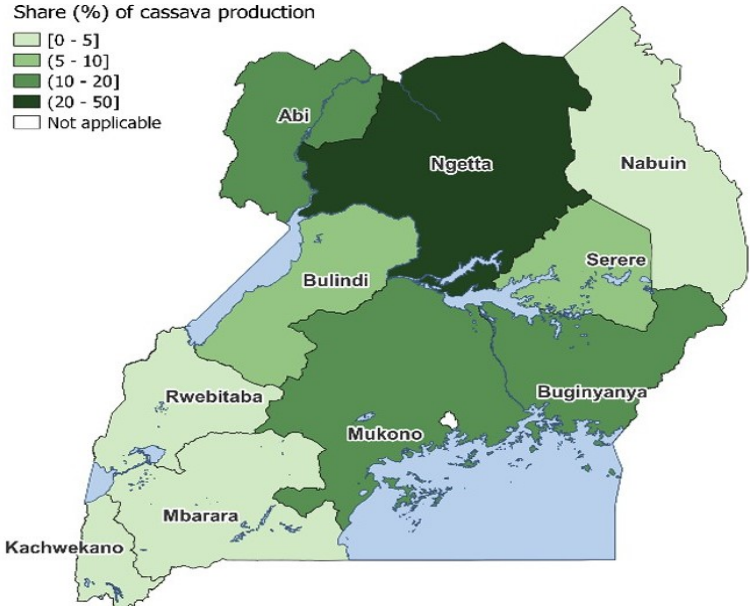

Figure 21. Share of cassava production by region in Uganda.

Overall, cassava can be produced and used sustainably, and the low fertilizer use contributes to lower GHG emissions. Nonetheless, if there is any clearing of land to expand cassava production, some GHG emissions may occur. Nonetheless, the low harvest yields for cassava point to strategies that enhance land productivity (i.e., crop yields) as the highest priority, rather than clearing additional land to increase production.

As noted above, an additional opportunity arises to produce biofuels, including SAF, from the starch-rich cassava stems and from starch-rich wastewater streams arising from cassava processing.

Economic/market-related issues

As an example of project implementation using this process, Satarem, an international engineering and technology company based in Switzerland, is aiming to develop a SAF plant in the Tiebissou area of the Belier region of Ivory Coast that uses both the starch in the tuber and the cassava stems.

Overall assessment

Cassava is an important food crop in Uganda and surrounding nations, and direct use for SAF production is unlikely, unless there is a significant increase in productivity. The most notable opportunity involves improving crop yields to levels approaching the continental average, which could quadruple cassava production. Nonetheless, as noted above, there are some proposals regarding biofuel/SAF production using cassava and cassava stems (see Table 9).

Table 9. Overall assessment of Cassava production.

Feedstock	Indicative collection / preprocessing cost [USD/t]	Approximate amount available in Uganda [million t/year]	Estimated SAF potential [million L/year]	Key sources
Cassava	15–30 (aggregation from farms; peeling/washing at plant)	1.7–2.8 (roots)	10–35 (if 10–20% diverted)	UBOS AAS 2020; FAOSTAT (cassava); IEA Bioenergy/DOE (ATJ yields)

2.2.5 Palm oil

Feedstock-related information

Palm oil is extracted from palm, using either mechanical pressing or a combination of mechanical pressing and solvent extraction to increase oil recovery. The resulting oil may be used in the HEFA process to produce renewable diesel and SAF, and it may be co-processed with crude oil in a conventional refinery to produce fuels with some renewable content. The solid residual from the oil extraction process, palm kernel cake, is suitable for use as a livestock feed, and with upgrading, may also be used as a component of poultry feed.

Uganda produces palm oil and has active public policies to develop that sector. However, production is still in an expansion/moderate phase and faces challenges (both operational and social/environmental).

The National Oil Palm Project is a project will be implemented in the mainland areas located in a narrow belt (25-30 km) along Lake Victoria and surrounding the two island districts of Kalangala and Buvuma, but also areas in the western (Bundibugyo, Masindi) and north-western (Arua) parts of the country. The Project will work in geographical hubs, where a hub is defined as "an agro-climatically suitable area (not an administrative district), within a radius of 30 km around a planned or actual CPO mill, and in which a minimum of 3 000 ha of OP production can be assured."

Other than this, the FAOStat database does not report any palm oil production, nor oil palm fruit, nor coconut oil. Consequently, this does not appear to be a relevant feedstock for biofuel/SAF production in Uganda.

Sustainability-related issues, including greenhouse gas emissions

The major concerns regarding palm oil production relate to emissions from land use change arising from conversion of tropical forests into palm plantations. If there are future plans to develop palm oil for biofuel production, land conversion issues will need to be a major consideration. More information on the lifecycle emissions when using palm oil as a feedstock can be found in ICAO's LCA methodology for CORSIA eligible fuels.

Overall assessment

The apparent low level of palm production in Uganda implies that palm-oil derived SAF production is unlikely (see Table 10).

Table 10. Overall assessment of palm oil production.

Feedstock	Indicative collection / preprocessing cost [USD/t]	Approximate amount available in Uganda [thousand t/year]	Estimated SAF potential [million L/year]	Key sources
Palm oil	Plantation harvest/FFB logistics ~USD 20–40/t; dominant cost is oil price (feedstock commodity)	40–60	7–28 (If 20–50% of CPO used)	MEMD/press on Uganda palm; IEA Bioenergy (HEFA yields); ASTM D7566 A2

2.2.6 Agricultural wastes and residues

Agricultural wastes and residues include, for example, stalks and stems of plants that are mainly grown for their grain, oil content, or sugar content. Examples relevant to Uganda include sugarcane bagasse, the stover from maize production, and leaves and stems from cassava production.

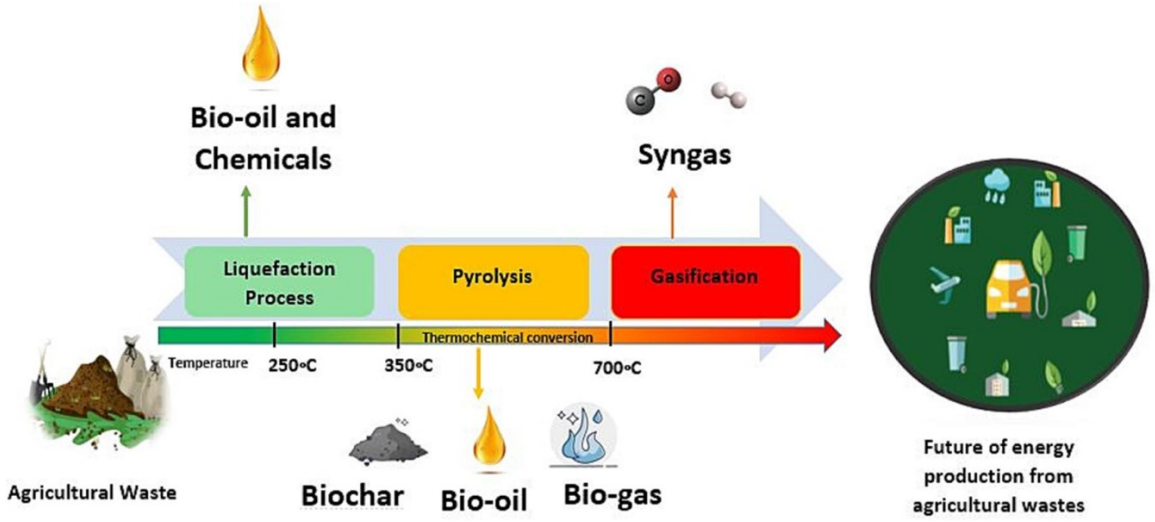

Figure 22. Process to produce SAF using agricultural waste.[54]

Feedstock-related information

Many crops are grown in Uganda for food/feed purposes, using the grain/oilseed/root/fruit part of the plant. These crops also include lignocellulosic residues - leaves, stems, stalks, cobs, etc. that could be used to produce bioenergy, including biofuel. Table 11 summarizes the projected amount of crop residues that would be produced from the major primary crops in Uganda.

It is not possible nor practical to harvest all of the residues associated with a primary crop. Typically, some must be left in the field to provide soil nutrients and present soil erosion. Nonetheless, about 50-70% of maize stover can be harvested, and the bagasse associated with sugarcane is already harvested and shipped to the mills that process sugarcane for sugar.

[54] Source: Khan, Niazi, et al. Thermochemical conversion of agricultural waste to hydrogen, methane, and biofuels: A review

Table 11. Summary of crop production and residues.[55]

Primary crop	Annual production [thousand t]	Residue type	Residue to product ratio	Residue quantity [thousand t]
Maize	5 000	Cobs	0.27	1 350
Maize	5 000	Stover	2	10 000
Cassava	6 983	Stems and peels	0.4	2 793
Cassava	6 983	Pseudo-stems	3	20 949
Banana	8 326	Leaves	0.48	3 996
Banana	8 326	Peels	0.44	3 663
Sugarcane	5 778	Bagasse	0.25	1 445
Sugarcane	5 778	Tops	0.32	1 849

In Tanzania, maize stover biomass production ranged between 1.7 and 2.8 t/ha. Using the observed maize yields in Uganda (2.2 to 2.5 t/Ha), coupled with the established harvest ratios and residue to product ratios, the projected stover biomass production is about 2.4 to 3.8 t/ha, or about 4 to 5 million t annually.

Sustainability-related issues, including greenhouse gas emissions

Harvesting lignocellulosic residues has comparatively few economic impacts, as long as sufficient biomass is left in the fields to support soil health. Typically, 50 to 70% of maize stover can be harvested, and upwards of 90% of sugarcane stalks and leaves can be harvested. Nonetheless, these harvest ratios depend upon geography and underlying soil quality, and thus, should be independently assessed at a regional/field level. More information on the lifecycle emissions when using agricultural waste as a feedstock can be found in ICAO's LCA methodology for CORSIA eligible fuels.[56]

Economic/market-related issues

These residuals are not primary food/feed crops, but they may be used by smallholder farmers for heat or cooking. This may reduce availability. Furthermore, there is already some use of sugarcane bagasse to produce heat/power. Nonetheless, the relative lack of competing uses means that the feedstock cost is largely associated with the cost to collect and transport these residuals to a centralized bioprocessing facility. Adding a fee to the farmer helps to raise the standard of living for rural farmers, while still leading to a comparatively low-cost feedstock for biofuel and bioenergy production.

The main barrier to use of these residuals is typically a lack of collection and transportation infrastructure. Achieving a high harvest yield typically requires some degree of mechanized harvest. Nonetheless, even with manual harvest, activities among a wide number of farming operations could produce sufficient residues for a viable biofuel production facility, particularly if it is based upon an ATJ pathway, which would likely be viable at a smaller scale (based on the amount of feedstock required).

[55] Crop production data sourced from FAOSTAT and UBOS (2020–2023). Residue generation assumptions are based on IEA Bioenergy Task 39 and Task 43 publications and regionally relevant residue-to-product ratios reported in Scarlat et al. (2010, Biomass and Bioenergy), UNIDO agro-residue studies in Uganda, and FAO bioenergy potential analyses.

[56] Source: https://www.icao.int/sites/default/files/environmental-protection/CORSIA/Documents/CORSIA%20Eligible%20Fuels/CORSIA_Supporting_Document_CORSIA-Eligible-Fuels_LCA_Methodology_V7.pdf

Overall assessment

There are already plans proposed to produce biofuel from cassava stems/pseudo-stems, and some bagasse is already being used for heat and power generation. Notwithstanding these competing uses, if all of the available/harvestable residues from maize, sugarcane, cassava, and banana were used for biofuel production, approximately 4.5 million t of distillates could be produced via a gasification-FT process. Similarly, converting these residues into ethanol via a lignocellulosic ethanol process could produce about 6 to 8 billion L of ethanol. Converting the ethanol into SAF could produce about 4 to 6 million t of SAF (see Table 12).

Table 12. Overall assessment of agricultural waste production.

Feedstock	Indicative collection / preprocessing cost [USD/t]	Approximate amount available in Uganda [million t/year]	Estimated SAF potential [million L/year]	Key sources
Agricultural waste	20–45 (collection, drying/size reduction)	1–3	90–360	FAOSTAT + RPR literature (Scarlat et al.); IEA Bioenergy Task 33/39

2.2.7 Municipal solid waste

Feedstock-related information

According to the literature, per capita waste production in Sub-Saharan African nations is about 0.46 kg/day.[57] The average amount of solid trash produced by households in Ugandan towns and cities, according to surveys, varied between 0.23 and 2.03 kg/capita/day (Baguma et al., 2023). According to Osman et al. (2023), Uganda's total municipal solid waste generation rate is expected to reach approximately 0.65 kg/capita/day by 2025 (19 690 t/day, or roughly 7.2 million t/year).

Other published reports indicate about 4 million tonnes of solid waste were generated in Uganda from 2021/22 to 2023/24. However, only about 1.5 million tonnes was collected - creating an environmental issue with the uncollected waste. Cities like Fort Portal and Soroti are reported to collect over 80% of the solid waste generated, while other jurisdictions collected at as little as 10% of the waste.

The bulk of Uganda's solid waste content is organic, according to a comprehensive analysis of the literature by Namanya et al. that included investigations from different towns and cities. A waste analysis indicated the primary components are food and green waste (43%). Paper and cardboard represent another 10% of the waste generated. Sub-Saharan African countries generate a large amount of organic waste because of the preparation of fresh food and the use of less packaging on goods that are sold in the markets (He et al., 2024). The organic content of the waste is well suited to bioenergy and biofuel production. Furthermore, the low collection ratio implies that there is an opportunity (and need) to collect additional waste that could add to the pool of potential feedstock for biofuel and bioenergy production. The inorganic fraction must be removed by pretreatment of the raw feedstock. Inorganic components cannot be converted into energy, and furthermore, trace metals and inorganic impurities can adversely affect downstream processes.

[57] Source: https://www.ijfmr.com/papers/2025/1/36446.pdf

Figure 23. Process of producing SAF using MSW as a feedstock.[58]

Sustainability-related issues, including greenhouse gas emissions

The large amount of uncollected solid waste poses an environmental issue. The high organic content of the waste (both collected and uncollected) would also have a high biomethane potential, creating a significant GHG burden as the organic material decomposes over time. Enhanced collection of solid waste and converting the organic fraction into biofuels and bioenergy would have significant environmental benefits, reducing landfill gas emissions and GHG emissions from uncollected wastes.

The CORSIA default LCA value is 5.2 g/MJ for SAF produced from MSW by the gasification-FT process. This is based upon MSW that has 100% biogenic content. Processing MSW with non-biogenic content (such as plastics and textiles) would increase the GHG emissions value, according to a formula specified under CORSIA.[59]

A separate study by Lee et al. indicated that MSW-derived FT fuels can become low-carbon fuels with low fossil carbon in the input stream. Since the avoided landfill emissions are significant, it is important to use waste feedstocks that have high landfill gas emissions to generate low carbon waste-derived fuels.

Economic/market-related issues

Preliminary evaluations of SAF production from MSW via gasification-FT projects with a minimum facility capacity of 100 million L/year of distillate, of which 40 million L/year of SAF would be produced. A plant with this capacity would require about 250 000 t of MSW. A high-level estimate of capital cost (for a North American plant) is USD 8 per L of distillate. A plant with a processing capacity of 1.0 to 1.5 million t of MSW is projected to cost much less, on the order of USD 2.9 per L of distillate

An alternative approach is to separate the organic fraction and process it separately to produce alcohol, particularly methanol, that may be converted to SAF. This technology has yet to be validated at a larger scale, and there is no default LCA value available under CORSIA.

[58] Source: Port of Seattle MSW study 2023 https://www.portseattle.org/sites/default/files/2024-03/MSW-Fuels_ExecSummary_240321.pdf

[59] ICAO CORSIA GHG calculator

Overall assessment

MSW is an attractive feedstock target, although not without some challenges due to its heterogeneity. There are also several challenges related to technological maturity. Several commercial pilot projects and demonstrations have faced numerous challenges throughout the industry.

As the technology continues to develop, Uganda could enhance MSW collection and use the MSW for biofuel/bioenergy, potentially addressing multiple issues - the burgeoning amount of MSW generated in the country, emissions arising from degradation of MSW, and an opportunity to reduce emissions by displacing fossil-derived jet fuel.

The primary issue relates to the heterogeneity of MSW, requiring extensive and potentially costly sorting to isolate the processible organic fraction. Furthermore, although MSW gasification is well established, the combination of MSW gasification with SAF production has thus far proven difficult, technically and financially, mainly due to impurities still present in the MSW after sorting. Isolation of the organic fractions to produce either biogas or (m)ethanol may be a more cost-effective and technically viable near-term pathway to process MSW (see Table 13).

Table 13. Overall assessment of municipal solid waste production.

Feedstock	Indicative collection / preprocessing cost [USD/t]	Approximate amount available in Uganda [million t/year]	Estimated SAF potential [million L/year]	Key sources
Municipal Solid Waste (MSW)	Sorting/clean-up 30–60; net feedstock cost often ≤ USD 0/t after gate fee	2025 projection ~7.2 total; biogenic ~50–60% ⇒ 3.6–4.3; recoverable 30–40% (drying assumed) ⇒ **~0.8–1.2**	70–140	World Bank *What a Waste 2.0*; Baguma 2023; Osman 2023; IEA Bioenergy (MSW-to-jet)

2.3 SUMMARY OF EVALUATED FEEDSTOCKS

Table 14. Overview of evaluated feedstock and conversion pathways.

Feedstock considered	Conversion pathway	Feedstock evaluation (supply)	Sustainability evaluation	Economic/market evaluation	Overall
Sugarcane	ATJ	Abundant, but strong competing demand	Generally positive. Main concerns surround emissions due to land conversion, and water use for processing and crop growth (if irrigated)	Higher feedstock cost coupled with comparatively low biofuel processing cost. High existing demand for food uses	Not favourable due to low SAF production potential.
Maize	ATJ	Abundant, but strong competing demand	Generally positive. Main concerns surround emissions due to land conversion, and water use for crop growth (if irrigated)	Higher feedstock cost coupled with comparatively low biofuel processing cost. High existing demand for food and feed uses	Very attractive. Technologically feasible, low cost profile and feedstock is abundantly available. Worth exploring a pilot-scale demonstration.
Jatropha	HEFA	Limited supply	Limited information. Concerns regarding water use	Limited market and financial information due to lack of supply	Challenging due to limited supply of feedstock
Cassava	ATJ	Abundant, but strong competing demand	Generally positive.	Higher feedstock cost coupled with comparatively low biofuel processing cost. High existing demand for food uses	Not favorable due to low SAF production potential.
Palm oil	HEFA	Limited supply	Main concerns relate to emissions from land conversion to create palm plantations. If mineral-based soils can be used, this is a positive option. If peatland (or high carbon stock rainforests) are converted, there are strong adverse environmental impacts.	In other jurisdictions, a moderate feedstock cost and a comparatively low biofuel processing cost. Limited supply in Uganda would imply reliance on imports	Challenging due to limited supply of feedstock

Agricultural waste	FT-SPK	Abundant, but harvest and collection infrastructure needs to be developed	Low impact, provided sufficient residues are left behind to support soil health	Among the lowest cost feedstocks available, albeit with higher biofuel processing costs compared to primary crops	Very attractive. Feasibility, cost and capacity exist to proceed to pilot-scale demonstration.
Municipal solid waste	FT-SPK	Abundant, with additional supply possible as collection grows	Collection and processing could mitigate several existing environmental issues - thus, a net benefit if MSW is collected and processed into energy/fuel	The lowest cost feedstock available, although pre-processing costs add to overall cost of the useful feedstock fraction, and processing costs are high	Very attractive. However, technological risks may not provide favourability on proceeding to a pilot-scale demonstration.

SECTION 3. IMPLEMENTATION SUPPORT AND FINANCING

From an implementation perspective, Uganda is in an advantageous position due to existing infrastructure and the possibility of establishing feedstock processing centres in optimized locations. This section provides more details on the existing implementation infrastructure, support possibilities and project financing opportunities.

3.1 IMPLEMENTATION SUPPORT

3.1.1 Tristar energy fuel farm

Uganda's aviation sector has entered a transformative chapter with the arrival of Tristar Energy Limited, a subsidiary of the UAE-based Tristar Group. As global standards in aviation fuel management evolve, Uganda is positioning itself as a regional leader by modernizing the infrastructure at its main gateway—Entebbe International Airport. At the centre of this transition is Tristar, a company renowned across more than 30 countries for its integrated energy logistics solutions (see Figure 24).

Figure 24. Tristar employees celebrate at a ceremony at Entebbe International Airport.

Tristar Energy's arrival in Uganda was formalized through a landmark 25-year Build-Operate-Transfer (BOT) agreement with the Uganda Civil Aviation Authority (UCAA), announced in late 2024. The agreement gave Tristar the mandate to design, construct, and manage a world-class aviation fuel farm and hydrant system at Entebbe International Airport. This project marks a major departure from the traditional aviation fuel supply systems that relied heavily on fuel bowsers and external storage depots, often plagued by inefficiencies and logistical delays.

The aviation fuel farm, now commissioned, features a 12-million-L underground storage facility, engineered for seamless expansion to 22 million L to accommodate future growth in air traffic and fuel demand. What truly sets the facility apart is the accompanying 7-kilometer underground hydrant pipeline. This pipeline, embedded with 43 aircraft hydrant points, allows fuel to be delivered directly from the farm to aircraft parked at gates. The system, monitored 24/7 and equipped with automatic leak detection and international-grade safety protocols, exemplifies a shift toward operational excellence.

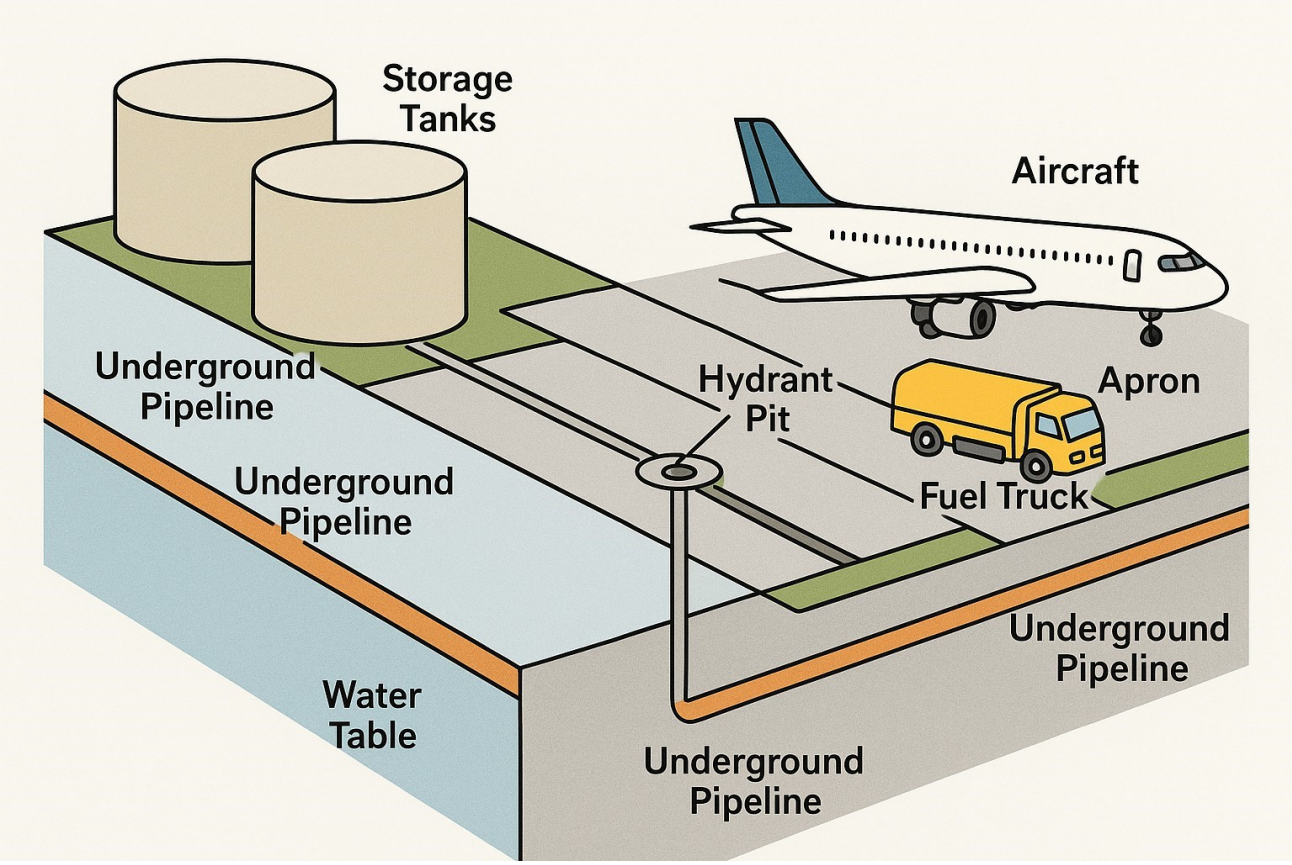

Figure 25. Illustration depicting the delivery of fuel from tanks to the aircraft via a hydrant system.

Built to comply with international aviation fuel standards such as those prescribed by IATA, JIG, and AFQRJOS, the Tristar fuel farm not only meets safety benchmarks but sets a new regional standard. It enhances both the safety and turnaround time of aircraft refuelling, streamlining what was once a cumbersome process involving fuel trucks navigating active runways. This innovation places Entebbe International Airport on par with other top-tier regional hubs in Nairobi, Addis Ababa, and Kigali, potentially even serving as a backup refuelling location for cargo flights and long-haul operations across East and Central Africa.

Beyond infrastructure, Tristar's investment in Uganda extends into human capital development. Ahead of the commissioning, Tristar launched a six-month aviation fuel training program aimed at equipping young Ugandan science graduates with critical skills in aviation operations, safety procedures, maintenance systems, and fuel quality management. This training initiative not only enhances local expertise but ensures long-term sustainability by building a pipeline of competent professionals who can manage and maintain complex fuel logistics systems.

The company's commitment to sustainability and community engagement has also been evident. In celebration of World Environment Day 2025, Tristar conducted tree planting initiatives at its Ugandan facility, echoing its broader environmental stewardship principles across its African operations. This gesture reflects a growing recognition of the need to harmonize infrastructure development with environmental conservation, particularly in the face of climate change and increasing global scrutiny on aviation emissions and carbon footprints.

Regionally, Tristar's operations extend beyond Uganda. The company has a significant presence in Kenya, South Sudan, Somalia, and the Central African Republic, where it manages aviation fuelling for both commercial and military operations, including support for United Nations missions. Tristar is responsible for servicing over 100 aircraft per day at some of these facilities, cementing its reputation as a trusted logistics partner in fragile and high-demand contexts.

Figure 26. The Tristar storage facilities at Entebbe International Airport.

Tristar's investment at Entebbe is not merely a capital-intensive infrastructure project; it is a strategic move that enhances Uganda's regional competitiveness in aviation services. By reducing fuel truck traffic, improving refuelling speed, and minimizing operational risks, the project increases the throughput capacity of the airport and supports future ambitions to make Entebbe a central hub for aviation in East Africa. The facility also opens avenues for bulk fuel purchasing, airline storage agreements, and even integration with future sustainable aviation fuel (SAF) blending facilities, should Uganda pursue green fuel transitions.

Economically, the BOT model employed ensures that Tristar recovers its investment while eventually transferring full ownership of the facility to the Ugandan government after the 25-year term. This aligns with

public-private partnership best practices, where infrastructure is built with private capital but serves long-term national interests. Furthermore, the model enables the Ugandan government to focus on regulatory oversight and strategic planning while allowing a specialized operator to manage the complex logistics and safety requirements of fuel supply.

As Uganda's air traffic continues to grow—with increasing cargo demand, rising passenger volumes, and stronger regional connectivity—fuel infrastructure like the Tristar facility becomes a critical enabler of economic development. Airlines operating in and out of Uganda can now benefit from world-class aviation fuel services, further attracting international carriers, boosting trade, and reinforcing Uganda's image as a reliable, modern air gateway.

In summary, Tristar Energy's project at Entebbe International Airport represents more than an engineering feat; it is a cornerstone for Uganda's aviation future. Through strategic investment, world-class standards, skills development, and operational innovation, Tristar has positioned itself as a key partner in Uganda's quest for modernization, regional influence, and economic growth through aviation logistics.

3.1.2 Hoima Oil Refinery

Tucked into the verdant heartland of Uganda, near the shores of Lake Albert, the town of Hoima is undergoing a dramatic metamorphosis. Once a quiet outpost in the Bunyoro sub-region, it is now rising as a linchpin of Uganda's energy ambitions. At the center of this transformation stands the Hoima Oil Refinery, a flagship infrastructure and industrialization project that promises to reshape Uganda's energy landscape, deepen regional integration, and inject a new wave of growth and export diversification into the national economy.

The refinery is strategically located in Kabaale, Buseruka sub-county, within the expansive Kabalega Petrochemical Industrial Park (KPCIP). This area has been earmarked as the nerve center for Uganda's midstream and downstream oil activities. It lies in proximity to the Kingfisher and Tilenga oil fields, which are the primary upstream fields supplying the crude feedstock. The location was selected for its relative geological safety, availability of land, and accessibility to logistics corridors and major population centers via future road, pipeline, and rail networks. The ambition is not just to process Uganda's crude oil for domestic consumption but to create a regional value-added hub of downstream industries, export capacity, and ancillary services.

When completed, the Hoima Oil Refinery will process 60 000 barrels of oil per day (bopd). The design incorporates high-efficiency units such as Atmospheric Distillation, Vacuum Distillation, and Residue Fluid Catalytic Cracking (RFCC), enabling conversion of heavy hydrocarbons into high-value end products like diesel, gasoline, jet fuel, and LPG. The modular nature of the design allows for phased expansion to 120 000 bopd as domestic and regional demand rises (see Table 15).

The infrastructure also integrates a 211-kilometer multi-product pipeline to Namwabula in Mpigi District, multiple storage terminals for refined products, a raw water intake pipeline from Lake Albert, a waste management system, and a 100-megawatt Nzizi thermal power plant to supply electricity.

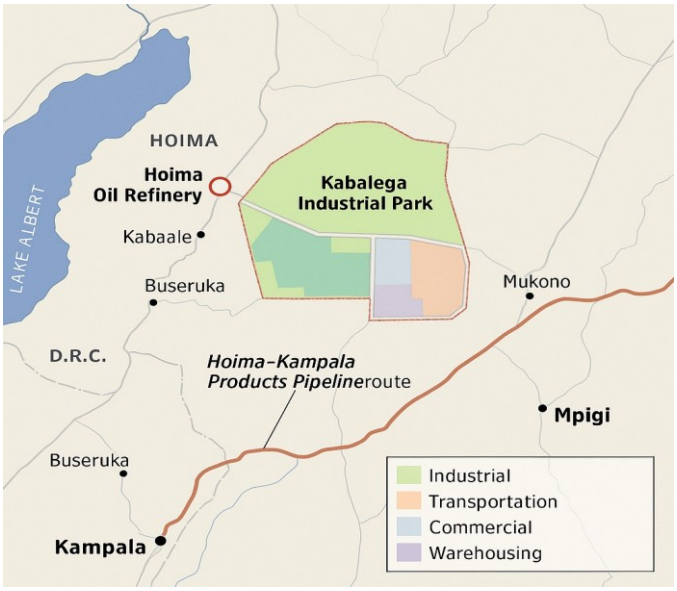

Figure 27. Location of Hoima Oil Refinery in Uganda.

Table 15. Key parameters of the Hoima Oil Refinery.

Component	Details
Daily Refining Capacity	60 000 barrels per day
Expansion Potential	Up to 120 000 barrels per day
Main Feedstock	Kingfisher & Tilenga crude oil
Power Source	100 MW Nzizi Gas-Fired Plant
Multi-product Pipeline	211 km (Hoima to Namwabula)
Storage Capacity	8+ tanks with combined 300 000 m^3 capacity
Main Outputs	Diesel, Jet A1, LPG, Gasoline, Naphtha
Construction Start	2024
Anticipated Commissioning	2026 - Phase 1

Public-Private Partnership and financing structure

Leading the development is the Uganda Refinery Holding Company (URHC), a wholly owned subsidiary of the Uganda National Oil Company (UNOC). It acts as the government's equity vehicle in the project. The main private investor is Alpha MBM Investments LLC, a UAE-based firm that was awarded the majority equity stake in 2025 following the exit of the Albertine Graben Refinery Consortium (AGRC), which had failed to secure final financial commitment.

The investment structure is a Build-Own-Operate-Transfer (BOOT) model, with a projected investment envelope of USD 4 billion. Approximately 30% of this is expected to come from equity contributions and 70% from commercial debt and international financing institutions. The financial close is expected to be achieved in early 2025, with significant guarantees and risk mitigation support from multilateral agencies such as the AfDB and Islamic Development Bank (see Table 16).

To maximize efficiency and ensure market access, the refinery is being tightly integrated into Uganda's broader transportation and energy grid. The planned Hoima–Kampala Petroleum Products Pipeline will link the refinery to storage and distribution centres in the central region. Road upgrades such as the Hoima–Kaiso–Tonya Road and feeder roads into the KPCIP are either under construction or recently completed (see Figure

28). A high-voltage transmission line—Hoima–Kinyara–Kafu—is also underway to support both the refinery and regional power distribution.

Project timeline and key milestones

Table 16. Project timeline and key milestones.

Year	Milestone
2010	Initial feasibility study and site selection
2012	Land acquisition and PAP compensation begins
2015	Cabinet approval and environmental assessments
2018	AGRC signs Project Framework Agreement with Government of Uganda
2020	Delays due to COVID-19 and financing uncertainties
2023	AGRC exits after financial close deadline lapses
2024	Alpha MBM selected; Implementation Agreement signed
2025	Financial close targeted; construction ramp-up begins
2026	Phase 1 of refinery expected to be commissioned
2027	Full refining capacity and product pipeline operational

Figure 28. Aerial shot of the construction activities and tank foundation preparation.

Additionally, a new international airport in Kabaale is being constructed to support cargo and logistics traffic, expected to handle heavy equipment imports, exports of refined products, and petrochemical goods.

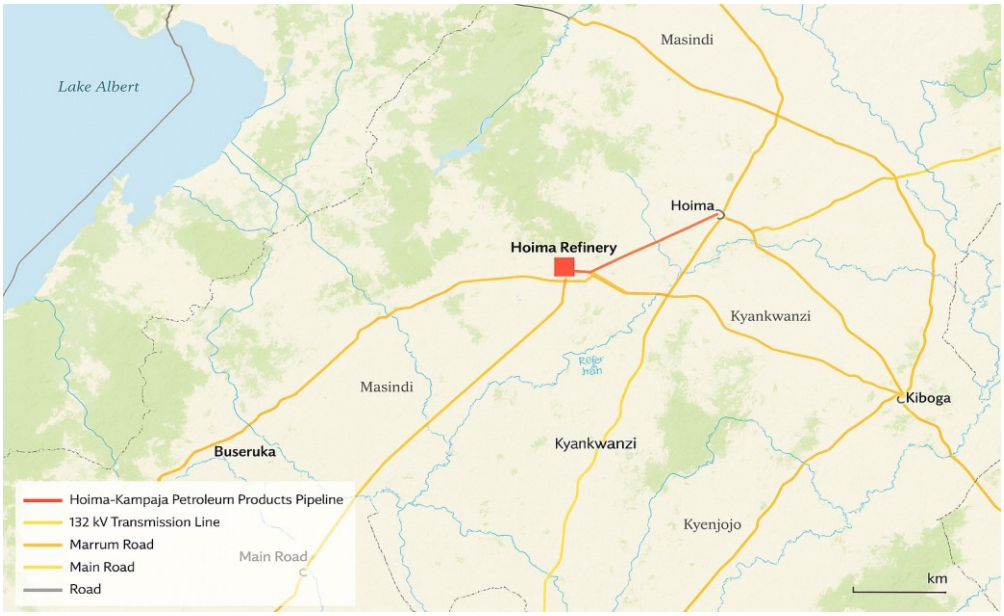

Figure 29. Infrastructure overlay map of Hoima refinery and transport grid.

Strategic and economic impact

Currently, Uganda imports nearly 100% of its refined petroleum products, exposing the economy to global price shocks, forex volatility, and supply chain disruptions. With the Hoima refinery, Uganda will be able to satisfy over 70% of its domestic fuel needs and become a net exporter to neighbouring countries such as Rwanda, DR Congo, South Sudan, and western Kenya.

The project will create over 4 000 direct and indirect jobs, boost regional industrialization, and attract secondary investments in fertilizer production, LPG bottling, plastic manufacturing, and lubricants blending. The surrounding Kabalega Industrial Park will serve as a special economic zone offering tax incentives, power subsidies, and logistics services (see Figure 30).

According to UNOC and PAU projections, Uganda could save approximately USD 800 million annually in refined fuel import costs once the refinery is fully operational. Combined with revenues from transit fees, local content services, and tax receipts, the refinery could add more than 1.5% to Uganda's GDP annually.

The Hoima Oil Refinery is not just an industrial asset; it is a nation-shaping venture that embodies Uganda's vision for energy independence, regional leadership, and economic transformation. By linking its upstream crude reserves to a world-class midstream facility and downstream export corridors, Uganda is positioning itself at the heart of East Africa's future energy architecture.

As construction accelerates and partnerships deepen, the Hoima refinery offers a compelling model of how emerging economies can harness natural resources for inclusive, long-term development. It is a bold signal to investors, neighbours, and citizens alike: Uganda is open for energy-driven growth, built on local talent, regional collaboration, and global standards.

Figure 30. Conceptual rendering of the full refinery and Kabalega Industrial Park.

3.1.3 Prospective feedstock processing sites

Using data shared by the World Bank, UNOC, NARO and NEMA, several locations have been identified as prime spots for SAF implementation in Uganda using a cross-referencing methodology that meets the following criteria (see Table 17).

Table 17. Selection criteria for top locations for feedstock processing.

Parameter	Priority
Feedstock presence	High-yield banana, maize, sugarcane, cassava, oil crops
Grid proximity	Near existing high-voltage transmission lines (≥33 kV)
Land availability	Moderate to low population density (for industrial siting)
Climate risk	Outside frequent flood/landslide zones

Top locations

Jinja – Kamuli Corridor (Eastern Uganda)

- Feedstock: High sugarcane (Kakira), cassava, and banana production; also implies access to abundant residues from these crops
- Energy Access: Close to the Bujagali hydro plant, multiple 132 kV lines, existing substations
- Transport: Road and rail access to Kampala and Entebbe
- Climate Risk: Moderate (some flood risk near Nile, but manageable inland)
- Example: Kakira Sugar's bagasse co-gen plant could co-locate SAF ethanol production (AtJ pathway)

Masaka – Rakai – Kyotera Belt (Central Uganda)

- Feedstock: Abundant banana and cassava, some sunflower and groundnut; residues from cassava and banana will also be abundant
- Energy Access: Intersected by 220 kV Masaka–Mbarara and 132 kV Masaka–Nkenda transmission lines
- Climate: Low landslide risk; medium drought index
- Justification: Centrally located for feedstock aggregation and distribution

Mbale – Sironko (Elgon Foothills, Eastern Uganda)

- Feedstock: High banana & maize residues from highland farming
- Energy Access: 33 kV–132 kV grid via Tororo or Mbale substations
- Risks: Landslide-prone on slopes—site facility downhill or westward
- Justification: Agro-industrial zone with growing energy demand and regional logistics network

Lira – Apac (Northern Uganda)

- Feedstock: High oilseed (sunflower, cottonseed), cassava cultivation; cassava and cassava residues would be the main opportunities here
- Energy Access: Proximity to Lira solar, 33 kV–132 kV distribution lines
- Electrification Gaps: Yes, but grid presence in town centers supports scaling
- Advantage: Could serve northern Uganda and supply SAF for inland airports or storage

Hoima (Western Uganda – Albertine Graben)

- Feedstock: Access to palm oil, cassava, maize waste; cassava, maize and their residues are expected to be the main opportunity here
- Energy Access: New 132 kV Hoima–Nkenda line, close to planned oil refinery
- Co-processing potential: Could integrate SAF with petroleum refining using co-feed models
- Strategic: Near airport, refinery, and Lake Albert for logistics

Table 18. Summary of top locations for feedstock processing.

Location	Feedstock type	Grid status [kV]	SAF Yield [t/year]	Notes
Jinja–Kamuli	Sugarcane, cassava, and their residues	132–220	35 700	Co-generation potential
Masaka–Rakai	Banana, cassava, and their residues	132–220	18 800	Strong transport options
Mbale–Sironko	Banana, maize, and their residues	33–132	13 100	Avoid slope zones due to flooding
Lira–Apac	Sunflower, cassava, cassava residues	33–132	13 200	Northern SAF hub with good interconnectivity
Hoima–Kikuube	Palm oil, cassava, cassava residues	132	13 800	Refinery synergy

3.2 FINANCING

Funding pathways and financing options for Sustainable Aviation Fuel (SAF) implementation in Uganda draw from a mix of international climate finance, development partners, public-private partnerships, and domestic green investment vehicles.

3.2.1 Grants and technical assistance

Grants are among the most critical sources of early-stage funding for SAF projects, particularly in developing economies. These are typically non-repayable funds allocated by governments, multilateral organizations, or

philanthropic institutions to support feasibility studies, research and development, capacity building, and technical assistance.

3.2.2 Green Climate Fund (GCF)

Offering up to USD 1–3 million for readiness programs, and up to USD 50 million for project-level funding with mitigation components, the Green Climate Fund (GCF)[60] is the world's largest dedicated climate finance mechanism under the UNFCCC and Paris Agreement, established in 2010. Its mission is to support climate adaptation and mitigation in developing nations. As of December 2023, the GCF had a portfolio of approximately USD 13.5 billion, unlocking over USD 51 billion in co-financing from 133 countries.

Uganda has been actively integrating GCF resources into national climate strategies. Via partnerships with the Government (especially the Ministry of Water & Environment, MoAIF, UNDP, and other agencies), the GCF has financed several climate-resilient projects (see Table 19).

Table 19. Ongoing Green Climate Fund supported projects in Uganda.

Project	Focus	Period
Building Resilient Communities, Wetland Ecosystems and Associated Catchments	Climate adaptation: Wetland restoration, flood/drought resilience in catchment zones	2017–2025
Integrated Landscape Management for Climate-Resilient Water Security (ILMAC)	Water, livestock, and land resilience in the cattle corridor	Concept phase; supported under GCF readiness facilities
Wetlands Management in Uganda	Grants for wetland protection and sustainable community livelihoods	Multi-year phase under GCF ecosystem programmes

Together, these initiatives aim to restore fragile ecosystems, safeguard water security, and empower communities affected by climate variability. The comprehensive wetland ecosystem project—ending in 2025—is a collaboration between the Ministry of Water and Environment, MoAIF, the Uganda National Meteorological Authority, and UNDP.

The GCF supports projects through mitigation, adaptation, and cross-cutting funding windows. It promotes direct access by strengthening in-country institutions and encourages public-private partnerships, with a focus on mobilizing private capital.

Uganda has engaged in the GCF's country programme, with technical support from NewClimate Institute and IISD/GIZ, to develop national capacities, project pipelines, and accreditation mechanisms.

In July 2025, the GCF announced an unprecedented disbursement of USD 1.2 billion across 17 new projects, including USD 150 million for East African food security initiatives, part of a global portfolio rising to USD 18 billion, drawing from USD 29.9 billion in pledged capital.

Recent reforms have also accelerated accreditation processes, reducing waiting times for direct-access entities, while enhancing oversight and co-financing mechanisms.

[60] Green Climate Fund - Uganda

Uganda is a strong candidate for additional GCF support for several reasons:

- Wetland and water system resilience: The cattle corridor and Lake Victoria basin are vulnerable to both droughts and flooding.
- Agrarian dependency: With agriculture as a mainstay, climate shocks can threaten food and income security.
- Institutional preparedness: Participation in country-programme initiatives enhances eligibility and capacity for future funding.
- Natural resilience opportunities: Uganda's ecosystems offer high-impact potential for both carbon sequestration and adaptation success.

The Green Climate Fund functions as a key global vehicle for climate financing, blending public and potential private investment in developing nations. Uganda has already benefited from GCF-backed wetland and landscape programs with measurable resilience gains. With stronger institutional readiness and new funding momentum, Uganda stands to gain more from upcoming GCF cycles—especially if it aligns climate-priority initiatives with global impact objectives.

3.2.3 ICAO Finvest Hub

As the UN specialized agency for international civil aviation, ICAO is uniquely positioned to convene governments, industry leaders, and financial institutions under a trusted multilateral framework. In February 2025 the Finvest Hub was launched by ICAO's Secretary General with Airbus, Boeing, GenZero and GIZ as partners. The platform aims to accelerate the financing of cleaner energy solutions for aviation, with a particular focus on developing SAF. By connecting project developers, investors, development finance institutions, and governments, Finvest aims to bridge the gap between aviation decarbonisation projects and the capital they need to develop

Whereas the ACT-SAF programme corresponds with building block 3 (implementation support) of the ICAO Global Framework for Sustainable Aviation Fuels (SAF), Lower Carbon Aviation Fuels (LCAF) and other Aviation Cleaner Energies, the Finvest Hub corresponds with building block 4 (financing).

In September 2025 ICAO and IRENA launched their joint platform Finvest@ETAF, enabling SAF projects to be assessed by IRENA's 14 partner financial institutions. In addition, the Finvest public project repository has been opened, allowing projects to be publicly showcased. At the moment of publication of this feasibility study, Uganda had submitted a proposal requesting funding for the development of a national SAF policy and incentive framework.

3.2.4 UK PACT and FCDO

Over the last decade, the UK's Foreign, Commonwealth & Development Office (FCDO), in partnership with the Department for Energy Security and Net Zero (DESNZ), has channelled its International Climate Finance (ICF) through innovative programmes. Among the standout initiatives is UK Partnering for Accelerated Climate Transitions (UK PACT)—a flagship climate partnership platform launched in 2018 to help developing nations leapfrog to low-carbon economies.

Combining expertise from FCDO and DESNZ, supported by providers like Palladium International, Arup, and Social Development Direct, UK PACT works across multiple continents targeting countries with significant greenhouse gas reduction potential. Though primarily active in countries like Kenya, Nigeria, and South Africa,

the model demonstrates how blended funding and technical assistance can unlock policy reform, capacity building, sustainable energy solutions, and green finance mechanisms.

The programme has been generously funded—with GBP 150 million committed since launch—as part of the UK's broader GBP 11.6 billion ICF commitment for 2021–2026. UK PACT projects are known for delivering transformative impact through flexible, country-led support, technical skills transfers, and long-term results beyond the UK's tenure.

The FCDO plays a central role in the UK's climate finance architecture. It manages a spectrum of programmes, including:

- NU-TEC: Supporting climate-smart agribusiness in Northern Uganda, aiming to bolster resilience for 250 000+ households through market systems and input support.
- Climate Finance Accelerator (CFA): A technical assistance facility to turn Nationally Determined Contributions (NDCs) into investable, scaled projects.
- Core ICF delivery with grants for clean energy, nature-positive economies, and performance-based forest protection—delivering billions in concessional resources through multilateral and bilateral mechanisms.

The UK's climate finance approach combines grants, capacity building, and blended finance, supporting both mitigation and adaptation priorities. Crucially, it maintains gender-responsive design and supports the emerging Taskforce on Access to Climate Finance, promoting predictable and locally led investments in climate resilience.

For Uganda, FCDO's ICF and UK PACT present new pathways to access expertise, policy reform support, and investment-ready frameworks. The NU-TEC programme in Northern Uganda exemplifies how FCDO support can build climate-resilient supply chains and rural incomes—an approach easily extended to green energy or SAF feedstock projects.

Meanwhile, UK PACT serves as a replicable model for future climate partnerships, such as embedding climate-smart agriculture, renewable power planning, or cleantech entrepreneurship into Uganda's development strategies. The modular, demand-driven design ensures tailored, sustainable interventions that align with national NDCs.

In summary, FCDO, through UK PACT and its wider ICF investments, brings a comprehensive toolkit to support Uganda's transition: from early-stage capacity building to project development, policy design, and private-sector mobilization. As Uganda seeks to green its economy and scale sectors like sustainable aviation fuels, renewables, and climate-smart agriculture, the UK's climate finance mechanism offers a strategic, collaborative entry point.

Recognizing the success of programmes like NU-TEC, Uganda could benefit from replicating UK PACT-style interventions—partnering with UK institutions to co-develop national frameworks, pilot innovation, and unlock private capital for climate investments.

3.2.5 Africa Climate Change Fund

The Africa Climate Change Fund (ACCF) has emerged as one of Africa's most impactful financing mechanisms for addressing climate change. Established in April 2014 and administered by the African Development Bank (AfDB), the fund was designed to bridge the significant gap in access to climate finance that many African

nations face. Its mission is to provide catalytic support—through small grants, capacity building, and project preparation—that enables countries, organizations, and institutions to design and implement low-carbon, climate-resilient development strategies.

At its inception, the ACCF began with an initial contribution of EUR 4.725 million from Germany's GIZ, and over time it has grown into a multi-donor facility. Additional funding has come from development partners including Italy, the Flemish government (Belgium), Canada (via Global Affairs Canada and the Government of Quebec), and the Global Center for Adaptation. By 2022, the total fund had grown to over EUR 11.4 million, reflecting international commitment to African climate priorities. Administered under the AfDB's strict fiduciary oversight, the fund operates through a technical committee and donor board that review and approve proposals across the continent.

The ACCF operates with two strategic objectives. First, it enhances climate finance readiness by supporting governments and institutions in building the policy, regulatory, and technical foundations necessary to attract larger-scale funding from major global mechanisms like the Green Climate Fund (GCF) or the Climate Investment Funds (CIF). Second, it finances pilot projects that test innovative climate solutions in real-world settings, often in sectors like agriculture, water resource management, energy access, and disaster preparedness. These small-scale initiatives—often receiving between USD 250 000 to 1 million—demonstrate proof of concept while empowering local actors.

Across Africa, the fund has supported more than 27 grants totalling nearly USD 17 million. Countries such as Mali, Eswatini, Côte d'Ivoire, Tanzania, and Kenya have used ACCF grants to develop national adaptation plans, gender-sensitive climate strategies, and localized energy projects. These grants have served as launchpads, helping countries strengthen their institutional readiness to access larger, more structured climate finance.

Uganda, in particular, has been a notable beneficiary of ACCF support. Through initiatives such as "How the Africa Climate Change Fund is planting power, growing gender equality and boosting climate resilience", the ACCF has financed projects that promote renewable energy deployment in rural communities while embedding gender equity into climate action. One such project emphasized decentralized solar electrification combined with agricultural productivity training for women in climate-vulnerable regions. The impact extended beyond improved energy access—enhancing community resilience, fostering economic independence, and building the skills necessary to withstand future climate shocks.

Additionally, Uganda has participated in ACCF-supported regional planning efforts that align with just transition principles—a framework to ensure social inclusion as countries move toward clean energy. Through collaboration with the CIF and AfDB, Uganda has begun laying the groundwork for an equitable energy transition, especially in industrial sectors and in urban transport. These efforts align closely with Uganda's National Climate Change Policy and the nationally determined contributions (NDCs) under the Paris Agreement.

One of the unique features of the ACCF is its inclusive eligibility criteria. Not only can national ministries and government agencies apply for funding, but also local governments, NGOs, research institutions, and regional organizations. This decentralized approach ensures that climate finance reaches a diverse range of stakeholders and supports bottom-up innovation. Projects funded by the ACCF must show clear alignment with national priorities, demonstrate impact potential, and ideally leverage co-financing or counterpart contributions of at least 5–10%.

In 2023, the fourth call for proposals opened with a total envelope of USD 10 million. This call sought innovative project concepts across thematic areas such as ecosystem-based adaptation, energy access, urban resilience, and gender-responsive climate action. While small in scale, the grants offer significant strategic value by de-risking early-stage projects and preparing them for expansion under larger financing vehicles.

For Uganda, the ACCF represents a critical opportunity to prototype new climate interventions—such as sustainable aviation fuel (SAF) feedstock systems, decentralized energy models in industrial zones like Hoima, or integrated water-agriculture adaptation systems in the cattle corridor. These could feed into national planning efforts while directly improving community livelihoods.

As the climate crisis accelerates, funding mechanisms like the ACCF offer hope—not just in monetary terms, but as enablers of institutional resilience and climate justice. By empowering local actors, promoting gender inclusion, and investing in context-specific solutions, the Africa Climate Change Fund is helping countries like Uganda to lead in innovation, preparation, and transformation.

In conclusion, the ACCF stands out as a model of accessible, inclusive, and catalytic climate finance. It ensures that no African country is left behind in the global race to climate resilience. For Uganda, it provides the tools, resources, and partnerships necessary to design bold solutions, test new approaches, and scale up those that work.

Grants are most effective for de-risking the "soft phase" of project development, including site selection, feedstock aggregation modelling, stakeholder engagement, and preliminary environmental assessments.

3.2.6 Concessional and sovereign loans

Large-scale SAF facilities, especially those involving capital-intensive Fischer-Tropsch (FT) or Alcohol-to-Jet (AtJ) processes, often require long-term debt financing. In Uganda, concessional loans—offered at below-market interest rates—can help reduce the cost of capital and increase project viability.

Key sources include:

- African Development Bank (AfDB): Through its Sustainable Energy Fund for Africa (SEFA) and Facility for Energy Inclusion (FEI), AfDB offers debt packages and project preparation funding.
- World Bank Group / IDA: Offers sovereign loans that may be on-lent to SAF developers through ministries or state-backed entities.
- Uganda Energy Credit Capitalisation Company (UECCC): Provides local concessional lending mechanisms such as credit guarantees, interest buy-downs, and energy access loans.
- Exim Banks and Development Finance Institutions (DFIs): Such as KfW (Germany), AFD (France), and JICA (Japan) that may co-finance SAF infrastructure through bilateral arrangements.

These loans typically require strong financial modelling, creditworthy sponsors, and clear revenue streams—such as long-term SAF offtake agreements with airlines.

3.2.7 Public-Private Partnerships (PPPs)

PPPs offer a mechanism for co-developing SAF projects by sharing costs, risks, and returns between government and private investors. In Uganda, PPPs are regulated under the Public Private Partnership Act, 2015, which enables long-term infrastructure development with clear concession terms.

Examples of PPP structures for SAF could include:

- Design-Build-Operate-Transfer (DBOT): Where a private partner designs and builds the SAF facility, operates it for 15–30 years, and transfers ownership to the state.
- Joint venture model: Shared equity ownership between government (e.g., via UNOC or UECCC) and a SAF developer.
- Lease-operate model: Government provides land or infrastructure (e.g., blending facilities at Entebbe Airport) while the private entity operates the plant.
- PPPs can attract both debt and equity investors while ensuring regulatory alignment, long-term land access, and shared use of critical infrastructure such as energy and water systems.

3.2.8 Blended finance

Blended finance refers to the strategic use of concessional public funds to mobilize private capital into projects that are high-risk or not immediately commercially viable. SAF, with its nascent technologies and long payback periods, is a textbook candidate for blended structures.

Typical instruments in blended finance include:

- First-loss capital: Public funds absorb initial losses to protect private investors.
- Credit guarantees: Reducing lender risk by covering defaults.
- Results-based financing (RBF): Payments made upon production or emission-reduction milestones.
- Viability gap funding (VGF): Bridges shortfalls between commercial return expectations and actual cash flow projections.

Organizations like Convergence Finance, Shell Foundation, and Climate Investment Funds (CIF) are active in structuring such models globally. Uganda could blend funds from GCF, AfDB, and UECCC to reduce perceived risk for commercial banks or private equity firms.

3.2.9 Carbon finance and green incentives

As SAF produces up to 80% fewer lifecycle emissions than fossil jet fuel, it qualifies under several carbon pricing mechanisms:

- CORSIA (Carbon Offsetting and Reduction Scheme for International Aviation): Airlines can offset emissions by purchasing verified SAF credits.
- Voluntary Carbon Markets (VCM): Developers can monetize SAF's carbon savings by issuing carbon offsets under standards like Verra or Gold Standard.
- EU ETS or ReFuelEU Aviation Directive: If SAF from Uganda is exported to Europe, it may generate compliance credits or benefit from EU subsidies.

Uganda may also explore tax breaks, VAT exemptions, or carbon-based incentives for SAF producers under national energy or climate legislation.

3.2.10 Equity investment and private capital

Equity financing—either via venture capital, infrastructure funds, or direct strategic investors—can supply the early capital needed for SAF demonstration plants and scale-up. Investors are typically attracted by long-term offtake agreements and policy stability.

Potential equity partners:

- Impact investors: Such as Acumen, DOB Equity, or Africa50, who focus on clean energy and job creation.
- Strategic investors: Airlines (e.g., Uganda Airlines, Ethiopian Airlines) or fuel suppliers may invest to secure SAF supply.
- Private equity and venture capital: Particularly for smaller-scale ethanol-to-jet or pyrolysis-based systems.
- Equity typically demands higher returns (15–25%) but offers flexibility and risk-sharing advantages over debt.

3.2.11 Domestic resource mobilization

Uganda may explore the creation of a National SAF Fund under the Ministry of Energy or through UECCC, pooling:

- Green bonds proceeds
- Petroleum levy revenues
- Airline SAF surcharges
- Local pension or sovereign wealth fund investments

This fund could act as a cornerstone investor in SAF plants, derisking projects and crowding in additional finance (see Table 20).

Table 20. Summary of potential funders for SAF projects.

Funder	Role	Notes
ICAO (Finvest Hub)	Technical & financial matchmaker	Uganda has submitted a project
UK Government (FCDO, UK PACT)	Capacity building, climate funding	Co-funding SAF feasibility
GCF	Large-scale SAF project financing	Up to USD 50 million per project
ACCF	Regional infrastructure & PPPs	Concessional finance & RBF
World Bank/IFC	Guarantees, blended finance	Risk mitigation for investors
UECCC	Local finance implementation	Credit guarantees, RBF
Airlines (e.g., Uganda Airlines)	Offtake buyers	Enable project bankability
Private equity/impact investors	Project development capital	Needs strong policy signals

SECTION 4. ACTION PLAN

4.1 POLICY AND REGULATORY FRAMEWORK

The successful development of a SAF supply chain in Uganda hinges critically on the establishment of a robust, forward-looking policy and regulatory framework. This framework would create a conducive environment for private sector investment, international partnerships, feedstock mobilization, and downstream fuel adoption — particularly by airlines, airports, and fuel distributors.

At present, Uganda lacks dedicated legislation or institutional guidance for sustainable aviation fuels. The existing national energy and transport policies focus largely on petroleum, electricity, and infrastructure development, but make minimal reference to alternative fuels or decarbonization of aviation. Addressing this regulatory gap is essential to stimulate SAF production and ensure alignment with international climate obligations, such as those set under ICAO's CORSIA program (Carbon Offsetting and Reduction Scheme for International Aviation).

4.1.1 Recommendation 1 – Establish a SAF council

Establishing a Sustainable Aviation Fuel (SAF) Council in Uganda would meaningfully accelerate SAF development and deployment. Many countries pursuing SAF (e.g., United States., United Kingdom., Brazil, Singapore, Japan) have set up formal industry–government coordination bodies that rapidly de-risk investment and unlock policy, infrastructure, and finance.

A SAF Council would significantly accelerate Uganda's transition to low-carbon aviation by aligning government agencies, industry actors, and development partners under a shared strategy. SAF development spans multiple sectors — agriculture, waste management, energy, aviation, and finance — and progress can stall when responsibilities are fragmented. A SAF Council would streamline policymaking by coordinating ministries such as energy, transport, and agriculture to design supportive measures including blending mandates, tax incentives, and sustainability standards.

The council would improve investment confidence by providing a clear national roadmap and helping structure airline offtake agreements, which are crucial for financing first-of-a-kind SAF plants. It would also lead feedstock mobilization efforts, including mapping biomass and waste resources, improving logistics, and protecting food security. Additionally, the council would coordinate airport and refinery readiness, ensuring cost-efficient blending, storage, and distribution.

International alignment is another benefit: the council would help Uganda meet ICAO CORSIA requirements and gain access to global climate finance. By uniting airlines, fuel producers, and regulators, it becomes easier to build market demand and secure long-term commitments.

Recommended structure of a Uganda SAF Council

Chair: Office of the Prime Minister OR Ministry of Energy & Mineral Development (MEMD)

Members:

- Government: MoWT, MAAIF, NEMA, URA, UCAA, UNOC, UIA
- Industry: sugar mills, ethanol producers, waste companies, fuel suppliers, airlines
- Academia: Makerere University, Kyambogo University, industrial research institutes
- Development partners: ICAO, AfDB, IFC, UNIDO, UK PACT, etc.

Includes dedicated Working Groups on:

- Feedstock governance & food security
- Financing & incentives
- Technology & certification
- Airport fuel system readiness
- Environmental safeguards & community engagement

Overall, a SAF Council would turn Uganda's strong SAF potential into implementable projects by reducing risk, accelerating decision-making, and creating the partnerships needed for successful deployment.

4.1.2 Recommendation 2 – Establish a SAF policy framework

A dedicated SAF Policy Framework would position Uganda well to accelerate SAF production and usage. This policy would define SAF in legal and technical terms — including the types of eligible feedstocks (e.g., cassava, sugarcane bagasse, jatropha, municipal solid waste), the approved conversion pathways (e.g., HEFA, FT-SPK, ETJ), and international quality standards (e.g., ASTM D7566 certification for Jet-A1 blending). Clear guidelines will give confidence to project developers, financiers, and off-takers.

To further enhance investment attractiveness, the government could explore fiscal incentives for SAF-related activities. These could include corporate tax holidays, feedstock production subsidies, import duty exemptions on SAF equipment, and green bonds or grants for SAF pilot facilities. Additionally, the URA and UIA could establish green investment classifications for SAF to streamline project approvals and licensing.

The UCAA will also play a critical role by integrating SAF into airport fuel handling regulations, safety protocols, and emissions reporting standards. The creation of a national SAF certification and compliance unit, jointly managed by UCAA and MEMD, would ensure that all SAF used and traded in Uganda meets international environmental and fuel performance standards, and can be verified for ICAO CORSIA credit accounting.

Additionally, it is advised that Uganda's SAF policy framework is designed in harmony with regional and global efforts. Collaboration with East African Community (EAC) counterparts, particularly Kenya, Rwanda, and Tanzania, could enable regional harmonization of SAF regulations and promote cross-border fuel corridors. International development agencies such as the World Bank, ICAO, UNDP, and the African Development Bank can provide technical support and climate finance to kick-start policy implementation and build local institutional capacity.

Table 21 shows various examples of policies that decision-makers in Uganda could consider combining, however, it is by no means exhaustive.

Table 21. Examples of policy mechanisms that could be considered in Uganda.

Short-term (0–24 months): Kickstart and de-risk	
Tax relief	VAT/excise exemptions on SAF; customs duty waivers for SAF equipment.
Production credit	Per-liter incentive tiered by carbon intensity (CI).
Grants & guarantees	Feasibility/FEED grants; loan guarantees; green H_2 support.
Offtake enablement	Government-backed contracts for difference (CfDs) or floor-price support for first plants.
Airport readiness	Entebbe blending/storage upgrades; ASTM D7566 handling SOPs.
Fast-track permitting	One-stop desk; 120-day decision SLA.
Feedstock mobilization	UCO buy-back program; MSW gate-fee allocation; residue aggregation hubs.
Sustainability/MRV	CORSIA-aligned LCA, traceability, and auditing rules via UNBS/NEMA/UCAA.
Medium term (2–5 years): Scale & standardize	
Ramp blend mandate	e.g., 1% → 3% → 5% with CI caps and flexibility (banking/carry-forward).
Revenue certainty	Multi-year SAF CfDs linked to CI benchmark.
Public procurement	Govt travel & national carriers to use SAF.
Grid & utilities	Green-tariff for SAF plants; priority interconnections; water reuse standards.
Waste policy	Source-segregation & long-term MSW supply contracts.
Human capital	Targeted technical training; O&M certification.
Long term (5–10+ years): Lock-in & export	
National target	e.g., 10% SAF by 2035; export eligibility.
Regional harmonization	EAC common specs, sustainability, and certificates.
Finance vehicles	Green bond window; development bank credit lines.
Pipelines & terminals	Multi-product upgrades for cost-down logistics.
R&D/innovation	Pilot funds for novel pathways (FT from residues/MSW, ETJ).

4.1.3 Recommendation 3 – Establish a national SAF mandate

Finally, the Government of Uganda — through the Ministry of Works and Transport (MoWT) and the Ministry of Energy and Mineral Development (MEMD) — could establish a National SAF Mandate. This mandate could, for instance, require that all aviation fuel sold in Uganda contain a minimum blend of SAF (e.g., 2% by 2030, rising to 5% by 2035). A blending mandate not only signals political commitment but also creates demand certainty for investors and feedstock suppliers. It would encourage fuel importers and distributors to begin adapting their infrastructure for SAF compatibility and promote downstream innovation in logistics and distribution.

In conclusion, the development of a viable SAF supply chain in Uganda cannot occur without regulatory support. A well-structured and inclusive policy framework — combining options such as mandates, incentives, standards, and institutional coordination — will be indispensable. It will not only unlock SAF's economic potential but also reinforce Uganda's commitment to environmental sustainability, regional leadership, and long-term energy security in the aviation sector.

4.2 CRITICAL SUCCESS FACTORS

Table 22. Summary of critical success factors to establish a SAF ecosystem in Uganda.

Domain	Critical success factor	Why it matters
Feedstock	Sustainable, year-round supply (including storage)	Ensures production reliability
Technology	Proven SAF conversion methods	Reduces technical, financial and certification risk
Policy	National mandates and incentives	Stimulates market demand
Finance	Investment from public and private sectors	Enables infrastructure and R&D
Market	Airline commitment via offtake	Drives demand and price stability
Collaboration	Cross-sector partnerships	Aligns goals and accelerates delivery
Awareness	Training and public buy-in	Ensures long-term adoption and success

4.3 ACTION PLAN

Table 23. Overview of the opportunities and challenges of identifying and establishing viable SAF supply chains in Uganda.

Opportunities	Challenges
▪ Development of SAF from local feedstocks can reduce imports and emissions ▪ Integration of SAF co-processing and/or blending into the planned Hoima refinery or nearby mini bio-refineries ▪ Creation of SAF logistics hubs in Hoima, Gulu, and Entebbe using shared infrastructure (such as the Tristar Energy Fuel Farm) ▪ Positioning Uganda as a regional SAF supplier to EAC airports (e.g., Kigali, Juba, Nairobi)	▪ Geopolitical and cross-border risks in fuel import routes (e.g., Kenya unrest) ▪ SAF production requires high capital investment and long ROI horizons ▪ Limited feedstock capacity in Uganda to support the projected SAF demand ▪ Competition from more advanced SAF markets (South Africa, Kenya, EU)

Table 24. Description of recommended actions to identify and establish viable SAF supply chains in Uganda.

Recommended actions	Timeline	Potential responsible entity
Aim 1: Technology, partnerships and investment mobilization		
Incentivize and partner with local feedstock producers (agri-residue collectors, used cooking oil aggregators).	2026-2028	NEMA / MEMD
Assess the viability of specific business cases by conducting a business implementation study.	2026-2028	UNOC / MEMD / UCAA / ICAO
Explore partnerships with airlines and global SAF producers for offtake and technology transfer.	2026-2028	UNOC / MEMD / UCAA
Shortlist 1–2 commercially viable SAF technologies suitable for pilot investment	2027-2028	UNOC / MEMD / UCAA
Build a public-private investment ecosystem that supports SAF development and scale-up.	2028-2030	MoFPED / UIA
Leverage ACT-SAF affiliation to submit proposals to GCF or AfDB.	2028-2030	MoFPED / UIA
Leverage ICAO Finvest Hub and UECCC to mobilize public / private capital.	2028-2030	MoFPED / UIA
Aim 2: Creation of a SAF hub and infrastructure/logistics planning		
Explore pilot PPPs (e.g., blending at Entebbe, small-scale SAF production).	2028-2029	UNOC / MEMD / UCAA
Plan and conduct pre-FEED studies on one or two pilot SAF production facilities near feedstock zones and/or major logistics corridors.	2028-2029	UNOC / MEMD
Pilot SAF blending/storage at Entebbe and other hubs (with logistics from Mahathi, etc.).	2030-2031	UCAA / Entebbe International Airport
Upgrade jet fuel storage depots (Hoima, Kampala, Entebbe) to include SAF	2030-2031	Tristar
Aim 3: Implementation of favourable policy and regulatory framework		
Establish a SAF Council	2027-2028	OPM / MEMD
Mandate UECCC to include SAF in its renewable energy portfolio.	2029-2030	MEMD
Develop a SAF policy framework under MoWT and Ministry of Energy	2029-2030	MoWT / MEMD
Design certification and quality assurance standards (align with ASTM D7566, ICAO CORSIA)	2029-2030	UNOC / MEMD / UNBS
Develop a national SAF mandate	2030-2031	MWE / NPA

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APPENDICES

APPENDIX A: STAKEHOLDER ENGAGEMENT

The list below includes the Ugandan national stakeholders that have contributed through information exchange to the development of this Study. Those are presented in order of the consultations held.

#	Stakeholder
1	Uganda Civil Aviation Authority (UCAA)
2	Uganda National Oil Corporation (UNOC)
3	National Planning Authority (NPA)
4	National Agriculture Research Organization (NARO)
5	National Environment Management Authority (NEMA)
6	Ministry of Energy (MOE)
7	Tristar company
8	Makarere University Kampala (MUK)
9	Uganda National Bureau of Standards (UNBS)
10	Uganda Revenue Authority (URA)
11	Ministry of Agricuture, Animal Industry and Fisheries (MAAIF)
12	Uganda Airlines