Unlocking Climate Finance to Accelerate Energy Access in Uganda

November 2, 2021
Research Context
This research is part of a series of reports from Catalyst Off-Grid Advisors and partners

They demonstrate the business opportunity to unlock billions in climate finance and deliver on multiple SDG goals

> Our 2018 research demonstrated the financing opportunity to achieve universal household electrification in Africa (SDG 7) via off-grid solutions

> First launched on Earth Day 2021, and covering all of Sub-Saharan Africa, this research shows off-grid solar’s social dividends, which cut across numerous SDGs

> Alongside the climate dividends attributable to low-carbon SDG 7 scenarios

> It forecasts the climate finance opportunity associated with these low-carbon SDG 7 scenarios

> Illustrating the multi-billion-dollar climate finance opportunity associated with the low-carbon scenarios
Modeling illustrates Uganda’s low-carbon scenarios and the impact they will have on SDG 13

SDG 7 – Ensure access to affordable, reliable, sustainable and modern energy for all
SDG 13 – Take urgent action to combat climate change and its impacts

Social Imperative: Universal access to modern, reliable electricity by 2030
10.2 M households connected

2°C or less low carbon scenario toward electricity access
Reduction of GHG emissions

High carbon scenario toward electricity access
Increase of GHG emissions
Low-carbon scenarios accelerate Uganda’s achievement of SDG 7 and SDG 13 via 3 pillars

Predictive modeling forecasts three scenarios for each thematic pillar: business-as-usual, high-carbon, and low-carbon, shows the avoided emissions between the latter two, and then provides the investment costs associated with the low-carbon scenario.

**Electricity Access**
Providing first-time electricity access

What will it take to provide first-time electricity access in Uganda via a low-carbon trajectory that avoids millions of tons of CO₂ emissions?

**Unreliable grid**
Solving the unreliable grid challenge

What’s required to get enterprises and households to transition off back-up generators and onto distributed renewable sources of power?

**Cleaner cooking**
Moving households onto modern cooking solutions

What is a credible scenario to move a portion of Uganda’s households onto modern cooking solutions?

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**Uganda’s Climate Finance Opportunity**
Improving access and reducing emissions across the continent

What level of CO₂ emissions are avoided via each pillars’ low-carbon scenario? What is the associated climate finance opportunity?
Setting the Scene
Uganda’s grid generation mix relies heavily on hydroelectricity

The country also has significant untapped renewable potential, including geothermal

> **143% increase in generation** since 2009, averaging 13% increase per annum
> **92% of generation from hydropower** in 2019, up from 75% in 2010
> **2% of generation from solar**, with a total solar potential of 5000 MW
> **1500 MW of geothermal** power potential
Uganda’s industrial sector accounts for the majority of electricity demand

Residential consumption is strikingly low in Uganda on a per household basis, underscoring affordability challenges, and bolstering industry’s level of consumption in comparison.

- **69% of global electricity demand** driven by industrial and commercial off-takers
- **78% of Uganda’s electricity demand** driven by industrial and commercial off-takers
  - Tariffs range from an average of $0.17 / kWh for small commercial customers to US$0.08 / kWh for large industrial customers
- **27% of global electricity demand** originates from households
- **22% of Uganda’s electricity demand** originates from households. Tariffs are $0.07 / kWh for the first 15 kWh and $0.21 / kWh thereafter

All $ in this deck refer to United States Dollars (USD)


UMEME
Ugandan households are electrified by diverse sources

This includes a surprisingly high level of standalone solar uptake in unelectrified areas

- 43% of households had no source of electrification
- 19% of households got their power from the grid
- 38% of households got their power from solar home systems or solar kits
- 0.2% of households got their power from mini-grid connection

Tier 1* Pathway: this low-carbon scenario enables Uganda to avoid 1.4 million tons of CO₂ emissions

BAU only achieves 63% access in 2030; a low-carbon scenario envisages significant scale up of grid (38%), off-grid (59%) and mini-grid (8 times) connections to deliver universal access

1°HH Access rate of 63% achieved

Assumes that 100% access is achieved

Impact 10.2 million households get first-time access
Financing opportunity $1.36 B (Low-Carbon)

<table>
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<tr>
<th>Scenario</th>
<th>Connections</th>
<th>Climate Finance Opportunity</th>
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<td>Total Access Rate: 63%</td>
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<td>• Grid: 4.7M HH (32%)</td>
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<td>• Mini-grid: 0.1M HH (1%)</td>
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<td>• Off-grid: 4.4M HH (37%)</td>
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<td>Total: $436 Million</td>
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<td>• Grid: 8.5M HH (58%)</td>
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<td>• Mini-grid: 0.6M HH (4%)</td>
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<td>• Off-grid: 5.6M HH (38%)</td>
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<td>Total: $902 Million</td>
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<td>• Off-grid Solar: $524M</td>
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<td><strong>Low Carbon</strong>†</td>
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<td>• Grid: 6.8M HH (46%)</td>
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<td>• Off-grid: 7.0M HH (48%)</td>
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<td>Total: $1.36 Billion</td>
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<td>• Mini-grid: $652M</td>
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<td>• Off-grid Solar: $706M</td>
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1° The low-carbon scenario has lower estimated emissions than the BAU scenario since emissions from electrification activities are more than offset by reductions in stopgap emissions.

* Tier 1 access is the minimum threshold for these scenarios and is defined as at least 4.3 kWh of electricity consumption per household per year – supporting basic lighting and device charging
Gamechanger 1: Specialized vehicle to underwrite off-grid financing risk

Financing improvements for off-grid solar PAYG sales in underserved areas of Uganda

The Challenge

> OGS needs to **serve areas where it is not feasible to connect households to the grid** or mini-grids
> Low-carbon scenario forecasts **4.5 million new connections** from OGS
> These underserved areas are often difficult to access; households **have lower willingness and ability to pay for solar**
> **Extending credit** to these households is considered particularly risky, and building credit risk management capabilities within solar companies is a complex, costly undertaking
> Many incumbent solar companies do not target these market segments
> Though solar lighting penetration is quite high in Uganda (**37% of HHs report solar as their primary lighting source**), over 75% of these products are non-VeraSol* quality verified

The Opportunity

> **Develop a pooled risk sharing facility** of PAYG loans that originate in underserved areas
> In addition to scaling sales of incumbent solar retailers in Uganda, **leverage existing last mile distribution** businesses to expand availability of quality verified products
> **Blended finance structure** for the facility, crowding in varied risk/reward appetites among climate financiers
> Facility will seek **net capital preservation**, creating value creation opportunities for more commercially-minded investors
> Retailers could **manage customer acquisition** (including basic creditworthiness screening), technical servicing, and payment recovery escalations. In the event of default, claims could be made on the facility

Source: Catalyst estimates; GOGLA Sales Data; USAID: UOMA: Uganda Household Electrification Survey; Access Insights Platform (AIP); GOGLA

*VeraSol is the evolved quality assurance program for off-grid solar products and appliances*
Gamechanger 1: Impact and key design considerations

If 30% of new OGS connections were underwritten by the facility, this could make a meaningful contribution toward achieving Uganda’s low-carbon SDG 7 scenario and crowd in significant climate finance.

Key Design Considerations

- **Facility structure and capitalization**: Separate windows for inventory financing and receivables underwriting, each capitalized with blended finance and set up as revolving windows.
- **Inventory**: Available to retailers on a consignment basis via the Facility.
- **Product Quality**: All products VeraSol Quality Verified.
- **Household Eligibility**: Geographic targeting to be done based on poverty mapping, ability to pay or other quantifiable metrics.
- **Management**: Competitively selected manager with extensive credit risk and collections management experience; could be done in partnership with local financial institutions to leverage existing infrastructure.
- **Distributor Eligibility**: Solar distribution experience, logistics and supply chain robust enough to reach targeted areas, and sound collections practices.
- **Technical assistance**: For distributors, focused on customer screening, after sales management and servicing, and collections.

**Gamechanger 1 Impact**

- **1.35 million HHs** would benefit from Tier 1 connections*
- **Avoided household stopgap emissions of 880,000 tons of CO₂**
- **~$132 million** in receivables that would need to be underwritten.

Sources: Catalyst estimates

*Currently this is modeled to focus solely on Tier 1 access as those households are expected to be the most difficult to reach and the group who would benefit most from the envisioned facility. In practice, it will likely need to cover larger Tier 2 and Tier 3 systems as well.
MEM: Targeting the Modern Energy Minimum (MEM)* in Uganda generates additional 2.2MT CO₂ emissions, unlock higher levels of household consumption

To achieve 300 kWh/capita/year by 2040, per capita consumption must exceed 136 kWh by 2030; generating 2.2 MT of additional CO₂ emissions compared to Tier 1

Sources: Catalyst estimates.

1The MEM calls for a higher, more inclusive level of electricity consumption as a better access metric to raise global energy ambitions; Energy for Growth Hub, 2020.
Gamechanger 2: Catalyzing use of productive use appliances

Leverage partnerships with grid and off-grid operators to spur power consumption by small enterprises

The Challenge

> Need to accelerate both on-grid and mini-grid demand via productive use applications. In the Low-Carbon Tier 1 Scenario, Uganda only reaches 72 kWh/capita well short of the 2030 MEM Interim Target (130 kWh/capita).

> This will help Uganda target the MEM, tackling energy poverty and spurring local economic development.

> Low affordability, limited access to capital, and low willingness to pay constrain household and enterprise investment in PUE opportunities.

> Lack of awareness and fit-for-purpose technologies, particularly in agricultural value chains.

> Promising pilot initiatives ongoing in Uganda, but these need to be scaled quickly.

The Opportunity

> Leverage Uganda’s ongoing pay-as-you-save, on-bill financing, asset-based financing, and other utility financing pilots to support household and commercial uptake of productive use applications (e.g., Twaake, Nyenje, EnerGrow).

> Partner with UMEME, other distribution providers, and mini-grid operators, helping to stimulate customer demand and utility and business revenues.

> Boost demand (and utility/mini-grid revenue) via increased roll out of more established and tested technologies like carpentry, cold storage, tailoring, and pumps.

> Help power providers and other parties to offer end-user financing for productive use assets (e.g., EnerGrow, Utilities 2.0).

Sources: Power for All / Rockefeller Foundation; Catalyst estimates
Gamechanger 2: Impact and key design considerations

Scaling Utilities 2.0 and other new utility frameworks to support downstream PUE, improve consumption, and grow utility revenue

Key Design Considerations

> Partner with UMEME, other distribution companies, and mini-grid developers to identify prospective customers

> Develop a menu of productive use technologies, including supporting local manufacturing and assembly when possible

> Mobilize productive use asset financing via specialized and existing local financial institutions

> Partner with power providers to deploy innovative mechanisms to manage repayment of PUE loans

> Provide catalytic concessionary capital for power providers to test new ideas, including emerging PUE technologies and business model innovations

> Create favorable market and regulatory conditions for PUEs to flourish in Uganda

> Customer engagement and outreach campaigns to foster awareness of PUE programs

Gamechanger 2 Impact

> Boost power consumption an average of 38-50% via PUEs

> Average 135% increase business revenues thanks to PUEs

> De-risking of investment and enhanced bankability of power providers thanks to increased revenue

> Lower connection costs (average 50% reduction), due to integrated energy approaches including distributed energy, smart metering, asset-based financing, open data, etc.

> Mobilize “$50 million in climate finance to scale these initiatives

Sources: Utilities 2.0 Power for All / Rockefeller Foundation; Power for All Appliance Finance and Demand Stimulation Report; Catalyst estimates
Unreliable Grid: Pathways and Gamechangers
Uganda’s grid, managed by UMEME, is reliable compared to neighboring markets
However, enterprises still invest heavily in backup gensets

Unreliable grid connections

> In developing countries, unreliable grids are the primary driver for genset use
> About 75% of sites using fossil-fuel powered gensets are “grid connected”

*In Uganda alone:*
> About 81.5% of firms experience outages
> 6.3 outages in a typical month for total downtime of about 64 hours (About 8.6% downtime)
> Unreliable grid connections result in an average 11.2% loss in business revenues

Use of backup gensets

> Backup fossil-fueled generators are used by households and enterprises
> Powered with fossil fuels, typically diesel or gasoline
> Significant source of air pollutants
> Uganda’s current fleet is 32,000 gensets and 1.5 GW
> Uganda’s genset fleet spends over $150 million per year on fuel
> Off-grid enterprises often resort to using gensets for power, particularly for productive use applications
> In Uganda, 14.8k gensets are deployed for commercial use (99% are on-grid businesses), while 17.2k gensets are deployed for residential use (45% are grid connected residences)

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1 An unreliable grid is defined as one in which local enterprises, on average, report 12 or more hours of electrical outages in a typical month;

Source: World Bank Enterprise Surveys; IFC Dirty Footprint of Broken Grid; SERC estimates; Catalyst estimates

*Based on US$1.046 / liter*
Replacing Uganda’s gensets with DREs can reduce emissions by 1.8 million tons of CO₂

- Emissions reductions are driven by the growth rate in back-up genset fleets and the rate at which back-up gensets are replaced by renewables; replacement rates are varied across scenarios.¹
- In the low-carbon scenario displacing over 50,100 assets with a total generation capacity of 2.6 gigawatts by 2030 would yield a $2.1 billion climate finance opportunity

¹ The modeling assumes that average capacity factors of back-up generators remain fixed over time, in line with historical averages (i.e., assumes no improvement or deterioration in grid reliability).

Sources: IFC Dirty Footprint of Broken Grid; SERC estimates; Catalyst estimates
Cleaner Cooking: Pathways and Gamechangers
Uganda’s clean cooking sector is strikingly underdeveloped
Charcoal and wood fuels dominate household cooking practices

- 94.8% of households utilize solid fuel or kerosene fuels
- 23,360 people killed annually from household air pollution
- 1.4% of households cook primarily with electricity
- 18.8% of households utilize multiple stove types

Uganda’s clean grid power presents an opportunity for electric cooking, though affordability presents a challenge

Electric cooking represents the cleanest path for those connected to the grid or to a DRE powered mini-grid, though the cost to cook may be a barrier to uptake

*Each fuel has a GHG emissions intensity factor (kgCO₂e per gigajoule of fuel burned) which illustrates the carbon-intensity of the fuel when burned. When used in a particular stove, only a percentage of the burned fuel is converted into useful energy, resulting in a higher GHG emissions intensity in practice.

Source: Authors’ analysis based on multiple sources including Penisse et al, Bailis et al; Clean Cooking Alliance’s Clean Cooking Catalog, inter alia.
Shifting households from charcoal to modern fuels could avoid 6.5M tons of CO₂ emissions

Households cooking with charcoal are likely to be able to afford to switch to a modern fuel; they’re also often close to infrastructure and supply chains that could be used for modern fuels.

> In the low-carbon scenario, **2.1 million households that cook with charcoal** would transition to modern fuels.
> 1.3M HHs cooking with electricity
> 700k HHs cooking with LPG
> 100k HHs cooking with ethanol
> $392 million investment required to primarily produce and distribute electric and LPG stoves as well as to support infrastructure development
> Significant health benefits, thanks to reduced household air pollution from charcoal combustion

1 In a household, the primary fuel is the one which accounts for the majority of cooking needs.
Sources: Catalyst estimates
Gamechanger 3: Catalyzing all urban charcoal users to switch to electric cooking

The Challenge

> Modern fuels are more expensive than charcoal on a per meal basis
> Electric pressure cookers (EPCs) can compete on some meals like matooke ($0.13 / meal for charcoal and $0.07 for EPC), but on shorter cook time dishes costs are less favorable
> Transitioning to electric cooking means buying electric cooking appliances (EPCs, induction stoves, etc.), with high upfront capital costs and behavior change challenges
> The market for efficient domestic electric cooking technologies is not well developed, so availability is limited, and costs are high

The Opportunity

> Power provider-led financing programs to foster end-user electricity demand and create new revenue streams
> Locally manufactured electric cooking solutions, particularly PAYGO enabled
> Results-based financing could support power providers to pre-finance appliances; households pay back via monthly deductions from electric bills
> Emissions savings (average of 5.4 kg CO$_2$e avoided / meal) can be tracked and monetized as carbon credits; proceeds can help subsidize upfront capital costs of the appliances and/or finance consumer awareness campaigns

Sources: Catalyst estimates; MECS Cooking with Electricity in Uganda: Barriers and Opportunities
Gamechanger 3: Impact and key design considerations

Transitioning Uganda’s 1.4 million urban charcoal users to electric cooking unlocks huge climate impacts and financing opportunities

Key Design Considerations

> Electric cooking **necessitates a robust electric grid**, which needs to be included in integrated electrification planning; grid-strengthening ancillary investments will need to be financed

> **Leverage existing pilots** (e.g. MECs) to track and certify emission reductions from electric cooking

> **Customer financing options** like PAYGO or Pay-as-you-save approaches to make appliances affordable

> **Support local manufacturing** of electric cookstoves, particularly electric pressure cookers, to help scale up the electric cooking sector in Uganda

> Explore potential for **commercial electric cooking schemes**, particularly for injera bread as a starting point for electric cooking acceptance and predictable planning for electricity demand

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**Gamechanger 3 Impact**

- **9 MT CO₂** avoided compared to status quo
- **$234M** in investment for electric cooking infrastructure and stoves
- **1.4 million households** with improved household health from avoided charcoal combustion and household air pollution
- **$100.8 million** in avoided fuel costs
- At a conservative $20 / ton, **$180 million of carbon finance could be mobilized** to support the capital costs for cooking devices
- **30-51% time savings** for staple meals with EPCs instead of charcoal

Sources: Modern Energy Cooking Services (MECS): *Uganda cooking transitions*; Catalyst estimates
Gamechanger 3: Climate finance should significantly lower costs

Climate finance can help lower upfront capital costs for consumers, and enable UMEME and other providers to offer special pricing on power used for electric cooking.

- **High upfront capital costs** for EPCs make switching to electric cooking very difficult for most households.
- At current prices households would **save an average $13 per year in fuel costs** using EPCs compared to charcoal and **would avoid ~5.4 tons of CO₂ per year**.
- If a small portion of potential carbon finance revenue was used to buy down the cost of EPCs to be equal to the cost of charcoal stoves (and then subsidize electricity costs), households could **save an average of $58 – $219 over the 3-year warranted lifetime of the EPCs**.
- Local manufacturing and partnerships could also lower the cost of electric pressure cookers.
- To help with adoption, **utility programs could be designed with specialized tariffs** to incentivize use of electric cooking over charcoal.
- Other **results-based financing for health outcomes** could also be stacked with carbon finance to help support cost competitiveness of electric cooking.

**Source:** Catalyst estimates; MECS *Cooking with Electricity in Uganda: Barriers and Opportunities*
Summary
Uganda’s energy sector: setting the scene

Key energy trends and their climate impacts illustrate the scope of the SDG 7 and SDG 13 challenges

Electricity access

- 43% of Ugandan households are unelectrified
- 38% use small solar solutions to meet basic needs
- 19% are connected to the grid
- Uganda’s grid power is extremely clean; 98% of generation comes from renewable sources

Unreliable grid

- Ugandan enterprises experiencing an average of 8.6% downtime, and 11.2% revenue losses
- > 32,100 backup gensets deployed in the country, with an installed capacity of 1.54 GW.
- These gensets consume 155.5 million liters / year of petrol and diesel fuels

Cleaner cooking

- >95% of Uganda’s population use solid fuels for primary cooking needs
- ~24,000 people in Uganda die annually from household air pollution
- 1.4% of households have transitioned to electric cooking

Source: Uganda Bureau of Statistics Household Survey 2019 / 2020; IFC Dirty Footprint of Broken Grid; SERC estimates; Catalyst estimates
The low-carbon scenarios avoid 9.7 million tons of CO₂ through 2030, deliver SDG 7 impacts, requiring substantial climate finance.

Emissions from Uganda’s low-carbon scenarios are benchmarked against high-carbon counterfactuals for avoided emissions.

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**Avoided CO₂**

- **1.4 MT CO₂ Avoided**
  - 10.2 million households get first-time access
  - $1.36B

- **1.8 MT CO₂ Avoided**
  - 50,100 gensets retired
  - $2.1B

- **7.5 MT CO₂ Avoided**
  - 2.1 million households using clean fuels
  - $392M
Summing up: Uganda’s low-carbon path
Uganda could unlock a $3.85 billion climate finance imperative

A low-carbon scenario contributes massively toward universal access
- 10.2 million new connections for energy access delivered
- More than 50,100 gensets used by enterprises and households replaced
- More than 2.1 million households with new modern cooking access

A low-carbon scenario benchmarked vs. a high-carbon scenario yields
- 9.7 million tons of avoided CO₂ emissions over the next decade

A low-carbon scenario requires substantial volumes of new capital
- $1.36 billion climate finance opportunity for first time access
- $2.1 billion climate finance opportunity to green back-up generation for enterprises and households
- $392 million climate finance opportunity for clean cooking
Potential gamechangers to accelerate energy access and development in Uganda

**Risk-sharing facility for PAYG solar**
- Off-grid solar (OGS) is not accessing underserved areas where there is also lower willingness and ability to pay;
- Underwrite consumer receivables for new OGS connections via a blended finance risk-sharing facility; could support 1.35 million households and avoid almost 900 thousand tons of CO₂

**Scaling productive use of energy**
- Accelerate both on-grid and mini-grid demand via end-user financing of productive use applications in partnership with UMEME, other distribution providers, and mini-grid operators;
- Early pilots show this could boost power demand 38-50% per customer, increase business revenues 135%, and bolster bankability of electricity service providers.

**Electric cooking**
- Uganda’s clean power grid could be used to scale uptake of electric cooking, with electric cooking appliances being financed by third parties and administered by electricity service providers;
- This could avoid 9 MT CO₂ emissions and $100 million in charcoal fuel costs for 1.4 million urban households cooking with charcoal, while also creating significant health and time savings.
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