



Energy Efficiency Roadmap for Uganda

Making Energy Efficiency Count

EXECUTIVE SUMMARY



ENERGY EFFICIENCY ROADMAP FOR UGANDA

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Key Findings:

- Scaling up energy efficiency investments in Uganda requires a combination of enabling policies that include regulations, enforcement, target setting, and financial schemes combined with development of technical expertise in the labor force and promotion of new business models, such as energy service companies.
- The technical potential analysis indicates that with available technology and best practice, 2,224 gigawatt hours can be saved in 2030 across all sectors, representing 31% of the forecasted load. This translates into 341 megawatts of peak demand reduction, representing 2.5 times the demand that will be supplied by the Isimba dam.
- Including energy efficiency in the national planning process could increase energy access to 6 million rural customers and reduce carbon dioxide (CO₂) emissions by 10.6M tonnes by 2030. Annual emissions reductions in 2030 represent 6% of the country's Nationally Determined Contribution pledge under the Paris 2015 United Nations Climate Change agreement.
- Approximately 91% of the technical potential is cost effective (7% discount rate), and 47% is achievable under conservative assumptions (20% discount rate and benefit-cost ratio greater than two).
- The main barriers to energy efficiency investment in Uganda consist of a lack of access to affordable capital and financing, a lack of confidence about energy efficiency investments, a lack of enabling policies, a lack of enforcement of regulations, and a lack of technical expertise.
- Based on a multi-criteria decision analysis (MCDA) tool, priority programs to implement were found to be: enacting the Energy Efficiency and Conservation Bill, prioritizing energy efficiency in integrated resource planning, developing regulations for energy audits and energy management systems for large energy users, and enforcing the existing standards and labeling (S&L) program.
- Next priority programs include: expanding the S&L program, setting industry targets, encouraging the market for efficient products, and encouraging energy efficiency in small and medium enterprises.
- Additional programs to implement include: developing training and accreditation schemes, developing building codes, recognizing champions of energy efficiency, developing financing schemes through an energy efficiency and conservation fund, encouraging development of clean industry, promoting building disclosure and benchmarking, developing government lead-by-example programs, and developing cities' and municipal councils' energy efficiency action plans.
- The implementation costs for these programs were estimated to approximate the cost to government, which is one of the MCDA tool criteria. The annual budget per recommendation ranges from US\$1,000 to US\$231,000, and averages US\$107,000.

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OVERVIEW

Uganda is experiencing economic growth and rapid urbanization, which are driving a steady increase in energy demand. Electricity demand is increasing at a rate of 8.2% annually, which translates to 125,000 new customers every year. Power generation capacity tripled over 13 years to an estimated 900 megawatts (MW) in 2015. This swift expansion has been fueled by a dynamic economy that is growing at an average annual rate of 7%, placing Uganda among the fastest-growing economies in the world.

Expanding rural access to electricity is another important factor driving demand. An estimated 74% of Uganda's population currently does not have an electricity grid connection, household solar, or diesel generator. By 2030 it is estimated that the demand of the grid-connected residential sector will have grown by more than 250% from current levels. The key driver of this increase is rural and urban electrification, which is supported by the aggressive goals of the *Ugandan Government National Development Plan* (Uganda Government NDP II, 2015).

Investment in Uganda's energy sector has focused mainly on increasing energy access by increasing supply. The links between energy efficiency and energy access, and the multiple benefits of energy efficiency for the level and quality of energy available, have been largely overlooked by many stakeholders in Uganda, including the international donor community. Energy efficiency and energy access are sometimes viewed as competing priorities for funding rather than elements that can work together to achieve the goal of providing improved access to energy services. Moreover, energy efficiency is often perceived as a short-term solution to power outages and load shedding without taking into account that it is also a source of energy for future electricity planning.

As recognized in the Sustainable Energy for All (SEforALL) objectives, energy efficiency is a core element of ending energy poverty and securing access to affordable, reliable, sustainable, and modern energy. Implementing energy efficiency in parallel with expanding both the electricity grid and new clean energy generation reduces electricity demand and helps optimize the power supply so that it can serve more customers reliably at minimum cost. Adopting efficient technology and appliances along with informed energy management practices allows rapid scaling up of energy efficiency to ease power constraints and lower utility bills for both the public and private sectors while supporting a sustainable framework for long-term energy stability.

The benefits of energy efficiency are numerous. Energy efficiency contributes to reducing power plant fuel inputs and thereby reducing costs of power generation, reducing harmful pollution, mitigating climate change, and enhancing energy security. Even more important for developing economies, energy efficiency allows deferral of costly investment in new power generation, thus contributing to reducing the cost of electricity. Energy efficiency is also a critically important component of increasing access to modern energy services. By enabling consumers to use less electricity to operate appliances and equipment, energy efficiency frees up electricity that can be used for accessing additional services. However, harnessing energy efficiency is a complex endeavor that requires first assessing the energy efficiency potential across sectors of the economy and identifying programs and policies that help remove market barriers to private investment in energy efficiency.

PURPOSE OF THE ENERGY EFFICIENCY ROADMAP

This Energy Efficiency Roadmap for Uganda (Roadmap) is a response to the important role that electric energy efficiency can play in meeting Uganda's energy goals. Power Africa and the United Nations SEforALL Initiative collaborated with more than 24 stakeholders in Uganda to develop this document. The Roadmap prioritizes recommendations for implementing energy efficiency and maximizing benefits to meet the goals and priorities established in Uganda's 2015 SEforALL Action Agenda and the SEforALL Investment Prospectus (SEforALL, 2015; 2016a). Like many countries that have joined SEforALL, Uganda developed an Action Agenda to outline milestones through 2030 for building the three main energy pillars of sustainable development: energy access, energy efficiency, and renewable energy. The Action Agenda identifies priorities and challenges, and this Roadmap provides additional detail on electrical energy efficiency opportunities along with support for designing and implementing policies and programs that will meet the SEforALL energy-saving goals. The Roadmap focuses on electrical energy efficiency; efficiency opportunities in the transportation sector and those associated with other fuels (e.g., biomass, kerosene) are outside the scope. The authors identify these as needed areas of focus for future research.

The Roadmap assesses in detail Uganda's electricity market and experience with energy efficiency programs (*Situation Assessment*), explains the potential for electrical energy savings (*Electricity Savings Potential*), and recommends actionable steps to advance energy efficiency (*Energy Efficiency Action Plan*).

SITUATION ASSESSMENT: BUILD ON SUCCESS AND ADDRESS BARRIERS TO ENERGY EFFICIENCY

Uganda has successfully evolved its power sector by unbundling power generation, transmission, and distribution, defining roles and responsibilities of relevant entities, and establishing an independent regulating agency, the Electricity Regulatory Authority (ERA).

Recent success in attracting private investment to develop new power capacity is evident in the Bujagali hydropower plant (250 MW), which is currently meeting 49% of the country's electricity needs. Additional planned capacity includes the construction on the River Nile of the Karuma and Isimba dams (783 MW, December 2018) and Ayago dam (840 MW, 2022) to produce hydro-electricity. Moreover, Uganda launched an innovative feed-in tariff program, the Global Energy Transfer Feed-in-Tariff (GET FiT), to fast-track the development of 170 MW of smaller, renewable energy investments.

However, additional capacity comes at a hefty cost. On average, the investment cost per MW is US\$2.6M. The Bujagali plant produces electricity at a cost of US\$0.11 per kilowatt hour (kWh). This cost does not account for the cost of transmission and distribution to deliver electricity to end-users. Uganda's electricity household tariffs are currently US\$0.18 per kWh, making energy efficiency a very attractive investment.

Despite the apparent business case for energy efficiency, a significant share of the potential to improve energy efficiency in Uganda remains untapped, and the level of investment in energy efficiency generally remains low. Barriers to energy efficiency investments are summarized in the table on page 4.

Barriers to Energy Efficiency in Uganda

	Barriers	Description	Remedy/opportunity
Regulatory	Lack of policies and regulations to enforce energy efficiency	Processes and procedures to enforce and prioritize energy efficiency requirements have not been put in place.	Enactment of the Energy Efficiency and Conservation Bill is needed to provide the legal basis for the elaboration and enforcement of the national policy.
	Lack of prioritization of investment in energy efficiency	Although energy efficiency is recognized as a resource to meet energy demand (NDPII, 2015), it is not yet prioritized in investment decisions.	<ul style="list-style-type: none"> ▪ Integrate energy efficiency in resource planning ▪ Mandate that large energy users invest in energy efficiency ▪ Regulate products sold in the market
Informational	Limited information and knowledge about the benefits of energy efficiency	Those making purchasing decisions do not have information about the energy performance of technologies, and there is an inadequate awareness of the benefits of energy efficiency investment.	<p>Develop programs to inform the private sector in investment decisions:</p> <ul style="list-style-type: none"> ▪ Labeling of appliances ▪ Awareness campaigns ▪ Incentivized audits ▪ Recognition awards ▪ Best practices ▪ Training
	Inadequate technical expertise	Expertise on energy efficiency opportunities and benefits assessments is currently inadequate.	<ul style="list-style-type: none"> ▪ Build capacity and create certification schemes to develop an established professional community ▪ Collaborate with UNBS* and ECREEE* to establish a testing facility to enforce market verification
Economic and Financial	Lack of access to affordable capital and financing	Uganda is among the countries with the highest cost of financing in the world. Uganda ranks 121 (out of 144 countries) by affordability of financial services. In comparison, Kenya and Rwanda rank 64 and 56, respectively (World Bank, 2015 a). Moreover, commercial banks do not have experience with financing energy efficiency projects and do not fully understand the profitability of energy efficiency loans.	<ul style="list-style-type: none"> ▪ Provide affordable financing for energy efficiency investment ▪ Support financial intermediaries to invest in energy savings opportunities ▪ Support financing access to energy service companies ▪ Establish funding for energy efficiency investments by leveraging funding from public (government and development partners) and private stakeholders ▪ Develop guarantee fund to cover for deflationary risk

*UNBS – Uganda National Bureau of Standards; ECREEE - Economic Community of West African States Regional Centre for Renewable Energy and Energy Efficiency

Uganda has had success in implementing energy efficiency programs during the past 10 years. A compact fluorescent light (CFL) distribution program reduced power demand by 32 MW at an investment of US\$0.05M per MW, which is more than 50 times cheaper than investing in a new baseload hydropower plant. The World Bank (WB)-funded Power Factor Correction Program reduced demand by 8.6 MW and helped stimulate the creation of energy efficiency consulting companies in Uganda. Recently, ERA allocated US\$4.1M toward demand-side management (DSM)¹ programs and developed a DSM plan that currently includes light-emitting diode (LED) procurement and distribution, a time-of-use (TOU) tariff program, and a public awareness campaign for energy efficiency.

Two programs that have not yet been fully successful but have the potential to succeed are appliance standards and labeling (S&L) and implementation of energy audit recommendations. If enforced, appliance standards could substantially improve energy efficiency. Similarly, implementation of energy efficiency recommendations from energy audits has been limited because of lack of access to affordable financing options as well as lack of confidence in the predicted energy savings.

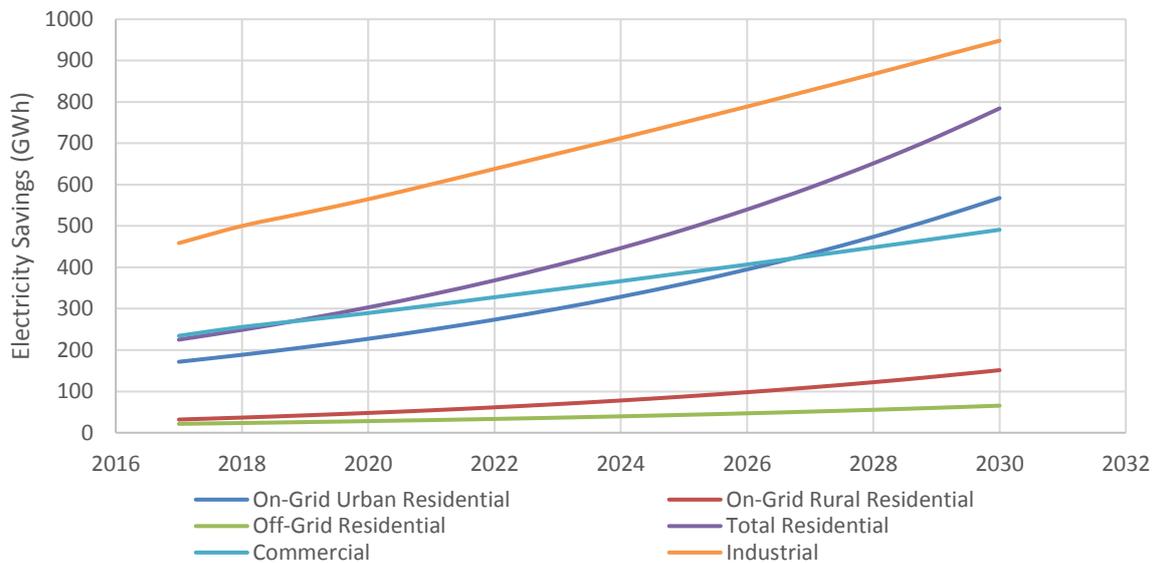
ELECTRICITY SAVINGS: ASSESS THE POTENTIAL

The energy efficiency opportunities recommended in this Roadmap were developed based on an assessment that started with a set of representative energy efficiency measures that are broadly suitable for application in developing world markets. These measures apply to electricity usage within the residential, commercial, and industrial sectors. As noted previously, the Roadmap focuses exclusively on electrical efficiency upgrades, so measures such as fuel switching to biomass or natural gas have not been considered. The technologies considered for this assessment were selected based on information and data gathered from research and stakeholder collaboration. Based on the energy efficiency measures considered, three levels of potential were calculated: technical, economic, and achievable economic.

The Roadmap assessment indicates a significant opportunity for energy efficiency to mitigate growing levels of electricity consumption and demand in Uganda. Considering available technology and best practice, our analysis of the estimated technical potential for savings in the year 2030 indicates that 2,224 gigawatt hours (GWh) of meter-level consumption can be saved across all sectors (see figure on page 6), which is equivalent to 31% of the forecasted load. The consumption savings from energy efficiency also translate into peak demand savings and thus the ability to provide electricity to more consumers without the need for additional power plants. It is estimated that energy efficiency improvements can save 341 MW of on-grid meter-level peak demand and an additional 15 MW of off-grid demand. Assuming the current transmission and distribution loss rate of 22.8%, energy efficiency can offset 442 MW of generation-level demand, which is nearly 2.5 times the demand that will be supplied by the Isimba dam (183 MW). Demand projections show no sign of declining in the short term, so energy efficiency offers an opportunity to extract the maximum value from each power generation facility. In total, an estimated 10.6 million tonnes of carbon dioxide (CO₂) emissions can be avoided through the implementation of energy efficiency measures.

¹ DSM refers to energy demand reductions through efficiency improvements or load shifting on the customer side of the electrical meter.

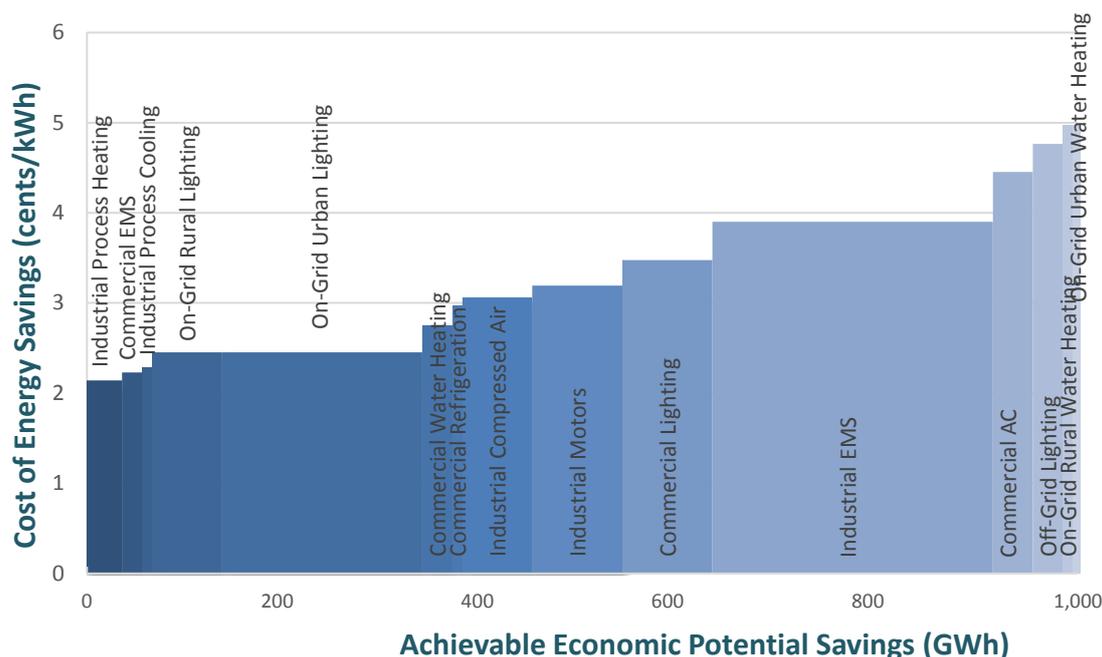
Electricity Consumption Technical Potential per Sector in Uganda, 2017-2030, Including Residential Subsectors



It is important to not overlook the large opportunity for energy efficiency to help manage load growth so that additional electricity capacity that is added can be used to increase access for new customers. Assuming a total electricity consumption of 1,060 kWh per year per urban customers and 369 kWh per year per on-grid rural customers (Parsons Brincherhoff, 2011), the on-grid efficiency savings in 2030 could allow grid access through grid extension to an estimated additional 2.1M urban customers, or 6M rural customers, without the need for additional generation. In other words, including efficiency in the national planning process could mean adding 6M rural customers without the need for new generation, at a cost that is likely to be lower than the cost of building additional grid supply capacity.

Out of the 2,224 GWh of technical potential, approximately 91% is included in the economic potential (2,022 GWh), and 47% is included in the achievable economic potential (1,052 GWh, medium case). This provides strong support for the cost-effectiveness of energy efficiency improvements in Uganda and reveals a significant opportunity for energy efficiency to benefit the economy. The figure on page 7 shows a breakdown of the top opportunities, prioritized by end-user cost of conserved energy (CCE). Highly cost-effective opportunities are found in a multitude of sectors and end-uses, including on-grid residential lighting, commercial water heating, and industrial motors. The largest opportunity is the implementation of energy audits coupled with energy management systems (EMSs) in the industrial sector. The magnitude of this opportunity strongly supports the prioritization that these systems have been given in the current draft Energy Efficiency and Conservation Bill. An uncertainty analysis of the achievable economic potential indicates that even with conservative savings estimates, energy efficiency is still capable of saving 663 GWh of electricity by 2030. This equates to approximately 16% of the anticipated load growth over the next 13 years, emphasizing that, even under unfavorable estimates, energy efficiency can make a significant contribution to meeting Uganda’s power needs for years to come.

**Top Opportunities for Achievable Economic Potential, Medium Case,
Prioritized by End-User Cost of Conserved Energy**



ENERGY EFFICIENCY ACTION PLAN: PRIORITIZE ACTIONS

Achieving the many benefits of energy efficiency requires bundling a package of policy instruments that best address the market failures hindering energy efficiency investment. Energy efficiency opportunities tend to be distributed across all sectors of the economy and among many technologies and practices. Policy makers have three basic types of policy tools available to address barriers to energy efficiency: regulations, knowledge diffusion, and financial incentives. A combination of these tools along with targets and continuous monitoring often best accelerates energy efficiency improvement. This Roadmap builds on these basic policy tools to recommend *building blocks* for energy efficiency: energy performance standards, target setting, information diffusion, capacity building, public awareness, and financing support.

Policy and program recommendations are provided for each sector of the economy based on the situation assessment, analysis of potential savings and international best practices. Each recommendation is discussed in detail, and actionable steps are identified for optimum implementation. The actionable steps are also used to estimate the government’s cost of implementation.

Based on a multi-criteria decision analysis (MCDA), programs and policies were prioritized to form a Roadmap of energy efficiency program recommendations according to five criteria:

- Energy savings
- First cost to government
- Speed of implementation
- Prerequisite to other measures
- Multiple benefits

The resulting Roadmap is shown on page 9. The priority programs are those dictated by the Energy Efficiency and Conservation Bill because their implementation creates the basis for further initiatives by establishing the regulatory frameworks, data systems, and stakeholder relationships needed to carry out successful energy efficiency programs.

The priority cross-cutting program recommendation is enacting the Energy Efficiency and Conservation Bill. Integrating energy efficiency into resource planning constitutes the next priority, as this will ensure that energy efficiency opportunities are considered in future investment decisions, on an equal basis with supply options. The S&L program is the next cross-cutting priority recommendation. This program is at an advanced stage of development and only lacks the enforcement necessary to make it very impactful. Moreover, S&L are prerequisite to many additional programs that require equipment energy performance identification. The final cross-cutting priority is the creation of an Energy Efficiency and Conservation Fund, which is critical to supporting energy efficiency incentives and investments by Ugandan businesses; the fund requires substantial resources to be developed.

Industrial energy efficiency is a priority because of the significant potential for energy savings and the high concentration of actors in this sector. The progression of program implementation recommended recognizes that auditing and energy management are foundation steps to drive investment toward energy efficiency improvements. Setting energy efficiency targets comes next, to galvanize industry toward more aggressive efficiency strategies. Programs targeting small and medium enterprises (SMEs) expand the outreach to smaller industries and increase their awareness of and capacity to undertake energy efficiency investments. Recognition of energy efficiency champions and expanding workforce trainings follow next in the order of priority.

Residential efficiency programs will be largely centered on uptake of efficient products enabled through the S&L program. Uganda has a unique opportunity to promote energy efficiency to newly grid-connected households as well as to off-grid communities, enhancing the off-grid sector at large. The well-documented benefits of energy efficiency for off-grid users can be achieved through accelerating the growth of Uganda's nascent off-grid appliance market, often in partnership with solar home system (SHS) companies.

The long lives of buildings create a strong impetus for improving building efficiency; building energy codes implemented today will reap benefits for the next 50 years or more. In this light, building efficiency codes are the first step. Building disclosure and benchmarking complement and advance building efficiency through mandatory energy performance reporting, target setting, and incentives. The government has an opportunity to lead by example by making smart investment in energy efficiency to reduce its energy bills and at the same time helping to develop new business models, such as energy service companies (ESCOs). Municipal leadership is the final priority program because of the great impact that city policies can have on a city's building stock, particularly the facilities owned by the municipality, but also because city policies play an important role in the implementation of building codes.

The intent of the Roadmap is that it be used to drive and track progress on each action in the short, medium, and long term in Uganda. The Ugandan Ministry of Energy and Mineral Development (MEMD) is the lead implementer of this action Roadmap, but support from key stakeholders is needed to design and implement these recommendations, and from international development organizations to optimize results.

Energy Efficiency Roadmap for Uganda



CONCLUSION: MAKING ENERGY EFFICIENCY COUNT REQUIRES LEADERSHIP

Improving energy efficiency is highly cost effective, but many barriers prevent residential, commercial, and industrial customers from investing in efficient appliances, buildings, motors, and processes. Important steps for Uganda to take to realize the full potential and benefits of energy efficiency investments include establishing enabling policies and financial incentives and developing technical expertise in the labor market to allow for promoting new business models, such as ESCOs. Uganda will benefit from developing and implementing new policies to overcome these barriers and to integrate energy efficiency into future energy resource planning.

MEMD has a key role to play in leading implementation of Uganda's energy efficiency action plans. Leadership is essential to motivate actions and communicate vision and purpose. Part of the leadership commitment is setting goals and monitoring progress to focus efforts and optimize resources. Regular data collection and program impact evaluation are necessary to support continuous energy efficiency implementation. MEMD can use the energy-saving potential of 185 MW from the achievable economic potential as an initial energy-savings goal for implementing the recommendations of the Energy Efficiency Roadmap.

MEMD also has an important role to play in leading others to consensus by reaffirming to all actors the critical role that improved energy efficiency can play in addressing energy reliability, energy access, and Uganda's environmental and economic objectives. The international development community should support MEMD's efforts, share experiences in successfully raising the level of energy efficiency in their own countries, as well as through investments in other countries, and committing to energy efficiency as a resource and economic growth tool in Uganda.



As a global platform, Sustainable Energy for All (SEforALL) empowers leaders to broker partnerships and unlock finance to achieve universal access to sustainable energy, as a contribution to a cleaner, just and prosperous world for all. We marshal evidence, benchmark progress, amplify the voices of our partners and tell stories of success and connect stakeholders. Follow SEforALL on Twitter at @SEforALLorg for the latest updates.

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The Ministry of Energy and Mineral Development's mandate is to establish, promote development of, strategically manage, and safeguard the rational and sustainable exploitation and utilization of energy and mineral resources for social and economic development. Key Energy Efficiency and Conservation Department functions are to develop strategies and programs to improve energy efficiency and conservation.

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Power Africa is a U.S. Government-led partnership launched in 2013. Power Africa's goals are to increase electricity access in sub-Saharan Africa by adding more than 30,000 megawatts of generation capacity and 60 million new home and business connections by 2030. For more information on Power Africa activities in Uganda, visit usaid.gov/powerafrica/uganda.

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