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How Can Electric Transportation Advance Africa's Sustainable Development Agenda?

The global push to decarbonize, coupled with rapidly growing markets for electric vehicles (EVs) in industrialized nations, is raising the question: what's needed to shape and invest in Africa's EV future? A just transition to low-carbon transportation will necessitate the creation of policies and solutions that support socio-economic development, sustainability, and affordability. [1] Tailoring these policies to local contexts will entail scrutinizing how transportation systems impact social and economic livelihoods, especially in marginalized communities, as well as exploring the symbiosis between electric transportation and the financial viability of electricity systems – including rural mini-grids.

Mini-grids increasingly provide access to electricity in rural parts of sub-Saharan Africa and improve livelihoods.[2,3] However, the economics of rural electrification via mini-grids assets remains a great challenge. EVs could help increase the financial viability of this model by stimulating demand, and by serving as either dispatchable load, distributed storage, or both.

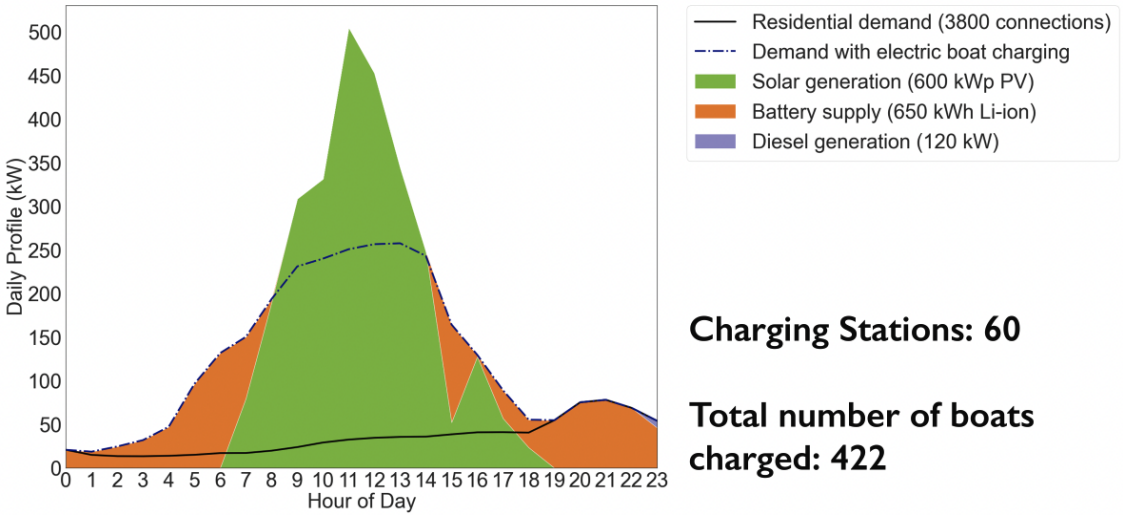
Electric fishing boats could be a key demand stimulation opportunity for solar mini-grids in Uganda

The STIMA Lab at UMass Amherst teamed up with Equatorial Power, a mini-grid developer based in Kampala, Uganda, to evaluate the business case for an innovative business model that provides asset financing to help local fishing boat owners replace their diesel outboard motors with electric motors charged via mini-grid. The program aims to help the fishing community increase incomes through avoided fuel costs, while at the same time reducing the harmful environmental effects of burning diesel fuel.[4] Key findings include:

- Electric-powered fishing boats have the **potential to increase revenues for mini-grid developers without increasing operation cost**. The majority of this community's fishing activity takes place during the night, meaning that boats are on shore during the day when solar production is at its peak. PV production from the mini-grid could therefore be sufficient to charge e-fishing boats without requiring power from a backup generator (Figure 1).[5]
- With this asset financing scheme – which includes a loan term of about 2 years, a 10% down payment, and a monthly interest rate of 2.55% per month – replacing a diesel outboard motor with an electric one **could save a fishing boat owner up to $20,000** over five years from avoided fuel purchase costs and engine maintenance costs. Cost savings could also trickle down the entire fishing value chain in the form of lower prices charged to fish processors, the majority of whom are women, therefore increasing their incomes.
- Electric-powered fishing boats have the potential to **enhance mini-grid reliability through demand response**. The timing and level to which batteries are charged could be controlled to match the intermittency of supply and maximize grid reliability. More generally, models using battery swapping and bidirectional chargers could enable mini-grids to draw energy from the surplus batteries not in use during peak hours instead of relying on expensive backup generators.

- Because they increase revenues for the mini-grid developer, electric-powered fishing boats have the potential to **cross-subsidize tariffs for residential customers**, which would also stimulate organic consumption growth. A lower tariff could be set for low-consumption residential customers to meet the affordability criteria, typically cross-subsidized from higher consumption electric boats.

FIGURE 1: Simulation of impact of electric boat charging load on a solar mini-grid on Lolwe Island



While electric fishing boats are a specific use case, more commonly used two- and three-wheeler EVs have similar potential benefits. In some parts of sub-Saharan Africa, two-wheeler EVs are already crucial for income generation through their use as a taxi service and enable the local economy by transporting goods to and from markets.[6]

Pairing EVs with rural mini-grids presents an opportunity to strengthen economic outcomes for communities while reducing dependence on conventional mobility models. However, the market is still nascent and several factors need to be considered to support wide-scale adoption.

Key considerations for enabling wide-spread adoption of electric transportation in mini-grid communities.

1. **Accessible high-quality pilot data.** Given the nascent nature of EV markets, particularly in rural Africa, we do not yet fully understand which key usage information will inform technology choices and business model development across different communities. It will therefore be critical to collect and make accessible high-quality telemetric mobility and charging data from pilot studies for further analysis.
2. **Innovative and proven financing mechanisms and business models** that remove the upfront cost burden from end-users and ensure adequate incentives for both the technology and electricity provider will be critical. Full-service leasing models, rent-to-own, and battery swapping business models can lower the barriers to adoption in these communities.[7] However, their financial sustainability hinges on economies of scale. It will therefore be crucial

to conduct market assessments to reliably evaluate viability and support investments in piloting appropriate business models. In addition, these types of business models require a regulatory framework to ensure standardization of the available battery technology, as well as a legal framework with clearly defined ownership structures.

3. **Raising public awareness in mini-grid communities** of the benefits of EVs over their gasoline counterparts will be essential in driving demand and ensuring long-term financial sustainability of the business models. The nascent nature of the technology creates a steep hurdle in convincing communities to adopt EVs. Development partners, governments, and other stakeholders should create policies and invest in pilot programs that increase the visible benefits of EVs, such as incentives and secure parking for e-mobility solutions, as well as information campaigns to address common misconceptions.
4. **Ensuring positive and equitable socio-economic outcomes for the community** through income generation, job creation, skill-building, and gender inclusion. National and local governments should enact policies that boost local assembly and manufacture of electric mobility solutions. These policies need to be accompanied by initiatives and funding opportunities to help all genders develop the necessary skills to manage the employment transition to the electric mobility sector, as well as a regulatory framework that ensures local transportation remains affordable.
5. **Cross-sectoral coordination** between mini-grid developers, community leaders, technology providers, public service officials, and key private sector actors will be necessary. Governments and development partners should facilitate stakeholder engagement training, paired with platforms to facilitate open discussions and exchange of information and good practices during policy development, feasibility study, and implementation phases.
6. **Establishing adequate supporting infrastructure**, such as charging stations to address range anxiety concerns, as well as integrated software solutions such as cloud platforms for charging management, battery management, communication, and payment systems. This should be accompanied by a clear definition of the role of the electricity providers, tariff design, and infrastructure ownership and operation, as well as subsidies and incentives to enable private actors to set up adequate charging infrastructure and supporting technology in their areas of operation.
7. **Strategies for proper battery waste management.** With a lifespan of about 10 to 15 years, bulk battery waste will likely accompany a widespread uptake of EVs, calling for proper infrastructure, policies, and legislation for battery waste management. This would entail reuse, recycling, or recovery options, as well as consumer education on the importance of proper battery waste disposal.

Endnotes

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