Essays on Access to Electricity in Sub-Saharan Africa

PhD Defense

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Motivation

- Access to modern energy services (**electricity and clean cooking fuel**) is essential for improved living conditions and economic development.
- Electricity access promotes industrial development and income generating activities.
- Access to electricity also significantly improves the quality of health services.
- Nevertheless, over 820 million people, worldwide, still live without electricity.
- Sub-Saharan Africa (SSA) is home to 80% of the world population without access to electricity.

Motivation

Lack of access to electricity and cooking fuel in SSA have huge economic costs

- 9.5 billion USD of tax revenue losses per year in SSA due to power cuts.
- 2.4 trillion USD per year for lack of access to clean cooking fuels (World Bank, 2020).

Electrification process has long been through grid extension. However, this solution is not cost effective.

- Dispersed nature of rural settlements
- Low electricity consumption
- Low willingness to pay for electricity service

Motivation

- However, with the declining cost of solar panels, the technology is emerging as a cost effective solution to bridging the access deficit in rural areas.
- Moreover, more than 60% of rural population in SSA are poised to get electrified through off-grid solutions (IEA).
- Nevertheless, the adoption rate is still very low.

Main Objective ?

Investigate the drivers of modern energy services adoption in Sub-Saharan Africa and more specifically the enabling role of financial inclusion.

Overview

1. Are Mini-grid Projects in Tanzania Financially Sustainable?

2. Does Financial Inclusion Facilitate Solar Panels' Adoption? Evidence from Tanzania

3. The Impact of Mobile Money on Households Cooking Fuel Choices: Evidence from Senegal

4. Pay-as-you-go contracts for electricity access: bridging the "last mile" gap? A case study in Benin

Are Mini-grid Projects in Tanzania Financially Sustainable?

Context

- Less than 50% of the Sub-Saharan Africa's population have access to electricity.
- Rural areas concentrate the overwhelming majority of the population without electricity.
- Mini-grids are the new pathway to bridging the high electricity access deficit in Sub-Saharan Africa (SSA).
- Private investors' participation is particularly crucial to meet the annual electrification investment needs of $120 billions in SSA.

Research question

1. Are mini-grid projects in Tanzania profitable from an investment perspective under the current tariff structure ?

Are Mini-grid Projects in Tanzania Financially Sustainable?

Methodology

1. Economic Buoyancy Vector (WRI) of the area of study to assess consumer's ability and willingness to invest in clean energy.
2. The Rural African load profile tool is used to estimate the potential electricity demand from Mafinga Town.
3. We use an optimization tool (HOMER) to estimate the Levelized cost of energy (LCOE) for three mini-grid project designs (Thermal, PV+Battery and Hybrid systems).

Data

- Tanzania 2012 National Population Census (2012) and Tanzania mini-grid portal.
- National Renewable Energy Laboratory (NREL).

Are Mini-grid Projects in Tanzania Financially Sustainable?

Main results

- The approved mini-grid tariffs and subsidy scheme in Tanzania still do not allow mini-grid for rural electrification projects to be profitable.
- Sensitivity analysis using the estimated future system component costs, discount rates and system reliability, off-grid projects are still not profitable from a private investment perspective.

Does Financial Inclusion Facilitate Solar Panels' Adoption? Evidence from Tanzania

Context

- Chapter 1 reveals that most households in rural areas cannot afford cost-reflective electricity price.
- Solar Home System (SHS) can therefore be an alternative solution given their low electricity consumption profile.
- However, its adoption rate by households is very low.
- Lack of access to credit and financial services are identified as barriers to solar adoption.

Research question

1. Does mobile money affect Tanzanian households' decision to purchase solar panels?
2. If yes, what are the underlying mechanisms at play?

Does Financial Inclusion Facilitate Solar Panels' Adoption? Evidence from Tanzania

Methodology

- Logit model and Linear Probability Model with an instrumental variable technique.
- **Instruments:** Mobile phone ownership and Mobile money agent availability within district.

Data

- The first wave of the re-sampled Tanzania National Panel Survey (TNPS) conducted between 2014-2015.

Does Financial Inclusion Facilitate Solar Panels' Adoption? Evidence from Tanzania

Main results

- The IV results reveal that mobile money leads to a 19% increase in the probability of adopting solar panels.
- Receipt of remittances, access to credit and participation in off-farm income generating activities are the mediating channels through which mobile money affects the probability of adopting solar panels.

The Impact of Mobile Money on Households Cooking Fuel Choices: Evidence from Senegal

Context

- Access to clean cooking fuels is essential to improving living conditions and pivotal in eradicating poverty.
- Sub-Saharan region concentrate the bulk of the population lacking access to clean cooking fuels, with an access deficit of 910 million people.
- The heavy reliance on solid polluting cooking fuels has detrimental environmental and health effects.

Research question

1. Does financial inclusion promotes the use of clean cooking fuels ?
2. What are the underlying mechanisms ?

The Impact of Mobile Money on Households Cooking Fuel Choices: Evidence from Senegal

Methodology

- Probit model and Linear Probability Model with an instrumental variable technique.
- **Instruments:** Mobile money agent availability within household's district.

Data

- A nationally representative sample of 4,767 Senegalese households.
- Data collected by the Initiative Prospective Agricole et Rurale (IPAR).

The Impact of Mobile Money on Households Cooking Fuel Choices: Evidence from Senegal

Main results

- Mobile-Money (MM) usage is positively associated with the adoption of cleaner cooking fuels.
- MM leads to a 24.5% and 44% inccrease in the probability of adopting clean and charcoal cooking fuels, respectively.
- The easy reception of remittance is identified as the underlying mechanism at play.

Pay-as-you-go contracts for electricity access: bridging the "last mile" gap? A case study in Benin

Context

- The country nationwide access to electricity in 2016 was 32% of the population.
- There is a huge gap between access to electricity in rural and urban areas.
- Only 5.5% of the rural population was connected to the electric grid in 2015.
- Electrifying the "last mile" is challenging.
- Pay-As-You-Go (PAYG) solutions are emerging as a cost effective solution to providing electricity access to rural areas.

Research question

1. Who are PAYG users ?
2. What are the determinants of successfully conducting PAYG credit ?

Pay-as-you-go contracts for electricity access: bridging the "last mile" gap? A case study in Benin

Methodology

- Descriptive analysis
- Simple multinomial logit model

Data

- Commercial contracts of 10,120 PAYG users living in Benin.
- Limited socioeconomic variables of PAYG users.

Pay-as-you-go contracts for electricity access: bridging the "last mile" gap? A case study in Benin

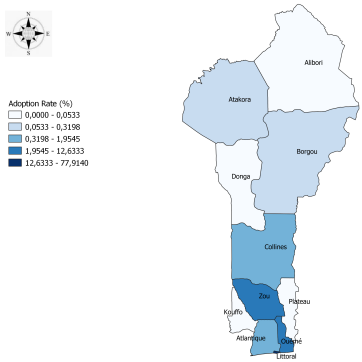

Figure: New PAYG users by department

Source: Authors' elaboration from ARESS sales database.

Pay-as-you-go contracts for electricity access: bridging the "last mile" gap? A case study in Benin

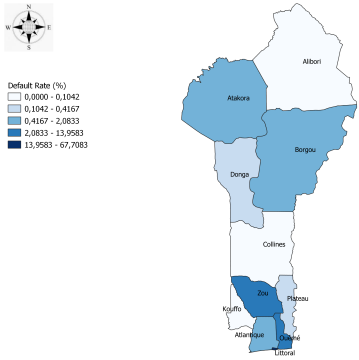

Figure: Default rate by department

Source: Authors' elaboration from ARESS sales database.

Pay-as-you-go contracts for electricity access: bridging the "last mile" gap? A case study in Benin

Main results

- The overwhelming majority of PAYG users in Benin are coming from better-off and well electrified areas.
- Consumers located in more periferic and less electrified areas have a low probability to default, as the substitution effect is weaker.
- Overall, in our case study, PAYG targets credit worthy consumers, in order to decrease the investment risk of the company providing solar devices.

Conclusion

This dissertation examines the determinants of modern energy services adoption in SSA with a particular focus on the role of financial inclusion.

Chapters

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Policy recommendations

This dissertation identifies some valuable lessons from the mini-grid regulatory and policy regime in Tanzania that may be worth emulating by other SSA countries.

- The implementation of the technology-specific and size-specific Standardized Power Purchase Agreements (SPPA) and Standardized Power Purchase Tariffs (SPPT).
- Provide financial support to local developers.
- Couple mini-grid projects with economic projects aimed at stimulating productive use of electricity.
- Finally, widen access to financial services to vulnerable population.

Thank you for your attention