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Off-grid electrification: Opportunities and challenges for key players in Rwanda's off-grid power sector

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03-03-2020

#TheAgenda


Background: Energy Access in Sub-Saharan Africa
Research Focus: Energy Access in Rwanda
Preliminary findings from exploratory interviews
Key Take-aways going forward

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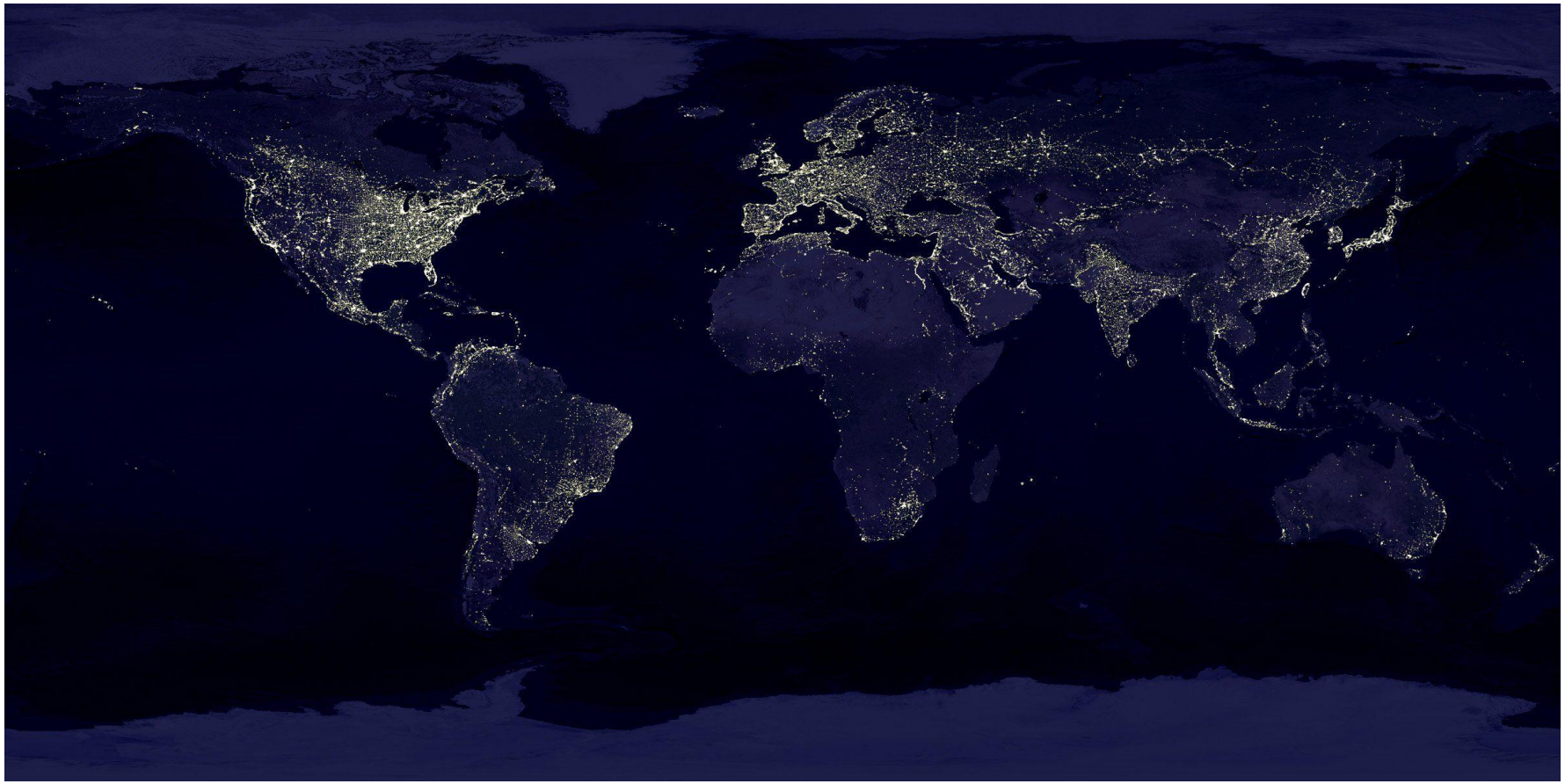
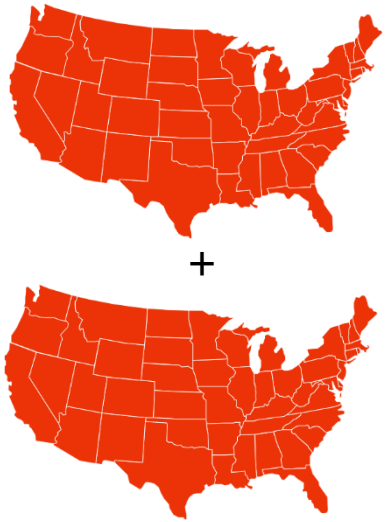
Access to electricity and the services that it enables are vital to overcoming the short comings of energy poverty



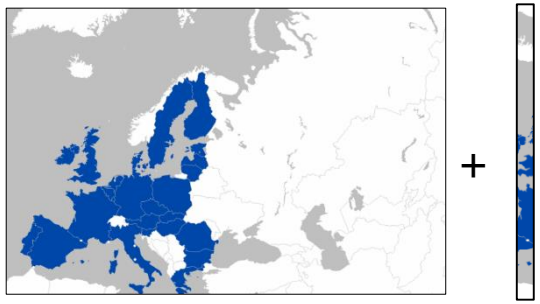
NASA Earth Observatory, Image of the Earth at Night, 2017

It is estimated that approximately 595 million people in Sub-Saharan Africa do not have access to electricity



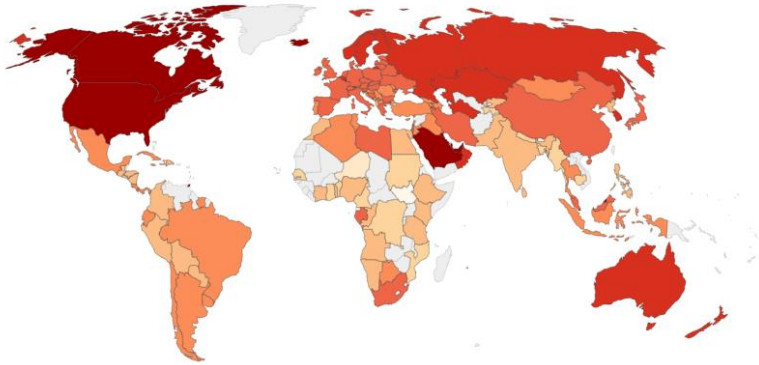
ca. **2x** Total US population

(Census.gov, 2020)



ca. **1.12** x Total EU population

(European Union, 2020)



ca. **60%** of the world's unelectrified population of ca. 940 million

(Ritchie and Roser, 2020)

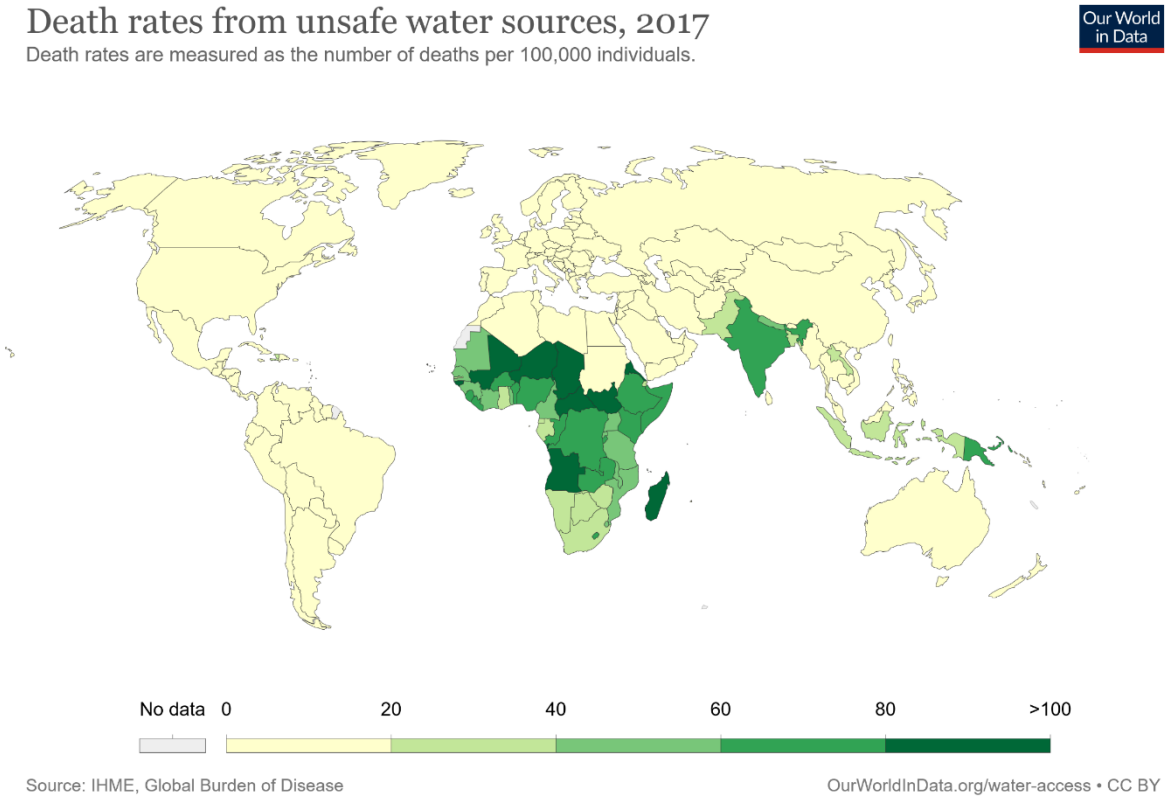
This part of the population therefore lacks access to energy services that can improve the quality of life and even save lives

A study of 11 major sub-Saharan African countries found that roughly **1 in 4 health facilities had no access to electricity**, (Adair-Rohani et al, 2013).

Lighting

"Approximately **95% of farmed land** in sub-Saharan Africa relies solely on **unpredictable seasonal rainfall** to meet water needs. (CLASP,2020)

Irrigation

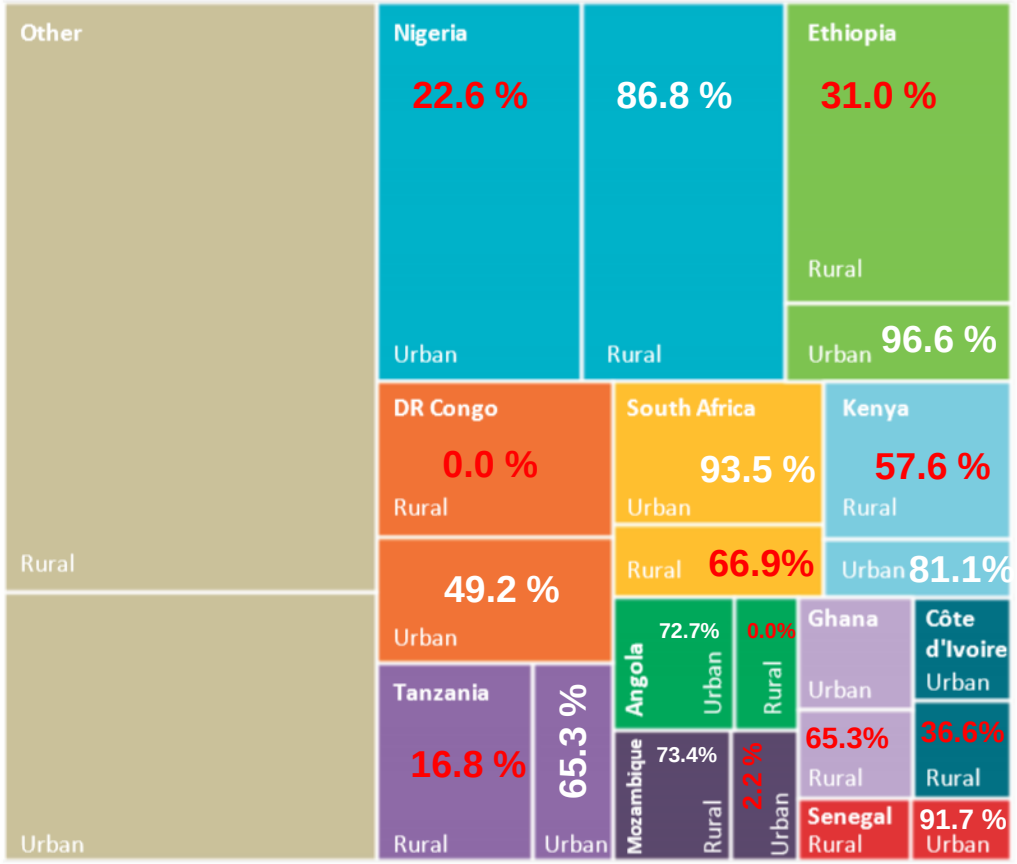


Water Purification

Potential Energy Services

A large portion of the unelectrified population in Sub-Saharan Africa resides in rural areas and come from the lower income bracket

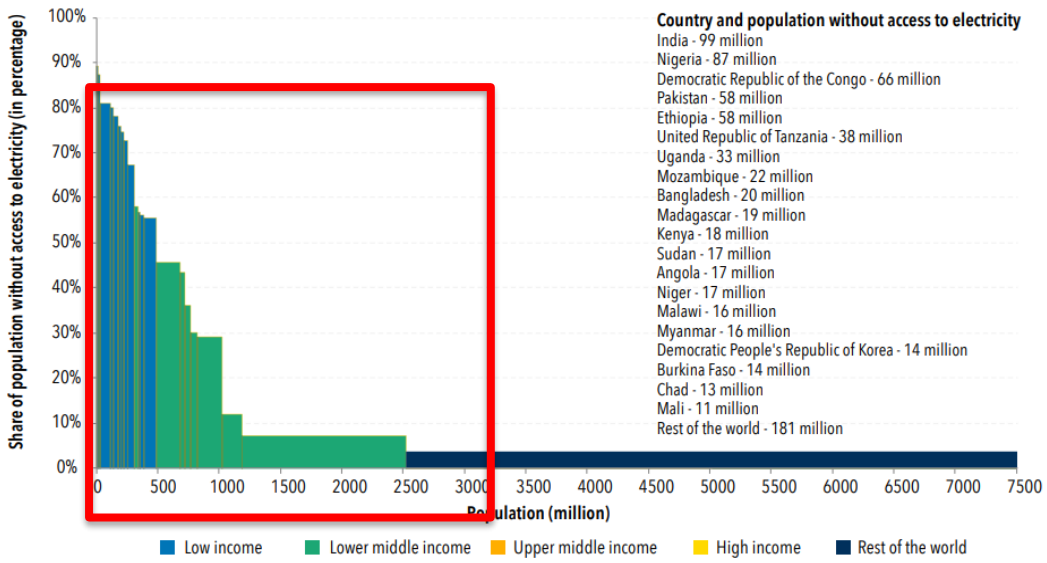
Graph showing urban/rural population ratio (2018) & % of each population electrified for countries accounting largest total population in Sub-Saharan Africa (2017)



35.4 %

Source: % electrified population World Bank (2017), Urban/rural population ratio (IEA,2019)

Share of the global population without access to electricity, top 20 access deficit & the Rest of the world , 2017

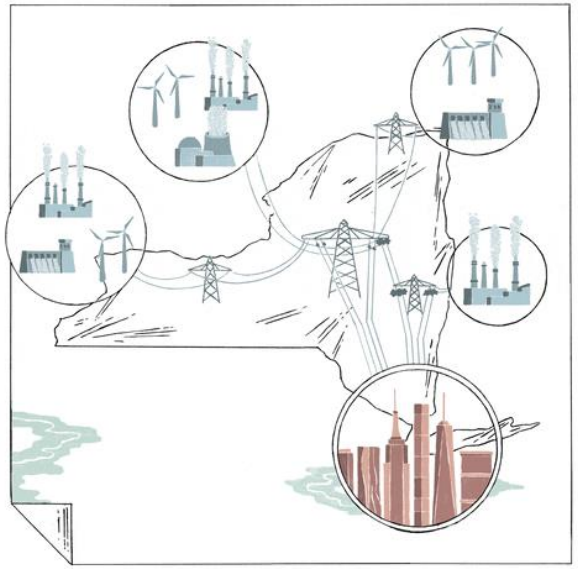


Source: World Bank.

Lower Income : ca. USD $ 84 per person per month

Reaching 100% electricity based service access will require the integration of on-grid and off-grid electrification approaches

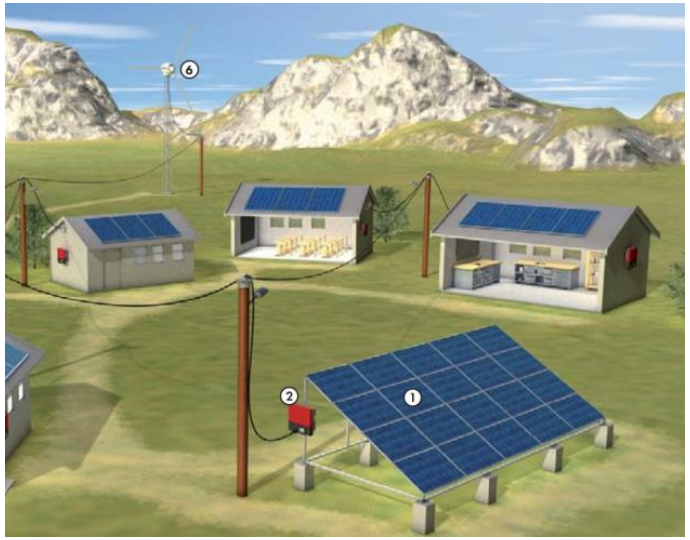
On-grid electrification approach - centralised



Grid

Photo courtesy: NewYorkTimes (2019)

Off-grid electrification approaches - decentralised



Mini-grids (MGs)

Photo courtesy:africa-energy-portal.org (2019)

Standalone systems – typically Solar Home Systems (SHSs)

Photo courtesy: greenplanet.com (2019)

Mini-grids (MGs) are designed to serve areas with large loads and numerous households while Standalone systems are serve individual users

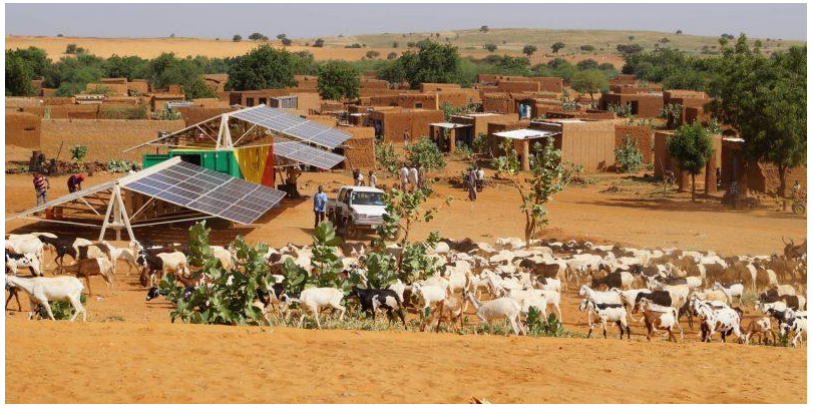


Photo courtesy: pv-tech.org (2020)

Photo courtesy: pv-tech.org (2020)

	Mini-grids	Standalone Systems (SASs) typically Solar Home Systems (SHS)
Capacity	• Typically 10 kW – 10 MW	• 15 W – 300 W
Customers serviced	• Large population clusters e.g villages & towns • Regions with productive loads e.g mines, posho-mills etc	• Individual households
Services offered	• Household electrification e.g refrigeration • Productive uses e.g water pumping	• SHSs Basic services such as lighting, radios, TV, mobile phone charging, fans • Some productive uses e.g standalone water pumps
Energy Source	• Solar PV+ Battery(most common) , Hydropower, Solar PV + diesel generators	• Solar + Battery (SHSs), Solar PV (Productive uses)

However, electrification is expensive and so it has been recognized that on boarding private sector is key to reaching the 100% electrification target

Financing Requirements

*The United Nations Sustainable Energy For All (SE4All) initiative estimates that energy access in developing countries requires **investments of US$ 45 billion annually by 2030** to step up to this challenge. -- (Global Tracking Framework: Sustainable Energy for All, 2013)*

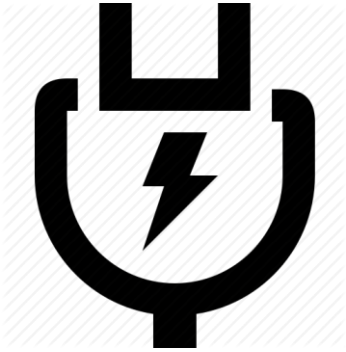
*According to IEA's World Energy Outlook, providing electricity for all by 2030 would require annual investment of **$52 billion per year**, more than twice the level mobilised under current and planned policies - (IEA,2017)*

Current progress

From SE4All Energising Finance Report, 2019. (Climate Policy Initiative and SE4All, 2019)

- *USD 36 billion in finance was committed in 2017 to energy access (most upto data available)*
- *The last report tracked **USD 30 billion** (2018)*
- *However, only **USD 12.6 billion of total tracked finance commitments for electrification benefits residential customers***

To this end, governments have made deliberate efforts to onboard private sector through policy, regulations and creating conducive environments to address barriers to scale



ELECTRICITY POLICY AND REGULATORY PROCESSES

- Electrification Planning
- Design and implementation of support mechanisms for renewable energy and rural electrification
- Permitting, licensing, and electricity/energy regulation

FINANCIAL SECTOR POLICY AND REGULATION

- Financial infrastructure(e.g. awareness & capacity amongst lenders)
- Financial Regulation
- Mobile money tariffs and regulation

FISCAL POLICY

- Subsidising electrification e.g tariffs
- Taxes on distributed renewable energy products

INSTITUTIONAL ARRANGEMENTS AND CAPACITY

- Clarity of mandates and institutional arrangements among government agencies
- Training and skills development infrastructure
- Standards and import control

Table showing different policy & regulatory frameworks that influence private sector entities working in off-grid electrification

(World Resources Institute, 2015)

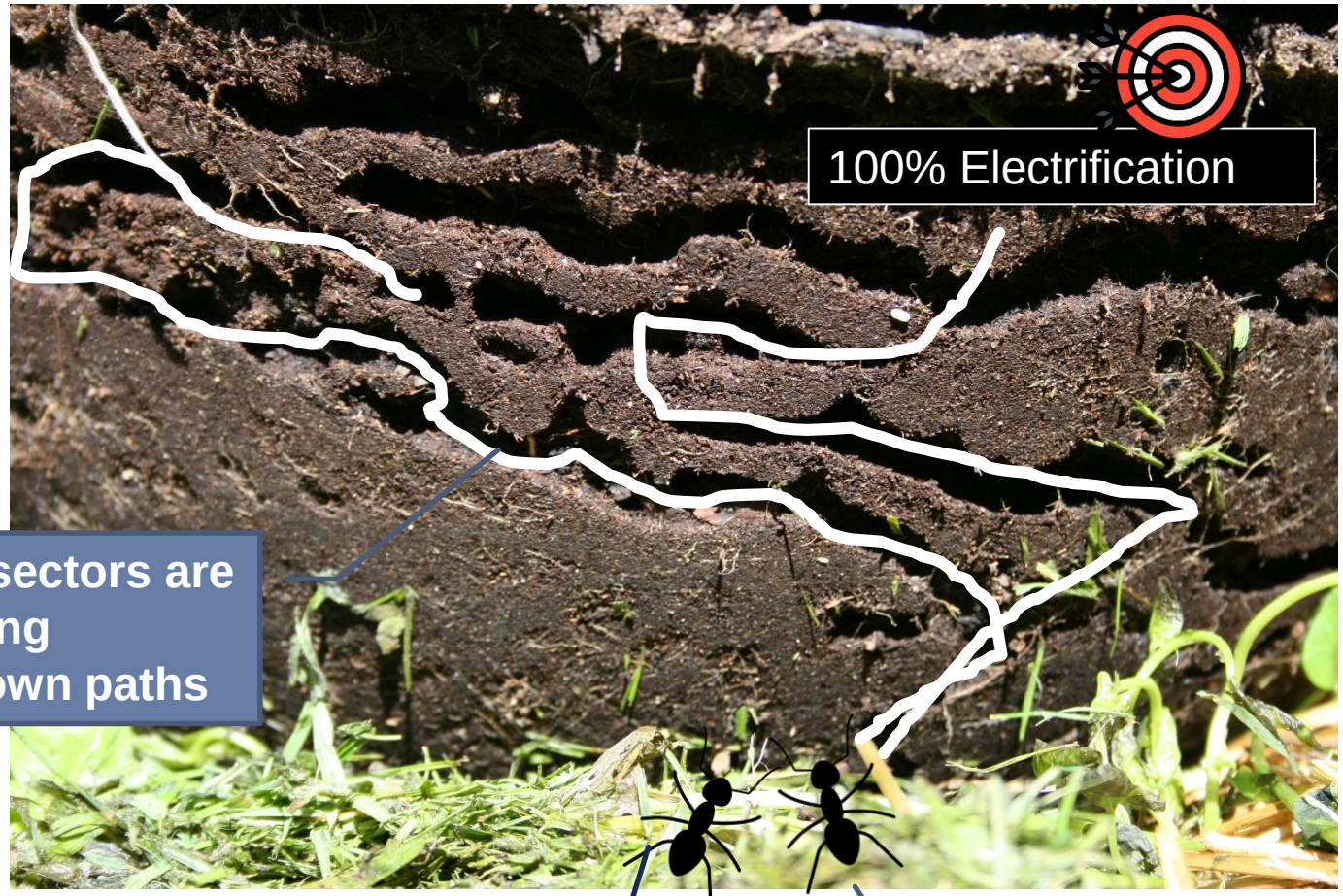
Onboarding private sector brings with it new challenges and opportunities for both the public sector and the private sector

Public Sector concerns (Policymaker/regulator)

- What is the most feasible way to reach 100% electrification?
- To what extent should MG & SHS companies be regulated?

Private Sector concerns (Business)

- How do I develop a product/service that can earn profit?
- How do I develop a business model to serve this niche market?



The overall goal of my research is to understand how public and private sector are charting paths towards reaching 100% electrifications

Public Sector concerns (Policymaker/regulator)

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- To what extent should MG & SHS companies be regulated?

Private Sector concerns (Business)

- How do I develop a product/service that can earn profit?
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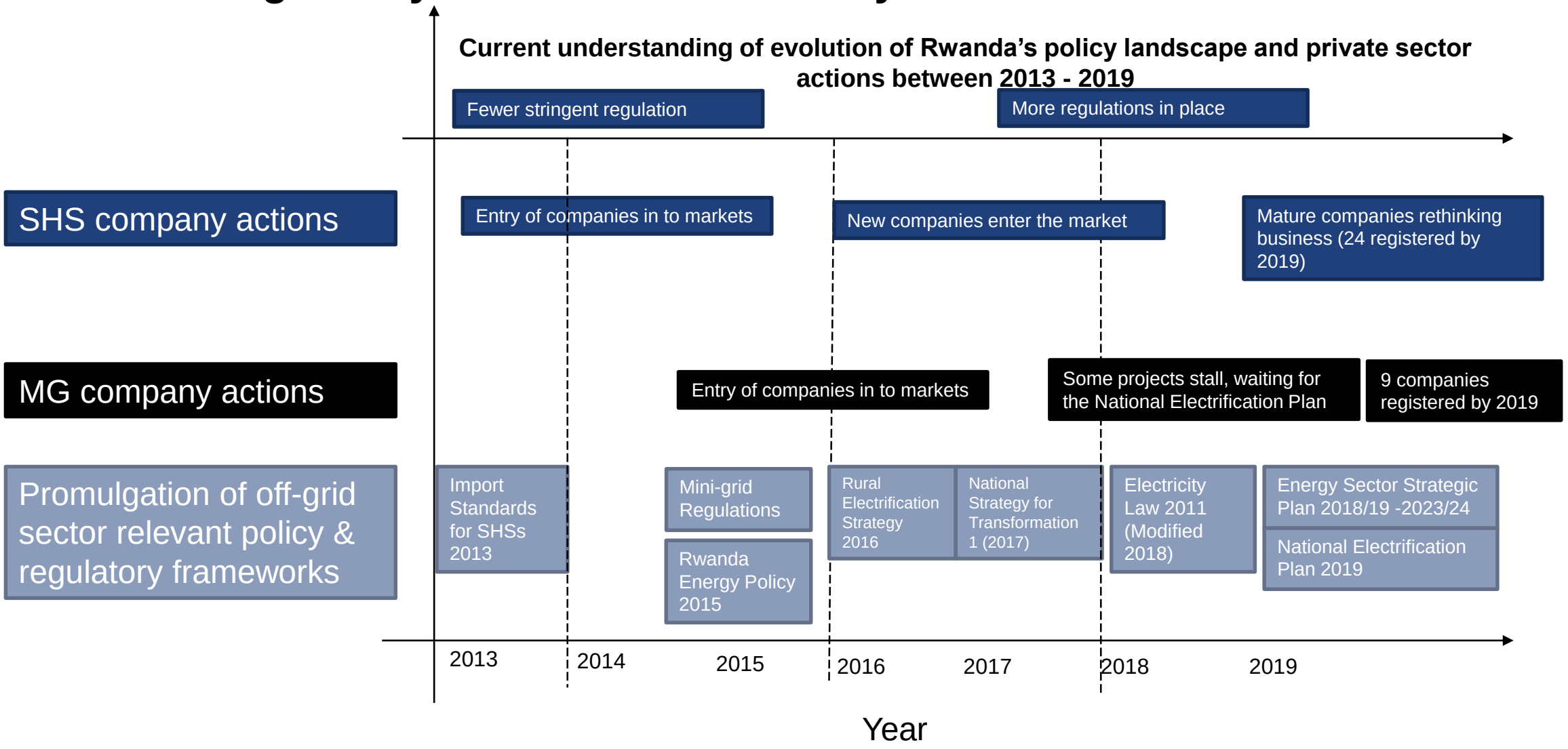
Overarching research questions:

- To what extent does institutional quality influence electrification approaches?
- How does public policy and policy change influence businesses in the off-grid electricity sector?

The research is carried out in Rwanda, because the country provides a conducive regulatory environment for analysis



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Currently 51 % of Rwanda's population has access to electricity, a majority of comes from urban areas

Map of Rwanda

Background: Rwanda

- Population: 12,187,400 (2018 est.)
- Urban/rural populations: **17.2% urban, 82.8% rural**
- Population with electricity: **37% on-grid, 14% off-grid (2019)**
- 5 provinces, 31 districts, 14,837 villages

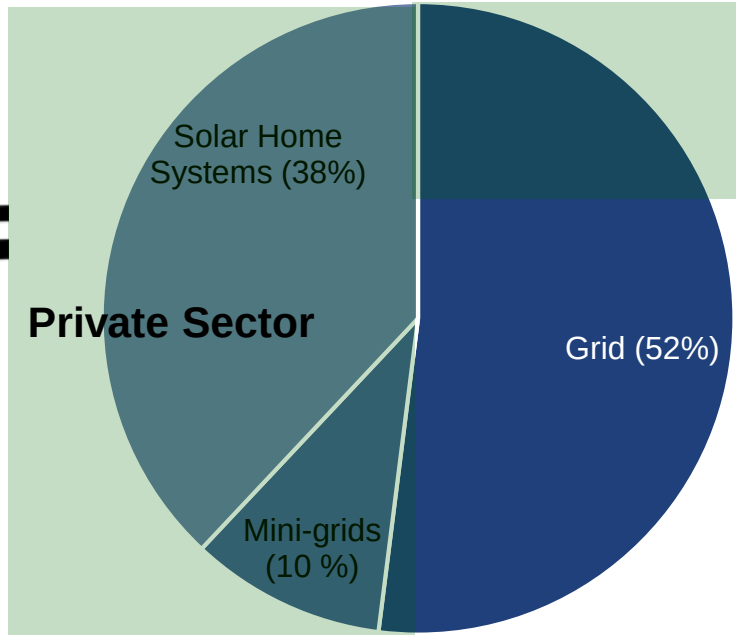
Reference:https://www.usaid.gov/powerafrica/beyondthegrid/off-grid-solar-assessment/rwanda

Rwanda has set a target to reach 100 % electrification by 2024, with 48% electricity being provided by the off-grid electricity sector

Background: Rwanda

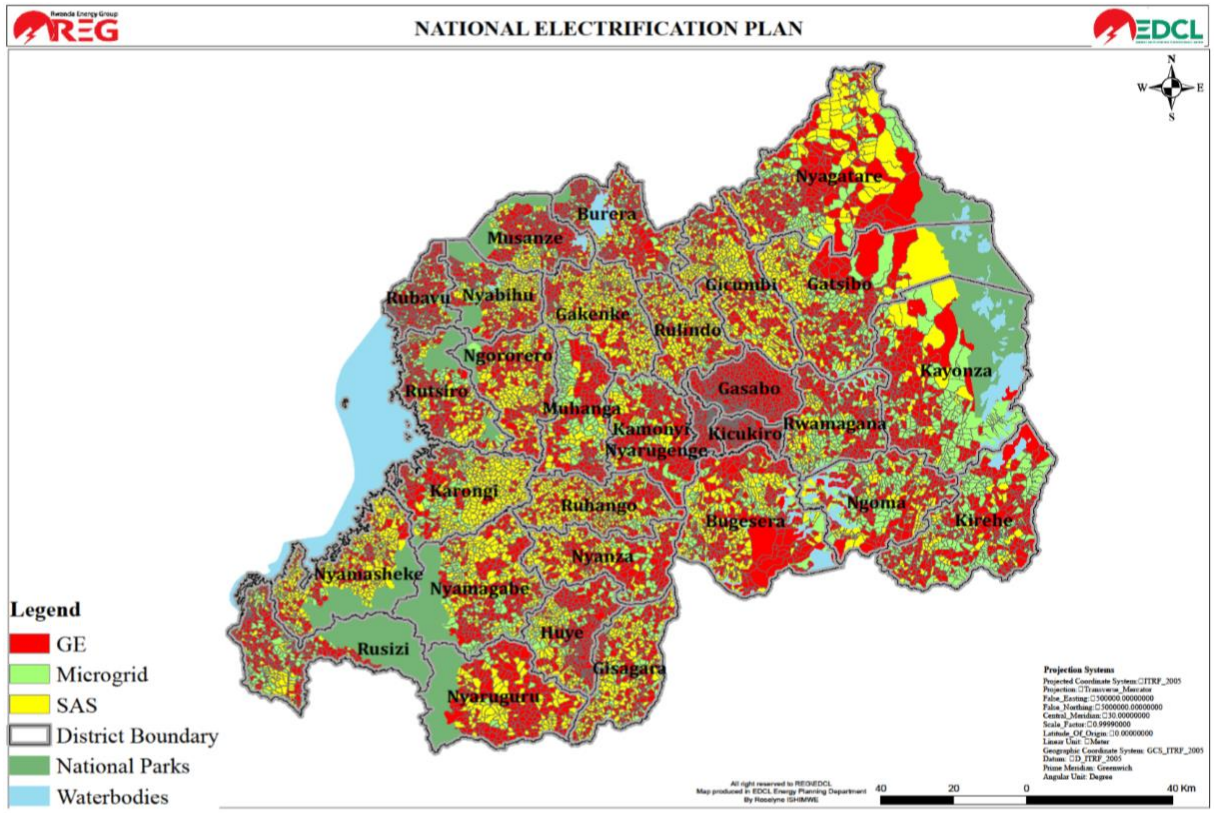
- Urban/rural populations: 17.2% urban, 82.8% rural
- Population with electricity: 37% on-grid, 14% off-grid (2019)

Expected electrification target by 2024



This target is reflected in the Energy Sector Strategic Plan, and is to be achieved using the National Electrification Plan

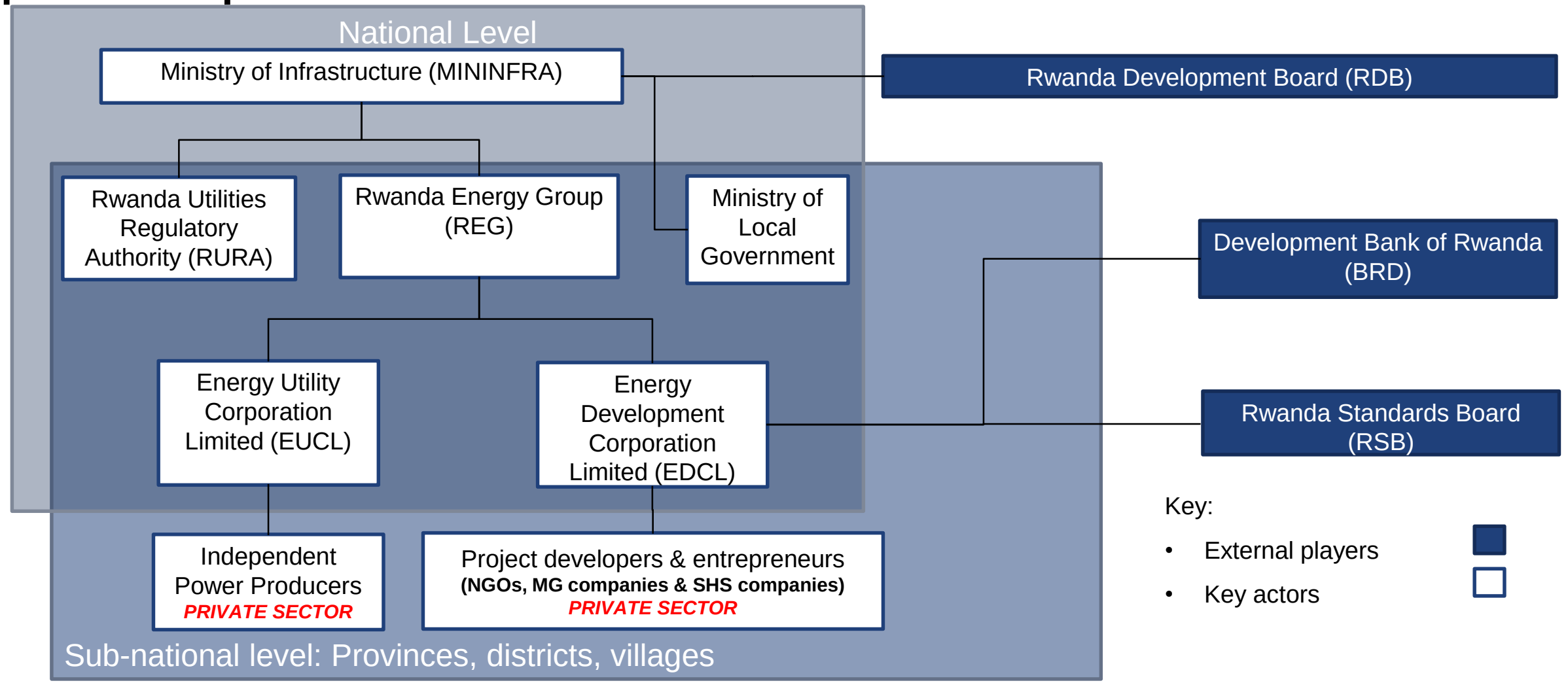
Map showing electrification approaches per village for the National Electrification Plan 2019



- Private sector intended to drive the off-grid sector
- The Ministry of Infrastructure(MININFRA) ***(since 2013)*** has been developing policy and regulations:
  - provide an enabling off-grid private sector to thrive
  - to regulate the off-grid electricity sector
- **Energy Sector Strategic Plan 2018/19 - 2023/24** – 100 % electrification by 2024
- The **National Electrification Plan 2019**, is intended to guide electrification in the country i.e which electrification solution is to be used for each village *(very granular)*

((Ministry of Infrastructure, 2018; Rwanda Energy Group, 2019)

Rwanda's power sector is driven by different actors at different levels both in public and private sector



(Africa Power and USAID, 2019)

I carried out exploratory interviews to gain perspective into what influences electrification decisions by key actors in Rwanda's power sector

Introduction

1. Background of the organization/company and your role in Rwanda's power sector?

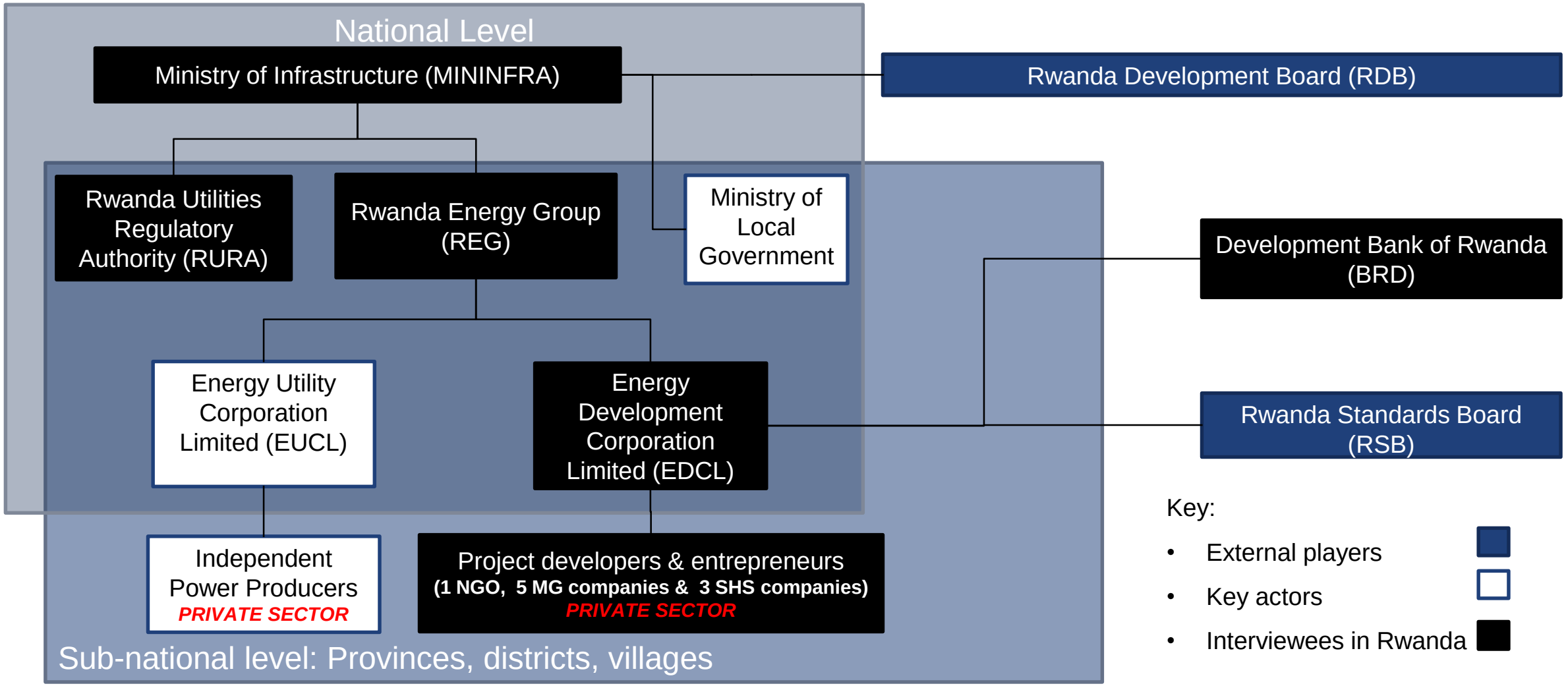
Connections to electrification targets and governing bodies in Rwanda

2. Touch points(interactions) with national/local government, NGOs, DFI's and other private sector players
3. Metrics for success?

Challenges in working towards 100 % electrification

4. What are some of the major challenges face currently in the power sector and in working towards 100 % electrification?
5. What do you think are the key levers necessary to ensure these challenges can be overcome?

For the interviews, I spoke to some of the key actors in the power sector



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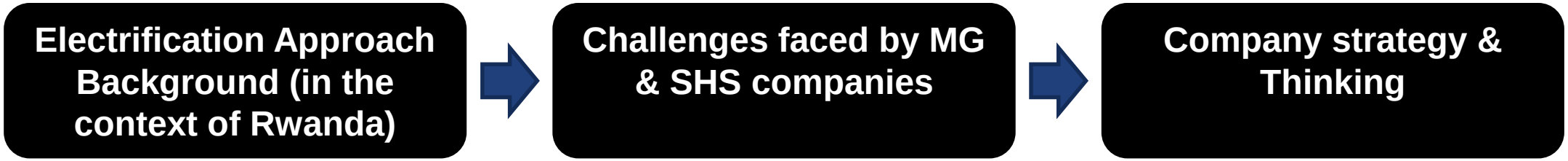
One key finding from my interviews was based on how SHS and MG companies see themselves in Rwanda's off-grid electrification landscape

- Solar Home System (SHS) companies have scaled and so are thinking about their long term strategies as a business
- Mini-grids have not developed a scalable business model and are hindered by additional barriers to scale and so they are focused on establishing themselves in the market

I use the below frame work to give you perspective into how these companies see themselves:

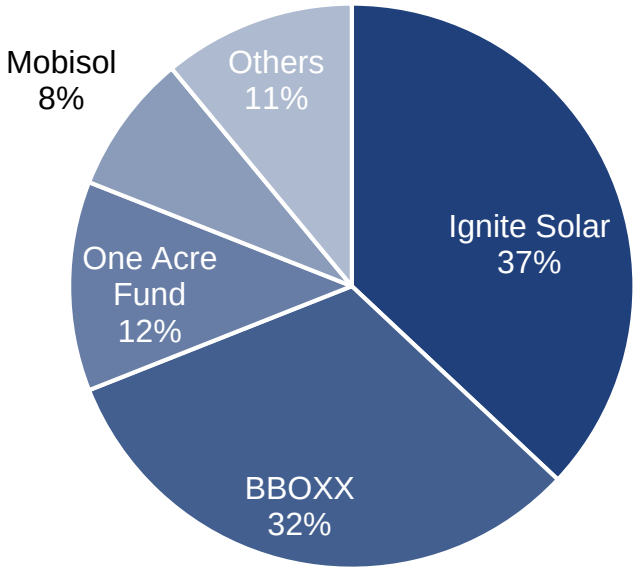


Solar Home System companies have developed a scalable business model which has allowed them to garner new advantages to leverage for growth

Business Model
- Mostly lease to own

Advantage over MGs
- Scalable – local agents stationed at sector/village level
- Modular units
- Short payback periods (Lease period is usually 12-18 months)

SHS market share in Rwanda, 2017



All named companies have been operating in Rwanda prior to 2015

New advantages achieved from having scaled

- A working relationship with clients
- Established client base across the country

(Energising Development, 2018)

These companies are therefore concerned with remaining sustainable long term

Challenges	Strategy/thinking long-term
Temporary solution in the context of electrification (Lead acid battery life ca. 3 years)	**What do you think?**
Competition from other similar technology service providers (24 screened companies in the market)	
Counterfeit products in the market (cheaper)	
Affordability – ***…The number of households that can afford SHSs is shrinking …*** Current default rates (5-6%)	

These companies are therefore concerned with remaining sustainable long term

Challenges	Strategy/thinking long-term
Temporary solution in the context of electrification (Lead acid battery life ca. 3 years)	Focus on customer retention through **established client base** e.g. insurance post payment of SHS
Competition from other similar technology service providers (24 screened companies in the market)	**Additional value**; diversify service offerings e.g Ignite is now selling solar water pumps
Counterfeit products in the market (cheaper)	-
Affordability – ***…The number of households that can afford SHSs is shrinking …*** Current default rates (5-6%)	Develop new business models e.g pay as you harvest

Mini-grids are still relatively nascent in Rwanda and so most grids are pilot projects that are mostly financed through grants

Business Models

- Still in the pilot phase testing different options
- Mostly pay per kWh consumed

Still trying to enter the market

Current private mini-grid deployments in Rwanda (Energy Private Developers, 2017)

Company	Technology	Size (kilowatt)	Number of household connections
MeshPower	Solar DC	1 kW x 57 systems	2,046
MeshPower	Solar AC/DC Hybrid	4 kW AC/ 1 kW DC	78
NESELTEC	Solar AC	30 kW	183
RENERG	Solar AC	30 kW	121
Absolute Energy	Solar AC	50 kW	505
ECOS	Hydro	11 kW	303
ARC Power *(from interview)*	Solar AC	15 kW	Not available

Advantage over SHSs

- Minigrids are seen to be able to provide **grid quality** electricity
- They can power large scale productive loads

Energy Private Developers (2017)

Mini-grid companies currently are primarily focused on establishing themselves in the market and scaling up mini-grids to be able to diversify risk and achieve economies of scale

Edge

- Minigrids are seen to be able to provide **grid quality** electricity
- They can power large scale productive loads

Challenges	Strategy/thinking
The National Electrification Plan is **unrealistic** in terms of region allocation (in some cases)	**What do you think?**
Limited access to cheap finance – most projects are financed through grants. Mini-grids are expensive.	
Affordability – **currently mini-grid tariffs are more costly in comparison to grid tariffs**	
Demand Uncertainty = Revenue uncertainty	

Mini-grid companies currently are primarily focused on establishing themselves in the market and scaling up mini-grids to be able to diversify risk and achieve economies of scale

Edge

- Minigrids are seen to be able to provide **grid quality** electricity
- They can power large scale productive loads

Challenges	Strategy/thinking
The National Electrification Plan is **unrealistic** in terms of region allocation (in some cases	• Find as many feasible sites from the NEP as possible
Limited access to cheap finance – most projects are financed through grants. Mini-grids are expensive.	• **Establish yourself in the market** to gain credibility and tacit knowledge of the sector • Longterm - operate more than one mini-grid to achieve **economies of scale** (*targets 200 -1000 MGs*)
Affordability – **currently mini-grid tariffs are more costly in comparison to grid tariffs**	• Explore ways to **reduce CAPEX**
Demand Uncertainty = Revenue uncertainty	• Explore options to “create value addition”; **stimulate demand** such as incorporation of appliances, awareness creation, demand stimulation programmes

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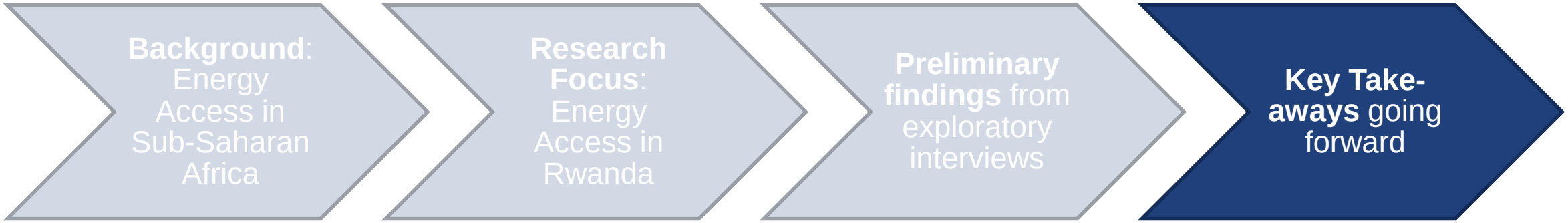
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Conclusion

	Mini-grids (MG)	Solar Home Systems(SHS)
Major Barriers	• Access to cheap finance • Lack of a sustainable revenue generating business model	• Indication of customer willingness to pay (5 % default rate on average)
What should happen for players to succeed?	• Access to more finance e.g RBF • Granular understanding/prediction of electricity demand	• Definition of the possible roles for SHS companies beyond 100 % electrification
Challenges for Rwanda's power sector	• Finding a way to make grid tariff = MG tariff • Access to finance to enable MG companies to scale	• Clarity on how NEP influences electrification by SHS companies (tech providers not bound by region)
Role in electrification (short term, 0-3 years)	• Key to understanding newly electrified users through large scale MGs and developing a working business model	• Access to basic electricity services
Role in electrification (medium term, 3-6 years)	• Provision of grid quality electricity in the off-grid sector	• Energy stacking & transitions to productive electricity uses (distribution network)
Role in electrification (medium term, 6+ years)		-

The conclusions above led to my current research questions:

Public Sector challenges(Policymaker/regulator)

- Understanding the cost of electrification
- Understanding the impact of policies implemented

Private Sector challenges (Business)

- Access to finance
- Clarity on electrification plans
- Niche market segments

Overarching research questions:

- To what extent does institutional quality influence electrification approaches?
- How does public policy and policy change influence businesses in the off-grid electricity sector

Thank You

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