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ENERGY ACCESS AND GREEN TRANSITION COLLABORATIVELY DEMONSTRATED IN URBAN AND RURAL AREAS IN AFRICA

DELIVERABLE 1.3
Regulatory framework and technical standards

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Main authors:	Nikolas Schöne, Lukas Otte, Boris Heinz (TUB), Nicolas Saincy (Nanoé), Dennis Wakaba (OPIBUS), Kornelia Iipinge (SACREEE), Emile Fulcheri (STIMA Boda)
Website:	https://www.energica-h2020.eu/

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DEM	Demonstrator, pilot, prototype, plan designs	
DEC	Websites, patents filing, press & media actions, videos, etc.	
OTHER	Software, technical diagram, etc.	

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PROJECT SUMMARY

Gathering 11 African-based partners and 17 Europeans with offices or subsidiaries in Africa, the ENERGICA project is ambitiously fostering the collaboration between partners of both continents on energy access and sustainable energy development. The main objective of the ENERGICA project is to demonstrate the efficient implementation of renewable energy technologies to match local contexts' needs. Three different demonstration sites will rely upon local Energy Transition Boards which will manage community-scale Integrated Community Energy Systems (ICESs). Based on these methodologies and respective innovative technologies, ENERGICA will demonstrate positive social, environmental, technical and economic impacts from the high energy-efficiency and low carbon emission RETs. Specifically, the project will develop innovative nanogrids in rural Madagascar; low-tech efficient biogas systems in peri-urban Sierra Leone; and solar-powered e-mobility solutions in urban Kenya.

OBJECTIVE AND EXECUTIVE SUMMARY

This report is part of the deliverables from the project "ENERGICA" which has received funding from the European Union's Horizon 2020 research and innovation program under grant agreement No. 101037428.

The Deliverable develops a flowchart to develop analyse the regulatory environment for i) lateral electrification processes and ii) electric vehicle charging station operation on the African continent. Based on a novel approach, the report defines distinct life-cycle steps of energy related interventions in the above-mentioned challenges. Thorough literature review of grey literature, scientific publications and national energy plans enables to develop indications that characterize the regulatory environment, while detailing the respective stakeholders involved in the distinct life-cycle step. The developed flowchart is exemplary executed on the demonstrator of the ENERGICA project, which foresee lateral electrification activities in rural Madagascar and peri-urban Sierra Leone, and electric vehicle charging station deployment in urban Nairobi.

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List of Abbreviations

AC – Alternating Current

CAPEX – Capital Expenditure

CDM – Clean Development Mechanism

CER – Certified Emission Reduction

CP – Charging Point

CPO – Charging Point Operator

DC – Direct Current

DSO – Distribution System Operator

EIA – Environmental Impact Assessment

EV – Electric Vehicle

EVSE - Electric Vehicle Supply Equipment

FC – Fast Charger

FiT – Feed-in Tariff

FOB – Free on Board

GDP – Gross Domestic Product

GHG – Greenhouse Gas

HV – High Voltage

ICE – Internal Combustion Engine

ICEV – Internal Combustion Engine Vehicle

IDA - International Development Association

IDC – International Development Cooperation

IEC – International Electrotechnical Commission

IEEE - Institute of Electrical and Electronics Engineers

IPP – Independent Power Producer

IRR – Internal Rate of Return

ISO - International Organization for Standardization

kW - Kilowatt

kWh – Kilowatt-hour

LCR – Local Content Requirement

LV – Low Voltage

MW – Megawatt

NDC – Nationally Determined Contribution

NPV – Net Present Value

NSP – Network Service Provider

OEM - Original Equipment Manufacturer

OPEX – Operating Expenditure

PCB – Printed Circuit Board

PPA – Power Purchase Agreement

PPP – Public Private Partnership

PUSE – Pay-per-Use

PV – Photovoltaics

RBF – Results-Based Financing

RE – Renewable Energy

SADC - Southern African Development Community

SAIDI - System Average Interruption Duration Index

SAIFI – System Average Interruption Frequency Index

SC – Slow Charger

SDG – Sustainable Development Goal

SHS – Solar Home Systems

SPD – Small Power Distributor

SPP – Small Power Producer

SPPA – Standardized Power Purchase Agreement

SSA – Sub-Saharan Africa

UL – Underwriter's Laboratory

V2G – Vehicle-to-Grid

VAT – Value Added Tax

VSPP – Very Small Power Producer

W - Watt

WEF – Water-Energy-Food

1. INTRODUCTION

1.1 Background and Relevance

In 2015, the United Nations have provided governments and organizations around the globe with a blueprint to “achieve a better and more sustainable future for all” – the Sustainable Development Goals (SDGs). The set of 17 SDGs comprise all dimensions of human, societal and environmental development. While the distinct SDGs have individual targets to strive for – and indicators to measure progress within – they are strongly interlinked.

SDG 7 has been formulated as a stand-alone goal to tackle one of the most vital challenges of modern humankind - combat energy poverty around the globe. Energy is a fundamental pillar for any kind of economic, environmental, and societal development – and knowledge steadily increases about the elementary importance of energy in the most rudimentary human needs of food provision and health provision. Therefore, SDG 7 aims to ensure access to affordable, reliable, sustainable, and modern energy for all. This includes universal access to energy services – specifically electricity, clean cooking fuels, and transportation service – raising the share of renewable energies within services, and improvements in energy efficiency.

Today, some eight years before the end of the timeframe envisaged in the SDG, still approximately 750 million people around the globe lack access to any kind of electricity. Of these people, a majority of 570 million live in Africa, making the continent the global hotspot of energy poverty (IEA & IRENA, 2021). Globally, 2.6 billion people rely on harmful and inefficient traditional cooking fuels – again, Africa stands out with 900 million people unserved by clean cooking fuels poverty (IEA & IRENA, 2021). Equally, there is an apparent need for transformation of the mobility sector in Africa. Transport in Africa still almost exclusively remains powered by fossil fuels. Road transport is the most dominant mode of motorized transport in Africa, accounting for 80% of cargo and 90% of passenger transport. In 2014, the CO_2 emissions from road transport in Sub-Saharan Africa were almost 0.2 Gt of CO_2 – with rapid growth to be expected considering the growth of population and economy (Collett et al., 2020).

As broad as the scope of the SDG 7 is, so are the challenges within. Moreover, the differences within affected countries are significant, and rural and urban regions face contrasting challenges.

Rural African areas are over proportionally affected by the lack of access to electricity. Only 28% (The World Bank, 2022a) of inhabitants can access electricity services, compared to 77% (The World Bank, 2022b) in urban areas. Connecting the widely dispersed populations to the main grid presents a major technical, organizational, and economic challenge. Often, a dual approach is followed in rural electrification efforts: On the one hand, utilities extend the grid to successively connect further regions and customers or interconnect existing grids. On the other hand, small home systems and mini-grids provide electricity in areas where a connection to the main grid does not appear as a viable option in the short- to medium-term. In theory, these off-grid solutions should be replaced by or interconnected to, the main grid once it arrives. Today, 49% of the Sub-Saharan African population is connected to off-grid solar solutions, with a lively private sector involved in supply (IEA & IRENA, 2021).

While efforts in rural areas may focus on providing basic access to electricity and cooking fuel, urban areas undergo challenges of a similar magnitude. Urban centres in Africa are growing rapidly, and supply needs to keep up with increased and changing energy usage, including the transport sector. By today, the vehicle emissions account for 90% of harmful emissions in urban centres, as transportation modes still rely on fossil fuels almost exclusively (AfDB, 2017). An electrification of the transport sector could relief this challenge. Especially in countries with a low grid factor –the share of fossil-based power supply to the national grid – such as Kenya (116g/kWh (Climate chance, 2019)), electrification of the transport sector offers great potential in saving greenhouse gas (GHG) emissions. However, transformation solutions must cope with the often-unreliable electricity provision and error-prone condition of the power grid. With increasing electrification of the transport sector, new challenges and opportunities for the energy system arise. While rising demand and peak loads can strain the network, Electric Vehicle (EV) batteries can act as storage systems for the network and thereby support the system stability at the same time.

Energy innovations/solutions tackling these challenges require an enabling environment designed by the respective government. Different measures have been taken by African governments, which are

- Primary measures: Measures intrinsically related to the national energy framework, and which remain under the maintenance of public institutions mandated with energy matters. Primary measures include **policies and regulations**, rural electrification plans and direct financial support for energy innovations.
- Secondary measures: Measures that are not specific to the energy sector, but support the viability of energy innovations. Such measures include the interlinked fields of environmental protection, banking, land property rights as well as overall (industry) taxation.
- Tertiary measures: Measures that may support the energy innovations indirectly and can be offered by local institutions, e.g., development finance institutions, NGOs etc. Examples of such measures are capacity building, training support, data collection and efforts to increase synergies with other sectors.

The individual combination of primary, secondary, and tertiary measures in the respective local contexts shapes the environment of energy innovations. Each level influences the subsequent levels of measures, with the primary level setting the foundation and defining the overall regulatory framework. As a first step in the analysis of the environment of energy innovations, it is therefore required to start with the “primary” roots of any energy landscape.

This report aims to provide a tool to any type of stakeholder to analyse the environment of energy innovations for rural electrification and urban transport electrification. This report therefore focuses on primary measures for supporting energy innovations, and specifically – as to satisfy the **need for a deep dive into technical innovations** – will focus on the **regulatory aspects**. However, any interlinkages with secondary and tertiary measures will be highlighted.

1.2 Ambition and research gap

The review of existing tools and frameworks to analyse the regulatory environment for energy innovations in Africa has revealed two fundamentally distinct approaches, both of which have significant shortcomings:

1. Single-country-case-studies: Most assessments take the form of structured case studies that focus on *regulatory governance*[1]. Depending on the resources that are available, the evaluation may be limited to an examination of the formal legal and institutional aspects of the regulatory system, or it may go more deeply and review how the formal elements have been employed. Single-country-case-studies allow for a detailed understanding of the regulatory environment – but remain applicable primarily to the specific country setting (including the stakeholders involved) with limited possible transferability.
2. Cross-country-descriptive-analysis: These are cross-country studies that are designed to compare the formal characteristics of regulatory systems in different countries. Typically, they focus on legally specified elements of governance, such as appointment and removal procedures, funding sources, appeals of regulatory decisions, and the division of responsibilities. While analysing existing regulations, cross-country-descriptive-analysis follows the structure of regulations rather than the structure of the technology or project itself – which allows for an overview of the regulatory system but hinders the derivation of precise consequences and actions to be taken for the different stakeholders involved within the course of a project.

To overcome these shortages of existing regulatory framework analyses, this document applies a novel approach of combining cross-country-descriptive analysis and single-country-case-studies, while analysing the regulatory system, separated in **life-cycle-steps** of the energy innovations. Therefore, the major demonstration activities of the ENERGICA project – **a) lateral electrification via off-grid systems in Madagascar and Sierra Leone** and **b) swappable Electric Vehicle (EV) charging station development in Kenya** – will be divided into life-cycle steps, following the typical procedure of a respective project development and operation. Within each life-cycle step, regulations will be observed according to *technical*, *process*, *economic* and *financial support* dimensions. Having reviewed best-practices and case studies of other countries' regulations, indicative questions will be developed. The indicative questions guide the reader through the regulatory analysis (= Cross-country-descriptive-analysis). This flowchart will be applied exemplarily to the ENERGICA demonstrators of Madagascar, Sierra-Leone and Kenya and will detail the regulations, relevant stakeholders, and documents in place for these countries (= Single-country-case-study). The applied approach addresses the previously described shortcomings of conventional regulatory analysis. In additional, the definition of life-cycle steps allows stakeholders to selectively access relevant information. Stakeholders, who are only involved in certain life-cycle steps of a respective project can directly access information tailored to their needs and involvement in the innovation process. The report will feed into a final output in the shape of a flowchart.

[1] Any regulatory system has two important dimensions: ***regulatory governance*** and ***regulatory substance. Regulatory governance*** refers to the institutional and legal design of the regulatory system and is the framework within which decisions are made. Regulatory governance is defined by the laws, processes, and procedures that determine the enterprises, actions, and parameters that are regulated, the government entities that make the regulatory decisions, and the resources and information that are available to them, i.e. the "***how"*** of regulation. ***Regulatory substance*** refers to the content of regulation. It is the actual decisions, whether explicit or implicit, made by the specified regulatory entity or other entities within the government, along with the rationale for the decisions, i.e. the ***"what"*** of regulation (Brown, 2006).

1.3 Structure of the report

This report will follow the described approach to provide thorough insights into the methodology used for the development of the flowchart. The flowchart will then be used as a basis for the analysis and discussion of regulatory issues related to off-grid electrification and e-mobility. Therefore, the structure of the report is as follows:

Section 2 explains the methodology applied to develop the flowchart. The energy innovation activities of the ENERGICA project are described and abstracted to derive transferable project activities. Subsequently, these activities are separated in distinct life-cycle steps. For each activity relevant stakeholder categories are defined. Finally, we provide an overview of the approach and sources consulted during literature review.

Section 3 presents the results of our analysis. At first, the flowchart is presented in tabular form, containing indicative questions that guide through the analysis of both the regulatory environment, and the relevant stakeholders involved in each regulatory aspect considered. Subsequently, we provide background and discussion of regulatory measures for a selection of the questions derived. Insights from the demonstrator countries of ENERGICA – Madagascar, Sierra Leone, and Kenya – will be provided.

Section 4 points to controversial or important findings from the result section and presents evidence, opinions, and statements from experts of the ENERGICA consortium on these. The report closes with summarizing and concluding on the main findings.

2. METHODS AND MATERIAL

The following chapter explains the methodological foundation for developing the regulatory analysis flowchart.

The methodology applied may be divided into distinct subsequent steps:

1. **Analysis of activity**: We analyse the foreseen activity of the ENERGICA project, thereby focusing especially on i) status-quo of the local context, ii) aim and scope, iii) specific challenge and iv) desired output/status at the end of the ENERGICA project.
2. **Abstraction of activity**: Consulting state-of-the-art reports on challenges of the energy sector in Africa, we embed the ENERGICA activities in the big picture of energy related challenges on the African continent.
3. **Development of an activity archetype in life-cycle steps**: We draft an archetype of an activity addressing the challenge identified in step 2. This archetype activity reflects the actual ENERGICA activity, while not being limited to the very specific technology, or local setting.
   We construct our archetype activity differentiating distinct life cycle steps. A common classification of project life-cycle steps distinguishes in i) initiating, ii) planning, iii) execution and iv) close-up. However, this classification may take an internal subjective perspective of the project developer, i.e., only step iii) execution foresees precise interaction with other stakeholders, while the other steps are of an internal, organizational nature. For the purpose of our analysis, we specifically aim to take a neutral perspective of the project activities themselves and focus on project processes between different stakeholder, rather than internal processes of involved actors. We therefore reduce the life-cycle steps to **i) initiating, ii) execution and operation and iii) close-up**, while focusing on the processes and interaction between stakeholders.
4. **Flow-chart development:** We review approaches and best-practices of technical, economic, process and financial regulation relevant for the project archetype considered. Detected regulatory topics are framed as an indicative question (for ease of use), while sorted into the defined life-cycle steps. We map stakeholder categories involved in the respective life cycle and regulatory issues considered.

This methodology is novel to the assessment of activities in the energy sector. However, the methodology is replicable and transferable to any context and energy activity considered. This report will demonstrate the application of the methodology on the ENERGICA demonstrators located in Madagascar, Sierra Leone and Kenya, which will reveal in two different contexts and activities, being i) lateral electrification of rural areas and ii) EV charging in urban areas.

2.1 Energy sector activities

The following chapter will carry out step 1 – step 3 of the methodology for each ENERGICA demonstrator, serving as case study in this report.

2.1.1 Case study Madagascar

The Malagasy demonstrator of the ENERGICA project aims to develop small-scale energy system solutions to provide electricity and productive uses to rural, unelectrified communities in northern Madagascar. While the integration of productive uses, e.g., direct current (DC) rice hullers and DC cooling, is at the centre of the ENERGICA project, the lifecycle of nano-grids (i.e., small-scale isolated off-grid systems) aims for lateral diffusion. Building on several isolated nano-grids, these nano-grids could at some point be physically interlinked, and thereafter even connected to the main grid once it is extended. This lateral diffusion for electrification, and other comparable concepts being discussed under the swarm-concept, will serve as a basis for defining the regulatory case representing the Malagasy demonstrator.

The Malagasy activity tackles the great challenge of electrification of rural areas in Africa. In moderately populated areas, in which both grid extension and deployment of a relatively large number of stand-alone electricity generation systems would be expensive, isolated grids are the most economical electrification option in many cases (Puig et al., 2021). Such grids – classified as minigrids or nanogrids according to their respective installed capacity– may profit from scale effects to enable for a high Tier-level of supply (ESMAP, 2022) – Tier 3 – 5 – serving high quality power at high reliability. Such supply enables to operate high-value devices, including machines utilizing electricity for a direct production of goods, such as in agricultural, commercial, and industrial activities, commonly referred to as productive uses. While these productive uses may have a positive impact on the income generating possibilities of the users, they as well increase the utilization of the isolated grid – thereby increasing the revenue for the grid operator, supporting his challenging business case of selling electricity to isolated communities of commonly low demand.

While alternating current (AC) current may still be the most common energy topology infrastructure, DC systems – and devices – are gaining increasing attention. DC systems are generally object to lower system losses and offer great potential for cost savings (Opiyo, 2019). However, markets on the demand side of DC electricity are still in their infancy and must be stimulated to allow customers of DC power easy access to spare parts or new devices.

Regardless of the type of current, isolated grids are expected to grow over their lifetime. With increasing access to electricity, and new sources of income, electricity demand, requirements and perceptions of suitable electricity supply grows. Additionally, seeking for universal electricity access with high quality will mean that every isolated village may be served by either small-scale grids or the national grid. It is therefore obvious – and envisaged – that any isolated grid may either be connected to other formerly isolated grids or the expanding national grid itself. This process is commonly known of lateral electrification – starting with small, isolated grids in rural areas to bridge the time until the main grid arrives. For an isolated system, this may be seen as the close-up of the project, but also as the beginning of a new project. Isolated grid operator, depending on the regulatory framework, may have different options how to operate and which functionality to take after grid arrival.

Tackling the above-described challenge, the answering project can be reflected in a project of lateral electrification in rural areas via small-scale isolated grids, supplied by renewable energies. The project foresees to develop a renewable energy generation facility to supply power within an isolated distribution grid in a small village. To increase the utilization of the system, demand stimulating productive uses are considered in the business case. The project will eventually expand and connect to other isolated grids or the national grid in future. Once connected, the project may sustain its function, change, or be even closed. We therefore formulate the project life-cycle steps:

i) **Initiating phase**: The initiation phase of the project includes the administrative and technical procedure in advance to any physical implementation of the project. The stakeholders involved may agree on conditions and modalities of power supply, and services.

ii) **Execution and operation phase**: The second phase includes the construction of the isolated grid, as well as its operation. Again, any associated services are respected.

iii) **Close-up phase**: The connection to another isolated grid or national grid may be seen as the close-up of the activity. However, eventually there are possibilities how to maintain the project, but reframe the purpose and role of the former project.

2.1.2 Case study Sierra Leone

The Sierra-Leone demonstrator of the ENERGICA project aims to develop small-scale energy system solutions to provide electricity and heat produced via a waste-to-energy process. The small-scale waste-to-energy plant is designed to process agricultural and food waste to produce gas of a high heating value. The gas is utilized in combined heat and power plants to produce electricity and heat. As by-product, fertilizer will be extracted from the process to improve the soil quality of agricultural sites. Water produced during the process will be purified by innovative solar disinfection. The system requires initial uptake of electricity, to process the waste streams into homogenous material. However, the source of electricity may commonly be a national grid, but could as well be any stand-alone but reliable source of electricity, e.g. a photovoltaic (PV)-battery system. On the other end of the system, the energy sink for electricity and – however unlikely heat –may be a national or local grid but can also be an isolated costumer.

The Sierra Leonean demonstrator tackles the challenge of electrification, while stimulating the water-energy-food nexus (WEF-nexus). The WEF nexus describes the close interlinkage between water security, food security and energy security. While the demand in each dimension continuously grows, the conditions to produce are becoming more challenging. Groundwater resources are exploited, soil quality has been jeopardized from intense and exhausting agricultural processes. Especially rural areas are unproportionally affected by the challenges, as agriculture is often a crucial contributor to the households' incomes, and access to water relies on individual solutions without any accessible central network. Innovative technical solutions may combat these increasing challenges. The project foreseen in Sierra Leone aims to showcase one of such innovative technologies, approaching the challenge from the energy-perspective with having a small-scale energy production unit at the centre of the project. The project aims to supply electricity and heat to such areas, in which the power grid providing electricity supply remains unstable, while stimulating synergies to the water nexus via water purification, and to the food nexus with generating fertilizer as a valuable by-product.

The activity envisaged in the Sierra Leonese demonstrator puts the supply of energy to peri-urban or rural areas at its centre. Therefore, the activity can be reflected in an electrification project similar to the Malagasy demonstrator, while the progress of lateral electrification depends on the area to serve; isolated rural area or grid connected area. We therefore adopt the life-cycle steps as detailed in the description of the Malagasy demonstrator into:

i) **Initiating phase:** The initiation phase of the project includes the administrative and technical procedure in advance to any physical implementation of the project. The stakeholder involved may agree on conditions and modality of power supply, and services. Such initiation may either be the arrangement to serve an off-grid customer, or to connect to the grid and arrange with the national grid operator. However, the end of the “initiating” phase is marked with the commissioning of the off-grid solution.

ii) **Execution and operation phase:** The second phase include the construction of the power production unit, as well as its operation on or off the grid. Again, any associated services are respected.

iii) **Close-up phase:** The connection to another isolated grid or national grid may be seen as the close-up of the activity. However, eventually there are possibilities how to maintain the project, but reframe the purpose and role of the former project.

2.1.3 Case study Kenya

The urban demonstrator located in Nairobi, Kenya, aims to integrate swappable EV charging stations to power electric 2-wheeler motorcycle fleets. The swapping stations will be located in the Low-voltage (LV) grid and equipped with a solar system and battery storage to ensure operation during electricity blackouts. While the swappable Lithium-ion batteries will serve locally produced local 2-wheeler, they are also supposed to provide stability services when an outage occurs in the LV grid. Smart management and charging algorithms will facilitate to detect the best integration and operation of the charging hubs in the LV network.

The Kenyan demonstrator tackles the great challenge of fossil-based, thereby expensive and polluting, transport and mobility in African cities while bringing relief to power grid instabilities. EVs can have a significant improving effect on the air quality in urban areas, as the local emissions reduce to hard-to-avoid wear effects of tires and equipment. However, the life-cycle emission of EVs mainly depend on the origin and production pathway of the electricity powering the EVs. Countries with a predominantly renewable energy production are ideal candidates for promoting EVs, as the carbon footprint of the electricity mix will be considerably low. Kenya, with over 80% renewables share in the grid mix, leading to 116g CO_2/kWh produced on average, serves as an ideal role model. In such settings, substituting polluting internal combustion engine (ICE) powered vehicles by electric powered vehicles, offers high potential on GHG emission savings. While the number of EVs in African cities is still very low (e.g. the number of EVs in Kenya is 350 by today (Statista, 2022)) due to comparatively high investment costs of the vehicles and the limited availability of charging points and infrastructure, short-distance two-wheelers may serve as a suitable entry point into the market. Innovative business models, such as retrofitting ICE motorcycles with electric engines, reduce the upfront burden for the customer, while offering expenditure savings during operation.

However, increasing the share of EVs in the mobility mix will accordingly lead to an increasing demand of electricity. At a certain level, EVs may have a sizable impact on the electricity load curve, which may constraint the power grid operation and electricity supply. Therefore, the location, the timing and the technologies and charging modes used will have great impact on future power grid related challenges. The main differences between types of charging equipment are (i) the power output range, (ii) the socket and connectors used for charging, and (iii) the communication protocol between the vehicle and the charger. Common electric two-wheelers use level 1 charger with up to 3.7 kW power. While such single charging points may be installed anywhere in the LV grid, the charging of a battery may require significant time to wait for the user, while be a hard-to-predict load for the network operator. Bundling batteries charging in swappable battery charging stations may overcome inconveniences for both parties. Battery swapping (or battery-as-a-service) allows EV owners to switch a discharged battery with a charged one at the swap station, in rewards to a payment. Such charging modality does not only offer a constant supply for the owner, but – as of a higher coincidence factor when increasing the number of batteries and user, the required load of the swapping station will become more predictable. Additionally, having overcapacities and redundancy of batteries, the charging stations may offer flexibility to the operator and grid.

Aiming for the electrification of 2-wheelers in urban Nairobi via swappable battery charging stations, the activity can be reflected in a project considering the deployment of public electric vehicle charging stations. As to capture the perspective from any stakeholder involved, we define the following life-cycle steps:

i) **Initiating:** The initiation phase of the project includes the administrative and technical procedures regarding i) the deployment of the charging station and ii) acquisition of EVs.
ii) **Execution and operation:** The second phase include the operation of the EV charging station and EV charging processes. Again, any associated services are respected.
iii) **Close-up:** The close-up of the energy activity life-cycle may be seen in the saturation of the market with EV charging.

2.2 Stakeholders

The following chapter will map the stakeholders involved in the respective energy sector activities of i) lateral electrification and ii) EV charging station roll-out. Evidence from the case studies will with specific entities will be provided.

2.2.1 Lateral electrification

Categorizing the stakeholders involved in lateral electrification projects reveals the following distinct groups:

Policy and Regulation:

- Policymakers: policymakers set the playing field for all electrification efforts, including grid expansion, mini-grids and solar home systems (SHS). Many African countries set out national electrification plans, which are complemented by international agendas such as the SDGs and SE4ALL. These frameworks then build the basis for policy packages and regulations. Policies should result in an enabling environment and counterbalance the (cross-)subsidies that national utilities receive so that private actors are able to compete.
- Regulatory authority: Regulatory activities can be taken up by different public and non-public actors. Public bodies include departments or ministries within the government, national electricity regulators, rural energy or electrification agencies, national utilities, or local governments. Other entities with regulatory tasks include international organizations and community organizations. Regulations might be enforced by the same or different entities, e.g., customs controls and other authorities.
- Rural Electrification Agencies: many governments set up dedicated agencies to administer the deployment of electricity in rural and other isolated regions. These agencies often

have a double mandate of reaching as many customers as possible while ensuring the financial viability of electrification projects.

- National grid representatives: main grids are often owned by national enterprises. Since the expansion of the main grid and the tariffs that national utilities charge strongly affect the viability of off-grid projects, representatives of national or other utilities constitute important stakeholders in mini-grid regulation and policy.

Mini-grid development and operation:

- Mini-grid developers: while many mini-grid actors integrate development and operation activities, the different steps in the life-cycle of a project might also be conducted by different players. Developers oversee planning activities, first administrative steps, procurement, installation of equipment and commissioning of the project.
- SPPs: SPPs are small, often independent producers of electricity that are not part of the main grid. This includes distributed generators, mini-grids and community-level mini-utilities.
- SPDs: SPDs are small distributors of electricity, which are usually connected to the main grid. Once the grid arrives in isolated areas, SPPs can develop into SDPs.

Financing and (international) development cooperation

- Commercial providers of finance: access to finance remains a challenging task for many businesses active in African countries. Loans handed out by national or foreign banks and other providers of finance can potentially spur electrification efforts by the private sector, since they reduce the need for equity and other forms of capital. Still, viable business models – especially in rural areas – remain a challenge, and off-grid projects involve considerable risks. Providing attractive business cases and hedging risks is thus key to access financial resources by commercial providers.
- Investors: investors might include national or foreign investors, ranging from individuals, community collectives and businesses (e.g., mini-grid developers and operators) to asset managers, private equity, or fiscal entities.
- Providers of grant assistance, funds and guarantees national and international actors might provide access to grants, repayable funds, guarantees and other supporting financing instruments. Actors at the national level include, for example, national development banks and state-owned funds. Beyond the national level, regional or international development banks, funds and financing facilities and other IDC programs and actors might provide such means.
- Technical assistance providers: again, both national and international providers might offer technical assistance at different levels. This includes support in the development of policies and regulations, the structuring of financing vehicles, as well as technical assistance directed at companies or individuals, e.g., trainings on installation and maintenance of equipment.

Other stakeholders:

- Local community: the local community remains a key factor for the success of any electrification project. It provides the customer base and might grant ownership of land and other resources.
- Customers**:** for the customers of mini-grids and other off-grid systems, the availability of electricity may result in a steep increase in social and economic opportunities. However,

many customers in African countries, and especially in rural areas, have low incomes at their disposal. This means that the purchasing power for electricity is usually low, and tariffs that an SPD can charge may not cover its production costs. Also, customers may not be able to provide the necessary capital for connection costs or other investments. Box 1 and Box 2 present a selection of important players on the energy landscape in Madagascar and Sierra Leone respectively.

EVIDENCE FROM MADAGASCAR

ADER: The Rural Electrification Agency (ADER) was established in 2002 to advance rural electrification. The focus was to promote access to basic electricity services for the rural population, primarily through renewable energy sources. Operational since 2004 following the Decree 2002–1550, ADER's main activities include: identifying potential sites for rural electrification, managing the competitive tender process and supervising concessions, writing and commissioning market studies, and quality checking project works.
Stakeholder category: Regulatory authority; Rural electrification agency

Ministry of Water Energy and Hydrocarbons: The Ministry of Water, Energy and Hydrocarbons (MEEH) and its respective Directorate develops and implements policies for the provision of adequate and reliable power supply in Madagascar.
Stakeholder category: Policy maker

ORE: The Electricity Regulatory Authority (ORE, soon ARELEC) is the regulatory body of the electricity sector. ORE was established in 2002 and is composed of the Council of Electricity, in charge of regulation, and of an Executive Secretariat, which executes the decisions taken by the board. Under the 2017 Electricity Code, the Council of Electricity will be renamed as the College of Commissioners. ORE's three principal missions are to agree, publish and oversee price tariffs and their application, oversee the quality of the services being offered on the grid (through licences, norms and contracts), and oversee free market competition.
Stakeholder category: Regulatory authority

JIRAMA: JIRAMA (Jiro sy rano Malagasy) is the vertically integrated state-owned water and electricity operator created in 1975 following a merger between the old Malagasy Society of Water and Electricity (SMEE) and the Malagasy Society of Energy (SEM). The company is under joint supervision of the Ministries in charge of Water, the Ministry of Finance and Budget, and the Ministry in charge of Energy and Hydrocarbons. JIRAMA generates, purchases, transports and distributes electricity in Madagascar. Since the liberalisation of the electricity sector in 1999, JIRAMA is no longer the only operator in the market, yet the company still has the transport and distribution monopoly for the main grids. As of 2016, MEEH counted 22 private operators in the market. *Stakeholder category: National grid representative*

IDA: In 2016, the World Bank approved an International Development Association (IDA) loan worth $65 million to help the Madagascan Government improve its electricity sector operations. The Madagascar Electricity Sector Operations and Governance Improvement Project (PAGOSE) aims to improve the operational performance of JIRAMA and improve the reliability of electricity supply. The restructuring programme should also include standardising tariff rates across the country as well as increasing the tariffs, so they become more cost reflective.
Stakeholder category: Financing and (international) development cooperation

Box 1: Important stakeholder on the energy landscape in Madagascar. Source: GMMDP, 2019a.

EDBM: The Economic Development Board of Madagascar (EDBM) is an agency of the Government (more specifically the presidency) that facilitates and promotes investment in Madagascar, acting as an interface between the private sector and the public sector. It was established under the 2007 Law on Investments in Madagascar which created an enabling environment for private investment. EDBM has three principal missions:

- Promoting investment and improving the business environment in Madagascar, working in close relationship with the Presidency of the Republic and contributing to policy reforms;
- Promoting a positive image of Madagascar as investment destination; and
- Providing a one-stop shop for investors, helping them to set up their companies and implement their projects

<u>Stakeholder category</u>: *Financing and (international) development cooperation*

Main players in the private off-grid sector: Mini-grid companies include AXIAN, Henri Fraise & Fils, EOSOL, BETC Nanala, ANKA, HIER; Solar Home System companies: MICROCRED, JIROGASY, HERI
<u>Stakeholder category</u>: *Mini-grid development and operation and related private sector company*

Box 1 continued. Source: GMMDP, 2019a.

<u>EVIDENCE FROM SIERRA LEONE</u>

MEA: Ministry of Energy (MoE) has oversight responsibility over the energy sector and is the public authority responsible for developing policies and programmes for the provision of affordable and sustainable energy services for the population of Sierra Leone. Rural electrification in Sierra Leone is implemented at present by the Renewable Energy Unit within the MoE, which in the absence of any implementation agency such as a Rural Electrification Agency (REA), receives considerable support from several donor organisations, including DfID, the Tony Blair Institute (TBI), GIZ, ECOWAS ECREE, Power for All, Barefoot Solar Women, USAID's Power Africa and UNOPS.
<u>Stakeholder category</u>: *Regulatory authority*

EGTC: The Electricity Generation and Transmission Company is the responsible national entity for electricity generation, being financially dependent from the Ministry of Finance and Economic Development (MOFED).
<u>Stakeholder category</u>: *National utility*

EDSA: The Electricity Distribution and Supply Authority is the responsible national entity for electricity distribution and supply, being financially dependent from the Ministry of Finance and Economic Development (MOFED).
<u>Stakeholder category</u>: *National grid representative*

Box 2 Important stakeholders in the energy landscape in Sierra Leone. Source: GMMDP, 2019b.

SL-EWRC: Ther Sierra Leone Electricity and Water Regulatory Commission Act of 2011 established the regulatory authority; the Sierra Leone Electricity and Water Regulatory Commission. The EWRC's mandate is to issue (i) generation licences, (ii) approve and determine tariffs, as well as (iii) formulate and monitor quality and compliance with regulatory frameworks for the safe, secure, affordable and reliable supply of water and electricity in Sierra Leone.
<u>Stakeholder category</u>: Regulatory authority

EPA: The Environmental Protection Agency (EPA) is the authority responsible for approving environmental impact assessments (EIAs) in the country, including for power sector projects.
<u>Stakeholder category</u>: Regulatory authority

MCC: The Millennium Challenge Corporation (MCC), among other international partners, has been providing capacity building to EWRC and EPA to undertake their mandated functions. In addition, the MCC supported the MoE with the development of the Electricity Sector Roadmap Reform 2017 to 2030.
<u>Stakeholder category</u>: Financing and (international) development cooperation

MAFFS: The Ministry of Agriculture, Forestry and Food Security has a key role in matters related to bioenergy and crop-related energy issues.
<u>Stakeholder category</u>: Policy maker

MTI: The Ministry of Trade and Industry (MTI) handles petroleum marketing and sales.
<u>Stakeholder category</u>: Policy maker

MoFED: The Ministry of Finance and Economic Development (MoFED) plays a supportive role in fiscal matters and has been providing subsidies to the newly established utilities EDSA and EGTC as these are not financially independent yet. Furthermore, to overcome the weak balance sheet of EDSA (as the sole off-taker based on the 2011 NEA), MoFED and MoE are co-signatories to any PPAs to reduce off-take risk.
<u>Stakeholder category</u>: Policy maker

REASL: The Renewable Energy Association of Sierra Leone (REASL) was formed in February 2016 as a result of a Power for All initiative and is a trade association to promote the development of the renewable energy market in Sierra Leone. The REASL currently has around 30 members including international companies present in Sierra Leone. The main achievements to date have been (i) establishing minimum quality assurance standards for imported solar products in Sierra Leone, (ii) engaging micro finance institutions, and (iii) successfully lobbying for the removal of the import duty on solar products based in 2016 (Finance Act, paragraph 26, 2011) provided they meet IEC standards.
<u>Stakeholder category</u>: Financing and (international) development cooperation

International donors in the off-grid sector: DFID, EnDev, GIZ, UNOPS
<u>Stakeholder category</u>: Financing and (international) development cooperation

Box 2 continued. Source: GMMDP, 2019b.

2.2.2 EV charging station roll-out

Categorizing the stakeholders involved in EV charging station roll out reveals the following distinct groups:

Policy and Regulation:

- Policymakers: since the costs of EV purchase and charging infrastructure are considerable, favorable policies are needed for a green transition of the mobility sector. Policymaking in these areas is embedded in overarching policy frameworks, such as national mobility, and GHG reduction plans as well as international agendas such as the SDGs and the Nationally Determined Contributions (NDCs) of the Paris Agreement. Since direct subsidies and other costly policy measures can considerably strain fiscal households, policy packages should be geared towards greatest effectiveness. For example, supporting the transition to EV-based public transportation appears favorable, as vehicles are operated extensively, thereby taking advantage of the low operation costs of EVs.
- Regulatory authority: regulatory activities can be taken up by different public and non-public actors. Public bodies include departments or ministries within the government, national electricity and mobility regulators, national utilities, or local and county governments. Other entities with regulatory tasks include international organizations and community organizations. Regulations might be enforced by the same or different entities, e.g., customs controls and other authorities.
- Distribution network operators (DSO): depending on national policies and regulations, the responsibilities of DSOs related to the provision of charging infrastructure may vary. At the most basic level, DSOs need to provide electricity access to charging stations. This means they must manage the changing demands on the grid, which might include adding generation capacity for meeting growing (peak) electricity demands, and ensuring grid stability by upgrading or adapting transformers, conductors and substations. Going beyond electricity supply, the DSO might also be involved in installing, operating and/or owning meters and electric vehicle supply equipment (EVSE).

EV acquisition:

- Private customers: governments can incentivize EV uptake by employing a host of policies and regulations, ranging from direct subsidies over tax exemptions to non-financial measures, such as preferential lanes or parking for EVs. In developing countries, however, the purchase of EVs for private use is often reserved for a small high-income class. Incentives and support for other groups should thus be considered, too.
- Commercial customers and fleet operators: aiming regulatory support for EV acquisition at the commercial sector and the operators of joint fleets appears promising, since these entities use EVs at a higher rate than private customers and can bundle negotiation power in discussions with suppliers and achieve favorable conditions. Taxi drivers and other mobility providers usually own and operate their ICE vehicles at the same time. Since EVs usually come at a higher cost, new financing models need to be found. Bundling the acquisition in larger entities and then leasing the vehicles to the drivers or employing them directly, allows for circumventing the high initial costs for individuals.

Charging station development and operation:

- Charging/swapping station developers: when planning the installation of a charging station, developers need to consider many different factors, including permits, land acquisition, technical feasibility, and financing. For example, different stakeholders might be involved in obtaining the necessary permits and ownership rights for setting up the station, and the costs of installation might be much higher than the costs of the needed equipment.

- Charging/swapping station operators: charging station operators might face different responsibilities, depending on agreements between stakeholders regarding the ownership structure and tasks. The operator might own the necessary equipment or lease it from the DSO, a government entity, or a private company. Accordingly, the settlement of electricity costs, maintenance and other factors may vary, as do underlying business models.
- Customers: in the planning phase of a charging and/or swapping station, it is crucial to keep in mind the customer's preferences and constraints. For example, the station should be situated at central and easily accessible transport hubs, the charging process or the specifications of the swappable batteries should meet the driving patterns of the customers, and the payment model should accord for the limited purchasing power of most customers.

Financing and (international) development cooperation:

- Commercial providers of finance: access to finance remains a challenging task for many businesses active in African countries. For the transition to the use of EVs instead of ICEVs, large investments are needed for financing the high-cost purchase of EVs and the installation of charging infrastructure. Loans handed out by national or foreign banks and other providers of finance can potentially support business models related to EVs and charging, since they reduce the need for equity and other forms of capital used for financing initial expenses.
- Investors: investors might include national or foreign investors, ranging from individuals, community collectives and businesses (e.g., charging station developers and operators) to asset managers, private equity, or fiscal entities.
- Providers of grant assistance, funds and guarantees national and international actors might provide access to grants, repayable funds, guarantees and other supporting financing instruments. Actors at the national level include, for example, national development banks and state-owned funds. Beyond the national level, regional or international development banks, funds and financing facilities and other IDC programs and actors might provide such means.
- Technical assistance providers: again, both national and international providers might offer technical assistance at different levels. This includes support in the development of policies and regulations, the structuring of financing vehicles, as well as technical assistance directed at companies or individuals, e.g., trainings on installation and maintenance of equipment.

Other stakeholders:

- Local community: the local community presents another important stakeholder for EV projects. Charging or swapping stations can cause significant traffic and noise or light pollution. The infrastructure can also conflict with other uses of available space. If the local community receives disadvantages by the operation and starts to lobby against it, the whole facility might need to be adapted or moved entirely. On the other hand, the community might also benefit, e.g., when shop-owners can increase revenues, or the mobility offer for community members improves.

EVIDENCE FROM KENYA

MoE: The Ministry of Energy (MoE) is the lead institution at the national level, mandated with policy formulation, and provides a long-term vision to all energy sector players. The Ministry oversees sectoral planning, electrification of rural areas and exploration of indigenous energy sources, promotes the development of renewable energy, and mobilises financial resources for the public sector.
Stakeholder category: Policy maker

EPRA: The Energy and Petroleum Regulatory Authority (EPRA) is an autonomous, independent sector regulator, that works to set, review and adjust consumer tariffs – to provide consumer protection, approve power purchase agreements (PPAs) and power tariffs, promote competition and provide regulation to energy sub-sectors, resolve consumer complaints and enforce environmental, health and safety regulations. EPRA supports the MoE in formulation of policy, as well as fiscal, legal and regulatory frameworks for exploration and production of all energy sources.
Stakeholder category: Regulatory authority

MoEF: The Ministry of Environment and Forestry (MoEF) acts as the focal point for climate change activities and coordinates the Climate Change Action Plan. The Ministry is the focal point for the Global Environmental Facility (GEF). One of its semi-autonomous government agencies, the National Environment Management Authority (NEMA), is the National Designated Authority (NDA) for the Green Climate Fund (GCF) climate finance.
Stakeholder category: Policy maker

NEMA: The National Environment Management Authority (NEMA) is a semi-autonomous government agency, assisting the MoEF in setting national CO_2 limits and formulating economic instruments on pollution reduction technologies.
Stakeholder category: Policy maker; Regulatory authority

MoD: The Ministry of Devolution (MoD) is responsible for intergovernmental relations (specifically related to service delivery), coordination of capacity building, and technical assistance.
Stakeholder category: Policy maker

NT: The National Treasury is responsible for coordinating the national development agenda - Vision 2030 - through medium term plans (MTP3 currently). The State Department for Planning within the Treasury is divided into seven Directorates: Macroeconomic Planning and International Economic Partnerships; Social and Governance; Sustainable Development Goals (SDGs) projects and programmes coordination; Economic Development Coordination; Monitoring and Evaluation; Infrastructure, Science, Technology and Innovation; and Public Investments Management (PIM).
Stakeholder category: Policy maker

Box 3: Important stakeholders in the energy landscape in Kenya. Source: Petrik, 2020.

PPPU: The Public Private Partnership Unit (PPPU) main function of the PPPU is the coordination of the review and approval process for PPP projects, in order to facilitate the flow of bankable, viable and sustainable projects that further the National Policy on PPP. Primary responsibilities include assisting each contracting authority (e.g., Ministry of Energy, Kenya Electricity Transmission Co. Ltd. (KETRACO)) to identify, select, appraise, approve, negotiate, and monitor PPP projects throughout their life cycle.
Stakeholder category: *Policy maker*

KenGen: The Kenya Electricity Generating Company (KenGen) is a parastatal where the government owns 70% and the private sector owns 30% of the company. KenGen is mandated with developing and managing all public power generation facilities but competes with independent power producers (IPPs). KenGen ist the largest electric power producer in Kenya.
Stakeholder category: *National utility*

KETRACO: Kenya Electricity Transmission Company (KETRACO) fully belongs to the government and owns, plans, designs, builds, operates and maintains high voltage electricity transmission lines (132kV and above) and associated substations.
Stakeholder category: *National grid representative*

KPLC: Kenya Power and Lighting Company (KPLC), commonly referred to as Kenya Power or KPLC, is a public liability company which transmits, distributes and retails electricity to customers throughout Kenya. KPLC is 51% government-owned, possesses most of the power supply network, and operates all national electricity transmission and distribution systems in Kenya. Kenya Power is the off-taker in the power market, responsible for the purchase of all bulk electricity from all power generators on the basis of negotiated power purchase agreements (PPAs).
Stakeholder category: *National grid representative and national utility*

REREC: The Rural Electrification and Renewable Energy Corporation (REREC) is responsible for implementing rural electrification through extension of the grid and off-grid projects, managing the Rural Electrification Programme Fund, mobilising funds in support of rural electrification projects, financing project preparation studies for rural electrification and recommending suitable policies to the government; developing, promoting and managing the use of all renewable energy and technologies excluding geothermal; and coordinating research in renewable energy.
Stakeholder category: *Financing and (international) development cooperation:*

MoL: The Ministry of Lands and Physical Planning is responsible for implementing strategic policy and administrative interventions in land ownership and use.
Stakeholder category: *Policymaker; Regulatory authority*

Box 3 continued. Source: Petrik, 2020.

MoTI: The Ministry of Transport and Infrastructure (MoTI) is responsible for the development of transport infrastructure, as well as the formulation of transport policies.
Stakeholder category: *Policy maker; Regulatory authority*

NTSA: The National Transport and Safety Authority (NTSA) is responsible for harmonizing regulation, licensing and registration of motorcycles and provides relevant data and information.
Stakeholder category: *Policy maker; Regulatory authority*

MoITC: The Ministry of Industry, Trade and Cooperatives (MoITC) is responsible for developing and maintaining standards for Electric Vehicles.
Stakeholder category: *Policy maker; Regulatory authority*

Box 3 continued. Source: Petrik, 2020.

2.3 Type of regulations

For the purpose of the report, we aim to classify different the regulations reviewed. Many possibilities of how to categorize and classify different types of regulation co-exist. We will take over the classification put in place by the World Bank (Tenenbaum et al., 2014): which divides regulatory categories in three major types, based on the subject of regulation (and, notably, not on the actual effect of regulation).

- Technical regulation: technical regulations mainly refer to such decisions relevant in engineering of the energy systems. Example being technical safety standards, such as minimum distance clearance between the ground and wires on distribution poles, or interconnection standards for national grid connection of small, isolated grids.
- Economic regulation: Economic regulation includes setting prices for some entities on selling their goods, e.g., tariffs allowed to charge, or defining rules on who must pay for certain events, for example interconnection of main grid and isolated grid.
- Process regulation: Process regulation specifies the processes by which the regulator´s technical and economic decisions are made, maintained and enforced. Such processes include deadline definitions for administrative processes for both the regulator and other parties.
- Although not directly explicitly included in the scope of regulation, for the purpose of this Deliverable, “financial support” is introduced as a regulatory category. This includes schemes or programs that offer financial support to stakeholders within each step of the energy innovation life-cycle.

2.4 Material

The above-described methodology required to carry out a thorough literature review. To capture a holistic view on both individual perspective of stakeholders involved in regulatory discussion and objective possibilities, we applied a mixed method approach, consulting multiple sources of literature. These included

- Grey literature to find evidence on regulations in place, (un)success stories and insights in the perspective of different stakeholder groups
- Scientific publications that describe the impact, technical suitability, and economic implications of regulations and
- National laws and plans that provide specific insights in the relevant types of stakeholders and the regulatory environment.

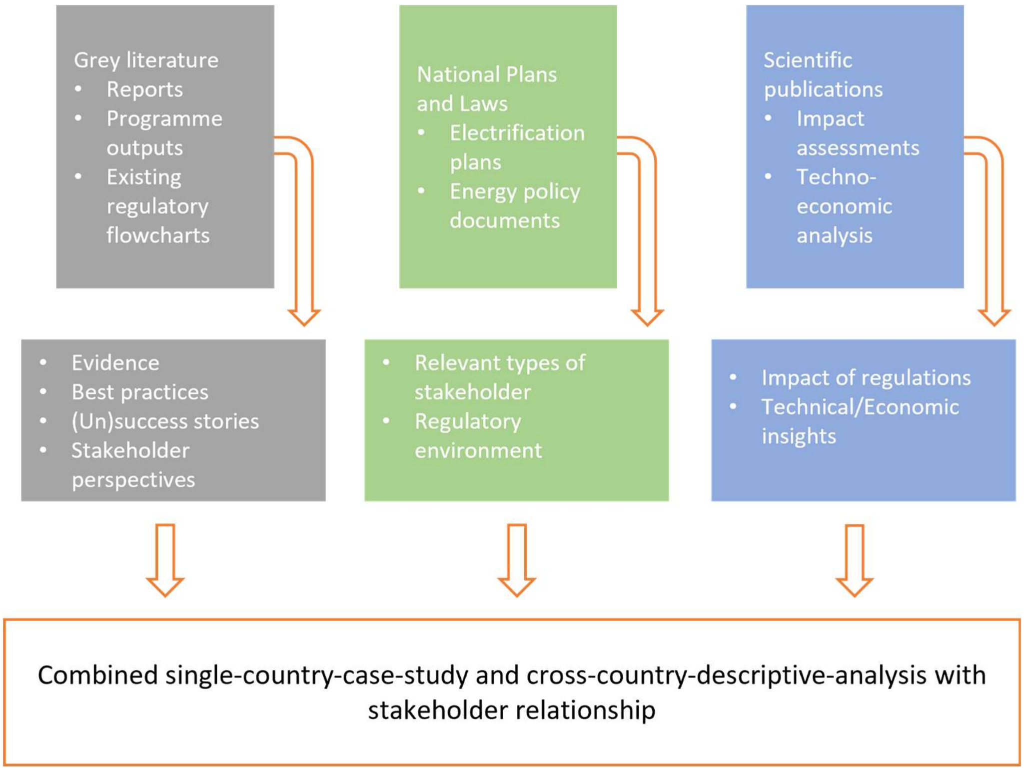

Figure 1: Sources consulted during literature review and use in analysis and discussion.

3. Results

The following section will present the regulatory flowchart constructed for i) lateral electrification activities and ii) EV charging station roll-out. The regulatory flowcharts include indications and guiding questions to point out specific regulatory aspects in the distinct life-cycle step of the activity. Further, the (mainly) involved stakeholder groups will be mapped along the indications. While the regulatory flowchart will be presented in tabular form, a selection of prominent points of regulation will be discussed right after. Evidence from Madagascar and Sierra Leone will be shared in evidence boxes.

3.1 Regulatory flowchart for lateral electrification activities

In many developing countries, electrification efforts follow a two-track approach of national grid expansion on the one hand, and promotion of isolated power generation and distribution systems, on the other hand. At some point, the isolated grids may be expected to connect to the main grid, and many governments set out ambitious plans regarding electrification and interconnection. In practice, it is not always clear when this interconnection will take place, or if some areas will be connected at all. These uncertainties regarding the long-term planning, and the dual approach itself, with differing regulations and timelines, might create inefficiencies and deter investors and other actors from engaging in electrification efforts. In addition, national utilities often take over many of the associated responsibilities and might find themselves confronted with competing priorities. Combined with a lack of financial and technical resources these utilities oftentimes face, timely progress can often not be ensured. Balanced, understandable and unbiased regulation is key in setting the right incentives and supporting electrification efforts.

In the field of rural electrification, technical and economic regulation appear most visible. They should thus be designed in an efficient, fair and timely way and be beneficial to SPPs in rural areas. This supports newly set-up SPPs, for which the time and money needed for adhering to complex regulation can be challenging. Still, regulation needs to ensure sufficient project quality and create a manageable workload for the governing authorities (ibid). In Sri Lanka and Nepal, for example, very generic applications for new projects were possible at low costs, resulting in an influx of unqualified requests, which overwhelmed the authorities. In Tanzania, in comparison, an efficient balance was struck by allowing SPPs to provide a simple registration instead of going through lengthy official licencing procedures.

3.1.1 Initiation phase

A clear and transparent regulatory framework helps to create confidence among investors and off-grid system developers. To support trust building for (private) investors, regulations and clear guidance should be in place at the beginning of a project development, when preparing and planning the actual system deployment.

Table 1: Regulatory indications and stakeholders involved in the initiation phase of off-grid projects.

			Relevant Stakeholders											
Category	**Indication**	**Subindication**	PM	RA	NG	PD	SPP	SPD	CR	CY	CFP	Inv	Do	TA
		Process Regulation												
Legal definitions				**x**		**x**	**x**	**x**						
	Are legally binding definitions/classifications for off-grid system developers (SPP/SPD) in place?													
		Does the definition foresee a classification according to project size?												
		Does the definition foresee a classification according to fuel used?												
		Does the definition foresee a classification according to technology applied?												
		Does the definition/classification depend on the status of grid connection?												
Licenses				**x**		**x**	**x**	**x**						
	What kind of entities can apply for a provisional approval? (individual, company, cooperative etc.)													
	Do exemptions for licenses exist?	Depending on the project size?												
		Depending on the proximity to the national grid?												
		Depending on the legal relation of producer and costumer?												
		Depending on the type of technology deployed?												

			Relevant Stakeholders											
Category	**Indication**	**Subindication**	PM	RA	NG	PD	SPP	SPD	CR	CY	CFP	Inv	Do	TA
		Depending on the type of current (DC or AC)?												
	What regions are available for project developer to apply for a project development?													
		Does the national utility own exclusive (e.g. nationwide) rights to serve electricity?												
		Does one application allow to include multiple sites?												
	Are the licenses restricted to a certain time period?													
		Within the time period of license permission, does the SPP hold exclusive rights (also against the utility) to serve electricity to the region considered?												
	Is there an application fee for provisional approval in place?	Is the application fee dependent on the size of the project?												
		Is the application fee dependent on the technology of the project?												
	Is there a standardized procedure on how the applications are processed? (first-come, first served etc.)?	How is the receipt of the application proven?												
	Is there a standardized procedure of steps to be followed for application?	Are all steps handled by one authority?												
		Are time limits to complete the steps (for both parties) in place?												

Category	Indication	Subindication	PM	RA	NG	PD	SPP	SPD	CR	CY	CFP	Inv	Do	TA
										Relevant Stakeholders				
		Do applicants gain temporary exclusivity at a stage of project application?												
	Are the documents relevant for project approval standardized?	Are the documents publicly available (online?)												
		Is a pre-feasibility study foreseen in project application? -Who pays for the study? -Can costs be reimbursed? - Is the prefeasibility study accompanied by a member of the regulatory authority/independent consult? - Are the elements to be included in the prefeasibility study predefined? - Are elements to be included in the study dependent on the technology used to generate power? - Are elements to be included in the study dependent on the technology used to generate power? - Are evaluation criteria publicly available?												
		Is proof of availability of financing required during proposal process?												
	Is there a standardized financial analysis tool to develop realistic business plans for SPPs to be used to apply at the regulatory authority?													

Category	Indication	Subindication	Relevant Stakeholders											
			PM	RA	NG	PD	SPP	SPD	CR	CY	CFP	Inv	Do	TA
	Is a resale market for permitted licenses allowed? Is a monitoring system for regular monitoring of the licensing procedure in place?													
Concessions	Does the regulatory authority provide predefined concessions? What kind of entities can apply for a concession) (individual, company, cooperative etc.) Does the conditions (duration etc.) depend on the project size?			**x**		**x**								
Local resource requirements	Does the regulator require a fixed share of locally sourced equipment or other resources?			**x**		**x**			**x**	**x**				**x**
		Technical Regulation												
Certification of appliances	Does the country refer to international standards on certification of appliances?			**x**		**x**								**x**

			Relevant Stakeholders											
Category	**Indication**	**Subindication**	PM	RA	NG	PD	SPP	SPD	CR	CY	CFP	Inv	Do	TA
	Does the country operate a national authority to permit certification of appliances?													
	Does the country refer to international appliance-testing laboratories (e.g. underwriters laboratory)?													
Standards for distribution grid	Are safety standards for the distribution grid in place?			**x**				**x**	**x**					
Commissioning	Is commissioning by an external party necessary?			**x**			**x**	**x**						**x**
		Does the external validator need to meet certain requirements?												
		Economic Regulation												
Tariff setting	Are cost reflective tariffs allowed to be charged?			**x**				**x**	**x**	**x**				
	Are different tariffs allowed to be charged for different costumer groups in order to cross-subsidize tariffs?													
		Industrial customers subsidizing residential customers?												
		High-usage residential customers subsidizing low-usage customers?												

			Relevant Stakeholders											
Category	**Indication**	**Subindication**	PM	RA	NG	PD	SPP	SPD	CR	CY	CFP	Inv	Do	TA
		urban customers subsidizing rural customers?												
		Is a lifeline tariff in place?												
		Is a progressive block tariff in place?												
	Does the regulator allow for bilateral power sales contracts between SPPs and business customers without obtaining prior or after-the-fact regulatory approval?													
	Are tariffs allowed to recover costs from lowering upfront costumer connection costs?													
	How are retail tariffs treated for projects receiving outside grants?													
	Is there a periodic cost of service review of recalculating tariffs?													
Tariff types				**x**				**x**	**x**	**x**				
	Energy tariffs (kWh)													
	Power tariffs (W)													
	Per device													
	Combination of energy and power charges													
Payment structure				**x**				**x**	**x**	**x**				
	Is prepayment of energy bills allowed?													

									Relevant Stakeholders					
Category	**Indication**	**Subindication**	PM	RA	NG	PD	SPP	SPD	CR	CY	CFP	Inv	Do	TA
Capital structure and ownership				**x**		**x**				**x**	**x**	**x**	**x**	
	Are certain types of capital supported by regulation or donors?													
	What types of capital should be used in the set-up of the project and for covering initial costs?													
		Project-based financing?												
		Equity?												
		Debt?												
		Mezzanine finance?												
		Grant money?												
		In-kind contributions (e.g. by the local community)												
		Other												
	What processes and legal requirements must be followed to acquire capital?													
	How is ownership of the project distributed?	What is the setup of the legal structure?												

			Relevant Stakeholders											
Category	**Indication**	**Subindication**	PM	RA	NG	PD	SPP	SPD	CR	CY	CFP	Inv	Do	TA
		Financial Support												
Financial support programs				x		x	x	x		x	x	x	x	
	Are there dedicated programs in place for rural isolated grids?													
Tax exemptions			x			x	x	x				x		
	Are waivers of taxes in place which are dedicated to the electricity sector?													
	Are production tax credits for electricity suppliers in place?													
	Are tax holidays offered in accordance with national electrification plans?													
Subsidies			x			x	x	x				x		
	Are initial capital cost subsidies in place, either for mini-grid systems and/or individual components?													
		Is the amount of subsidy granted dependent on project size?												
		Is a minimum contribution of the project developer foreseen?												
		Is there an upper limit of subsidy per recipient defined?												
	Are operating cost subsidies in place?													
	Is a consumption subsidy scheme in place?	Which costumers are eligible for receiving consumption subsidies?												

			Relevant Stakeholders											
Category	**Indication**	**Subindication**	PM	RA	NG	PD	SPP	SPD	CR	CY	CFP	Inv	Do	TA
Results-based financing				**x**		**x**						**x**	**x**	
	Are results-based financing schemes available?													
		What kind of entities is eligible for RBF payments?												
		What is the payment trigger? (Import, Sale, Renting, Start-up component)												
		What is the subsidy based on? (Fixed FOB, Variable(tender), Technical specifications, Flat subsidy)												
		Are bonuses paid for addressing e.g. regional conflicts, certain appliances etc.?												
		What is the measure of result? (Service or deployed asset or both?)												
		What are the time intervals for recurring control?												
		Who and how must the result be verified? Is there a standardized procedure?												
Grants						**x**	**x**	**x**					**x**	
	How is profit regulated for investments acquired by grants?													

			Relevant Stakeholders											
Category	**Indication**	**Subindication**	PM	RA	NG	PD	SPP	SPD	CR	CY	CFP	Inv	Do	TA
Access to financing facilities						**x**	**x**	**x**		**x**	**x**	**x**	**x**	**x**
	Are financing facilities (Access to credit etc.) available?													
	Are financing facilities available granting concessional loans?													
	Do SPPs have access to advance payments/commercial bank loans?													
		Do commercial banks have minimum equity requirements to obtain commercial bank loans?												
Connection costs			**x**	**x**		**x**			**x**				**x**	
	Are grants available to reduce the connection costs for new costumers?													
		Are grants available to any type of costumer (Or only the poor)?												
		Are proxies defined to detect eligible customers for connection grant?												
Technical assistance						**x**								**x**
	Are there institutions or programs available offering technical assistance to off-grid developer?													

Stakeholder categories:

PM – Policymaker	SPP – Small Power Producer	CFP – Commercial Finance Provider
RA – Regulatory Authority	SPD – Small Power Distributor	Inv – Investor
NG – National Grid Representative	CR – Customer	Do - Donor
PD – Project Developers	CY – Community	TA – Technical Assistance Provider

Process regulations

The regulator may monitor or define the regulatory processes and procedural aspects of off-grid system development. These regulations may include the licensing procedures – including timeframes bound to these – processes for stakeholder communication and public/private consultations (US-AID). Such processes - as well as downstream regulations of other types - may differ for distinct actors and stakeholder groups. Prominent classifications of actors are guided by the type of activity the relevant stakeholder plans to carry out – power generation, power distribution or power supply. Furthermore, within these groups of actors, sub-classifications may be defined to further distinguish and apply different regulations to these groups. Common indications to provide a classification is the project size, power generation technology or fuel used for generation, or status of grid connection.

A legally binding definition of such stakeholder groups allows to promote certain activities in the electrification sector, via granting special rights to some stakeholder groups. For example, Tanzania legally defines SPPs and Very Small Power Producer (VSPPs) according to the project size, <100 kW and <10 kW respectively. Both groups are granted with special rights by the regulator during licensing and tariff determination processes. VSPPs, for example, do not require any licensing procedure, but only must register and provide periodic reports to the regulatory authority. Also, the regulatory authority does not require prior review of VSPP´s retail tariffs but can review the tariff when receiving complaints from the retail customers on an after-the-fact basis. With this, the Tanzanian government tries to reduce the market entry barrier for small businesses and to promote private sector engagement in the electrification of rural areas.

However, such special treatment must be in alignment with the overarching goal of the policy. For example, when renewable energy deployment is the main goal, a clause on special treatment of SPP using renewable energies (or, vice versa. punishment of fuel using SPPs) might be useful. For electrification purposes, the World Bank suggests instead to not distinguish between legally binding definitions, but to classify different tariff schemes depending on the used fuel.

To avoid that off-grid electrification systems fail after initial operation, leaving the communities unelectrified or with a low tier-level of electrification, project developers in many African countries need licenses to deploy off-grid systems. Such licenses grant off-grid (or on-grid) project developers the right to construct, own and/or operate a system (US AID). During the licensing procedure, the regulatory authority may ask for proof that the project is technically, legally, and financially feasible. While overly complicated and extended licensing procedures may deter project developers, minimum licensing standards ensure a sustainable existence of the project and therefore sustainable electrification.

The first decision to be taken by the regulatory authority is which kind of entities are eligible to apply for a license, and therefore to operate an off-grid electrification system. Eligible entities may include state-owned bodies, companies, cooperatives, and individuals or any other legal entity. While the superordinate decision of allowing the private sector to apply for licenses has become a popular decision on the African continent to speed up electrification, rules on which kind of private entity may apply for a license are not homogenous. For different kinds of entities, the motivation in system development may differ, and, accordingly, different regulations must be in place during operation. For example, companies might be interested in gaining profit, seeking to maximize the tariff allowed to charge per connection which therefore must be limited. In contrast, community cooperatives might underestimate the tariffs required for system operation, which requires the opposite of minimum tariffs in place (see economic regulations for more insights on this). In general, opening the licensing approval to different private entities may speed up the electrification process but requires additional attention from the regulatory body. A prominent example has been observed in Sri-Lanka, in which any legal entity can apply for provisional approval. However, only companies are eligible for financial support, such as tax concessions and customs duty waivers. With low margins to be expected in Sri Lankas tariff system, this implicit barrier has hindered any other entity than companies from applying for a license.

To promote either certain technologies or stakeholder groups – as defined in the previous section – exemptions from licensing or reduced procedures might be defined. Common practice is to exempt small-scale projects from licensing procedures. The definition of small-scale projects varies considerably between African countries, ranging from 2.000 kW in Uganda, over 100 kW in Ghana and Nigeria, to 50 kW in Rwanda, and 20 kW in Mali (SE4all, 2020). Besides generation technology, an option to promote innovative and efficient energy technologies in alignment with SDG 7 could foresee different licensing procedures for AC and DC systems. While the majority of installed off-grid systems are AC, rural communities with low power demands may be suited to DC technology. DC systems are more commonly used in certain countries such as Rwanda and tend to have a lower capital expenditure (CAPEX) per watt as they require fewer components (e.g., inverters) and are directly compatible with energy-efficient DC appliances. Lowering licensing procedures for DC systems could motivate investors to invest in such technologies.

One of the most prominent issues of regulation is the definition of eligible regions for which project developers can apply. Historically, in most countries, the national utility maintained a nationwide, exclusive electricity serving right. But with the common regulation of uniform tariffs across the country, many utilities failed to gain sufficient profit when serving expensive-to-reach remote regions. In some cases, losing money for each costumer they served, many utilities changed tactics towards financial loss minimization rather than electrification maximization, leading to a stagnation of the electricity status. When opening the market for private sector investors, in some countries the utility still maintained priority to serve several geographical regions. Prominent evidence from India showcases potential problems resulting: The national utility overestimated the ambition to serve regions and to extend the national grid in their electrification plans. Failing to achieve the target, the population, which could potentially have been reached by off-grid system developers, was left unserved. To counteract this problem, three options could be proposed:

1. The national utility could maintain priority service, but such regions not covered in a certain time-period which have been indicated in the electrification plan, are opened to the private sector. Still, the problem of overestimating utilities could deaccelerate the electrification process.
2. The private sector may apply for any region yet not supplied, but the utility must be informed with the option to serve the region in a defined time period. The option requires clear rules and timeframes for the application process, to reduce the time of the licensing procedure.
3. Exclusivity bands close to the existing national grid are defined, which are only available for the national utility. Everything outside this area is opened to the private sector. Many Latin American countries as well as Mali have chosen this option.

Especially for the second option, but also for other regulations, an important measure to be taken by the regulator is to define the lifetime of the license, and with this to grant exclusivity rights for the SPP to serve electricity to the granted region. Otherwise, any project developer must fear either a competitive off-grid system developer to enter the same region or – more likely – the national utility to extend the grid and serve the customers for a lower tariff. If such long-lasting exclusivity rights are not in place, regions that are expected to be reached by the national grid in the mid-term future would be left unserved by any private developer.

Yet another aspect to consider is whether to grant exclusivity rights during the application process already. Such temporary exclusivity allows for long-term planning and a minimum of security for the project developer. Therefore, measures must be defined to register and process incoming applications for licenses, such as a first-come-first-serve process, and security measures for the applicants, e.g., a receipt. South-Asian countries commonly use an electronic token as official reference to proof the start of an application. While applications are processed on a first come-first-serve basis, violating any deadlines during the application process may lead to losing the preferential status.

To avoid plugging the regulator with too many applications to review, the regulator should define measures to reduce the number of applications and exclude unrealistic project proposals. A proven concept is to require a fee for application. A required payment would deter any project proposals which are unlikely to be carried out due to a lack of resources or the quality the applicant can provide in the near future. However, the quantity of fee must be evaluated for the specific setting, as over-dimensioned application fees would hinder small private applicants from starting the application process. Regulators may therefore decide to vary the application fee according to the project size. Further – to direct the applications into alignment with the national policy – the application fee might vary with the (generation) technology or type of current foreseen for the project.

To accelerate the application process and ensure a sufficient quality standard of applications, standardization measures might be in place. This includes standardization of documents available for project approval, potential pre-feasibility studies, proof of availability of financing as well as an adequate monitoring of the approval process. Some countries have developed standardized tools to be used by the applicants to develop realistic business plans and proof these towards the regulatory authority. In Tanzania for example, a spreadsheet is required to be used, which includes i)Capital costs, including plant costs and costs of extending the local mini-grid, ii) Grants, including grants received from the REA for providing connections to new customers, as well as other grants from donors, iii) Operating costs, including salaries, maintenance, and fuel costs, iv) construction schedules, v)portions of financing coming from debt and equity, vi)Interest rate (for debt) and expected returns (for equity), and vii) Loan grace period and term. The tool allows to calculate the project internal rate of return (IRR), after tax IRR on equity, project net present value (NPV), equity NPV, annual project cash flows, Debt service coverage ratio and tariffs needed to make the project financially viable. With this, the Tanzanian regulatory authority can minimize effort and time in reviewing the applications and granting licenses.

Once received a license, the applicant may be granted with the exclusive right to develop a project at the considered site. However, in some cases it might be reasonable or financially attractive to not carry out the project by himself, but resale the license. The regulator therefore needs to decide, if such a resale market is allowed, or if permitted licenses are bound to the applicant. Criticism on such resales is straight forward: A resale of licenses would allow speculators, having no actual intention of project development, to clog the application system, and deaccelerate the project implementation. Further, the market price for resold licenses might be unaffordable for small private entities. However, the first of these doubts could be counteracted by firstly keeping the originally established deadlines to be met by the new owner. Secondly, Tenenbaum et al. (2014) argue, that if the resales price for licenses would be too high, i.e. earning too much profit for the seller, the problem would rather be that tariffs are set too high and the tariffication system must be revised.

For system construction, regulators might set local resource requirements for the purchase of materials and equipment used in the construction of mini-grid facilities and productive uses. This means that a certain share of components, or certain types of equipment, need to be sourced locally. While local resource requirements support the local economy, reduce transportation needs and might potentially result in lower purchasing prices, these regulations may also present a barrier to the most effective implementation. For example, certain components might not be available at a certain quality, price or point in time.

EVIDENCE FROM MADAGASCAR

In 2017, the Government of Madagascar introduced a new Electricity Code, which foresees multiple reforms of the electricity sector. The electricity code sets the legal basis for market liberalization, in on-grid as well as off-grid sector in alignment with the New Energy Policy (NEP) for 2015 – 2030. While striving to open the market for the private sector, it remains to either legal entity of companies or – if private persons – citizens of Madagascar to serve electricity under the Malagasy law.

To support off-grid electrification by private sector and achieve the ambitious rural electrification plans stated in the NEP, ADER, supported by the GIZ, has developed electrification masterplans, called Indicative Regional Development Plans (Plans de développement régional indicatifs – PDRI). Part of these plans identifies and prioritizes regions and villages to be electrified in near future and provides information on pre-existing assets as well as available resources in these areas to the public. While generation, transmission and distribution in urban areas remains under the monopoly of the state utility JIRAMA, the areas identified in the PDRI are cast into "lots" to be put out to tender for project developer to apply for a license with a technical solution to be proposed by the applicant (call for project), or for a license to develop a project with defined technical solution (call for application). The openness towards the chosen technology thought to increase the energy access more generally, with giving project developers the liberty to use different technologies to optimize project viability (e.g. cross subsidizing mini-grids with SHS returns).

Aside the tendering process, an unsolicited application for license has been reported. Such spontaneous applications must include an economic, social and environmental impact study. To allow potential competitors to propose a project on the same site, the application must be made public for at least one months. Applicants may reach out to ADER and – if successful – are granted with an exclusive right to serve the desired area, while no timeframe appears to be scheduled within the project must be developed. This jeopardizes the efforts in electrification, as reserved regions will not be included in the tendering process. In case it does not come to a project development by the spontaneous applicant, the region will remain unserved.

Regardless of the type of application process, Article 18 of the new electricity code legally defines the licensing requirements for different stakeholder groups. The new regulatory context (progressively built since 2018) has created a new classification distinguishing Power Producers, Power Distributors and Power Suppliers. Power producers and power distributors need a permit for every new power production or distribution project. Four different levels of permissions are available for power production: i. Concession, ii. Authorisation, iii. Declaration and iv. Simplified declaration, while only the first two are relevant for distribution projects, each depending on the size of the project determined by its production or distribution capacity, and generation technology. Power suppliers only selling power to the final users without any distribution activities require an additional license for supply. For Power Supply, a "Green power supplier" license exists and is supposed to offer tax benefits but the licensing procedure is the same than for other power suppliers. Table 2 provides an overview of the required permits per activity, while a simplified declaration is required for power production activities below the stated thresholds. For PV solar power plants below 10kW, customers must complete a simplified form available from ORE.

Box 4: Evidence on process regulations during the initialisation phase for lateral electrification projects in Madagascar.

Table 2 Required permits per activity, type of power generation and peak power in Madagascar.

Type of permit	Activity	Technology	Peak power
Declaration	Generation	Hydro	≤ 500 kW
	Generation	Wind	≤ 250 kW
	Generation	PV Solar	≤ 150 kW
Authorization	Distribution	Any	≤ 5 MW
	Generation	Thermal	≤ 500 kW
	Generation	Hydro	500 kW < P ≤ 5 MW
	Generation	Wind	250 kW < P ≤ 5 MW
	Generation	Solar thermal	≤ 5 MW
	Generation	PV Solar	150 kW < P ≤ 5 MW
	Generation	Biomass	≤ 5 MW
	Generation	Geothermal	≤ 10 MW
	Generation	Marine	≤ 10 MW
	Generation	Waste	≤ 5 MW
Concession	Distribution	Any	> 5 MW
	Transmission	Any	Any
	Generation	Thermal	> 500 kW
	Generation	Hydro	> 5 MW
	Generation	All other	> 5 MW

The MoE is in charge of any on-grid projects, while the management of so-called "rural electrification project" is in hands of ADER. Rural electrification being defined by the electricity code as "the part of the Electricity sector whose purpose is to supply electricity to (i) the rural or peri-urban areas of the territory of the Republic of Madagascar in which no Distribution network of medium and low voltage is installed and (ii) mini-grids not connected to a interconnected Transmission or Distribution network (iii) to the exclusion of all Self-production facilities intended to meet only own needs of the Autoproducer". While ADER reviews technical aspects, economical aspects are reviewed by ORE. ORE requires both a business plan and a financial analysis to proof a sustainable project. However, no tool or specified format is available. Larger projects might require separate revision by the Ministry of Energy.

When reviewing the technical aspects of a call for applications and call for projects, ADER defines evaluation criteria and opens these for public view. These evaluation criteria may vary for each call but seem to consider three main factors in evaluation: the number of connections proposed, the nature of the infrastructure proposed for installation, and the minimum tariff suggested by the developer. ADER first makes a choice based on the project with the greatest potential to meet the needs of the area. No evaluation criteria for spontaneous applications are publicly available.

The resales of licenses is allowed in Madagascar but only with a prior validation of the MoE or ADER.

Box 4 continued.

EVIDENCE FROM SIERRA LEONE

Section 66 of the Sierra Leone National Electricity Act (NEA, 2011) established the Electricity and Water Regulatory Commission (EWRC) as the regulator and licensing authority in the power sector. Supported by the MCC and UNOPS, EWRC has developed the mini-grids regulations. These regulations allow companies to apply for two license categories: (i) a basic mini-grid license for projects below 100kW, and (ii) a full mini-grid license for projects between 100kW and 10MW for each generation, distribution and sales of electricity. Several sites might be bundled under one license, provided the thresholds are not exceeded. In addition to these licenses, off-grid system developers require an environmental license from the Environmental Protection Agency (EPA-SL). This agency assesses project proposals according to an environmental and social impact assessment. Renewable energy projects benefit from a reduced scope of the application process and reduced application fees. The application fee settled depends on the type of license the applicant is applying for and the duration of the validity period according to Table 3. Renewable energy technologies may benefit from reduced fees. According to the regulations stipulated by the EWRC there are two distinct types of licenses available:

1. A basic mini-grid license: the license allows to generate and sell electricity in an unserved area stated in the license, with any generation technology up to 100 kW.
2. A full mini-grid license: the license allows to construct, install and operate isolated mini-grids, which thereby includes generation, distribution, and sales of electricity in mini-grids of above 100 kW and up to and including 1MW of distributed power per site and not exceeding 10 MW in aggregate

Table 3: Overview of type of licenses available in Sierra Leone.

No.	License Category	Validity Period [y]	Fee for Application or Amendment of License	Fee for Renewal or Extension of License Tenure	License Fee for Lice Validity Period
1	Basic Mini-grid 1-100 kW	10	2,000,000	1,500,000	40,000,000
2	Full Mini-grid >100-2000 kW	20	2,500,000	2,000,000	100,000,000
3	Mini-Grid Developers Permit (All capacities)	1	1,500,000	1,000,000	3,000,000

The application procedure at EWRC follows a strict application process timeline and procedure. Given that no alterations occur, the final process step of the license application may be completed within 60 days from application. Relevant documents to be submitted are compiled in openly availably databases. These include technical project parameters, relevant background of the applying entity, environmental impact studies and business plans. Further timelines for commissioning of the plant and operation must be declared. Feasibility studies include economic and financial analyses and a social impact assessment. However, the format of especially the latter is not specified

A transfer of licenses after acquisition seems possible, given a written approval of the EWRC. However, evidence on such second market establishment and activities is absent.

Box 5: Evidence on process regulations during the initialisation phase for lateral electrification projects in Madagascar.

Technical regulations

In many cases, regulators will set minimum standards that appliances have to meet. Standards can be defined on the national level or refer to international standards such as those of the International Organization for Standardization (ISO) and the International Electrotechnical Commission (IEC). Similarly, national or international institutions evaluate and implement standards. The use of international standards entails different costs and benefits that should be weighed in each case. Requiring certified products facilitates international trade and the market entry of international players, ensures the use of high-quality products and ensures a harmonization of equipment that is used in electrification efforts. This can be of great use once grids are interconnected, since the systems should already be compatible and do not need to be adapted. Notwithstanding, certified products are costlier, and lower-quality, cheaper manufacturers may be excluded from entering the market even though their products may suffice for local needs. It may also pose a barrier for local manufacturer to enter the market, and hence jeopardize the emerge of a local market.

EVIDENCE FROM MADAGASCAR

The certification of appliances in Madagascar does not refer to international standards and appliance-testing laboratories. Certified appliances can receive benefits (access to finance, tax exemptions) in the context of projects and programs that involve international donors. One example would be the subsidized provision of solar home systems within the World Bank's Off-Grid Market Development Fund. Since imported stand-alone PV products do not need to meet quality standards, low-quality products have flooded the market (UNCDF & UNDP, 2020).

Box 6: Evidence on technical regulations during the initialisation phase for lateral electrification projects in Madagascar.

EVIDENCE FROM SIERRA LEONE

In Sierra Leone, a national authority regulates the certification of appliances. The certification refers to international standards and appliance-testing laboratories. The certification of electricity meters, for example, needs to comply with IEC 62052-11 and 62053-21 norms and receive a test certificate from an independent, internationally accredited (according to ISO/IEC 17025) testing laboratory (SLEWRC MiniGrid Reg. Act, 2019). Full licence holders of projects with generation capacities of 1 – 10MW need to prove certification by an independent international laboratory.

Box 7: Evidence on technical regulations during the initialisation phase for lateral electrification projects in Sierra Leone.

Economic regulation of isolated electricity systems refers to the definition and maintenance of retail tariffs. As the parties involved in the discussion – mainly SPP, national utility, and costumer – may have different motivations and positions at the table, a variety of tariffs and regulations have been developed on the African continent. The following subchapter will discuss prominent concerns for the regulator to decide on when considering tariff regulation. For the ease of understanding, we define fundamental distinct tariff principles, following the suggestions of the World Bank (Tenenbaum et al., 2014):

- Uniform national tariffs: While citizens may be clustered in different tariff categories, all citizens of the same tariff category pay the same tariff for electricity regardless of their place of living or energy supplier.
- Avoided-cost tariffs: The electricity tariff to be settled by an SPP is allowed to equal to the costs that the consumer would have been paying on alternative energy purchases (e.g. kerosene) that are replaced by the electricity purchases from the SPP.
- Cost-reflective tariffs: The SPP is allowed to charge tariffs that produce enough revenues to recover all capital and operating costs.

As foundation for any further concerns, the question of which kind of tariffs are allowed to be charged must be the first concern for any stakeholder in the market, regardless of whether it is the utility that wants or is obliged to serve a rural community, or a private SPP:

A uniform tariff historically may be in place because of a very simple (and important) reason: equality. When a national tariff is settled for any customer connected to the main grid – reserved that the tariff however could differ amongst different customer groups – it may be an obvious claim of an isolated community to request the same tariff when being supplied with an off-grid system. Especially for politicians being under pressure of votes it might be difficult to argue that rural populations may have an economic disadvantage when being confronted with deviating tariffs. However, a uniform tariff ignores the fact that energy supply - -even without grid extension – may be more costly in rural areas than close to urban areas, as service and maintenance expenditures increase with distance from service centres and capital expenditures of small-scale systems are still considerably high. With that, a uniform tariff settled at a regular national tariff will not allow any off-grid electricity supplier to recover costs and sustain a profitable business[2]. The off-grid supplier only has two possibilities to receive sufficient revenue to sustain in the long run: Firstly, the operator may receive upfront and ongoing subsidies that close the revenue gap and earn sufficient profit. Secondly, the operator may be allowed to charge different tariffs for different customer categories, e.g. business and residential customers, and use the difference to cross-subsidize customers that are expensive to supply. A common subject in national tariffs is a special case of cross-subsidies referred to as social or lifeline tariff. That is a low-cost or even free electricity service for poor customers with low levels of monthly consumption. While the idea of such a tariff is noble, it increases the financial pressure for the respective supplier as even less if any revenue is collected from these customers.

The first option of ongoing subsidies, in turn, poses significant challenges to the government. While funds are often used as grants for initial capital expenditures, an ongoing financial support over the

[2] We exclude the possibility of increasing the overall national tariff and allow for heavily cross-subsidizes here, as evidently many African public authorities are afraid of the general public's reaction to raise the overall tariff.

lifetime of a project is more uncommon. Further, from the viewpoint of the electricity supplier, such a dependency may cause long-term financial risks, which may deter from investing in an off-grid electricity system.

Many African countries have therefore explored market driven mechanisms on how to enable sufficient revenue for off-grid electricity suppliers. Therefore, governments often decide to allow for tariffs charged at a higher rate than the national utility´s uniform tariff. Cost-reflective tariffs cover the costs of generating and distributing the electricity plus a reasonable profit, while possible funding options could decrease the tariff for consumers to less than the full cost reflective tariff would suggest. To determine a fair cost-reflective tariff, both the expected costs for the SPP to serve power, and the possible financial burden to the customer must be balanced. To estimate the costs for the SPP, electricity regulators may use standardized templates and procedures, in which the potential project developer must indicate several financial characteristics of the project and the entity. This may for example include capital costs, grants, operating costs, construction schedules, share and conditions of debt and equity and loan grace period and term. On this basis, both the project developer and the regulator are able to calculate financial project indicators, e.g. the internal rate of return, net present value and cashflows, which allows for both entities to calculate a minimum tariff required to develop and sustain the project under given assumptions. The process might be iterated during the project lifetime, to reduce the error risks of initial assumptions and adjust the tariffs over the project lifetime. Self-reflective tariffs may also benefit from cross-subsidies, which can be enabled by charging different tariffs to different customer groups. By this, it may be possible to reduce the tariff for low-consumption residential customers to an affordable level and ensure the ability to pay in the long-run.

Special treatment might be necessary for community operated projects. Evidently, community operators tend to charge tariffs lower than required to sustainably maintain and operate the off-grid system. The regulator may have to introduce special measures to overcome this threat. Examples could be to require communities to have private operators running their generation or distribution system, encourage community SPPs to increase their financial resources by taking bank loans or restrictive access to grants and other resources depending on the tariff and ongoing operational success.

Increasing the complexity of accurate tariff determination, different tariff charging schemes have developed over time. *How* and *when* to charge the tariff may be discussions motivated by ease of comfort for the operator, as well as maintained power over the customer. While post-paid bills can potentially be exceeded, the pre-payments including an automatic switch that allows to only serve electricity when the customer has stored money on his account, reduces the risk of low collection rates for the operator. On the other hand, such techniques may be disadvantageous for the customer, in case the time span between recharging the account and uptake of electricity service may be long. Additionally, operators may decide to choose for a tariff charging structure that is unfamiliar or not transparent for the customer – notably not necessarily with reprehensible rationale but with the intention to increase the system or the billing efficiency. However, the regulator may need to decide, if other than conservative energy tariffs are allowed to be charged for retail customers. Prominent counterexamples to energy tariffs (charged per kWh) are:

- Power tariffs: tariffs that are based on the peak power consumed (also referred to as flat-tariff)
- Device tariffs: Tariffs that charged per outlet or device, e.g. per lightbulb
- Combined energy and power tariffs.

Power or combined tariffs are often chosen to have clearness and control on the maximum peak demand of the system, which allows the project operator to design a system efficiently and protects from financially jeopardizing his operations by over dimensioning the systems. However, for customers such tariffs are hard to compare with other tariffs, such as the national tariff, that are most commonly charged on a kWh basis. If tariff charges differ from the conventional national charging scheme, communication between the project developer and the customer must be ensured to increase the transparency of financial consequences for the user.

EVIDENCE FROM MADAGASCAR

While a national tariff is applied for the national utility JIRAMA; project developers in off-grid zones may propose deviating tariffs to the ORE on a project-by-project basis. Proposals must justify the tariff according to a business plan over 15 years, that also considers the origin of financial resources. While evidence from other countries show a different treatment for the part of financial resources coming from external grants – e.g. in Peru it is prohibited to earn a return on outside capital but the regulator must use an annual depreciation for any capital equipment provided to off-grid developers that was financed through a government grant – no such differentiation is made in Madagascar. Once approved, the tariff will pose as a ceiling tariff for the site and developer, while other project sites and developer may ask for other tariff conditions. A national wide cap for the tariff is not in place, but ORE takes into account the need to ensure the financial equilibrium of operators and the ability to pay of end customers per case individually. A decree detailing a procedure for periodic tariff revision is expected to be published in near future.

With the long-term goal to uniform off-grid tariffs across Madagascar (however this will be challenging due to the wide variety of conditions in the country), a national fund has been established to cross-subsidize rural electrification projects. The fund foresees to be financed by international donors and taxes on tariffs paid by urban clients to the national utility, which constitutes an indirect cross-subsidy for off-grid tariffs. By 2022 however, the national utility has stopped transferring these collected taxes to the national fund. Other direct cross-subsidies occurring from differential tariff charges amongst customer groups is not explicitly defined, low-quality products have flooded the market (UNCDF & UNDP, 2020).

The tariff charging structure for off-grid project developer in Madagascar can be designed as electricity charge tariff, power charge tariff or a mix of these two per decree. Current discussions aim to set clear rules on a charge per device. While the charging structure is legally defined, no clear rules exist on the time of billing. Prepayments are not treated in the regulatory framework but already implemented by the national utility and some rural electrification operators in some areas. A regulatory treatment might be expectable in future.

Box 8: Evidence on economic regulations during the initialisation phase for lateral electrification projects in Madagascar.

EVIDENCE FROM SIERRA LEONE

Since revision of the EWRC mini-grid regulations in 2018, off-grid project developers are allowed to charge cost-reflective tariffs. A basic license holder (<100kW) may charge any tariff to the retail customers, provided the respective community authority agrees to it. In contrast, tariffs for mini-grids falling under the full license (100 kW – 10 MW) must ask for approval of the tariff by the EWRC. The EWRC uses a standard tariff determination tool and a cost-of-service approach using a revenue requirement methodology on a monthly or yearly basis. Further, the charging structure may be different across projects, or even within projects but across different customer groups. The project internal differentiation between customer groups allows for direct cross-subsidies of electricity tariffs. Table 4 exemplary presents the Segbwema mini-grid tariff structure of PRESS-D. Notably, a project developer is required to submit annual performance reports to the EWRC, which may be used to revise the tariff charges.

Table 4 Tariff types and conditions available in Sierra Leone.

Tariff	Customer	Power limit (9W)	Energy limit (kWh/d)	Energy price (USD/kWh)	Minimum monthly charge (USD/kWh)	Connection Fee (USD/kWh)
1.0	Residential basic	440	1	0.25	2.03	35.58
1.1	Residential advanced	2,200	4	0.29	3.56	71.16
2.0	Commercial	3,500	7	0.33	5.59	71.16
3.0	Industrial single phase	10,000	15	0.36	7.12	71.16
3.1	Industrial three phase	11,000	Unlimited	0.36	7.12	177.28

Such average cost-reflective tariffs will charge the customer between 0.8 – 0.9$/kWh. Notably, this significantly differs from the average rate of 0.28 $/kWh in Sierra Leone. Still, rural populations might face trouble in paying these relatively low tariffs given their low-income level. Prepayments via mobile money is a common practice in RREP mini-grid sites.

Box 9. Evidence on economic regulations during the initialisation phase for lateral electrification projects in Sierra Leone.

Financial support regulations

Commencing and maintaining operations in rural areas presents significant challenges to project developers and SPPs, including limited geographical reachability, and both low purchasing power and electricity demand. As discussed in the sections above, serving electricity to rural customers may require expenses that exceed the revenue of project developers. Further, initial costs for upfront systems pose a financial challenge to any potential developer. To close the gap to financial profitability, many project developers rely on financial support from a third party. Such support may occur in various forms, with essential contributions being

- National funds or dedicated programs that support by e.g. granting subsidies or loans to license holders. Typically, government agencies, private foundations and non-profit development organizations give out grants to rural electrification developers, i.e., money, that does not need to be repaid.
- International funds and donors that grant financial support. As with national funds, international funds and donors typically support with grants. Grants can be an important precondition for the viability of renewable energy (RE) deployment in challenging settings, and when initial financial resources are scarce. Usually, beneficiaries are not allowed to receive equity returns on assets financed by grant money. Ideally, grants should act as an enabling component, levering further private capital.
- Banks that offer debt for private entities. Such debt – in the form of loans or credit lines – must be repaid over time with interest.

Angel investors or venture capital investment firms that invest in a start-up company on terms favourable to the company. Typically, such investors support by providing equity, i.e., funds given in return for partial ownership of the company.

Many African countries have bundled financial (as well as technical or regulatory) support into uniform programmes that guarantee clear and uniform conditions for participating companies. However, a potpourri of financial support schemes have been demonstrated in the past, with varying success. Prominent examples are:

- Tax exemptions can create important incentives for RE investments and contribute to the (financial) viability of projects. With a thought-through system of exemptions and other fiscal measures, markets can be steered into a direction that coincides with national development plans. At the same time, exemptions reduce the government's tax revenue and should thus be targeted carefully. As with other measures, exemptions should be universally implemented and be monitored constantly.
- Subsidies: In many African countries, the costs of producing electricity are higher than the revenues that can be generated by tariffs that are affordable for local businesses and the general population. In one way or the other, production is thus subsidized by the state or other entities. This is even more applicable to electricity generated by renewable sources, which are often more expensive than their traditional, fossil-based counterparts. To support the roll-out of renewables, subsidies for REs should be strengthened, while those for fossil-based generation should be reduced or phased out entirely. Subsidies might include initial capital cost subsidies, operating cost subsidies or consumption subsidy schemes.
- Private financing: SPPs usually need to invest considerable sums for preparing and implementing operations. Months or years might pass before these investments generate first incomes. To bridge this gap and similar issues such as delayed payments, advance payments or commercial loans might be needed. Also, external loans reduce the equity share in the business and increase the economic viability of a project. In developing countries and emerging markets, access to financial means might be lacking entirely, or be expensive and subjected to currency- and other risks. Often, banks will set minimum equity requirements to reduce the risks associated with a given investment, and secure commitment of the borrower.

High minimum equity requirements, however, can be a significant hurdle for pioneer projects and new market players, as they might lack the financial resources to provide such requirements. Grants and guarantees are one possible way of circumventing these challenges. Firms in developing countries and emerging markets often face trouble in accessing capital markets. Limited market liquidity, high capital costs and missing credit history present only some of the challenges of local financial markets. Additionally, projects might pursue innovative approaches or operate in markets with low revenues and thus be unattractive or too risky for traditional loan providers. Financing facilities can thus play a critical role in providing capital and pioneering new avenues in renewable energy deployment and electrification.

Yet another special type of financing are results-based financing schemes (RBF-schemes). RBF schemes intend to set incentives for desirable behaviour, e.g., a distribution of SHS that favours poor households. By rewarding outcomes instead of activities, RBFs intend to improve management, increase accountability and transparency and support innovative, localized approaches.

In Africa, the costs of grid connection are among the highest in the world (Tenenbaum et al., 2014). Covering these costs is challenging for market participants, especially in low-income countries. Grants can be a viable solution to overcome this initial barrier. When connection costs are not too high compared to income levels, financing of the connection costs, which can then be paid back over time, might present a cheaper alternative.

Another indirect but financially impactful support is to provide technical assistance. Technical assistance provides valuable support in contexts where regulations are complex, or market knowledge is limited. By transferring best practices, the assistance allows new projects to build on previous experiences and a detailed knowledge of the local context, thereby reducing costs and the probability of failure. Technical assistance can thus act as an important catalyst for firms that are new to REs and rural electrification, or foreign investors who hesitate to invest in new markets.

EVIDENCE FROM MADAGASCAR

The government of Madagascar supports the development of rural isolated grids by means of the aforementioned calls for projects and calls for applications. Other national support structures are not in place. International donors support further programs (including National Fund for Sustainable Energy (Fonds National de l'Énergie Durable – FNED), Off-Grid Market Development Fund (OMDF), National Fund for Mini-grids).

The government employs a number of tax exemptions to foster the deployment of REs. These include VAT and custom duty exemptions for PV components (e.g., PV panels, solar kits, batteries) for electrification projects obtaining permits and partial VAT exemptions on the sale of electricity. The VAT exemptions do not differentiate according to product quality, which contributes to the use of low-quality products (UNCDF & UNDP, 2020). Furthermore, VAT exemptions are not implemented and monitored systemically (ibid).

Box 10 Evidence on financial support regulations during the initialisation phase for lateral electrification projects in Madagascar.

Generally, the revenues generated by residential and commercial PV systems receive a tax reduction of 50%. Together with simplified procedures for the connection of on-roof PVs, the government aims to thereby spur investments in solar PVs for self-consumption and thereby relieving the national provider JIRAMA. Investments in REs are subsidized with tax credits of 50% of the investment sum, applied to the revenue taxes paid. Tax holidays for supporting renewable energy deployment are not employed.

In Madagascar, the national fund for electrification provides initial capital cost subsidies for developers awarded in calls for application or call for projects. While not part of the regulatory framework, the size of the subsidy and the minimum contribution of the project developer varies according to project size. An upper limit to the subsidy is not defined. Operating cost and consumption subsidies are not available.

The World Bank's Off-Grid Market Development Fund offers results-based financing (RBF) for Lighting Global certified solar home systems in Madagascar. The fund was established in 2020 by the government and the World Bank, with a volume of USD 40 million. It is hosted by Société Générale Madagasikara and managed by Bamboo Capital Partners, an impact investment platform. Only SHS distributors are eligible for this RBF scheme, and a fixed amount (based on technical criteria of the product) is paid out for every solar kit sold or rented out for a predefined period. A bonus is paid out or sales and installations in rural or poor areas, and for sales that include consumer finance components (e.g. PAYG or micro-loans). In line with the eligibility criteria, results of the RBF are measured as number of deployed assets.

The *Universal Energy Faculty* offers results-based incentives to mini-grid developers. The faculty employs a volume of USD 3 million in grant funding and is managed by SEforALL; partners include the Rockefeller Foundation, Shell Foundation, Power Africa, Good energies, UK aid, Carbon Trust and the Africa Minigrid Developers Association (AMDA) In a pilot project, the faculty pays out USD 433 per newly installed electricity connection. Later financing rounds will incentivize clean cooking and SHS.

In Madagascar, small power producers have limited access to financing means. Bigger players might gain access to commercial bank loans, but this is still associated with considerable difficulties. Most local developers thus only rest on capital and grants.

The Regional Liquidity Support Facility (RLSF) hosted by African Trade Insurance Agency (ATI), KfW and GIZ, provides insurance protection for SME energy projects in Sub-Saharan Africa. The facility has a total volume of USD 63 million and is active in six countries. By providing guarantees to independent power producers (IPPs), the facility helps these producers to reduce costs, protect them from delayed payments by (national) grid providers and meet the criteria of investors, who often require such guarantees. Minimum equity requirements of the commercial banks are not publicly available and might depend on the individual case.

Pan-African facilities include SREP (World Bank, AfDB), ElectriFI (European Union), Power Africa (USAID), Green Mini-grid (African Development Bank), SUNREF (AFD) and others.

Box 10 continued.

The *Scaling Up Renewable Energy in Low Income Countries Program* (SREP) aims to improve access to electricity and help low-income countries tap their RE potential by identifying and tackling barriers to public and private investment. The program is active in 14 African countries, including Madagascar, Sierra Leone and Kenya. Large donors are the World Bank and African Development Bank, other donors in Madagascar include the EU, UNIDO, GIZ, AFD and the private sector. Its activities in Madagascar focus on two main areas: (1) improvement of the three main grids and (2) rural electrification and hybridization of JIRAMAs isolated centres. Out of 250 eligible projects, 68 were selected for funding, totalling about USD 94 million of mobilized finance.
USAIDs Power Africa program was initiated in 2018 with a total volume of USD 3 million and the aim of providing 400.000 people with electricity. In Madagascar, it works with the Ministry of Energy, ADER, and the private sector and hands out grants to mini-grid companies.

Private actors and NGOs provide further small-scale financing. Carbon compensation provider Atmosfair, for example, provided low interest loans for five rural mini-grids connecting 20.000 people.

As indirect financial support, the German development cooperation agency GIZ provides technical assistance to public and private actors. This includes support in energy policy and regulation, thereby advancing transparency in the electricity market and increasing legal certainty for private investors. The agency also advises in regard to concessions and licences and supports the establishment of the National Fund for Sustainable Energy (FNED). GIZ also hosts workshops for international investors on PV project development in Madagascar. Many other pan-African programs offer technical assistance to private project developers.

Box 10 continued.

EVIDENCE FROM SIERRA LEONE

The Sierra Leone Rural Renewable Energy Project (RREP) aims at supporting the government's goals of a low emission, climate resilient, sustainable growth trajectory under consideration of gender aspects by establishing rural electrification projects and facilitating an environment conducive to private sector activities related to rural mini-grids. The program is implemented by the Ministry of Energy with support of UNOPS and is funded by DFID. Infrastructure projects include the set-up of mini-grids and the electrification of community health centres. Activities to support an enabling environment include the development of mini-grid regulation and tariffs, an EPA guideline, capacity building as well as competitive tenders. Additionally, the project supports the identification of productive uses and the access to necessary equipment and services.

By 2019, 54 health centres were electrified and 50 mini-grids installed. The project has played an important role in advancing regulation, as it has supported the development of a first mini-grid regulation, a first cost-reflective tariff model for mini-grids, and the first EPA guidelines for renewable projects. The mini-grid regulation guidelines include provisions regarding market entry, retail tariffs, technical and service standards, and regulations on what will happen when the main grid arrives.

Under the RREP project, three private companies have signed PPPs with the government, totalling $ 10M in investments. These companies take over the operation of existing mini-grids, connection of households to the grids and are also expected to invest in additional mini-grids over time.

In Sierra Leone, solar power supplying mini-grids is exempted from tax payments. With the exemptions, the government aims to provide affordable electricity to the rural population and support RE deployment throughout the country (Sierra Leone Finance Act, 2021). Certified solar equipment is exempted from import duties and sales taxes. However, this does not apply to equipment used for distribution or storage, and administrative processes for the exemptions seem unclear. Generally, the government aims to attract private sector funding in infrastructure. One measure are tax exemptions for 15 years for large-scale projects with development costs of over USD 20 million.

In Sierra Leone, no initial capital cost subsidies could be identified. With a lack of fiscal support, international donors fill this gap and often provide the equipment needed for setup, completely or in parts. This support is crucial to ensure the basic economic viability of the projects, since the high initial expenditures cannot be redeemed by high-enough tariffs.

Grant money for mini-grid projects in Sierra Leone is used in different settings, e.g., for the purchase of generation or distribution equipment, or for connection costs.

Box 11: Evidence on financial support regulations during the initialisation phase for lateral electrification projects in Sierra Leone.

In Sierra Leone, project developers can approach commercial banks for accessing credit. Financing facilities granting concessional loans could not be identified. No grants directly related to connection cost reductions could be identified. They may, however, be part of the distribution network financing involved in projects such as RREP. High connection costs may impede customers from joining the grid, and financial support from the government may thus be helpful for electrification efforts.

In Sierra Leone, German development cooperation agency GIZ and the donor partnership Energising Development (EnDev) provide technical assistance to mini-grid developers. GIZ promotes the training of solar technicians and builds a platform for connecting different stakeholders in the energy sector. EnDev is active in three countries in the region: Guinea, Liberia and Sierra Leone.

The Millennium Challenge Corporation (MCC) and UNOPS have provided technical assistance to EWRC and EPA, resulting in important regulations (mini-grid regulations and the 2030 Roadmap).

Box 11: continued.

3.1.2 Execution and operation phase

The following section outlines regulations and standards related to the operation of off-grid systems. The operation phase is often less regulated than the initial phases of planning and installation. Table 5 outlines the regulatory issues and stakeholders involved in this phase.

Table 5: Regulatory indications and stakeholders involved in the operation phase of off-grid projects.

			Relevant Stakeholders											
Category	**Indication**	**Subindication**	PM	RA	NG	PD	SPP	SPD	Cust	Com	CFP	Inv	Do	TA
		Process Regulation												
Quality-of-service standards				x			x	x	x					
	Are quality-of-service standards in place?	Quality of commercial services?												
		Technical Regulation												
Quality standards				x			x	x	x	x				
	Are quality-of-product standards in place?													
		Quantified (SAIFI) or qualitative?												
	Are quality-of-supply standards in place?													
		Quantified (SAIDI) or qualitative)												
	Is a monitoring and enforcement scheme established at the REA/regulatory authority?													
Maintenance														
	Are regulations on maintenance procedures in place?													
		Are maintenance intervals regulated?												
		Should maintenance be conducted by outside or specialized staff?												
		Do maintenance activities need to be documented?												

			Relevant Stakeholders											
Category	**Indication**	**Subindication**	PM	RA	NG	PD	SPP	SPD	Cust	Com	CFP	Inv	Do	TA
		Economic Regulation												
Tariff setting				x	x			x	x	x	x	x		
	What kinds of tariffs can be charged?													
		Tariffs for residential customers												
		Tariffs for business customers, e.g. productive uses												
		Cost-reflective tariffs?												
		Tariffs similar to national tariffs?												
Carbon credits and clean development mechanism			x				x			x	x	x	x	x
	Is the country eligible for CDM participation as member of Annex B party of the Kyoto protocol?													
	Does the foreseen activity reduce carbon emissions against the business-as-usual?													
	Is a bundled application possible for the foreseen project?	Are other SPPs using the same generation technology?												
		Is the aggregated size of the SPPs below the UNFCCCs small scale requirements?												
		Is the location of other SPPs known in advance?												
	Program of activity application	Are other SPPs operating under a common program?												
		Financial Support												
Guarantees						x	x	x		x	x	x	x	x
	Are guarantees on loan payments in place?	Are support schemes in place offering guaranteed loan payments?												
Pay-per-use financing								x	x	x	x	x	x	x
	Are financing schemes dedicated to PUSE available?													
		Are financing schemes tied to certain technologies?												
	Is technical support offered to financing institutions?													

Category	Indication	Subindication	PM	RA	NG	PD	SPP	SPD	Cust	Com	CFP	Inv	Do	TA
			Relevant Stakeholders											

Stakeholder categories:

PM – Policymaker

RA – Regulatory Authority

NG – National Grid Representative

PD – Project Developers

SPP – Small Power Producer

SPD – Small Power Distributor

CR – Customer

CY – Community

CFP – Commercial Finance Provider

Inv – Investor

Do - Donor

TA – Technical Assistance Provider

Technical regulation

On electricity markets, both the cost of electricity, or tariffs, and the quality of provided services are regulated (Brown et al., 2006). When liberalizing markets and allowing private actors to provide electricity, authorities should set a minimum regulatory framework in which these companies operate. This ensures that actual developments on the ground are coherent with national electrification plans and social objectives. To do this, the quality of service, product and supply should be regulated. To regulate quality of services, certain criteria can be established and monitored, including the number of complaints and their processing times, maintenance requirements, and others. This ensures that customers can rely on electricity supply and build trust. The quality of the provided electricity is an important factor for uptake by customers, and the utility they receive from consumption. Unsuitable supply with inappropriate voltages and alternating supply can damage appliances. Low grid reliability with frequent and/or long-lasting blackouts and other disturbances can completely impede certain use cases. To avoid this, technical standards and regulations regarding grid reliability can be implemented. Monitoring and enforcing relevant regulations is key for ensuring implementation and efficacy of these standards. Authorities should introduce adequate regulation schemes to ensure regular monitoring and enforcement.

EVIDENCE FROM MADAGASCAR

In Madagascar, the operation of mini-grids is not subject to quality of service standards. Product and supply regulations are lacking, as do relevant enforcement schemes. These areas should be strengthened to support rural electrification efforts and reliable, qualitative access to energy. While overregulation should be avoided, the introduction of simple regulations would ensure that operators meet certain requirements and provide the population with reliable energy.

Box 12: Technical regulations in the operation phase of off-grid projects in Madagascar.

EVIDENCE FROM SIERRA LEONE

In Sierra Leone, mini-grid operators need to meet several quality standards (SLEWRC Mini-Grid Regulations Act, 2019). These include power quality, availability, and reliability as well as accountability and performance reporting. A monitoring and enforcement scheme was introduced in 2011 (SLEWRC Act, 2011) but enforcement is lacking.

Box 13: Technical regulations in the operation phase of off-grid projects in Sierra Leone.

Financial support

While financial support is crucial for the early, capital-intensive stages of off-grid projects, continued financial support can be a decisive factor for the long-term survival of such projects. In addition to the ongoing capital costs for these early expenses, production costs may be high, and potential revenues low, leaving little profit margins or even negative cashflows. Since off-grid solutions are part of national electrification efforts and ESG goals, both the national government and international donors might have strong interests in supporting such projects, even though they may not be financially viable on their own. Financial support during the operating phase include operating subsidies, tax exemptions or other fiscal measures, as well as grants, guarantees or preferential financing. This support can target both the SPP itself, as well as customer groups and other stakeholders that should profit from such projects.

Certified emission reduction (CER) credits are payments offered by the UN's CDM or other emission-abatement programs to entities that are able to offer a reduction in a specified and audited amount of carbon emissions against an estimated "business-as-usual" benchmark. Since carbon credits are a distinct service the SPP offers, regulators should evaluate the revenues generated from these activities separately from other incomes and funding (e.g., grants and subsidies) the producer receives, when setting tariffs or other regulatory measures.

As applying for CER credits is prohibitively expensive and time consuming for a single SPP, individual SPPs can submit a joint application, using either a bundled application or program of activity application.

Depending on the capital structure, SPPs need to service their debt by meeting interest payments and paying back the initial capital. As mentioned before, the market setting these companies operate presents high risks to lenders, since low revenues, additional costs or currency risks might undermine an SPPs ability to pay. To decrease the risk of default and increase the attractiveness of such projects to banks and investors, national or IDC funds and facilities can offer safeguard loan repayments. This can be achieved by direct guarantees on loan payments, or by first-loss loans, where the supporting entity (e.g., a development bank) is the last stakeholder to be repaid, thereby partly securing commercial lenders' loans.

EVIDENCE FROM MADAGASCAR

RE SPPs in Madagascar can generally participate in CDM. However, applying for these schemes is complex, costly and time-consuming in relation to expected gains, which can reduce the uptake by small producers with limited capabilities. At the moment, SPPs do not operate under a CDM common program.

In Madagascar, some insurance companies (e.g., Solidis) offer guarantees. The National Fund should also hand out guarantees, but this mechanisms implementation seems to lag behind. Financing schemes related to PUSE are not available.

Box 14: Financial support in the operation phase of off-grid projects in Madagascar.

3.1.3 Close-up phase: Interconnection of grids

A major question arising in the planning and implementation of off-grid projects is what will happen once "the grid arrives". Without clarity on legal provisions and regulatory requirements, investors and developers might refrain from engaging in mini-grid projects. Once the main grid arrives, several options are possible for the formerly isolated IPPs or small networks (Tenenbaum et al., 2014). They could be allowed to (1) sell to the (national) utility operating the main grid (SPP option), (2) buy electricity from the utility and sell to consumers (SDP option) or (3) engage in a combination of both (combined option). Alternatively, the utility could (4) buy the smaller producers' assets according to pre-defined conditions (buyout option), or (5) the IPPs could abandon operations in the area e.g., when a facility nears the end of its lifespan (abandonment option). An additional option is for the IPP to act as a back-up source for the utility (back-up option) (Greacen et al., 2013). For each option, numerous aspects need to be considered, ranging from technical standards and interoperability to purchasing agreements and tariffs. Another important question is who pays for interconnection costs. Usually, SPPs should pay for the interconnection costs and reimburse other SPPs or customers when using existing appliances. (Tenenbaum et al., 2014). The SPP can then keep all assets up to the connection point and should hand over downstream assets to the utility at zero cost.

Interconnecting mini-grids and the main grid provides several benefits for producers and customers (Greacen et al., 2013). Customers profit from enhanced grid capacity and availability. This can boost electricity consumption in additional productive uses and attract new customers. Additionally, IPPs can increase their revenue by selling excess electricity to the utility operating the main grid.

Even before the connection of mini-grids to the main grid, individual mini-grids in a region might be interconnected. Factors to be taken into consideration are manifold, and include technical specificities, such as frequency and voltage of the networks, regulations that need to be adhered to, as well as ownership and compensation schemes.

EVIDENCE FROM MADAGASCAR

In Madagascar, a speedy extension of the grid, and consequent connection of mini-grids to the main grids, seems unlikely. Grid extension and rural electrification follow separate plans, which might be hard to integrate into a common vision. In addition, JIRAMA rather seems to consolidate its activities in regions that are already covered and might privatize more isolated grids. The new operators might reinforce interconnection efforts when economically and technically feasible, but a wide-spanning, national grid would still not emerge in this case.

Box 15: Electrification plans in Madagascar.

Table 6: Regulatory indications and stakeholders involved in the close-up phase of off-grid projects.

			Relevant Stakeholders											
Category	**Indication**	**Subindication**	PM	RA	NG	PD	SPP	SPD	Cust	Com	CFP	Inv	Do	TA
		Process Regulation												
Classifications				x	x		x	x						
	Do legally binding classifications for the grid connection of SPPs/SPDs exist?	Does the definition foresee a classification according to project size?												
		Does the definition foresee a classification according to fuel used?												
		Does the definition foresee a classification according to technology applied?												
Legal entities				x	x		x	x						
	Which entities can become a SPP/SPD?	Community-owned projects?												
		Individuals?												
		Companies?												
		Joint ventures?												
		Government-supported entities?												
National planning			x	x	x		x	x		x				
	Is there an official national electrification plan in place, detailing the electricity grid expansion plans?													
	Who is responsible for grid interconnection?													
	Are incentives in place to support grid interconnection?													
		Adapted licencing schemes?												

Category	Indication	Subindication	PM	RA	NG	PD	SPP	SPD	Cust	Com	CFP	Inv	Do	TA
							Relevant Stakeholders							
		New or adapted subsidies?												
		Engineering and other forms of technical assistance?												
	Are PPPs and "regulation by contract" possible?													
Interconnection requirements				**x**	**x**		**x**	**x**		**x**				
	Are isolated SPP required to connect to the main grid, once it has arrived?													
Interconnection options				**x**	**x**		**x**	**x**		**x**				
	SPP option	Does the isolated SPP have the general permission to sell electricity at wholesale to the national grid operator (but no longer to retail)?												
	SPD option	Does the isolated SPP have the general permission to convert from an SPP to an SPD, that is to buy electricity at wholesale from the national grid and resell it at retail to the local customers?												
	Combined SPP and SDP option	Does the isolated SPP have the general permission to carry out both activities of SPP and SPD?												
	Buyout option	Does the isolated SPP have the option to sell its asset to the national grid operator or any other entity for receiving compensation?												
	Side-by-side / backup-option													
	Abandonment option													
Feasibility study				**x**	**x**		**x**	**x**						**x**
Is a connection feasibility study required?	Who is responsible for planning and implementation of the study (utility, SPP)?													

			Relevant Stakeholders											
Category	**Indication**	**Subindication**	PM	RA	NG	PD	SPP	SPD	Cust	Com	CFP	Inv	Do	TA
Interconnection fees				x	x		x	x						
	Are interconnection fees required?	Who is responsible for paying interconnection fees?												
Grid connection procedure														
	Are standardized grid connection procedures in place?	Regarding the…		x	x		x	x						x
		… application process?												
		… clarification of responsibilities for analysis and approval of interconnection?												
		… responsibilities for payments and construction?												
		… safety and protection requirements?												
		… testing and commissioning procedure?												
		… communications and data exchange between SPP, utility and regulator?												
		Technical Regulation												
Technical standards of connection				x	x		x	x						x
	Are there technical standards detailing the requirements for mini-grids to connect to the grid?													
		Are technical standards made publicly available?												
		Are national standards in place or international standards?												
	Are safety standards for grid connection in place?													
		Are safety standards for connection made publicly available?												
		Are national standards in place or international standards?												
Quality-of-supply standards				x	x		x							x

			Relevant Stakeholders											
Category	**Indication**	**Subindication**	PM	RA	NG	PD	SPP	SPD	Cust	Com	CFP	Inv	Do	TA
	Power factor? Total harmonic distortion?													
	Capacity factor?													
	Is the quality of supply monitored by regulators?													
Islanding				**x**	**x**		**x**							**x**
	Is intentional islanding (provided this can be done safely) allowed?													
	Are protocols for islanding in place?	Disconnection thresholds?												
		Passive islanding detection method?												
		Active islanding detection method?												
		Are reconnection protocols in place?												
		Economic Regulation												
Power Purchase Agreements				**x**	**x**		**x**							
	Does the country offer long-term PPAs/SPPAs for SPPs?													
	Are SPPAs publicly available?													
	Dependent on project size?													
	Dependent on generation technology?													
	Are standardized PPAs or SPPAs in place?													
	PPAs awarded through auction?													
	Are the PPAs settled on national or international currencies?													
	Do PPAs include a deemed energy clause?	Does the deemed energy clause differ according to who was guilty of not-delivering/receiving?												

							Relevant Stakeholders							
Category	**Indication**	**Subindication**	PM	RA	NG	PD	SPP	SPD	Cust	Com	CFP	Inv	Do	TA
	Are performance requirements included in the PPAs?													
	Are positive incentives in place to trigger utilities buying inform SPPS?													
	Are any risk minimizing financial back-ups available, in case the utility cannot pay (or too late)?													
	Are PPAs reviewed regularly by regulators?													
	Do PPAs include "sell all" clauses?													
RE promotion			x	x	x		x							
	Does the county provide prioritized grid access for RE?													
	Does the country promote RE via priority in dispatch?													
Lost generation compensation				x	x		x							
	Are mechanisms in place to compensate for any lost generation due to redispatch/curtailment?													
Backup Power				x	x		x							
	Are Backup Power Tariffs in place?													
	Does the tariff differ for different SPPs or costumer types?													
	How is the tariff settled?	According to different voltage levels?												
		Energy charge or peak demand charge tariff, or mix?												

								Relevant Stakeholders						
Category	**Indication**	**Subindication**	PM	RA	NG	PD	SPP	SPD	Cust	Com	CFP	Inv	Do	TA
	Is it mandatory to enter a backup capacity tariff as SPP?													
Feed-in-tariffs				**x**	**x**		**x**							
	Are feed-in-tariffs in place?													
	Method of calculation: Avoided cost or cost-reflective method?	Avoided costs: are the avoided costs calculated according to financial, economic or social costs?												
	Are FiTs settled on local currency or hard currency?													
	Do FiTs include a capacity reward?													
	Do FiTs include peak tariff premium, or time of day/season rates?													
	Are granted FiTs adjustable over time?	Are floors and caps included for adjustable FiTs?												
		Are adjustments to inflation or currency devaluations foreseen?												
	Are FiTs for new projects periodically reviewed/adjusted?	Are tariff adjustments tied to certain capacity targets?												
	Are Caps for eligibility of FiTs foreseen?													
	Are Top-up FiT supports available?													
	Do FiT and PPA duration and terms align?													
Retail tariffs				**x**	**x**			**x**	**x**	**x**				
	Is the SPD allowed to charge a retail tariff that provides sufficient	If not, are subsidies in place to support the SPD?												

Category	Indication	Subindication	PM	RA	NG	PD	SPP	SPD	Cust	Com	CFP	Inv	Do	TA
	margin to earn a profit against bulk electricity prices?													
	Are SPDs allowed to charge individual tariffs?													
	Are uniform tariffs planned in the long-term?	Will SPDs be supported with subsidies?												
	Are SPDs allowed to charge different tariffs for different customers groups?	Residential customers?												
		Business customers?												
		Anchor customers?												

Stakeholder categories:

PM – Policymaker

RA – Regulatory Authority

NG – National Grid Representative

PD – Project Developers

SPP – Small Power Producer

SPD – Small Power Distributor

CR – Customer

CY – Community

CFP – Commercial Finance Provider

Inv – Investor

Do - Donor

TA – Technical Assistance Provider

Process regulation

The interconnection of small producers to the main grid should follow clear rules and regulations. When utilities have competing interests, they might otherwise be incentivized to slowing interconnection with complex or unclear requirements. A fair solution which benefits both SPP and utility should thus be found.

The application process for interconnection should be easy and transparent, while providing sufficient information to the utility to make an informed decision on whether to accept the SPP into its grid and under what conditions. Based on the provided information, applicants are informed about the next steps in the interconnection process. Based on comprehensive and correct information, the process can be sped up significantly. Small producers might be allowed to provide reduced information for approval.

By allowing SPPs to install the necessary equipment, the responsibility to implement the interconnection is often shifted to the SPPs. This may speed up the process and allow the utility to focus on other tasks, such as grid extension.

Once the necessary appliances are installed, independent experts conduct initial testing. Regular monitoring after commissioning might occur through annual or ad-hoc inspections and manual or digital metering systems.

Costs for the interconnection process are highly context-specific and depend on hardware, labour requirements, utility fees and other factors.

The processes and requirements of grid interconnection may be classified according to project size, used fuels or generation technology. For example, smaller projects might be excluded from interconnection fees, or be allowed to use a reduced application. Also, different requirements might exist for fuel and generation technologies, especially when SPPs are expected to further feed in electricity into the system.

Different legal entities and groups of producers may pursue differing project goals, and certain rules related to grid interconnection may apply according to legal forms, capital structures and other factors. For community-based and other social enterprises, the purpose of the project may have been to bridge the time until the main grid arrives, and continuing operations might not be a viable option for them. When grant or government money was used in earlier stages, an economic exploitation of these resources by selling assets or generating operational profits might be forbidden. In other cases, the legal framework for interaction might be complicated, as would be the case with individuals without registered enterprises, or joint ventures owned by multiple parties. At the core, however, stands the question of what options legal entities can pursue once the grid arrives.

Transparent and reliable national plans on electrification efforts are crucial for any stakeholder involved in national electrification. Private investors will be reluctant to invest in off-grid systems close to areas of the main grid, when having no clarity on future planning of the grid expansion. Such plans must detail the timeline and geographical regions considered for national grid extension as well as the consequences for isolated system operators when the grid reaches their project borders. Popular evidence from Cambodia shows the lack of investments in isolated grids, when no clarity on grid expansion exists. Sites close to the grid have not been electrified, or with poor measures, quality and safety standards (e.g. wires were tied to the trees). The Cambodian regulator has overcome these issues by allowing every SPP mini-grid, that meets sufficient technical standards, to connect to the main grid and become a SPP or SPD (earning profit through sufficient margin between the bulk purchase tariff and retail sale tariffs).

Regulatory bodies may pre-set the options and responsibilities of SPPs once the main grid arrives. Mini-grids may, for example, be obliged to connect to the main grid, or to sell their operations to the utility. Regulating these options may clarify long-term plans early on and thereby establish certainty for planning, but at the same time establish inflexible and inefficient structures.

Similar to the initial project planning phase, a feasibility study may be required to ensure that an interconnection of mini-grid and main grid is possible. Again, the study should consider all regulatory aspects, update earlier assumptions and adapt process, technical, economic and financial support requirements and options accordingly. To ensure comprehensibility and usefulness of the study, its requirements, costs, and implementation mode (by whom, etc.) should be determined early on.

Fees might be required for the efforts related to the interconnection. For a comprehensive assessment, fees should be managed and communicated transparently.

Grid connection procedures are complex and involve manifold responsibilities for different stakeholders. They involve application processes and approvals, responsibilities for planning, construction works, payments, safety and protection, as well as testing and commissioning procedures. Throughout these processes, communication and data sharing between SPP, utility, regulators and further stakeholders needs to be ensured. A common approach is to leave the responsibility for equipment and installation with the SPP, while the utility provides the necessary technical coupling points from its side. The utility may also be allowed to inspect the appropriate installation from the SPP’s side.

EVIDENCE FROM MADAGASCAR

In Madagascar, plans for grid expansion and rural electrification are in place. It is unclear, however, how these plans will finally be synchronized, and this point in time, clear and timely implementation of these plans is not evident (LOI n° 2017-020 portant Code de l’Electricité à Madagascar - Art. 4).

The options regarding the connection of isolated SPPs to the main grid are outlined in the electricity code (LOI n° 2017-020 portant Code de l’Electricité à Madagascar). SPPs are not obliged to connect to the main grid and are entitled to selling their electricity to the utility (Contrat-Autorisation-type Art.25 & Art. 11). The regulation thus seems in favour of SPPs and provides a certain security for the private sector.

An existing grid code is currently under revision (LOI n° 2017-020 portant Code de l’Electricité à Madagascar - Art 62; GRID CODE). The Grid Code foresees a joint feasibility study process with shared responsibilities between SPP and grid operator (GRID CODE: Chapter II.4.1). It is mainly conducted by the SPP and reviewed and validated by the grid operator. The SPP also needs to support the interconnection costs (Contrat d'achat-type - Art.6).

Box 16: Process regulations in the close-up phase of off-grid projects in Madagascar.

EVIDENCE FROM SIERRA LEONE

In Sierra Leone, the Mini-Grid Regulations Act (2019) determines interconnection requirements, options and procedures. National electrification plans are outlined in the Electricity Sector Roadmap 2016-2030.

Different interconnection requirements are in place according to the license type of a project (Mini-Grid Regulations Act, 2019). Full licence holders (1-10MW) are obliged to connect to the main grid once it arrives. Smaller producers, on the other hand, are required to abandon their operations without compensation within two months and remove all facilities.

Once the grid arrives, full licence holders can either opt for the SPP/SPD or buyout option. With the first option, they enter into an agreement with the national utility and keep on operating the interconnected mini-grid. In the second case, the equipment that the national utility finds usable is being sold to the utility before the grid arrives. Different calculation methods were proposed for determining the scope of the compensation, including calculations based on tariff-setting, previous revenues or residual value after depreciation.

Box 17: Process regulations in the close-up phase of off-grid projects in Sierra Leone.

Technical regulation

When connecting the grids, IPPs need to meet the technical requirements of the utility. Mini-grids need to connect, disconnect and reconnect timely and safely, and coordinate frequencies, voltages and protective equipment with the utility. Different generator types, for example, exhibit different interconnection requirements. When distribution lines and other equipment does not meet technical standards, it might need to be rebuild.

International standards (including IEC and IEEE standards) are commonly used for governing grid interconnection but might be adapted to local contexts. Standards should be uniform and easy to follow. Many countries employ their own distribution codes, including Tanzania and Kenya.

When connecting mini-grid and national grid, it is important to ensure consistent quality the distributing party can rely on. By setting supply standards, further instability in the grid could be avoided, and the quality of service for customers maintained or improved. Quality standards might also include times of service and provisions regarding the maximum frequency and length grid disturbances.

Islanding refers to a condition in which parts of the network decouple from the grid but remain energized by own sources. Traditionally, islanding was seen as unfavourable as it could damage equipment and endanger network stability. With decentralized generation and in contexts of low network reliability, however, islanding provides a viable solution for ensuring the functioning of sub-units of the grid, if done safely.

EVIDENCE FROM MADAGASCAR

In Madagascar, off-grid systems underlie the same norms and standards as the national grid. ORE inspects new installations before launch. Existing grids adhere to international standards, and a national, universal standard was planned as part of the new electricity code. Such common standards facilitate the interconnection of mini-grids and the national grid or other large grids. For older mini-grids that have built on different standards on a case-by-case basis, however, interconnection might prove more difficult.

The connection of IPPs to the main grid seems unclear. For example, the Grid Code for IPPs might also apply to distribution grid operators. Also, experiences in this regard are lacking, since no independent producers are connected to the grid so far. Accordingly, safety standards for grid connection appear inconclusive as well.

Box 18: Technical regulations in the close-up phase of off-grid projects in Madagascar

EVIDENCE FROM SIERRA LEONE

Regarding the safety of grid connections in Sierra Leone, mini-grid licensees are responsible for taking reasonable measures ensuring the secure use by end costumers (Mini-grid regulations Act, 2019). This includes ensuring the installation of protective devices by customers. As part of the mini-grid regulations, these standards are publicly available. In cases where standards are not defined in the relevant document, international standards (IEC, British standards) need to be followed at installation.

Box 19: Technical regulations in the close-up phase of off-grid projects in Sierra Leone.

Both utilities and SPPs have valid interests regarding the design of PPAs and other contracts, which regulation should intend to balance. For SPPs, security around revenue streams and payments is crucial, while utilities might not be able to afford electricity at high prices from third parties, especially if these have preferential access.

Several aspects should be acknowledged in the design of PPAs to ensure minimum transaction costs and ensure security for (small) producers. PPAs should be set for the same timeframes as FITs to ensure that the utility pays an agreed-upon price over the entire term and should the loan structure of the SPP. The utility should also be obliged to buy all produced electricity. The PPAs should be standardized, ensuring equal treatment of SPPs and simplifying negotiations, regulatory reviews and due diligence by financiers.

Deemed energy clauses govern cases in which electricity could be provided by the producer but the utility is unable to obtain it due to grid interruptions or other failures from its side. Administering such instances is rather complex and requires significant regulatory costs. Tenenbaum et al. (2014) thus suggest providing historical data on interruption length and frequency, on which investment decisions by SPPs and other producers can be based.

Many developing countries aim for a combination of providing access to energy and leapfrogging to renewable methods of generation. Additional to adapted FiTs, prioritizing RE projects in grid connection or dispatch can be important incentives related to grid interconnection. Early access to the main grid can – in combination with a viable post-connection business model – ensure the long-term operation and viability of the project. Priority in dispatch, as part of PPAs and FiT agreements, strengthens the business case of RE projects compared to traditional generation, and ensures a nearly risk-free revenue guarantee.

SPPs typically enter into PPAs with the utility, and the amount of electricity the utility needs to buy, and at what price, is regulated. At times, the SPP might however be unable to supply energy to the system, for example when the grid experiences blackouts or the interconnection is separated. Further, the utility might curtail the generation provided by REs to stabilize the grid, or redispatch electricity. For such cases, regulations can be put into place, detailing the compensation for SPPs.

Backup tariffs regulate the costs of electricity provided by the utility to the SPP when the SPP cannot produce sufficient electricity for meeting its own demands, for example when the SPP employs insufficient generation capacity or needs to restart its generators. These tariffs can be relatively high, and SPPs might feel disadvantaged when, in the first place, the reason for the restart was the utility itself (Tenenbaum et al., 2014). This might happen when the system is unstable and experiences blackouts or excess loads that decouple the SPP from the network. Backup tariffs should consider these issues in the tariff structure.

FITs set the prices that independent producers can expect when supplying the utility with electricity. Energy produced from REs often receives advantageous treatment by means of preferential feed-in and higher tariffs. FITs can be calculated using different methods (see Tenenbaum et al., 2014). In the avoided-cost approach, the costs that are avoided by the generation, for example for the utility, the environment and society, are calculated. Since this approach is often complex and costly, a simple calculation might be used instead. In simple calculations, REs and fossil-based generation are assessed according to financial costs only and REs often appear financially unviable or less attractive than fossil-based alternatives. Another alternative is a standardized, cost-reflective, technology-specific calculation for different modes of generation with several assumptions (e.g., reasonable profits, capital structure). This method allows to raise the RE share by paying a premium price. In developing countries, however, this approach might not be suitable when (national) utilities lack the financial means to pay premium prices. Tenenbaum et al. (2014) thus recommend setting the FITs at the buying utility's avoided costs or below. In this scenario, not all RE projects might be profitable and donor or taxpayer money can be used to raise FITs to levels that subsidize these projects.

Once SPPs are connected to the main grid, tariff structures may change considerably. Customers may now expect to pay uniform tariffs, which should usually be lower than the tariffs of isolated systems. This raises the key question of whether the (former) SPP will be able to remain profitable as an SPD or a combined SPP and SPD, given the new conditions. As SPDs buy at wholesale prices and resell at retail prices, they rely on the margins between those tariffs, which are usually small. Tenenbaum et al. (2014) estimate that a margin of $ 4-5 cents per kWh is needed for the profitable operation of a medium-sized SDPs in Africa. For operators that keep producing electricity, a similar problem arises, as the production costs of small systems are usually higher than those of larger facilities, leaving little margin when selling to the utility or retail customers. Given these adverse circumstances, producers should either be allowed to charge tariffs accordingly, or profit from (cross-) subsidies in a similar fashion as large utilities.

EVIDENCE FROM MADAGASCAR

SPPAs are not available in Madagascar. Requirements for PPAs could also not be identified, including project size and generation technology. Standardized PPAs or SPPAs exist, but buying tariffs are not standardized (Contrat d'achat-type). Some PPA are awarded through auctions. Settlement of PPAs is done through national currency, but the price will be revised on a monthly basis taking into account the exchange rate compared to the Euro (Contrat d'achat-type - Art. 11). Deemed energy clauses are partially embedded in the contracts between SPPs and utility (Contrat d'achat-type), favouring the utility. While the SPP cannot expect a compensation in instances where the utility is unable to receive the produced energy by its own fault, malus payments are foreseen for failures on the supply side i.e., by the SPP (Contrat d'achat-type - Art. 12). The PPAs include some, rather light, performance requirements (Contrat d'achat-type - Art. 3). Positive incentives for buying from the SPPs are not in place. In addition, the contracts do not include payment guarantees from the utility's side (Contrat d'achat-type). Given that the national provider has frequently provided payments later or not at all, SPP protection thus appears insufficient. Overall, PPAs could be extended, and be adapted to create a secure environment for SPPs. FITs are not in place. Instead, buyout tariffs are negotiated on a case-by-case basis.

REs receive priority in dispatch according to the law (LOI n° 2017-020 portant Code de l'Electricité à Madagascar - Art 13). It is not clear, however, whether these provisions will be followed in practice. Backup Power Tariffs are not in place, and regulating backup electricity scenarios would thus be advisable.

Box 20: Economic regulations in the close-up phase of off-grid projects in Madagascar.

EVIDENCE FROM SIERRA LEONE

In Sierra Leone, PPAs are not needed for SPPs with generation capacities below 1MW. Instead, SPPs usually discuss these contracts directly with community stakeholders. Projects with more than 1MW are, however, obliged to sell their production to the national utility EDSA and agreeing on a PPA with the authority. In practice, many projects have reached these agreements by PPP provisions and other forms of “regulation by contract”. As in other contexts, the financial resources of the national utility can prove challenging for IPPs, for example when payments might be delayed. In Sierra Leone, SPPs receive prioritized access to the grid (Renewable Energy Policy, 2016). No mechanisms are in place to compensate for generation losses due to redispatch or curtailment.

Box 21: Economic regulations in the close-up phase of off-grid projects in Sierra Leone.

3.2 Regulatory flowchart for EV charging station roll-out

The transport sector can be considered the lifeblood of modern economies, as it facilitates the movement of goods and labour. Transportation needs have grown steadily in the past decades, driven by growing economies and populations as well as people's increased desire for mobility. In 2018, the transport sector contributed to 17% of global greenhouse gas emissions (Statista, 2022), a number which is likely to increase as demand rises further. Especially in urban areas, traffic clogs the infrastructure, resulting in hundreds of hours spent in traffic jams, and its emissions harm both humans and the environment.

To tackle these issues, governments in both industrialized and developing countries have set ambitious goals of transforming the transport sector, to meet environmental, economic and social goals. While this may encompass a wide array of policy fields and measures, such as redesigning the transport infrastructure in urban centres, prohibiting private transport in certain areas or incentivizing the use of public or shared transport, a key question remains the fuel used for powering the sector. Three alternatives appear viable for replacing fossil fuels in the transport sector: biofuel, hydrogen or electric vehicles (EVs) and, given the current state of technology, EVs may be the most promising solution for a swift transition that builds on existing infrastructure.

In Africa, the challenges facing the transport sector appear even more pronounced. Today, emission levels appear comparatively low with Sub-Saharan Africa contributing only 3,8% of greenhouse gas emissions worldwide (Siemens Stiftung, 2020). However, population growth and economic development will lead to enormous growth in transportation demands. Supplying the needed infrastructure would present a considerable challenge on its own, and enabling a green transformation of the sector within only a few decades additionally complicates this endeavour. At the same time, a well-planned transformation could mean that African countries can leapfrog the developments of industrialized countries and focus directly on a green expansion of the transportation sector.

Some of the challenges in Sub-Saharan Africa related to switching from traditional modes of transport to EVs include low reliability of power grids, a high share of fossil fuels used in electricity generation and limited purchasing power. In many places, electricity supply is unreliable with frequent blackouts and other failures, equipment is outdated and susceptible to shocks, and electricity loss, including by theft, is widespread. Given the mostly low incomes, vehicles are bought second-hand and imported from Europe and other industrialized areas. This context presents all involved stakeholders with significant challenges: governments need to establish coherent policy packages to enable the transition, utilities must find ways to manage the increased demand for electricity, and private sector operators need to build context-specific business models.

The transition towards electric mobility in African urban centres may still be in its infants but offers great potential for leapfrogging. Traditional modes of mobility result in high health and economic costs, which makes a swift transition to cleaner transport a pressing issue. Ambient air pollution, for example, resulted in an estimated 394.000 deaths in 2019, and economic costs of about 1% of GDP in Ethiopia, Ghana and Rwanda (Fisher et al., 2021). Two and three-wheelers, in particular, produce heavy emissions. These motorcycles are mostly used as taxis and provide the largest source of self-employment for the young population in Africa. This sector thus promises great potential in electrification. In Kenya, the government has introduced dedicated programmes to promote EV technologies. However, for a successful uptake of the solution it will require stimulus on both sides, the supply side – notably of EVs and EV charging – and demand side of EVs. In any case, the parties will see themselves confronted with an innovative technology, bringing high risks and uncertainties. In such events it is crucial to reduce uncertainties for users and potential market actors, through defining clear and powerful guidelines as regulations.

3.2.1 Initiation phase a) EV acquisition

To stimulate the intrinsic uptake of EVs by private and public owners, governments and regulators may apply regulations to guide the market entry of EV technologies.

Table 7: Regulatory indications and stakeholders involved in the initiation phase (EV acquisition) of charging stations.

			Relevant Stakeholders										
Category	**Indication**	**Subindication**	PM	RA	DSO	PD	CPO	CR	CY	CFP	Inv	Do	TA
		Process Regulation											
Vehicle licensing				x				x					
	Does the licensing scheme differ for EVs and ICEVs?												
	Are waivers on licensing plate limitations available for EVs?												
		Technical Regulation											
EV battery regulations				x		x	x	x					x
	Are technical standards on batteries available?												
		Does the country refer to national or international standards?											
Vehicle retrofit regulation	Are regulations regarding the retrofit of ICEVs in place?			x		x	x	x					x
		Financial Support											
EV support programs			x	x		x	x	x	x	x	x	x	x
	Is there any EV program in place?	For private transport?											
		For commercial and/or industrial transport?											
		For fleet programs?											
Subsidies			x	x		x	x	x		x	x		

Category	Indication	Subindication	Relevant Stakeholders										
			PM	RA	DSO	PD	CPO	CR	CY	CFP	Inv	Do	TA
	Are subsidies programmes dedicated to EV purchase in place?	For private transport?											
		For commercial and/or industrial transport?											
		For fleet programs?											
	Are subsidies mandated for capital costs, or cover for leasing programs?												
	Do subsidies differ between battery technologies used?												
Fiscal incentives			x	x		x	x	x		x	x		
	Are tax exemptions in place?	Purchase tax?											
		License/registration tax exemptions?											
		Import taxes on EVs?											
		VAT?											
		Annual circulation vehicle tax?											
	Reduction of EV insurance?												
	Exemption of custom duties?												
Retrofit support				x		x	x	x		x	x	x	x
	Are financial support schemes for retrofitting ICEVs with electrical engines in place?												

Category	Indication	Subindication	Relevant Stakeholders										
			PM	RA	DSO	PD	CPO	CR	CY	CFP	Inv	Do	TA
Other support policies			x	x		x	x	x	x				
	Are other support mechanisms and incentives in place?	Special lane access											
		Parking perks											
		Exemptions from road and congestion charges											
		Exemptions from driving and purchase restrictions											
		Restrictions of driving areas											
		Ban on fossil fuel vehicles											

<u>Stakeholder categories:</u>

PM – Policymaker

RA – Regulatory Authority

DSO – Distribution System Operator

PD – Project Developer

CPO – Charging Point Operator

CR – Customer

CY – Community

CFP – Commercial Finance Provider

Inv – Investor

Do - Donor

TA – Technical Assistance Provider

Process regulations

The purchase of EVs, compared to ICEVs still might deter potential customers. Reasons for this are manifold and complex, but may include higher upfront costs, perception on innovative technologies and fewer available options of supply. While upfront costs may be tackled with financial and fiscal incentives, the latter could be overcome with introducing measures that ease the process of EV acquisition. This includes promoting awareness through dedicated campaigns, and may also include reducing the legal processes required for EV registration. An especially successful measure in this context includes the treatment of licensing processes of EVs. Preferential treatment in the vehicle licensing process can support the uptake of EVs. Regulators might prioritize EVs in the handout of licenses or offer reduced fees. When licensing plates are restricted, EVs can receive additional quotas or be completely excluded from these restrictions. Other non-fiscal incentives may include prioritized parking perks, exemption from road and congestion charges, exemption from driving and purchase restrictions, restriction of driving areas or even a ban on fossil fuel vehicles.

In the Republic of China, for example, the ban of traditional vehicles in inner cities, i.e., a restriction of certain driving areas and a local ban on fossil fuel vehicles, has resulted in the widespread adoption of EVs. Other policies include special lane access, parking perks, exemptions from road and congestions charges or driving and purchase restrictions.

EVIDENCE FROM KENYA

The Kenyan government promotes the uptake of EVs – especially electric motorcycles – through a set of dedicated programs. Part of the programs is to increase the knowledge in electric mobility products. Partnering with different stakeholders from the mobility sector, the government promotes building public interest on electric mobility products. In the course of this programme, fact sheets detailing the state of Kenya's advancements on issues of electric mobility, quick facts on electric mobility and an electric mobility brochure answering common questions on electric mobility have been made publicly available (https://renewableenergy.go.ke/electric-mobility/).

To date, there are no non-fiscal incentives targeting licensing and registration procedures for EV acquisition available in Kenya. Any updates on this will be announced via NTSA. However, during the last years a shift in the type of vehicles mostly registered could be evidenced. While – regardless their type of engine – the number of vehicles registered declined for any type of vehicle in 2020, motorcycles registration increased by 17%. This may give opportunity to further increase efforts in electrically powered motorcycles in future.

Box 22: Evidence on process regulations during the initialisation phase for EV acquisition in Kenya.

Technical regulations

As the technology of EVs and associated components is still immature, technical implications for users might neither be clear and visible, nor homogenous. Common usus for regulators facing the introduction of a new technology via private sector companies is to set technical standards that ensure a minimum quality for the user, environment, and processes. For motorcycle EVs in Africa, such standards could especially be formulated for the battery, as well as the process of retrofitting ICEVs to EVs.

The battery as key component of the EV – both financially but also technically – could be a matter of regulation for various reasons:

- Environment: The primary battery types used in EVs are lead and lithium-ion batteries. Regulators may ban or restrict the use of lead batteries, since they can cause environmental damage and prove difficult to recycle.
- Technical: Technical minimum requirements might be set to ensure a minimum quality (e.g. energy density etc.) and ensure safety during usage and charging.
- Infrastructure: Harmonizing technical specifications and standards for the battery can increase the efficiency of the system-wide infrastructure. Charging stations and modes on public charging stations could potentially serve any battery. Standardizing batteries for certain vehicle types, however, enables innovative market schemes, such as swappable battery charging stations.

Retrofitting means to convert ICEVs into an electric vehicle. The process involves changing the original engine and other related components and a new alternative energy source to be transplanted into the existing vehicle body. It can either be an additional system added to the existing vehicle motor or to completely replace the existing engine with a new motor and drivetrain, while all other components remain the same on the vehicle. Retrofitting ICEVs can present an attractive, cheap alternative to manufacturing completely new EVs. Costs for the retrofit are assumed to be about 70% of the purchase of a new EV (Zeenews, 2022). Retrofit may be subject to regulation, for example when only certified providers are allowed to offer the service, or when equipment needs to meet certain quality or other technical standards.

Replacing the ICE and exhaust system with an electric drivetrain will alter the weight distribution of the vehicle. For new EVs this will be assessed in the design and testing stages prior to manufacturing. However, for an electric retrofit, the vehicle has not initially been designed to carry an electric drivetrain, and, therefore, if not considered, it may affect the loads on the chassis, which could cause structural damage during usage, as well as adversely affect dynamic handling and braking. Additionally, depending on the size and mass of the batteries, they can pose a mechanical hazard, which requires appropriate mounts or clamps, preventing potential instability of the vehicle. Yet another aspect to consider is safety during maintenance. It is necessary to include, within regular maintenance, testing of the insulation resistance of HV parts and testing the leakage current controller function, as well as checking battery condition.

While many technical standards are in place for new EVs, standards for retrofitted EVs could potentially adopt these, as a lot of same components will be utilized. However, it may be difficult to reach the same standards as new EVs, logistically and economically. Further, African countries must decide on whether to adopt international standards, such as the ISO standards often required in European countries, or whether to formulate own standards. Key European standards include ISO 26262 and ISO 9001. ISO 26262 refers to the functional safety of road vehicles and, in particular, to safety-related systems that have an electrical and/or electronic system and are installed in production road vehicles. It highlights how to document the testing process of a component and how to assign an appropriate risk level, using automotive safety integrity levels. ISO 9001 highlights the requirements for a quality management system, based on principles such as a strong customer focus and continual improvement, to ensure customers receive high-quality services and products.

EVIDENCE FROM KENYA

The Kenyan government and regulator have introduced a program dedicated to developing standards for EVs. Supported by development partners, the GIZ and UN Environment, the Kenya Bureau of Standards detects required items to standardize and formulates appropriate standards. Doing so, the partners follow the approach to adopt international standards of the International Organization for Standardization (ISO). By now, 24 standards have been developed for EVs. These cover specifications and testing procedures for safety aspects as well as performance and power consumption elements, terminology and classification and battery-specific standards. The set of standards is publicly available under https://renewableenergy.go.ke/electric-mobility/. By now, the set of standards does not specifically name regulations for retrofit of EVs, but any vehicles must comply with KS1515- code of practice for inspection of road vehicles, generally valid for operational and vehicle deployment regulations. Kenyan regulators also grant licences for the conversion of ICEV to EVs, for companies like Knights Energy and OPIBUS.

Box 23: Evidence on technical regulations during the initialisation phase for EV acquisition in Kenya.

Financial support regulations

Governments can support the uptake of EVs with numerous policy interventions, including financial measures, such as subsidies, tax and duty exemptions, as well as non-financial incentives, such as the allowance to drive in inner cities or preferential lane and parking access. EV support programs can combine different measures, resulting in a comprehensive incentive package. Programs can target different groups of users, and may set different incentives for the private sector (e.g. direct subsidies and non-financial measures) than for commercial uses (e.g. capital cost subsidies and tax exemptions). Government-funded EV fleets used for public transport and public services are a third area in which financial support is paramount. Many national policies and regulations aim for financial and fiscal incentives, as proven main lever for the uptake of new solutions. Such fiscal incentives include tax exemptions, subsidies or other financial support schemes to improve economics of EV production processes, such as the retrofit of ICEVs.

Compared to ICEs, EVs usually come at higher purchasing costs, while operating costs are often lower due to reduced maintenance requirements and the lower cost of energy as compared to fossil fuels. Lowering the initial costs to that of traditional vehicles by offering purchase subsidies can prove an important incentive for customers. Given that subsidies might amount to several thousand dollars, this measure is relatively expensive for governments, and needs to be well targeted. In the African context, government funds are usually constrained, which is why the subsidies should only apply to certain groups. For example, subsidizing commercial use might be preferable over private use, since private customers are usually part of a small group of economically well-off elites, and commercial users operate the vehicles more frequently and extensively than private users do. Also, commercial users might acquire a higher number of units and thereby achieve lower purchasing costs from the start. Eligibility and design of the subsidy might also depend on vehicle types and battery technology. Additional to pure purchase subsidies, the capital costs of financing or leasing a vehicle might also be subsidized to account for other modes of financing the vehicle acquisition. Spreading the costs of purchase over the lifetime of the vehicle, e.g., by offering lease models, can raise the economic attractiveness of EVs to consumers.

Other fiscal incentives for EV uptake include tax exemptions, reductions of insurance premiums and custom duty exemptions. Tax exemptions may refer to taxes on purchase, license and registration, import, VAT, or annual circulation vehicle taxes. In regard to private use of vehicles, tax exemptions and other support measures especially support wealthy shares of the population, which can afford purchasing EVs. Governments should thus consider supporting other population groups, too.

Retrofitting ICEs to EVs may present a cheap option for African countries to manage the transition, given that imports of EVs may be prohibitively expensive and the local production of EVs take considerable time to develop. The know-how and capacities built by retrofitting could also present a steppingstone for local production (and repair) of EVs later on. Still, retrofitting might be prohibitively expensive for certain customer groups, and subsidies might be needed to support economic viability and facilitate uptake.

EVIDENCE FROM KENYA

Currently, there are no subsidies available for EVs or their components. However, the use of subsidies for fleets and individuals is currently being discussed by KRA and the ministry of trade and industrialization. However, since 2019 the government has set a 10% excise duty tax on EVs, which is considerably lower than 25%-35% levied on ICEVs. Other tax exemptions are currently under discussion, especially including the reduction of EV insurances.

Several pilot programs are initiated and supported by the Kenyan government to showcase the benefit of EVs, including fleet programs. A prominent example is the supported cooperation of Opibus - a Swedish-Kenyan technology company that develops, designs, and manufactures electric vehicles tailored for the African continent - and the platform provider Uber. The two parties aim to launch 3,000 electric motorcycles in 2022 to be used by Uber drivers in Nairobi.

Kenya is involved in several international programs related to the transport sector (GIZ, 2022). For example, the TrIGGER model was developed by international partners, including GIZ and the IFEU institute, and is employed in Kenya and other countries. With the Advancing Transport Climate Strategies (TraCS) programme, GIZ supports authorities in Kenya, Morocco and Viet Nam in activities related to the transition of the transport sector. Activities include improving data collection, estimating transport sector forecasts, and building on these foundations, developing policy measures and regulatory frameworks. The activities are aimed at strengthening local expertise.

International donors provide EVs to the Kenyan market within pilot projects, with the goal of generating know-how, increasing awareness and building use cases for EVs. UNEP, for example, provided rangers in national parks with EV motorcycles in a cooperation with Kenya Power and Lighting company, private companies and local authorities (UNEP, 2021: Kenya gets a breather courtesy of electric motorcycles).

The Accelerating E-mobility Solutions for Social Change programme developed a blueprint that allows EV stakeholders, e.g. fleet operators and retrofitters, to develop carbon credits to be marketed on the voluntary market. The revenues from these carbon credits can be used to subsidize investments and structure financial products.

Box 24: Evidence on technical regulations during the initialisation phase for EV acquisition in Kenya.

3.2.2 Initiation phase b) Charging station installation

The availability of charging stations is a crucial factor for the uptake of EVs and needs to go hand in hand with supporting EV acquisition. Users need to be sure they can access charging stations in regular intervals, where they can charge their vehicles according to their schedule and at decent costs. Charging infrastructure can be publicly accessible, or limited for private use, for example in private homes or company spaces. For public stations, regulation might determine who is responsible for electricity supply and operation of the charging station. In some EU countries, for example, DSOs are responsible for both the supply of electricity and the instalment and operation of charging stations (e.g. in Ireland), while in others, DSOs only provide electricity to the charging station, which is operated privately and is considered the same as any other customer of the DSO (e.g. in the Netherlands, Czech Republic). These regulations evolve further, with a tendency towards market-based, private operation as was the case in Italy, where DSOs are by now forbidden to operate charging stations in favour of private operators.

Different options are available for charging EVs: slow chargers (SCs), fast chargers (FCs) and swapping stations. SCs are used when vehicles remain parked for a longer time period, e.g., for overnight charging, and can provide energy at low costs. FCs can recharge the battery of the vehicle within 30 to 60 minutes and are therefore used for quick recharging sessions during long trips, or for vehicles that are used permanently, such as public buses. The intensive supply of energy results in higher electricity costs, however, which can increase by the factor three compared to SCs. Swapping stations combine the advantages of both systems, since they can provide energy in an instant by fitting the vehicle with a set of recharged batteries, while these batteries can be charged flexibly and in off-peak hours at low costs.

Depending on the local concentration of charging activities, equipment and facilities might need to be adapted. For several private chargers, for example, transformers may need to be replaced. With higher charging demands, for example by an array of FCs for large vehicles, substations and the distribution might need to be adapted. On the highest level, overall generation capacity during peak demand times might need to be increased. To avoid additional costs and instabilities related to the higher peak demands, smart charging of EVs is key. By calibrating the charging activities according to the system’s capacities and the user’s needs, energy consumption can be smoothed. By using EVs as a storage system that feeds electricity back into the grid (V2G), the flexibility of the system can be increased further, albeit these efforts are still in an early stage and face additional challenges in developing countries. Charging stations can act as an anchor customer, especially for RE off-grid systems in rural or other isolated contexts. Battery swapping systems, in particular, provide both consistent demand and flexibility to the grid in these contexts.

EVIDENCE FROM KENYA

The Kenyan government intends to raise public awareness on e-mobility, and, together with stakeholders, identify barriers and possible solutions in the market. Both KenGen and Kenya Power plan to invest in charging stations.

Box 25: Regulatory efforts related to charging station installation in Kenya.

Table 8: Regulatory indications and stakeholders involved in the initiation phase (installation) of charging stations.

			Relevant Stakeholders										
Category	**Indication**	**Subindication**	PM	RA	DSO	PD	CPO	CR	CY	CFP	Inv	Do	TA
		Process Regulation											
Registration	Is registration of EV charging points in public buildings required?			**x**	**x**	**x**	**x**		**x**				
Legal entities	Who is allowed to install public EV charging stations?	Private company?		**x**	**x**	**x**		**x**					
		Public entity?											
		DSO or utility?											
Licensing				**x**	**x**	**x**							
	Are concessions/lock-in of applications for public charging in place?												
	Do private stakeholders benefit from preferential claims on charging station deployment?												
	Are tendering and bidding procedures in place for public charging?												
Location requirements				**x**	**x**	**x**			**x**				
	Are locations for EV charging deployment predefined and publicly available?												
		Are minimum requirements on potential locations for EV charging stations defined?											
		Do EV charging stations benefit from preferential treatment on land application?											

		Legal requirements for installation of minimum charging infrastructure in residential/public buildings? Are clear guidelines on regulated spaces and land available for EV charging stations in place?						
Installation procedure	Are standardized procedures for EV charging installation in place?	Is an application fee in place?	x	x	x			x
		Technical Regulation						
Grid connection	Are technical requirements for grid connection defined?		x	x	x	x		x
		Does the country refer to international standards or establish national standards? Are testing and verification procedures for technical equipment defined? Are technical communication guidelines for charging station - grid communication defined? Are safety requirements defined? Does the country refer to international standards (UL, IEC, ISO, …) or establish national standards?						
	Is bi-directional (smart) charging allowed?							
Interoperability	Are interoperability standards defined for public charging?		x	x	x	x		x
		Technical instructions on network access and connection? Technical guidelines to network grid communication and smart charging communication?						

	How is financial transaction interoperability regulated?												
		Are minimum payment methods defined?											
		Are payment methods harmonized across all publicly available charging stations?											
	Are regulations to enable public lightning as access to charging infrastructure in place?												
Road infrastructure	Are construction codes on maintenance and development of road infrastructure in place?		x	x	x								x
		Financial Support											
Subsidies			x	x	x	x				x	x		
	Are subsidies programmes dedicated to charging stations in place?	Are conditions to receive subsidies publicly available? (e.g. technical requirements etc.)											
Charging and metering	Are support schemes for charging and metering in place?			x	x	x				x	x		
Tax exemptions	Are fee or tax exemptions for charging station installation in place?		x	x	x	x				x	x		

Stakeholder categories:

PM – Policymaker	PD – Project Developer	CFP – Commercial Finance Provider
RA – Regulatory Authority	CPO – Charging Point Operator	Inv – Investor
DSO – Distribution System Operator	CR – Customer	Do - Donor
	CY – Community	TA – Technical Assistance Provider

Process Regulations

The regulations regarding the processes involved in charging station planning and installation are strongly tied to the implementation mode that regulators opt for – ranging from state-led to market-based development of the national charging infrastructure. The implementation model might also change with increasing EV penetration. For example, initial efforts might be directed by state authorities and DSOs to kick-start investments and coordinate activities centrally. Later, the market might be opened to individual providers. Following a different model, the charging market may first be scarcely regulated, but with higher EV adoption rates and increasing competition in the EV charging market, additional regulation is introduced. In the 'wild west' phase, first movers follow an individual approach in CP rollout and use their own systems and standards. Later, regulators publish bidding processes for land and operation concessions, set common standards and regulate tariffs and access systems. Process regulations thus refer, among others, to actor's allowances and responsibilities, eligible locations, application procedures, and registration and installation procedure requirements.

National plans detailing the locations and requirements of potential CPs are important for informing the investment decisions of private operators. The number and distribution of CPs may be determined by different factors, e.g., a ratio of EVs per CP, the number of low-income households who cannot afford private charging, or a certain number of CPs per square kilometre or per kilometre of public road. In Germany, for example, a toolkit is available on planned locations, providing the information needed before entering the bidding process. Construction codes mandating a minimum number of EV charging points in buildings, parking spots and other infrastructure can support the rollout of CPs, too. Another crucial factor is an enabling legal and regulatory environment, with effective application requirements and procedures and preferential access to land and usage rights.

Technical Regulations

Technical regulations that are relevant for charging station installation refer to the connection of the station to the grid and bi-directional charging, interoperability standards for charging and financial transactions, and construction codes for maintenance and development of infrastructure.

Technical requirements for the grid interconnection relate to transformer equipment and complementary safety appliances, lines and cables, the civil works required for the setup of the station, and the electrical works ensuring safety. Further, the vehicle access, e.g., the type of vehicle allowed to be charged at the station, and charger specifications, such as the number and types of chargers in the station, may be regulated. The mix of standards and regulations is context-dependent: In India, for example, clear technical requirements are in place, but charging stations for 2- and 3-wheelers are free in choosing a charger type.

Regulators may employ international standards or establish national frameworks for grid interconnection. International standards may facilitate the market entry of international company and the import of foreign vehicles, but at the same time, standards might not fit the local context, require high investments, and it might be difficult for local actors to meet them. National standards, on the other hand, need resources, time and know-how to be developed, and may hamper interoperability. International EV charging standards relate to three areas: charging components, grid integration and safety (Das et al., 2020). For charging components, IEC standards are widely used in Europe, and are partly similar to SAE standards used in the US. IEC 61851, for example, refers to EV communication and safety requirements, and IEC 62196 defines standards for plugs, socket-outlets, vehicle connectors and inlets. Japan and China, on the other hand, use own standards. For grid integration, IEEE and UL standards, among others, are available. Safety provisions are part of many of the aforementioned standards, and NFPA and NEC standards further regulate EV safety. Safety requirements aim at the prevention of overloading, direct/indirect contact or external effects. IEC 62840-2:2016, for example, provides the safety requirements for battery swap systems. Other applicable standards and regulations may refer to the testing and verification of technical equipment.

The communication of charging station, grid, and external parties is a key component of a public charging station's business model and might be subject to regulations. Connecting to a network service provider (NSP) enables the company to provide a platform for users, where customers can remotely check available charging capacities and book a time slot of service. In India, for example, charging stations must connect with at least one NSP, to enable online bookings of charging slots by EV owners. The online information must include information regarding location, type and numbers of chargers available, service charges, and more. This does not apply to internal use or company´s fleets.

Interoperability of charging infrastructure and payment options is important on both the operator's side, connecting to the electricity grid, and on the customers' side, using charging services. Common standards of network grid communication and smart charging options ensure a frictionless integration of charging stations into the grid. Interoperability regarding the offered services facilitates ease-of-use for customers and can therefore be an important factor in the attractiveness of public charging stations. For fast charging, for example, different systems are in place: the SAE Combined Charging System (CCS) is widespread, while CHAdeMO (Nissan, Mitsubishi) and the Tesla Supercharger (Tesla) are only available for certain vehicle types. While it may be expensive for charging providers to provide different charger types, technical interoperability is crucial for EV adoption. In the US, for example, different charger types prohibited EV drivers to use all stations, and a lack of open access data resulted in outdated and erroneous information on charging service platforms. In the EU, on the other hand, uniform chargers are in use. With uniform charging access points, customers can connect to any station and do not need to single out the service providers that serve their vehicle's needs. Common communication and information offerings ease customers' search for available stations and pre-registration. Lastly, economic transaction interoperability guidelines are required to ensure that users have access to the charging infrastructure network. For example, minimum standards on credit card or app payments can be set, as is the case in California. With increasing EV penetration, the access to charging stations and the available payment options should be unified. This ensures that users can connect to all stations, and do not face uncertainty about acceptable modes of payment.

EVIDENCE FROM KENYA

In Kenya, the connection of the charging station to the grid is not regulated in detail. Occupation and safety standards are covered by ISO standards and local policies on electrical handling procedures, ISO standards are used for charging, with Level 1 (120V AC), Level 2 (240V residential and 208V commercial AC) and DC fast chargers with up to 120kW available. Fast chargers are installed in malls in Nairobi, and partially fed by at-site RE generation. Charging facilities include wall boxes, in-house electrical installations and charging stations.

Regarding the integration of charging stations into the grid, no regulations on bi-directional charging are in place, but Kenya Power has been implementing smart load sensing technologies to regulate and make power distribution more efficient. Since EV uptake and charging infrastructure is still at an early stage, operating systems are not standardized. Private companies build individual applications that customers can use to access their services.

Box 26: Evidence on technical regulations during the initialisation phase for charging station installation in Kenya.

Financial Support Regulations

Supporting the expansion of charging infrastructure with subsidies has been shown to be a cost-effective way of fostering EV uptake compared to direct subsidies for EV purchases. Still, many governments have prioritized direct subsidies for the purchase of EVs over support for the charging infrastructure. For battery swapping models, in particular, support with subsidies and other measures has been low. Tax reductions or exemptions, grants and low-interest loans can support the installation of charging infrastructure and are usually coupled to proofs of accountability. Support measures can also consist of direct subsidies for charging station planning and installation, or exemptions on fees. The conditions for support should be publicly available, outlining the technical and other requirements that applicants need to meet in order to be eligible for support. To ensure an effective distribution of CPs, financial incentives and support of the charging infrastructure should be coupled with an implementation plan detailing the locations, timeframes, and other details. In Berlin, for example, the government supported charging stations with funding in the early 2010s, but a lack of planning resulted in low usage of the stations. Central coordination bodies can tackle this problem, examples of which can be found in China, Norway and the Netherlands.

When the rollout of EV charging points is considered part of national electrification or mobility plans, investment costs can be lowered by cross-subsidies or direct fiscal investments and grants. In China, California; Costa Rica and Uruguay, for example, utilities are responsible for the installation of long-distance charging infrastructure along the national road network. The costs for the charging infrastructure are thus distributed among the utilities' customers. While such cross-subsidies support infrastructure deployment, policymakers should consider the effects on low-income customers who might not even be able to use the charging infrastructure that they contribute to.

EVIDENCE FROM KENYA

For the Kenyan context, no support measures for the installation of charging stations, such as exemptions on import duties or VAT, could be identified. Kenya Power plans to build a country-wide network of charging stations. To this end, the company works with the government for promoting support subsidies for charging stations and storage, and lobbies for tax cuts on charging station equipment. Other advocates promote the introduction of subsidies for tariffs and connection fees.

Box 27: Evidence on financial support measures during the initialisation phase for charging station installation in Kenya.

3.2.3 Operation phase: Charging station operation

Among the issues that arise in the operation phase of EV charging stations are interoperability requirements, legal structures and tariff setting. Table 9 highlights common regulatory issues in charging station operation, and the involved stakeholders.

Table 9: Regulatory indications and stakeholders involved in the operation phase of charging stations.

Category	Indication	Subindication	Relevant Stakeholders										
			PM	RA	DSO	PD	CPO	CR	CY	CFP	Inv	Do	TA
Process Regulation													
Legal entities	Who is allowed to operate public EV charging stations?	Private company? Public entity? DSO or utility?		**x**	**x**		**x**						
Responsibilities	Who is responsible for managing energy and financial flows from operations of the electric mobility network?				**x**		**x**						
Customer types	Are public stations available for use to any costumer?						**x**	**x**	**x**	**x**	**x**		
Technical Regulation													
Communication protocols	Are communication protocols with users in place? Are communication protocols with other providers in place? Are communication protocols with the DSO in place?			**x**			**x**	**x**					
Economic Regulation													
Tariff setting	Are tariffs harmonized across all public stations or do they differ between operators/regions?		**x**	**x**	**x**		**x**			**x**	**x**		

Category	Indication	Subindication	Relevant Stakeholders										
			PM	RA	DSO	PD	CPO	CR	CY	CFP	Inv	Do	TA
	Are time-of-use tariffs allowed? Is dynamic pricing allowed and offered? Smart charging tariff mechanisms?	Based on kWh or time of charge?											
Settlement				x	x		x						
	Is public charging billed as electricity sales or service units? Who is the operator of the charging station? How are network charges settled for the charging station operator?	Are price caps in place?											
Interoperability				x			x	x		x	x		
	Are economic interoperability standards for public networks defined?												
		Financial Support											
Support programs			x	x	x		x			x	x		
	Are any financial support schemes available for charging station operation?												
Fiscal incentives			x	x	x		x			x	x		
	Are fiscal incentives, such as tax exemptions for charging station operation in place?												

<u>Stakeholder categories:</u>

PM – Policymaker	PD – Project Developer	CFP – Commercial Finance Provider
RA – Regulatory Authority	CPO – Charging Point Operator	Inv – Investor
DSO – Distribution System Operator	CR – Customer	Do - Donor
	CY – Community	TA – Technical Assistance Provider

Process Regulations

With increasing EV penetration, the involvement of DSOs in the setup and operation of charging infrastructure typically decreases. At low levels of EV penetration, the DSO might oversee the operation of charging stations. In this case, the DSO is considered the final electricity consumer, offering energy services to EV customers. With increasing penetration of EV, charging stations might be managed by other operators, on behalf of other service providers. In this case, the DSO is not involved in installation or operation of the charging infrastructure anymore. Still, its key role for grid connection and energy supply remains. In the European Union, for example, DSOs are not allowed to install or operate CPs except for their own use but expected to cooperate with any other actor involved in the development or operation of CPs, including the facilitation of the grid connection. Other operators include public bodies, PPPs, fleet operators and private charging companies with different business models and approaches. For operators such as hotels, parking providers or shopping centres, including (free) charging might be an attractive incentive for customers, while automakers and other manufacturers might hope to increase sales of EVs or equipment by providing and operating the needed charging infrastructure.

EVIDENCE FROM KENYA

In Kenya, any legally registered business entity can deploy chargers. However, there are policy proposals under deliberation that EPRA should regulate CPOs similar to petrol stations. Operators may own or lease the necessary equipment and are responsible for managing energy and financial flows at the stations. KeBS is working to increase interoperability and charger standardisation to have any charger station available to any customer. Still, private operators may restrict the usage to certain customer groups, for example in semi-public models.

Box 28: Evidence on process regulations during the operation phase of charging stations in Kenya.

Technical Regulations

Depending on the individual setup of the charging station, CPOs need to manage energy from different sources: from the grid, off-grid solutions, such as local solar panels, and storage systems. Further, the communication between vehicle, charging installations and the grid needs to be ensured. Using a common platform for charging station communication allows the electricity provider to coordinate charging output without having to consider different communication standards for each OEM. Interoperability of communication between different charging providers allows all CPOs to conduct customer authorization, and to settle B2B and customer payments. In the EU, for example, rollout of CPs was not regulated, resulting in a low-efficiency distribution of chargers due to redundancy and non-uniform access for customers: In a 2020 survey by NewMotion, users in Europe stated to own an average of 2.5 membership cards for charging services. Uncoordinated implementation of technical and coordination systems can thus result in a patchwork of processes with considerable drawbacks for customers and operators. The differing systems increase transaction costs, limit revenues and complicate or completely prohibit the access of entire customer groups.

Economic Regulations

The economic regulations related to charging station operation include tariff setting, settlement procedures and interoperability requirements. CPOs need to settle costs and agree to tariffs at different points along the value chain: with the DSO that supplies energy to the station, with customers who use charging services, and with other operators, when customers can access the charging points of different providers by using a unified system (roaming), where costs are then settled between the operators. A key question for the operation of CPs is whether public charging is defined as electricity sale, a commercial service, or both. Considering charging activities as a service, as implemented in the US, the EU and several countries in Latin America, was an important driver of private sector investment.

Regulators may allow the involved stakeholders to set individual tariffs or require harmonized tariffs across certain regions or for certain types of providers. Different tariffs are available for consumers of public charging stations. Charging per kWh is similar to many private electricity tariffs, and to traditional petrol stations, where fuel is sold at a fixed price per quantity. Other options include charging per minute, per session or tiered pricing dependent on the maximum charging speed for the vehicle. Customers prefer charging per kWh, since they have experience with similar pricing models in other contexts and because this option is very transparent. Additionally, tiered pricing might be used to account for fast charging, which demands more energy and results in higher costs for the CPO. For the DSO supplying energy to CPs, spot-, time-based and dynamic pricing present a favourable option since lower prices during off-peak hours shift demand, provide flexibility to the grid and can thereby reduce generation costs, stress on the grid and investment needs. Supplementary tariff regulations may be put into place in cases where smart charging, including V2G, is in place.

EVIDENCE FROM KENYA

In Kenya, charging is offered both in the form of electricity sales and as a commercial service. In the initial phases of e-mobility in the country, companies have acted as pilots and are currently the main operators of charging points. With further adoption, public institutions may increasingly host or operate CPs in the future. Tariffs related to EV charging are not strictly regulated, with no price caps in place. EPRA is working on a methodology for tariff determination. Markets push towards per-unit billing of power required for charging, but dynamic pricing models and regulations for smart charging are under consideration, too. Economic interoperability standards have not been defined so far but are being worked on by technical committees under KeBS, supported by electric mobility players.

Box 29: Evidence on economic regulations during the operation phase of charging stations in Kenya.

Financial Support Regulations

The installation of charging stations requires considerable investments, especially when fast chargers are installed. The capital costs related to these initial expenses, and the costs for electricity, maintenance and other factors can result in considerable operating costs. For example, grid operators may charge additional fees for the high demand caused by fast charging. This may sharply increase the rates the CPO charges its customers, threatening the economic viability of EVs. Subsidizing fees and electricity costs could thus present an option for supporting the operation of charging stations and lowering the tariffs that consumers must pay. Further, tax incentives for low carbon enterprises and carbon pricing schemes can support the business case of charging stations.

3.2.4 Close-up phase: Market saturation

As described before, we classify the close-up phase of EV projects to be reached once EVs are widely used, and an extensive charging infrastructure is installed and available to EV owners. For this phase, a comprehensive framework for description and analysis of the regulatory environment should not be needed, and we therefore do not include this step in the presented report.

4. DISCUSSION

The previous chapter has discussed regulatory approaches and their implementation in selected country contexts, namely Kenya, Madagascar and Sierra Leone. This included the identification of best practices and potential room for development of the regulatory environment in the three demo contexts. The following chapter summarizes the previous findings and drafts a way forward by presenting evidence and opinions from the ENERGICA consortium experts regarding the current state of regulations and the most effective ways of creating a supportive environment for the energy transition.

4.1 Off-grid electrification

Together with consortium partners, we identify a number of challenges related to the regulation of off-grid electrification in Africa and discuss possible regulatory approaches that could support electrification efforts. Kornelia Iipinge, project coordinator at SACREE, and Nicolas Saincy, co-founder at nano-grid start-up Nanoé, share their insights on common regulatory themes, for both Madagascar and the African continent.

In many African countries, specific policies on mini-grid development and integration into national electrification plans do not exist or are still under development. This impacts site selection, licensing and permitting procedures, and future grid integration. It also restricts the access of developers to national subsidy schemes for rural electrification activities or cross-subsidies for grid extension. This lack of regulatory guidance is even more pronounced for electrification projects that do not classify as "classic" rural mini-grids but pursue innovative approaches instead. Common mini-grids are marked by the use of an AC system, centralized production and storage units with fixed capacity, and a business model based on the sale of kWh. Alternative approaches, such as smaller hybrids between SHS and mini-grids, solar kiosks, solar charging stations, hybrids of DC/AC grids, peer-to-peer SHS grids and others, employ different technical solutions and business models. For example, they might use a DC system, provide decentralized production and storage with variable capacity, and sell energy services instead of energy units. Such solutions offer great potential, but regulation appears troubled keeping up with the speed of innovations. In cases where the swift development of comprehensive regulations for emerging innovations in the sector is not a viable option, governments at the national levels should define institutional frameworks in which new approaches can be experimented and their costs and impacts compared with already established solutions.

In most countries, quality standards and codes of practice for the off-grid sector are insufficient or lacking entirely. Additionally, regulations and processes are many times complex, little transparent and rules are only partially enforced. The time required to apply for required concessions, licenses and environmental approvals is substantial and has often delayed project development. Although most mini-grids are exempt from generation and distribution licenses, they may still need to go through a process to secure this exemption. Regulatory requirements can also be very expensive. Many environmental impact assessments (EIAs), for example, are fixed costs, independent of the size of the project. In countries where the processes are clear and developers have gained experience, such as in Tanzania, development proceeds more quickly and smoothly.

The protection of mini-grid asset cash flows, in particular, is not regulated in detail: Few governments in countries that need sustained investment in rural electrification explicitly provide regulations that protect private mini-grid owners. For example, many governments lack regulations that protect privately owned isolated mini-grids once the main grid arrives. In order to spur private investment, countries need to have clear and transparent guidelines for mini-grids to be connected to the national grid and compensated accordingly. There should be a mechanism for either the developer to maintain and operate the mini-grid and sell power to the national utility through a PPA, or for the national utility to buy the mini-grid from the developer at fair value and take over operations.

Regulations efforts in African countries strongly concentrate on the development phase of electrification projects, while regulations for the later stages of operation and exploitation are only partially developed or not applied. It is thus extremely difficult for an operator to develop a new project because of the many standards and regulations on technical, environmental, social, economic, financial and juridic aspects the project needs to meet during the permitting process. However, once permits are obtained and the system is commissioned, operators enjoy a local power distribution monopoly for long periods (usually around 20 years) that is very lightly controlled. For example, almost no controls are made on connection rates, population coverage, service quality and continuity, and tariffs. Although a significant share of operators fails to deliver good service quality and extensive coverage, permits revisions or cancellations are extremely rare. To increase both the quality and the access rate to modern energy services of rural populations, the main regulatory challenge is to both lighten regulations in the development stage of projects and to strengthen regulations in the operation stage.

Financial support measures play a crucial role in raising the economic viability and attractiveness of off-grid markets. These markets are characterized by customers' low and varying demands and purchasing power, which complicates the development of sustainable business models: Rural mini-grid operators sell electricity to customers that often have little income and limited ability to pay. Power demand from these customers can be limited and unpredictable as many rely on agriculture for income. Varying weather conditions, seasonality and crop yields all directly impact the ability of these customers to pay their bills. This constricted demand is further coupled with limited options of revenue generation. Regulatory bodies tend to push for mini-grid tariff ceilings as close as possible to national grid tariffs to protect the customers. However, national tariffs are often not cost-reflective (i.e., cover costs and generate a return on investment) due to cross-subsidisation. This results in the need for mini-grid developers to secure grants or subsidies for their capital expenditures (CAPEX), and in some cases also their operating expenses (OPEX). Adding to the challenging market environment, most off-grid endeavours are not attractive to investors due to the small size of such projects: The majority of rural mini-grids range from just 10 to 100kW. Private financiers tend to favour larger deals that allow them to amortize transaction-related costs over larger volumes of capital (and, in many cases, earn larger fees). As a result, many are unwilling to invest the time and effort required to conduct due diligence and provide financing for projects that may require as little as USD 1 million or less.

The integration of productive uses and identification of anchor customers can build an important foundation of revenue generation. However, not all countries have adopted and have put in place support measures to encourage productive uses. As such, project developers are forced to initiate and support productive use on their own, without clear regulatory guidance. This is even more true for productive uses that should be powered by renewable energies. Most rural productive uses are today powered by diesel engines thanks to heavily subsidized oil products. The main regulatory challenge to power them with renewable energy is to level the playing field in terms of tax and subsidies to allow these solutions to economically compete with fossil-fuel based power solutions. Another regulatory challenge for the integration of productive uses is to increase competition between energy service providers for powering productive users. The current status of regulations based on permitting and attribution of local monopolies to a single power provider does not support the rapid uptake of new solutions to quickly power productive uses. Relating to Madagascar as one of the demonstrator sites, the Southern African Development Community (SADC) region has adopted the Water-Energy-Food nexus framework, which is yet to be adopted at member state level. Strengthening the deployment of (RE) productive uses by providing regulatory support and tailored incentives could thus present an important catalyst in off-grid electrification efforts.

Another point of interest for policymakers and regulators is the introduction of local content requirements (LCRs). Countries have different procurement rules and requirements, especially when it comes to public assets and projects. Some of the rules and regulations have strict requirements for local content, registration with several bodies and involvement of local stakeholders. Such requirements aim at embedding electrification efforts within the surrounding context and strengthening the local economy. However, these rules and requirements may prove onerous for small scale developers, which is why clear, well-targeted regulations on local integration are needed.

One way of achieving this is going beyond strict requirements and incorporating other measures that support local value creation. For example, mandatory requirements are a effective solution for the recruitment of local staff, since these requirements are straightforward to implement and can have a direct positive impact. For products or material resources, other measures might be better suited, because the design and control of these kinds of requirements are far more complex, requiring an in-depth understanding of linkages by the local regulators. Other regulations, such as import duties, tax exemptions and other measures, can also (unintendedly) influence local demand. An example for this is the regulation of energy meters in Madagascar. Local producers pay a 40% import tax on every electronic component, imported for their production, such as semi-conductors, PCB, and resistors. The import of fully assembled energy meters, in contrast, is exempted of this import tax according to the Malagasy custom regulations. Such contradictory measures can indirectly hamper the development of local industry.

If local content requirements are not able to capture the complex interconnections of global value chains and different regulations, they might miss their intended purpose, or even result in a net negative impact on local production. Additional to well-planned LCRs, measures such as reserved markets, bonus points in tenders, tax exemptions, and subsidies can be used to strengthen local economic activity and make local manufacturing economically competitive with imported solutions. Such provisions could ensure that the electrification process on the African continent constitutes economic opportunities not only for foreign players, but for African actors and economies, too.

Given the challenging policy and regulatory environment in many locations, coordination and concerted efforts are key for fostering the further development of regulatory frameworks on the African continent. Regional associations have an important role to play in improving coordination and closing the information gap between practitioners, investors and policymakers. Groups such as the Alliance for Rural Electrification (ARE), African Mini-grids Developers Association (AMDA), and SEforALL Mini-Grids Partnership (MGP) offer valuable platforms for private and public-sector stakeholders to consult and collaborate on building enabling regulatory and financial frameworks for the sector. Based on an analysis of the EEP portfolio, AMDA and other such groups should prioritise activities related to permitting policies and tariff frameworks. In terms of scaling up projects, the main priority under regulatory issues is the development of grid integration frameworks.

4.2 EV Charging

The assessment of electric mobility regulations illustrated some of the complexities related to EV adoption and charging infrastructure rollout. Dennis Wakaba, Projects Coordinator and Business Developer at the Swedish-Kenyan technology company Roam Motors (formerly OPIBUS) and Emile Fulcheri, CTO at e-mobility firm STIMA Boda, highlight some of the challenges that private companies face, how regulation could support the mobility transition, and why Kenya could be a role model for the region.

The consortium partners identify regulatory challenges on multiple levels that impede a successful transition to EV mobility in African countries in general, and Kenya, in particular. On the level of policy planning and national goals, no strategic plan or roadmap guiding the shift to electric mobility is in place. This is true for both public and private transport, on the national level and for the continent as whole. Combined with a lack of political will and inadequate commitments by governments on the national and the local level to spearhead the adoption of electric mobility, the growth of markets and the industry is curtailed. This also shows in the workforce capacity: there is a shortage of electric mobility expertise within the continent, which would be needed for successful implementation.

Further, existing frameworks are not comprehensive by now, as seen in a lack of permitting systems for charging infrastructure installation, and the implementation of incentive programs is slow. For example, processes regarding lowered duties and taxes for electric vehicles and charging infrastructure, are often unclear, and not well established. In Kenya, for example, no specific policy scheme related to electric motorbikes is currently in place, and inconsistencies in regulations disadvantage electric motorcycles compared to ICEVs: Only electric cars benefit from a specific import tax regime relative to ICE cars, while electric motorbikes enter in the same category as fuel motorbikes and therefore do not receive targeted support. This lack of support and tax incentives, combined with high taxes on motorbikes and lithium-ion batteries presents a major challenge to e-mobility companies: Most import taxes and duties on vehicles (including motorbikes) are proportional to the value of the vehicles. Since electric vehicles are more expensive up-front than fuel motorbikes, taxes are more important in absolute value for EVs than ICE vehicles. High import taxes also do not give the incentive to invest in quality (and more expensive) vehicles.

Another policy in Kenya was implemented to support the local assembly of motorbikes. This policy states that assemblers can benefit from reduced import tariffs if they manage to source a given list of components locally. However, several of these components are specific to fuel motorbikes and are not found in electric motorbikes. Electric motorbikes are thus not only faced with a lack of support but excluded from support schemes that traditional vehicles receive. This highlights the need to include the category of electric vehicles in policies and regulations, and to take into account their specificities. In regard to coordination efforts and data-driven development, partners identify a lack of continuity and harmonization of electric mobility studies, reports and ambassadors, which hinder the transmission of knowledge, standards and best practices.

Partners in the consortium further agree on the regulatory measures that would benefit EV adoption and charging the most. The most impactful regulations relate to the cost of vehicle acquisition and charging infrastructure installation compared to ICEVs. Lowering import taxes and duties and introducing VAT exemptions on the import and sale of EVs would significantly reduce the upfront costs of EVs and the equipment needed for charging infrastructure. VAT exemptions for local manufacturing and assembly would strengthen local markets and ensure that the transition to cleaner transport benefits the national economy. Other incentives for the development of local industry include offering free land, tax holidays or reduced taxes on input materials and components. The partners further agree that reducing power tariffs for EV charging lowers the operation costs for both commercial providers and private users and would therefore promote e-mobility. The government should also act as a role model and set a minimum share of EVs for public transport, both at the national and local level. These measures would result in a great boost to EV adoption and charging infrastructure in Africa.

The partners highlight manifold cases from around the world that could serve as examples for African cities. There are many good examples of regulation efforts around the world, and combining the best approaches and lessons learned could help African cities to quickly come up with a supporting framework for EVs and EV charging. Many European countries have developed effective E-mobility incentives and standards. Norway, for example, has introduced several non-financial incentives such as free parking, and access to bus lanes and certain zones. The government also supports the charging infrastructure by providing charging points at home, the workplace and in shopping areas. Countries in Europe have further adopted a common charging plug, which was a major milestone for ensuring interoperability. Other notable examples are national and local policies in India, such as the FAME incentive program, and incentives for manufacturers in China. On the African continent, Rwanda is a very good model of ambitious national policy supporting the development of EVs in Africa. The country passed a comprehensive policy supporting electric vehicles, which includes exemptions of import duties on EVs, exemptions of VAT on import and sale of EVs, exemption of VAT on sale of charging services, and lower industrial electricity tariffs applied to EVs charging.

For OPIBUS’ and STIMA Boda’s business model, standards for batteries and battery swapping applications are very important. In Japan, major OEMs, including Honda, Suzuki, Yamaha and Kawasaki, have made important progress in this area. African cities may also introduce congestion charging, stringent emission standards and zero emission zones to promote the uptake of EVs. And India is currently implementing a new regulation specifically on battery swapping that could be an interesting model to look at for policy makers in Africa. Because of the specificities of the African 2&3 wheeler market, which is highly cost sensitive and characterized by intensive usage of vehicles with taxi and delivery activities, battery swapping could play a key role in the transition of African light vehicles to e-mobility.

Consortium partners agree on the outstanding role that Kenya plays in the region: the country acts both as an early adopter of e-mobility, and, in a general sense, as a role model in many policies and regulations. The country is one of the first movers in e-mobility for the continent and counts a significant (probably the highest) number of start-ups focusing on electric motorbikes in Sub-Saharan Africa. The market conditions in Kenya are very favourable for the deployment of electric mobility: High fuel costs and the intensive usage of vehicles result in a strong business case for EVs with their low operational and fuel costs. An extensive market of moto-taxis of more than 1.5 million riders provides a large customer base that, combined with the short lifecycle of traditional motorcycles, presents an enormous possible market demand. Adding to this, taxi riders in cities like Nairobi dispose comparatively high purchasing power and can therefore afford tailored e-mobility solutions. A relatively attractive business environment, particularly for start-ups, and adequate access to electricity, further strengthen the incentives for e-mobility private actors in the country.

While Rwanda was the first mover to support e-mobility in East Africa, Kenya could follow that example and become a hub for e-mobility in East Africa. In other areas, Kenya is seen as a role model for policies and regulations by many of its East African neighbours and should thus fast-track the formulation of electric mobility policies, establishment of manufacturing bases, and deployment of electric mobility products for private and public transport. With a high share of renewable energy from sources such as solar, geothermal energy or wind, it is a great case study for a green electrification of vehicles and fleets. Acting as an early adopter, Kenya could offer guidance to other countries in the region and spearhead the development of a better transport sector.

5. SUMMARY

This report outlines regulatory issues related to rural electrification, EVs and EV charging stations in Africa. Combining the strengths of a general framework for analysis with context-specific information, we paint a holistic picture of the many different facets that produce the regulatory environment that relevant stakeholders operate in – ranging from regulatory authorities over private operators and investors to customers and the local community. Building on a review of the available literature and regulations as well as the expert knowledge of consortium partners, allows for a differentiated view on both common issues and specific local challenges along the life-cycle of energy projects.

The results highlight the importance of a clear and reliable policy environment, outlining the general direction of transition. For off-grid systems, this includes the alignment of electrification efforts and security for private operators. For the deployment of EVs and the associated charging infrastructure, a clear distribution of roles and responsibilities is key. In both cases, targeted support measures for the costly set-up and operation of off-grid systems and charging infrastructure are an important foundation for the economic viability of early-stage projects. Processes related to application procedures, licences and support schemes should be uniform, transparent, and efficient to ensure fairness and low transaction costs for both regulatory authorities and the private and public entities active in electrification efforts and the mobility transition. Often, regulatory intentions and the reality on the ground differ, and regulations and financial support should thus be implemented timely and consistently.

Applying these general topics to the local contexts, it can be concluded that the governments of Kenya, Madagascar and Sierra Leone have made important steps in support of electrification and e-mobility. Still, developing the regulatory frameworks further would support the ongoing efforts of relevant stakeholders and contribute to energy access, cleaner transport, and economic development. As of its transferable methodology and flowchart, this report can inform further analysis and discussion of regulatory measures in African countries and beyond and contribute to the exchange of know-how and best practices.

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