A Renewable Energy Mini-Grid Technical Assistance Guide

Take-aways from 15 years of GIZ support in mini-grid market development

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List of Abbreviations

ABC	Anchor, Business, Community
BOOT	Building, owning, operating, transferring
CAPEX	Capital Expenditure
EnDev	Energising Development
EPC	Engineering, Procurement, Construction
ESCO	Energy Service Company
ESMAP	Energy Sector Management Assistance Program
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH
KfW	Kreditanstalt für Wiederaufbau
MDA	Ministries, Departments, Agencies
MG	Mini-Grid
O&M	Operation & Maintenance
OPEX	Operating Expenditure
PPP	Public Private Partnership
PU	Productive Use
REA	Rural Electrification Agency
RBF	Results Based Financing
SEFA	Sustainable Energy Fund for Africa
TA	Technical Assistance
UNIDO	United Nations Industrial Development Organization

Executive Summary – Mini-grid technical assistance recommendations in a nutshell

Over the last 15 years, Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) has trialed, adjusted and refined approaches to providing technical assistance (TA) to governments interested in rural electrification with mini-grids. This report uses the wealth of experience gathered by various GIZ mini-grid programs and derives some essential lessons leading the way towards a new understanding of the role and aim of mini-grid TA.

Successful mini-grid TA overcomes the dilemma of expectations between governments and mini-grid companies. Governments typically want to see successful pilots readily deployed in their own country, plus potential financing for large-scale mini-grid roll-outs lined up before they take the effort of adjusting the policy and regulatory framework. In contrast, private mini-grid companies want to see an enabling policy framework in place before they start investing. The TA provider brings the "loose ends" together through the promotion of successful mini-grid pilots, rural electrification and energy access planning, the development of mini-grid regulation in cooperation with the government, capacity building with the public sector as well as the private sector, the development of country specific tender mechanisms, the acquisition of funding for large-scale mini-grid roll-out and the promotion of productive use of electricity and new business model development. GIZ project managers report that **embedding a mini-grid expert into the government partner's organization** has facilitated communication and capacity building, while various units and external experts address the many aspects of project preparation and implementation. On the **private sector's side, hands-on support for pilot implementation** (system design, financial modelling, capital acquisition, etc.) is usually more welcome than theoretical training sessions. The TA provider's main challenge is to coordinate all relevant stakeholders including Ministries, Departments and Agencies (MDA), parliament, private sector, academia and civil society, towards **finding a national consensus on the degree of government funding channeled into mini-grids vs. mini-grid tariffs charged to electricity customers and institutionalizing implementation instruments.** While a complete national consensus is usually impossible to achieve, getting as close as possible to this national consensus requires comprehensive coordination efforts, as well as the use of technically clear language in explaining state-of-the-art delivery models and regulatory concepts. Usually, the delivery model and related regulatory concept selected for implementation is also a direct derivative of the discussion on the national consensus level. "The devil is in the detail", and this is where GIZ's long-term on-site presence, intercultural competence, institutional relations and long-term mini-grid TA experience has proved to play out especially well.

Mini-grid TA providers must understand that they have succeeded once the mini-grid market thrives without them and their service is no longer required. This can be achieved best through thorough front-to-end planning, whereby **the endgame of mini-grid TA is the hand-over of all market coordination tasks** to a group of organizations managing the large-scale roll-out of mini-grids. These are usually **government entities in cooperation with a development bank.** In the past, this hand-over has often not worked as fluently as possible. In some cases, TA provider and development bank have found each other in competition for the same government staff resources in the implementation of projects on both ends. In other cases, development banks find frameworks have been developed in a manner unsuitable for large-scale investment, ignoring the fact that TA without the lever of large-scale financing which only development banks bring along, makes governments much less motivated to adapt and thus success is much harder to achieve.

When mini-grid TA providers are aware of development banks' conditions to start a mini-grid roll-out program and financiers give a clear indication to the government that once these frameworks are in place, access to large-scale finance shall be available, both conflicts above can be resolved. In this manner, mini-grid TA providers have a clear aim to work towards, and development banks find perfect starting conditions once they enter the mini-grid space in a country. It is critical for the health of a renewable energy market that primary stakeholders are aligned, sending one clear message to the private sector, and for this, intense cooperation between government, TA providers and development banks is necessary.

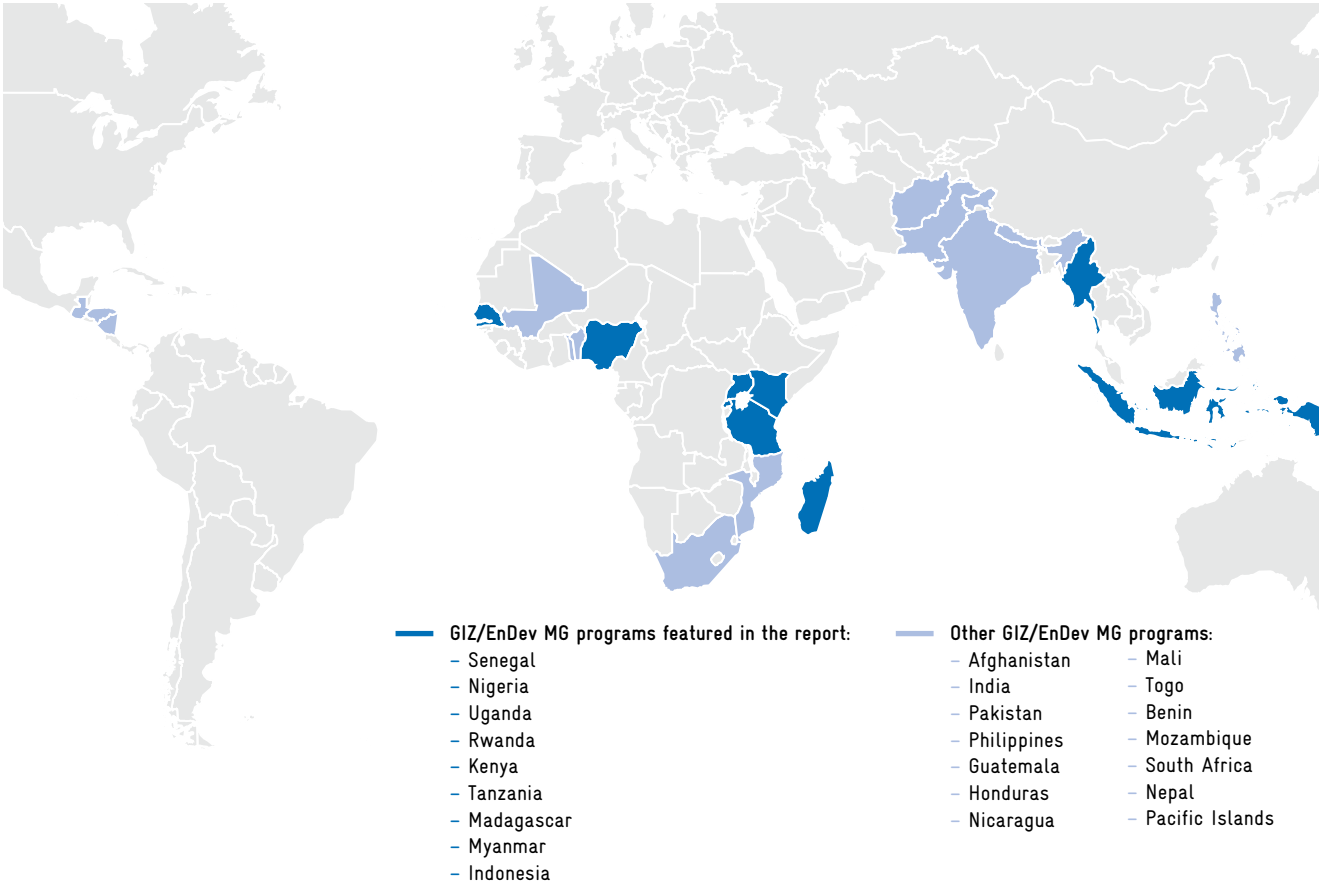

Photo: GIZ Kenya / Alex Kamweru

The most fundamental condition for a mini-grid roll-out is the financial sustainability of mini-grids. Innovations improving the financial sustainability of mini-grids are evolving with support from mini-grid TA. So-called Fourth Generation business models use mini-grids as a starting point to generate additional revenues beyond electricity sales to village customers. While larger financing windows are coming online in an effort to accelerate off-grid electrification, **mini-grid TA is now tasked to identify and implement Fourth Generation mini-grid business models in cooperation with mini-grid operators**. In addition, new methods of electricity demand projection based on household Average Revenue Per Customer evaluations will probably soon help reduce the highest risk for profitability in mini-grids, the demand or volume risk. If TA can also overcome the mistrust between private sector and governments, leading to the private sector not embracing regulation, the basis for a successful and flourishing mini-grid sector is set.

SECTION 1

Introduction

FIGURE 1. Map of GIZ and EnDev mini-grid programs



For more than four decades, the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH has worked with the governments of more than 40 countries in Africa, Asia and Latin America on providing access to electricity in their rural areas. When developing mini-grids, GIZ works in a practical, outcome-oriented way on the global, regional, national and local level. It provides technical assistance (TA) to regional organizations and governments of partner countries, as well as hands-on support to local institutions, communities and the private sector. Over the past 15 years, GIZ mini-grid programs have supported many countries in developing mini-grid policy and regulatory frameworks and directly or indirectly contributed to the implementation of more than 1000 mini-grids (GIZ, 2007).

GIZ aims to continue its TA services and thus support the expansion of mini-grids globally. Through the contribution of GIZ, it is expected that the number of mini-grids in countries where GIZ is active will show a threefold increase from 2020 to 2025 (See **Figure 4**).

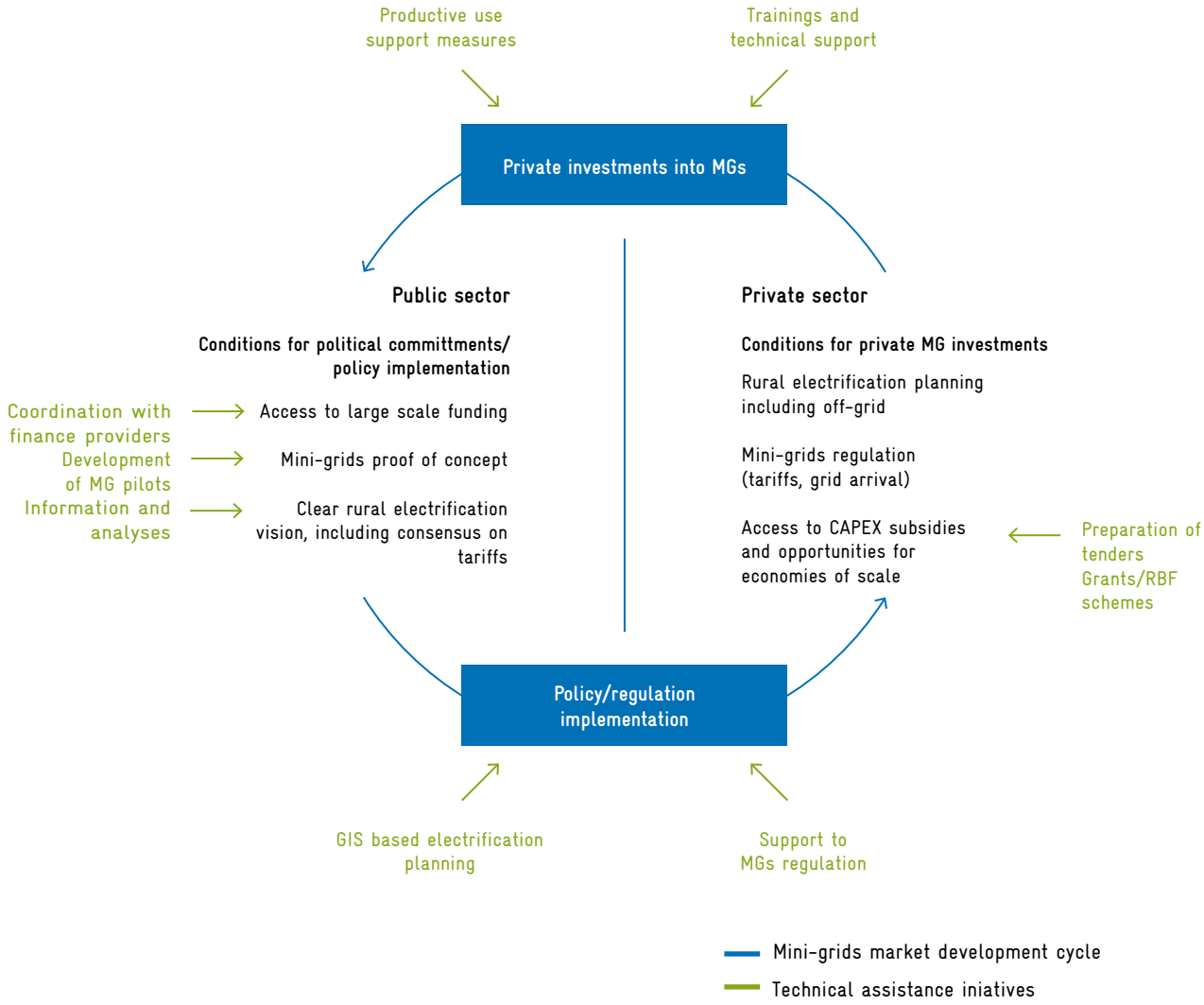
This report shall serve as a mini-grid technical assistance handbook, benefiting from GIZ's outstanding experience, which can be used by other actors in the sector. It is a written accompaniment to the work conducted by GET. transform which supports mini-grid project implementers with advice, tools and knowledge on how to build conducive frameworks. In order to serve its purpose, this report draws conclusions from interviews conducted with leading GIZ and EnDev representatives of mini-grid programs in various countries and related institutions. The interviews were structured along the main question: What sort of TA is required to kick start a mini-grid market and what can be learned from past successes and mistakes to improve future TA programs?

In addition to the interviews with GIZ program managers, several interviews were conducted with representatives from other relevant actors in the mini-grids space, such as the World Bank ESMAP program, the African Development Bank SEFA program, KfW and UNIDO. Building on these conversations, the next sections of the report provide an explanation around how mini-grid markets develop (Section 2) and then integrate such explanation and the lessons learned from the interviews into a mini-grid TA handbook (Section 3 and 4).

SECTION 2

Driving mini-grid market development through technical assistance

FIGURE 2. TA enables the cycle of market development through various specific actions (green arrows) to attract private investments into mini-grids.



The latest developments in the mini-grids sector are rather encouraging. Mini-grids are beginning to receive support by governments in some countries, while private companies build expertise in mini-grid operation and get ready to invest in mini-grids on a larger scale. However, there are still widespread challenges and barriers that need to be overcome. Most notably, private sector requires mini-grid supportive policies and regulations, while the public sector requires private investment and expertise into the mini-grid market, to be convinced that mini-grids are a real solution for rural electrification, and that the effort of changing the framework pays off politically.

At this stage, professional TA is essential to identify and elaborate on strategies to overcome these barriers. Through a broad portfolio of supporting actions, TA builds bridges between the public and private sector and therefore enables sustainable mini-grid market development. **Figure 2** illustrates the cycle of market development, as well as specific actions to align public and private sector's interests and conditions. Mini-grid TA helps overcome barriers between government and private sector step by step and accelerates the virtuous cycle of enabling framework establishment and increasing investment into the sector.

A professional and successful TA provider functions as an implementer, a facilitator, and an advisor to ensure the coordination of interests between various stakeholders. TA interventions are required to intensify promotion of mini-grid markets by strengthening the opportunities and mitigating the risks. TA coordinates the whole market development cycle and supports during each individual step. TA brings mini-grid market development to the attention of investors in order to secure financing for a large-scale mini-grid roll-out through efficient coordination with respective financial institutions. Additionally, TA defines a clear space for mini-grids by demonstrating commercial and technical viability to the government through pilot projects.

On the private sector side, TA simplifies grant schemes and accelerates the allocation of funding. Moreover, TA can offer support to the private sector by providing trainings, developing feasibility studies for candidate mini-grids, as well as providing cutting-edge (Fourth Generation Mini-Grids) business models to increase the financial viability and sustainability of mini-grid projects.

Consequently, successful TA streamlines coordination and enables cooperation between private and public sector, by effectively implementing the actions above and thus accelerating an efficient mini-grid roll-out. **TA functions as the key link between private and public sector to ensure sustainable success of mini-grid roll-out programs**. GIZ offers the entire portfolio of instruments required to successfully provide TA, based on long-term experience and qualified experts.

2.1 Mini-grid market development results

Based on GIZ expert interviews, the degree of market development was assessed in the nine countries investigated in this report. The following table presents an overview of where those countries stand in a number of relevant areas.

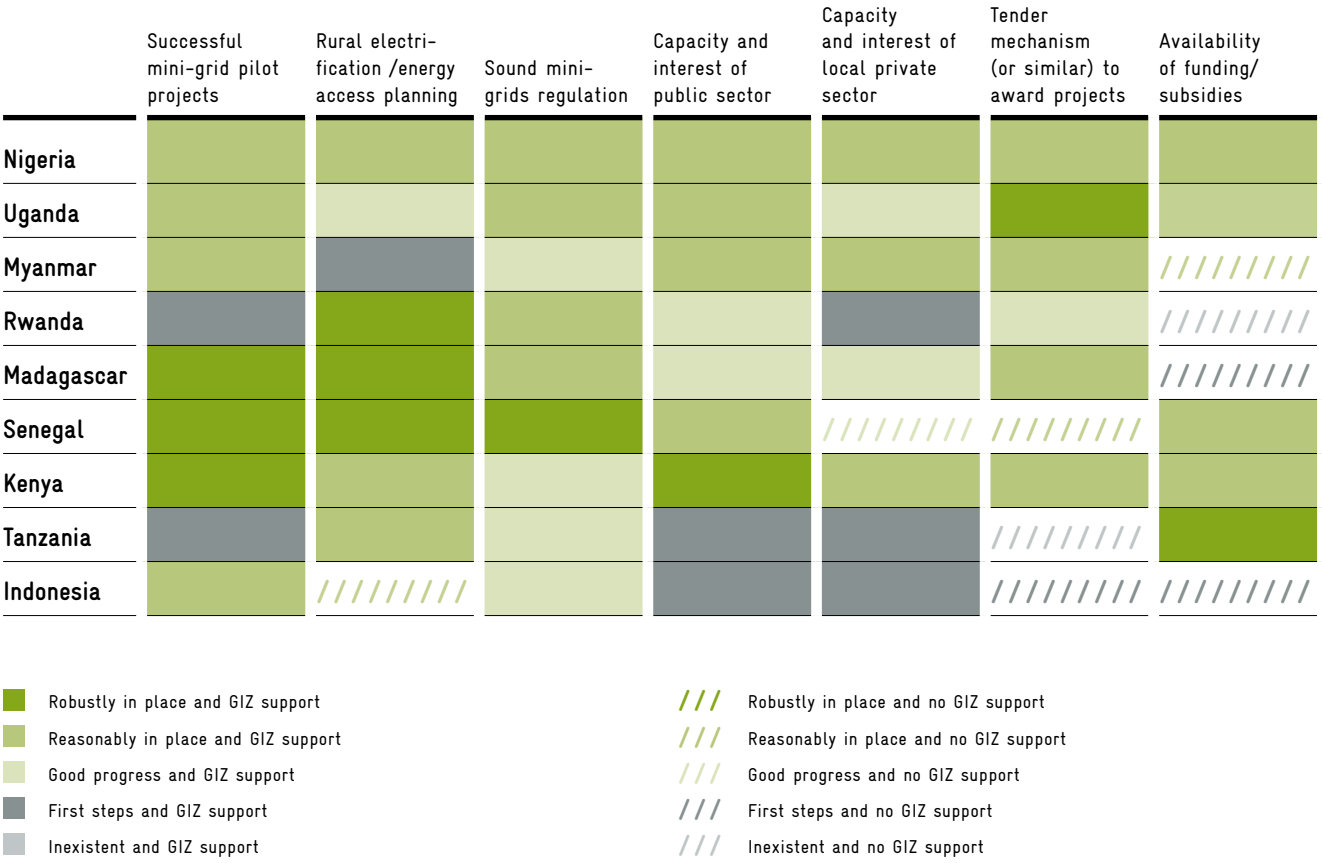
Countries like Nigeria, Uganda and Myanmar seem to be leading market development efforts and are successfully attracting mini-grid investments[1]. All of them have managed to secure the required policy and regulatory framework, have committed public and private sectors, have defined call for proposals/ tender mechanisms to award projects, including grants, and have access to large-scale funds. Nigeria and Myanmar are successful examples of cooperation between GIZ, who has been providing on the ground TA on many areas, and World Bank, who is financing the scale-up of the sector. In Uganda, a similar collaboration can be witnessed between GIZ and KfW.

As a second group, Madagascar and Rwanda have successfully managed to implement the right framework conditions, but are still a bit behind in terms of rolling-out mini-grids, mostly due to lack of large-scale funding. These examples underscore the opportunity for GIZ to work on more challenging, less developed markets (and less donor-crowded geographies) to begin setting up the framework for a mini-grid market. At the same time they call for a better coordination with financing partners early in the programs, to facilitate a smooth transition from the so-called 'framework development phase' to the roll-out era.

Finally, there is a third group of countries, including Indonesia, Kenya and Senegal, where mini-grids are being

1 While India can also be considered a leading market, here the private sector drove the proliferation of mini-grids despite a lack of enabling environment, partly even against existing legal rules.

FIGURE 3. Mini-grid market assessment in selected countries



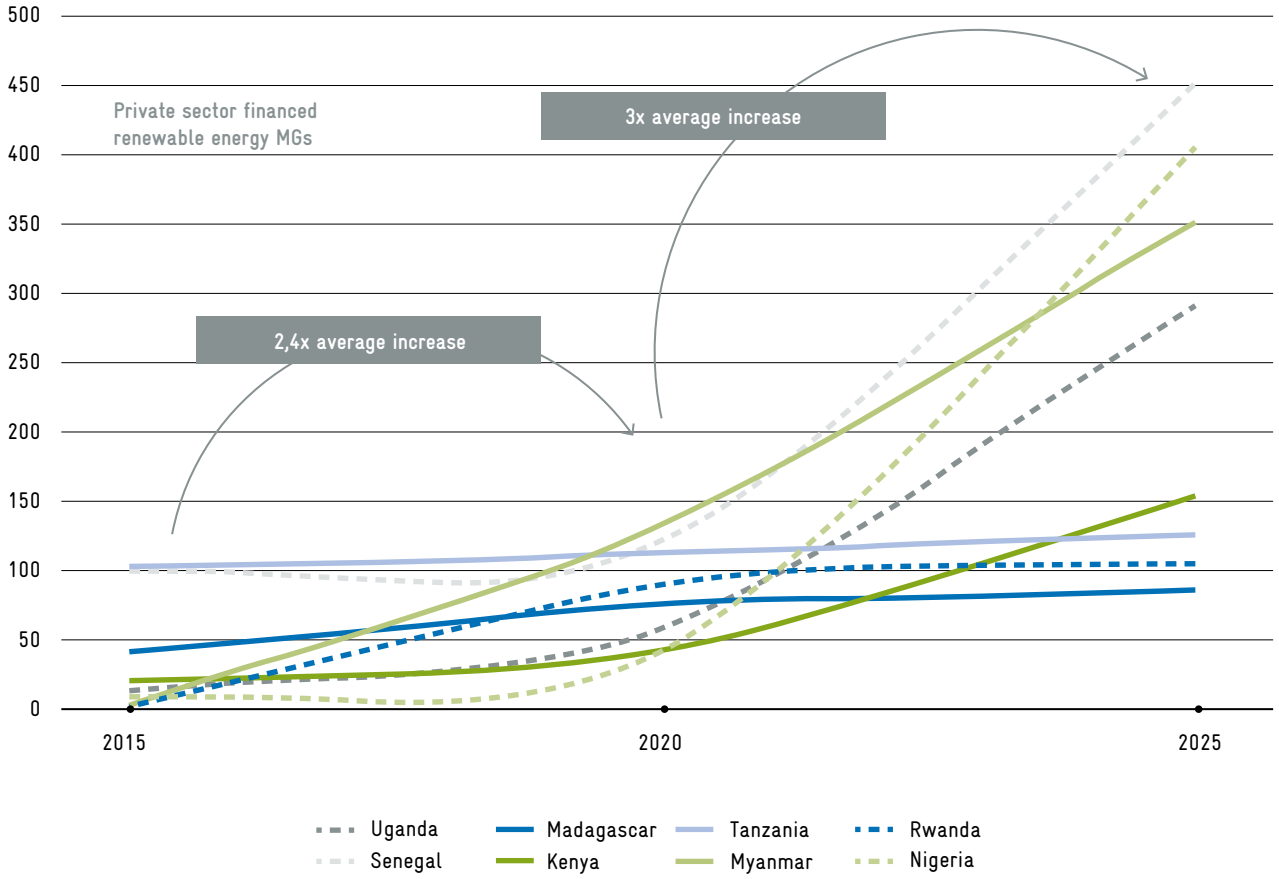
developed by privileging a public sector, heavily subsidized approach, driven by a call for national uniform tariffs including mini-grids, making private sector models less viable. In the case of Kenya, this shift of government priorities towards public sector mini-grids happened while GIZ was already implementing private sector focused TA programs, highlighting the need for coordination (as well as for flexibility in case of sudden changes). Also in Tanzania a similar shift can currently be observed. In these countries, market development efforts have been affected by high-level political changes and/or decisions, making a private sector approach to mini-grids less viable. In Senegal, GIZ partly changed its approach towards the new government direction and could provide valuable support to the success of the government-led mini-grid implementation scheme.

Figure 4 presents the evolution of private sector financed[2], renewable energy mini-grids in the countries included in this report. As seen, over the past five years (2015–2020) mini-grid numbers have more than doubled in our sample countries, from a total of 270 in 2015 to a total of 658 in 2020.

When it comes to the expected evolution for the next five years, the number of mini-grids is again expected to grow up to around 2000 mini-grids in 2025. Future mini-grids have been included only if funding for the corresponding subsidies has already been approved. This means that the actual number of mini-grids might actually increase considerably if donors decide to provide additional financing in the coming years.

2 Mini-grids where at least a fraction of the initial investment has been provided by the private sector, see **figure 8** in page 20 for an overview of typical private sector investment fractions in these countries.

FIGURE 4. Mini-grids market assessment in selected countries



SECTION 3

Structured mini-grid technical assistance

Photo: Rachel Mabala

This section builds on lessons learned by GIZ and EnDev mini-grid programs. It is intended to provide guidance for mini-grid TA design and implementation. While specific country-level differences always require specific attention and flexibility, this chapter seeks to capture the main ingredients of mini-grid TA (whether developed by GIZ or other actors) that need to be in place in all cases in order to implement successful programs.

Generally, the approach of technical assistance conducted by GIZ can be categorized into three major areas:

1) **Defining the strategy**

   b) Identify a clear need/space for mini-grids

   c) Develop a shared vision for mini-grid electrification

   d) Define private sector responsibilities and business models

2) **Front-to-end planning of technical assistance interventions: roles, processes and instruments**

   a) Plan for scale from the beginning

   b) Coordinate and align work across all relevant areas

   c) Create consensus on subsidy levels vs. tariff levels as a prerequisite for mini-grid roll-outs

   d) Paying attention to productive use and Fourth Generation Mini-grid business models

3) **Stakeholder support and coordination**

   a) Establishing a trust relationship

   b) Building capacity and developing processes in government institutions

   c) Building capacity in and for the private sector

This fundamental structure is the basic framework of a professional mini-grid TA. It requires a long-term presence in-country, close working relationships with government institutions, and a range of development cooperation instruments including diplomacy, financing, project staff and consultants. In the following section, the individual steps of such mini-grid TA are examined in detail and the key factors for success are highlighted.

3.1 Defining the strategy

3.1.1 Identify a clear need/space for mini-grids

Mini-grids are not a one-size-fits-all solution but rather a compromise between grid extension and individual stand-alone systems, which is only optimal if certain conditions are met (e.g. population distribution, ability to pay, potential for productive activities, etc.). While previous studies have estimated a total share of 30% for mini-grids (Africa Energy Outlook, 2019), this percentage differs strongly from one country to another. This is why robust energy access policies and planning is required (or needs to be developed) in order to assess the potential of mini-grids in a given country.

Based on previous GIZ experiences, such assessment of mini-grid feasibility and market size should not only be based on geo-spatial planning and/or techno-economic optimization tools, but rather consider these analyses as inputs for additional discussions with governments, local communities and prospective developers. This should then provide a more realistic picture of the existing potential and appetite for mini-grids. Mini-grid TA cannot be successful without the total backing of the government, and thus it is indispensable to develop a shared vision for mini-grid electrification with full support of all stakeholders.

If this previous step is omitted, there is a significant risk that complex and costly mini-grid TA programs will only have a minor impact due to the lack of opportunities for scaling up, something which will also negatively affect the reputation of the sector and of TA providers in other locations.

3.1.2 Develop a shared vision for mini-grid electrification

Before a program can be implemented, a consensus between the donor and the beneficiary government is required. The way this collaboration is structured strongly influences the success of the TA program. This activity is not specific to mini-grid related programs but is required for any type of development cooperation.

It is unavoidable for the success of mini-grid frameworks to reach a **national consensus about tariffs and level of grants**. Besides the ministries, the parliament must be onboard on the desired level of tariffs and grants, as communities tend to revert to Members of Parliament when things are amiss on the ground. The TA assists as a facilitator to find this consensus between all stakeholders and accelerate the procedure. Following aspects require attention by the TA to streamline the consensus-building process:

1) Involvement of all MDAs related to mini-grid projects. These typically are Ministry of Energy, Ministry of Environment, Public Private Partnership Authority, Rural Electrification Authority, Electricity Regulator, Ministry of Lands, Ministry of Finance, Planning Commission, Ministry of Works, Authority for Health and Safety, Ministry of Education, etc.

2) Important aspects requiring consent of the parties mentioned above:

   a) Tariff levels to be charged to customers in mini-grids;

   b) Grant provision to the mini-grid sector (level and amount);

   c) The degree of private vs. public sector lead in mini-grid roll-outs.

3) The provision of TA can only be successful if two components are incorporated into the approach:

   a) Pilot projects showcase effectiveness of mini-grids under the unique national constraints and the framework established;

b) Larger grant funds will be provided as per agreement if certain precedent conditions are met (e.g. regulation with certain protection for investments). Grant funds to the mini-grid sector can be provided in terms of sovereign debt to the government. Governments are usually only motivated to debate a certain subject if tangible results with effects in a certain magnitude follow their decision. This is not the case if large-scale funding is not in sight when mini-grid TA starts. In addition to this, governments usually require a proof of concept before deciding for a roll-out of a new approach.

3.1.3 Define private sector responsibilities and business models

Countries vary in political orientation regarding mini-grid roll-outs. Some believe strongly in the efficiency and innovation of private sector for optimal service delivery and prepare a framework that attracts private sector investments, others prefer being in control especially regarding mini-grid tariffs and thus follow a government-driven implementation strategy.

The roll-out strategy chosen by the respective government has influence on various key factors. The interaction between business models, government funding level, tariff level and corresponding policy for government-driven vs. private sector-driven mini-grids is shown in **Figure 5**.

Public-private partnership delivery models maximizing synergies between government and private sector can be structured into four categories.

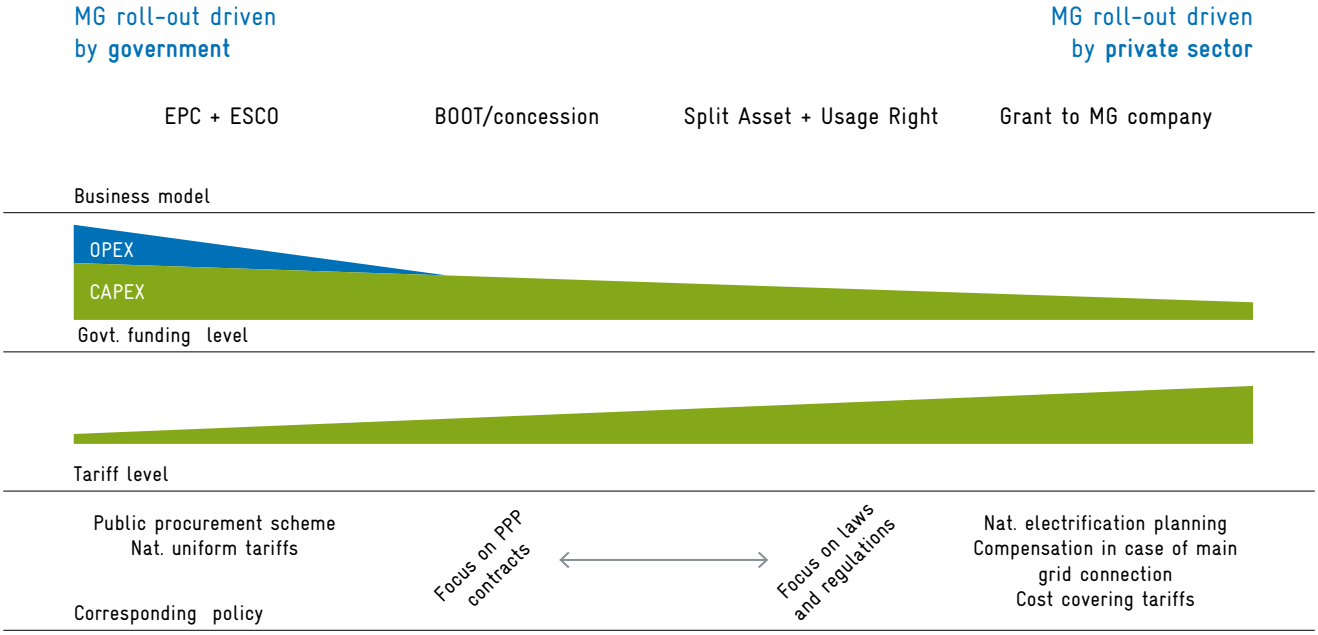
— **EPC + ESCO model**: Mini-grid is funded, owned and operated by the government through a local energy service company (ESCO).

— **BOOT/concession**: A private company is building, owning and/or operating the mini-grid, before transferring it, e.g. to the national utility.

— **Split asset + usage rights**: A grant is used to build the distribution grid, which is then leased to the developer. The developer finances, owns and operates the generation.

— **Grant to mini-grid companies**: The private developer receives a grant. The developer is fully responsible of building and operating the mini-grids.

FIGURE 5. Business models, government funding level, tariff level and corresponding policy for government-driven vs. private sector-driven mini-grids



Following the figure from left to right, the government funding level is declining as private sector participation increases. This applies for CAPEX, as well for OPEX. However, OPEX is fully covered by private enterprises in the split asset and grant model, as the government is not responsible for any generation assets or the operation of the mini-grid. Attracting private sector investment could thus be of interest to governments, as the level of funding is falling significantly. However, the degree of control over the mini-grid market declines proportionally. It is therefore a trade-off between control and level of financing.

The tariff level runs contrary to the level of funding by the government; it increases as the private sector involvement/ investment increases, allowing the investor to recoup greater private financing. The applied tariffs are consequently the highest in a fully privately owned and the lowest in a state-owned mini-grid. Regulation of electricity tariffs under the respective constraints, minimizing financial burdens for electricity customers while allowing for adequate profits of private investors and operators, applies to each of the cases mentioned above. Both policy and regulation documents must be drafted accordingly. The requirements of corresponding policies also evolve depending on the degree of influence of various stakeholders. In a government-driven mini-grid roll-out, rules and guidelines of a public procurement system, and usually national uniform tariffs, need to be developed. Further, the development of public-private partnership models (e.g. BOOT or EPC + ESCO) is a crucial factor. In contrast, with the increasing influence of the private sector on the mini-grid roll-out, laws and regulations are at the center of policy development. Laws and regulations are crucial to have in place to enable later scaling of the mini-grid roll-out. In addition, the increasing privatization of the mini-grid sector poses challenges, which must be in focus from the outset. Tariff regulations must be in place for the mini-grid roll-out and solutions must be drawn up in case a mini-grid site is connected to the main grid (e.g. compensation for the private companies).

Summarizing, the privatization of the mini-grid sector has benefits and drawbacks for the respective governments. Nevertheless, regulations and policies have to be in place to provide security for the much needed investments into off-grid electrification. Further, responsibilities of the private sector and the applied business model must be defined in detail to ensure a successful mini-grid roll-out.

3.2 Front-to-end planning of technical assistance interventions: roles, processes and instruments

3.2.1 Plan for scale from the beginning

The interviews with GIZ mini-grid programs show that those programs that conduct front-to-end planning are most successful. This means that any program should consider not only the market preparation phase, but also the scaling phase right from the beginning. Governments will more likely make a serious effort to adjust the policy framework if a positive large-scale macro-economic effect is within reach. This means that e.g. large-scale public funding for the roll-out must be available under the condition of a conducive policy framework being in place. Here are some examples:

1) In Madagascar, the government proceeded to the implementation of mini-grids without access to public funding for the roll-out. This led to a situation where the framework is already in place but no roll-out is happening. Private sector is becoming increasingly disappointed about this stop-and-go strategy.

2) In Nigeria, the GIZ Nigerian Energy Support Program provided TA to the Nigerian government implementing the framework for an open mini-grid market. Based on this framework, the World Bank came into a position to provide a loan to the government that the latter hands out as grants to private mini-grid developers.

3) In Uganda, GIZ supported the government to implement a conducive policy framework for mini-grids. Now, the German Climate Technology Initiative together with KfW and others consider the framework to be on track for mini-grid roll-outs and are preparing related funding programs in parallel to finalizing regulatory changes. KfW complains that the TA has not been fully effective in some respects. However, if full implementation of a detailed mini-grid framework under GIZ TA had been made a condition for larger scale KfW funding right from the beginning, the government would have been more committed to making the required changes in the policy framework. Though the GIZ mini-grid TA was structured along the KfW funding guidelines right from the beginning, without a direct link between TA and large-scale funding, government's motivation to take required decisions was limited and results of the GIZ mini-grid TA were not as satisfactory as they could have been.

FIGURE 6. Mini-grid market development cycle and scaling phase

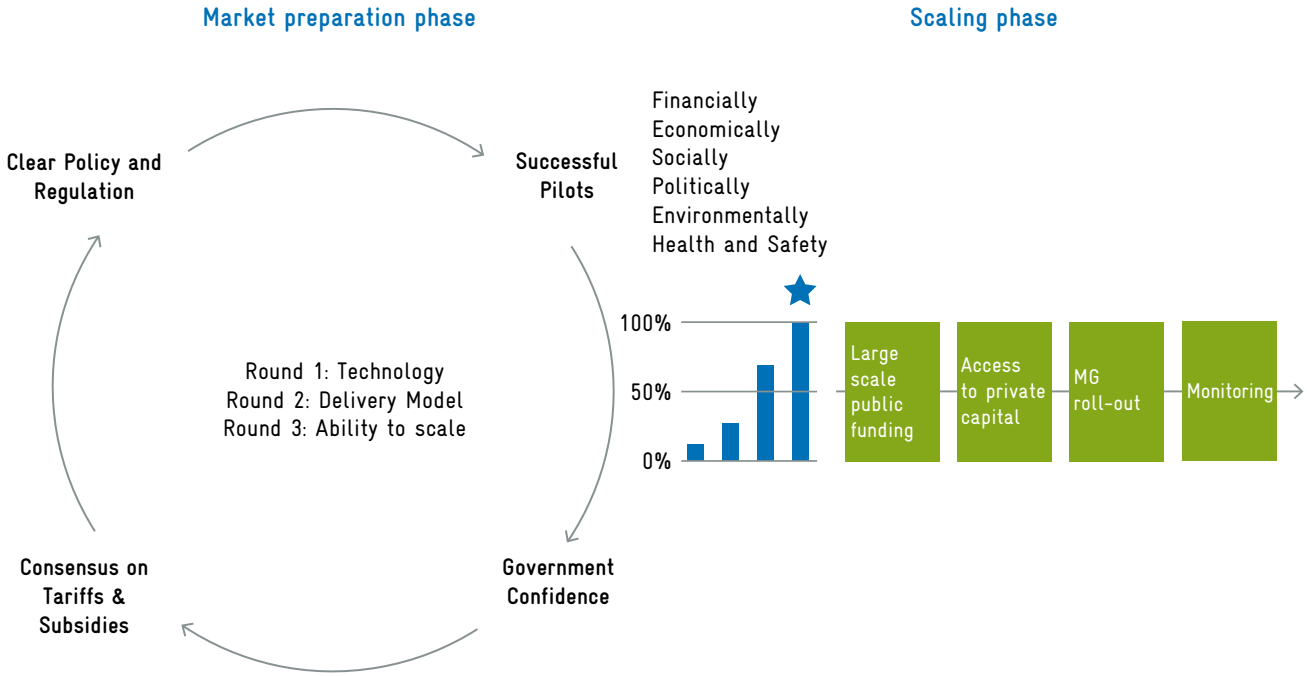


Figure 6 highlights the structure of a successful approach of front-to-end planning of TA interventions. It is divided into two categories: the market preparation phase and the scaling phase. As already mentioned above, the scaling phase must be in consideration right from the outset to ensure the success of the roll-out.

The four key steps of the market development cycle shown in the figure (Successful Pilots; Government Confidence; Consensus on Tariffs & Subsidies; Clear Policy & Regulation) define the degree of success of the market preparation phase. In each round of the market preparation phase (Technology, Delivery model and Ability to scale), the entire cycle of the four core steps shall be applied before the market is ready to scale. The TA shall provide its entire action portfolio to ensure efficiency of the market preparation phase. The scaling phase can only start after successful implementation of these steps. During the market preparation phase, striking the right balance between pilot projects and more macro level interventions, provides significant benefits. Pilot projects can be used to visualize the benefits of mini-grids and can also serve as a testbed for policy/regulatory/financing intervention. Further, the relationship and trust between the TA and the government is crucial. The success of the mini-grid program is determined by the degree of government confidence of the mini-grid potential and the roll-out strategy.

The effectiveness of the mini-grid program also depends on the tariff and subsidy level. An inciting environment for investors, as well as private developers shall be created. Mini-grid development requires a clear policy vision towards rural electrification and a stable, long-term planning approach. Finally, policies and regulations must be in place before starting the scaling phase.

The Ugandan example shows how powerful the consideration of the scaling phase during the TA phase can be. Early coordination of the TA provider with financing institutions may streamline processes and provide extra motivation to the government.[3]

3 Interview with Moses Kakooza, GIZ, MG Project Coordinator within GIZ Energy Program, Uganda, 23.09.19

Another positive example is the mini-grid roll-out program in Myanmar. GIZ is partnering with the World Bank to ensure a smooth and efficient mini-grid roll-out. The World Bank offers loans – debt financing – to the government with a focus on strengthening developers' capacities, while GIZ supports the government call for proposals (e.g. technical requirements for villages).[4]

On the other hand, Madagascar serves as an example of how a mini-grid roll-out is hindered by lack of funding. Initially, the national electrification fund was meant to take up the funding for scaling (fixed payment through cross subsidy from urban users to rural through up to 70% CAPEX subsidies). The fund, however, failed due to a lack of payment to the fund (used to cover utility losses instead, among others). GIZ advised the government on a new financing mechanism, culminating in the creation of a local development bank supporting renewable energy developers in new projects. However, the approach with the independent financing institution could have been over-ambitious, as the establishment of a local development bank is a time-intensive procedure. The delay in implementation, as well as the absence of interim solutions is delaying the whole mini-grid sector in Madagascar. The recommendation resulting from the mentioned problems is to secure financing for roll-outs in the first place, before tendering out the project. It is thus imperative to consider the scaling from the beginning of each mini-grid roll-out.[5]

The examples above demonstrate the importance of front-to-end planning. For the success of the entire mini-grid program, it is indispensable that the TA offers the full cycle of what is required to implement a mini-grid project effectively. The following section presents a portfolio of services for a successful mini-grid TA.

3.2.2 Coordinate and align work across all relevant areas

According to historic development and adapting to lessons learnt, GIZ has developed a number of specialized services. The following paragraphs describe the main services provided by GIZ in the mini-grids space:

1) **Mini-grid pilot projects**: GIZ has a solid background of developing mini-grid pilot projects in many different locations, with varying degrees of participation of other actors, both public and private. The main benefit of such pilot projects is to actually prove that mini-grids are sustainable both from technical and commercial perspectives, and to increase government attention towards the sector and its support for required policy and regulation changes.

2) **Regulation, policy and public sector support**: successful implementation of mini-grids typically requires strong attention to policy and regulatory aspects. Among others, these include identifying suitable areas for mini-grids, defining the available business models and the degree of public sector participation and setting tariff and service quality regulations. GIZ has substantial experience working with governments in the development of such instruments, as well as more broadly strengthening governments and local institutions through capacity development activities and long-term presence and relationships with institutions.

3) **Private sector support**: another important area of work for GIZ in the mini-grid space is the support of (local) mini-grid operators. The existence of a strong management and O&M model in a mini-grid is usually considered a key prerequisite to achieve sustainable operation over time, requiring specific capabilities, from technical and commercial operation to financial management.

4) **Financing**: access to equity and debt financing, as well as provision of grant funding schemes is currently required for mini-grid projects. In order to tackle this barrier, GIZ has experimented with a range of specific approaches, such as involving the local banking sector, providing Results Based Financing (RBF) or working with communities and local institutions in implementing co-financing mechanisms.

5) **Identification of and training on Fourth Generation mini-grid business models**: This new sector of mini-grid TA focusses on the development of business models which use the mini-grid as a tool to access markets beyond electricity sales to village customers. Examples can be agricultural hubs, KeyMaker Models, Anchor, Business, Community (ABC) models or Multi Utility Models. GIZ Nigeria with its NESP program is currently promoting a set of

4 Interview with Patrick Pawletko, GIZ, Advisor Promotion of Rural Electrification (RELEC), Myanmar, 13.09.19
5 Interview with Monika Rammelt, GIZ, Head of Energy program, Madagascar, 13.09.19

KeyMaker Models to show that mini-grids can become profitable investment opportunities. Further information on Fourth Generation mini-grid business models can be found in chapter 3.2.4.

3.2.3 Create consensus on subsidy levels vs. tariff levels as a prerequisite for mini-grid roll-outs

Mini-grid development requires a clear policy vision towards rural electrification and a stable, long-term planning approach. The pace of the mini-grid roll-out is highly dependent on the level of subsidy provided by the respective government, as well as the applied tariff level. When embarking on the mini-grid agenda, it is important to be conscious of a number of trade-offs for strategic, policy and regulatory decision making.

Figure 7 illustrates the correlation between the subsidy and tariff level, as well as the impact on the velocity of mini-grid roll-outs. It also indicates the status-quo of the respective countries.

The pace of implementation increases with rising subsidy and tariff level. However, a willingness to pay threshold must be observed. Thus, subsidies are still required to ensure the financial viability of mini-grid projects, as unsubsidized (cost reflective) tariffs would be higher than willingness to pay of customers in rural areas; the same is of course true for grid power, which receives significant tax funding when the necessary infrastructure is considered. All projects interviewed report CAPEX subsidy needs between 50% and 80%, as well as a trade-off between subsidies and end-user tariffs.

FIGURE 7. The speed of mini-grid roll-outs is strongly influenced by the subsidy level provided to the sector and the tariff level charged to the electricity customers

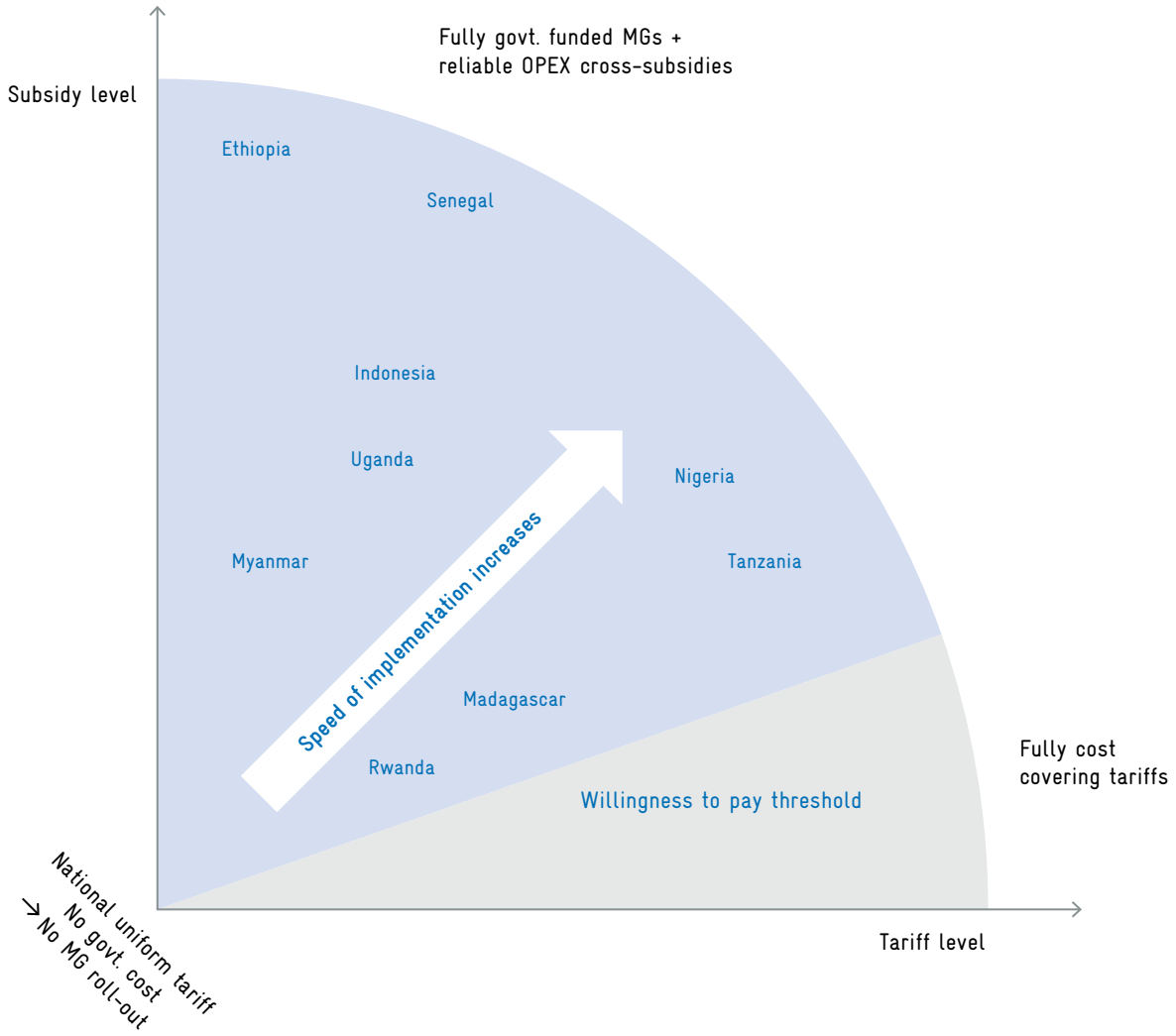


FIGURE 8. Tariff and subsidy levels in different countries

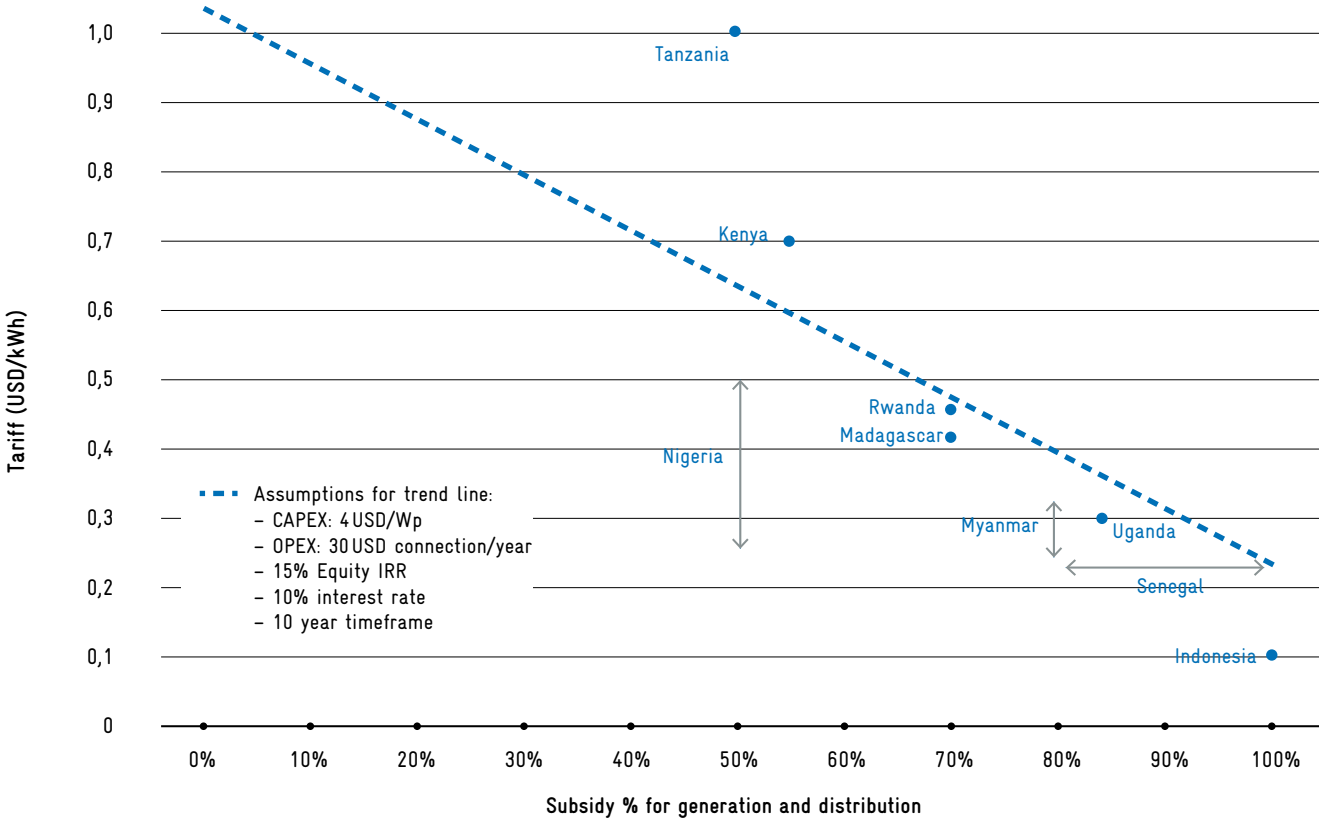


Figure 8 presents the average subsidy levels for renewable energy mini-grids in different countries, as well as the corresponding average tariffs being charged. The subsidy percentage is related to the total CAPEX costs, including generation and distribution assets. In some countries, two-sided arrows indicate that there is currently a range of values for either subsidies or tariffs, rather than a single data point.

According to the latest experiments and investigations on electricity price elasticity in mini-grids carried out by Cross-boundary and Energy4Impact (2019), the three village based customer groups react to electricity price changes in different manners.

Households seem to have a fixed weekly budget for electricity expenditure which in many African countries is between 1 and 2 USD on average. Below the saturation limit, any household would therefore consume as much electricity as it can while staying within budget. This means that, within certain limits, changing a tariff does not affect the total revenue generated from this customer group at all. Instead, the amount of electricity to be delivered to the customers changes. It goes up with decreasing tariffs, resulting in larger power station capacity requirements and thus higher CAPEX.

Productive users, like mills, wood or metal workshops consume as much electricity as required to serve their customers (process the flour, wood or metal product). They use electricity as long as it is cheaper than any alternative energy supply option, like diesel motors. Therefore, with a decreasing electricity tariff, the amount of electricity sold stays constant and the revenue generated with this customer group decreases.

Commercial users can be expected to have a behavior somewhere in between households and productive users.

Once verified scientifically, this understanding of price elasticity in mini-grids may change the mini-grid grant funding approaches in some countries considerably. This would be the

case in villages with many household customers as a certain PPP and grant funding structure may allow significantly lower tariffs that still cover the micro utility's O&M cost. It may also change the approach that regulators use to set mini-grid tariffs. Thus, **Figure 7** and **Figure 8** may change accordingly in the future.

However, various subsidy models are possible to enable the mini-grid roll-out. The following table describes three different subsidy models, presenting respective advantages and drawbacks:

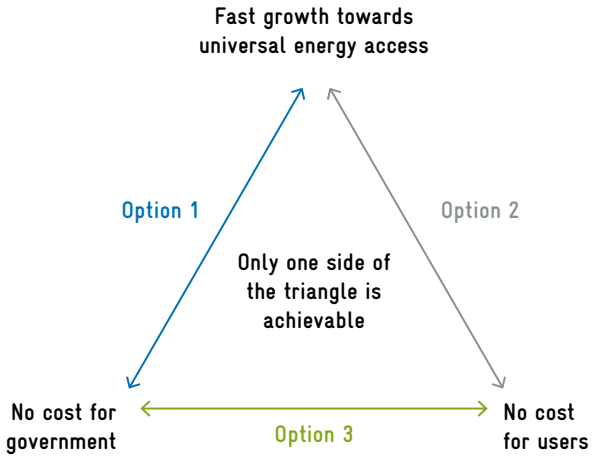
TABLE 1. Pros and Cons of mini-grid subsidy models

	PROS	CONS
Upfront subsidy	— Could accelerate implementation, as developers need initial capital — Donor control on how implementation is to take place	— Risk of non-delivery or late delivery — Inflexibility for developers on how to achieve results — Not result-oriented — Hinders developer's innovation
RBF subsidy	— Developer is encouraged to deliver rapid results — Flexibility of recipient how to achieve results — Innovation is encouraged — Financial risk associated with the non-delivery of results shifts from the donor to the recipient — Increases effectiveness — Focus on results	— Increasing responsibility of developers may lead to reduced delivery-quality — Developer may experience difficulties in upfront financing/ lack of initial capital — Less donor control of implementation process
Staged subsidy	— Encourages demand stimulating activities — Stages of disbursement follow the growth of electricity demand — Less risk of non- or late delivery (compared to upfront subsidy) — Trade-off between upfront and RBF subsidy	— More complex/uncertain budget planning for donors/TA providers

There is no "one-size-fits-all" subsidy model suitable for every mini-grid roll-out program. It is recommended to assess in detail, which of the subsidy models fits best to the respective program.

Another challenge for governments is the impossibility to achieve inexpensive and rapid growth towards universal energy access, while offering an affordable, low-cost tariff for end users. This trilemma is illustrated in **Figure 9**.

FIGURE 9. The trilemma of rural electrification



The triangle visualizes the unfeasibility of reconciling all three objectives in rural electrification. Governments, as well as other rural electrification stakeholders, have to decide on a trade-off between the options shown in the figure. It is only feasible to reconcile two of the three objectives.

3.2.4 Paying attention to productive use and Fourth Generation Mini-Grid business models

While mini-grids are designed to allow for economic development, lack of productive use activities reduces demand for electricity and often hinders the economic sustainability of mini-grids. The financial viability of mini-grid projects depends to a large extent on the existence and stimulation of productive use activities. Thus, once mini-grids are operational, developing productive use activities requires explicit focus and attention. There are different approaches to stimulate productive use demand:

- Direct support to productive uses, grants to pay for equipment, etc.
- Stronger coordination with other sectors and value chains: rural development, water, agriculture …
- Support to mini-grid developers that put productive use at the core of their business models
- Incentivizing tariff structure for productive uses, e.g. lower (daytime) tariffs for productive uses.

These productive use stimulating measures must be determined in the planning phase from the outset. A detailed strategy should be elaborated to ensure success of the mini-grid project.

In addition to the "traditional" approach of productive use, "Fourth Generation Mini-Grids" extend and evolve the approach of productive use. It is likely that the mini-grid sector will change within the near future. From a technological point of view, mini-grids will be plug-and-play, as well as fully digital. With the development of technology, digitalization and the associated increasing ease of operation, various industrial sectors may identify mini-grids as a means to expand their business. Accordingly, new business models will evolve in the mini-grid sector. Mini-grids can be instrumental for some sectors to explore and open up new markets in rural areas (cross-selling opportunities). Others may use mini-grids to get access to inputs/resources required for their business. The following business models, focusing on productive use, are some of the models that are covered by the terms "Fourth Generation Mini-Grids":

- KeyMaker Model
- Agricultural hubs (e.g. through electrically driven drip irrigation)
- Anchor load based mini-grid (ABC model with e.g. telecom towers)
- Multi Utility Model

As described by González-Grandón & Peterschmidt (2019):

The KeyMaker model is an approach to include underprivileged, deep rural areas of developing countries into national and international trade using mini-grid electricity and staff resources, and benefitting not only the community but also the mini-grid operator. Decentralized

pre-processing of locally produced goods reduces the volume and weight of these good, which drastically reduces their transport cost and finally makes the goods competitive when arriving at the trade hub. This may channel considerable cash-flows into deep previously unelectrified rural areas leading to accelerated rural development and increased living standards, while opening new input sourcing options for industries. Electricity supply from mini-grids for local processing of goods is the Key to open these trade options, the mini-grid operator bringing in the required management capacity for the trade business is the KeyMaker.

(González-Grandón & Peterschmidt, 2019)

Agricultural hubs offer an opportunity to increase the productivity of agricultural activities and thus accelerate rural development. Pilot projects (e.g. solar irrigation) have successfully demonstrated the potential of modern technologies in rural areas to increase yields, as well as protect the local population from environmental impacts (e.g. droughts). Further, correlation between power and agricultural activities can be utilized (e.g. biomass gasification). (EEP, 2018)

Anchor load based mini-grid business models target anchor clients, who ensure a continuous revenue for the developer from a source outside of the community (Pedersen, 2016). Through the anchor client (mostly telecom towers), the economic viability can be increased, while supplying power to rural villages.

Multi Utility Models also generate additional revenue from outside of the village community by providing public services which are paid for usually by the government. An example is the Ugandan mini-grid company KIS which runs a ferry and a road for the government under a service contract and then started supplying electricity to the island through a solar mini-grid.

All the above-mentioned Fourth Generation mini-grid business models dramatically increase the profitability of mini-grid projects and will therefore be in the focus on the way towards non-subsidized mini-grid projects. The TA is obliged to evolve continuously to meet the increasing requirements of interventions. Future approaches of productive use must therefore be considered in front-to-end planning of TA interventions.

3.3 Stakeholder support and coordination

3.3.1 Establishing a trust relationship

One of the reasons why TA may fail to result in a functional mini-grid market is the missing trust between the government and the consultant provided by the TA. This is either related to the government considering the consultant to be missing certain understanding or knowledge, or if the government suspects the consultant to follow their own, or their donor's agenda instead of fully supporting the government.

GIZ, as a TA provider, can overcome this trust issue through its long-term partnership and reputation for good cooperation with governments. Governments tend to build a trust relationship faster with an organization that has a lasting relationship and outstanding reputation in rural electrification. In addition, GIZ places great emphasis on embedded experts. Local cooperation between governments and experts improves efficiency of the roll-out program, as well as strengthening the trust between parties.

Motivation of mini-grid stakeholders

Politicians want rural connections which lead to votes, and are ready to learn what needs to be done to achieve this on the job, but only if the goal is achievable.

Private mini-grid developers and operators aim at making profits and are ready to learn what needs to be done to achieve this aim, but only if their objective is achievable.

The task of TA is to continuously show that both aims are achievable and that all conditions to achieve this aim can be met. A clear path to success with milestones can help keep everybody motivated while working on the implementation.

3.3.2 Building capacity in government institutions

Even though there are numerous approaches for capacity building in government institutions, one approach stood out during the interviews conducted: It is the embedded expert approach. Governments frequently ask for continuous long-term support and rapid response. An embedded expert who is always up-to-speed regarding latest discussion, but whose ToR relate to the accomplishment of the project, i.e. does not report directly to the institution's head, is usually the best answer to this ask.

One of the key factors of GIZ ensuring a successful and efficient TA is the deployment of embedded experts. GIZ differentiates itself by having a strong local presence, long-lasting institutional relationships and more specifically, by often employing "embedded experts" working within the local institutions. Due to the lack of technical competencies and organizational capabilities of local institutions, external expertise is required. The expert can be embedded in different local institutions (e.g. ministry, regulator, REA) and several contracting options are possible. **Table 2** describes the advantages and drawbacks to consider in employing embedded experts:

TABLE 2. Pros and cons of embedded experts

	PROS	CONS
Embedded experts	— Long-term local presence — Building trust — High technical and organizational capabilities — High degree of knowledge transfer — Increased transparency	— Might hinder employment of local experts — Intercultural barriers — May interfere with local innovation

The employment of embedded experts ensures a high degree of knowledge transfer and is building trust, which improves the relationship between TA and government considerably. The positive impact of embedded experts can be seen in Myanmar. The embedded expert employed by GIZ has a desk in the ministry without being directly answerable to the minister. Through his employment the process management was streamlined and the mini-grid roll-out made more efficient. Further, by employing an embedded expert, transparency and fairness could be ensured.[6]

An embedded expert must meet several criteria and have a defined set of skills to ensure the success of his/her employment. A high degree of cultural understanding is inevitable, as the embedded expert is responsible for a trust relationship to the government. In depth technical knowledge, as well as great endurance is also a prerequisite. In addition, in the case of Madagascar, it has been advantageous to employ an expert with long-term professional experience to ensure a high level of credibility.[7]

Conflicts between TA provider and government

Sometimes government priorities change and, as a result, implementation of mini-grid programs can be affected. This is particularly frequent when it comes to financial aspects, such as subsidies and tariffs, and more broadly to the choice between public- and private-led approaches for mini-grids. Tanzania, Kenya and Senegal mini-grid programs have experienced such situations in one way or another. This situation can to some extent be prevented by securing a strong partnership with key actors and making clear that the provision of TA is linked to the agreed approach, especially if the latter is a promising way to acquiring large-scale financing for a mini-grid roll-out.

However, this doesn't fully protect framework development TA from sudden political changes. Should this happen, successful strategies in the past include steering and sector groups that can function as a mediator and coordinate actions, ideally involving other donors in the sector. Finally, if the change is irreversible, TA can also adopt a more defensive approach and focus on preserving some valuable aspects of the mini-grid landscape (such as existing regulations or master plans).

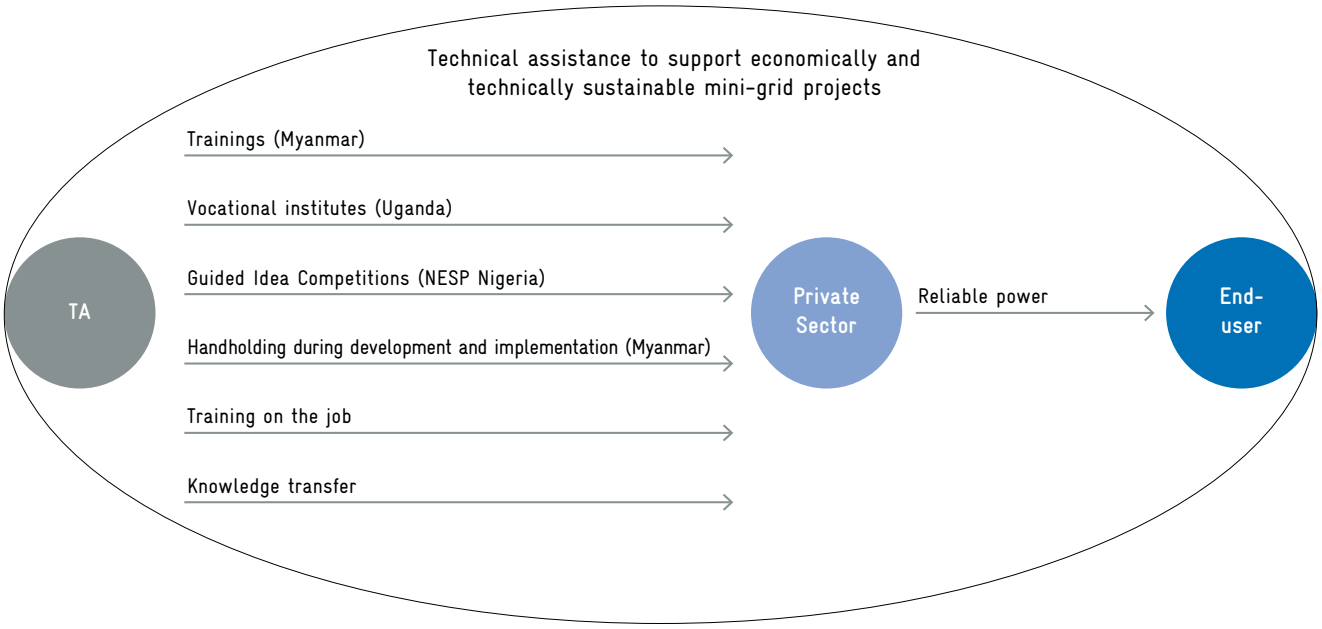
3.3.3 Building capacity in and for the private sector

Even if international companies are leading the mini-grid developers' market, local companies and technicians are required and can strengthen the mini-grid value chain. Business development skills are generally lacking.

In the past, expectations on trainings of rural entrepreneurs in mini-grids were exaggerated. In some cases, attempts were made to train persons with primary education on processes

6 Interview with Patrick Pawletko, GIZ, Advisor Promotion of Rural Electrification (RELEC), Myanmar, 13.09.19
7 Interview with Monika Rammelt, GIZ, Head of Energy program Madagascar, 13.09.19

FIGURE 10. Examples of successful TA for the private sector



that require higher degrees of education using workshops and mentoring/coaching approaches. Accordingly, the level of effort was high while the output was limited. Later approaches rather connected rural citizens to public education and training institutions while supporting the national education and training institutions in integrating rural entrepreneurial skill sets into their curricula.

Cooperation of international and local companies may bring together international professional company management and operational excellence, while the local company could provide the local knowledge and network, as well as village level communication/engagement.

Knowledge transfer between TA and the private sector and various training programs must be part of a professional TA, to ensure a successful and smooth mini-grid roll-out.

Figure 10 demonstrates what specific training could be required by the private sector, indicating the respective country of implementation. It is inevitable to assess the needs of the private sector and adjust the training program accordingly. To provide professional training is a key factor to leverage the potential of the private sector and ensure a competent mini-grid roll-out.

SECTION 4

Next level mini-grid technical assistance services

Photo: Silvia Puddu

Based on GIZ's long-term experience, there is still space for improvement in the optimization of mini-grid roll-outs. The next level mini-grid TA service will focus on the streamlining of the transition from mini-grid pilots to mini-grid roll-outs. To achieve this goal, adequate funding must be secured in the first place. By improving the coordination between TA provider and financing institutions, as well as building strong partnerships, the efficiency of the funding process and the mini-grid roll-out will be increased. The coordination between TA and development banks must be placed in the focus from the outset of the TA planning phase. Based on many years of experience, GIZ is able to function as key connector between governments and financing institutions in order to streamline the entire mini-grid roll-out.

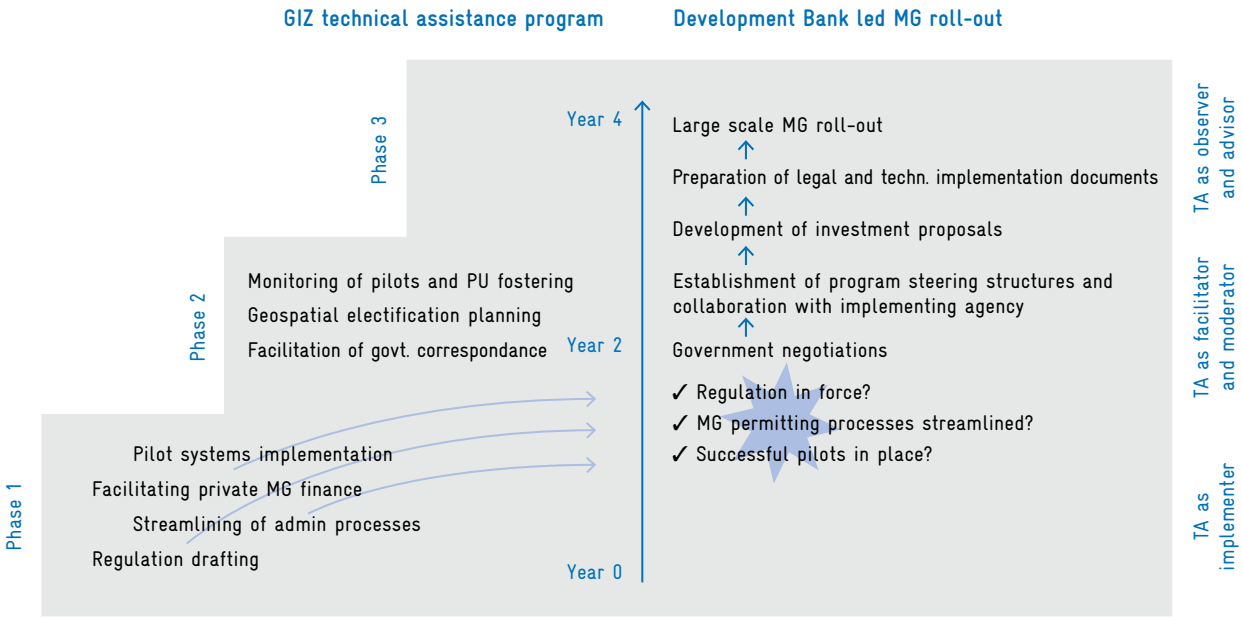
4.1 Focus on technical assistance, building partnerships for financing

GIZ's most valuable/unique resources are technical competence, ability to provide independent advice and strong local presence. This remains the core business of GIZ.

Given that GIZ often lacks the budget to support larger scale mini-grid development, such technical assistance focus can be specifically efficient when partnering with other organizations offering financing. **Figure 11** illustrates what a partnership between GIZ and a financing authority might look like.

The proposed partnership structure between GIZ and a development bank is subdivided into three phases. In the first phase, the TA works as an implementer, in the second

FIGURE 11. Proposed partnering structure of GIZ and a financing institution



phase as a facilitator or moderator and in the final phase as an observer and advisor. A huge (and yet unexploited) potential for optimization is the improvement of coordination between TA and development banks. This advanced partnership structure can streamline the transition from mini-grid pilots to large-scale mini-grid roll-outs and thus accelerate the pace towards achieving the goal of universal energy access.

The positive examples of Myanmar and Uganda (explained in 3.2.1) underline the tremendous potential of an advanced cooperation structure. Having the financing secured in the first place, enables a smooth and efficient scaling phase of the mini-grid roll-out. In addition, Madagascar's negative example only highlights the necessity for early stage consideration of relevant funding for scaling. Front-to-end planning of the entire roll-out, as well as strong cooperation should be seen as key factors for improving efficiency and effectivity of mini-grid programs.[8] [9]

4.2 Consider challenging geographies/countries as an opportunity

Countries where the mini-grid sector has not attracted so much attention might offer more opportunities to make a real difference, as opposed to more donor-crowded locations.

Despite the challenges posed by the lack of funding in the past, Madagascar offers high potential for mini-grid development. The main grid in Madagascar consists of three isolated networks with thermal power stations. This means that Madagascar has experience with isolated grids, which could be used for a mini-grid roll-out. In addition, there is a huge demand in rural areas for mini-grids and Madagascar offers enormous potential for hydro and solar. Furthermore, Madagascar could benefit from a well-established private sector for planning and construction. However, operational capacity is lacking (companies have good engineers, but no capacity for financial modelling and business plans). By providing high quality and professional TA, as well as the necessary financing for scaling, Madagascar's mini-grid market could evolve.[10]

8 Interview with Moses Kakooza, GIZ, MG Project Coordinator within GIZ Energy Program, Uganda, 23.09.19

9 Interview with Patrick Pawletko, GIZ, Advisor Promotion of Rural Electrification (RELEC), Myanmar on 13.09.19

10 Interview with Monika Rammelt, GIZ, Head of Energy program, Madagascar, 13.09.19

Another potentially promising mini-grid market is Rwanda. Despite several remaining barriers (e.g. lack of purchasing power and electricity demand, lack of financing, few productive users), initial approaches are already being implemented to facilitate mini-grid roll-outs. In 2015, the mini-grid framework was revised and made clearer through the introduction of various plans and guidelines (e.g. simplified licenses, regulation for grid arrival). At the end of 2019, the framework is being finalized, with clear definitions of procedures and regulations. Through simplification of the mini-grid framework already two solar, two hydro and 57 diesel mini-grid projects have been implemented successfully. More mini-grid projects are under development through GIZ's program.[11]

4.3 Stay "ahead of the pack" by addressing the latest mini-grid research topics

Making mini-grid models work financially is a prerequisite for access to finance, for convincing governments of the sustainability of mini-grids and the growth of the market in general. Today, even with high tariffs and high subsidy levels (see caveat on latest research in chapter 3.2.3), in Sub Sahara Africa, no solar mini-grid company has achieved financial break even with its business model so far. This needs to change soon to enter into the next mini-grid market growth phase. The following are the most pressing questions that need to be answered to help private sector adjust their business models towards profitability:

1) **How do we overcome mistrust between private sector and governments? This is leading to the private sector not embracing regulation (example Nigeria) even though it protects their investment when properly applied.**
Trust issues between mini-grid operators and the government may have various reasons. On the one hand, loopholes for changes in regulation may need to be closed and enforceability of regulation from the private sector side may need to be strengthened, on the other hand, cases of trust misuse from the past may need to be tidied up with to re-establish trust. Only once trust is re-established, existing regulation can unfold its full potential and finally help open the market.

2) **How can electricity demand be predicted more accurately and how can the demand risk be mitigated best?**
With the understanding that electricity demand in households follows a fixed monthly budget as long as the saturation limit has not been reached, the assessment of household budgets for electricity sales should be the target instead of the kWhs people would like to consume (if they had unlimited budget). Once, enough data from various sites has been gathered and evaluated, simple socio-economic data could provide quite an accurate picture of the future electricity demand. The same applies to the electricity demand growth with increasing economic development in the village community. At the same time, demand of productive users depends on the volume of products manufactured. With some reference from a large number of mini-grids, also here, more accurate projection can be generated. Both theories first need to be proven scientifically before they can be applied. Even with these new methodologies, demand may in many cases not be projected accurately enough to guarantee a profitable business. In these cases, mitigation instruments like staged implementation need to be considered by private sector, in grant funding programs and regulation.

3) **What Fourth Generation mini-grid business models does the future hold?**
KeyMaker Model, telecom ABC model, Agricultural Hub and Multi Utility Model are just the start of a new way of thinking about mini-grids. While these business models may gain track record faster if TA is provided, new models will be developed following the same logic that the above models are using already (use the mini-grid as a basis to generate additional revenues beyond electricity sales to villagers; don't try to make rural electricity supply profitable, but think about how you can use the electricity supply and structures set up for it to generate additional income which makes the business profitable). TA may take the lead in generating these new business models together with private mini-grid operators.

11 Interview with Selen Kesrelioglu, Advisor, EnDev, Rwanda, 18.09.19

4) **How can mini-grid TA transfer more smoothly into development banks' mini-grid roll-outs?**
As outlined in 4.1, for a mini-grid TA program, handing over to a development bank for the large-scale roll-out should be the aim and not a threat. This requires openness from both the mini-grid TA experts and the bankers. Research needs to be done on how the two worlds can better coordinate and where clearly defined interfaces can be developed. Aspects like language, the way of handling business and communication, patience while waiting for results, the way of treating government partners, etc. need to be coordinated. Understanding for another institution's way of handling things must be created to get a collaboration started. GIZ is in a good position to access the data and initiate the talks required to answer these questions through its existing networks, relationships and monitoring systems.

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