David MANETSGRUBER • Bernard WAGEMANN • Bozhil KONDEV • Katrin DZIERGWA

RISK MANAGEMENT FOR MINI-GRIDS

A new approach to guide mini-grid deployment

Photo credits: FRES; Gunnar Wegner, James Hazelton; Schneider Electric; Smart Hydro Power

Alliance for Rural Electrification
Shining a Light for Progress

HNU HOCHSCHULE NEU-ULM UNIVERSITY OF APPLIED SCIENCES

Institute id-eee

giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

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Table of Abbreviations

AC	Alternating Current
ADB	Asian Development Bank
ARE	Alliance for Rural Electrification
BCD	Business Customer Development
BMZ	Federal Ministry for Economic Cooperation and Development
DC	Direct Current
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH
HNU	Hochschule Neu Ulm / Neu-Ulm University of Applied Sciences
HSU	Hochschule Ulm / Ulm University of Applied Sciences
IADB	Inter-American Development Bank
IEA	International Energy Agency
IFC	International Finance Corporation
IRR	International Rate of Return
LCOE	Levelised Cost of Electricity
MIGA	Multilateral Investment Guarantee Agency
NASDAQ	National Association of Securities Dealers Automated Quotations
NGO	Non-Governmental Organisation
OPIC	Overseas Private Investment Corporation
PCG	Partial Credit Guarantee
PRI	Political Risk Insurance
PV	Photovoltaic
RSC	Regional Support Center
SBI	Sustainable Business Institute
SHS	Solar Home Systems
SME	Small and medium enterprises
SPS	Single Power Stations
SRMP	Standardised Risk Management Process
UKC	Unique Key Characteristics
USD	US Dollar

Preliminary Notes

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ARE is an international business association representing the decentralised energy sector working towards the integration of renewables into rural electrification markets in developing and emerging countries.

Alliance for Rural Electrification
Shining a Light for Progress

The Alliance enables improved energy access through business development support for more than 90 members along the whole value chain for off-grid technologies by targeted advocacy and facilitating access to international and regional funding.

It is the objective of the association to attract and unite all relevant actors in order to speak with one voice about rural electrification with renewable energies.

Photo credits: EarthSpark; Smart Hydro Power; ZeroBase

ARE serves as a global platform for sharing knowledge and best practices to provide for rapid implementation of available and advanced renewable energy technologies and services.

Please visit the ARE website for more information: www.ruralelec.org

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Preface of ARE

According to recent forecasts by the World Bank and the International Energy Agency, off-grid rural electrification in developing countries and emerging markets has great potential for both the public and the private sector. Indeed, 1.1 billion people remain without access to electricity[1], and more than 84% of them live in rural areas. In order to trigger the increased involvement of the industry and the finance sector, future global collaboration between the private and public sectors will be crucial.

Increasing demand for clean, reliable and affordable electricity services plus the strong linkage between energy and socio-economic development and the fast growth of the world population have brought clean energy to the forefront of the international development agenda. For the first time, for example, the United Nations stated energy provision as a primary target when announcing the post-2015 development agenda in September 2013.

As mini-grids powered by renewable energy are highly relevant to realising the SE4All targets, the Alliance for Rural Electrification – in combination with other leading international bodies – launched the "SE4All High Impact Opportunity (HIO) on Clean Energy Mini-grids" in June 2014. This HIO brings together public, private and civil society stakeholders and aims to increase the deployment rate of clean energy mini-grids and achieve a market transformation impact. Its Secretariat is hosted jointly by ARE and the UN Foundation, and its membership is open to all organisations with interest and activities in the area of clean energy mini-grids. More info on www.se4all.org/hio/clean-energy-mini-grids/.

In 2010, the International Energy Agency (IEA) estimated that "to achieve universal access to electricity, 70% of the rural areas that currently lack access will need to be connected using mini-grid or off-grid (decentralised) solutions." Specifically for Sub-Saharan Africa, of the population gaining access in rural areas, mini- and off-grid solutions account for 70% of new access-related demand over the period to 2040.

The main reasons for this generally positive perspective are (i) the possibility for more rapid, scalable and tailor-made deployment in comparison to grid-solutions, (ii) the fact that there is no dependence on grid extension, which is important for remote areas and (iii) the positive impact on local business development and job creation opportunities.

Moreover, due to falling costs of renewable energy generation and improvements that make system maintenance easier, there is an increasing interest of developing countries in accelerating deployment through more effective regulatory and financial framework conditions.

At the same time, with the majority of mini-grid projects still in the pilot phase, knowledge on which financial conditions increase the probability for successful mini-grid implementation is insufficient. In addition, the potential deployment of mini-grids is slowed down due to existing disadvantageous regulatory framework conditions (e.g. unbalanced subsidy policy with more support for fossil fuels) and a lack of credit experience of the finance sector for this emerging market (especially in cases of higher upfront costs caused by monopolistic or pseudo-monopolistic structures of the national utilities or by lack of appropriate credit facilities within banks). In full respect of the results achieved within the framework of past supporting schemes, the relevance of concrete risk assessment tools and mitigation strategies for the private sector has become increasingly obvious.

This study was initiated by the Alliance for Rural Electrification (ARE) and GIZ in order to :

1. improve the business environment for mini-grid development with a focus on greenfield projects through the provision of a guidance framework for decision-makers and development partners on issues related to the risks of mini-grids and also;
2. strengthen public-private dialogue on the promotion of private sector mini-grid development.

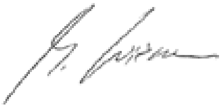
With the Institute id-eee and the Neu-Ulm University of Applied Sciences, ARE has chosen two partners with extensive experience and know-how in the fields of

[1] Source: World Bank, 2015

risk identification, assessment, mitigation strategies and instruments which can now be combined with the competence as well as the outcome of the daily economic practice of ARE members and partners who are active in the mini-grid sector. The work carried out is a combination of profound literature research and also takes into account the experience of practitioners by means of questionnaires, focusing on the identification and relevance of existing risks and their impact potential as well as barriers and challenges affecting the entire business area.

The empirical results of this study are based on questionnaires including interviews, on-site evaluations, and literature research.

Policy-makers and practitioners are invited to make use of the study results and thereby also to contribute to a business-friendly framework, which, in turn, will help both the pioneers in the market as well as the newcomers, to accelerate the deployment and the scaling up of clean energy mini-grids and thus increase access to clean energy services.



Marcus Wiemann
ARE Executive Director

August 2015, Brussels

Photo credits: Smart Hydro Power; Studer Innotec-Photolia

Executive summary

A significant challenge for mini-grid deployment is a communication and language gap between mini-grid developers and investors about mini-grid risks and their management. While investors usually think in financial risk/return dimensions and are often unaware of the specific challenges in the field of mini-grid electrification, project developers and mini-grid operators have immense expertise in overcoming these specific challenges in terms of preventing threats but often do not use risk management tools as usually expected by bankers and investors.

Standardised risk management processes would be of enormous help to overcome this gap and to create an improved base of understanding on both sides. Establishing such reliable frameworks will be a crucial issue to foster the development of the entire rural electrification market and attract investors from the private sector in particular.

Risk management provides support to decision makers by:

- specifying the complete risk profile;
- identifying offsets of chances and risks and ensuring a sustainable operation; and
- supporting decisions on capital expenditures.

	Definition	Tools for risk mitigation	Approaches
Political risk	The risk that an investment's returns could suffer as a result of political changes or instability in a country	Political Risk Insurance	Relation Management with Public Authorities
Payment risk	The risk that the off-taker reduces or stops payment	So far not available for respective projects	Holistic Business Models
Risk of resource price variability	The risk that the price of energy sources increases (e.g. biomass, diesel)	So far not available for respective projects	Hybridisation of Mini-Grids

Figure 1: Major risks and possible mitigation strategies

Risk management is not meant to completely rule out all risks but to point out benefits from changing established procedures, for example :

- Early recognition of crucial risk driving factors;
- Maintaining a balance between chances and risks;
- Initiating focused actions at an early stage to limit risk exposure;
- Opening up options for new projects.

The empirical survey conducted for this study has identified a wide range of risks affecting mini-grid development and operation.

Evidence shows that three particular types of risks pose the most significant challenges for the further development of the mini-grid sector and should be well addressed and tackled with appropriate tools.

Political Risk: Even though certain instruments to reduce the political risk are available, there is a strong demand for the political implementation of reliable policy frameworks. Until such frameworks have been established, political risks should be shifted to a third party wherever possible, but unfortunately, adequate instruments for the rural decentralised electrification sector are seldom available.

Payment Risk: To reduce the payment risk, holistic business models integrating concepts of sound technical design, promotion of productive use of electricity and customer relationship management provide better conditions to increase both the electricity customers' ability and willingness to pay.

Resource Price Variability: This addresses mainly diesel and biomass mini-grids. Hence, in terms of increasing diesel prices, the hybridisation of mini-grids seems to be a promising approach to at least achieve a certain degree of risk reduction. To hedge against increased biomass prices, there are no standardised schemes available yet, but improved agricultural models (technology and management) may contribute to a certain stabilisation of prices.

Need for sustainable operational models with business rationale

Mini-grids need to prove that they can be operated successfully, be financially viable and be sustainable in the long-term. Unfortunately, concepts like financial viability and sustainability of mini-grids are only slowly gaining popularity amongst rural electrification professionals. At the same time there is also a need to advance business-enabling framework conditions. Following such approaches for rural electrification is necessary and will make it easier to tackle some of the main risks for operators. Business models that incorporate such concepts usually also include:

- a broader involvement of stakeholders;
- intensified capacity development and training of operator and users; and
- stronger support for local business development and productive use of electricity.

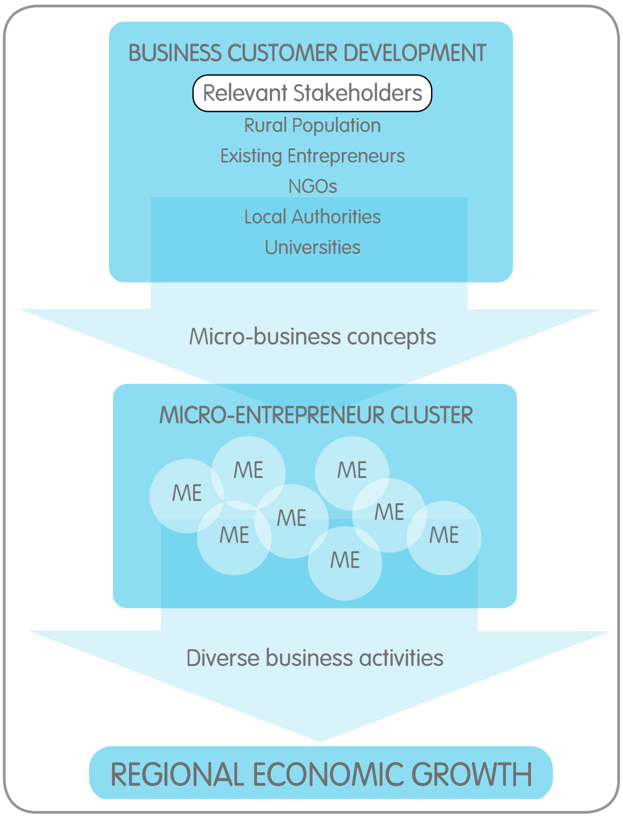


Figure 2: Local and regional economic growth by the coached development of ME's improving their ability to pay (ME = micro-entrepreneur)

Successful projects need high initial investments to establish the necessary management and operational practices of the developer. With regards to the broad range of necessary activities, it might in most cases be reasonable to break down such activities into smaller sub-projects. Joint initiatives of private and public actors with the objective of harmonising local, national and international institutions and companies and their respective expertise are well suited for this. At the same time, experience shows that the public sector will need to continue to show further leadership to establish confidence into positive market developments. A successful implementation of a holistic business model that addresses the needs of electricity customers and enhances their entrepreneurial capacity can result in positive regional economic development. Mini-grid operators that focus not only on delivery of electricity but also on developing entrepreneurial capacity can enable the creation of clusters of microentrepreneurs who through their diverse business activities can spur economic growth.

Need for a Standardised Risk Management Procedure (SRMP)

A systematic and professional management of all types of risks is essential for the successful implementation of mini-grids. This includes, but is not limited to strict adherence to risk-handling procedures. More important is the optimal steering of a comprehensive risk profile spanning all aspects of business.

Particularly, a risk management process has to be installed to make risks across all types of business activities and across all organisational elements comparable and to aggregate these to describe comprehensively the overall risk situation of a mini-grid project. An optimal approach for handling risks would ideally be agreed upon by the most important stakeholders, i.e. major governmental institutions, development banks, and specific insurance agencies.

INTRODUCTION

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Photo credits: FRES; James Hazelton; RVE.SOL; TTA

1. Introduction

1.1. Background

"The desolate technical condition and performance of solar or hybrid mini-grids is often caused by an inappropriate management of the integral system or lack of finance to operate and manage the system." (Caroline Nijland, Director Business Development FRES)

For the year 2014, the International Energy Agency (IEA) estimated the number of people without access to electrical energy at 1.3 billion. As can be seen in figure 3, the IEA also forecasts that in Africa, the number of unelectrified people will probably even increase from 589 million to 689 million – in contrast to the other regions listed. This estimate is mainly caused by population growth being higher than the increase in the electrification rate.

years, more recently a lot of attention has focused on mini-grids. Nevertheless, multi-user electrification schemes like mini-grids that involve generation, distribution, commercialisation and consumption of electricity are among the most vulnerable of electrification projects. In the past, large numbers of mini-grids did not work properly in terms of meeting the needs of the rural population and achieving financial viability. In many cases, systems failed completely and had to be abandoned. By learning from past lessons and recognising the complex nature of mini-grids, the expert discourse around mini-grids has been shifting. With increased private sector interest in the operation of mini-grids and higher accountability requirements by financiers, the pressure to develop strategies that reduce the risk of electrification schemes failing is high. Trends like these are expected to facilitate more professional engagement of mini-grid actors and draw more investment to the mini-grid sector.

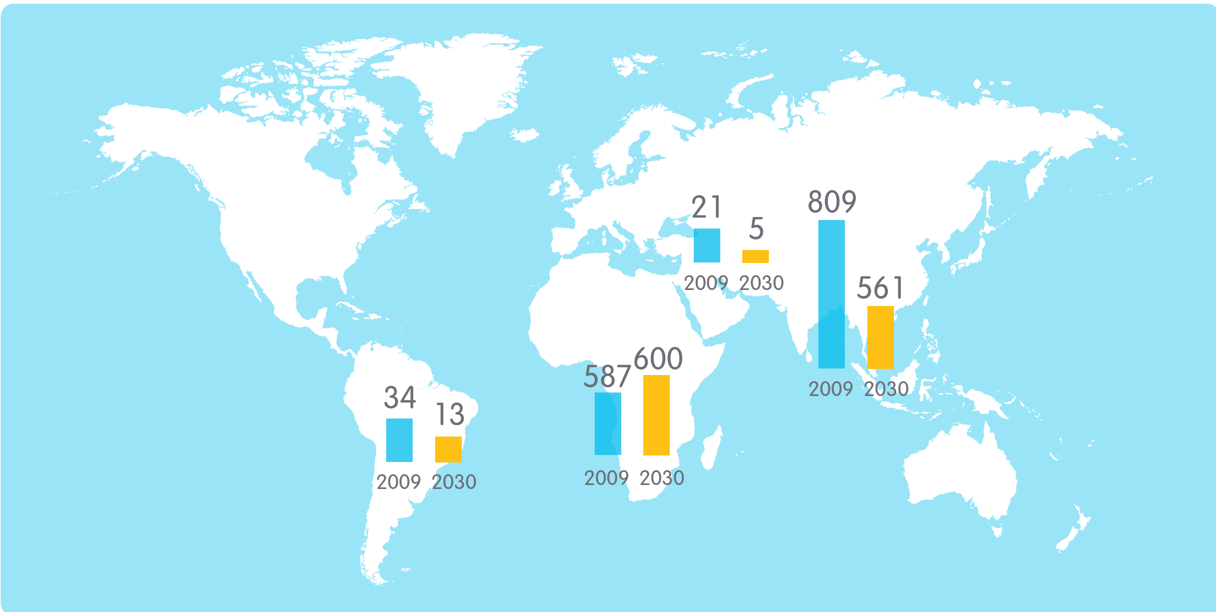

Figure 3: Unelectrified populations across the world - year 2009 compared with 2030 (population quoted in million) [2]

Private investments in renewable energy have increased significantly worldwide over the years 2004 to 2012 demonstrating a market opportunity resulting from the falling prices of individual technologies like solar PV. Benefitting from these trends, the decentralised electrification sector is also seeing an emergence of investor interest. Improving policy and regulatory frameworks in certain regions is drawing the attention of entire business communities and requiring the electrification industry to engage in the sector more actively and with greater professionalism. While the market for standalone systems like off-grid lighting products and solar home systems has seen the most private sector engagement over the last 10

Today, holistic business models are already being piloted around the world. Mini-grid developers in East Africa and South Asia are innovating by taking different stakeholder demands into account and catering to various types of customers, leveraging managerial expertise and employing solid financial planning.

Yet, in order to realise the diverse opportunities in this

[2] Source: IFC, 2012

relatively new market, mini-grid developers and operators need to be constantly aware of major risks and barriers, and devise strategies to overcome them. As mini-grid businesses are moving to maturity, the consideration of risk factors, their identification and assessment as well as the mitigation of present and future risks will play a key role in improving the viability and sustainability of investments in rural electrification.

1.2. Objectives

The present publication represents an analysis of the experiences of mini-grid experts with risk assessment and risk mitigation for mini-grids. The analysis is based mainly on views of experts in the rural electrification sector, mini-grid project developers and mini-grid operators. This study has been conceptualised as a framework which tries to:

- present the current situation in the mini-grid sector with regards to risk management and identify which risks have highest relevance in the mini-grid sector;
- suggest specific measures for the management of risks affecting mini-grids; and
- outline a mindset for future actions and investigations in the area of mini-grid risk management.

The report aims to provide guidance to entrepreneurs with a long-track record in investing, developing, implementing and operating mini-grids, as well as "mini-grid newcomers" who are about to enter the mini-grid market or are considering such a step. The report also aims to inform experts in development organisations, banks and insurance companies, about relevant risks faced by mini-grid practitioners and stimulate discussions for the development of risk mitigation instruments for the rural electrification sector.

The study tries to provide arguments that a Standardised Risk Management Procedure (SRMP) for mini-grids can strengthen the awareness of managers and help to limit negative deviations from agreed targets and to exploit business potentials to the benefit of investors, communities and consumers.

From the viewpoint of the authors, further analysis and work should be done to define the SRMP in an industry-specific and easy-to-handle form as recommended within this study to:

- design a concrete guideline how a SRMP could be achieved, and to deliver concrete suggestions on an easy-to-handle content seen from the viewpoint of the rural electrification sector;
- design concrete templates and support tools for practitioners on how to obtain the data and declarations needed within such a SRMP; and
- carry out country-specific evaluations (e.g. in India) on the practical experience of practitioners when working with such a SRMP.

1.3. Methodology for the study

The following results and the recommendations for action are based on extensive research consisting of:

1. Comprehensive review of available secondary literature such as industry analyses, case studies, scientific articles, websites of companies and associations, etc.
2. Standardised interviews with members of the Alliance for Rural Electrification (ARE);
3. Discussions with mini-grid experts from the public sector and academia;
4. Collection of feedback from experts after presentations at industry events like the EU Commission Workshop in Brussels on 29-30 September 2014; and
5. Collection of feedback from experts on a summary paper with initial findings.

Altogether 24 ARE members provided input for the study based on the standardised survey. Members included system integrators, mini-grid operators, equipment resellers and distributors as well as consultants.

Purposefully, the research targeted a small, but diverse sample of companies. Instead of quantitative representativeness, the research relied on in-depth data collection that can deliver high quality results on the experiences of the industry. The purpose is the qualitative representativeness of the results, therefore the collection and consideration of experiences of a very specific branch regarding very specific topics. At the same time, it has to be highlighted that only due to the cooperation with ARE was it possible to find such a number of companies willing to provide researchers with an insight into the sensitive area of risk management.

The selection of a heterogeneous set of interviewees shows that, despite the limited number of participants, the survey results offer an overview of the various risks occurring in different fields of activity of the whole industry.

SCOPE FOR MINI-GRID RISK MANAGEMENT

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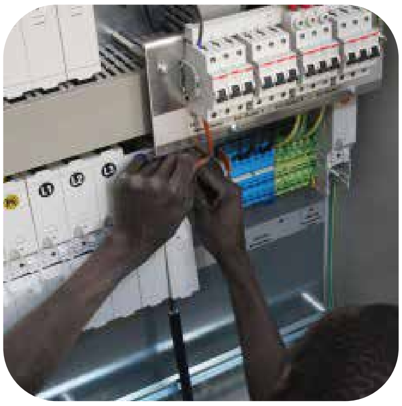

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2. Scope for mini-grid risk management

2.1. Mini-grids as an electrification approach

"A mini-grid could consist out of many independent systems. The "link" that makes the mini-grid is the operator, not the copper between users." (Claude Ruchet, Studer Innotec)

There are three general approaches for expanding the access to electricity in rural areas - stand-alone systems, mini-grids, and grid extension. While stand-alone systems usually offer limited energy service, grid extensions and mini-grids can provide users with a higher degree of power supply in terms of voltage and capacity.

While there is not a single definition of the term mini-grid, most electrification professionals use the term to describe an electricity scheme consisting of small-scale electricity generation system (in most cases under 3 MW) feeding power into a distribution network which supplies a limited number of customers. Mini-grids can operate in isolation from national electricity networks and in most cases are employed to supply electricity to relatively remote and at the same time concentrated settlements.

Mini-grids function to a large extent like large utilities, but at a smaller scale. The central part of a mini-grid is the operator of the system, often a private, public or a community based entity. Like in the case of large utilities, mini-grid operators have a number of differing and often challenging tasks.

Some of the tasks that mini-grid developers and operators need to fulfill include:

- Estimation of the expected initial electricity consumption, its fluctuations as well as its medium-term development;
- Financing of the installation and operation until the break-even point is reached;
- Set-up of a functioning business structure for securing central tasks around electricity generation, electricity sales, administration, finance and controlling; and
- Stakeholder relations management and agreement on electricity tariff structures which are socially acceptable but at the same time do not endanger the mini-grid's liquidity and formation of reserves.

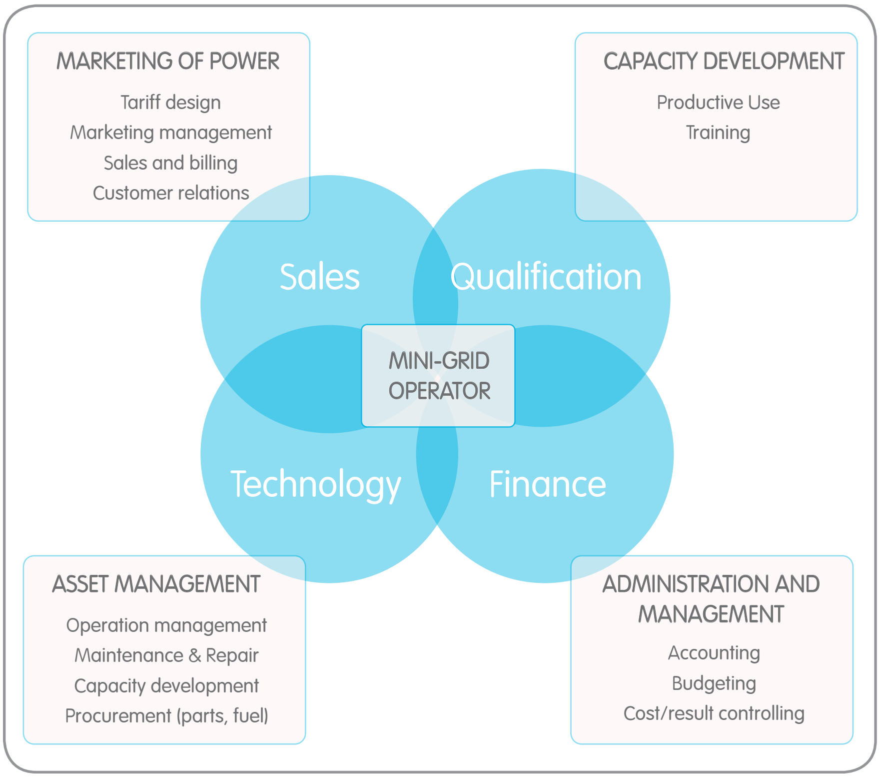

Figure 4: Key functions of local mini-grid utilities

Mini-grids offer a promising approach for rural electrification due to the fact that they can serve the demand for electricity of households, public services and local economy in rural and remote areas. Nevertheless, mini-grid developers and operators have to invest a lot of effort in order to ensure the effective functioning of the system and if necessary recover investments. By offering a reliable source of electricity, mini-grids can also create an impact on livelihoods in rural areas by enabling productive uses and thus supporting the development for small businesses and micro-enterprises. Managing productive loads on a mini-grid system is another task which requires appropriate strategies and business model adjustments. If operated effectively and efficiently mini-grids are able to provide the necessary infrastructure to foster local economic growth at a competitive cost. The financial viability of mini-grids often improves with the streamlining of functions of the operator and the economy of scale achieved through larger demand for electricity and high number of customers.

Translating this great potential into a real business success story has turned out to be extremely challenging. Deployment of mini-grids involves complex financial and organisational questions which can be assigned to challenges in the fields of sales, technology and finance [figure 4]. A successful business model satisfies the demand of the customers with high quality and 24/7 availability based on sound pricing models, and relies on adequate funding. Ideally, the funding should be both from the private and public sectors, and regarding the technology it should operate reliably and be easy to maintain.

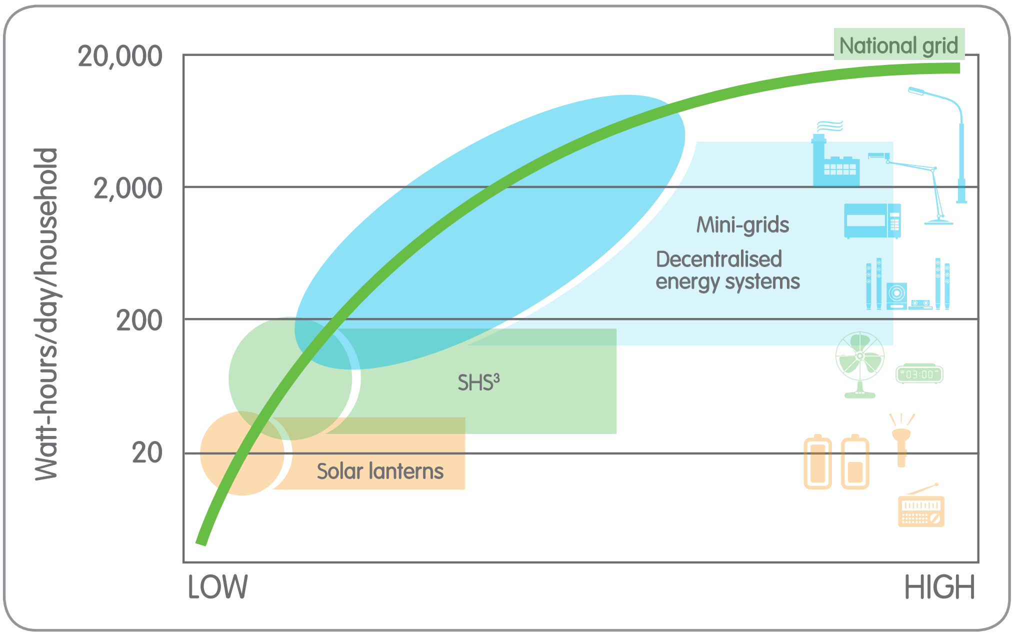

Figure 5: Possible electrification strategies [4]

Electrification strategies

Usually, electrification strategies have been classified according to the kind of systems and technology implied. This classification and definition of strategies is relatively easy to carry out and to understand and in this sense is a practical means to reduce the complexity of the subject.

Depending on the number of off-takers for rural electrification, in general three main strategies can be differentiated (figure 5).

These are as follows:

- National Grid Extension;
- Mini-grids or Hybrid Mini-grids; and
- Stand-alone Systems (Single Power Stations and Solar Home Systems).

These strategies differ in their respective kilowatt capacity, technical configuration and customer setting. The illustration in figure 5 shows this relationship. The decisive value added of the mini-grids compared to SHS is the fact that they enable the use of high power equipment needed for productive applications.

Stand-alone systems:

Single Power Stations (SPS) are power-generating facilities serving one single customer, as for example, a telecommunication tower, mining corporation, resort, farm, or other larger remote users. Due to this fact, single power stations which are mainly based on diesel gensets in most times have a professional business background with increased energy consumption and are sized from 100 kW up to several megawatt capacities.

Solar Home Systems (SHS) are basically used by private customers for home lighting, radio, TV or other smaller household appliances as well as for micro-businesses such as mobile phone charging, solar barbers, and many other low power intensive applications.

Mini-grid Systems: Figure 6 shows a typical example of a remote mini-grid without connection to the national grid. Hence, power production and distribution have to be done in a completely autonomous manner. In some cases mini-grids can be connected to the national grid. In this particular case, arrangements have to be made between the operator of the mini-grid and the respective national or regional utility to which the mini-grid is connected to. Asset ownership, compensations for electricity trade or technical adjustments necessary need to be clarified between the two parties.

Figure 6: Possible electrification strategies [3]

[3] Due to the rapid development in this sector, modern SHS today are able to double or triple the 200 Wh/day capacity

[4] Source: ADB, 2013

2.2. Bottlenecks for private investment and rationale for risk management in mini-grids

Historically, most of the decentralised electrification systems based on renewable energy have been able to offer an affordable service through generous financial support by governments, development partners and philanthropic donors. The traditional flaw of this approach has been the focus on technology demonstration and immediate impact to beneficiaries. Financial viability and long term sustainability stayed away from strategies for grant-based off-grid electrification.

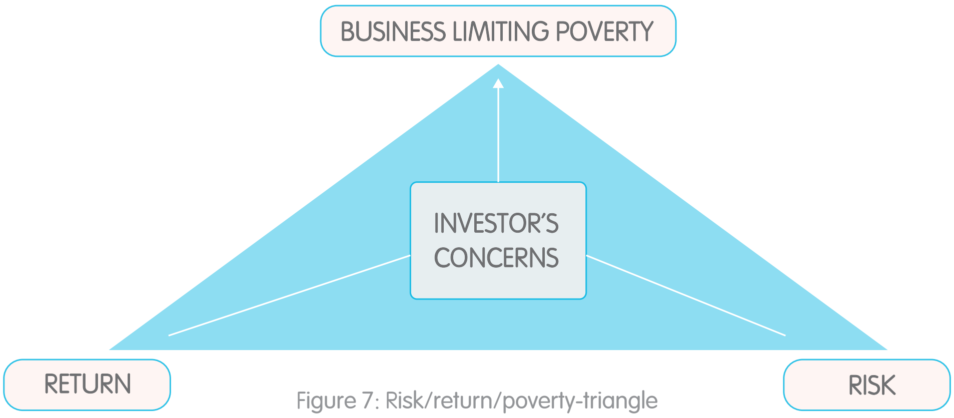

Figure 7: Risk/return/poverty-triangle

Today, political priority to provide universal access to energy is calling for a paradigm shift in electrification efforts leveraging private investment and following a holistic approach for the development of business models for off-grid projects. Until now, only few mini-grids have been fulfilling the expectations of their capital sponsors. Long payback times, low returns and limited availability of secondary markets for mini-grid assets are some of the reasons why private investors see mini-grids as unattractive investments.

Compared to large utility investments, higher risk profiles of mini-grids come with investor expectations for considerably shorter payback periods and higher returns (IRRs). However, for the time being, the return of mini-grids is relatively small and typically in the range of 10 to 15% IRR, much smaller than the 20% and above a typical investor would expect for a comparable on-grid project. To solve this challenge, two main options are generally available:

- Improve the IRR to compensate for the higher risk; and
- Reduce the risk of the project, i.e. stabilise cash flows so that the lower risk profile of the business model corresponds to the low IRR the projects generate.

As the first approach - "increasing returns" - requires operators to increase income of operators, by for example hiking the electricity tariffs to levels that may be socially prohibitive, the second approach - "lowering risks" - presents a case that offers a larger number of possibilities for intervention and is worth exploring in more detail.

A major challenge in pursuing the first strategy is the low income situation in rural communities where the rural customers are faced with financial burdens. Considering the existing risks of mini-grids private investors would expect a relatively high return which cannot be enforced by increasing the electricity prices because of the limited incomes of the rural population.

Unless higher local incomes and hence more likely willingness and ability to pay for electricity are given, mini-grid operators will continue to struggle to find a compromise between profitability and social acceptance (ability and willingness to pay). This dilemma can be considered as the most essential bottleneck hindering the involvement of private capital within rural electrification. In chapter 5.3. possible solutions to overcome this bottleneck will be discussed.

Mini-grid project developers face a range of barriers and challenges. This study concentrates on the most significant challenges determined by interviewing company representatives, most of whom have a long track record in the sector. Nevertheless, barriers may differ between those entrepreneurs who have well established partners in the country where they operate and those who will enter the market in future.

The three barriers, which according to private developers hinder the implementation of mini-grid projects are:

- Uncertain legal and/or policy framework;
- Lack of appropriate funding instruments; and
- Inadequate size of available funding instruments ("ticket sizes.")

The uncertainties or the lack of clear policy frameworks hamper most of the mini-grid projects are compounded by the lack of funding schemes within the range of USD 100,000 up to USD 5 million.

On the question whereby barriers hinder the scaling up of mini-grids, practitioners responded that the lack of access to finance instruments is the most important factor.

Our survey also showed that structured risk management tools and methods are neither widely known nor used in daily operational processes (see figure 29). One central question at this point is why structured risk management is not practiced during the deployment of mini-grids.

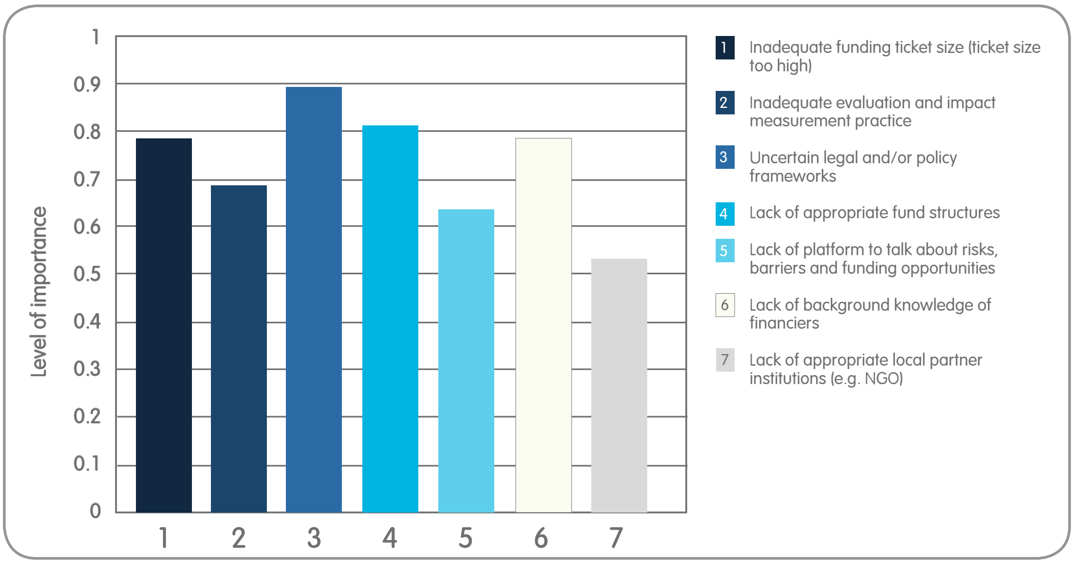

Figure 8: Common barriers and challenges of mini-grid operations (evaluation of importance: low = 0; 1 = high)

When mini-grid experts were asked about the use of risk management tools, some responses ranged in some cases from "not being aware of the benefits" to "have never heard of those tools".

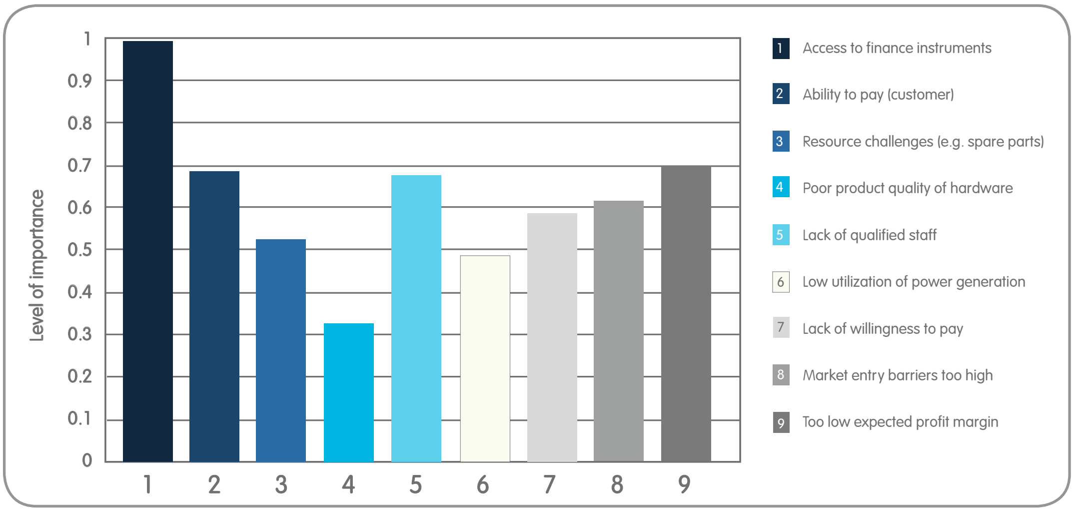

Figure 9: Upscaling barriers for mini-grids (evaluation of importance: low = 0; 1 = high)

The survey carried out demonstrated that mini-grid developers rarely deploy risk management tools. Yet, a focus on risk management as part of the development of a comprehensive business plan and during the operation of a mini-grid can help mini-grid developers and operators tackle some of the main challenges such rural electrification projects face.

The following chapter provides background information around risks and risk management and aims to assist the reader in gaining basic knowledge about risks and risk management.

INTRODUCTION TO RISK MANAGEMENT

3

Photo credits: Engineers without borders; NOVIS; RVE.SOL; Sunlabob

3. Introduction to risk management

3.1. Basic aspects of risk management

At the present time, there is no general valid risk management approach for mini-grids available. Different industries elaborated their own strategies and approaches according to their requirements and specific understanding of risks. BASEL III, for example, is a concept to mitigate financial risks related to banks, COSO ERM is widely used by the industry whereas the ISO 9001 classification focuses on issues related to quality management. As rural electrification markets display a high degree of complexity, it is obvious that this sector requires its own tailor-made risk-management approach.

With regard to the definition of risk, a very concise wording is employed by the Irish Health and Safety Authority: "A Hazard is a potential source of harm or adverse health effect on a person or persons." (www.hsa.ie)

Whereas the National Association of Securities Dealers Automated Quotations (NASDAQ) states a more formal definition: "A risk is often defined as the standard deviation of the return on total investment." (www.nasdaq.com)

THREE BASIC CHALLENGES

COMPLEXITY — No clear cause/effect relationships

UNCERTAINTY — No exact forecast of impacts; Difficulties to measure

MISSING AWARENESS — Lack of knowledge and mindfulness; Language gap

Figure 10: Basic challenges of risk management

It has to be pointed out that risk management processes are generally faced with underlying basic challenges, (see figure 10) such as complexity, uncertainty and lack of awareness (ignorance).

Complexity:

A system can be called complex when the respective cause/effect relationships of the functions and structures cannot be clearly described because of interrelationships of elements and influences, which are difficult to understand. For example, the effect of non-payment of electricity tariffs by customers: it cannot be said in advance whether it is caused by the unwillingness to pay, for example as a result of bad service, or by inability to pay due to limited income.

Uncertainty:

Uncertainties are caused by a huge range of different outcomes or simply by errors in estimations. Regarding the example of non-payment, an estimation error could occur when trying to rate the probability of non-payment in future.

Missing awareness:

Human behaviour strongly depends on different individual ratings of threat. As the feature of selective perception drives the grading of the risk, risks are hard to determine in an objective way. In the case of mini-grids, the risks are perceived differently by most of the relevant stakeholders (project developers, investors, mini-grid operators and community officials).

Based on this fact, every risk management process which leads to a successful result is done by approximation to an optimal solution. In addition to the basic challenges, some risks could also reveal intense interdependencies and relationships.

Due to individual characteristics of risk awareness, three different basic risk management styles can be distinguished (see figure 11).

- Risk ignorance ("Cowboy"): By ignoring risks or being unaware of the consequences of these impacts, the project developer or risk manager in charge can endanger the whole business operation and put invested resources at risk or lose them. This, in fact, happened to several rural electrification projects where the risk of non-payment was not precisely evaluated and the costs for replacement and maintenance could not be shouldered.
- Risk meticulousness ("Bureaucratist"): In contrast to risk ignorance, the risk meticulousness type would hamper every operation because the total expenses afforded are not in relation to the potential negative

impact of risks. This management style might be found rarely in the field of rural electrification, as this is typical for large corporates operating in saturated markets and public services.

- Adequate risk awareness ("Balanced Action"): The objective of professional risk management should be to reach an optimal level of risk consciousness in order to develop effective and efficient risk mitigation strategies without missing out on attractive business opportunities.

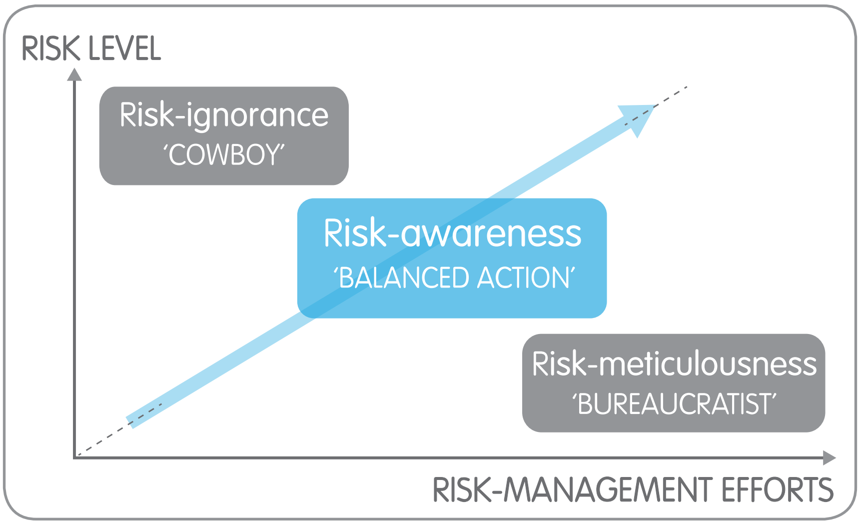

Figure 11: Different risk management styles

3.2. Risk management as a dynamic process

For practical reasons, managing risks in projects is an iterative process that can be divided into several distinctive steps. While diverse definitions of these steps exist, this report suggests a very basic model as shown in figure 12.

The risk management process includes as a minimum four distinctive steps.

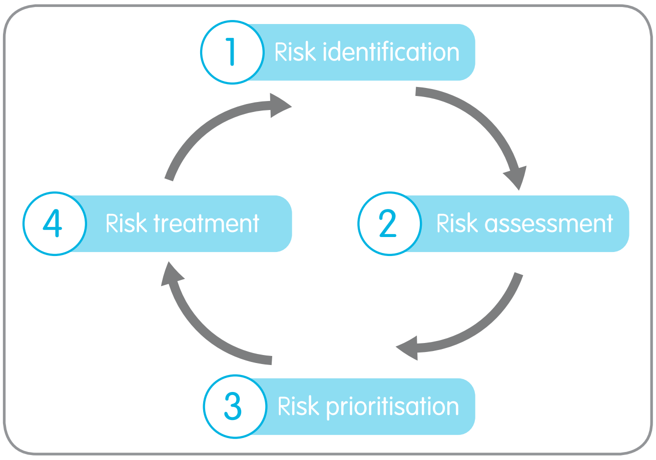

Figure 12: Risk management control circuit

(1) Risk identification

This first step of the risk management process enables the gathering of insights and thoughts on the full range of potential risks. In order to be able to develop a comprehensive list of risks, it is crucial to get input from a heterogeneous group of stakeholders (i.e. in the case of mini-grid projects including developers, investors, communities, large possible customers and mini-grid operators) to ensure that differing risks of all fields of activity are addressed properly. Ideally, the result of risk identification is an overview of the entire risk environment of the project.

(2) Risk assessment

The second step of the process pursues the objective to determine the potential impact of each of the identified risks or risk categories both qualitatively and quantitatively. A quantitative assessment of risk (as suggested in ISO 31000) is based on the damage in case of the occurrence and the probability of occurrence.

(3) Risk prioritisation

Risk prioritisation is a process to compile all risk-relevant information in a format appropriate to make decisions about corresponding risk management strategies during the final step of the process. Common tools for data aggregation are risk maps (shown in figure 13). The different colors give an indication of the risks and their different levels of importance. Data aggregation appropriate reporting tools like risk maps facilitates effective and efficient decision making by the management of the organisation.

(4) Risk treatment

Step 4 of the process represents the ultimate purpose of the risk management process, which is the decision on appropriate risk mitigation measures. These decisions are usually made by the managers in an organisation and, if necessary, also involve selected stakeholders or technical and economic experts. The decision on risk treatment requires an expertise of the effectiveness of certain measures. Additionally, there is the need to consider the benefits of actions and the respective costs.

Process iteration

Successful risk management requires a periodical iteration and an ongoing monitoring of the entire process. This necessity is caused by the fact that new risks may emerge or that risk measures may influence the probability of occurrence or potential impacts of certain risks.

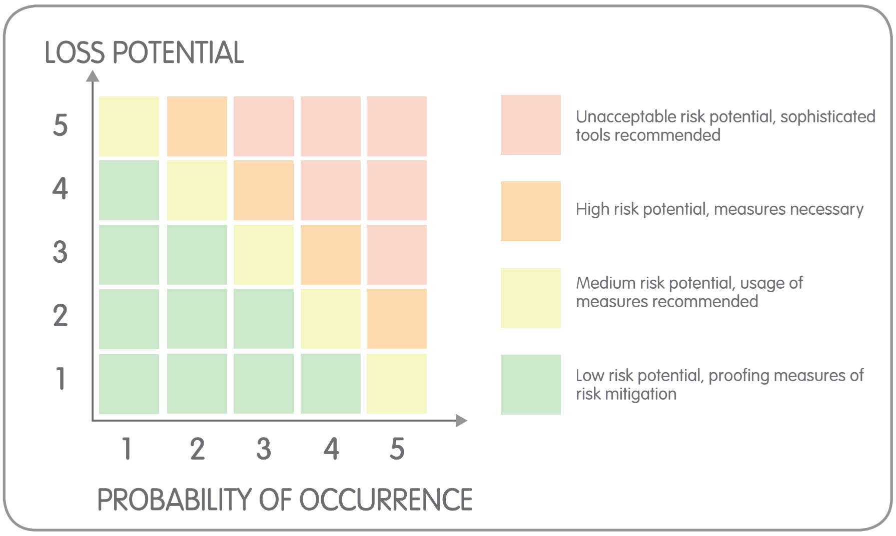

Figure 13: Strategy derivation based on the risk map

3.3. Major categories of risk mitigation strategies

Business risks can be of extremely heterogeneous character and require risk mitigation strategies which help address the specific circumstances and situations accordingly. Nevertheless, within a structured risk management, a differentiation between four basic strategies (primary strategies) is possible. Primary strategy means that the listed strategy should be considered as a first solution and if not feasible or appropriate, then alternative strategies should be taken into account. The strategies can be derived from the structure of the risk map according to the magnitude of the impact potential on the one hand and probability of risk on the other. The four primary-strategies are:

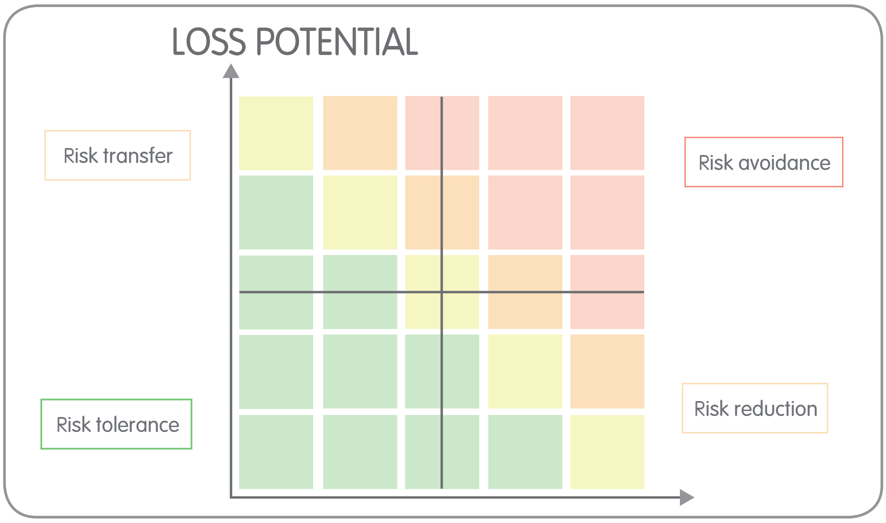

Figure 14: Risk map with four generic strategic risk zones

- Risk tolerance (to accept risks)
- Risk reduction (to mitigate and reduce mainly the potential impact of risks)
- Risk avoidance (to decrease the probability of occurrence of risks)
- Risk shifting (to share, insure, transfer or outsource risks)

For each risk, a careful decision has to be made to choose the best appropriate risk mitigation strategy and the required actions.

Risk tolerance:

Certain risks may occur very rarely and have a potentially low negative impact. Stakeholders should be aware of them, but usually no further actions are required, as in many cases the implementation of risk mitigation measures could imply higher cost than the risks themselves. The recommended strategy in this case is to accept or tolerate the risks while simultaneously observing and reevaluating them. These types of risks are classified as low risk potential.

Risk transfer:

Risks with high impact potential and a low probability of occurrence are able to cause significant harm to an investment or a project. The risks in this category should, wherever possible, be transferred to or covered by a willing third party such as insurance companies as it is not usually viable for the mini-grid companies and other stakeholders, especially lenders, to accept these risks. This risk type is usually classified as medium risk potential.

Risk reduction:

The primary strategy to deal with risks which are characterised by high probability of occurrence and low impact to reduce the risk potential. In this case, project developers might use emergency measures or resource buffers to reduce the possibility of the risk occurrence. Risk reduction can also be achieved through establishing specific operational practices, training and education and technology upgrades. While the complete elimination of all risks is rarely achievable, a risk-reducing strategy is designed to deflect or prevent as many threats as possible in order to avoid the costly and disruptive consequences of a negative event.

Risk avoidance:

In contrast to all other strategies mentioned above, the primary strategy of risk avoidance requires in most cases actions to decrease the probability of occurrence of related risks significantly. Ideally the risks should be mitigated in terms of their probability of occurrence down to a level of the category "risk shifting". In some cases this may only be achievable by avoiding the business or exit of the project if the risks could not be decreased to an appropriate level.

RISK MANAGEMENT FOR MINI-GRIDS

4

Photo credits: FRES; INENSUS; RVE.SOL; Smart Hydro Power; Trojan Battery-ZeroBase

4. Risk management for mini-grids

4.1. Identified and assessed risks

"Conflicts between [...] authorities and micro-utilities have been one of the main reasons for micro-utilities to fail." (SBI (2013)).

Mini-grid operations are exposed to several specific risks which can be a direct outcome of political, economic, socio-cultural, legal, technology and, environmental influences. Based on the input from mini-grid experts and an analysis of mini-grid businesses, a number of specific types of risks have been identified.

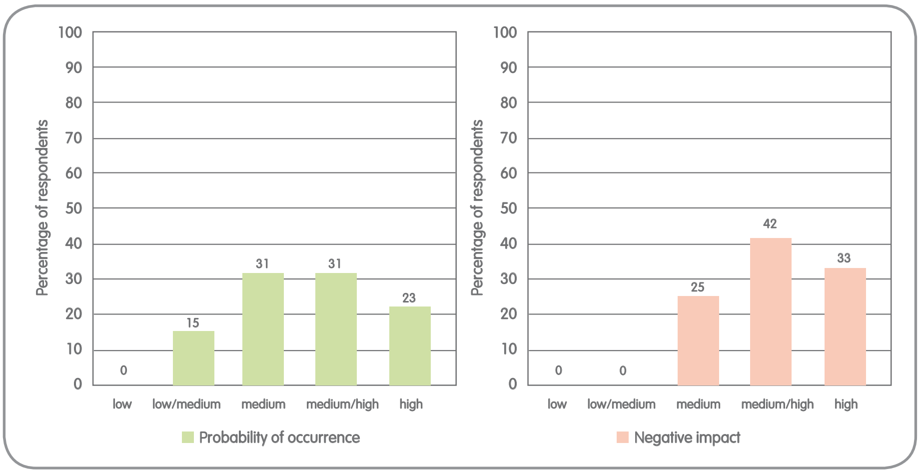

Figure 15: Evaluation of risks: political risk

Political and legal (regulatory) risk: Political risks are a large group of risks caused by any kind of political instability, unrest, war or changes in policy or legal frameworks, e.g. with regards to tariffs. All these risks can pose a significant challenge for the mini-grid operator and disrupt the operation of the mini-grid very quickly. In such cases, political risks with high probability of occurrence may be hard to mitigate without external support.

Other types of political risks which are possible, like delays in approvals, or any arbitrary actions of public authorities (e.g. withdrawal of granted authorisations) could pose smaller or moderately adverse effects on the mini-grid development and operations.

Also, the arrival of the national grid is considered a political risk as the payback of the mini-grid investments and further cash flows are in danger or threatened. This risk is classified as a political risk because the planning and realisation process for grid extension is in most cases highly dependent on the political electrification roadmap of the respective government or public utility.

The results of the survey show that political risks can have a high damage potential, but also occur with a relatively high probability.

Example of interpretation: In case of political risk, 23% of the respondents stated that the political risk is of a high probability. 33% of the respondents stated that the political risks in case of occurrence are estimated to be of high negative impact.

Risk of non-payment of electricity bills: Non-payment of electricity bills by customers could be caused by either inability or unwillingness to pay. The inability to pay for electricity bills occurs when the customer has no available resources to cover their initial connection charge or their recurrent electricity bill. Sometimes, initial connection charges can be higher than the monthly income of individuals and thus be prohibitively expensive and limit the number of customers that subscribe for the electricity service. The risk of temporary inability to pay

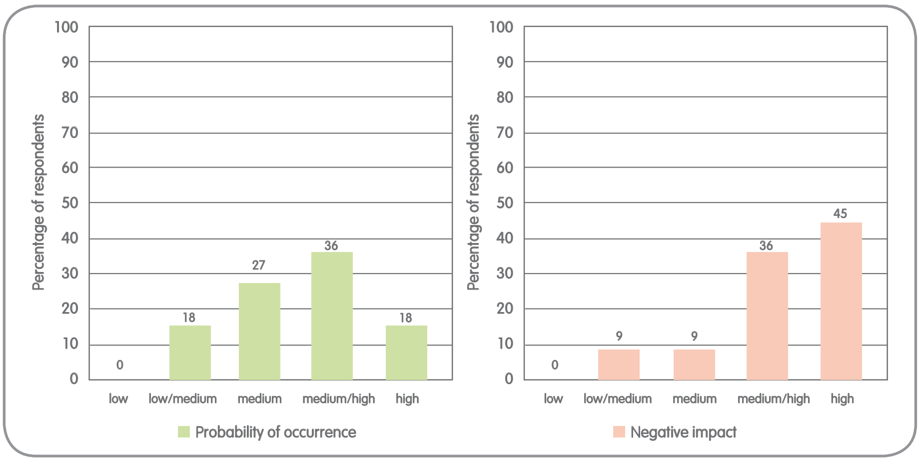

Figure 16: Evaluation of risks: payment risk

is often high in rural areas shortly before harvesting season when the financial resources of individual customers are nearly depleted. The unwillingness to pay can occur, for example, in cases of electricity rate increases or when the customer is not satisfied with the electricity service provided by the operator. According to the experts interviewed, the probability of this risk occurring is medium and the negative impacts on mini-grid operations can be high.

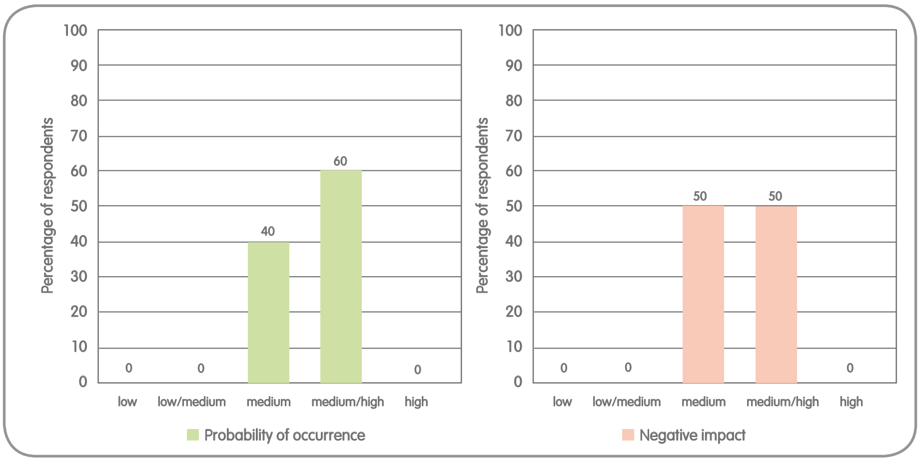

Figure 17: Evaluation of risks: resource price variability

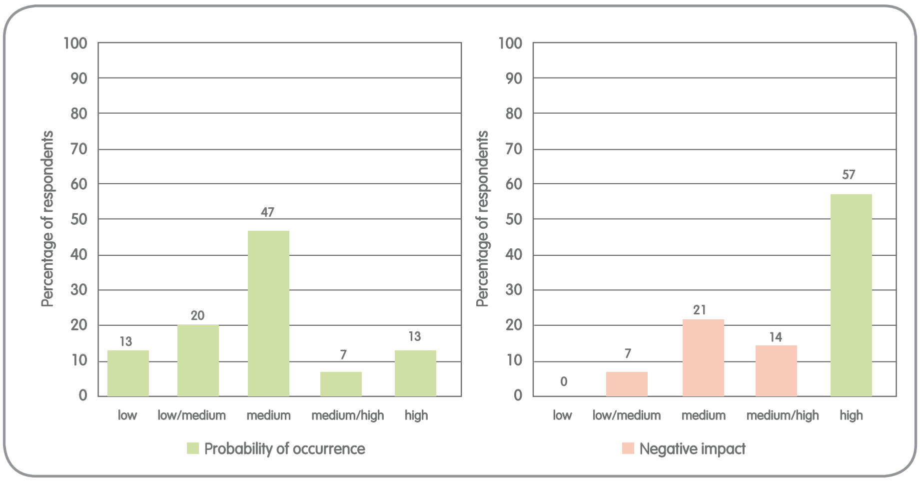

Figure 18: Evaluation of risks: technology and performance risk

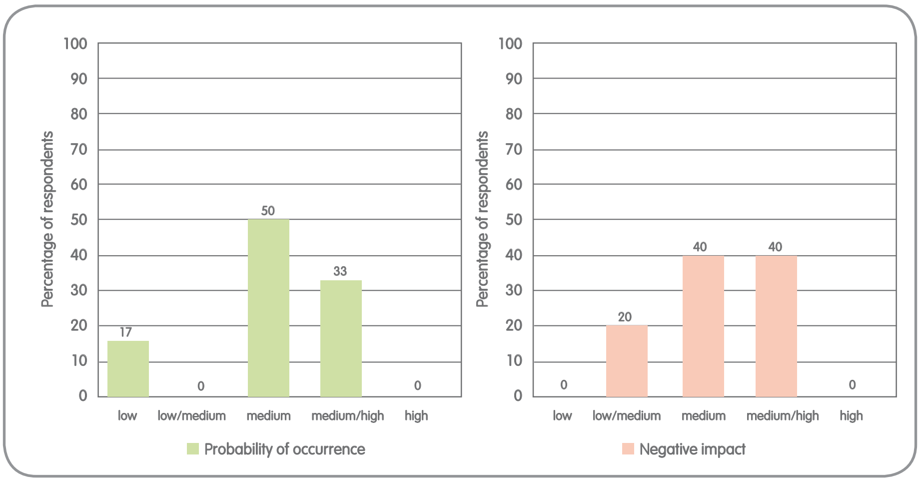

Figure 19: Evaluation of risks: resource availability

Resource price variability: When diesel or biomass is used for power generation in a mini-grid, the increase in price to obtain them can result in higher operational costs. Interviews carried out found that the price for biomass feedstock for gasifiers is steadily increasing due to higher demand by mini-grid operators and other users. Crop yield fluctuations from year to year due to pests, dry spells or heavy rainfalls can also have an influence on the price for biomass feedstock. In the case of diesel mini-grids, the price of diesel in remote rural areas is the main driver for the operational costs of the system. Fluctuating international oil prices and changes in transport conditions make the variability of diesel prices also relevant on the local level.

Technology risk: Technical malfunctions, defects, or failures of the mini-grid system or parts thereof pose a risk that the assets installed do not perform according to the expectations of the mini-grid operator and the customers. The reasons for such problems could be poor quality of components, inadequate installation, or maintenance among others. According to the experts interviewed, the probability of such risks occurring is low to medium, but the negative impacts are very high.

Resource availability: In case of biomass projects, the availability of biomass feedstock could be critical. In cases when agricultural residues are used as fuel, changes in agricultural activities in small rural markets from time to time could result in substitution of fuels. The different calorific values of biomass fuels may require technology modifications and thus have an impact on the performance of the generation assets or cause the plant to shut down temporarily. The risk of resource availability is very closely linked to other risks like environmental risks and resource price variability. According to the interviewed experts, such risks have an above average probability of occurrence and predominantly a moderate impact.

Construction completion risk: A risk with a medium probability of occurrence, but relatively high negative impact is the construction completion risk. Causes that may lead to the non-completion of projects include cost overruns, material shortages, structural difficulties and engineering challenges.

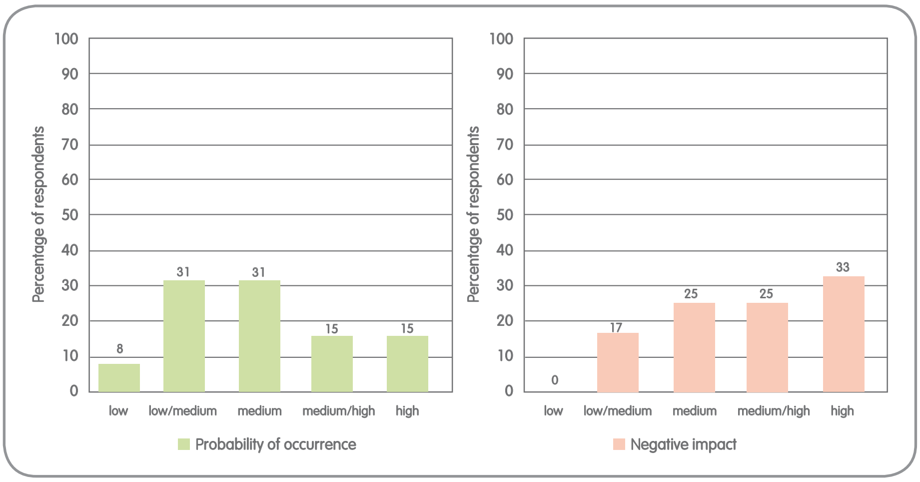

Figure 20: Evaluation of risks: construction completion

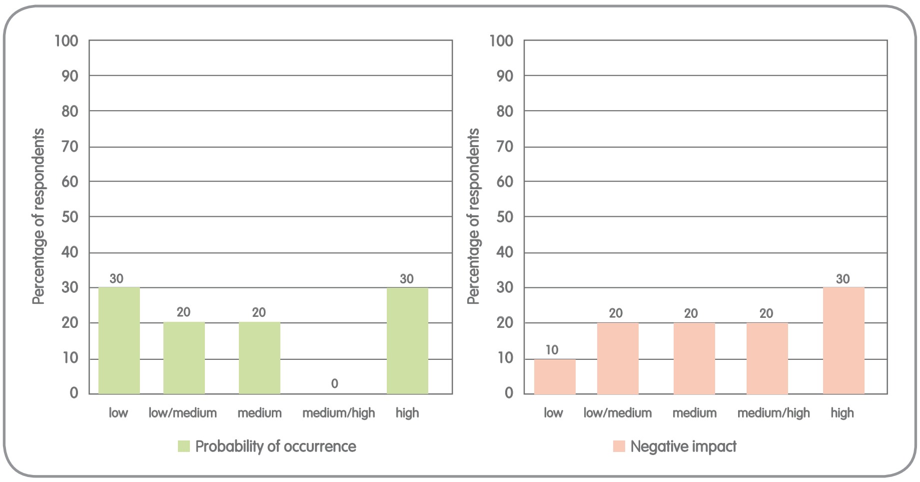

Figure 21: Evaluation of risks: unpredictable demand

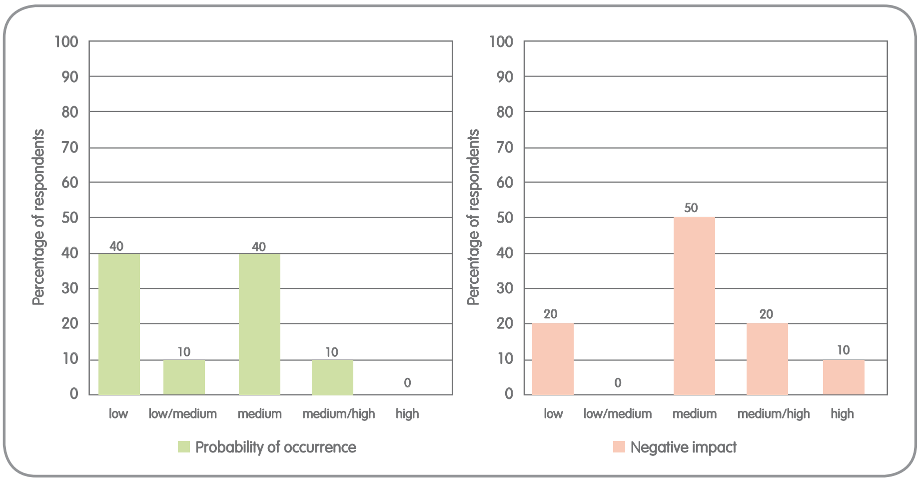

Figure 22: Evaluation of risks: social acceptance

Risk of unpredictable electricity demand: Accurate projections for electricity demand are very difficult to make, yet extremely important for the design and sizing of the electricity generation assets in a mini-grid and therefore also for the cost structure of a mini-grid project. Once the mini-grid system has been installed, unexpected changes in electricity demand can cause significant negative impact on mini-grid economics. Demand which is lower than expected may result in reduced income for the mini-grid operator and can endanger the financial viability of the mini-grid investment relatively quickly. Similarly, a higher than expected demand can cause power shortages, damage to components and result in unplanned blackouts. According to the mini-grid experts interviewed, the probability of this risk occurring can differ from case to case, however the risk is from medium to high.

Social acceptance risk: One of the tasks of the mini-grid developer is to ensure that the mini-grid project is well embedded in the socio-cultural context of the village or the region where the project is built. If public opinion, transparency and involvement of local capacities are not part of the overall mini-grid project, the risks of the rural electrification project failing are high. The interviewed experts indicated that the probability of occurrence of such risks is low to medium, and that the negative impacts are moderate.

Environmental risk: This risk type is caused by direct environmental influences which can include, for example, weather events like cloud coverage, low rainfall, hail and lightning. Environmental risks could affect the development and operation of mini-grid projects by making roads or water routes impassable.

In the case of biomass facilities, decreased harvest due to bad weather conditions could lead to scarcity of the biomass feedstock and hence high prices for fuel. Experts in the mini-grid sector consider such risks to have relatively low probability, but according to experiences, the impact of such risks could range from low to medium.

Force majeure risk: The force majeure risk is very closely linked to the environmental risk, as environmental disasters like severe storms, typhoons, sandstorm, volcanic eruption, earth quakes, mud slides, etc. are considered as force majeure.

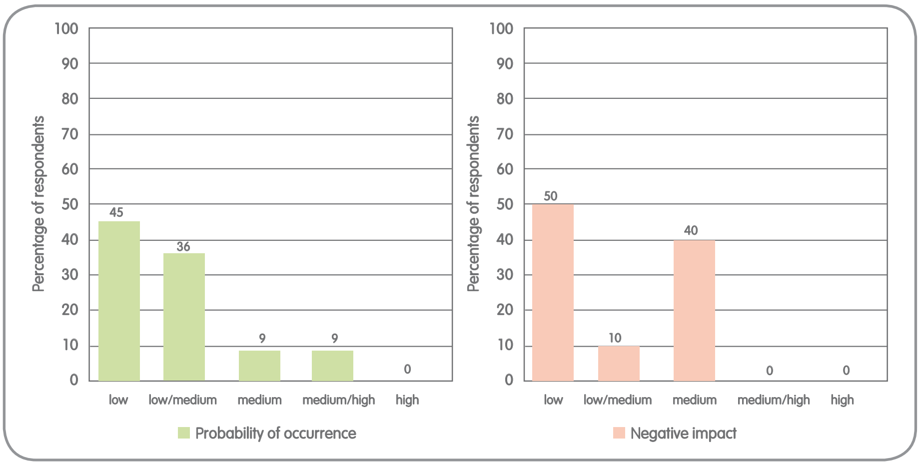

Figure 23: Evaluation of risks: environmental risk

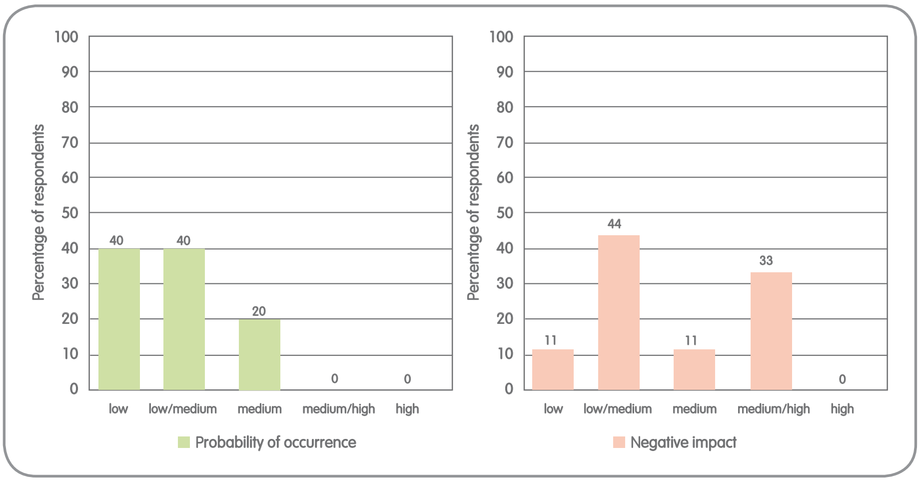

Figure 24: Evaluation of risks: force majeure

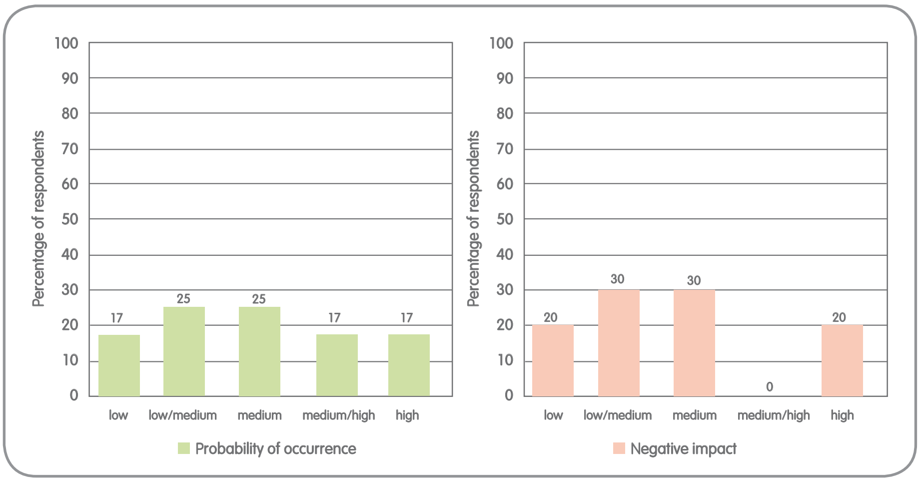

Figure 25: Evaluation of risks: foreign exchange risk

Foreign exchange risk: Project-related investments are exposed to fluctuations in foreign exchange rates, if the cash flow of the project is in local currency.

The foreign exchange risk is measured by the variance of the domestic currency value of assets, liabilities, or operating income which is attributable to unanticipated changes in exchange rates.

Theft and vandalism: Fuel, copper wires, PV panels and other valuable materials or system components, for which there is a secondary market, are in danger of being stolen. Particularly when considering ongoing conflicts of interests between the stakeholders of a mini-grid, vandalism could be a major factor. According to the mini-grid experts interviewed the probability of such a risk occurring is medium to low and the negative impact can be moderate.

Operational risk: Operational risks are mainly caused by imperfections such as miscommunication between business and customer, lack of skilled technical or managerial personnel, conflicts of interests, fraud, temporary power outages, etc. Operational risks can affect electricity customer satisfaction, shareholder value and the reputation of the mini-grid operator. The probability of occurrence of such risks is estimated by experts as medium, and the impact is low to medium.

4.2. Risk prioritisation and risk reporting

After the identification and assessment of the impact of individual mini-grid risk has been completed, the data can be plotted on a risk map. As mentioned earlier, risk maps are a common and widely used method to visualise the results during an ongoing risk management process. A risk map helps to better understand the current risk situation at a particular moment in time and also represents the outcome of risk mitigation interventions. The aggregate results of the risk assessment presented in the previous chapter allow to plot the individual risks into one of the four risk strategy quadrants (tolerance, reduction, transfer and avoidance). By following this procedure, the decision maker (in most cases the project developer) can obtain a first insight into the type of basic risk management strategies and mitigation efforts necessary for a certain project.

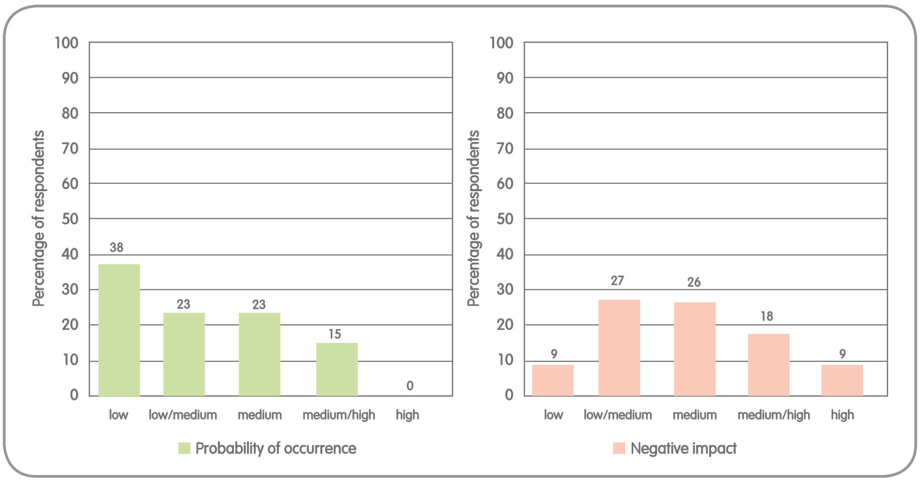

Figure 26: Evaluation of risks: theft and vandalism

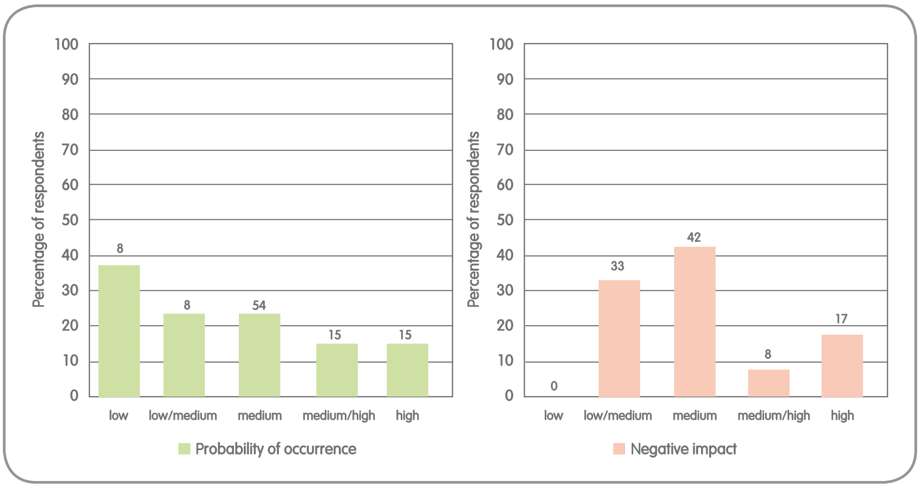

Figure 27: Evaluation of risks: operational risk

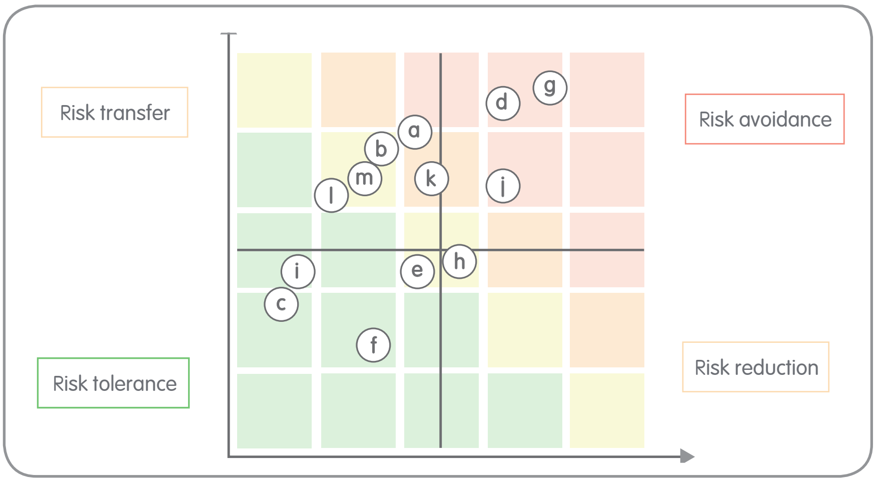

Figure 28: Aggregated risk data of mini-grids

4.3. Deriving risk mitigation measures

According to figure 28, the following four general risk management strategies can be derived from the reported data in the risk map. Every risk is positioned in one of four sectors which are linked to one of four available generic risk-strategy approaches. These approaches are divided into four escalation levels:

- Level 4: Risk avoidance
- Level 3: Risk transfer
- Level 2: Risk reduction
- Level 1: Risk tolerance

The specific methods for managing each risk have to be elaborated and evaluated separately. The measures described below provide an overview of what measures can be implemented as part of a standardised risk management process. The derived recommendations should be seen as primary strategies which are to be considered as first mitigation solution. It is important to know that in some cases, the primary strategy is not achievable or may not be appropriate (e.g. due to lack of reasonable products in case if risks are transfered to a third party). In this case the strategy related to the next lower risk level should be taken.

Strategies for risk avoidance:

Risk avoidance means that the probability of occurrence should be reduced significantly. The inability to mitigate such risks can lead to hindrances for the project or financial losses. According to our analysis, the following risks that require measures that reduce the impact and/or probability of occurrence include:

(d) Payment risk
(g) Political risk
(j) Resource price variability.

But of course, with regard to these risks, measures have to differentiate between already existing and new mini-grids.

The payment risk or risk of non-payment is one of the most important threats mini-grid projects have to overcome. Efforts that can mitigate such risks can be incorporated in various stages of the design and operation of a mini-grid. First, customers need to be made aware of the consequences of non-payment such as supply cut-off or penalties due to delayed payments. Secondly, mini-grid developers could also contribute to increasing their customers' ability and willingness to pay by promoting productive use of electricity and hence increase the income of the customers. Additional awareness creation measures, such as the high costs of traditional fuels and the negative health impacts of fossil fuels like kerosene could reduce the risk of non-payment. Ease of settling bills and non-bureaucratic procedures for getting a connection and paying for electricity consumed can improve the rate of tariff collection. Furthermore, the utilisation of smart metering systems equipped with tamper protection or in combination with incentives for electricity use, could also contribute to stabilising payments and cash flows. Further solutions to overcome such problems includes establishing an appropriate customer relationships management systems, and ensuring that conflicts are resolved via established community institutions and/or and involvement of relevant stakeholders like village leaders or village power committee management.

Political risks differ in each country and affect businesses in general. Political risk maps or security risk maps, for example like the ones developed by the company "Controlrisks", could be useful to get a first insight when entering new markets. At national level, some political risks can be covered by insurance instruments, however the ones that are usually available are designed primarily for large-scale projects and can be hardly accessible for small- and medium-size projects like mini-grids. Nevertheless, some instruments are available from Overseas Private Investment Corporation (OPIC) or the Africa Trade Insurance Agency (ATI-ACA). For the time being, insurance instruments specific to mini-grids remain largely unavailable. Although policy regulations at national level are improving in some countries, small regional or local mini-grid projects often face a regulatory framework which is not always clearly determined. An important measure for dealing with political risks is to engage and build the trust of local authorities.

The continuous involvement and consultation of local authorities during the development and implementation of mini-grid projects is an approach which has proven successful in ensuring fruitful cooperation and successful mini-grid operation. Additionally in the case of the impending arrival of the national grid, project developers and/or mini-grid operators should seek the dialogue with the responsible authorities at the earliest point to develop an appropriate strategy. To generate cash flow even with the arrival of the national grid, a feed-in tariff may often be an optimal solution to overcome this risk.

The risk of resource price variability has to be considered for systems using diesel gensets or biomass gasification facilities. As the price of diesel in rural areas is closely linked to international prices, national fossil fuel policies and local factors like transportation costs, mini-grid project developers relying on diesel generators have relatively few opportunities of mitigating the risk of increasing diesel prices once the system is installed. During the design stages of hybrid mini-grid projects, the share of diesel can be adjusted in order to reduce the exposure to price volatility risks. Project developers, who implement biomass-based energy facilities, need to ensure that the price is stable over time. In this case appropriate mitigation strategies could be:

- Establishing close relationship to local biomass supply sources;
- Creating dependency by supplying the supplier (waste-ash as fertiliser); and
- Offering bargain electricity price for biomass suppliers (instead of pay for biomass).

Strategies for risk transfer:

Based on the analysis conducted, the following types of risks can be outsourced:

(a) Technology and performance risk
(k) Resource availability
(b) Construction completion risk
(m) Risk of unpredictable demand
(l) Social-acceptance risk

Construction completion risk is among the few risks for which insurance products are readily available. For the other risks, alternative measures for risk transfer are possible.

Technology and performance risks can be minimised through the use of standardised components which adhere to quality standards. It is advisable for mini-grid developers to rely on component suppliers who offer quality products that come with comprehensive warranty and customer service. Performance risks can also be mitigated by hiring reliable contractors for installation and certain elements of the operation of the mini-grid. An effective approach is also to rely on construction consultants that are tasked to oversee the entire project implementation and ensure that contractors comply with the expectations of the developers. The International Federation of Consulting Engineers (FIDIC) has published a number of useful guidelines and contract models for construction, plant design, EPC, and operation of projects that have been used by some mini-grid practitioners.

Resource availability risks are of major importance for project developers focusing on biomass gasification projects. The scarcity of feedstock for the plants can mean a disruption in the power supply or unplanned outages that can lead to conflict with customers. An effective strategy to manage such risks is to diversify suppliers and sources of feedstock. Another possible option for mini-grid operators to mitigate such risks is to attract processors of agricultural products who operate rice dehuskers or grain mills to become electricity customers and use their organic waste as feedstock for the biomass gasification plant.

Because the construction completion risk is very close to the area of high-risk potential, it could be advantageous to consider the use of appropriate tools or strategies. Basically, this specific type of risk could be insured in some cases by means of a Delay in Start Up insurance. This instrument is in most cases not available, particularly for small-scale mini-grid projects. As a result, due to its relatively high risk potential further development of these tools is necessary to meet the needs of mini-grid projects.

The mitigation of the risk of unpredictable demand could be very challenging as demand in unelectrified areas is hard to determine in advance. Guidance about the potential demand that can be expected from a mini-grid could be obtained from mini-grid projects of similar size and customer composition. Another approach could be to limit the initial generation capacity and increase it gradually as demand grows. Tariff designs and prepaid meters are additional options that could be applied to manage consumption according to the available mini-grid capacity. A possible tool that has been suggested by some practitioners is a demand guarantee which could be provided to the mini-grid operator by a third party to cover for losses in case of deviations in demand that the operator is unable to predict.

The risk of social non-acceptance is relatively difficult to manage due to the complexity of different factors that can lead to it. A reliable strategy to mitigate such risks is to include the whole community throughout the development and operation of the mini-grid project. Partnerships with local organisations that have a proven track record in carrying out community projects in the area can help to facilitate the relationship between the mini-grid developer and the customers. The implementation of capacity building measures and dedicated promotion of productive use of energy could also help support in establishing local support.

Strategy of risk reduction:

The strategy of risk reduction could be recommended for the following category:

(h) Operational risks

Operational risks are a large set of risks that are best dealt with by the mini-grid operator. Risks like administration errors or fraud can be reduced by applying some simple standardisation like appropriate accounting and regular auditing. The establishment of internal rules and the standardisation of processes (e.g. for asset management, procurement, maintenance) is a good approach to streamline operations and reduce the occurrence and impact of potential risks. Social conflicts can be avoided by putting in place appropriate relationship management systems and involving external stakeholders as advisors. Regular training of staff can ensure continuous improvement in operational efficiency and service delivery.

Strategy of risk tolerance:

A risk tolerance strategy could be recommended for the following risk categories:

(c) Environmental risk
(f) Force majeure risk
(i) Theft and vandalism
(e) Foreign exchange risk

As risk management in the cases of environmental and force majeure risk basically requires huge efforts, an implementation of risk-appropriate strategies could entail higher costs than benefits.

The risk of theft and vandalism could be mitigated by developing a sense of ownership within the local community. Direct involvement of electricity users during the planning, development and implementation of the system could help to strengthen cooperative relationships between the operator and the users. However, any planned action to mitigate risks should be tested to evaluate its advantages for the project.

Project developers and mini-grid operators transacting with significant amounts of foreign currency could cover risks of currency fluctuations and depreciation by using hedging instruments. However, such instruments may be complex and expensive. In a nascent market like mini-grids currency hedging instruments could, for example, be offered by international financing organisations within the scope of a new financing mechanism.

Furthermore, by involving local investors, the risk of foreign exchange volatility could be eliminated completely. Also in case of feed-in tariffs, project developers often prefer payments in the currency their bank loans are accounted in (World Bank (2013)).

4.4. Examples of existing risk management instruments

While there are a lot of available tools used for risk management in developed economies, only relatively few of these are available to or have been adapted to mini-grid projects in developing countries. Risk maps, which were presented earlier are one of the most common tools used by risk management practitioners. Some other existing tools include:

Cash flow at risk

Cash flow at risk is a Monte Carlo simulation methodology with a long time horizon aimed at determining the potential impact of risks on standard financial parameters of a business. Cash flow at risk offers a statistical approach that demonstrates the market in the best and worst case. This methodology can be very useful for decision makers to estimate risk-adjusted earnings in future, and to budget projects appropriately. For example, a haulage contractor can use it to simulate what fuel costs he might incur over six months, a year or longer depending on the variability of fuel price.

Risk-based audit

The risk audit is defined as a methodology that links internal auditing to an organisation's overall risk management framework. Risk audits allow internal auditors to provide additional certainty to the risk manager or board that risk management processes are treating risks effectively.

Partial Credit Guarantee (PCG)

Partial Credit Guarantees (PCGs) cover private lenders against various risks during a specific period of the financing term of debt for an investment. PCGs are generally provided for privately funded projects and are specially designed to help financial institutions become more comfortable with lending to specific groups of borrowers. Guarantees help share risks with lenders and help to improve the perception of risk of lenders.

Partial Credit Guarantees are available for example at the following institutions:

- World Bank
- International Finance Corporation (IFC)
- Asian Development Bank (ADB)
- Inter-American Development Bank (IADB)

Political risk insurance and policy coverage

Political risk insurance (PRI) can be very useful in developing countries to cover risks like breach of contract, changes in political regime, currency inconvertibility, transfer restriction, expropriation, terrorism, war, and civil unrests. Some products also cover against e.g. major changes to feed-in tariffs, critical changes to taxation and repudiation of concessions. Providers of PRIs include:

- the Multilateral Investment Guarantee Agency (MIGA);
- the Overseas Private Investment Corporation (OPIC);
- export credit agencies; and
- private insurers (e.g. AXA, Lloyd's of London).

For example, OPIC offers discounted insurance rates for SMEs and the scope could be determined case by case for every particular project and application.

Weather insurance and weather derivatives

Generally, weather insurance products cover against all possible impacts caused by any change of the expected weather conditions. Products insuring against weather impacts are mostly used for offshore wind energy projects, but they could be extended to cover other weather-related impacts. There are some small-scale weather insurance products available, for example offered by ALLWEATHER Insurance Agency, which cover rain insurance, temperature insurance, wind insurance, and several more to control the financial risks associated with adverse weather.

Transport insurance

Transport insurance is a common insurance type, which is widely used by project developers and entrepreneurs. Transport insurances are offered by most of the transportation companies operating internationally. The value of transported project-related assets is covered by an insurance which is offered by the logistics company. The insurance policies cover against loss and damage due to causes such as fire, collision, embezzlement, etc.

Beside the already described financial risk-mitigation instruments, several other tools would be of benefit for rural mini-grids e.g. the foreign currency hedging.

Usage of risk-management methods and tools

	Frequency of usage
Risk map	RARELY
Cash flow at risk	MEDIUM
Risk audits	RARELY
Partial credit guarantee	MEDIUM
Political risk insurance	RARELY
Weather insurance	RARELY
Transport insurance	OFTEN

Figure 29: Frequency of usage of common risk management tools and methods by mini-grid practitioners

Foreign currency hedging

Cross-currency swaps are a common instrument for mitigating foreign exchange risks of large investment projects. The swaps represent a contract in which one party borrows one currency from another party and at the same time lends a second currency to the same party. Such swaps are usually used by financial institutions and are often unsuitable for smaller investments like individual mini-grid projects. Nevertheless, in the case of aggregation and clustering of smaller projects currency swaps can become relevant for mini-grid projects.

Figure 29 presents the results of our survey on the use of standard risk mitigation tools by mini-grid practitioners. The limited use of these tools by mini-grid practitioners is an indication that there is a substantial potential to benefit from structured approaches and procedures to assess and deal with risks in order to increase bankability of projects and ensure sustainable operations.

4.5. Costs and benefits of risk mitigation

While risk management can result in various benefits for a mini-grid project, its implementation requires time and resources to prevent hazardous incidents from occurring.

Some of the most important benefits that risk management instruments deliver is a substantial reduction in the cost of capital and potentially of project costs as well.

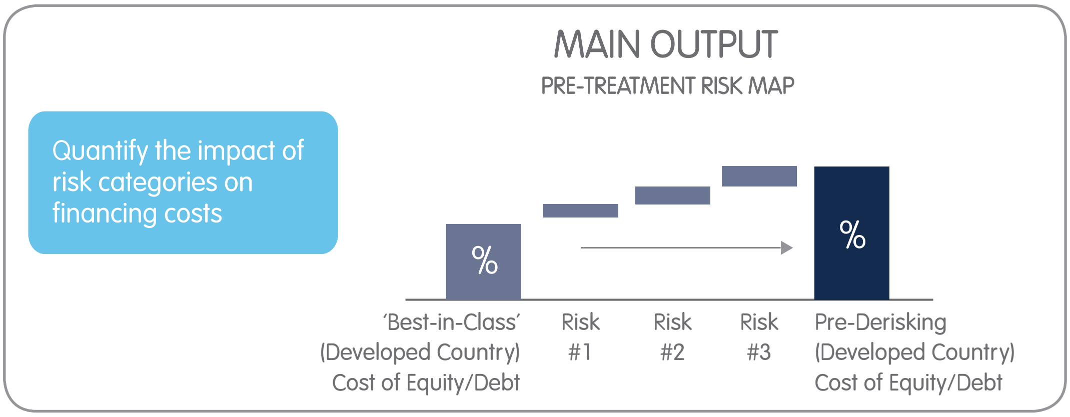

Figure 30: Cost of capital before risk mitigation step 1

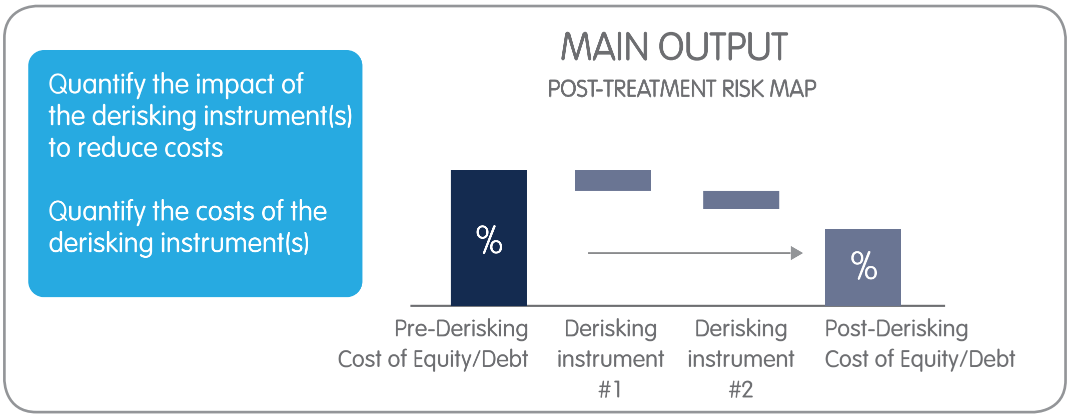

Figure 31: Cost of capital after risk mitigation step 2

Yet, the identification of sources of risks and the implementation of risk mitigation measures carry a substantial amount of costs, which need to be considered during project planning. These costs results from the process of risk assessment as well as from the design of measures and their respective implementation.

A sound risk management has the target to balance out the cost of risk management and the benefits of reduced negative impacts. Risk is properly accounted for when the costs of risk management do not exceed the potential cost of risk impact (figure 32).

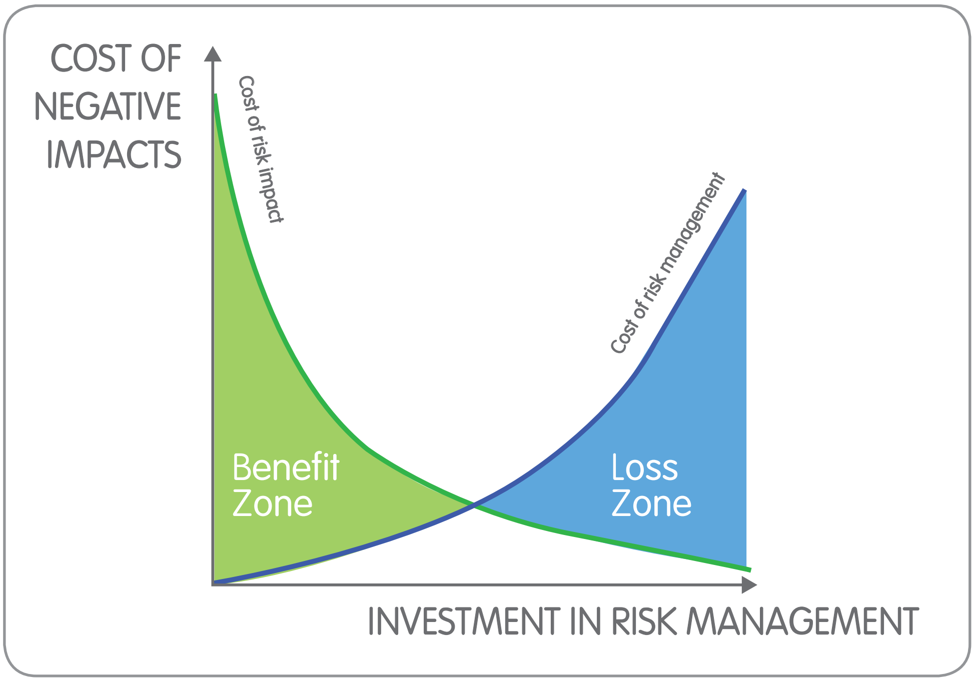

Figure 32: Costs and benefits of risk management

ALTERNATIVE METHODS FOR IMPROVING THE RISK PROFILE OF MINI-GRID PROJECTS

5

Photo credits: Photalia; Studer Innotec; Sunlabob; Trojan Battery - ZeroBase

5. Alternative methods for improving the risk profile of mini-grid projects

Risk assessment carried out for a mini-grid project or a cluster of mini-grid projects often results in the identification of a number of risks with high impact potential. A viable approach to deal with the set of risks is to develop a comprehensive strategy for risk management. Once the risk process cycle is completed and measures to mitigate specific risks have been implemented, the risk profile of the mini-grid project is expected to improve.

The result of the successful risk management for a set of risks has been plotted on a risk map shown below. The left hand side of the figure shows the individual risks and their respective impact potential and probability of occurrence prior to the implementation of risk mitigation measures. The right hand side shows the result of the risk assessment after measures have been implemented. The fictitious example below shows a notable reduction in the loss potential and the probability of occurrence (figure 33).

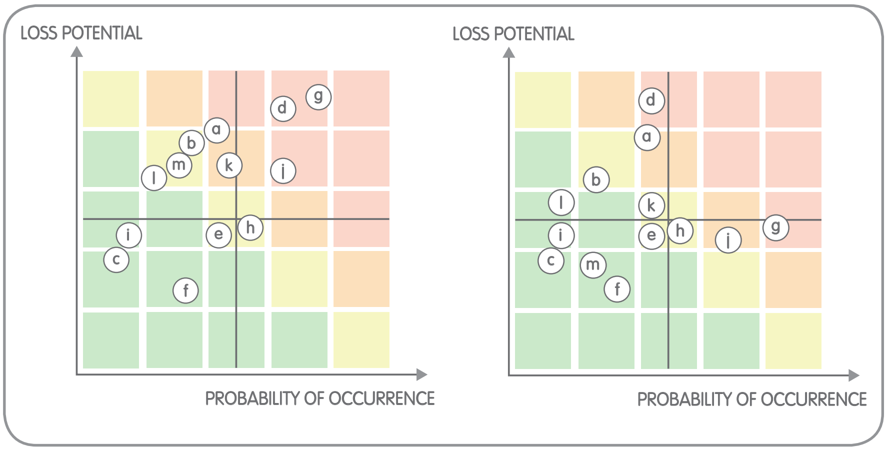

Figure 33: Risk maps before (left) and after (right) risk treatment.

The results of our survey demonstrated contradicting results. While the particular risks of rural electrification projects like mini-grids were graded rather high, standard methods for risk management were seldom used and were unknown to some practitioners. Based on the analysis carried out and the interviews with industry experts, it was observed that:

- Mini-grid installers and some developers are rarely in charge of the long-term viability and sustainability of a mini-grid project and therefore make limited use of systematic risk management.
- Despite the availability of some existing risk management tools for large infrastructure projects, their application in mini-grids projects is either impossible or too costly.
- Rural electrification experts see a need for an easy-to-handle and industry-specific risk management procedure that is adapted to the nature of mini-grid projects and fits the needs of stakeholders in the sector.

5.1. Standardised Risk Management Procedure (SRMP)

The development and implementation of a Standardised Risk Management Procedure (SRMP), designed and agreed upon by representatives from the rural electrification industry and from relevant financial institutions could bring various potential benefits to the mini-grid sector. It can help accelerate rural electrification by bringing private capital. The SRMP can help assure investors that the rural electrification industry can meet the challenges of project implementation and operation in rural areas and provide objective and transparent information whereby risks can be mitigated and spread across a portfolio of projects. The SRMP could increase risk awareness significantly and improve risk treatment within the rural electrification industry. Furthermore, a SRMP can diminish the knowledge and language gap between investors and project developers by:

- identifying and assessing the risk profile of mini-grids;
- suggesting a mutually agreed and standardised risk treatment program; and
- implementing a reporting procedure which is useful for all stakeholders – including financial institutions – to communicate risk profiles and the status of applicable risk mitigation measures.

A higher degree of understanding and adequate management of risks for investment opportunities like mini-grids would pave the way for companies to enter the rural electrification market. Such a tool could not only allow financial institutions to get involved but could also be used by large utility companies to increase their level of activity in this sector.

5.2. Sound technical and business model design

This area of activity comprises measures which have been deployed either in already implemented mini-grids (see chapter 6: Case studies). Such measures include for example:

- Comprehensive technical design of the mini-grid system in compliance with a sound assessment of the local conditions and the expected load profiles;
- Electricity tariff and payment arrangements reflecting socio-economic parameters like willingness to pay, income fluctuations and payment culture;
- Establishment of reserve accounts to cover maintenance and servicing costs as well as unexpected expenses; and
- Utilisation of an ongoing risk management process.

The topics related to technical design of mini-grids have already been treated sufficiently in existing literature. Hence for the purpose of this document, this has not been covered in this publication.

5.3. Promotion of productive use and local entrepreneurship

Measures that address the sources of risks can be integrated as part of the business model of mini-grid developers and operators too. One proven strategy for mitigating several risks at the same time is the promotion of productive use of electricity. The majority of interviewed company representatives stated that they have already been exploring possibilities to encourage productive use with great effort.

Efforts to promote productive use of energy either by enhancing the productivity of existing businesses or through the establishment of new businesses is a viable measure to make optimum use of the available power.

Linking rural electrification with entrepreneurship initiatives to stimulate productive use of electricity is an appealing proposition for developers and could be followed as a primary strategy to increase the viability of the investment and the positive socio-economic impact wherever possible.

New and additional commercial users of the electricity could enable a higher and more balanced distribution of the load, hence increasing the utilisation factor of the plant and possibly reducing costs of storage in the case of PV systems. In the case of hydro power based mini-grids, an optimised load profile could help ensure lower mechanical stress on components and thus reduce operation costs. Such improvements means that electricity can be offered at a lower rate to customers.

Commercial activity resulting from the use of electricity enables income generation and could contribute to local employment creation. Higher incomes for the self-employed and higher wages for the employed increase the ability to pay and could have a positive impact on tariff collection. In rural areas, the agricultural sector is well placed to benefit from electricity which can enable irrigation and processing of agricultural products.

Although beneficial for mini-grid operation, the promotion of productive use represents a demanding and challenging task for mini-grid developers as efforts to accomplish such tasks often reach far beyond the mere installation of a power plant. Potentials for productive use of energy need to be identified and specific measures need to be implemented. The approach may require investments in technologies and additional capital at the early stage of project development. In order to reap the full benefits of productive use of electricity, cooperation with public authorities, economic development specialists, educational institutions and community organisations is encouraged.

5.4. External support and the role of the state

After the installation of the mini-grid is completed, mini-grid operators usually require support to deal with a number of technical and managerial challenges (see chapter 2.2). Unfortunately, professional support may not be readily available in rural areas or may be too costly for the operator. In countries where the public sector is actively involved in rural electrification, a possible solution to provide support to mini-grid operators is through the establishment of a dedicated unit within a public institution or avail support as part of a public-private partnership.

Dedicated support structures could assist several mini-grid developers and operators simultaneously and ensure the smooth provision of electricity in multiple communities.

Such support structures could also take on a role of enhancing the practical skills of operators.

Specific support that such mini-grid support centre could offer may include:

- technical assistance during operation and maintenance;
- advice on financial management and administration;
- coordination and mediation with electricity consumer groups or similar Institutions;
- advisory on tariff design and adjustments;
- negotiation with banks, insurance companies and relevant public authorities;
- arbitration in cases of conflict; and
- training new staff and holding refresher courses for existing staff.

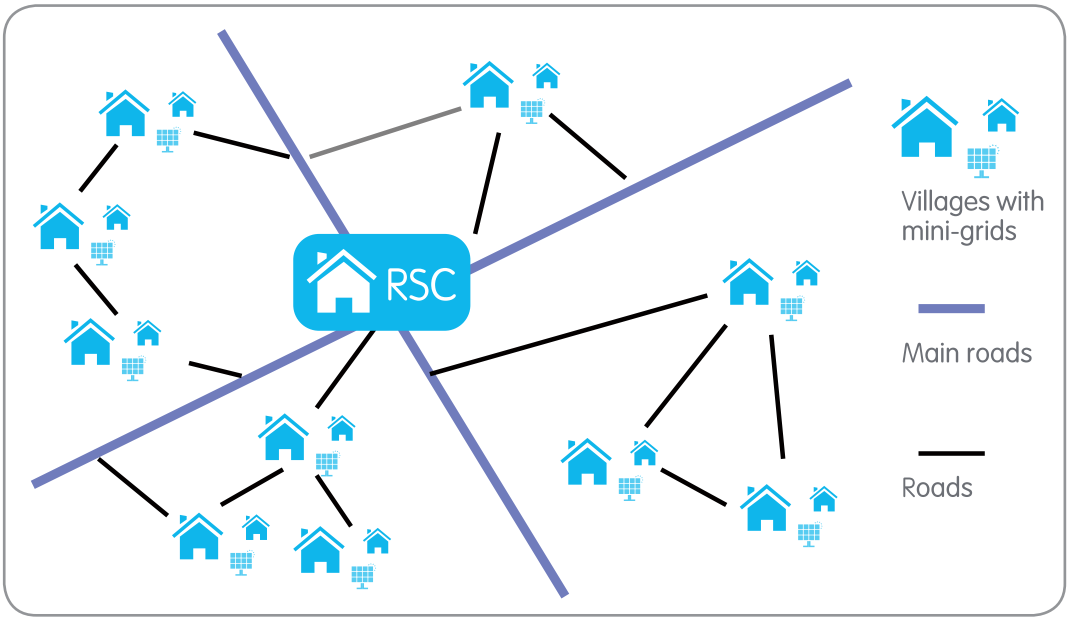

Figure 34: An example of a Rural Support Center (RSC)

The work of support centers could e.g. be funded by public resources or implemented as a public-private partnership.

Mini-grid operators and developers could receive the assistance free of charge or at reduced rates.
The added benefit of such centres is that they can facilitate linkages with public authorities, development institutions, academic institutions, as well as financiers.

The assistance provided could be dependent on the operator's needs and experience and be availed either as a standard package of support or through a customised set of services.

Such efforts by public institutions could help enhance the effectiveness of efforts on decentralised electrification through the private sector by improving the capacity for mini-grid development and operation and addressing specific challenges around mini-grid implementation.

Nevertheless, the establishment of support structures should not distract attention from the core tasks of policy makers in developing conducive regulations and policy.

Clarity around tariff levels, licencing requirements, minimum standards for quality of service and transparent information on where and when extensions of the national grid are to be expected are as important for the investment decisions of mini-grid developers as is the day-to-day operation of mini-grid systems.

CASE-BASED ANALYSIS ON THE ECONOMICS OF MINI-GRIDS

6

Photo credits: Gunnar Wegner; Schneider Electric; Smart Hydro Power; Sunlabob; Trojan Battery - ZeroBase

6. Case-based analysis on the economics of mini-grids

6.1. Dimensions and criteria of evaluated data

Mini-grid projects are faced with several specific challenges, depending on the used technology, business concepts and implemented area. Thus, it is necessary to analyse the similarities and differences with respect to the varieties of risks.

Several different but representative projects are presented and analysed in this chapter. The specific projects have been chosen due to their unique key characteristics (UKC) with regard to their different power generation techniques, their different business models approaches and their integration in the given circumstances. Please find the detailed project descriptions on the next page.

a) PV/Diesel mini-grid with anchor customer (Kirchner/Uganda)

Photo credits: Kirchner

>> Specific UKC: Anchor business customer

Project overview and structure:

Kirchner Solar Group, founded in 1991, a leading Germany based PV distributor, initiated a groundbreaking project in Uganda in 2012.

The basic idea of the entire project was driven by the fact that the rural population with daily incomes of USD 1-2 could not contribute to sustainable project finance.

The solution of Kirchner Solar and their cooperation Partner GIZ was to ensure steady revenue streams by using a telecommunication company as an anchor customer. Remaining overcapacities of the PV power-generating source allow three connected nearby villages to make use of the electricity. In addition to the anchor customer, nascent micro-entrepreneurs are contributing to increasing the long-term demand.

In this particular case, GIZ assumed the following tasks, among others:

- Connecting the project developer to the mobile communications company;
- Embedding the project into regulatory frameworks; and
- Capacity building of local service providers.

Derived risk-mitigation strategies:

The mini-grid project implemented by Kirchner Solar is an outstanding example for reducing the payment risk, including the lack of willingness or ability to pay. To ensure stable loads and cash flows, Kirchner Solar is using an anchor customer, in this particular case a telecommunication tower, which reduces one of the major risks.

By electrifying nearby villages, the project developers foster the generation of additional revenues by supporting local micro-entrepreneurship.

Photo credits: Kirchner

b) Nam Kha II hydro-pv-diesel mini-grid (Sunlabob/Laos)

Photo credits: Sunlabob

>> Specific UKC: Risk management by asset splitting

Project overview and structure:

The innovative Sunlabob, a Laos based company, has set up a rural electrification project which is installing a hybrid AC mini-grid providing 650 households in five villages with reliable energy.

On the technical side, power is generated by a combination of photovoltaic cells, a hydro plant and a backup diesel genset. All project assets are divided into moveable assets and non-moveable assets. The moveable assets, such as power generating hardware and control and regulation units, belong to the private player and non-moveable assets are publicly owned.

The villagers are now able to run small machines to support micro-entrepreneurship. For daily operation purposes, a village energy committee has been initiated. The ECF (Enterprise Challenge Fund) has contributed 49% of project costs with a total volume of around USD 500,000.

Project outcome:

- The Nam Kha project will serve over 4,500 people with electrical energy, currently serving more than 2,000.
- Creation of four jobs as every village grid has its own caretaker who is responsible for daily operation and maintenance.
- The village communities could establish small micro businesses to improve livelihoods. Some businesses have already been established. According to Helvetas, the local branch of a Swiss NGO, there are small furniture businesses, rice mills and a water-bottling plant which have been established.
- Due to the availability of light 24/7 to schools, one class can be held at night and is now attended by 76 students.

Derived risk-mitigation strategies:

Sunlabob's ambitious approach of electrifying several villages to create one regional grid contains several unique risk mitigation strategies.

First of all, the payment risk will be reduced by negotiation with the national utility to ensure steady incomes when the national grid arrives. To accelerate this process, Sunlabob pools several customers into one regional cluster to reach a critical mass. Moreover, additional revenues are also generated by supporting local micro-entrepreneurship.

The technology and performance risk in combination with the resource availability risk are reduced by diversifying the used power-generating sources, which are as follows: hydro, PV, and a diesel genset for backup and to counter peak loads. To reduce the risk of total loss of investment, Sunlabob unbundled the ownership and split the assets into three categories. All moveable assets are owned privately, infrastructural assets such as the grid are owned publicly and assets of productive use are owned by villagers or local micro-entrepreneurs.

This approach prohibits the total loss of investment even when emerging in a worst-case scenario and provides a sound base to avoid conflicts of interest.

Photo credits: Sunlabob

c) Sine Moussa Abdou Wind/PV-mini-grid (INENSUS/Senegal)

Photo credits: Sandy Haessner

Photo credits: Gunnar Wegner

INENSUS

>> Specific UKC: Tradable energy packets

Project overview and structure:

The Germany-based INENSUS, founded in 2005, established a hybrid mini-grid project in Sine Moussa Abdou (Senegal) through a joint venture with the local company Matforce. The project was supported by GIZ and offers electricity from 5 kW photovoltaic array, a 5 kW wind turbine and an 11 kW diesel genset to about 900 villagers living in 70 households. The villagers also run small enterprises. For example, rice mills, peanut peelers and electrical sewing machines have been used to improve the quality of life by generating revenues all over the village.

Particularly noteworthy in this case is the payment system. The tariff system is based on the purchase of "energy blocks". These energy blocks have to be consumed in a certain amount of time, otherwise they expire and cannot be used anymore. An intelligent measurement and regulation unit monitors the consumption and also allows intra-village trade of unused energy blocks. The villagers can determine the price of the tradable blocks themselves. Furthermore, the meters in use divide customers into two categories, high priority customers and low priority customers. High priority customers will remain connected to the grid longer in the case of power scarcity while low priority customers will be disconnected.

Project outcome:

- Due to electrical lighting, education was improved in the village school.
- Immediately after the village electrification, the entrance exam success rate was 100% in that school. It also was the first time in the history of the village that such a high rate has been achieved.
- Effective productive use of energy led to the establishment of several micro-businesses in the fields of agriculture, milling, sewing and metal work.

Derived risk-mitigation strategies:

In terms of mitigating risks, INENSUS went on to implement several specific measures. Due to the usage of an intelligent smart meter, the customers are able to monitor their own consumption and trade unused energy blocks. The prepaid electricity (energy blocks) reduces the risk of unpredictable demand as energy blocks are sold in advance before using. As customers are able to sell electricity blocks and to determine the price on their own, additional income opportunities could emerge. In addition, the risk of technology and performance and the risk of resource availability could be reduced by using different energy sources.

Dividing customers into ranked categories makes sure that high priority customers would be served in times of energy shortage, which contributes to the reduction of the risk of unpredictable demand as energy loads decrease when low priority customers are cut off.

Photo credits: INENSUS

d) Biomass gasification (NOVIS/Senegal)

Photo credits: NOVIS

>> Specific UKC: Holistic agricultural approach

Project overview and structure:

The cooperative project between DEG and Stadtwerke Mainz AG provides viable and clean energy to 1,200 villagers of Kalom north of Dakar in the Senegal, which is funded by DEG to an amount of nearly 50% of the USD 680,000 project volume. A 32 kW biomass gasifier is used to generate and provide 24/7 the necessary annual amount of 128,000 kWh (based on 4,000 running hours). The price per kWh is about USD 1. In cases where the assigned maximum power limit is exceeded, the household in question will be disconnected by cutting off the power. The project also generated seven direct jobs in the village as local staff have been trained for maintenance, the daily operational work and accounting. In the field of accounting, the project developer called for a double signature in case of higher expenditures.

The ownership structure is as follows: 70% of ownership belongs to the Stadtwerke Mainz Foundation: Energy for Africa, with another nine local owners holding between 2 and 5% ownership each.

The distinguishing fact of this approach is that biochar, which is mainly used for gasification, is also used as fertiliser for nearby agricultural cultivation. So, in case of overcapacity of the gasifier, additional values can be created. In addition, this project generates indirect job opportunities for the rural population outside of the village as biomass becomes a valuable merchandise.

Project outcome:

- Process-related biochar is used as fertiliser, which supports agricultural applications in the village.
- Due to the usage of biomass, a new market has been established since biomass becomes a valuable good. As a result, rural people in the vicinity around the village can generate revenues by selling biomass.
- Seven direct project related jobs in the village have been created.
- 1,200 villagers benefit from the usage of electrical power either in terms of livelihood or micro-entrepreneurship.

Derived risk-mitigation strategies:

NOVIS's holistic biomass project uses biochar, created during the process of generating electricity, to fertilise nearby farms. This reduces the risk of non-payment in an indirect manner as new business opportunities have been created for the power-generating facility.

Furthermore, due to the necessity of double signature when high expenditures have to be made, the operational risk and the risk of theft could be minimised. The demanding challenge of reducing the risk of social acceptance has been tackled by including several stakeholders in different project phases.

Photo credits: NOVIS

e) PV/Diesel mini-grid (TTA/Cape Verde)

Photo credits: TTA

>> Specific UKC: Upscaling steps already carried out

Project overview and structure:

Trama Techno Ambiental, founded in 1986 in Barcelona, established an electrification project in Santo Antao, Cape Verde. The funding for the facility was granted by the ACP-EU Energy Facility. The project is owned by the Porto Novo Municipality.

About 60 households, a school, a church, a kindergarten, a health center, a satellite dish center and three stores are electrified.

Electricity is generated by photovoltaic cells with a total capacity of 27.3 kWp. The training and daily maintenance is done by a group of three members of the local municipality. Due to the usage of a smart meter, which provides as much energy as needed by contract plus a buffer of three days of estimated consumption, the load management can be managed in an efficient and technically safe manner. The energy meter also shows the user the available energy so that the consumers are able to determine and adjust their future demand.

Furthermore, next to the electrification business a small ice micro-business has been established so that excess electrical energy can generate additional revenues.

Project outcome:

- Providing electricity to public buildings (church, medical center, kindergarten and school).
- Adjustable energy consumption by usage of smart meter allows stable usage of electricity.
- Overcapacity of electrical energy is used by a micro-business, which has created ice for cooling purposes.
- As a result of the smart load management and the affordable price, one consumer has already bought a refrigerator.

Derived risk-mitigation strategies:

The mini-grid project, developed by TTA, contains several risk mitigation strategies affecting different risk types. The mitigation of the payment risk is caused by developing an intelligent tariff design. Using an ice machine when the facility exhibits overcapacities generates additional income and reduces the risk of unpredictable demand which is also additionally reduced by using smart meters and intelligent energy buffer design.

Photo credits: TTA

f) Holistic business model approach (KAITO/Senegal)

Photo credits: KAITO

>> Specific UKC: Full holistic business approach

Project overview and structure:

The emerging project of the company KAITO based in Munich (Germany) is entirely detached from the concept that micro-businesses will emerge more or less accidentally after the provision of electrical energy.

To ensure long-term project revenues, KAITO fosters the development of micro-businesses before beginning the operative phase of the electrification project. For this purpose, KAITO, HNU and RLI, with the support of the CDW Foundation, have developed a framework for business creation, which will be implemented in the area of Mlomp/ Senegal.

The framework includes the electrification of diverse micro-businesses concentrated in one market area, called "zone d'activité". This concentration is necessary to shorten the grid length and to reduce administrative efforts. During the first project phase, only this specific market area will be electrified. After the first phase of electrification, it is possible that increased incomes in this area will allow private households to afford the required cost-covering tariffs.

Project goals / (planned project outcome):

- Increased prosperity due to capacity building.
- Business creation as "ignition spark" for local economic growth.

Derived risk-mitigation strategies:

The outstanding point of the KAITO approach is that business customer development is done in advance. To ensure stable payments after implementation of the power-generating facility, the micro-entrepreneurs should be encouraged and trained. This reduces the risk of non-payment, as the ability to pay has been previously assured. Involving all relevant stakeholders at a very early point in time also helps to reduce the risk of social acceptance significantly.

Photo credits: KAITO

6.2. Lessons learned

All business models demonstrated by the cases above have certain advantages resulting from their different unique key characteristics. The experience gained from these projects can guide the further development of holistic concepts for mini-grids. It is unlikely that there will be only one holistic model that fits all given situations.

Decision-makers need to identify the business model that best suits a given situation and adapt it to the respective socio-cultural, environmental, technical, economic and political-legal circumstances. Experiences and the exchange thereof can however help accelerate the process of designing and implementing mini-grids.

7 FUTURE PROSPECTS AND RECOMMENDATIONS

Photo credits: Ankur Scientific; NOVIS; Smart Hydro Power; Studer Innotec; UNDP

7. Future prospects and recommendations

Based on the findings of this study, several recommendations for stakeholders in the area of mini-grids can be made:

Sustainable business models

To ensure the sustainable operation of mini-grid projects and to generate benefits for all stakeholders, the development and implementation of holistic, adaptive and robust business models is indispensable. This can be achieved through adequate qualification of involved staff, collection and consideration of information on the demand of electricity, well-organised stakeholder integration and the attraction of local business activities. As anchor business customers are not available in most of the unelectrified regions, the promotion of productive use of electricity might be an appropriate solution to overcome diverse risks.

Dialogue should be initiated on developing strategies that strengthen capacity building of and technical assistance to mini-grid developers with the aim to improve the viability and scalability of sustainable business models. Such strategies should be aligned with complementary policy and regulatory advisory to improve the investment framework for mini-grids.

Adaptation of existing and development of alternative and new tools for risk management

The evaluation of existing and the development of alternative and new tools for risk management would be helpful to accelerate the development of the mini-grid sector. Efforts should be concentrated on specific tools and instruments targeting mini-grid related risks and to assess their ability to be deployed in the short to medium term.

Standardised risk management procedure

The implementation of a standardised risk management procedure is one of the options for mini-grid developers and operators to streamline parts of their operations and thus reap operational and financial benefits. The added value of risk-management processes comes on the one hand through the development of an overview of different risks, threats and barriers and communication of these to financiers and relevant stakeholders on the other. By developing systems for identifying, assessing and managing risks, a transparent basis for the dialogue between different parties and stakeholders could be established.

In order to advance the application of risk management in the area of mini-grids, further analysis and work is necessary to define a SRMP in an industry-specific, effective and efficient form. This process will require:

- to design a concrete guideline for a SRMP and to deliver concrete suggestions on an easy to handle content. With regard to this procedure, there are three major objectives:

    1. to achieve transparency for financial institutions;
    2. to establish a common understanding between project developers, energy service companies and finance institutions; and
    3. to have easy-to-follow checklists and tools for practitioners.

- to design concrete templates that supply support for practitioners for data gathering and declarations needed within such a procedure; and
- to carry out evaluations on the practical experience of practitioners when working with such a SRMP especially for further improvements.

By combining efforts of a number of relevant stakeholders, the Standardised Risk Management Procedure (SRMP) can be developed and implemented in the short to medium term.

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APPENDIX A
Questionnaire I & II

Mini-Grid Task Force questionnaire I

Risk Questionnaire

Respondent profile

Company name	*free text*		
Name of respondent	*free text*		
Title of respondent	free text		
Type of Company	*please tick in the check box*	Mini-Grid Operator (takes care of daily operational issues of rural mini-grids)	☐
		System Integrator (Installation and maintenance of mini-grids)	☐
		Other (Reseller, Distributor, Consultant, ...)	☐

1. Activities of your company or institution

1.1.	**Have you ever been working on mini-grid business models beside the installation of hardware?**	*please tick in the checkbox*	yes	☐
			no	☐
		comments		

1.2.	**If the answer in [1.1.] is positive: Please rate the intensity of effort in the mentioned case.**	Pease rate the intensity of effort you/your company have had.	*intensity of effort* *high* ☐ ☐ ☐ ☐ ☐ *low*

1.3.	**Which geographies are you focusing on?**	*free text*	

1.4.	**Have you ever considered to implement a holistic business model? ***	*please tick in the checkbox*	yes	☐
			no	☐
		comments		

* Holistic business model include training and education measures for productive use of electricity

1.5.	**Which rural activities benefit directly from your electrification projects?**	*please estimate percentage*	Agriculture	%
			Health	%
	Please fill in and name any missing		Education	%
			Local Administration	%
			Manufacturing Industry	%
			Crafts	%
			…	%
				100 %
		comments		

1.6.	**Are you considering to establish a new electrification project within the next 6 months?**	*please tick in the checkbox*	yes	☐
			no	☐
			probably	☐
		comments		

1.7.	**Which RE resources are used in your projects?**	*please tick in the checkbox*	Solar (PV)	☐
			Hydro	☐
			Wind	☐
			Biomass	☐
			Geothermal	☐
		comments		

2. Risk Management Instruments

2.1. Are you familiar with the following risk-management tools?

please tick in the checkbox

RiskMap	☐
CashFlow at Risk	☐
Risk Audits	☐
Partial Credit Guarantee	☐
Political risk insurance	☐
Weather insurance	☐
Transport insurance	☐

comments

2.2. With which risk management tools are you familiar beside the above (in 2.1.) mentioned?

please name the tools

comments

2.3. Which risk management tools have been used in your projects and how often?

please tick in the checkbox and rate

		usage *often*				*rarely*
RiskMap	☐	☐	☐	☐	☐	☐
CashFlow at Risk	☐	☐	☐	☐	☐	☐
Risk Audits	☐	☐	☐	☐	☐	☐
Partial Credit Guarantee	☐	☐	☐	☐	☐	☐
Political risk insurance	☐	☐	☐	☐	☐	☐
Weather insurance	☐	☐	☐	☐	☐	☐
Transport insurance	☐	☐	☐	☐	☐	☐
…						
…						
…						
…						

2.4. Which risk management tools do you think will be necessary in future?

please name the tools and rate them

	importance high				low
…	☐	☐	☐	☐	☐
…	☐	☐	☐	☐	☐
…	☐	☐	☐	☐	☐
…	☐	☐	☐	☐	☐
…	☐	☐	☐	☐	☐
…	☐	☐	☐	☐	☐
…	☐	☐	☐	☐	☐

comments

3. Risk Identification

3.1. Please rate the following upscaling barriers and fill in any missing.

please name and fill in any missing

	importance high				low
Access to finance instruments	☐	☐	☐	☐	☐
Ability to pay (customer)	☐	☐	☐	☐	☐
Resource challenges (e.g. spare parts)	☐	☐	☐	☐	☐
Poor product quality of hardware	☐	☐	☐	☐	☐
Lack of qualified staff	☐	☐	☐	☐	☐
Low utilization of power generation	☐	☐	☐	☐	☐
Lack of willingness to pay	☐	☐	☐	☐	☐
Market entry barriers too high	☐	☐	☐	☐	☐
Too low expected profit margin	☐	☐	☐	☐	☐
…	☐	☐	☐	☐	☐
…	☐	☐	☐	☐	☐
…	☐	☐	☐	☐	☐
…	☐	☐	☐	☐	☐

…	☐	☐	☐	☐	☐
…	☐	☐	☐	☐	☐
…	☐	☐	☐	☐	☐
…	☐	☐	☐	☐	☐

comments

3.2. Which of the mentioned risks have to be managed in your projects?

Please tick all that apply and add any missing and value probability of occurrence and negative impact

		probability of occurrance					*negative impact*				
		high				*low*	*high*				*low*
Technology / performance risk (malfunctions, technical failures)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Construction completion risk	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Environmental risk	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Payment risk (willingness to pay)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Foreign exchange risk	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Majeure risk	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Political risk	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Operating risk	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Resource variability (hydro/wind...)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Theft / Vandalism	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Resource price variability (biomass)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Resource availability (biomass)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Social acceptance risk	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Risk of unpredictable demand	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
…		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
…		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
…		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
…		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
…		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
…		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

comments

3.3. Please name and rate the most important challenges from your perspective when considering / doing business in the sector of mini-grids.

please name and rate the challenges

	importance high				low
…	☐	☐	☐	☐	☐
…	☐	☐	☐	☐	☐
…	☐	☐	☐	☐	☐
…	☐	☐	☐	☐	☐
…	☐	☐	☐	☐	☐
…	☐	☐	☐	☐	☐
…	☐	☐	☐	☐	☐
…	☐	☐	☐	☐	☐

comments

3.4. What about these challenges? <u>Please rate them and name any missing.</u>

	importance high				low
Inadequate funding ticket size (ticket size to high)	☐	☐	☐	☐	☐
Inadequate evaluation and impact measurement practice	☐	☐	☐	☐	☐
Uncertain legal and/or policy frameworks	☐	☐	☐	☐	☐
Lack of appropriate fund structures	☐	☐	☐	☐	☐
Lack of platform to talk about risks, barriers and funding opportunities	☐	☐	☐	☐	☐
Lack of background knowledge of financiers	☐	☐	☐	☐	☐
Lack of appropriate local partner institutions (e.g. NGO)	☐	☐	☐	☐	☐
…	☐	☐	☐	☐	☐
…	☐	☐	☐	☐	☐
…	☐	☐	☐	☐	☐
…	☐	☐	☐	☐	☐
…	☐	☐	☐	☐	☐
…	☐	☐	☐	☐	☐

comments

3.5. Which financial instruments do you usually prefer?

please tick in the check box

Debt	☐
Equity	☐
Mezzanine	☐

comments

3.6. What is your target and minimum investment return?

Target ______

Minimum ______

comments

3.7. Do you agree with following statement?

"Risk mitigation can only be done successfully by using appropriate holistic business models, which means that the main question is how to teach and educate the rural population in terms of productive use of energy"

Level of acceptance

high ☐ ☐ ☐ ☐ ☐ low

comments

3.8. Have you changed risk management tools, if yes what were the reasons for the decision?

☐ yes
☐ no

comments

Mini-Grid Task Force questionnaire II

Finance and Funding Questionnaire (The questions concern mini-grid operations below 1MW)

Respondent profile

Company name	*free text*	
Name of respondent	*free text*	
Title of respondent	free text	

Type of Company — *please tick in the check box*

Mini-Grid Operator (takes care of daily operational issues of rural mini-grids)	☐
System Integrator (Installation and maintenance of mini-grids)	☐
Other (Reseller, Distributor, Consultant, ...)	☐
Capital lending organization	☐
Beneficary - capital providing organization	☐

1. Funding / Financing Questions

1.1. What are the financial bottlenecks for your company?

please tick in the checkbox please name and rate

	importance *high*				*low*
...	☐	☐	☐	☐	
...	☐	☐	☐	☐	☐
...	☐	☐	☐	☐	☐
...	☐	☐	☐	☐	☐
...	☐	☐	☐	☐	☐
...	☐	☐	☐	☐	☐
...	☐	☐	☐	☐	☐
...	☐	☐	☐	☐	☐
...	☐	☐	☐	☐	☐
...	☐	☐	☐	☐	☐
...	☐	☐	☐	☐	☐

comments

1.2. Please tick in the used equity sources of your projects.

please fill in and name any missing

own financial ressources		%
third party venture capital fund/risk capital		%
…		%
…		%
…		%
…		%
…		%
TOTAL OF ALL EQUITY SOURCES USED	**100**	%

comments

1.2. Please tick in the used debt sources of your projects.

please fill in and name any missing

Bank loans		%
Bonds		%
…		%
…		%
…		%
…		%
…		%
TOTAL OF ALL DEBT SOURCES USED	**100**	%

comments

1.3. State your cost of capital

please estimate avererage of your projects

Equity return		%
Debt interest rate		%

1.4. What is the typical volume of financing that the projects you are involved in require?
(What range should be more developed in terms of accessability for project developers)

please tick in the checkbox

Amounts ins USD	
1 - 10,000	☐
10,001 - 100,000	☐
100,001 - 1 Mio.	☐
1 Mio. - 15. Mio	☐
> 15 Mio	☐

comments

1.5. Please name the funding institutions/funds and the offered type of capital you are/were using.

please name the Institution and/or Fundname used and fill in the provided type of capital (equity/debt or both)

Institution/Fund Name	*provided type of capital (debt/equity)*
KFW/DEG	
AusAid/ECF Fund	
ADB	
AfDB	
AusAid	
….	
….	
….	
….	
….	
….	
….	
….	
….	
….	

comments

1.6. What type of funding instruments are necessary from your perspective as project developer in future?

please tick in the checkbox and rate

…
…
…
…
…
…
…
…
…
…
…

1.7. Which risk management tools do you think will be necessary in future?

please name the tools and rate them

	importance high				low
…	☐	☐	☐	☐	☐
…	☐	☐	☐	☐	☐
…	☐	☐	☐	☐	☐
…	☐	☐	☐	☐	☐
…	☐	☐	☐	☐	☐
…	☐	☐	☐	☐	☐
…	☐	☐	☐	☐	☐

comments

1.8. What sources of funding are used in your projects to cover up-front costs during the early-stage-phase of your projects?

funding source	*capital type (grant, loan, own equity ressources)*

comments

1.9. Please rate the amount of up-front cost regarding your total project costs.
(up-front costs including, all preperation costs before setting up a specific project)

up-front costs regarding the total project costs in % ____ **%**

comments

2.0. What needs to happen in the area of finance for more mini-grid projects to be implemented?

	level of acceptance high				low
Reducing the specific volumes of existing funding instruments by simultaneously increasing the amount of extensions (loans grants etc.) would play a major role in improving rural electrification business.	☐	☐	☐	☐	☐

Statement	level of acceptance: high				low
Creating a fund providing smaller funding volumes would foster businesses in the field of rural electrification.	☐	☐	☐	☐	☐
Increasing expertise for financiers would be of importance to facilitate access to adequate funding sources.	☐	☐	☐	☐	☐
A centralized data structure (database, actualized paper, etc.) providing information and general requirements of different funding sources could play a significant role in supporting rural electrification business.	☐	☐	☐	☐	☐

2.1. Further questions

a) Do you have possibilities within your market position to compensate for financing risk costs through cost plus calculations when setting prices for your products?

Yes ☐ No ☐

b) Does the type of financing change throughout the project period (preparation to implementation and operation)

Yes ☐ No ☐

please fill in your comments

What is needed to support? (regarding 2.1. b), question above)

c) Does the type of financing change throughout the project period (preparation to implementation and operation)

Yes ☐ No ☐

d) To what extent does the choice of financing instrument impact the return in your business?

level of extent: high				low
☐	☐	☐	☐	☐

Contributors :

Alliance for Rural Electrification (ARE):
ARE is an international business association representing the decentralised energy sector working towards the integration of renewables into rural electrification markets in developing and emerging countries.

Neu-Ulm University of Applied Sciences (Hochschule Neu-Ulm):
The Hochschule Neu-Ulm (HNU) is an internationally oriented management school with faculties in business and economic sciences, information management and health care management. It has its location at Neu-Ulm (Bavaria/Germany)
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Institute for Decentralized Electrification, Entrepreneurship and Education (id-eee):
id-eee is a private institute for applied research and project management in the field of decentralized rural electrification. The institute is based in Ulm Germany and associated with the Neu-Ulm University of Applied Sciences.
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Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH:
GIZ offers customised solutions to complex challenges. As an experienced service provider, it assists the German Government in achieving its objectives in the field of international cooperation.

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Alliance for Rural Electrification

Shining a Light for Progress

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