HNU HOCHSCHULE NEU-ULM UNIVERSITY OF APPLIED SCIENCES

HNU Discussion Paper

Standardized Risk Management Procedure (SRMP) for Mini Grids
Case Study: Mini-Grid Sunderbans, West Bengal, India

Elmar Steurer[a`*] Bernard Wagemann[a], David Manetsgruber[a]

[a]*Neu-Ulm University of Applied Sciences, Department Business & Economics, Wileystr. 1, 89231 Neu-Ulm, Germany*

August 2017

Abstract

Rural electrification by using mini-grids has been the objective of many development policies over the past years. Most mini-grid projects turned out as failures because of poor suitability to user needs, local conditions and expectations of investors and several other risks. In order to shed light on the principles and processes involved in determining a mini-grid risk rating this paper develops and elaborates a risk rating model based on a standardized risk management procedure (SRMP). Five key criteria were outlined and explained in detail using an empirical case study on a mini-grid located in India. Ultimately, this paper aims to have shown how a methodology to achieve a risk rating for a mini-grid could be structured. In this sense a mini-grid rating is a decision supporting tool to enable sound investment decisions for debtholders and shareholders in a mini-grid and to contribute for de-risking renewable energy investments. The proposed standardized risk management procedure (SRMP) for mini grids should be considered as an educated, systematic attempt at measuring current and future development of a mini-grid's capability to fulfill future payment obligations and profitability expectations.

Keywords: Decentralized rural electrification; Mini-Grids; Renewable Energy; Risk Rating; Risk Management; Infrastructure Finance

* Dr. Elmar Steurer. Tel.: +49-731-9762-1400; fax: +49-731-9762-1499.
E-mail address: elmar.steurer@hs-neu-ulm.de

1. Introduction

Rural electrification by using mini-grids has been the objective of many development policies over the past years. Most mini-grid projects turned out as failures because of poor suitability to user needs, local conditions and expectations of investors and several other risks. It can be stated, that usually inadequate business models are the reason why most of the mini-grids do not work properly [1]. In addition practical experience showed that hybrid mini-grids, powered by a renewable energy resource and a Diesel generator ("diesel genset") for back-up or peak-load purposes are generally the most competitive technical solution. Usually photovoltaic is chosen for the renewable source due to the objective of availability. However, translating this great technical potential into a real business success story has turned out to be extremely challenging. The deployment of mini-grids involves complex financial and organizational questions which can be assigned to challenges in the fields of sales, technology and finance (Fig. 1). A successful business model satisfies the demand of the customers with high quality and 24/7 availability is based on sound pricing models and relies on an adequate funding. Ideally the funding should be both from the private and public sector, and the technology should be reliably and easy to maintain.

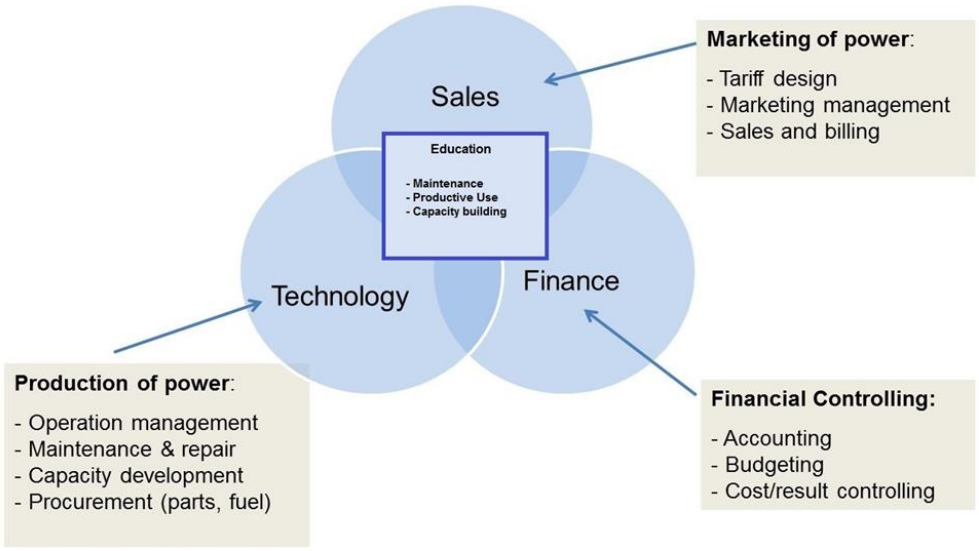

Fig. 1. Key functions of a mini-grid for decentralized electrification.

The major stakeholders of a mini-grid are typically:

- Consumers and small and medium sized enterprises (SME)
- Suppliers for the technological equipment including operation & maintenance as well as communities for capacity building, training and education
- Public and private investors responsible for funding

Due to these manifold financial and organizational challenges it can be an insurmountable challenge for private and public investors to maintain proper risk awareness. Without an assessment of the different risks influencing the economic performance of a mini-grid, the uncertainty given by the complex structure of a mini-grid could lead to the point where lack of transparency discourages investments in decentralized electrification. Crucial questions that an investor will ask himself when assessing the risks of a potential investment in a mini-grid for decentralized electrification are:

- Is socio-political stability given?
- What about the mini-grid's economic stability?
- How, if at all, are the aforementioned circumstances likely to change and how will these parameters affect the financial stability of the mini-grid?

A mini-grid specific risk assessment aims to reduce uncertainty and effectively contains aggregated answers to such crucial questions (see for the empirical background [3]. This paper will propose a methodology to evaluate a rating measuring the risk of a mini-grid, i. e. a standardized risk management procedure (SRMP) for mini-grids. The methodology is described based on a risk rating assessment for a specific mini-grid in India as an empirical means of illustration to outline and analyze the criteria and assumptions involved in the proposed approach. Thus, a mini-grid rating is understood to be a measure of the capability of a mini grid to meet financial obligations and profitability expectations in the middle and long term. The paper is structured as follows; the first chapter illustrates and analyzes the methodology involved in assigning a rating. This is done by using a mini-grid located in the Sunderbans, State West Bengal, India as an example. This chapter draws on an empirical study of a mini-grid rating to illustrate how the SRMP rating is derived using the methodology proposed. Chapter two begins by providing background information on the methodology and proceeds to examine the five key criteria in determining a mini-grid rating covering the

1. Regulatory framework
2. Economic environment
3. Technology equipment
4. Finance situation
5. Education measurements

The detailed examination of these five criteria is supplemented by an empirical case study comprised of a proprietary and unique Excel module that uses real data and valid assumptions to calculate an overall rating for the selected mini-grid. The final chapter concludes by summarizing the insights and possibilities to transfer the proposed methodology to other mini-grids located in other countries than India.

2. The structure and the criteria of the SRMP approach to rate a mini-grid

This section addresses the center piece of this paper by analyzing an unique and proprietary Excel model that was created specifically to supplement this paper's attempt at proposing a methodology to determine a mini-grid risk rating. The empirical case study employs the Excel model to produce a rating for mini-grid located in the Sunderbans in the State of West-Bengal, India. The following subsections provide an outline of key information pertaining to the structure and criteria of a mini-grid risk assessment including the scale used to report and interpret them. This background information leads up to a detailed analysis and run-through of individual rating criteria which ultimately concludes this chapter by producing and interpreting a mini-grid rating for the chosen case in the Sunderbans.

2.1. The five key criteria of the SRMP mini-grid rating

This subsection will outline core components and summarize key ideas of the aforementioned approach in order to explain the methodology behind the rating model. Fig. 2 illustrates that the rating model consists of five core criteria that are evaluated into a combined score: the regulatory framework score, the economic score, the technology score, the finance score and the education score. The following subsections discuss each of these five key criteria in detail.

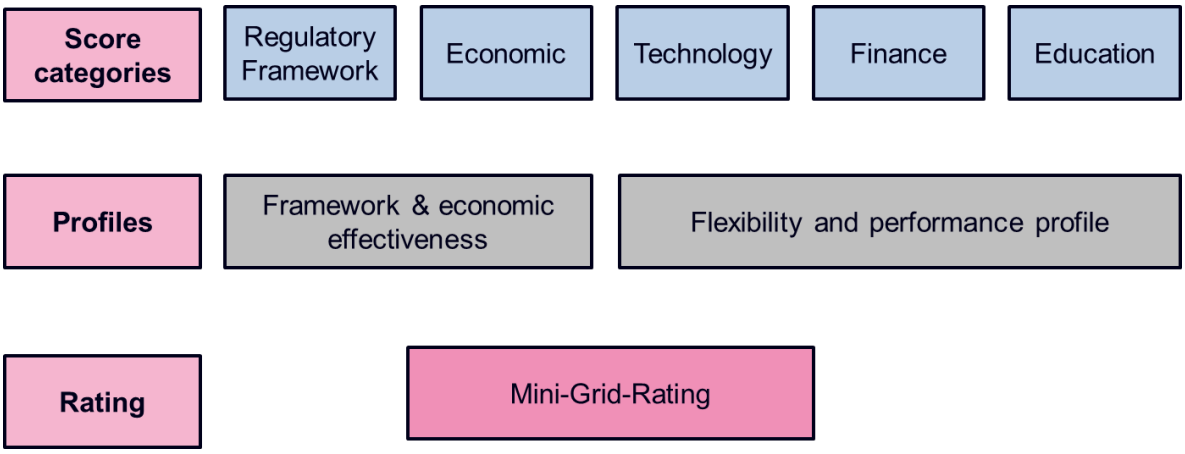

Fig. 2. Mini Grid Rating Framework.

In order to make sense of the overall mini grid rating it is important to know that the mentioned five core scores are given on a scale of 1 until 6. Fig. 3 shows the scale by which the criteria are scored.

Score categories –
Measured by score values:

- „1“: very low risk
- „2“: low risk
- „3“: intermediate risk
- „4“:moderately high risk“
- „5“: high risk
- „6“: very high risk

Fig. 1: Criteria Scale

It is a convenient coincidence that the scale above strongly resembles the German high school grading system. Each of the five criteria described previously is weighted when a single score of the five criteria is aggregated to achieve a profile. For example, the regulatory framework score is combined with the economic score at equal 50% weighting to yield the overall “framework and economic effectiveness profile”. Meanwhile, the scores from the remaining three criteria, i.e. the technology, finance and education scores, each account for 33% of the overall “flexibility and performance profile”. The two scores of these intermediate profiles are then combined to achieve a rating level which represents the final, overall mini grid rating. Table 1 shows the different rating levels that various combinations of the two profiles lead to.

The overall mini-grid rating is condensed and reported in form of rating levels ranging from AAA to D and results from an equal 50% each weighting of the “framework and economic effectiveness profile” and the “flexibility and performance profile”. It is important to note that the achieved ratings correspond to the commonly applied credit ratings used in capital markets and released by the international rating agencies, e. g. Standard & Poor’s, Moody’s and Fitch and typically reported in rating levels ranging from AAA to D [4]. The rationale for that is to provide a decision support to the institutional investor community they are familiar with. One of the most important intentions of the SRMP mini-grid rating development is to strive for a strong alignment of private investors to encourage them to invest in mini-grids.

Table 1: Indicative Rating Levels - Own development based on [4]: Sovereign Government Rating Methodology And Assumptions

Regulatory framework effectiveness and economic score (A&B)												
Flexibility and performance profile (C&D&E)	Category	Superior	Extremely strong	Very strong	Strong	Moderately strong	Intermediate	Moderately weak	Weak	Very weak	Extremely weak	Poor
Category	Score	1,0	1,5	2,0	2,5	3,0	3,5	4,0	4,5	5,0	5,5	6,0
Extremely strong	1	aaa	Aaa	aaa	aa+	Aa	a+	A	a-	bbb+	N/A	N/A
Very strong	1,8	aaa	Aaa	aa+	aa	aa-	a	a-	bbb+	bbb	bb+	bb-
Strong	2,3	aaa	aa+	aa	aa-	A	a-	bbb+	bbb	bb+	bb	b+
Moderately strong	2,8	aa+	Aa	aa-	a+	a-	bbb	bbb-	bb+	bb	bb-	b+
Intermediate	3,3	aa	aa-	a+	A	bbb+	bbb-	bb+	bb	bb-	b+	b
Moderately weak	3,8	aa-	a+	a	bbb+	Bbb	bb+	bb	bb-	b+	b	b
Weak	4,3	a	a-	bbb+	bbb	bb+	bb	bb-	b+	B	b-	b-
Very weak	4,8	N/A	Bbb	bbb-	bb+	bb	bb-	b+	b	B	b-	b-
Extremely weak	5,3	N/A	bb+	bb	bb-	b+	b	b	b-	b-	ccc/cc	ccc/cc

The following paragraphs describe the five key components of a mini-grid rating in detail using data, facts and assumptions about the applied Sunderbans case. A detailed description of each criterion is supplemented with the relevant extract from the Excel model as a means of illustration. The analysis of each individual criterion will focus on the concepts and theory underlying the model, rather than on the workings of the Excel applications. The Excel model is designed to reflect the approach described in the previous section and to resemble the output contained therein.

2.1.1 Regulatory Framework

This criterion reflects the impact that official bodies and authorities supervising electrification have on a mini-grid. There are several criteria that affect this score. As a matter of understandability the criteria are allocated to two factors. The primary factor (Table 2) scores the effectiveness, stability, and predictability of the policymaking and political institutions on community and block level. Here, special attention is paid to the alignment of the local bodies and the population to a mini grid project. Hence, the attitude of the local major with the electrification project is assessed and the support of the local population is measured. Basically this could be done by the measure of different surveys. As a matter of simplicity following questions to be answered are proposed here:

- How is the local major aligned with the HMG?
- What about a public discourse that questions the legitimacy of tariffs?

Furthermore crime rates of the community are assessed, as that is the potential for on-going conflicts with potential severe negative impacts to an electrification project. Another crucial determinant of the regulatory framework score is the level of transparency, accountability and process reliability of the other involved institutions, especially the block and district level (Table 3). In short: the extent to which the local bodies take measures to signal its accountability for its policy decisions and their outcomes. This field is captured by the secondary factor. Obvious conflicts of interests are one of the criteria to be considered. This requires some critical questioning needs reading between the lines when analyzing the organizational structure of the mini-grid. Further generally unbiased enforcement of contracts and respect for the rule of law contribute to this. Structural challenges for mini-grids typically tie up to a large part by a significant gap between written contracts and what actually is

done in practice. Finally significant and sustained issues between entities on state level and local level are another crucial factor in determining the risk score of this factor.

Table 2: Regulatory Framework Score, Primary Factor

Primary factor	**Weighting**
The effectiveness, stability, and predictability of the policymaking and political institutions on	**75%**
Condition of the community	**Score**
How is the local major aligned with the HMG?	4
Crime rates	3
A public discourse that questions the legitimacy of tariffs	5

Table 3: Regulatory Framework Score, Secondary Factor

Secondary factor	**Weighting**
The transparency, accountability and process reliability of the other involved institutions, especially the block and district	**25%**
Visibility of the block	**Score**
Obvious conflicts of interests	**4**
Generally unbiased enforcement of contracts and respect for the rule of law	**4**
Significant and sustained issues between entities on state level and local level	**4**

The following extract from the model (Table 4) shows the outcome of the final addition of both factors to achieve a score covering the regulatory framework risk of the investigated case of a mini-grid located in the Sunderbans, State West-Bengal.

Table 4: Regulatory Framework Total Score

=	**Primary factor weighted**	**Weighting: 75%**	**Score: 4,0**
+	**Secondary factor weighted**	**Weighting: 25%**	**Score: 4,0**
=	**Total Score**		**Score: 4,0**

2.1.2 Economic score

The economic score results from the analysis of the local population's purchasing power (retail score) and the diversity of the regional economic sectors (commercial score). Both scores are averaged to calculate the economic score (Table 5). In the Sunderbans case a total economic score of 2.5 is assigned. The village income level per capita is the measure of choice regarding the retail score. This is a measure of the average monthly income per person of the village the mini-grid is operating and is compared to the corresponding average income level of a peer group (Table 6). The peer group is typically given by the region. In this case the average income level of the State West Bengal is applied. The achieved ratio is averaged over the last three years. In the analyzed Sunderbans case this leads to an income ratio of 67%.

Table 5: Economic Score

Components and score	Score
Retail Score	3,0
Commercial Score	**2,0**
Total Economic Score	**2,5**

The income ratio is finally scored according to Table 7. In this case the income ratio of 67% leads to an accordingly satisfying score of 3.

Table 6: Retail score - database

	2013	2014	2015
Average income level village USD per month	200,0	200,0	200,0
Average income level peer group (i.e. state West Bengal)	300,0	300,0	300,0
Ratio	67%	67%	67%
Average (2013-2015)	**66,7%**		

The multitude and diversity of pillars that the local economy is built on is another crucial determinant of the economic score, measured by the commercial score. An economy that relies on several different pillars is able to overcome crises in any one or more sectors of its economy which makes its overall economic performance less volatile. As a result concentration on one sector is seen as negative.

Table 7: Retail score assignment

	2004	2005	2006	2007	2008	2009	2010	2011	2012
	90%	80%	70%	**60%**	50%	40%	30%	20%	10%
Income score	1,0	2,0	2,5	**3,0**	3,5	4,0	5,0	5,5	6,0

Thus, in the case of rural mini-grids it is important to note that a high share of agricultural activities would lead to a negative assessment. Based on this consideration the share of agricultural business is taken into account for the overall local economic power – a higher share leads to higher risk for the mini-grid. In this case the agricultural sector shows up a share of roughly 32% (Table 8) and thus a subordinated importance to the local economy despite the fact that the agricultural sector is the biggest employer in the investigated village..

Table 8: Commercial score - database

	2006	2007	2008	2009	2010	2011	2012
Share of agricultural business	32%	32%	32%	32%	32%	32%	32%
Share of commercial customers	70%	70%	70%	70%	70%	70%	70%

In addition the share of commercial customers revenues compared to total revenues of the mini-grid is used for measuring the commercial strength [2]. A higher share contributes to lower risk for the mini-grid. In the case of the Sunderbans the most important customer is a coffee shop offering services for regional tourism in the Sunderbans. That contributes to this specific diversification of the economy of the village. Further commercial customers amount to a remarkable high share of 70% of the mini-grid's revenues contributing to a strong stable demand to electricity and a subdued and manageable credit risk for the mini-grid operator. Both ratios contribute to the commercial profile and are combined to produce an overall commercial score. Table 9 demonstrates the process of this combination. The combination of 32% agricultural business share and 70% share of commercial customer yield to an accordingly strong commercial score of 2.

Table 9: Commercial score assignment

		Economic diversification				
		Share of agricultural business (% of total activities)				
		30%	**40%**	**60%**	**75%**	**90%**
Share of commercial customers / demand	**70%**	1	**2**	3	4	5
	50%	2	3	4	5	6
	30%	3	4	5	6	6
	10%	4	5	6	6	6

2.1.3 Technology score

The technology score should deliver evidence about the reliability and the resource efficiency of the system. Hence maintenance costs and the share of renewable energy are selected to measure how much attention is paid to provide a reliable technology. and to measure the resource efficiency of a mini-grid is. Maintenance costs are set in relation to the investment and the share of renewable energy is calculated by the yearly energy produced by renewables compared to the total yearly energy produced. In the case of the Sunderbans the maintenance costs over the years 2012 until 2014 amounted to 6,5% and the share of renewable energy produced by the solar modules accounted for 48.5% (Table 10).

Table 10: Technology score database initial score

	2012	2013	2014	Average
Maintenance costs / Investment	5,0%	6,0%	7,0%	**6,5%**
Share of renewable energy (% avg. Energy output)	40,0%	42,0%	55,0%	**48,5%**

Table 11: Technology score: Initial assignment

Technology score		**Maintainence costs / Investment**			
Initial score		**15%**	**10%**	**5%**	**0%**
	100%	1	1	1	2
	80%	1	1	2	3
	60%	1	2	3	4
Share of renewable energy					
	40%	2	3	**4**	5
(% avg. energy output)					
	20%	3	4	5	5
	10%	4	5	5	6
	0%	5	6	6	6

However, any additional source, especially based on renewables, leads typically to inefficient supply structures and additional sources of technical failures. Table 12 shows that in the case of the Sunderbans a missing procurement process for spare parts leads to a negative adjustment of one score.

Table 12: Technology score adjustment

		Adjustment
Procurement process for spare parts in place?	**No**	**1**
Complex technology (Solar incl. Batteries, Biomass) ?	**No**	**0**
Adjustment total		**1**
Total Technology Score		**5**

2.1.4 Finance score

The finance score is measured by a similar process as applied in the case of the technology score. First, two important quantitative Tables are taken to achieve an initial score by applying a scoring grid. Then the initial score could be improved in the case of a positive adjustment and worsened by a negative one.

Table 13: Finance Initial Score: Database

	2012	2013	2014	Average
Share of debt	30,0%	33,0%	40,0%	**36,5%**
Cost of debt	22,0%	20,0%	15,0%	**17,5%**

The initial score is based on calculating the average of the share of debt and the cost of debt over the previous three years. In this way the financial flexibility and independence is measured by the amount of the net debt as percentage of the total capital and the interest expenditures as a percentage of the revenues. In the case of the Sunderbans, the respective values amount to 36.5% and 17.5% (Table 13), which lead to an initial score of 2 by composing both values in the initial finance scoring grid as shown in Table 14.

Table 14: Finance initial score: assignment

Finance initial score		**Share of debt**			
		30%	**50%**	**70%**	**100%**
Cost of debt / revenues	**0%**	1	1	1	2
	10%	1	1	2	3
	20%	1	**2**	3	4
	40%	2	3	4	5
	60%	3	4	5	5
	80%	4	5	5	6
	100%	5	6	6	6

The initial score could be changed by a positive or a negative adjustment. The initial score could be improved by one category if a grant is provided to fund the mini-grid. Typically a grant influences the flexibility of a mini-grid in a very positive way enabling the management of the mini-grid to operate without financial pressure by the investors over longer distressed periods of time. On the other hand this should not lead to moral hazard or to support a development to neglect necessary structural investments. To cover this feature the participation of private investors is checked. A private investor can be regarded as very important to avoid to undervalue profitability targets. Hence, a negative adjustment takes place if no stake is hold by a private investor. In the case of the Sunderbans there is neither a grant nor a private investor with commercial targets. This leads to a negative adjustment by one score (Table 15).

Table 15: Finance score adjustment

		Adjustment
Grant? Yes ? (-1) / No (0)	**No**	0
Private Investor? Yes (0) / No(+1)	**No**	1
Adjustment total		**1**
Total Finance Score		**3**

2.1.5 Education score

This criterion is understood to be an assessment of the management's ability and willingness to coordinate, communicate and deliver educational aims to ensure continued economic performance and to keep technical

failures in check. The score is based on taking solely quantitative data into account, meaning no qualitative adjustments are applied for. In the end it is necessary for a management of a mini-grid to be able to actively drive and affect the technological quality via a planned education policy. The quality of the educational efforts is assessed by the number of education measures and the cost of education activities in relation to the total costs averaged over the previous three years. Both Tables are aggregated to a score by applying a scoring grid. The number of education measures in the case of the Sunderbans amounted to 14, whereas the cost of education in relation to the total costs was given by 8% (Table 16). Both values were composed by the corresponding scoring grid (Table 17) and lead to a education score of 3 in the case of the Sunderbans.

Table 16: Educational Score: Database

	2010	2011	2012	average
Number of education measures p.a.	20	12	10	**14,0**
Cost of education	10%	5%	8%	**8%**

Table 17: Education score: Adjustments

Cost of education / revenues	**Number of education measures**				
	16	**12**	**8**	**4**	**0**
0%	1	2	3	4	5
5%	2	**3**	4	5	6
10%	3	4	5	6	6
15%	4	5	6	6	6

2.2 Overall SRMP mini-grid rating

As alluded to in section 2.1 the five key components of a mini-grid rating which have been distilled into two profile categories – the "Regulatory framework effectiveness and economic profile" and the "flexibility and performance profile" – will be summarized and combined to produce a final, overall mini-grid rating. Table 18 demonstrates this process in the case of the Sunderbans.

Table 18: Final mini-grid rating – Sunderban case

Factor	**Score**
A - Regulatory Framework	**4**
B – Economic	**2,5**
C – Technology	**5**
D – Finance	**3**
E – Education	**3**
Profiles	**Score**
Regulatory framework effectiveness and economic profile (A&B)	**3,25**
Flexibility and performance profile (C&D&E)	**3,7**
Total Rating	**bbb+**

The two aforementioned profiles that were created as an intermediate step are the base to attain the final, overall SRMP mini-grid rating. Both profiles were combined by the rating grid, as already outlined in section 2 and shown by Table 1.

Taken together, the proposed rating model yields a "lower medium grade" (bbb+) rating in the case of the Sunderbans. It is important to note that strength and weaknesses were made evident by the score values of the five risk categories. The chart as shown in Fig. 4 makes clear that the Sunderbans mini-grid has room for improvement in the technological side and is exposed to a non-supporting regulatory framework. On the other hand this mini-grid can be seen in a pretty good shape to master either technological as well as commercial challenges. Nonetheless the possibility of unexpected events causing sudden changes to the achieved mini-grid rating remains. Also, the further into the future a forecast goes, the more likely it is inaccurate or wrong, hence it should be duly noted that this rating concerns only the next 1-2 years. Overall the Sunderbans mini-grid has the potential to improve its rating in the future, especially if the technological side is managed in a more accurate way.

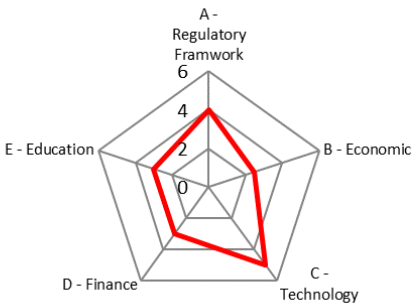

Fig. 4: Score overview Sunderbans case

3. Conclusion

In order to shed light on the principles and processes involved in determining a mini-grid risk rating this paper has developed and elaborated on a rating model based on a standardized risk management procedure (SRMP). The model is based on Standard & Poor's methodology to assess a sovereign rating. The five key criteria were outlined and explained in detail using the empirical case study on a mini-grid located in India. Analysis of the case study on India showed that there are several aspects of a mini-grid rating that local political entities can proactively influence with their policy decisions. On the other hand, it has also been noted that unforeseen events that are beyond any control of local authorities can cause sudden changes in a mini-grid rating. The description of the Sunderbans mini-grid case pointed out several factors that make this mini-grid a preferred location to invest. However, the examination of the accompanying risks also revealed several challenges that the mini-grid will face in future. Ultimately, this paper aims to have shown how a methodology to achieve a risk rating for a mini-grid could be structured. In this sense a mini-grid rating is no more than an estimate or a guideline to help support investment decisions pertaining for debtholders and shareholders in a mini-grid. Due to the complex and interrelated underlying economic forces and risks involved, no mini-grid rating should be taken to be infallible, nor should it be considered a 100% precise measure of a mini-grid's economic strength and creditworthiness. Rather, the proposed mini-grid rating should be considered as an educated, systematic attempt at measuring current and future development of a mini-grid's capability to fulfill future payment obligations and profitability expectations.

References

[1] CAT. The future of mini-grids: from low cost to high value. Using demand driven design to maximise revenue and impact. 2013
[2] Harper M. Review of Strategies and Technologies for Demand-Side Management on Isolated Mini-Grids. 2013
[3] Manetsgruber D, Wagemann B., Kondev B, Dziergwa K. Risk Management for Mini-Grids. Brussels: ARE; 2015
[4] Standard & Poors. Country Risk Assessment Methodology and Assumptions. 2013