Social Impact of Mini-grids: Monitoring, Evaluation and Learning

Tools and Guidelines for Practitioners and Researchers

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December 2018

This report was carried out with GCRF funding through the Scottish Funding Council and is part of a wider research project exploring the impacts of rural electrification. For more information please contact aran.eales@strath.ac.uk
1. Executive Summary
The purpose of this toolkit, comprising this report and accompanying spreadsheet, is to provide guidelines and tools for monitoring and evaluating the social impacts of mini-grid projects. The toolkit is intended for mini-grid practitioners and academic researchers to better understand the purpose and contribution of monitoring and evaluation (M&E) to learning about and informing adaptation of approach, programming, strategy, and future design of minigrids, to ultimately improve the service to minigrid customers.

Following an introduction to mini-grids as an enabler for energy access, a justification and evidence base is given for a proposed M&E methodology, followed by guidelines and survey tools for mini-grid practitioners and researchers to adapt and use. The intention is to enable improved, standardised and more streamlined data collection and analysis wherever mini-grids are in operation, facilitating better decision-making and reporting, more efficient grid operation and management, and ultimately increasing the quality of service offered to and benefits received by mini-grid customers. A diagrammatic overview of the recommended process to be followed is provided below:

2. Introduction
2.1. Mini-grids as an enabler for energy access
Over a billion people live without access to electricity, mostly in Sub-Saharan Africa and South Asia. Mini-grids are said to present the least-cost and most timely option for providing electricity to over 40% of these people, with renewable energy mini-grids expected to account for the majority share of off-grid generation [1]. Cost reductions, business model innovations and novel technologies are making mini-grids and other decentralised energy systems cost effective electricity solutions, often in areas which are unlikely to ever be connected to national grids.

Mini-grids can have an array of socioeconomic impacts on individuals, households, businesses and communities for previously unserved populations. Lighting can enable children to study during the evenings and remove the harmful effects of kerosene and paraffin. The operation of appliances can enable income-generating and cost-saving activities: for example, water-pumping can eliminate the need for individuals to walk for miles every day to collect water and refrigeration can increase the shelf-life of produce and dairy. Mini-grids also enable community uses of energy, providing for instance energy for schools, which can improve the quality of education, or for health clinics, which can reduce mortality rates and help maintain cool chains for vaccines.

2.2. Why measure the social impact of mini-grids?
Although there is a general acceptance of the benefits of rural electrification through mini-grids, it is rarely based on empirically measured evidence and published data is limited. This is due to the cost (or perceived cost) of collecting such data, a lack of understanding about what data to collect and how, and challenges with standardising data which can then be aggregated across different sites and projects.
An effective M&E strategy ensures that accurate and reliable data is collected, synthesised and analysed into useful and insightful information, which can enable effective decision-making. M&E to understand how communities are impacted by mini-grids is important for a number of reasons [2]:

- **Informs service appraisal**: It enables organisational learning and better decision-making about improving services and achieving maximum impact.
- **Inform options appraisals**: It facilitates a better understanding of sector performance and allows better comparison with alternatives for investment when making decisions on options for sustainable electrification (e.g. can help attract social investors or inform government investment policy).
- It increases the value derived to customers via a more efficient and tailored service by increasing willingness to pay for services and further increasing the financial viability of business models.
- **Informs (and sets) performance benchmarks for providers/donors**: It demonstrates accountability to customers, partners and donors.
- **Informs funders of social ROI**: For donor-funded projects, it allows donors and implementers to assess the social return on investment.
- It allows for lessons learnt to be communicated, and can help to improve the quality of mini-grid implementation internationally through adaptations and innovation in mini-grid business models for base of the pyramid customers.
- Linking technical performance (i.e. system design, supply vs demand data) to social impact may also unlock substantial business model optimisations, as detailed in section 4.7.
- **Informs customer satisfaction and tariff setting**: Allows providers to assess and correlate levels of satisfaction with social impacts and willingness to pay.

### 3. What we know so far: evidence-base and justification

This section summarises a recent academic literature review conducted on the social impacts of mini-grids [3], as well as summary findings from surveyed mini-grid practitioners, asked about their current M&E strategies. The purpose is to provide context and justification for this report, and an evidence base for the methodology presented in Section 4.

#### 3.1. Literature review summary: social impacts of mini-grids

While electricity access clearly has a positive impact on education, health, employment and gender equality, there is a need for a robust means of assessing the extent of any social value and impact derived specifically from mini-grid energy provision.

Within industry literature a substantial lack of information can be found concerning mini-grid impact, with few reports containing qualitative analysis of mini-grid performance or effects. Most are intended as progress reviews to inform future investment in the sector and as a result tend to focus on technical and financial aspects of installations. These rarely involve a comprehensive methodology that considers the full range of potential impacts; with societal impact factors being a notable omission from most. In addition, such techno-economic data on energy systems is often commercially sensitive, much more so than measured social impacts, which could explain the dearth of available literature.

Existing mini-grid evaluations have been conducted mostly utilising a mixture of electronic data logged for consumption and associated income patterns, with site visits, household surveys and informal interviews used to set a baseline and conduct regular reviews. Social impacts identified specifically include effects on schools, health, security, and income generating activities. Productive uses of energy are highlighted as key to improving the socio-economic conditions of the recipient community. However, none of these impacts have been effectively validated through rigorous M&E.

Social impact focussed M&E data would provide a critical evidence base for supporting claims of the beneficial impacts and highlighting potential unintended negative impacts of mini-grids. Recommendations for a methodology to quantify such social impacts is presented in this paper.
3.2. Summary findings from practitioners

A variety of mini-grid practitioners were interviewed to determine current M&E practices in the sector. The practitioners all operate in sub-Saharan Africa and predominantly offer domestic and productive use electricity services through solar micro-grids, however the learning is applicable to other technologies and scales. The practitioners interviewed are listed in Appendix 1, with key learnings as follows:

Approaches to Monitoring and Evaluation

- Generally no formal M&E methodology is followed by practitioners, with each using their own methods and approaches to quantify indicators of interest to their unique business model or service offered.
- The drivers for M&E are twofold: to optimise operations and planning (e.g. to adjust tariffs based on customer satisfaction); and to report to donors and/or investors.
- The key impact area of interest is economic, specifically increased uptake of productive uses of energy, and the effect of mini-grid electricity on household and business incomes. This follows the assumption that a wealthier community is socially better off, but will also have higher ability and willingness to pay, further increasing the viability of the mini-grid business.
- Many want to better understand the social impact of their mini-grids to improve their service and make a case to impact investors, but don’t have the time or resources to invest in comprehensive M&E strategies. Any M&E processes therefore need to be streamlined, efficient and pragmatic.

Challenges with conducting surveys

- Practitioners found that income data can often be inaccurate, as customers often don’t track their spending and sometimes deliberately avoid providing accurate answers. Non-cash income is particularly difficult to track, as are estimates of quantities and time in general.
- Questions requiring aggregated numerical responses are difficult and answers sometimes need to be inferred (by asking, for example, how often do you top up kerosene and how much is each top up; as opposed to how much do you spend on kerosene per month). Providing a list of possible answers or numerical brackets can be useful.
- There are concerns about surveyor bias when customers don’t understand questions and when answers are inferred. Inaccurate answers can also arise if participants are intimidated by surveyors, from cultural and language differences, and through gender dynamics.
- Using trusted community members can be useful to reduce inaccuracies, although training is required to ensure prevent bias. In general, there is a need for assistance from the local community or those familiar with the community. Dedicated enumerator teams are better because they become specialised and efficient.
- Politically sensitive questions should be avoided.

3.3. A summary of research findings

A summary of the key findings from the research is outlined in the table below.

<table>
<thead>
<tr>
<th>Literature Finding and Recommendation</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>A lack of technological data collected on operating mini-grids:</td>
<td>Meters enable system optimisation and design; especially demand-supply balancing, per capita consumption and growth trends. Without proper usage data, it is hard to quantitatively assess the development impact of an energy system.</td>
</tr>
<tr>
<td>• <em>Meters should be installed in all systems</em></td>
<td></td>
</tr>
<tr>
<td>A lack of data on the social impacts of operating mini-grids:</td>
<td>Better understanding of social dynamics will have a significant effect on the uptake and utility of mini-grids in rural communities. Further evidence is also still required to substantiate the asserted social impacts of rural electrification via mini-grids.</td>
</tr>
<tr>
<td>• <em>Regular surveys should be carried out</em></td>
<td></td>
</tr>
<tr>
<td>Collected data tends to be from point of operation:</td>
<td>Without baseline studies conducted before construction, it is challenging to accurately assess the impact of an intervention. This will therefore be critical to generating reliable data with which to make the development case for mini-grids. This isn’t always possible is systems are already in operation. First surveys can establish the current situation to be used as a proxy baseline.</td>
</tr>
<tr>
<td>• <em>Social and technical baseline studies should be carried out</em></td>
<td></td>
</tr>
</tbody>
</table>

This report and toolkit has drawn on the research summarised above to develop indicators to measure the social impacts of mini-grid interventions which are broadly able to be standardised.
4. Proposed Methodology

This section lays out a concise framework for practitioners and researchers to follow to introduce pragmatic but useful M&E into their business activities. It is intended to be used primarily for ongoing monitoring, which enables progress to be tracked and issues to be identified and addressed on a continuous basis.

Some of these indicators can also be used for the purpose of evaluation, reviews, or more in-depth research pieces. Evaluations do not occur routinely and are done at a specific point in time (often at agreed junctures, such as after 2 years and 4 years of operation). The purpose of an evaluation is to dive deeper into complex issues and assumptions in order to understand whether interventions have achieved their intended outcomes and goals and why they may or may not have done so. Evaluations would build upon and triangulate existing monitoring data, but would also identify where any gaps in evidence/data exist and where improved or increased monitoring or studies/evaluations are required. More information about evaluation is contained in section 4.9.

Donors or investors may be interested to fund evaluations to create a case for continued or increased investment and report to their stakeholders and audiences. Evaluations should be an integral part of any M&E strategy to ensure that whatever data can be captured to help inform an evaluation is captured from the outset. Not all practitioners will be able to plan, fund or support an evaluation, but it should be considered when developing the M&E strategy.

4.1. Obtaining institutional and employee buy-in to M&E

Institutionalising M&E within an organisation is crucial to increase the quality and efficiency of the process as a whole. This is listed as the first action so staff are involved throughout the following steps. Below is a list of suggested ways to engage staff:

- Clear communication from leadership and accompanying awareness raising and training is required on why M&E is being done, why it matters and how data will be collected, analysed, used, stored and shared. Messages as to how M&E can help ease tasks and heighten performance of certain roles/duties will be important. The message of ‘collecting data just in case or for the sake of it’ is highly detrimental to staff buy-in to M&E.
- Roles and responsibilities need to be clearly defined and incentives put in place to ensure these roles are carried out (e.g. when and how to undertake data collection). M&E will not work if it falls to one person as their sole responsibility: aspects of M&E need to be absorbed into most roles, whilst one person should have overall oversight and responsibility for co-ordination.
- Staff should be able to see in practice when and how M&E data is used and how it influences decision-making and identifies impact.

4.2. Decide what to measure and develop a Theory of Change for your mini-grid/operation/project

Theories of Change (ToC) are used commonly within the development community to provide a comprehensive description and illustration of how and why a desired change is expected to happen in a particular context. A theory of change starts with the desired ultimate impact or goal. The activities that need to be undertaken are then derived by working back from this desired impact(s), identifying all the conditions (outcomes) that must be in place (and how these relate to one another causally) for the impacts to occur. Though the structure varies, a general form breaks this approach into four levels:

1. Impact level: What impact(s) do we wish to achieve? (i.e. what is the change that we want to see?)
2. Outcome level: What conditions are necessary to achieve this(these) impact(s)?
3. Output level: What outputs are necessary to achieve these outcomes?
4. Activity level: What activities must be undertaken to achieve these outputs?

It is also important to identify what assumptions are inherent in your ToC (what are you assuming about the external environment or certain behaviours of stakeholders that will lead x to y). These assumptions should be tested by your M&E strategy. It is also important to highlight any risks associated with your ToC, identifying what key barriers and challenges could stand in the way of reaching impact. A ToC can ground and help define important considerations of any set of activities, including any assumptions that have been made. It makes it easy to identify the main goal and where there are causal gaps between this goal and planned activities. It also helps to establish what activities or outputs are valuable or not against a goal. Reducing the number of elements monitored will decrease the cost, but it...
is crucial to ensure that the right data is being tracked. A ToC is a useful tool to do this, helping prioritise the key data and information to track to monitor the route to impact. A hypothetical example of a ToC is given in Appendix 2.

The process of developing a ToC is often as important as the finished theory, which can be a diagram or narrative (in good practice is often both). It can be useful to get key stakeholders from community, practitioner, donor or investor levels together to jointly construct the ToC via a facilitated workshop. Any changes required to the ToC should be identified, allowing a ToC to evolve as a ‘living document’ rather than a static ‘one-off’ tool or exercise. It is important that the ToC is tailored to the particular mini-grid project and context in which it is taking place.

Several resources and literature provide guidelines and training on ToC:

- [www.betterevaluation.org](http://www.betterevaluation.org)
- [www.bond.org](http://www.bond.org)
- [www.intrac.org](http://www.intrac.org)

4.3. Develop indicators

Once a theory of change is in place, the next step is to develop indicators against key components at each level. These are used to track and quantify progress of activities linked to outputs, outcomes and impact.

The Key Performance Indicator (KPI) workplan in Appendix 3 and accompanying spreadsheet contains a variety of indicators developed specifically for impact areas practitioners may be most interested in, but can be adapted and expanded as needed.

The indicators are split into core and optional:

- Core indicators are recommended as a minimum to track the overall performance of a mini-grid
- Optional indicators are presented as a menu for practitioners to select from on the basis of organisation or project priorities as established in the Theory of Change

Using this approach, practitioners can tailor their M&E needs as appropriate, based on mission, investor requirements and/or company-based drivers.

4.4. Develop tools to collect data

### Smart Meters (data on generation and consumption)

Monitoring mini-grid power generation and consumption through the use of smart meters can enable mini-grid operators to make decisions that will increase utilisation and reliability: whether or not to connect new customers, to promote increased or decreased consumption at certain times of day, or to add new generation or energy storage. When monitoring data is transmitted to the decision-maker in real-time, load control decisions or demand-side management actions can be taken on an hour-by-hour or even minute-by-minute basis, and can involve pre-programmed automated responses. Control actions can include the switching on and off of individual customers or sub-sections of the network as part of a load-shedding regime.

Smart meter technology allows for monitoring of individual consumption patterns and payment frequencies, and should be analysed alongside non-technical data described in the proceeding section. Generally, customer data is logged via a meter at the point of consumption to a local server, which is then uploaded to a digital server through a mobile data or wifi connection to be accessed through an online dashboard or downloaded as a spreadsheet for processing through data analysis software. It is important to establish trust with consumers to install the meters, by explaining the benefits to them for having a meter installed in their house through effective community sensitisation prior to installation (including how and why their data will be collected, used, retained and shared). An overview of available products for monitoring, control and payment technologies, including indicative costs is summarised in [4] can be found in Appendix 4.

### Survey Designs (data on usage, service and social impact)

Asking customers questions directly through surveys allows for both qualitative and quantitative data to be collected and is recommended as the main data collection process. SMS or telephone based interviews are a potential way to save on costs, however the use of trained enumerators to conduct in-person surveys enables higher quality and qualitative data to be collected. Enumerators need to be able to speak the local language and understand local culture and context. Gaining community trust is essential to ensure accurate information. It is also important to consider
having enumerators of both sexes to enable male and female members of the community to feel comfortable. Group interviews and surveys can be considered to maximise efficiency, but must be carefully selected and sampled (see next section) to eliminate bias and any intimidation.

Surveys allow for standard quantitative data entry which is helpful for tracking performance (see below), however including qualitative data questions can be useful to gain more descriptive or anecdotal information which can provide subtle guidance on how to improve the service and increase the impact of the mini-grid.

Consideration should be given to avoiding survey bias when designing the questions. Survey bias can occur by phrasing questions to elicit either a positive or negative reaction from the respondent, often termed ‘leading questions’. The key is to keep the phrasing as neutral as possible. Another key consideration is the time surveys take, since if the surveys are too long there is a risk participants will get bored and give short or inaccurate answers to hasten the survey. Practitioner experience suggests keeping surveys to 30 minutes provides a balance between obtaining reliable and useful information and maintaining participant interest. Frequency of surveys is also a consideration: if surveyed too frequently, stakeholders can become reticent to devote more valuable leisure or productive time to surveying. This can lead to ‘stakeholder fatigue’ where those surveyed become either less engaged in terms of full or accurate answers, or stop engaging in surveys completely. Trained local enumerators should be able to help establish a suitable frequency in liaison with key community stakeholders. Sharing of survey and impact results back to the community is also important to retain stakeholder engagement.

Several software tools are available to conduct surveys utilising smart phones. Surveys are recorded on mobile devices or tables and uploaded to a digital server when a mobile data or Wi-Fi connection is present. This method is faster than paper and pen approaches, allows for validation, standardisation, and streamlining of data collection, and reduces risk of data loss. Survey questions for core indicators described in the next section are provided in the spreadsheet accompanying this report, ready to be uploaded to digital data collection platform kobocollect https://www.kobotoolbox.org/

Tips on Sampling

Consideration should be given to robust sampling strategies. The purpose of sampling is to select individuals, groups, households and businesses for interviews from the total population in the target region (and potentially in a control region¹) in a way that is governed by chance (or at least by clear, transparent purposive sampling), not by the researcher’s or enumerator’s choice/bias (referred to as probability sampling). The resulting randomness of sample selection is crucial for guaranteeing representativeness of the collected data. It is not always possible to have random samples and where this is the case purposive sampling is another option.

Random sampling can be conducted in a relatively straightforward way, by taking a customer list and generating a random sample on excel. Further sub-sampling may be required to ensure adequate gender and other stakeholder group balance.

A convenience sample is an accidental sample, or a matter of taking what you can get. Although selection through convenience sampling may be unguided, it is not random, using the correct definition of everyone in the population having an equal chance of being selected. Volunteers would constitute a convenience sample.

A good sample size calculator can be found at https://surveysystem.com/sscalc.htm. Best practice would be 95% confidence level with a confidence interval of 5%, but confidence levels can be extended to 10% and still be credible. Key considerations are to be transparent and clear about the sampling methodology used and the confidence intervals or constraints associated with that and therefore any conclusions made.

4.5. Develop data collection processes for each indicator

Establish Roles and Responsibilities

Establishing roles and responsibilities for undertaking each stage of these processes is essential for accurate and timely data collection. If it is not clear who is responsible, for what and when, it won’t happen.

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¹ use of control groups in social impact studies or exercises has serious ethical questions and should be used only under careful consideration and advisement. It is often difficult to establish a pure control group in any given social or developmental context.
Setting baselines and targets

Once the indicators to be tracked are defined and tools to collect the data developed, the next stage is to establish the baseline values of these indicators, where relevant. These values will form the first column of the Planned row for each indicator (column “I” in the accompanying spreadsheet). The rest of the columns on the Planned row should be filled with target values for each indicator at the date set for each major milestone (either at regular intervals or by major activities completed). For example, if the baseline established the number of jobs present in the village at the start of project development, then a target could be for a 5% improvement over this baseline for each year the project was operational.

Technical Data Collection Processes

Collecting technical data is key to understanding load characteristics, demand growth, and frequency of payments, which are all linked to the mini-grid’s profitability but also to the social impact. Technological performance monitoring is recommended for use in conjunction with suitable social impact quantification; only by combining the results of both social impact and technological performance can the full success of a scheme be determined.

Following the installation of the smart meters by an accredited external or in-house installation team, an individual or team should be responsible for maintaining the meters and checking the data is accurately collected. Many smart meters automatically upload data to a cloud server where it can be accessed remotely, but it should be someone’s responsibility to keep track of data acquisition, cleaning and analysis as mentioned in the previous section.

Non-technical Data Collection Processes

Non-technical data collection processes can include for example demand assessment surveys, customer acquisition surveys, customer sign up forms, entrepreneur training surveys, and customer satisfaction surveys. Different processes can be tailored to practitioner needs, available resources and required data to fulfil the requirements of the Theory of Change. Following the guidance in section 1, individual or teams should be assigned to specific processes, with adequate training given on how to collect the data. Examples of possible data processes are summarised below.

<table>
<thead>
<tr>
<th>Process</th>
<th>Timing of collection</th>
<th>Timing of reporting</th>
<th>Who is surveyed?</th>
<th>M&amp;E Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site selection surveys</td>
<td>Once during site selection exercise</td>
<td>Feasibility study stage</td>
<td>Potential customers at potential sites</td>
<td>Capture baseline data</td>
</tr>
<tr>
<td>Customer acquisition survey</td>
<td>During site evaluation</td>
<td>Baseline reporting</td>
<td>Customers interested in being connected to the mini-grid</td>
<td>Capture baseline data</td>
</tr>
<tr>
<td>Micro entrepreneur training survey</td>
<td>After every training session</td>
<td>Quarterly</td>
<td>All micro entrepreneurs</td>
<td>Track KPIs related to job creation and skill development</td>
</tr>
<tr>
<td>Customer impact survey</td>
<td>6-monthly</td>
<td>6-monthly</td>
<td>Random sample of customers</td>
<td>Capture progress data to track against baseline data</td>
</tr>
<tr>
<td>Focus Group Discussion</td>
<td>During Baseline, then annually</td>
<td>Annually</td>
<td>Village-level FGDs can be held with women, village elders, community leaders, teachers, or business people. Village meetings can also be used for FGDs.</td>
<td>Capture more qualitative data that isn’t necessarily picked up in surveys</td>
</tr>
<tr>
<td>Expert Interview</td>
<td>6-monthly or annually</td>
<td>Annually</td>
<td>Individuals of high standing in the village or someone with an integral stake in the mini-grid, e.g. local mini-grid vendor/agent/technician, village headman, headmaster</td>
<td>Capture more qualitative data that isn’t necessarily picked up in surveys</td>
</tr>
</tbody>
</table>

4.6. Data Collection and Reporting

As M&E is undertaken over the lifetime of the project, using developed data collection processes and tools, the Actual values for each indicator can be filled into the tracking framework. For simplicity, we recommend aligning surveys and other M&E activities with the milestones in the KPI tracking framework.

Data cleaning and analysis should be conducted, and regular reports produced. At the very minimum, an individual or team within the organisation needs to be responsible for reviewing and checking data at regular intervals and reviewing the reports being produced. Analysis, conclusions and a supporting narrative can then be provided on a regular basis.
4.7. Using the data

KPI tracking

Measuring project performance and value for money – parameterised indicators

One important measure of the performance of a project is value for money (or cost efficiency), assessing the costs incurred against performance/outputs achieved. This is done by tracking project/programme spend against indicator actuals, but the indicators used can vary. Economic or business indicators such as number of connected customers, peak generating capacity, annual revenue or peak demand are often used as the proxy for project progress, with costs accordingly parametrised in units i.e. $/MW, $/connection and $/kWh. More socially-focused metrics can also be used here, with a couple of examples given below:

<table>
<thead>
<tr>
<th>Tracked performance metric</th>
<th>Parametrised Cost Unit</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of additional people and businesses with access to clean, affordable, reliable and economically viable energy services.</td>
<td>$/person (with access to clean . . . )</td>
<td>Strong demonstration of the impact of a project, as also integrates criteria around quality of service</td>
</tr>
<tr>
<td>Additional average household income increase, as a result of access to off-grid electricity</td>
<td>$ {\text{Additional average household income}} / $ {\text{annual tariff payments} + \text{cost per connection if applicable}}</td>
<td>This ratio shows the rate of return and payback period on a household’s investment</td>
</tr>
</tbody>
</table>

The recommendation for this report is to track a number of these indicators, which align with your organisation’s thinking and strategic objectives, including both economic/business and socially-focused indicators. If built into the tracking framework template provided then the conversions into these parameterised units can be done automatically.

Further tracking framework functionality

The template provided enables basic tracking of planned vs actual for selected indicators, but further analysis can easily be built onto this framework as needed. For example, it is easy to add a Percentage completed row underneath planned and actual, showing the actual value as a percentage of the planned. This percentage completion value can easily be aggregated across multiple or all indicators to provide an overall measure of project/organisational progress.

Conditional formatting could also be applied to each Milestone’s Actual cell, to show by colour when the Actual value differs from the Planned by an agreed proportion i.e. 10% below. This would allow quick identification of lesser performing elements of a project, flagging them for close attention and remedial/adaptive action.

Making recommendations from the analysis

As introduced previously, technical, business and social impact data is useful for many broad stakeholder groups:

- **Practitioners** - Technical design and business model optimisation
- **Governments** - Private sector advocacy to justify government support (subsidies and policy change)
- **Investors** - De-risking investments, promoting awareness and justifying social impact motivations. Also establishing a ‘licence to operate’ and reducing reputational risks and enhancing public image.
- **Donors** – To apply for and report against grant/concessional funding and to demonstrate beneficiary impact
- **Customers/beneficiaries** – it is advisable to share results/conclusions in some form back to communities/users on a reasonably regular basis (at least annually) to ensure continued engagement in M&E and the project/operations more generally

Exactly which of these functions is relevant and how will be different for different organisations, depending on their delivery model and what indicators they choose to track. A few common examples are illustrated here, but it is recommended that consideration is given to the full range of outcomes that could be delivered utilising the data that is collected. In all cases it is beneficial for the sector if there is greater data being collected and made available (even if anonymously), which can be used to inform the decisions of the above stakeholder groups.

For practitioners - technical design and business model optimisation

Mini-grid profitability relies on strong understanding of the end-users and their economic and cultural contexts, which is difficult and requires a lot of time and resources. Regular monitoring and evaluation of end-users and their
interactions with an energy systems is key, enabling adaptation/tailoring over time. A few examples of areas with high potential for optimisation include:

- Tariff structures and levels
- Customer engagement strategy
- Incentive structures for demand stimulation
- Changes in technical design to better reflect use patterns

All of the above optimisations rely on inferring the causality between technical design and performance to social and economic impacts, for example linking the impact of implementing new customer training to customer drop-out rates. The recommended level of M&E in this report, with regular data collection of planned versus actual performance across multiple metrics, will enable much more accurate and precise analyses of such relationships (provided that organisations/businesses carefully tailor their indicators to the questions and causality they want to assess). This will increase the certainty with which optimisations can be designed and implemented. In the given example, customer surveys might show that previously there was a lack of understanding over a certain aspect of the tariff structure, which meant that power was not being drawn for fear of incurring higher than average tariffs. This could then be mitigated by targeted user training, changed wording on this tariff structure, or a change to the tariff structure itself (this would then be validated by further surveys assessing customer understanding post-training, etc.).

**For governments - private sector advocacy to justify government support (subsidies and policy change)**

A supportive policy environment and subsidies for mini-grids is vital to enable them to scale and operate sustainably. Many governments now at least partially recognise that mini-grids can be economically viable solutions for certain remote communities, but a number of misgivings and misunderstandings remain. For example, mini-grids are often seen as providing an inferior service when compared to grid power, or that mini-grids are only owned and installed by international companies using international equipment.

In order to secure long-term government support for mini-grids through policy change and subsidies, it is necessary to convince governments both that mini-grids deliver against their socio-economic development objectives and that sufficient value is created and retained within the country itself (including job creation). These factors require supporting evidence. Given a lack of this evidence currently, support is likely to be readily available to those developers that can demonstrate strong socio-economic impact and value creation. This report therefore recommends government advocacy using evidence generated by improved M&E, both individually and through collectives and associations. National renewable energy associations are a good starting point, as well as regional/global initiatives such as the African Mini-Grid Developers Association.

**For investors - de-risking investments, promoting awareness, improved public image and justifying social impact motivations**

The lack of demonstrated successful business models and precedents means that key stakeholders, especially investors, perceive mini-grids as high risk. Perceived returns or those returns able to be evidenced are not sufficient to bear the perceived risks for investors, limited by low ability to pay and demand. The IFC concluded that “there is a dearth of data-driven analysis of the operational and financial performance of the sector” and “limited insight into what constitutes a financially sound business” [5]. This is arguably the main factor limiting the scale of mini-grid businesses globally.

Increased access to data on the financial, technical and socio-economic performance of successful mini-grids is essential to unlock sufficient volume and combinations of capital flow to projects at the critical points in their life cycles. A number of benchmarking exercises have been initiated, including a cost benchmarking of mini-grids for the World Bank’s Energy Sector Management Assistance Program, but the gap remains substantial.

**4.8. Research and Evaluation**

Some indicators present challenges with proving attribution and are normally out of scope of standard M&E, for example, improved school performance as a result of electricity access. However these indicators aren’t impossible to
track and can come under the scope of academic longitudinal studies\(^2\) or evaluations (particularly specific ‘impact evaluations’). The KPI framework contains a selection of such research and evaluation questions should practitioners wish to explore them in more detail. Some of the long-term impact indicators with suggested questions included in the KPI framework are included in Appendix 3. Research questions are often answered in a different way from evaluation questions – although there is some cross-over.

Whilst many of these long term questions can be explored and measured via research studies and evaluations, it is important to note that attribution is not always possible or indeed desirable to measure. Take the example above of improved school performance. Many factors could contribute to improved school performance besides improved lighting/energy access at home, such as: change in government education policy or resourcing; an education project or initiative being run in the same area by a donor/NGO; or a health/nutrition project being run in the same area providing free school meals. It will often be difficult to define a causal attribution in this kind of context, and often it may be presumptuous to do so. What may be more effective is seeking to ascertain contribution to certain impacts.

Nonetheless, longitudinal research studies and social impact evaluations of energy interventions will be crucial in achieving a scaled mini-grid sector, through the unlocking of sustained investment and government support. It is therefore a strong recommendation of this report to support the construction of this body of evidence, by setting up and joining partnerships for longitudinal/research studies and evaluations and (anonymised) data and lesson sharing through third parties. Donors/investors should also be approached to fund/co-fund evaluations – stressing the importance of contributing to the body of knowledge and evidence in the sector.

Before commissioning an evaluation or piece of research, it is important to decide on approximately 3-5 key research/evaluation questions that you are seeking to answer. Many evaluations are based around the OECD/DAC criteria ([www.oecd.org](http://www.oecd.org)) and you may want to select questions from particular criteria within these. These questions can focus purely on impact, or can assess other areas like operational efficiency, process effectiveness or cost effectiveness, sustainability, etc. Having a clear set of concise and precise questions allows the research/evaluation team to determine methodology: which data to collect, how to analyse it and how to report on it. Key evaluative questions should be:

- Specific enough to be useful in guiding an evaluation team
- Open questions that are able to be assessed using data
- Meaningful and result in learnings that can be acted upon
- Limited in number (recommended 3-5 questions)
- Able to be answered respective to the resources available for the evaluation (e.g. a narrower scope may often be more realistic and effective, rather than spreading the evaluation too wide)

Examples of key evaluative questions for mini-grid projects include:

- Is the work delivering on outcomes as planned?
- What significant changes have occurred in people’s lives?
- Are the key changes likely to be sustained?
- What have been the unexpected outcomes (positive and negative)?
- Is demand for energy increasing and if so, why? To what extent is demand growing organically vs as a direct result of intervention?
- How have women been impacted (positive and negative) and what more could be done to empower women?
- To what extent has wealth been increased at the community level?
- Have customers been appropriately involved and empowered throughout the intervention?

Examples of key research questions for mini-grid projects include:

- To what extent can key changes be attributed to the intervention?
- What leads some productive use activities to succeed and others to fail?
- Are increased incomes leading to a greater investment in education or other important areas?

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\(^2\) A longitudinal survey is a research study looking to establish correlated or causal relationships, which involves repeated observations of the same variables over long periods of time
5. References


6. Appendices

Appendix 1: Mini-grid practitioners surveyed

<table>
<thead>
<tr>
<th>Practitioner</th>
<th>Countries of Operation</th>
</tr>
</thead>
<tbody>
<tr>
<td>MeshPower</td>
<td>Rwanda</td>
</tr>
<tr>
<td>PowerGen</td>
<td>Kenya, Tanzania</td>
</tr>
<tr>
<td>RENEWVIA</td>
<td>Uruguay, Kenya, Pacific Islands, USA</td>
</tr>
<tr>
<td>Rubitec Solar</td>
<td>Nigeria</td>
</tr>
<tr>
<td>Rafiki Power</td>
<td>Tanzania</td>
</tr>
<tr>
<td>RVSol</td>
<td>Kenya, Portugal, Tanzania, Mozambique</td>
</tr>
<tr>
<td>Standard Microgrid</td>
<td>Zambia, Tanzania, Kenya and the DR Congo</td>
</tr>
</tbody>
</table>

Appendix 2: Example Theory of Change productive use activities of small-scale energy development projects. [6]
Appendix 3: KPI Framework

Link to KPI framework:

https://drive.google.com/file/d/1OHG5o5OR0RjEEVtIcMbY6kqHdJmFC9cl/view?usp=sharing

Core Indicators:

<table>
<thead>
<tr>
<th>Indicator Categories</th>
<th>Description</th>
<th>Example Indicators</th>
</tr>
</thead>
</table>
| Technical            | Metered data on customer demand and system performance | • Household, business and community services time-step, average and seasonal consumption  
• Total peak/average load drawn by households, businesses and community services |
| Tracking Customers    | Data about numbers of customers, disaggregated to log variety and type of customers/beneficiaries | • Number of households, businesses and community services connected  
• number of people in household, disaggregated by women and children, number of children going to school, occupation (formal and informal responsibilities), education level, and marginalised/vulnerable social groups |
| Household            | Domestic customer data and profiles | • Income and expenditure  
• Appliance ownership  
• Other fuels used for lighting and cooking |
| Productive Uses of Energy | Key data on businesses powered by the mini-grid | • As above but for businesses  
• the number of new jobs created (formal and informal)  
• Energy cost savings made by businesses since electrification |
| Gender               | Monitoring impact on female customers | • total number of women with possibilities to pursue both productive and recreational activities after nightfall  
• Female access to electricity  
• Female PUE |
| Education            | Measuring the impact the mini-grid has on schools and education | • Schools with access to ICT  
• Access to energy for after school/evening studies |
| Health               | Measuring outcomes related to health of customers. | • Proportion of people/households with access to improved health and sanitation facilities/services |
| Social               | Other social indicators of a more general nature. | • Number of street lights operating  
• Percentage of households with access that want it  
• General satisfaction with grid service |

Selection of Additional Indicators:

<table>
<thead>
<tr>
<th>Category</th>
<th>Example Indicators</th>
</tr>
</thead>
</table>
| Health - Additional     | • Hours of hospital access to electricity daily  
• Share of energy consumed by vaccination and medicine storage |
| Education - Additional  | • Hours of freed up time from drudgery while creating time for studies  
• Share of people with awareness around clean energy issues |
| Immigration             | • Share of skilled working migrants in community since electrification |
| Agriculture             | • Total number of farms electrified  
• Percentage increase in production due to electricity |
| Irrigation              | • Effects of electricity in the extension of cultivable land through irrigation.  
• Effects of electricity on the creation of new nursery seedling sites |
<p>| Gender                  | • Number of women included in the sociotechnical design of new energy systems |</p>
<table>
<thead>
<tr>
<th>Water Development</th>
<th>• Hours spent cooking with electric appliances</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rural Housing</td>
<td>• Total number of boreholes installed</td>
</tr>
<tr>
<td>Environmental</td>
<td>• Influence of electricity on water quality</td>
</tr>
<tr>
<td>Labour</td>
<td>• Number of households accessing news through radio and TV, communication, etc.</td>
</tr>
<tr>
<td>National Registration Bureau</td>
<td>• Calculated GHG emissions due to electrification</td>
</tr>
<tr>
<td>Economic</td>
<td>• Local training rate post electrification</td>
</tr>
<tr>
<td></td>
<td>• Scale of digitalisation of records since electrification</td>
</tr>
<tr>
<td></td>
<td>• Total number of registrations recorded due to electricity access</td>
</tr>
<tr>
<td></td>
<td>• Access to bank account, mobile money, and credit</td>
</tr>
</tbody>
</table>

Research and Evaluation Questions Indicators:

**Questions**

What proportion of connected households are reporting improved equality as a result of access to electricity?

How many lives have been saved due to access to electricity?

How has the maternal mortality rate been affected by access to electricity?

What is the percentage decrease of pollutant related sicknesses (incidences of acute respiratory infections) related to access to electricity?

What is the percentage of students who perform better due to access to electricity?

How has the job satisfaction of teachers been affected by access to electricity?

**Appendix 4: Smart Meter Suppliers (adapted from [4])**

<table>
<thead>
<tr>
<th>Name of company/product</th>
<th>Monitoring, control and payment technology</th>
<th>Energy services</th>
<th>Business model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lumeter</td>
<td>Off-grid electricity meter that allows prepayments through mobile phones. Cloud accounting software transmits data on payments and time of usage to renewable energy providers. The meter can be integrated into appliances provided by other suppliers.</td>
<td>Provide smart metering systems to mini-grid developers.</td>
<td>Meters have a payment mechanism similar to a pre-paid cell phone system, where customers can use their cell phone’s text message service (SMS) to buy electricity credit.</td>
</tr>
<tr>
<td>SparkMeter</td>
<td>Metering systems that allow both pre and post-payment, either for energy consumed or a flat-rate tariff. Technology allows real-time monitoring and control on microgrids. The system consists of four hardware components, a cloud-based operator interface, and a mobile money or cash-based pre-payment system.</td>
<td>Provide smart metering systems to microgrid developers.</td>
<td>Each micro-grid utility puts Spark Meter’s flexible tariff system and load management to use in ways that are most beneficial to their business models, whether time-of-use or monthly fixed tariffs.</td>
</tr>
<tr>
<td>Powerhive</td>
<td>Honeycomb m-PowerOS™ cloud-based software platform and mobile money pre-payment.</td>
<td>Indirect: offers technologies and services to partners</td>
<td>Powerhive partners with energy providers, project developers and local entrepreneurs that take the role of ESCOs</td>
</tr>
</tbody>
</table>
SteamaCo BitHarvester smart meters monitor and control mini-grid equipment and industrial hardware and relay information to SteamaCo’s cloud software Steama. Indirect: offers equipment/products and services to partners implementing mini-grids. SteamaCo’s business focus is the development and sale of technologies that enable remote metering, control and payments. SteamaCo sells its hardware to micro-grid developers and leases access to the interface (Dashboard) software on a monthly basis.

<table>
<thead>
<tr>
<th>Table: indicative costs for a smart meter [7]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meter cost per customer</td>
</tr>
<tr>
<td>Base station</td>
</tr>
<tr>
<td>Modem</td>
</tr>
<tr>
<td>Monthly software cost to access data</td>
</tr>
<tr>
<td>Shipping Costs</td>
</tr>
</tbody>
</table>