BENCHMARKING AFRICA'S MINIGRIDS

Authored By

ECONOMIC CONSULTING ASSOCIATES

AMDA

Benchmarking Africa's Minigrids

Forward

With this report, the Africa Minigrid Developers Association (AMDA) is opening the door to a new era in the minigrid sector. One of continental transparency in performance, cost, and scale information that will allow decision-makers in national governments, donor institutions, and investors to make more informed choices than ever before. And it will help minigrid companies understand how they are performing vis-à-vis their peers for the first time as well.

AMDA's mandate from day one has been to improve policy and financing environments for private sector minigrids by expanding the evidence base of sector performance and also by providing expert guidance and advocacy around best practices and sector needs. We are therefore extremely proud to release our first major publication, "Benchmarking Africa's Minigrids," to deliver on this mandate. With less than ten years left until the globally agreed 2030 deadline to deliver universal energy access for all, this publication and all our work at AMDA is focused on offering insight into what the sector needs to radically scale up progress towards this objective.

This report makes a great leap forward in this regard, showing how minigrid companies are rapidly reducing costs and are already significantly cheaper on a per connection basis in rural areas than their state utility counterparts. We also show the immense need to support regulatory streamlining across Africa, without which, achieving universal access in a timely manner will not be possible.

We invite you to read and absorb the insights found in this report and to reach out to the AMDA team to collaborate both on overcoming the barriers keeping minigrids from scaling as quickly as needed, and more broadly on our work to ramp up the progress of this essential sector.

Aaron Leopold
Chief Executive Officer
Africa Minigrid Developers Association (AMDA)

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Contents

Benchmarking	2
Africa's Minigrids	2
Forward	3
Acknowledgements	4
Contents	5
1. Executive summary	7
Key Findings	8
Recommendations for decision-makers:	9
2. Introduction	11
2.1 Who We Are	12
3. Methodology	15
4. Sector Growth	19
4.1 Electricity Access and Growth of Energy Services	20
4.2 Total connections	20
4.3 Total installed kW and number of sites	21
4.4 Concessional Funding: True Scale Requires Systemic Support	21
4.5 National Government subsidies in the electricity sector	25
4.6 Key insights	25
5. Costs	27
5.1 CAPEX trends	28
5.2 Explaining 2019 Costs through Economies of Scale and Market Expansion	31
5.2 Operational Expenses	33
5.2.1 Overview of operating expenses	34
5.3 Key insights	35
6. Consumption and Growing the Load	36
6.1 Average revenues	39
6.2 Increasing Consumption by Increasing Incomes: Productive Energy	40
6.3 Sector job creation	41
6.4 Key insights	43
7. Service Quality	45
7.1 Service uptime	46
7.2 Performance & Service Quality	47
7.3 Percentage of customers within communities served	48
7.4 Key insights	49
8. Policy and Regulation will Make or	50
Break Chances of Achieving SDG 7	50
Policy and Regulation will Make or Break Chances of Achieving SDG 7	51
8.1: Licensing and regulatory frameworks	51
8.2 Key insights	54
9. Conclusion and Next Steps	55
Conclusion and Next Steps	56
9.1 Next steps	56
10. References	58

Contents

Table 3.1: Overview of developers and reported sites 18
Table 3.2: Overview of quality of data received 18
Figure 4.1: Overview of total number of connections 20
Figure 4.2: Installed capacity and commissioning of new sites[4] 21
Figure 4.3: Funding Received by Region 22
Table 4.2: Funding received 23
Figure 4.4: Comparison of funding by type 23
Figure 4.5: Lead time of funding on new connections 24
Figure 4.6: Growth rates for minigrid deployment 24
Figure 5.1: Comparison of relative installed costs 29
Figure 5.2: CAPEX costs 30
Figure 5.3: Average and median total installed costs with one standard deviation 30
Figure 5.4: CAPEX per connection trends by experience 31
Figure 5.5: CAPEX per connection trends by experience 32
Figure 5.6: Comparison of costs for established and new developers 33
Figure 5.7: Number of sites per developer 33
Figure 5.8: Breakdown of OPEX 34
Figure 6.1: Comparison of average monthly consumption per user[15] 37
Figure 6.2: Difference in average consumption per user within a single developer 38
Figure 6.3: Comparison of average reported performance against ARPU 39
Table 6.1 Power requirements, costs and indicative payback periods of selected income-generating appliances 40
Figure 6.4: Minigrids local value chain 42
Figure 6.5: Village jobs and local employees 42
Figure 7.1: Percent uptimes of sites with generation capacity 46
Figure 7.2: Project sites with diesel generators by year installed 47
Figure 7.3: Electrification rate and connections within minigrid communities 48
Figure 8.1: Evolution of average licensing time 52
Figure 8.2: Average time to obtain licences in countries that require licenses[26] 52
Figure 8.3: Licencing Timeline in months 53
Source: Nigerian Electricity Regulatory Commission 53
Box 8.1: Nigeria's regulatory framework 53

1. Executive summary

Photo Credit: EngiePowerCorner

Executive summary

Over the last decade, leading authorities have repeatedly heralded minigrids as essential to providing electricity to approximately half of all unelectrified communities in Africa. Despite this, investment, political buy-in, and scale have remained elusive. One of the key reasons this has been the case is that to date, national-level decision-makers, investors and donors have had to rely on data and evidence from individuals or small groups of companies. This being because there has been a general lack of reliable, neutral information available on the sector as a whole.

With this report, the African Minigrid Developers Association's (AMDA) and Economic Consulting Associates (ECA) present analysis of a one of a kind dataset collected from nearly all established market leaders across Africa as well as a significant sample of smaller, newer companies that together represent the vast majority of private sector minigrid companies on the continent. This report provides the most comprehensive analysis on minigrid financing, economics, regulation, service quality, & impact available to date, and also offers key insights into the barriers facing the sector and what can be done to overcome them.

Key Findings

Overall, the African minigrid market is behaving predictably both as a nascent industry, with significant price reductions emerging as investments increase, and also as a rural electrification sector, in that public funding has proven an essential catalyst to bring in private investors and kickstart cost reductions through the scale-up process. Logic holds that continued public support will see continued scale-up and price reductions.

The data demonstrates a fundamental interconnection between concessional funding, private investment, political environments and deployment of connections. AMDA's data illustrates how these different pieces of the enabling environment feed off one another to build the trust, confidence, and experience necessary to see increased delivery of energy access. These elements are so fundamentally intertwined that disruptions within the cycle can derail growth or even devolve into negative feedback loops.

AMDA's data shows the sector is beginning an impressive scale-up phase. As donor funding steadily increased over the reporting period, connection numbers did as well; going from under 2,000 connections in 2016 to over 41,000 in 2019. These connections have provided over 250,000 people, businesses and community facilities with high quality, productive energy. To date, this growth has largely taken place in East African markets, where the sector got an earlier start.

The sector's growth over 2014-2018 also coincided with a tremendous drop in costs, with the average price per connection falling from US$ 1,555 at the beginning of our reporting period to US$ 733 in 2019. Established developers have been able to reduce CAPEX pricing by 57% over the reporting period. Cost for new companies entering a market has reduced by 33% in the same period. Another interesting contrast between new and experienced developers is that in well-established markets, experienced firms were on average 41% less expensive than new developers in those same markets, again illustrating the logical evolution of sector as companies gain experience and scale.

In well established markets, experienced firms were on average 41% less expensive than new developers in those same markets, again illustrating the logical evolution of sector as companies gain experience and scale.

Taken together, our data show that rural minigrid connections are often thousands of dollars cheaper than those of state-run utilities. With the primary concern of governments today being the higher kilowatt costs of minigrids, these enormous cost savings could easily be transferred into end-user subsidies or other cost reductions tools, and still save governments and donors billions vis-à-vis traditional grid expansion across the continent.

Our most alarming finding is that across the continent, regulatory compliance processes on average take more than one year per site. With the World Bank estimating that Africa requires 140,000 minigrids, regulation represents an enormous barrier to sector growth and to SDG 7. Neither will be achievable without the urgent development and adoption of more automated and bundled approval processes that allow for higher volumes of approvals at greatly increased speeds.

An unsurprising but confirmatory key finding is the challenge of low consumption. The average consumption per customer is only 6.1 kWh per month across the continent. Low consumption makes it difficult to ensure operational costs can be covered for residential consumers, let alone that a return on investment might be possible. Interestingly, the data does not show a correlation between higher average revenue per user and a higher level of consumption, utilisation rates or installed generation capacity. This is likely due to tariff pricing effects, as well as difficult operating environments where external factors and the demographic make-up of customers create large variabilities in revenue generation.

Recommendations for decision-makers:

Support is urgently needed however to address the dual issues of low demand and complex regulatory environments.

In summary, concessional funding is working to unlock private capital and catalyse investment that is allowing the sector to grow and reduce costs as it gains experience and scale. Support is urgently needed however to address the dual issues of low demand and complex regulatory environments. Only once these issues are mitigated will the sector be able to grow quickly enough to play the role it is being called on to play in ending energy poverty for good.

With this in mind, AMDA has identified three key areas for decision-maker action based on the evidence presented in this report:

1. **Public funding has been very successful at crowding-in other investors and more is needed.** While these investments have already begun a scaling effect that is significantly lowering prices, because the sector is still in its early stages, broad, systemic public funding is still is needed to bring in private investment continentally and realize true economies of scale. Therefore large-scale, multi-country funding programs would be the most ideal tools to give investors and minigrid companies predictable, easy to understand pathways to invest and build across multiple geographies.

2. **Low consumption is a systemic problem that requires coordination and collaboration among all stakeholders.** Because of this systemic challenge, bankability will remain elusive until a systemic, long-term collaborative response from minigrid companies, the donor community and national governments is deployed at scale. While not based on the evidence presented in this report, experience shows that ideally, a broad-scale demand-growth program would likely need be a combination of micro-finance (for appliance purchases), micro-entrepreneurship training (ensuring appliances and small businesses are increasing incomes) and agricultural extension work (minigrid sites and customers will remain largely agrarian for some time). Right now, systemic efforts to address this core sectoral issue do not exist, and helping fill this gap will be a key area of AMDA's work moving forward.

3. **Minigrid regulations must be made more appropriate to the projects they are regulating.** Current regulations are largely based on regulator experiences approving and monitoring small numbers of large energy projects, and must urgently be re-designed to do the inverse - approve hundreds or thousands of small projects over a short period of time. Digitizing processes as much as possible, while making use of smart- and remote-monitoring technologies will go a long way in allowing regulators to reduce up-front application burdens, as well as allow approvals to move in batches rather than one-by-one.

2. Introduction

Photo Credit: REDAVIA

Introduction

Minigrids are standalone energy systems that offer grid-quality electricity for an entire community, its businesses and even small-scale industry. Since the prices of components and technological advancements in renewable energy systems have dramatically improved over recent years, minigrids are more and more being seen as a core solution to the energy needs of rural and remote communities around the world.

With over 600 million Africans still living without access to electricity, minigrids are particularly recognized as the most appropriate technology for around half of this energy-poor population. Indeed, the World Bank has estimated that over 140,000 minigrids are needed in Africa alone to solve this problem[1]. However, because the sector is relatively new and the customer base for these minigrids represents poor, rural and often vulnerable and marginalized groups, there are both government sensitivities and investor scepticism around wholesale support of this technology from their respective viewpoints.

One of the reasons for this is that there is very little robust data available on the sector due to its small scale and due to the remoteness of their operations. Governments and investors genuinely do not have good understandings of the sector, its performance or its ability to deliver at scale. This report represents a major milestone in closing this information gap, permanently.

In 2019, after more than a year of efforts to collaboratively create a robust data collection and sharing methodology, AMDA partnered with Odyssey Energy Solutions and Economic Consulting Associates (ECA) to respectively collect and analyse a significant dataset collected from AMDA members across the continent. What has resulted is this report. The first of its kind, this report offers insights never before seen into the performance of minigrid companies across Africa, as well as key insights into the barriers the sector is facing and how we can work together to overcome them.

The data presented here cover up to a 10-year period in some cases. We focus on important metrics such as installed and operating costs, financing, revenue per user, quality of service and various other key sector indicators.

Results show that installation costs have decreased rapidly over the period to far below the average of state-run utility connection costs, and the number of new sites and connections have grown radically since 2016. Our analysis indicates that much of this gain can be attributed to funding coming into the sector and the steps taken by governments to create conducive regulatory frameworks for minigrid developers.

The data also shows, however, that much more work is needed on both of the funding and regulatory fronts before we see the scale and cost reductions needed to bring minigrids into the mainstream.

An unsurprising but confirmatory key finding is the challenge of low consumption. Moving forward, it will be fundamental for developers, donors and national governments to work together to enable and encourage customers to increase productive energy use that can bring economic benefits to rural communities. This will in turn ensure a financially viable operating environment for minigrid companies.

2.1 Who We Are

Africa Minigrid Developers Association (AMDA) was created by private sector minigrid developers and operators, donors and investors interested in improving the political economic environment for minigrid companies. AMDA's work focuses primarily on helping the sector scale up using data, evidence and member experiences to inform policies, regulations and investment.

[1]World Bank ESMAP. (Forthcoming, 2020). Minigrids for Half a Billion People

It is AMDA's and our members' belief that the fastest, most economical way to deliver universal energy access is through a mix of public and private approaches. The private sector can play a pivotal role given its ingrained incentives to seek profitability by reducing costs, innovating ways to increase demand and operational efficiency while providing high quality services. Hence, AMDA's membership is currently limited to growth-oriented (mostly private sector) companies.

Today, AMDA represents over 30 companies (encompassing all market leaders) who are operating minigrids across 12 countries (see highlighted countries in map below). The minigrid market is growing rapidly but is still small. For this report, our members provided data on their combined 288 sites, serving over 40,735 connections. Because of our private sector focus and membership, you will see that countries which do indeed have hundreds of minigrids, such as Senegal, are not included in this analysis because these are state-owned.

In efforts to deliver on our mission to help the sector scale, AMDA members and sector stakeholders agreed that one of the most helpful roles we can play is to work to create transparency around industry performance. Key decisions on how to electrify rural and remote populations cannot be made effectively without a comprehensive understanding of technologies, business performance and trends.

One of the biggest challenges for minigrids in Africa is that they are inherently located in hard to reach, hard to monitor areas. This, coupled with the fact that their customers are often vulnerable, marginalized and remote communities, means that there are both challenges in understanding minigrid operations and also in ensuring that their customers are indeed being served well and served fairly.

It is within this context that AMDA has produced this first data benchmarking report with our partners Odyssey Energy Solutions and Economic Consulting Associates (ECA).

Odyssey Energy Solutions is an online investment and asset management platform developed to facilitate large-scale deployment of capital into the energy access sector. The Odyssey platform manages data across the full lifecycle of distributed energy portfolios, helping to streamline project development, financing, and operations. Odyssey also has powerful data analytics tools that provide secure data-sharing and analysis between industry stakeholders. The platform integrates large data sets of information from all angles of the sector into standardized key performance indicators, allowing for easy and clear evaluation of minigrids and other energy access projects. It allows governments, investors, donors and minigrid companies themselves to better visualize and understand the sector.

Currently, the Odyssey platform is being used in more than 30 countries across Africa, facilitating nearly US$ 500 million of capital into solar minigrids and other distributed energy projects. The platform is supported and used by leading financiers, governments, private companies and industry organizations to manage and share critically important sector data with key stakeholders. As a leader in results-based financing (RBF) technologies, the Odyssey platform is managing sector-leading RBF programs, including some of the largest rural electrification financing programs in history. Odyssey's advanced analytical tools are being used to remotely monitor tens of thousands of distributed energy systems, verify electricity connections, measure system performance and reliability, and track program impact.

Odyssey has proven that digital technologies can significantly reduce the cost of large-scale deployment and financing of minigrids and other distributed energy projects, while increasing transparency, efficacy, and visibility to all stakeholders. Odyssey, in partnership with AMDA, aims to provide a data-driven approach to decision-making and investment into the minigrid sector.

Economic Consulting Associates (ECA) is an economic and regulatory consultancy specialized in advising private companies, governments, regulators, utilities, and donors on issues relating to the energy, water, and infrastructure sectors. One of ECA's core competencies is advising on market assessments, investment planning, and energy access frameworks and financing across the world, with a special focus on mini-grid development. ECA has prepared minigrid policy and regulatory frameworks for governments, conducted market due diligence and project feasibility studies for developers and investors, and designed financing facilities for donors and private financiers across Africa, Asia, and the Pacific region.

3. Methodology

Photo Credit:EngiePowerCorner

Methodology

The data in this report represents the culmination of work of AMDA's data working group of minigrid developers and operators, alongside researchers, investors and other key sector stakeholders[2]. This group collaborated for over a year to develop a methodology and set of metrics that delivers information that decision-makers need while also protecting the interests, anonymity and intellectual property of private minigrid businesses. The resulting data collection tool pulled together information on over 60 different indicators.

All AMDA members and two developers that were not members submitted data. This represents the vast majority of companies on the continent and encompasses all market leaders and a good sample of smaller, newer companies as well. The flowchart below outlines the process for developing and executing the benchmarking study.

01

AMDA Develops Reporting Structure

Metrics designed over multi-day internal workshop addressing data needs, collectability, calculations and intellectual property concerns

02

External Stakeholder Review and Structuring

Multi-day meeting with 20 sector experts to ensure metrics and methods were in line with sector needs, professional research standards and external expectations.

03

Multiple NDAs signed

- Between developers and AMDA
- Between AMDA and Odyssey
- Between ECA and AMDA
- Between Odyssey and ECA

04

Data upload to Odyssey

- Developers input site and company data, and maintain ownership of their data
- Odyssey anonymizes data
- Developer grants AMDA access to data outputs only, not raw data

05

AMDA grants ECA access to raw, anonymized data

- ECA cleans data
- ECA poses queries to AMDA where gaps & uncertainties exist
- AMDA works with developers to rectify data issues or links developed with ECA

06

Preparation of data analytics and report

- ECA aggregates and analyses anonymized data points.
- ECA writes initial draft report

07

Peer Review

- Key researchers and institutions peer review the report.
- Peer review comments/ suggestions were incorporated into the document.

08

Odyssey data tool hosted on AMDA's website

- Interactive map
- Visualisation of sector information at continental and national levels.

08

Publication and Dissemination

- Published report presented to key stakeholders via webinars, blog posts, bilateral meetings, and public events.

[2]Participants in design: Rockefeller Foundation, Shell Foundation, CrossBoundary Energy, Energy4Impact, RMI, TFE Consulting, University of Massachusetts at Amherst, Carnegie Mellon University, SparkMeter, SteamaCO, Odyssey, GIZ, New Sun Road, AMMP, National Renewable Energy Laboratory (NREL), and the Power Africa Off-grid Project (PAOP).

The data questionnaire was separated into three sections (the template can be found in Annex A):

- **Projects** – Data was requested for each minigrid site owned and operated by developers in this study. The data collected includes capital and operating costs, operational data, sales, number of connections and other technical and operational data.
- **Organisations** – The data was collected at a developer level and included data on time required for acquiring licenses and number of employees for every year of the developer's operations.

- **Finance** – Finance data was also collected at a developer level and included the amount received, funding source, the type of funding and year of receiving the funding. The developer's own equity and interest rates on debt were excluded from the data collection.

The data was collected through three Microsoft Excel data templates, corresponding to the sections listed above. All developers were given a randomised unique ID to preserve anonymity. Developers reported on site-specific data for all operational sites commissioned before June 30, 2019. In one case, this included historical and technical data dating back to 2010. The vast majority of data, however, was from 2016-19, and operational data such as operational expenses (OPEX) and average revenue per uses (ARPU) were collected for the 12-month period from July 2018 – June 2019.

While the data in this report represents the most robust sectoral data in Africa, there are several limitations of the dataset. It only represents private sector minigrids and does not provide comprehensive comparisons to national utility operations, as very little data exists for them. We have provided national utility figures where possible, but much more research and analysis is needed in comparing the two. This will really only be possible if more transparent national utility data is made available however.

In line with most industry datasets, this report relies on self-reporting. In this case, from 28 developers operating across 12 countries. The data presented for revenue, consumption and operations costs all comes from a single year and therefore we are unable to track longitudinal trends in this study. Changes over time will however be analysed in subsequent benchmarking studies as our dataset grows.

While all developers reported on most metrics, there are some gaps in the data from a subset of the developers that limited the analytics that could be derived. Responses for 90% of the questions were standard and required no clarification or follow-up. After collection, a data cleaning process was undertaken to identify outliers and consult with developers to correct any errors. Where validation of the data was not possible, outliers were excluded from the dataset. Care was taken to only exclude outliers resulting from an error in the data collection process.

Due to the amount of commercially sensitive information in the dataset, steps have been taken to ensure information presented here cannot be traced back to any single developer. These steps included not visually presenting data in tables and charts from periods when few developers were operating and providing regional data rather than country-specific data for countries where identifying companies would be possible due to the small number of operators there.

Given this, the categorisation of Western & Central Africa and Eastern & Southern Africa was developed to ensure the anonymity of data. The countries included in each region are:

- **Western & Central Africa** – Benin, Cameroon, Mali, Mauritania, Nigeria, Sierra Leone, Togo
- **Eastern & Southern Africa** – DRC, Kenya, Madagascar, Tanzania, Zambia.

Solar photovoltaic (PV) was the prevalent generation technology in the dataset, with two hydropower sites as the only exceptions. Because there is a significant difference in the cost structure and operating behaviour of hydropower and solar PV, the two hydropower sites have been excluded in all cost analytics. Nonetheless, their exclusion was not statistically significant to influence the outcome of the analysis.

Table 3.1: Overview of developers and reported sites

	Total sites	Number of developers	Year of first site	Year of latest site
Benin	1	1	2019	2019
Cameroon	7	1	2014	2019
Democratic Republic of Congo	1	1	2017	2017
Kenya	192	6	2010	2019
Madagascar	7	2	2014	2019
Mali	23	1	2007	2018
Mauritania	2	1	2017	2018
Nigeria	3	4*	2017	2018
Sierra Leone	3	1	2019	2019
Tanzania	43	7	2012	2019
Togo	1	1	2019	2019
Zambia	5	2	2018	2019
Total	288	28		

* Includes non-AMDA developers who provided partial data

Table 3.2: Overview of quality of data received

Data category	Responses received	Complete responses	Partial responses	Limited responses*
Project data	288	67	19	91
Organisational data	79	47	25	7
Financing data	64	64	0	0

*Limited responses are all responses that did not provide sufficient data to be included in cross-sectional analytics. Most responses included under this heading were not incorrect, but due to the developers' business models, short reporting period or data gaps, they could not be used in the analysis

.

4. Sector Growth

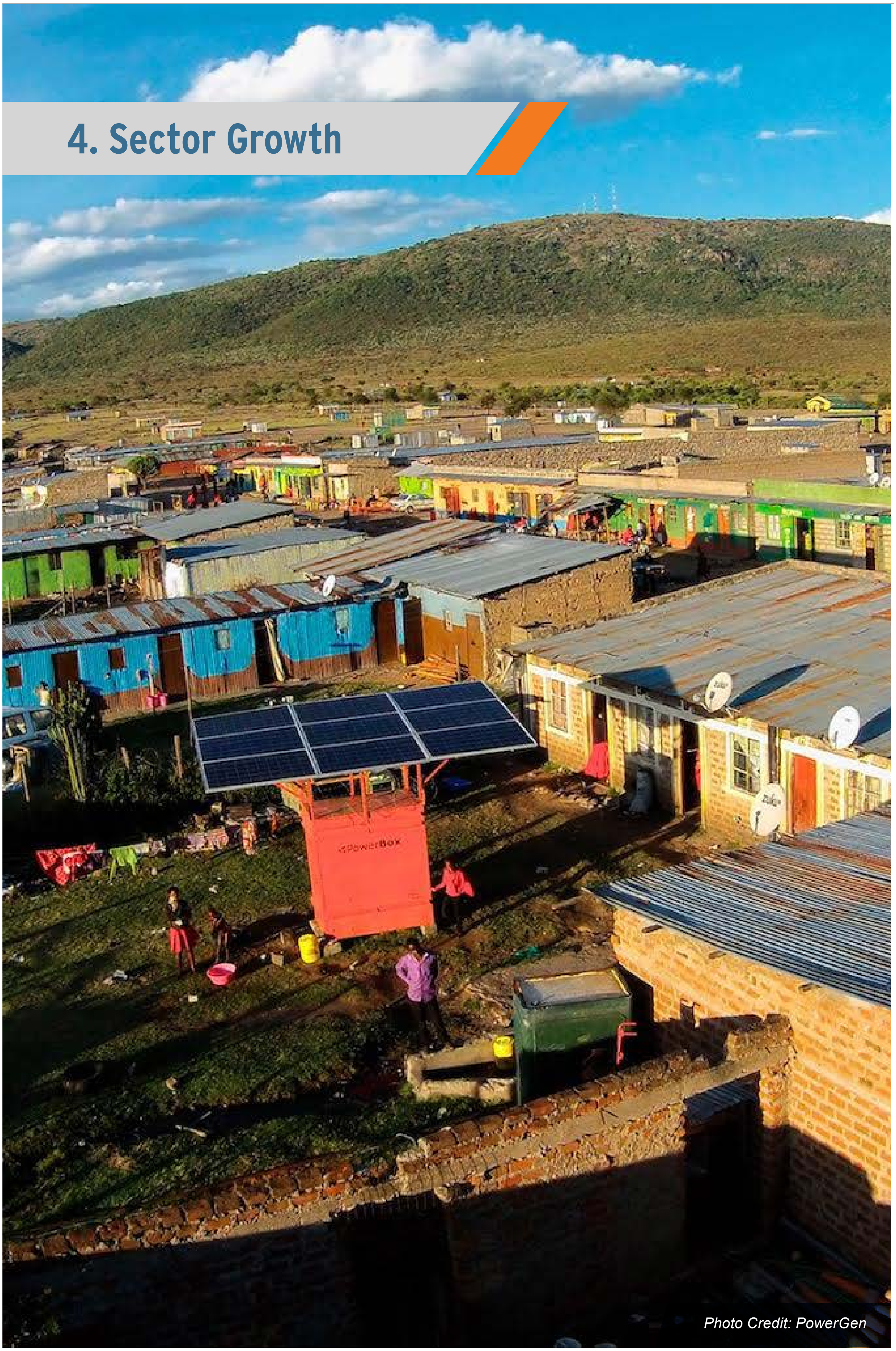


Photo Credit: PowerGen

Sector Growth

4.1 Electricity Access and Growth of Energy Services

The analysis in this section shows that the minigrid sector i s on the cusp of commercial scale. By 2019, more than 200,000 people and over 40,000 households, health facilities, schools and businesses were electrified by the developers represented in this study. We estimate that developers represented in this report account for approximately 35% of operational, non-utility-owned renewable energy minigrids across all of Africa and 60% of Solar PV and Hybrid Solar PV minigrids in the countries represented in this study[3]. NGOs, government utilities, and captive power minigrids make up the vast majority of remaining minigrids.

Our data show that in 2017, connection rates began to increase rapidly, showing impressive year-on-year growth. The rapid growth in the last three years overlaps precisely with the timelines of various policy/regulatory changes and donor programs that, particularly in East Africa, began exploring how to support the sector more robustly. Our data reassuringly shows that, like any other sector in any other market, good policy and the right incentives foster growth that lowers costs and improves service.

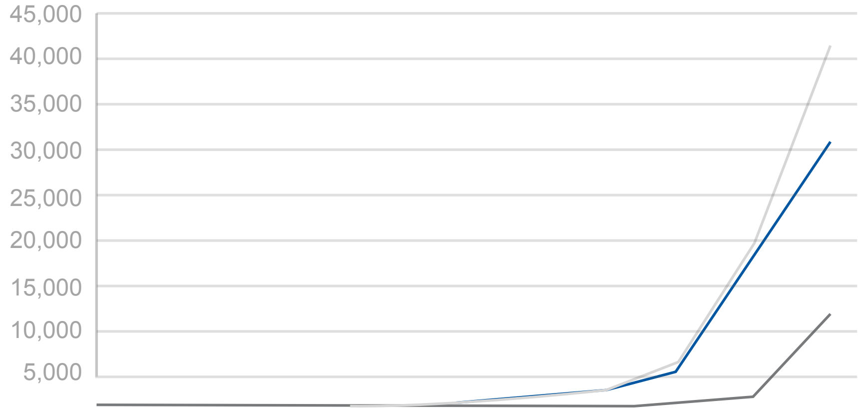
In what follows, the numbers of connections are correlated to single accounts tied to unique electricity meters. While occasionally a household and business connection may be combined into one, for the most part, behind every connection there is a household, facility or business that now has access to electricity for their lighting, social, heating, and productive needs.

4.2 Total connections

In 2010, there was a single AMDA member operating and less than 1,000 connections. By beginning of 2016, there were still less than 5,000. However, just three years later in 2019, services had been extended to 288 communities across 12 countries, increasing the number of connections to over 40,000.

Of all the countries in which AMDA members operate, two countries in particular have shown the greatest growth in the number of connections - Kenya and Tanzania. Together they account for approximately 70% of all new connections in the dataset, over 28,000 in total.

Figure 4.1: Overview of total number of connections



	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Eastern & Southern	85	85	85	407	778	1014	1,892	4,428	17,102	29,860
Western & Central	0	0	0	0	10	10	40	616	1,421	10,875
Total Connections	85	85	85	407	788	1,024	1,932	5,044	18,523	40,735

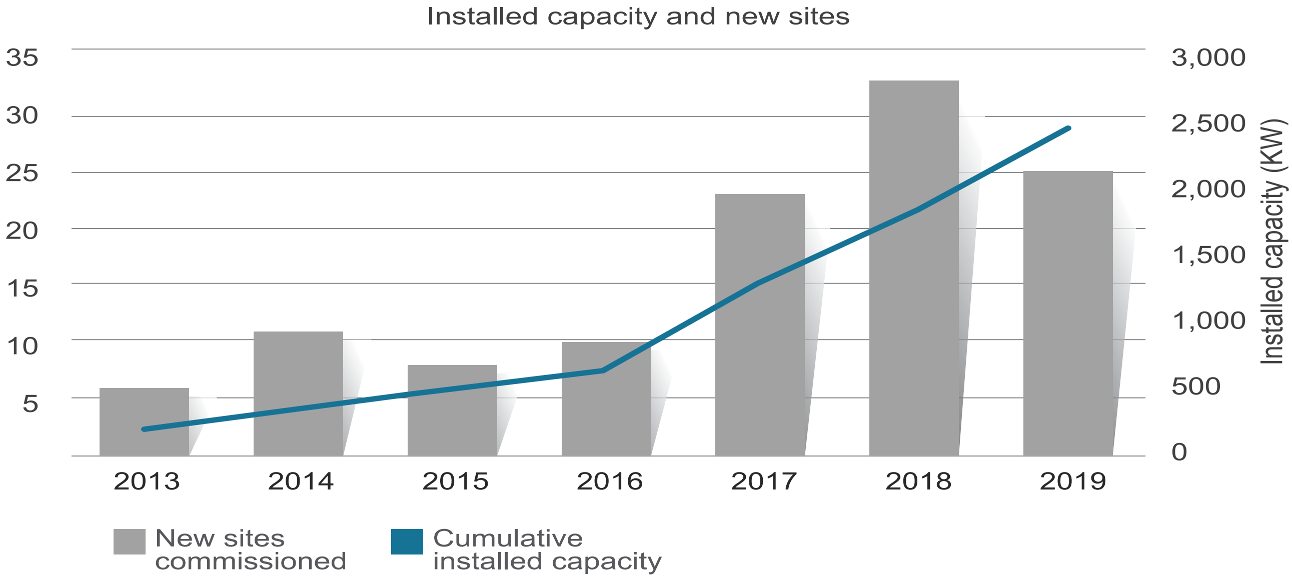
[3]Cross referenced using the Bloomberg NEF global minigrids project database (Publication forthcoming)

With construction ramping up in Nigeria, and programs starting to come online in Benin, Sierra Leone, Zambia and many others in development elsewhere, we expect this balance to shift in the coming years. Note that under normal circumstances, those with a head start would stay in the lead. However, due to policy and regulatory hurdles now being seen in Kenya and Tanzania, we are seeing slow-downs in connection rates in established markets and a migration of developers and donor funding into new markets.

4.3 Total installed kW and number of sites

Alongside increasing connection numbers, the installed generation capacity of developers has also increased over ten times from January 2013 to June 2019, from 203 kilowatts (kW) to just under 2,500kW of solar PV capacity. At the same time, the number of new sites has been increasing rapidly, with over 81 sites commissioned in 2019. The total installed capacity for minigrids across the continent is projected to grow in direct proportion to the concessional funding available, as this funding is essential in enabling growth.

Figure 4.2: Installed capacity and commissioning of new sites[4]



4.4 Concessional Funding: True Scale Requires Systemic Support

Similar to rural electrification efforts worldwide[5], sub-Saharan Africa needs some degree of subsidy to bridge the gap between the high cost of infrastructure and the low incomes of communities they serve. The growth trajectory for the minigrid sector is therefore unsurprisingly directly linked to access of concessional funding (both grants, and more recently, concessional debt). Broadly speaking there are two avenues through which this support can be channelled:

- Demand-side measures, where the customers are encouraged to consume more electricity by subsidising kilowatt consumption, appliances or incentivising the creation of local businesses. The result of demand-side support is increased revenue for developers and more affordable electricity for all customers, as discussed in Section 6.

- Supply-side measures such as direct grant funding, subsidised loans or results-based financing (RBF) schemes provide money to minigrid developers. These measures aim to reduce the cost of supplying electricity and encourage developers to expand their supply to new households.

[4] 2019 data is partial data only for sites commissioned between Jan 1, 2019 and June 30, 2019

[5] Duke University's Energy Access Project. (2020). Lessons for Modernizing Energy Access Finance, Part 1: What the Electrification Experiences of Seven Countries Tell Us about the Future of Connection Costs, Subsidies, and Integrated Planning. Available at: https://energyaccess.duke.edu/publication/learning-from-the-past/

The majority of funding received by developers in this survey were supply-side grants aimed at reducing capital costs. Since 2012, the donor community's contribution to minigrids has steadily increased, with over $2 billion in committed funding to the worldwide minigrid sector. Of this funding, close to $1.6 billion has been allocated to the minigrid sector in sub-Saharan Africa Much of this funding was approved to be disbursed by recipient governments through nationally managed procurement processes.

At the time of writing, only about 13% of the approved $1.6 billion in funding has been disbursed.

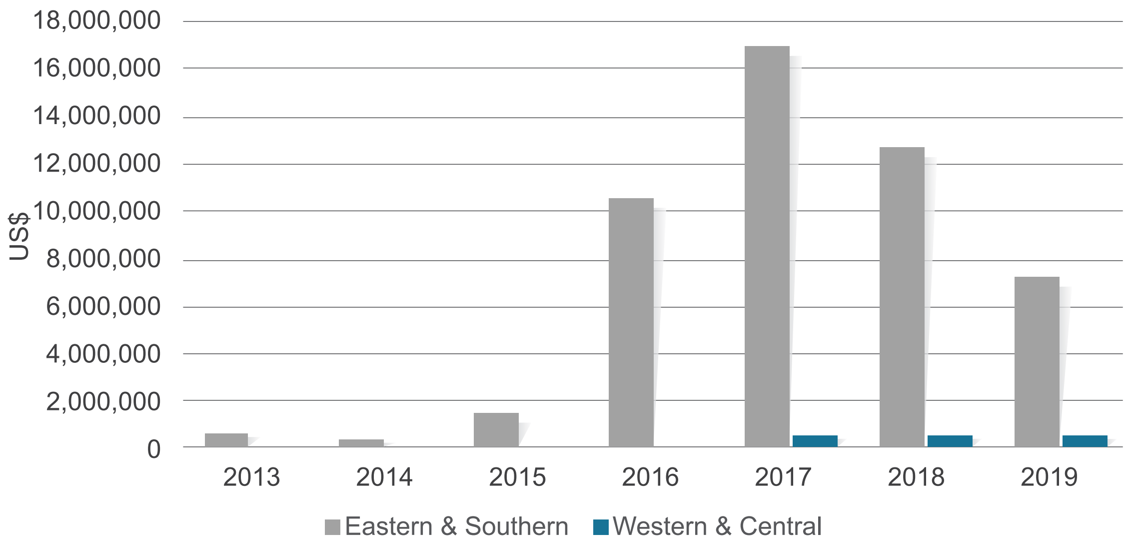
However, due to limited capacity to manage these procurement processes, most of this funding has not been disbursed. At the time of writing, only about 13% of the approved $1.6 billion in funding has been disbursed.[6] For developers in this study, only approximately US$ 40 million of public and private grants, and US$ 10m in concessional debt has been contracted and paid out since 2013. Data on equity investments from DFI's and other investors was not collected but will be in subsequent studies.

Funding from Tanzania's RBF scheme, managed by the Rural Energy Agency (REA), accounts for close to 20% of total funding received by all developers across the continent during this period and 30% of total donor funding, as reported by developers in this study. Figure 4.3 shows the imbalance of funding towards East Africa in these early years of the minigrid sector's development, which reflects the substantially larger number of connections seen in East Africa thus far.

Indeed, the donor funding into Kenya and Tanzania led to private investments in nearly all companies in those countries.

The grant and concessional funding only supplied a portion of the total capital required to build the 40,000 connections we see today, however. Its main function has been to unlock the private and impact investment capital that was interested in, but uncertain about, the minigrid sector. Indeed, the donor funding into Kenya and Tanzania led to private investments in nearly all companies in those countries. This public support is so important that groups of investors have written a position paper calling for more RBF schemes from donors to help unlock further investor capital, which they are keen to invest in minigrids.[7]

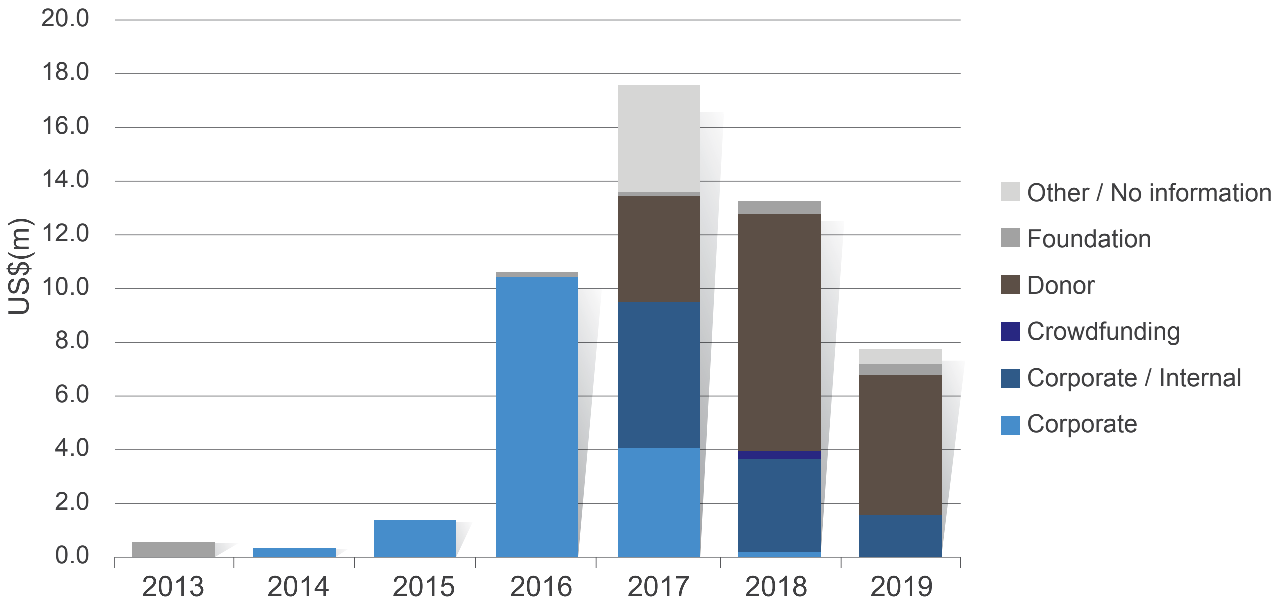
Figure 4.3: Funding Received by Region



[6]Global Minigrid Partnership. (2020). State of the Mini-Grids Market.
[7]Power for All. (2019). Investor Position Paper: Unlocking Private Capital for Minigrids in Africa. Available at: https://www.powerforall.org/resources/calls-to-action/investor-position-paper-unlocking-private-capital-minigrids-africa

In figure 4.4 and table 4.2, below, all donor and foundation funding was in the form of grants. The funding labelled "corporate" below is from private entities in the form of grants or debt and is separate from private equity investments. "Corporate / internal" funds represent both grant and debt funding from corporate entities that have a legal connection to the recipient. While we do not have private equity investment numbers due to the sensitivity of private investment data, it is clear that the Green Minigrid (GMG) facility in Kenya and RBF facility in Tanzania enabled significant private investment that led to the rapid growth in sites and connections.

Figure 4.4: Comparison of funding by type



Donor category includes donor funds disbursed through RBF schemes managed by government entities

Table 4.2: Funding received

	Grants – Capex	Grants – Opex	Debt
Corporate	4.2 million USD	-	-
Corporate / Internal	0.4 million USD	-	10.0 million USD
Crowdfunding	-	-	0.3 million USD
Donor	27.0 million USD	3.0 million USD	-
Foundation	1.4 million USD	0.2 million USD	-
Other/ No information	1.3 million USD	3.2 million USD	-

One important linkage between funding and connections is the time between payment of concessional funding and delivery of a connection. Due to the length of time it takes to secure additional private funding, ensure regulatory compliance, and then procure, build and commission a minigrid, there is usually a lag of one to two years between the allocation of public funding and measurable results from the site. This shows the importance of creating reliable, predictable, long term public funding and the need to streamline processes such as licensing, tariff approvals and other government permissions. We explore these enabling environment factors in Section 8.

[8]The decreased growth rate in 2019, however, can be explained by the fact that at the time of data collection, only first half-year connections had been submitted by developers.

Figure 4.5 below shows how significant public funding is for unlocking capital and connections for the sector, as well as the lag between disbursement and having a live connection. Given the delay between funding dispersal and commissioning of sites thus far, funding from 2018 and 2019 should provide an indication of the number of new connections delivered by June 2021. [8]

Figure 4.5: Lead time of funding on new connections

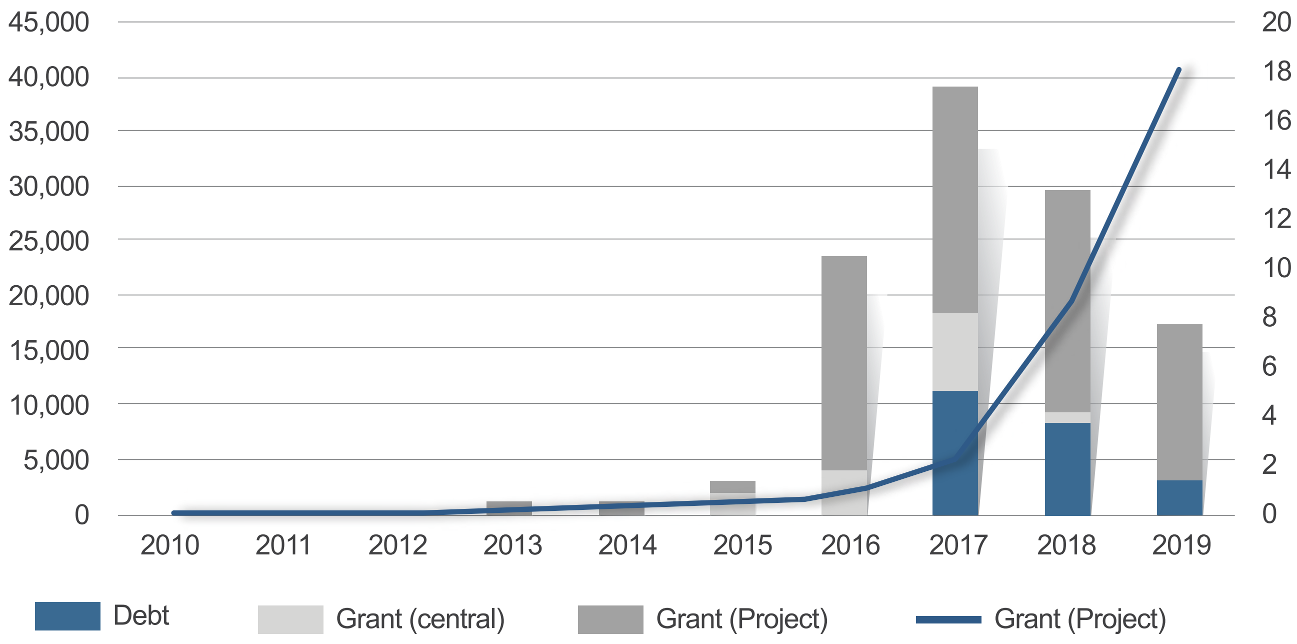
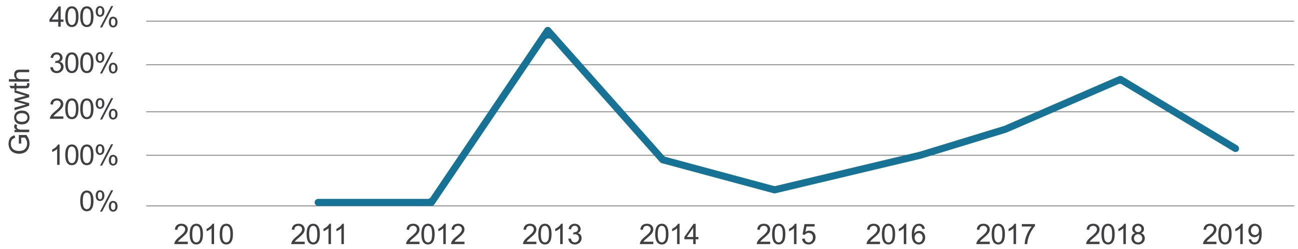


Figure 4.6: Growth rates for minigrid deployment



Public funding in years 2016 and 2017 led to connection growth rates of 161% in 2017 and 267% in 2018

The vast majority of this is directly attributed to the availability of the GMG facility in Kenya and RBF facility in Tanzania. Public funding in years 2016 and 2017 led to connection growth rates of 161% in 2017 and 267% in 2018 as shown in Figure 4.6.

[9]World Bank Group. (2016). Financial Viability of Electricity Sectors in Sub-Saharan Africa. Available at: http://documents.worldbank.org/curated/en/182071470748085038/pdf/WPS7788.pdf

4.5 National Government subsidies in the electricity sector

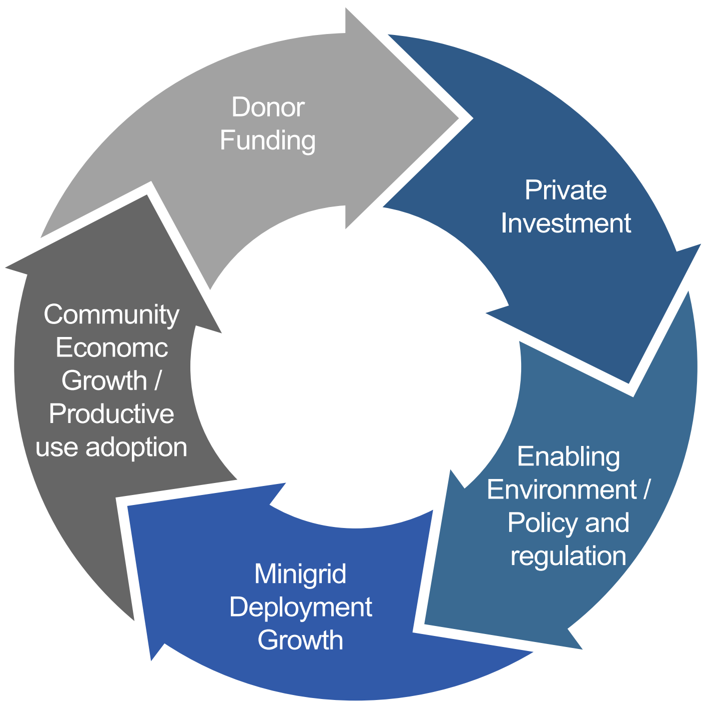
Providing subsidised funding or grants to electric utilities is the most common method used by governments and donors to make electricity more affordable to consumers. Due to the lack of government subsidy information in most sub-Saharan African countries, estimating the true cost of electricity supply is not currently possible – but it is significant.

Financial deficit, or hidden subsidy, of the electricity is sector to equal approximately 1.5% of each country's GDP on average.

In efforts to at least understand if public utilities in Africa were covering their costs, a 2016 World Bank study found that only two Sub-Saharan African countries had financially viable electricity sectors at the time, Uganda and the Seychelles[9]. When accounting for transmission and distribution losses, 18 countries were only able to recover operating costs but not their capital costs. The study estimated the financial deficit, or hidden subsidy, of the electricity is sector to equal approximately 1.5% of each country's GDP on average.

Within countries, cross-subsidies flow between profitable areas and un-economic areas. Also within profitable locations, these cross subsidies flow between profitable and unprofitable classes of customers. In particular, high consuming and dense urban customers generate a lot of revenue and are inexpensive to connect. These urban customers pay the same or higher tariffs as their rural counterparts, subsidizing low consuming, sparsely populated areas.

Because minigrid operators only serve rural consumers, it is very difficult to cross-subsidize their customers, particularly when companies only have a few communities in their portfolio. Hence comparing national utilities with minigrids on the basis of tariffs does not capture the full picture of either business and is not an even comparison.



4.6 Key insights

The data show that the African minigrid market is not substantively different to any other nascent industry or rural electrification efforts globally: public funding for minigrids in rural sub-Saharan Africa is a key element in kick starting scale up, largely by crowding-in other investors.

Furthermore, concessional funding is a crucial part of the positive feedback loop that generates scale: The interlinkages between concessional funding, private investment, enabling environment and deployment work together to ramp up delivery of energy access. The interconnectedness of these elements are so fundamental that disruptions can derail growth or even turn this into a negative feedback loop. For the sector to scale all aspects of the cycle need to be operating holistically.

[10]ESMAP (forthcoming, 2020). Minigrids for Half a Billion People.

Specific insights from the evidence presented here for sectorstakeholders include:

- Policy makers and regulators – Minigrids can deliver connections to rural and remote communities at scale. Regulatory timelines lead to delays between public investment and private investment – and therefore also delays the positive impact governments want to see. Working with development partners and the private sector to reduce delays will lead both to more confidence, and more money from investors, enabling a pathway to faster results.

- **Development partners** – Public funding works. Setting up predictable, longer term support facilities will enable companies and their investors to plan, build expertise and technical capacity, and deliver rural energy access at scale. Due to the regulatory bottlenecks noted here and explored later in much more detail in section 8, technical assistance on digitizing, simplifying and otherwise streamlining regulatory processes is urgently needed. Particularly around bulk approval of multiple sites at once. Individual approvals for the 140,000 sites Africa needs will not be possible using current approaches.[10]

- **Investors** – the sector has begun a radical expansion that will only continue if investors are open and transparent about their intention to invest and the conditions of that expected investment. Making investor needs crystal clear will guide donors and policymakers in supporting the sector, and minigrid developers to match their actions and strategy to investor needs.

5. Costs

Photo Credit: PowerGen

Costs

Capital expenditure related to the construction of new minigrids is one of the main cost inputs determining the affordability of electricity to end-users. As can be seen from the figures presented in this section, costs have been decreasing, resulting in more affordable electricity for households and more rapid improvement in the quality of lives of the
recipient households.

An interesting caveat to this trend is in regards to new players and new market entry. Our evidence shows an increase in installed costs in 2019, which is linked to new, inexperienced players entering the sector as well as experienced companies moving into new, unfamiliar markets where their lack of familiarity and on-the-ground knowledge sees a loss of past cost reductions.

Our data show that across the board, as developers gain more experience and are allowed to scale up their operations, the cost of new installations decreases, resulting in more affordable electricity. Given that the survey indicates most AMDA developers presently only have between 1-3 sites, there is considerable potential for scale to quickly reduce costs through economies of scale and experience-based learning moving forward.

5.1 CAPEX trends

There is much more than global price of commodities or equipment to consider when evaluating capital expenditure (CAPEX) costs. Economies of scale, investment and regulatory stability play major roles in final construction costs. Although it is not possible to distinguish the impact of each of these variables on the CAPEX costs in the dataset, an analysis of the more experienced developers in the dataset reveals that average costs per connection decreases as developer portfolios increase. For our research, CAPEX costs for a minigrid site were broken down into six categories:

- **Generation assets** – includes the cost and installation of assets relevant to the generation and supply of electricity such as solar PV panels and balance of system, batteries, back-up diesel generators and other relevant assets.

- **Distribution assets** – includes the cost and installation of assets and equipment related to delivering electricity to the end-user and includes items such as wiring, poles insulators and safety equipment.

- **Logistics, transport, warehousing** – costs associated with transporting equipment, storage costs and logistics during planning, construction & labour.

- **Metering and termination** – Overhead accessories for dropline to the home, meters & other costs for customer connection, including internal wiring and basic power kit of light & socket

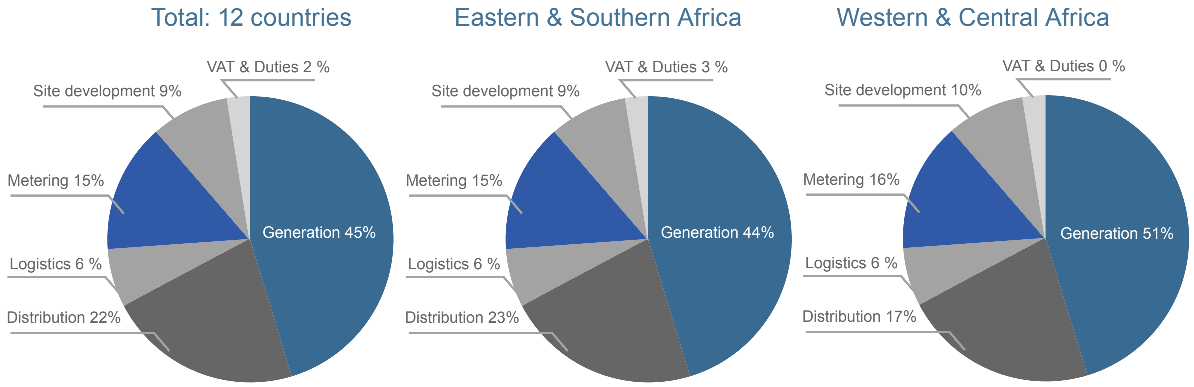
- **Site development** – costs associated with preparing the site for construction.

- **VAT and Duties** – any VAT and duties paid on solar assets that should be exempt from taxes but are incurred due to inconsistent application of VAT and duty exemption laws.[11]

Of these, costs associated with generation assets were shown to make up about 45% of total installed costs. The figures below show a comparison of each cost category as a percentage of total installed costs.

[11]Not all developers incur these costs in the importation process and are only seen in 2019 data.

Figure 5.1: Comparison of relative installed costs



Our data show that development costs of minigrids have been consistently decreasing since 2014 across all regions in sub-Saharan Africa. Although costs have been decreasing on average, the data show that there is still a significant difference in costs between developers or ranging from about US$ 4,000/kW for the lowest cost site to about US$ 11,000/kW for the highest cost site. Given the small size of the sample and limitations of the data collected, we cannot conclusively determine all the factors driving costs down. However, it is clear that developer experience plays an important role. Expertise in site selection allows for more appropriate communities to be identified, driving down distribution costs; and over time efficiencies in navigating regulatory compliance, procurement, and importation drive down costs as well.

Over the last decade, global prices of solar PV panels and batteries decreased significantly and have played a role in the trend of decreasing minigrid costs. However, global pricing is derived from bulk procurement. Given that only 2,468kW have been installed across all AMDA developers, procuring assets at the global market price is not possible and will not be possible until considerably larger portfolios are developed and asset procurement is significantly larger.

The average installed costs decreased by 65% between 2015 - 2018 from approximately US$ 14,000/kW to US$ 6,200/kW

Figure 5.2 below shows the evolution of the average installed costs per kW. The average installed costs decreased by 65% between 2015 - 2018 from approximately US$ 14,000/kW to US$ 6,200/kW. Cost figures from 2019 are an exception to this trend, as costs increased across all cost categories and for most regions due to costs associated with new market entry. As is explained in the next section, prices remain stable for experienced developers expanding operations in their existing markets.

Figure 5.2: CAPEX costs

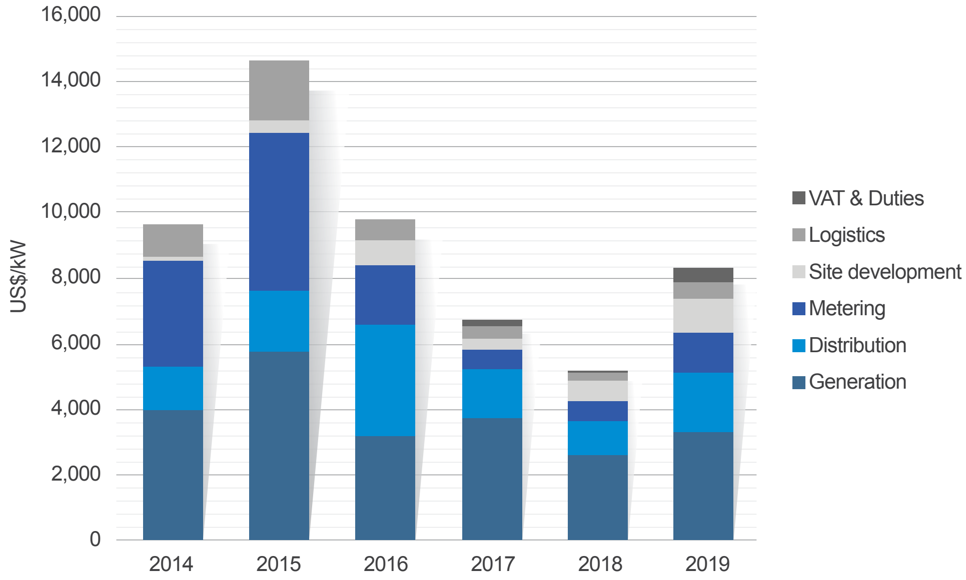
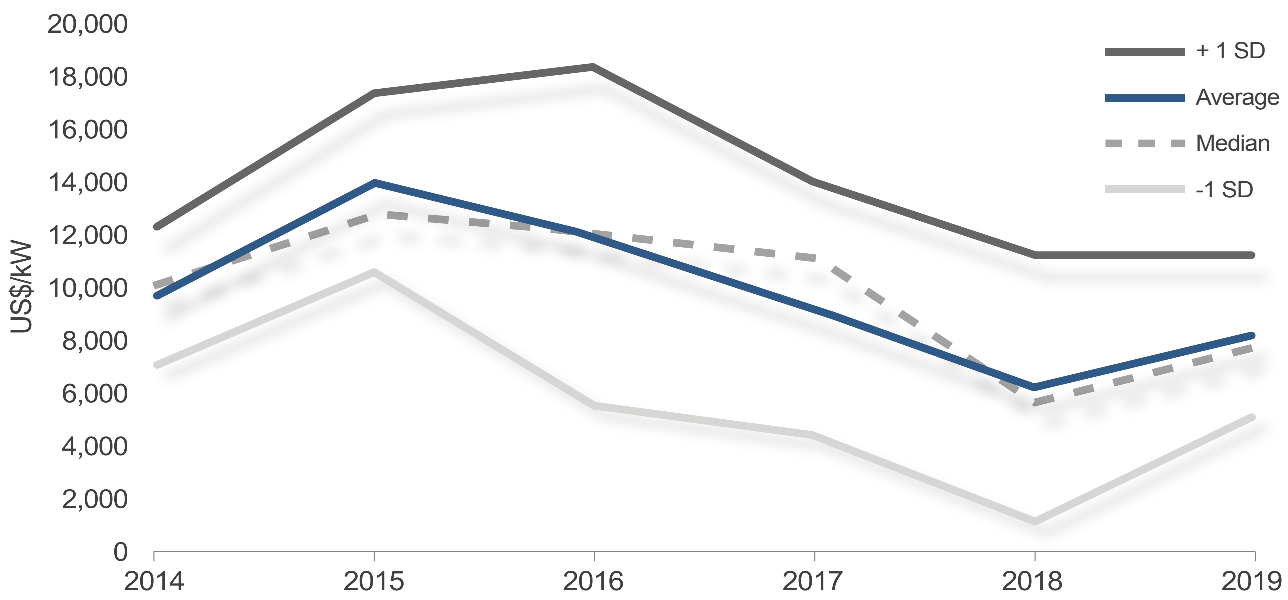


Figure 5.2 shows the evolution of average installed costs from 2014 - 2019 for all cost categories, but it fails to capture the significant difference in reported costs among developers. The reported costs per kW differed both within each country and between developers. The largest internal differences in costs are for distribution, logistics and site development, suggesting that a part of this cost is due to a particular site.

Figure 5.3 below shows the same total average cost trend as the figure above, but with the addition of the median and one standard deviation above and below the total average. A wide range in the average installed costs is evident. The reasons for this cannot be extracted from the dataset, but such observations are common in nascent industries. We expect the CAPEX cost variances to shrink as the sector matures and businesses coalesce further around common best practices.

Figure 5.3: Average and median total installed costs with one standard deviation

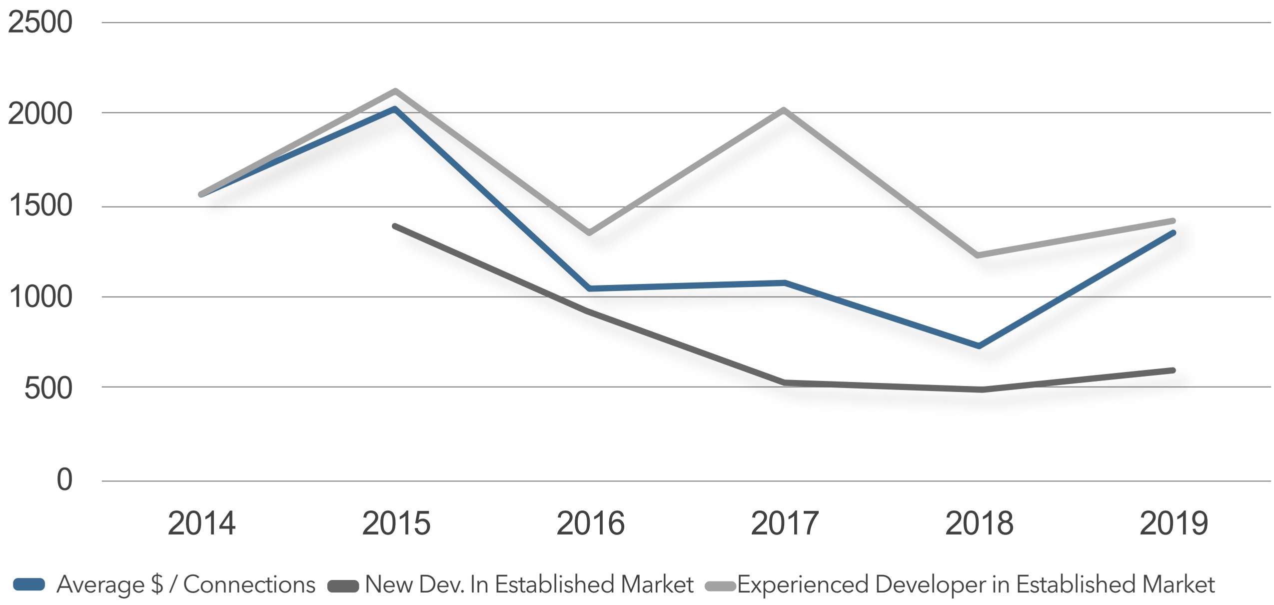


5.2 Explaining 2019 Costs through Economies of Scale and Market Expansion

Figure 5.4, below shows the average cost per connection for minigrid developers over the past six years. Cost per connection data allows for a more direct comparison to utility costs as well as normalizes fixed consumer costs (i.e. metering). Between 2014-2018 minigrid developers saw a dramatic price drop across the continent as costs fell from US$ 1,555 per connection to US$ 733 per connection in 2018.

After multiple year-on-year reductions in both US$ / kW and US$ / connection figures, data from the first half of 2019 shows an increase. While this may raise initial red flags to the casual observer, this is due to new (inexperienced) minigrid companies coming into the market while existing companies are expanding operations into new markets, as illustrated by figures 5.5 & 5.6.

Figure 5.4: CAPEX per connection trends by experience



The increase in 2019 cost per connection is multifaceted. However, it is rooted in experience and the number of new developers that entered the market in 2019. In 2018, 78% of new sites were constructed by established developers in established markets, whereas in 2019, only 40% of new sites were in established markets, with 60% in new markets.

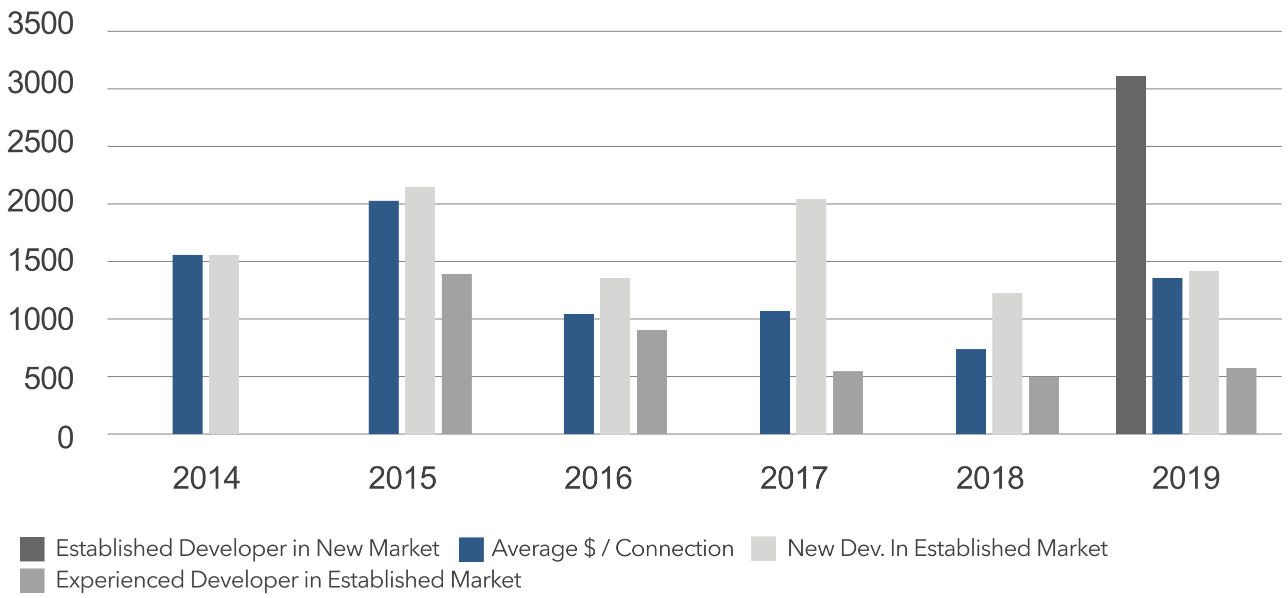
Experienced developers in established markets between 2016 and 2019 were on average 41% less expensive than new developers in those same markets. 2019 saw the first real expansion of existing operators into new markets. As can be seen from figure 5.6, this expansion increased the average cost per connection. While we do not have enough data to fully explain the cost increase in new markets, a partial explanation is that increased system sizes, VAT costs on solar assets, fewer connections per site and higher site development costs contributed to the overall cost increases. We will be able to better understand how new markets affect pricing in subsequent reporting as our data set grows.

[12]Zesco. (2018). Preparation of the National Electrification Program Report 2018.

[13]Castellano A., Kendall A., Nikomarov M., & Swemmer T. (2015). Brighter Africa: The Growth Potential of the Sub-Saharan Electricity Sector. McKinsey & Company. Available at: https://www.mckinsey.com/~/media/McKinsey/dotcom/client_service/EPNG/PDFs/Brighter_Africa-The_growth_potential_of_the_sub-Saharan_electricity_sector.ashx

[14]World Bank Group. (2014). World Bank Group Support to Electricity Access, FY2000-2014: An Independent Evaluation. Available at: https://openknowledge.worldbank.org/bitstream/handle/10986/22953/96812revd.pdf?sequence=9&isAllowed=y

Figure 5.5: CAPEX per connection trends by experience



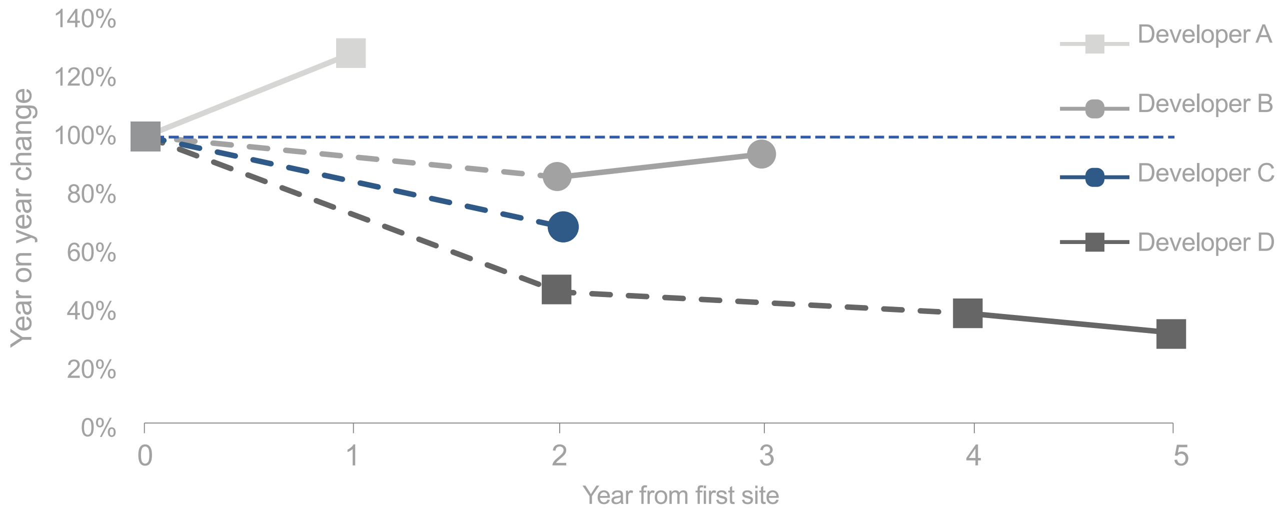
For veteran developers operating in their home markets such as Tanzania, Zambia and Kenya, connection costs are continuing to decline. In these markets, minigrid companies have established site development and logistics systems, procurement expertise and experienced teams that are efficient in their execution. However, as can be seen from figure 5.6, even the most experienced developers showed cost increases in their first year in new markets.

While national utility connection cost data is rarely made publicly available, national connection rates in Zambia range for US$ 800-26,000 per connection[12] and estimations for rural utility connections in Tanzania are US$ 2,300.[13] In countries with low access to electricity, World Bank funded programs to national utilities yielded US$ 4,000 per connection on average between 2000-2014. Moreover, the median length of these electricity projects was nine years.[14] This in direct contrast to minigrids that average less than US$ 1,000 per connection and deploy sites in less than 2 years.

Enormous cost savings minigrids offer per connection could be reallocated to subsidize the consumer price of power for up to a decade at almost any kWh price

But these savings are not currently viewed as such by governments. Minigrids are instead seen as additional high costs to communities due to their kWh price. If however, a nuanced look at this picture were taken, everyone could be a winner. If a strategic, long term view on rural electrification was taken, the enormous cost savings minigrids offer per connection could be reallocated to subsidize the consumer price of power for up to a decade at almost any kWh price and still save donors, African governments, and their taxpaying citizens hundreds of millions of dollars compared to grid extension costs.

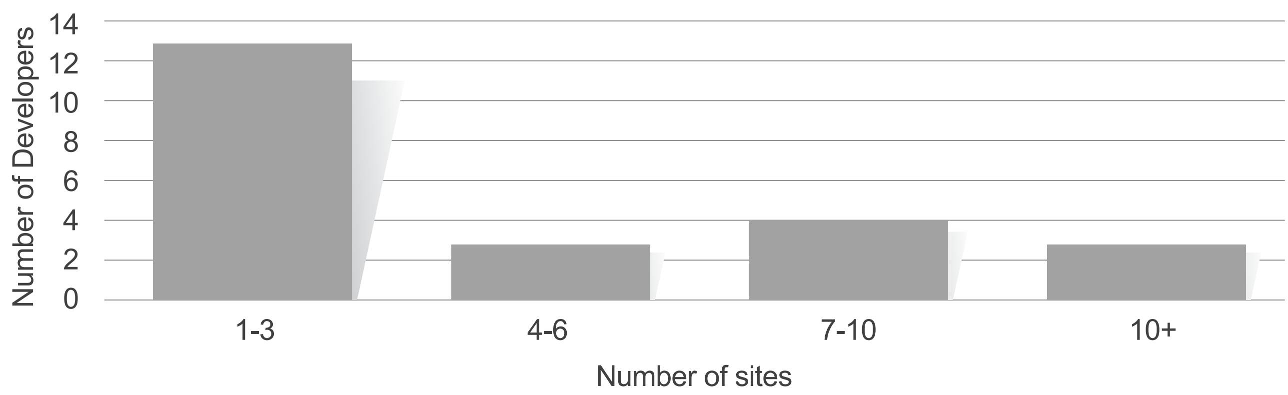
Figure 5.6: Comparison of costs for established and new developers



There is considerable potential to achieve further cost reductions and efficiency gains as the sector grows and matures.

The figure above shows the change in average installed costs for the most experienced developers. This analysis reveals that average costs per kW installed decreases as developer portfolios increase. New developers commissioning sites in 2016 were able to radically reduce costs by 2018. Because the sector is still early in its early development stage, with 55% of developers currently operating three sites or less, there is considerable potential to achieve further cost reductions and efficiency gains as the sector grows and matures.

Figure 5.7: Number of sites per developer



5.2 Operational Expenses

With modern minigrids, operational expenses when a system is running fine are much lower than they were ten years ago due to the high degree of remote and automated processes available today. Smart meters, remote system management tools and mobile payments (where available) have all helped make running a network of hundreds or thousands of minigrids a realistic objective for developers / operators. However – operational expenses do indeed remain high while minigrid numbers are low. When maintenance and repair are needed, this often involves sending a team on a multi-day journey due to the remoteness of minigrid sites. Those costs will be difficult to reduce until developers do have large numbers of sites and can afford to have regional and local offices servicing multiple clustered sites.

Additionally, operating minigrids in sub-Saharan Africa involves significant challenges and uncertainties both on the demand and supply side that affect operating costs. Despite the availability of good solar resources on most of the continent, many regions see seasonal shifts in solar exposure and must rely on diesel generators as back-ups. Logistics and the lack of secure fuel supplies can provide further challenges to developers.

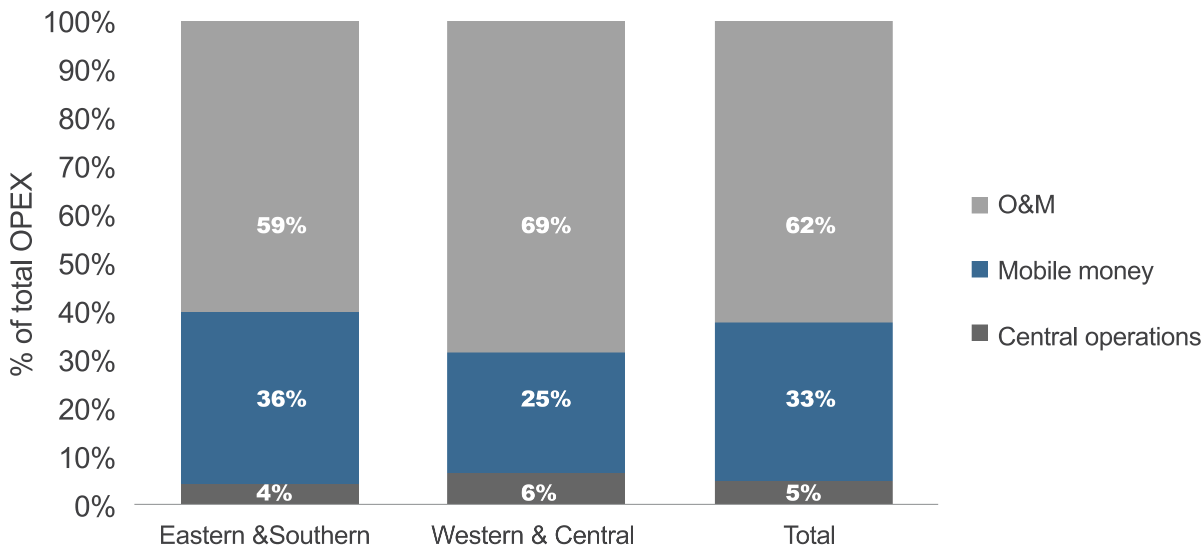
5.2.1 Overview of operating expenses

Operational costs of minigrids consist of expenses incurred on a recurring basis such as staff salaries, routine maintenance of equipment and fuel for a diesel generator. For our data collection work, developers were asked to provide information on operating costs under three categories:

- **Operations and maintenance (O&M)** expenses reflecting the costs of the day-to-day operations and technical maintenance of the minigrid, fuel costs, transportation and logistics, replacement of components and customer service.
- **Fixed operational costs:** costs including billing and payment collection expenses, mobile money infrastructure and data, software platform costs, metering, and land leasing.
- **Central operations** expenditures including legal and central staff labour costs, training expenses and non-site-specific travel expenses.

The average breakdown of different OPEX components is provided in Figure 5.8. The data show that operations and maintenance costs account for the largest share of total operational expenditures, followed by fixed operational costs.

Figure 5.8: Breakdown of OPEX



The contribution of various OPEX costs to the total are similar across regions, with Western and Central African countries spending slightly more on operations, technical maintenance, and central operations than Eastern and Southern Africa. We do not have clear indications as to why this is, but it could be due to experience and/or scale. In general, most reported OPEX costs were in the range of US$ 2.50 – 6.00 per customer per month.

Some expenses decrease with scale in particular. For example, O&M costs and central operations costs will decrease as the number of sites increase due to economies of scale. Given that the majority of developers in this study operate three or less sites, and that many companies in West Africa in particular are newer and smaller, we expect significant reductions as these companies grow and are able to, for example, centralize maintenance trips within a region and allocate central costs across more sites and consumers.

Despite many operating costs being influenced by the number of customers, fixed costs won't see the same reduction in pricing as they are incurred on a per-customer basis. For example: customer service costs require a basic level of infrastructure that is needed to address customer requests. This includes having customer service agents who can handle a fixed number of customer requests per month. The same principal applies to mobile money costs, repair and maintenance and other aspects of operating costs.

That said, even the largest AMDA members remain small by global industry standards and will continue to dramatically benefit from economies of scale on OPEX prices as they expand operations.

5.3 Key insights

While variances in costs differ by region, installed capacity, number of connections and experience, the automation and remote operation technologies that have entered the market over recent years have dramatically reduced many operational expenditures for minigrid companies.

Economies of scale will allow additional costs such as maintenance and repair to drop even further, which will facilitate many of the cost reductions being demanded of the sector. While more research is needed at the national level to compare costs and trends, it is clear that if investment in the minigrid sector continues, the impact of expansion of service and cost reduction will be significant.

Specific insights from the evidence presented here for sector stakeholders include:

- **Policy makers and regulators** – Because cost is the biggest concern of most governments and economies of scale lower costs, policy makers and regulators should focus on how to foster sector growth. Supporting bulk / portfolio licensing frameworks and favourable tariff regimes are at the core of such an approach.

- **Development partners** – Development agencies can support cost reductions by adopting a longer-term view of sector support aimed at as broad a set of firms as possible. Predictable multi-year, multi-country financing for minigrids is urgently needed. Furthermore, innovative support around scale, such as bulk procurement facilities for companies and TA support to governments on laying the policy / regulatory groundwork for scale is needed as well.

- **Investors** – Scaling is working – collaboration with industry, development agencies, and governments to establish predictable, long term de-risking finance is needed. Governments and donors need specific ideas and requirements from investors to help design effective donor programs to make investing at scale possible.

6. Consumption and Growing the Load

Photo credit: Nuru Energy

Consumption and Growing the Load

As discussed in the OPEX section, a large part of the operating costs associated with minigrids are fixed costs incurred regardless of the amount consumed by each customer. By increasing the utilisation of assets and average consumption, minigrids are able to raise more revenues for servicing their liabilities, which will lead to more affordable electricity prices for rural communities in sub-Saharan Africa.

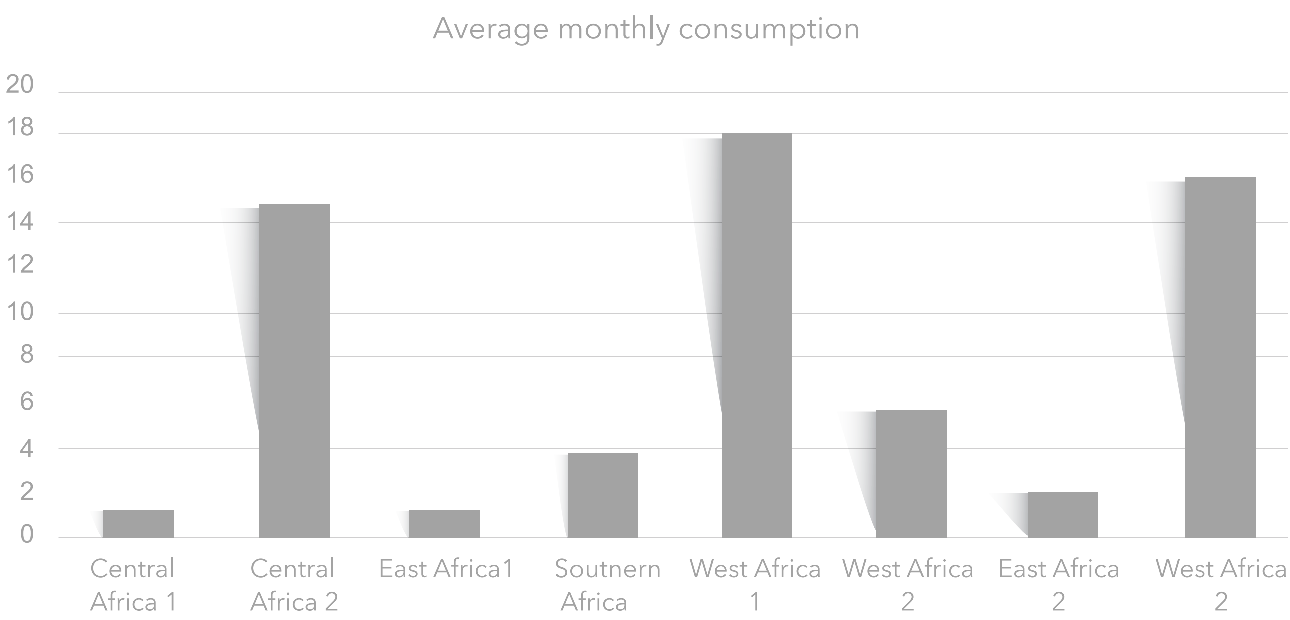
Currently, average consumption remains very low across most of the region. By encouraging productive use of electricity, governments, development partners and developers can unlock economic benefits to local communities and reduce the price of power as consumption grows. This is possible because higher consumption means fixed asset costs are shared among more units of energy and thus result in lower electricity tariff requirements. Enabling customers to consume more is the single most important strategy governments, donors and developers can pursue to ensure developers can be financially sustainable.

Average consumption figures across countries are strikingly varied. While national average consumption per user as reported by the developers in this study in Madagascar, Mauritania and Nigeria were between 9.5-30 kWh per month, developers from the remaining countries reported figures much lower, in the range of 2.5-5 kWh per month.

Across the entire dataset, the average consumption per customer was 6.1 kWh per month and the median value 3.5 kWh per month, highlighting the range in average consumption between sites. Statistical analysis of the data did not reveal significant correlation between average consumption and the size of installed solar array, number of connections, region or the year of installation.

The levelized cost of electricity (LCOE) is not included in this analysis due to the lack of consensus on how discount rates are calculated, and because the high variability of discount rates among companies and across countries. In subsequent work, AMDA hopes to explore LCOE across the continent and work with stokeholds to create international standardization of minigrid discount rates.

Figure 6.1: Comparison of average monthly consumption per user[15]



[15]Countries are anonymized in order to ensure developer anonymity as there is only one or two developers operating in several of the listed countries.

Statistical analysis of the data did not reveal a significant correlation between average consumption and the size of installed solar array, number of connections, region or year of installation. However, country level differences in consumption patterns were staggering. While anecdotal at this stage, the high consumption in some countries is likely reflective of existing commercial loads, the high density of consumers or both. Further research is needed to better understand how commercial loads can cross subsidize household consumers and how household consumption patterns shift in areas where density is higher and commercial loads are present.

Currently, it is not possible to establish clear causality in consumption due to the limitations in this study and the lack of site or consumer characteristics. We posit that average consumption is highly dependent on the makeup of customers and the ability of minigrid companies to understand village economics and consumer makeup at the time of site selection.

The highly varied nature of consumption can be observed in Figure 6.2 below, where all sites of a single developer are compared. All the sites except numbers one and two - which are slightly larger - are of similar specifications and size. Sites four and five show the largest discrepancy in average consumption despite having the same technical specifications, being located in the same country and being installed the same year.

We believe one of the major reasons for these discrepancies is that to date, site selection has been more of an art than a science. In most African countries, national grid expansion plans are not public. Therefore, minigrid developers are forced to search for remote sites that often do not have much economic activity. Those that do have economic activity mostly only have individual or a small group of relatively larger consumers, with the vast majority of other customers being small residential loads. In such cases, the risk is high that if one larger load disappears, the economics of the whole system are affected.

The ideal scenario would be for governments and national utilities to collaborate with the minigrid sector to establish realistic integrated energy plans. This will take the cost and operations burden of servicing remote areas off the hands of the utility and give minigrid companies clarity on where they can operate. This would also allow minigrid companies to choose truly viable communities to begin with and then work outwards into more challenging areas as their experience increases and costs reduce enough to make smaller or very remote locations more viable than they are today.

Historically, forecasting load growth potential for minigrid sites has also been very challenging. Because both site selection and load growth are so challenging, the sector requires support to create predictive models on village growth potential and how companies can help facilitate this growth (more on this in the productive uses section later).

Figure 6.2: Difference in average consumption per user within a single developer

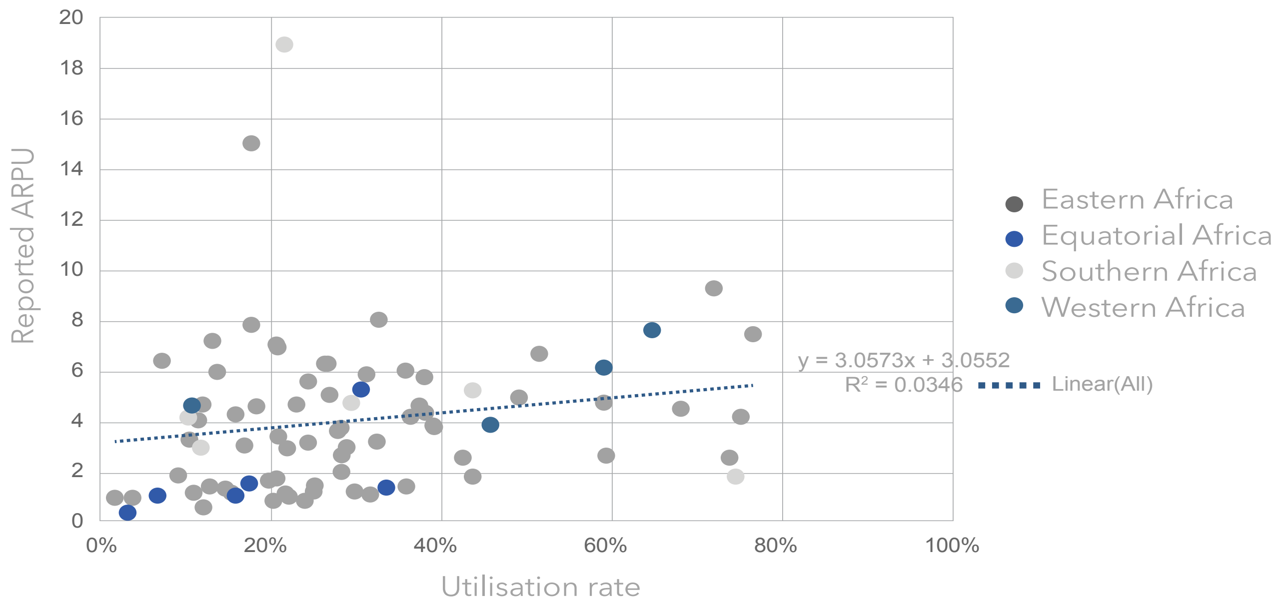
6.1 Average revenues

Ensuring minigrid operators are able to collect revenues sufficient to service their liabilities and operating costs is imperative to fostering a healthy and sustainable sector. Without the ability to collect sufficient revenues, developers cannot afford to carry out necessary maintenance, replace batteries or pay employee salaries. As discussed in the section above, an important step towards making electricity supply more affordable is to incentivise and provide opportunities for customers to increase productive consumption.

The revenue raised by developers is influenced by various factors such as the number of customers, how much electricity these customers consume, and the tariffs developers are able to charge. In most regions, developers cannot raise tariffs to ensure financial viability and therefore must invest in expanding access to new customers and/or find ways to promote higher levels of consumption per customer so that overall, the utilisation of their assets is increased and higher levels of revenue can be collected.

Despite being a logical presumption, the data does not show any correlation between high reported average revenue per user (ARPU) and high levels of consumption, utilisation rates or installed generation capacity. This is most likely due to the fact that minigrid developers operate in highly varied environments where external factors and the demographic make-up of their customers are going to be the biggest variables in generating revenue.

Figure 6.3: Comparison of average reported performance against ARPU



From Figure 6.3 above, we cannot infer a high positive correlation between the utilization rate and ARPU. ARPU figures were provided by developers, and the utilisation rate was calculated using the reported installed capacity of solar array. The utilisation rate was found by calculating: total energy sales (in kWh) / (installed solar array (in kW) x hours in year (8760 hours) x 20% capacity factor).[16]

While there is currently not enough data to support a correlation between ARPU and utilization, this variance is likely due to radically different tariffs between developers and across regions. Based on initial data from the CrossBoundary Innovation Lab, tariff reductions lead to an increase in utilization rates, while ARPU remains stable. While we are not able to do a comparative analysis of utilization rates, ARPU and tariff pricing due to limitations within the reported data, we will explore this link in future research.

[16]Twenty percent is the minimum threshold utilized by the World Bank as noted in ESMAP (2019). Minigrids for Half a Billion People. Available at: https://www.worldbank.org/en/topic/energy/publication/minigrids-for-half-a-billion-people

Average monthly ARPU between June 2018-July 2019 in Tanzania was $4.58, in Kenya it was $2.96, & Nigeria it was $4.83. In subsequent reporting, we will track ARPU against annual trends. Recall that OPEX costs are between US$ 2.50 – 6.00 per customer per month, highlighting the urgent need to work on demand growth, as discussed below in the section on productive use.

While these numbers are sobering – minigrid companies are not the only ones facing these challenges. Rural electrification in general is costly and revenues are low across the board, this is part of the reason why only two African utilities are profitable. Recently, Kenya Power revealed that 55% of its customers, who are largely concentrated in rural areas, spend less than $3 a month on electricity.[17] Even at higher levels of consumption, University of Massachusetts Amherst's Jay Taneja's analysis of KPLC data has shown the payback period on a typical KPLC rural connection is over 44 years.[18]

Overall, West Africa ARPU and utilization rates are better than in East Africa. While all of the factors leading to this are not known, we suspect that West African customers are more likely to have transitioned from existing electrical power in the form of generators, while many East African sites have not been using as much electrical power and have instead been transitioning from kerosene and biomass. This means West African customers have more existing electrical appliances and experience paying for electricity.

6.2 Increasing Consumption by Increasing Incomes: Productive Energy

Productive uses of energy refer to the agricultural, commercial and industrial activities powered by electricity to generate income and create economic value. These activities allow consumers and businesses to reap the benefits of extended operating hours, enhanced working conditions and higher productivity, while improving living standards. Because consumption is otherwise low as evidenced in the previous section, productive uses are also a key factor influencing the affordability of electricity and financial sustainability of minigrid operators. The table below illustrates various productive use appliances, their power requirements and economics.[19]

Table 6.1 Power requirements, costs and indicative payback periods of selected income-generating appliances

Sector	Appliance	Power required (kW)	Cost from supplier	Payback period (months)
Primary industries (agriculture, fishing)	Egg incubator	80 to 160W	$50 to $100	1 to 3
	Grinder for pulses and beans	5.2 kW	$1,500 to $4,000	6 to 12
	Water irrigation pump	3.7 to 22.4 kW	$200 to $1,000	3 to 6
	Sterilizer (for dairy processing)	3 to 6kW	$600 to $2,000	1 to 3
	Packager	250W to 3kW	$500 to $1,000	6 to 12
Light manufacturing	Electronic welding machine	3 to 7.5 kW	$200 to $300	6 to 12
	Jigsaw	400W	$100	3 to 6
	Electric drilling machine	400W	$20 to $50	3 to 6
	Popcorn maker	1.5 to 2.1 kW	$50	1 to 3
Commercial and retail activities	Computer	15 to 100W	$250 to $800	3 to 6
	Printer/scanner	0.5 to 2kW	$150 to $250	3 to 6
	Sewing machine	200W	$30 to $100	3 to 6
	Television for local cinemas and bars (including decoder)	50 to 200W	$100 to $200	1to 3

[17]Business Daily. (2018.) Half of Kenya Power clients use Sh10 daily. Available at:
[18]www.businessdailyafrica.com/economy/Half-of-Kenya-Power-clients-use-Sh10-daily/3946234-4643380-tmq6js/index.
[19] GreenTech Media (2018). Private Minigrid Firms Deserve a Chance to Compete Against Slow Utilities in Africa. Available at: https://www.greentechmedia.com/articles/read/a-faster-path-to-rural-electrification
ESMAP (2019). Minigrids for Half a Billion People.

AMDA does not have data to present on this topic at the moment. The purpose of this section is purely to begin the conversation that all experts in the sector know is needed. Load growth is fundamental to the future success of the mini grid sector yet agreed upon standardized practices to promote them do not exist, nor do efforts to establish such practices across the sector.

There are two schools of thought around whether productive use activities should be core to minigrid business models or not, and every company approaches this complicated subject in their own way. Some do not want it as core to their business, claiming they energy companies only, while others list it is one of the major drivers for their desire to work in this sector. The schools of thought are
as follows:

- **The case against minigrid companies focusing heavily on productive energy:** decades of rural development work by national governments, development agencies and NGOs have not led to clear, well understood and replicable pathways for rural economic development. It is therefore not appropriate to put this responsibility onto minigrid companies whose primary role is something else – energy provision, which they are still learning how to do at scale.

- **The case for minigrid companies to focus heavily on productive energy:** minigrid companies have seen that rural energy consumption does not grow as quickly as once hoped, and therefore load growth must become a core element of their businesses to be viable. Furthermore, minigrid companies are often the first firms in history to commit to doing business in these communities over the long term, representing an unprecedented opportunity to develop lasting rural development efforts together with partners.

The reality is that every company does work on productive uses in some way. However, because of the hit-and-miss nature of this work, investors see it more as “nice to have” rather than something they are keen to pay for. Another reason for the lack of investment in this area is that investors generally invest in discreet minigrid projects, and rarely put money into companies’ central teams. This makes it difficult for minigrid companies to have dedicated productive use units, which will inevitably require significant flexibility to experiment, innovate and learn as they work with partners to establish replicable approaches to productive use work.

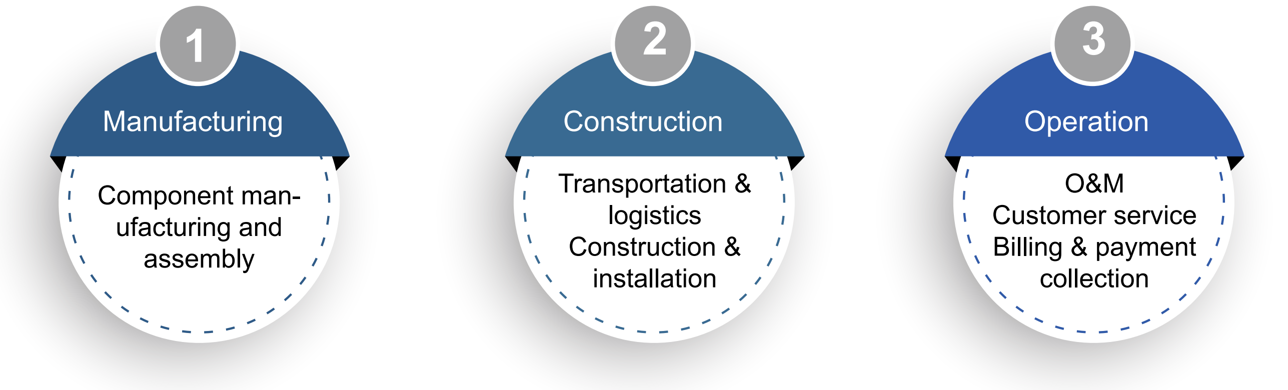
This is where the rationale for broad, more systemic sectoral support from donors and governments comes in. Looking ahead five years to a time when the sector hopefully has dozens of companies with 500 – 1,000 minigrids, AMDA speculates that minigrid productive use efforts should probably look like a combination of broad scale micro-finance (for appliance purchases), micro-entrepreneurship training (ensuring appliances and local businesses are increasing incomes) and agricultural extension work (minigrid sites and customers will remain largely agrarian for some time) all wrapped into one.

Such a complex set of activities are not appropriate for struggling energy companies to tackle on their own. Yet it is also not a job that NGOs or governments are stepping up to work on either. The conversation around how to deliver productive use support systematically is of existential importance not only for minigrid companies, but most importantly for the poor and marginalized communities that minigrids are trying to serve. We need to have this conversation – now – and we hope you can join us as AMDA begins work on this important topic.

6.3 Sector job creation

In addition to economic opportunities created in and for communities, minigrid companies of course provide direct employment themselves across the full sector value chain, as illustrated in Figure 6.4.

Figure 6.4: Minigrids local value chain



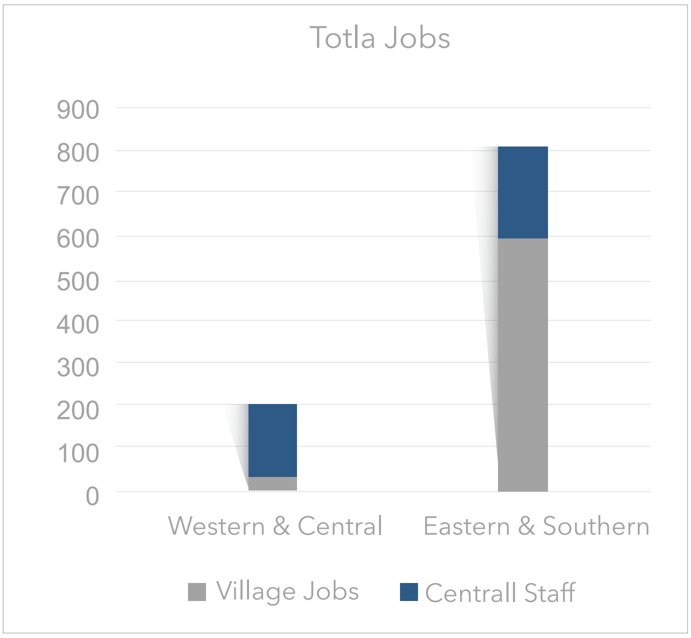
The types of minigrid employment opportunities analysed in this section were determined by the data available: local village employment and central employees. These refer to:

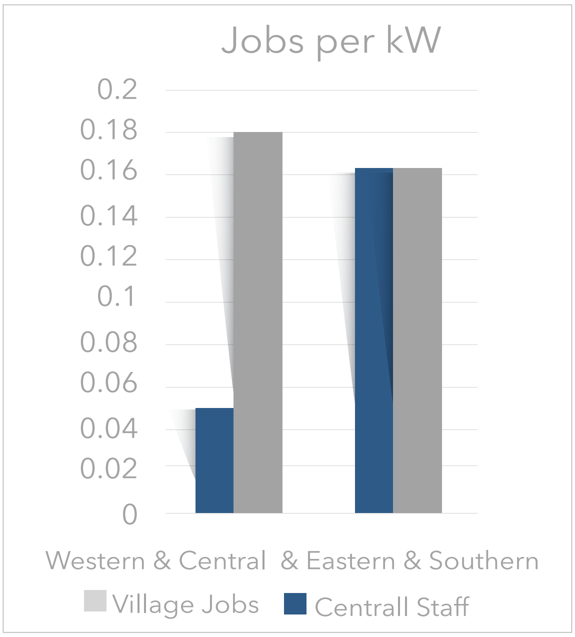
- **Local village employment -** reflects jobs in initial construction and installation, and thereafter basic operations and maintenance.
- **Central employment -** reflects core operations, management, customer service and payment collection, among others.

AMDA's data provides evidence that investments in minigrid development have generated a significant number of jobs in both categories. Figure 6.5 shows that a total of 621 local village jobs and 402 central staff jobs were created during the period 2010 - 2019 by developers across all 288 sites. The regional difference in absolute jobs created is due to the higher number of sites in Eastern and Southern Africa compared to the rest of the continent.

On average, a minigrid site creates between 0.14-0.16 full time positions for every kW of installed generation capacity. A standard size for a small minigrid of 20 kW will therefore create about 3 full-time jobs.

Figure 6.5: Village jobs and local employees





[20]Power for All. (2019). Powering Jobs Census 2019: The Energy Access Workforce. Available at: http://powerforall.org/ powering-jobs-census-2019

The results do not account for the creation of induced jobs stimulated through newly acquired access to electricity in previously unserved communities. Induced jobs are created through higher spending on goods and services which benefit the larger economy. As an example, minigrid construction generates induced employment at the construction site for drinking water and food vendors

.

All told, Power for All's 2019 "Powering Jobs Census" found that the decentralized energy sector employs twice as many workers through informal jobs as it does through direct employment, and five times as many through local productive use jobs created by the energy access they bring.[20]

Nevertheless, unlocking this potential requires local workforce readiness to ensure the smooth operation of minigrids. Potential employees need to gain the skills necessary to ensure the smooth operation of minigrids and exploit new productive use opportunities. This creates a challenge for policy makers, researchers, training organizations and development partners to work together to enhance technical and managerial skills in local communities.

6.4 Key insights

Reported figures on consumption vary dramatically across sites and countries. The cause for this disparity is not entirely clear from the limitations of our dataset, however we expect this is related to population density, the presence of commercial or semi-commercial offtakers, as well as consumer familiarity with energy (e.g. older sites where customers have had time to adjust to using more power, or new sites that are replacing existing diesel generators).

Irrespective of the reasons, efforts to increase demand are win-win-win. Donors and governments achieve development objectives, minigrid firms are more financially viable and communities earn more incomes and consuming more energy, which will also eventually allow for the lower electricity prices everyone is pushing for. By assisting communities to expand electricity-powered productive activities, a virtuous cycle will be created in which electricity consumption will increase alongside increasing household incomes. The final element of this virtuous cycle is that increased consumption will eventually allow companies to reduce electricity prices as well.

Specific insights from the evidence presented here for key stakeholders include:

- **Policy makers and regulators** – Consumption growth rates for utilities are low[21] and are not showing improved growth trends. Improving consumption is a systemic issue for rural electrification. Minigrid companies are particularly incentivised to improve consumption through productive uses, as they currently cannot rely on OPEX subsidies or cross subsidization to ensure revenues. Creating partnerships between minigrid developers and governments helps ensure continued investment in rural economies and can be leveraged to support national efforts to improve economic performance.

- **Development partners** – Supporting the sector to better grow the load by adding productive use work to their business models is urgently needed. While productive use projects have been around since the beginning of the sector, working with companies and investors to imbed productive use employees and asset financing these into minigrid business and financing models is where donor support would now make the most impact. This will likely need to be undertaken in collaboration with governments and ideally utilities as noted in the point above. Most likely these programs will need to be a strategic and broad scale support for micro-finance, micro-entrepreneurship training and agricultural extension work.

[21] Toman M., & Peters, J. (2017). Rural electrification: How much does Sub-Saharan Africa need the grid? Available at: https://blogs.worldbank.org/developmenttalk/rural-electrification-how-much-does-sub-saharan-africa-need-grid

- **Investors** - The positive correlation shown between ARPU against utilisation rates, consumption and number of connections provides an understanding of key drivers of a project's bankability during a due diligence or capital raising engagement. We need investors to work with donors, minigrid companies, and NGOs to call for more support to companies on utilization and productive use to help increase the attractiveness of the sector to investors.

- **Minigrid developers** – Just like investors need to be putting money into companies, initially at least, minigrid companies need to be investing in (some of) their customers. Building productive use opportunities and productive asset finance into minigrid business models is a challenge and an added cost, but one that will likely pay dividends over the course of a project lifecycle in terms of increased ability to pay and ARPU.

7. Service Quality

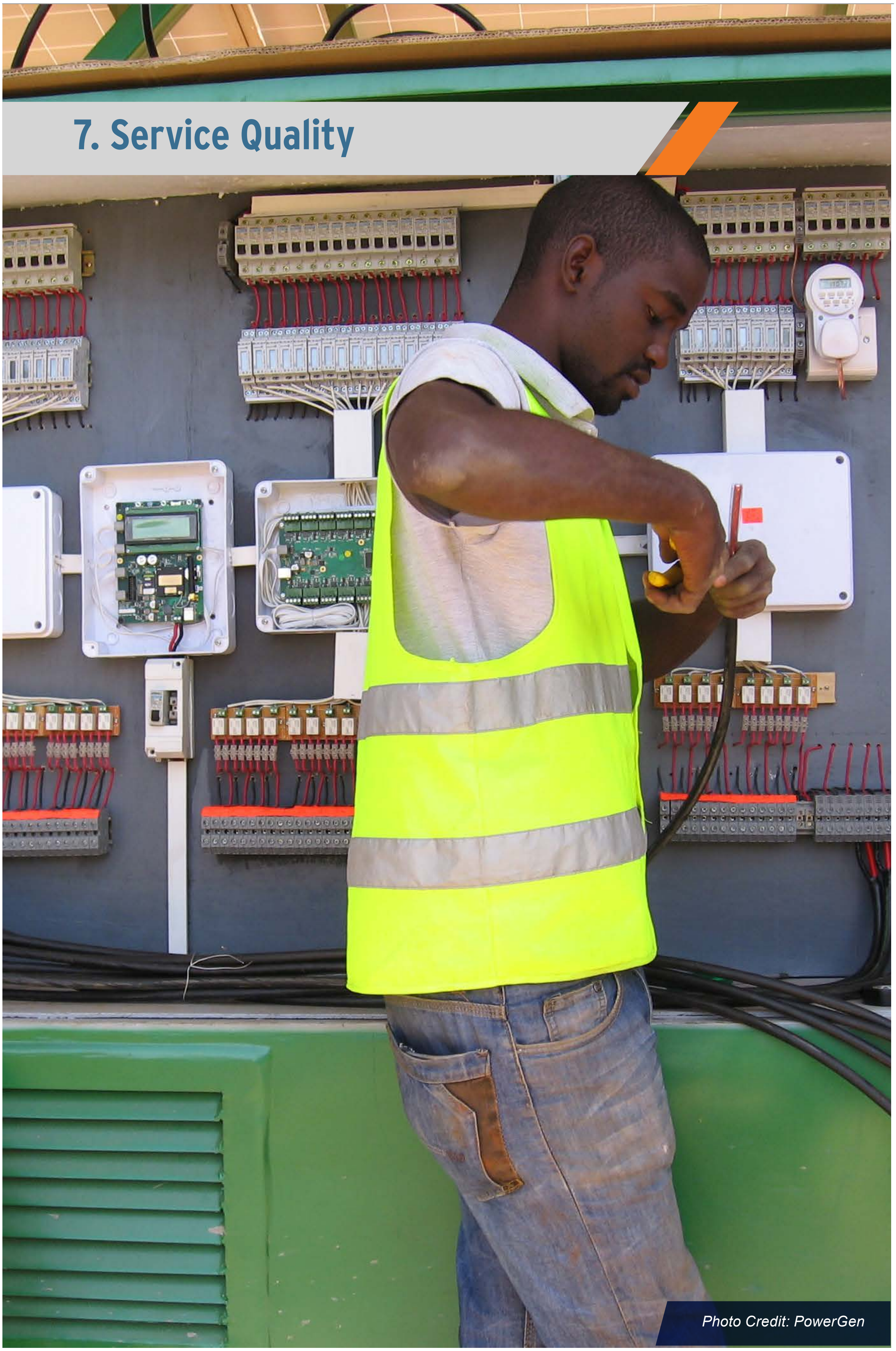


Photo Credit: PowerGen

Service Quality

Access to reliable power is one of the most fundamental elements of any modern economy, and one which most people in countries with reliable energy do not even think about. Power outages and lack of reliable supply can have adverse consequences for households, health facilities, schools and businesses and is essential to participation in the digital economy. Reliable energy services are fundamental to everything that drives modern economic progress

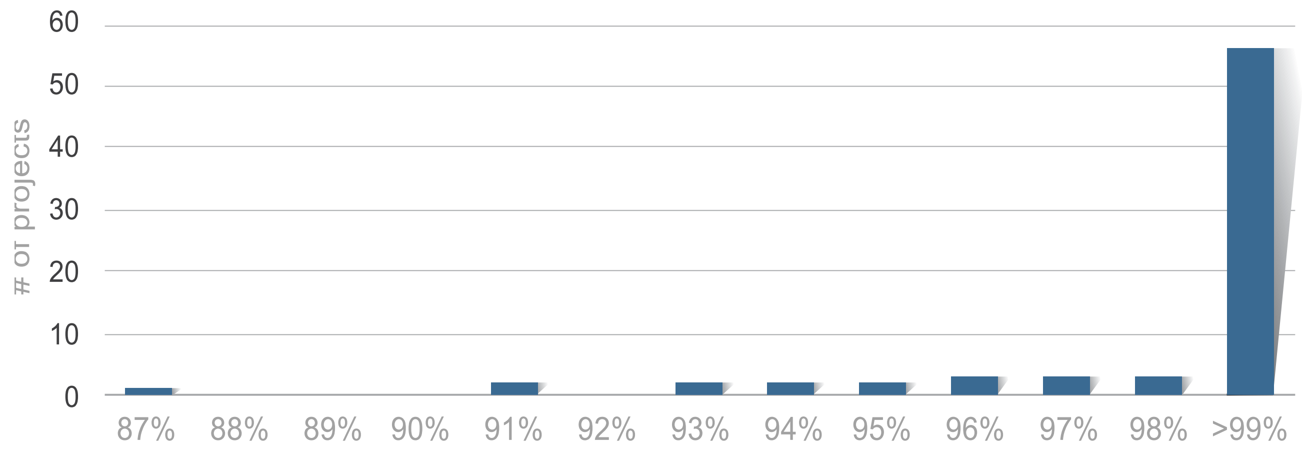
The data show that minigrid reliability has been increasing over recent last years, and today AMDA members' reported system uptimes are close to 99%. This is significantly higher than what national utility grids in Africa are able to offer. Indeed, the rural and remote populations served by AMDA members universally have higher quality, more reliable power than those in the capital cities of their respective countries. This is due both to the reliability of renewable energy systems themselves but also due to the adoption of innovative technologies. For instance, smart meters usually flag problems immediately, oftentimes bringing them to customer service teams before customers report an issue.

7.1 Service uptime

Figure 7.1 shows that the large majority of minigrids for which data was available reported percent uptimes22 above 97%, with an average of 99% across all countries. Unfortunately, similar to utility subsidy data and grid plans, service quality data from national utilities in Africa is extremely limited. According to the ESMAP RISE report, only 4 of the 12 countries they analysed make service data publicly available.23 AMDA was only able to find public data from Zambia, which shows the average national availability of power from the generation source was 72% in 2017.[24]

AMDA's data suggests average monthly outages and downtime from minigrid system faults have decreased over the last few years, reflecting the deployment of high quality, innovative hardware and software technologies used to increase service quality and satisfy customer demands. These technologies include remote monitoring

Figure 7.1: Percent uptimes of sites with generation capacity



[22]Uptime percentages are calculated based on system inverters measure of dispatched power.
[23]ESMAP Rise Report. Available at: https://rise.esmap.org/countries
[24]Zesco. (2017). Zesco Integrated Report, pg 28. Available at: https://www.zesco.co.zm/integratedReports/ZESCO-Integrated-Report-2017.pdf

systems and software that analyses operational data to predict faults and efficiently address problems before they affect energy service quality. Additionally, smart meters can provide both firms and customers with detailed information on their energy consumption patterns.

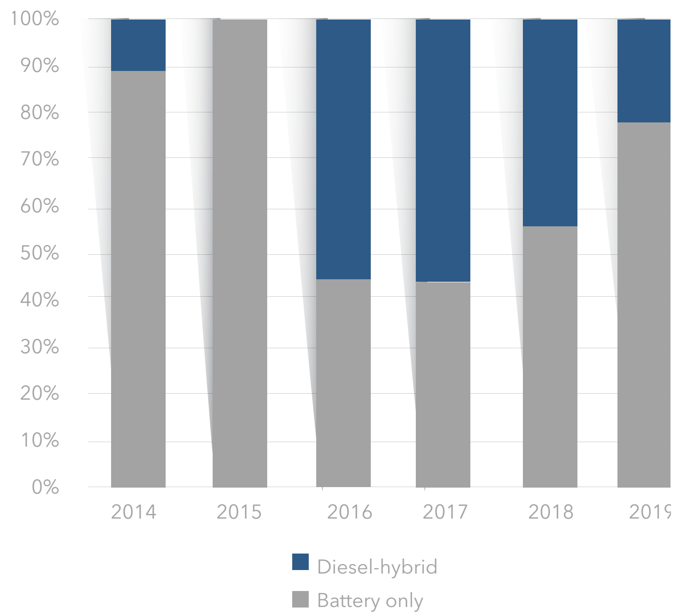
7.2 Performance & Service Quality

Providing reliable energy services means minigrid operators must have the ability to meet peak demand, which can be difficult to predict. As a result of this challenge, minigrids are oversized, which can significantly affect the costs and financial returns of a project.

For a solar PV based minigrid, electricity either comes directly from the PV array (which is limited by installed PV capacity, inverter rating and daylight hours), from the battery bank (which again is limited by the installed storage capacity and inverter rating), or from a diesel generator. A large number of AMDA developers reported still relying on diesel back-up supplies to limit power outages and downtime and ensure reliable electricity services. However, since 2017 an increasing number of developers have chosen to rely exclusively on battery storage.

Figure 7.2 illustrates how developers in this study have been adjusting their preferred back-up capacity solution in favour of battery storage in the past year in particular. This is at least partially related to external pressure and requirements from donors and impact investors to build 100% renewable infrastructure. Developers may also be choosing 100% renewable solutions as battery prices drop and batteries dramatically reduce O&M costs associated with generators and fuel. The negative aspect of this shift is that systems using only battery back-ups reported 40% more unscheduled outages than systems with diesel genset backups, indicating there is currently a service quality trade-off to going green, which minigrid companies and development partners should collaborate on to address.

Figure 7.2: Project sites with diesel generators by year installed



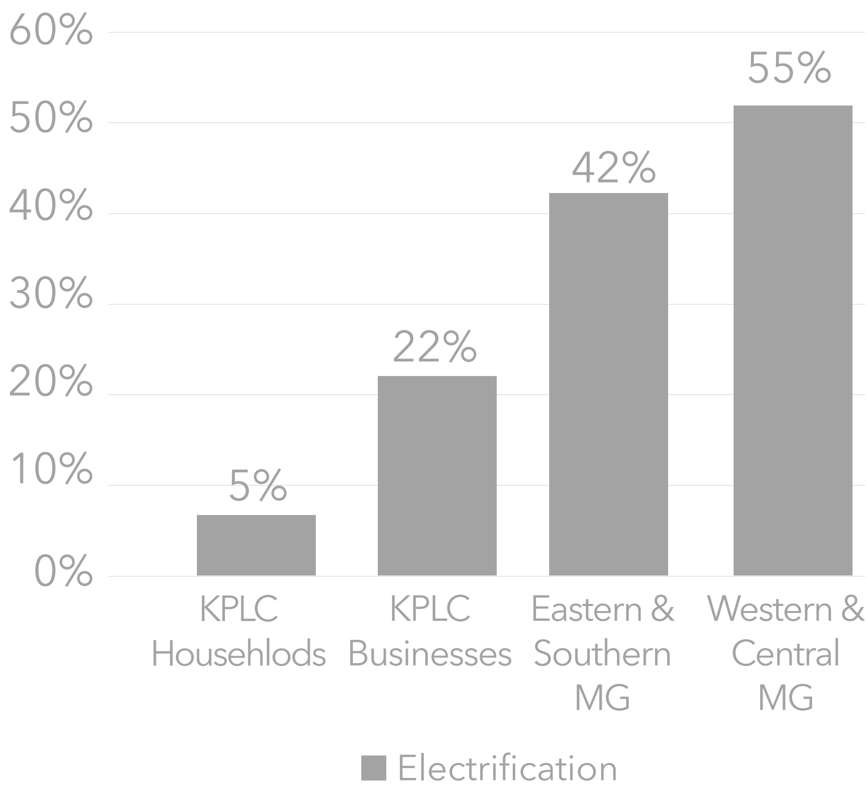
7.3 Percentage of customers within communities served

AMDA's data show that within communities served by our members, the average electrification rate is around 50%. This is in direct contrast to national utility service rates in rural areas, where a University of California, Berkeley study that "even in a seemingly ideal setting, where there is high population density and extensive grid coverage, electrification rates remain very low, averaging 5% for rural households and 22% for rural businesses."[25]

Because minigrid connection costs to customers are lower than for the main grid, individuals and business not electrified by minigrids have mostly either chosen not to be connected, are waiting for the next round of extensions or are too far from the grid to extend the grid due to financial and/or technical constraints. In such cases, in contrast to national utilities who do not offer alternative ways to access electricity, most minigrid developers offer solar home system solutions to those not able to connect. Figure 7.3 gives an overview of the percentage of households and businesses in each community served with a minigrid connection and the average number of connections in each community in each region.

Although minigrid operators in Eastern and Southern Africa have managed to connect nearly twice as many customers on average as minigrids operating in Western and Central African countries, both regions achieved a similar electrification rates within the communities they serve. These results suggest that developers are achieving similar success rates in connecting households and businesses, but targeted communities in Western & Central Africa are smaller on average.

Figure 7.3: Electrification rate and connections within minigrid communities



[25]Elsvier. (2016). Electrification for "Under Grid" Households in Rural Kenya. Available at: https://www.sciencedirect.com/science/article/pii/S235272851530035X

7.4 Key insights

Minigrid quality of service has been improving over the last few years due to the adoption of improved technology, better connectivity and falling hardware costs. In addition, minigrid developers have increased the security of supply by including diesel generators and additional battery storage for back-up supply in their designs. This has led to decreasing power outages and downtimes and more reliable electricity services. However, the data suggest that by increasingly choosing battery storage without diesel back-up, unscheduled downtime might increase during extended periods with little sunshine.

Specific insights from the evidence presented here for sector stakeholders include:

- **Policy makers and regulators** – Recognizing the importance of the reliability, high quality of service and high levels of customer care offered by minigrids is an important step in taking a collaborative, most appropriate technology approach to national planning. The minigrid sector urgently needs policymakers to take this step and work with off grid and minigrid technology providers to achieve national goals in a way that is generally not happening today.

- **Development partners** – Supporting grid extension projects without question or serious encouragement to diversify technologies/approaches in countries with poor service quality and poor local connection coverage is stifling least cost electrification options. Requiring that service quality and local connection availability be integral parts of national energy planning exercises will ensure that donors support the provision most appropriate technologies for achieving national goals.

- **Minigrid developers** – By keeping quality and reliability of supply consistently high, and being transparent about their service record, minigrid companies can further improve the case for putting minigrids at the heart of rural electrification planning.

8. Policy and Regulation will Make or Break Chances of Achieving SDG 7

Photo Credit: Standard Microgrid

Policy and Regulation will Make or Break Chances of Achieving SDG 7

A sustainable operating environment is a major contributor to reducing the development costs of minigrids. Investors must be sure that their investment is secure and will yield the necessary returns. Perceptions of country risk and regulatory certainty feed into the required return on equity and, more fundamentally, whether an investor chooses to invest or not. As the perceived risk increases, investors require ever high rates of return to offset the possibility of not being able to recover their investment.

Without radical improvements in regulatory approval processes, achieving SDG 7 will be an impossibility.

This section explores the current operating environments for minigrids in several sub-Saharan African countries as reported by developers. The data show that the regulatory processes have not caught up with the decentralized nature of minigrids. Indeed, on average AMDA developers have to wait more than 52 weeks for a single minigrid to fully comply with all regulatory rules. It is clear therefore, that without radical improvements in regulatory approval processes, achieving SDG 7 will be an impossibility.

8.1: Licensing and regulatory frameworks

Minigrid developers must go through a series of regulatory procedures and approvals before their projects can move forward. These approvals may include generation and distribution licences, tariff approvals, importation licences, rights to operate a business, environmental approvals and local-level rights to use land for the construction and operation of a minigrid.

Licences grant the legal rights to develop minigrid projects and to generate and distribute electricity to the local community. Regulation is important to ensure power being generated and distributed is safe, reliable and appropriately priced, and licensing processes provide regulators the formal opportunity to review potential projects.

Given the many approvals minigrid companies are faced with, for the sector to grow it is critical to ensure their procedures are as straightforward and efficient as possible, while at the same time not compromising on fundamental health and safety requirements. AMDA's data collection found that although governments have worked to reduce this timeline (see Figures 8.1 and 8.2), currently regulations remain overly burdensome considering the small size, scope, low risk and high socio-economic (and environmental) rewards of renewable energy minigrids compared to other options.

It would take 140 years to process these all the required licenses using current practices.

Given that the World Bank estimates that 140,000 minigrids are needed across the continent, even if regulators could process 1000 applications a year, which is 3.5 times the total amount of AMDA member minigrids existing today, it would take 140 years to process these all the required licenses using current practices.

To truly scale the sector, regulatory structures must reflect the decentralized nature of minigrids. Generally, less onerous licensing and permitting frameworks for minigrids are urgently required, and more specifically, we must urgently support governments to digitize processes and develop ways to approve portfolios of multiple sites at once. These changes would not only result in faster expansion but would also lower costs, as the uncertainty of waiting periods are both an added risk for investors and also mean that minigrid companies have to pay staff for idle waiting time.

Figure 8.1: Evolution of average licensing time

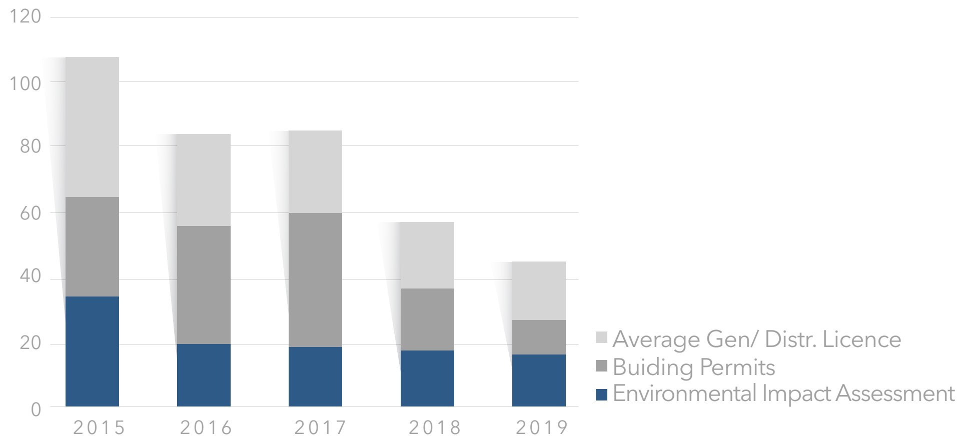


Figure 8.2: Average time to obtain licences in countries that require licenses[26]

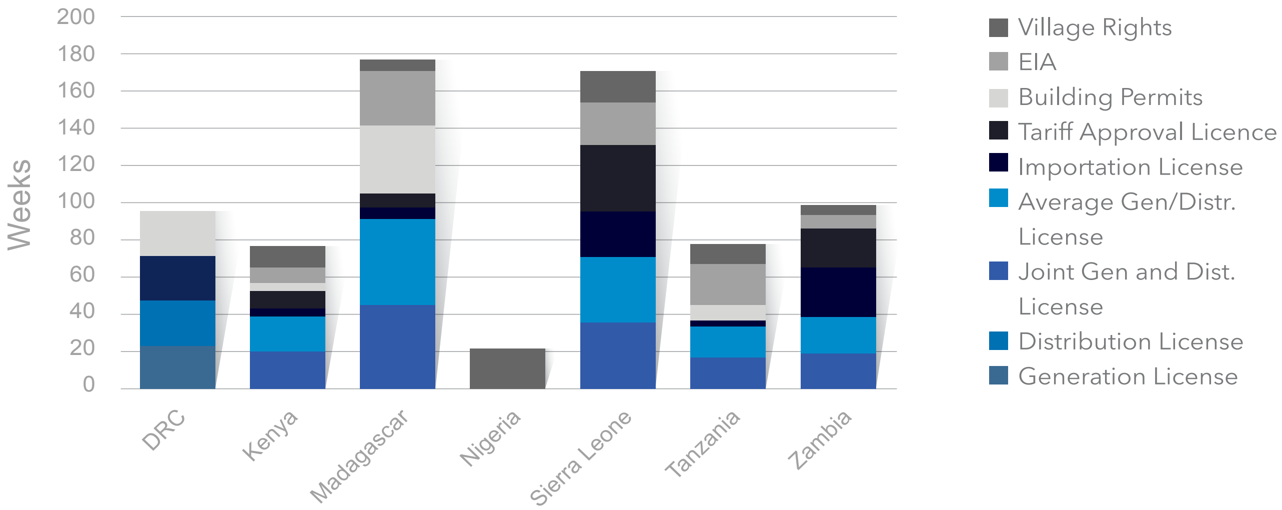
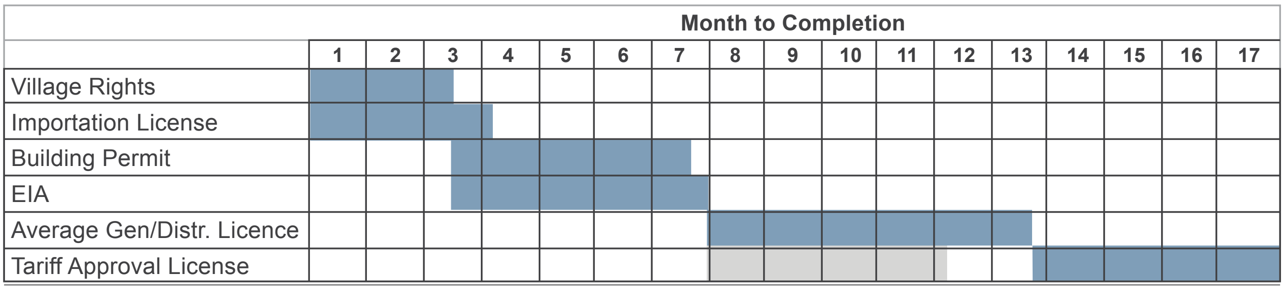


Figure 8.2 illustrates the average time it takes to obtain different types of licences and permits in several countries. The timelines for approval processes and licensing for minigrid projects differ across countries but remain consistently higher for Western and Central African countries, with the exception of Nigeria (see Box 8.1 on Nigeria's regulatory framework). While some of the regulatory approvals can be done concurrently, many must be done sequentially, adding to the length of time to ensure compliance. Figure 8.3 below shows how one regulatory approval triggers the next.

[26]At the time of this reporting developers in Nigeria were still in the process of getting regulatory approval. Timelines for License acquisition and EIA were not available at the time of this reporting.

Figure 8.3: Licencing Timeline in months



Countries have different approaches and timelines for regulatory processes and approvals. An emerging trend is to structure approval procedures around classes or categories of minigrids based on generation and distribution capacity, exempting projects falling below a specific threshold from the licensing process. Similarly, some regulators use different licensing criteria based on primary generation technology. However even with these classifications the exemption processes are still arduous.

These structured requirements aim to reduce administrative burdens for companies and regulators and also to reduce the monitoring and enforcement requirements on regulators as well. An example of such light-handed frameworks is Nigeria, where our data bears testimony to the efficacy of this approach.

Box 8.1: Nigeria's regulatory framework

The Minigrid Regulation (2016) released by the Nigerian Electricity Regulatory Commission (NERC) specifies approval processes, timelines, and selection criteria to support developers during their application process.

After identifying an unserved area, the minigrid developer must consult the community and the regulatory authority to legally reserve the site through an exclusivity agreement while the company carries out feasibility studies and project development. Subsequently, minigrid developers are required to collect building permits, EIAs and evaluate the options for NERC registration and licensing.

The guidelines released by NERC require only large minigrids (greater than one megawatt [MW]) to obtain a licence. For small minigrids, the guidelines set out different regulatory requirements for different categories of minigrids:

- For minigrids with distribution capacity above 100kW and generation installed capacity below 1 MW, developers are required to apply for a simplified permitting procedure and are entitled to adequate compensation upon arrival of the main grid.
- For minigrids with a distributed capacity below 100 kW, developers are only required to complete a simple NERC registration form, but have the option of deciding to apply for a permit that offers the same regulatory framework and incentives (such as compensation with the arrival of the grid) as the larger minigrids.

Source: Nigerian Electricity Regulatory Commission

Light-handed approaches to licensing procedures and streamlined timelines reduce red tape and regulatory burdens on both minigrid developers and regulators, decreasing the time and effort required to construct sites and expand access to rural communities. Currently the approach has focused on system sizes as the indicator for reducing the regulatory burden. However new approaches based on bulk, or portfolio applications, would likely yield faster turnaround times.

8.2 Key insights

As we have seen, minigrid service quality is exceptional, costs are coming down as technology, experience and expansion give minigrid developers the opportunity to adapt and innovate. Despite this progress regulatory hurdles remain a major sectoral challenge that is outside minigrid developers' control. These burdens actively increase costs, reduce investor trust and interest, and radically slow the pace of providing energy to those living in darkness.

The data suggest that countries have already taken steps towards simplifying licensing processes, but they remain complex and the average time needed for receiving licenses is still unreasonably high in most countries – over one year on average.

Currently regulators in most African countries are using regulatory frameworks designed to be used for non-renewable independent power producers instead of tailored frameworks for renewable energy minigrids. The shift to a regulatory approach reflecting the decentralized and clean energy nature of minigrids is underway but currently not sufficient to ensure universal electrification. Furthermore, regulators haven't yet found the balance between control and support.

This is unsurprising given that the majority of the energy supply is non-renewable in most countries and environmental and social impacts from large scale utility projects do pose risks to communities. However, the risks of minigrids are different and much smaller, and this must be reflected in regulation if we are to have hopes of achieving universal electrification goals, and for the sector to bring down costs through scale.

Specific insights from the evidence presented here for sector stakeholders include:

- **Policy makers and regulators** – Universal access to electricity can only be achieved if policy, regulation, and public spending on energy are streamlined and focused on the dual objective of supporting the sector to scale and lowering costs to end-users. Regulators can help achieve these objectives by digitizing approval processes and developing ways to approve companies rather than sites, and / or portfolios of sites rather than individual sites.

- **Development partners** – Technical assistance to regulators on designing policy and regulation for scale, particularly around bulk approvals, is urgently needed. Equally as important are well-structured support programmes that allow for rapid disbursements to assist developers in attracting finance and build fast enough to achieve global energy access goals.

- **Investors** – To encourage regulatory and subsidy reform, investors need to work jointly with other stakeholders to ensure decision-makers understand trade-offs between IPP structured regulation and light-handed regulations more appropriate for lower risk, decentralized technologies.

- **Minigrid developers** – Minigrid companies need to work hard to build out realistic, large scale project pipelines to convince regulators, utilities, investors and donors that changing the national regulatory, subsidy and policy landscape is worth the effort and public money to do so.

9. Conclusion and Next Steps

Photo Credit: PowerGen

Conclusion and Next Steps

Over the past three years, we have seen an exponential increase in the number of minigrid connections across the continent, and the sector is now beginning to move from its infancy to scale. As it undergoes this transition, it is essential that donors, governments, investors and other stakeholders continue to support its growth.

Between 2015 and 2018, the cost per connection reduced from over US$ 2,000 to US$ 733, far below the cost to connect to national utility grid in most countries. With further growth and experience, we can expect further reductions in both CAPEX per connection and per installed kW, as well as continued operational cost reductions. These lower costs combined with the high levels service quality in rural and remote areas make minigrids the ideal rural electrification collaborator for achieving universal electrification. But data and evidence on how much reduction is possible and how it can be achieved remain elusive.

It is evident that providing access to funding for minigrids, be it through grants or subsidised loans, is one of the most important actions governments and donors can take to speed up the rate of electrification in rural communities in sub-Saharan Africa. The increase in funding, particularly in East Africa, over recent years has led to, on average, a 181% increase in connections each year.

While regulators across the continent have made substantial efforts to reduce the time required for developers to comply with all minigrid related regulation, it still takes over one year for most developers to get through all approval processes. This is significantly slowing efforts universalize access and must be a major focus of reform and technical assistance moving forward.

Key drivers of growth in revenue per user are high utilization rates and larger system sizes. We can extrapolate from this that larger sites have more robust economic activity and are therefore better consumers of electricity. While it is too early to see trends in consumption patterns from the data, it is clear that consumption is nearly universally low and there is considerable work required to improve the utilization of energy.

One of the biggest questions for the minigrid sector to tackle is how to increase economic vitality in smaller communities. Case studies and best practices publications on productive uses have yet to convince developers, investors, governments and donor institutions to develop more systemic ways to ramp this work up. Demand stimulation has therefore been something investors and companies have found difficult to price into their projects and staffing costs, and remains a major technical assistance requirement for the sector.

On this note, it is fundamental that we begin building training, productive asset finance and local business support into minigrid business models in a way that builds investor trust to the level that they begin investing into these efforts as well. Hence there is an urgent need to create systemic support for productive use work. This will serve not only to help grow the load, but also will develop data and evidence to show what works, and help rural communities improve their lives and livelihoods at the same time.

9.1 Next steps

This report presents an overview of the true costs of minigrid development and some of the main issues facing minigrid companies in sub-Saharan Africa. This is a major contribution to knowledge about the sector, but remains only an incomplete snapshot into its current state, and must be followed up by regular and expanded data collection exercises that foster collaboration on sectoral challenges.

AMDA will continue to improve upon this first benchmarking study and aims to publish regular updates to ensure decision makers have access to the most up to date information on the sector. In addition, AMDA believes more extensive action-oriented research is urgently needed in a number of areas, including on:

1. Implicit and explicit national utility subsidies,
2. Cost and service comparisons between different electrification options,
3. Monitoring and guidance on regulatory improvements and best practices, and
4. Productive use success in growing economic development.

AMDA looks forward to building partnerships to explore new research opportunities on these and other areas of import to the energy access space. It is AMDA's firm belief that expanding the evidence base is an essential part in the creation of nuanced solutions to the structural challenges facing Africa's energy access challenge today.

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We look forward to hearing from you.