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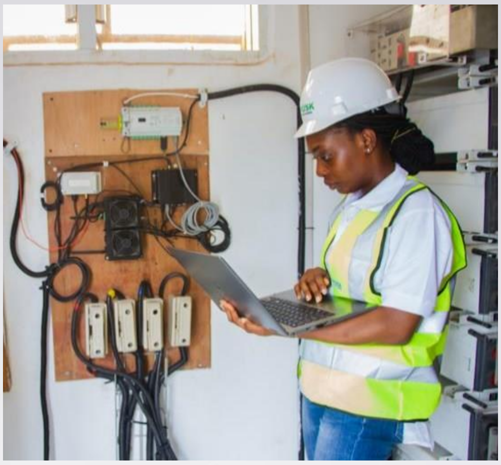

BENCHMARKING AFRICA'S MINIGRIDS REPORT

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In 2020, the Africa Minigrid Developers Association (AMDA) released the inaugural Benchmarking Africa's Minigrids Report, a comprehensive and valuable tool that has allowed more informed decision-making by governments, donor institutions and investors, whilst providing minigrid companies, suppliers, system integrators, EPC companies, and other ecosystem players with an in-depth understanding of their performance compared to their peers.

As the centrepiece of our commitment to improve the policy and financial environment for private minigrid developers, AMDA is proud to publish the report's second edition, which provides a broad database of industry performance as well as expert advice and recommendations on best practices and industry needs.

Building on three years of data, the second edition presents an in-depth analysis of changes that occurred in the industry in 2020 and 2021, including the impacts of the COVID-19 pandemic, and uncovers emerging opportunities for achieving immediate scale and long-term sustainability. Insights in the report also offer a high-level roadmap for all stakeholders, from minigrid developers to policymakers, on the actions required to grow the industry.

With less than a decade to go, we are clearly off track in reaching Sustainable Development Goal (SDG) 7 by 2030. Despite some progress, the International Energy Agency (IEA)'s Stated Policies Scenario project that in 2030, 660 million people will still lack access to electricity. The pandemic stunted progress towards universal electrification. According to the World Energy Outlook 2020, the number of unelectrified people in Africa increased by more than 13 million people in 2020[1]. This means the access rate will have to more than triple between now and 2030. In Africa alone, this would mean connecting around 85 million people every year.

Renewable minigrids are a critical part of the solution. Minigrids are currently electrifying off-grid towns, parts of cities, rural and remote communities, and are increasingly interlinking with national grids to provide more stable power within existing weak grid networks. This modern, renewable infrastructure has the potential to ensure stable, consistent power throughout the continent, while also building climate resilience and mitigating carbon emissions.

According to this new report, minigrid developers in Africa managed to almost double the number of connections in the middle of a global pandemic. While still small in comparison to the scope of the energy crisis, minigrid developers now provide more than 500,000 people, healthcare facilities, schools, and businesses with some of the most reliable and stable electricity on the continent.

The industry is also seeing revenue steadily increasing the longer assets are deployed. Revenues increase every year sites are operational. Minigrids that were operational prior to 2019 have an average monthly revenue of USD $8.30 per customer, and it is not unreasonable to expect this number to exceed USD $10 per user per month after 5 years of operations. The revenue growth over time, coupled with the need to connect half a billion people, sets up the industry to potentially generate more than USD $5 billion in annual revenue.

We have an opportunity to build dynamic, smart, renewable energy infrastructure that helps grow communities and economies. But to realise this potential, the minigrid industry needs the support of governments and donors, and investors must understand the true potential for the market.

This report highlights key issues that the sector needs to address to maximize the potential of minigrids, including:

1) Current regulatory structures were not appropriately designed for decentralised infrastructure. Because of this, the sector

[1] IEA. (2020). World Energy Outlook 2020. Available at: https://www.iea.org/reports/world-energy-outlook-2020

cannot deploy minigrids quickly enough to achieve universal energy access on any reasonable timeline. Dramatic simplification and shortening of licensing timelines, as well as bulk licensing of portfolios rather than individual sites, is urgently needed.

2) Concessional capital commitments are not being honoured or deployed. Only USD $10 million of donor money was disbursed to developers in 2020. This slow funding trickle inhibits growth and does not align with global objectives to develop renewable and resilient energy systems for universal electrification.

3) Billions of dollars continue to be poured into parastatal utilities that fail to deliver quality services, but minigrids, which outperform utilities on service, connection rates and costs, remain marginalised.

This disparity is a major reason why the previous two points are problems and is also completely solvable. If commitments to universal energy access are real, this must change quickly and dramatically.

We hope that the insights provided in this report will spur action. AMDA is actively seeking collaboration as we continually strive to find ways to address the barriers that prevent minigrids from scaling up as quickly as they need to, and, more broadly, to further our work in accelerating the industry's progress.

Jessica Stephens,
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On the left from top to bottom, Guinea Energy, Nuru and on the right from top to bottom, Husk Power Systems, Energicity, Winch Energy.

Abbreviations and acronyms

AMDA	Africa Minigrid Developers Association
ARPU	Average revenue per user
Capex	Capital expenditure
ECA	Economic Consulting Associates
EIA	Environmental impact assessment
ES	Eastern and Southern African countries
IEA	International Energy Agency
kW	Kilowatt
kWh	Kilowatt hour
kWp	Kilowatt peak
LCOE	Levelized cost of electricity
Opex	Operating expenditure
PUE	Power usage effectiveness
PV	Photovoltaic
RBF	Results-based financing
SDG	Sustainable Development Goals
WC	Western and Central African countries

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1. EXECUTIVE SUMMARY

Minigrids continue to gain traction as an integral component of the global energy ecosystem. Major institutions such as the World Bank and the International Energy Agency (IEA) estimate that minigrids are essential to providing electricity to approximately half of all unelectrified communities in Africa[2]. As governments revise their electrification plans, there is growing interest in mainstream minigrids; donors and foundations continue to publicly commit funding to the industry and new businesses emerge to support the overall ecosystem. Despite the increasing interest, however, scale has remained difficult to achieve. This report aims to provide clear, neutral, and quantitative evidence that can support decision makers as they determine pathways to universal electrification.

With this report, the Africa Minigrid Developers Association (AMDA) presents the second edition of its Benchmarking Africa's Minigrids series, which evaluates the performance of private minigrid companies across Africa, provides key insights into the barriers the industry is facing, and suggests what can be done to overcome them.

Overall, the African minigrid market is experiencing the typical evolution of a nascent industry. Some market leaders are beginning to emerge as developers expand into new markets and build out off-grid project pipelines. In the last two years, under-the-grid and integrated minigrids have emerged as key elements to improve electricity access in areas where the existing grid is weak. Even as the world was ravaged by COVID-19, the industry managed to increase both the number of minigrids and connections across the continent. Between December 2019 and December 2021, the number of connections almost doubled from 40,700 connections to more than 78,000, a 95% increase. The count of operational private sector minigrids grew 39% from 288 sites in 2019 to 400 in 2021. While much of the world economy contracted, the minigrid industry in Africa managed to grow, more than doubling the number of people with access to modern electricity - reaching over 500,000[3] people, businesses, hospitals, and schools.

Key findings

This report builds on data and findings from the first benchmarking report published in 2020, the first and only sectoral report that provides a comparative analysis on consumption and revenue trends for the same minigrid sites over multiple years. This edition of the report highlights four key trends and opportunities.

First, revenues are consistently growing while operational costs are dropping. This trajectory indicates that the industry is approaching financial viability.

Based on the latest data, average revenue per user (ARPU), a key metric of industry sustainability and business success, increases the longer that customers are connected to minigrids. For sites commissioned before 2019, the monthly ARPU is currently USD $8.30. By comparison, ARPU in the 2020 AMDA report stood at USD $4.44. The steady growth of ARPU confirms that revenue and consumption increase over time, a major indicator of long-term industry viability. These encouraging numbers surpass those of highly subsidized national grids with very low revenues. While national utilities data is hard to come by, one example of Kenya's national utility, the Kenya Power and Lighting Company, shows that its rural ARPU hovers just under USD $1.00 per month.

Year-on-year growth in ARPU also increased. A subset of minigrid sites showed that ARPU grew by USD $1.93 over 2019 and 2020. However, data showed that adding new customers into existing sites somewhat slowed

[2] IEA (2020). Sustainable Recovery: World Energy Outlook Special Report in Collaboration with the International Monetary Fund. Available at: https://iea.blob.core.windows.net/assets/c3de5e13-26e8-4e52-8a67-b97aba17f0a2/Sustainable_Recovery.pdf

[3] This is an estimate of 5.5 humans per connection (78,000 connections) +400 school, connections assuming an additional 300-500 people per school

ARPU growth. First-time energy consumers use considerably less power at first than established customers, which impacts overall ARPU. While it is encouraging to see healthy revenue growth, the projected lower revenues in the first 2-3 years of operating a site will have an outsized impact on newer and smaller firms. This points to a potential opportunity for demand-side subsidies for developers to onboard newly acquired customers.

Opex costs are gradually declining, as forecasted in our previous report[4]. In 2021, Opex per customer per month ranged between USD $1.00-$4.00, a 30%-60% decrease from the 2019 figures of USD $2.50–$6.00. As the sector scales and developers operate more sites in closer proximity to each other, economies of scale and operating efficiencies will bring down these figures even further.

Scale and efficiency, combined with rising consumption and revenue growth, point to a future of financial viability. At least two developers project that they will achieve operational profitability at the country level before the end of 2022.

Second, despite the minigrid industry's progress on essentially all business metrics, the rate of disbursement of critical concessional capital remains too slow to meet electrification needs.

Rural electrification worldwide has historically required some form of subsidy to bridge the gap between the high cost of infrastructure and low-income levels of rural households. Despite this, public and donor capital fails to flow into minigrid companies that are building infrastructure. Of USD $1.6 billion committed to the minigrid industry to de-risk projects and close the consumer pricing gap, only 13%, or USD $208 million, had been deployed as of June 2020[5]. At the end of 2021, the newly launched Global Energy Alliance for People and Planet (GEAPP) pledged an additional USD $1.5 billion[6] to support the decentralised renewable energy (DRE) sector in developing markets, doubling the total committed capital.

While the data shows that cumbersome regulatory processes impact concessional capital deployment, it does not fully explain the low rates. Perceptions of risk, appropriateness of fund design, complex regulatory structures, the absence of local currency debt and a limited amount of de-risking instruments have also contributed to slow disbursement rates. Further delays to capital disbursement would be incredibly problematic and would negatively impact a number of companies that are able to put forward bankable pipelines, with service levels and grid stability significantly better than highly subsidized national grids. Without support, the industry will be unable to achieve the scale needed to reduce costs and radically increase deployment rates, both necessary to achieve SDG 7 and end energy poverty in Africa. AMDA is committed to ensuring that this capital is effectively disbursed to support minigrid infrastructure.

Third, the glacial pace of regulatory and compliance processes remains a fundamental barrier to accelerating scale.

The World Bank indicates that Africa needs 140,000 minigrids by 2030[7], meaning 17,000 minigrids must be built every year. However, only Sierra Leone to date has been able to license more than 50 minigrids in one year[8].

Governments and development organizations are grappling with how to regulate a decentralised energy market. The average time to complete full regulatory compliance, including obtaining ESG, EIA, Licensing and

[4] AMDA. (2020). Bench-marking Africa's Minigrids. Available at: africamda.org

[5] SEforALL. (2020). State of the Global Minigrids Report 2020. Available at: https://www.seforall.org/system/files/2020-06/MGP-2020-SEforALL.pdf

[6] Global Energy Alliance for People and Planet. FAQ. Available at: https://www.energyalliance.org/about-us/faq/

[7] Energy Sector Management Assistance Program. 2022. Mini Grids for Half a Billion People: Market Outlook and Handbook for Decision Makers.

[8] Hunt, S. (2020). 5 Years on from the Launch of Green Mini-Grids Africa – What's been Achieved, and What have we Learned? Available at: https://infracoafrica.com/5-years-on-from-the-launch-of-green-mini-grids-africa/

Tariff Approval, is 58 weeks for every 100kW[9]; most steps can only be done sequentially.

One of the most efficient ways to reduce this timeline is to allow for bundling of sites and applying for licenses as part of a portfolio - structures that reflect the decentralised nature of minigrids. As per our findings, on average, 80% of the total compliance time is spent in licensing (26 weeks) and completing ESG (19 weeks). If the time to acquire these two approvals is reduced, while also allowing developers to submit portfolios of regionally-clustered sites, the industry could remove this bottleneck to scale. From our findings, there are already some examples of success in this regard, with Nigeria having streamlined their process to the shortest compliance time in the market at 31 weeks, and Kenya at a close second of 38 weeks.

Fourth, minigrids continue to outperform national and sub-national utilities on service metrics, including uptime, power quality, number of reliable connections and downstream job creation.

While billions of dollars have been poured into traditional utilities, service provision has not improved. In an enterprise survey conducted by the World Bank, businesses in Lagos reported an average of 393 power outages per month in 2018[10]; businesses in Nairobi reported 45. Minigrid customers, by comparison, experience less than one outage per month. In other words, national grids experience 13 to 15 more outages in one day than minigrids do in one month.

In addition to normal business and household activities, a stable and reliable power supply is key for both environmental and economic impact. Our data suggests that for most of the reporting sites, minigrid systems have a consistently high service uptime of above 99%. If the primary source of power is unstable, back-up diesel generators are used to power mills, home appliances, irrigation systems and refrigeration - increasing emissions. Energy also creates jobs, both directly and indirectly. Our findings show that in 2020, minigrid developers created more than 900 new jobs while building and maintaining minigrids; for every 100kW deployed, 7 permanent direct jobs were created. Finally, minigrids continue to contribute to indirect job creation and local economic development by increasing the number of high-consumption users, generating new labour opportunities for communities, as well as facilitating income-generating activities.

Recommendations for decision-makers

Minigrids provide governments and donors the opportunity to build the grid of the future, a bi-directional network constructed with smart, renewable technology that grows communities and economies. Growth in minigrid consumption and revenue signals the long-term health of the industry as well as broader rural economic growth. The market opportunity is enormous, with more than half a billion potential customers and a market that could generate more than USD $5 billion in annual revenue. In order to turn this potential into reality, however, there needs to be a massive increase in capital flowing into the sector as well as regulation and grant structures designed to support a decentralised grid.

AMDA has identified three key areas for stakeholder action:

1) Providing access to commercial and concessional funding for minigrids, whether through grants, subsidies, or concessional loans, is one of the most important actions governments and donors can take to accelerate the rate of electrification in Sub-Saharan Africa. This funding would scale procurement and reduce capex and Opex costs, de-risk projects, close the viability gap and support reduction in consumer pricing. Donors, governments, and developers need to urgently reach a mutual understanding on critical capital is not flowing,

[9] In most African markets most developers deploy an isolated minigrid of 100kW or less, anything above 100kW may require additional regulatory oversight.

[10] The World Bank. Enterprise surveys: What businesses experience. Available at: https://www.enterprisesurveys.org/en/data/exploretopics/infrastructure

unblock any barriers and adapt existing funding programs to support scale.

2) Minigrid regulations need to reflect the decentralised nature of the industry. Current regulations are based on approving and monitoring small numbers of large energy projects but must urgently be expanded to do the opposite - approve hundreds to thousands of small projects over a short period of time. Measures such as portfolio or regional licenses, streamlined and digitized processes, smart and remote monitoring technologies, sufficiently staffed regulatory offices and concessions must all be considered. These changes would go a long way to improve regulatory approval timelines and reduce the costs associated with regulatory compliance, positively affecting the rate at which people are connected and declining the cost of the power they receive.

3) The energy ecosystem must be unified, and electrification funding and planning need to happen more holistically.

Currently, on-grid and off-grid planning is frequently siloed, creating competition between the two when they are, in fact, complementary. Besides the well-understood role of off-grid communities, minigrids in weak-grid areas increasingly support entire towns or integrate with the grid as last-mile distribution franchisees. Competition within government ministries and donor institutions promotes one modality over the other irrespective of costs and service, which directly harms rural communities' ability to access power. Decisions about how subsidies flow and how customers get connected should be based on the ability to pay for and maintain infrastructure, capex costs, customer tariffs, and the quality and stability of the power supply.

If donors and DFIs continue to pour billions into traditional utilities without mechanisms to ensure improved service - all while under-funding minigrids - the grid will remain unstable and minigrid power will remain more expensive. We need the best of both worlds, which will only be possible if planning for and funding of electrification is done collaboratively.

2. INTRODUCTION

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Minigrids are widely acknowledged as the most appropriate solution to deliver power to almost 300 million Africans living without access to electricity. Although electricity access in Sub-Saharan Africa (SSA) more than doubled between 2000 and 2019, a critical shortfall remains in reaching the United Nations Sustainable Development Goal 7 (SDG 7) - affordable, reliable, and modern energy services for all by 2030. More than 50% of the African population, 590 million Africans in total, is still energy-poor[11].

Minigrids represent a significant opportunity to help governments and donors close this access gap and cost-effectively deliver universal electrification to their citizens, bolstering local economies and improving climate resilience in the process. The International Energy Agency (IEA) estimates that minigrids are the least costly and most effective solution for half of all the new connections required to meet SDG 7, together with off-grid solar systems[12]. However, minigrid deployment in SSA has been slower than projected and insufficient to meet SDG 7. The World Bank estimates that over 140,000 minigrids are required to solve the energy access problem in Africa, but deployment is ten times slower than it could be[13]. This is despite a strong potential return on investment - 140,000 minigrids can generate annual revenues of USD $5 billion at just USD $10 average revenue per user (ARPU).

Much of the slow pace of deployment is due to lack of information. Because the sector is relatively new, and the customer base is often comprised of poor, rural and vulnerable or marginalised groups, there is very little robust data available on issues like unit economics of minigrids and blockers to their rapid deployment. Stakeholders struggle to understand how minigrids compare to traditional grids, leading to government hesitancies and investor scepticism that has delayed capital investment into minigrid development.

The Africa Minigrid Developers Association (AMDA) aims to close this information ap, improve transparency and understanding of the sector, identify which factors facilitate or slow progress, and analyse the tools needed to shift the status quo. This report represents a transformational milestone in this mission, delivering critical data on minigrid performance, growth, operational environments, and sector trends.

Minigrids are off-grid and weak-grid energy systems providing localised electricity generation and distribution, usually based on renewable technologies. They provide electricity to remote communities that might be beyond the reach of the national grid, or where the national grid is weak or unstable. Minigrids can vary widely in terms of generation peak capacity and generation technology according to the needs of the area. Modern minigrids can operate in "island mode" where they are completely independent of other energy systems. Alternatively, they can operate as inter-connected, bi-directional off takers or inputs into larger grid systems. Because minigrids overcome challenges of connecting sparsely populated communities and unreliable national grid services, they are widely considered an integral element of rural electrification strategies worldwide.

This report is the second edition of Benchmarking Africa's Minigrids, a follow up to AMDA's inaugural *Benchmarking Africa's Minigrids* report published in August 2020. This report analyses macro and micro changes witnessed in the sector from 2020 to 2021, including the impact of the COVID-19 pandemic, and highlights new potential opportunities for growth and long-term sustainability. The report also offers insights for key stakeholders, from minigrid developers to policy makers, and provides guidance on levers

[11] African Union. (2020). AUC-IEA Ministerial Forum: Securing Africa's Energy Future in the Wake of COVID-19 [Press release]. Available at: https://au.int/es/node/39632
[12] IEA. (2020). Africa and Covid-19: Economic Recovery and Electricity Access go Hand in Hand. Available at: https://www.iea.org/commentaries/africa-and-covid-19-economic-recovery-and-electricity-access-go-hand-in-hand
[13] Energy Sector Management Assistance Program. (2022). Mini Grids for Half a Billion People: Market Outlook and Handbook for Decision Makers. Available at: https://www.esmap.org/Mini_Grids_for_Half_a_Billion_People_The_Report

driving sector growth, such as consumption, financing and licensing.

The presented insights and results followed a rigorous process of data collection and analysis conducted across Sub-Saharan Africa by AMDA in partnership with Odyssey Energy Solutions and Economic Consulting Associates (ECA). Nearly all AMDA members submitted data from 2020 and 2021 for this effort, covering, in some cases, up to 12 years of data. Information was sourced from 35 companies across 12 countries, including established market leaders and newer companies representing about 85% of the private sector developers in Africa.

Analysis of the provided data focuses on key metrics such as installed and operating costs, financing, revenue per user and quality of service, which gives a concrete indication of the sector's health. Tellingly, while the number of new sites and connections grew radically between 2016 and 2019, the rate slowed down significantly between 2020 and 2021 as the COVID-19 pandemic hampered growth and convoluted the data. AMDA also noticed differences in market priorities around who to connect - many low-consuming customers versus fewer commercial connections, for example - highlighting the trade-offs between universal access and commercial viability. Table 1 on the next page gives a broad overview of some key sector metrics.

The remainder of the report will dive deeper into these issues and discuss what is needed to achieve universal electrification while balancing commercial, impact, and regulatory goals.

Table 1: Overview by country

	Monthly consumption average per connection (kWh)		Capex average per connection (US$)		Capex average per kWp (US$)		Monthly ARPU (US$)	
Year of data collection	2019	2020	2019	2020	2019	2020	2019	2020
Kenya	4.1	3.7	1271	1,077	8,446	6,604	2.9	4
Madagascar	8.1	6.8	3,304	2,778	9,771	6,194	7.3	6.2
Mauritania	44.4	44.4	3,604	3,604	5,788	5,788	11.7	11.7
Nigeria	15.8	11	2,153	1,005	5,887	3,833	4.8	2
Sierra Leone	1	6.4	2,176	428	8,180	3,165	5.3	4.1
Tanzania	6	8	1,175	1,096	10,200	9,844	4.6	4.8
Zambia	1.5	1.5	815	815	6,891	6,891	6.1	6.1

2.1 Our organisations

The Benchmarking Africa's Minigrids report has been a collaboration between AMDA, Odyssey Energy Solutions and Economic Consulting Associates (ECA). Odyssey led the data collection and stored data in their platform. As the lead author, ECA then analysed, contextualised, and synthesised insights.

2.1.1 The Africa Minigrid Developers Association (AMDA)

AMDA was founded in 2018 to improve awareness of the capabilities, needs, status and effectiveness of African minigrids and help governments, donors, and investors scale the sector. AMDA represents private sector developers that efficiently deliver high-quality, low-cost electricity at scale. The organisation plays a catalytic role in creating enabling policy and safer investment environments for the private minigrid sector and those who fund it. AMDA's position at the nexus of policy and regulation – as well as between concessional and commercial capital investment – supports key players to overcome market barriers, make decisions based on robust data and evidence, and maximise the impact of combined efforts to universalise electrification.

Launched by 11 minigrid developers, AMDA now operates with 13 full-time (equivalent) staff across 5 country chapters and represents 42 member companies, all private decentralised utilities that develop and operate minigrids across 19 countries in Sub-Saharan Africa. AMDA members comprise approximately 85% of developers who have commissioned at least 1 site on the continent (see the map below) and provide connections to over 78,000 households, commercial, and other public and private institutions. Their 400+ deployed minigrids provide electricity to more than 500,000 rural and peri-urban people in SSA, totalling a capacity of approximately 7,000 kW.

Figure 1: AMDA's geographical reach

2.1.2 Odyssey Energy Solutions

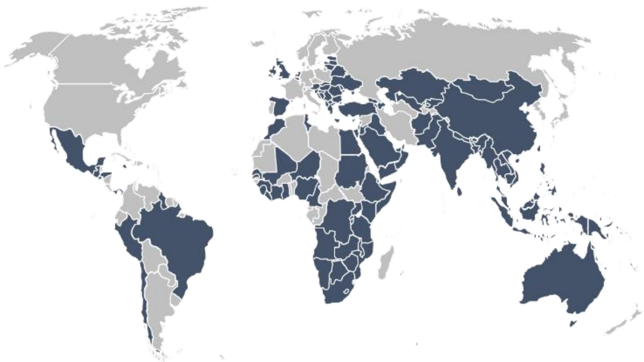
Odyssey Energy Solutions is an online investment and asset management platform developed to facilitate large-scale capital deployment in the minigrid sector. The platform integrates and synthesises large data sets from all sector angles into key performance indicators, allowing for easy and clear evaluation of minigrids and other energy access projects for governments, investors, donors, and minigrid companies.

The Odyssey platform has been deployed in more than 30 countries across Africa, with their advanced analytical tools used to remotely monitor tens of thousands of distributed energy systems, verify electricity connections, measure system performance and reliability, and track programme impact. To date, Odyssey has facilitated the funding of nearly USD $500 million into solar minigrids and other distributed energy projects. For this benchmarking report, Odyssey provided the primary data collection and monitoring portal that powers the research findings and insights.

2.1.3 Economic Consulting Associates (ECA)

For over 20 years, ECA has advised governments, private companies, investors, and regulators in issues relating to energy, water, and infrastructure, providing specialist economic and regulatory consulting services. ECA compiled the data and analysis for this work, as well as drafted the main elements of the report.

ECA is an excellent partner for AMDA given their extensive expertise and experience on minigrids. This includes activities in over 65 countries focusing on minigrid-related work on: market due diligence and programme design; policy, regulatory and financial support design; feasibility studies, electrification strategies and plans; and development of financing facilities.



3. METHODOLOGY

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The findings in this report are based on data provided by 32 AMDA members on 324 minigrids (the full list of developers consulted is outlined in Annex A1.) The analysis presented provides the most up-to-date and comprehensive overview of private sector minigrids across SSA.

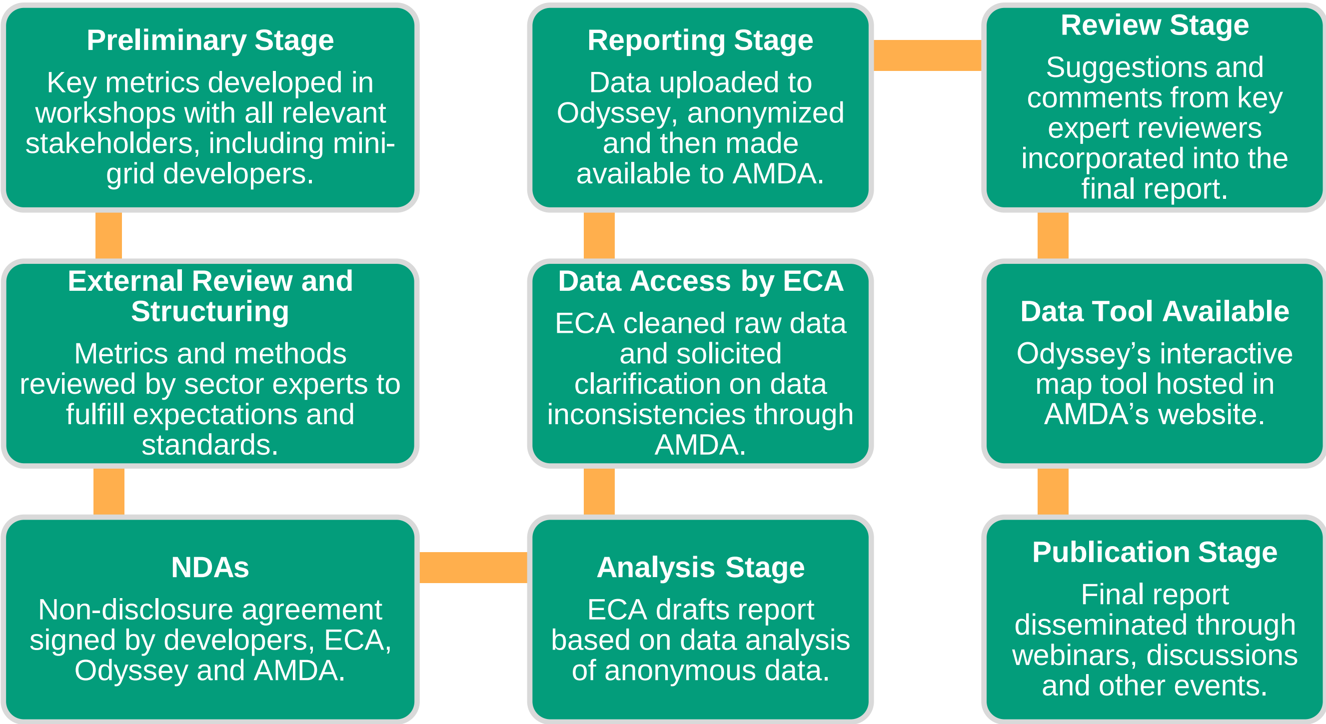
Tool Development

AMDA's data working group consists of minigrid developers and operators as well as researchers, investors, and other key sector stakeholders. From 2018 to 2019, the group collaborated to develop a methodology that established a set of metrics to deliver necessary information for decision-makers while also protecting the interests, anonymity, and intellectual property of private minigrid businesses. The resulting data collection tool puts together information on more than 60 different key indicators from a representative sample of data spanning diverse geographies, demographics, corporate experience, and history, giving a comprehensive view of the sector. The tool will continue to be refined with each subsequent report.

Development of the Report

The following flowchart illustrates the process followed in the development of this report, including planning, data collection, analysis, and publication[14].

Figure 2: Development of the report



Data Collection

Data collection responsiveness was higher for this survey than in the previous 2019 survey, with developers providing data from over 56% of all sites in 2020, compared to about 50% of sites the year before.

The data collection template included three sections:

- **Project Data (*Update* and *New Sites*):** Collected for each site owned and operated by developers. Includes over 50 indicators describing general information on the site, generation, consumption, operating expenses (Opex), capital

[14] The methodology was developed following consultations with several key stakeholders including 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)

expenditure (capex), and service quality. The *Update* section includes data submitted for the previous report with updated values for the 2020 reporting period. Information of sites commissioned after July 2019 is provided in the *New Sites* section.

- **Organisation Data:** Collected at the developer level and includes 10 indicators describing average time to achieve milestones and create jobs within communities.

- **Financing data:** Collected at the developer level and includes information about the type of capital and amount received, source, and (wherever possible) grant application processes.

Data was collected through Microsoft Excel templates sent to each developer along with a unique ID code to ensure anonymity. Besides some questions regarding grant application processes, the *Organisation* and *Financing* data sections included the same indicators as in the previous survey. In addition, each developer's previous data submissions were provided for review and clarification of issues. Finally, the process of data cleaning and clarification through follow-up interviews with private developers increased the number of data points included for the analysis conducted in 2020 as compared to 2019.

Improvements to the Tool

For *Project* data, some improvements were made compared to the 2019 report:

- **Consumption:** The 2020 template includes a section focused on consumption, in which five different consumption levels are specified. For each category, developers were asked to provide the total number of customers and the aggregate energy consumed.

- **Revenues:** For each category, developers were asked to provide the total electricity revenue rather than ARPU to simplify data gathering and increase scope for reporting.

- **Capex:** Indicators for generation, distribution, and metering were disaggregated further to obtain a more granular view of these capex components. Finally, a section on subsidies and grants was added to complement the financing data, thereby obtaining more detail on funding sources and allocation.

Context and Caveats

Due to COVID-19 delays, most indicators analysed in this report come from data up to 2020. However, for data concerning connections and number of sites developed, it should be noted that the comparative data was collected up to December 2021.

Secondly, although the analysis presented in this report provides the most comprehensive overview of private sector minigrids across SSA, there are some caveats.

While some national utility figures have been used for high-level comparisons, detailed analysis in this report is based exclusively on data from private developers. Although data from national utilities would provide a more comprehensive view of minigrids in national electrification strategies, reliable data from national utilities is not public and was not available for this report.

In addition, there are occasional gaps in the dataset due to the lack of information for individual sites, or because of confidential information considered to be intellectual property or of commercial value. Incomplete data was excluded from analysis.

The survey did not distinguish between different types of connections, such as single-phase versus three-phase, nor between customer categorisations, as different developers use different categories. Instead, customers were disaggregated by average monthly consumption bands. Therefore, data on consumption, while useful for conclusions on general trends, cannot inform comparisons on different connection types.

Finally, while geography does have an impact on some findings, presenting country-level data would allow some developers to be identifiable. Thus, to ensure anonymity of the developers in the report and to maintain consistency with the previous report, the regional clustering of countries is as follows:

- **Western and Central Africa:** Benin, Cameroon, Mali, Mauritania, Nigeria, Sierra Leone, and Togo;
- **Eastern and Southern Africa:** Democratic Republic of Congo, Kenya, Madagascar, Tanzania, and Zambia.

Table 2: Overview of developers and reported sites by country

The table below provides an overview of the number of developers and sites included in our analysis.

	Total sites	Number of developers	Year of first site	Year of latest site
Benin	1	1	2019	2019
Cameroon	8	1	2014	2019
Democratic Republic of Congo	6	3	2017	2021
Kenya	145[15]	6	2013	2021
Madagascar	14	2	2017	2021
Mali	28	2	2007	2021
Mauritania	2	1	2017	2018
Nigeria	37	7	2013	2021
Sierra Leone	66	3	2019	2021
Uganda	8	2	2021	2021
Tanzania	76	7	2012	2020
Togo	1	1	2019	2019
Zambia	6	3	2009	2019
Total	400	35	2009	2021

Note: Values include preliminary data from 2021

[15] More than 30% of these sites are interconnected and therefore not independently licensed.

4. SECTOR GROWTH

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While the sector did not grow at the same rates as in previous years, it withstood 2020's challenges.

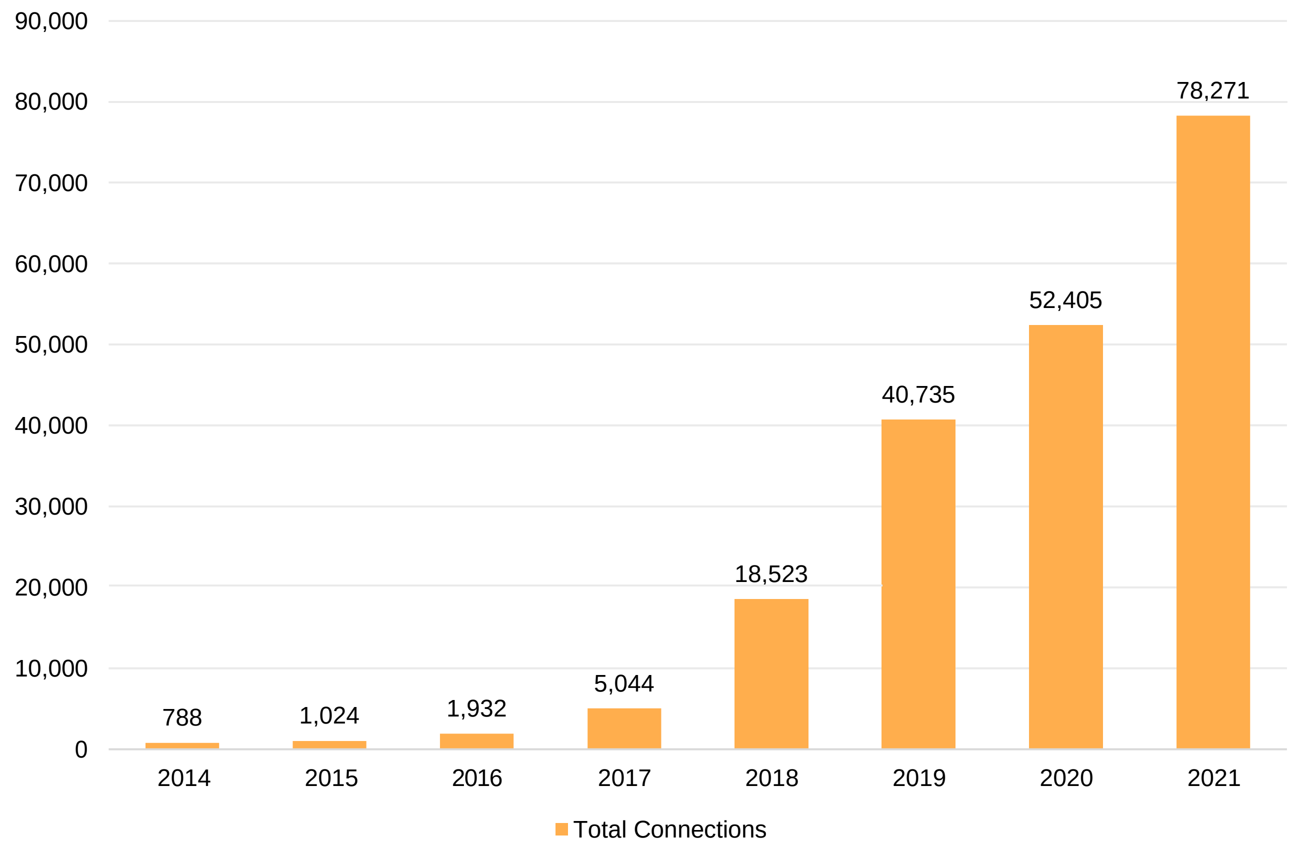
2020 was a difficult period for most industries as governments, development partners and other key stakeholders responded to the COVID-19 pandemic. As a result, the minigrid sector in SSA saw limited growth due to abrupt changes in spending priorities and increased regulatory uncertainty. Despite this, the sector still registered growth in total connections, sites, installed capacity and funding.

4.1 Number of connections

While the COVID-19 pandemic slowed growth of the minigrid sector in 2020 and 2021, developers were able to continue building sites. AMDA members facilitated almost 36,000 new connections between 2019 and 2021, bringing vital renewable electricity to small businesses, households and health facilities that helped SSA contain the virus and boost post-pandemic economic recovery. In 2020, the total number of connections grew by 28% to over 52,000. In 2021, connections grew 45% to over 78,000[16] across communities in 12 countries (see Figure 4). Eastern and Southern Africa drove most of the upward trend in connections and installed generation capacity, but Western and Central Africa achieved modest growth as well, demonstrating sector resilience and positive future prospects.

However, while there was improved growth in 2021, the sector has still not fully recovered; growth rates remain below the 2018 peak of 367%.

Figure 3: Total number of connections

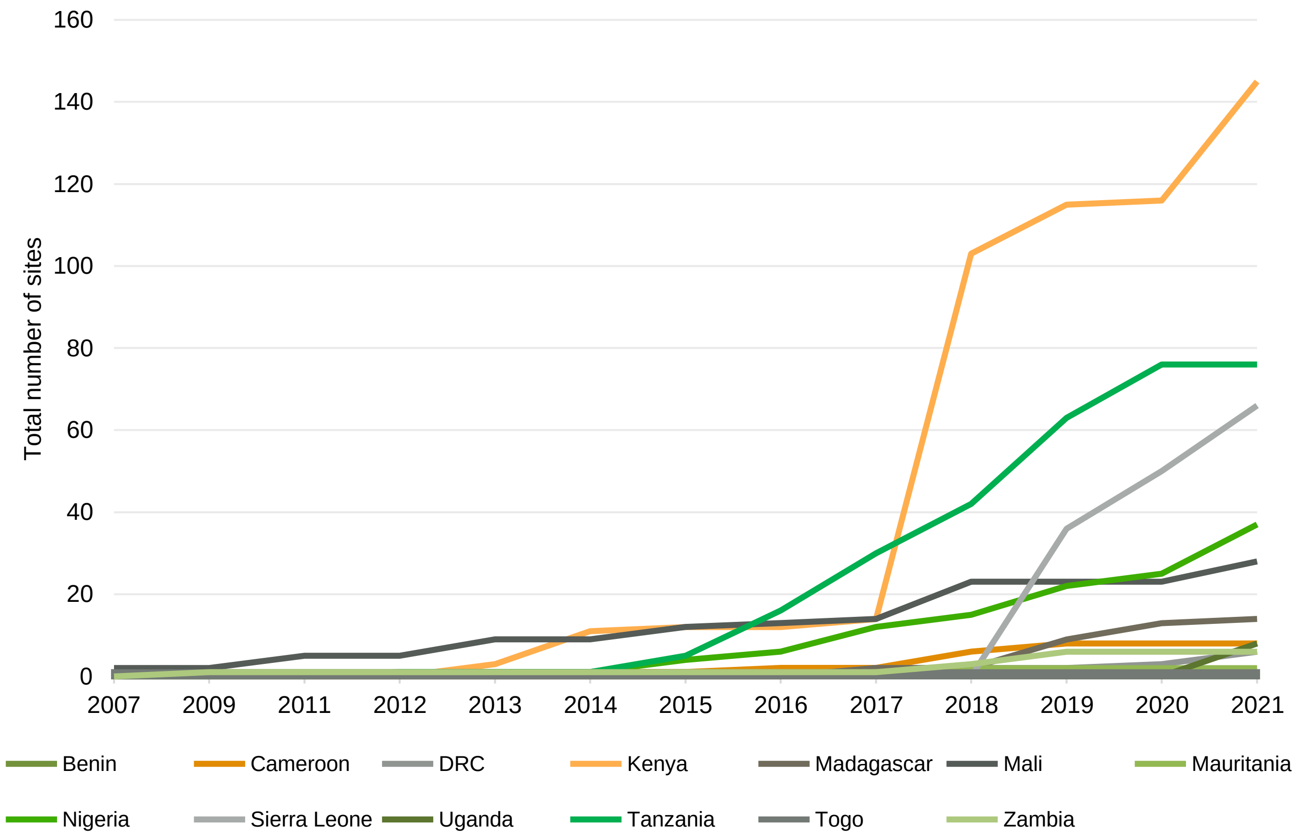


[16] While the analysis presented in this report is based on data collected up to December 2020, data is also included from 2021 specifically for number of connections.

4.2 Total installed capacity and number of sites

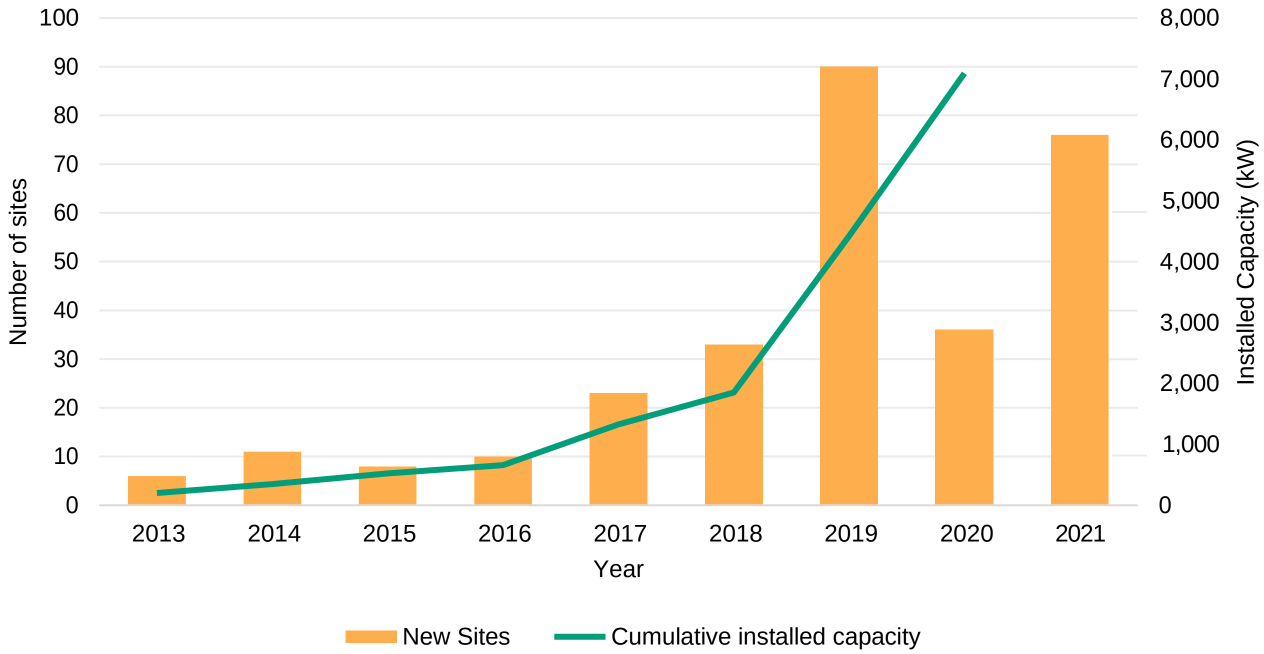
By the end of 2020, AMDA members had built 36 new minigrid sites across 13 countries, mostly in Tanzania and Sierra Leone (see Figure 4). Preliminary data shows members have built an additional 76 new sites throughout 2021, bringing the total number of sites to 400

Figure 4: Evolution of number of sites by country



Although the rate of new sites built slowed between 2019 and 2020, sites added in 2020 were much larger, connecting more people in each site. The average peak load capacity increased by more than 50%, while the average number of connections per site jumped from 196 in 2019 to 319 in 2020. Throughout 2020, more than 2,600 kW of additional solar PV capacity was installed, compared to 2,300 kW added in 2019 (Figure 5). By the end of 2020, the total installed solar array capacity of minigrids was around 7,000 kW across the continent, representing more than a 30-fold increase over seven years

Figure 5: Installed capacity and new sites added

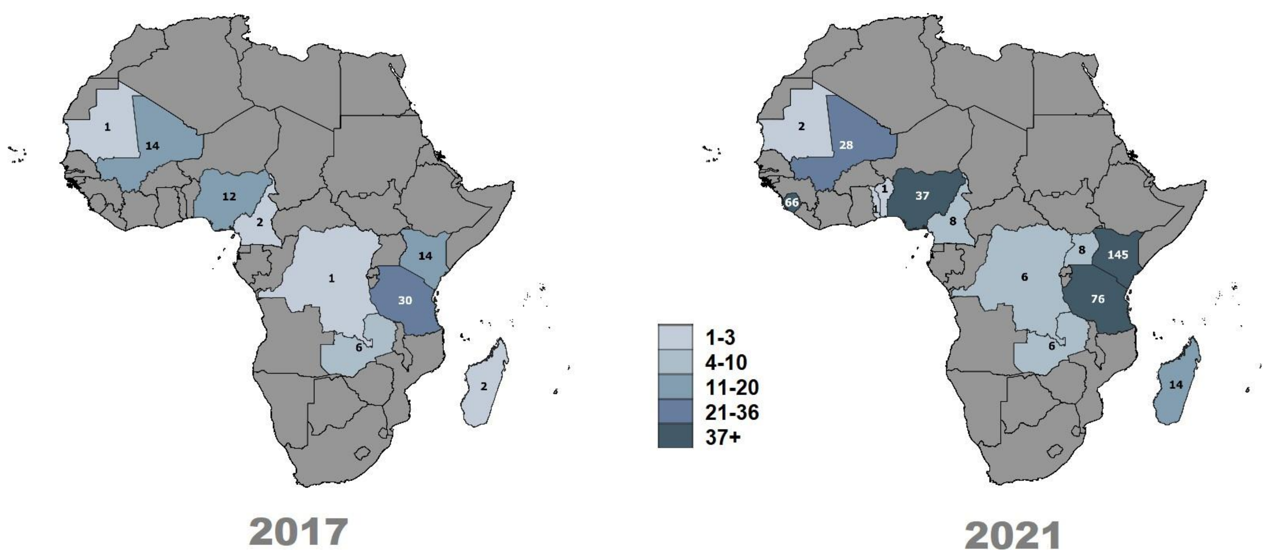


Developers are expanding into new geographies.

Between 2017 and 2020, AMDA members expanded minigrid deployment from 9 countries to 12. In addition to expansion in established markets in Eastern and Western Africa, smaller markets in Central and Southern Africa emerged over the past 3 years (see Figure 6).

As more sites open in each country, developers create best practices to navigate the regulatory framework, making it easier to install more minigrids and accelerate regional sector growth.

Figure 6: Number of sites reported in 2017 versus 2021



4.3. Funding

Similar to rural electrification efforts worldwide,[17] SSA minigrids need concessional capital, grants and subsidies to bridge the gap between the high cost of infrastructure and low-income communities' initial inability or unwillingness to pay. This capital de-risks minigrid investments for private and impact investment capital that is interested in but uncertain about the sector. This is particularly true in markets where national utilities struggle to reach and effectively service rural and peri-urban communities.

Role of Concessional Capital

There are multiple types of investments for minigrids, as presented in Figure 7 below

Figure 7: Types of capital investments for minigrids

Grants	Equity	Debt	Mezzanine financing
Funds provided to a company that do not need to be repaid. They aim to achieve specific development objectives. Grantmakers include donor agencies, governments, and non-profit development organisations.	Funds provided to a company in return for a share of the company's ownership. Equity can be provided by impact investors, investment funds, strategic investors, angel investors, and venture capitalists.	Funds borrowed by a financial entity that needs to be repaid with interest over a certain period. Debt can be provided in the forms of loans or in lines of credit.	Funds provided in the form of a loan, which can become equity if the borrower is unable to pay.

Source: ECA

SSA minigrids benefit from supply-side subsidies that reduce connection costs or demand-side subsidies that reduce the tariff for consumption.

- Demand-side measures: Kilowatt consumption subsidies reduces the cost of electricity for customers, stimulating increased consumption. Affordable electricity ultimately results in increased revenues for developers over a 3–5-year time horizon, as discussed in Section 6.

- Supply-side measures: Schemes that reduce the cost of supplying electricity and encourage developers to expand their supply to new households. Supply-side measures include:

  - ❖ Cash contributions to subsidise initial investment. These can be in the form of Performance-Based Grants (PBG) such as results-based financing (RBF) schemes that are paid out upon the developer achieving verifiable milestones.

  - ❖ An upfront grant. This may be a percentage of eligible costs and may be

[17] 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/

awarded and paid out based on a bidding process.

- Indirect fiscal support by governments. This includes exemptions from taxes and duties for minigrid components and services.
- In-kind grants. This involves procurement of equipment, such as back-up diesel generators, smart meters, poles, wires or productive use equipment funded by donors or government agencies.

Because concessional capital is leveraged to improve the flow of private capital, the minigrid sector's growth trajectory is directly linked to access to concessional funding - both grants, and more recently, concessional debt. For example, historically, donor funding into Kenya and Tanzania has led to private investments in nearly all companies in those countries.

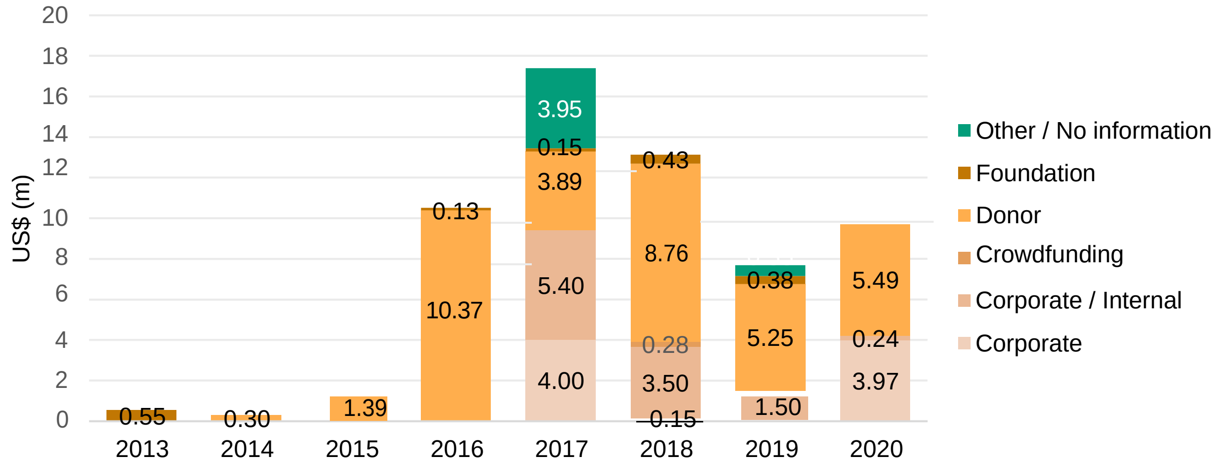
Overall Sector Funding

Between 2013 and 2020, AMDA developers that participated in the study received a total of USD $60 million in the form of project grants, corporate grants, and concessional debt[18]. Data on equity investments from investors was not collected due to the sensitivity of private investment data.

Corporate financing and working capital debt have increased considerably over the past few years, though it remains limited[19] as regulatory challenges make some markets, such as Tanzania[20], less attractive. As seen below, there was a remarkable increase of over USD $3 million in external corporate funding[21] for minigrid projects, mostly in the form of grants, while contributions from entities with a legal connection to the developer reduced. This funding was made directly to individual companies as larger European and American firms began to cautiously explore investments in the minigrid sector.

[18] The small size of the sector and the difficulty in accessing information about publicly announced deals limited the ability to collect information on equity deals.
[19] Wood Mackenzie. (2019). Strategic investments in the off-grid energy access sector: Scaling the utility of the future for the last mile. Available at: https://africa-energy-portal.org/sites/default/files/2019-03/0Strategic_Investments_in_Off_Grid_Energy_Access_final draft.pdf
[20] In July of 2020, the government implemented a tariff cap, jeopardising the viability of the businesses in Tanzania and highlighting instability in the regulations.
[21] 'Corporate funding' refers to funding provided by private entities that are not connected to the beneficiary or minigrids developer in the form of grants or debt. 'Corporate/internal' refers to funding provided by private entities that have a legal connection to the recipient.

Figure 8: Funding by type[22]



Note: Corporate refers to funding from a private entity with no legal connection with the developer, while corporate/internal refers to funding from a private entity that has a legal connection with the developer

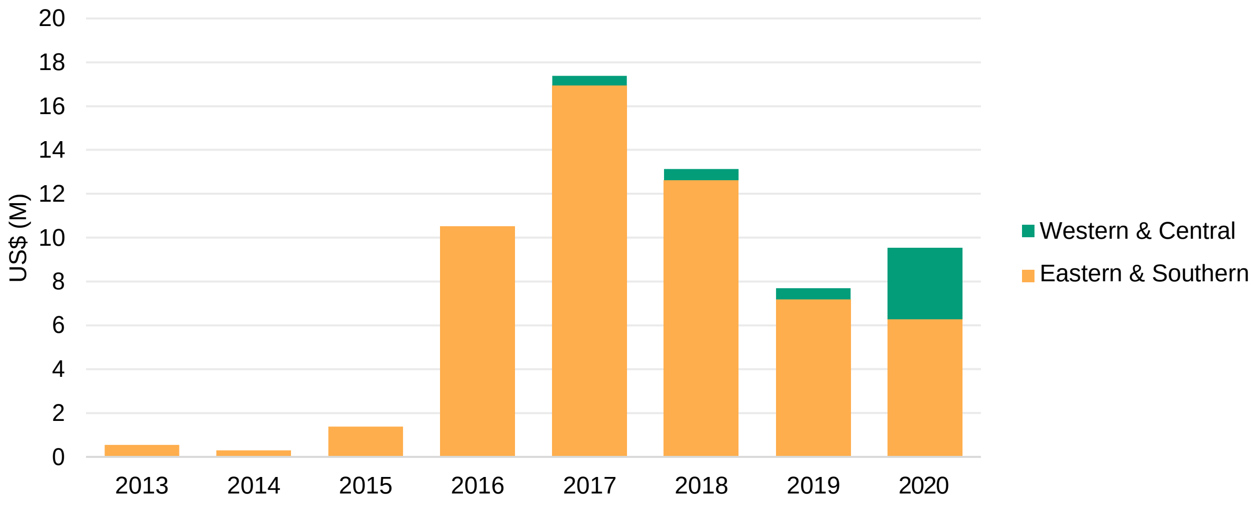
Table 3: Funding allocation since 2013 (in USD $MM)

(In USD $MM)	Capex	Opex	Debt
Corporate	8.17	-	-
Corporate / Internal	0.64	-	10.0
Crowdfunding	-	-	0.3
Donor	31.31	4.0	0.17
Foundation	1.4	0.2	-
Other/No information	1.3	3.2	-

2020 also witnessed a funding move to new markets. While both value and number of investments in the sector have traditionally concentrated around Eastern and Southern Africa, 2020 saw a six-fold increase of funding available in Western and Central Africa to USD $3 million (Figure 9), an improvement in the conditions in some of those countries' markets. This presents more opportunities for developers and investors searching for relatively new markets.

[22] For Figure 9 and Table 3, "donor" funding includes DFI, bi-lateral and multilateral donors and "foundation" funding" is funding received from foundations, usually 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 debt funding from corporate entities that have a legal connection to the recipient. "Corporate" funding represents both grants and equity that came from corporate entities (such as Total or EDF) as an investment into specific firms or projects

Figure 9: Funding received by region



Commitment and Disbursement of Concessional Capital

Between 2012 and 2019, donors committed USD $1.6 billion to the minigrid sector in SSA. This figure doubled in late 2021 with the formation of the Global Energy Alliance for People and Planet (GEAPP) and their subsequent 1.5-billion-dollar commitment to support Universal Electrification.

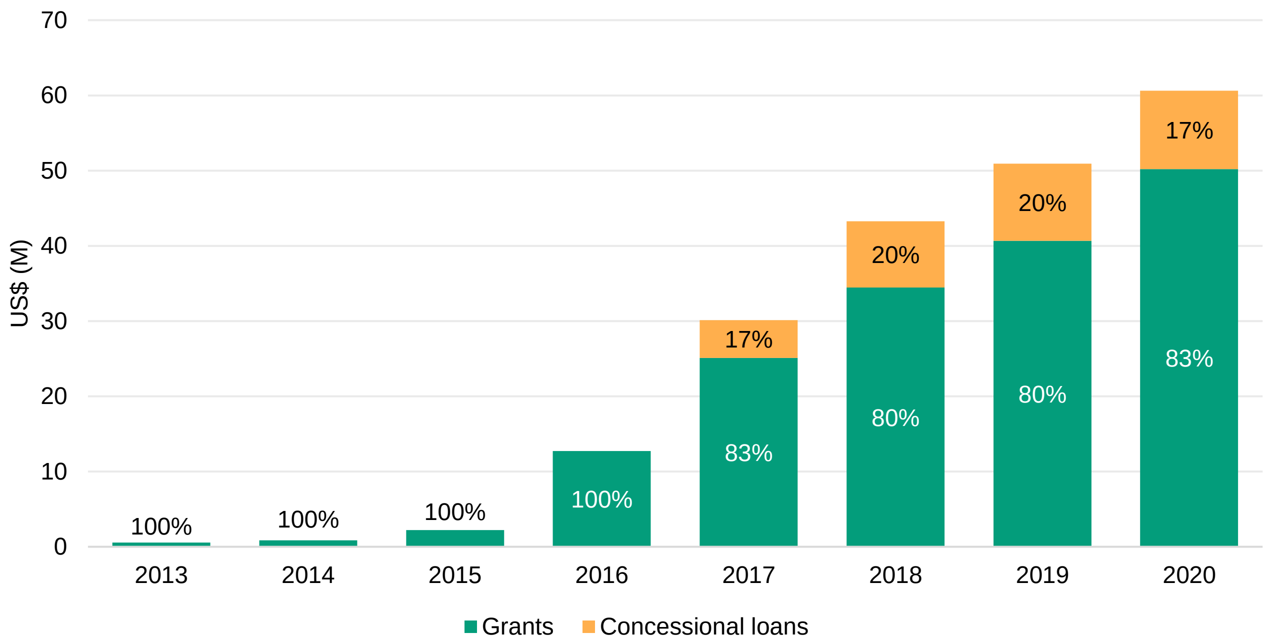
However, from the original committed USD $1.6 billion, only 13%, or USD $208 million, had been deployed as of June 2020[23] as reported by the Minigrid Funders Group. Only USD $50 million in grants and subsidies has actually been used to build minigrid infrastructure, a marginal amount in comparison to both the need and the investments into the national utility sector. For example, Nigeria alone received **USD $1.25 billion** through the Power Sector Recovery Programme (PSRP)[24] of which USD $500 million was specifically allocated to grid expansion.

As a result, grant and concessional funding only supplied a portion of the total capital required to build the 78,000 new connections in the year 2021.

[23] SEforALL. (2020). State of the Global Minigrids Report 2020. Available at: https://www.seforall.org/system/files/2020-06/MGP-2020-SEforALL.pdf

[24] Vanguard. (2021). World Bank: We Aided Nigeria's Power Sector with $1.25bn. Available at: https://www.vanguardngr.com/2021/04/world-bank-we-aided-nigerias-power-sector-with-1-25bn-2/

Figure 10: Grants to minigrids by AMDA members over the past eight years



In addition, as national healthcare systems mobilised to react to COVID-19, electrification to operate healthcare infrastructure was considered a critical pandemic response strategy, especially in rural communities. Numerous programmes responding to the pandemic included off-grid energy financing solutions, such as the Energy Access Relief Fund (EARF) and the COVID-19 Off-Grid Recovery Platform[25].

However, these programmes took substantial time to establish, with most not disbursing money until 2021.

Energy access continues to be a core facet of post-pandemic recovery in Africa, especially for continued support for healthcare, education, and economic development as part of overall community engagement[26].

Table 4 below shows some of the emerging concessional programs. These programs have potential to galvanise the minigrid market to scale assuming disbursement challenges due to fund design, risk appetite, and regulations are addressed.

[25] African Development Bank Group. (2020). The African Development Bank Launches $50 million Facility to Support Energy Access Companies through and beyond the COVID-19 Pandemic. Available at: https://www.afdb.org/en/news-and-events/press-releases/african-development-bank-launches-50-million-facility-support-energy-access-companies-through-and-beyond-covid-19-pandemic-39746

[26] World Bank. (2020). Energy Access takes Centre Stage in Fighting COVID-19 (Coronavirus) and Powering Recovery in Africa [Press release]. Available at: https://reliefweb.int/report/world/energy-access-takes-center-stage-fighting-covid-19-coronavirus-and-powering-recovery

Table 4: Grant Programs

Program	Description of Program	Program Amount	Countries
Clean Energy Inclusion Fund (CEI) Africa	The facility from KfW is currently managed by a consortium of Triple Jump, GreenMax Capital and Persistent Energy	EUR €49 million	Country selection is currently ongoing
Universal Energy Facility	The facility is a multi-donor program that was structured to be a USD 500M facility by 2023	USD $500 million facility by 2023 (USD $100 million by 2021)	Pilots have been launched in Benin, Sierra Leone, and Madagascar
Increased Access to Electricity and Renewable Energy Production (IAEREP) Program	Program by the European Union and Zambian Government	EUR €25 million	Zambia
Beyond the Grid Fund	Funded by SIDA, PowerAfrica (in-kind), Denmark Ministry of Foreign Affairs, German KfW; managed by NEFCO	EUR €30 million first call (Burkina Faso, Liberia, Zambia), EUR €6.7 million second call (Mozambique), EUR €20.7 million third call (Uganda)	Zambia, Burkina Faso, Liberia, Mozambique, and Uganda.
Project To Support the Social Component Rural Electrification Programme Cizo (PRAVOST)	Funded by AfDB and the EU; executed by Togolese Rural Electrification and Renewable Energies Agency (AT2ER)	EUR €12 million	Togo
Nigeria National Electrification Project (NEP)	Funded by the World Bank, the program is structured as a Performance Based Grant PBG and a Minimum Subsidy Tender MST	USD $150 million	Nigeria

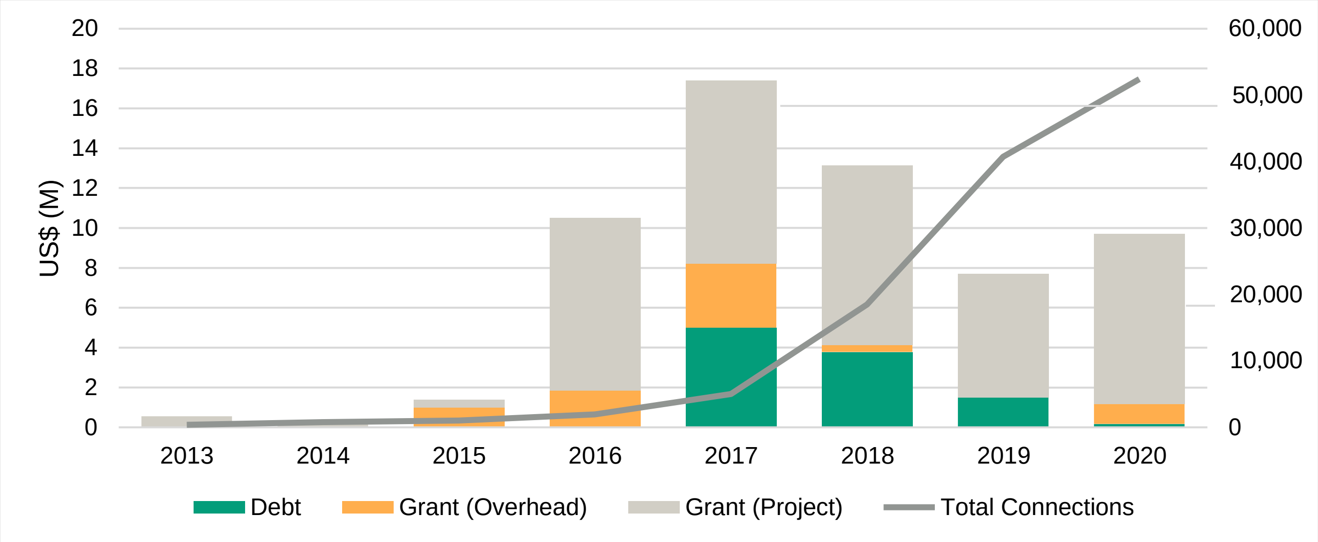
The Africa Minigrids Program (AMP)	A new UNDP-led Africa-wide initiative, funded by the Global Environment Facility, and in partnership with African Development Bank and the Rocky Mountain Institute. The AMP will support an initial 18 African countries in developing the enabling environments to increase the commercial viability of minigrids	USD $650 million	1st Round Angola Burkina Faso Comoros Djibouti Eswatini Ethiopia Madagascar Malawi Nigeria Somalia Sudan 2nd Round Benin Chad Niger Mali Mauritania Sao Tome Zambia
Access to Distributed Electricity and Lighting in Ethiopia (ADELE)	Funded by the World Bank, the program is structured as a Performance Based Grant PBG and a Minimum Subsidy Tender MST	More than USD $50 million	Ethiopia
BRILHO	Financed by FCDO (formerly UKAid) and implemented by SNV	Businesses can apply for BRILHO's MDF financial support ranging from GBP £50,000 up to GBP £1.5 million	Mozambique
Scaling Minigrid Program to Increase Energy Access	Funded by IFC with program partners AMDA, Government of Canada, Global Infrastructure Facility. The program aims to deploy 180 megawatts of installed solar PV capacity to the cities of Mbuji-Mayi and Kananga.	USD $400 million (planning to raise this year)	DRC

Funding Disbursement Impact on Connections

As noted in the 2019 Benchmarking report, the time between payment of concessional funding directly correlates to the delivery of a connection. Due to the length of time necessary 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.

Figure 11 below shows the delay between funding disbursement and commissioning of sites thus far; funding from 2020 and 2021 should provide an indication of the number of new connections delivered by December 2022.

Figure 11: Funding and total connections by year



4.3.1 National government subsidies in the electricity sector

To date, rural electrification programs and donor electrification programs have been bifurcated between off-grid and on-grid programs, leading to large investments into national utilities with considerably smaller minigrid programs. This structure creates incentives for governments to expand on-grid programs into unviable areas when it is not the most effective or best quality electrification option, causing significant challenges to the minigrid sector's growth. For example, Kenya Power's Last Mile Connectivity Program mobilised USD $770 million in donor funding[27], while the minigrid program GMG was envisaged to deploy EUR €30 million in concessional capital. While the Last Mile Connectivity Program established one million connections, only 30% of these connections are consuming power. Deploying and maintaining distribution infrastructure to low-consuming customers has created additional financial pressure on national utilities.

In addition, most countries' national utilities are already supported by hidden subsidy; a 2016 World Bank study found that only two Sub-Saharan African countries, Uganda and the Seychelles had financially viable electricity sectors at the time[28]. 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 sector equals, on average, approximately 1.5% of each country's GDP.

Minigrid operators struggle without similar subsidies or concessional capital and face increasing pressure to show the efficacy of connecting rural consumers. Within countries, cross-subsidies flow between profitable areas and un-economic areas as well as between profitable and unprofitable classes of customers. High-consuming and densely populated urban customers generate a lot of revenue and are inexpensive to connect; they therefore pay the same or higher tariffs as their rural counterparts, subsidizing low consuming,

[27] World Bank. (2019). Maximizing Financing for Development in Action: The Kenya Energy Sector Experience. Available at: https://www.worldbank.org/en/results/2019/04/18/maximizing-financing-for-development-in-action-the-kenya-energy-sector-experience

[28] Trimble, Chris; Kojima, Masami; Perez Arroyo, Ines; Mohammadzadeh, Farah. (2016). Financial Viability of Electricity Sectors in Sub-Saharan Africa: Quasi-Fiscal Deficits and Hidden Costs. Policy Research Working Paper; No. 7788. World Bank. Available at: http://documents.worldbank.org/curated/en/182071470748085038/pdf/WPS7788.pdf

sparsely populated areas. However, 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.

4.3.2 Moving towards Public-Private Partnerships

Public-private partnerships (PPPs) help create more market stability by ensuring government buy-in. Concession agreements stipulate the lifetime of the projects and ensure that the regulatory frameworks are underpinned by contractual obligations. Licenses and tariffs cannot be unilaterally adjusted due to political changes (as recently witnessed in Tanzania[29]) and can also provide government oversight on service terms where the market is developing. This overcomes situations where tensions between local and national approvals are at odds, such as in East Africa.

There are examples of success in programs that highlight how PPPs and concessions support a pathway to scale. For example, the UNOPS program in Sierra Leone deployed 94 sites in 2 years[30]. In addition, the Millennium Challenge Corporation (MCC) program in Benin is on track and has signed 16 off-grid electrification co-financing agreements that are expected to leverage USD $46 million in private investment with USD $31 million of compact funding[31].

4.4 Key insights

During one of the most difficult years for any nascent market, the minigrids sector managed to expand both in terms of size and geographic reach.

While growth was lower than in previous years, the sector was resilient enough to expand with the help of increased funding. Data clearly showed funding increased in Western and Central Africa, signalling the expansion of new markets. The sector is on the right path for achieving commercial scale as funds reach more countries.

The evolving funding mix is a sign of the sector's growing maturity.

Over the last seven years, minigrid projects have been reliant on grants and subsidies from donors and DFIs. The sector is now showing signs of maturing as the number of later-stage investors, such as strategic investors and commercial debt providers, has increased as seen in Figure 9. Even though equity flows to the sector have not been included in our analysis due to the sensitivity of investment data, it is suggested[32] that they account for most of the investment. As the sector matures, commercial funding is expected to increase and become the main source of financing.

However, while the sector is on a positive trajectory, several challenges prevent it from realising its full potential. Concessional capital, which is fundamental for all energy projects, has been slow to deploy. Historically only small amounts of the committed capital have been used to build infrastructure.

Low Disbursement Rate of Concessional Capital

While the specific reasons for the low disbursement rate of concessional capital are not fully understood, AMDA believes it is due to long timelines for regulatory compliance, which exceed one year to approve a single site less than 100kW. Since grant programs are structured along individual project approvals with long application timelines, the speed with which sites can be built and funding dispersed

[29] See Tenenbaum, et. al. (2022, Box 3.2)
[30] InfraCo Africa. (2019). Sierra Leone: Sierra Leone Mini-grid Project: Rolling out off-grid energy access. Available at: https://infracoafrica.com/project/sierra-leone-mini-grid-project/
[31] Millennium Challenge Corporation. Benin Power Compact. Available at: https://www.mcc.gov/where-we-work/program/benin-power-compact
[32] Wood Mackenzie. (2019). Strategic Investments in the Off-grid Energy Access Sector: Scaling the Utility of the Future for the Last Mile. Available at: https://africa-energy-portal.org/sites/default/files/2019-03/0Strategic_Investments_in_Off_Grid_Energy_Access_final draft.pdf

is very slow. Similarly, minigrid developers access concessional capital on a site-by-site basis. Even small concession agreements (10-25 sites) take two to three years to negotiate, which impacts the speed of deploying capital.

For concessional capital to leverage commercial financing, regulatory and grant mechanisms focused on individual site approval and oversight need to be adapted for scale.

Enabling Environment

A more conducive business environment within the minigrid sector will allow policymakers and developers to unlock private capital, facilitating financial sustainability without the need for grants. Public funding is necessary to offset investment and market risks and ensure that customers do not bear the full burden of electrification. RBF grant facilities have been catalytic in facilitating growth in the early stages of market development, but they are one of many concessional tools needed to ensure that Africa collectively meets its electrification goals. More public funding will be necessary in the form of RBF and guarantees to de-risk investments, as well as tariff buy-downs and long-term infrastructure debt to encourage the participation of private financiers.

This report will further explore enabling environmental factors, such as creating reliable, predictable, long-term public funding and streamlining processes such as licensing, tariff approvals and other government permissions, as detailed in Section 9.

The Power of Public Private Partnerships (PPPs)

As grid integration becomes more prolific and the line between off-grid and on-grid continues to blur, concession agreements will be essential in mitigating risk.

While real and perceived risks continue to delay and complicate investment in the sector, developers opt to participate more in tenders based on PPP structures. These provide clear risk mitigation frameworks, such as allocating obligations between parties and dispute resolution processes. This approach is critical in increasing the adoption of de-risking tools and guarantee instruments that will bring more long-term infrastructure debt facilities to the minigrid sector.

Two key government actions must be taken.

The first is to simplify and automate as much of the licensing and approvals processes as possible.

The second is to design large-scale tender processes that consider sector needs. While a completely free market approach is attractive for many reasons, minigrids are highly regulated infrastructure in Africa and cannot operate under the same free market principles as unregulated sectors. Financing infrastructure requires large investments; the scale of investments needed will only move when there is sufficient certainty, clarity, and pipeline, which large-scale concessions would indeed bring. Concession models should not be based on previous energy deals that focus primarily on lowest cost per connection or kW installed, but a multi-criteria evaluation that include a variety of metrics including impact, ability to work at scale and service quality

Insights for sector stakeholders

Policymakers 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 delays the positive impact for which governments strive. 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. Concessions for portfolios of sites is emerging in West Africa as a viable approach to support electrification goals. For markets that have traditionally opted for a more developer-driven approach, concessions could offer a longer-term solution.
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 Section 9, technical assistance on digitising, simplifying and streamlining regulatory processes is urgently needed - particularly around the development of concession and regulatory processes designed for speed and scale. Individual approvals for the 140,000 sites that Africa needs will not be possible using current approaches[33].
Investors	The minigrid sector in Africa shows enormous market potential and promises to reach commercial scale. If 140,000 minigrids can be deployed in the next 10 years, this could translate into annual revenues of over USD $5 billion, assuming an ARPU of only USD $10 per month. The financial, institutional and impact potential of the mini-grid market still requires a concerted effort by the parties involved, but the data compiled in this report provides grounds for optimism. If investors are open and transparent about their intention and terms of investment, donors and policy makers will be more likely to support the sector, and minigrid developers will be able to tailor their actions and strategy to the expectations of investors.

[33] Energy Sector Management Assistance Program. (2022). Mini Grids for Half a Billion People: Market Outlook and Handbook for Decision Makers. Available at: https://www.esmap.org/Mini_Grids_for_Half_a_Billion_People_The_Report

5. COSTS

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With the pandemic putting upward pressure on costs, total capital expenditure per kWp slightly increased, while operating expenses per unit fell in 2020 compared to the previous year.

The extent to which minigrids can deliver affordable power to rural populations largely depends on installation and operation costs, which are impacted by scale, global market pricing and subsidies. As costs decrease, electricity becomes more affordable, which attracts new consumers and allows them to increase their electricity consumption. These economies of scale ultimately lead to greater revenues and financial sustainability for minigrid operators and investors.

This section provides an analysis of capex, including the costs incurred for installation and major replacement, and Opex, which includes the operation and maintenance cost of the minigrids. Where necessary, further subdivisions have been made to assess long-term trends concerning costs and their changes in 2020.

The data shows that across the board, as developers gain more experience and scale up their operations, the cost of new installations decreases, resulting in more affordable electricity. Since most AMDA developers presently only have between 1 to 3 sites, there is considerable potential for scale to quickly reduce costs.

5.1 The impact of COVID-19 and market trends on prices

The COVID-19 pandemic caused widespread disruption in most sectors, including minigrids, as demand and consumption patterns changed and supply chains were forced to adapt. The global pandemic immediately impacted deployment as all construction was temporarily halted at the beginning of the pandemic. During this time, AMDA worked with relevant ministries in all countries where their members operated to ensure that minigrids were considered essential services. Developers were therefore allowed to perform operation and maintenance (O&M). From the available data, O&M services were optimally maintained based on the uptime data and consumption data.

Increase in capex was mainly driven by increases in distribution costs. The impact on prices during COVID-19 was complex. Higher prices per watt in components, such as distribution lines and electrical components, can be attributed to the shortage of raw materials and higher demand[34]. Supply chains have yet to adapt to the changes induced by the pandemic, but it is expected that this effect on prices will be temporary. For transport costs, on the other hand, the effect might not be as short-lived. For example, during 2020, the cost of shipping from China to Western Africa increased five-fold[35] and international shipping has become significantly more expensive in 2021. While logistics is not a prominent component in capex (see Section 6.2), it remains to be seen whether this will contribute to future price increases.

Opex has decreased, partly due to the sharp reduction in the prices of diesel and domestic transport. Given the decrease in global demand resulting from lockdown measures, oil prices fell sharply[36] reaching USD $40 per barrel by the end of the year which subsequently decreased the cost of diesel. In Tanzania[37], the diesel price caps reached to a historic minimum in June, while in Nigeria[38]

[34] Eco Green Energy. (2021). Industry Trends: Solar Module Price Rise in September. Available at: https://www.eco-greenenergy.com/industry-trends-solar-module-price-rise-in-september/

[35] PV Magazine. (2021). African Solar Installers Feel the Pinch of Rising Panel Prices. Available at: https://www.pv-magazine.com/2021/04/26/african-solar-installers-feel-the-pinch-of-rising-panel-prices/

[36] Macrotrends. (2021). WTI Crude Oil Prices - 10 Year Daily Chart. Available at: https://www.macrotrends.net/2516/wti-crude-oil-prices-10-year-daily-chart

[37] The Citizen. (2020). Fuel prices drop to a record low in Tanzania. Available at: https://www.thecitizen.co.tz/tanzania/news/fuel-prices-drop-to-a-record-low-in-tanzania-2710236

[38] National Bureau of Statistics. (2020). Automotive Gas Oil (Diesel) Price Watch Dec 2020. Available at: https://www.nigerianstat.gov.ng/pdfuploads/Automotive_Gas_Oil_(Diesel)_Price_Watch_DEC_2020.pdf

diesel prices experienced year-on-year reductions every month from March 2020. As mentioned in Section 5.1, this reduction allowed hybrid-diesel systems to become more competitive than PV-battery systems. Overall, this resulted in lower domestic travel costs that benefited both technologies. However, as with the price of PV components, this effect might only be temporary, as oil prices have since risen in 2021 to their highest level since 2018. Therefore, it is unclear whether this will increase overall Opex, but it will play a substantial role in developers' choice of generation technologies.

5.2 Capex trends

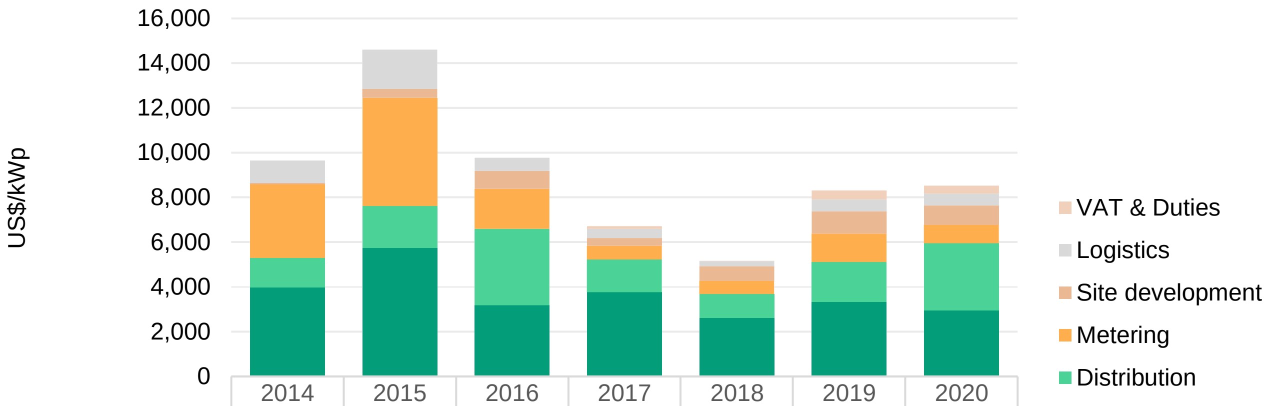
Capex refers to all the costs involved in the process of installing a minigrid, from costs incurred before site development to the installation of meters on consumers' premises. In general, these costs decrease as developers become more experienced, achieve economies of scale and action on best practices to navigate the regulatory framework more efficiently. Nonetheless, capex is also subject to price and availability of materials and components. Therefore, this analysis uses the following sub-categories for capex:

- **Generation assets:** Includes cost and installation of PV panels, batteries, diesel generators and other relevant assets for generation;
- **Distribution assets:** Includes costs incurred for wiring, poles, insulators and safety equipment related to the distribution of electricity to the end-user;
- **Logistics, transport, and warehousing:** Include costs of transporting equipment, storage and logistics in all stages of site development;
- **Metering and termination:** Include costs of meters, internal wiring, basic power kits and other costs associated with customer connection;
- **Site development:** Includes costs incurred preparing the site for construction;
- **VAT and duties:** Include any taxes paid on solar assets.

Capex in 2020 was slightly higher than in 2019. The average total capex in 2020 was just over USD $8,500 per kWp including distribution costs, a small increase of 2.5% from 2019 and above the three-year running average of USD $7,330 per kWp. In terms of composition, however, there were some noticeable changes. As shown in Figure 12, generation costs have decreased, while distribution costs have increased substantially in 2020 from 2019. This is likely due to the island location of more than 30% of the sites, with more extensive distribution networks connecting more customers. Moreover, the growth in VAT[39] and duty costs in 2019 slowed down a year later, as these costs experienced a 12.5% decrease accounting for less than 5% of capex.

[39] This is in large part due to VAT exemptions that were reinstated in Kenya

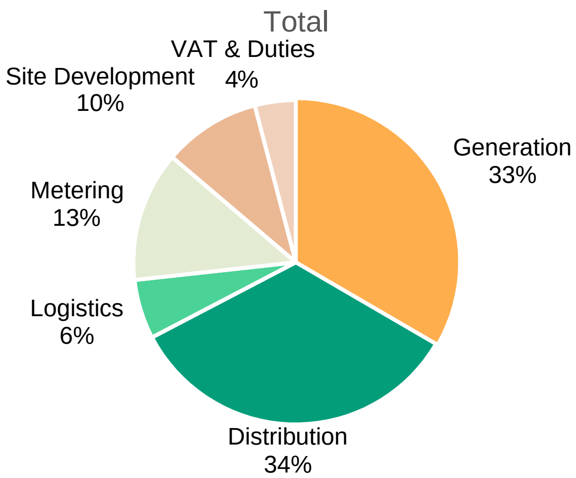
Figure 12: Capex per category



	2014	2015	2016	2017	2018	2019	2020
VAT & Duties	0	0	0	124	16	403	359
Logistics	986	1,760	589	411	222	522	524
Site development	88	405	801	342	658	1,004	858
Metering	3,274	4,804	1,780	616	590	1,270	828
Distribution	1,305	1,871	3,416	1,450	1,052	1,778	2,998
Generation	3,993	5,760	3,180	3,765	2,624	3,330	2,950

Data suggests that the increase in the share of distribution costs is a regional phenomenon. Figure 13 provides the distribution of the total capex components in 2020. In the Eastern and Southern regions, distribution represents the largest share of capex in 2020, following a reduction in generation costs, which accounted for 44% of total capex in 2019. The increase in the cost of distribution in 2020 is correlated with the number of connections, as the average number of connections per site jumped from 192 in 2019 to 319 in 2020, which had a drastic impact on the percentage of overall project capex. Sites in West Africa tend to have a higher density than those in East Africa, which can explain some of the regional differences in the distribution costs. Finally, in Western and Central Africa, the share of logistics costs represents an increase from 6% in 2019 to 12% in 2020, which can be attributed to the transport costs mentioned above.

Figure 13: Total capex composition in 2020

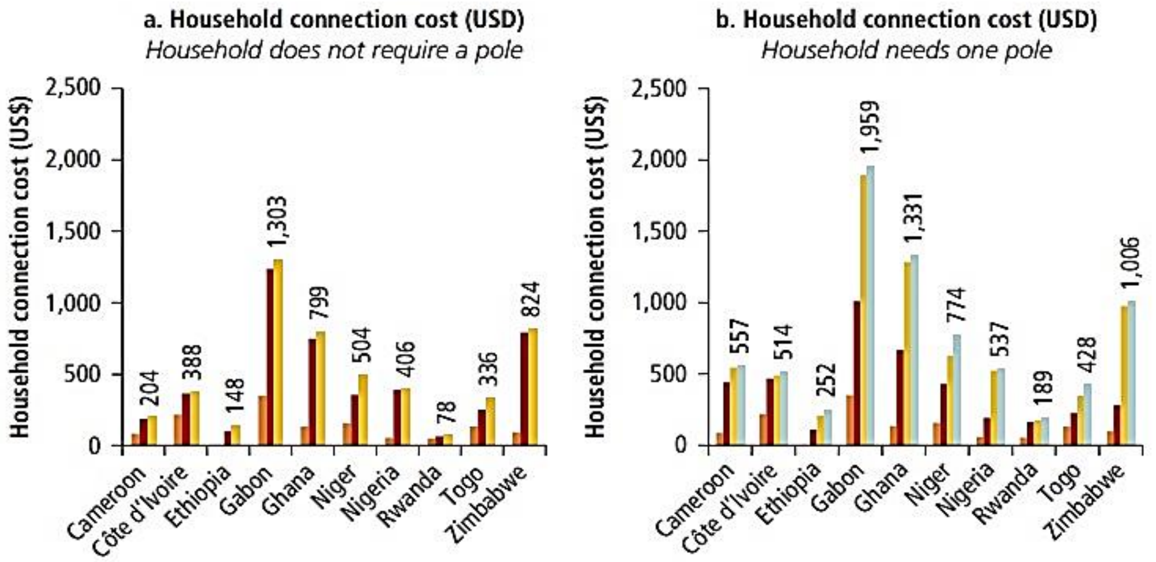


The average capex per connection for 2020 was USD $930, 32% lower than in 2019. However, the differences in capex per connection between regions is substantial.

Historically, consumer connection costs vary quite widely across markets. Countries with high population density and more expansive networks generally see lower costs per connection as the distance to expand the infrastructure is lower. In recent years, utilities have tried to reduce the consumer connection costs by leveraging donor funds to provide connection subsidies for consumers.

During the year 2020, there were substantial differences between average capex per connection between the Eastern and Southern region and Western and Central region. While there was a slight increase in the year 2020, the average cost of connection of USD $930 is still lower than the average rate of connection for national utilities in rural areas, which range from USD $1,000 to USD $2,100

Figure 14: Utility connection charges to consumers[40]



While national utility connection cost data is rarely made public, some information was found for comparative analysis. National connection rates in Zambia range from USD $800-$26,000 per connection[41] and estimations for rural utility connections in Tanzania are USD $2,300.[42] In countries with low access to electricity, World Bank-funded programs to national utilities yielded USD $4,000 per connection on average between 2000-2014. The median length of these electricity projects was nine years[43]. From our data, this is much higher than costs for minigrids, which average less than USD $1,000 per connection and deploy sites in less than 2 years.

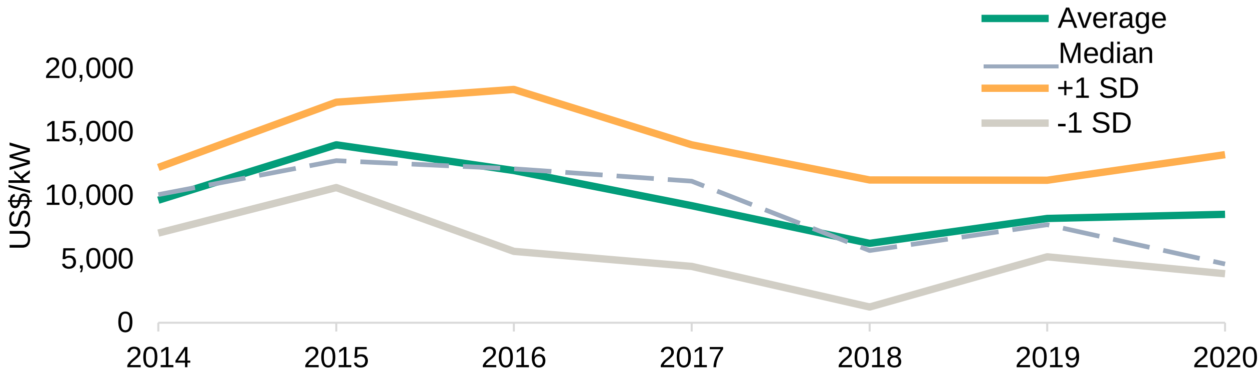
[40] Africa Development Forum. (2020). Electricity Access in Sub-Saharan Africa. Available at: https://openknowledge.worldbank.org/bitstream/handle/10986/31333/9781464813610.pdf?seq

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

[42] 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

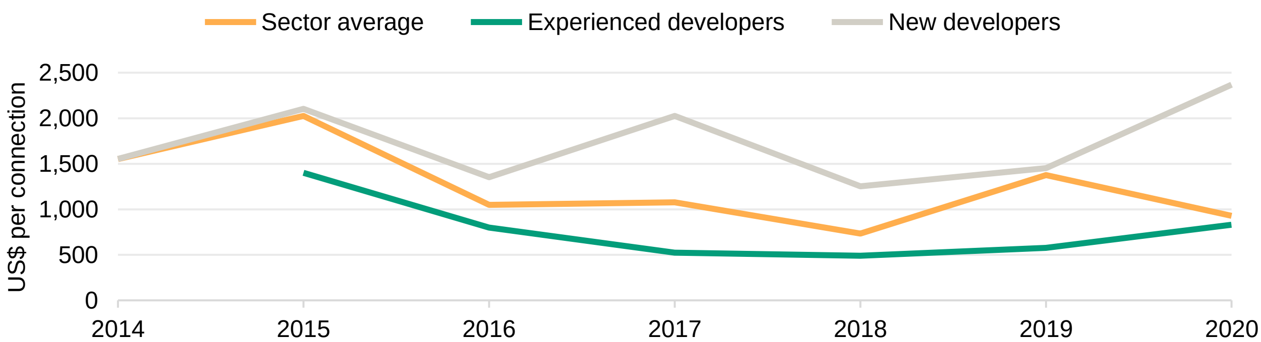
[43] World Bank Group. (2014). World Bank Group Support to Electricity Access, FY2000-2014: An Independent Evaluation. Available at: https://openknowledge.worldbank.org/bitstream/handle/10986/22953/96812revd.pdf?sequence=9&isAllowed=y

Figure 15: Average and median installed costs with one standard deviation



While there is also a varied range of costs between developers, the sites that have larger cost per kWp are correlated directly with the number of connections. The greater the number of connections per site, the higher the distribution costs, which then creates a higher cost per kWp. This raises questions on how the sector balances costs to connect with the goal of expanding electrification.

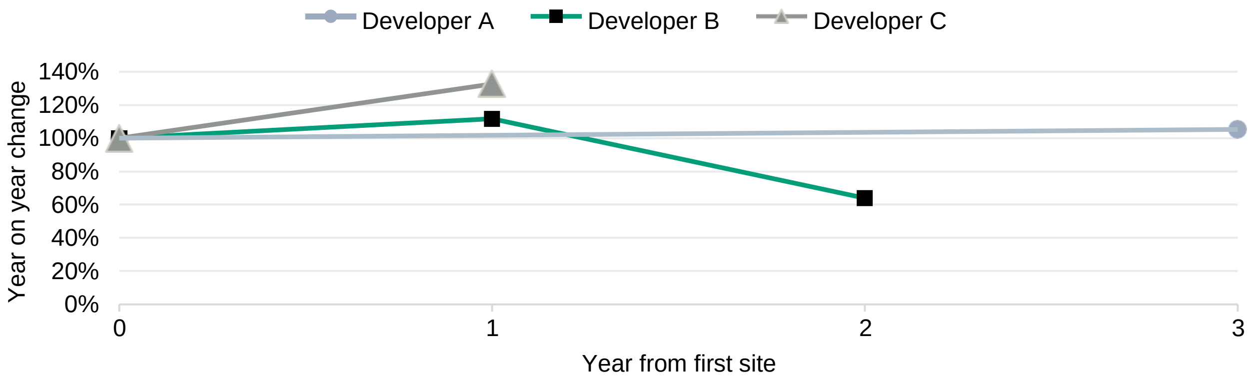
Figure 16: Capex per connection by level of experience



Less experienced developers face higher capex than more experienced ones. The difference in capex per connection between less experienced and more experienced developers grew to levels not seen since 2017 (Figure 16). 2020 was a difficult year for developers who had built less than 5 sites, faced with higher procurement costs compared to more experienced developers[44]. More experienced developers are more efficient in their procurement and installations and often have the track record and financing to develop more sites concurrently, both of which drive down overall capex costs.

[44] For this section, developers that reported fewer than five sites installed in a period of less than two years are classified as new. Two developers were classified as such in 2020. Those with at least ten reported sites installed in a period of two years are classified as experienced, with 11 being part of this cohort in 2020.

Figure 17: Comparison of costs for experienced and new developers



Note: For each developer, the last year corresponds to 2020 with previous data points corresponding to previous years. For example, developer B started reporting in 2018, showing a small increase after one year (in 2019) compared to the year of their first site and a marked decrease after two years (in 2020) compared to the year of their first site.

Figure 17 above compares three developers that added new sites during 2020 at various levels of experience. While developer C's costs remain almost identical to those of their first site in 2017, developer B showed a clear decrease in costs compared to 2019 and 2018. Developer A, who entered the market in 2019, saw a substantial increase in their installation costs in 2020. This increase is greater than the one experienced by developer B in their second year of operations. This might indicate that new developers in 2020 might have faced greater challenges navigating the challenges compared to experienced developers.

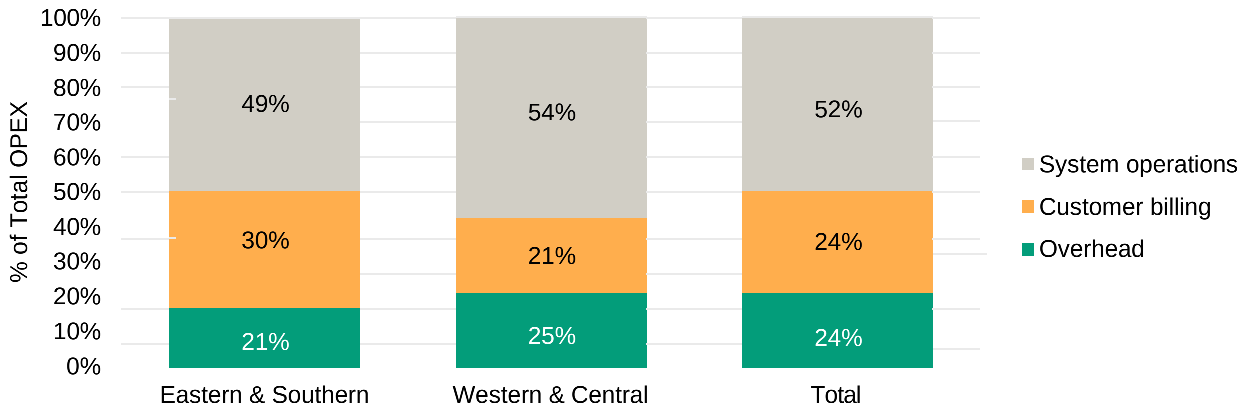
5.3 Opex trends

Opex is all costs associated with the recurring day-to-day functioning of a minigrid site, such as salaries and maintenance. Some costs are fixed and independent of the utilisation of the site, while others are determined by changes in demand, such as fuel for back-up diesel generators. Opex therefore varies based on economies of scale and consumers' demand for electricity. To assess specific Opex dynamics, the following three categories were analysed:

- **System operational costs:** Includes day-to-day expenses for fuel, maintenance, transportation and logistics, customer service and other day-to-day operations;
- **Customer billing costs:** Includes billing and collection expenses, metering, and payment processing costs such as infrastructure and software for mobile money transactions;
- **Overhead costs:** Includes labour costs, training, and non-site-specific travel expenses.

The downward trend on Opex has continued in 2020, with reported Opex ranging between USD $1 and USD $4 per customer per month. The decrease can be attributed to the significant fall in oil prices for most of 2020, as well as increased efficiency from the use of intelligent digital technology. -Data also shows there is a substantial increase in the share of overhead costs across all regions. Secondly, the share of system operational costs reduced in line with overall cost reductions (Figure 18). This may be the result of more costly activities such as training and non-site travel, as health and sanitation measures and travel restrictions were implemented during the pandemic.

Figure 18: Breakdown of Opex in 2020



5.4 Diesel-hybrid vs. PV-battery generation

Most sites in the dataset generate electricity using solar power, with two specific technologies:

- Diesel-hybrids use solar power to generate electricity with batteries and a back-up diesel generator to ensure consistent supply.
- PV-batteries operate solely on solar and include batteries to store electric charge to provide energy when photovoltaic generation is unavailable. They are cost-competitive against diesel-hybrid systems in the long-term due to lower Opex offsetting higher capex.

Governments are keen to provide rural customers with service equivalent to that of urban customers connected to the main grid. In order to provide a stable power supply to ensure customers can use necessary assets, developers opt for hybrid systems with back-up diesel generators to ensure uninterrupted supply even during cloudy periods. Relying exclusively on batteries leads to oversizing the PV array and subsequently to higher costs of supply.

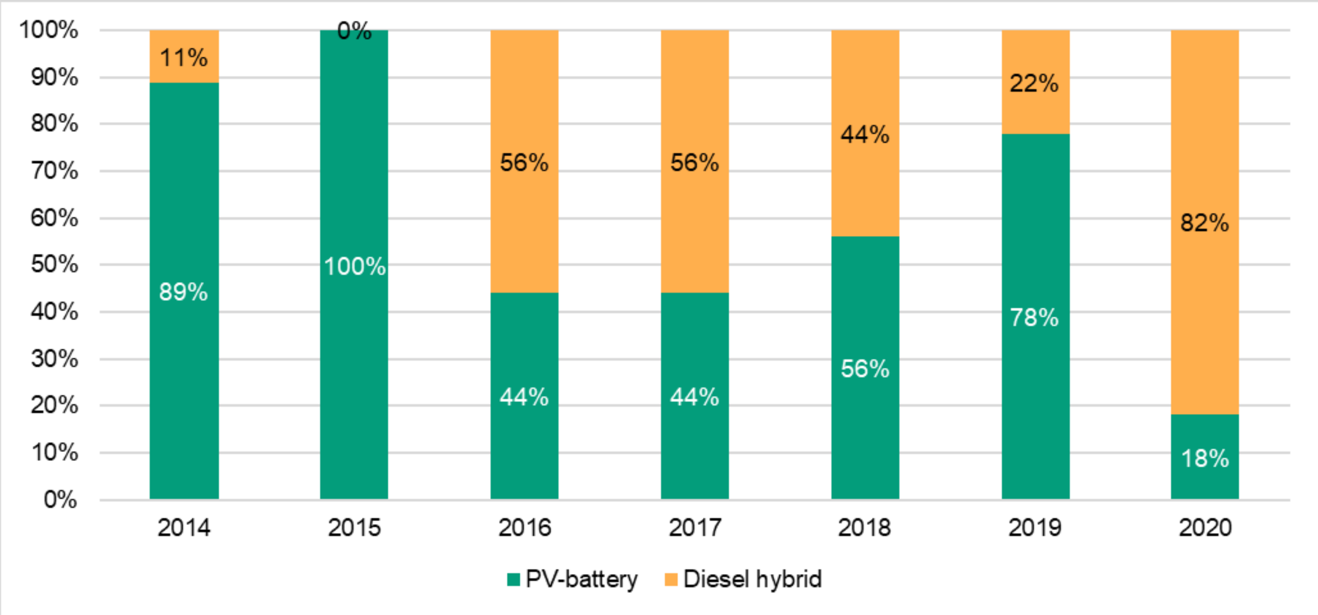
Most new mini-grid sites developed in 2020 included diesel generators. Starting in 2016, and following the accelerated expansion that started in 2017, developers were increasingly choosing to rely on PV-battery systems without diesel generation back-up. As seen in Figure 19, almost 80% of new solar sites in 2019 did not include a diesel generator, up from less than half in 2016 and 2017. The trend was reversed in 2020 when the share of PV-battery installations dropped to less than 20%.

The price of diesel and PV components might be a possible explanation for this drop. Between March and June of 2020 there was a sharp reduction in the price of diesel within countries where services were expanded, such as Tanzania[45] and Nigeria[46]. This might have tipped the least cost option in favour of diesel-hybrid systems, a situation which was further exacerbated by an increase in the price of PV panels and international transport costs (see Section 6.1). Thus, PV-battery systems, which are cost competitive in the long-term against diesel-hybrid systems due to lower OPEX costs offsetting initially higher CAPEX costs, have experienced a combination of factors sufficient to offset the strong previous trend.

[45] The Citizen. (2020). Fuel Prices Drop to a Record Low in Tanzania. Available at: https://www.thecitizen.co.tz/tanzania/news/national/fuel-prices-drop-to-a-record-low-in-tanzania-2710236

[46] National Bureau of Statistics. (2020). Automotive Gas Oil (Diesel) Price Watch. Available at: https://www.nigerianstat.gov.ng/pdfuploads/Automotive_Gas_Oil_(Diesel)_Price_Watch_DEC_2020.pdf

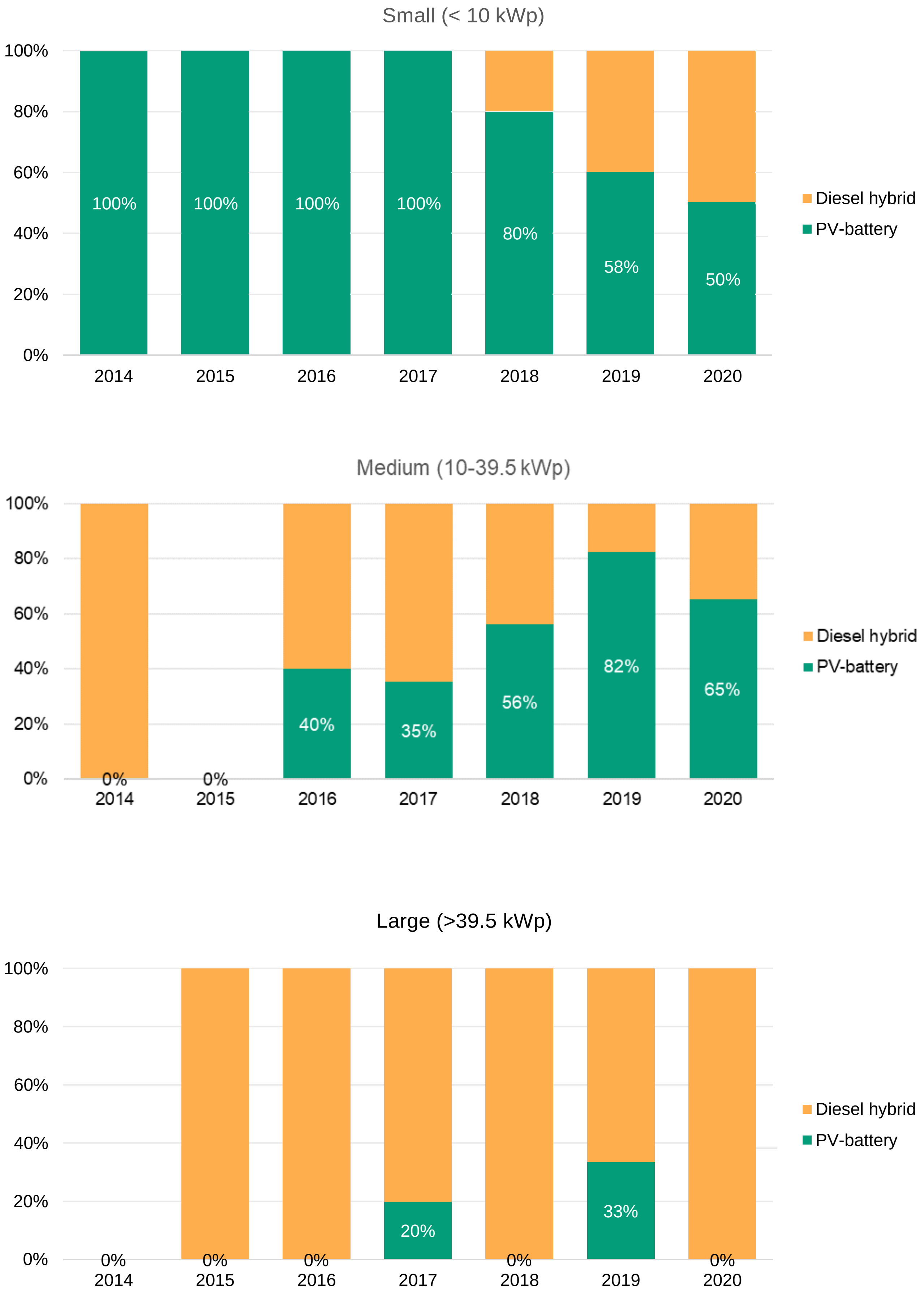
Figure 19: Share of sites by generation technology



Because these generation technologies utilise different back-up supply, the associated costs also vary, which might provide an edge at a given size when choosing one technology over another. For this analysis (Figure 20), sites are defined as:

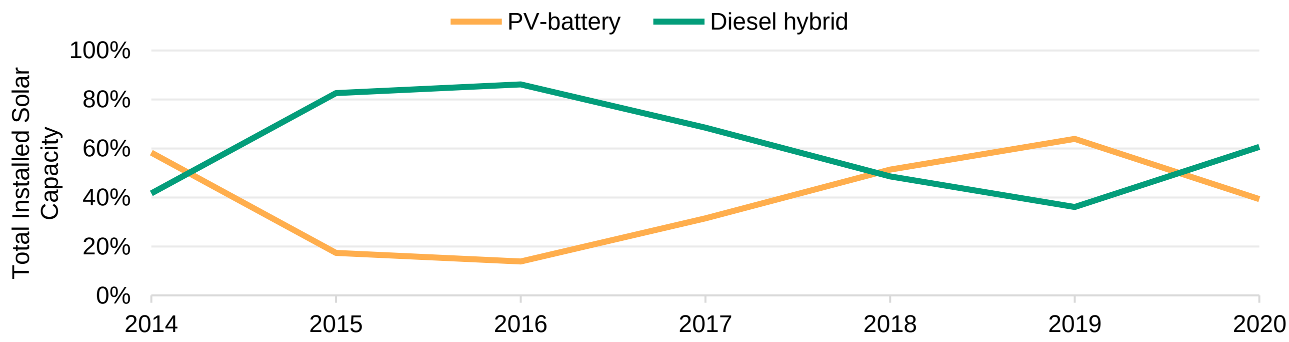
- Small: Below 10 kWp installed capacity;
- Medium: Between 10 kWp and 39.5 kWp installed capacity;
- Large: Above 39.5 kWp installed capacity.

Figure 20: Share of sites by generation technology by size



The price of diesel and PV components might have affected the change in the share of minigrids with a diesel generator. Between March and June of 2020, there was a sharp reduction in the price of diesel within countries where services were expanded, such as Tanzania[47] and Nigeria[48]. This situation was further exacerbated by an increase in the price of PV panels and international transport costs (see Section 6.1). As seen in Figure 21, the aggregate total solar capacity installed from sites without a diesel generator was higher than diesel-hybrid sites in 2019. However, with half of new sites developed in 2020 including a diesel generator, the share of solar in the total installed capacity has dropped to 39%. This implies higher Opex as compared to PV-battery systems due to the purchase of fuel and maintenance requirements

Figure 21: Total installed solar capacity by generation technology mix



The sudden increase in the share of diesel-hybrid systems is likely to be temporary, considering the long-term trend towards PV-battery systems due to global decarbonisation plans and technological advances resulting in lower prices. Despite the temporary fluctuations in prices from semiconductor shortages and COVID-19 lockdowns, it is unlikely that gensets will be eliminated from the energy mix in a hybrid system until battery-only solutions are financially viable for the site and the consumer.

5.5 Key insights

There was a small increase in capex and a reduction in Opex in 2020. Despite the considerable upward pressure on supply-side transportation and PV components, the relatively small decrease in Opex is likely to be the result of experienced developers achieving economies of scale, helping them efficiently manage price fluctuations.

Experience plays an important role, which might have implications for the design of financing support mechanisms. For new developers, 2020 was an extremely challenging year that resulted in much higher capex compared to more experienced developers. This highlights the need for specific measures to support new developers who have been more severely affected by increased prices following the pandemic. That said, the number of minigrids needed to reach universal access will require big, established developers, and governments must support incumbents as much as start-ups.

[47] The Citizen. (2020). Fuel Prices Drop to a Record Low in Tanzania. Available at: https://www.thecitizen.co.tz/tanzania/news/national/fuel-prices-drop-to-a-record-low-in-tanzania-2710236

[48] National Bureau of Statistics. (2020). Automotive Gas Oil (Diesel) Price Watch. Available at: https://www.nigerianstat.gov.ng/pdfuploads/Automotive_Gas_Oil_(Diesel)_Price_Watch_DEC_2020.pdf

Insights for sector stakeholders

Policymakers and regulators	Policy actions should reduce capex and Opex for minigrids to make electricity more affordable. Financial incentives, more efficient regulatory practices, and elimination of duties, VAT and other taxation would be important to improve the unit economics and reduce costs of the sector. On licensing and other regulatory approval processes, bulk or portfolio applications will be essential and must be universalised across Africa.
Development partners	Economies of scale are the main driver of cost reductions for minigrids. Supporting pooled purchasing for bulk procurement, especially for new or smaller developers, would be critical for reaching scale. Evidence-based work on how tax reductions on minigrids would result in an increased tax base over time is another key area for development partner support.
Minigrid developers	Within the range in capex pricing, a convergence would bring new developers closer to the mean. As stated above, pooled procurement would support economies of scale. Minigrid developers must additionally continue to push improvement of internal processes to reduce costs, and specifically leverage remote monitoring to improve Opex and procurement processes.

6. CONSUMPTION AND GROWING THE LOAD

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When customer demand and supplier profitability do not meet at equilibrium, there is not a functioning market. At present, many rural customers lack the willingness or ability to pay market prices. For example, Kenya Power recently published statistics showing their average rural customer brings in less than USD $1 per month.[49] Without some sort of demand-side intervention, national utilities, minigrids and even off-grid solar will not consider rural electrification a strong market opportunity.

Minigrid companies recognise that increasing consumers' demand is essential to distribute fixed operational costs, making the sites more financially sustainable. To cover costs and grow profits, developers can either increase the number of their connections or increase electricity demand per customer. While it is not possible to expand the number of connections indefinitely to bridge cost gaps, increasing average consumption can significantly impact both the sustainability of minigrid sites and the living standards of consumers.

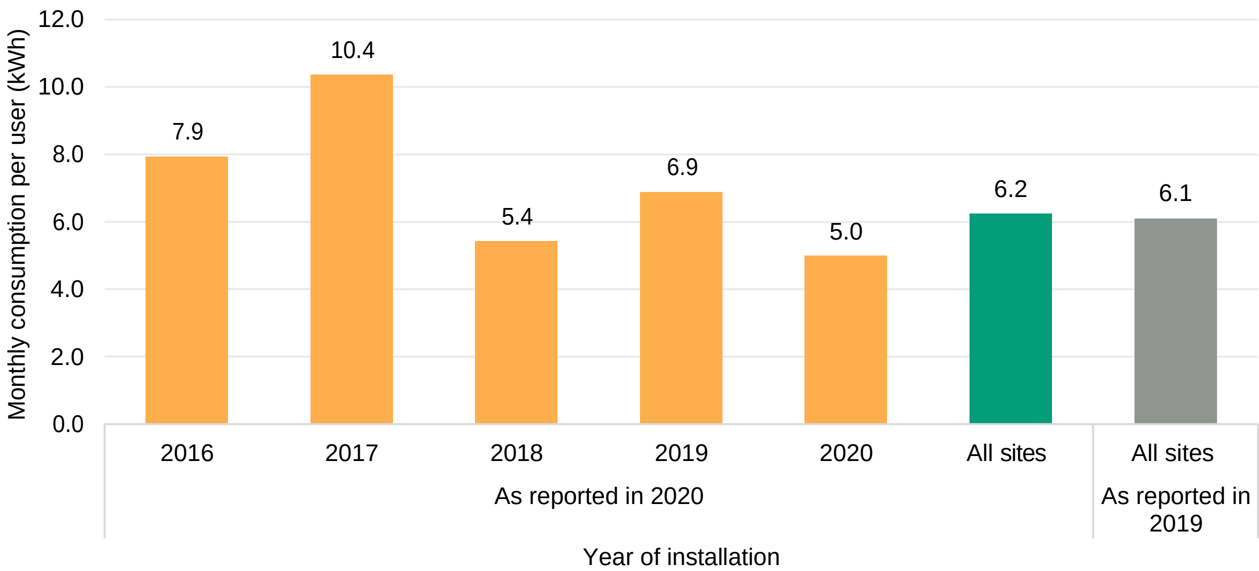
6.1 Consumption per user

Customers who have had a longstanding minigrid connection consume more electricity than new customers, but average consumption levels remain low.

In 2020, average monthly consumption per user was 6.2 kWh, an increase of 2.3% over 2019. However, average monthly consumption is significantly higher for older sites, with average consumption of over 10kWh for sites installed in 2018.

Data suggests that the longer users have access to electricity, the more power they are likely to consume. This pattern appears to apply to all customers, not only commercial customers. As shown in Figure 22, newly installed sites have a significantly lower average monthly consumption per connection, while consumption per connection in sites that were installed in 2016 and 2017 is much higher.

Figure 22: Average monthly consumption per connection in 2020 by year when minigrids were installed

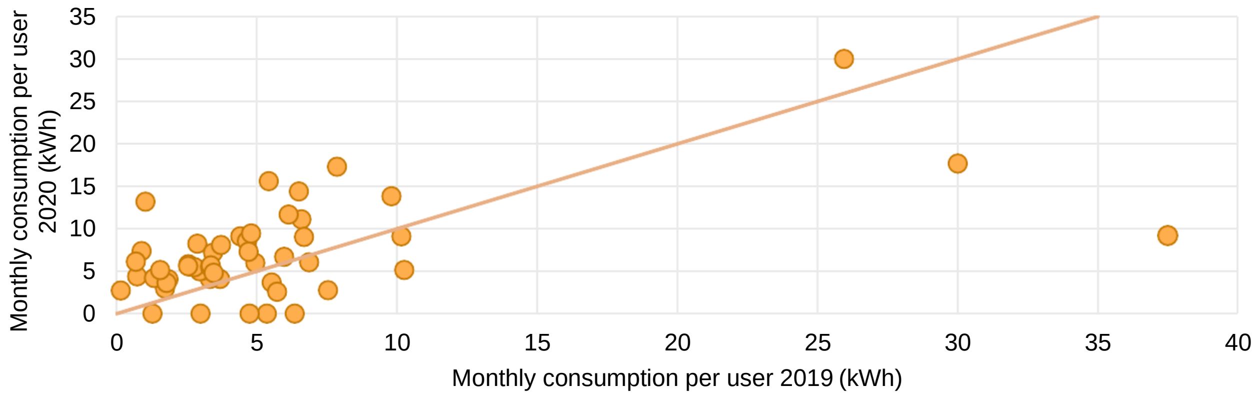


[49] Business Daily (2021). Kenya Power Revenues Hit as Rural Homes use Sh3.34 Daily. Available at: https://www.businessdailyafrica.com/bd/corporate/companies/kenya-power-revenues-hit-as-rural-homes-use-sh3-30-daily-3461252

Figures 23 and Figure 24, show that between 2019 and 2020, consumption per user across the same sites increased by 25% or 1.29 kWh per month. This increase is even higher for sites with a level customer base that did not add new connections; monthly consumption increased by 60% or 3.02 kWh per connection per month. Although some of this may be due to urban migration out of cities during COVID-19, it is difficult to directly attribute all changes to COVID-19. These increases are significantly higher than the sectoral average changes in consumption, at only a 0.14 kWh increase between 2019 and 2020.

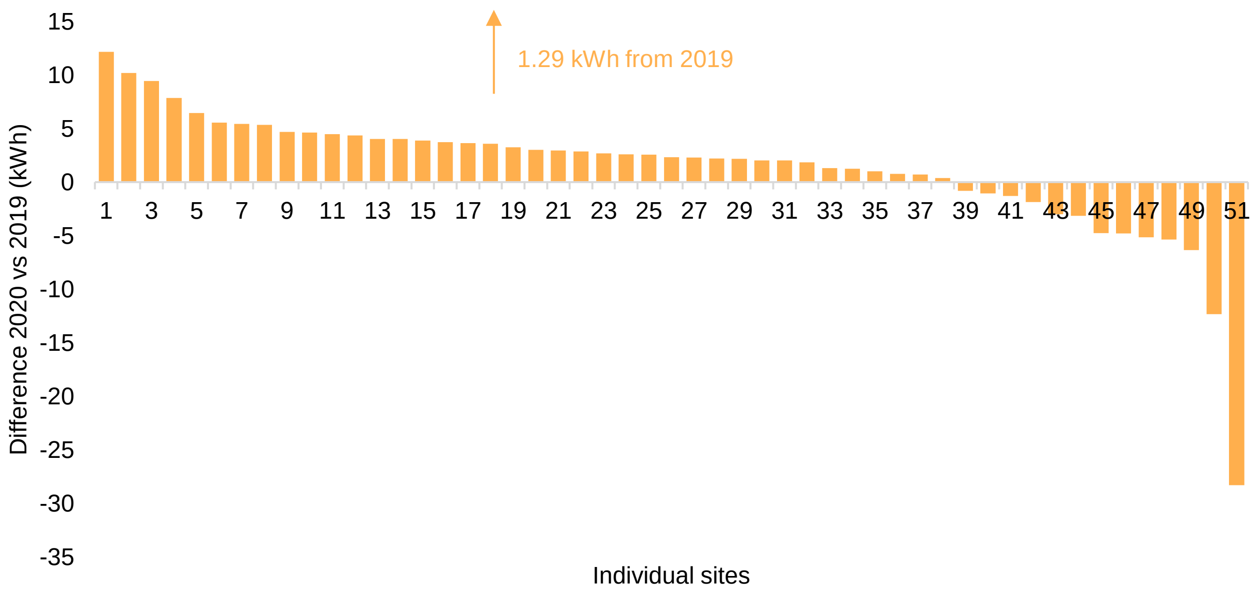
This indicates that first-year consumers drive down the overall consumption averages of minigrid customers and further demonstrates that, over time, minigrid users are likely to increase their consumption levels. A data set with a longer time horizon will be necessary to understand the factors that affect and time needed for minigrid customers to increase consumption.

Figure 23: Monthly consumption per user for individual sites in 2020 vs 2019



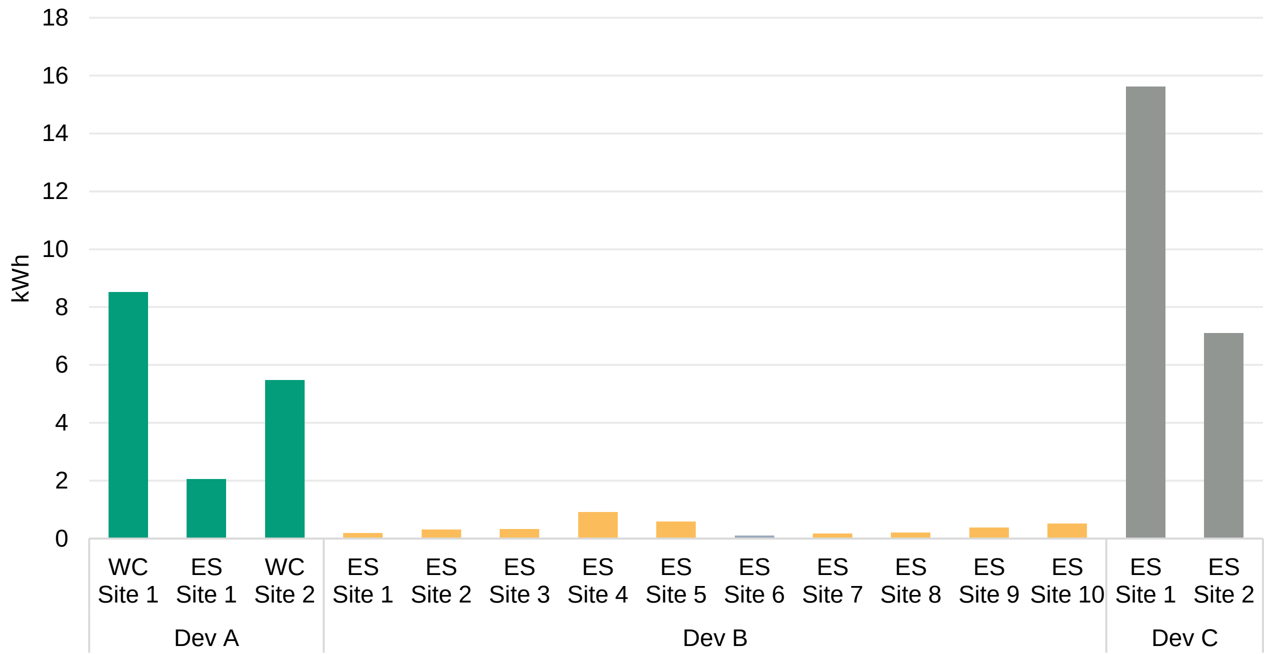
Note: For sites above the 45-degree line, the monthly consumption in 2020 was higher than in 2019

Figure 24: Differences of monthly consumption per user in 2020 vs 2019



However, the additional value varies widely across dimensions like region or country. In Figure 25, developers' data from 2020 reveals that average monthly consumption can differ between sites serviced by the same developer in the same region and country. Such differences are driven by local socio-economic demographics and are largely affected by commercial activities.

Figure 25: Average monthly consumption for selected developers, by region, in 2020



Note: WC refers to a site installed in the western and central Africa region, while ES refers to a site installed in the eastern and southern region

6.2 Consumption patterns

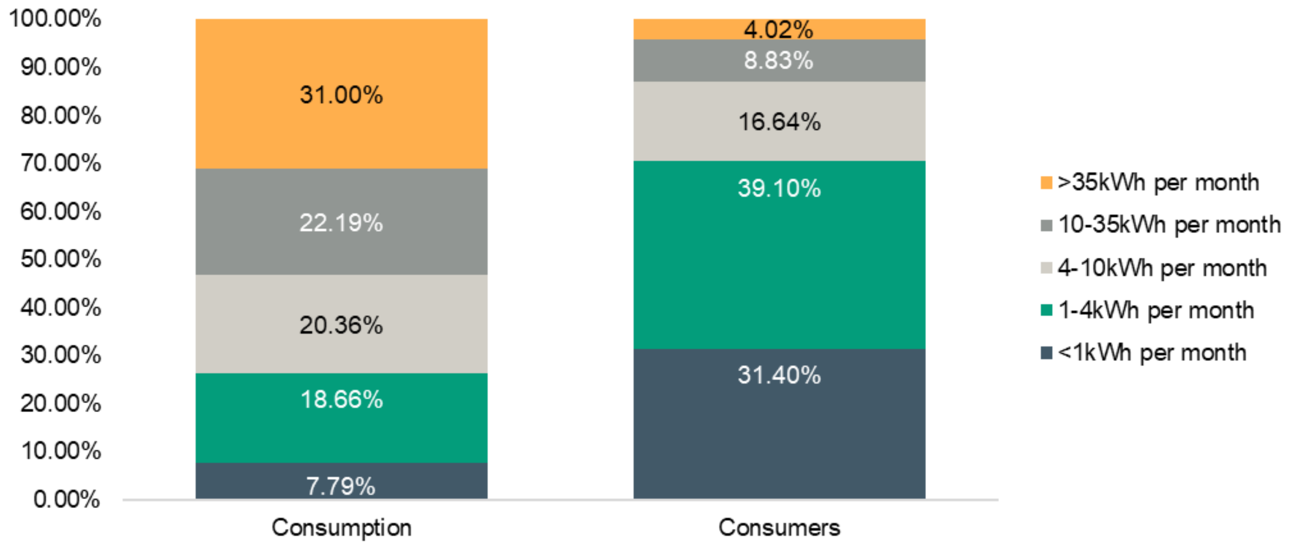
In 2020, 13% of the consumer base accounted for over 50% of total consumption.

To understand the consumption patterns of minigrid users in 2020, users were divided into five categories according to their average monthly consumption. Low consumption users are defined as those consuming less than 4 kWh per month, whereas high consumption users are those consuming more than 10 kWh per month. Two patterns emerge:

- *Consumer distribution is skewed towards low-consuming customers*: In 2020, 70% of minigrid customers were low consumers, using less than 4 kWh per month; the majority of these consumed between 1 and 4 kWh per month. As consumption increases, the number of consumers per category decreases, with only 4% consuming more than 35 kWh per month.

- *Demand distribution is skewed towards high-consuming customers*: 53% of electricity is consumed by high consumption customers (using more than 10 kWh per month), while just over a quarter is used by those with low consumption.

Figure 26: Total number of customers and total consumption by consumption category in 2020



It is not surprising that high-consuming[50] anchor customers, such as non-residential businesses or public facilities, drive the financial viability of sites by providing a continuous stream of revenue that can be used to further expand the network in residential areas with low consumption patterns.[51]

6.3 Average revenue

Our analysis suggests that average revenues per user (ARPU) is higher for older sites than for newly installed ones.

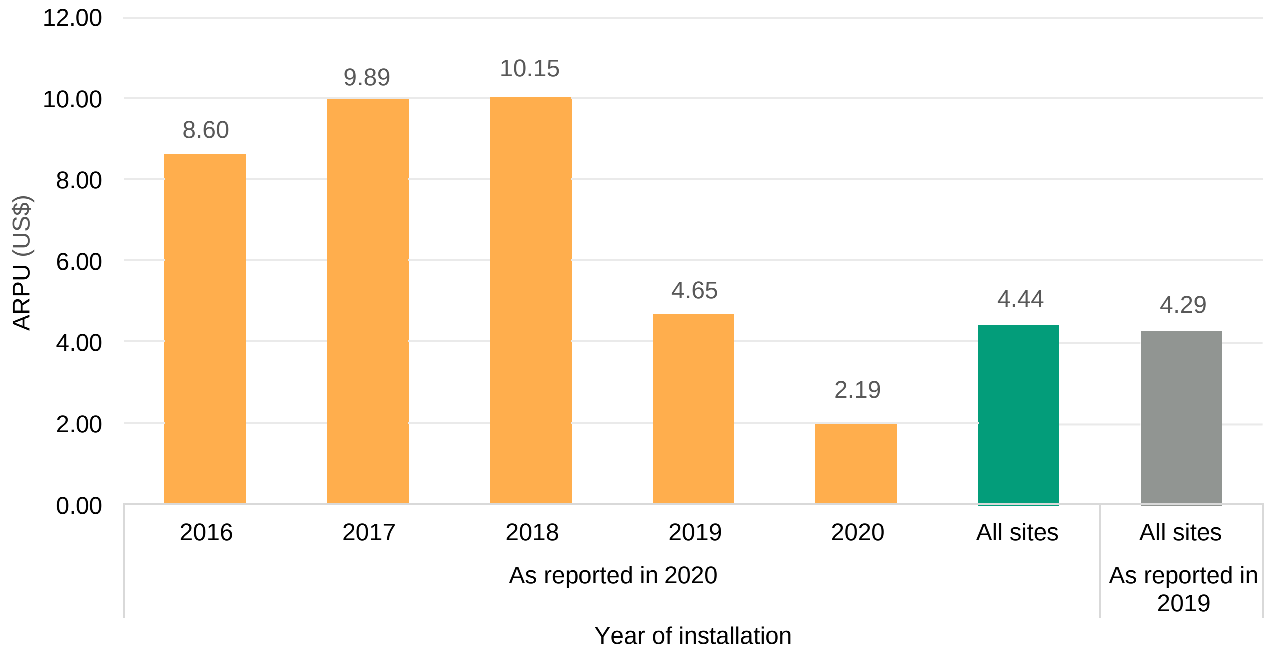
As can be seen in Figure 27, the ARPU between newly installed sites and older sites in 2020 followed a similar pattern to average monthly consumption.

In 2020, overall ARPU stood at USD$4.44, a small increase from USD $4.29 in 2019. However, ARPU for new sites remained considerably lower at USD $2.19, compared to over USD $10 for sites installed in 2018, a 78% increase in ARPU.

[50] Beath et al. (2021). The Cost and Emissions Advantages of Incorporating Anchor Loads into Solar Minigrids in India. Available at: https://www.sciencedirect.com/science/article/pii/S2667095X21000039

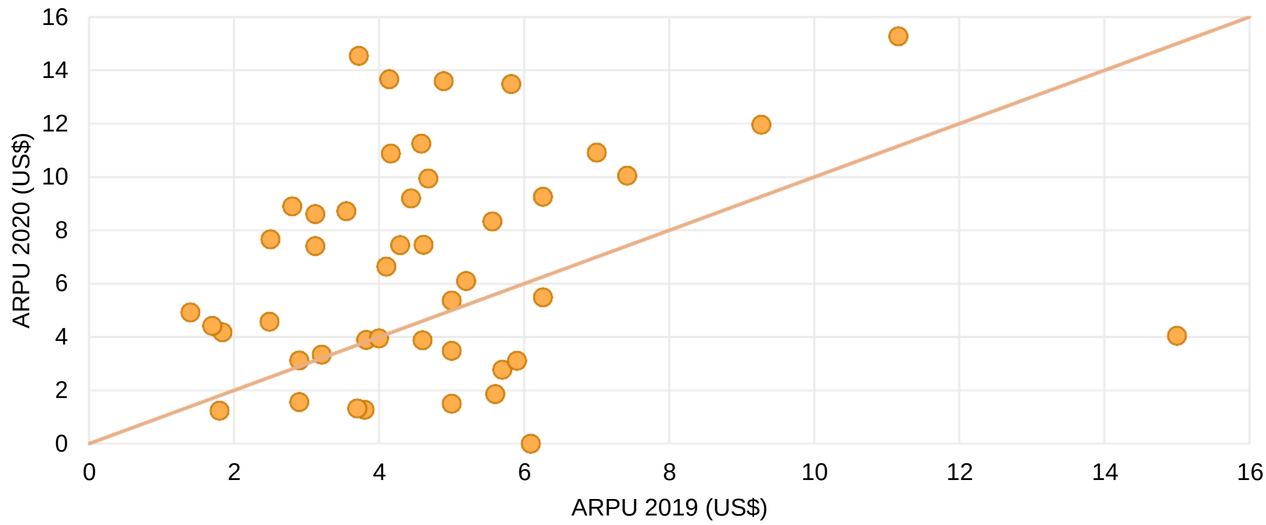
[51] Beath et al. (2021). The Cost and Emissions Advantages of Incorporating Anchor Loads into Solar Minigrids in India. Available at: https://www.sciencedirect.com/science/article/pii/S2667095X21000039

Figure 27: ARPU of sites by year installed



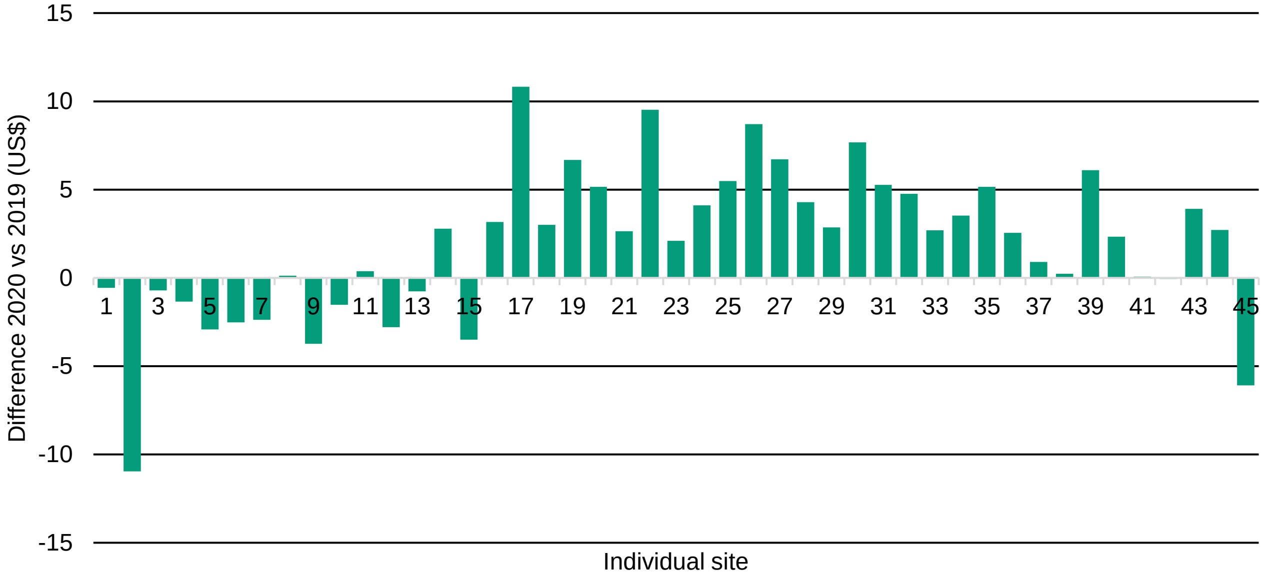
Among the sites that reported year-over-year data, ARPU increased from 2019 to 2020. As seen in Figure 28, most sites reported a higher ARPU in 2020 than in 2019, with an average difference of USD $1.93. The increase was even higher for sites that maintained the same number of connections, with an average growth of USD $2.61.

Figure 28: ARPU for individual sites in 2020 vs 2019



Despite average ARPU increasing, a proportion of sites experienced year-on-year decreases (Figure 29) compared to the monthly consumption data (Figure 30). While the data do not explore this further, it is likely that the impacts of COVID-19 such as closed businesses, job losses, and diversion of incomes to healthcare expenditures at least partially drove the ARPU reductions.

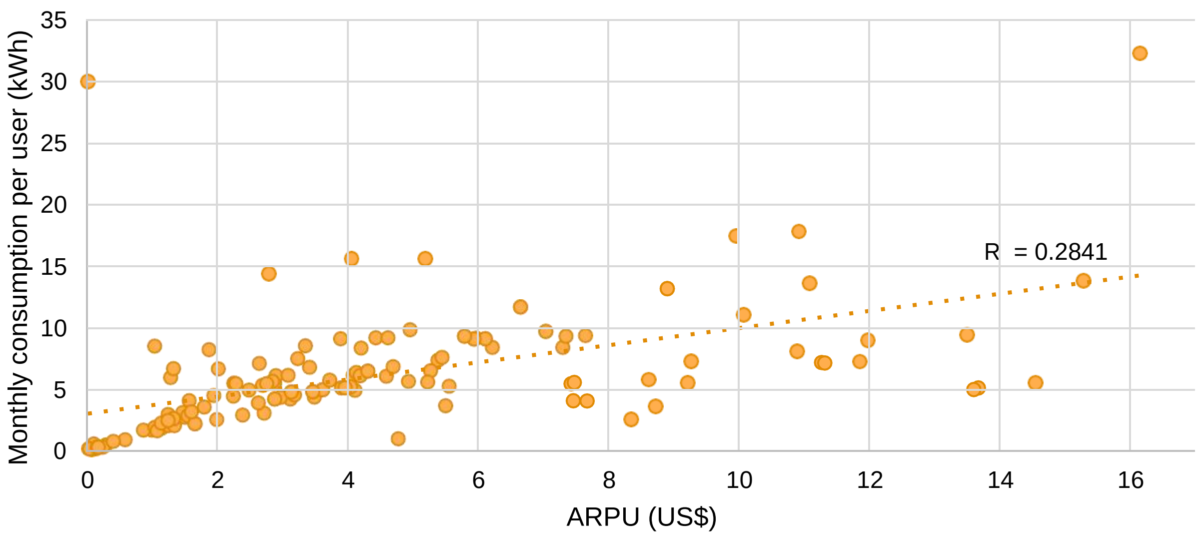
Figure 29: Differences of ARPU in 2020 vs 2019



The correlation between consumption and revenue per user was stronger in 2020 than in 2019. As seen in Figure 30, there is a positive, but statistically insignificant correlation between ARPU and average monthly consumption per user. 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.

This report was not able to conduct a comparative analysis of utilization rates, ARPU and tariff pricing due to data limitations, but it will be explored in future research.

Figure 30: ARPU vs monthly consumption per user in 2020



It should be noted that while ARPU is widely considered an important metric for analysing developers' performance, it can be a misleading one. Some developers have taken an approach in which customers pay a fixed monthly charge, which is more reliable for both customers and suppliers but will not grow ARPU over time. An increase in customers without an accompanying increase in capacity or costs would expand business but lead to a fall in ARPU.

6.4 Growing the Load

Growing the load is critical for the financial success of minigrid developers and to achieve the goal of universal electrification. As seen above, low consumption in the first few years of minigrid operations creates a revenue problem for new developers who need capital to cover their higher capex (see Section 6.2). Given that most costs related to minigrid development are fixed, reaching more consumers, and increasing their average consumption is key to making electricity more affordable.

Underperforming households represent the greatest potential for positive change. As seen in Figure 26, data found low consumption users, most households, account for over 70% of the minigrids consumer base in 2020, while accounting for less than 30% of total consumption.

At present, often the only household energy consumption is lighting or charging a phone or a device, which can be done cheaply with a solar home system. Poor households also need time to save for energy-consuming assets and must carefully decide how to spend their very limited incomes. This indicates that, despite the touting of economically productive use of energy (energy for earning money) as the key to rural electrification success**,** efforts to support the household userbase are more critical to the future of the sector. People both cannot afford and, in remote areas, often simply do not have physical access to the productive energy tools and appliances they could use to increase their incomes.

Local early adopters of both energy connections and of productive use technologies are key to helping more cautious - or more poor - customers learn about experiences with the energy service in terms of quality, value, and usefulness. For example, more affordable and locally appropriate electric cooking options can help households, which are generally loss-leading, evolve into higher tier, more reliable daily consumers of electricity.

Sector stakeholders are currently investigating and creating best practices around accelerating the demand curve. For example, CrossBoundary's Innovation Lab takes a systematic, research-oriented approach to experimenting around growing the load.

Demand stimulation service providers are emerging to fill a gap, just like smart metering companies began to do earlier in the sector's history. Today's market-leading smart metering companies SteamaCo and Sparkmeter both originated within minigrid companies that did not have a way to remotely monitor their sites.
Below are some examples of upstream and downstream segmentation and service provision that can support sector scale:

Agsol *links productive agricultural machines with scalable solar power to provide agricultural and energy access solutions to off-grid farming communities. They partner with solar companies, Agri-machinery suppliers, Agri-service providers, mini-grid developers, asset financing companies and project developers to bring our unique machines to rural markets. As a social enterprise, Agsol commits to reinvest the majority of any profits into furthering its social mission.*

EnerGrow *in Uganda partners with minigrid companies to provide microfinance and business training to minigrid customers for productive use assets that they could not otherwise afford. Linking directly into smart meters, EnerGrow works closely with minigrid company partners to monitor load growth and impact over time. Research by Power for All found that after EnerGrow worked in their pilot communities for 6 months, the community consumed what an average Ugandan community would consume after six years of organic, unsupported energy usage, increasing lifetime customer value by over 400%. After gathering enough data and evidence, they will offer a demand "de-risking" service to energy companies and their investors which could hasten and simplify fundraising.*

Easy Solar *in Sierra Leone finances high-quality solar products and appliances for those with limited or no access to the conventional grid. Customers can finance their purchase over time by paying in weekly or monthly instalments, with* *the option to pay via cash or mobile money. To date, Easy Solar has reached more than 400,000 beneficiaries, distributed through its extensive network of agents and outlets throughout Sierra Leone and Liberia.*

Inspira Farms *in Kenya has been selling cool rooms primarily to mid- and large-scale commercial farms, powered by grid, genset or solar-hybrid electricity. With grant support from Carbon Trust and Shell Foundation, they are currently piloting a smaller, off-grid, solar-powered 'first-mile' cooling room for small-scale farmers and cooperatives, typically produce out growers, to use in between the collection point and the centralised pack shed. They aim to reduce wastage and provide additional on-farm processing opportunities*

Sunculture *uses off-grid solar technology to provide customers with reliable access to water, irrigation, lighting, and mobile charging, all within a single system. Their most popular products combine solar water pumping technology with high-efficiency drip irrigation so farmers can grow more while spending less. Sunculture partnered with dairy processor Brookside in Kenya to provide farmers with solar-powered irrigation system to boost milk production. With SunCulture, farmers can increase their crop yields by 300% and reduce their water usage by 80% with a simple push of a button. Their impact assessments have found that 90% of users increased crop production, 96% improve their way of farming, and 94% improved their quality of life.*

SureChill *in Kenya offers a cooling technology that continuously cools for weeks without power. SureChill's technology delivers consistent temperature without constant power or negatively impacting the planet. They have also developed vaccine refrigerators ideal for protecting vital medical and livestock vaccinations. This helps ensure lifesaving supplies, like blood, vaccines, and insulin, remain perfectly cool. Their aim is to work collaboratively with customers to create innovative and natural solutions.*

6.4.1 Demand stimulation: productive uses of electricity

As energy markets in the United States and much of Europe were built, energy companies sold or financed appliances and tools that used electricity to their customers. Their newly electrified customers did not already have access to these technologies in their areas, lacked the capital to afford them, or both.

Energy customers in most of Africa today face the same challenges, which is why energy companies and investors want more financing and offerings for productive use technologies. To date, however, most productive use activities have been project-related or experimental in nature, with funding windows limited to specific time frames, technologies, or geographies.

Technology companies working on productive uses are generally focused on standalone products for agricultural work (InspiraFarms); DC-powered systems such as solar irrigation (FuturePump, Tulima Solar, SunCulture); or super-efficient designs of other existing technologies such as refrigeration (SureChill) or milling (AgSol). As a result, there are not many companies that do broad-spectrum productive use work alongside minigrid companies. EnerGrow, described above, is the only company discovered by this report that aims to be a technology-agnostic productive use partner for energy companies.

Funding opportunities for productive uses are also extremely limited when not attached to technology companies, and there are even fewer specialized investors focused specifically on productive uses. Those that are, such as UnTapped, prefer to work with companies using pay-as-you-go technologies that are more easily and remotely trackable. While this makes sense for specially-designed standalone products, a minigrid can power any off-the-shelf technology that does not need special design for Africa, like normal carpentry equipment, welding equipment, refrigeration, agro-processing equipment, cooking equipment, sewing machines, TVs for restaurants and video halls. These are all valuable technologies for increasing minigrid consumption - and are indeed in demand in minigrid communities - but very few funders seek to invest in such prospects.

Due to the above trends and restrictions, longitudinal, multi-country evidence on productive use effectiveness has been lacking; therefore, larger-scale programs, funds, and work on productive uses in general have not emerged. Concessional facilities and commercial investors tend to invest in discreet minigrid projects, rather than into central teams working on PUE. Even donor funding tends to restrict staffing, decreasing flexibility to experiment, innovate and learn as companies work with partners to establish replicable approaches. Instead, minigrid companies themselves have to self-fund their productive-use work. However, there have not been any clear successes across the market that consistently demonstrates load growth, which makes commercial investment into that growth difficult.

6.4.2 Small is beautiful - helping small businesses and households consume more

Looking ahead five years, when the sector hopefully has dozens of companies with 500 to 1,000 minigrids, AMDA speculates that minigrid productive use efforts should combine broad scale micro-finance through third party vendors like EnerGrow, micro-entrepreneurship training (ensuring appliances and local businesses are increasing incomes) and agricultural extension work (as minigrid sites and customers will remain largely agrarian for some time). Evidence from AMDA members participating in CrossBoundary's Innovation Lab shows definitively that asset financing for small productive use appliances and tools does indeed have an impact on growing the load. Initial data from Utilities 2.0 work undertaken in Uganda[52] have also shown substantial demand increases over short periods of time with this approach.

Two very promising areas that have not been significantly explored to date are electric cooking and e-mobility. Pressure cookers, hot plates and kettles all are major energy consumers, but, if customers are currently paying for any type of other fuel, it is generally cheaper to cook on electricity. There are major cultural and behavioural hurdles to overcome with cooking, but many AMDA members have had promising experiences beginning to grow household loads using these technologies. Despite concerns, A2EI has shown that e-cooking technologies do not pose real grid-overload risks.[53]

6.5 Key insights

While consumption grew slightly between 2019 and 2020 at a rate of 2.3%, consumption growth over time is a positive indication of future growth. In early years of the sector, load growth forecasting was overly ambitious, assuming quick upticks in consumption early on. This report shows that, just like the market for any other product or service, there are limited enthusiastic early adopters. It is common for minigrid companies to install connections for new later customers over a year after initial customers were connected. Although it takes time, it is reassuring that consumption does indeed grow over time and that this trend seems to be consistent across regions. For integrated planning efforts, where governments and utilities want to see minigrids "prepare" communities for grid-interconnection, it is promising that communities have high potential to be good paying customers.

Stimulating electricity use, especially for new users, is therefore a top priority for developers to achieve a continuous funding source that makes the sites financially sustainable.

[52] Power for All. (2022). Campaign Update: March 2022. Available at: https://www.powerforall.org/news-media/campaign-updates/campaign-update-march-2022

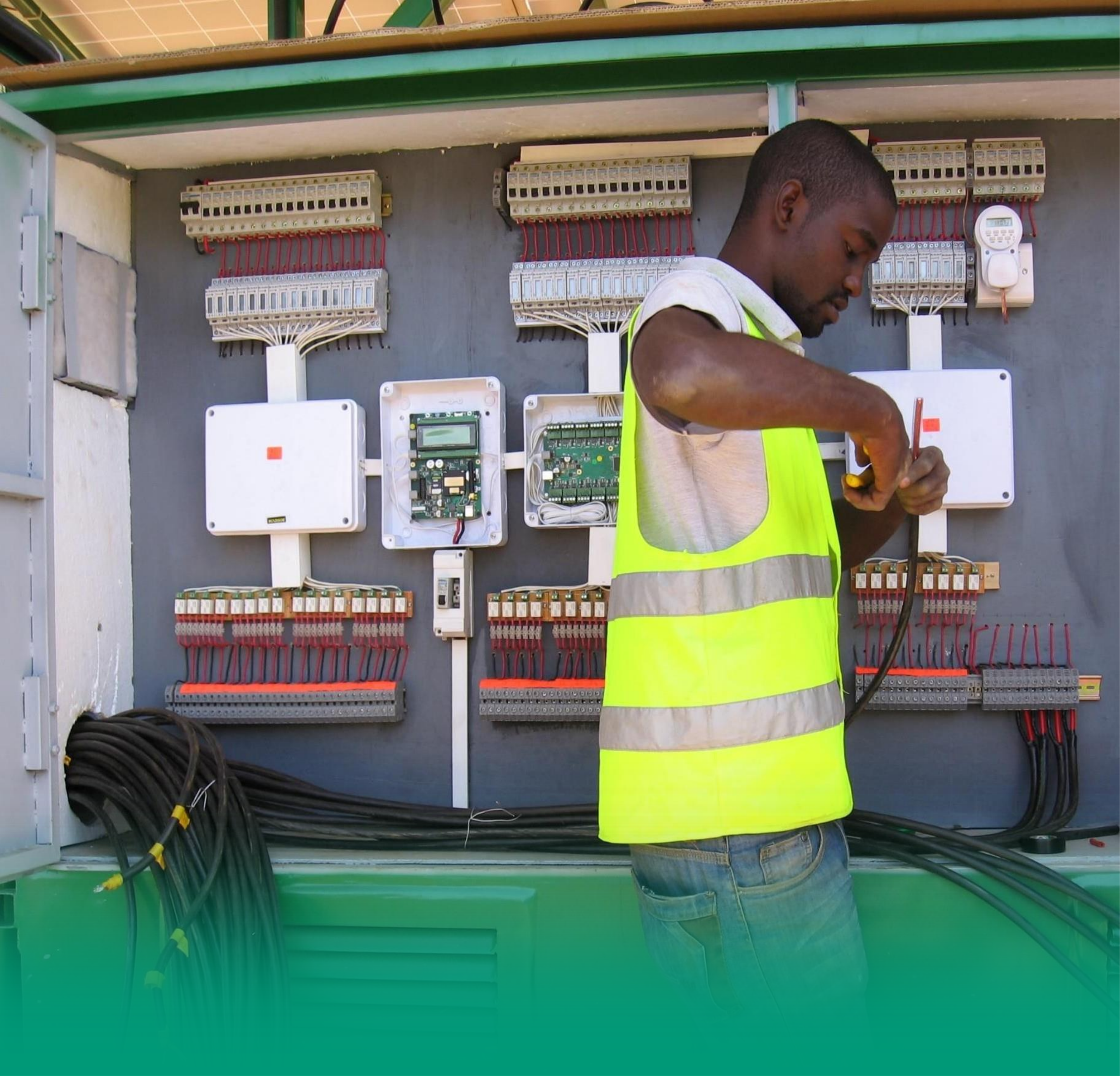
[53] A2EI. (2022). #StopGuessing. Clean-E-Cooking: Revealing Opportunities. Available at: https://a2ei.org/resources/uploads/2022/01/WEBINAR-StopGuessing-Revealing-Clean-Cooking-Opportunities-slides.pdf

That said, similar to national utility customers, minigrid customers are comprised largely of low consumption customers, with more than 70% consuming less than 4 kWh per month, compared to 13% that consume more than 10 kWh. While this poses a risk to sites' financial sustainability, it also presents an important opportunity for stimulating demand in these communities. This can be achieved by, for instance, bundling electricity sales with the purchase of appliances or by promoting productive use activities. National demand stimulation efforts by governments, donors, and others are essential to redefining rural electrification economics.

Insights for sector stakeholders

Policymakers and regulators	Improving consumption is a systemic issue for rural electrification as it affects not just minigrids but utilities. 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. Because demand-side subsidies[54] are more likely to improve consumption, policymakers should explore options to incentivise productive uses of electricity, as well as earmark funds for connecting public institutions. The electrification of health facilities and schools is particularly impactful for communities; policy makers should consider providing incentives and streamlining regulatory approval processes to encourage developers to connect them to the minigrids.
Development partners	While several supply-side measures are currently being implemented to support the expansion of activity in the sector, there is a lack of demand-side support. Because higher demand should lead to lower prices, development partners should work with government and minigrid developers to develop national productive use or load growth programs that lead to increased incomes and improved livelihoods.
Minigrid developers	Productive use interventions have been proven to work, but minigrid developers often lack the financing and staff resources to invest in them. Developers should continue to integrate productive use of electricity and social services, such as the electrification of public institutions, into their operations. Working in collaboration with energy companies that focus on PUE and appliance financing can remove the risk of appliance financing while supporting load growth.
Investors	Minimum revenue guarantees are an important de-risking instrument used by many debt investors in the sector. Supporting productive use efforts on the ground can achieve the same goals. It would be better to channel funding currently paying for insurance products to instead contribute to real world impact on the ground.

[54] Cross Boundary. (2020). Innovation Insight: Measuring the Impact of Reducing Mini-grid Tariffs on Customer Consumption and Grid NPV. Available at: https://www.crossboundary.com/wp-content/uploads/2020/09/CrossBoundary-Innovation-Lab-Tariff-Reduction-Innovation-Insight-Final-September-2020.pdf



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7. EMPLOYMENT

7.1. Sector job creation

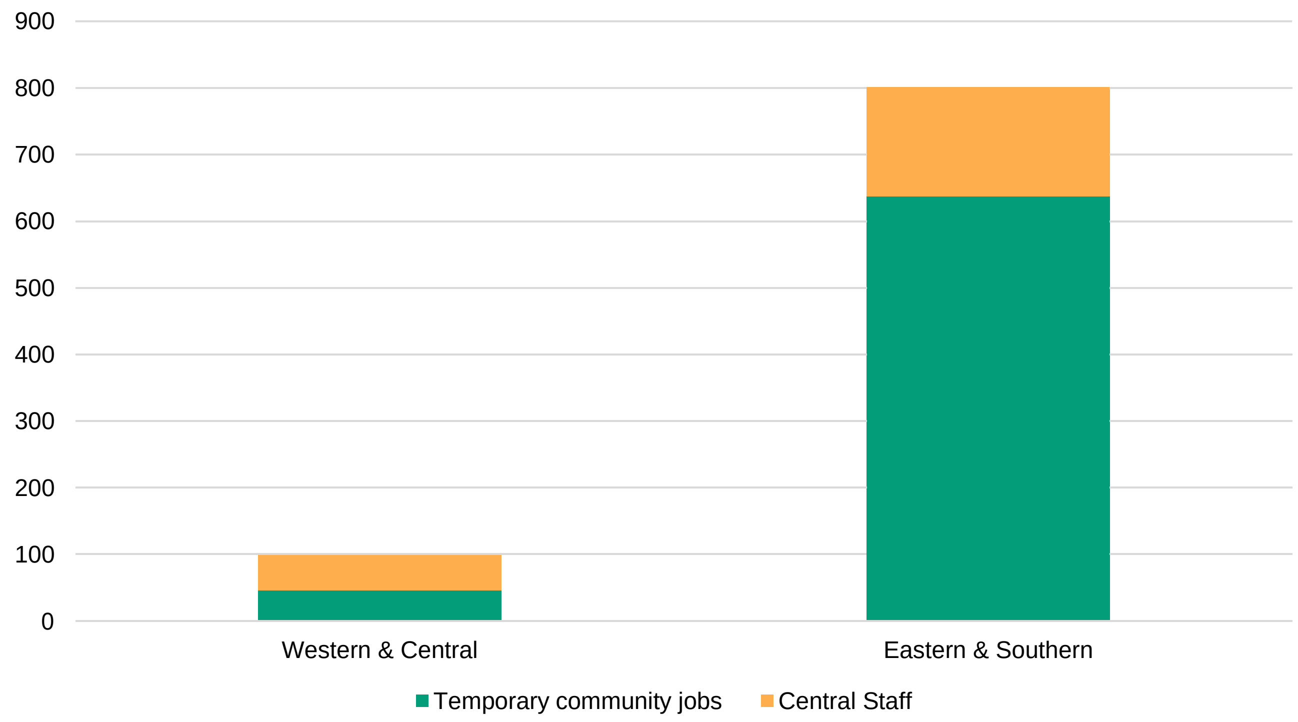
The minigrid sector created more jobs in 2020

While the economic development that follows community electrification is well understood, the sector's value chain also has an indirect effect on the local labour market. For this analysis, below are identified categories of jobs created:

- *Central staff jobs*: Permanent jobs in core operations of the site, management, customer service, and payment collection;
- *Direct temporary community jobs*: Temporary jobs created in the construction and installation stages, as well as basic operations and maintenance;
- *Indirect community jobs*: Jobs created because of the arrival of electricity in the sites. These are permanent jobs, such as new shops, established once the business gains access to electricity.

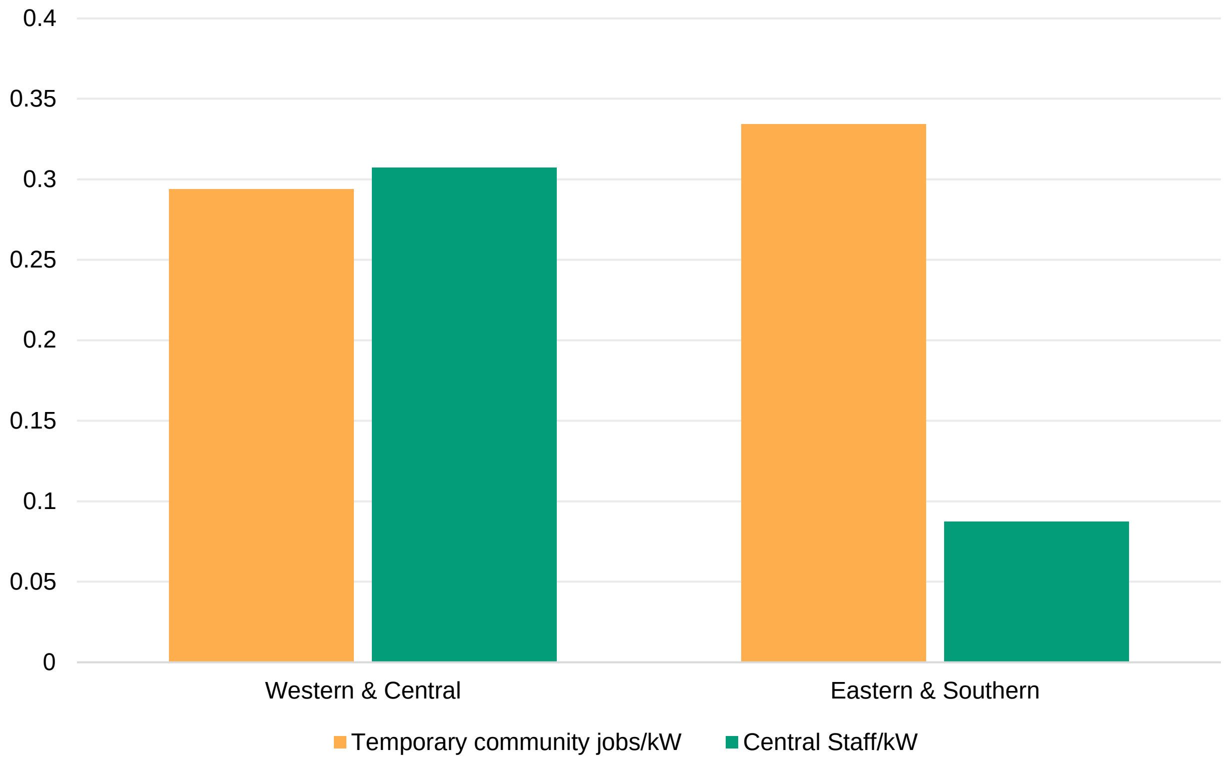
Investments in new minigrid sites from AMDA developers resulted in the creation of a significant number of jobs. Almost 900 jobs were created in 2020 alone, as seen in Figure 31. Most of these jobs were created in Eastern and Southern Africa, which is where most of the newly installed capacity and new sites were concentrated. However, the majority of new jobs were not permanent positions, but temporary jobs created during and after the installation of the minigrid.

Figure 31: Local community jobs and central staff added in 2020



In 2020, direct **job creation per kW of installed capacity** increased to between 0.25 and 0.28 (Figure 32). This means that five full-time jobs were created for every 20 kW of installed capacity in 2020. While this may suggest lower efficiency, since more employees are needed to assist with its construction and installation, it could indicate that supply chain disruption from the pandemic resulted in more local employees being hired.

Figure 32: Local community jobs and central staff added in 2020 per kW



It should be noted that the above figures do not include indirect community jobs. As sites are built and then operated, the local community increases spending in goods and services, stimulating the creation of formal and informal jobs in the food industry and retail sector. For example, minigrid construction encourages drinking water and food vendors at the construction site.

7.2 Key insights

Job creation from the development of new minigrid sites has been higher than ever.

Any subsidies proposed for the sector should consider financial benefits for improving living standards, reducing poverty and other support provided to previously unemployed citizens.

Power for All's 2019 "Powering Jobs Census" found that the decentralised 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.[55] However, unlocking this potential requires coordinated local workforce readiness and skill development programming to ensure the smooth operation of minigrids and leverage new productive use opportunities.

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

Insights for sector stakeholders

Policymakers and regulators	Expanding the use of electricity in rural areas is not only a way to increase the living standards, but also to accelerate economic development. Policies that increase access to education and skills development in local communities would further increase the benefits of minigrids.
Development partners	Minigrids have the potential to become an integral part of local economic development programmes for remote areas. Coordination with other programs such as community and business engagement would enhance their overall impact by providing the electricity for running new businesses alongside the training. Development partners should help ensure that those skills learned in temporary jobs are transferable to new markets.
Minigrid developers	Continued scale and investment in the companies and ecosystem will help continue to grow employment figures.

8. SERVICE QUALITY

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AMDA developers are providing reliable service quality that often outperforms national grids.

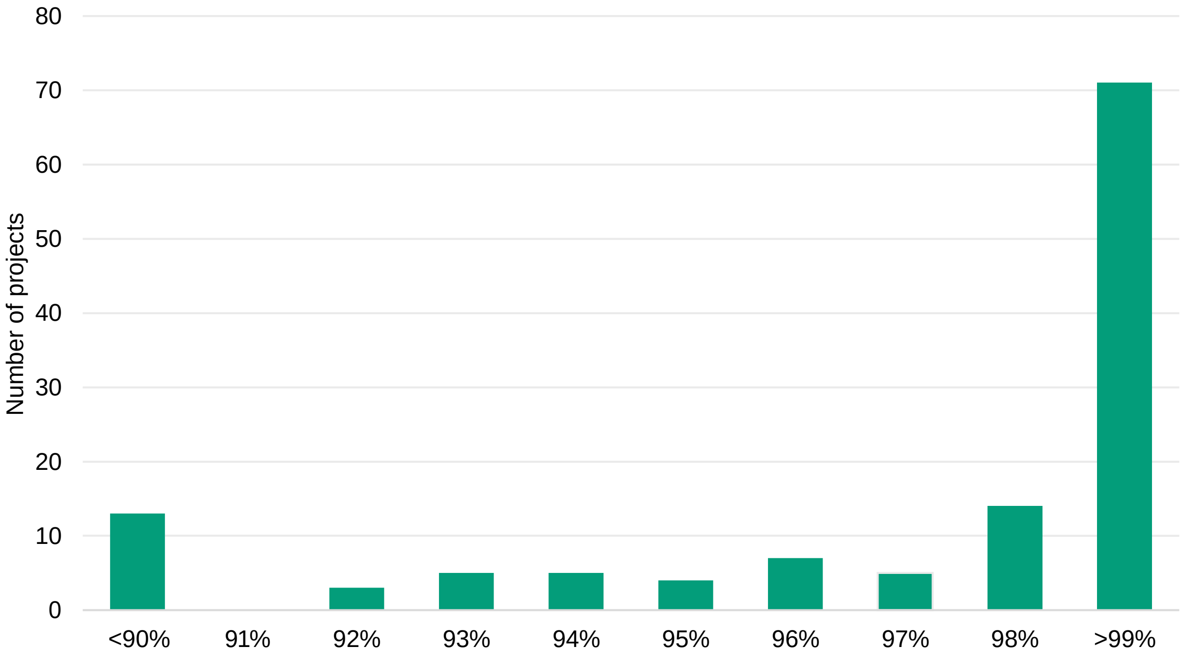
While most of the electrification discussion tends to focus on affordability and sustainability, reliability is also critical. Sudden outages can have serious repercussions for machinery, health and education facilities, and businesses that depend on a continuous electric supply for their operations. Our analysis shows an upward trend in minigrid service reliability in looking at service uptime and frequency of outages.

It should be noted that comparative data from national utilities is limited, as most do not publicize their service quality data. Comparisons are therefore extrapolated from external or self-reported data from other surveys. However, the expected standard as compared to European utilities is uptime of 99.9%.

8.1 Service uptime

Our data suggests that for most of the reporting sites, minigrid systems have a consistently high service uptime of above 99%. The high reliability of supply can be attributed to the use of new monitoring and back-up technologies that reduce minigrid outages. As seen in Figure 33, for sites installed in 2020, only two out of 35 reported a service uptime of less than 99%. As with most of the findings for 2020, it will be necessary to review if these trends hold once activities return to normality following the COVID-19 pandemic.

Figure 33: Service uptime for all sites



8.2 Outages and service quality in 2020

2020 marked the lowest number of monthly outages for AMDA developers' minigrids.

Common reliability measurements are the System Average Duration Index (SAIDI), which captures the duration of outages in a given year, and the System Average Interruption Frequency Index (SAIFI), the frequency of power outages. Other research estimates that utilities report, on average, only 15% of outage durations due to either lack of ability or incentive to accurately measure.

Compared to the three previous years, 2020 saw the least monthly outages per site[56] at 1.05; this is less than half the value of 2019 and an eighth of 2018. The System Average Interruption Frequency Index (SAIFI) in 2020 was approximately 0.89. The service level of utilities in Nigeria and Kenya is shown in table 5 below:

Table 5: SAIDI and SAIFI average total outage[57]

Grid-Tied SAIFI/SAIDI	Nigeria	Kenya
SAIDI (Hours)	4565.76	264.48
SAIFI (number/year)	393.6	45.6

Note: This is reporting on manufacturing and anchor load clients only and does not represent outages for household consumers estimated to be significantly higher. SAIDI, System average international duration index – Annual average total duration of power interruption to a consumer, in hours; SAIFI, System average interruption frequency index – Average number of interruptions of supply that a consumer experiences annually.

This improvement in service quality was significant during 2020, given the increased need for emergency healthcare services related to the COVID-19 pandemic. Furthermore, improving the quality of service will likely increase the trust of both current and potential users in minigrids, expanding the number of connections and thus making the projects more financially sustainable.

PV-battery system performance

The high performance of PV-battery systems in terms of uptime and outages is equivalent to diesel-hybrid systems. While there is not enough information yet to fully assess the performance of PV-battery systems and diesel-hybrid systems during the pandemic, our initial data suggest that performance is similar. Only one PV-battery system presented outages, while only one diesel-hybrid system site presented a considerable number of outages, with most sites not having any outages at all.

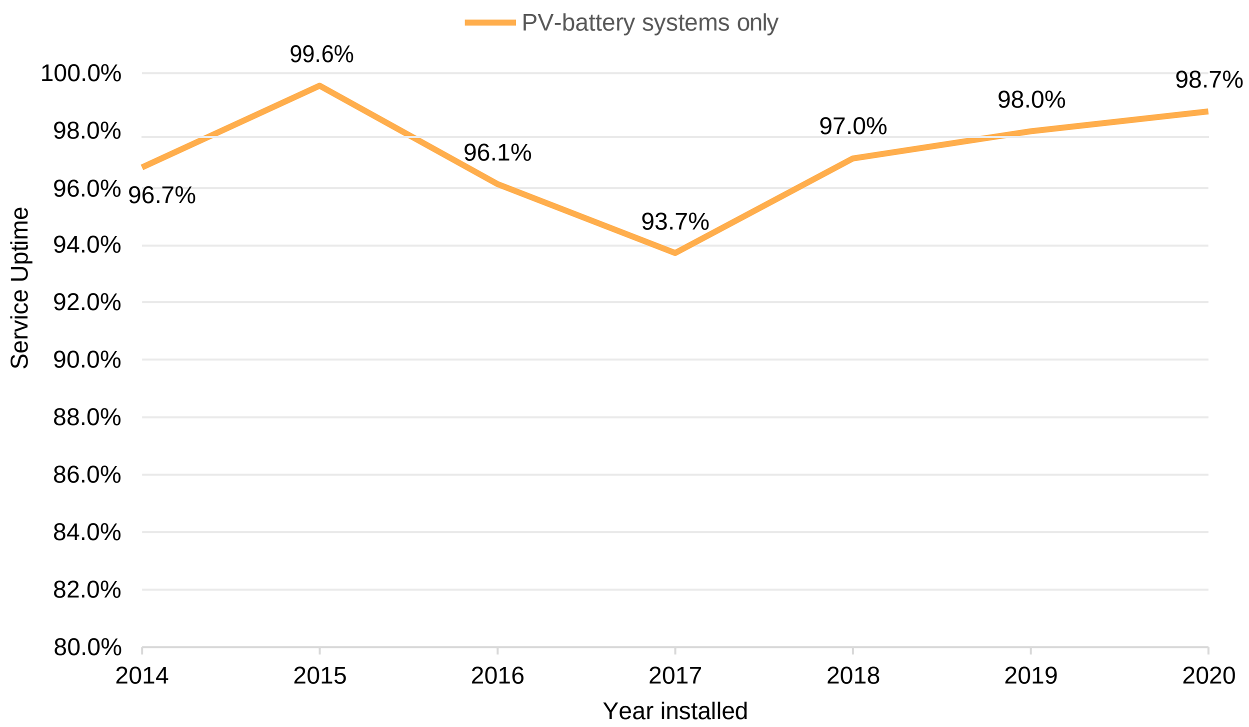
Uptime for PV-battery systems might be constrained once load increases closer to its designed capacity, at which point extended periods of low sunshine would result in outages. However, our data does not provide much evidence to this effect; older PV-battery sites present only small differences in service uptime when compared to new sites as seen in Figure 34.

[56] Only sites installed after 2017 are included in order to have an appropriate number of datapoints.

[57] Elsevier. (2020). Measuring "Reasonably Reliable" Access to Electricity Services. Available at: https://www.wame2030.org/files/catalogue/2020/8/1_s2.0_S1040619020301202_main_1.pdf

This is particularly important given the additional pressure to remove diesel generation from minigrids as part of combating climate change, while also providing uninterrupted service, especially to public facilities. Therefore, maintaining and improving service quality even further will be key for the sector to position itself as a reliable way to provide electricity to remote areas.

Figure 34: Average service uptime by year installed



8.3 Percentage of communities served

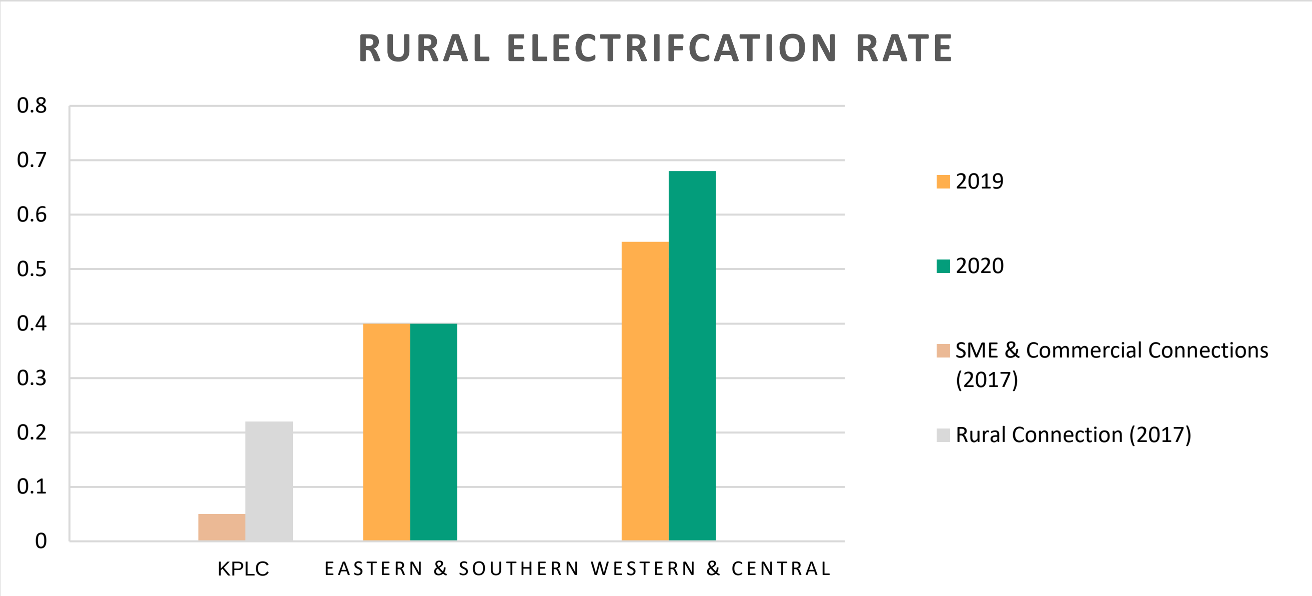
The average electrification rate in communities where AMDA members operate increased in 2020.

In rural communities served by the national grid, connection rates average 5% for households and 22% for commercial customers[58]. Our findings show that within communities served by AMDA members' minigrids, however, connection rates were 40% for the Eastern and Southern region in 2019 and 2020. In the Western and Central region, rates were 55% in 2019 and increased to 68% in 2020 (see Figure 35).

Minigrid developers have more flexibility to reach rural households compared to the national grid, which may explain these differences. While reliable data is limited, further analysis could track the electrification growth rate in communities serviced by minigrids before and after their installation and compare that figure to the national rural electrification rate.

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

Figure 35: Electrification rates evolution by region among AMDA members



8.4 Key insights

Quality of service from minigrids has improved substantially in the last few years, often surpassing the performance of urban areas connected to the national grid due to improved technology and the digitalisation of operations.

Insights for sector stakeholders

Policymakers and regulators	Given the high reliability and security of supply that minigrids provide to their customers, policies should ensure that they are fully integrated into rural electrification planning and strategies. In addition, given the ability and flexibility of the sector to meet the electricity needs of rural consumers, policies should focus on how to provide adequate service quality standards.
Development partners	Because minigrids can provide the most cost-effective reliable supply, reliability needs to be considered and encouraged as part of the design of financing support programmes. While diesel back-up generation has been seen as necessary to ensure reliability, evidence increasingly suggests that PV-battery systems have achieved parity. Public funding, in the form of grants and subsidies, are warranted for developers to invest in new technologies that promote greater quality of service.
Minigrid developers	Service quality and reliability are two important parameters when choosing the choice for rural electrification. Adapting new technologies that increase uptime and reduce the number of outages per site will improve the reputation of the sector across its customer base and incentivise development partners and policy makers to provide further support to the sector.

9. POLICY AND REGULATION

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Minigrid developers in Africa are regulated by the same bodies that oversee national utility companies, as well as developers operating under Power Purchase Agreements (PPAs). For all power providers, national regulatory bodies approve and supervise generation and distribution licences, tariff approvals, importation licences, business operations rights, environmental approvals, and local land use rights for minigrid construction and operation.

However, governments often issue permitting rules for minigrids based on large-scale projects and require disproportionate time and money for developers to meet. Unlike traditional utilities or large-scale power providers, minigrid developers are required to go through the licensing process for each individual site - essentially completing an entire regulatory cycle for every 100kWs installed. Furthermore, the process often requires dealing with different agencies with their own different processes and practices. Although there is a positive trend of reducing licencing times in recent years, this analysis shows that the average time needed to obtain full approval for the installation of each site can still exceed one year.

Regulations are, of course, critical to ensure that power generated and distributed is safe, reliable and appropriately priced. However, the current structure of and instability in regulations and efficiency significantly impact the sector's potential for investment, growth and profitability. To truly scale the sector, regulatory structures must design around the decentralised nature of minigrids.

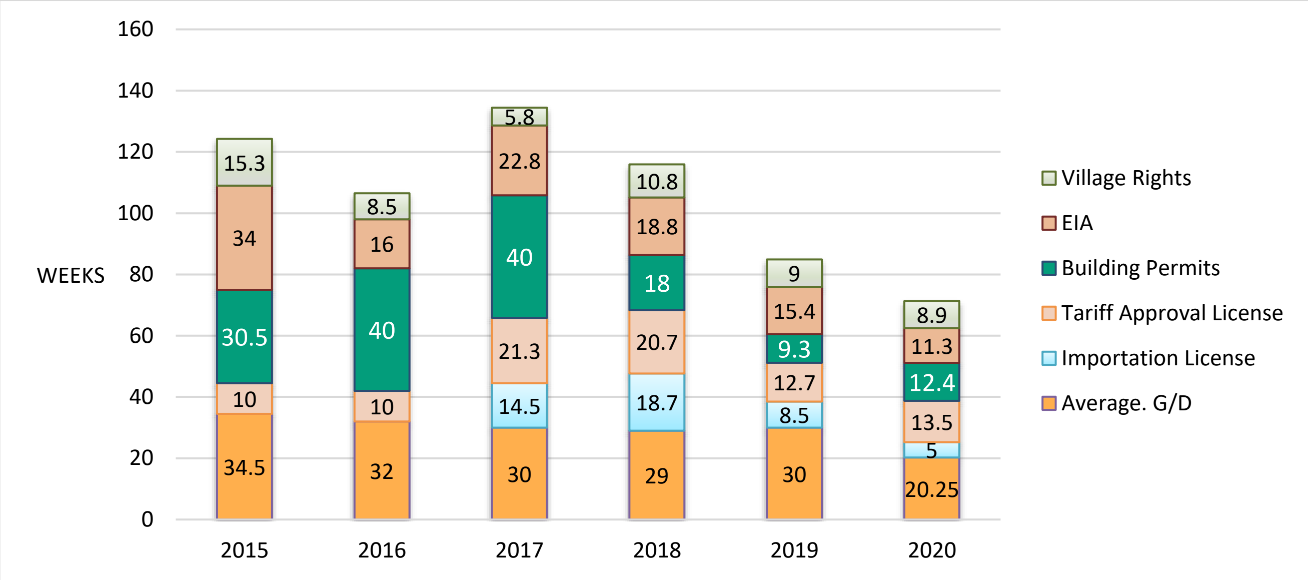
9.1 Licencing and regulatory timelines

While the trend to reduce licensing times continues, progress is still insufficient. For a single site, the average total time to attain all licences and approvals is 58 weeks[59] (see Figure 36).

Since 2019, the processing time for generation and distribution licences and building permits increased slightly, while the time needed to process an Environmental Impact Assessment (EIA) has been reduced. In 2020, this can be attributed partly to the emergency measures taken in response to the COVID-19 pandemic that required regulatory officials to work remotely, resulting in disruptions to the operations of regulatory offices across SSA.

[59] The 58 weeks represents the actual calendar weeks from start to finish and accounts for regulatory processes that can be done concurrently

Figure 36: Evolution of average regulatory compliance timelines

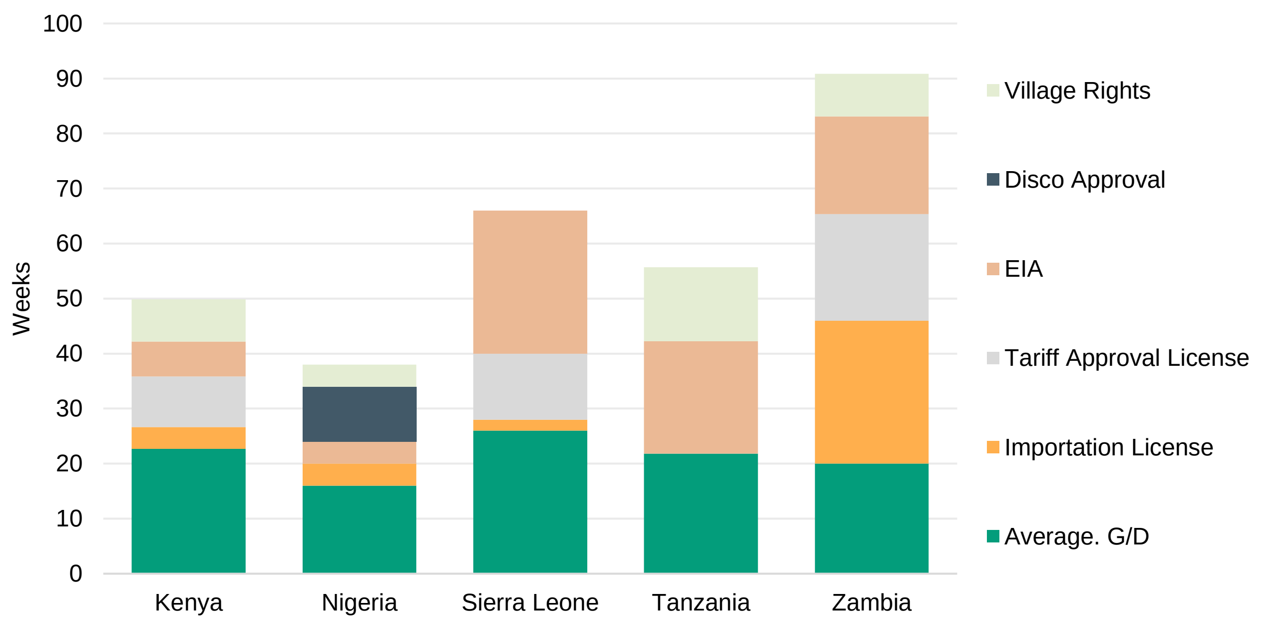


Note: This does not reflect timelines to negotiation concession agreements, nor does it reflect all aspects of regulation in all markets, just regulatory components that are standard across multiple markets.

Figure 37 illustrates that the average time to complete different steps of full regulatory compliance is consistently high across several countries. As seen, distribution licences and tariff approvals are the lengthiest processes, taking an average of 20 weeks. The data assumes that regulatory approvals are done sequentially, as only some of the approvals can be done concurrently.

Note that country-level data in 2020 was limited given that only a handful of markets developed new assets.

Figure 37: Licensing and approval processing times per country as of 2020



Note: While data describes the developers' reported processing times, some might be part of larger programmes that might be subject to faster processing times

As seen in the chart above, Nigeria has the shortest compliance time which is partially due to the fact that regulatory framework does not have a separate tariff approval process.

The sequencing and slow pace of approvals indicate that it would be regulatorily impossible to reach the World Bank target of 140,000 minigrids. Currently, Sierra Leone is the only market that has approved more than 50 sites in a single year[60]. Even if regulators in multiple markets could process 1000 applications a year, it would take 140 years to process all the required licences

Regulatory reviews

Box 8.1: AMDA's role in reviewing Kenya's Regulatory Framework

Beginning in 2020, in accordance with the Energy Act, 2019, the Energy and Petroleum Regulatory Authority (EPRA) in Kenya began to draft Mini-Grid Regulations with the support of Economic Consulting Associates (ECA). The Regulations cover site development, licensing, pricing, interconnection, and other key regulatory processes in the sector.

The initial versions of the Mini-Grid Regulations were released in early 2021. Subsequently, EPRA engaged stakeholder feedback from County governments, civil society organizations, and the private sector. AMDA and its members submitted detailed feedback on the draft Regulations at multiple points in 2021, both during the stakeholder engagement events and virtually.

EPRA incorporated feedback from all stakeholder respondents to complete a final draft of the Regulations in November 2021. The final draft reflects feedback submitted by AMDA and its members and is considered by the industry to recognize private minigrids' meaningful role in achieving Kenya's ambitious rural electrification goals. AMDA's collaboration with EPRA, ECA, and other stakeholders to provide input was well-organized and efficient, and AMDA partners and members expressed appreciation for EPRA's understanding of sector considerations throughout the process.

9.2. Key insights

Despite minigrid projects' small size, low risk, and high economic impact, the extensive regulatory processing time and high cost remains one of the main disincentives to minigrid implementation.

To reduce time, regulators could allow different stages to be processed concurrently, facilitate the approval of multiple sites at once[61], and allow online submissions and reviews of applications. Another proposed solution is to establish 'one-stop shops' to obtain all relevant permits to install a minigrid[62]. Lower fees for obtaining licences could provide additional support for smaller minigrids.

Regulatory and financing frameworks are often complex to navigate without prior experience, a hurdle, particularly for new developers. Developers should receive up-to-date support with key information on requirements and formatting required to apply for licences, possible incentives and subsidies, and local government regulations for site

60 SeforALL. (2021). Increasing Energy Access in Sierra Leone. Available at https://www.seforall.org/system/files/2021-05/Energy-Access-SierraLeone-SEforALL.pdf

61 ESMAP. (2021). Energy Sector Management Assistance Program (ESMAP) Annual Report 2021 (English) Available at: https://documents.worldbank.org/en/publication/documents-reports/documentdetail/615511640189474271/energy-sector-management-assistance-program-esmap-annual-report-2021%C2%A0

62 SEforALL. (2020). State of the Global Minigrids Market Report 2020. Available at: https://www.seforall.org/system/files/2020-06/MGP-2020-SEforALL.pdf

development. They should also receive clear guidelines on what happens after the arrival of the national grid at minigrid sites and the absence of tariff regulation. Finally, regulators should clearly communicate whether changes made during the pandemic will be made permanent, such as prohibition on disconnections, reduction in site visits for permits, and remote communication between regulatory bodies and developers.

While the COVID-19 pandemic caused many disruptions, it also unlocked new opportunities for governments to consider a digital strategy for regulating decentralised energy solutions. An innovative approach was developed by Odyssey as part of Nigeria's National Electrification Programme (NEP) and implemented by the Rural Electrification Agency. The platform provides a user-friendly way of compiling site-specific information, including survey data, generation and distribution design, and financial information to apply for a performance-based grant. Similar approaches could be deployed in regulatory processes across other markets.

Insights for sector stakeholders

Policymakers and regulators	Regulators can accelerate the growth of the sector by restructuring processes for the decentralised minigrid sector. ● Digitize approval processes and develop ways to approve companies and/or portfolios rather than individual sites. ● Define responsibilities of different regulatory agencies to avoid overlap and potential confusion. ● Set application and licencing fees at nominal levels that are proportionate to the size of minigrids. ● Permanently adopt COVID-19 pandemic approval measures to reduce administrative burdens of processing and monitoring permits and licences.
Development partners	Provide technical assistance to regulators on designing policy and regulation for scale, particularly around bulk approvals, as well as well-structured programmes that support regulators in logistics and organisation needed to visit sites for EIA approval and commissioning.
Minigrid developers	Minigrid companies need to build realistic, large-scale project pipelines to demonstrate to regulators, utilities, investors, and donors that changing the regulatory, subsidy, and policy landscape are worth the effort and public financing.
Investors	Investors can help decision-makers understand trade-offs between IPP-structured regulation and light-handed regulation more appropriate for lower risk, decentralised technologies and how that impacts investor appetite in a market.

10. CONCLUSION

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Minigrid sites have the potential to transform electrification across Sub-Saharan Africa, help develop local economies, expand the number of high consumption users, create new job opportunities for communities and facilitate income generating activities needed to increase household electricity consumption levels. The sector's track record in innovation and geographic and product expansion is impressive, leading to reduced costs and increased service quality. With improved support from governments and development partners, the minigrid sector has the potential to surpass the current growth trajectory and achieve SDG 7 targets of universal electrification.

Since 2017, the minigrid sector has experienced tremendous growth in the number of connections and installed capacity. Even throughout the pandemic, the minigrid sector was able to grow by 28%. As of 2021, minigrids supply over 78,000 connections with a total installed capacity of 7,000 kWp.

In 2020, capex per kWp slightly increased, despite improvements in technology. This is mostly due to supply chain disruptions related to the COVID-19 pandemic, although the level of developer experience played a significant factor.

Quality of service remains a top priority in the sector, with most sites experiencing virtually no outages. The continued upward trend in service quality surpasses the intermittent service provided by national grid operators in several of the countries in which members operate.

2020 witnessed a reversal in trends of generation technology usage. The pandemic-related drop in oil prices and increased PV component costs resulted in more new sites using diesel-hybrid generation technologies rather than PV-battery systems. Nonetheless, the quality of service in both sites is now similar. Considering the long-term economic and environmental benefits of PV-battery systems, this trend will likely resume in the coming years.

Increasing consumers' demand for electricity is essential to spread fixed costs of operation, making electricity more affordable and the sites more financially sustainable. Consumption grew at a rate of 2.3% between 2019 and 2020, a positive indication of future growth. Stimulating electricity use, especially for new users, is a top priority for developers to achieve financially sustainable sites.

AMDA developers that participated in this study raised a total of USD $10 million in 2020. These funds were geographically dispersed between Eastern, Western and Central Africa, with a greater share of funding earmarked for company operations rather than solely for developing new sites.

Increased 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 accelerate the rate of electrification. Only 13% of the current committed USD $1.6 billion (USD $208 million) has been dispersed.[63] The reasons for low deployment rates need to be addressed to inject capital that can de-risk projects and leverage traditional private financing.

Complex licensing and regulatory frameworks remain a substantial hurdle for developers to navigate. Given the enormous possibility for expansion, reducing waiting times for permits is essential to fulfil the sector's potential.

It is estimated that between USD $100 billion and USD $200 billion will be needed to reach about 500 million people across Africa through

[63] SEforALL. (2020). State of the Global Minigrids Market Report 2020. Available at: https://www.seforall.org/system/files/2020-06/MGP-2020-SEforALL.pdf

minigrid sites.[64] Technology and socio-economic dynamics give the sector momentum, but all stakeholders need a more concentrated effort.

10.1 Next steps

This report presents an overview of the true costs of minigrid development and the main issues facing minigrid companies in Sub-Saharan Africa today. While it is a major contribution to sectoral understanding, it still needs to be a complete snapshot about its current state.

AMDA will continue to collect data and improve upon this critical research to ensure decision-makers have the most up-to-date information on the sector. AMDA also believes that more extensive action-oriented research is urgently needed in a number of areas, including:

1) Implicit and explicit national utility subsidies,

2) Cost and service comparisons between different electrification options,

3) Monitoring and guidance on regulatory improvements as best practices, and

4) Productive use success in growing economic development.

It is AMDA's firm belief that expanding the evidence base is essential in creating nuanced solutions to the structural challenges facing Africa's energy access challenge today. AMDA looks forward to building partnerships to explore new research opportunities in the energy access space.

[64] Lawrence, D. (2020). Investors Forecast Bright Future for Minigrids in Africa. Available at: https://www.ifc.org/wps/wcm/connect/news_ext_content/ifc_external_corporate_site/news+and+events/news/insights/africa-mini-grids

ANNEX

A1 AMDA's members surveyed for this study

The following AMDA members provided data for the analysis presented in this report:

- *ACCESS SA,*
- *A4&T Power Solutions,*
- *ANKA Madagascar,*
- *Ashipa Electric,*
- *BBOXX,*
- *CREDC,*
- *Energicity,*
- *Ensol,*
- *Equatorial Power,*
- *Guinea Energy,*
- *GVE,*
- *Havenhill,*
- *Husk Power,*
- *Jumeme,*
- *KYA Energy,*
- *Nal Offgrid,*
- *Nuru,*
- *Engie PowerCorner,*
- *PowerGen,*
- *PowerHive,*
- *Redavia,*
- *REI Cameroon,*
- *Renewvia Energy,*
- *Rift Valley Energy,*
- *Rubitec,*
- *RVE.SOL,*
- *Standard Microgrid,*
- *SteamaCo,*
- *Virunga,*
- *WeLight,*
- *Winch Energy,*
- *Yandalux.*

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