



White Paper

Carbon Credits for Off-grid Solar in Sub-Saharan Africa

Lessons from Energy-access Companies in the Voluntary Carbon-credit Market

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Abbreviations and glossary

Abbreviations

ACMI	Africa Carbon Markets Initiative
CAGR	compound annual growth rate
CDM	Clean Development Mechanism
GHG	greenhouse gas
ICROA	International Carbon Reduction and Offset Alliance
MRV	measurement, reporting, and verification
tCO ₂ e	tons of carbon-dioxide equivalent
UN	United Nations
VCM	voluntary carbon market

Glossary

additionality	A key principle in carbon markets which ensures that a carbon credit represents a genuine emission reduction or removal that would not have occurred without the carbon-market incentive.
baseline	A reference scenario that represents the greenhouse-gas (GHG) emissions that would have occurred without a specific carbon project.
carbon credit	A tradable certificate that represents the reduction or removal of 1 ton of carbon-dioxide equivalent (tCO ₂ e) from the atmosphere.
carbon offset	A reduction in GHG emissions, or an enhancement of GHG removals, that is used to compensate for emissions occurring elsewhere.
carbon pricing	A market-based mechanism that assigns a cost to GHG emissions, providing an economic incentive to reduce emissions.
carbon project	An activity or set of activities designed to reduce or remove GHG emissions, which can generate carbon credits.
carbon registry	A platform that tracks the issuance, ownership, transfer, and retirement of carbon credits, ensuring transparency and traceability in the market.
carbon standard	A set of rules, methodologies, and procedures that define how carbon credits are generated, verified, and traded.
co-benefits	Additional environmental, social, and economic benefits that result from a carbon project, beyond the direct reduction or removal of GHG emissions.

Executive Summary

Power Africa is a collaborative initiative led by the United States Government in conjunction with African governments, private-sector organizations, and multilateral institutions. Power Africa's goal is to increase electricity access by adding 30 megawatts of new generation capacity, and 60 million new connections through on- and off-grid solutions by 2030. Power Africa defines energy "access" as the number of new households and businesses connected to electricity through an on- or off-grid power source.

This paper offers insights for off-grid solar companies keen to explore the voluntary carbon market. The paper builds on the technical assistance with carbon credits that Power Africa and CarbonClear provided to two off-grid companies. This resource also draws on CarbonClear's experience of working with more 20 solar companies to evaluate the opportunity and risks of implementing a carbon-credit program. By focusing on sub-Saharan Africa, this paper examines some of the obstacles that solar companies face and explores effective carbon-credit strategies to navigate this market successfully.

The voluntary carbon market (VCM) is an evolving mechanism that enables an entity to offset its greenhouse-gas emissions by purchasing carbon credits from emission-reducing projects. Although Africa holds significant potential for climate finance and sustainable development, it currently composes only a small portion of the global VCM. One initiative to expand Africa's share of the carbon-credit market is the Africa Carbon Markets Initiative. Launched in 2022, the Africa Carbon Markets Initiative aims dramatically to scale voluntary carbon markets across Africa by producing 300 million credits annually by 2030, unlocking \$6 billion in income, and supporting 30 million jobs.¹

The VCM promises to reduce emissions significantly, although it faces challenges. These issues are the possibility of double counting and lack of transparency; companies' using the VCM to avoid making substantive changes to their business practices; the quality of carbon credits and associated projects; and the market's lack of regulation and oversight. To resolve these shortcomings, those participating in the VCM should enhance transparency, ensure high-quality carbon credits, and strengthen regulatory oversight to maintain the credibility and effectiveness of the VCM.

Off-grid solar companies can participate in Africa's VCM in many ways, including by designing their own carbon projects or joining data-driven carbon programs like CarbonClear to navigate the off-grid carbon market. Developing custom carbon projects typically requires a longer timeline and higher up-front costs, but reduces risk once credits are issued. Retrieving real-time consumption data from pay-as-you-go-enabled devices can offer a faster, more cost-effective route to the carbon market, although

Topics covered

- Voluntary carbon market
- Market transformation
- Carbon-credit pricing
- Challenges and needs in the voluntary carbon market
- Carbon-credit strategies
- Business cases and toolbox
- Lessons

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¹ "Africa Carbon Markets Initiative Launched to Dramatically Expand Africa's Participation in Voluntary Carbon Market," Climate Champions, November 8, 2022, accessed May 22, 2023, <https://climatechampions.unfccc.int/africa-carbon-markets-initiative/>.

the International Carbon Reduction and Offset Alliance's standards do not currently recognize digital strategies to participate in the VCM. Companies must consider trade-offs to choose a model that suits their needs based on financial circumstances, installation portfolio, and go-to-market preferences.

1. Voluntary Carbon Market (VCM)

The VCM is a market mechanism that enables businesses, governments, and individuals to purchase carbon credits to offset their greenhouse gas (GHG) emissions voluntarily. These carbon credits are generated by projects that reduce or remove emissions, such as renewable-energy projects, reforestation efforts, and energy-efficiency initiatives. The VCM has grown significantly in recent years, driven by increased corporate commitments to reduce emissions and growing awareness of climate change.

The VCM is experiencing significant growth and transformation, presenting an opportunity to meet the climate-finance needs of African economies. By expanding energy access, creating jobs, protecting biodiversity, and driving climate action, carbon markets can help to develop the region sustainably. Despite this potential, Africa today accounts for only a fraction of the global VCM market.

To aid Africa’s VCM, the Africa Carbon Markets Initiative (ACMI) has announced its goal to produce 300 million carbon credits annually by 2030. Achieving this level of production would unlock \$6 billion in income and support 30 million jobs. By 2050, ACMI aims to produce more than 1.5 billion credits annually in Africa, leverage \$120 billion, and support 110 million jobs.

The VCM is a dynamic ecosystem consisting of market participants that generate and retire carbon credits. The market can be categorized into three main segments: Origination, distribution, and end-buyers.

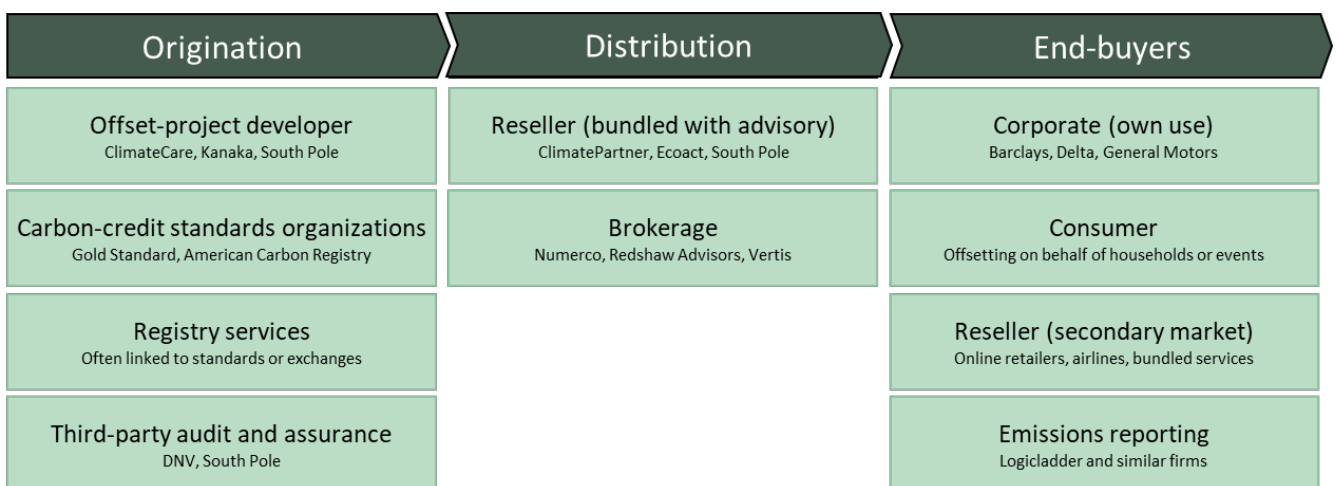


Figure 1: Stakeholders in the VCM

Several organizations can originate carbon credits.

- **Offset-project developers** design, implement, and manage emission-reduction projects that generate carbon credits. They often collaborate with local communities and organizations to maximize the projects' environmental and social benefits.
- **Carbon-credit standards organizations** such as [Gold Standard](#), [Verified Carbon Standard](#), and emerging standards like [CarbonClear](#) develop and maintain the methodologies and protocols to quantify and certify emission reductions, ensuring the environmental integrity of carbon credits issued in the VCM.
- **Registry services** monitor carbon credits as they are issued, transferred, and retired, ensuring transparency and accountability within the market. Individual standards manage this service and each operates its own registries. To obtain a comprehensive view of the entire VCM market, one can use platforms such as [AlliedOffsets](#) or refer to the consolidated data file provided by the [University of California Berkeley](#).
- **Third-party audit and assurance providers** are independent verification bodies that typically form part of the International Carbon Reduction and Offset Alliance (ICROA). Established organizations in other sectors, such as the world's largest classification society, *Det Norske Veritas*, offer audit and assurance services to assess the credibility and compliance of emission-reduction projects with established methodologies and protocols. These organizations verify the reported emission reductions and ensure that carbon credits are issued accurately and transparently.

Entities that distribute carbon credits are:

- **Resellers**, which purchase carbon credits from project developers or other market participants and sell them to end buyers, often alongside advisory services that help buyers select suitable projects and navigate the VCM.
- **Brokerage and exchanges**, which help market participants trade carbon credits and are intermediaries that connect buyers and sellers. Exchanges can also help clients discover prices, complete trades, and clear and settle transactions.

A variety of end-buyers of carbon credits are available.

- **Corporations** purchase carbon credits to offset their GHG emissions and meet sustainability goals. Large companies have voluntarily committed to reduce their emissions in line with the Paris Agreement and are increasingly using the VCM to achieve their targets.
- Individual **consumers** are becoming more conscious of their environmental footprint and are using the VCM to offset their personal emissions by purchasing carbon credits from sustainable projects.

- **Resellers** on the secondary market purchase carbon credits from other resellers or end-buyers and sell them to new buyers. This market activity helps maintain liquidity and reveal prices in the VCM.
- The market participants above work together to ensure that the VCM functions smoothly. They drive the growth of the market and help to decarbonize economies.

Market forecast

In 2021, VCM transaction volume exceeded 200 million metric tons of carbon-dioxide equivalent (MtCO₂e), with an estimated market value of \$2 billion. Africa shows significant potential in the VCM, given its abundant natural resources and ample opportunities for carbon projects.

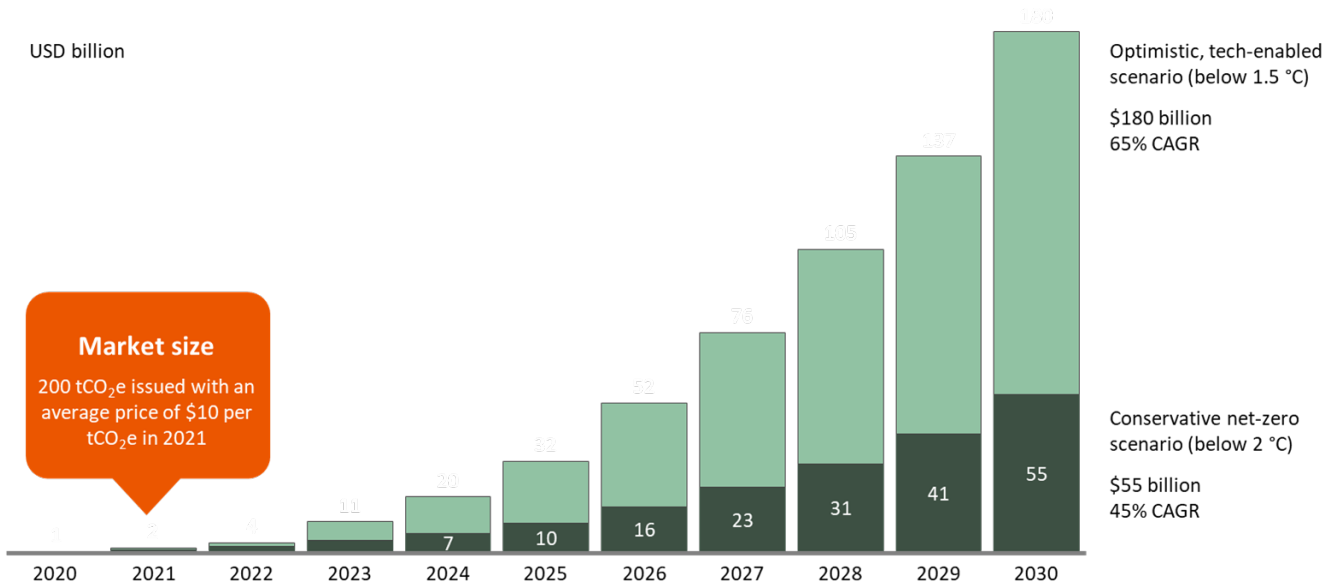


Figure 2: The chart illustrates the projected growth of the VCM under two scenarios. The first is a more conservative scenario aligned with a global temperature increase below 2°C. The second, optimistic, scenario assumes that the global temperature will increase less than 1.5°C. The conservative scenario estimates a VCM valuation of \$55 billion by 2030, reflecting a compound annual growth rate (CAGR) of approximately 45 percent. In contrast, the optimistic scenario envisions a market size of \$180 billion, with a CAGR of 65 percent. These projections stem from the 2021 market baseline, in which approximately 200 million t CO₂e was issued at an average price of \$10 per ton.^{2,3}

The growing market presents opportunities for African off-grid solar companies to generate additional revenue by participating in carbon-offset projects.

² Christopher Blaufelder, Cindy Levy, Peter Mannion, and Dickon Pinner, “A Blueprint for Scaling Voluntary Carbon Markets to Meet the Climate Challenge,” McKinsey, January 2021, accessed May 23, 2023, <https://www.mckinsey.com/~media/mckinsey/business%20functions/sustainability/our%20insights/a%20blueprint%20for%20scaling%20voluntary%20carbon%20markets%20to%20meet%20the%20climate%20challenge/a-blueprint-for-scaling-voluntary-carbon-markets-to-meet-the-climate-challenge.pdf>.

³ EY Net Zero Center, “Essential, Expensive and Evolving: The Outlook for Carbon Credits and Offsets,” EY, 2022, accessed May 31, 2023, https://www.ey.com/en_au/forms/2022/download-carbon-offsets-report.

Market dynamics

As climate change continues to be a pressing global issue, the demand for carbon credits in the VCM is growing. This heightened demand, coupled with increasingly stringent regulations, promises to drive significant changes in carbon-credit pricing. This chapter discusses the factors influencing the pricing forecast for the VCM and presents data suggesting that prices could range from \$50 to \$120 per MtCO₂e by 2030. Several factors contribute to the anticipated increase in carbon credit pricing in the VCM.

The balance of supply and demand determines the price of carbon credits to a large extent. As demand for credits outpaces supply, prices are likely to increase. As the market matures, the demand for high-quality projects with multiple social benefits may lead to price premiums for such credits.

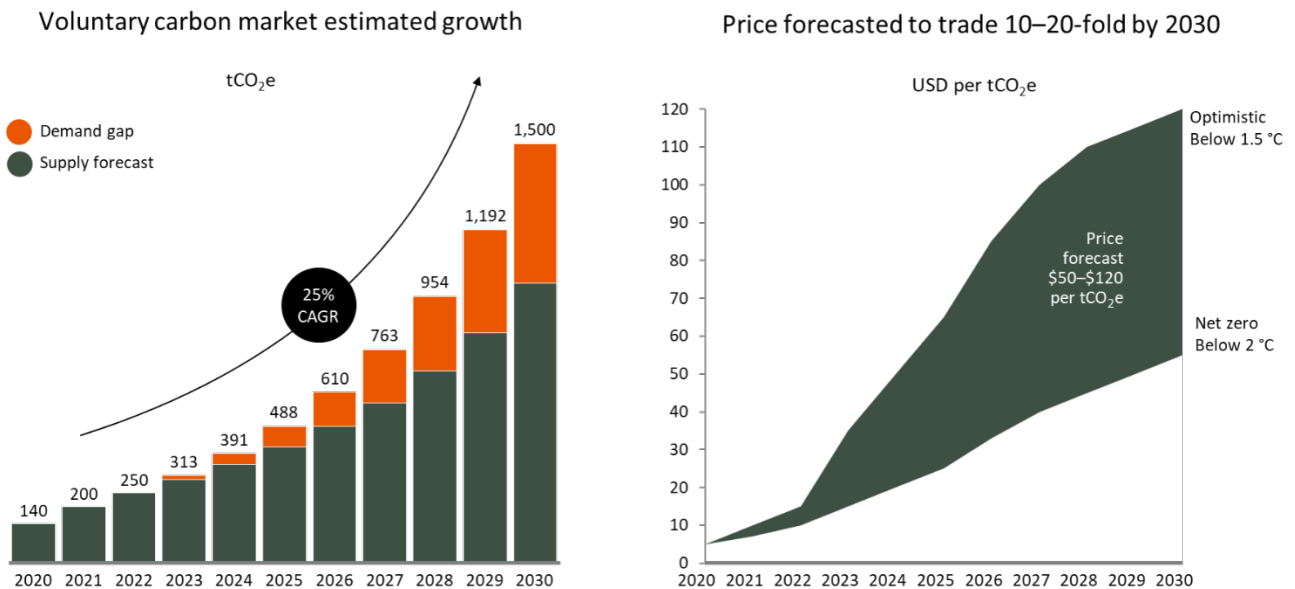


Figure 3: The bar chart on the left estimates the growth of the VCM until 2030. The chart on the right forecasts the price of carbon credits and estimates a significant increase in carbon-credit prices. This upward trend is primarily driven by growing demand for carbon credits, fueled by regulatory developments and corporate commitments to reduce emissions.⁴

⁴ Ibid.

Criticism and risks of the voluntary carbon market

Despite the benefits of the VCM, publications and organizations such as the *Guardian*⁵ and Greenpeace have expressed reservations and criticisms about its effectiveness. These criticisms state that:

- Carbon-offset projects do not reduce the promised volume of emissions.
- Carbon credits allow polluting industries to delay their transition to cleaner technology and practices.
- The absence of a central registry and standard reporting procedures can enable entities to sell the same carbon credits more than once.
- Carbon offsetting can come with social and environmental harms (such as monoculture tree plantations which reduce emissions, but also biodiversity).
- Inconsistent standards and regulations undermine the VCM's effectiveness.

Although the VCM is an opportunity for businesses and governments to reduce their contribution to global emissions, the limitations of the VCM are worth solving to ensure the market's long-term success. Such improvements should focus on enhancing transparency, ensuring high-quality carbon credits, and strengthening regulatory oversight to maintain the credibility of the VCM.

⁵ See: Patrick Greenfield, "Revealed: More than 90% of Rainforest Carbon Offsets by Biggest Certifier Are Worthless, Analysis Shows," *Guardian*, January 18, 2023, accessed May 23, 2023, <https://www.theguardian.com/environment/2023/jan/18/revealed-forest-carbon-offsets-biggest-provider-worthless-verra-aoe>.

2. Market Transformation

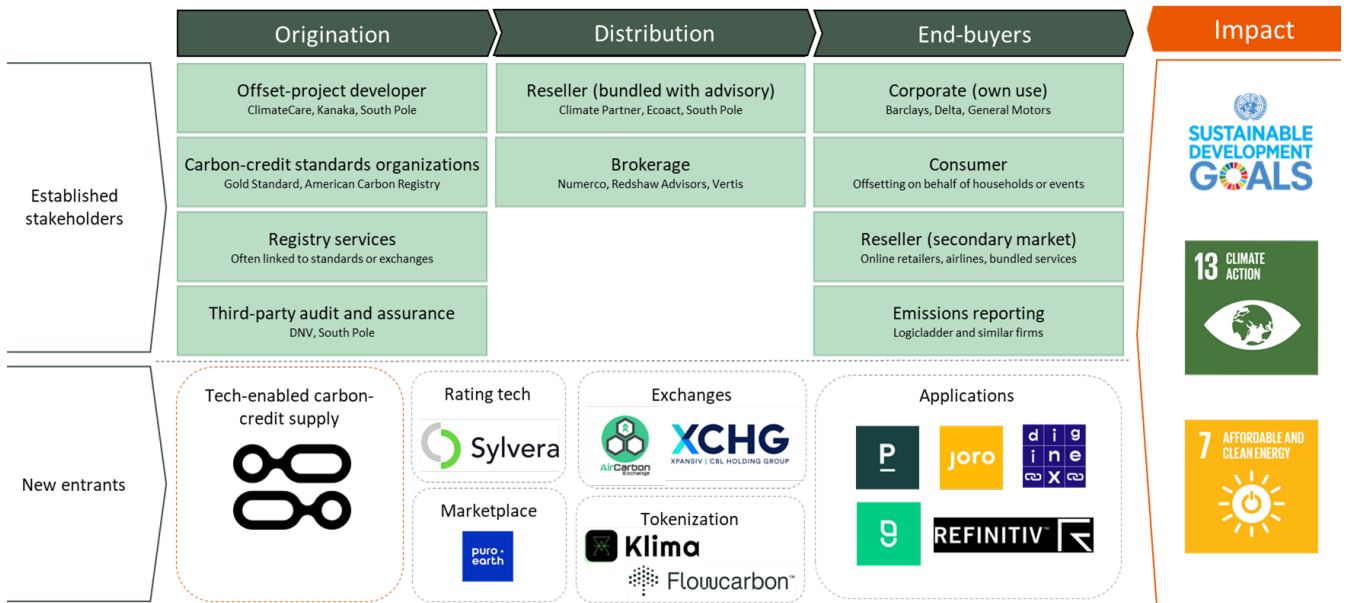


Figure 4: The VCM value chain illustrated with new entrants and United Nations Sustainable Development Goals outcomes for the off-grid solar industry.

The VCM's growth has attracted new market entrants, including large corporations, financial institutions, and technology companies. African off-grid solar companies can benefit from the market's expansion by forming partnerships with these new entrants, fostering innovation, and driving further growth in the VCM.

The VCM is undergoing a significant transformation toward data-driven methodologies, higher quality, and more transparent carbon credits. African off-grid solar companies can take advantage of this shift by adopting data-driven methodologies while adhering to the principles of the UN Clean Development Mechanism's approved methodology (known as AMS I.L. version 3), ensuring the credibility of carbon-offset projects.

Emerging standards and methodologies

Because organizations develop their own standards and methodologies for carbon-offset projects, no single or centralized framework governs the entire VCM. The major carbon standards in the VCM are the Verified Carbon Standard, the Gold Standard, the Climate Action Reserve, and the American Carbon Registry, which together contribute most credits in the market. These standards aim to maintain the integrity of the market and the credibility of projects. Independent standard-setting bodies, such as the Integrity Council for the Voluntary Carbon Market ([ICVCM](#)), have emerged and aim to create a high-integrity VCM that finances real and verifiable climate-mitigation projects. In recent years, the VCM has

evolved to accommodate an array of methodologies, particularly for technology-driven carbon-credit applications and projects in developing countries.

African off-grid solar companies should monitor the VCM market for technologies that can track carbon credits more reliably, such as blockchain and satellite monitoring. Technology can also influence the types of carbon-offset projects in demand, such as those which remove CO₂ from the air directly.

Technology-driven carbon-credit applications

Digital tools are transforming the VCM, enabling more accurate and efficient monitoring, reporting, and verification (MRV). Such digital tools are:

- Internet-of-things (IoT): IoT devices enable real-time monitoring and data collection of GHG emissions, significantly improving the accuracy and reliability of MRV. These devices can be deployed in various sectors, such as off-grid solar, agriculture, energy, and waste management, to enhance the credibility of carbon-credit projects.
- Blockchain and distributed ledger technology: Blockchain can offer a transparent, secure, and tamper-proof platform to issue, trade, and retire carbon credits. These technologies can improve the traceability of carbon credits and reduce the risk of double counting, fraud, and other market inefficiencies.
- Remote sensing and satellite imagery: These technologies can monitor land-use and deforestation. These tools can help project developers and verifiers assess the environmental outcomes of carbon-credit projects with greater accuracy.

3. The African Voluntary Carbon Market

Regional implications

The VCM presents opportunity for qualified African off-grid solar companies to generate additional revenue and contribute to the global transition toward a low-carbon economy. By understanding the market's latest developments and engaging with its participants, African off-grid solar companies can navigate the complexities of the VCM and capitalize on its growth.

Africa Carbon Markets Initiative (ACMI)

As more African countries commit to climate-change-mitigation goals, and as the international community focuses on supporting the Global South in this effort, the market for African carbon credits is forecasted to grow to \$6 billion by 2030 and more than \$100 billion by 2050.⁶

To realize these forecasts, SEforALL has launched the Africa Carbon Markets Initiative (ACMI). Led by a thirteen-member steering committee of African leaders, CEOs, and carbon credit experts, ACMI was launched in 2022 to increase Africa's participation in the VCM. The initiative aggregates demand-side interest to purchase all types of carbon credits, not only those sourced from the off-grid solar sector.

ACMI runs programs to secure up to \$1 billion in market commitments to promote high-quality African carbon credits, develop projects with new methodologies tailored to African contexts, and significantly increase the volume of credits generated on the continent.

ACMI's reports indicate more than \$200 million in advanced market commitments were secured from global corporations. Seven African nations—Burundi, Gabon, Kenya, Malawi, Mozambique, Nigeria, and Togo—signed up to develop carbon-activation plans; an equal number of corporate buyers are preparing to commit to the program.

⁶ "Africa Carbon Markets Initiative (ACMI)," Sustainable Energy for All, n.d., accessed May 24, 2023, <https://www.seforall.org/our-work/initiatives-projects/ACMI>.

4. Carbon-credit Pricing

Pricing in the VCM can vary widely, with some credits trading at just a few dollars per metric ton of CO₂e, whereas others can fetch more than \$50 per metric ton. Factors that influence the price of carbon credits are the quality and credibility of the project, the social and environmental co-benefits it generates, and the methodologies used to quantify emission reductions. Corporate demand for high-quality credits, driven by ambitious climate commitments, can also increase prices in the VCM. As the market evolves, increased transparency, standardization, and new methodologies and technologies will lead to more efficient pricing mechanisms and greater liquidity in the VCM.

Corporate commitments

Many corporations are reducing their carbon footprint and adopting more sustainable business practices to align themselves with the goals of the Paris Agreement, which seeks to reduce GHG emissions globally. These corporate commitments can be categorized into four activities:

- Avoid nature loss, such as deforestation.
- Sequester carbon naturally through, for example, reforestation.
- Reduce GHG emissions such as methane from landfills.
- Remove CO₂ from the atmosphere with carbon-capture technology.

As companies make public and financial pledges to improve their environmental effects, social benefit, and corporate governance, they contribute to the growth and credibility of the carbon and credit markets.

Large corporations such as Amazon, Apple, Alphabet, and J.P. Morgan Chase have purchased significant volumes of carbon credits, recognizing the importance of reducing their emissions and investing in sustainable projects. These companies are integrating carbon credits into their business models and driving demand for carbon offsets. As more companies follow suit and commit to reducing their carbon emissions, the carbon-credit market will expand and evolve, playing a crucial role in the effort to combat climate change. To maintain credibility and public trust, it is essential for corporations to uphold their commitments, ensure transparency, and be held accountable for their actions.

5. Challenges and Needs in the Voluntary Carbon Market

Market challenges

The main challenges that prevent enterprises—particularly smaller ones—from flourishing in the carbon market are:

- **Transaction and evaluation speed:** Implementing and verifying emission-reduction projects can be a cumbersome process. The complex procedures involved in generating and selling carbon credits can delay revenues, which is prohibitive particularly for small projects and local enterprises.
- **Cost:** Setting up carbon projects is often expensive. High costs can be a significant barrier for smaller enterprises that lack the financial resources to invest in carbon-credit programs. In turn, limited participation in the VCM can also reduce revenue streams.
- **Awareness and access:** Limited awareness and understanding of the carbon market among potential buyers and investors, combined with complex regulatory frameworks and a lack of standardization in carbon-credit issuance and trading, exclude smaller enterprises from the VCM. If Africa’s VCM is to grow, it must bring aboard local businesses through simpler and more uniform regulations and transactions.

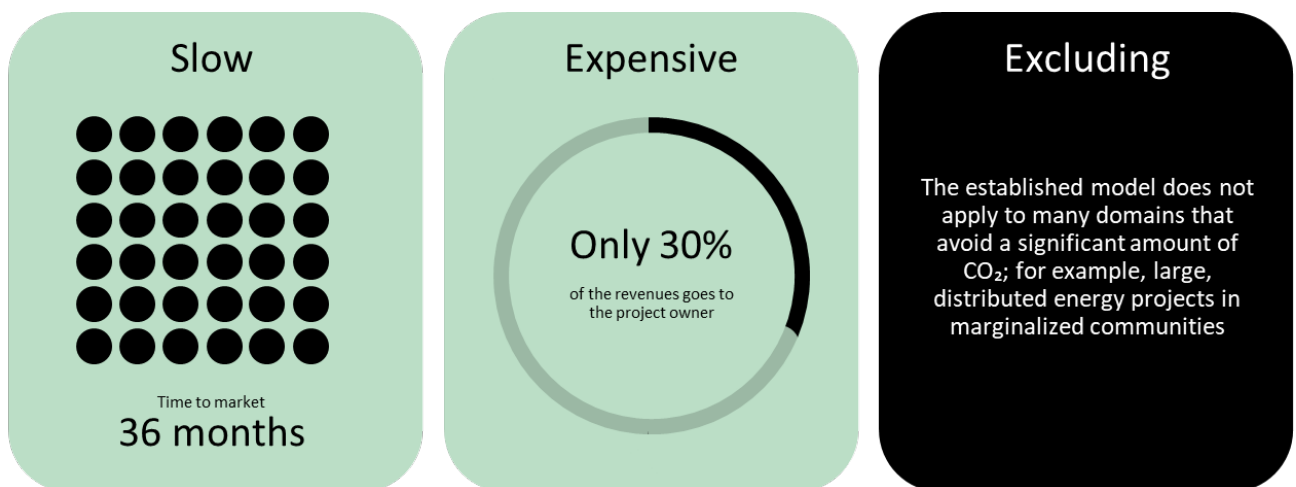


Figure 3: Challenges in the VCM.

Market solutions

To tap the potential of Africa’s VCM, the market must cater to the needs of off-grid solar companies in this region. To do so, the VCM should be:

- **Fast:** To make the carbon credit market more accessible for off-grid solar companies, carbon-credit standards authorities should simplify and streamline the credit-generation process through:

- Simpler and faster verification and issuance processes, which make carbon offsetting more approachable for small projects and businesses.
 - Remote digital monitoring that improves transparency while reducing data-collection costs.
- **Cost-effective:** Off-grid solar companies can benefit from the VCM if most revenues go to the carbon projects' owners. For the VCM to be lucrative, it should also be more cost-effective through:
- Reduced transaction costs: Platforms have yet to be established that aggregate small off-grid solar projects, enabling implementers to pool resources and share the cost of verifying, generating, and trading carbon credits. Distributed costs help lower the barriers to the VCM.
 - Technical assistance: Off-grid solar companies require guidance from donors to navigate the VCM and gain access to funding. Thorough knowledge of the VCM and its opportunities help project owners optimize their operations, reduce costs, and maximize revenue from carbon credits.
- **Inclusive:** Organizations that seek to involve more businesses in the VCM should:
- Encourage collaboration and knowledge-sharing among solar companies, regulators, and other stakeholders to promote best practices and overlooked businesses, such as those supplying solar home systems.
 - Establish partnerships between off-grid solar companies, governments, and international organizations to allocate resources for off-grid solar carbon projects throughout Africa.
 - Inform project developers, financiers, and buyers of the opportunities and benefits that the VCM offers. This will help build trust and drive investment in off-grid solar projects in marginalized communities.

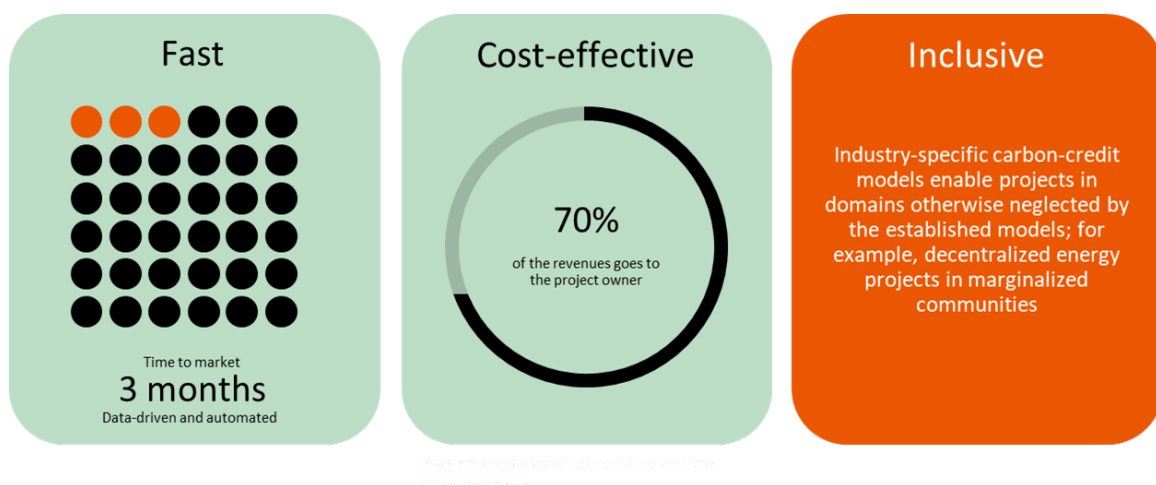


Figure 4: Suggested metrics to establish carbon-credit projects in developing countries.

6. Carbon-credit Strategies

To navigate the off-grid carbon market, off-grid solar companies in sub-Saharan Africa can choose between two main carbon-credit strategies:

1. Design carbon projects with ICROA standards, which allows companies to retain control over the project.
2. Join an industry-specific program such as CarbonClear, which can accelerate companies' access to the VCM and lower upfront costs.

Designing carbon projects with Carbon Reduction and Offset Alliance (ICROA) standards

Companies can tailor carbon-offset projects to their needs so that the resulting carbon credits align with their long-term goals. Additional benefits of designing custom carbon projects are the opportunity to build in-house expertise in carbon methodologies and standards as set out by [ICROA](#), the Integrity Council for the Voluntary Carbon Market ([ICVCM](#)), and the Taskforce on Scaling Voluntary Carbon Markets ([TSCVM](#)). A custom project also requires a significant investment in time, resources, and expertise to design, deploy, and get verified.

Eligibility

To align their projects with ICROA's standards, solar companies must ensure that their sourced hardware is not already linked to a carbon scheme driven by the manufacturer of the solar equipment. Companies should also establish transparent contractual agreements with their customers to maintain the rights to any carbon credits produced.

Time to market

The time to market for carbon-credit projects that adhere to ICROA-endorsed standards, such as [Gold Standard](#) and the [Verified Carbon Standard](#), can be a significant challenge for off-grid solar companies. The extended time to market is due to the intricate nature of project development. Typical implementation times are three years from inception to issuance, followed by the promotion and sales period. Depending on the complexity and scope of the project, the time to market ranges from two to ten years.

Developing a carbon project involves multiple stages in which the company identifies a project, assesses its feasibility, engages with stakeholders, determines baselines, monitors implementation, and has the project validated by an independent third party. Each stage demands a high level of expertise and precision to ensure that the project meets the stringent criteria that ICROA sets forth.

Verifying and measuring the progress of carbon projects are often manual and time-consuming, contributing to the lengthy timeline. If the MRV process is not digitized, project developers must rely on costly and labor-intensive manual audits. Added to these technical considerations are the regulatory landscape and carbon-credit standards with which the off-grid company should comply.

Fee structure

Carbon standards, project design, and consultants' services often come with fees of which off-grid solar companies should be aware. Companies should carefully evaluate their financial capabilities and resources before committing to a carbon credit project. For projects following ICROA-aligned schemes, companies must have a strong cash flow and the capacity to generate a large amount of carbon credits to offset the project costs. These projects typically require an initial fee for listing the ICROA standard for issuance, ranging from \$100,000 to \$200,000. Project developers must pay annual fees to retain issuance rights to their carbon credits.

Income potential

Carbon credits under ICROA-aligned schemes offer income potential with relative certainty because they adhere to major carbon standards and are accepted by mainstream resellers. Developing custom carbon projects can be uncertain and costly for small and medium projects in Africa, mainly because of significant upfront investments and extended timelines. Larger projects, such as the [Northern Rangelands Trust](#), have a stronger business case because of their larger scope and volume.

The price of carbon credits is crucial to realize a positive return on investment for project developers. With the growing and evolving market, the average price of carbon credits is approximately \$10 per tCO₂e. This price is expected to see significant growth in the coming years, with forecasts suggesting prices of \$50 to \$120 per tCO₂e by 2030.⁷

According to the Berkeley [Voluntary Registry Offset Database](#), the volume of carbon-credit issuance to date is 137,873. In the category of solar home systems in Africa, 25,159 of these credits have been retired and sold. Most of the programs are ongoing, with completion dates from 2025 to 2030. The estimated annual non-binding assurance from the 15 projects within this category is approximately 326,000 tCO₂e per year. Pico-solar systems (which are not solar home systems) have 24 programs that have issued about 297,000 carbon credits, of which 144,000 have been retired and sold.

⁷ EY Net Zero Center, "Essential, Expensive and Evolving: The Outlook for Carbon Credits and Offsets," EY, 2022, accessed May 31, 2023, https://www.ey.com/en_au/forms/2022/download-carbon-offsets-report.

Joining an industry-tailored carbon program

For those seeking a more accessible and cost-effective path to carbon-credit generation, alternative programs such as CarbonClear take advantage of modern technology and streamlined processes to offer a faster route to the carbon market than traditional carbon projects.

Eligibility

Off-grid companies looking to join a data-driven carbon program should first exclude batches of solar home systems financed by donors, development-finance institutions, governments, or other parties that could claim the resulting carbon credits. Only rooftop-mounted systems are eligible and, as with other programs, the distributor and its customers should agree that the company will retain the right to the carbon credits. The program uses a standardized baseline, making it advantageous for distributors operating in multiple countries. Ongoing issuance is based on data transfer.

Time to market

The time to market for this strategy is approximately three months, which is significantly faster than other carbon-credit strategies. This rapid timeline enables off-grid solar companies to gain access the carbon market quickly and start generating revenue from carbon credits sooner.

Fee structure

The newer generation of carbon programs eliminate upfront costs and implement a transparent revenue-sharing arrangement. Unlike traditional carbon-credit programs that charge flat hourly and item-based fees, industry-tailored programs charge fees only once the carbon credits are sold and retired from the registry. This fee structure is based on a percentage of the carbon credit's retail price, making it more accessible and cost-effective for project developers. This approach lowers the financial barriers often faced by distributors in the carbon-credit market, enabling them to focus on developing and implementing projects.

Income potential

Off-grid solar companies participating in data-driven solar programs can expect to generate carbon credits in line with the methodology of the UN's CDM. The CO₂ yield from these programs is comparable to that of mainstream carbon standards. The credits become available on the registry much faster, as the data-driven solution allows for credits to be

issued daily or weekly. The cost to the distributor is also much lower because fees are paid only once the credits are sold.

The intended buyers for these credits are small and medium enterprises looking to offset their CO₂ emissions with high-quality carbon credits. Mainstream credit retailers, which prioritize traditional standards like Gold Standard and the Verified Carbon Standard, are not the primary sales channel for data-driven carbon programs. Instead, buyers may pay a higher price per ton of CO₂, focusing on smaller orders of between 100 to 1,000 tons per transaction. This “rack rate” is higher than that of mainstream credits sold through retailers, making smaller orders more compatible with the CO₂ output of small and medium solar-home-system distributors.

Trade-offs

Carbon-credit programs designed for off-grid solar companies are still a new approach compared to the established ICROA standards. Buyers and partners less familiar with newer models require additional time and effort from solar companies, which should educate and convince stakeholders of the programs’ credibility and benefits.

Large corporate buyers may initially be hesitant to adopt carbon credits generated through industry-tailored models because of their greater familiarity with ICROA-endorsed standards. Solar companies using the data-driven model may need to invest additional resources in marketing and sales to build trust and confidence among potential buyers.

Despite these trade-offs, modern carbon-credit models are an opportunity for solar companies to gain access to a more efficient, transparent, and cost-effective carbon-credit generation process.

7. Lessons from Off-grid Solar Companies

The VCM is complex and fast evolving. This section offers insights that companies have gained from exploring how to monetize their carbon credits. Although these lessons do not compose an exhaustive guide on carbon finance, an overview of the challenges and opportunities of the VCM is key to navigate this market. An important aspect of voluntary credits is that they are unregulated: Their price and quality vary and are negotiated between the buyer and the seller.

Key lessons from the VCM are:

1. No one-size-fits-all solution exists for carbon-credit projects.
2. Carbon credits are a complementary revenue stream, not a substitute for equity.
3. Off-grid solar companies should choose the right methodology.
4. Management buy-in is necessary for successful carbon-credit programs.

This section concludes with a six-month action plan that African solar companies to chart their way toward issuing carbon credits.

Carbon-credit projects do not have a one-size-fits-all solution

Off-grid companies such as d.light, ENGIE Energy Access, and Sunk King are exploring opportunities to monetize their efforts to reduce emissions. Although carbon credits can be a valuable source of revenue, they are not suitable for every company in the sector. Companies considering entering the market must carefully assess their eligibility, scale, and capacity to navigate the complex methodologies and verification processes involved. Key considerations are:

1. Eligibility and scale: Not all off-grid solar companies are eligible for carbon credits. A company must meet financial criteria and must be large enough to participate in the VCM, which may be difficult for smaller companies or those with limited resources. Projects may also have a limited window of opportunity because of additionality principles, such as vintage, for generating and monetizing carbon credits, potentially making the effort less profitable for companies that are unable to act quickly.
2. Market volatility and uncertainty: The carbon-credit market is subject to price volatility and regulatory uncertainty. For example, emissions savings can count as a national contribution, making it legally impossible to sell credits on the VCM. Price and regulatory uncertainty also affect off-grid solar companies' estimates of returns on their investment. Prices for carbon credits fluctuates from \$1 to \$30 depending on the method used to offset carbon. For small, decentralized household devices, the average price in 2022 for a Gold Standard–verified carbon credit was \$11.⁸
3. Partnering with specialists: To navigate the complexities of the VCM, off-grid solar companies should work closely with consultants or issuing companies such as [3Degrees](#), [ClimatePartner](#), and [South Pole](#). Collaboration helps companies gain knowledge and resources to make informed decisions, avoid common pitfalls, and maximize the benefits of the VCM.

⁸ AlliedOffsets, "2022 VCM Forecast and Retirement Analysis," AlliedOffsets, 2022, p.26, accessed May 30, 2023, <https://alliedoffsets.com/wp-content/uploads/2022/09/2022-VCM-Forecast-and-Retirement-Analysis.pdf>.

A complementary revenue stream does not substitute equity fundraising

Although carbon credits can benefit off-grid solar companies in Africa by generating additional income and supporting environmentally friendly initiatives, businesses should not aim to use credits to replace equity or traditional sources of funding. As always, companies should maintain diverse funding sources, and should see carbon credits as an opportunity to:

1. **Diversify income:** Carbon credits help a company reduce dependence on a single revenue stream, enhancing financial stability and attractiveness to investors.
2. **Enhance projects' viability:** By incorporating carbon-credit revenues into their financial models, solar companies can demonstrate the environmental and financial benefits of their projects, increasing the chances of securing traditional funding.
3. **Improve access to finance:** Participating in the VCM enables solar companies to tap into a global market of buyers looking to offset their emissions and invest in renewable energy in Africa.
4. **Generate long-term revenue:** Carbon credit programs can provide a steady, long-term revenue stream for solar companies, as they continue to generate and sell credits throughout the project's lifetime.

Selecting the right methodology

The methodology is the foundation of a carbon-offsetting project, as it outlines the procedures and guidelines to quantify and monitor reductions in GHG emissions. A universal methodology does not exist, and companies must find a methodology that aligns with their portfolio footprint, industry, and geography.

The right methodology will:

1. **Align with the project's objectives:** The methodology should align with your company's off-grid solar portfolio and scale.
2. **Comply with standards:** The mainstream VCM standards have come under increasing scrutiny because of concerns about the disproportionate costs and lack of traceability. Digital methodologies are paving the way for more accurate and tailored approaches to carbon offsetting.
3. **Be realistic to implement:** Some methodologies can be complex and challenging to implement, requiring significant technical expertise and resources. Consider the ease of implementation when selecting a methodology, as this factor can influence the cost and length of the project.
4. **Be recognized in the market:** The credibility of the chosen methodology can affect the demand for your carbon credits. Select a methodology that is widely recognized and accepted in the VCM to enhance the appeal of your credits to buyers.

Management buy-in is necessary for carbon-credit programs to succeed

A successful carbon-credit program relies on more than a sufficient volume of solar installations and high-quality data. It also demands that the management of the company commit to the program. The company's leadership should recognize the importance of minimizing carbon emissions, appreciate the business case the VCM presents, and be willing to allocate resources to generate carbon credits. Management sets the tone for the organization, and should foster a culture of sustainability.

Our experience working with solar companies in sub-Saharan Africa has shown that engaged CEOs can significantly expedite the evaluation process by making swift decisions with minimal delegation. African off-grid companies with committed senior executives are more likely to succeed in their carbon-credit programs. The case of Easy Solar demonstrates that CEOs who are engaged in carbon-offsetting make decisions quickly, streamlining the evaluation process.

Six-month action plan to issue carbon credits for an African solar company

The steps below describe the onboarding process for the CarbonClear program.

Step 1: Assess financial viability

When launching a carbon-offsetting program, the company should first estimate the value of the carbon credits that the off-grid energy solutions can generate. The business should also evaluate the cost of implementing the program. This information will reveal potential revenue streams from selling carbon credits and help the company determine if the program is viable.

Decision point: Positive return-on-investment calculation.

Step 2: Formalize agreements

Establishing the partnership agreement between the solar company and CarbonClear creates the framework for setting up other agreements such as those for sharing data with a third-party pay-as-you-go provider. The agreement outlines the terms and conditions of the partnership, including the scope of work, responsibilities, and timelines.

Decision point: Signed agreements.

Step 3: Conduct due diligence

As part of CarbonClear's due-diligence process, we require our partners to complete an onboarding form. This form collects information for our verifier to authenticate the data and ensure that it meets the necessary standards.

Decision point: Approving or declining the partnership based on the due-diligence process.

Step 4: Integrate data

Integrating data involves establishing a data-sharing agreement with a third-party data provider, such as [Angaza](#) or [Paygee](#). Depending on the volume of data and frequency of updates, the data integration can be automated and updated in real time. Once fully operational, the shared data enables CarbonClear accurately to calculate the CO₂ emissions that the off-grid technology saves.

Decision point: Data-quality approval followed by automated data sharing.

8. Business-case Toolbox

The Carbon Credit Business Case Toolbox helps energy-access companies determine the viability of carbon credits and forecast profitability based on real-world tCO₂e-offset prices. Developed in collaboration with energy-access companies, the Toolbox consists of four calculators: Carbon Credit, Price Sensitivity, Issuance Budget, and Return on Investment.

Carbon-credit calculator

The Carbon Credit Calculator estimates the number of carbon credits that solar home systems can generate. The calculator considers factors such as system size, location, and technology. To use the Carbon Credit Calculator effectively:

- Enter accurate and up-to-date information on system specifications and deployment locations.
- Update the calculator regularly with any changes in technology or deployment parameters to maintain accurate projections.

Price sensitivity

The Price Sensitivity module analyzes the effect of changing carbon-credit prices on the profitability of the project. To take advantage of the Price Sensitivity module:

- Monitor market trends and carbon-credit prices to understand their effect on project revenues.
- Explore price scenarios to determine the break-even point and assess project's resilience to market fluctuations.

Issuance budget

The Issuance Budget module helps companies estimate the costs associated with obtaining carbon credits, including fees to develop projects and verify and issue carbon credits. Effective ways to use this module are to:

- Research and gather accurate data on the fees to issue carbon credits, which help the company estimate the cost of the offsetting project.
- Monitor changes in fee structures or regulatory requirements to update the budget.

Return-on-investment calculator

The Return on Investment Calculator estimates the financial returns on deploying solar home systems and shows the income generated from selling carbon credits sales. When using this calculator:

- Update it with accurate data on costs, revenues, and carbon-credit prices to maintain realistic revenue projections.
- Compare the return on investment of different carbon-credit strategies (such as developing a carbon project, partnering with suppliers, or joining a data-driven carbon program) to discover the best approach for the company.

9. Appendix

A sample of listed African carbon-offsetting projects using solar home systems:

Carbon Credits: Solar – Distributed – Solar Home Systems (SHS)	Project ID	Registry	Status	Country	Project Developer	Methodology	Issuing Period	Credits Issued	Credits Retired	Credits Remaining	Estimate annual (non-binding)
Off-grid Solar in LDCs	CC1	CarbonClear	Certified	Africa region	CarbonClear ApS	AMS-1.L	2022-2030*	82,662	2,162	80,500	1,500,000
GS2527 – Mobisol Solar Home Systems in Tanzania ä€” VPA 1	GS2528	GOLD	Certified	Tanzania	Mobisol (Engie EA)	AM0019	2015-2025	25,447	25,159	288	9,630
Off-grid Solar PV project at IAMGOLD Essakane SA Gold Mine	VCS2434	VCS	Certified	Burkina Faso	Essakane Solar S.A.S.	AMS-1.A.	2018-2025	29,764	0	29,764	19,904
Solar Power for Rural Villages in Mali	GS11166	GOLD	Certified	Mali	atmosfair GmbH	AMS-1.L	2021-2026	0	0	0	3,000
Distributed Emission Reductions by Bbox Energy Solutions	GS11598	GOLD	Certified	Burkina Faso	BBOX LTD	AMS-III.AR	2021-2026	0	0	0	35,856
Emission Reductions due to distributed energy solutions by Bbox - I	GS11600	GOLD	Certified	Rwanda	BBOX LTD	AMS-III.AR	2021-2026	0	0	0	35,856
Solar Power for Rural Regions in Nigeria	GS11936	GOLD	Certified	Nigeria	atmosfair GmbH	AMS-1.D.	2022-2027	0	0	0	10,000
Pico Solar Home Systems Ethiopia	GS4217	GOLD	Certified	Ethiopia	atmosfair GmbH	AMS-1.A.	2015-2022	0	0	0	5,000
Solar systems for small businesses and households	GS11407	GOLD	Registration	Nigeria	Access to Energy	AMS-1.A.	2022-2032	0	0	0	60,000
Solar systems for small businesses and households ä€” CPA01	GS11408	GOLD	Registration	Nigeria	Access to Energy	AMS-1.A.	2022-2032	0	0	0	60,000
Rural electrification program Madagascar	GS7623	GOLD	Registration	Madagascar	atmosfair GmbH	AMS-1.L	2020-2026	0	0	0	5,000
Solar Home Systems In Lagos – Tranche 1	VCS2725	VCS	Registration	Nigeria	Solynta Energy Limited	AMS-1.E.	2020-2027	0	0	0	17,761
Malawi Solar Power and Adult Literacy Project	VCS2953	VCS	Registration	Malawi	SCB Brokers LLC	AMS-1.A.	2021-2028	0	0	0	21
Installation Of Solar Milling Plants for Household In Zambia, Project VCS2966	VCS2966	VCS	Registration	Zambia	Infinite Solutions	AMS-1.F.	2021-2028	0	0	0	28,014
Installation Of Solar Milling Plants for Household In Zambia, Project VCS2967	VCS2967	VCS	Registration	Zambia	Infinite Solutions	AMS-1.F.	2020-2027	0	0	0	25,998
Nesa Solar PV Grouped Project	VCS3659	VCS	Registration	South Africa	Nesa Power	AMS-1.F.	2020-2027	0	0	0	10,078
* The CarbonClear period is ongoing without an end date											
Grand totals								137,873	27,321	110,552	1,826,118

* The CarbonClear period is ongoing without an end date

Search: Renewable Energy – Solar – Distributed – Solar Home Systems (SHS)

Geography: Africa

Description: Solar Home Systems (SHS) are standardised off-grid PV systems that are generally self-contained and offer a cost-effective way to generate electricity for households and small businesses.

Source: Berkeley Voluntary Registry Offsets Database

<https://vvr.berkeley.edu/research-and-impact/centers/ccpp/projects/berkeley-carbon-trading-project/offsets-database>

A sample of listed African carbon-offsetting projects using pico-solar systems:

Carbon Credits: Solar – Lighting – Pico Solar Systems (PSS)	Project ID	Registry	Status	Country	Project Developer	Methodology	Issuing Period	Credits Issued	Credits Retired	Credits Remaining	Estimate annual (non-binding)
GS5304 MKOPA Solar Lighting Programme of Activities – Kenya VP	GS5314	GOLD	Certified	Kenya	Natural Capital Partners	AMS-III.AR	2015-2025	146,514	79,010	67,504	42,000
GS5304 MKOPA Solar Lighting Programme of Activities ä€” Kenya 1	GS5317	GOLD	Certified	Kenya	Natural Capital Partners	NULL	2017-2027	35,340	6,381	28,959	42,000
GS5304 MKOPA Solar Lighting Programme of Activities – Uganda V	GS5315	GOLD	Certified	Uganda	Natural Capital Partners	AMS-III.AR	2015-2025	34,440	20,793	13,647	42,000
Solar Lighting in Rural Kenya – VPA 2	GS3626	GOLD	Certified	Kenya	myclimate Foundation	AMS-1.A.	2017-2027	19,494	18,285	1,209	10,000
Namene Solar Light Company: Solar Lighting Project Zambia 1	GS7002	GOLD	Certified	Zambia	Namene Solar Lights Ltd.	AMS-III.AR	2021-2025	10,078	284	9,794	41,869
Namene Solar Lights Distribution Programme in Southern African G	GS10875	GOLD	Certified	Botswana	Namene Solar Lights Ltd.	AMS-III.AR	2023-2043	0	0	0	42,605
Namene Solar Lights Distribution Programme in Zambia – VPA1	GS10876	GOLD	Certified	Zambia	Namene Solar Lights Ltd.	AMS-III.AR	2023-2028	0	0	0	42,605
Namene Solar Lights Distribution Programme in Ethiopia	GS10831	GOLD	Certified	Ethiopia	Namene Solar Light Compa	AMS-III.AR	2021-2026	0	0	0	35,000
Namene Solar Lights Distribution Programme in Ethiopia – VPA 1	GS10868	GOLD	Certified	Ethiopia	Namene Solar Light Compa	AMS-III.AR	2021-2026	0	0	0	35,000
Namene Solar Lights Distribution Programme in Malawi – VPA2	GS10877	GOLD	Certified	Malawi	Namene Solar Light Compa	AMS-III.AR	2021-2026	0	0	0	35,000
Namene Solar Lights Distribution Programme in Zimbabwe – VPA1	GS11343	GOLD	Certified	Zimbabwe	Namene Solar Lights Ltd.	AMS-III.AR	2021-2026	0	0	0	42,605
Solar Lighting Mayotte	GS11657	GOLD	Certified	Mayotte	FONROCHE LIGHTING	AMS-1.L	2021-2026	0	0	0	1,000
Biolite Solar Lighting Project in Malawi	GS11397	GOLD	Certified	Malawi	Biolite Inc	AMS-1.A.	2020-2025	0	0	0	84,397
Biolite Solar Lighting Project in Rwanda	GS11398	GOLD	Certified	Rwanda	Biolite Inc	AMS-1.A.	2020-2025	0	0	0	63,298
GS5304 MKOPA Solar Lighting Programme of Activities – Kenya VP	GS7731	GOLD	Certified	Kenya	Natural Capital Partners	AMS-III.AR	2019-2029	0	0	0	42,000
Solar Lights and Solar Home Systems for Lesotho	GS6282	GOLD	Certified	Lesotho	atmosfair GmbH	Other	2018-2025	0	0	0	10,000
Solar Lighting in Rural Ethiopia – VPA 1	GS922	GOLD	Expired	Ethiopia	myclimate Foundation	AMS-1.A.	2010-2020	51,159	19,865	31,294	10,000
GS5304 MKOPA Solar Lighting Programme of Activities ä€” Tanzan	GS5316	GOLD	Expired	Tanzania	Natural Capital Partners	NULL	2016-2023	0	0	0	40,642
Lighting up Africa	VCS1324	VCS	Expired	South Africa	Standard Bank Plc	ACM0002	2014-2024	0	0	0	38,883
Mobisol Solar Home Systems Micro Scale PoA	GS2527	GOLD	Expired	Tanzania	Mobisol	AMS-1.L	2014-2021	0	0	0	0
Solar Lighting in Rural Areas PoA	GS911	GOLD	Expired	Ethiopia	myclimate Foundation	AMS-1.A.	2010-2017	0	0	0	0
*SolarAid Microsolar Lanterns Project for Malawi	GS393	GOLD	Expired	Malawi	Unknown Project Develop	Other	2008-2015	35	35	0	2,700
M-KOPA Solar Lighting PoA	GS5304	GOLD	Never certified	Kenya	Natural Capital Partners	AMS-III.AR	2016-2024	0	0	0	166,642
Namene Solar Light Company: Replacing Kerosene lights and paraff	GS7784	GOLD	Never certified	Namibia	Namene Solar Lights Ltd.	AMS-III.AR	2021-2026	0	0	0	41,869
Grand totals								297,060	144,653	152,407	912,115

Search: Renewable Energy – Solar – Lighting – Pico Solar Systems (PSS)

Geography: Africa

Description: Pico Solar Systems (PSS) are mainly portable lighting systems, typically below 10 Wp, such as lanterns, flashlights, etc., which may or may not include access ports for charging cell phones and radios.

Source: Berkeley Voluntary Registry Offsets Database

<https://vvr.berkeley.edu/research-and-impact/centers/ccpp/projects/berkeley-carbon-trading-project/offsets-database>