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Distributed renewable energy in Colombia: Unlocking private investment for non-interconnected zones

Lylah Davies,

Deger Saygin

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Distributed renewable energy in Colombia

Unlocking private investment for non-interconnected zones

PWB 2021-2022 item 2.3.2.3.2 on Mainstreaming Sustainable Finance

This working paper considers opportunities to unlock further investment in renewable electricity in Colombia's non-interconnected zones, building on international experiences from LAC and other regions. This includes a first section on global trends in the distributed renewable energy market, as well as new business models and financing models that have supported recent growth; an overview of the Colombian market and enabling conditions for distributed renewable energy in non-interconnected zones; a discussion on eventual mechanisms and de-risking instruments that can support the necessary capital flows for these solutions at scale; and finally, lessons learnt from eight case studies on measures that can maximise the impact of public and development funds to leverage private finance.

Lylah Davies Lylah.davies@oecd.org; Deger Saygin Deger.saygin@oecd.org.

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Abstract

Colombia has prioritised the use of renewable energy to expand and improve electricity services for its population in zones non-interconnected to the national grid. Recent policies and regulations have supported this ambition with successive measures to strengthen investment conditions for distributed renewable energy, like standalone solar photovoltaic (PV) solutions and hybrid solar PV mini-grids.

Still, the distributed renewable energy market in non-interconnected zones is relatively immature, reflected by the high costs for connecting new users. New business and financing models will be critical to bringing down the cost of renewable energy technologies, accessing private equity and debt in larger volumes, and ultimately progressing towards replacing existing inefficient and polluting diesel generation systems.

Building on international experiences, this paper discusses approaches to strengthening investment conditions, looking at support mechanisms and de-risking instruments used elsewhere, which can help bridge the financing gap in Colombia.

Keywords: renewable energy, distributed energy sources, energy Access, rural electrification, finance and investment, blended finance

JEL Classification: Q40, Q42, Q48, Q52, Q56, G20, H32, H54, H71

Résumé

La Colombie mise sur les énergies renouvelables pour étendre et améliorer l'accès à l'électricité des habitations non raccordées au réseau national. Plusieurs dispositions stratégiques et réglementaires ont récemment été adoptées pour renforcer les conditions favorables à l'investissement, notamment dans les installations solaires photovoltaïques autonomes et les mini-réseaux hybrides.

Cependant, ce marché manque encore de maturité, comme en témoigne le niveau élevé des coûts de raccordement. Il est ainsi nécessaire de déployer de nouveaux modèles économiques pour réduire le coût de ces technologies, de faciliter l'accès aux capitaux privés et à la dette tout en augmentant leur volume, et d'accélérer le remplacement des systèmes de production diesel existants.

En s'appuyant sur l'expérience internationale, les auteurs du présent document passent en revue différentes approches visant à renforcer les conditions d'investissement, identifiant plusieurs mécanismes de soutien et instruments de réduction des risques qui pourraient contribuer à combler le déficit de financement des énergies renouvelables décentralisées en Colombie.

Mots-clés : énergie renouvelable, sources d'énergie distribuées, accès à l'énergie, électrification rurale, financement et investissement, financement mixte.

Classification JEL : Q40, Q42, Q48, Q52, Q56, G20, H32, H54, H71

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The Clean Energy Finance and Investment Mobilisation (CEFIM) programme aims to support governments in emerging economies in South and Southeast Asia, Latin America and Africa to enable finance and investment in renewable electricity, energy efficiency and decarbonisation of industry ("clean energy").

There is considerable untapped renewable potential in Colombia's non-interconnected zones. Distributed renewable energy solutions, which can tap into local, sustainable energy resources like solar, wind, bioenergy, or waste, offer new economic and sustainable opportunities to improve the urgently needed clean and affordable energy services and achieve electrification. This working paper supports Colombia's Institute of Planning and Promotion of Energetic Solutions in the Non-interconnected Zones (Instituto de Planificación y Promoción de Soluciones Energéticas para las Zonas no Interconectadas, IPSE) by exploring opportunities to unlock finance and investment in renewable electricity in areas of Colombia that are unconnected to the national grid.

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The responsibility for the content of this publication lies with the authors.

Abbreviations and acronyms

ASE	Exclusive Service Areas Áreas de Servicio Exclusivo)
BEIS	UK Department for Business, Energy and Industrial Strategy
BMUV	Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection (German: Bundesministerium für Umwelt, Naturschutz, nukleare Sicherheit und Verbraucherschutz)
BMZ	German Federal Ministry for Cooperation and Economic Development (Bundesministerium für wirtschaftliche Zusammenarbeit und Entwicklung)
BNDES	Brazilian National Development Bank (Banco Nacional de Desenvolvimento Economico e Social)
BOOT	Build–Own–Operate–Transfer
CAPEX	Capital Expenditures
COP	Colombian Peso
CO_2	Carbon Dioxide
CVM	The Securities and Exchange Commission of Brazil (Comissão de Valores Mobiliários)
DC	Direct Current
DFID	UK Department for International Development
DRE	Distributed Renewable Energy
EE	Energy Efficiency
ERA	Government of Uganda, Electricity Regulatory Authority
EU	European Union
FAER	Fund for financial support of the expansion of energy services in rural zones (Fondo De Apoyo Financiero Para La Energización De Las Zonas Rurales)
FAZNI	Financial Support Fund for the Energization of the Non-Interconnected Zones (Fondo de Apoyo Financiero para la Energización de las Zonas No Interconectadas)

FCDO	Foreign, Commonwealth & Development Office
FENOGE	Fund for Non-Conventional Energy and Energy Efficient Energy Management (Fondo de Energías No Convencionales y Gestión Eficiente de la Energía)
FIDC	Green Receivables Fund (Fundo de Investimento em Direitos Creditórios)
FNR	National Royalties Fund (Fondo Nacional de Regalías)
FOES	Fund for social energy (Fondo de Energía Social)
FSSRI	Solidarity fund for subsidies and redistribution of income (Fondo De Solidaridad Para Subsidios y Redistribución de Ingreso)
GIZ	German development agency (Deutsche Gesellschaft für Internationale Zusammenarbeit)
GW	Gigawatt
IDB	Inter-American Development Bank
IPSE	Institute of Planning and Promotion of Energetic Solutions in the Non-interconnected Zones (Instituto de Planificación y Promoción de Soluciones Energéticas para las Zonas no Interconectadas)
KOSAP	Kenya Off-grid Solar Access Programme
kW, kWh, kWp	Kilowatt, kilowatt-hour, kilowatt-peak
LCOE	Levelised cost of energy
Lmhr/day	Lumen hour per day
m, m^2, m/s	Meter, square meter, meter per second
MEMD	Government of Uganda, Ministry of Energy and Mineral Development
MME	Ministry of Mines and Energy (Ministerio de Minas y Energia)
MSME	Micro, Small & Medium-sized Enterprises
MTF	World Bank Multi-Tiered Framework
NES	Government of Uganda, National Electrification Strategy
OPZS	Stationary PanZer plate Standard (Ortsfest PanZerplatte Standard)
PAYG	Pay-as-you-go
PV	Photovoltaic
PIEC	Indicative Plan for the Expansion of Electricity Coverage (Plan Indicativo de Expansión de Cobertura de Energía Eléctrica)

PPA	Power Purchase Agreement
PPP	Public-private partnerships
RE	Renewable Energy
REA	Government of Uganda, Rural Electrification Agency
REP	Government of Uganda, Rural Electrification Programme
RISE	Regulatory Indicators for Sustainable Energy
SHS	Solar home system
SIDA	Swedish International Development Cooperation Agency
UNOPS	United Nations Office for Project Services
UPME	Ministry of Mines and Energy's Planning Unit (Unidad de Planeación Minero Energética)
USAID	United States Agency for International Development
USD	United States Dollar
W, Wh, Wp	Watt, Watt-hour, Watt-peak
ZNI	Non-interconnected zones (Zonas No-Interconectadas)

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Executive Summary

Colombia has set an ambitious greenhouse gas (GHG) emission reduction target of 51% compared to its baseline scenario to be realised by 2030. To operationalise this commitment set in line with the Paris Climate Agreement, its Renewable Energy Law of 2014 and Energy Transition Law of 2021 will be critical to accelerate the use of renewable energy (excluding large hydropower). These two regulations prioritise expanding and replacing electricity services in non-interconnected zones. The most recent Indicative Plan for Expansion of Electricity Coverage (Plan Indicativo de Expansión de Cobertura de Energía Eléctrica PIEC) for 2019-23 reflects these goals by specifying the use of solar photovoltaic (PV) home systems and hybrid solar mini-grids to reach full electrification.

This working paper supports Colombia's Institute of Planning and Promotion of Energetic Solutions in the Non-interconnected Zones (Instituto de Planificación y Promoción de Soluciones Energéticas para las Zonas no Interconectadas, IPSE) by exploring opportunities to unlock finance and investment in renewable electricity in areas of Colombia that are unconnected to the national grid. These ambitions have been reaffirmed by plans under the new administration of President Gustavo Petro to develop a roadmap for a just energy transition.

There is considerable untapped renewable potential in Colombia's non-interconnected zones. These are areas where costs or logistical barriers have constrained traditional grid extensions and diesel generation currently provide the lion's share of electricity. While home to only 4% of Colombia’s population, these zones cover just over half the national territory, including diverse geographies and social contexts, which add to the complexity of new project development. Distributed renewable energy solutions, which can tap into local, sustainable energy resources like solar, wind, bioenergy, or waste, offer new economic and sustainable opportunities to improve the urgently needed clean and affordable energy services and achieve electrification. Transitioning towards renewable energy technologies also represents a significant opportunity to reduce costs to the government, linked to the supply and transport of diesel to remote and hard-to-reach locations.

Given the investment needed to reach full electrification through clean energy and eventually replace existing diesel generation, government funds alone will be insufficient, highlighting the importance of designing interventions to access private equity and debt in larger volumes. Indeed, with USD 2 billion in investment highlighted under the most recent expansion plan, Colombia’s non-interconnected market represents a considerable investment opportunity.

As Colombia designs and reviews interventions to support the renewable energy market in non-interconnected zones, it will be essential to consider measures that can lower the overall costs for the government, while strengthening the market's sustainability, and ensuring that the quality of electricity services continues to improve. To achieve the economies of scale that will be needed for its power system transformation with small-scale renewable power, systemic innovations in policy and new finance and business models that interact and reinforce each other are needed. Furthermore, given the rapidly evolving nature of off-grid markets, the government should continue to monitor instrument selection to ensure that they continue to be well suited to the market's particular stage of development.

Colombia can learn from experiences elsewhere on tools to support market development in a way that progressively reduces the need for capital subsidies and encourages participation of private capital. In particular, Colombia should consider the following areas where the public programmes and development partners can strengthen enabling conditions for private investment and support business model innovation:

- Programmes to support operators in developing technical capacity, including improved metering capabilities, would help existing resources be used more efficiently and support the sustainability of existing businesses. At the same time, better data on operations can be a critical tool for accessing finance.
- Development programmes can be tailored to strengthen the capacity of local financial institutions to offer green products. Building internal capacity and including procedures, such as simplified methodologies for evaluating off-grid renewable projects, can help reduce barriers to finance, including stringent collateral requirements.
- Supporting standardised documentation can increase transparency and provide investors with a more robust understanding of renewable hybrid mini-grid and off-grid solar sectors. Greater comparability amongst projects can also support financial aggregation and off-balance sheet financing.
- Project aggregation is a powerful tool for overcoming barriers to investment. Notably, it can create a pathway to tap into capital markets and attract international expertise to projects. Colombia can build on the site identification undertaken in electricity planning activities to develop multi-site tenders, which would help achieve economies of scale by reducing the individual transaction costs of each project.
- Where government support is critical to project success, notably for mini-grid projects in complex zones, approaches such as results-based financing or minimum subsidy tenders can help catalyse additional private investment. In particular, coupling grants with competitive procurement can support price discovery by providing insights into cost drivers in the local market.
- There are a number of different public funds that are available to distributed renewable energy project in non-interconnected zones, but lengthy and complicated grant application procedures can discourage their use. Simplifying procedures or creating a single window for grant applications could help extend the reach of existing resources.
- Both public and private sources of financing have a vital role in developing renewable energy solutions in Colombia's off-grid market. Therefore, interventions should prioritise the mobilisation of additional finance to bridge the finance gap for distributed renewables. Blended finance approaches, such as credit guarantees, can help strategically mobilise commercial lending.

Part I Unlocking private investment for distributed renewable energy in Colombia's non-interconnected zones

Introduction

Distributed renewable energy (DRE), such as solar photovoltaic (PV) systems, offer new opportunities to provide households, industry and commercial consumers with clean energy, independently from centralised systems. These installations are increasingly widespread, with 167 gigawatts (GW) of distributed PV systems installed globally between 2019 and 2021 (IEA, 2022[1]).

Where electricity grid expansion is uneconomical, DRE systems can play a central role in improving energy access and quality of service, capitalising on available natural resources. There is a largely untapped renewable potential in Colombia's non-interconnected zones, which could contribute to meeting multiple sustainable development goals through local low-carbon energy sources. In zones where electricity services are lacking or intermittent, these solutions can help improve access to sanitation, health services, education and productive employment whilst reducing local air and noise pollution linked to diesel generation. At the same time, increasing the use of renewable energy solutions can help alleviate the high costs of supply and transport of fossil fuels, mainly diesel, to remote and hard-to-reach locations.

The Government of Colombia has already taken several successful steps to drive new investment in renewable energy in non-interconnected zones. In 2019, the Ministry of Mines and Energy's Planning Unit (Unidad de Planeación Minero Energética, UPME) published expansion plans outlining the role of distributed renewable energy solutions in expanding electricity coverage in the country's non-interconnected zones. Most recently, the electricity tariff and subsidy regulations have been updated to improve cost recovery on operation and maintenance. These policies' effects are already seen through the deployment of solar PV home systems between 2020 and 2022, which have increased the renewable energy capacity in non-interconnected zones from to 16 MW to 46 MW.

Still, the renewable market in non-interconnected zones faces a number of challenges, not least of which, very high costs for providing electricity services and connecting new users. New business models will be critical to bringing down the cost of renewable technologies, whilst also improving access to finance and investment and continuing to affordably improve the quality of electricity services and achieve the replacement of existing diesel generation.

1 Global trends in distributed renewable energy

Globally, the cost of renewable technologies is falling, creating new opportunities for distributed renewables. At the same time, new financing and business models are improving the accessibility and sustainability of off-grid renewable energy solutions and providing new channels for technology suppliers and mini-grid project developers to access commercial finance. These models are helping bring down the costs of distributed renewables solutions, such as standalone solar PV systems combined with battery storage or renewable hybrid mini-grid systems and can support greater deployment in remote and hard-to-reach communities, like in Colombia's non-interconnected zones.

2021 has seen strong momentum for renewable power

At the end of 2021, the total global installed renewable energy capacity had exceeded 3 000 GW from 257 GW of new capacity additions. It is the 10th year in a row that renewable energy additions have exceeded non-renewables globally (IRENA, 2022[2]). In 2021, total installed solar energy capacity also surpassed wind for the first time, reaching 849 GW to become the second-largest renewable energy capacity after hydropower (IRENA, 2022[2]). Annual solar PV capacity additions are projected to reach somewhere between 210 GW and 240 GW by 2027, representing nearly two thirds of total annual renewable capacity additions (IEA, 2023[3]). While utility-scale solar makes up the bulk of this, distributed solar PV systems have been an important driver of growth, representing around one-third of total additions depending on the year (IEA, 2021[4]; IEA, 2023[3]). Under accelerated growth scenarios, distributed solar PV annual additions would reach almost 170 GW by 2027 (IEA, 2023[3]).

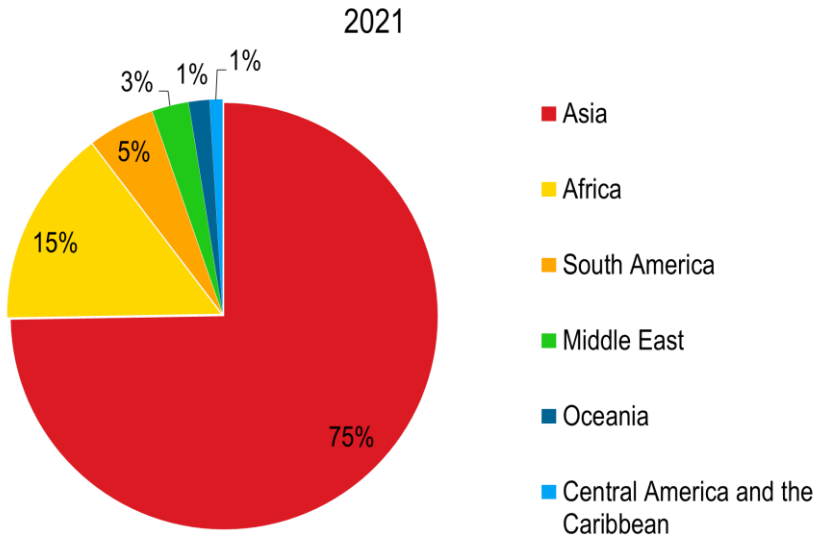
Distributed solar PV systems, and other renewable energy technologies that have the autonomous capability to satisfy electricity demand through local electricity generation (commonly referred to as *distributed renewable energy (DRE)*, offer new opportunities to provide clean energy to households, industry and commercial users, independently from centralised systems (IRENA, 2015[5]). Capacities can range from less than one kilowatt (kW) in stand-alone systems and individual electrification, to as high as a few megawatts (MW) in commercial and industrial buildings. Systems up to 50 MW are also used in mini-grids in hybrid mode with diesel generators to serve rural communities, institutional buildings and commercial/industrial plants and buildings (IRENA, 2015[5]). DRE can also be used for systems designed for productive uses such as telephone towers, water pumps or street lighting (IRENA, 2015[5]).

Solar PV, biomass, hydro, wind and in some cases, mainly on volcanic islands, geothermal energy are used in off-grid systems. Some common types of standalone and individual electrification systems used at small scale include micro- (100 kW and 1 MW) and pico- (less than 100 kW) hydropower plants, biogas plants (less than 100 kW) and few kW-size wind turbines (100 kW).Thanks to falling capital costs and improved technology for control systems, renewable mini-grids can be designed to incorporate multiple distributed energy resources including, for example, a dedicated solar PV installation and battery storage, but also solar home systems installed at customers' residences (Bloomberg, 2020[6]).

The use of off-grid systems is predominantly in emerging and developing economies. Of the 11 GW off-grid renewable energy systems installed globally in 2021, three quarters were located in developing Asia (IRENA, 2022[7]) (Figure 1.1). In particular, off-grid solar PV systems have had an important role in providing and maintaining energy access, with installed capacity growing rapidly over the last decade. While 1 GW was installed between 2007 and 2013, this quadrupled by 2018, with an additional 3 GW installed. From 2019 to 2024, 5 GW of new installed capacity is expected, which would more than double cumulative installed capacity (IEA, 2019[8]).

By 2021, cumulatively, 4.9 GW of off-grid solar PV had been installed, representing the largest share (45%) of total global installed off-grid renewable energy capacity. A further 2 GW of off-grid capacity was made up of off-grid hydropower, and the remaining 4 GW was a mix of different renewable technologies (IRENA, 2022[7]).

Figure 1.1. Breakdown of the total installed global off-grid renewable energy systems, in 2021



Source: (IRENA, 2022[7]) Capacity statistics Renewable Capacity Statistics 2022

Distributed renewable energy is improving electricity services in off-grid communities

Drivers to invest in DRE, and the subsequent benefits that can be gained, will depend on the type of user. For instance, off-grid DRE can be used to provide electricity to communities who currently do not have access to modern energy services. It can also improve the energy independence of communities who rely on a few hours of inefficient, expensive, and polluting sources for their daily uses of power, cooking, heating and cooling.

In remote communities, off-grid solutions assume an important function for providing and improving access to electricity. In many cases, extending the main grid is prohibitively expensive, and in small populations, where there is limited electricity demand, infrastructure costs cannot easily be recovered through the user's electricity consumption. By contrast, off-grid renewables offer lower cost solutions that are well adapted to the size and needs of communities, with solutions that can be tailored to provide different levels of electricity services. For instance, stand-alone systems can be well adapted to areas where there is low population density and electricity demand is starting from a very low base (i.e. lighting solutions). For zones

that have sufficient demand and population density for commercial viability (i.e. where schools and business operate), but where costs or barriers are too high to deliver on the timely arrival of the national electricity grid, mini-grids can be an economically viable option.

The World Bank Multi-Tier Framework (MTF) provides an approach for looking at the quality of electricity services, which can range from simple lighting for a few hours a day (Tier 1) to at least 23 hours of sufficient electricity to power high-load appliances, such as air conditioning units and electric cookers (Bhatia and Angelou, 2015[9]) (Box 1.1).

Furthermore, off-grid DRE can support productive end uses, which enhance the income and welfare of local communities, through improved processes for agriculture and greater access to health services and education, amongst others. This is done by meeting the power needs of numerous scattered and small-scale electricity-using devices, including water pumping for irrigation, lighting, information and communication systems, vaccine refrigeration and other health-related energy needs. Direct economic gains can be made by avoiding extensive reliance on fossil fuel supply and its logistics (e.g. storage). In addition, costly expansion of distribution grids to locations with low power needs would no longer be needed, and power could be supplied from clean and low-cost energy resources.

At the same time, investing in small-scale renewable power can create significant social and economic benefits. These systems are labour-intensive across their design, installation, and operation and maintenance phases. This means that small-scale renewable power can create new economic activities across the value chain, which require higher-skilled and better-paid jobs, thereby improving the welfare of societies that invest in them.

Box 1.1. World Bank Multi-Tier Framework (MTF)

- The World Bank MTF represents an effort to develop metrics and a database for evaluating electricity access in a non-binary fashion. It redefines energy access from traditional accounting of who is connected or not connected and who is cooking with firewood or not, to a multidimensional metric that considers whether energy services are adequate, available, when necessary, reliable, of good quality, convenient, affordable, legal, healthy and safe for all.
- Developed in the context of the Sustainable Energy for All (SEforALL) initiative, the MTF supports efforts to measure progress towards Sustainable Development Goal 7 (SDG7), to "Ensure access to affordable, reliable, sustainable and modern energy for all."
- Energy access is measured on a tiered spectrum, from Tier 0 (no access) to Tier 5 (the highest level of access). This means that the quality of access is evaluated, rather than just access to any source of electricity. According to the new definition, a grid connection does not necessarily mean access to electricity, since other aspects such as reliability and affordability, among other attributes, are considered.

Figure 1.2. Attributes of multi-tier framework

Note: watt (W), watt-hour (Wh), kilowatt-hour (kWh), hours (hrs), lumen hour per day (lmhr/day)
Source: (Bhatia and Angelou, 2015[9]) Beyond Connections: Energy Access Redefined

Renewable power and enabling technology costs are declining

Distributed renewable energy and off-grid solutions, which can tap into local, sustainable energy resources like solar, wind, bioenergy, or waste, offer new economic and sustainable opportunities to improve clean and affordable electricity services. Technological innovations have contributed to bringing down the cost of manufacturing, whilst also increasing the efficiency of distributed renewable technologies and related appliances. These unprecedented cost reductions across various renewable energy technologies, coupled with continuous improvements to battery technology, are increasing the quality and affordability of distributed and off-grid system solutions (IRENA, 2021[10]).

Some of the most impressive growth has been seen in distributed solar PV (notably, for commercial and residential use), which makes up nearly a third of the global renewable capacity additions forecast until 2027. This is largely driven by high natural gas prices which are increasing retail electricity bills (IEA, 2023[3]). In addition, distributed solar PV already makes up the lion's share of installed off-grid renewable energy capacity, accounting for 4.9 GW of the total 11.2 GW installed off-grid in 2021 (IRENA, 2022[7]). Solar PV also represents the fastest growing share of off-grid distributed renewables (IEA, 2019[8]).

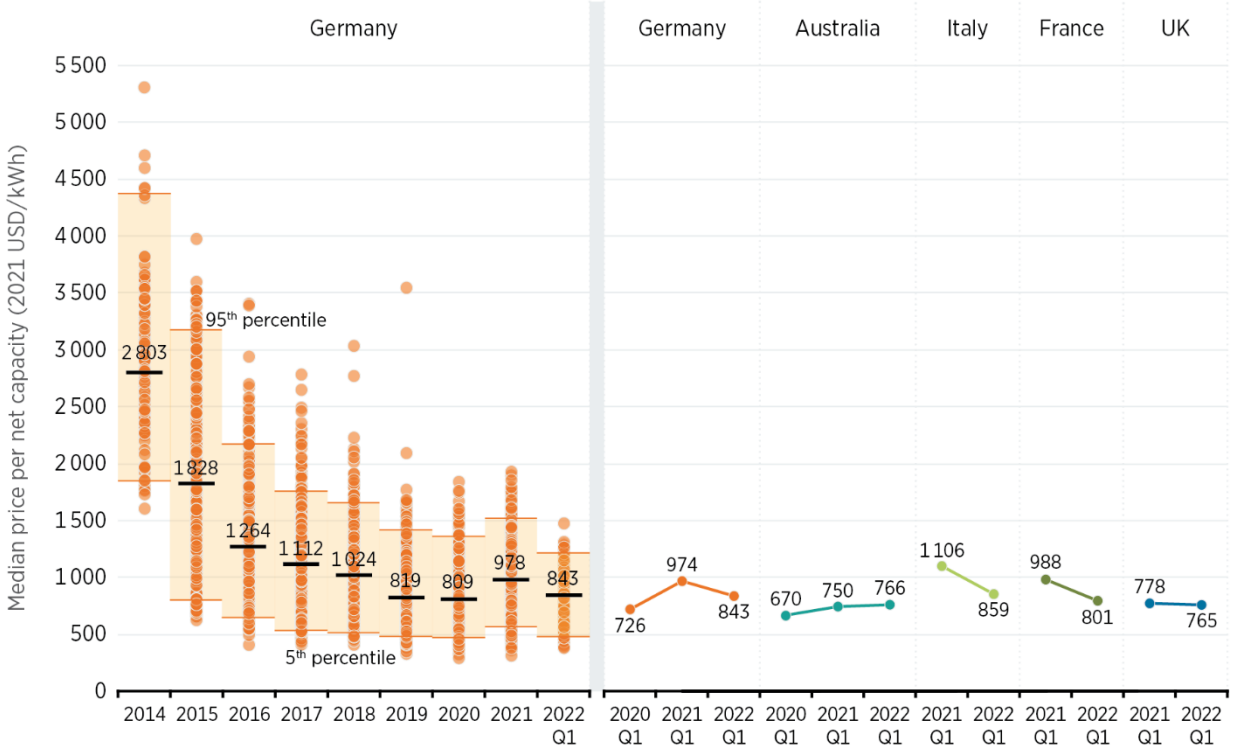
The levelised cost of rooftop solar PV systems decreased by 46%-85% between 2010 and 2020, depending on the market. Commercial system costs decreased by between 69% and 88% in the same period. Similarly, the cost of electricity generation from utility-scale solar PV systems declined by 82% between 2010 and 2021. This brought the average cost down to below USD 5 cents per kilowatt-hour (kWh) in 2021. This was driven by a similar rate of decline in capital costs as well as the increased efficiency and capacity factors of newer systems. The higher costs of residential rooftop PV systems compared to utility-scale ones can also be a proxy for distributed solar PV systems (IRENA, 2022[11]). Nevertheless, there are large disparities in the costs of systems across countries. Typically, developing Asian countries have the cheapest systems, but costs are still relatively higher in certain countries, such as Thailand, explained by the source of equipment and supply chain disruptions.

At the same time, the falling cost of storage systems is driving increasing investments. Estimates show that at the end of 2021, behind-the-meter storage investments reached an all-time high of about USD 2.3 billion per year, but still half of grid-scale battery storage systems (IEA, 2021[12]). Costs decline was the main reason for this growth; as an example, costs of small-scale residential battery systems in Germany fell by 71% between 2014 and 2020 (IRENA, 2021[10]) (see Figure 1.3). This is particularly interesting for off-grid solutions, as performance and system benefits can be increased when integrated with energy storage systems. Both lithium-ion and lead-acid batteries are commonly used in off-grid solar PV systems. The quality of batteries can vary for both technologies. Lithium-ion batteries tend to be more expensive but are more efficient and flexible at storing power per unit mass and have a longer lifecycle compared to the conventional lead-acid technology.

In this context, the cost of solar-battery–based mini-grid and standalone solar PV solutions are declining at a faster rate than systems powered by other renewable technologies. Capital costs for hybrid solar mini-grids in Africa and Asia have fallen from USD 8 000 to USD 3 900 per kW of firm power output from 2010 to 2018 - with estimations that this could drop to below USD 3 000 per kW of firm power output by 2030 (ESMAP, 2019[13]). Solar hybrid systems combine solar PV systems with another energy source, typically diesel. The use of diesel generators enables the mini-grid to fill the gap between the load and the power generated by the PV system. The system performance can be further enhanced with battery storage.

In addition, the falling cost of other components including inverters and smart meters has improved the quality of service these solutions can provide. The efficiency of Direct Current (DC) appliances is also improving, which expands the number of appliances available in the off-grid market. Previously, typical Alternative Current (AC) powered appliances would require additional investment in inverters to convert solar PV's DC power to AC.

Figure 1.3. Behind-the-meter residential lithium-ion battery system prices in Germany, Australia, France, Italy and the United Kingdom, 2014 - Q1 2022



Source: (IRENA, 2022[11]) Renewable Power Generation Costs in 2021

Off-grid renewable solutions are becoming more affordable

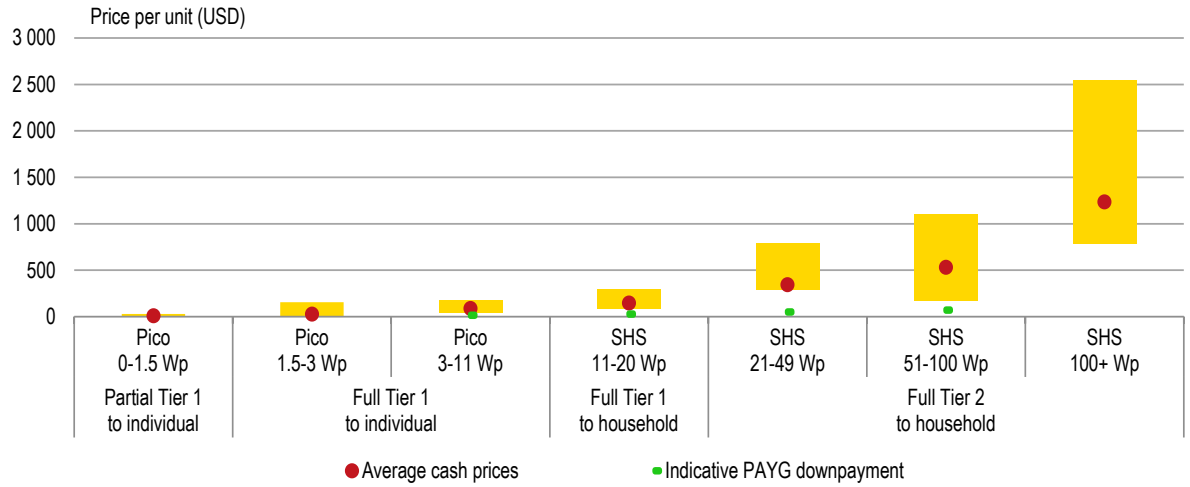
Off-grid renewable project costs are typically much higher than simple solar PV installations. Depending on the country, the region and the size of the installation, costs for procuring and installing systems can significantly increase overall costs. This is linked to difficulties accessing and installing systems in remote areas, especially where there are few potential users and where economies of scale are limited. As risks and costs are higher, there are also fewer installers than in urban areas. In addition, the project uncertainties of expanding solar PV systems to low income and low energy using consumers increases project risks from the perspective of lenders and investors and can drive up the cost of capital.

Nevertheless, off-grid solar is also seeing declining costs. The levelised cost of electricity (LCOE) in 2018 for an efficient solar-battery-diesel system serving more than 1 500 household customers was about 55 cents per kWh. By 2030 this is predicted to fall to 20 cents per kWh (ESMAP, 2019[13]). Predicted cost reductions are notably linked to declining capital costs, increased use of remote-controlled management systems, smart meters and geospatial portfolio planning tools, and expected increase in productive uses of electricity during the daytime. Geospatial portfolio planning tools can significantly reduce pre-site preparation costs from around USD 30 000 per site to USD 2 300 (ESMAP, 2019[13]).

For off-grid solar, a wide variety of products are now available at different price points and user needs. As expected, solar home systems that provide higher levels of electricity access, tend to be more expensive, notably due to the cost of battery storage, which can enable use of energy intensive appliances. Pico systems, on the other hand, which are small-scale devices that contribute to improved lighting and possibly phone charging for a few hours, are much less costly (Figure 1.4). Moreover, there is large price variation within system sizes linked the supplier, the technologies used, and other costs added through tax and

import policies. Quality standards can be a notable cost driver, with prices increasing for components, which have undergone quality verification and benefit from warranties.

Figure 1.4. Global Indicative Price Ranges of Pico and SHS Products by Wattage and MTF Tier



Notes: Watt power (Wp), Solar home system (SHS), multi-tiered framework (MTF), Pay-as-you-go (PAYG)
Source: (IFC, 2020[14]) Off-grid Solar Market Trends Report 2020

Investments for universal modern energy access need to scale up

Already, the off-grid market has attracted significant levels of investment. In 2020, the market for individual solar solutions attracted a cumulative USD 1.5 billion in capital investment, with an estimated 180 million units sold (IFC, 2020[14]). By 2019, at least 19 000 mini grids had been developed, providing access to 47 million people across 134 countries. This represents an estimated total investment of USD 28 billion. Between 2010 and 2020, the global electricity access rate has increased from 83% to 91%. In the same period, the number of people who did not have access to electricity fell from 1.2 billion to 733 million.

The pace of development is accelerating, with twice as many solar-hybrid mini-grids built between 2014 and 2018, as those built between 2009 and 2013. Looking ahead, more than 7 500 mini-grids are planned over the next years to connect 27 million people, mostly in Africa, for an investment representing USD 12 billion (ESMAP, 2019[13]).

Despite this progress, efforts towards achieving affordable access to clean energy under Sustainable Development Goal 7 need to be prioritised. Projections suggest that the pace of electrification has slowed, and that the world will reach only 92% electrification by 2030. This is in part due to the complexity of reaching last-mile communities which are increasingly remote and hard to access. The unprecedented impacts of the COVID-19 pandemic have further slowed progress (World Bank, 2022[15]).

At the same time, it is vital to continue increasing the quality of electricity services to communities that already have access, bringing access from Tier 1 lighting to Tier 3, Tier 4 and Tier 5, which respectively enable the increasing use of appliances for refrigeration, cooking, heating and cooling for more hours throughout the day and night. Indeed, globally there are still 2.5 billion people relying on solid biomass, kerosene or coal as their primary cooking fuel, which impacts on both human health and carbon dioxide (CO_2) emissions (IEA, 2022[16]).

To achieve universal access and maintain development aligned with the net-zero pathway, much more investment is needed in renewable solutions of off-grid communities. The scope of the challenge largely

depends on the level of electricity services to be provided, as well as the means of electrification. Distributed renewable solutions (including standalone solutions and mini-grids) and grid extensions will each have different roles to play in providing access to modern energy services.

The World Bank estimates that to provide 617 million people with Tier 1 standalone solar products as their main source of electricity, USD 6.6 - 11 billion in additional financing is needed. This would provide access to basic lighting, phone charging or a radio for a few hours a day (Box 1.1). This is foreseen alongside electrification through the continued deployment of mini-grids and grid extensions, which would provide up to Tier 5 access, ultimately allowing for full electricity access. Of the estimate financing needed, USD 6.1 to 7.7 billion is estimated to be needed as external investment into off-grid solar companies, and up to USD 3.4 billion for public subsidies to bridge the affordability gap (IFC, 2020[14]). With respect to electrification through hybrid mini-grids, another World Bank study had also estimated that over 210 000 mini-grids would be needed to reach 490 million people by 2030, representing USD 220 billion in investment (ESMAP, 2019[13]).

Tracked cumulative investments of USD 13.6 billion by 2019, point to a significant gap that needs to be closed.[1] Financing flows for access to electricity also remain well below what is needed. The latest data on financing flows from public, private, international and domestic sources show that 2019 marked a three-year low of USD 31.9 billion for the 20 countries that represent 80% of the electrification access deficit (SEforALL, 2021[17]).

Project delivery models for mini-grids and standalone solutions are evolving rapidly

Distributed renewables in off-grid zones are developed under different project delivery and business models, which differ significantly for mini-grids and off-grid solar.

Mini-grids are best suited to densely populated communities, where the installation, operation and maintenance costs of these systems can be recovered through the energy use of consumers. Various business models exist but no one proven model has emerged for private sector-led deployment. This is reflective of the distinct contexts in which mini-grids have been deployed. Indeed, mini-grid systems built over the last 100 years were generally small-scale and isolated diesel and hydro systems, developed by the government, local communities or entrepreneurs to provide electricity to communities in remote areas.

Many delivery models now exist, including build-own-operate and various other forms of public-private-partnership. Several different approaches also target project initiation, for instance through donor site identification and implementation with partners, tenders and reverse auctions (NREL, 2018[18]). Modern renewable hybrid systems, which incorporate technologies such as PV and battery energy storage, more often involve non-local investors who bring with them technical expertise and foreign technology suppliers. The business model for these is principally dependent on ownership, operatorship, project size, customer target and technology (Bloomberg, 2020[6]).

Pilot programmes now use mini-grid aggregation to attract investment. One form of aggregation is operational bundling of projects with a similar business model, geographical area, technology and customer type, under one developer. This can help reduce development and operating costs (e.g. maintenance and fuel) through economies of scale and dilute the impact of project specific risks. Another

[1] This includes country-specific data from Angola, Congo (DR), Ethiopia, Kenya, Mozambique, Nigeria, Tanzania and India as well as aggregate data for all sub-Saharan African countries except for South Africa and aggregate data from developing Asia based on Bangladesh, Myanmar and Pakistan.

form of aggregation is financial bundling, which is the aggregation of projects into a portfolio to attract more private finance and investment through increased size and portfolio de-risking (NREL, 2018[18]).

In addition, community ownership models are now starting to emerge. These are models for collective ownership and management of DRE, where through cost-sharing, individual participants are able to own assets with lower levels of investment (Box 1.2).

Box 1.2. Community ownership models

Community-ownership projects vary in size but tend to be between 5 kW and 5 MW, and often are solar PV, wind or biomass plants. These projects are developed to fulfil the electricity needs of the local community, and any additional electricity generation can be sold to third parties and businesses or stored to be used later if batteries are available. Under a community-ownership model, local stakeholders own most of the project and retain majority voting rights. The local community therefore benefits from most of the project's socio-economic benefits.

By implementing the project as a community, consumers can opt for a larger project size or aggregate demand to enable bulk procurement of smaller systems. Demand aggregation can help communities negotiation for better prices with installers, project developers and equipment suppliers, thus lowering the upfront investments needed from community members. For example, community battery storage provides economic advantages over household storage as costs per kWh decrease with increasing battery size.

By lowering the upfront investment, these models can help rural communities access renewable energy at lower costs. At the same time, community-ownership could be implemented together with flexible payment methods, such as pay-as-you-go models, extending access to population with the lowest incomes. In addition, these projects can improve livelihoods by enabling productive uses, such as agro-processing, cold storage, irrigation or supporting greater productivity amongst micro-enterprises.

Source: (IRENA, 2020[19])

For standalone solar solutions, cash-based sales have been the backbone of the industry, accounting for over three-quarters of unit sales in 2020. This can be explained by the number of pico products sold, which accounted for over 80% of the 180 million units sold by 2020 (IFC, 2020[14]). Pico products, which are small-scale devices that contribute to improved lighting, are often lower than Tier 1 access (Bhatia and Angelou, 2015[9]). These units are now competitive and have a multitude of technology suppliers, providing users with highly affordable lighting solutions. With increased competition in the market, pico products are being sold at increasingly lower prices and suppliers face reduced margins. Companies are therefore turning towards the pay-as-you-go (PAYG) solar home system market (Box 1.3). This approach enables sales of higher margin household appliances given the potential of PAYG to increase the affordability of larger systems and connected appliances such as fans, televisions and refrigeration (IFC, 2020[14]).

Box 1.3. Pay-As-You-Go (PAYG) models

Energy service providers can offer PAYG with power supply services ranging from Tier 1 power supply, which would include just lighting and phone charging, to Tier 5 access which could power multiple home appliances throughout the day.

PAYG models include a combination of payment rules and ownership and financing schemes. Notably this can include:

- Lease-to-own models, also referred to as the "consumer finance retail" model.
- Usage-based payment model, or the "micro utility" model.

Under lease-to-own models, over a given period, the customer will pay for the solar home system in small instalments. This typically can take between one and three years. For example, a standalone solar solution which can provide Tier 1 access (power light bulbs and radios and charge mobile phones) can be priced at approximately USD 150. Solar PV systems with batteries that can provide Tier 4 access (power major appliances such as refrigerators that need uninterrupted supply) can cost up to USD 1 000. This can be repaid by customers in instalments over six months to three years. In the case of payment default, the equipment can be reclaimed by the energy service provider. A majority of PV systems provided under PAYG operate using the lease-to-own model.

Under usage-based payment models, the customer prepays electricity supply (in kilowatt-hours), by loading money onto a prepaid meter. The customer can therefore use the amount of electricity that corresponds to the amount of money paid. Once consumed, the solar PV system can be automatically turned off through a remotely managed control system until the next payment is made. Under this mode, the customer never owns the system and only consumes the electricity generated.

PAYG models can be implemented for households or broader communities. Although PAYG is most commonly with solar home systems and standalone solar PV systems, it can also be implemented as a micro-grid solution to provide electricity supply services to communities.

Source: (IRENA, 2020[20])

In rural low-income communities in developing countries, Solar PV systems are often times completely subsidised by the government. Under other models, such as in Colombia, government or utilities procure solar home systems through bulk purchases from technology suppliers, to provide energy services to end users, under a usage-based payment model (see for example the case Kingo, a solar home system and appliance supplier in Colombia in Box 3.1).

The standalone solar system market has picked up momentum over the last years, reaching USD 1.75 billion annual market turnover in 2020, up from USD 1 billion in 2017. The market's rapid uptake over the most recent years has been driven by higher-priced PAYG-enabled household appliances, such as fans and televisions (IFC, 2020[14]). The cumulative market opportunity across televisions, fans and refrigerators, which represents the value of sales to households if the financing were available, was estimated at USD 12.6 billion globally in 2019 and could rise to USD 25.3 billion in 2030 (Efficiency for Access, 2019[21])

Productive uses that leverage renewable technologies represent an emerging opportunity for off-grid renewable sector. Various solar-enabled appliances, such as solar water pumps, cold storage for agricultural applications or refrigeration, can increase the productivity of small businesses (IFC, 2020[14]).

This market is still largely dependent on government support, but there is a growing commercial opportunity. In Sub-Saharan Africa alone, the value of sales to businesses if the financing were available would be USD 11.3 billion (IFC, 2020[14]).

New business models beyond energy services are now emerging, making use of data collected through PAYG platforms to evaluate creditworthiness and upsell new products, such as loans to small businesses or micro insurance. Across these business models, artificial intelligence and the Internet of things will continue to increase operational efficiency, by improving data management, customer service, and providing remote monitoring and control over solar PV systems and enabled appliances (IFC, 2020[14]).

Supportive policy and regulatory frameworks are critical to facilitating investment

Supporting regulation and policies are needed to enable renewable energy business models and improve the affordability of technologies.

For grid-connected projects, the uptake of small-scale renewable energy systems has been largely driven by the regulatory frameworks in place, which can include provisions for self-consumption, net metering, net billing, feed-in tariffs, feed-in premiums and in some cases, auctions. The feasibility of these options depends on the tariff at which electricity can be sold to the grid as well as the retail tariff, i.e. the rate electricity is purchased from the grid.

Enabling these models will depend on suitable electricity tariffs (including enhanced time of use tariffs that can enable demand response, shifting demand to when there is large renewable energy outputs) (Poudineh, Mukherjee and Elizondo, 2021[22]). Voluntary approaches such as green tariffs (green premium over standard tariffs for procurement of renewable power) and corporate sourcing models complement regulatory frameworks. Certificates of origin, corporate power purchase agreements (PPAs) and green procurement programmes are common corporate sourcing instruments used so far.

In off-grid markets, supportive policies and frameworks are even more critical to bring down costs and risks to investors. For both mini-grids and standalone solutions national programmes, financial incentives, standards and quality requirements are critical elements for mobilising investment. Given the price sensitivity of end users of standalone solar PV system, governments are increasingly deploying fiscal incentives to bring down costs. For example, in Bangladesh, solar panels and modules are value added tax (VAT) exempt since 2018, and in Niger, off-grid solar components such as PV modules, batteries and inverters are exempt from import and tax duties (IFC, 2020[14]). For mini-grids dedicated legal frameworks for mini-grid operations and the ability to charge cost-reflective tariffs are particularly important to reduce risks and costs (ESMAP, 2021[23]).

Cost recovery through tariffs is a critical factor in the decision to invest in any type of distributed renewable project development. Off-grid residential consumers are typically characterised by low-income segments of the population who consequently have uncertain energy demand profiles and a low ability to pay for electricity services. Under these conditions, tariffs must meet the dual objective of cost recovery and energy access. In developing and emerging economies, more capital-intensive distributed renewable solutions, such as solar mini-grid systems, can oftentimes require some form of subvention to bridge the gap, either in the form of a tariff subsidy or a capital cost subsidy, or a combination of both.

Still, complex procurement and tariff negotiations for mini-grid can lead to delays in project development and uncertain cost recovery. This consequently increases project development costs, and will impact on the cost of capital, as investors require higher interest rates to compensate for risks. Comprehensive sets of regulations can help reduce risk to the developer and cut down on the time needed for project development. In Nigeria for example, dedicated regulation has been developed for licensing, retail tariff

setting, and compensation for the early arrival of the main grid which helps provide a predictable investment environment (ESMAP, 2019[13]).

To keep pace with rapidly evolving markets, enabling frameworks need to be flexible. New business and financing models are becoming critical enablers for increased investment in distributed renewable energy, including PAYG, consumer financing and project aggregation, to name a few. In addition, given the increasing importance of PAYG solutions paid for through mobile phone, as well emerging use of artificial intelligence and IoT, digital and financial sector regulations around mobile money and digital payment services will be pivotal to the off-grid sector (IFC, 2020[14]).

Various financial models have supported the expansion of mini-grid and standalone solutions

The off-grid DRE sector has historically been largely dependent on development finance, although the market for standalone solar PV systems is seeing increasingly maturity.

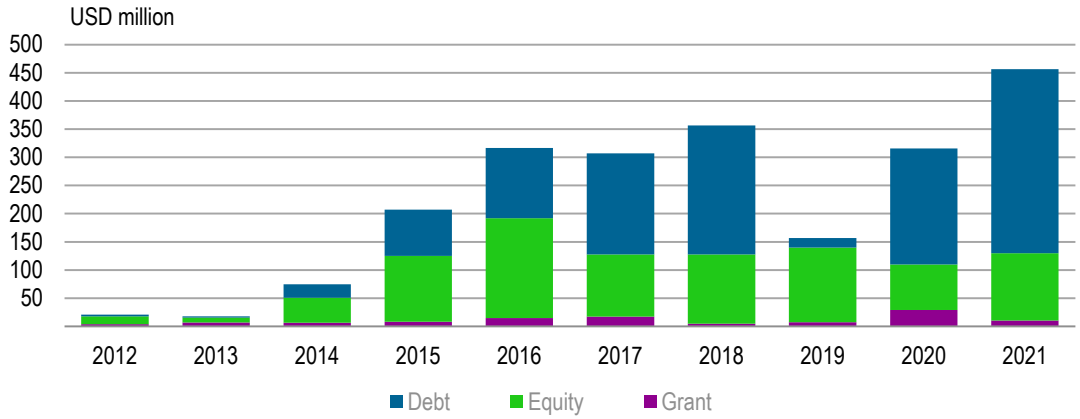
To date, the financial sustainability of mini-grids in remote access has been largely dependent on grants, subsidies, seed equity and concessional loans. Since 2007, development finance institutions (DFIs), public funds, donor agencies, impact investors and foundations, belonging to the *Mini-grids funders group,* have approved USD 2.07 billion, aimed at assisting private mini-grid developers and providing technical assistance to the government to strengthen regulation and policy (ESMAP, 2019[13]).

The main types of financing structures for the mini-grid market are upfront grants combined with developer's equity; results-based financing grants closing the viability gap for developer's equity and commercial debt; and public-funded projects under public-private partnerships (PPP) where the government provides upfront capital expenditures (Bloomberg, 2020[6]). The involvement of the public sector or development institutions in these models has been critical to overcoming perceived and real risks in the mini-grid market, for example regarding regulatory uncertainty or lack of historic data on consumer's power demand.

Although, the privately driven market for mini-grids is relatively immature, new private finance approaches are emerging. This includes project financing of aggregated projects and use of convertible notes, although the latter has seen relatively few examples (Bloomberg, 2020[6]). Since 2018, strategic financiers including oil majors, trading houses and venture capital firms are starting to enter the market. A few dedicated debt providers, such as Sun Funder, have provided commercial finance. Still, both commercial lenders and strategic financiers tend to engage in the mini-grid sector where there is also support from development partners or public sector (ESMAP, 2019[13]).

By contrast, the market for standalone solar systems is maturing, as demonstrated by increasing debt and larger ticket sizes. There are now several generations of solar technology suppliers. Amongst these, first movers benefited from higher levels of equity from impact investors and venture capital funds to grow their businesses. From 2015, more debt became available from DFIs and specialised debt providers such as Sun Funder and SIMA, and crowdfunding platforms such as Trine, enabling these early companies to grow rapidly (Figure 1.5).

Figure 1.5. Total capital raised for individual solar solutions



Notes: United States Dollars (USD)
Source: (GOGLA, 2022[24]) Investment data - Total capital raised and financing blend

This trend has led to a concentration of investment amongst the top 10 recipients, who have received 78% of total investments. These are Zola Electric, D. light, M Kopa Solar, BBoxx, Mobisol, Nova Lumos, Greenlight Planet, Azuril Technologies, Kingo and Solar Now. For these companies, impact investors and venture capital funds have been instrumental in supporting the sector's initial development, but funding constraints are now diminishing their influence on the sector (IFC, 2020[14]).

New companies are finding it more difficult to match their predecessor's growth as equity and grants are now limited in availability. With large amounts of venture and impact investor capital locked into first-generation companies, these entities are now prioritising debt as means to make catalytic investments in off-grid companies. Crowdfunding is also bridging this gap, notably through peer-to-peer business lending for smaller ticket sizes. This is primarily providing capital to younger companies that cannot access mainstream debt, although this trend is also picking up for larger companies. At the same time, specialised debt providers are becoming more influential. Their specific impact mandates to support access to clean energy have helped them develop the required expertise to evaluate renewable developer credit risks and manage smaller ticket sizes (IFC, 2020[14]).

DFIs are now prioritising debt facilities and funds to support off-grid solar, increasingly with direct lending in local currency. Local commercial debt has remained limited to date due to a lack of experience and capacity to deal with off-grid business models. DFIs can therefore have strategic role in de-risking projects and sharing technical experience in the off-grid market to crowd in commercial finance. Mobilising local currency financing is particularly beneficial to the sector, as it can help off-grid solar suppliers avoid exposure to additional risk through currency exchange fluctuations (IFC, 2020[14]).

Increasingly, blended finance arrangements, which use development funds to mobilise private capital, are being recognised for their potential to support DRE markets. With a small amount of development finance, interventions can be designed to overcome project and investment barriers and mobilise private capital. Blended finance can, for example, support securitisation models through grants and guarantees (OECD, 2022[25]).

2 Recent trends for distributed renewable energy in Colombia's non-interconnected zones

Colombia has a high level of electrification, reaching 98.2% of its 51 million population in 2020 (UPME, 2021[26]). Access to electricity is particularly high in urban areas (99%) but falls to 86% in rural zones (Garces et al., 2021[27]). Parts of the country connected via the national electricity grid (Sistema Interconectado Nacional, SIN) have the highest electrification rates, although some rural zones within the SIN's territory have little or no access.

While only 4% of the population lives out of the reach of national electricity grid, non-interconnected zones (zonas no-interconnectadas, ZNI) cover just over half the national territory (52%). In these zones, technical, financial or environmental challenges have created barriers to extending transmission and distribution infrastructure. In some cases, these challenges are the legacy of social conflict. In 2022, around 250 thousand "users", which include households and public or private buildings such as schools, had access to electricity services through small local grids or standalone solutions (IPSE, 2022[28]). A remaining 450 thousand users do not yet have access this electricity.

Almost 90% of the ZNI territory is made up of rural sparsely populated zones. In 1999, the average population density across the territory was recorded to be 3 inhabitants per square km (DNP, 1999[29]). Diesel generation supplies the bulk of electricity in these zones in the form of standalone generators. In more densely populated cities and towns isolated grids and diesel power plants are often used (Garces et al., 2021[27]). While this share is declining thanks to the penetration of renewables, in 2022, diesel still accounted for 85% of electricity generation in ZNI (IPSE, 2022[28]). There is therefore a high dependency on fossil fuels, which must travel long distances before reaching the end user, the cost of which is largely subsidised by the state. Distributed renewable solutions offer the opportunity to tap into ZNI's abundant local energy resources, including solar, wind, bioenergy or waste, and can offer new economical and sustainable opportunities to improve the coverage and quality of electricity service provision.

Colombia has a competitive power market largely dominated by hydro

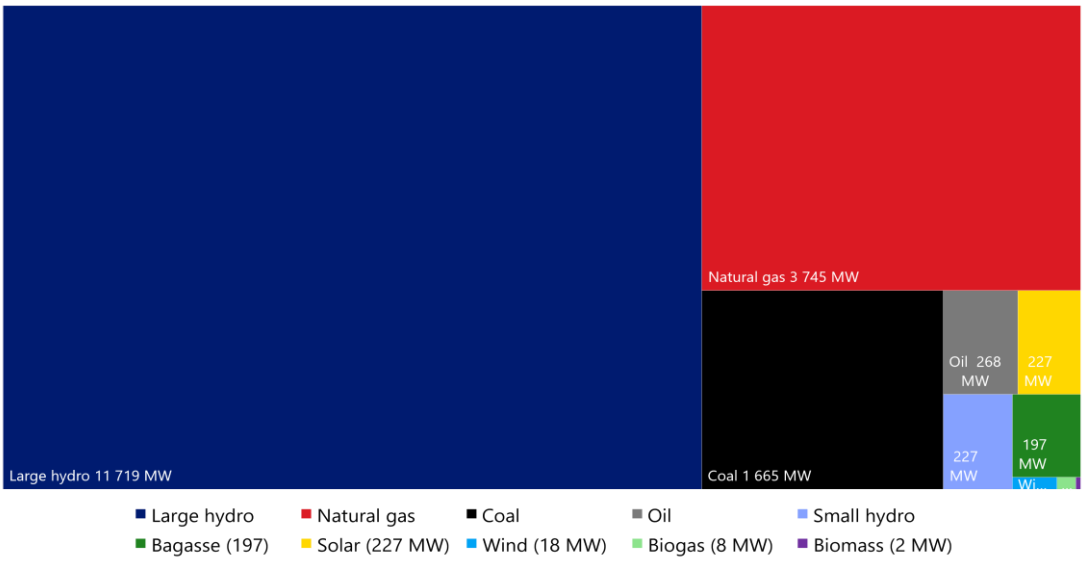
There has been a significant restructuring of the electricity market since the early 1990s with a priority on improving access to reliable and affordable electricity supply. Law 142 of 1994 (later modified by Law 689 of 2001) and Law 143 of 1994 established the regime for core public services, regulatory commissions, market competition rules and standards, which support private investment in generation capacity. These reforms led Colombia towards a liberalised energy market, characterised by unbundled generation, transmission, distribution and commercialisation.

In 2022, Colombia had around 18 GW of installed power generation capacity connected to the national grid (IEA, 2022[30]). Abundant water resources have played a central role in developing Colombia's low-cost power system, with large hydropower representing nearly two-thirds of the total installed capacity

(Figure 2.1). This is reflected in the sector's carbon intensity, which averaged around 160 grammes of CO_2 per kWh (gCO_2/kWh) over the last two decades, compared to a world average of about 475 gCO_2/kWh in 2018 (IEA, 2019[31]).

Yet, extreme weather events linked to El Niño and La Niña phenomena, which respectively can cause prolonged droughts and extreme flooding, have adversely impacted hydroelectricity production. In years of low hydro availability, coal, oil and natural gas power generation ramp up. Therefore, while fossil fuels may only represent 30% of installed power generation capacity, they nevertheless play a critical role in ensuring a secure supply of electricity in years of prolonged drought. This leads to corresponding increases in related emissions, as well as increased dependence on energy imports. This also contributes to spot price volatility in the electricity market, for electricity not sold under contracted prices.

Figure 2.1. Installed grid-connected power generation by source, 2022



Note : megawatts (MW)
Source : (SIEL, 2022[32]) Generation statistics (Estadísticas y variables de generación)

In addition to Colombia's decarbonisation ambitions, increasing dependence on energy imports over the next decades has encouraged the government to increase the development of non-conventional renewable energy (NCRE) sources, which can help diversify the electricity generation matrix. These are defined under Colombian law as renewable energy sources outside large hydro, which had remained relatively untapped, with solar and bioenergy representing less than 1% of installed renewable capacity (roughly 300 MW) in 2019 (IRENA, 2022[33]).

Recent developments such as the country's first renewable energy auctions held in 2019 and 2020[2] and the establishment of renewable portfolio standards[3] have been met with interest from both domestic and international actors. The auction of October 2019 secured more than 1.3 GW of new wind and solar projects, representing an estimated USD 2.2 billion of investment, primarily from large international and national players such as Trina Solar, EDP Renovables, Celsia, and Jemeiwaa Ka'I (later acquired by AES

[2] MME Decree 570 of 2018 established the blueprints for long-term PPAs through renewable energy auctions. MME Resolutions 40791 and 40795 of 2018 then provided operational guidance for the auctions.

[3] MME Resolution 49715 of 201920 mandated that at least 10% of electricity sold to regulated customers by retailers be sourced from NCRE (excluding all hydro) through long-term contracts of ten years or more.

Colombia) (IRENA and USAID, 2021[34]). Along with other approved projects, these planned additions should add at least 2.5 GW of renewable electricity capacity by 2022 (Djunisic, 2020[35]; ITA, 2021[36]).

By September 2022, around 18 MW of wind and 227 MW of solar generation capacity was connected to the national grid. Small hydro accounted for another 227 MW of installed capacity, followed by 207 MW of bioenergy, mostly in the form of sugarcane bagasse (197 MW) and biogas (around 8 MW) (SIEL, 2022[32]). Altogether, these NCREs represented about 4% of the total installed grid-connected capacity.

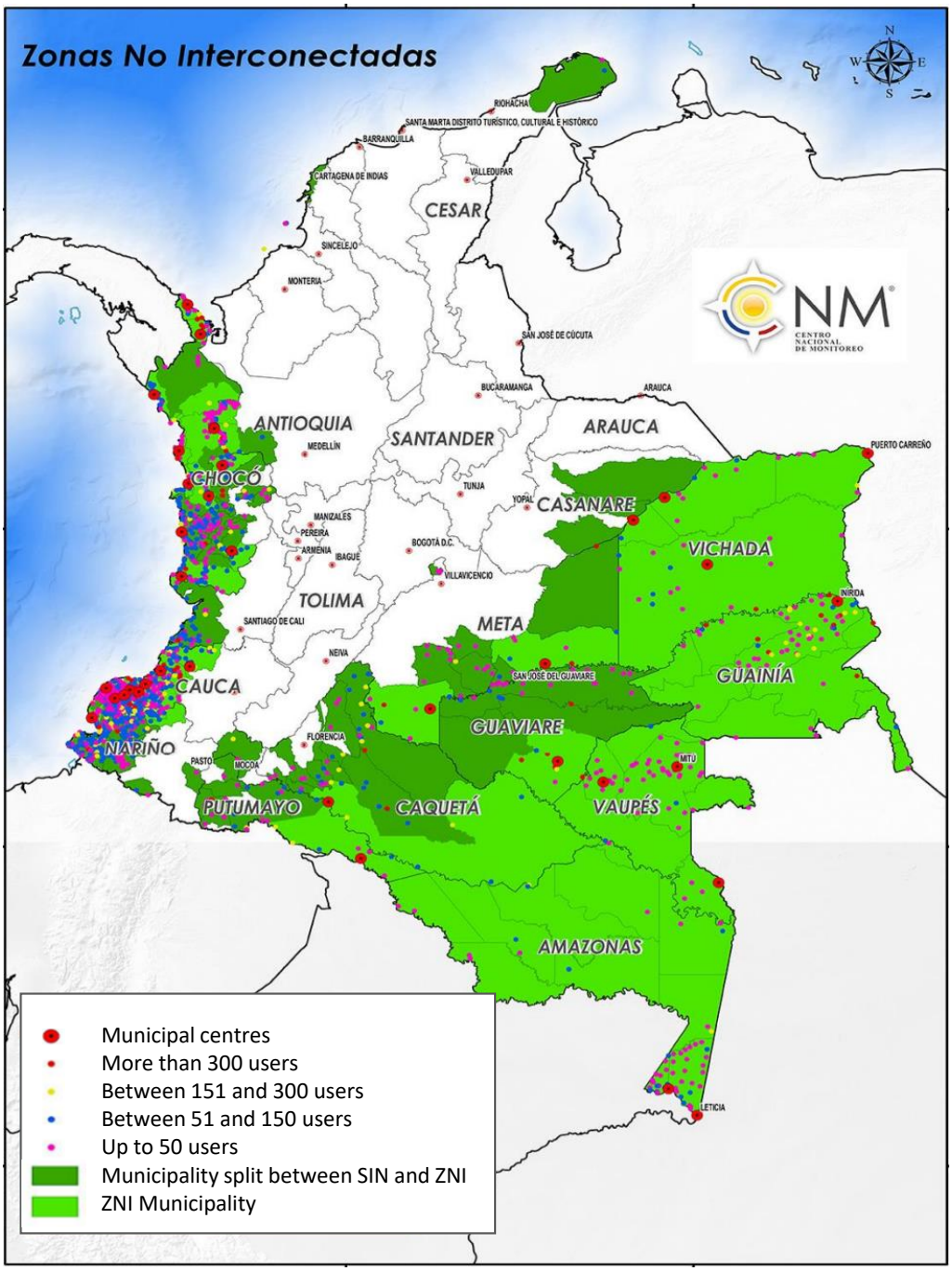
Non-interconnected zones represent a large and sparsely populated territory

Colombia's non-interconnected zones span across eighteen departments and account for 52% of the national territory. Within these zones, there are 77 municipalities, with 28 municipal centres and 5 departmental capitals. In 2019, the National Monitoring Centre (CNM or Centro Nacional de Monitoreo) validated the co-ordinates of a total of 1 772 different localities, which are sites with existing or prospective electricity users. This is 354 sites more than recorded in 2018 and a further 210 sites have tentatively been identified, but their coordinates were not yet confirmed, highlighting some of the challenges of data collection in ZNI. As much as 87% of ZNI localities have fewer than 150 users, with more populated localities tending to be in Nariño, Chocó and Cauca Figure 2.2 (UPME, 2019[37]).

In 2022, around 251 thousand "users", which include households and public or private buildings such as schools, had access to electricity services through small local grids or standalone solutions. Of these, 46 thousand were connected by solar home systems, with over half connected in the last three years alone (IPSE, 2022[28]).

Fossil fuel generators and mini-grids have been the primary mode of electrification for Colombia's non-interconnected zones. Historically, these technologies have been identified as least cost solutions, under Colombia's system of indicative plans for expansion of electricity coverage (Plan Indicativo de Expansión de Cobertura de Energía Eléctrica, PIEC). Based on a techno-economic analysis, these plans determine infrastructure and investment needs to achieve rural electrification, considering parameters such as distance from the national grid, density of the population and cost of alternative technologies. Improved data on renewable resources in UPME and IDEAM's solar and wind atlas have enabled renewable potential to be included in the assessments.

Figure 2.2. Non-interconnected zones of Colombia



Note: Non-interconnected zones (zonas no interconectadas)
Source: (RAP-E, 2020[38]) State of the coverage of electricity and zones non-interconnected in the central region (Estado de la cobertura eléctrica y las zonas no interconectadas en la región central)

Of users with access to electricity (excluding those only connected by solar home system), in 2022, 35% received 24 hours of electricity service. A further 6% received between 10 to 20 hours, 46% between 5 to 10 hours and 16% received less than 5 hours of service (CNM, 2020[39]; IPSE, 2022[28]; MME, 2021[40]). Electricity services are most reliable in more populated ZNI areas, such as departmental or municipal centres. For example, the municipality of Leticia, which has more than 10 000 users, has electricity

24 hours a day via an isolated diesel mini-grid. But nearly 90% of ZNI localities with fewer than 300 connected users had an average of fewer than 6 hours of electricity per day in 2018, often linked to limitations or disruptions to the fuel supply (Garces et al., 2021[27]).

A further 1.5 million people still lack access to electricity, which UPME's expansion planning in 2019 has identified to be 500 thousand users (households and other buildings) (UPME, 2019[37]). This number has since dropped to 450 thousand users largely thanks to solar home systems (IPSE, 2022[28]; UPME, 2019[37]). A large share of the population without access to electricity lives in areas along the Pacific coast, in the Amazon, in the Orinoquia and Guajira regions, and on islands, where the renewable potential for wind and solar are at the highest, and where there can also be good potential for small hydro and bioenergy (Garces et al., 2021[27]).

The government of Colombia has set targets to provide all communities with access to basic electricity services, and distributed renewables represent an opportunity to improve the quality of service. Subsidies for standalone solar solutions only start for units over 50 W, which, with at least 4 hours of sunlight, can provide up from 200 Wh, giving access to electrical lighting and multiple appliances such as a fan, a television and phone charging. The PIEC assumes a much higher consumption of an average of around 3 kWh[4] per day per user (or 90 kWh per month, which would allow for high-powered appliances (Bhatia and Angelou, 2015[9]). For communities with over 25 users, greater consumption is assumed for businesses, schools, hospitals or other public services, requiring connection via mini-grids. For these communities a multiplier is applied to monthly consumption, for example, for communities with 150 users, 9kWh per day is assumed for each user (or 270 kWh per month) (UPME, 2019[37]).

There is considerable untapped renewable potential in non-interconnected zones

ZNI benefit from a wealth of natural resources, including considerable renewable energy potential to provide local, sustainable energy. Distributed renewable solutions are being given a central role in electrification efforts under current policies, reflecting their potential to slow down expenditures on fossil fuels subsidies and to provide clean electricity solutions adapted to the size and needs of communities. At the same time, these solutions can reduce greenhouse gas emissions and the adverse consequences of diesel emissions on the health and well-being of local communities.

Colombia has favourable conditions for wind and solar energy. In 2022, there were less than 100 MW of installed solar PV, pointing to large untapped potential. The theoretical solar potential is high in the country, averaging 4.9 kilowatt-hours (kWh) per square metre (m^2) per day (ESMAP, 2020[41])(Figure 2.3). By comparison, in 2019, Spain, which receives on average around 3-3.5 kWh/m^2 per day in solar irradiance, had over 11 GW of installed solar capacity in 2019, and Germany, which averages around 2.2-3.2 kWh/m^2 per day, had over 49 GW of installed solar capacity (IRENA, 2020[42]; World Bank, 2020[43]). Potential for solar generation is particularly strong in certain non-interconnected zones such as La Guajira, Vichada in the east and San Andrés islands in the Caribbean, where average radiation reaches as high as 6.0 kWh/m^2 per day (IDEAM, 2020[44]; López et al., 2020[45]).

By 2021, 18 MW of wind power had been developed. Yet, certain zones of Colombia have amongst the highest wind speeds in Latin America. Notably, wind potential is very strong in the department of La Guajira, a non-interconnected zone in the north of Colombia, where there is an estimated potential for 18 GW (Mordor Intelligence, 2020[46]), more than the total current installed electricity generation capacity in Colombia. Average annual wind speeds in certain locations off-shore of La Guajira are as high as 11 metres per second (IDEAM, 2020[47]), more than double the minimum wind speed needed for

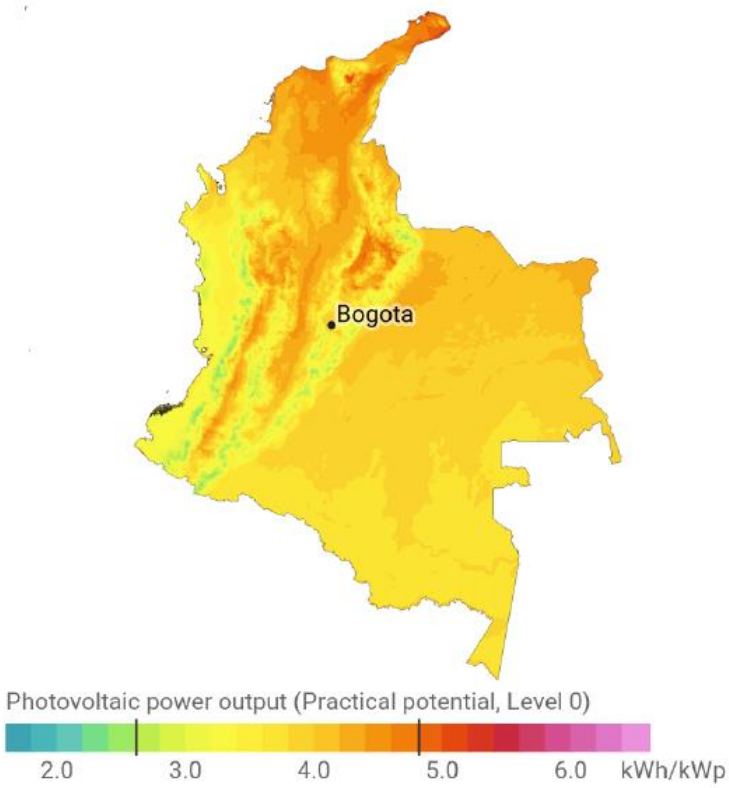
[4] The PIEC assumes that sites of less than 25 users will consume 90 kWh per month per users, unless they are above 1000 m altitude where they will consume 60 kWh per month (PIEC, 2019).

utility-scale installations, and one out of only two regions in all of Latin America to reach these levels (Norton Rose Fulbright, 2016[48]).

Bioenergy equally has a strong potential to contribute to diversifying Colombia's energy mix and support access to reliable electricity in rural areas. There is large unexploited potential from available waste and residues in Colombia, yet outside of biofuel production and electricity and heat cogeneration in the sugarcane and palm industries, the use of bioenergy remains relatively limited, accounting for 141 MW in 2021. Use of technologies such as anaerobic digesters and direct use of biomass and waste could help. For example, biogas production has a technical potential of 11 TWh from agricultural residues such as bagasse residues and a further 1.7 TWh from livestock waste. The technical potential of municipal solid waste, if fully exploited, could reach as much as 1.4 TWh per year (OECD, 2022[49]). Some research even points to bioenergy having a greater potential in Colombia, as compared with solar PV and wind (Lezcano Oquendo, 2012[50]).

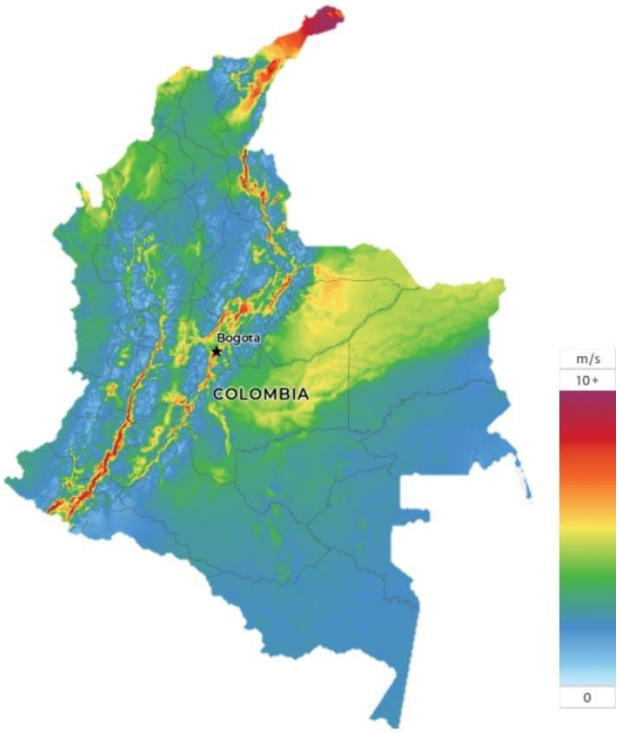
Small hydropower has an estimated potential of 25 GW. With 227 MW of installed small hydro power connected to the national grid and a further 4 MW in ZNI, less than 1% of this potential has been tapped into. This is in part due to climatic variations in Colombia, which produce lower rainfall and resource uncertainty for hydro power in certain years (LIU et al., 2019[51]).

Figure 2.3. Photovoltaic power potential in Colombia



Note: kilowatt-hour (kWh); kilowatt peak (kWp)
Source: (ESMAP, 2020[41]) global photovoltaic power potential | country factsheet

Figure 2.4. Mean wind speeds at 100m



Note: wind speed at 100 meters altitude in meters per second (m/s)
Source: (ESMAP, 2022[52]) Global wind atlas

Table 2.1. Technical potential for biogas production by residue type and quantities

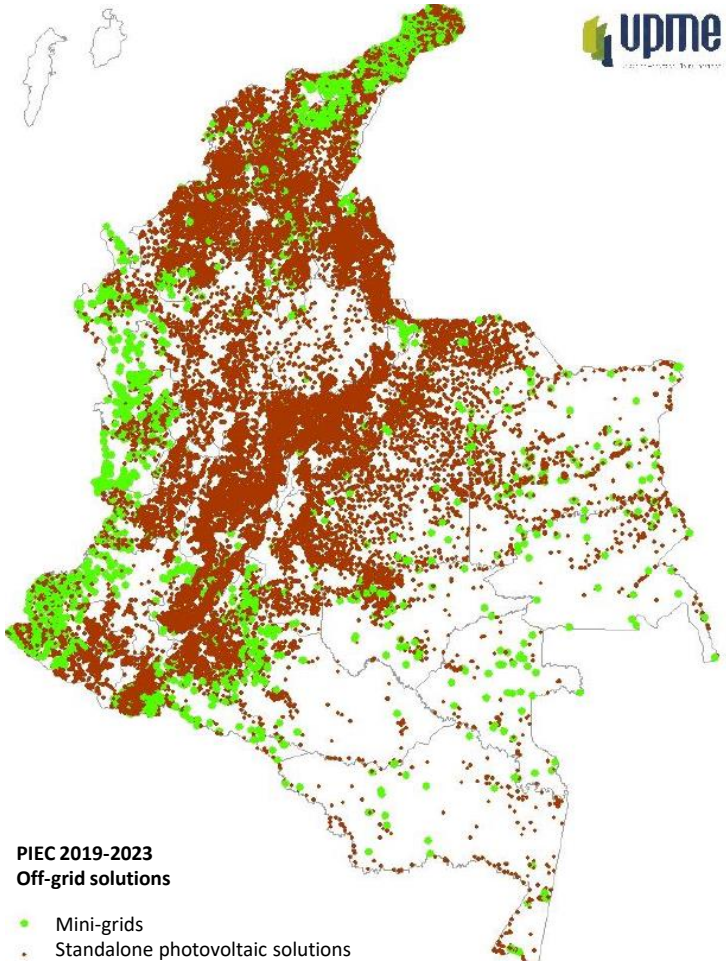
Sector	Residue	Quantity	Technical potential	
		thousand tonnes/year	*million m³/year*	*GWh*/year*
Livestock	Poultry manure	2 793	168	1 000
	Swine manure	1 410	99	589
	Bovine manure	501	20	120
Agriculture	Rice straw	252	353	2 054
	Banana fruit rejects	249	0.4	2
	Coffee pulp	185	5	28
	Coffee mucilage	63	5	63
	Corn stalk	559	287	1 372
	Oil palm (oxidation pond)	6 710	134	854
	Plantain fruit rejects	117	0.2	1
	Sugarcane bagasse	6 549	1	6 294
	Panela cane bagasse	238	<0.1	227
Municipal	Solid urban waste (organic)	4 278	282	724
	Sludge (sewage)	289 969	101	654
Industrial	Dairy sludge and fats	10	0.4	5
	Brewery sludge	2	0.1	1
	Cane stillage	9 587	158	902
	Slaughterhouse rumen	62	1	6
Total		**323 534**	**1 615**	**14 896**

Source: (OECD, 2022[49]) Enabling conditions for bioenergy finance and investment in Colombia

Renewables are taking a larger role in electrification efforts

The most recent indicative PIEC, for 2019-2023, differs from previous editions[5] by prioritising expansion through renewables. It foresaw that out of 500 thousand users to be connected, 170 thousand would be connected through hybrid solar microgrids, using less than 15% diesel per year. A further 168 thousand users through individual solar photovoltaic solutions benchmarked on 330 W peak solar panels, 3000 Ah Stationary batteries (OPZS), and 1 kW inverters (UPME, 2019[37]). The remaining 157 416 users would be connected through grid extension (Figure 2.5).

Figure 2.5. Means of expanding electricity access



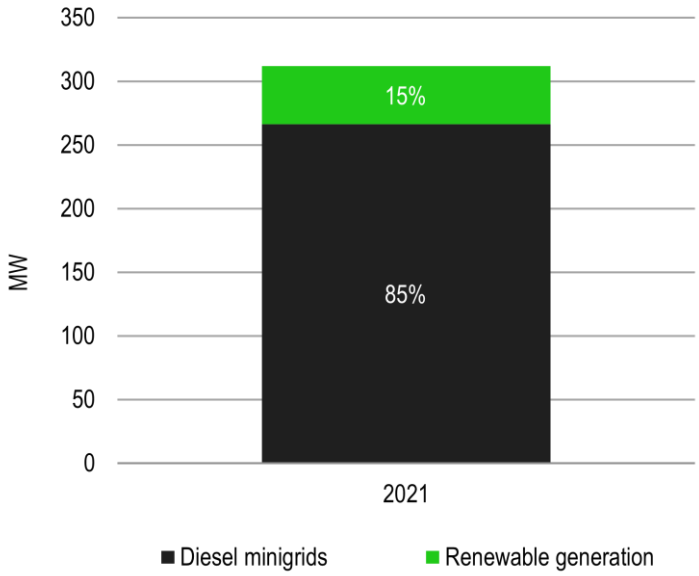
Notes: Plan Indicativo de Expansión de Cobertura de Energía Eléctrica (PIEC)
Source: (UPME, 2019[37]) Indicative plans for expansion of electricity coverage (Plan Indicativo de Expansión de Cobertura de Energía Eléctrica, PIEC) 2013-2017

To date, diesel generators and diesel-fired power plants have been the primary source of electricity in non-interconnected zones (Figure 2.6). Given the wide availability, easy maintenance and low cost of diesel technologies, these solutions have been the primary means of electrifying localities and providing access to modern services in remote communities. However, the low efficiency of machinery and increasing

[5] As determined by Decree 1523 of 2015.

demand are leading to rising consumption of diesel, and in 2020, nearly 14 million litres of fuel was allocated to ZNI each month (MME, 2021[40]). Given the remoteness of these localities, fuel dependence is a significant cost driver, as fuel must travel over long distances, often via several modes of transport, before arriving at the end user. Equally, the transport of non-local technicians and equipment for maintenance and repairs is costly and is reflected in the kW/h cost of energy service cost. In addition, as a source of GHG and other pollutants that are harmful to human health, as well as noise pollution, diesel generators bear notable negative externalities for local communities (RAP-E, 2020[38]).

Figure 2.6. Diesel and renewable generation in non-interconnected zones in 2022



Note: megawatts (MW)
Source: (IPSE, 2022[28])

Under the regulatory framework for electricity service provision in non-interconnected zones, the shortfall between the tariffs charged to the user[6] and the cost of generation is subsidised to the retailer. In 2018, over USD 70 million was spent on tariff subsidies for users in ZNI, and over a third of this (USD 25 million) was dedicated to fuel supply for power generation (CNM, 2020[39]). The approximate cost of transporting fuels to ZNI varies depending on location and can be a significant cost component. For example, the cost of diesel in November 2017 was set at USD 0.71 per litre, and the highest transportation cost identified in ZNI was USD 0.99 per litre, resulting in a total cost of USD 1.7 USD per litre (González-Montoya et al., 2018[53]). Depending on the region, the cost of transport can therefore more than double the cost of diesel per litre.

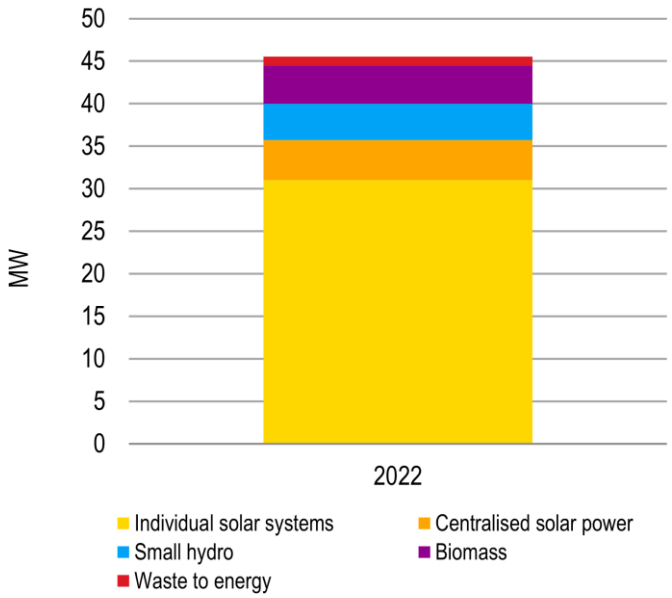
As electrification efforts continue, these costs could more than triple over the next decade if Colombia maintains the existing generation mix in ZNI. Transitioning towards renewable technologies can help reduce the cost of service-provision, of which diesel supply currently makes up a large proportion. Hybrid mini-grids and solar home systems can reduce operating costs linked to diesel supply and shifting energy service provision away from fossil fuel in ZNI is therefore an important cost consideration for the

[6]Tariffs paid by residential users are determined based on the income level of the user, under Resolution 181891 of 2008 (updated by Resolution 91873 of 2012).

government. Despite higher upfront costs linked to renewable technologies, hybrid mini-grids can result in lower overall costs over the lifetime of the unit by lowering operating expenses (UNDP, 2018[54]).

Positive outcomes from the government's renewable ambitions are already starting to be seen, and the share of renewable energy in ZNI regions is increasing rapidly. In 2022, there were nearly 46 MW were renewable, including 31 MW of Individual solar systems, 5 MWp of centralised solar power systems, 4 MW of small hydro, 5 MW of biomass and 1 MW of waste to energy (Figure 2.7). From 2018 to 2022 alone, renewable generation more than quadrupled from 10 MW to 45.5 MW (CNM, 2020[39]; IPSE, 2022[28]).

Figure 2.7. Installed renewable generation in non-interconnected zones in 2022



Note: megawatts (MW)
Source: (IPSE, 2022[28]) Electrical characteristics of non-interconnected areas (Caracterización Energética de las ZNI)

Yet, the costs of connecting new users are well above global averages

Electricity projects in ZNI, both renewable and non-renewable, bear several challenges across all stages of the project that drive up costs and risks for investors. A large part of this cost is linked to the challenges of reaching communities in a large and diverse territory. Distance and complex landscapes create technical and logistical constraints. This also reduces the number of interested developers or installers, which can increase costs further. In certain localities, important ecosystems, such as forests and deserts (e.g. in the Amazon and Choco) lead to environmental constraints for developing energy projects or additional hurdles for obtaining appropriate project licences. The ethnic, cultural and social diversity of communities in ZNI is also an important consideration for the successful deployment and operation of mini-grids and standalone solutions alike, requiring time to be factored in for public consultation and engagement activities. In particular, there are important considerations around land rights for new projects, which requires negotiations with local communities. Populations without access to electricity in Colombia often live in very rural areas out of reach of other modern services such as mobile coverage and internet, which can hinder the development of business models such as mobile-money for pay-as-you-go systems.

At the same time, high costs can also be linked to the lack of maturity of ZNI off-grid renewable markets, which still require support to build up scale and replicability, and achieve cost reductions. Indeed, higher

levels of market uncertainty are priced into the cost of equity and debt. This is notably important for more capital-intensive technologies, such as mini-grids, whose economics will be most susceptible to high financing costs (see chapter on distributed renewable energy trends above).

In fact, in 2019, connection costs per user were benchmarked at roughly USD 6 000 per connection for both standalone solutions and mini-grids, which is well above global averages (Table 2.2) (UPME, 2019[37]; Wood Mackenzie, 2019[55]). The PIEC costs are determined based on historic investments in distributed renewables and will likely fall as deployment continues. But this also points to the urgent need to identify cost drivers for new connections, for instance through a competitive procurement to enable better price discovery and to identify where actions can increase affordability, such as through de-risking to bring down the cost of finance.

Table 2.2. Local vs global average connection cost per new user

	Global average	Colombia ZNI
Standalone systems <500W	USD 80 - 550	USD 5 993
Renewable mini-grids 500 kW to 5 MW	USD 500- 2 000	USD 6 353

Note: exchange rate of 30 December 2019 - 3271.897 Colombian Person (COP) = 1 United States Dollar (USD)
Source: (Wood Mackenzie, 2019[55]) Strategic investments in off-grid energy access; (UPME, 2019[37]) Indicative plans for expansion of electricity coverage (Plan Indicativo de Expansión de Cobertura de Energía Eléctrica, PIEC) 2019-23

Nearly USD 2 billion in investment is needed to deploy distributed renewables

To date, investment in energy in Colombia's non-interconnected zones has been largely driven by government funding, in the form of CAPEX grants, but also subsidies on operations and maintenance through regulated tariffs. Between 2001 and 2019, USD 420 million of government funding contributed to electrifying 220 thousand households between 2001 and 2019, averaging at close to USD 2000 per connection (Garces et al., 2021[27]).

However, with view of the investment needed to reach full electrification, government funds alone will not be sufficient. Under the PIEC 2019-2023 estimates, nearly USD 2.3 billion (COP 7.4 trillion)[7] will be needed, to reach the remaining 500 000 users without access to electricity, increasing the cost of connecting new users to USD 4 600 (Table 2.3). The average connection cost foreseen for remaining users will therefore be more than double what it was over the last decade.

Table 2.3. Investment cost for universal access (2019-2023)

Means of connection	Users to connect	Investment needs	Average connection cost per user
Interconnection	157 416	USD 172 106 000	USD 1 093
Microgrids	170 261	USD 1 081 822 000	USD 6 353
Standalone solutions	168 158	USD 1 007 734 000	USD 5 993
	495 835	**USD 2 261 662 000**	**USD 4 561**

Note: exchange rate of 30 December 2019 - 3271.897 Colombian Person (COP) = 1 United States Dollar (USD)
Source: (UPME, 2019[37]) Indicative plan for expansion of electricity coverage (Plan Indicativo de Expansión de Cobertura de Energía Eléctrica, PIEC) 2019-2023

[7] Exchange rate of 30 December 2019 - 3271.897 Colombian Person (COP) = 1 United States Dollar (USD).

Of this investment, hybrid mini-grids and individual solar home systems together represent about USD 2 billion (UPME, 2019[37]). The estimated USD 1 billion investment needed for individual solar homes systems is particularly striking, as the entire global market for standalone solar solutions is estimated to have attracted just over USD 1.5 billion in financing between 2012 and 2019 (IFC, 2020[14]).

While interest in renewable solutions is starting to grow, notably under the new tariffs and subsidy regulation, given the scale of capital needed, continuing to strengthen enabling conditions for investment in distributed renewable energy will be essential to help build momentum in the off-grid market.

3 Current enabling conditions and finance for distributed renewable energies

The Government of Colombia has recognised the potential for renewable and hybrid solutions to provide affordable and clean electricity solutions to remote communities. In 2019, Colombia undertook an in-depth review of current energy policy under the *Energy Transformation Mission and Modernisation of The Energy Industry: Roadmap for the Future's Energy (Misión de Transformación Energética y Modernización de la Industria Eléctrica: Hoja de Ruta para la Energía del Futuro, the Energy Transformation Mission)*. Under its fourth pillar, this mission specifically looked at closing policy gaps, increasing coverage and quality of service and improving the targeting of subsidies in non-interconnected zones, as well as some connected zones that do not have full coverage. The recently released 2022 national strategy for Energy Transition set forth by the National Council for Social and Economic Policy (Consejo Nacional de Política Económica y Social, CONPES), has also drawn attention to the need to strengthen the enabling conditions for distributed renewable energy, both in connected and non-interconnected zones.[8]

In addition, recent energy policies and expansion plans have made renewable energy a priority in new investments in electricity services in non-interconnected zones. Key examples of this are the PIEC 2019 and the recent and ongoing electricity tariff and subsidy reform, which are amongst most the supportive in LAC for off-grid solar solutions. The effects can already be seen in the doubling of renewable capacity over 2020 and 2021, particularly through the deployment of solar home systems.

Still, the market for renewable energy remains relatively immature, and largely dependent on subsidies, particularly for hybrid-mini grids, which are more capital-intensive. As Colombia continues to update its policies to support the renewable market in non-interconnected zones, it will be important to consider measures that can help strengthen the sustainability of the market whilst eventually lowering the overall costs for the government and users.

National policies support the accessibility and sustainability of renewable solutions

Colombia's Ministry of Mines and Energy (MME) formulates and adopts national energy policies. They have the ultimate responsibility for policy-making to expand and improve the quality of service in non-interconnected zones. The Institute of Planning and Promotion of Energy Solutions (Instituto de Planificación y Promoción de Soluciones Energéticas para las Zonas no Interconectadas, IPSE), supports this role by planning, structuring and implementing projects in non-interconnected zones. This work is

[8] National Energy Transition Strategy (CONPES de Transición Energética). More information available: https://www.dnp.gov.co/Paginas/CONPES-de-Transicion-Energetica-que-consolidara-el-proceso-hacia-un-desarrollo-y-crecimiento-economico-sostenible-aprobado.aspx.

supported by MME's planning unit, UPME, which contributes to the formulation and implementation of said policies, while the Regulatory Commission for Energy and Gas (Comisión de Regulación de Energía y Gas, CREG), sets the framework for tariffs and subsidies.

Through various laws and regulations, and in particular Law 1715 of 2014, known as the "Renewable Energy Law" and Law 2099 of 2021, known as "the Energy Transition Law", the government has indicated that MME should prioritise renewable solutions in its policy-making in both connected and non-interconnected zones. This law also mandated that MME develop incentive schemes to partially or entirely replace current diesel generation with renewable energy sources, although no specific timeline has been given. Together with supporting regulations, these laws have established various measures to incentivise market development including fiscal incentives for renewable technologies (import duty and value-added-tax exemptions) and public awareness campaigns. In addition, the Renewable Energy Law provided the basis for the Fund for Non-Conventional Energy and Energy Efficient Energy Management (Fondo de Energías No Convencionales y Gestión Eficiente de la Energía, FENOGE) to finance renewable energy and energy efficiency programmes.

In addition, recent updates to subsidy and tariff regulation in ZNI support the drive for more renewable energy, by working towards levelling the playing field between fossil fuels and distributed renewables. In particular, CREG resolution 701 001[9] of 2022, provides a revised tariff structure in non-interconnected zones. This defines a differential tariff for solar home systems and provides improved conditions for renewable energy projects to recover operating expenses, which can be a significant cost-driver in remote locations.

Government still plays a central role in energy investments

The government of Colombia plays a central role in planning and executing projects. Various government funds are available to energy projects in ZNI, which can provide up to 100% upfront capital expenditure grants towards the construction and installation of electricity infrastructure and subsidies on operations and maintenance. These include, for example, the Financial Support Fund for the Energization of the Non-Interconnected Zones (Fondo de Apoyo Financiero para la Energización de las Zonas No Interconectadas, FAZNI) and the Fund for Financial Support of the Expansion of Energy Services in Rural Zones (Fondo De Apoyo Financiero Para La Energización De Las Zonas Rurales, FAER). The Fund for Non-Conventional Energy and Energy Efficient Energy Management (FENOGE) also supports the development of electric infrastructure and the use of non-conventional energy sources across Colombia (Table 3.1).

IPSE plays a leading role in planning and investing in the installation of electricity infrastructure. Projects funded by the state can also be handed over to a municipality or network operator through a special contribution contract or a commodatum contract.[10] The network operator or municipality can then either provide the electricity service or procure a public utility company to take charge of the operation and maintenance.

[9] More information: http://apolo.creg.gov.co/Publicac.nsf/1c09d18d2d5ffb5b05256eee00709c02/1a94ec453ab7e5dc052587e000020245/$FILE/Creg701%20001.pdf.

[10] Law 142 of 1994, the general law of domiciliary public utilities.

Table 3.1. Annual resources on energy service provision in Colombia

Fund	Objective	Resources
FENOGE - Fund for Non-Conventional Energy and Energy Efficient Energy Management	Supports non-conventional renewable energy and energy efficiency projects	USD 7.8 million (in 2020)
FAZNI - Financial Support Fund for the Energization of the Non-Interconnected Zones	Supports construction and installation of electrical infrastructure in ZNI	USD 29 million (in 2020)
FAER - Fund for Financial Support for The Expansion of Energy Services in Rural Zones	Supports projects increasing energy provision in Interconnected Rural Areas and in interconnection with ZNI	USD 35 million (in 2020) (ZNI and SIN)
FNR - National Royalties Fund	Supports electrical infrastructure projects	Unknown
FSSRI - Solidarity Fund for Subsidies and Redistribution of Income	Provides subsidies for low-income end users in ZNI and SIN	USD 60 million (in 2019 - only on ZNI)
FOES - Fund for Social Energy	Provides subsidies for users located in hard-to-manage areas, less developed rural areas and subnormal urban areas.	USD 35.9 million (in 2020) (ZNI and SIN)
Works for Taxes Fund	Supports infrastructure works, services, education and healthcare. Companies can fulfill 50% of their tax obligations by contributing to this fund	Not available

Notes: Fund for Non-Conventional Energy and Energy Efficient Energy Management (Fondo de Energías No Convencionales y Gestión Eficiente de la Energía, FENOGE); Financial Support Fund for the Energization of the Non-Interconnected Zones (Fondo de Apoyo Financiero para la Energización de las Zonas No Interconectadas, FAZNI); Fund for Financial Support of the Expansion of Energy Services in Rural Zones (Fondo De Apoyo Financiero Para La Energización De Las Zonas Rurales Interconectadas, FAER); National Royalties Fund (Fondo Nacional de Regalías, FNR); Solidarity Fund for Subsidies and Redistribution of Income (Fondo De Solidaridad Para Subsidios y Redistribución de Ingreso, FSSRI); Fund for Social Energy (Fondo de Energía Social, FOES)
Source : (XM, 2020[56]); (Garces et al., 2021[27])

The number of different funds available for renewable project development in ZNI comes with certain challenges for multiple government entities to co-ordinate and align amongst themselves to efficiently make use of resources. Co-ordination amongst these entities, therefore, remains a priority to avoid project delays and uncertain allocation of responsibilities, efficient allocation of resources and transparency. Colombia's Energy Transformation Mission's fourth pillar on closing gaps and improving coverage and quality of service highlighted this need for improved co-ordination of government. This is particularly important for project developers who must navigate various procedures for accessing grants, which can create asymmetries in information on available sources of funding and increase the time needed to develop projects.

Law 2099 of 2021, Article 45, takes steps towards addressing these challenges by empowering IPSE to structure and present plans and projects to public funds that make investments in the electricity sector. Law 2099 of 2021 Article 41 has also laid the foundation for FONENERGIA which would have the purpose of unifying different funds under one fund. This was formalised by Decree 1580 of 2022 and should collect

and unify resources of FAER and FAZNI as well as the Electricity Grid Normalisation Programme (Programa de Normalización de Redes Eléctricas, PRONE[11]), which operates with resources under FAER to strengthen electricity grids and Special Fund Natural Gas Development (Fondo Especial Cuota Fomento Gas Natural, FECFGN). Efforts are already underway, and in July 2022 the Operational Manual of the Single Fund for Energy Solutions FONENERGÍA[12] was issued. This would create a single window for receiving project proposals to simplify the funding application process and could be an important lever for infrastructure improvements projects in the ZNI, notably for mini-grid projects in localities that have a deficient provision of electricity service.

Cost recovery for renewable projects via tariffs and subsidies is improving

Subsidised consumer tariffs and generation activities have been an essential tool for attracting private service providers, by reducing demand risk linked to the ability to pay for low-income users. Under the regulatory framework for electricity service provision in non-interconnected zones, the shortfall between the tariffs charged to the user and the cost of generation is subsidised to the retailer. This is in accordance with Article 368 of the Political Constitution of Colombia and Law 142 of 1994 on public services, which provides for lower-income households to access residential public services to cover their basic needs. The rate paid for the provision of a residential public service is linked not only to the user's level of consumption, but also to the costs incurred by the respective company in order to provide the good or service under competitive conditions and is determined by the benefit that the user finally receives.

Therefore, on the demand side, residential users are subsidised based on their status and income level.[13] On the supply side, generators are able to recover costs on electricity infrastructure according to a regulated formula on the cost of generation for each technology, irrespective of user demand.[14] The tariff and subsidy schemes were recently reformed under MME Resolution 40239 of 2022.[15]

Under the previous regulation, formulas for cost recovery on operation and maintenance activities have tended to favour diesel generation, which could recover the cost of fuel supply, whereas photovoltaic solutions had been limited to a fixed charge. Consequently, guaranteeing service provision through solar technologies has borne higher risks, with a narrower scope for cost recovery. Importantly, the reform aims to simplify the complex framework for cost recovery, which had been hard for operators to navigate. It also looks to prioritise the use of at least 30% renewables technology in new generation infrastructure and provide a more comprehensive subsidy for the operation and maintenance of new and existing photovoltaic installations (MME, 2021[40]).

In 2022, an update to the tariff structure for individual solar solutions was adopted under CREG resolution 101 026.[16] MME is also currently amending the subsidy framework based on a new tariff scheme proposed

[11] More information available : https://www.minenergia.gov.co/es/misional/energia-electrica-2/fondos-especiales/programa-de-normalizaci%C3%B3n-de-redes-el%C3%A9ctricas-prone/.

[12] More information available: https://www.minenergia.gov.co/es/servicio-al-ciudadano/foros/expedici%C3%B3n-manual-operativo-del-fondo-%C3%BAnico-de-soluciones-energ%C3%A9ticas-fonenerg%C3%ADa/.

[13] Resolution 181891 of 2008 (updated by Resolution 91873 of 2012).

[14] CREG Resolution 091 of 2007 (amended by CREG resolutions 161 and 179 of 2008, resolutions 056, 057, 097 of 2009, and resolution 072 of 2013).

[15] More information: https://gestornormativo.creg.gov.co/gestor/entorno/docs/resolucion_minminas_40239_2022.htm.

[16] More information available: https://gestornormativo.creg.gov.co/gestor/entorno/docs/resolucion_creg_101-26_2022.htm.

by CREG. Already, ahead of the update, a transitory tariff had been provided in 2020 (CREG Resolution 166) for photovoltaic solutions with over 500 W. Together with a transitional subsidy regulation (Resolution 40296 of 2020), set to roughly 86% of the tariff for solar PV systems (AmbitoJuridico, 2020[57]), these regulations significantly improved the business model for renewable projects. This has helped to attract new solar technology suppliers either working directly with customers or operating through existing utilities or government (Box 3.1).

However, the tariff scheme for mini-grids remains more complex. MME resolution 40239 of 2022[17] was published in July 2022 presents benefits for mini-grids that use renewable energies and defines a new tariff scheme. However, as specified by CREG Circular 079 of 2019,[18] the tariff request to CREG for each locality must be done independently for each project, with final technical design for the mini-grid must be specified in the tariff application. The timeline for a decision from CREG can take up to a year in practice. This can create challenges, as the project must be designed without having a clear picture on the project's ability to recover its costs through tariffs. This implies risks to developers and can contribute to the challenging environment for securing financing.

Box 3.1. Kingo

Kingo, a Guatemalan start-up specialising in off-grid systems across LAC works with communities, companies and governments to provide solar home systems, access to lighting and electronic appliances.

The initial business model of Kingo based on the PAYG model, where users paid on a daily, weekly, or monthly basis, allowed the company to build significant expertise in business-to-customer (B2C) sales, working with off-grid low-income customers. Since then, lower-risk business models have helped the company continue to expand its services and attract investment. This has notably been through business-to-business (B2B) sales, providing renewable solutions under contract with utilities, and business-to-government sales (B2G) under government procurement.

Kingo has also explored different business models which have helped the company mature and spread its portfolio risk. Building on its experience, with B2C sales which are a riskier and costlier market, Kingo has learnt to be more selective in entering new markets and its decision will be largely dependent on subsidies available.

B2B sales are attractive business models, as customers, primarily energy service providers, are often looking to buy many solar home systems under a single contract. The capacities of these units typically range between 50 and 100 watts (W). Given that the energy service provider works with the end customers, and manages applications for any relevant subsidies, the off-taker risk and regulatory burden of such transactions are much lower. Under this model, Kingo receives regular fees for service, and given the higher credit rating of these customers, it can raise local funds by creating a special-purpose vehicle with the assets generating revenue.

In turn, B2G sales involve the least amount of risk given the participation of the local government in the transaction, which in turn helps Kingo raise commercial finance. Moreover, given the large size of

[17] More information: https://gestornormativo.creg.gov.co/gestor/entorno/docs/resolucion_minminas_40293_2021.htm.

[18] More information: http://apolo.creg.gov.co/Publicac.nsf/52188526a7290f8505256eee0072eba7/370a13eee40852280525847e0079ce56?OpenDocument.

orders, the company can benefit from economies of scale when fulfilling orders for these contracts. The capacities of these units typically range between 500 W and 1 kilowatt (kW).

Source: Kingo Interview (2022) OECD CEFIM

Resources for electricity service provision vary across regions

Energy service providers in ZNI represent a diverse group of actors, which vary in size and resources depending on the areas they serve. In 2020, there were a total of 94 electricity suppliers, primarily (71 out of 94) set up as public utility companies, either private and publicly owned. Only very few of these are utilities that also operate in the SIN, due to the differing business model. Notably ZNI have much higher costs and risks to providing electricity service, due to the lower payment capacity of users and the complexities of the service provision (Garces et al., 2021[27]). Electricity services were also provided by 20 municipalities, which is permitted when there is the separation of accounts and reporting of electricity services and normal municipality activities. There are also a few exceptions, which include one central government-owned supplier and two cases of community-organised energy services (CNM, 2022[58]).

An additional challenge are operating costs, which vary across provinces depending on differences in geography, and political or social stability across zones, which increases costs for the transport of personnel, hiring administrative personnel and general services, obtaining spare parts, and billing and payment collection. Low population density also contributes to higher operation and maintenance costs for the electricity generated, as staff must travel for fewer users. As much as 87% of ZNI localities have fewer than 150 users (UPME, 2019[37]).

The findings of the Energy Transformation Mission pointed a number of gaps and challenges for service provision in non-interconnected zones. Notably, the Mission highlighted the need to deploy new technologies, improve the monitoring of the quality of services, and incentivise operators in connected systems to enter non-interconnected zones.[19] The government is taking a number of actions to start addressing constraints, but there remain sizeable challenges.

In particular, improving gaps in data on energy service provision is critical to improving the effectiveness of energy access policies. Collecting accurate information is made more costly by a lack of modern services such as access to the internet and mobile coverage. Indeed, in 2020, only 104 (5%) of communities connected to electricity services had telemetering, with a further 48 communities connected to these. CREG has highlighted the importance of embedding information management tools in the value chain for energy service provision. With telemetering, utilities can collect data on the electricity consumed in the community which improves quality of services and accurate billing (CNM, 2020[39]). A recent review by the superintendent of public services (Superintendencia de Servicios Público, SSPD) underscores this by finding that out of 18 localities without metering, 17 were below the subsidised service provision of Resolution 182138 of the Ministry of Energy (later repealed by Resolution MME 40239 of 2022) (SSPD, 2020[59]). To accelerate deployment, the government has held several public tenders to procure metering systems in ZNI in the last few years.

Across energy services providers, there is an effort to implement international financial reporting standards, to enable better monitoring of the financial performance and sustainability of providers. SSPD is accompanying providers in these efforts, and the majority of public electricity service providers in the ZNI

[19] Energy Transformation Mission (Misión de la Transformación Energética). More information available here: https://www.minenergia.gov.co/es/servicio-al-ciudadano/foros/propuestas-de-documentos-de-la-misi%C3%B3n-de-la-transformaci%C3%B3n-energ%C3%A9tica/.

(57 in 2018) have been complying with the obligation to report financial information to the SUI. Ongoing studies, under IPSE, are looking into how to continue to improve operator performance. Recommendations include strengthening methodologies for planning and control of financial resources and implementing procedures for permanent review and control of compliance with budgets. Introducing a code of good governance can equally help define appropriate management and control structures and avoid conflicts of interest.

Access to credit is increasing but remains challenging

With view of the challenges to providing electricity services in ZNI, accessing finance for widescale deployment of off-grid distributed renewable energy solutions remains more challenging than for larger grid connected renewable energy projects. Specifically, financial institutions can be reluctant to provide finance for off-grid decentralised renewable projects due to the high costs associated with supplying in remote areas, uncertain customer demand, and willingness and ability to pay above subsidised consumption levels. This can affect business viability, which, in turn, brings uncertainty to financiers on the ability to recover costs and make investment returns. Other deterrents include weak credit ratings (or lack thereof) of the borrower and inability to meet stringent collateral requirements. Small-scale enterprises operating a business-to-customer model will have characteristically lower debt capacity as their revenues are generated from short-term contracts with low-income populations, which can create uncertain and unpredictable cash flows. Moreover, smaller developers typically have less market power when negotiating with lenders and can be burdened by unfavourable or inflexible debt structures (UNDP, 2022[60]). In addition, the combination of smaller transactions and higher risk can contribute to high transaction costs for the lender, who will have to evaluate each project on a case-by-case basis, often with little standardisation across project documentation (Deloitte, 2019[61]). These factors can prompt banks to extend only short-term loans with high collateral requirements and interest rates.

Colombia has used programmes to support green investments in non-interconnected zones. Concessional lending programmes have helped to raise the financial sector's experience with distributed renewable energy projects. In 2015, Inter-American Development Bank (IDB) provided USD 10 million in concessional financing to Bancóldex, Colombia's entrepreneurial development bank, to increase their capacity to support existing energy generation operators and technology providers in non-interconnected zones with long-term finance for renewable energy projects (BASE, 2016[62]).

This has borne fruit and commercial finance has started to enter the distributed renewable market for a few attractive projects in Colombia's non-interconnected zones. In particular, Bancolombia is already providing commercial finance for renewable projects, including Unguía Choco working with HG Ingeniera y Construcciones SAS (Box 3.2) (IPSE, 2022[63]), with several more under development. The market for renewable energy in non-interconnected zones, is therefore evolving, with commercial lending becoming attainable for attractive projects. But more can be done to support commercial lending to riskier projects. Equally, lending for small businesses, through microfinancing, could be strengthened to help businesses to invest in solar panels, or solar irrigation, for example, to improve the productivity of their current activities.

As discussed in the subsequent chapter, development finance can play an important role in supporting early market development and increasing access to finance. This can take the form of upstream actions to strenghten enabling conditions at government level, or work downstream with project developers for example with technical assistance to increase the efficiency of operation and maintenance activties. It could also take the form of a pilot public procurement programme, or vehicles to de-risk investments, with for instance guarantees. Through technical assistance, development finance can also help strengthen the ability of the financial sector to offer green lending to distributed renewable projects, to extend access to finance to micro, small and medium enterprises located in non-interconnected zones.

Box 3.2. Unguía Choco working with HG Ingeniera y Construcciones SAS

El Sol Brilla para Unguía is a large-scale hybrid generation project developed by HG Ingeniera y Construcciones SAS, operated by Genercol SAS ESP and retailed by ESPUN. This case is highlighted by IPSE as a success story for private investment in electricity service provision in non-interconnected zones, thanks to the participation of private commercial investors which provided debt on 70% of the project.

El Sol Brilla para Unguía is 1 990 kW solar diesel hybrid project, including 662 kWp from solar PV, increased by 116 kWp with a battery. This project was built to serve 10 000 users in the municipality of Unguía with 22 hours of electricity service and the potential to extend to 24 hours.

The investment was made with 30% equity from the developer and 70% debt provided by Bancolombia under its green credit line. The project also benefited from fiscal incentives, such as value added tax exemptions and accelerated depreciation.

The highest operations costs are recorded to be fuel (40-43%), spare parts and lubricant (7%), fixed costs (13.2%) and fuel delivery to the site of operation. The main staff costs have been for administration, operation, and maintenance, for an expert to submit tariff requests to the regulator, CREG, and a team to support engagement with the public alongside the retailer.

Part of the success of this project is linked to the strong focus on client relations by ESPUN, the electricity retailer, who provides a webpage with information and client services for request and claims. Time was also spent building relationship and sharing information on the project with local households, businesses, and schools.

A review found that more than 90% of users in Uguía could afford the tariff costs of the subsidised tariffs for electricity, which are determined according to income and status:

- User group 1, with subsidies on 81% of the tariff pay 273.3 COP/kWh
- User group 2, with subsidies on 76% of the tariff pay 343 COP/kWh
- User group 3, with subsidies on 65% of the tariff pay 514.3 COP/kWh
- Commercial users pay 952.18 COP/kWh
- Public sector users pay 952.18 COP/kWh

Generators also receive subsidies on generation assets from MME for approximately 84% of the unit costs of electricity service provision. As seen in the section above, the unit cost of providing electricity services is determined by tariff regulation, expressed in pesos per kilowatt hour ($/kWh), which corresponds to the sum of the efficient costs of each of the activities in the electricity chain. Following Law 2099 of 2021, the renumeration of subsidies was paid directly to the generator.

The overall cost of service-provision is reported to be 1476.4 COP/kWh. The cost of generation is reported as 1243.1 COP/kWh, just slightly above the unit cost of generation approved by GREG 1.230 COP/kWh. The cost of distribution and retail are respectively 22.39 COP/kWh and 72.81 COP/kWh.

Source: (IPSE, 2022[63])

4 Actions to support finance and investment for distributed renewable energy

Colombia has already taken many steps to increase investment in renewable energy in non-interconnected zones, which has led to the tripling of renewable capacity from 2020 and 2022 from 16 to 46 MW (CNM, 2022[58]). Yet, to meet ambitions for distributed renewable energy laid out under the Renewable Energy Law and to reach the investment needs highlighted under the PIEC, there is a need to access private equity and debt in larger volumes.

Development programmes and public spending can help bridge the investment by targeting interventions towards crowding in private finance and investment. Indeed, with USD 2 billion in investment highlighted under the PIEC, Colombia's non-interconnected markets represent a large investment opportunity.

Yet, new business models will be critical to bringing down the cost of new project development. Estimated connection costs via hybrid mini-grid and solar home systems, which are based on historic investments, remain well over global averages (Table 2.2). As Colombia designs and reviews interventions, measures that can lower the overall costs for the government and users will be essential.

The subsequent chapter explores priority areas for the Colombian market for increasing finance and investment for distributed renewable energy, exploring lessons drawn from development programmes deployed internationally.

Strengthened planning can improve programmes to deploy distributed renewable energy

To meet distributed renewable ambitions, and build on Colombia's progress, a clearer strategy with near and long-term actions could help facilitate renewable deployment. This can help stategically target public and developmet funds to where they can have the most impact in mobilising private investment to meet sustainable energy needs.

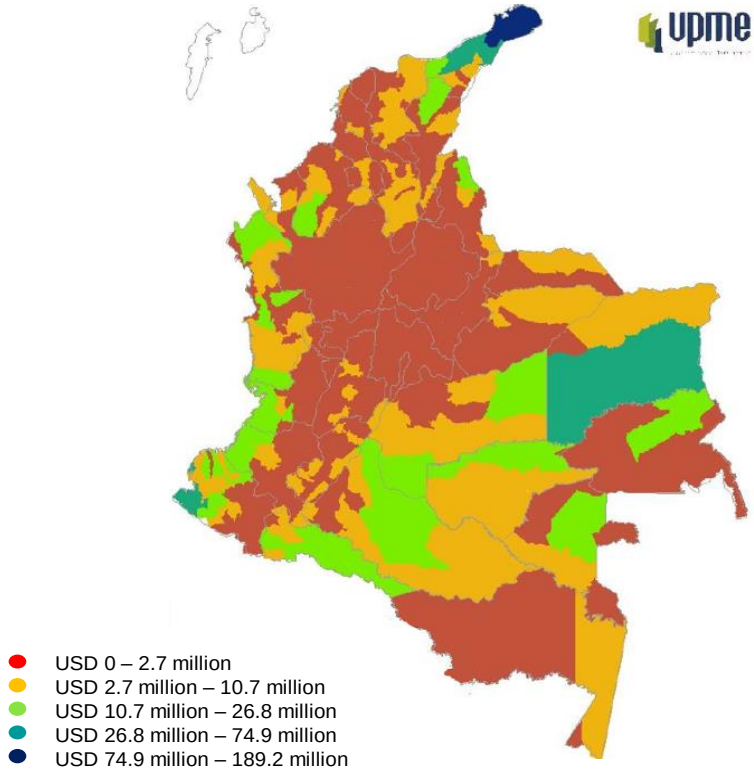
While the PIEC sets out high-level ambitions, spelling out actions at the regional level could help increase the effectiveness of deployment strategies. For example, current planning does not provide a clear plan for replacing existing diesel generation which makes up nearly 300 MW of installed capacity and would represent a lower-risk investment given pre-existing data on demand and expected return.

Moreover, in the costliest zone of the ZNI in Colombia's northernmost peak of la Guajira, municipal costs for expanding electricity services are 70 times that of municipalities located adjacent to the national grid (Figure 4.1). Yet, these same locations have the best wind resources in the country, with several large-scale off-shore wind projects under preparation. Other renewable solutions, such as bioenergy and waste to energy could leverage existing activities to reuse residues for energy production. For example, as

highlighted in the OECD's *Enabling Conditions for Bioenergy Finance and Investment in Colombia*, local organic waste from agricultural and municipal activities could be used to produce biogas for electricity generation (OECD, 2022[49]).

Developing regional and cross-sectoral strategies could help leverage opportunities to capture local benefits from large project development or existing agricultural activities. As discussed below, this can be coupled with use of subsidies and procurement strategies to provide incentives for the private sector to enter riskier markets.

Figure 4.1. Municipal investment cost for universal access (2019-23)



Source: (UPME, 2019[37]) Indicative plans for expansion of electricity coverage (Plan Indicativo de Expansión de Cobertura de Energía Eléctrica, PIEC) 2019-2023

Results-based financing is catalysing private investment in off grid markets

Subsidies will continue to play a pivotal role in supporting electrification for the poorest and hardest-to-reach consumers, notably in zones in the North Pacific and South Pacific, which struggle to attract private investment or face challenges in improving the quality of electricity service. Still, public funds should be targeted to ensure that they minimise the risks of market distortions and are targeting areas most in need. Useful lessons can be drawn from other regions on designing subsidies with a focus on scaling up commercial opportunities and unlocking further market potential.

In particular, where there is commercial potential, supply-side subsidies that target companies and investors can be well-placed to support market development. For example, results-based financing instruments are increasingly being used in programmes targeting hard-to-reach populations, by incentivising incremental private investment and ensuring the quality of service. This approach links the disbursement of project funding to project development milestones or verification of pre-agreed results. As

developers must use their sources of funding to bridge the gap until funds are disbursed, this approach increases accountability and incentivises timely delivery (Sanchez, 2021[64]) . At the same time, a milestone approach can promote long-term project success and help improve the overall efficiency of the mini-grid project development and operation, rather than just covering the initial costs (BloombergNEF and SEforAll, 2020[65]).

Results-based financing has proven to be an effective means of catalysing additional private investment in development programmes, such as the World Bank Kenya Off-grid Solar Access Project (KOSAP), as it can bring down both costs and risks to developers (Box 4.1). Under the GIZ Pro Mini-grid programme in Uganda, results-based financing was also used to reduce the risk of early-stage debt and increase investor confidence by rewarding project achievements (Box 4.2).

In addition, the use of competitive tendering can bring down the costs of subsidies. Under a minimum subsidy tender, prospective energy service providers are evaluated not only on the quality of the bid or their technical competence but also on the amount of subsidy they require to connect new users. Financing for projects is awarded to service providers who meet technical requirements and who need the lowest subsidy.

For example, this approach is employed by Nigeria's Rural electrification Agencies to expand mini-grid deployment (REA, 2022[66]). Under competitive conditions, in order to win the bid, service providers have an incentive to provide accurate estimates of the financial support needed for the project to be financially sustainable, which helps government gain a better understanding of the cost drivers for the project. The KOSAP programme used competitive tendering to attract solar home system providers active in other parts of the Kenya market, to expand activities in underserved communities. A cap was placed on the amount of subsidy each service provider could be granted under the call for proposals, allowing several service providers to operate in each market (Box 4.1).

Box 4.1. World Bank Off-Grid Solar Access Project

The Kenya Off-grid Solar Access Project (KOSAP) was designed by the World Bank to support the wider uptake of distributed renewable energy in Kenya's remote, low-density and traditionally underserved areas, typically located in the north of the country. This programme was designed as a USD 150 million financing facility, dedicated to supporting energy access through renewable energy resources for cooking and electrification of community facilities and enterprises.

USD 48 millions of this facility is dedicated towards results-based financing and debt facilities with the target of expanding service to 250 000 households in underserved zones. This approach aims to leverage the thriving solar home systems market in the rest of Kenya and provide existing service providers with support to equip 1.1 million inhabitants with solar home systems and distribute 150 000 clean cooking stoves across 8 counties.

Results-based financing was found to be one of the most effective tools for encouraging incremental supply. Indeed, the objective of results-based financing is to catalyse private investment by bringing down costs and risk, while providing an incentive for further investment. The financing compensates service providers for a portion of initial, ongoing incremental and opportunity costs associated with an expansion of operations in underserved counties. At the same time, instalments of the financing are paid based on the achievement of pre-agreed connection milestones and satisfactory after-sales service support. This provides an incentive to deliver in an efficient and timely manner, as the service provider must rely on their sources of finance until reaching milestones where grants will be disbursed.

In addition, a competitive tender is used to determine an efficient level of subsidy for service providers. Bidders compete on technical qualification and the level of subsidy needed for each user connection, with financing awarded to the lowest qualified bid. This process supports price discovery, where government actors can gain a more realistic view of the cost-of-service providers' activities in the region. This is complemented by a cap on the share of financing that each developer can access, which ensures that multiple service providers compete and can operate within the targeted geographic zones.

Under this component, 100 000 units have already been deployed, with the expectation that the 250 000 units target will be exceeded by the end of 2023.

Source: World Bank Interviews (2022) OECD CEFIM

Public procurement and multi-site tendering are useful market development tools

Various public procurements have been deployed across distributed renewable energy markets, including public-private partnerships or tenders for private multi-site aggregation. Site aggregation to create larger ticket sizes is a particularly useful tool to attract investors, which could be explored under pilot programmes in Colombia. This can also help attract international companies with experience in distributed renewable technologies and innovative business models that can help reduce costs and reach customers. UPME's work under the PIEC in identifying project sites through least-cost modelling could support this process and facilitate the identification of sites with different risk and demand profiles. Geospatial portfolio planning tools, in particular, can significantly reduce pre-site preparation costs from around USD 30 000 per site to USD 2 300 (ESMAP, 2019[13]).

In Uganda, under the GIZ Pro Mini-grids programme, bundled site procurement allowed developers to benefit from economies of scale in the costs associated with project preparation and development. Having several projects to develop and operate can also justify the cost of setting up a local office. In these sites, developers were given exclusive licences for the specific geographic zones, with view of implementing renewable mini-grids for electricity service provision (Box 4.2).

Colombia has already implemented exclusive licences for specific geographic zones, permitted under Law 142 of 1994 which establishes Colombia's regime of domestic public services. Known as Exclusive Service Areas (Áreas de Servicio Exclusivo, ASE), public service utilities (SOPESA S.A. E.S.P. and ENAM S.A. ESP) were given exclusive rights to provide electricity services including generation, distribution and marketing of electricity, respectively in the Archipelago of San Andrés, Providencia y Santa Catalina,[20] and the department of Amazonas.[21]

For remote areas, these exclusive service areas have demonstrated improvements in quality and continuity of service indicators. In the case of the department of Mitú, Vaupés and Puerto Leguízamo, Putumayo 24-hour service provision has been achieved. By contrast, in some localities of the North Pacific and South Pacific Zones, where the free competition model operates, a majority of energy users did not receive the service equivalent to the subsidy that had been assigned (SSPD, 2020[59]).

No further Exclusive Service Areas have been established to date, but concession models, under various forms, remain a potential tool available for attracting private investment. This specific type of Exclusive Service Area can only be granted by MME acting on behalf of the state. Other forms of concessions can also be granted directly by municipalities under Law 142 of 1994 for procuring services in their territories

[20] Concession contract 067 de 2009.

[21] Concession contract 052 of 2010.

(Ivan Darío González Guarín, 2020[67]). For example, a private company could be assigned the responsibility of undertaking, maintaining and expanding the electricity service provision activities in a municipality over a given period, including establishing robust billing and collection systems, under a regulated tariff (Ignacio Perez Arriaga, 2020[68]).

Box 4.2. Pro Mini-grid programme in Uganda

The Pro Mini-Grids programme supported the government of Uganda in securing private investments for solar mini-grids in 15 villages in the south of the country and 25 in the north of the country. The programme provided subsidies on capital expenditures for generation assets and support for project aggregation and contract preparation to simplify procedures and create a larger ticket size for investors to pursue.

The small and disaggregated nature of off-grid projects creates challenges for mobilising investment at suitable scale to meet electrification targets, as these projects are generally too small to attract large investors. By bundling projects into a multi-site tender, the pilot was able to attract a larger developer who could benefit from economies of scale on project costs. The developer's risks were also reduced as contracts and agreements were pre-drafted, financing mechanisms determined in advance, and the electrification authority involved in site selection.

At the same time, the use of grants and results-based financing for upfront capital costs has helped improve the return profile for the investment. Under the Pro Mini-grid programme, Winch Energy, the winner of the tender, was eligible to receive a subsidy of up to 80% of the total upfront capital cost including generation and distribution infrastructure and connections, under a results-based financing instrument designed to catalyse private investment.

Milestones included completion of assembly and shipping of mini-grids to location; construction of mini-grids in the villages; connection of customers and start of electricity supply. Distribution infrastructure was also provided as an in-kind contribution by the regulatory authority and customer connections were performed by the mini-grid developer but repaid under a results-based approach.

Through this process, government authorities gained familiarity about the type of requirement international lenders prefer to include in contracts, for example, around compensation of early grid arrival and recourse to international arbitration. Equally, lenders and developer have gained experience on the Uganda market.

Source: (Pérez-López, 2020[69]) Uganda - a bundled approach to mini-grid tendering; GIZ Interview (2022) OECD CEFIM

Support for operators would extend the reach of existing resources

The government of Colombia dedicates tens of millions in public resources, annually towards energy in rural zones. This includes upfront capital subsidies for new projects from funds such as FENOGE and FAZNI, as well as subsidised tariffs to support operation and maintenance activities. Still, the distributed nature of small-scale projects means that several actors are involved, including municipalities and local grid operators, many of whom may not have the right training, capacity, or awareness to support market development and financing. Operators in smaller localities of ZNI tend to have fewer staff and resources to identify available sources of public funding and prepare documentation.

Providing a single point of entry for grant applications under FONENERGIA which unifies various funds would help simplify requests and improve access to existing resources for renewable project development in Colombia's non-interconnected zones. Greater transparency around grant funding requirements, project selection and a single point of contact under MME or IPSE would help operators have equal information on the opportunities available. On the government side, it would help simplify, co-ordinate and track project applications and grant disbursements, to align with PIEC planning and avoid duplications or overlapping projects.

To streamline the review and approval of mini-grid licensing and other regulatory requirements, several countries use a single-window clearance facility under a rural electrification agency or similar body (Energy Catalyst, 2020[70]). Other approaches for facilitating small-scale off-grid electrification include simplifying procedures, such as relaxing requirements for installations below a certain threshold or standardizing agreements and environmental assessments. This can help cut down costs and lengthy procedures for obtaining relevant technical and environmental approvals for the project and reduce the risks of project development at the pre-feasibility and feasibility stages (Energy Catalyst, 2020[70]).

Furthermore, operators in non-interconnected zones will have varying resources and capabilities, and gaps in training, capacity or awareness will create significant barriers to market development and access to finance. Project development could be supported by a co-ordination point or "back office" to help inform operators on procedures, licencing, tariffs and technical standards for renewable solutions. Such a contact point could be hosted by IPSE as this would fit well with their mandate to oversee the planning of energy solutions in non-interconnected zones. IPSE has already strengthened its information availability with an updated website with resources for developers.[22]

Facilities, which offer support, training and advice to operators, can help existing companies, use available resources more efficiently. Digital technologies, notably for metering and billing have a central role to play in reducing costs and improving performance and transparency, notably by enhancing the quality of data collected on operations. For example, in Peru, the second phase of the Global Environment Facility and World Bank Rural Electrification Project provided staff training and assistance in developing online tools for utilities to manage solar home systems, as well as supporting the development of billing and collection arrangements (World Bank, 2019[71]).

Standardised documentation enables better risk evaluation

Supporting standardisation can be an important tool to facilitate the evaluation of risks and returns of projects. For example, the application of international technology standards can reassure international financiers that the project will be able to deliver the required service over time (SER, 2020[72]). It can also facilitate smaller projects to be pooled together as assets are more readily compared.

For a prospective investor or lender one of the main contributors to transaction costs will be due diligence and complexity, or lack of information on financial performance will be a barrier to assessing risks and opportunities. Standardisation of documentation can help simplify this process and lower the costs of due diligence.

At the multi-site level, projects can be supported through grants to provide pooled off-grid renewables projects with shared legal services, technical advice and common documentation in a more cost effective way than would be possible for a single project (IRENA, 2018[73])

More broadly, technical assistance programmes can play an important role in building consensus from industry stakeholders on standard documentation needed for distributed renewable projects in the ZNI

[22] More information available: https://ipse.gov.co/guia-practica-de-estructuracion-de-proyectos/.

context. Initiatives such as the Climate Aggregation Platform[23] work in-country to develop working groups, market assessments and action plans to support financial aggregation of small-scale projects. Uniform and standardised data is an essential basis for transparency for modelling aggregated receivables. Eventually, if projects are deployed under a similar or common proven business model, this will increase project comparability and make the process of aggregation much easier (GBN, 2019[74]).

Supporting access to data on mini-grid and standalone operations, through consistent reporting and standardised definitions, increases transparency and provides investors with a means of gaining a more robust understanding of local markets in Colombia's ZNI. Development programmes can help co-ordinate the development of an accurate methodology for data collection and encourage data collection amongst distributed renewable energy companies and municipalities, which in turn can improve project bankability. In addition, by including elements on diversity including gender and indigenous or minority communities, this can help investors better understand the social impact of projects.

Financial and operational bundling brings in larger investments

Pooling small projects into much larger assets can make them more attractive as larger investment sizes make it easier for project sponsors to interest a broader range of financiers and investors. In addition, the costs and risks of the investment are spread over several projects, which can help bring down the cost of finance (Weston et al., 2018[75]). Multi-site tendering, such as the GIZ Pro mini-grids programme, is one possibility for aggregating projects (Box 4.2). The winner of the tender, Winch Energy, raised capital from several investors and lenders, by creating a dedicated limited recourse platform. This was made possible by combining 25 projects from Uganda with a further 23 projects awarded under a separate tender in Sierra Leone, to create a large investment (Box 4.3).

[23] More information: https://www.undp.org/climate-aggregation-platform.

Box 4.3. Limited recourse financing under Winch IPP

Winch Energy is an off-grid renewable energy developer owned by Total Eren, Itochu Corporation, Al Gihaz Holdings and Winch Partners. In 2017, Winch Energy was awarded 25 renewable mini-grid projects in a multi-site mini-grid tender through the GIZ Pro Mini-grid programme in Uganda (Box 4.2).

Typically, the small and disaggregated nature of projects creates challenges for mobilising investment, as investors and lenders are looking for investment's worth tens of millions of USD. In addition, the risk and costs of developing small projects will be higher. Individual site tendering leads to a higher proportion of transaction costs in the overall project cost. Uncertainty over obtaining government licences or approvals also increases the risk of unrecoverable planning costs if the project does not go ahead. Lenders are also particularly conscious of risks affecting mini-grid operations, including early arrival of the national grid and changes in consumer tariffs, which could negatively influence cost recovery.

By developing 25 mini-grid sites in Uganda under one tender, investment needs to be increased to between USD 5-8 million. At the same time, the role of government in the tender significantly improved project bankability. Project development risks were reduced by having sites pre-identified and agreements are drawn in advance. The 10-year build-own-operate-transfer implementation agreement also provided greater predictability for mini-grid operations. For example, government agreements provided compensation for force majeure and early grid arrival.

The size of investment needs was further increased by aggregating the Ugandan project with a further 23 projects awarded under public-private partnership tender in Sierra Leone. This allowed Winch Energy to mobilise USD 16 million for both projects and attract a strategic partner, NEoT Off-grid Africa, a private investment platform dedicated to financing decentralised energy in Africa.

Together, Winch Energy and NEoT Off-grid Africa established a dedicated limited-recourse financing vehicle, which raised USD 12 million in equity and USD 4 million in debt. NEoT Off-grid Africa injected the lion's share of equity, and a syndicated facility between FMO, the Dutch entrepreneurial development bank, and the Renewable Energy Performance Platform (REEP). Closed in 2021, this is currently the largest limited-recourse financing portfolio for off-grid solar mini-grids in Africa.

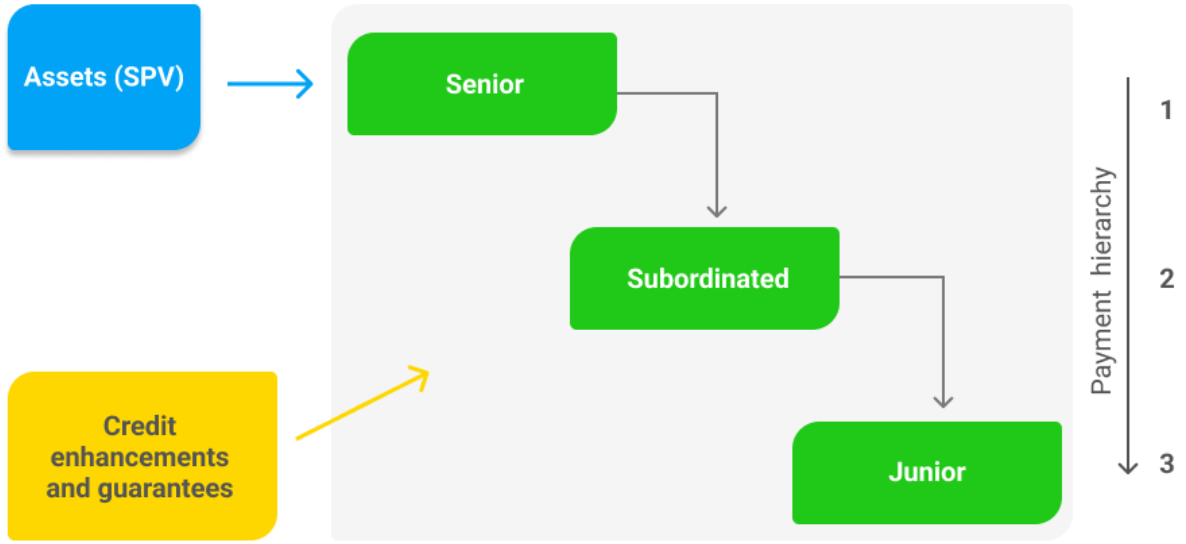
Source: Winch Energy Interview (2022) OECD CEFIM

Equally, financial aggregation can be applied to operating assets, to unlock new sources of finance for small-scale clean energy projects. Under this process, multiple distributed renewable assets, projects or companies are bundled into a portfolio so that they can receive financing from investors based on future cash flows. With the aggregated portfolio acting as an entry point for investors, transaction costs are reduced as compared to investing in assets individually. Furthermore, financial aggregation provides a means of managing portfolio risk. The operational risks of individual assets are diluted within the portfolio, and combinations of assets with specific risk profiles can be chosen to meet investor risk appetite.

Bundling small-scale distributed renewable projects in ZNI under a special purpose vehicle can facilitate securitisation, whereby sponsors issue individual securities based on existing or expected revenue streams. Capital can then be reinvested through the sale of securities on the secondary market, thereby replenishing the amount available for renewable energy projects (IRENA, 2016[76]). This type of model has been successfully employed in Brazil under the Green Receivables Fund (Box 4.4) which adapts existing regulation for the mortgage market to provide funds for green projects.

Through the creation of various individual tranches with a variety of ratings, risks and returns to appeal to different investor appetites, asset aggregation can also help to attract risk averse investors, such as institutional investors. Payback on certain tranches can be prioritised to create lower and higher risk securities. Under this approach, the senior tranche, which has the highest rated security, will receive principal and interest payments first. The junior tranche would be the last in line to receive principal and interest payments. This process can be supported by development partners who provide credit enhancement or guarantees on the lower tranches (IRENA, 2016[76]) (Figure 4.2).

Figure 4.2. Cash flow waterfall for securities



Notes: Special Purpose Vehicle (SPV)
Source: adapted from (IRENA, 2016[76]). Unlocking renewable energy investment: the role of risk mitigation and structured finance.

Box 4.4. Green Receivables fund

In 2016, the Green Receivables Fund ("Fundo de Investimento em Direitos Creditórios" FIDC) was designed as a securitisation instrument in the Brazilian market to address the lack of long-term finance for clean energy projects, as well as to overcome barriers, such as illiquidity of assets and risks associated with foreign exchange, macroeconomic conditions and projects.

This instrument builds on FIDC's existing regulatory framework which allows for securitisation through asset-backed securities, regulated by the Brazilian Securities Commission (CVM). Through a special purpose vehicle (SPV), receivables for contractual debt can be pooled, and financial securities backed by income-generating assets can then be sold to investors. There was already a sizable market for FIDC shares in Brazil for commercial and residential mortgages, credit card debt, and car loans.

Under this model, the existing FIDC regulatory framework is combined with green certification criteria and a financial model adapted to suit the needs of clean energy projects such as renewables and energy efficiency. This allows for securities against future revenue streams of one or more clean energy projects pooled under an SPV for financing.

This approach also provided a means to allocate risks to investors best suited to handle them, taking a blended finance approach to use concessional funds to mitigate risk and attract private finance.

In 2021 Albion Capital and Órigo Energia, a renewable energy developer, announced the close of Green FIDC Solar GD, the first FIDC issued as a climate bond in Brazil, at USD 35.8 million (BRL 201.5 million). Moreover, based on the Green FIDC model, Albion Capital and Órigo Energia also launched a Green CRI (Certificado de Recebíveis Imobiliários) a Brazilian form of mortgage-backed security designed for real estate investors, securing USD 14.3 million (BRL 80.1 million).

Source: (The Lab, 2017[77]) Green Receivables fund (Green FIDC); (CPI, 2021[78]) Brazil's first FIDC and CRI issued as a climate bonds raise USD 50 million.

Targeted support can strengthen green lending in the local financial sector

The market for distributed renewables in ZNI is evolving, with attractive renewable mini-grid projects and established solar home system suppliers starting to receive commercial finance. Development programmes can build on this progress by targeting financial sector capacity building to increase lenders' ability and confidence in lending to standalone solar technology suppliers and for financing mini-grid projects in non-interconnected zones. Access to finance is particularly critical for supporting smaller businesses or operators, which often operate with limited free cash flow. Delay in the disbursement of finance, or lack of finance for business growth can represent significant hurdles.

In addition, programmes can specifically target green lending to small and medium-sized enterprises (MSMEs). For example, the IDB's EcoMicro programme, works directly with financial intermediaries on consumer loans for renewable technologies and finance for green entrepreneurs and MSMEs (EcoMicro, 2022[79]). The aim of the programme is to help the local financial sector develop a clearer understanding of business models for MSMEs, and of the risks and costs of clean energy investments, as well as to support the application of an appropriate interest rate. Through capacity building, the programme works on strengthening local financial institutions' abilities to design tailored financing products for farmers and agro-enterprises to scale up use of renewables in agriculture. This helped lower the need for traditional collateral on land titles and instead used renewable energy technology as collateral, and better aligned

interest rates, repayment schedules and flexibility, based on the financial background and cash flows of the potential borrower (IRENA, 2016[76]).

Box 4.5. Eco Micro

Eco Micro is an initiative set up by the innovation laboratory of the Inter-American Development Bank (IDB Lab) to help bridge the financing gaps of MSMEs by working with financial intermediary partners to help them become better equipped to provide green finance.

Eco Micro is working from 2020 - 2022 with the Development Finance Corporation (DFC) in Belize to support renewable energy and energy efficiency lending to MSMEs. This programme supports a credit line from the Caribbean Development Bank (USD 1-2 million), with additional financing sources coming from the CARICOM Development Fund (CDF) and a new credit line with IDB of which 30% is allocated for climate finance.

Under the Eco Micro programme, Econoler, a sustainable energy consulting firm provides technical assistance to DFC to help them gain the appropriate tools and know-how to analyse the market and design green financial products that respond to local needs. Research undertaken by Econoler under the Eco Micro programme informed recommendations on improving access and attractiveness of green finance products for MSMEs. This helped to reduce collateral requirements for clean energy loans and streamline audit templates to better evaluate projects.

The programme has also helped to disseminate information to MSMEs in Belize about the benefits of renewable energy and energy efficiency investments and bring attention to the development banks' green lending options that provide debt at attractive interest rates of 5.5-6%. As the economic situation improves, interest in clean energy loans is expected to increase, notably in the context of increased price volatility, where such investments can help bring about long-term energy savings.

Source: Eco Micro Interview (2022) OECD CEFIM

Blended finance is an important tool for scaling up private investment in distributed renewables

The strategic use of development finance for the mobilisation of additional finance towards sustainable development in developing countries can be critical to bridge the finance gap for distributed renewables. Blended finance, which draws on finance from development institutions (such as donors and multi-lateral development banks) makes use of various strategies, including financial de-risking or technical assistance, to mobilise private finance and enlarge the total amount of resources available to developing countries.

Development programmes can support the uptake of distributed renewable markets through financial de-risking and creating private financing opportunities with levels of risk that are acceptable to the lender or investor. For example, credit enhancement tools can be a means to support local currency lending by bridging the gap between the financial requirements of projects and the financial terms available from the local market. By reducing risk to lenders, local banks can lend to more risky projects or offer lower interest rates that reflect the reduced risk Box 4.6 This can be an important tool for local currency financing and reducing risks around currency convertibility. Other tools include revenue guarantees, which can be used to protect investors against the risk of revenue shortfalls, particularly in the early stages of distributed renewables projects when the risk of misalignment of demand and supply is higher Box 4.7.

Taking a systematic approach to development programmes to ensure their additionality and the mobilisation of commercial finance, can help maximise the impact of said programmes in Colombia. The OECD's Blended Finance Principles offer a common policy framework to guide the use of blended finance. Meeting the Paris goal of limiting global warming to 1.5°C by the end of the century will require an unprecedented mobilisation of finance. Blended finance can be a critical tool for scaling commercial finance and investment for clean energy (Figure 4.3) (OECD, 2022[25]; OECD, 2020[80]).

Box 4.6. GuarantCo partial credit guarantee to Bboxx

GuarantCo is a long-term local currency credit solution provider funded by several development agencies, established to help close the infrastructure-funding gap in lower income countries across Africa and Asia. In 2021, GuarantCo helped mobilise local currency commercial finance for Bboxx, an off-grid solar supplier operating in Africa. This was done through a partial guarantee against a loan provided by SBM Bank Kenya, a local commercial bank.

Banks in Kenya, and across the region, can be reluctant to lend to solar home systems providers in early growth phase where profitability may not yet have been reached. GuarantCo's partial credit guarantee helped mobilise local currency financing at an affordable rate in a market where financing was either unavailable or only available at prohibitive interest rates.

GuarantCo, provided a KES 1.2 billion (around USD 10 million) partial guarantee against the KES 1.6 billion (equivalent to around USD 15 million) loan facility. Under the partial credit guarantee GuarantCo assumes the risk of non-payment of scheduled debt service for up to 75% of the underlying loan between SBM bank and Bboxx. A recourse agreement is established between the Bboxx and GuarantCo to cover, amongst other provisions, the payment of fees to GuarantCo and the rights and obligations of Bboxx, GuarantCo and the SBM bank following a potential call under the guarantee. This guarantee acts as a collateral substitute or supplement in the security package, which enables the loan to take place, where otherwise it would likely not have been possible. The transfer of risk also enables the commercial bank to improve credit terms for the borrower.

This enabled Bboxx to expand its business in Kenya to provide access to clean, reliable and affordable energy to nearly half a million people through off-grid solar home systems in Kenya. The funds will be used by Bboxx Kenya to purchase new inventory over two years including 89,600 solar home systems and essential appliances such as fridges and mobile phones.

Source: GuarantCo Interviews (2022) OECD CEFIM

Box 4.7. SIDA

As part of its mandate to promote sustainable development, inclusive economic growth and poverty reduction, the Swedish Development Cooperation Strategy (SIDA), Sweden's government agency for development co-operation, supported Trine Investment (Trine) crowdfunding platform with a guarantee instrument. Through this instrument, SIDA aims to enhance access to credit for solar entrepreneurs - micro, small and medium sized energy service providers who usually struggle to access finance.

Guarantees can be an effective and flexible tool to support investments in socially and environmentally beneficial projects, such as renewable energy. Guarantees work by redistributing the risk of these investments between the public and private actors. SIDA's guarantees are like insurance for lenders; the guarantee beneficiary pays a fee for the guarantee, and if the borrower defaults, the lender recovers a share of the money.

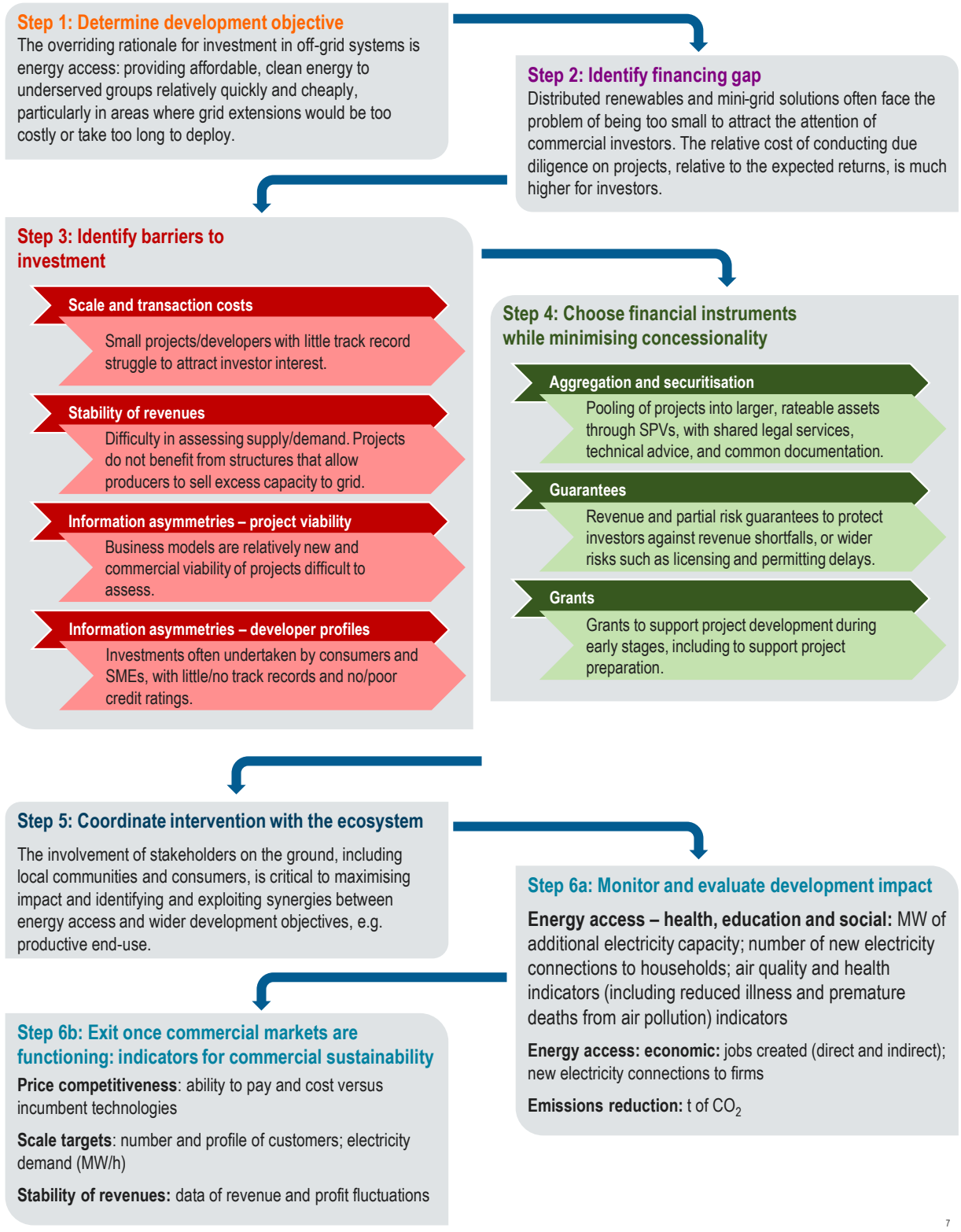
In the case of Trine, which acts as a financial intermediary, the guarantee enables crowdfunding investors to recoup part of their costs if the solar energy entrepreneur defaults (SIDA, 2019[79]). SIDA and Trine agreed upon a guarantee agreement for 10 million Euros of mobilised private capital from the "crowd", to be used as loans for solar energy service providers in the agreed countries. The loan tenor for solar entrepreneurs was between 4 and 6 years, and under this arrangement, 60% of investors' principal was guaranteed. This was arranged as a *pari passu* guarantee, which means "equal in right of payment", so creditors to the loan, in this case crowd investors, are treated equally and compensated proportionately for the predetermined share of losses.

As a development assistance instrument, additionality is imperative in SIDA's guarantee. The intention is that the guarantee allows the beneficiary to mobilise additional capital that would not have been otherwise invested, or reach entrepreneurs and businesses in developing countries, for example, women and young entrepreneurs, or businesses operating in a conflict-prone environment.

These investments helped Trine scale up its lending in the Sub-Saharan Africa and build confidence in its business model. The default rate was lower than expected at under 3.3%. It also helped to demonstrate the commercial opportunity to lend to solar energy entrepreneurs and small and medium sized energy service companies through crowdfunding platforms.

Source: SIDA interviews (2022) OECD CEFIM

Figure 4.3. Blended finance guidance for off-grid clean energy systems



Source: (OECD, 2022[25]) OECD blended finance guidelines for clean energy; (OECD, 2020[80]) The OECD DAC Blended Finance Guidance

5 Conclusions

The cost competitiveness of small-scale renewable power is improving, and countries have clear opportunities to invest in them. Accelerating deployment and reaping their benefits will depend on how fast the investment gap can be closed.

In Colombia, tapping into private equity and debt in larger volumes will be essential to scale up investment to improve and expand access to clean energy to populations in non-interconnected zones who are still without, and secondly to determine a pathway for long-term power transformation plans and fossil fuel phase-out policies that will support net-zero emission targets.

There is a significant cost linked to the supply and transport of fuel, mainly diesel, to remote and hard to reach locations. In 2018, the government spent over USD 25 million on fuel subsidies for operators in non-interconnected zones (CNM, 2020[39]). As electrification efforts continue, if the same diesel generation technologies are used, this number would more than triple within a decade. Transitioning towards renewable technologies therefore represents an important opportunity to reduce costs to electricity consumers and to the government.

Already, updates to the electricity tariff and subsidy regulations have increased confidence in the distributed renewable market, by improving cost recovery on operation and maintenance for solar home systems. Installed solar home system capacity has doubled between 2020 and 2022, increasing from 16 to 46 MW (CNM, 2022[58]). Financial incentives have been valuable in creating early markets and enhancing the cost competitiveness of small-scale renewable power. Yet, based on historic investments, expansion plans (PIEC 2019-2023) foresee that nearly USD 2 billion investment would be needed to reach the remaining 500 000 users without access to electricity in Colombia. As Colombia designs and reviews interventions to support the renewable market in non-interconnected zones, it will be critical to consider measures that continue to lower the overall costs for the government.

To achieve the economies of scale that will be needed for a transformation of the power system with small-scale renewable power, systemic innovations in policy, regulation and new finance and business models that interact and reinforce each other are needed. In particular, Colombia should consider areas where the public sector and development partners can help strengthen the enabling environment for private investment and support business model innovation:

- Programmes to support operators in developing technical capacity, including improved metering capabilities, would help existing resources be used more efficiently and support the sustainability of existing businesses. Better data on operations will be a critical tool for accessing finance.
- Development programmes can be tailored to strengthen the capacity of local financial institutions to offer green products. Building internal capacity and including procedures, such as simplified methodologies for evaluating off-grid renewable projects, can help reduce barriers to finance, including stringent collateral requirements.
- Supporting standardised documentation can increase transparency and provide investors with a more robust understanding of renewable hybrid mini-grid and off-grid solar sectors. Greater comparability amongst projects can also support financial aggregation and off-balance sheet financing. In addition, by including elements on diversity including gender and indigenous or minority communities, this can help investors better understand the social impact of projects.

- Project aggregation is a powerful tool for overcoming barriers to investment. Notably, it can create a pathway to tap into capital markets and attract international expertise to projects. Colombia can build on the site identification undertaken in electricity planning activities to develop multi-site tenders, which would help achieve economies of scale by reducing the individual transaction costs of each project.
- Where government support is critical to project success, notably for mini-grid projects in complex zones, approaches such as results-based financing or minimum subsidy tenders can help catalyse additional private investment. In particular, coupling grants with competitive procurement can support price discovery by providing insights into cost drivers in the local market.
- There are a number of different public funds that are available to distributed renewable energy project in non-interconnected zones, but lengthy and complicated grant application procedures can discourage their use. Simplifying procedures or creating a single window for grant applications could help extend the reach of existing resources.
- Both public and private sources of financing have a vital role in developing renewable energy solutions in Colombia's off-grid market. Therefore, interventions should prioritise the mobilisation of additional finance to bridge the finance gap for distributed renewables. For example, blended finance approaches, such as credit guarantees, can help strategically mobilise commercial lending.

Part II Case Studies

Introduction

In regions around the world, the falling cost of technology and delivery model innovation are helping suppliers and end users access affordable, long-term financing for distributed renewable energy solutions. Public programmes, blended finance and the use of innovative financing vehicles, aimed at reducing barriers to private capital, can build scale in these markets.

Colombia can learn from experiences elsewhere on tools to support market development in a way that progressively reduces the need for capital subsidies and encourages participation of private capital. Furthermore, given the rapidly evolving nature of off-grid markets, the government should continue to monitor the effectiveness of instruments to ensure that they continue to be well suited to the market's particular stage of development.

This analysis provides a range of case studies on business and financing models and the policy and financing instruments used to accelerate the uptake of small-scale renewable power. These include approaches for pooling private and public revenue streams and new incentives to address market failures or scale up ongoing development activities (Figure 0.1).

Figure 0.1. Case studies on financing and business models for distributed renewable energy

	Financial instrument	Financing strategy	Business model	Country / region	Timeline
Eco micro	Grant	Technical assistance to financial sector	Green financial products for RE and EE	Latin America and The Caribbean	2010 - ongoing
GIZ Pro Mini Grids	Grants, concession and commercial finance	Limited recourse financing, project aggregation	Energy as a service mini-grids	Uganda	2017 - ongoing
Green FIDC	Grants, concession and commercial finance	Securitisation of RE and EE projects	Various business models	Brazil	2016 - 2017
GuarantCo	Risk-sharing	Partial credit guarantee	Lease to own SHS	Kenya	2021 - ongoing
Kingo energy	Patient capital and concessional finance	Concessional debt and equity	Lease to own, and energy as a service SHS	Latin America and The Caribbean	2013 - ongoing
SIDA guarantee	Risk-sharing	Credit guarantee on crowdfunding portfolio	Various business models	Africa	2018-2023
World Bank off-grid solar access project	Grants and concession finance	Results based financing and debt facility	Lease to own SHS	Kenya	2019 - ongoing
World Bank RERED	Grants and concession finance	On lending and technical assistance	Lease to own microfinance SHS	Bangladesh	2012 - ongoing

Notes: SHS: solar home systems; RE = renewable energy; EE = energy efficiency

1 The Ugandan framework for bundled tendering

Figure 1.1. Overview of the GIZ Pro Mini-grids programme

Financial instrument	Grants, concession and commercial finance
Financing strategy	Limited recourse financing, project aggregation
Business model	Energy as a service mini-grids
Country	Uganda
Timeline	2017 - ongoing

Background

Uganda has a large renewable energy potential from various resources including solar, hydro, biomass and wind. Using this potential will be crucial to reach full electrification. In 2022, around 50% of the country's population had access to any form of electricity of which 24% had access to electricity more than four hours per day (Tier 1) (Bhatia and Angelou, 2015[9]; GIZ, 2022[81]). In particular, mini-grid systems have been highlighted as cost-effective solutions for extending energy supply where grid extension is too costly or technically challenging. In 2020, Uganda already had installed 34 renewable-based (including hybrid with fossil fuels) decentralised systems representing 56 megawatts (MW) of generation capacity. At the time, this was equivalent to about 6% of Uganda's total installed capacity (SEforAll, 2020[82]).

Uganda's solar and hydro hybrid mini-grid market is expanding and nearly three-quarters of projects have attracted private investment with most of the remainder owned and operated by local communities. Yet, the market is less mature in terms of the number of projects and operators than in other eastern African countries, such as neighbouring Kenya and Tanzania (SEforAll, 2020[82]).

The Ugandan government has sought to accelerate mini-grid projects much faster to increase electrification rates. With the support of the German Federal Ministry for Cooperation and Economic Development (BMZ) and the European Union (EU), implemented by the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), the Ugandan government has substantially developed its policy and regulatory framework for mini-grid systems to enable projects to reach economies of scale. In 2017, the

Ministry of Energy and Mineral Development (MEMD), its Rural Electrification Agency (REA) – now renamed as the Rural Electrification Programme (REP) - and the Electricity Regulatory Authority (ERA) launched an integrated tender mechanism to foster market development. This approach was designed to bundle multiple sites under a single tender to reduce time and cost for developers by undertaking several stages of contract and licence preparation ahead of the call for proposals.

Recent policy has helped strengthen conditions for investment in mini-grids. Notably, in the first half of 2020 the regulator published a dedicated mini-grid regulation. At this time, the REP masterplan was also published, and a national electrification strategy (NES) was finalised in 2022. This helped address project development risks, by providing a cohesive regulatory framework, providing clear targets for mini-grids development, simpler licencing and clarity on plans for the expansion of the power grid. The mini-grid regulation equally provided a clear framework for cost recovery.

An integrated procurement framework reduced costs and project risks for developers

The Ugandan framework was developed as a pilot project under the Pro Mini-Grids programme, funded by the Government of Uganda with support from Germany (BMZ) and the European Union and implemented by the MEMD, REP, ERA and GIZ on developing the integrated procurement strategy. Alongside the Pro Mini-Grids programme, additional support for developing the regulatory framework was also provided by the United States Agency for International Development (USAID).

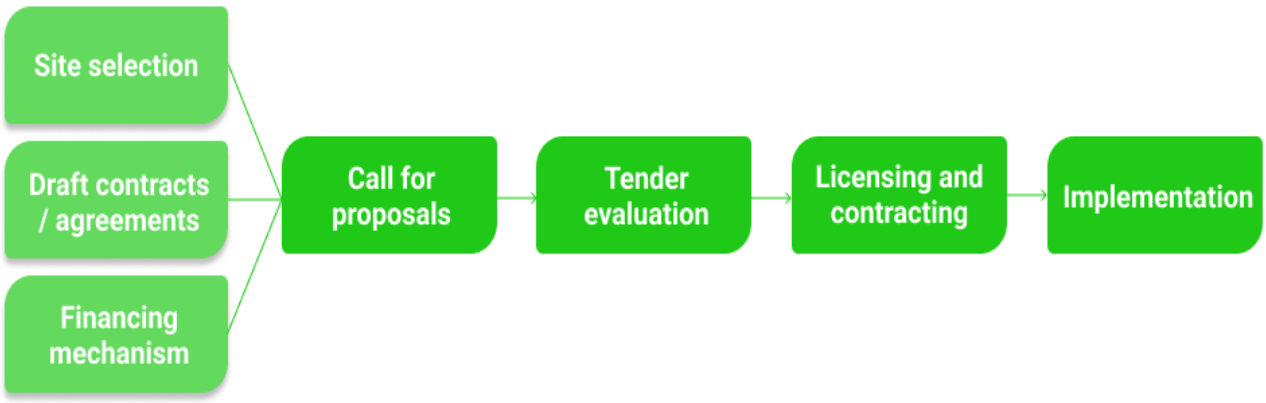
The integrated approach aimed to facilitate the uptake of the market by bundling mini-grid sites into one tender creating a larger ticket size for investors to pursue. By also bundling pre-prepared government contracts and licences the programme aimed to reduce unrecoverable planning costs and therefore a large proportion of known risk about lengthy and complicated government licencing and approval processes (Pérez-López, 2020[69]).

In the first phase, authorities selected several different sites suitable for the installation of mini-grid systems and established technical specifications for project development. These sites could then be bundled into two multi-site tenders, each with a single contract, allowing for larger project sizes and economies of scale. This avoided typical costs of individual site tendering which requires developers to dedicate time and resources towards the preparation of documentation and engagement with various authorities, increasing costs, time and uncertainty over the outcome. Under the integrated approach, the developer contracts and agreements were also pre-drafted and financing mechanisms both grant and results-based were determined in advance. As a final step, the project's alignment with national grid extension planning was confirmed under the rural electrification master plan, reducing the risk of the early arrival of the grid.

This project was a work of significant collaboration between GIZ and various entities within the Uganda government, notably REP and ERA, under the policy steering of MEMD. ERA was in particular responsible for issuing licenses, approving and setting tariffs and overseeing technical standards to be published in the call for tenders to ensure projects are licensable upon selection of a developer. ERA also regulated the conditions under which a mini-grid can be connected to the national grid. On the other side, REA's mandate focused on rural electrification, including developing master plans and designating potential mini-grid locations. REA was also responsible for implementing rural electrification strategies, funds and policies, therefore hosting the tendering process and determining financing mechanisms.

Once finalised, procurement was then undertaken through a call for proposals and tender, under a Build-Own-Operate-Transfer (BOOT) contract, with a concession period of 10 years. The selected developers were awarded licenses from ERA and signed the pre-drafted contracts and financing agreements, to allow them to move speedily into the implementation phase. During project development, REA finances, commissions and owns the distribution grid, which is then leased to the mini-grid developer.

Figure 1.2. Overview of the Ugandan Pro Mini-Grids tender process

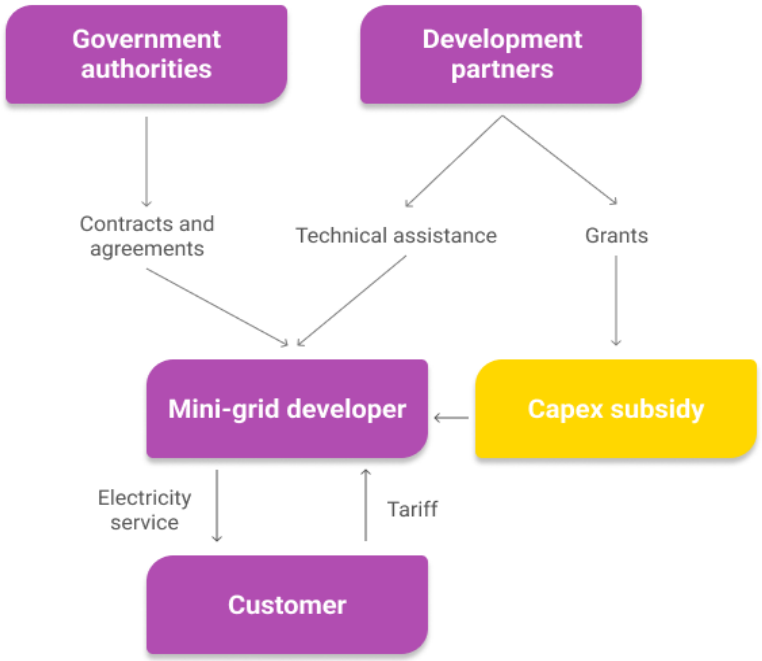


Source: Adapted from (Pérez-López, 2020[69])

Attracting new actors through grants and results-based financing

The objective of this framework has been to attract the private sector into a landscape deemed high-risk. Through the integrated approach to planning, financing, licensing and procurement under a single process, the new framework helped reduce the total duration, costs and risks of project development, by collectively undertaking these activities before the call for tenders. REA also reduced the risks of community land acquisition by directly securing the land through the government and then leasing it to developers (Figure 1.3).

Figure 1.3. Actors in the Ugandan bundled tender framework



Source: Adapted from (Pérez-López, 2020[69])

Risks were also reduced through the public-private partnerships (PPP) BOOT concession contract, which aimed to improve project bankability through the government's role in the transaction. The concession provided the developers with a stable 10-year business model, including compensations for *force majeure* and further risk mitigation was provided for early grid arrival happening, whereby mini-grid developers could claim economic compensation. Concessions in the renewable mini-grid market typically are for 20 years, as solar panels can last for 25 years or more. The shorter period was chosen as there was uncertainty over the arrival of the national grid after 10 years.

Another key challenge that the Ugandan mini-grid market has faced was cost recovery through tariffs. Under this model, the winning bidders were eligible to receive a subsidy of between 80% of the total upfront capital cost including generation and distribution infrastructure and also connections. Within this, GIZ provided a subsidy of up to 70% of the upfront capital cost of generation assets disbursed based on milestones and results. Milestones included completion of assembly and shipping of mini-grids to location; construction of mini-grids in the villages; connection of customers and start of electricity supply. The subsidy was set as a proportion of the total installed capacity rather than a lump sum, to encourage developers to size projects according to the size of demand. Distribution infrastructure was also provided as an in-kind contribution by the REA. Customer connections are performed by the mini-grid developer but are repaid under a results-based approach. Based on Uganda Electricity Connections Policy, customer connections are paid by public funds, GIZ pays 50% of the connections, REP pays the other 50% of the connections and developers are reimbursed their costs after the connections have been made and verified to be compliant with regulatory requirements (Pérez-López, 2020[69]).

When submitting their bids, developers were asked to calculate the tariff they would need to recover operation and maintenance costs, their share of private investment after the subsidy on generation assets, and also to meet their necessary return rate. The 10-year concession rather than a 20-year period was an important factor in this calculation, as capital costs needed to be recovered over a shorter timespan than the useful lifetime of the solar panels. As this puts pressure on the business model, it usually leads to higher tariffs or higher subsidies.

Tariffs proposed by the bidders of around 0.50 USD/kWh were deemed too high for customers and the government set a tariff level of 0.29 USD/kWh. To help developers achieve this, the level of subsidy on the capital costs of generation was increased from an initial 50% to the final 70%. For future programmes, a Minimum Subsidy Tender approach will be implemented, under which the tariff is determined by the regulator based on customers' ability to pay, and bidders propose the subsidy needed to meet it (Pérez-López, 2020[69]).

Risk mitigation did not cover demand risk as it was anticipated that mini-grid developers could assume this part by appropriate project sizing decisions, adequate tariff structures, as well as the promotion of energy efficiency productive use and awareness creation in the communities.

The development partner programme also helped alleviate demand risk through grants provided by BMZ and the EU provided subsidies for Uganda projects. The Foreign, Commonwealth & Development Office (FCDO) provided for Sierra Leonean projects. Under the Pro Mini-grids model, developers were granted up to 80% subsidy on the capital costs of generation, distribution and connection (70% on generation costs), as results-based financing and in-kind contribution to operate under a fixed tariff of 0.29 USD/kWh (Pérez-López, 2020[69]). In Sierra Leone, a tariff of 0.75 USD/kWh was set, and a subsidy was provided for the capital costs of generation, distribution and connection.

Multi-site project development under Winch Energy

Winch Energy is an off-grid renewable energy developer and former technology supplier developing a number of solar mini-grid projects in Angola, Benin, Mauritania, Sierra Leone and Uganda. Incorporated in 2016, Winch Energy is owned by Total Eren, Itochu Corporation, Al Gihaz Holdings and Winch Partners.

In 2017, under a separate mini-grid programme, Winch Energy was awarded a multi-site tender under a BOOT implementation agreement for 25 renewable mini-grid projects in the Lamwo region of Northern Uganda, bordering South Sudan. Winch Energy raised finance for projects in Uganda by further aggregating these with 24 projects awarded under a public-private partnership tender in Sierra Leone in the districts of Tonkolili, Koinadugu and Bombali. The United Nations Office for Project Services (UNOPS) implemented this separate bundled tender under the Rural Renewable Electrification Project in Sierra Leone, and the UK Department for International Development (DFID) provided grant funding.

This aggregation of projects allowed Winch Energy to mobilise USD 16 million for both projects under a dedicated limited-recourse financing vehicle established with NEoT Off-grid Africa, a private investment platform dedicated to financing decentralised energy in Africa. Closed in 2021, to date, this is the largest limited-recourse financing portfolio for off-grid solar mini-grids in Africa.

By June 2022, the 25 mini-grid sites in northern Uganda were connected and electricity was supplied. Building on the experience gained in the first lot of projects, in 2022, Winch Energy signed agreements for a second multi-site tender for 15 villages in Southern Uganda. There are strong positive social and environmental outcomes for renewable mini-grid projects, which can provide the least cost solutions for access to electricity services for rural households. The 25 mini-grid sites in northern Uganda alone are estimated to mitigate over 550 tonnes of carbon dioxide-equivalent emissions per year by reducing the demand for kerosene and diesel and will supply new electricity connections for at least 2,300 households (SunFunder, 2021[83]).

Limited recourse financing of aggregated mini-grid projects

Typically, the small and disaggregated nature of projects creates challenges for mobilising investment at a suitable scale to meet electrification targets. Under the aggregation of projects within Uganda, this raised the project size to roughly USD 5-8 million. By further aggregating this bundle of projects with tenders won in Sierra Leone, Winch Energy was able to establish a dedicated financing vehicle together with NEoT Off-grid Africa. The combined 48 mini-grid projects were structured under a newly incorporated company, Winch Energy IPP Holdings Limited, which raised USD 16 million (NEOT, 2021[84]). Within this, Winch Energy and primarily NEoT Off-grid Africa injected the bulk of the investment, with USD 12 million in equity.

Set up as a limited-recourse financing platform, Winch Energy IPP owns the assets and lenders can recover costs on the revenue underlying mini-grid generation assets and the cash flow they generate, helping to mitigate risks to attract lenders. USD 4 million debt was provided from a syndicated facility where FMO, the Dutch entrepreneurial development bank, was the lead arranger. FMO funds were provided through its Access to Energy Fund, which supports private sector projects for increasing access to sustainable energy in developing countries. This allowed Winch Energy IPP to benefit from competitive interest rates for the project. The second partner in the facility the Renewable Energy Performance Platform (REEP), is a UK government funded programme supporting the growth of renewable energy industries in Africa. REEP finance was managed in this transaction by Camco Clean Energy, a specialist fund manager focused on renewable energy, climate finance and impact in emerging markets, who was also able to bring its experience on mini-grid project development to the transaction (NEOT, 2021[84]).

For projects in Uganda, Winch Energy mobilised a further USD 2 million loan from SunFunder, a financing company dedicated to solar energy in emerging markets, to act as a bridge loan until reaching milestones where subsidies for upfront capital cost of generation assets were disbursed.

The financing vehicle, Winch Energy IPP Holdings, has ambitions to continue growing the portfolio worth to reach USD 100 million over the next years and become the largest portfolio of mini-grid systems in the sub-Saharan Africa region. FMO's syndicated loan facility therefore also includes a second tranche of up to USD 6 million to finance future projects since Winch Energy IPP plans to expand its operations in Sierra Leone, Uganda and other countries. In 2022, Winch Energy had already been awarded another

portfolio of 48 mini-grids (42 in Uganda and 6 in Sierra Leone) for which they are targeting financial close by end of 2022 and construction by 2023.

Lessons Learnt

This framework has supported the mobilisation of private finance, by facilitating a larger ticket size and reducing project risk, which has helped developers raise interest amongst investors and financiers. The use of grants and results-based financing for upfront capital costs has equally helped improve the return profile for the investment.

Winch Energy, the first winner of the tender, has almost completed the construction of one of the two multi-site bundles of 25 mini-grid projects in the Lamwo region of Northern Uganda. Winch Energy was able to mobilise significant levels of finance thanks to the terms of these projects. This includes investment under Winch Energy IPP Holdings, a dedicated financing vehicle, created specifically for this project and a further bundle in Sierra Leone, with intentions to later expand to new projects. In 2021, Winch Energy also launched a crowdfunding campaign for the Uganda bundle and then mobilised a further USD 2 million loans through Sun Funder, a financing company dedicated to mobilising debt capital for solar energy in emerging markets. Supply chain disruptions linked to the COVID-19 pandemic, processes for customs clearance, and technical issues in connecting the mini-grid systems have led to some delays. Projects were finalised in June 2022.

The Ugandan projects also took 2 - 3 years to reach a financial close. This was in part due to the involvement of numerous actors in the project, including several technology providers, lenders and equity providers. Working with debt financing in particular comes with stringent requirements on reducing exposure to risk. This can be more costly for the developer to manage in a first-of-kind project where there is still a lot of uncertainty. Under the first tender in Uganda, all parties underwent a learning process. For instance, the land is typically used as collateral in project finance, yet in off-grid projects land rights can often be unclear or protected, requiring alternative arrangements in contracts. To meet lender requirements, certain other terms of the project did need to be revisited with the government, notably regarding recourse to international arbitration.

For other risks, Winch IPP had to provide commitments to the lender including performance bonds and demand guarantees, including a USD 1 million-reserve fund to guarantee against demand risks. Many of these risks will be reduced on subsequent projects. With the first successful round of mini-grids installed in the 25 villages in the north of Uganda, Winch Energy was able to collect market data, strengthening estimates of potential energy consumption provided lenders, thereby reducing the need for guarantees.

Winch Energy was later awarded the 15 sites in the south of the country and signed agreements with authorities in 2022. A key objective of this design was to reduce preparation time for future mini-grid project development. The first tender process took 18 months as all tender documents, contracts and agreements had to be developed for the first time. However, the second tender took only six months as all documents and contracts and agreements were already in place, demonstrating positive outcomes in terms of streamlining licencing. Through this process, government authorities have gained familiarity with the mini-grid project developments and the type of requirement international lenders prefer to include in contracts, for example, around compensation of early grid arrival and recourse to international arbitration. Equally, lenders and developers have gained experience in the Uganda market. Notably, Winch Energy is now collecting market data on the mini-grids installed in the 25 villages in the north of Uganda, allowing it to better assess and provide evidence to lenders on potential energy consumption for future projects.

Moving forward, larger ticket sizes, closer to USD 20 million would further increase project attractiveness and enable economies of scale. For Winch Energy IPP's first projects, transaction costs were close to 10 to 20% of the transaction, which is larger than they would have hoped. These costs will fall for the next projects, for example, on the costs of setting up local offices in the country.

2 GuarantCo partial risk guarantee to Bboxx projects in Kenya

Figure 2.1. Overview of the GuarantCo partial risk-guarantee for Bboxx

Financial instrument	Risk-sharing
Financing strategy	Partial credit guarantee
Business model	Lease to own SHS
Country / region	Kenya
Timeline	2021 - ongoing

Background

Kenya is one of the largest economies in Sub-Saharan Africa and the Government of Kenya (GoK) has set the objective of transforming Kenya into a “newly industrialising, middle-income country providing a high quality of life to all its citizens” under its Vision 2030. Energy is identified as one of the key sectors to the achievement of the vision.

Over the last decades, electrification has increased rapidly. In 2020, 71% of the population had access to electricity, up from 42% in 2015 (World Bank, 2022[85]). Several programmes have supported last-mile connectivity through the World Bank, African Development Bank (AfDB), the European Union (EU), the European Investment Bank (EIB), and the French Development Agency (Agence Française de Développement [AFD]). The Kenya Off-Grid Solar Access Project (KOSAP) is currently the flagship project in the off-grid sector. The Government of Kenya’s ongoing commitment to scaling up off-grid electrification can be seen through the Kenya National Electrification Strategy, developed in 2018, with ambitions to establish two million new connections by 2022, notably through solar home systems and mini-grids.

By 2018, Kenya had approximate total sales of over USD 5 million in off-grid products, ranking it as the leader in solar home system sales in Africa (USAID, 2019). Indeed, the solar home system sector in Kenya has become a hub for innovation, particularly through the use of ”mobile money” for tariff collection, which represents a cost-effective mechanism for collecting and handling payments. Already this market has

attracted several private actors, including Azuri, Barefoot Power, Bboxx, Bidhaa Sasa, BioLite, Bright, D. light, Fosera, Givewatts, and Greenlight Planet (USAID, 2019[86]).

Yet, Kenya's solar home system market is not without challenges, including notably high costs, challenging security situations, sparse population, poor infrastructure, low willingness or ability to pay, and underserved pastoral geographies (USAID, 2019[86]).

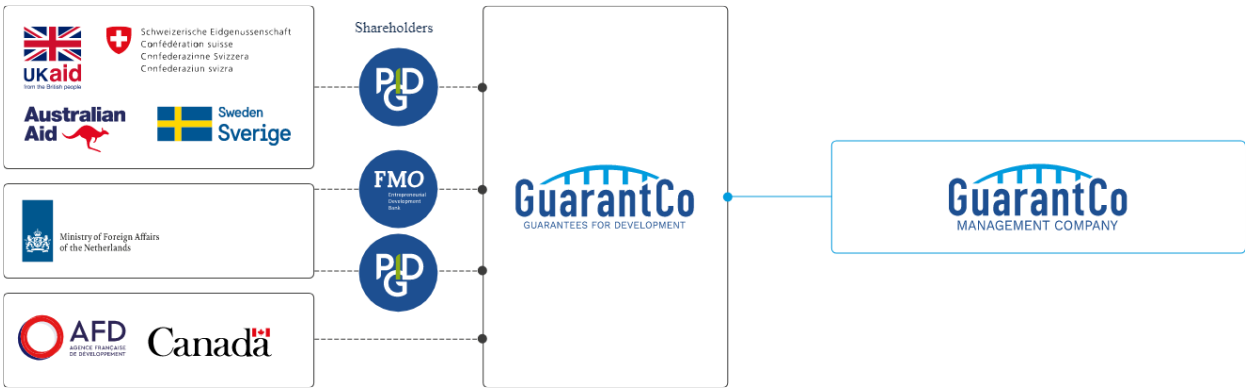
Another key challenge is foreign exchange risk. Historically, investments on the African continent in the off-grid sector have been made in hard currency, but given that end, users pay in local currency, which exposes companies to risks associated with exchange rate fluctuation. Insurance can help hedge against these risks, but this requires fronting the cost of Kenyan Shillings (KES) currency devaluation and overall market fluctuations up-front, making the cost of the local currency debt significantly higher. Local banks have tended to be risk-averse, which is reflected in their higher interest rates. They also tend to prefer short-loan tenors, largely because they do not have the experience to assess the credit risk of long-term infrastructure projects (GuarantCo, 2021[87]). This has led to many companies continuing to borrow in hard currency, leaving their equity investors to bear the foreign-exchange risk (USAID, 2019[86]).

In 2021, GuarantCo helped mobilise local currency commercial finance for Bboxx, an off-grid solar supplier operating in Africa. This was done by providing a partial guarantee against a KES 1.6 billion (equivalent to around USD 15 million) loan provided by SBM Bank Kenya, a local commercial bank, to Bboxx to provide access to clean, reliable and affordable energy to nearly half a million people through off-grid solar home systems in Kenya.

Mobilising local currency finance through blended finance

GuarantCo is a long-term local currency credit solution provider established in 2005 to help close the infrastructure-funding gap and alleviate poverty in lower-income countries across Africa and Asia. Funding for its activities comes through the development agencies of the United Kingdom, Switzerland, Australia and Sweden, using the Private Infrastructure Development Group (PIDG) Trust, through the Netherlands, via FMO, the Dutch development bank and the PIDG Trust, and through the French Development Agency and Global Affairs Canada. Cardano Development (CD), the fund manager, manages and executes GuarantCo's portfolio and investment strategy via the GuarantCo Management Company (GMC) (Figure 2.2).

Figure 2.2. Funding and management structure



Source: (GuarantCo, 2021[87])

GuarantCo provides blended finance solutions to support sustainable infrastructure projects in lower-income countries across Africa and Asia. Development finance channelled through this company is used to develop financial risk management products, which can mobilise local currency financing. This enables it to use development funds to leverage equity by up to three times. Since its inception in 2005, GuarantCo has guaranteed bonds and loans enabling USD 6 billion of total investments and USD 5 billion of private sector investment giving 43 million people improved access to infrastructure and creating around 327 000 jobs in Africa and Asia at the end of 2021 (GuarantCo, 2021[87]; PIDG, 2021[88]).

GuarantCo uses a range of credit enhancement tools to bridge the gap between the financial requirements of a project and the financial terms available from the local market. These are aimed at reducing risk to investors and financiers at different stages of the project life cycle and across the capital structure. Products can include full or partial credit guarantees, which protect investors and lenders against borrower defaults due to various causes such as the government's failure to meet specific obligations under project contracts or demand risk. Depending on the guarantee, GuarantCo would step in to pay principal and/or interest up to a pre-determined amount or indemnify holders for an agreed share of losses from the asset pool. GuarantCo also provides a tenor extension or liquidity guarantees, which helps banks provide long-term local currency finance. It can also provide joint guarantees that share liability as a group for the borrower's indebtedness or counter guarantees where GuarantCo provides a guarantee to a second bank or financial institution issuing a guarantee for the transaction, thereby reducing the second bank's risk. Furthermore, GuarantCo's recently affirmed credit rating (Fitch: AA-/Stable – Moody's: A1/Stable) is typically higher than sovereign ratings in lower-income countries across Africa and Asia, which give local banks and institutional investors, such as pension funds and insurance companies, confidence in a project to help it obtain finance at sufficient scale and tenor.

Transferring risks for distributed renewable projects through partial guarantees

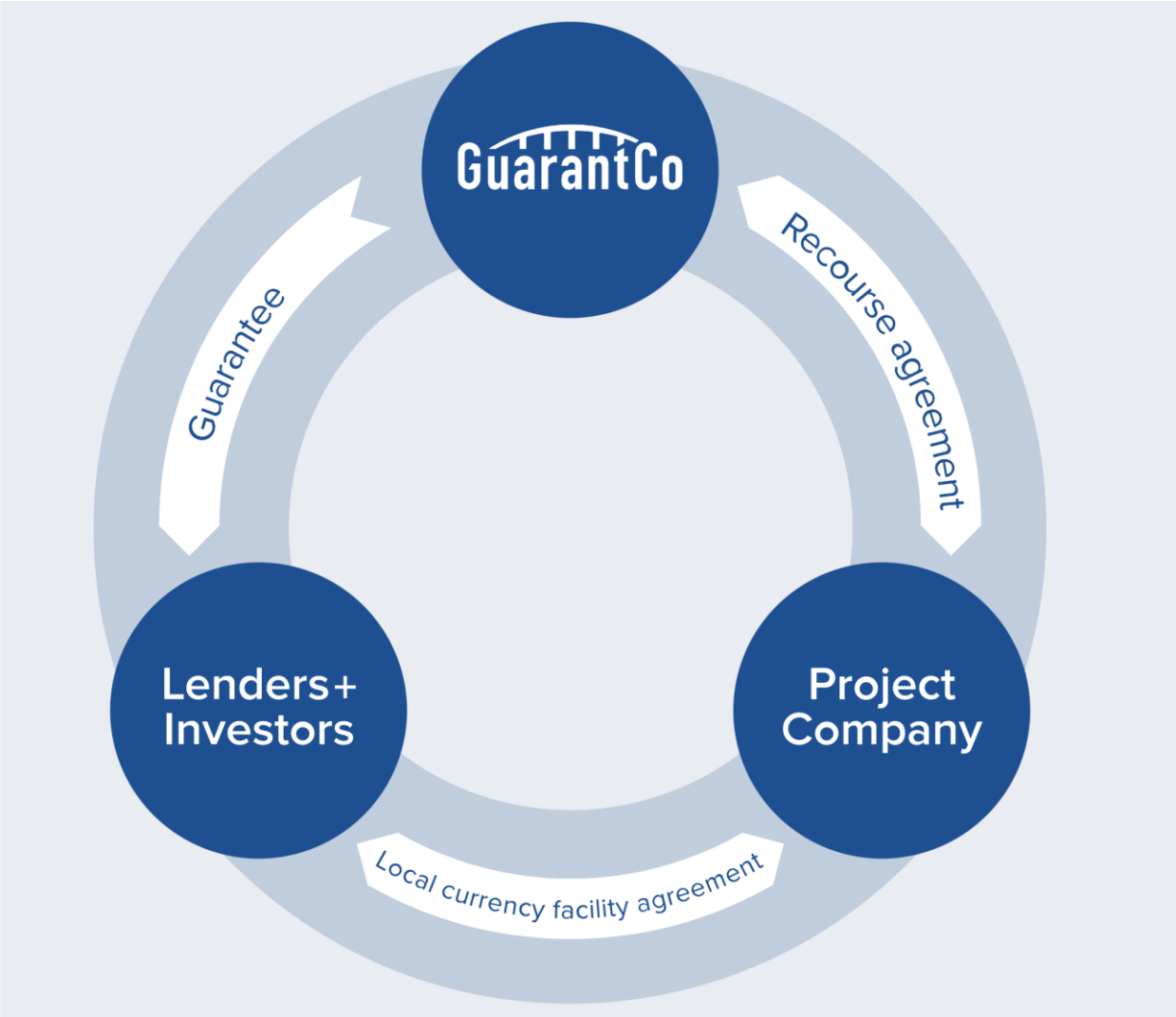
In 2021, Bboxx, a virtually integrated business that designs, manufactures, distributes and finances decentralised energy solutions, secured a KES 1.6 billion (around USD 14 million) loan to expand its lease-to-own solar home system business in Kenya. Bboxx has been active in Kenya since 2011 and is known as next generation utility business. It uses pay as you go models, advanced metering and the Internet of Things to monitor operations and remotely control distributed products, reaching customers across remote locations.

The loan was provided by SBM Bank Kenya, a local commercial bank, and was specifically structured to fund revenue-generating growth for Bboxx. The deal was facilitated by GuarantCo, who provided a KES 1.2 billion (around USD 10 million) partial guarantee against the loan facility covering 75% of the debt to Bboxx Kenya. Under this model, GuarantCo offered full credit risk transfer to the lender for the portion of its guarantee. This form of guarantee commits GuarantCo to cover the non-payment of scheduled debt service of the underlying loan between SBM bank and Bboxx up to the established limit. Under this instrument, a recourse agreement is established between Bboxx and GuarantCo to cover, amongst other provisions, the payment of fees to GuarantCo and the rights and obligations among Bboxx, GuarantCo and the SBM bank following a potential call under the guarantee (Figure 2.3). In addition, InfraCo Africa, who is also part of the Private Infrastructure Development Group (PIDG), invested in Bboxx and provided USD 15 million in the form of convertible notes to Bboxx's parent company.

By mobilising funding from a local commercial bank, which aligns with the currency of operations and collections, Bboxx was able to avoid exposure to foreign currency exchange risk. The partial guarantee was critical to obtaining funding and risk transfer on 75% of SBM's exposure was reflected in the interest margin they were able to offer Bboxx. This transaction is expected to have wider market benefits through demonstrating a model for domestic banks and increasing their appetite for lending. The intention is for the guarantee to help mobilise further private finance and investment. Since Bboxx's closing, interest in

this market remained high, notably from larger institutions looking at securitisation structures. There is also a better understanding of risk profiles, and the market is gradually moving towards lower guarantee percentages.

Figure 2.3. GuarantCo Credit Guarantee agreements



Source: (GuarantCo, 2021[87])

Lessons learnt

GuarantCo interventions aim to align with sustainable development goals. The funds will be used by Bboxx Kenya to purchase new inventory over two years including 89,600 solar home systems and essential appliances such as fridges and mobile phones. There is therefore a clear environmental benefit for the project through reducing and avoiding emissions in communities dependent on burning biomass or kerosene as their main sources of lighting and cooking. This project also supports socio-economic development as the funding was aimed at supporting the delivery of reliable, clean and affordable electricity to nearly half a million people, 80% of whom are based in rural areas, improving the quality of life of local populations and supporting small businesses.

Given that this intervention uses development funds, GuarantCo must ensure additionality of the intervention. Banks in Kenya, and across the region, can be reluctant to lend to solar home systems providers in early growth phase where profitability may not yet have been reached. This is despite the business model's growth potential, especially in countries like Kenya where there are strong electrification needs in rural areas. This intervention's objective was to get the private sector involved by bringing in local banks to the solar home systems market, a market that previously could not get any financing or at prohibitive interest rates. This type of intervention does come with certain transaction costs, which implies it is most suitable for projects above USD 10 million. Due diligence before entering into this type of guarantee agreement requires in depth exchanges between parties in order to consolidate the appropriate documents. Preparation equally requires an in-depth review of local and international regulations relevant to the transaction in order to create a resilient and enforceable security package with agreements on various aspects of financing, operations and assets. Bboxx's and GuarantCo's presence in both London and Nairobi, was a notable advantage in facilitating due diligence, negotiation and financial close at the end of 2021, particularly under limited travel during the COVID-19 pandemic.

GuarantCo's partial credit guarantee helped mobilise local currency financing at an affordable rate, where otherwise there likely would not have been local currency commercial finance, demonstrating the intervention's additionality. This guarantee acts as a collateral substitute or supplement in the security package, which enables the loan to take place, where otherwise it would likely not have been possible. The transfer of risk also enables the commercial bank to improve credit terms for the borrower.

3 Kingo, solar technology provider

Figure 3.1. Overview of Kingo, a growing off-grid renewable technology supplier

Financial instrument	Patient capital and concessional finance
Financing strategy	Concessional debt and equity
Business model	Lease to own, and energy as a service SHS
Country / region	Latin America and The Caribbean
Timeline	2013 - ongoing

Background

Distributed renewable markets are growing rapidly. Between 2010 and 2018, there was just under USD 1.7 billion in global disclosed energy access investments. The year 2018 marked a historically high level to account for over USD 500 million of this total. This has particularly been driven by pay-as-you-go (PAYG) models such as fee-for-service and lease-to-own (credit sale), which account for over 80% of the total investments between 2010 and 2018 (Wood Mackenzie, 2019[89]). Financing is particularly advanced for standalone solutions under PAYG models, which removes the barriers associated with high upfront costs of renewable energy technologies. Instead, the consumer pays in instalments by purchasing time units of solar energy.

In 2018, nearly 80% of total distributed renewable energy for access investments were concentrated in the African continent (Wood Mackenzie, 2019[89]). Latin America and the Caribbean (LAC) represented a relatively small market in this, accounting for only 6% of the total with the difference partly explained by the higher rates of electrification achieved in the continent (98.5% at the end of 2020). There are several exceptions in the content with low electrification rates such as Haiti (46%) and Nicaragua (89%) (IEA, 2022[90]).

In closing the remaining electrification gap, governments still play a leading role in energy access investments in LAC, indicating an untapped potential to attract private finance. However, the business case in last-mile communities can be complex. Populations without access to electricity in LAC live generally in very rural areas, with limited access to other modern services such as mobile coverage and internet. Geography brings other challenges because of desert formations, high-density forest areas and steep

mountain ranges, making it hard for infrastructure to penetrate landscapes and fragile ecosystems to access highly dispersed households. Electricity access is further hindered by high poverty levels. All of these factors increase both costs and risks for project developers.

Blended finance arrangements, early-stage capital, patient and concessionary finance and grants from the public and donor sectors, have an important role in derisking investments and helping suppliers grow. This has been the case for Kingo, a Guatemalan start-up created by local entrepreneurs. Since 2013, this venture has grown since to be a large off-grid system supplier working locally and in Colombia with communities, companies and governments to provide solar home systems as well as access to lighting and electronic appliances where users can pay on a daily, weekly, or monthly basis. The company currently has 57 000 clients and it plans to expand by 2030 to other countries in LAC and beyond to reach a total of one million clients.

Blended finance supporting growth in start-ups

The business model for supplying solar home systems, under PAYG and fee-for-service models, requires upfront funding to build and install systems, and ongoing capital for operation and maintenance. As customers only provide a small upfront payment, the number of outstanding loans increases with every new customer, increasing portfolio risk. The cost and availability of capital is therefore a critical factor and different sources of funding are required at different stages of maturity of the business.

Analysis suggests that at a very early financing stage, solar home system suppliers typically require less than USD 1 million (mostly equity funding) to invest in the business planning process. Then at the early development stage, USD 3–5 million is sought in equity for the implementation of a pilot project and market entry. At growth stages, company expansion requires between USD 10 million and USD 20 million through equity and debt finance, with as much as USD 50–100 million in debt finance for further scale-up (IRENA, 2020[91]).

The case of Kingo Energy also demonstrates how different means of finance and investment at various stages of maturity can support growth in solar system suppliers. For Kingo, investment came at different times from Proparco, which is the private sector arm of the Agence française de développement (AFD), Nederlandse Financierings-Maatschappij voor Ontwikkelingslanden (FMO), Inter-American Development Bank (IADB) and the People Fund. Additionally, the Small Enterprise Assistance Funds (SEAF) nominated Kingo Energy as a finalist of the Growth Stage Impact Ventures (GSIV) initiative that promotes Sustainable Development Goal-aligned investments.

Kingo started in 2013 as a social enterprise with the ambition to supply renewable energy resources to residential and small business communities through solar home systems. Initial capital was raised from a small pool of local businesses in Guatemala that wanted to support the venture. The company organically grew this way to roughly 300 users before receiving investment from the IDB Lab. This investment, in many respects acted as a grant and allowed the solar supplier to grow quickly to 15 000 users.

Early growth allowed Kingo to do a first-round seed funding (Series A) amongst Guatemalan investors. Following this, to support the expansion of the company, FMO invested USD 2 million as a convertible note, which acts as a debt instrument that converts into equity on the subsequent round of equity raising.

This enabled Kingo to go for a second round of equity funding (Series B) from institutional investment abroad, venture capital firms, and utilities including EPM and Engie, where it raised USD 12 million by the end of 2016. The proceeds of funds were mainly used to pay for the solar home kits and installation and maintenance activities (EWS, 2018[92]). Over this period, Kingo was able to continue innovating and upgrading to more secure technologies, which helped reduce incidences of loss of equipment or theft and ensure continued service to customers.

In 2018, Kingo was able to raise USD 10 million in debt from a development finance institution (FMO). While this provided more capital to expand activities, this type of senior debt, albeit development finance, had the consequence of increasing pressure on the company that was still growing and not yet making a profit. Additionally, the funding came with requirements to continue scaling up operations, leading the business to expand to more remote communities requiring higher unit costs. During this period, significant levels of development finance were entering the solar home system market, and a number of suppliers encountered similar difficulties in keeping up with debt servicing at this stage of relative growth and maturity. Recognising this challenge, the lender worked with Kingo to explore a restructuring to better manage its finances. This led to a third round of capital raising (series C).

In 2020, Kingo Energy raised USD 5 million in equity investment (series C), including a USD 4 million blended finance investment from the Clean Technology Fund (CTF) managed by IDB Invest. This contribution provided value-added patient capital to the company for scaling up and IDB Invest provided additional support in developing an innovation laboratory and implementing best practices in corporate governance and gender policies. This is in alignment with the CTF that includes a set of gender, diversity, and inclusion performance incentives to accelerate the implementation of a Gender Action Plan (GAP) (IDB Invest, 2020[93]).

Solar home business models adapting to different markets

Solar system providers supply the energy solutions with various revenue models such as cash sale + service, fee-for-service and lease-to-own (credit sale). Cash sales are typically used for small-scale systems. In the lease-to-own model, customers pay for the entire service over a period of one to three years, reducing the upfront investment cost for the customers. Under a fee-for-service, the ownership of the equipment remains with the supplier and the user pays an ongoing fee for electricity services. The purchase or use of various household appliances can be added to these different models.

Kingo started its operation as a lease-to-own model for the base-of-the-pyramid in remote rural communities, providing a solar home system, and optionally a battery storage system and appliances. As the company advanced, its business model evolved towards a remote utility service or a fee-for-service, whereby the solar home systems remain the assets of the company. This allowed Kingo to ensure affordability for users, whilst also continuing to make a profit through continued electricity generation.

Generally, in solar home system markets, mobile money is used to pay for the service. However, many of the target customers in LAC live in rural areas lacking mobile connection and internet. Kingo therefore forged long-term relationships with local shops to create a distribution network where customers were able to recharge cards with a prepaid energy credit. In the future, as satellite internet becomes increasingly available, the remote utility service model is expected to evolve to allow for more flexible payment collection.

Under the fee-for-service model, operation and maintenance costs over the long run tend to be higher than the initial capital costs, given the range of activities needed to guarantee ongoing service. These costs are in particular linked to sending staff to remote locations for equipment installation and repairs. In order to keep down the costs of operation and maintenance, the company has increased investment in the equipment to ensure that systems are robust and work effectively for 5 to 10 years, reducing the need for regular maintenance. Currently, to collect data on performance, Kingo uses the distribution network of shop keepers to record information on system operation for local customers. Advances in satellite internet will enable costs reductions on these activities, thanks to remote system monitoring and control.

The initial business model of the Kingo based on the PAYG model allowed the company to build significant expertise in business to customers (B2C) sales. As the company grew it then moved into business to business (B2B) sales, and later to business to government sales (B2G).

B2B sales are an attractive business models, as customers, primarily energy service providers, are often looking to buy a large number of solar home systems under a single contract. The capacities of these units typically range between 50 and 100 watts (W). Given that the energy service provider works with the end customers, and manages applications for any relevant subsidies, the off-taker risk and regulatory burden of such transactions is much lower. Under this model, Kingo receives regular fee for service, and given the higher credit rating of these customers, it can raise local money by creating a special purpose vehicle with the assets generating the revenue.

In turn, B2G sales involve the least amount of risk given the participation of local government in the transaction, which in turn helps Kingo raise commercial finance. Moreover, given the large size of orders, the company is able to benefit from economies of scale when fulfilling orders for these contracts. The capacities of these units typically range between 500 W and 1 kilowatt (kW).

Kingo's original business model, B2C, remains the riskiest market. While electricity tariffs are subsidised, there is no guarantee of consumption given the typically low income and low energy demand of users. This means that Kingo must guarantee that the solar home systems are supplying effectively, assuming operations and maintenance costs, but there is no guarantee that energy will be used. Moreover, there is the administrative burden of navigating regulation in order to secure subsidies. For B2C, the company has now moved to selling smaller units as cash sale and lease-to-own over a short period, rather than providing energy as a service. If it sells larger units, the model involves co-operation with a microfinance institution who assumes the risk of payment collection. Equally Kingo, has learnt over time that it is important to profile the community to assess whether the operation costs are reasonable for the number of units installed, and where government support would be needed to make service provision feasible.

Lessons learnt

The size of the business and the business model are important determinants of financing needs. At Kingo's level of maturity and track record for its business model and operations, it is possible to raise commercial debt. However, blended finance has been an important lever at growth stages to reach this stage of maturity. Yet, Kingo's experience with development finance also highlights some of the risk of start-ups taking on debt too early, which can place significant financial stress on the business.

Kingo has also explored different business models which have helped the company mature and spread its portfolio risk. Particularly under the B2B and B2G models, Kingo was able to deliver systems under large contracts to customers with higher credit ratings. Building on its experience, for B2C sales which are a riskier and costlier market, Kingo has learnt to be more selective in entering new markets and know when to seek out subsidies.

Finally, in the context of recent supply chain shortages, such as those experienced during the COVID-19 pandemic, inventory and imports can be a notable source of risk. Already, Kingo has simplified its design to be able to use off the shelf components to reduce costs of orders and mitigate against inventory shortages. Aggregation with other suppliers could help obtain better prices, especially from importers that struggle to meet the orders.

4 SIDA portfolio guarantee for Trine crowdfunding platform

Figure 4.1. Overview of SIDA's portfolio guarantee for the Trine crowd-funding platform

Financial instrument	Risk-sharing
Financing strategy	Credit guarantee on crowdfunding portfolio
Business model	Various business models
Country / region	Africa
Timeline	2018-2023

Background

The number of people without access to electricity in Sub-Saharan Africa, increased in 2020 for the first time since 2013. In this region, the share of the population without access to electricity rose from 74% in 2019 to 77% in 2021 (IEA, 2022[90]). Standalone renewable solutions, such as solar home systems, can help increase access to electricity in Sub-Saharan Africa, as a lower cost and faster alternative to grid extensions. New business models for energy service provision also offer alternative means of financing renewable energy investments. For example, under the lease-to-own model, customers can make down payments through their mobile phones over one to several years, until they become the owner of their solar home system. Still, it can be challenging for renewable energy service providers to obtain finance through traditional banks, since low-income customers may not necessarily have the needed credit history. This can create difficulties to accelerate electrification for people and for energy service providers to expand their businesses. Crowdfunding, where funding is raised from a large number of retail investors, typically via the internet, has emerged as a financing instrument to mobilise private capital.

Trine Investment (Trine) is a leading crowdfunding platform for solar energy entrepreneurs, where individuals can invest and earn a return on solar energy projects in developing countries. With their investments, Trine arranges debt funding to entrepreneurs and small and medium-sized energy service companies in Sub-Saharan Africa that offer renewable energy solutions. The solutions are primarily offered under a pay-as-you-go lease-to-own model to customers who lack access to electricity and cannot afford the entire upfront investment costs.

As part of its mandate to promote sustainable development, inclusive economic growth and poverty reduction, the Swedish Development Cooperation Strategy (SIDA), Sweden's government agency for development co-operation, is supporting Trine's crowdfunding platform. Through a guarantee instrument, SIDA aims to enhance access to credit for solar entrepreneurs; micro, small and medium sized energy service providers, who usually struggles to access finance.

Development assistance through guarantees

Guarantees can be an effective and flexible tool to support investments in socially and environmentally beneficial projects, such as renewable energy. Guarantees work by redistributing the risk of these investments between the public and private actors. SIDA's guarantees are similar to insurance for lenders; the guarantee beneficiary pays a fee for the guarantee, and if the borrower defaults, the lender recovers a share of the money. In the case of Trine, which acts as a financial intermediary, the guarantee enables crowdfunding investors to recoup part of their costs if the solar energy entrepreneur defaults (SIDA, 2019[94]).

As a development assistance instrument, additionality is imperative in SIDA's guarantee. The intention is that the guarantee allows the beneficiary to mobilise additional capital that would not have been otherwise invested, or reach entrepreneurs and businesses in developing countries, for example, women and young entrepreneurs, or businesses operating in a conflict-prone environment.

SIDA selects projects through a call for expression where proposals are compared based on their alignment with development objectives and geographic scope. Credit enhancements, such as partial guarantees, are complex structured finance transactions requiring strong knowledge and financial capacity of the guaranteeing institution. Indeed, guarantees tend to be more time consuming to structure than, for example, a results-based financing.

Due diligence on the beneficiary is an important step of this process. An analysis is undertaken to assess legal and financial aspects of the financial actor. In particular, the Swedish Debt Office undertakes an in-depth analysis of the financial risks of the guarantee for SIDA, based in part on Moody's risk analytics for the business and markets in question. In this case, expected losses were in the region of 4%.

Under this process, Trine provided an overview of the pipeline of potential projects in order to assess potential social, environmental and economic impacts that this assistance would deliver. Indeed, given the focus on additionality, reporting on the impacts of the project was particularly important.

Once these steps have been passed successfully, SIDA and the beneficiary negotiate the type of guarantee and its fee. Given the complexity of this process, an arrangement fee is also charged if the guarantee goes ahead, ranging between 100 000 and 150 000 Euros.

Mobilising private capital through loan guarantees

The SIDA guarantee for Trine that was launched in 2018 will run through to 2023. The guarantee targeted solar energy services companies funded by Trine in Tanzania, Rwanda, Kenya, Uganda, and Zambia. The pipeline of projects borrowing through the Trine platform is expected to provide around 100 000 clients or 560 000 people with access to renewable energy services in Sub-Sahara Africa based on an estimated 1 megawatt (MW) of renewable energy and corresponding reduction of 200 000 tonnes in carbon dioxide (CO_2) emissions (SIDA, 2020[95]).

SIDA and Trine agreed upon a guarantee agreement for 10 million Euros of mobilised private capital from the "crowd", to be used as loans for solar energy service providers in the agreed countries. The loan tenor for solar entrepreneurs was between four and six years and, under this arrangement, 60% of the investor's principal was guaranteed. This was arranged as a *pari passu* guarantee, which means "equal in right of

payment", so creditors to the loan, in this case crowd investors, are treated equally and compensated proportionately for the predetermined share of losses. As an unfunded guarantee, these losses could take several months to be recovered, as Trine must submit a claim of the default which is reviewed by SIDA to ensure its compliance with the requirements (e.g. that technology and geographic scope are aligned with the agreed terms).

Under the negotiations a fee for the guarantee was determined and then priced into the return obtained by the crowd/retail investor. Consequently, the return on the investment for a crowdfunded project with the guarantee would be marginally lower than for an unguaranteed investment, where the risks are higher.

After several crowd funding campaigns, in 2022, Trine had already disbursed 90% of the 10 million Euro loan guaranteed by SIDA. As an online platform they were able to test campaigns to fundraise for projects with and without the guarantees and compare results. Trine found that guaranteed projects did raise more funds, and retail investors were willing to accept lower returns in exchange for the lower risk. This indicates that the guarantee was successful in providing confidence among investors by decreasing perceived and actual risks of investment losses to expand financing resources for the beneficiary borrowers.

Lessons learnt

These investments helped Trine scale up its lending in Sub-Saharan Africa and build confidence in its business model. In reality, the default rate was lower than expected at under 3.3%. It also helped to demonstrate the commercial opportunity to lend to solar energy entrepreneurs and small and medium sized energy service companies through crowdfunding platforms.

This experience is particularly interesting as crowdfunding draws in retail investors who will have different requirements than other types of investors, such as institutional investors. Trine was able to collect data on investor interest in guaranteed and non-guaranteed projects, with several different pricing strategies, partially or fully passing along the cost of the guarantee to the investor. The data showed that retail investors were less sensitive to changes in the return than, for example, institutional investors.

Crowdfunding has proven to be an effective model to support solar energy service providers, however, there remain some challenges for entering difficult market segments and reaching micro and small solar entrepreneurs. This is because due diligence on more complex borrowers requires increasing technical, financial and legal capacity. This can be difficult to manage with small teams typical of these types of crowdfunding platforms. Additional support in the form of a grant, which works alongside the guarantee, could help build the capacity to reach different borrowers.

Increasing the additionality of assistance is a key focus for SIDA in designing its financial instruments. Yet, much of this is determined before it enters into agreements with the financial intermediary. This means that even if SIDA is willing to take on more risk, the financial instrument has in most cases already been designed. Increasing dialogue directly with investors at an earlier stage could help structure projects with even greater transformational impact.

Finally, as development partners seek to increase financial support for climate change mitigation and adaptation in developing and emerging economies to meet commitments under the UNFCCC Paris Agreement, it is important to consider how climate finance is tracked and reported. It is critical to take into consideration the leverage ratio of interventions for mobilising the private capital, which is much needed to achieve climate goals. Indeed, while a 15 million Euro guarantee and 15 million Euro grant can be reported as an equivalent disbursement of development climate finance, this fails to capture the different levels of private capital mobilised by the respective instruments towards achieving climate goals.

5 The World Bank Off-Grid Solar Access Project

Figure 5.1. Overview of the World Bank Kenya Off-grid Solar Access Project (KOSAP)

Financial instrument	Grants and concession finance
Financing strategy	Results based financing and debt facility
Business model	Lease to own SHS
Country / region	Energy as a service mini-grids
Timeline	2019 - ongoing

Background

The Kenyan government's overarching Vision 2030 aims to transform the country into an industrialised middle-income country. Electricity access in Kenya has doubled between 2014 and 2020 to reach a level of 71% of the country's population. The Kenya National Electrification Strategy of 2018 committed the country to full electrification by 2020, later modified to 2022, requiring two million new connections notably through solar home systems and mini-grids (USAID, 2019[86]).

Kenya's electrification strategy has supported a transition away from fossil fuel powered distributed generation, notably due to the high cost of fossil fuel supply for generation. This resulted in high electricity tariffs cross subsidised by the government through a levy on electricity bills. To support new project development, the government of Kenya's initial action was to provide the investors with clear processes and procedures. Development programmes have enabled this, for instance the guidance on mini-grid licensing published by the GIZ and the Ministry of Energy and Petroleum of Kenya. Other programmes included the Agence Française de Développement's (AFD) Kenya Off-Grid Retrofitting Program[24] and the

[24] More information: https://kplc.co.ke/img/full/Prequalification%20Document%20for%20Retrofitting%20(Supply,%20Installation%20and%20Commissioning%20of%20Solar%20Photovoltaic-%20Wind%20Energy%20Component)%20of%2023%20Diesel%20Mini%20Grids%20in%20Kenya.pdf.

World Bank's Kenya Solar Lighting Program.[25] Furthermore, regulation has been tailored to support project development with the Energy Act of 2019, which provided dedicated guidance on mini-grid systems, and the Finance Act of 2018, which provided exemptions from import duty and value added tax for solar energy equipment.

Kenya's mini-grid market has already attracted large international project developers who can raise equity for developing projects at scale. For instance, in 2016, Powerhive received a USD 11 million equity investment from Enel Green Power to build and operate a 1 megawatt (MW) portfolio of renewable mini-grid systems across 100 villages serving approximately 90 000 people in western Kenya (FinSMEs, 2016[96]). By 2018, Kenya had approximate total sales of over USD 5 million in off-grid products, ranking it as the leader in solar home system sales in Africa (USAID, 2019[86]). Indeed, the distributed renewable sector in Kenya has become a hub for innovation, such as through the use of "mobile money" which has provided cost-effective solutions to collect and handle payments from Kenyan customers.

Building on these positive developments, the World Bank has developed the Kenya Off-grid Solar Access Project (KOSAP) to help support wider uptake of distributed renewable energy in Kenya's remote, low-density, and traditionally underserved areas, typically in northern Kenya. These zones represent roughly 20% of Kenya's total population of 54 million and 70% of landmass, and they are inhabited by pastoral communities. KOSAP is part of several infrastructure programmes aimed at creating economic opportunities in the region. Besides increasing access to modern energy resource, the programme aims to enhance income and improve welfare by supporting the productive use of energy for instance in agriculture or small businesses. Equally, it aims to support new economic activities in the value chain of distributed renewable systems by developing local capacity for operations and maintenance (O&M) of equipment.

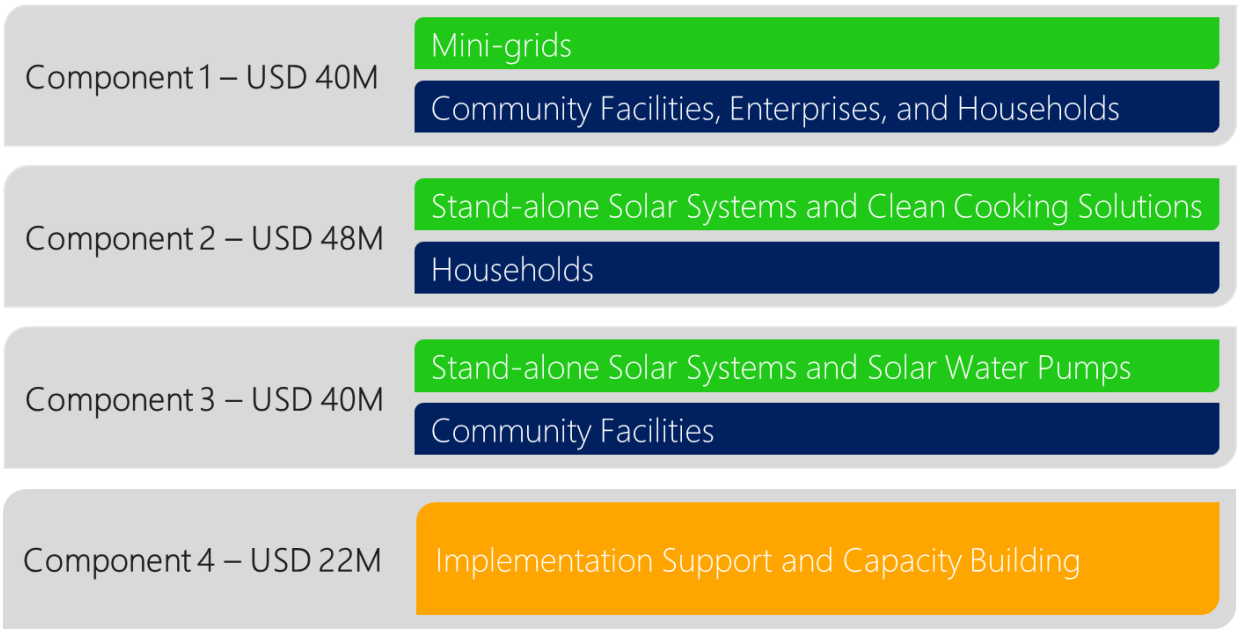
Kenya Off-Grid Solar Access Project

KOSAP involves total financing of USD 150 million from the World Bank in support of universal energy access through modern renewable energy resources for cooking and to electrify community facilities and enterprises (AFDB, 2021[97]). Since 2018, the Ministry of Energy and Petroleum (MOE), Kenya Power and Lighting (KPLC), and the Rural Electrification Authority (REA) have been implementing this programme, which will run until 2023. The facilities target 14 of the 47 counties in Kenya (West Pokot, Turkana, Marsabit, Samburu, Isiolo, Mandera, Wajir, Garissa, Tana River, Lamu, Kilifi, Kwale, Taita Taveta, and Narok) which have been identified as marginalised areas.

The KOSAP programme consists of four components, which respectively focus on mini-grid systems, solar homes systems for households, solar systems for businesses and a final capacity-building component (Figure 5.2). The MOE is the beneficiary of this programme and is responsible for the co-ordination of the project, as well as the implementation of the second and fourth components. KPLC and REA are in turn responsible for the implementation of the other two components (SNV, 2019[98]). The project is governed by a Steering Committee that has the power to take decisions supported by the Technical and County Working Groups.

[25] More information: https://projects.worldbank.org/en/projects-operations/project-detail/P163538.

Figure 5.2. KOSAP facility



Source: adapted from (SNV, 2022[99])

The USD 40 million Component 1 aimed to mobilise investment in a total of 120 mini-grid systems over 14 counties of Kenya. This component provides funds to KPLC to enter into a public-private partnership (PPP) with private developers, with KPLC responsible for the construction and partial financing of the generation systems and distribution network for each mini-grid. Each site for mini-grid construction should meet a population density criterion of having 100-700 prospective users (including households and commercial or public buildings) with a demand of 20 to 300 kilowatts (kW)). These sites were geospatially identified and together they would provide energy to 27 000 consumers.

The USD 48 million Component 2 aimed to leverage the thriving solar home systems market in the rest of Kenya by providing results-based financing, solar debt facility and the sale of clean cooking solutions to developers to expand service to underserved counties. It targets 250 000 households that consist of 1.1 million inhabitants with solar home systems and the distribution of 150 000 clean cooking stoves across eight counties.

The USD 40 million Component 3 provides funds for community facilities developed by the Ministry of Health, Ministry of Education and the Ministry of Interior with power for optimum performance. A private-sector contractor is procured by the KPLC for each service territory to supply, install and maintain standalone solar systems in community facilities. While past approaches focused on supply and installation with limited O&M consideration, the emphasis under this component moves towards a performance-based, long-term service delivery. Additionally, about 380 boreholes associated with community facilities in the 14 counties are planned to benefit from the installation of solar-powered water pumps.

The USD 22 million Component 4 sets aside resources to build the required skills set for the Project Coordination Unit in the MOE as well as for the Project Implementation Units of the KPLC and REA, and Project Implementation Units. Within this component, technical studies, implementation support, and capacity building of the sector and counties will be undertaken.

Mini-grid programme developed under the PPP approach

Mini-grids for access projects typically require additional support to be economically viable, either in the form of a grant for technical assistance or capital expenditure, subsidy on the upfront capital cost or ongoing support on the electricity tariff or operating expenditures. Mini-grids have been an important component of Kenya's electricity system, and while most have been publicly funded, by 2018 at least 23 systems in operation had been privately developed (USAID, 2019[86]).

PPPs can be attractive solutions for developing projects in hard-to-reach zones. Public funding can help reduce perceived risks and shorten timelines for private developers to recoup costs. This in turn can increase access to and lower the cost of finance from commercial banks. Additionally, under the PPP structure government participation can increase access to credit enhancement and alternative sources of financing from development partners, such as credit guarantees or concessional loans. The investment and therefore partial ownership by the government can reduce currency convertibility, expropriation, and regulatory risks. PPP examples have been successfully applied in mini-grid projects in the past across Bangladesh (Infrastructure Development Company Limited, IDCOL), Mali (Foundation Rural Energy Services, FRES), Mexico (ACCIONA) and Uganda (Tiger Power) (Saarcenergy, 2020[100]) and in many parts of Southeast Asia (UNEP, 2015[101]).

Under KOSAP, procurement came under a PPP, for systems that combine solar PV, battery storage and thermal units running on diesel. During the appraisal of the KOSAP programme, 120 sites with sufficient population density for mini-grid systems were identified. The capacity requirement identified ranged between 50 kW to 2 MW (mostly in the region of 500 kW). The sizing of the final project would depend on the number and type of users to be supplied (households, enterprises, community facilities, etc.). The programme was designed to run as a competitive tender for sites, with the winning bidders signing a 7 to 10-year power purchase agreement (PPA) and service contract with KPLC.

Under this PPP model, both private investment and public funds are used to co-finance the construction of generation facilities and public funds are used to finance the construction of the distribution network of each mini-grid. The PPA with KPLC is for the O&M of the generation system and it ensures the recovery of the privately financed part of the investment. The developer is also made responsible for the distribution network's O&M under the service contract with KPLC.

After the recovery of the private investments, the Kenyan government owns all assets (generation and operation). All electricity consumers supplied through the mini-grid systems are KPLC customers and they pay the same tariff for each category charged to users connected to the national grid. The idea is to ensure the effective implementation of a national uniform tariff policy.

Solar Debt Facility

Solar home systems are planned to be commonly used in most remote areas of the 14 counties. Under the programme, a target of 250 000 standalone solar systems and 150 000 clean cookstoves was set.

Two typologies of business models underpin the majority of solar service providers that operate in the Kenyan market. First are service providers that sell solar products on an over-the-counter (cash sale) basis. These service providers require shorter-term debt in USD or any other major foreign currency to finance costs associated with hardware manufacture and transit to Kenya (typically from China). This cycle typically lasts anywhere between six and nine months.

A second prevailing business model is pay-as-you-go (PAYG), whereby customers pay for the systems in monthly instalments (typically between 12 and 36 months), and service providers carry the default risk during the payback period. These businesses typically require debt financing that is commensurate with the lending terms that they extend to their customers. Given that service providers' revenues are in local

currency, the debt instrument will also offer loans in Kenyan Shillings in addition to the USD (or other foreign currency).

Given that activities in these regions are primarily pastoral, the programme aimed to use the PAYG which allows users to pay off the units over six months before they entirely own it, thereby reflecting the seasonal nature of the economy. In order to help bring down the costs of solar home systems, Component 2 gives eligible solar service providers access to results-based financing and a debt facility (Figure 5.3).

The results-based financing, is a form of a grant provided to developers in instalment payments based on the achievement of pre-agreed connection milestones and satisfactory after-sales service support, aiming to catalyse further supply, whilst also bringing down costs. Grants are competitively awarded, to compensate service providers for initial, ongoing incremental and opportunity costs associated with an expansion of operations in underserved counties. A percentage cap is set within each lot so that multiple service providers will have the opportunity to operate within the space. A competitive approach is used, whereby service providers will bid based on a grant amount per household connection, with the lowest grant requirements winning.

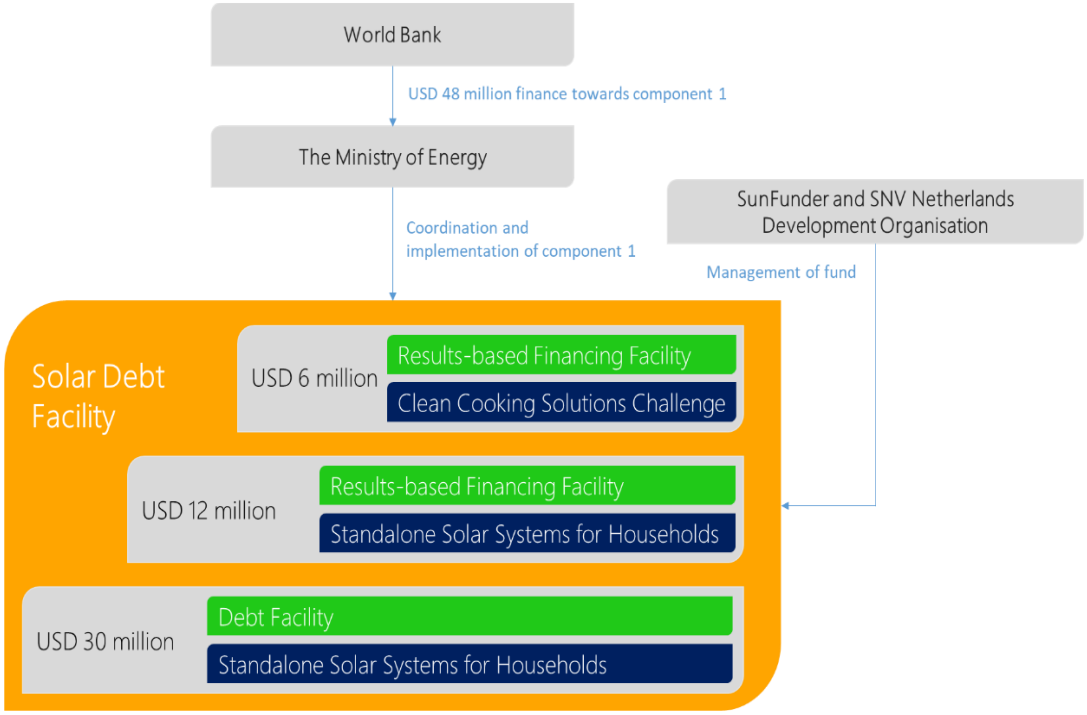
In addition, a solar debt facility was set up to provide interest rates at the market rate to suppliers. Under the facility, service providers are provided with debt financing to support upfront costs associated with getting hardware inventory into the market and medium-term consumer financing is provided to enable households to pay off the systems over time.

While commercial banks in Kenya are gaining familiarity with the solar home system market, they are generally less confident lending for projects in these marginalised zones covered by KOSAP. The objective of the facility was to enable providers to supply solar home systems at competitive rate in zones where lenders have been reluctant to enter so far. The debt facility is managed by the SNV Netherlands Development Organisation, an international development body, in partnership with SunFunder, a specialist financing company for clean energy and climate investments.

Debt facility loans could only be used to finance the purchase of solar home system inventory and receivables financing in the 14 KOSAP Service Territories. It offered loans ranging from KES 10 000 000 to KES 500 000 000 (USD 80 000 – USD 4 000 000) for the following purposes:

- Inventory financing: short-term balance sheet loan for purchasing a product with a tenor of 6-12 months and a total amount of KES 10,000,000+.
- Receivables financing: Balance sheet (B/S) loan structured to match the complete working capital cycle of a PAYG Company with a tenor of one to three years and a total amount of KES 25,000,000+.
- Co-lending: KOSAP can lend alongside other lenders into facilities via a syndication agreement whereby KOSAP will only finance the share of the facility that corresponds to inventory purchases (for inventory financing), or units sold and future receivables (for receivables financing) in the KOSAP Service Territories. It can also participate in receivables financing via a Special Purpose Vehicle (SPV).

Figure 5.3. Component two debt facility



Source: adapted from (SNV, 2022[99])

Lessons learnt

KOSAP has seen mixed results under its first component. Under the tenders, the private investors were only able to mobilise USD 10 to 15 million for the projects. Key challenges include delays in the implementation of the programme and issues around land rights. Land owned by the community is not registered and there are sensitivities around transferring ownership. To date, roughly 20 sites have been identified as commercially viable and the programme was able to remove the grant component to have these developed as private projects. This underscores the benefits of site identification in facilitating private project development. The programme is currently being restructured for the remaining projects, to develop these under a concession model with generation and distribution infrastructure publicly funded through the Component 1 funds, and private developers competitively bidding for the concession to construct and operate the systems.

For the second component, 100 000 units have already been deployed, with the expectation that the 250 000-unit target will be exceeded by the end of 2023. However, the use and impacts of the two financing instruments vary. The results-based financing was found particularly effective for encouraging incremental supply and bringing down costs. It has been used for capacity building to promote productive end uses in the communities. Conversely, only two to three developers have made use of the substantial debt facility where up to at least 20 were expected. This gap has been put down to the availability of other sources of funding from development finance institutions, which undercut the rates from this facility. Additionally, developers noted that the requirement to use funding only for project development in these 14 counties created significant constraints for them, as they would prefer to spread the risks through projects in different markets within the portfolio, such as in Nairobi. Other World Bank facilities which have wider remits, such as the Regional Infrastructure Financing Facility, have had more success in attracting developers, including those targeted by the KOSAP debt facility. This has led to discussion around the restructuring of the facility, to allow for its use in other regions, or for more funds to be diverted towards the results-based financing which has been particularly effective. Components 3 and 4 are still ongoing.

6 Eco Micro programme in Belize

Figure 6.1. Overview of the Eco Micro programme

Financial instrument	Grant
Financing strategy	Technical assistance to financial sector
Business model	Green financial products for RE and EE
Region	Latin America and The Caribbean
Timeline	2010 - ongoing

Background

Renewable energy solutions have the potential to meet diverse energy needs for micro, small and medium-sized enterprises (MSME). For example, in the agricultural sector, decentralised solutions can be deployed in remote areas to strengthen energy supply across the sector's value chain, from primary production to processing, storage, distribution, and final consumption. Today throughout Latin America and the Caribbean, many companies are not able to access funding for clean energy technologies that can help to reduce the energy bill, improve competitiveness and enhance climate resilience.

Eco Micro is an initiative set up by the innovation laboratory of the Inter-American Development Bank (IDB Lab) to help bridge the financing gaps of MSMEs by working with financial intermediary partners throughout Latin America and the Caribbean, to help them become better equipped to provide green finance. The goal is to increase access to renewable energy and energy efficiency products and services and to advance mitigation and adaptation to climate change. The Eco Micro programme is designed to provide technical assistance to financial intermediaries to help them gain the appropriate tools and know-how to analyse the market and design green financial products that respond to local needs.

In Belize, an Eco Micro programme will run from 2020 to 2022 to support the local development bank, the Development Finance Corporation, in lending to MSME's for renewable energy and energy efficiency technologies. Econoler, a consulting firm specialising in the design, implementation and evaluation of sustainable energy projects and programmes, is implementing this programme, and the technical assistance aims to strengthen green credit products, including lending for clean energy investments under Energy Performance Contracting (EPC).

IDB lab's Eco Micro programme

The IDB lab created Eco Micro in the early 2010s, and the United Nations Framework Convention on Climate Change (UNFCCC) granted it a Lighthouse Activity Award in 2014. Operated by IDB lab, Eco-Micro is a USD 17 million technical co-operation facility, which receives funding from the Multilateral Investment Fund (MIF), a member of the Inter-American Development Bank (IDB) Group, Global Affairs Canada, and the Nordic Development Fund.

Financial intermediaries in the region compete for Eco Micro grants, which are disbursed under three-year pilot projects. Partners include credit unions, microfinance providers or national development banks. In Latin America, Eco Micro has also started working with non-traditional partners—for example, anchor companies in the agricultural industry that already provide seasonal loans to farmers.

IDB Lab works with the financial intermediary to develop green finance solutions tailored to the local context and market conditions. The solutions are aimed at the financial intermediary's clients, but also at the intermediary themselves to reduce their loan portfolio's vulnerability to climate change and greenhouse gas (GHG) emissions. At the outset, IDB lab launches an Expression of Interest for pre-qualified global consulting firms to provide support with ongoing technical assistance. The consulting firm works closely with the financial partner to design and implement market assessments and develop appropriate gender-responsive financial products and services to respond to local needs, challenges and priorities.

Eco Micro covers about 70% of the project budget through grants, and the financial intermediary provides the rest, either in cash or through in-kind contributions. The grant money is used to develop, market, and launch green finance products in each participating microfinance institution – unlocking private funds that would not otherwise be available for climate activities.

The type of products that Eco Micro helps design include productive loans for those interested in becoming renewable energy or energy efficiency technologies. It also helps design financial products and services to support adaptation goals, as well as micro finance and insurance for green entrepreneurs and MSMEs, including crop insurance for smallholder farmers (EcoMicro, 2022[79]).

Strengthening RE and EE lending for MSMEs

Eco Micro is currently working with the Development Finance Corporation (DFC) in Belize to support renewable energy and energy efficiency lending to MSMEs. This programme was initially supported by a credit line from the Caribbean Development Bank (USD 2 million), with additional financing sources from the CARICOM Development Fund (CDF) and a new credit line with IDB of which 30% is allocated for climate finance.

At the start of the project, Econoler spent six months undertaking a market study and assessment of DFC's current green finance products. This research allowed them to recommend a review of collateral requirements for clean energy loans and to develop a simple template for energy audits, to facilitate data collection and evaluate risk and return on energy investments consistently across customers. Another key output was a gender analysis of their lending portfolio, which highlighted that women were taking out fewer and smaller loans, but their default rate was equally much lower. Consequently, the DFC developed its "Empowered Business Loan" product for women and youth, including concessionary interest rates and lower collateral requirements for women.

Since its inception, DFC's clean energy loan programme has made availble a total of USD 1.1 million mainly to MSMEs, with loans of between USD 20 000 and USD 200 000. Of this, USD 500 000 has been lent since the start of the Eco Micro programme in 2020. The programme provides debt at interest rates of 5.5-6%, rates which are much lower than the typical MSME lending rates in Belize, which are in the order 12%-15% per annum, and lower than the typically high (22%) microfinance institute rates in other

jurisdictions. Lending activities have focused on tourism, agricultural processing, and small-scale commercial and industrial activities, for example, wood furniture manufacturing and aquaculture. Initially, the demand for credit under the program was slow due to a lack of public knowledge of the benefits of clean energy investments. Credit demand increased as DFC promoted the program, but lending for clean energy investments plummeted during the peak of the COVID-19 pandemic due to the reduced economic activity within the economy and in particular tourism. Over this period, the priority for MSMEs has been a credit to bridge gaps in revenue and keep businesses afloat during the pandemic, and later to kick start operations again post-pandemic.

Nevertheless, MSME lending has increased as the economy has picked up in 2021 and 2022. DFC's clean energy lending product for MSMEs has also been strengthened by the launch of the CDF's Credit Risk Abatement Facility (CRAF). This facility was set up to support the development of the clean energy sector within the Caribbean region by providing credit guarantees to eligible bankable projects, which otherwise would not have been financed by the corporation because of some barrier (e.g. lack of adequate collateral). The facility was established by the CDF with assistance from the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), and the CARICOM Energy Unit.

The programme also highlights the potential for energy savings. Energy prices in Belize are relatively high, at around USD 22-23 cents per kilowatt hour (kWh). While this is lower than average energy prices for Caribbean countries (30 cents per kWh), of which Belize forms part, it is much higher than electricity tariffs in Latin American countries that neighbour Belize on the continent (between USD 10-12 cents per kWh). Unlike Belize, many Caribbean countries are also island nations with significantly drive-up costs (e.g. of fuel supply). Currently, there is no feed-in tariff regulation to support selling distributed generation back to the grid, but this would further increase the attractiveness of renewable energy investments. As part of its Nationally Determined Contribution to the UNFCCC, Belize has committed to establishing regulations that will facilitate connecting distributed renewable to the grid by the end of 2022.

Lessons learnt

Through Eco Micro, IDB Lab also aims to expand knowledge of how to make climate finance more accessible and affordable, especially for underserved populations in Latin America and the Caribbean. Eco Micro projects aim to support the exchange of ideas through knowledge-sharing events. The programme also works to create connections between adaptation and mitigation specialists, technology suppliers, service facilitators, development partners and other financial institutions, to support a stronger green finance ecosystem.

The COVID-19 pandemic has had a significant impact on the programme, as without tourism the economic activity in Belize was reduced. This in turn decreased MSME borrowing activities for clean energy investments, as the priority shifted to preserving businesses. In addition, supply chain issues have increased delivery time to supply renewable energy and energy efficiency technology to the country, delaying projects when they do go ahead.

Nevertheless, the research undertaken by Econoler under the Eco Micro programme has informed recommendations on how to improve and increase the attractiveness of the Development Finance Corporation's green finance products for MSMEs. The programme in Belize has been successful in helping the bank better understand its target market and design financial products, accordingly, reducing collateral requirements for clean energy loans and streamlining audit templates to better evaluate projects.

The programme has also helped to disseminate information to MSMEs in Belize about the benefits of renewable energy and energy efficiency investments and brings attention to the development bank's green lending options that provide debt at attractive interest rates of 5.5-6%. As the economic situation improves, interest in clean energy loans is expected to increase, notably in the context of increased price volatility, where such investments can help bring about long-term energy savings.

7 Green Receivables Fund

Figure 7.1. Overview of the Green Receivables Fund

Financial instrument	Grants, concession and commercial finance
Financing strategy	Securitisation of RE and EE projects
Business model	Various business models
Country	Brazil
Timeline	2016 - 2017

Background

Under its Paris Agreement commitments, Brazil aims to reduce its greenhouse gas (GHG) emissions by 37% by 2025 and by 50% by 2030, compared to 2005, and to reach climate neutrality by 2050 (Climate Action Tracker, 2022[102]). Renewable energy and energy efficiency are crucial components of this strategy. By 2030, Brazil aims to increase energy efficiency by 10% compared to 2005 and reach a share of 23% non-hydro renewable generation in the electricity sector.

Access to low cost and long-term financing will be critical in materialising these targets. Up until 2017, the Brazilian National Development Bank (BNDES) had played a central role in financing renewable energy projects. Yet, lower lending from BNDES due to the economic recession starting in 2014 and corresponding fiscal constraints reduced provision of finance for new renewable projects. Equally, capital market activity for renewable projects has remained underdeveloped, leading to a financing shortfall (The Lab, 2017[77]).

In 2016, the Green Receivables Fund ("Fundo de Investimento em Direitos Creditórios" FIDC) was designed as a securitisation instrument in the Brazilian market to address the lack of long-term finance for clean energy projects, as well as to overcome barriers such as illiquidity of assets and risks associated with foreign exchange, macroeconomic conditions and projects. Based on existing FIDC regulatory framework in Brazil, this instrument works by issuing securities against future revenue streams of one or more clean energy projects pooled under a special purpose vehicle (the FIDC itself) for financing.

A model for securitisation to raise additional capital for clean energy projects

This instrument builds on FIDC's existing regulatory framework which allows for securitisation through asset-backed securities, regulated by the Brazilian Securities Commission (CVM). Through the FIDC, receivables associated with contractual future cash flows (credit rights) can be pooled, and financial securities backed by income-generating assets can then be sold to investors. There was already a sizable market for FIDC shares in Brazil, which totalled USD 9 billion in 2015, although the FIDC was historically used in sectors such as consumer finance, factoring, credit card debt, and car loans (The Lab, 2017[103]). Under this model, the existing FIDC regulatory framework is combined with (i) green certification criteria; (ii) an extensive coverage of insurance policies, project guarantees and collaterals; (iii) a governance structure designed to provide rights of supervision and intervention; and (iv) a financial model adapted to suit the needs of clean energy projects such as renewables and energy efficiency. This allows for projects to secure financing based on future cash flows from energy sales.

From 2016 to 2017, the Green FIDC concept was launched by Albion Capital a Brazilian asset management firm developing and managing structured investment products to finance companies and projects in the sustainable infrastructure space. The instrument was originally designed to raise funding for clean energy projects in two stages (Figure 7.2):

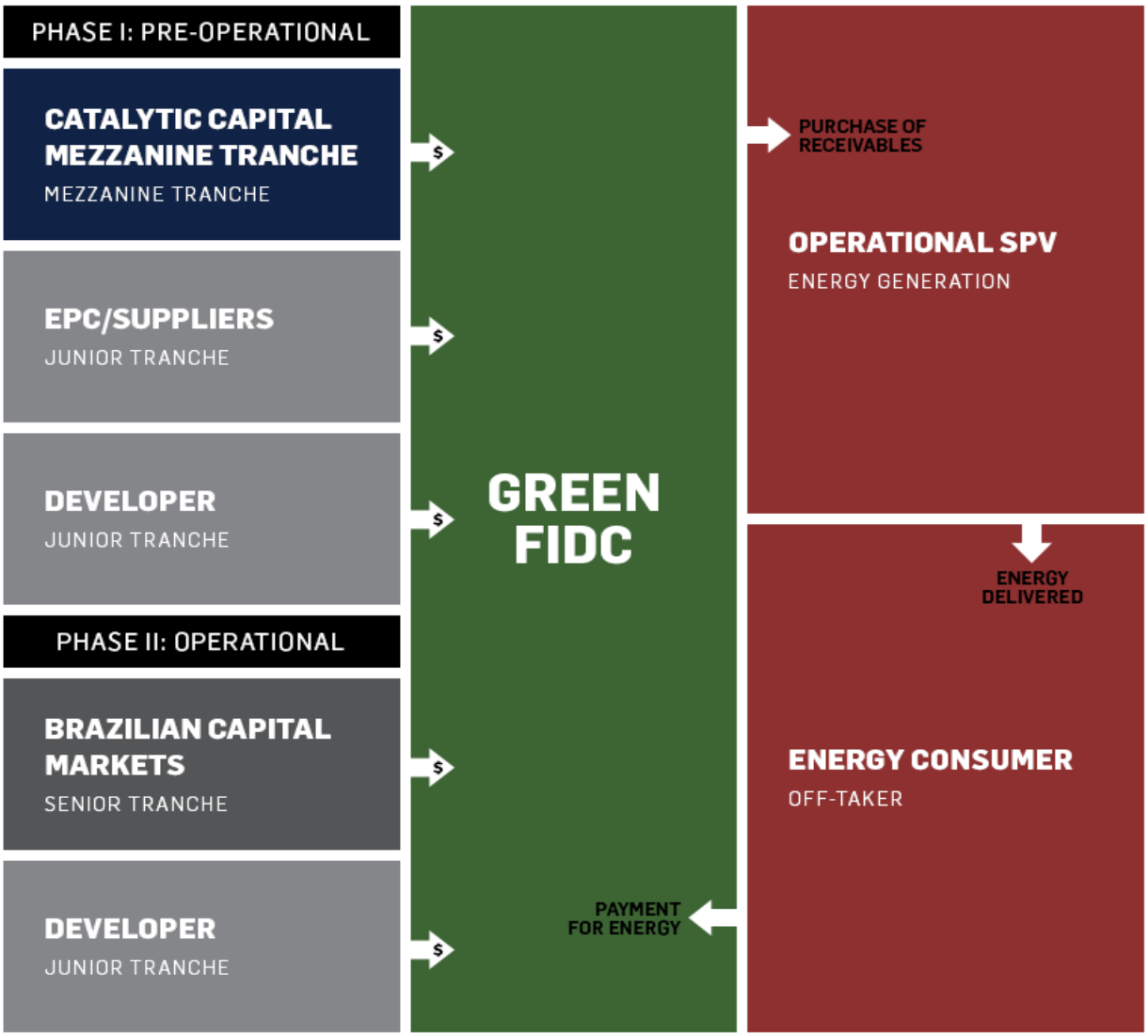
- To finance the development and construction of green projects, capital would be provided by project developers and public funders respectively under a junior tranche and a mezzanine tranche.
- Once operational, underlying projects would be refinanced through the issuance of senior tranches in the Brazilian capital markets to local private investors. In this stage, initial investors are provided with an exit from the project and liquidity to invest in additional projects that helps crowd in institutional investment.

This approach aimed to allocate risks to investors best suited to handle them and it also segregated the funding providers and the operational management to reduce the risk to public and private investors. Importantly, the concept took a blended finance approach, using concessional funds to mitigate risk and attract private finance in early-stage project development. The use of concessional capital would provide guarantees against the risk of non-realisation of the revenue stream. Once fully operational as a bankable business with stable cash flows, public capital is designed to be repaid or recycled.

However, during the circle of development and implementation of the Green FIDC, Albion was able to review the concept to a different setting. While certain projects – subject to longer construction periods and facing higher pre-operational risks – would still need the two phases approach; other projects, such as Solar DG, could be financed using a Double Waterfall System, where the combination of escrow accounts and the FIDC 3-tier capital structure provide protection to mezzanine and senior investors.

Such instruments help to overcome some of the main barriers to financing green infrastructure in Brazil, namely scarce early-stage equity financing, especially for small scale projects. They also help to increase access to debt as without the project finance structure, lenders would require recourse from sponsors as well as projects, in which case the balance sheet of the sponsor can limit their ability to develop additional projects. Under a Green FIDC transaction, project risks are assessed independently.

Figure 7.2. The Green Securitization Concept



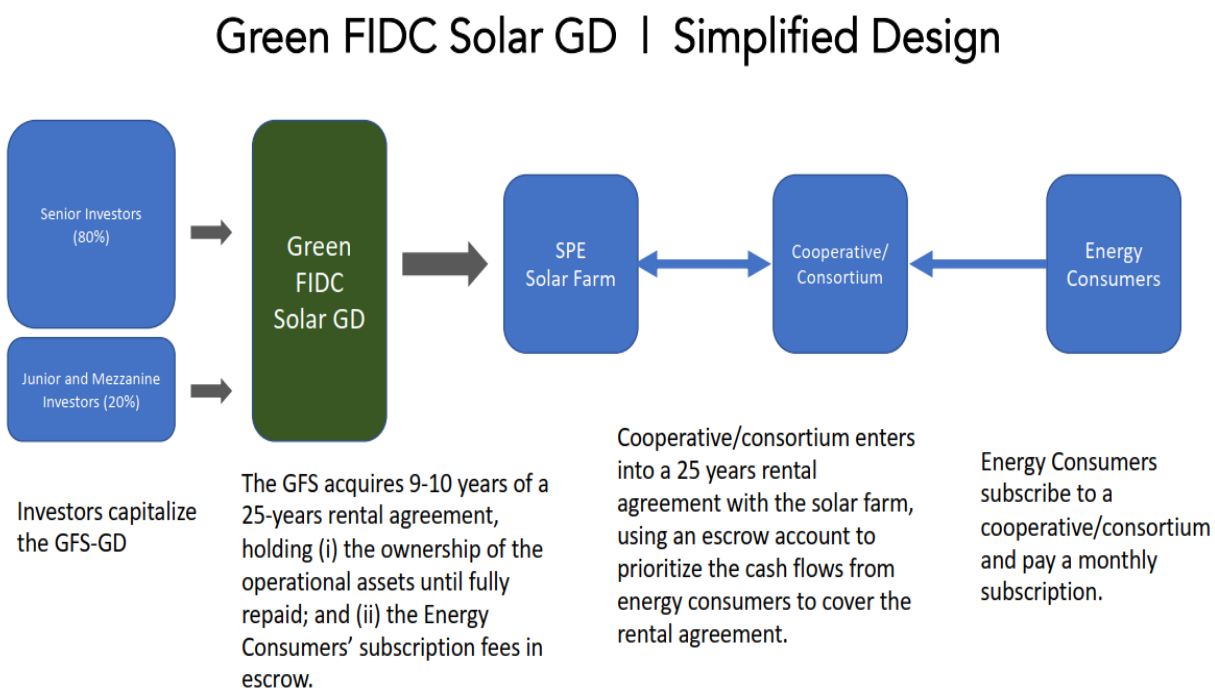
Note: Special Purpose Vehicle (SPV); Engineering, procurement, and construction (EPC)
Source: (Albion Capital, 2022[104]) The Green Securitization Concept

In 2017, Albion submitted the Green FIDC concept to the Brazil Innovation Lab for Climate Finance (The Lab), under its call for ideas. The Lab specialises in reviewing promising transformative green finance instruments under its expert working groups and developing them to pilot or launch. The Lab is funded by Bloomberg Philanthropies, the German Federal Ministry for the Environment, Nature Conservation, and Nuclear Safety (BMU), the Netherlands Ministry for Foreign Affairs, The Rockefeller Foundation, The Swedish International Development Cooperation Agency (SIDA), and the UK Department for Business, Energy & Industrial Strategy. Climate Policy Initiative serves as Secretariat.

In 2018, the Green FIDC was nominated by the P4G Summit in Copenhagen as one of the most innovative concepts in climate finance. In the same year Albion Capital was also awarded a design funding grant by Convergence to develop the Green FIDC concept, supporting the research, structuring, and development activities required to bring the Green FIDC model to Brazilian capital markets (CPI, 2018[105]).

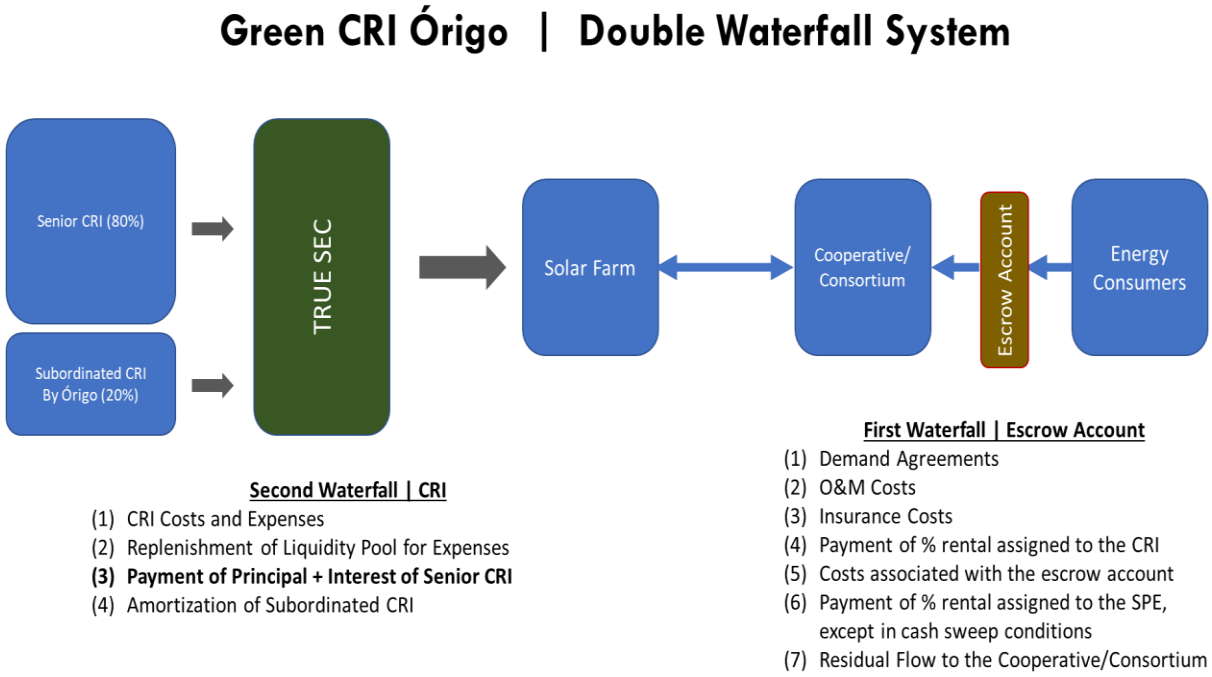
In 2021 Albion Capital and Órigo Energia, a renewable energy developer, announced the close of Green FIDC Solar GD, the first FIDC issued as a climate bond in Brazil, at USD 35.8 million (BRL 201.5 million). Moreover, based on the Green FIDC model, Albion Capital and Órigo Energia adapted the Green FIDC concept to be launched as a Green CRI (Certificado de Recebíveis Imobiliários) a Brazilian form of mortgage-backed security designed for real estate investors, expanding the pool of potential investors and securing another USD 14.3 million (BRL 80.1 million). The Green FIDC Solar GD and the Green CRI Órigo are each the first of their kind of security to be certified climate bonds for the Brazilian market (CPI, 2021[106]). In 2022, Albion Capital replicated both the Green FIDC and the Green CRI, reaching in total, 80MW in financed capacity for Solar DG plants (Figure 7.3, Figure 7.4).

Figure 7.3. Green receivables fund structure for Solar GD – Simplified Structure



Notes: Green FIDC Solar (GFS)
Source: (Albion Capital, 2022[104])

Figure 7.4. Green CRI Órigo - Double Waterfall Structure



Note: Operation and maintenance (O&M), Real estate receivables certificate (Certificado de Recebíveis Imobiliários, CRI)
Source: (Albion Capital, 2022[104])

Lessons Learnt

The Green FIDC has been recognised as an internationally awarded project finance concept, which represents an attractive opportunity in Brazil due to relatively predictable cash flows and inflation-linked tariffs. The development of this securitisation instrument has been supported by the Brazil Innovation Lab and Convergence, which helped to take this instrument from concept to pilot. This process was also strengthened by the experience of Albion's international partner, the Climate Bonds Initiative, who provided certification on the instrument.

By using an instrument that was already familiar to Brazilian investors, Albion Capital was able to make use of existing regulation, and tap into capital markets for green project financing. The recent launch of the Green FIDC Solar GD I and Green FIDC Solar GD II – as well as the Green CRI I and II - are expected to help further prove the concept and allow for wider use of this instrument. Given the versatility and replicability of this model it can in the future be used across different types of green infrastructure projects.

8 World Bank RERED programme

Figure 8.1. Overview of the World Bank Rural Electrification and Renewable Energy Development (RERED) project overview

Financial instrument	Grants and concession finance
Financing strategy	On lending and technical assistance
Business model	Lease to own microfinance SHS
Country / region	Bangladesh
Timeline	2012 - ongoing

Background

The distributed nature of small-scale renewable projects means many local actors are involved, many of whom may not have the right training, capacity or awareness to support market development and financing. Local financial institutions can also be reluctant to lend to these projects, given weak credit ratings (or lack thereof), stringent collateral requirements and high transaction costs (Deloitte, 2019[61]), part of which is due to lack of standardised project documentation.

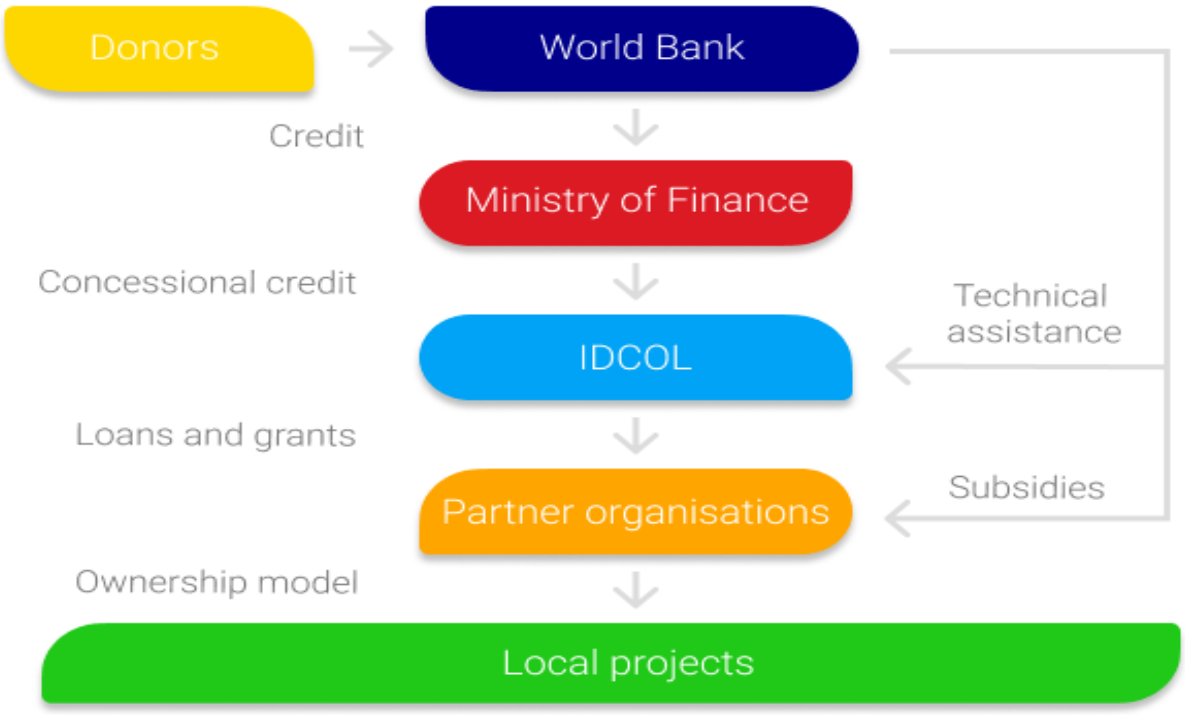
To address such barriers, financial intermediaries can work with partners (e.g. multilateral development banks) to build upon existing work with local banks and microfinance institutions and deploy potential products, such as lines of credit, revolving loans and even venture capital, in support of households and MSMEs seeking finance for renewable energy solutions. These could equally be complemented by support for innovative business models to address specific challenges constraining rooftop solar financing (CEEW, 2018[107]).

As the following example from Bangladesh shows, this can help increase overall comfort and capacity by local lenders with renewable energy projects, while also help enable market uptake through actors that know their local partners well. Increased deployment through this strategic partnership can also help improve local economies of scale (e.g. via improved supply chains and technical capacity). Not only does this improve the financial viability and affordability of renewable energy solutions, but it equally can help to create new jobs and business opportunities.

Bangladesh's solar home system programme

Bangladesh's rural electrification agenda was set in 1997, but concerns over its pace and costs led the Government to seek more cost-effective solutions for remote households. In response, a solar home system initiative was developed with the World Bank Rural Electrification and Renewable Energy Development (RERED) programme (see Figure 8.2).

Figure 8.2. World Bank RERED programme



Source: (Sadeque et al., 2014[108]) Scaling up access to electricity: the case of Bangladesh

The programme aimed to reach rural households using a combination of concessional credit and subsidies to help make the systems more affordable (Sadeque et al., 2014[108]). The initial programme in 2008 was successful and was broadened to other technologies such as clean cooking stoves and solar irrigation pumps.

By 2020, 3.1 million households had a solar home system. The programme also supported construction of 14 solar mini-grid projects as well as the installation of 1 153 solar irrigation pumps, 10 486 small domestic biogas digesters and 1.9 million improved cooking stoves (World Bank, 2020[109]).

The solar home system initiative was financed by the World Bank's International Development Association, which provided concessional credit with long-term maturity (38 years) to Bangladesh's Ministry of Finance.

The Ministry then channelled this finance through concessional credit to Infrastructure Development Company Limited (IDCOL),[26] a government-owned non-bank financial institution that implemented the programme. Some of the funds were disbursed as grants (though liability for the overall credit from World Bank remained). The World Bank was also a conduit for grants from other parties such as the Global

[26] More information: https://www.idcol.org/.

Environment Facility (GEF), Global Partnership on Output Based Aid, KfW, the Asian Development Bank and USAID. These grants supported World Bank technical assistance in developing IDCOL's capacity for technology promotion and market development activities, programme administration, and monitoring and evaluation. Donor funds also supported subsidies disbursed by IDCOL to partner organisations for early market development.

The RERED programme provided several rounds of financing, subsidies and technical assistance to develop the solar home system market and to reach rural consumers. The use of subsidies with partner organisations evolved over time with regard to purpose and amount:

- Direct subsidies for market development, which covered costs to establish a new business line for solar home systems. Subsidies also supported capital-buy down grants passed onto consumer through market competition. The average subsidy in 2003 was USD 90 per system, decreasing to USD 45 in 2006. By 2013, a USD 20 subsidy remained only for systems of 30-Watt power or below.
- Indirect subsidies for capacity building, which supported technical training for new partner organisations to ensure they gained proficiency in the market, including with technology, supplier selection and aftersales services. Training also included topics such as cash flow management and business planning.
- Indirect subsidies for consumer awareness, which supported customer training and awareness raising to promote the systems. These activities were co-financed using a cost-sharing basis in which partner organisations initially bore 20% of the cost, later bearing most of the costs as the programme evolved.

Partner organisations were central to the strategy. These microfinance institutions, often non-governmental organisations, ranged from small entities operating in specific localities to large microfinance banks. Of these, one key partner was Grameen Shakti27, a not-for-profit microfinance supplier of renewable energy technologies established under Grameen Bank28. Notably, the partner organisations had pre-established relationships with rural low-income customers to whom they could sell the solar home system through purchase contracts. Supported by refinancing from IDCOL (as well as some grants in the early programme to help bring costs down), partners sold the solar home systems to households using microcredit agreements.

IDCOL's selection committee screened potential partner organisations, using clear eligibility criteria. Once in the programme, their technical and financial capacity was developed through training. An operations committee was also available to provide operational solutions. Specifically, IDCOL provided training to help partners develop technical expertise beyond their normal financial activities, which allowed them to become solar home system dealers (e.g. with technicians installing the systems).

To ensure a high standard of the installed systems, IDCOL also set up a multi-layered monitoring and quality control process. In addition, partner organisations were required to submit a monthly programme report to IDCOL, providing data on installation and credit repayment.

Improved finance for solar access

Partner organisations were responsible for all technical, commercial and financial aspects of the solar home system business, including procurement and pre-financing of the systems. They also installed the

[27] More information: https://ashden.org/winners/grameen-shakti/.

[28] More information: https://grameenbank.org/.

systems using their own network of technicians and looked after maintenance as well as aftersales service, including any related training or capacity building for customers.

Prospective consumers were screened using pre-defined eligibility criteria. Group lending and social collateral models were also employed. Once approved, consumers placed a down payment equivalent to 10-15% of the system cost, with the remainder typically repaid over 2-3 years on microcredit terms spelled out in the purchase contracts, generally at prevailing market interest rates (typically 12-15%).

To help bring down the cost of credit, refinancing through IDCOL acted as an incentive for partner organisations. Between 70-80% of credit to customers was eligible for refinancing at market rates of 6-9%, with a 5–7-year repayment period and a 1-1.5-year grace period.

The refinancing also helped to ensure quality, as IDCOL carried out technical verifications of installed systems within 21 days of the refinancing claim before providing the improved credit, along with any applicable subsidy (World Bank, 2014[110]).

In case of default, partner organisations could reclaim a solar home system. Conversely, customers had a buy-back guarantee at depreciated price if they obtained a grid connection within a year of purchasing the system. Once the loan was repaid, partner organisations offered an optional service contract for an annual fee.

Lessons learnt

The RERED solar home system experience highlights the central role partner organisations played in accessing an existing customer base. For instance, the programme benefitted considerably from the extended network and reputation of Grameen Shakti.

IDCOL also played an important part as a financial intermediary, addressing barriers and challenges with partner organisations, particularly as the sector had previously been unwilling to finance “non-productive loans” such as those for solar home systems.

Flexible project design using a range of subsidies and system sizes equally allowed for adaptation with evolving technology and market conditions, as well as with consumer feedback.

The combination of consumer credit and subsidies particularly helped to make the system affordable for early market adoption. As competition in the local supplier market increased and local technical competencies improved (e.g. through training), system costs came down, allowing the subsidies to be reduced.

Economies of scale through the partnerships also helped to bring down the cost of technology. Notably, the success of the partnerships in achieving sizable demand (through existing customers) and in working with supply chains helped to achieve attractive costs early in the programme.

The success of this initiative in Bangladesh contributed to numerous private competitors outside of the RERED programme entering the solar home system market.

Adapting to this evolving context, the RERED II programme in 2014 expanded to clean cooking stoves, solar irrigation pumps, biogas digesters and solar mini-grids. While solar home systems continued to be a component of the programme, these were mostly targeted to small systems designed for the poorest households.

Elements of the RERED programme could be used to deploy local, small-scale solar solutions for homes and businesses in other countries such as India. Future programme design could also consider additional or alternative elements beyond concessional credit, such as credit guarantees or partial risk-sharing agreements, depending on the needs of eventual partner organisations.

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