6

Financing: The Key to Africa and the Middle East's Solar Energy Future

6.1 Introduction

Section 6 addresses the holy grail of solar energy deployment in Africa, the Middle East, and elsewhere the availability of investment funds and the way financing is structured. It reviews the basics of such financing efforts by the United Nations, the World Bank Group, and other international organizations to provide investment funds and enable access to electrical services, the emerging concept of pay-as-you-go that is opening many new opportunities for solar deployment, and the use of large-scale auctions to reduce solar energy costs. The availability in recent years of affordable financing for energy projects in Africa is underwriting the continent's rapid economic development in the 21st century.

The Sun Is Rising in Africa and the Middle East: On the Road to a Solar Energy Future
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6.2 Solar for Energy Access in Africa

Richenda Van Leeuwen[79]

Africa today has a limitless amount of sunlight.
About 11 terawatts of electricity can be generated from the sunlight in Africa alone, so we haven't even scratched the surface on that.[80]

—Akinwumi Adesina, President, African Development Bank (AFDB), 2017

For many years, it was difficult to generate international interest to invest in renewable energy on the African continent. Despite its abundant natural resources and high levels of solar insolation for much of the continent that would appear to support renewable energy solutions, the prevailing viewpoint in the mid-2000s was that financial returns on conventional energy projects were far more robust. At that time, prohibitive system capital costs, including the high cost of solar panels, meant that there was an opportunity cost to investing in solar photovoltaic generation and most other renewable energy solutions. Exceptions were grid-tied hydropower, as well as small-scale solar photovoltaic installations such as in Morocco and thermal rooftop installations for water heating in several countries in North Africa.

Solar is a vanity. We need "real" electricity.

—Senior West African government official in conversation with the author,[81] 2010

By 2016, the situation had changed enormously. According to the Bloomberg New Energy Finance Climatescope report,[82] clean energy investment across sub-Saharan Africa had nearly doubled in the 1-year period between 2014 and 2015, totaling US$ 5.2 billion. International Renewable Energy Agency (IRENA) data indicate that Africa's total solar PV installed capacity increased from around 500 MW in 2013 to 1,330 MW in 2014 and

[79] Richenda Van Leeuwen's biography is on page 242.
[80] https://www.businesslive.co.za/bd/companies/energy/2017-05-23-sas-renewable-energy-auction-system-the-best-in-africa/.
[81] Richenda Van Leeuwen.
[82] http://global-climatescope.org/en/region/africa/.

close to 2,500 MW by the end of 2016. Much of this increase was driven by South Africa, with roughly $4.1 billion of the total by the end of 2015. If measured in terms of megawatts, large grid-tied solar photovoltaic and solar thermal projects, from the 160 MW Noor I project in Morocco to large solar photovoltaic projects in South Africa, have in recent years attracted significant commercial debt and equity investment. This has been due in part to the following:

- economies of scale
- competitiveness of other markets leading developers to begin to look at African opportunities
- rapid drop in price of solar PV panels
- focus on improving regulatory and policy frameworks in Africa through the use of supportive mechanisms such as auctions and national feed-in tariffs (REFIT)

While these numbers and growth rates are impressive, in many other parts of the African continent, renewable energy is still very much emerging. Many announced projects remain in project evaluation phase. Clearly more work needs to be done in countries that have not adopted solar solutions at the rate of South Africa or Morocco.

6.2.1 "Below," "Beyond," and "Off" the Grid: Powering Energy Access

There is a second story on renewable energy in Africa beyond that of grid-tied generation capacity, one that has really emerged over the past 10 years. This has largely been a story of small-scale, off-grid and, increasingly, mini-grid solar PV solutions. Again, this has been driven in part by decreased prices for solar panels, combined with the availability of LED lights, and small-scale lithium ion batteries. It has also been driven by a number of companies and charities that were established over the past decade with a specific mission focus to develop and make small-scale solar solutions available to off-grid families. Early companies included such names as D. Light, Barefoot Power, Greenlight Planet, Stiftung Solar Energie and Solar Aid (the charitable arm of UK solar company, Solar Century). All these entities focused on delivery of small-scale off-grid products and solutions to off-grid households in developing countries in Africa and some in other parts of the developing world.

Urban and rural families have increasingly adopted a range of small-scale household and community level solar photovoltaic power solutions. These have ranged from "entry level" solar lighting products mentioned above, and more recently "pay-as-you-go" financing for purchase or rental of household and small business systems. This has resulted in a massive sea change in the way solar solutions are financed across Africa in the last 5 years, with newer companies utilizing mobile money solutions scaling rapidly in the provision of hundreds of thousands of small systems to off-grid consumers. Many have focused initially in East Africa and have included companies such as M-Kopa, BBOX, Mobisol, and others. Some of the product companies such as D.Light have now also moved to focus more on pay-as-you-go financing, since it allows consumers to rent, or rent to own systems, without a sizable initial down payment, required in more traditional bank financing of solar systems. In addition to these home systems, community-level solar and hybrid "mini-grids" have also seen an increased focus by policy makers and investors alike. Both of these system types are covered in more depth in Chapter 6.3. Solar-powered irrigation, including drip irrigation, is also increasing in some markets.

In this off-grid electrification sector, success is no longer measured in terms of megawatts installed. It is assessed in the life-enhancing services facilitated through enabling people to access electricity—often for the first time—which in turn support a range of development benefits related to education, health, and livelihoods. These include applications such as electricity to power modern health care service delivery, to light a home in the evening enabling a child to study, or the electrification of a livelihood that can lead to greater productivity and income. System sizes vary, from as little as 0.5 W to 100 W for home systems for off-grid home use, and to multiple, even tens of kilowatts or more for community use. These solutions have provided at a minimum basic lighting and energy services, allowing customers to transition away from dependence on dirty, dangerous, and relatively expensive kerosene and candles. These had remained the mainstay of household lighting in millions of homes across

Sub-Saharan Africa and in other parts of the developing world well into the 21st century. In 2010, tens of millions of people living without the grid were still using kerosene as their primary fuel for home lighting. According to the International Finance Corporation's Lighting Africa Initiative, African "Base of the Pyramid" (low income) households and small businesses spent more than $10.5 billion annually on lighting, with kerosene being the dominant fuel for that purpose.

6.2.2 Why Solar for Energy Access in Africa?

By 2016, across Africa, nearly 600 million people still did not have access to electricity, as reported by national electrification rates by the International Energy Agency in its 2017 World Energy Outlook. Nonetheless, this deficit was not evenly distributed across the continent. Rural electrification continues to lag urban electrification significantly, and regional variations exist across the continent. Central Africa still lags East Africa, which has seen significant progress since 2012, and which has become a focus area for many off-grid and mini-grid companies, with strong engagement in Kenya in particular, and increasingly Rwanda, Tanzania, and Uganda. Other countries, like the Democratic Republic of the Congo (DRC), where civil unrest remains, still have massive electrification deficits. Additionally, across Africa, many people whose homes and businesses are connected to the national grid, but for whom grid power remains unreliable due to a large number of power outages, have adopted solar power systems as a supplemental source of power.

6.2.3 Why Hasn't the Grid Been Extended across Africa?

A combination of factors has led to countries not extending the grid to cover their entire population. While some countries in Africa such as Algeria and Tunisia have achieved more or less universal grid access, extending the central grid to remote, low-population-density areas is relatively expensive. Poorer households generally have low demand profiles and therefore may not be considered a high priority for grid extension, particularly where a central utility is already struggling with financial viability issues. Successful grid extension programs require a financially and technically viable utility that can manage connection mechanisms for poorer households to connect to the grid, as well as payments, and address issues such as line losses from large-scale transmission. The IEA has estimated that, globally, an additional $30 billion per year on average will be required to provide universal access to electricity by 2030, far more than the $8 billion per year current level of investment. This includes projections around grid extension as likely to be the most suitable—and cost-effective—option for all urban areas and for around 30% of rural areas, with mini-grids and off-grid solutions completing the rest.

6.2.4 Global Catalysts: Renewed Attention at the UN and Beyond

Significant renewed attention to the issue of energy access has taken place in the international development community since 2010, with a strong push to recognize—and appropriately value—the close correlation between economic development, social benefits, and the availability of and access to electricity.

In 2011, former UN Secretary-General Ban Ki-moon, recognizing that at that time some 1.3 billion people around the world lacked access to electricity, launched his signature campaign, the "Sustainable Energy for All" initiative. The UN General Assembly declared 2012 to be the UN International Year of Sustainable Energy for All and 2014–2024 to be the Decade of Sustainable Energy for All. The aim of "Sustainable Energy for All" was—and remains—to support three goals: achieving universal access to modern energy services by 2030, increasing energy efficiency, and doubling the share of renewable energy in the global energy mix by 2030.

In 2015, UN member states adopted the Sustainable Development Goals, including Goal number 7, focused on achieving universal energy access by 2030. This was a significant win for the development community and for renewable energy advocates, many of whom believed that energy had been a "missing" component of the earlier UN Millennium Development Goals.

Energy is the golden thread that connects economic growth, social equity, and environmental sustainability[83]

—Former United Nations Secretary-General,
Ban Ki-moon, 2012

The UN initiative also drew increased attention to the need for a range of solutions not limited to the provision of grid electricity. As part of its contribution, the World Bank and partners developed a "multi-tier" framework for measuring energy access, focusing on the number of hours of electricity per day, and indicative types of power provision available in a given "tier" from Tier 0 (no access) to Tier 5 (highest level of access) (Fig. 6.1).

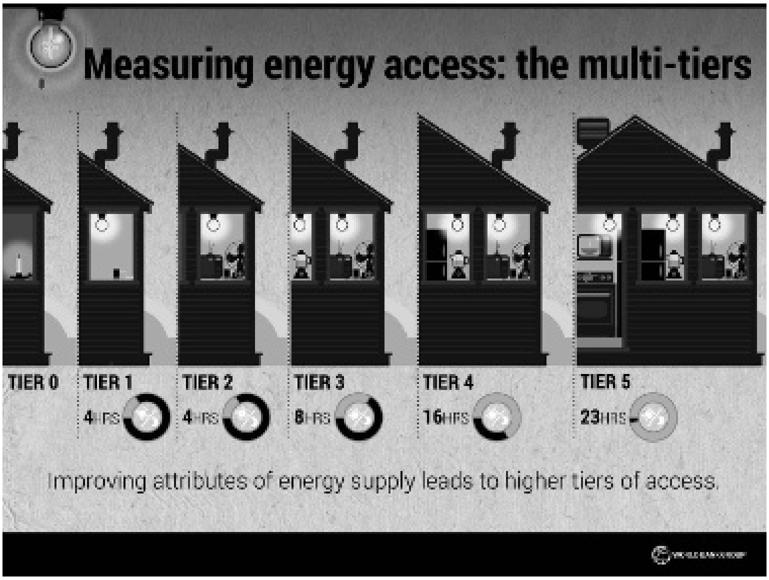

Figure 6.1 UN Sustainable Energy for All: Energy Access Multi-Tier Framework.[84]

Tier 0 is characterized as using candles or kerosene for lighting, with no appliance use. Tier 1 includes 4 hours of lighting, as represented by a small light and cell phone charging.

[83]https://www.un.org/press/en/2012/sgsm14242.doc.htm.
[84]Mikul Bhatia, Niki Angelou (2015). *Beyond Connections: Energy Access Redefined.* ESMAP Technical Report 008/15. World Bank, Washington, DC. © World Bank. https://openknowledge.worldbank.org/handle/10986/24368. License: CC BY 3.0 IGO.

The follow-on tiers include Tier 2, also with 4 hours, but adding small appliances such as a small solar LED TV or a fan, with these being powered by a home solar system. Tier 3 moves to 8 hours of electricity, including additional small appliances. Tier 4 also includes refrigeration in addition to lighting and small appliances, at 16 hours per day, which could possibly be powered by a larger micro-grid. Tier 5 essentially represents full energy access, with 23 hours per day of electricity. Tier 5 is assumed to mean having access to grid power, with enough reliability to power a full range of household lighting and appliances close to 24 hours per day.

The intention was never to define minimum levels for the provision of power. Instead, it was to recognize that for households starting from a very low base of using candles and kerosene for lighting (in some cases not even that), an initial transition to a small solar light represents an improvement in access, albeit not full access. The framework provides a methodology for measuring the availability of power (but not the quality) rather than focusing on specific appliances that are powered, since they will vary by consumer and context.

Global attention around energy access helped to inspire national initiatives, such as the US government's "Power Africa" initiative launched by US President Barack Obama in 2013. Power Africa's goals include providing 30,000 MW of new and cleaner power generation and 60 million new electricity connections. Its "Beyond the Grid" off-grid electrification sub-initiative specifically focuses on household solar and micro-grids, with the aim to add 25–30 million new connections (of the overall 60 million goal of Power Africa) by 2030. This initiative, recognizing that financing remains a key constraint in many markets, has taken a transaction-focused approach to energy access, seeking to address market barriers and financing issues within the context of an individual project or transaction. By 2016, Power Africa reported that its public and private partners had committed more than US $50 billion, including US $40 billion from private sector partners, to the initiative (see also Chapter 4.3).

Countries across Africa have embraced their own national targets for electrification and are focusing on different targets related to their SDG7 commitments, their Sustainable Energy for

All commitments, or their 2015 Paris Climate Accord "Nationally Determined Contributions" (NDCs), or some combination of all of them. Increased utilization of GPS planning tools also plays a role in a number of African countries, to help model "lowest"-cost options comprising both on- and off-grid solutions for planning purposes, although cultural factors and consumer preferences play a role in addition to cost and enabling environment.

The UN initiative was not the first development initiative to focus on bringing small-scale solar PV to sub-Saharan Africa. In addition to an earlier International Finance Corporation Photovoltaic Market Transformation Initiative (PVMTI), whose strongest success in Africa was, arguably, in Morocco, by 2008 the World Bank and the IFC had formed the "Lighting Africa" initiative. This sought to take the market well beyond North Africa and help to support bringing modern lighting by 2030 to off-grid African families. Lighting Africa has focused on the need to develop "a market" for affordable small-scale lighting and power solutions to be made available to low-income communities lacking grid power. One early aspect they focused on to do this was to support market studies in several countries in Africa to determine demand and provide needed data analytics to companies that were largely still at that point too small and early stage to be able to invest significant funds into market research. During this time, there was also a new focus on support for small-scale solar lighting products, entry-level products that were much smaller than the solar home systems, and typically used 1–3 W of solar power. A strong focus was taken on quality assurance (details are provided in Chapter 6.3) to help ensure the quality of the solutions being provided, given that a low-income customer would struggle to purchase a replacement product if their initial purchase was a fake brand, was defective, or broke soon.

6.2.5 Market Expansion

Apart from a number of pioneer companies, such as D.Light, Barefoot Power, and Greenlight Planet, many newer entrants have entered the sector over the past 10 years, including a plethora of others offering small-scale lighting products, small solar home systems, and larger systems for community applications. These were again enabled in part by dramatic cost decreases in the price of solar PV panels in recent years, the inclusion of LED lighting rather than incandescent bulbs or even compact fluorescent bulbs (CFLs), improvements in battery technology, and in software and in appliances. Applications for the use of solar for drip irrigation were explored through non-profits showing improvements in agricultural productivity,[85] and solar power water pumping began to be explored (see Chapter 5.2). Unfortunately, low-cost fake products have also increased in many markets, undermining sector quality and reputability.

By 2010, while the recession across much of the world decimated markets, in a sense it helped catalyze the market for solar PV in the developing world. In part driven by the European market for solar PV plummeting in 2009 due to the recession and abrupt changes in tariff regimes in some key markets such as Spain, solar panel manufacturers began expanding their reach into new parts of the world. Small companies that had previously struggled to acquire the panels that they needed for small-scale installations suddenly began to have more traction in the market, and panel makers began to look at markets they had previously ignored. This led to increasing availability of a range of sizes of panel suited to small-scale applications, and not only the standard 200 Wp sizes used in most grid-tied projects.

This chapter would not be complete without a mention of consumer household and small business appliances. The fast pace of innovation and the advent of super-efficient appliances, combined with smart software, have enabled even small amounts of power to provide significant benefits to a household at low cost. When combined with financing that allows for payment over time, these appliances become accessible to much larger market segments. Appliance makers in the past did not really cater to the off-grid market. The growth of such appliances as award-winning low-wattage DC (and AC) LED color TVs, now increasingly available in many African markets, as well as super-high efficiency fans, means that some of the services previously out of reach to poor homes are now becoming more financially accessible. Not all of these appliance makers today are large global brands like Samsung. One smaller German company manufacturing solar appliances is Fosera, which produces an

[85]http://self.org/sustainableenergyforall/.

array of solar products and systems. Among its product lines is an award-winning 12 V solar-powered LED television, which only uses 6.5 W of power, highly compatible with even a small DC solar PV system. The company sells its products in 11 African countries.

This trend of growth in off-grid and mini-grid systems is likely to continue and, if embraced by governments, may allow low-income households to adopt a better quality of lifestyle. This does not automatically necessitate a correspondingly high kW per capita usage, or even grid access, as was the case in OECD countries. Some off-grid solar companies will now include financing for appliances within their overall pricing structure for consumers, recognizing that what the customer wants is not the electricity as such, but the use of the appliance that is powered by it. This is an area that is likely to see significant further change in the coming years, particularly with the dawn of the "Internet of things" (IOT). This sees smart appliances that gather enormous amounts of data being interconnected to each other and the Internet. While there are potential vulnerabilities associated with this (such as system hacking), it can in principle help to tailor services more specifically to consumers in these markets over time.

6.2.6 Future Directions

While price decreases have led to massive increases in the number of people across Africa being able to adopt some type of solar energy access solution, the size of the residual challenge remains immense. Financing remains an issue, although unevenly in different parts of the market and the continent. Regulatory policy, including import tariffs, can also help to drive or hinder market development. Even in countries with well-developed regulatory structures, their existence alone does not mean that the market will develop well. Political engagement will remain important as will educating financial institutions on the range of opportunities and financing types needed by solar companies. This includes how this sector and individual projects can be successfully de-risked, and either funded commercially or through a well-tailored package of commercial and concessional financing—and, of course, ensuring that consumers can afford to access solutions that meet their needs and reach suitably high quality standards through appropriate quality controls as well as tailored consumer financing mechanisms, whether pay-as-you-go or through other approaches.

Above all, if the 2030 goal of achieving universal energy access is to be achieved across Africa or in other parts of the developing world, a clear and continuing goal should be to ensure consumers are not simply getting access to a solar-powered electricity solution but can utilize it successfully to support and maintain an improved quality of life.

6.3 Financing Solar in Africa and the Middle East

The investment in a solar energy system is usually made using a combination of equity and debt. Since banks are fundamentally risk averse, the debt equity ratio decreases with an increase in the risk environment. In very stable and developed markets, up to 90% of the total investment can be borrowed, whereas in conflict zones, often no credit is available and everything has to be paid with equity. In most cases, however, the debt equity ratio is between 50% and 80%. Other types of financing include leasing or lease–purchase schemes, which are often used in pay-as-you-go schemes.

Since most of the cost of ownership of a solar energy system lies in the upfront investment, the sources of capital and the way the financing is structured are important parameters in the overall cost of the service the solar system provides. Although falling renewable energy technology costs have significantly lowered the capital needed to invest in new systems, financing renewable energy projects is still difficult in many parts of the world. There are major differences and the cost and availability of financing depends on the region where the investment is taking place, as well as on the type of investment. For example, financing a large grid-connected solar PV system that supplies electricity to a government entity with a solid credit rating in one of the Gulf countries is relatively straightforward. The recent world record low tariffs for PV electricity in the United Arab Emirates and Saudi Arabia were partly due to historically low costs of borrowing in those markets. Furthermore, the currencies in those markets are pegged to the US dollar, so the tariffs can be used to repaying the investment, which is also typically in US dollar, without currency hedging, which typically adds to the cost. Such favorable circumstances cannot be found elsewhere in the Middle East or Africa, where a different environment for financing prevails. There are multiple and interesting possibilities of financing solar systems in Africa. This section aims to provide a snapshot of how solar is currently being financed in Africa.

6.3.1 Size Matters

In terms of overall investment, it should not come as a surprise that the bulk of money for solar in Africa is invested in large grid-connected solar plants, simply because they comprise the bulk of megawatts deployed. As reported by IRENA (see Section 8), at the end of 2016, some 2.5 GW of solar PV capacity has been installed in Africa, roughly a quarter of which is off-grid. So, 75%, or 1.9 GW, comprises grid-connected systems, the majority of which is in South Africa. According to Bloomberg's Climatescope,[86] which tracks most sizeable investments, from 2011 up to 2015, more than US$ 24 billion was invested in renewable energy in sub-Saharan Africa; US$ 11.3 billion, or 47% of that, was investments in solar energy.

As described in Chapter 6.4, South Africa has successfully introduced ever more economical solar PV through a well-planned system of consecutive auctions. However, it is important to note that even though South Africa's economy lies well ahead of the average economy in sub-Saharan Africa, the entire US$ 7.3 billion that was lent to solar energy projects in 2012 and 2013 was provided by local South African banks. According to Citibank, for them to bid from abroad, including a currency hedge would have added 400 bips, or 4%, to any dollar amount provided by them or any other international bank, making them uncompetitive. Given the size of the South African economy and the liquidity in the banking sector, this was not a problem. However, local banks in other sub-Saharan African countries are, first, not very experienced in lending to renewable energy projects and, second, not as strong as the South African banks. Also, the investment climate in most countries and the requirement for long loan tenures make it difficult for developers of such projects to secure commercial finance. For this reason, international financial institutions such as the World Bank, the African Development Bank, the European Investment Bank, the Islamic Development Bank, and the Green Climate Fund provide funding to solar energy investments in Africa. Chapter 4.4 describes the World Bank's efforts in this respect. However, adding an international financial component

[86]http://global-climatescope.org/en/download/reports/regions/climatescope-2016-africa-en.pdf.

adds complexity to the process, which comes at a cost. The entire process of due diligence, risk management, negotiation, etc., is intrinsically expensive, especially in an international setting, leading to relatively high costs for such transactions. It then becomes difficult for smaller or medium-size projects to obtain such concessional financing. Many solar projects are relatively small. A 5 to 20 MW solar power plant, which in many sub-Saharan African countries would be sizeable, costs much less than US$ 50 million these days. This is not much for a project finance structure, making it difficult for most International institutions to engage, simply because their internal costs are too high for such investments.

Apart from South Africa, Morocco should be mentioned if large-scale solar investments in Africa are discussed. Although predominantly concentrating solar power (CSP), Morocco has successfully mobilized billions of US dollars in the Noor and Midelt solar complexes. Morocco's MASEN, which not only co-invests but also guarantees the power offtake on behalf of the Moroccan government, is a unique entity aimed to foster bankable investments in Morocco. Masen's structure and the size of the investments—Noor 1, 2, and 3 together amount to 510 MW—enabled access to a concessional finance package resulting in weighted average cost of capital (WACC) of slightly more than 4%, lower than anywhere else in Africa. This package was provided by the World Bank, the European Investment Bank, and others. As a result of this international support, CSP could come down in cost, recently leading to Dubai's 7.3 USc/kWh for a 700 MW CSP project, giving the CSP technology a new lease on life. These examples show that financial support for large-scale solar energy investments in Africa and elsewhere have served their purpose and brought down cost over time.

Important approaches to reducing transaction costs are to work toward standardization and pool investments. The main document in a grid-connected solar PV project is the power purchase agreement (PPA). IRENA and several other international organizations have started working on a standard PPA document, which aims to be instrumental in lowering the transaction costs of renewable energy investments. Equally, pooling smaller investments can increase the volume of the overall financing package to lift it over the minimum barrier for banks and investors.

Such mechanisms could also help securitize renewable energy assets for the purpose of trading in capital markets, like credit card debt or mortgages.

6.3.2 Risk

Risk or the perception thereof is one of the main topics determining the cost of capital for a renewable energy investment. It can best be described as a piece of art: The perception differs from person to person and depends on how you look at a subject. According to IRENA,[87] a perception of high risk constrains the development and financing of renewable energy projects. Project risk, perceived or real, can take multiple forms. These include political and regulatory risk; counterparty, grid, and transmission link risk; currency, liquidity, and refinancing risk; and resource risk. Public finance institutions such as the World Bank and the African Development Bank have a range of tools to support private investors with risk mitigation instruments. These include guarantees, currency hedging instruments, and liquidity reserve facilities. They help mobilize private capital while reducing the capital requirements of the public finance institution. However, according to IRENA, to increase the use of risk mitigation instruments, these organizations need to simplify procedures, reduce transaction costs, set internal incentives, and further expand their toolbox with instruments specifically targeting renewable energy project needs. More needs to be done to make financing available for renewable energy investments throughout Africa.

6.3.3 Financing Off-Grid

At the end of 2016, Algeria, Egypt, Ethiopia, Kenya, Morocco, South Africa, and Uganda all had more than 20 MW of off-grid capacity installed. Some of that capacity is found in sizeable mini-grids (Egypt, Morocco, Algeria), while in South Africa off-grid may not be truly off-grid (standalone) either, but backup systems and panels installed to reduce electricity bills.

[87]https://www.irena.org/DocumentDownloads/Publications/IRENA_Risk_Mitigation_and_Structured_Finance_2016.pdf.

Chapter 6.4 describes the main business models seen in the off-grid solar market in Africa. An important growth sector is the pay-as-you-go (PAYGO) solar concept. Although PAYGO companies constitute just about one-fifth of all companies in the off-grid solar sector, the companies that transitioned from cash-sales to PAYGO saw a substantial increase in customer uptake, providing evidence that this is a game-changing addition to the business model. According to Bloomberg New Energy Finance, there are typically four stages of financing PAYGO companies: the seed stage, the early stage, the expansion stage, and the scale-up stage. In the seed stage, companies look for funds up to $1 million, usually from angel investors or grants. This is mostly equity. In the early stage, companies such as PAWAME typically seek amounts ranging $3–5 million, also mostly equity. In the expansion phase, firms such as M-Kopa, Off-Grid Electric, D.Light, BBOXX, Nova Lumos, Fenix International, and Mobisol have all announced at least one transaction larger than $10 million, in a combination of equity and debt. Several companies have now reached the scale-up phase and they are looking for amounts ranging $50–100 million, which would be debt. Given the limited balance sheets of these companies, an important element would be some form of securitization of assets. Given that this asset class is new, and much of the value is dispersed over thousands of households in rural areas in developing countries, it probably requires some time before lenders understand this and get comfortable with the risk profile. Nonetheless, this mechanism can potentially develop very fast. Residential solar securitization in the United States rose from $53 million to $803 million in just 2 years.

There is anecdotal evidence, however, that the pool of capital provided by venture capital funds is drying up. The business model is such that a large amount of money is required upfront. A substantial investment in the back office, sales, and installation staff and, of course, all the solar systems is required. Although the customers have to make a down payment, most of the investment is recouped through small payments over a longer period. This means that it will take several years before such company returns a solid profit, especially since most of them are growing aggressively. Since many companies started around the same time, the investor community would first like to see proof that the business model works before investing more money.

Traditional donors seem to have a bias toward larger cash-generating projects such as power plants with a power purchase agreement. However, a mini-grid in a rural area or a PAYGO Company is a business, rather than a project. This makes it more complicated to tap into traditional sources of concessional finance. Several international financing institutions have recognized this problem and either established dedicated funds or invested in existing funds. One example is KawiSafi Ventures, anchored by the Green Climate Fund, which focuses on the off-grid energy sector in East Africa to provide universal access to energy to people located.

Solar energy is one of the most universal energy sources, capable of providing modern energy to even the farthest corners of Africa and the Middle East—corners where the grid struggles to reach because of the low population density. Solar PV is one of the most competitive energy sources nowadays, and there beyond the foreseeable grid connection and at the bottom of the economic pyramid are proven and viable business models for the entire range of applications, from the smallest solar lantern to megawatt-scale power plants. However, many companies and end users are often struggling to access capital to finance their systems, despite the undisputed benefits for the economy and development of remote communities. What is required is a concerted and focused effort by the financial community to provide innovative financing solutions that match the innovation of the solar business community.

6.4 Pay-As-You-Go and Community Solar

6.4.1 Where the Grid Doesn't Reach

More than 620 million people in sub-Saharan Africa are not connected to the grid, and this number is rising despite spectacular economic growth in many countries. The number of people living off the grid has risen by more than 114 million on the continent since 2000, with several million more joining every year. Although many governments are working on expanding their electricity grids, many people live in sparsely populated areas far away from main transmission corridors. For such areas, extending the grid is a very expensive option, costing between $500 and $1,000 per connection, and the expected demand for electricity will be limited for years to come. Dedicated off-grid solutions are in many cases a more economical and appropriate solution. The standard solution so far has been a diesel generator. The recent cost competitiveness of renewable energy, especially solar PV, has made business models based on renewables much more compelling. Renewables don't need fuel and the lack of moving parts in the case of solar PV, reduces the need for maintenance. Several solutions using modern renewables to provide off-grid electricity have been around for some time. They include solar products such as solar lanterns, solar home systems, and mini-grids, but also dedicated solutions to power a business.

6.4.2 Solar Products

People that do not have access to grid electricity will meet their energy needs by other, often expensive, means. According to a report released early 2016 by the World Bank Group and Bloomberg New Energy Finance, in collaboration with the Global Off-Grid Lighting Association,[88] globally 240 million mobile phone subscribers live off-grid. These phones are often charged by small businesses costing on average $0.20 per charge. Expressed in electricity, this equates to an astounding $30–50 per

[88]https://www.lightingafrica.org/launch-of-2016-world-bank-group-bloomberg-off-grid-solar-market-trends-report/.

kWh. For a proper cost assessment, one would have to include the travel time to the charging point, which can be substantial. This shows the enormous potential for cost-effective off-grid electricity solutions, including solar. Figure 6.2 shows that people spend $2.4 billion on mobile phone charging in Africa each year. But they also spend over $14 billion on kerosene, batteries, and candles for lighting, an amount almost as high as the GDP of a country like Zambia. The annual expenditure bill for household lighting varies from country to country but ranges $100–140/year. Kerosene lanterns, a century-old technology, not only are costly but also are fire hazards. The wicks smoke, the glass cracks, and the light provided is often too weak to read by. The World Health Organization says the fine particles in kerosene fumes cause chronic pulmonary disease, affecting women and children.

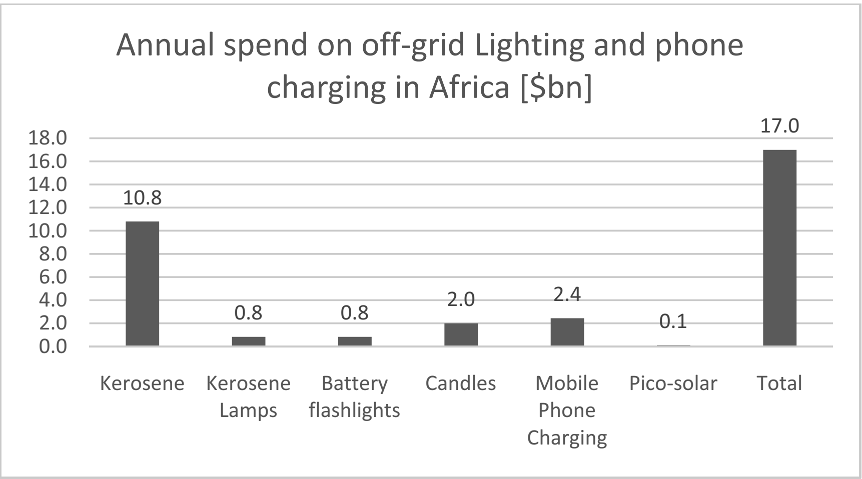

Figure 6.2 Estimated annual spend on off-grid lighting and phone charging in Africa (2014, billion dollars; source: footnote [89]).

However, in recent years, with solar panels becoming more and more affordable and LED lights becoming more and more practical, so-called solar lanterns have been selling in the millions.

[89]Fatih Birol, et al., IEA (2014). *Africa Energy Outlook: A Focus on Energy Prospects in Sub-Saharan Africa*.

Solar lanterns consist of an electric lamp (usually an LED) with a rechargeable battery that is charged with a small solar panel. If the solar panel is smaller than 10 W, the system is called a pico-solar system.

Figure 6.3 A solar lantern with phone-charging capability.[90]

Figure 6.3 shows a solar lantern with phone-charging capability. Even the most basic solar lamps outperform kerosene lanterns in terms of ease of use and quality of light. A typical solar lantern takes 8 to 10 hours to charge and then provides 4 or 5 hours of light from high-efficiency white LEDs. The number of times solar lamps can be charged before their rechargeable batteries wear out has improved enormously in recent years, along with their ability to cope with dust, water, and being dropped. A simple solar lantern can cost as little as $5, with higher-quality models, for example, with phone-charging capability, costing up to $50. Although this is not cheap for a poor rural household, the savings on kerosene and mobile phone charging provide for compelling economics. A "typical" solar lamp costing $13 has a payback time of just a few months in most sub-Saharan African countries. Assuming a life of 2 to 3 years for a product from a reputable manufacturer, customers can enjoy at least 1 year of free lighting until they have to make another investment.

[90]http://sunnymoney.org/index.php/solarlights/.

Until the end of 2015, more than 20 million units have been sold in Africa, with half of those supplied by reputable companies with a quality product, the other half comprising lower-cost generic products. In the second half of 2016 alone, an additional 1.87 million solar products were sold in Sub-Saharan Africa.[91] It is no surprise that quality products, requiring a price premium, have been copied by manufacturers of generic products, with lower-quality components and a consequential shorter life or inferior service.

Lighting Global[92] is the World Bank Group's platform supporting sustainable growth of the off-grid solar market. Through Lighting Global, the International Finance Corporation (IFC) and the World Bank work with the Global Off-Grid Lighting Association (GOGLA), manufacturers, distributors, and other development partners and end users to develop the off-grid lighting market. An important aspect is the quality of the products. Lighting Global provides a quality assurance methodology with the following key aspects:

- **Truth in Advertising:** Advertising and marketing materials accurately reflect the tested product performance.
- **Durability:** The product is appropriately protected from water exposure and physical ingress and survives being dropped.
- **System Quality:** The product passes a visual wiring and assembly inspection.
- **Lumen Maintenance:** The product maintains at least 85% of initial light output after 2,000 hours of operation.
- **Warranty:** A 1-year (or longer) retail warranty is available.

Quality is important, since a survey done by SolarAid in Tanzania,[93] where a lot of low-quality products are being sold, showed customer satisfaction slipping from 97% for quality-verified brands to 60% for other brands due to lower product quality.

[91]*Global Off-Grid Solar Market Report: Semi-Annual Sales and Impact Data*, July–December 2016, Public Report, GOGLA, Lighting Global, IFC, Berenschot.
[92]https://www.lightingglobal.org/
[93]SolarAid (June 2015). *Research Findings: Baseline and Follow-Up Market Research in Kenya, Tanzania and Zambia*.

6.4.3 Solar Home Systems

One step up from pico-solar are solar home systems. In 1992 Dr. Anil Cabraal of the World Bank ASTAE division came up with the idea (Chapter 4.4), which was named “Solar Home System” (SHS). These systems were believed to be a potential solution for the 1.6 billion people who do not have grid electricity. Solar home systems are individual household systems consisting of a solar panel, a battery, associated control circuitry, and one or more domestic appliances.

Compared with conventional energy available in rural areas, such as kerosene and disposable batteries, the cost of a solar home system must be paid up front. This typically requires some sort of financing, since most people in rural areas of developing countries cannot afford such a large amount. Although most developing countries have systems of rural credit supply, most traditional loans are given toward productive uses, e.g., to buy seeds for the next year’s crop, assuring the bank there will be a future income to pay back the loan. Although clean household energy for light, mobile phone charging, and radio/TV supports development in the long run, it is difficult for a bank to identify additional income in the time they require to recoup the money they lend to the rural customer. So, solar home systems have traditionally been supported by development finance institutions (DFIs) such as the World Bank, the African Development Bank, and others, which supported local banks that had the infrastructure in place to provide such loans in rural areas. Also, 20 years ago, one needed big solar panels and heavy car batteries to power inefficient appliances for an individual household. However, now, with LED lights and efficient DC appliances, and low-cost reliable storage based on Li-ion batteries, which are much lighter and last longer than lead acid batteries, the overall energy demand is reduced. So a much smaller panel is required. And since the price of solar has fallen dramatically, the overall cost of the system is much more affordable now than 10–20 years ago.

6.4.4 M-Kopa

It wasn’t until another innovation became available—mobile money—that we saw a real breakthrough in the market uptake of solar home systems in East Africa. M-Kopa[94] is the company that pioneered the application of mobile money in combination with solar systems, first in Kenya and now in more and more countries. M-Kopa basically provides a financing solution so that people can afford solar PV.

In 2006, Chad Larson and Jesse Moore were doing an MBA at Oxford University, when they met Nick Hughes. Nick presented M-Pesa, the first successful mobile money system as pioneered by him, when he was working for Vodafone in Kenya. The success of M-Pesa[95] intrigued them and they kept in touch with Nick in the years following his presentation. In the years between 2007 and 2010, they all had other jobs. In 2009, however, both Jesse and Nick left their jobs to explore business opportunities based on mobile banking. Both of them had a background in telephony and they were happy that Chad joined them in 2010, since he was a banker. In 2010, they successfully applied for grant money to pilot a few businesses based on mobile phones in Africa, among others from the Shell Foundation. They introduced a mobile savings account, they started a company providing health services by linking into a network of medical doctors, and they piloted a business providing solar home systems that incorporated a switch that can be operated remotely using a SIM card in a modem. Of the three ventures, the solar venture was by far the most successful. They installed 300 pilot systems and 95% of the people actually paid back their dues because of that switch. The additional response from neighbors, etc., was overwhelming. They had so many requests for additional systems that they realized that this was a winning formula.

Their system works as follows: The client can charge credit via the modem using his cell phone. If the credit used to pay for the solar system is depleted, the system automatically switches off. The entire system is automated, customers get an SMS warning them of low credit, and they will be warned again when the system is remotely switched off. The credit used is the normal mobile phone credit that can be bought at roadside stalls throughout the country.

[94]http://www.m-kopa.com/.

[95]https://www.worldremit.com/en/m-pesa-mobile-wallets?gclid=CO3Tu8qdxs0CFUFehgodNFUMkA&ef_id=Ue2rSQAAAY8sp3yU:20160626173650:s.

At present, people spend considerable amounts of money on kerosene and disposable batteries. M-Kopa targets rural customers who typically have one or two phones in the household. Most households spend half a dollar each day on kerosene and batteries, and M-Kopa charges that amount for a much better solar electricity service. With new technology, solar can now easily replace kerosene and batteries and supply enough energy for a DC radio, a flashlight, and even a TV. The technology as marketed by M-Kopa provides the experience of having grid electricity. The system is supplied with cabling and light switches, so when people enter their house, they can switch on the light immediately. A 20 W solar panel provides enough electricity to charge a lithium-ion battery, with a 5-year life, to watch 4 hours of TV on a 15° DC-powered TV set. In the future, M-Kopa is thinking about a small, highly efficient fridge. In terms of people's demand for electricity services, they want light, TV, phone charging, a fan, and possibly a fridge. All of these services can be competitively supplied with solar, which is more affordable then a grid connection. For such a grid connection in Kenya, a potential customer has to pay a deposit of US$ 400 to the grid company, and in addition there is a substantial tariff, consisting of a fixed and flexible rate.

After the success of the pilot project, the M-Kopa founders knew that to roll out a proper business, they needed additional money. They started a fundraising effort and managed to attract Gray Ghost Ventures out of Atlanta in the United States, which invested $1.5 million in the first round of financing, together with a few other institutional investors. This enabled them to design a back-office that could handle hundreds of thousands of micro transactions every day without a glitch. They also further refined the solar system and its components. Jesse and Chad moved to Kenya in 2011 and started hiring staff. As of May 2017, they employ 1000 full-time staff and 1,500 sales agents in East Africa. The company has more than 500,000 customers in Kenya, Uganda and Tanzania and adds 500 customers each day. After Kenya, they selected Uganda and Tanzania as next markets because the countries all have approximately 40 million people, low electrification rates, and most importantly, have well-introduced mobile money systems.

In Kenya, for example, people even buy roadside snacks and pay for them using mobile money. It is expected that in the next 10 years, many more countries will introduce mobile money systems. Countries such as Nigeria and Bangladesh have introduced mobile money and its adoption rate is growing fast, so they will be future markets for M-Kopa or other companies using mobile money.

There are an estimated 20 companies like M-Kopa, active in the pay-as-you-go or PAYGO segment, which is just about one-fifth of all companies in the off-grid solar sector. However, the companies that transitioned from cash-sales to PAYGO saw a substantial increase in customer uptake, providing evidence that this is a game-changing addition to the business model. According to Bloomberg New Energy Finance,[96] substantial new capital was injected in PAYGO companies in 2016, with more than $223 million of investment funds announced. This puts the sector well above the $158 million injected in 2015. Off Grid Electric, BBOXX, Nova Lumos, and Mobisol all raised individual rounds of at least $18 million.

[96]https://data.bloomberglp.com/bnef/sites/14/2017/01/BNEF-2017-01-05-Q1-2017-Off-grid-and-Mini-grid-Market-Outlook.pdf.

6.5 Large-Scale Auctions

6.5.1 Introduction

Governments have used several mechanisms to stimulate the deployment of renewable energy. European countries, most notably Germany, championed the use of feed-in tariffs. Feed-in tariffs provide renewable energy generators with a fixed price for the energy that they produce. These tariffs, which until recently were a fixture of Germany's Renewable Energy Act, were instrumental in the German "Energiewende" or energy transition and helped boost renewable energy's share in the national electricity production mix from less than 4% in 1990 to more than 30% today. Spain, another country that implemented feed-in tariffs, has steadily increased its renewable coverage of electricity demand from 18.4% in 2006 to 37.4% in 2015. A feed-in tariff system is relatively simple, provides certainty for the investor, and is characterized by low transaction costs. However, getting the tariff right is not easy and for a while Spain's tariffs were too generous, leading to windfall profits for developers. The Spanish government was unable to respond quickly enough to rapidly falling prices for most notably solar technology and consequently felt forced to introduce retroactive cuts to their feed-in tariff. Following Spain's example, more countries introduced similar retroactive cuts, which caused substantial confusion in the European market. Many investors started legal proceedings against European governments, and these court cases have still not been resolved. Although highly successful in bringing substantial renewable energy capacity online quickly, in recent years, more and more countries have replaced or complemented feed-in tariff systems with more market-oriented support schemes such as renewable energy auctions.

Structured price-based competitive procurement (auctions) of utility-scale solar PV has been a major factor in driving down the cost of solar PV in the past couple of years. There has been a substantial increase in the number of countries that carried out renewable energy auctions, from 7 countries in 2005 to 60 countries in 2015.

There are various types of auctions: sealed-bid auction, descending clock auction, and hybrid auction.

6.5.2 Sealed-Bid Auction

In a sealed-bid auction, bidders simultaneously submit a technical bid and a financial bid. The technical bids are checked whether they meet the minimum technical requirements, and the financial bids of the qualified technical bids are then opened and ranked. Projects are awarded until the sum of the quantities that they offer covers the volume auctioned. If it is a single project auction such as the 160 MW CSP Ouarzazate I project in Morocco (2011), the lowest bidder wins. The alternative is a pay-as-bid auction, which results in the allocation of multiple units of the same product with different prices. This can be to more than one project developer (e.g., the 3,725 MW auction of South Africa in 2010).

Often these auctions are carried out in two stages: a pre-qualification stage, resulting in a shortlist, and an evaluation stage.

6.5.3 Descending Clock Auctions

In a descending clock auction, the auctioneer starts with a high price and progressively lowers the price until the quantity offered matches the quantity to be procured. It differs from the sealed-bid auction in that it uses multi-round bids. Participants know each other's bids and adapt their price and quantities accordingly in subsequent rounds, which allows for a strong and fast price discovery, making it very efficient. Transparency also makes it less prone to collusion or corruption.

6.5.4 Hybrid Auctions

Some countries have introduced hybrid auctions, consisting of a first phase with a descending clock auction, allowing them to need supply with a certain margin and find a price, which can be used as a ceiling in a next phase, which is a sealed-bid auction, to meet the actual demand with the lowest price. Brazil has carried out such hybrid auctions.

Renewable energy auctions have become the instrument of choice for governments for the following reasons:

- Multi-project auctions typically have lower transaction costs than individually negotiated projects.
- The transparency associated with publicly run auctions will attract international investors.
- Auctions are quicker and less resource-intensive for the buyer.
- Auctions have been proven to yield lower pricing, especially in consecutive rounds.
- A bundled approach creates an opportunity to provide stapled finance with better financing terms, reducing the overall cost to the buyer.
- A structured process with clear oversight increases trust, reduces risk premiums, and leads to lower costs.

Countries that have achieved tariffs well below $0.10/kWh through such an approach until early 2017 include Mexico ($0.035/kWh), Jordan ($0.06/kWh), South Africa ($0.073/kWh), Peru ($0.05/kWh), Zambia ($0.06/kWh), the UAE—Dubai/Abu Dhabi ($0.03/kWh/$0.024/kWh), and Jamaica ($0.085/kWh). Several other countries are now considering auctions to procure cost-effective solar PV capacity.

Apart from the low cost, another main feature of PV is that it can be built extremely fast. The 75 MW Kalkbult solar PV power plant in South Africa was built in 8 months only, which compares extremely favorably with conventional power. A similar experience was made in Uganda, with KfW's GETFiT program. A 5 MWp PV system was built in 6 months, much faster than the 2–3 years required for hydropower projects developed under the same scheme. The low environmental and social impact and modular nature of the technology contribute to this fast deployment.

6.5.5 South Africa

In 2009, the South African government began exploring feed-in tariffs (FiTs) for renewable energy, but these were later rejected in favor of competitive tenders.[97] The resulting program, now known as the Renewable Energy Independent Power Producer Procurement Program (REIPPPP),[98] has successfully channeled substantial private sector expertise and investment into grid-connected renewable energy, including solar PV, in South Africa at competitive prices.

The following provides an overview over the first bidding rounds.

In August 2011, an initial Request for Proposals (RFP) was issued, and a compulsory bidder's conference was held with over 300 organizations attending. By November 2011, 53 bids for 2,128 MW of power generating capacity were received. Ultimately, 28 preferred bidders were selected offering 1,416 MW for a total investment of close to $6 billion. Major contractual agreements were signed on November 5, 2012, with most projects reaching full financial close shortly thereafter. The first project came on line in November 2013. A second round of bidding was announced in November 2011. The total amount of power to be acquired was reduced, and other changes were made to tighten the procurement process and increase competition. Seventy-nine bids for 3,233 MW were received in March 2012, and 19 bids were ultimately selected. Prices were more competitive, and bidders also offered better local content terms. Implementation, power purchase, and direct agreements were signed for all 19 projects in May 2013. A third round of bidding commenced in May 2013, and again, the total capacity offered was restricted. In August 2013, 93 bids were received totaling 6,023 MW. Seventeen preferred bidders were notified in October 2013 totaling 1,456 MW. Prices fell further in round three. Local content again increased, and financial closure was expected in July 2014. A fourth round of bidding was commenced in August 2014 and concluded with the award of contracts for 1,121 MW renewable energy capacity to six preferred bidders.

[97] Anton Eberhard, et al. (May 2014). *South Africa's Renewable Energy IPP Procurement Program: Success Factors and Lessons.* (http://www.gsb.uct.ac.za/files/ppiafreport.pdf).

[98] http://www.gsb.uct.ac.za/files/ppiafreport.pdf.

Figure 6.4 shows the tariff learning curve achieved over four consecutive rounds of competitive procurement in South Africa.

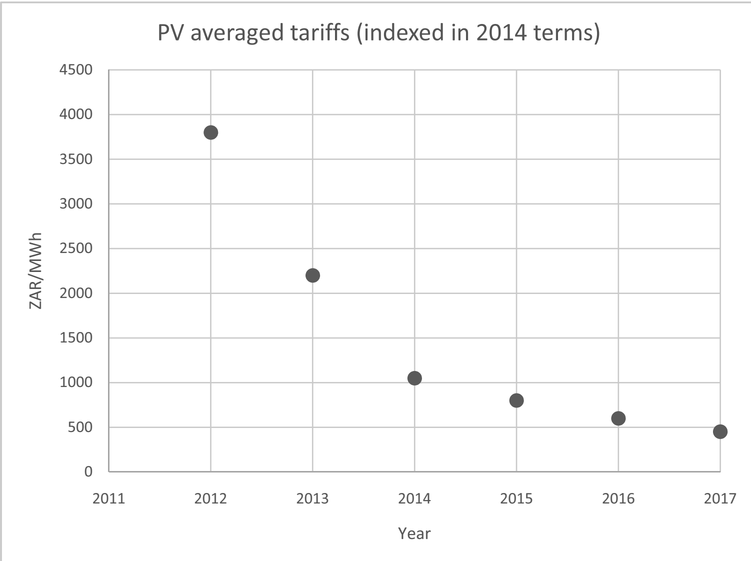

Figure 6.4 Development of electricity tariff in South Africa over consecutive competitive procurement rounds (ZAR = South African Rand (1 USD = ZAR 13.6)).

Similar tariff learning curves have been observed in many other countries in the world, making a strong case for a structured procurement approach with several previously announced auction rounds.

6.5.6 IFC's Scaling Solar

During his 2-year tenure as deputy director-general of IRENA, one of the authors (Frank Wouters) frequently came across the African renewable energy developer conundrum. When interacting with ministers, they often mentioned the lack of finance for projects in their countries. On the other hand, international financial institutions complained about the lack of bankable projects. An analysis of this paradox shows that typically the problem lies with the (local) developers of these projects, who often lack critical skills. It is not so much the lack of project opportunities, but rather the lack of capacity to turn such opportunities into bankable projects. Compared with other technologies, solar PV is relatively straightforward and not as complex as wind, geothermal, or hydropower projects.

With these things in mind, a group of people at the World Bank Group's private sector arm, the International Finance Corporation (IFC), started the development of a standardized approach to accelerate the deployment of utility-scale solar PV projects throughout Africa, which they called Scaling Solar. It began to take shape in 2013, when IFC chief investment officer Jamie Fergusson, principal investment officer Yasser Charafi and senior investment officer Dan Croft, who was then working in the IFC's advisory division, realized they were all working on a similar concept but coming at it from different angles. Croft, Fergusson, and Charafi believed that solar projects were fundamentally straightforward. They had analyzed how typical auctions were structured and had a close look at the South African experience. They realized that other sub-Saharan African countries require a lot more support than South Africa, and they developed a set of documents and procedures that could be replicated easily. South Africa has a strong banking sector and when the government designed their procurement process for renewable energy projects, local banks were involved. Consequently, the documents could be presented as non-negotiable, because they were bankable from the outset, saving a lot of time that would otherwise be spent negotiating details in the contracts with different developers. It was this element the IFC team wanted to replicate. The IFC constructed a package involving other divisions of the World Bank Group, including the Multilateral Investment Guarantee Agency (MIGA). The package has been designed to provide security to governments, bidders, and financiers. Before the auction starts, the Scaling Solar team will do all due diligence using donor funds rather than expecting the bidders to do their own, saving costs for the developer. In addition, the World Bank will provide a partial risk guarantee, which means governments need not provide a sovereign risk guarantee to satisfy financiers, although the template does include a government support agreement with direct government undertakings. The result is a process that substantially reduces the risk for the developer and the banks and that can be carried out very fast, which should lead to lower-cost solar electricity.

6.5.7 Zambia

A recent example of a successful Scaling Solar PV auction is Zambia.

Zambia is a landlocked country north of Zimbabwe. Of its total installed electricity generation capacity of 2,347 MW, hydropower is the most important energy source in the country with 2,259 MW (96%), followed by diesel contributing about 4% to the national energy supply. However, the low rainfall in 2015 has resulted in a national power generation deficit of about 560 MW. Scheduled power outages were having a negative impact on homes and businesses, and in 2015 Zambian President Edgar Lungu directed Zambia's Industrial Development Corporation (IDC) to develop at least 600 MW of solar power in the shortest possible time to address the power crisis. The IDC is an investment company wholly owned by the Zambian government, incorporated in early 2014, whose mandate is to catalyze Zambia's industrialization capacity to promote job creation and domestic wealth formation across key economic sectors. The IDC plays its role by serving as co-investor alongside private sector investors. The IFC has worked with the IDC on the development of two 50 MW solar PV independent power projects in Zambia, following the IFC's Scaling Solar initiative.

The two locations were pre-developed, meaning that the grid connection studies were done, the solar resource was assessed, and a complete finance package was provided by the IFC in the form of stapled finance. The term stapled finance describes a pre-arranged financing package that is "stapled" to the documentation and offered to the developers to use (they are not obliged). They then carried out a two-stage auction, with a pretty strict qualification phase. As a result, a select number of credible developers could focus fully on providing their best price for the solar electricity. The results, which came out in May 2016, exceeded everybody's expectations. The winning bids were for just 6.02 cents per kWh and 7.84 cents per kWh—the lowest prices for solar power to date in Africa, and among the lowest recorded anywhere in the world. Because the tariff is fixed for 25 years and will not rise with inflation, it represents about 4.7 cents per kWh over the life of the project—on par with recent auctions in Peru and Mexico and lower than the lowest tariff achieved for solar in South Africa so far. The two new solar power plants will increase the country's available generating capacity by 5% and will also help restore water levels in its Kariba and Kafue Gorge dams.

On February 21, 2017, the IDC signed an agreement with the IFC to develop up to 500 MW of clean, renewable energy through two to four additional projects.

In addition to Zambia, the IFC is working with the government of Senegal to develop 200 MW, with Madagascar to develop 30–40 MW, and with the government of Ethiopia to develop up to 500 MW of solar PV.

6.5.8 Epilogue

Auctions for large-scale solar have proven to be an effective tool for governments to increase solar generation capacity quickly and transparently. Auctions are among the best mechanisms to find the current price of a certain technology, and a set of well-structured consecutive auctions is instrumental in building a local knowledge base and reducing the cost over time. As has been proven by the case of Zambia, the IFC's Scaling Solar approach has enabled finding a tariff in sub-Saharan Africa that is comparable with global benchmarks.

Recent results have shown that auctions can be structured in specific ways to achieve desired outcomes. In general, achieving the lowest possible tariff is an important driver behind auction design, and an analysis of the lowest achieved prices, most notably the recent records achieved in Dubai and Saudi Arabia, yields a number of important elements that have contributed to such price levels. Carrying out a substantial amount of pre-development work reduces development risk and helps developers focus their efforts on building a project most cost-effectively. This includes designating and potentially preparing a site. In Dubai, the land was offered for free. Furthermore, one should consider carrying out a bankable resource assessment, geotechnical and seismic studies, offering grid-connection, etc. The more such elements are taken away from the developer, the risk profile is reduced and the lower the tariff will be.