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# PAYG MARKET ATTRACTIVENESS INDEX – 2018 REPORT

**Prepared for International Financial Corporation**

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## ACKNOWLEDGEMENTS

This first edition of the Pay as You Go Market (PAYG) Attractiveness Index report was developed by IFC to provide information on the market attractiveness for PAYG energy services in Sub-Saharan Africa.

This Index was conceptualized by Daniel Shepherd, Itotia Njagi and Yann Tanvez (IFC). The development of the Index was done in partnership with the Public – Private Infrastructure Advisory Facility (PPIAF).

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## CORPORATE BIOS

:vivideconomics

Vivid is a specialist consultancy working at the nexus between the public good, business and investment strategies. We support clients across the world in major sectors related to energy, water, forestry, urban and rural development as well as industry. We also have a high amount of experience in design of and access to public and private finance. Our team brings a rich set of expertise in climate change and environmental science, natural capital accounting, social impact assessments, spatial forecasting and optimisation incorporating economic, social and environmental goals.

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Pegasys is an advisory group driving developmental impact in emerging economies. We work to solve complex challenges and improve quality of life. Our sustainable energy practice works towards realising Africa's clean energy potential by supporting low-carbon energy production and scaling up renewable energy and energy efficiency. We assist governments and companies in the transition towards technically and economically viable renewable energy sources.

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SNV is a not-for-profit international development organization, working in Agriculture, Energy, and Water, Sanitation & Hygiene. Founded in the Netherlands in 1965, SNV has built a long-term, local presence in more than 30 countries in Asia, Africa, and Latin America. SNV's global team of local and international advisors work with local partners to equip communities, businesses and organisations with the tools, knowledge and connections they need to increase their incomes and gain access to basic services – empowering them to break the cycle of poverty and guide their own development.

# 1. OVERVIEW

## 1.1 OBJECTIVES OF THE PAYG MARKET ATTRACTIVENESS INDEX

**This short report introduces a new tool developed to provide information to companies, investors and policy makers on market attractiveness for pay as you go (PAYG) energy services in Sub-Saharan Africa.** The index comprises 70 indicators of market attractiveness, organised under three main pillars – demand, supply and enabling environment - and a variety of sub-pillars, as set out in further detail below.

**This first version of the index has been developed for 14 countries across Sub-Saharan Africa, to develop the concept for a manageable number of countries.** Kenya and Tanzania are included as markets which are already relatively developed to help calibrate and give context to the scores for each indicator and pillar. The remaining 12 countries were selected to provide a representative range of geographies, market development, and context across each of the supply, demand and enabling environment pillars.

**The PAYG market attractiveness index provides policymakers and practitioners with a flexible and accessible tool that can be used to investigate the factors that make a national market more or less favourable for the development of energy services through this business model.** It presents a structure for decision-making criteria for use on entry into a market, and for deepening market penetration. The purpose is to provide a guiding framework and indicators that highlight the relatively more favourable conditions and challenges in each market, rather than to suggest one market is more or less attractive than another per se. The metrics included are intended to give an indication of various aspects of market attractiveness, and supplement other quantitative and qualitative market research.

**The index is not a substitute for investor due diligence, or within country geospatial analysis.** It should be supported and complemented by targeted research by companies and investors to enable detailed analysis supporting market entry decisions in specific locations and business models. In aggregating indicators to a national level, some indicators may lose valuable nuance that would be required to make sub-national entry and expansion decisions. For that, there are other tools available. In particular: *http://globalsolaratlas.info/ and https://solargis.com/maps-and-gis-data/download/*.

## 1.2 MARKET CONTEXT AND ROLE OF THE INDEX

**The off-grid energy sector is expanding rapidly across Sub-Saharan Africa and is likely to play an important role as both a transitional and permanent option for accessing clean and modern energy services.** Attaining the Sustainable Development Goal 7 target of 100% access to clean and modern energy services by 2030 will require a mix of grid extension, and off-grid technologies delivered using a range of business models. The IEA estimates that around 70% of the world's rural populations currently without access to electricity are best served by off-grid solutions (International Energy Agency, 2011).

**Access to modern energy services is not a binary outcome; rather consumers will progress up the 'energy access ladder' (ESMAP, 2015).** This begins with small products for lighting and charging mobile phones, through larger home systems up to mini-grid and different quality (that is reliability) of grid access.

**Substantial progress has been made in developing off-grid energy solutions, with rapid uptake in solar lighting and energy products in the developing world.** Some 89 million people in the developing world have at least one solar lighting product in their household, providing power to lift 21 million people onto the first tier of the energy ladder (Bloomberg New Energy Finance & The World Bank, 2016). However, this leaves around 1.2 billion people without access to electricity, spending $27 billion annually on lighting and mobile phone charging from traditional fuels and stop-gap technologies. In absolute terms, there are as many households without energy access as there were about a decade ago (Hystra, 2017).

**Solar home systems (SHS) provide a flexible solution for the 1.2 billion people without access to the grid.** They range in size from small systems which can charge a mobile phone and provide basic lighting, up to larger systems which can power large appliances such as televisions and fridges.

**The development of markets for solar home systems faces a number of challenges.** One of these is the development of a business model that can provide an accessible product to consumers, including dispersed rural and low-income communities. A range of business models promote accessibility, and have different characteristics depending on the type of solar products offered.

**Starting around 2010, businesses have developed pay as you go (PAYG) models that effectively combine a distributed energy service with consumer finance.** Crucially, PAYG does not provide a 'conventional' energy service, but provides access to a package of services, enabled by an energy technology, and purchased on consumer credit. Customers are provided with access to a suite of services, such as the installation and maintenance of a solar home system including the energy product (solar panels) and consumption devices such as mobile phone chargers and televisions. The cost of access to these services is repaid through a pre-agreed payment plan over a number of months.

**The PAYG business therefore combines the approach of distributed energy services companies (DESCOs) with the provision of consumer credit along the lines of Micro Finance Institutions (MFIs).** Most PAYG companies currently focus on providing equipment in the range of 10W to 240W, which covers a range of appliances from phone chargers to refrigerators (ESMAP, 2015). PAYG companies are increasingly expanding the range of products offered into larger systems including for productive use such as multiple dock mobile-phone chargers, hair cutters, large stereos, water pumps and fishing lights. Across this spectrum of products, as well as providing a step up the energy ladder, the PAYG business model can support customer financial inclusion by establishing a first meaningful banking relationship for consumers (Dalberg Global Development Advisors & Lighting Global, 2018).

**Over the past five years PAYG energy services have grown rapidly, although they are heavily concentrated in a few country markets.** PAYG companies raised $223 million in 2016, up from just $3 million invested in 2012 (IFC, 2017). While the majority of sales have been concentrated in East Africa, and in particular in Kenya and Tanzania, the PAYG business model is now being used by over 30 companies in at least 30 countries worldwide. The strategy of how to enter and scale a PAYG market is complex, as it needs to take into account both the appropriateness of the technology involved, and of the credit-based business model (Barrie & Cruickshank, 2017). As the PAYG business models evolve, companies are seeking new partnerships to expand into other markets and maintain growth rate.

**The IFC commissioned the development of this PAYG Market Attractiveness Index to help companies and investors to expand into new markets in SSA**. Nevertheless, the IFC does not believe that PAYG is the panacea or the only approach for closing the energy access gap. The PAYG model has some clear advantages in terms of scaling up, as the business model typically relies on mobile payments that can allow for low operating costs, and a means of providing consumer finance well suited to dispersed urban and rural markets, with an effective payment enforcement mechanism (that is, to disactivate the package of distributed energy services if payment is not made). The focus of this index is on the development of markets for PAYG solar home systems, taking into account the complexities and development of the PAYG ecosystem.

# 2.
# PAYG MARKET ATTRACTIVENESS INDEX STRUCTURE

*Figure 1. PAYG market attractiveness structured under demand, supply, and enabling environment indicators*

## DEMAND

**Market Size**
- population size, density and demography
- current rate and means of access to energy
- urban and rural populations

**Ability to pay**
- income and poverty levels
- expenditure on energy
- income volatility and credit worthiness

**Willingness-to-pay**
- cost and quality of alternatives
- familiarity with credit products
- access to use of mobile payment
- aspirations for package of consumer goods

## SUPPLY

**Access to finance**
- private sector finance for the PAYG sector
- existence of government/donor finance

**Operational considerations**
- cost of sales and distribution
- reliability of solar yield throughout the year
- potential for key partnerships

**Market penetration**
- number of active PAYG companies in the market
- volume of supply of solar technologies

**Human capital**
- local human capital - sales and executive
- labour regulation – including for foreign workers
- languages and linguistic diversity

## ENABLING ENVIRONMENT

**Information and communication technology**
- mobile and data connectivity
- mobile service infrastructure
- mobile phone penetration
- utilisation of mobile payments

**Legal and regulatory**
- existence and enforcement of standards
- banking regulation of the sector
- taxes and subsidies affecting PAYG business model

**Trade and commerce**
- ease of doing business
- macroeconomic conditions
- ease of acces to credit and information

*Source: Vivid Economics*

**The market attractiveness index is structured under three main pillars:**

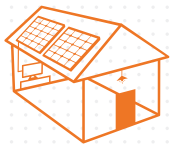
- **demand:** that is, the size of the addressable market, ability of customers to pay, and willingness to pay for PAYG products;
- **supply:** that is, access to finance, operational considerations to provide PAYG products, and potential partnership opportunities to support the PAYG value chain, penetration of PAYG and related products in the market, and access to human capital;
- **enabling environment:** this covers broader conditions to support the development of PAYG markets that are not directly associated with the supply chain or in generating demand. This includes: information and communication technology sectors – in particular mobile money, the legal and regulatory environment - and conditions for trade and commerce.

## 2.1 DEMAND SIDE

For a market to develop or grow there must be a demand – with ability and willingness to pay for the services offered. PAYG use will largely be driven by household users, although is also increasingly explored for productive use in the case of small businesses, or for irrigation. The potential strength of demand will depend on a number of factors including:

- **the size of the market,** in this case, the size of population in rural and peri-urban areas which does not have access to electricity, as well as those with limited and/or unreliable access to the grid;
- **ability to pay,** which is influenced by income levels, household composition, seasonality of income and the cost of the service offered. It may also depend on consumer ability to access finance;
- **willingness to pay,** which depends on the cost and quality of alternative energy access options, information about and trust in the products offered, proportion of income spent on energy and so on.

### Market size



**Between 2012 and 2014, the population of SSA grew by 52 million, but only 38 million people gained access to electricity.**

**In absolute terms, Sub-Saharan Africa household access to electricity is not keeping up with population growth, and rates of electrification remain low.** Between 2012 and 2014, the population of SSA grew by 52 million, but only 38 million people gained access to electricity.[1] Rates of electrification across SSA remain low – from 11% in Malawi to 64% in Côte d'Ivoire, the average for the region being 43%. Coupled with a gradual increase in incomes in recent decades, and expected continued growth, this suggests there is unmet or 'suppressed' demand for access to sustainable electricity services.

**The size of the market in years to come will depend on socioeconomic trends, in particular urbanisation and population growth, as well as income growth and purchasing power.** Rural customers are an important market segment for PAYG energy, although they typically represent lower income market segments. Population growth in urban and peri-urban areas may put pressure on already stretched grid services, which may not be able to reliably meet the additional demand. PAYG markets

[1] Data from Global Tracking Framework, World Bank, 2017

have developed in peri-urban areas, where population density is sufficient to support distribution channels and there is an ability and willingness to pay for 'medium' sized energy solutions (Hystra, 2017).[2]

## Ability to pay

**A major reason cited by customers and sales agents for customers defaulting related to seasonality of income.**

**Ability to pay will largely be determined by income levels and poverty distribution.** As incomes increase, consumers will be better able to afford energy services, either by purchasing a standalone system upfront or through the regular payments of a PAYG model.

**Current expenditure on energy services may be a good indication of ability to pay.** Expenditure on kerosene and other fuels provides a benchmark for how much disposable income is available and currently spent on energy services.

**Cashflow management for rural populations with wide monthly variation in income may also present a challenge.** This will differ from one country context to another, depending on the 'lumpiness' of income, and the PAYG business model (Zollmann, Waldron, Sotiriou, & Gachoka, 2017). A major reason cited by customers (75% of those interviewed) and sales agents (c. 50%) for customers defaulting related to seasonality of income (Barrie & Cruickshank, 2017). Income volatility affects not just the ability to pay for the SHS technology, but also the ability to meet the PAYG business model of regular repayment over time.

## Willingness to pay

**Providing consumers with reliable and understandable information and maintenance option strengthens trust in new products, increasing WTP especially in early stages of market development.**

**Willingness to pay depends on a complex set of factors, including price and quality of alternative means of energy access.** Those currently without access to sustainable electricity can face very high prices for a supply that is both insufficient and unreliable. Consumers without access to the grid rely on expensive fuels with health and supply risks, whilst on average 34% of those with access to the grid experience a connection that works less than half of the time (Afrobarometer, 2016). In these circumstances, customers may be prepared to pay for a higher quality of energy service provided by a SHS under a PAYG model. This is important for both rural and peri-urban areas, where SHS can provide an alternative or back-up solution to a grid connection.

**PAYG companies may face a challenge in consumer awareness and trust when expending into relatively new markets.** Providing consumers with reliable and understandable information and maintenance option strengthens trust in new products, increasing WTP especially in early stages of market development. Often, replication of existing business models can be challenging, with there being a need to educate consumers in digital finance and new technologies, or to tailor payment collection methods (GSMA, 2017a). In general, awareness on the customer side, ability to access and trust credited products can influence demand for PAYG products.

**Leveraging established consumer confidence and awareness of financial services is an important facilitating mechanism for PAYG operators.** Familiarity of consumers with credit or instalment-based payment is limited in some countries, which may limit demand for PAYG products since the ownership model is unfamiliar. Financial inclusion is a key driver of PAYG demand, and may in turn also be supported from PAYG market growth where this is accompanied by improved access to financial services.

[2] Medium consumption refers to appliances that range between 30W (e.g. a fan) to 100W (e.g. a fridge)

## 2.2 SUPPLY SIDE

For a market to develop and scale, it must also be attractive to suppliers to operate a business model. Suppliers need to be able to access consumers, deliver goods and services to them, and develop a system of trust in the product. The factors determining attractiveness to supply in the PAYG market are organised under four sub-pillars:

- **access to finance:** for companies to establish and manage cashflow including making up-front capital investment which is recovered over time as a stream of repayments from end users;
- **operational considerations:** relating to distribution, including the 'last-mile' interface with customers, and technological considerations;
- **market penetration:** current level of supply and depth of related products available in the market;
- **human capital:** both local and ease of access to international labour markets to support development of PAYG agents and supporting services;

### Access to finance for PAYG companies

**Debt is becoming increasingly important as the market matures, rising from 14% of total finance for PAYG in 2012 to 61% in 2017.**

*Dalberg Global Development Advisors & Lighting Global, 2018*

**Access to finance for business operations is a strong determinant for growth of the PAYG off-grid solar sector.**[3] PAYG companies require substantial amounts of capital compared to other solar business types – up to eight times that of a cash sale-based company (Dalberg Global Development Advisors & Lighting Global, 2018). PAYG companies raised around $773 million of capital during 2012-2017, accounting for about 85% of all funds raised in the off-grid solar sector. Debt is becoming increasingly important as the market matures, rising from 14% of total finance for PAYG in 2012 to 61% in 2017 (Dalberg Global Development Advisors & Lighting Global, 2018). In absolute terms, grant finance for the sector has increased annually since 2012.

**PAYG companies must front the capital for the value of solar products to the supplier and collect a stream of revenue over a period of years from customers.** Initial business start-up costs include a requirement for access to local currency to finance local operations. Consequently multi-national operators need to be able to access local currency when establishing operations, and to subsequently exchange local currency to for example US dollars as they generate revenue.

**While most capital leveraged by PAYG companies is international, country linked finance sources may be important when assessing the relative market attractiveness of a country.** For instance, in Uganda and Kenya M-KOPA was funded by Stanbic Bank (syndicated to also include CDC Group, FMO, and Norfund) and in Togo, BBOXX was provided with a line of financing from UTB. Availability of local finance may be particularly valuable for smaller companies and as markets grow over time.

### Operational considerations for distribution of PAYG products

**Practitioner interviews identify last-mile distribution in rural areas as a major supply side constraint** (Hystra, 2017). The logistics of last-mile distribution are an important value driver, especially in retaining a stable customer base (Bloomberg New Energy

[3] Importantly, this section relates to the ease and cost of PAYG companies raising capital to support business expansion. This is different from the extent to which consumers are willing and able to use credit-based models to purchase energy services (covered in section 2.1).

**Partnerships for last mile delivery are an important element of market attractiveness, especially for smaller horizontally integrated companies.**

Finance & The World Bank, 2016). **Partnerships for last mile delivery are an important element of market attractiveness, especially for smaller horizontally integrated companies.** Smaller companies often leverage existing service delivery networks to increase the chances of success in a new market. The source of these partnerships is not limited to the solar market – any market with wide reaching distribution networks presents a good opportunity. The best partnership strategy will often be specific to country / region.

**PAYG companies may partner with existing credit organisations.** In some cases, consumers are already widely able to access credit through microfinance institutions (MFI) and/or savings and credit cooperative organisation (SACCO) loans. The potential for partnership will be determined by how well suited the credit organisation is to absorb PAYG service offerings.

**On the technology side, for solar based PAYG models, the resource yield – solar irradiation – may affect the potential size of the supply market.** Variation within the country is important, and across the year. To be attractive as a product, there must be reliably enough sunlight and irradiation to power the solar products and charge storage (battery) on a daily basis.

**Partnerships for last mile delivery are an important element of market attractiveness, especially for smaller horizontally integrated companies.**

## Market penetration and current levels of supply

**The rapid growth of the PAYG markets has been characterised by relatively low levels of competition, to date.** Larger companies in the market have tended to be first or second movers in their respective country markets, and have been able to convert that advantage into near monopolistic and/or oligopolistic positions (Dalberg Global Development Advisors & Lighting Global, 2018). However, some markets are now witnessing an increase in the number of PAYG companies.

**Alongside the number of companies operating, the volume of similar technology products also provides an indication of the current or historic market conditions.** For example, the sales of PAYG, Pico and solar lantern products as recorded by GOGLA and provide an interesting indicator. In general, a large volume of sales, in conjunction with a high number of players, may indicate a market which can support a large number of suppliers.

**The relationship between competition and market attractiveness is complex.** Early movers may have high shares of market penetration, especially in new markets that have challenging conditions. It may also signal capture by one strongly branded supplier or high barriers to entry, in which case the market resembles a 'natural monopoly'. In this case it is not clear that a 'high' concentration indicates an attractive market. Similarly, a 'low' concentration characterised by a large number of players increases competition, but may also indicate a market that is growing and can support further entry / deepening.

**Harnessing trained staff and local agents is key for the long-term sustainability and expansion of PAYG companies, as well as being a principal cost item of their businesses.**

## Conditions in the local labour market

**PAYG companies highlight access to human resources as one of the major constraints they face.** In particular, companies need access to specific skills and experience for recruiting sales agents, technicians, credit officers and IT specialists. For executive human capital, companies typically rely on MBA graduates (Dalberg Global Development Advisors & Lighting Global, 2018). Additional barriers include foreign worker restrictions, and working in environments where a wide range of languages and dialects are spoken.

**Recruiting field staff to operate local sales distribution networks is a pre-requisite to scale PAYG models in new markets.** Commission-based contractors may focus on the 'easy' customer segments, which are quickly saturated, then become increasingly inactive (Hystra, 2017). Harnessing trained staff and local agents is key for the long-term sustainability and expansion of PAYG companies, as well as being a principal cost item of their businesses.

## 2.3 ENABLING ENVIRONMENT

**The attractiveness of the market to both demand side customers and supply side operators is influenced by a broader country 'enabling' environment.** This is distinct from the supply and demand side indicators, in that it concerns broader market conditions, not those specific to the PAYG value chain and its customers. The PAYG MAI structures these indicators under three sub-pillars:

- **information and communications technology (ICT):** such as availability, access to and cost of online or mobile payment systems; mobile phone penetration and usage; mobile phone subscription costs and pricing structures; online banking prevalence and uptake and so on;
- **legal and regulatory:** relating to the energy sector in general, and standalone systems specifically, including tax regimes, quality standards, banking regulations and so on;
- **trade and commerce:** such as ease of doing business, macroeconomic conditions and forecasts, access to information.

### Information and communications technology

**Mobile channels are important in a number of ways: enabling remote payment collection; providing a control/interface with PAYG assets and services, communications between providers and users and support services/networks for providers.**

*GSMA, 2017b*

**Growth in usage of mobile phones and availability of mobile payment platforms has gone hand in hand with the development of PAYG markets.** The effectiveness of PAYG in reaching dispersed, low-income customers, has been linked to the spread of mobile telephones (USAID, 2017), and 'advanced mobile infrastructure and mobile payment platforms' (PwC, 2016). Mobile channels are important in a number of ways: enabling remote payment collection; providing a control/interface with PAYG assets and services, communications between providers and users and support services/networks for providers (GSMA, 2017b).

**There are alternatives to mobile money to collect payments, but these tend to be more complex and costly to administer.** Scratch cards have been used by providers such as Azuri Technologies or WakaWaka in Rwanda to launch their PAYG solar operations, but this requires a complex stock of cards and agents to administer. Furthermore, most alternative mechanisms rely on a mobile connection. A more attractive alternative could be accepting air-time credit as form of payment, as it has been used in by a PAYG company in Nigeria after partnering with a mobile network operator (GSMA, 2017b).

**A conducive regulatory and policy framework can be a major support to market development.**

## Legal and regulatory

**The legal and regulatory environment affects both the extent to which solar technologies are supported, and the business environment for PAYG business models.** This includes power sector regulations, clean energy and energy access targets, fiscal incentives and specific policy support and standards for standalone solar systems. An important success factor for the development of early PAYG systems was that they operated in an 'unregulated electricity space' (PwC, 2016). A conducive regulatory and policy framework can be a major support to market development. One of the most important factors spurring solar growth is whether or not PAYG systems are exempted from VAT and import tariffs which make small scale solar options more competitive relative to cheaper alternatives (Hystra, 2017). Similarly, the European Union's flagship electrification programme in Africa, ElectriFi, emphasises the importance of clear and reasonable import tariffs and duties as well as value-added tax (ElectriFi, 2016).

**The existence of standards for solar standalone systems is a key factor for off-grid solar providers.** These include standards for technology and equipment, certification standards for installers, or environmental standards for end-of-life disposal. Such standards, if enforced, reduce consumer uncertainty in the market by penalising lower quality products, helping to build consumer confidence and can play a part in increasing customer willingness to pay (Bensch, Grimm, & Peters, 2015).

**The overall Ease of Doing Business score for a country provides a high-level indicator of trade and commerce attractiveness, and sub-components of the Ease of Doing Business index are particularly relevant to PAYG businesses.**

## Trade and commerce

**The environment for undertaking trade and commercial activity influences the market for businesses and financiers.** This includes transparency, corruption perception, access to and the cost of credit, and legal protection for corporations. These indicators are not specific to the PAYG market, but enable the establishment and growth of business operations at scale.

**The World Bank's Ease of Doing Business index covers a range of relevant factors, including administrative and legal costs that a company bears to undertake operations.** The overall Ease of Doing Business score for a country provides a high-level indicator of trade and commerce attractiveness, and sub-components of the Ease of Doing Business index are particularly relevant to PAYG businesses.

**Market transparency facilitates predictability and stability, lowering risk for investors and increasing financing available to PAYG companies.** Similarly, businesses prefer operating environments that are less prone to political and security risks. In the PAYG context, such stability is particularly important, as PAYG companies tend to both be newer and require high up-front investment (Dalberg Global Development Advisors & Lighting Global, 2018).

**For PAYG companies, a favourable wider credit environment is important for the long-term access to finance needed to keep up with quickly expanding markets and technology.** This means that the regulatory and policy environment for credit is an important indicator for the PAYG business model. An established credit ecosystem supports confidence in the availability of a long-term finance stream for PAYG companies, which can evolve with the companies' needs.

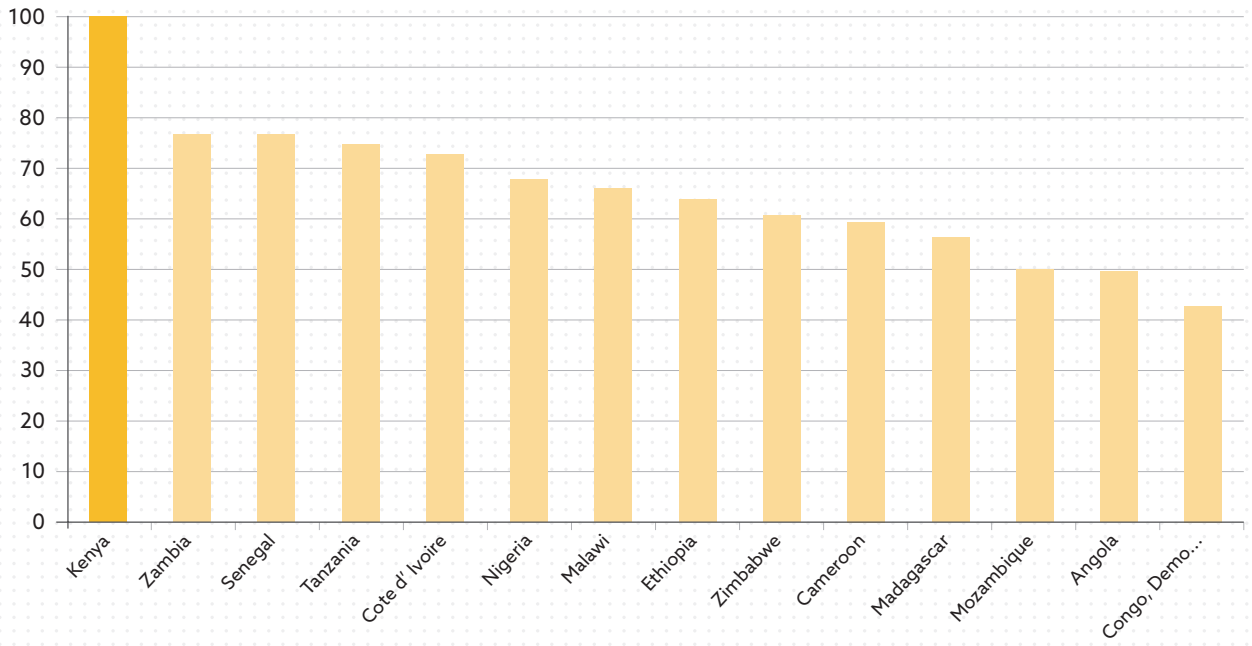
# 3.
# SUMMARY OF RESULTS

**This section provides an explanation of how to use and interpret the results of the market attractiveness index.** It presents results under 'default' weights for each of the pillars and sub-pillars, and explains how to interpret these. The default weights are coded into the tool, and can be retrieved at any time, but users are encouraged to edit these weights to generate results based on the combination of pillars and sub-pillars best adapted to their business models and factors of interest.

**A user guide for the tool is presented in Appendix A, while the complete description of the individual indicators used is provided in Appendix B.** The user guide includes a description of the pre-set weights and how these have been derived. The description of indicators includes the explanation and unit of measure, year and source.

**As shown in Figure 2, under the default weights, Kenya has the highest overall market attractiveness score, followed by Zambia.** These results are sensitive to the weight placed on each of the pillars as well as on the sub-pillars within each of the three main pillars. The following pages provide a more detailed discussion of the scores under each pillar. In Box 1 we provide a worked example of the application of the tool to a country case study for Nigeria.

*Figure 2. PAYG market attractiveness index – summary index scores*

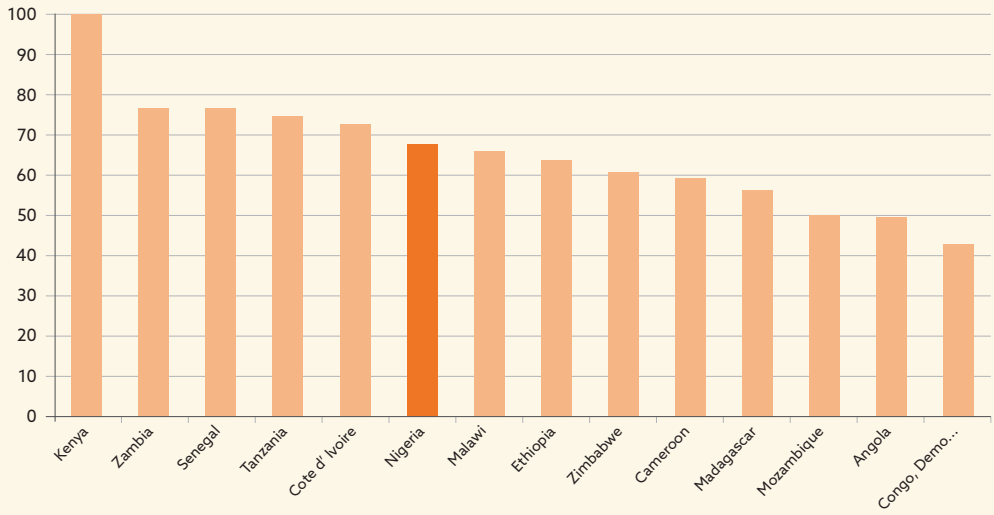



*Source: PAYG market attractiveness index*

*Note: The overall score presents a weighted average of the respective scores within the three main pillars of the index; that is demand, supply and enabling environment. The top-ranking country will always score 100. The default weights assign 20% of the overall score to the demand pillar, 50% to supply, and 30% to the enabling environment.*

## Box 1. Applying the PAYG market attractiveness index to Nigeria – a country with large potential demand, and some favourable supply and enabling conditions

*Figure 3. Nigeria places 6 out of 14 across the overall index score*




*Source: Vivid Economics*

**Nigeria places 6th on the overall rank of the market attractiveness index with a score of 68 out of 100.** It scores particularly well in the demand pillar, coming in 2nd just behind Kenya, and places 8th on both the supply and enabling environment pillars.

*Table 1. Nigeria scores highly on the demand sub-pillar because of its high scores on ability to pay and market size*

| | Rank | Score | Average |
|---|---|---|---|
| **Overall Score** | **6** | **68** | **65** |
| **Demand** | **2** | **94** | **70** |
| *Market Size* | | *91* | *65* |
| *Ability to pay* | | *100* | *56* |
| *Willingness to pay* | | *40* | *52* |
| **Supply** | | **55** | **59** |
| *Access to finance* | | *52* | *57* |
| *Operational Considerations* | | *66* | *62* |
| *Market Penetration* | | *29* | *21* |
| *Human Capital* | | *44* | *71* |
| **Enabling Environment** | | **65** | **65** |
| *ICT* | | *60* | *47* |
| *Legal & Regulatory* | | *13* | *48* |
| *Trade & Commerce* | | *83* | *63* |

*Source: Vivid Economics*

**Nigeria has a large potential market of consumers with good ability to pay, due to a large and relatively wealthy population.** With a total population of over 180 million people, it is the most populous country in the index sample. It is also densely populated throughout much of the country, with pockets of high density population clusters. While many customers have a grid connection, the quality of the grid is poor, which presents an opportunity for alternative forms of distributed energy. Annual household expenditure on lighting and mobile phone charging is relatively high at 288 USD, and customers are relatively affluent with high aspirations for distributed energy services.

**A deeper understanding of the most attractive regions for PAYG products, particularly on demand for different size of distributed energy solutions, would be a valuable deep dive beyond the MAI index results.** Understanding the customer experience of progression through the PAYG product ladder would provide valuable market information on the type of product and pricing structure that could be demanded in the market, currently and in the future. A more detailed analysis of regions within the country where demand is likely to be particularly strong for different sized product would be a useful next step.

**A key barrier to market development is access to and familiarity with mobile money.** Only 6% of the population is using a mobile-money account, due in part to affordability concerns and poor coverage (GSMA, 2015). Those who do have access to a mobile, use it less often than subscribers in other African countries.

**Barriers to increased use of mobile money include affordability and poor data service connection:** (i) affordability – use of a mobile a mobile phone represents around 5% of personal income in Nigeria, (ii) limited 3G coverage, extended to only 51% of the population, with especially limited access in rural and northern populations (GSMA, 2015). Further investment in telecom services is therefore needed to improve quality of services and to introduce innovative services to consumers. This could be facilitated by improving the regulatory and policy environment, improving ease of doing business and reducing tax burden and complexity.

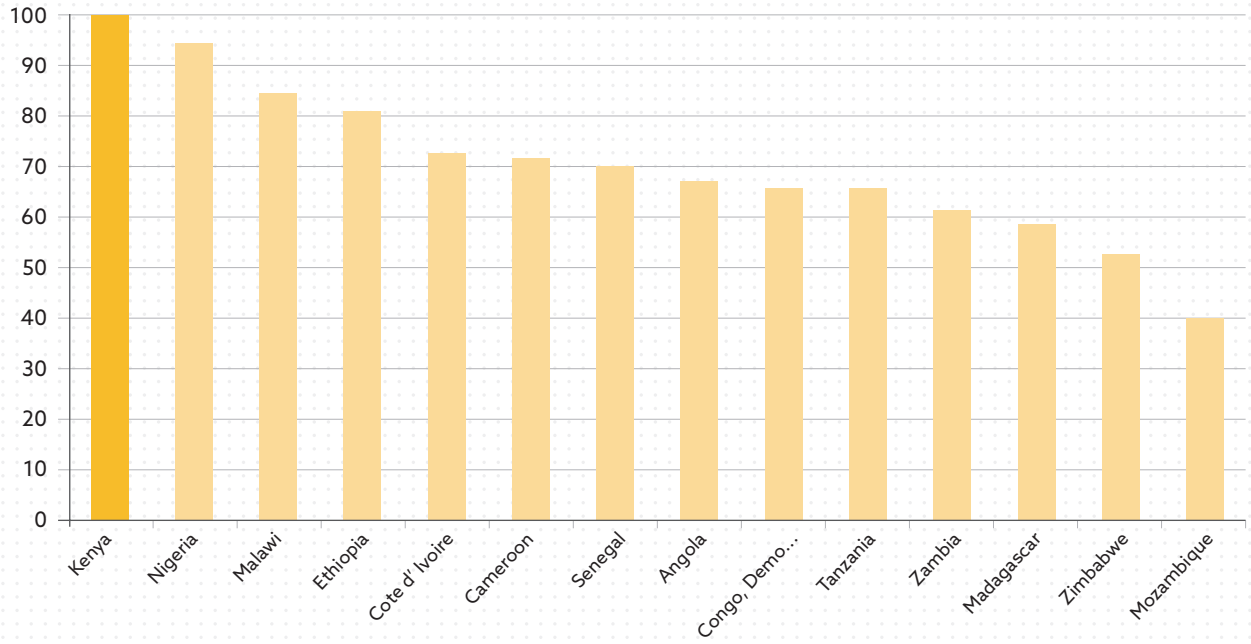
**Improving access to mobile wallets and use of mobile money operators would help develop the PAYG market at scale.** Additionally, providing a stable policy and regulatory environment for the use of airtime transfers as a payment mechanism would leverage existing experience in Nigeria and provide a platform for growth. Lumus has developed a successful partnership model with telecoms operator MTN, to leverage MTNs knowledge of the local market, customer base, and enabling a payment mechanism through airtime credits (GSMA, 2017b).

**On the supply side, solar yield across the country is relatively consistent throughout the year, and the operating environment is attractive for last mile PAYG distributions networks.** Finance stability is also relatively good, with high scores on both the short and long-term economic risk indicators. However, in terms of access to human capital, Nigeria has a lower quality education relative to other countries in the index and is also extremely diverse linguistically. Understanding the extent to which this linguistic diversity and potential skills gaps in the PAYG supply chain can be tackled would be very valuable, including insight into how PAYG companies can maximise their impact on employment generation and improving income opportunities.

**Nigeria has a particularly low score on legal and regulatory conditions which could be improved by review of fiscal and import duty schemes.** Across the RISE indicators, which form a subset of the MAI index, Nigeria lacks specific subsidies or tax breaks to support solar home systems. Similarly, there is scope for the government to introduce public financing facilities for new solar technology and business models, encouraging investment and improving ease of access to local finance.

## 3.1. DEMAND SIDE PILLAR RESULTS

*Figure 4. Kenya has the highest demand-side pillar score, closely followed by Nigeria and Malawi*




*Source: PAYG market attractiveness index*

*Note: The demand pillar score presents a weighted average of three sub-pillars; that is market size, ability to pay, and willingness to pay. As with the overall index score, the top-ranking country will always score 100. The default weights assign 40% of demand pillar score to market size, 30% to ability to pay, and 30% to willingness to pay.*

**As shown in Figure 4, under the default weights, Kenya has the highest score in the demand pillar, closely followed by Nigeria.** Kenya is an attractive market with a concentrated distribution of population centres, a large rural population and a significant population proportion of population with exposure to borrowing on credit. It also has a high proportion of the population with a mobile money account (73%), a feature that has been a key enabler to growth in PAYG markets to date. In Nigeria, the drivers are different. It has the largest absolute market size (185 million people), the highest average population density (204 people per square kilometre), and the most unreliable grid connection, which would be expected to generate demand for PAYG products in peri-urban areas. Additionally, Nigeria scores the highest on the ability to pay sub-pillar, with a high annualised off-grid population expenditure on electricity and mobile phone charging (228 USD) and relatively high GNI per capita (2,850 USD).

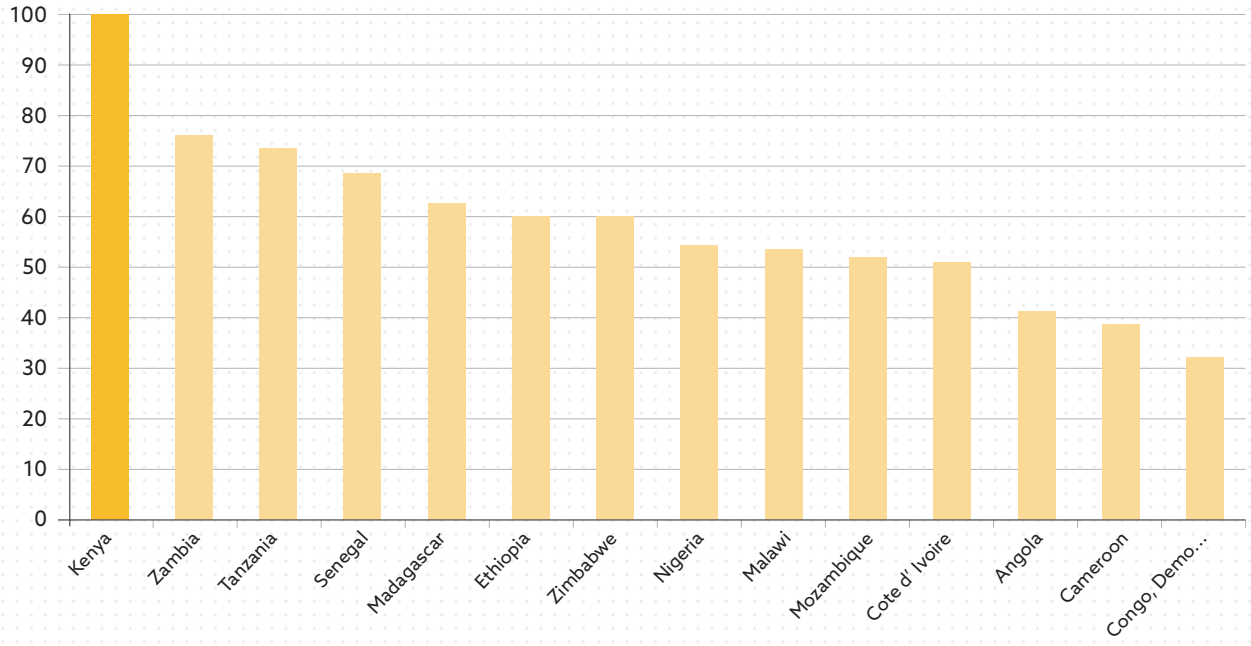
This indicates that Nigerian consumers would be able to afford PAYG products if they were to redirect their current expenditure on energy into solar products. A high GNI indicates strong overall economic performance which may be indicative of longer-term market potential.

**Malawi and Ethiopia also represent markets with large potential demand, although with some challenges to overcome.** In Malawi, the driver of strong demand stems from a high score on willingness to pay. Although Malawi has a small population it has a large PAYG market. It scores highly on the proportion of rural population (84%), as well as on the population density distribution indicator (72%). Although the absolute size of the population is relatively small, the market size for PAYG is large since the population is densely distributed and mostly found in unconnected rural areas – 97% of the rural population is disconnected from the grid. However, ability to pay is a major challenge in Malawi, with the lowest GNI per capita score across the 14 countries, and most customers classified as 'poor'. It does however have high annual household expenditure on lighting phone charging. Ethiopia has a similarly good market size with densely distributed population (73%) and a high level of unconnected rural population (74%). However, it has a lower overall demand side score since off-grid consumers spend less on electricity and mobile phone charging than consumers from Malawi (156 USD compared to 246 USD in Malawi).

At the other side of the spectrum, Zimbabwe and Mozambique have the lowest score on the demand side pillar. Zimbabwe has a relatively small addressable market, with a dispersed population (only 2% in 'medium' density areas), and a low rate of both urbanisation (0.1%) and population growth rate (2.2%). Mozambique households have relatively low ability to pay, with the lowest annual per person expenditure on electricity and mobile phone charging. Rural households in Mozambique also have the highest level of estimated agricultural income volatility in the market (24%), which may pose a challenge in meeting the regular payments required from the PAYG credit service.

## 3.2. SUPPLY SIDE PILLAR RESULTS

*Figure 5. Kenya has the highest score on the supply-side pillar, where Zambia and Tanzania come second and third respectively, over 20 percentile points behind Kenya's score.*




*Source: PAYG market attractiveness index*

*Note: The supply side pillar is composed of 4 sub-pillars; these are access to finance, operational considerations, market penetration and human capital. As with the demand side pillar, countries have an overall score, of which the top country scores 100. Of the 50% default weight assigned to the supply-side pillar the sub-pillars have default weights of 30%, 30%, 20% and 20% respectively.*

**Under the default weights, Kenya scores highest on the supply-side pillar, followed by Zambia.** Kenya has the highest current total solar capacity installed (7,271 kWh), and a strong and reliable high solar yield year-round. Zambia has a less developed solar sector, ranking only 7 out of the 14 countries on market penetration. However, it has the most favourable conditions in the 'access to finance' sub-pillar with a high proportion of firms not identifying finance as a major constraint (80%), and the lowest risk premium on lending. Zambia also has favourable operational conditions, ranked just behind Zimbabwe on the Rural Access Index which suggests that product distribution and maintenance may be less costly.[4] Finally, both countries perform well on human capital with high scores on the quality of education, indicating that the local labour market can supply PAYG companies with many of the skills needed to construct and utilise client and supply networks.

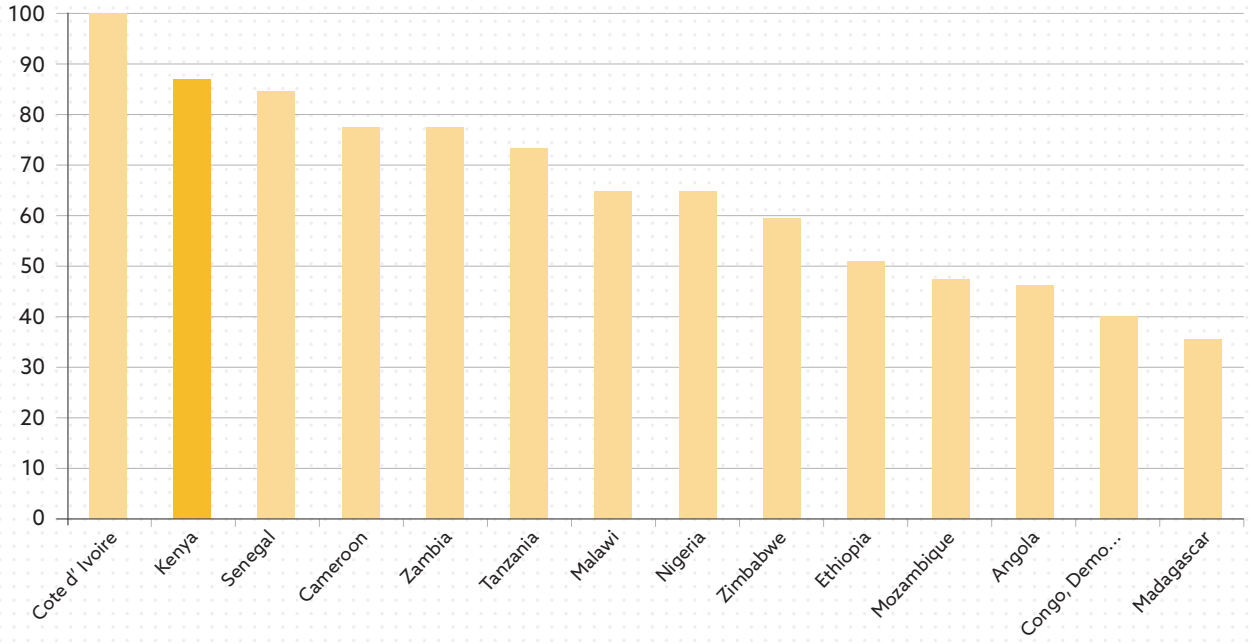
**Tanzania and Senegal follow on from Zambia, with similarly strong supply-side conditions.** Tanzania has high scores on the access to finance and on operational considerations sub-pillars. It has affordable financial services as well as good availability of early stage equity relative to the other countries in the sample. Senegal scores particularly well on the human-capital sub-pillar, with good managerial and specialist training, so would be expected to be a relatively easy location to develop a well-qualified sales and maintenance network. Both Senegal and Tanzania score well on operational considerations, with reliable solar irradiance year-round.

[4] The RAI is a measure of transport connectivity using spatial data and techniques, and comprising data on both road density and road condition.

**At the bottom of the ranking, Cameroon and Congo, Dem. Rep. (DRC) have the lowest supply side scores facing operational and access to finance barriers respectively.** Firms in DRC have poor access to finance, with 73% of firms identifying finance as a major constraint and facing expensive financial services. Cameroon scores poorly on operational considerations, in particular with poor accessibility as measured by the Rural Access Index (20%), which may imply a costly distribution and communication network. It also scores poorly on market penetration, with the lowest volume of PAYG, PICO and SHS sales, emphasising underdeveloped sales and distribution networks.

## 3.3. ENABLING ENVIRONMENT PILLAR RESULTS

*Figure 6. Côte d'Ivoire has the highest score under the enabling environment pillar followed by Kenya*




*Source: PAYG market attractiveness index*

*Note: Enabling Environment is composed of three sub-pillars; these are Internet and Communication Technology (ICT), legal and regulatory, and trade and commerce. The same structure applies with the top country scoring 100. Of the 30% default weight assigned to the pillar, the sub-pillars have default weights of 50%, 30%, 20% respectively.*

**Côte d'Ivoire has the top score in enabling environment, followed by Kenya.** Côte d'Ivoire's high score results primarily from high scores across the ICT sub-pillar, including ranking first across most indicators in this sub-pillar. It has the highest mobile subscriptions per 100 people (126),[5] highest SIM penetration (133 per 100 people), and greatest use of mobile broadband. Kenya scores well in general and is the best performer in the number of secure internet servers per million people. It also scores well across most of the (binary) indicators under the legal and regulatory pillar, such as existence of programmes to support standalone energy systems, duty exemptions on solar modules and so on. It also scores will in the Trade and Commerce sub-pillar, with the best score on 'depth of credit information', overall ease of doing business, the lowest cost to import and the lowest capital required to start a business.

[5] Côte d'Ivoire is the only country that has more than one mobile cellular subscription, with 126 per 100 people. The next highest performer is Senegal with 99 mobile cellular subscriptions per 100 people.

**Senegal and Cameroon also score relatively high on enabling environment, with an above average score across all three sub pillars**. Senegal scores the highest on the legal and regulatory environment sub-pillar, with attractive fiscal incentives such as solar module subsidies and duty exemptions on equipment related to standalone solar systems. Additionally, it has strong ICT conditions with a high annual number of cellular subscriptions (99 per 100 people). Cameroon has similarly good ICT and legal and regulatory conditions. However, it ranks lower than Senegal with a poor score on the Corruptions Perception Index and the Global Peace Index, a high cost of importing and a low score on the Ease of Doing Business Index.

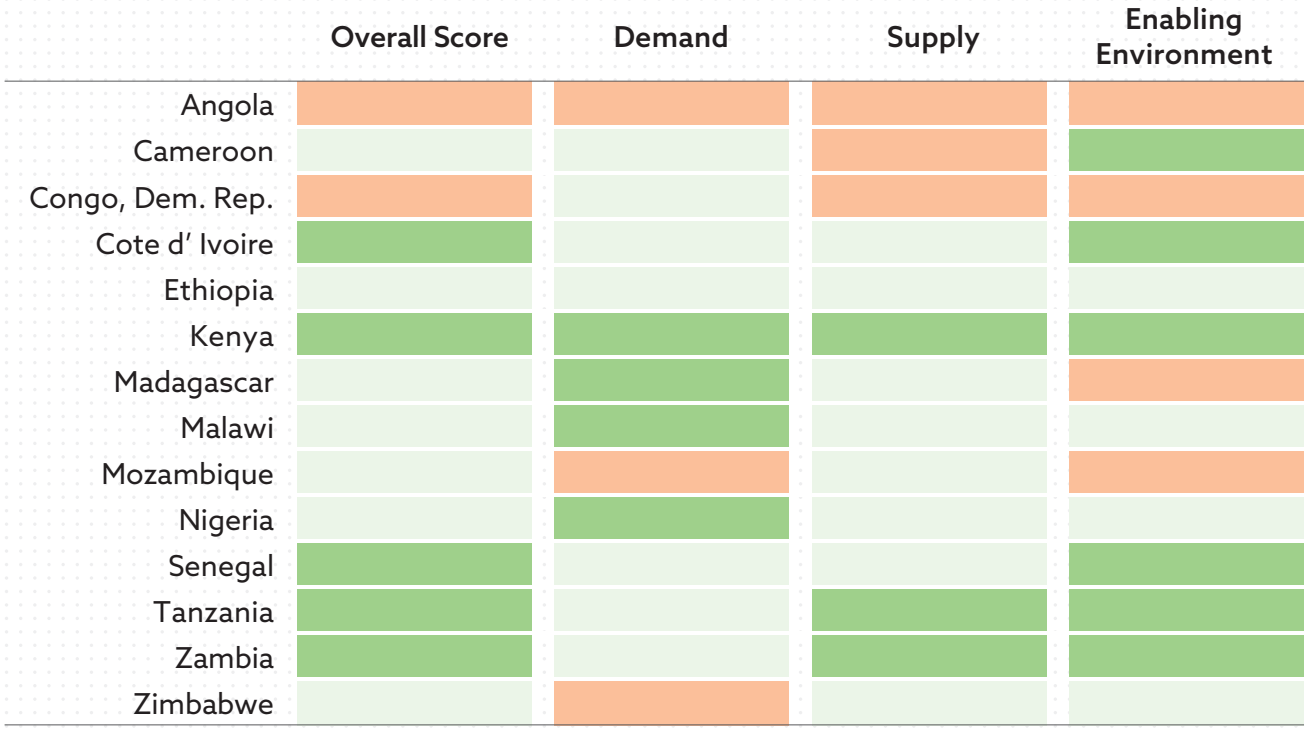
**DRC and Madagascar have low enabling environment scores stemming from underdeveloped ICT, and weaker trade and commerce conditions.** In DRC 6% of population was recorded as using the internet and there are only 39 annual cellular subscriptions per 100 people. Although it has a relatively high score under legal and regulatory conditions, it has a low score on the Ease of Doing Business and the Global Peace Index signalling a challenging environment beyond regulation and consumer behaviour. Madagascar in contrast, has better scores under the ICT and trade and commerce sub-pillars, but has less attractive regulatory and legal incentives.

# 4.
# CLOSING REMARKS

## 4.1. OVERVIEW SUMMARY OF INDEX RESULTS

**The scores in the PAYG market attractiveness index provide a high-level overview of relative market attractiveness of the 14 countries in the index.** Figure 5 shows the scores of each country in the index overall, and across the three main pillars, using a colour coded scoring system. Orange represents relatively poor scores, light-green mid-range scores, and dark green the highest scores within each pillar.

*Figure 7. RAG status by country by pillar*




*Source: PAYG market attractiveness index*

**Kenya is the best performer across the demand and supply pillars, and also scores highest on the index overall.** Tanzania, Zambia and Senegal have similar profiles, scoring well on the index overall, with mid-range demand scores but strong scores on both the supply and enabling environment pillars. Côte d'Ivoire also achieves a 'green' status on its overall index score and has the highest score on the enabling environment pillar, but is mid-performing on the demand and supply pillars.

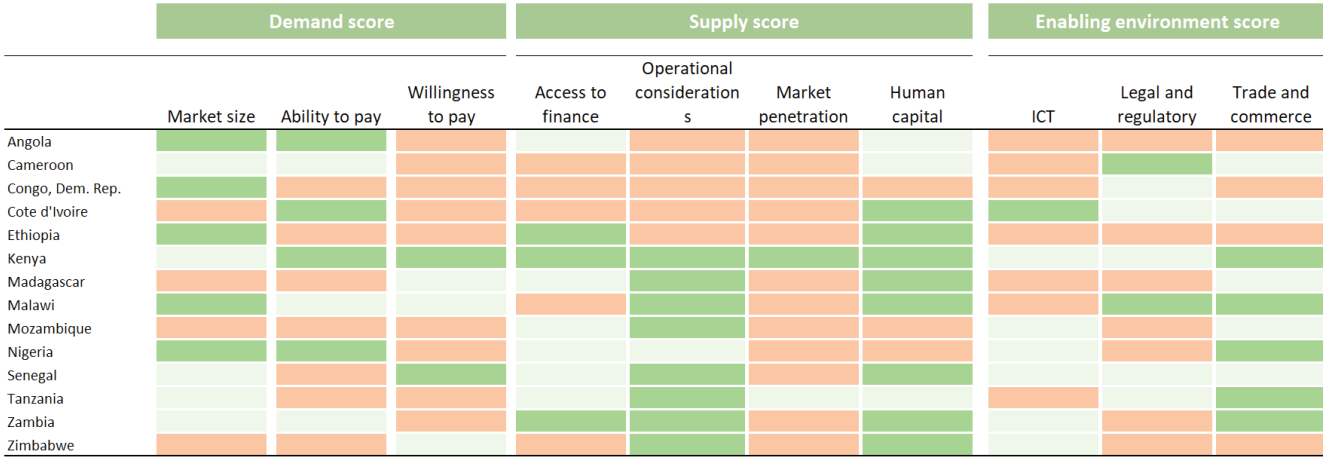
**Those in the mid-range have variable performance across the index pillars.** Malawi and Nigeria have no orange scores across the three pillars, so have some attractive attributes across demand, supply and the enabling environment, and both have strong potential in terms of market demand. Madagascar has a good potential market in terms of demand, but has a weak enabling environment. Cameroon has strong enabling conditions, but faces operational challenges for supply.

**The Democratic Republic of Congo and Angola have the lowest scores, indicated by orange status in the overall score column of Figure 7.** Both countries have relatively weak performance across all pillars, with the exception of a potentially attractive profile of demand in DRC.

**Figure 8 provides an overview of the scores across each of the sub-pillars in the index.** Some sub-pillars have more variation than others, while some have more countries in either 'green' or 'orange' status. For example:

- most countries have relatively low scores in the willingness to pay sub-pillar. This is because most countries are 'closer' to Angola at the bottom of the index, than they are to Kenya and Madagascar at the top, presenting a challenge in developing commercial models without support from government and/or development partners, especially for rural customers.
- operational considerations have mostly either relatively strong or relatively weak performers. Achieving a 'good' on operational considerations is almost a pre-requisite for the development of a PAYG market at scale.
- market penetration has only one 'green' and one 'amber' rated country. This reflects the current asymmetric distribution of PAYG companies and directly related products which are heavily focused in Kenya and, to a lesser extent, Tanzania. While this demonstrates relatively 'less' attractive markets to date, it also clearly presents an opportunity in many of the markets where scores on the remainder of the index are attractive.
- the ICT sub-pillar has only one 'green' status country. Côte d'Ivoire is far ahead of other countries in this sub-pillar reflecting the high levels of SIM penetration, mobile cellular subscriptions and users, use of mobile broadband and so on.

*Figure 8. RAG status by country by sub-pillar*




*Source: PAYG market attractiveness index*

## 4.2. KEY FINDINGS AND RECOMMENDATIONS FOR MARKET GROWTH

**Across the stakeholder engagement, analysis and index construction, several core messages on the development of PAYG markets consistently came to light.** While the index does not prescribe any particular market entry strategy – in the case of PAYG markets it is definitely the case that one size does not fit all – a number of key themes emerge, reflecting that the PAYG model provides a complex set of consumer services.; it is a package of energy, credit, and consumer goods.

**The paragraphs below summarise five key factors for the development of PAYG markets.**

### 1. Higher density, unconnected or with poor quality grid connection, is an ideal target market

**A relatively densely distributed population minimises distribution costs for sale and after-sale services and raises consumer awareness within an accessible geographic market.** Even though the size of the off-grid population is important, what matters more is whether this population is accessible for sales and after sales services. This allows PAYG companies to deliver their services with lower distribution costs and facilitates customer awareness of what remains a novel product in many contexts.

**Consumers in urban and peri-urban areas who are experiencing poor grid connectivity present a good opportunity for PAYG products.** Grid electricity consumers in urban and peri-urban areas are often connected to over-stretched grid infrastructure which leads to an unreliable connection. The PAYG product is an attractive alternative or back-up supply source for consumers in this market.

**For example, Nigeria and Malawi are large, densely populated potential markets.** Ethiopia and Kenya also both have high density population clusters. Malawi is also a largely rural population (84%), and the vast majority of this rural population is not connected to the grid (97%), while in Nigeria the quality of grid connections is poor.

### 2. Income stability and/or flexible payment plans are essential for wide-reaching products bought on credit

**Income stability and predictability is an important determinant of matching consumer payments to the PAYG model.** PAYG energy services are offered as a credit product, typically with a repayment schedule spanning a couple of years. As such, they rely on customers consistently meeting their scheduled payments. This is easier where customers earn a relatively higher income, and where their income comes in predictable and regular instalments. While companies could adapt payment schedules to variable income, it can present a barrier as income can be uncertain, in addition to irregular.

**Agricultural income for households in the DRC, Côte d'Ivoire, Zambia and Madagascar appear relatively stable from year to year, based on the income volatility of main crop types.** A greater challenge in these countries is a lower ability to pay, with low GNI per capita.

## 3. Mobile money has been a key driver of PAYG growth – and vice versa – and this is likely to remain the case

**Credit awareness and availability of credit and mobile money are necessary to activate the PAYG product offering.** A large part of the PAYG model success stems from the innovative offering of SHS at credit through the use of mobile money payments. Strong consumer awareness of credit and/or a well-established network of micro-finance and consumer credit organisations may help the development of PAYG markets or present partnership opportunities.

**Despite some alternative models for payment collection, most PAYG companies rely on well-established mobile networks to uphold innovative service delivery.** While alternatives such as scratch-cards have helped support early market development, these alternatives tend to be more expensive and more difficult to achieve at scale. Rapid development of PAYG markets has tended to go hand in hand with use of mobile money payments.

**After Kenya, where mobile money is widely used, Zimbabwe, Tanzania, Côte d'Ivoire, Senegal and Zambia have a growing share of the population with mobile money accounts.** Côte d'Ivoire has a very high rate of mobile phone subscriptions and sim card penetration (both over 1 per person), and the highest rate of mobile broadband in the index.

## 4. Favourable international business conditions and local regulatory and tax policy need to support international supply chains

**Pay-As-You-Go companies typically rely on international supply chains and financing structures, and a supporting business environment in the country of operation.** Most PAYG companies rely on international investment and supply chains before they can deliver their product locally. A business environment conducive to foreign investment and open trade policy will therefore facilitate PAYG product delivery.

**Facing high upfront capital costs, PAYG companies will thrive under a supportive environment for multi-national business operations.** With relatively high capital costs that are recovered over time from customer repayments made in local currency, ability to access local currency and convert to international currencies is important. This is to enable companies to raise finance in international markets, and to procure intermediate goods in local markets.

**Cameroon has a particularly favourable regulatory and financial regime for standalone solar systems.** The governments of Angola, Cameroon, Ethiopia and Malawi offer financing facilities for standalone solar systems. Cameroon also offers duty exemptions on standalone systems, as does DRC, Côte d'Ivoire, Senegal and Zambia. Market finance facilities for project developers for standalone systems are available in Cameroon, Kenya, Nigeria and Tanzania.

### 5. Developing partnerships and a local sales network is essential and differs from one market to another

**Building partnerships throughout the supply chain with MFIs, MNOs, SACCOs, distribution partners and others does not follow a common model.** Companies follow different partnership models – some partnering with finance institutions while others offer credit for the product directly. Local distribution partners vary by country and grow out of early market research and company-specific connections. Partnering with mobile money operators and mobile network operators is important to ensure facilitation of the customer payment process. The ability to form such partnerships is consistently highlighted as key to success, even if it is not easily captured by a single indicator.

**To reach and engage consumers in new markets, PAYG companies rely on local human capital with sales skills.** As a relatively new service, PAYG companies rely on strong local sales networks to capture demand and deliver on-going technical and after-sales services. This requires both managerial capacity and an on-the-ground network of sales agents with language and technical skills.

**The formation of partnerships has not followed a common model across companies and countries, and typically develops organically through company networks.** Zimbabwe and Malawi have a relatively small number of languages spoken and relatively low linguistic diversity, which may make developing a national sales network relatively easier. Senegal, Kenya and Côte d'Ivoire offer relatively high quality specialised technical training services and have high quality management schools.

## 4.3. POLICY IMPLICATIONS AND FURTHER RESEARCH

**This index provides a flexible tool to compare market conditions across countries**. It does not prescribe which markets are more or less attractive, as this will depend on the market entry and deepening strategy of companies and on support provided by policy makers and development partners. The supporting research for this market attractiveness index highlights a number of key qualitative findings. These are summarised above in Section 4.2.

**A number of areas would benefit from further research and policy focus, summarised in the bullets below:**

- **understanding income volatility for consumers to understand default risk and match to payment profiles.** It is generally accepted that income stability and predictability is an essential factor in identifying customers who will be able to keep up with payment schedules, and that understanding the profile of income generation and recourse for customers at risk of default is complex. The current market attractiveness index includes an indicator of income volatility from agricultural production, only identifying part of the story. Many PAYG customers will have sources of income that are not based in the agriculture sector. Furthermore, in some cases the payments are made by relatives in cities, not by rural households themselves. A deeper understanding of the relationship between income stability and payment profiles would help develop PAYG markets and match to customers where the PAYG credit model is most appropriate.

- **the role of productive use and application of the PAYG business model.** Capturing the potential of PAYG for productive use is an important determinant of market size and attractiveness for business models. Determining which markets offer the most potential for productive use is a relatively new area of research, and more sophisticated indicators will need to be added to the index as productive use markets develop.

- **offering alternatives to mobile money and developing alternative payment systems.** While much of the focus in the market attractiveness index is on the parallel development of mobile money networks, alternatives may also offer opportunities for growth, at least in the early stages of market development. Alternatives such as over-the-counter payments (e.g. using scratch-cards) and air-time credit from telecom operators offer good potential alternatives, although mobile money is likely to remain the most cost-effective way to develop markets at scale.

- **'aspirational' demand is an important driver of market potential across countries.** Customers in markets with similar characteristics will have different preferences on the type of PAYG product. For instance, some customers will value ability to charge a phone regularly or watch television more than others, independent from their ability to pay. In some markets customers may also reveal a surprising willingness to pay for higher end products, which would of interest to PAYG companies looking to offer those services.

- **combining the market attractiveness index and lens with within-country decision making tools.** The current index provides a useful high-level diagnostic to compare across countries, but it is not designed to support locational decisions within a country. However, there is scope for the indicators to be viewed at sub-national level to support regional market development decisions.

# APPENDIX A
# METHODOLOGY AND INDEX USER MANUAL

## Structure and methodology of the index

The index is an Excel based tool designed for user flexibility and ease of use. It incorporates clearly highlighted user input options, automated updating of results and a selection of outputs to quickly access performance across the overall index and its pillars, an overview of performance for a particular country, or performance across specific indicators. This section provides a short description of how to use and interpret the Excel based tool.

The index is divided into 3 pillars, and a total of 10 sub-pillars. Users can select the importance (weight) placed on each of the three pillars, and on each of the sub-pillars within these three areas. The location of the 70 indicators in the index is shown in Figure 9.

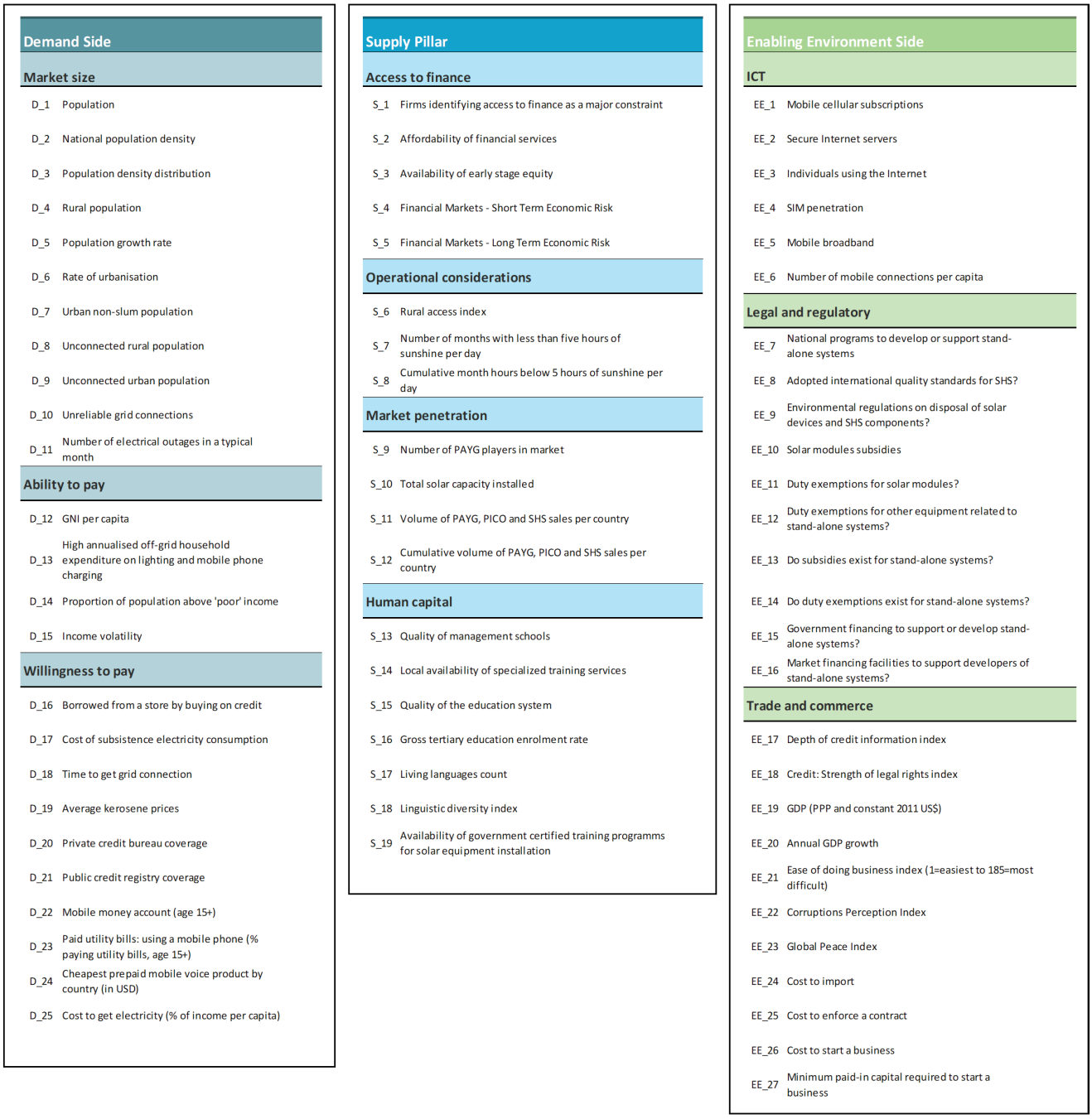
Each indicator is normalised on a scale of 0-100. The 'lowest' performing country scores a 0, the 'highest' performing country scores 100. Weightings can be manually adjusted on the PAYG MAI tab for each pillar, and for each sub-pillar. The index is presented with default weights based on market research and engagement, and an assessment of the type and range of the raw data for each indicator, and its relative importance in contributing to market attractiveness. The weights on specific indicators cannot be modified, but the 'INDICATOR TAB' displays further information on specific indicators, which users can select to display one at a time.

The 10 sub-pillars are a weighted sum of their individual indicators. The range of each sub-pillar is scaled so the highest performing country scores 100. Each indicator is weighted based on: (i) whether it is binary, discreet, or continuous, (ii) the range of variation in the raw indicator scores across the 14 countries, (iii) the relative importance of the indicator. In general, binary indicators are given a lower weight than continuous, as countries can only receive either a full 100 score, or a 0 score on these indicators. Binary indicators would therefore dominate when adding overall indicators. Indicators with a wider range are assigned a higher weight for the same reason. Finally, indicators that are considered more 'important' are weighted more strongly. This assessment is based on expert judgement and stakeholder conversations, and used to provide a sensible calibration of the index. Critical factors, such as the distribution of population density, are weighted highly.

Each of the three main pillars is a weighted average of the relevant 10 sub-pillars it comprises. The range of each pillar is scaled so the highest performing country scores 100. Users can define these weights to investigate which markets appear most attractive when different sub-pillars of the market are weighted differently. As a sub-pillar weight is modified, the scores and country rankings of the pillar within which it sits will be affected, as will the score and ranks on the overall index.

The overall index score is a weighted average of the three main pillars. The range of the overall index is scaled so that the highest performing country scores 100. As with the sub-pillars, users can choose the weight they want to assign to each of the 'Demand', 'Supply' and 'Enabling Environment' pillars. Changing these weights will only affect the scores and country rankings of the overall index.

*Figure 9. Index structure and indicator location*




*Source: PAYG market attractiveness index*

## Using the index

**User modifiable cells are highlighted with a yellow background, and orange text.** All user selections are on the basis of a drop-down menu. In cases where user inputs can push the index into error, this is clearly highlighted. For example, users can select how to weight the pillars and sub-pillars, but if the user selects weights that do not sum to 100% this is highlighted by a red error message.

**There are three tabs where users can choose from a set of options, and view updated results:**

- **The 'PAYG MAI' tab:** presents overall index scores, and scores across the three main pillars. Users can select which pillar they want to display at the top of the tab, from a choice of the overall index, or each of the three main pillars of the index. The chart and country scores and rankings will update automatically.

  Users may also select a country to highlight. This provides a dark-green highlight to show the country selected on both the column chart and the text table of scores, ordered by country ranking.

  Finally, users can change the weight of each of the sub-pillars, and the three main pillars. The weights for each sub-pillar, and the three main pillars, should sum to 100%. An error message will be prompted in red if this is not the case.

- **The 'COUNTRY' tab:** provides an accessible summary of all indicators for a single country of interest. The top half of this tab presents a summary of the overall pillar, and sub-pillar scores for the country selected. It also shows a 'spider' diagram of scores across the overall index and the three main pillars, against a comparator country which the user can also select. The table and graph in this top panel are dependent only on the primary country selected, and the comparator country selected (see below).

  The bottom half of the page shows the indicator scores – in both raw format and for the normalised scores (between 0 – 100). These tables update to display the scores for indicators for one sub-pillar at a time, and depend on the primary country selected and on the sub-pillar selected (see below).

  Users first select the country of interest in the 'COUNTRY DISPLAY' dropdown. This defines the country for which all indicators will be selected. The 'SELECT COUNTRY FOR COMPARISON' dropdown defines the second country to be displayed on the spider diagram.

  By using the 'PILLAR DISPLAY' dropdown, the user selects which set of indicators will be displayed. The tab displays all the indicators, organised under sub-pillar headings, for one of the three main pillars at a time. For example, if the user selects 'DEMAND' they will see all the demand side pillars displayed under the three sub-pillar headings (market size, ability to pay, and willingness to pay).

- **The 'INDICATOR' tab:** allows users to see the latest year of data, raw data and normalised scores by country for a single indicator. Next to the main results table a selection of further summary details is given, including the pillar and sub-pillar within which the indicator is located in the index, the unit of measurement, source, and a longer free-text description.

  The user first selects which of the three main pillars they want to select an indicator from in the 'PILLAR DISPLAY' dropdown. Next, they select an individual indicator in the 'INDICATOR DISPLAY' dropdown.

  Finally, the user can select a country to highlight in the table of results, by using the 'COUNTRY HIGHLIGHT' dropdown.

# APPENDIX B
# COMPLETE LIST OF INDICATORS

## Demand side pillar indicators

*Table 1. Market size indicators*

| # | Name | Description | Year | Source |
|---|---|---|---|---|
| D_1 | Population | Absolute population size | 2017 | WB World Development Indicators,http://databank.worldbank.org/data/reports.aspx?source=2&series=SM.POP.TOTL&country= |
| D_2 | National population density | Average population density across country | 2016 | WB World Development Indicators, http://databank.worldbank.org/data/reports.aspx?source=2&series=SM.POP.TOTL&country= |
| D_3 | Population density distribution | Proportion of population that is 'medium density', i.e. < 1000 pp / sq km and > 100 pp / sq km | 2018 | Vivid Economics calculation, based on UN WPP density data, https://esa.un.org/unpd/wpp/dataquery/ |
| D_4 | Rural population | Proportion of population urban | 2017 | WB World Development Indicators, http://databank.worldbank.org/data/reports.aspx?source=2&series=SM.POP.TOTL&country= |
| D_5 | Population growth rate | Rate of population growth between 2015 and 2025 | 2025 | WB World Development Indicators, http://databank.worldbank.org/data/reports.aspx?source=2&series=SM.POP.TOTL&country= |
| D_6 | Rate of urbanisation | Rate of urbanisation between 2015 and 2025 | 2025 | WB World Development Indicators, http://databank.worldbank.org/data/reports.aspx?source=2&series=SM.POP.TOTL&country= |
| D_7 | Urban non-slum population | Proportion of urban homes not classified as slums | 2014 | WB World Development Indicators, http://databank.worldbank.org/data/reports.aspx?source=2&series=SM.POP.TOTL&country= |
| D_8 | Unconnected rural population | Proportion of rural population with no access to electricity | 2016 | WB World Development Indicators, http://databank.worldbank.org/data/reports.aspx?source=2&series=SM.POP.TOTL&country= |
| D_9 | Unconnected urban population | Proportion of urban population with no access to electricity | 2016 | WB World Development Indicators, http://databank.worldbank.org/data/reports.aspx?source=2&series=SM.POP.TOTL&country= |
| D_10 | Unreliable grid connections | Proportion of those with a grid connection who state that connection works less than all of the time | 2016 | Vivid Economics calculation based on Afrobarometer surveys, http://afrobarometer.org/data/merged-round-6-data-36-countries-2016 |
| D_11 | Number of electrical outages in a typical month | Number of electric outages in a typical month as reported by businesses in the Enterprise Survey | Various depending on the country, latest 2016 | Enterprise Surveys, World Bank Group, http://www.enterprisesurveys.org/Custom-Query |

*Table 2. Ability to pay indicators*

| # | Name | Description | Year | Source |
|---|---|---|---|---|
| D_12 | GNI per capita | Gross national income per capita (Atlas method) | 2017 | World Development Indicators. http://databank.worldbank.org/data/reports.aspx?source=world-development-indicators |
| D_13 | High annualised off-grid household expenditure on lighting and mobile phone charging | Annual expenditure of high intensity off-grid consumers on energy and electricity including expenditure on kerosene and other fossil fuel consumption, and battery replacement. There are missing values for Congo, Dem. Rep. and for Mozambique. These were assigned the lowest value of the sample, 156, corresponding to Ethiopia. | 2015 | IRENA. Solar PV in Africa: Costs and Markets. International Renewable Energy Agency, 2015https://www.irena.org/DocumentDownloads/Publications/IRENA_Solar_PV_Costs_Africa_2016.pdf |
| D_14 | Proportion of population above 'poor' income | Proportion of population above 'poor' income level. There are missing observations for Congo, Dem. Rep. and for Zimbabwe. Values were estimated by scaling the observations from countries most similar to Congo Dem. Rep. (Kenya and Nigeria respectively). | 2016 | Vivid Economics projection to 2016 baseline, based on 2011 data from Pew Research Centre and scaled for expected shift between income categories in line with income growthhttp://www.pewglobal.org/2015/07/08/a-global-middle-class-is-more-promise-than-reality/ |
| D_15 | Income volatility | Weighted average volatility of crop yields for all major crop types (>5% of annual production). | 2017 | Vivid Economics analysis of FAO crop yield data 1990 – 2017http://www.fao.org/faostat/en/#data/QC |

*Table 3. Willingness to pay indicators*

| # | Name | Description | Year | Source |
|---|---|---|---|---|
| D_16 | Borrowed from a store by buying on credit | Denotes the percentage of respondents who borrowed any money in the past 12 months from a store by using instalment credit or buying on credit. Data for Mozambique was missing. It was assigned the lowest value of the sample (0.59%) corresponding to Tanzania., | 2014 | Global Financial Inclusion, http://databank.worldbank.org/data/reports.aspx?source=1228# |
| D_17 | Cost of subsistence electricity consumption | annual cost of subsistence consumption (30kWh/month) as a percentage of GNI per household of bottom 20 percent of population? | 2017 | RISE, World Bank Group http://RISE.worldbank.org |
| D_18 | Time to get grid connection | time required to get electricity (days) | 2017 | Doing Business, World Bank Group http://databank.worldbank.org/data/reports.aspx?source=2&series=IC.BUS.EASE.XQ&country= |
| D_19 | Average kerosene prices | Average price in US$ per one litre of kerosene. There are missing observations for Angola and Madagascar. Their value was estimated by multiplying the countries diesel price by the sample correlation between diesel prices and kerosene prices. | 2015 | Vivid Economics projection based on Climatescope and World Bank indicators http://global-climatescope.org/en/download/ |
| D_20 | Private credit bureau coverage | Percentage of adults covered by private credit | 2017 | Global Financial Inclusion, http://databank.worldbank.org/data/reports.aspx?source=1228# |
| D_21 | Public credit registry coverage | Percentage of adults covered by public credit. | 2017 | Global Financial Inclusion, http://databank.worldbank.org/data/reports.aspx?source=1228# |
| D_22 | Mobile money account (age 15+) | The percentage of respondents who report personally using a mobile money service in the past 12 months. | 2017 | Global Financia lInclusion, http://databank.worldbank.org/data/reports.aspx?source=1228# |
| D_23 | Paid utility bills: using a mobile phone (% paying utility bills, age 15+) | Among respondents reporting personally making regular payments for water, electricity, or trash collection in the past 12 months, the percentage who report making these payments through a mobile phone. | 2017 | Global Financial Inclusion, http://databank.worldbank.org/data/reports.aspx?source=1228# |
| D_24 | Cheapest prepaid mobile voice product by country (in USD) | Cheapest prepaid mobile voice product in Africa, 30 Calls / 100 SMS. | 2017 | Research ICT Africa, 2017 https://researchictafrica.net/ramp_indices_portal/ |
| D_25 | Cost to get electricity (% of income per capita) | All the fees and costs associated with completing the procedures to connect a warehouse to electricity are recorded, including those related to obtaining clearances from government agencies, applying for the connection, receiving inspections of both the site and the internal wiring, purchasing material, getting the actual connection works working and paying a security deposit. | 2017 | Doing Business, World Bank Group http://databank.worldbank.org/data/reports.aspx?source=2&series=IC.BUS.EASE.XQ&country= |

## Supply side pillar indicators

*Table 4. Access to finance indicators*

| # | Name | Description | Year | Source |
|---|---|---|---|---|
| S_1 | Firms identifying access to finance as a major constraint | Percentage of firms identifying this as a major constraint | Various depending on the country, latest 2016 | Enterprise Surveys, World Bank Group, http://www.enterprisesurveys.org/Custom-Query |
| S_2 | Affordability of financial services | Answer to the question: In your country, to what extent does the financial sector provide the products and services that meet the needs of businesses? [1 = not at all; 7 = to a great extent] | Various depending on the country, latest 2017 | The Global Competitiveness Report 2017-2018http://reports.weforum.org/global-competitiveness-index-2017-2018/#topic=data |
| S_3 | Availability of early stage equity | Answer to the question: In your country, how easy is it for start-up entrepreneurs with innovative but risky projects to obtain equity funding? [1 = extremely difficult; 7 = | Various depending on the country, latest 2017 | The Global Competitiveness Report 2017-2018 http://reports.weforum.org/global-competitiveness-index-2017-2018/#topic=data |
| S_4 | Financial Markets - Short Term Economic Risk | Index measure of the short-term economic risk of financial markets. It is a short-term measure of how easy it is for companies to operate in the country's financial markets. Amongst other parameters, this includes capital controls and currency risk. | 2018 | BMI Research, 2018 |
| S_5 | Financial Markets - Long Term Economic Risk | Index measure of the long-term economic risk of financial markets. It is a long-term measure of how easy it is for companies to operate in the country's financial markets. Amongst other parameters, this includes capital controls and currency risk. | 2018 | BMI Research, 2018 |

*Table 5. Operational considerations indicators*

| # | Name | Description | Year | Source |
|---|---|---|---|---|
| S_6 | Rural access index | The Rural Access Index provides a consistent basis for estimating the proportion of the rural population which has adequate access to the transport system. | Various depending on the country, latest 2004 | "Roberts, Peter; KC, Shyam; Rastogi, Cordula. 2006. Rural Access Index : A Key Development Indicator. Transport paper series;no. TP-10. World Bank, Washington, DC. © World Bankhttps://openknowledge.worldbank.org/handle /10986/17414 |
| S_7 | Number of months with less than five hours of sunshine per day | Counted the number of months in one year, where the average hours of sunshine per day were lower than 6 | 2018 | Vivid Economics calculation based on various sources including http://fr.allmetsat.com/climat/tanzanie-rwanda-burundi.php?code=63844 |
| S_8 | Cumulative month hours below 5 hours of sunshine per day | Cumulative hours per representative monthly days less than 6 hours per day | 2018 | Vivid Economics calculation based on various sources including http://fr.allmetsat.com/climat/tanzanie-rwanda-burundi.php?code=63844 |

*Table 6. Market penetration indicators*

| # | Name | Description | Year | Source |
|---|---|---|---|---|
| S_9 | Number of PAYG players in market | Number of active PAYG companies in a market at the given time of research (2018) | 2017 | Vivid consortium research |
| S_10 | Total solar capacity installed | Sum of capacity for installed solar technology in the country. Data is missing for Angola, the country has been assigned the lowest value in the sample, 3 kWh, corresponding to Congo, Dem. Rep. | 2017 | IRENA Costs database, http://resourceirena.irena.org/gateway / dashboard/ |
| S_11 | Volume and type of PAYG, PICO and SHS sales per country | The total sum of solar units sold in the second quarter of 2017. There is missing data for Angola, which was assigned the lowest value in the sample, 1,967 units, corresponding to Cameroon. | 2017 | Provided by GOGLA |

*Table 7. Human capital indicators*

| # | Name | Description | Year | Source |
|---|---|---|---|---|
| S_12 | Quality of management schools | Answer to the question: In your country, how do you assess the quality of business schools? | Various depending on the country, latest 2017 | The Global Competitiveness Report 2017-2018http://reports.weforum.org/global-competitiveness-index-2017-2018/#topic=data |
| S_13 | Local availability of specialised training services | Answer to the question: In your country, how available are high-quality, professional training services? | 2017 | The Global Competitiveness Report 2017-2018http://reports.weforum.org/global-competitiveness-index-2017-2018/#topic=data |
| S_14 | Quality of the education system | Answer to the question: In your country, how well does the education system meet the needs of a competitive economy? | 2017 | The Global Competitiveness Report 2017-2018http://reports.weforum.org/global-competitiveness-index-2017-2018/#topic=data |
| S_15 | Gross tertiary education enrolment rate | The total enrolment within a country in a specific level of education, regardless of age, expressed as a percentage of the population in the official age group corresponding to this level of education | 2017 | The Global Competitiveness Report 2017-2018http://reports.weforum.org/global-competitiveness-index-2017-2018/#topic=data |
| S_16 | Living languages count | count of living languages | 2017 | Simons, Gary F. and Charles D. Fennig (eds.). 2018. Ethnologue: Languages of the Worldhttps://www.ethnologue.com/ |
| S_17 | Linguistic diversity index | variation of local languages | 2017 | Simons, Gary F. and Charles D. Fennig (eds.). 2018. Ethnologue: Languages of the Worldhttps://www.ethnologue.com/ |
| S_18 | Availability of government certified training programmes for solar equipment installation | Response to the question: Is there a government certified program for solar equipment installers? | 2017 | RISE, World Bank Grouphttp://RISE.worldbank.org |

## Enabling environment side indicators

*Table 8. Information and communications technology indicators*

| # | Name | Description | Year | Source |
|---|---|---|---|---|
| EE_1 | Mobile cellular subscriptions | Mobile cellular telephone subscriptions are subscriptions to a public mobile telephone service that provide access to the PSTN using cellular technology. | 2016 | International Telecommunication Union, World Telecommunication/ICT Development Report and database via World Development Indicatorshttp://databank.worldbank.org/data/ reports.aspx?source=2&series=IT.CEL.SETS&country= |
| EE_2 | Secure Internet servers | Secure servers are servers using encryption technology in Internet transactions | 2016 | World Development Indicators via Netcrafthttp://www.netcraft.com/ |
| EE_3 | Individuals using the Internet | Internet users are individuals who have used the Internet (from any location) in the last 3 months. The Internet can be used via a computer, mobile phone, personal digital assistant, games machine, digital TV etc. | 2016 | International Telecommunication Union, World Telecommunication/ICT Development Report and databasevia World Development Indicators http://databank.worldbank.org/data/ reports.aspx?source=2&series=IT.CEL.SETS&country= |
| EE_4 | SIM penetration | Proportion of the population with the use of SIM | 2017 | GSMA intelligence 2018, https://www.gsmaintelligence.com/ research/ ?file=7bf3592e6d750144e58d9dcfac6adfab&download |
| EE_5 | Mobile broadband | Proportion of the population with mobile broadband use | 2017 | GSMA intelligence 2018https://www.gsmaintelligence.com/ research/ ?file=7bf3592e6d750144e58d9dcfac6adfab&download |
| EE_6 | Number of mobile connections per capita | Ratio of number of mobile connections to total population, connections per capita | 2017 | World Bank population data 2017, and GSMA data on total mobile connections for Q4 of 2017https://www.gsmaintelligence.com/ research/ ?file=7bf3592e6d750144e58d9dcfac6adfab&download |

*Table 9. Legal and regulatory indicators*

| # | Name | Description | Year | Source |
|---|---|---|---|---|
| EE_7 | National programs to develop or support stand-alone systems | Response to the question | 2015 | RISE, World Bank Group http://RISE.worldbank.org |
| EE_8 | Adopted international quality standards for SHS? | Response to the question | 2015 | RISE, World Bank Group http://RISE.worldbank.org |
| EE_9 | Environmental regulations on disposal of solar devices and SHS components? | Response to the question | 2015 | RISE, World Bank Group http://RISE.worldbank.org |
| EE_10 | Solar modules subsidies | Response to the question | 2015 | RISE, World Bank Group http://RISE.worldbank.org |
| EE_11 | Duty exemptions for solar modules? | Response to the question | 2015 | RISE, World Bank Group http://RISE.worldbank.org |
| EE_12 | Duty exemptions for other equipment related to stand-alone systems? | Response to the question | 2015 | RISE, World Bank Group http://RISE.worldbank.org |
| EE_13 | Do subsidies exist for stand-alone systems? | Response to the question | 2015 | RISE, World Bank Group http://RISE.worldbank.org |
| EE_14 | Do duty exemptions exist for stand-alone systems? | Response to the question | 2015 | RISE, World Bank Group http://RISE.worldbank.org |
| EE_15 | Government financing to support or develop stand-alone systems? | Response to the question | 2015 | RISE, World Bank Group http://RISE.worldbank.org |
| EE_16 | Market financing facilities to support developers of stand-alone systems? | Response to the question | 2015 | RISE, World Bank Group http://RISE.worldbank.org |

*Table 10. Trade and commerce indicators*

| # | Name | Description | Year | Source |
|---|---|---|---|---|
| EE_17 | Depth of credit information index | Depth of credit information index measures rules affecting the scope, accessibility, and quality of credit information available through public or private credit registries. | 2017 | Doing Business, World Bank Group http://databank.worldbank.org/data/ reports.aspx?source =2&series=IC.BUS.EASE.XQ&country= |
| EE_18 | Credit: Strength of legal rights index | Strength of legal rights index measures the degree to which collateral and bankruptcy laws protect the rights of borrowers and lenders and thus facilitate lending. | 2017 | Doing Business, World Bank Group http://databank.worldbank.org/data/ reports.aspx?source =2&series=IC.BUS.EASE.XQ&country= |
| EE_19 | GDP (PPP and constant 2011 US$) | GDP in purchasing power parity, constant US 2011 prices | 2015 | World Development Indicators. http://databank.worldbank.org/ data/reports.aspx?source=world-development-indicators |
| EE_20 | Annual GDP growth | expected GDP growth rate 2015 - 2025 | 2016 | World Development Indicators. http://databank.worldbank.org/ data/reports.aspx?source=world-development-indicators |
| EE_21 | Ease of doing business index (1=easiest to 185=most difficult) | Ease of doing business, from the World Bank Doing Business project. | 2017 | Doing Business, World Bank Group http://databank.worldbank.org/data/ reports.aspx?source =2&series=IC.BUS.EASE.XQ&country= |
| EE_22 | Corruptions Perception Index | The index, which ranks 180 countries and territories by their perceived levels of public sector corruption according to experts and businesspeople, uses a scale of 0 to 100, where 0 is highly corrupt and 100 is very clean. | 2017 | Transparency International, 2017https://www.transparency.org/news/feature/corruption_perceptions_index_2017 |
| EE_23 | Global Peace Index | Ranks 163 independent states and territories according to their level of peacefulness. | 2017 | Institute for Economics and Peace, 2017. http://visionofhumanity.org/app/uploads/2017/06/GPI17-Report.pdf |
| EE_24 | Cost to import | Documentary compliance captures the time and cost associated with compliance with the documentary requirements of all government agencies of the origin economy, the destination economy and any transit economies. | 2017 | Doing Business, World Bank Group http://databank.worldbank.org/data/ reports.aspx?source =2&series=IC.BUS.EASE.XQ&country= |
| EE_25 | Cost to enforce a contract | Cost as a percentage of total claim | 2017 | Doing Business, World Bank Group http://databank.worldbank.org/data/ reports.aspx?source =2&series=IC.BUS.EASE.XQ&country= |
| EE_26 | Cost to start a business | Cost as a percentage of income per capita | 2017 | Doing Business, World Bank Group http://databank.worldbank.org/data/ reports.aspx?source =2&series=IC.BUS.EASE.XQ&country= |
| EE_27 | Minimum paid-in capital required to start a business | Paid in capital as a percentage of income per capita | 2017 | Doing Business, World Bank Group http://databank.worldbank.org/data/ reports.aspx?source =2&series=IC.BUS.EASE.XQ&country= |

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LIGHTING GLOBAL

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## ABOUT LIGHTING GLOBAL

Lighting Global is the World Bank Group's initiative to rapidly increase access to off-grid solar energy for the one billion people living without grid electricity around the world. We work with manufacturers, distributors, governments, and other development partners to build and grow the modern off-grid solar energy market, which is expected to reach 740 million people by 2022. Our programs – which include Lighting Africa, Lighting Asia, and Lighting Pacific – provide market intelligence, quality assurance, consumer education, business support services, and support for access to finance, at the global, regional, and country levels. We are also poised to address new markets and opportunities that emerge as the off-grid energy sector evolves. Our activities now include support for the productive use of solar (e.g. solar irrigation & milling), community services (e.g. for schools and health centers), super-efficient household appliances (e.g. fans, TVs, household refrigeration), and innovative pay-as-you-go (PAYG) business models that enable rural, low income populations to access modern clean energy solutions.

Lighting Global is managed by the International Finance Corporation (IFC) and the World Bank, with support from the Energy Sector Management Assistant Program (ESMAP). For more informa on about how and where we work, please visit ***www.lightingglobal.org .***