



# Pay-As-You-Go Market Attractiveness Index 2019





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## Acknowledgements

This second edition of the Pay-as-You-Go (PAYGo) Market Attractiveness Index (MAI) Report was developed by Lighting Global to provide information on the market attractiveness for PAYGo energy services in Sub-Saharan Africa and South Asia. It accompanies the 2019 edition of the PAYGo MAI, an excel based tool publicly available on the [Lighting Global platform](#). A country focus case study on Nigeria has been developed alongside the 2019 index.

This extension and update of the PAYGo MAI, launched in June 2019, was led by Miguel Soriano, Naomi Bruck and Itotia Njagi (IFC). Vivid Economics was commissioned to extend and update the 2018 edition of the index. This work has been conducted by Ed Day, Anita Hafner, Caroline Stuyt and Jake Wellman. The first edition of the PAYGo MAI was conceptualized by Daniel Shepherd, Itotia Njagi and Yann Tanvez (IFC) and developed in partnership with the Public-Private Infrastructure Advisory Facility (PPIAF). The development of the index was conducted by a consortium led by Vivid Economics. Lighting Global and its advisors would like to extend thanks to the wide set of stakeholders who have supported the development of the PAYGo MAI and this report, and the development of country focus brief for Nigeria. This includes Allwell Nwankwo (IFC), Leigh Vial (Solar Nigeria Program), and Wiebe Boer (All-on Impact Investors), as well as representatives from PAYGo solar companies operating in Nigeria and the Nigerian Rural Electrification Agency.

Design and Layout: Euclide Namema



Lighting Global is the World Bank Group's initiative to rapidly increase access to off-grid solar energy for the 840 million people living without grid electricity world-wide. Lighting Global – managed by IFC and the World Bank – works with manufacturers, distributors, governments, and other development partners to build and grow the modern off-grid solar energy market. Our programs are funded with support from the Energy Sector Management Assistant Program (ESMAP), The Public – Private Infrastructure Advisory Facility (PPIAF), The Netherlands' Ministry of Foreign Affairs, The Italian Ministry for the Environment, Land, and Sea (IMELS), and the IKEA Foundation.

## :vivid economics

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## FOREWORD

Energy access remains a critical challenge for the more than 860 million people lacking access to modern energy. In the last ten years, solar off-grid lighting and energy solutions have transformed the global energy access landscape, providing a reliable compliment to the grid. Today, close to 180 million people have benefited from using Lighting Global Quality Verified solar lighting products. The transformation of these off-grid markets received a major boost with the introduction of the Pay-As-You-Go (PAYGo) business model – an innovative approach that has revolutionized consumer financing. The PAYGo model has not only demonstrated tremendous promise in scaling up access and closing the energy gap, but also in graduating consumers to larger solar home systems (SHS) that can provide an expanded array of needs beyond lighting.

The statistics from the PAYGo model are compelling – sales volume grew by 30% in 2018, with revenues having an even better trajectory with 50% growth, primarily driven by larger SHS sales. According to the [2018 July-December GOGLA market trends report](#), PAYGo companies represent 24% of the sales volume but accounted for 62% of the industry's revenue. The success transcends energy access, with PAYGo having an impact in driving and expanding financial inclusion across Africa through digital payments. In some markets, solar payments have represented many consumers' first interaction with digital/mobile payments.

But where the model holds great promise across global markets, PAYGo companies have largely concentrated their efforts in East Africa. The region accounts for nearly 70% of global PAYGo market segment revenues. It is a market characterized by an attractive solar, fiscal, digital and financial policy environment, making market insights and data readily available. The PAYGo market attractiveness index (PAYGo MAI) responds to the industry's need for deeper market insights to inform and facilitate PAYGo expansion and entry plans. The 2019 version of the PAYGo MAI now covers 24 countries across Sub-Saharan Africa and Asia.

The index provides businesses, policymakers and practitioners with a tool to assess these markets along a 71-point indicator matrix under three main pillars: demand, supply and enabling factors. In addition, we hope that development partners and policy makers will use the PAYGo MAI as a diagnostic tool to highlight gaps and opportunities for policy interventions and reforms.

A critical factor to note is that this tool does not seek to supplement the equally vital qualitative market research that companies should undertake to define their own value propositions, route to market, unit cost economics of last mile distribution, and other elements. Neither was this tool intended to classify, or rank countries based on their PAYGo attractiveness. Any such classification is incidental, relative, and comparative to others. Finally, focus summaries for select countries have been developed to provide a deep dive into specific PAYGo solar markets. These summaries are due to be published throughout the 2019 calendar year.

We hope that this index provides an informative tool to inform strategic and policy reform plans. We know that this business model holds great promise that will soon extend into the productive use of solar energy in agriculture and beyond.



**Russell Sturm**  
Global Lead For Energy Access  
IFC



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## 1 OVERVIEW

### 1.1 Objectives of the PAYGo Market Attractiveness Index (MAI)

**This report introduces the updated PAYGo MAI, a tool developed to provide information to companies, investors and policy makers on market attractiveness for pay as you go (PAYGo) energy services in 24 countries across Sub-Saharan Africa and Asia.**

The index comprises 71 indicators of market attractiveness, organized under three main pillars – demand, supply and enabling environment - and a variety of sub-pillars, explained in detail below. A previous version<sup>1</sup> of the PAYGo MAI released in 2018 assessed the PAYGo market for 14 countries across Sub-Saharan Africa. This updated version of the index has been developed for 24 countries across Sub-Saharan Africa and Asia, selected with the aim to provide a representative range of geographies, market development, and context across each of the supply, demand and enabling environment pillars.

The 2019 version of the tool includes the following countries: Angola, Cameroon, Dem. Rep. of Congo, Cote d'Ivoire, Ethiopia, Guinea, India, Indonesia, Kenya, Madagascar, Malawi, Mozambique, Myanmar, Niger, Nigeria, Pakistan, Papua New Guinea, Senegal, Sierra Leone, Tanzania, Togo, Uganda, Zambia and Zimbabwe.

**The PAYGo MAI provides policymakers and practitioners with a flexible and accessible tool that can be used to examine the factors that make a national market favorable for the development of energy services through this business model and those that do not.** The tool provides 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 favorable conditions and challenges in each market.

The metrics included are intended to give an indication of various aspects of market attractiveness (such as size of population not connected to reliable electricity sources and policy incentives from renewable energy development), and supplement other quantitative and qualitative market research.

**The index is not a substitute for investor due diligence, neither does it contain subnational analysis.** It should be supported and complemented by targeted research conducted by the companies and investors themselves 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.<sup>2</sup>

The PAYGo MAI is an Excel based index built for user-led comparison of country characteristics for market attractiveness. It is designed for user flexibility and ease. The index 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. It provides an overview of the performance of a selected country, as well as the option to compare all countries across selected sub-pillars and indicators.

### 1.2 Key findings

**The 2019 PAYGo MAI compares 24 country-level markets across Sub-Saharan Africa and Asia on 71 indicators of relevance to the development of PAYGo technologies.** This version of the index finds that Indonesia receives the highest overall score, supported by a high score (100/100) on both the enabling environment and supply pillars. Kenya is highly ranked across all three pillars, including demand. India, Pakistan and Myanmar also receive high scores in the overall index, indicating relatively strong performance from new countries added to the index in 2019 and in Asia in particular.

<sup>1</sup> <https://www.lightingglobal.org/resource/paygo-market-attractiveness-index-user-guide/>

<sup>2</sup> There are other tools available at a sub-national level. In particular: <http://globalsolaratlas.info/> and <https://solargis.com/maps-and-gis-data/download/>

**Potential market segments within index countries continue to grow.** Despite continued urbanization across countries included in the index, rural populations are growing and access to energy remains a key development challenge. Urban populations remain an important potential market as well and several countries in the index have high scores within the demand pillar driven by a large population with unreliable grid connections.

**PAYGo sales and use of mobile money technologies are growing across the index countries, with early adopters deepening their markets.** Kenya's mobile money penetration has reached 73% penetration, an increase from 58% in 2014. In Myanmar, modest PAYGo sales have grown from 4,000 units in H2 2017 to 27,000 in H2 2018. In Asia, micro-credit and credit bureaus are providing a rapidly increasing route to market for potential PAYGo customers.



*The index 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.*

### 1.3 Using the PAYGo MAI and this report

**The PAYGO MAI (accessed at the link below)** allows for deep dive in any of the countries and customized weighting of the index – see appendices to this report for a user manual and full list of indicators.

<https://www.lightingglobal.org/resource/paygo-market-attractiveness-index-user-guide/>

**A detailed user guide for the tool is presented in Appendix B along with a complete description of the individual indicators.** The list of indicators includes the description, year, source, impact direction and rationale for each indicator.

**The remainder of this summary report is structured as follows:**

- Section 2 provides an introduction to the PAYGo market, the structure of this index and reviews updates to the PAYGo MAI
- Section 3 reviews key findings of the PAYGo MAI across the demand, supply and enabling environment pillars
- Section 4 summarises the state of the PAYGo market as demonstrated by the updated PAYGo MAI

Figure 1: Index structure and included indicators

DEMAND PILLAR	SUPPLY PILLAR	ENABLING ENVIRONMENT PILLAR
<b>Market size</b>	<b>Access to finance</b>	<b>ICT</b>
D_1 Population size	S_1 Firms who don't identify access to finance as a major constraint	EE_1 Mobile cellular subscriptions
D_2 National population density	S_2 Affordability of financial services	EE_2 Secure Internet servers
D_3 Population density distribution	S_3 Availability of early stage equity	EE_3 Individuals using the internet
D_4 Rural population	S_4 Financial Markets - Short Term Economic Risk	EE_4 SIM penetration
D_5 Population growth rate	S_5 Financial Markets - Long Term Economic Risk	EE_5 Mobile broadband use
D_6 Rate of Urbanisation		EE_6 Number of mobile connections per capita
D_7 Urban non-slum population	<b>Operational considerations</b>	<b>Legal and regulatory</b>
D_8 Unconnected rural population	S_6 Rural access index	EE_7 Do national programs to develop or support stand-alone systems exist?
D_9 Unconnected urban population	S_7 Number of months with less than five hours of sunshine per day	EE_8 Has the government adopted international quality standards for stand-alone systems?
D_10 Unreliable grid connections	S_8 Cumulative month hours below 5 hours of sunshine per day	EE_9 Are there environment regulations on disposal of solar devices and SHS components?
D_11 Number of electrical outages in a typical month	<b>Market penetration</b>	EE_10 Do subsidies exist for solar modules?
<b>Ability to pay</b>	S_9 Number of PAYGo players in market	EE_11 Do duty exemptions for solar modules exist?
D_12 GNI per capita	S_10 Total decentralised solar capacity installed excluding minigrids	EE_12 Do duty exemptions for other equipment related to stand-alone systems exist?
D_13 Annualised off-grid household expenditure on lighting	S_11 Most recent sales volume of PAYGo, PICO and SHS products	EE_13 Do subsidies exist for stand-alone systems?
D_14 Proportion of population above global poverty level	S_12 Cumulative sales volume of PAYGo, PICO and SHS products since 2014	EE_14 Do duty exemptions exist for stand-alone systems?
D_15 Income volatility	<b>Human capital</b>	EE_15 Do government incentives exist for renewable electricity?
<b>Willingness to pay</b>	S_13 Quality of management schools	EE_16 Do specific financing facilities exist for operators in energy access?
D_16 Borrowed from a store by buying on credit	S_14 Local availability of specialised training services	<b>Willingness to pay</b>
D_17 Cost of subsidised electricity consumption	S_15 Quality of the education system	EE_17 Depth of credit information index
D_18 Time to get connection	S_16 Gross tertiary education enrolment rate	EE_18 Strength of legal rights index
D_19 Average kerosene prices	S_17 Living languages count	EE_19 GDP (PPP and constant 2011 US\$)
D_20 Private credit bureau coverage	S_18 Linguistic diversity index	EE_20 Annual GDP growth
D_21 Public credit registry coverage	S_19 Availability of government certified training programmes for solar equipment installation	EE_21 Ease of doing business index (1 = easiest to 185 = most difficult)
D_22 Mobile money account (age 15+)		EE_22 Corruptions Perception Index
D_23 Paid utility bills; using a mobile phone (% paying utility bills, age 15+)		EE_23 Global Perception Index
D_24 Cheapest prepaid mobile voice product by country (in USD)		EE_24 Cost of import
D_25 Cost to get electricity (% of income per capita)		EE_25 Cost to enforce a contract
		EE_26 Cost to start a business
		EE_27 Minimum paid-in-capital required to start a business

Source: Vivid Economics



## 2 INTRODUCTION TO THE PAYGo MAI

### 2.1 PAYGo MAI structure

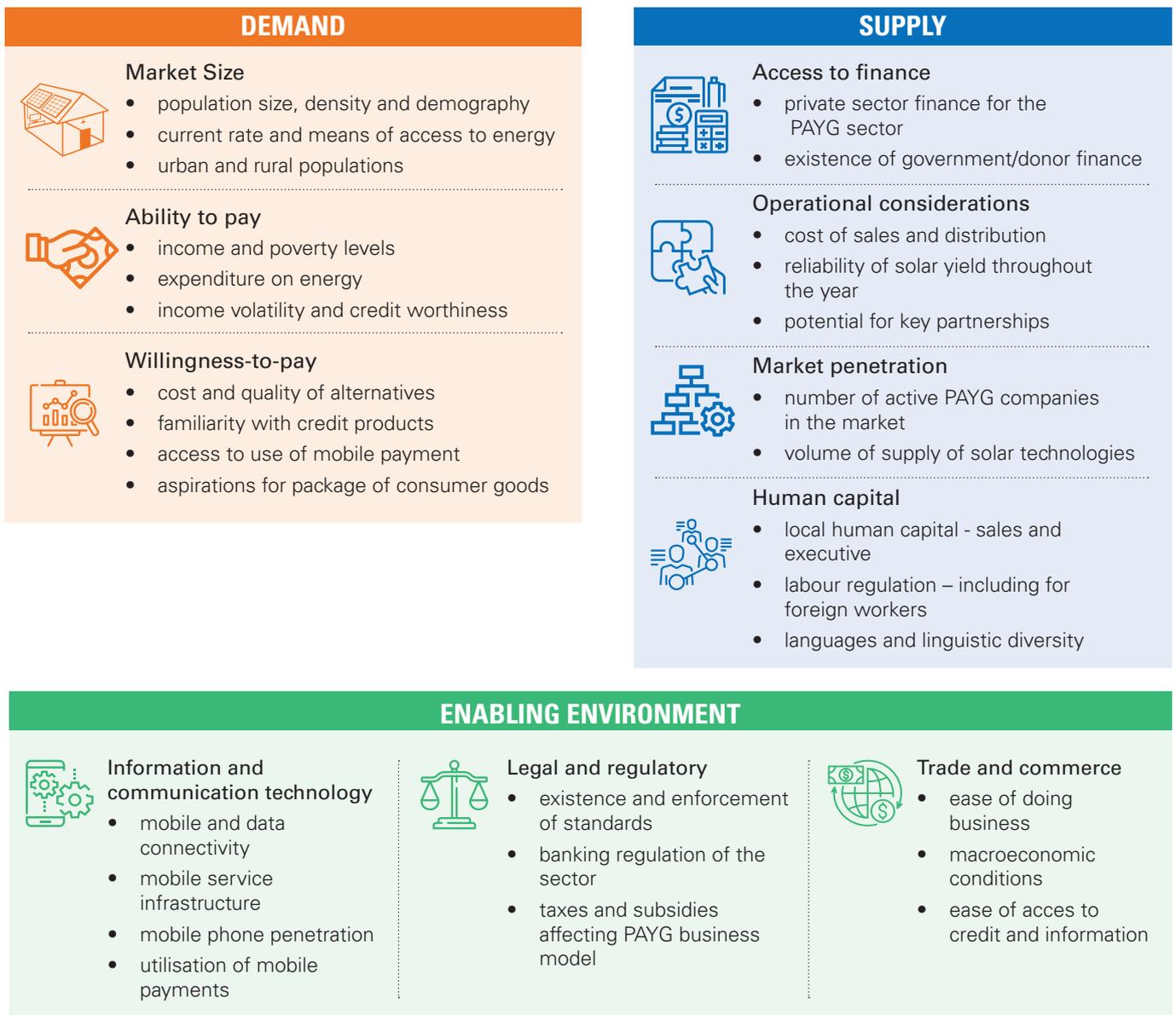
The market attractiveness index is structured under three main pillars:

- **Demand:** the size of the addressable market, ability of customers to pay, and willingness to pay for PAYGo products;
- **Supply:** access to finance, operational considerations to provide PAYGo products, and potential partnership opportunities to support the PAYGo value chain, penetration

of PAYGo and related products in the market, and access to human capital;

- **Enabling Environment:** this covers broader conditions to support the development of PAYGo markets that are not directly associated with the supply chain or in generating demand. This includes: information and communication technology sectors – mobile money, the legal and regulatory environment - and conditions for trade and commerce.

Figure 2: The PAYGo MAI is structured across demand, supply, and enabling environment pillars



## 2.2 What's new in 2019?

### The 2019 PAYGo MAI builds on the 2018 edition of the index and incorporates a few changes.

More detail on these changes is provided in the technical appendices to this report:

- Index has been extended to cover 24 countries;
- Some variables with important outlier values are normalized to adjust and prevent 'skewing' of results;
- Where data is missing, the approach to fill gaps has been updated to preserve the score for each country based on indicators where it does have data available;
- Data sources have changed for a small number of indicators to ensure consistent coverage across the extended range of countries;
- the publication of the 2018 index, some data have become available and are updated in the 2019 version, as detailed in the technical appendix of this report;
- Some indicator descriptions have been updated to reflect changes to source data;
- A supplementary country focus for Nigeria has been included and is summarised in Box 1 of this report.

## 2.3 Interpreting the PAYGo MAI 2019 results

**The PAYGo MAI tool is just that – a tool – which presents a wide array of information in a comparable and consistent format.** It should be used and interpreted to provide information in an accessible format, as one source among many to inform business and policy decisions.

**By its nature, the index will present information on countries which confirms some expectations, presents new information, and at times may appear counter-intuitive.** There is no 'one size fits all' definition of market attractiveness for off-grid solar (OGS) PAYGo products, and for this reason the index does not intend to present countries that are 'more' or 'less' attractive.

Indeed, the overall score on the index depends on the weights placed on individual indicators, on each of the ten sub-pillars, and on the three main pillars. By aggregating values of the 71 indicators (and the respective pillars and sub-pillars) results could confirm expectations for one country and appear counter-intuitive for others. **For this reason, the results of the index must be complemented with further research and country focus studies.**

**There are two key reasons why index results alone should not be interpreted as defining attractiveness of one country over another.** First, the data sources used are limited to a) sources with broad coverage across countries, b) official sources, reported at the national level – often drawing on self-reported data (which may not pick up on regional differences e.g. in India) and c) most recently published data. To build on and improve this coverage, further in-country research, such as the included country focus Nigeria, as well as stakeholder engagement can provide a more robust view of the market for PAYGo at the national or regional level.

Second, default weightings for indicators, sub-pillars and pillars are set in the index to allow for comparison across the 24 countries included in the market. Users interested in a market segment or characteristic can change these weightings at the sub-pillar and pillar level, (see technical appendix). The 'Country Deep Dive' and 'Indicator tab' sheets in the tool allow users to research more deeply information on indicators of interest.

**Understanding the weightings can help users to navigate and better understand the results. A few examples include:**

- The demand pillar includes indicators for both 'populations with an unreliable grid connection' and 'unconnected populations;'
- Given the novelty of PAYGo technologies in many countries, PAYGo MAI presents information that may be relevant for identifying future attractiveness for the development of PAYGo products; and
- The supply pillar considers solar power generation and access to finance for businesses alongside PAYGo market penetration.

In the case of Nigeria, a relatively high level of grid unreliability (100/100) drives a high-ranking score on the demand pillar (80/100). As shown in the Nigeria country focus, unreliable grid connections have driven a PAYGo market that largely serves urban markets with poor connections, rather than the rural unconnected markets as seen in other geographies. This example shows the relative interest of different parts of the index to different stakeholders.

**Pakistan's scores also provide an illustrative example of how the index can provide relevant insights for future PAYGo activities.** Pakistan's scores relatively high score in:

- access to finance for businesses (63-85/100)

- significant amounts of installed solar capacity (65/100)
- operational considerations for PAYGo solar power generation (77-100/100)

Outweighing relatively low scores in 'PAYGo market penetration to date' (17-38/100), producing a highly ranked supply pillar score for Pakistan (97/100). This example demonstrates the logic behind the predefined weightings and indicators included in the index. PAYGo market penetration to date can be less important than other measures of market readiness for PAYGo operators to consider entering the market.



### 3 SUMMARY OF RESULTS OF THE PAYGo MAI 2019

**This section provides a summary of results from the 2019 index as well as a suggestion on how to interpret these results.** 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.

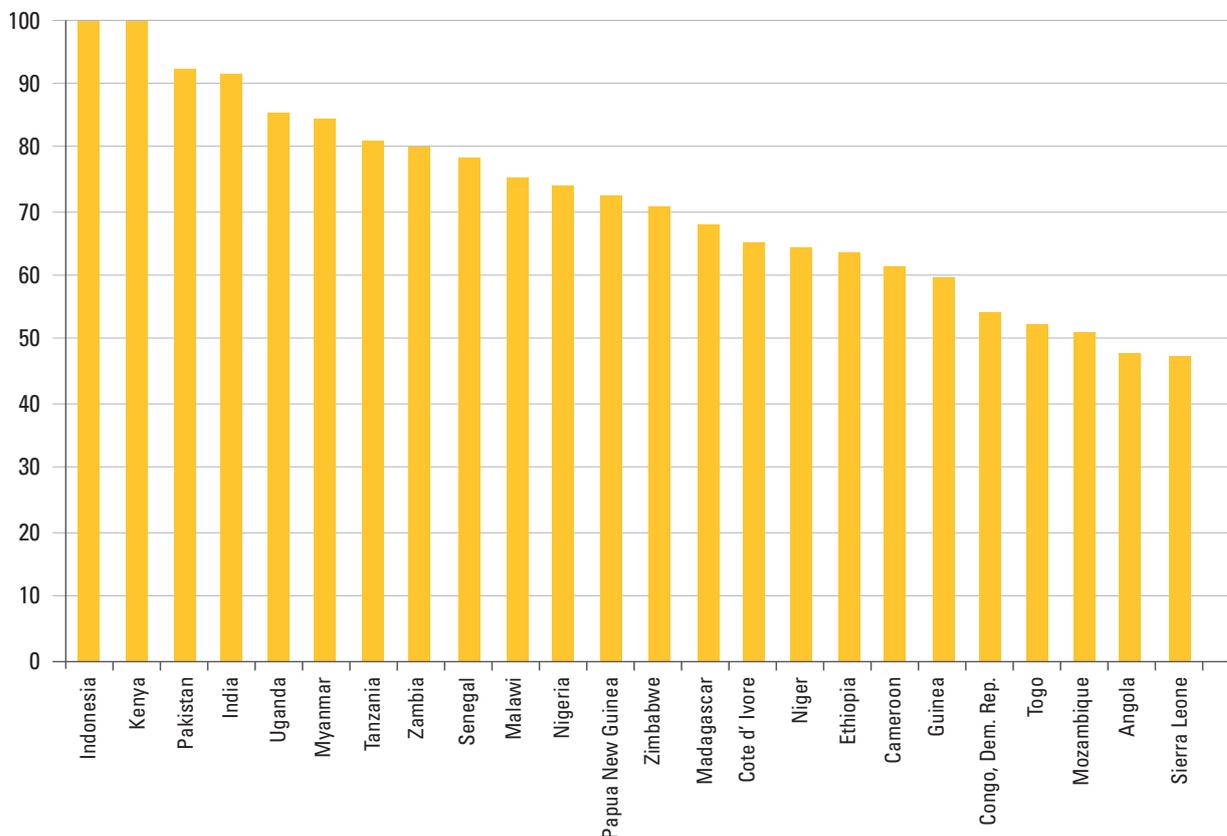
**Overall scores reflect the weighted totals of country scores across the demand, supply and enabling environment pillars.** The following pages provide a more detailed discussion of the overall scores as well as country scores under each pillar. In Box 1 we provide a worked example of the application of the tool to the country case study for Nigeria. All data and index scores cited in this section are included in the PAYGo MAI 2019, and all data sources are listed in the appendix.

#### 3.1 Overall scores

**Under default weights, Indonesia has the highest overall market attractiveness score, followed by Kenya, then Pakistan (Figure 3).** These countries score higher than all other countries in the sample on a combined measure of demand, supply and enabling environment indicators. Sierra Leone, Angola and Mozambique score lower than other countries in the sample. The default weights of the three pillars in the PAYGo MAI place relatively larger weight on supply factors within the country, such as access to finance, operational considerations to provide PAYGo products, or potential partnership opportunities. To better understand which respective strengths of countries, drive these overall scores, it is necessary to examine results at the pillar level.

A case study of PAYGo MAI application and supporting qualitative research is provided for Nigeria in Box 1.

Figure 3. PAYGo MAI 2019 – overall scores



*Note: The overall score presents a weighted average of the respective scores within the three main pillars of the index: 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.*

Source: PAYGo MAI 2019

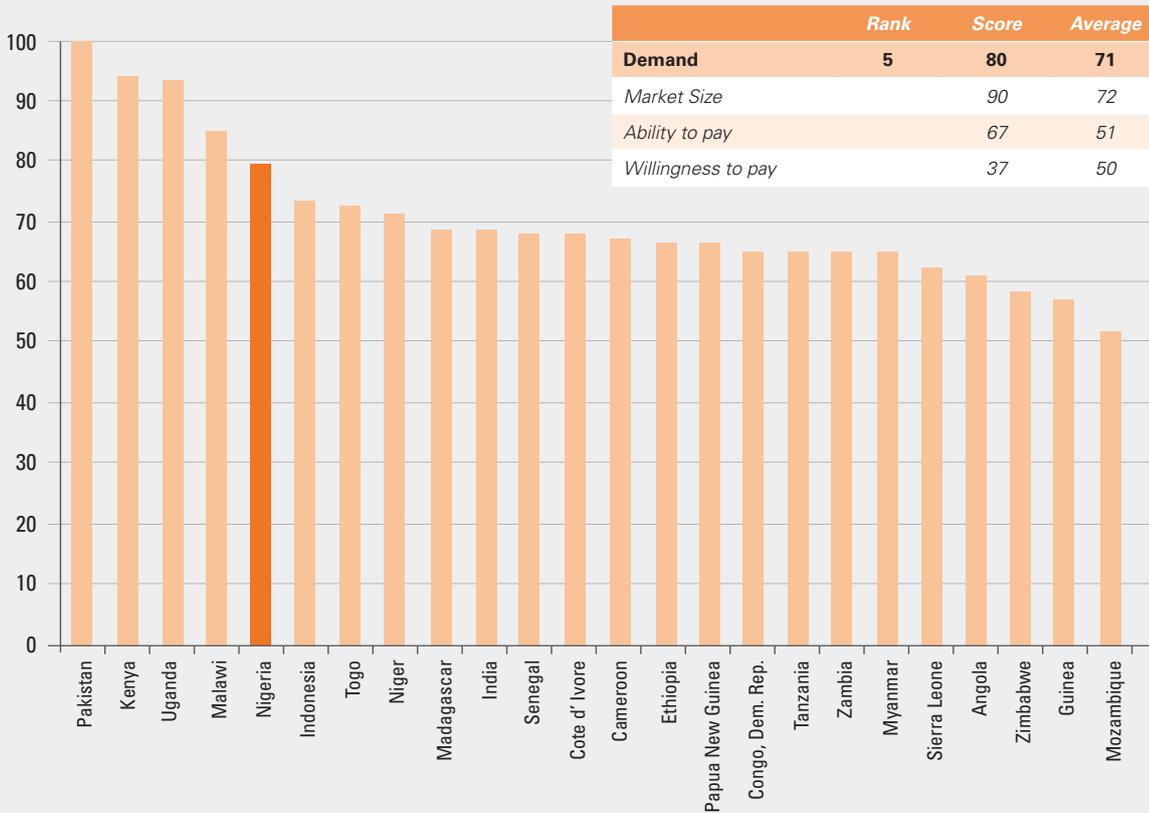
**BOX 1: COUNTRY FOCUS: NIGERIA**

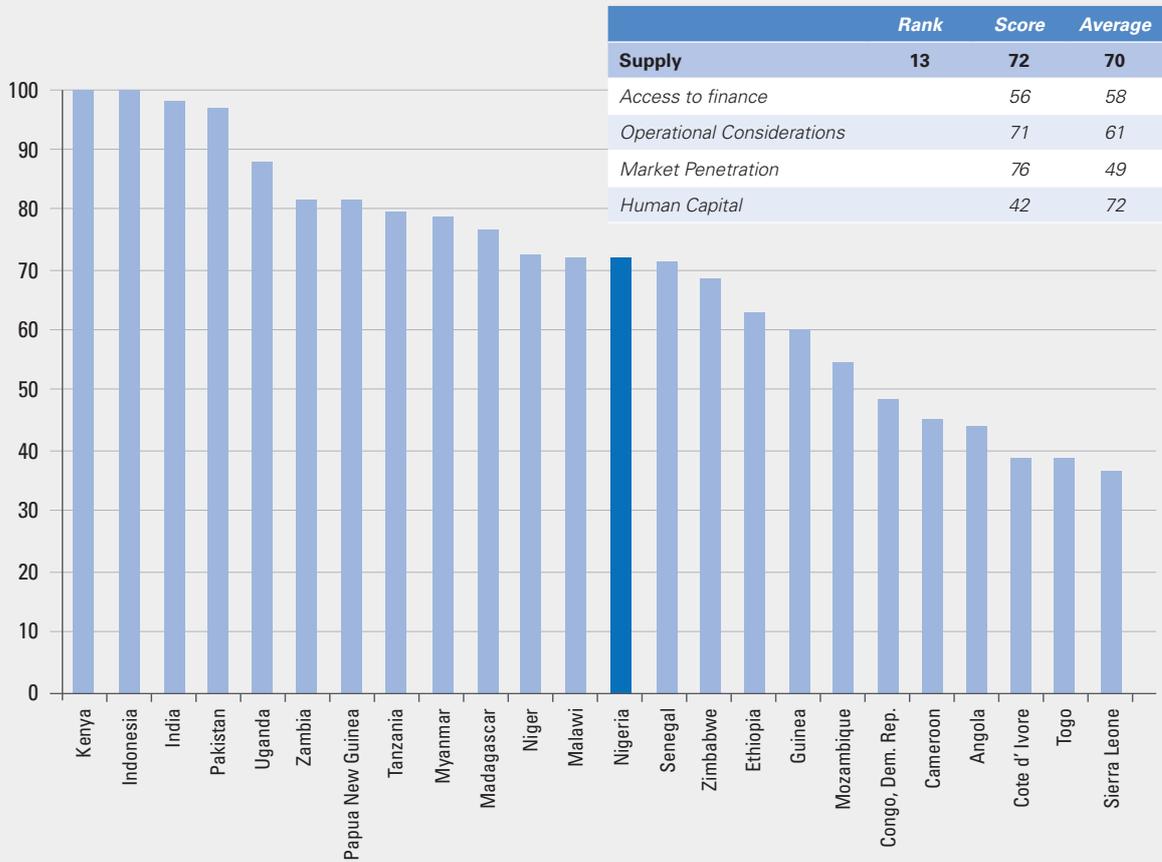
The PAYGo MAI shows Nigeria’s significant potential demand for off-grid solar PAYGo energy services. Nigeria’s off-grid solar PAYGo market has experienced rapid growth over recent years, with over 1.7 million households now using off grid solar products. Current market penetration is nonetheless low, at 4% of the potential market, reflecting high levels of unreliable grid connections and unelectrified populations.

The country’s performance on the supply pillar of the PAYGo MAI indicates market interest amongst providers, but with barriers to scaling business models. Interest amongst PAYGo companies is high with many entering the market, but lead-times for business development time can be up to three years before the company makes its first sales. These start-up time requirements include developing local market intelligence, training field agents and importing equipment into the country for distribution.

Though policy ambitions for future solar energy generation are high, few incentives are currently offered to PAYGo companies. Direct policy support for PAYGo is limited, but national policies include targets aligned with PAYGo market development. Policy goals include 8,000 MW of off grid solar power in rural areas by 2030, expanded ICT access in rural areas and improvements in access to both electricity and financial services. Recent Central Bank regulations aim to expand the mobile money offerings in the country by allowing mobile network operators to serve as Payment Services Banks.

Figure 4 Nigeria is ranked high in the PAYGo MAI demand pillar, but average for enabling environment and supply indicators





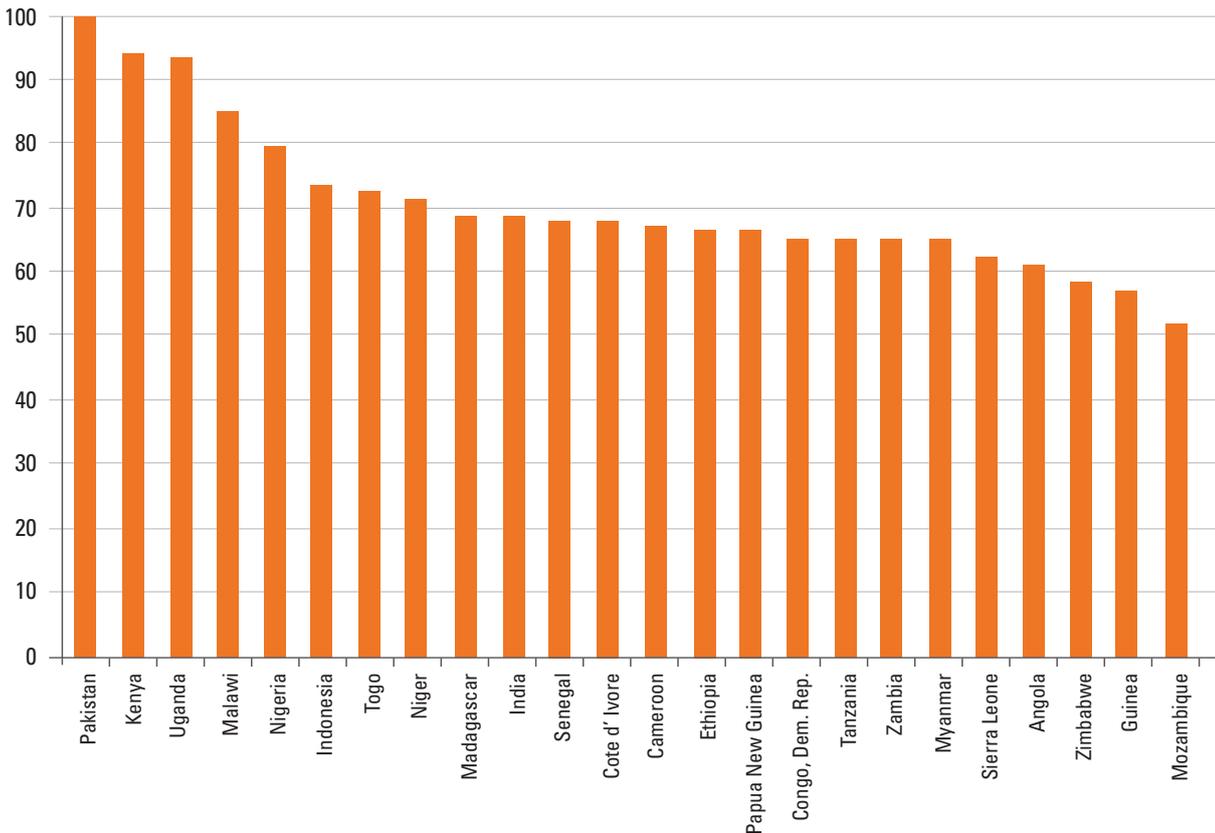
Source: Vivid Economics, based on PAYGo MAI

As explored in the Nigeria Country Focus, the West African nation stands apart from other PAYGo markets in several ways. Innovative business models, including partnerships with mobile operators for airtime credit-enabled PAYGo products and retail banks to leverage agent networks have helped some operators overcome barriers to market in hard-to-reach areas and within a complex regulatory environment. A large existing market in diesel and gas generators has inspired PAYGo companies to sell to urban markets where OGS devices serve as secondary sources of electricity during frequent electrical outages.

Interviews with PAYGo companies and supply chain members identified a number of barriers in the market that can be addressed by both policy and capacity development. Consumer finance is an issue as mobile money platforms limit their engagement to their pre-existing bank account holders. Businesses find access to finance a constraint on growth. Government support for legal frameworks that support innovative finance to PAYGo companies (e.g. special purpose investment vehicles) may be an effective intervention to improve access to finance.

### 3.2 Demand pillar results

Figure 5. Pakistan has the highest demand pillar score, closely followed by Kenya and Uganda



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.

Source: PAYGo MAI 2019

**Under the default weights, Pakistan receives the highest score in the demand pillar, followed by Kenya and Uganda (Figure 5) who score more than 10 points less.** Pakistan is a large market with especially strong scores in indicators relating to 'willingness to pay' and 'market size'. Pakistan has a large population of nearly 200 million people, and a large share of its population lives in medium density areas (70%).

Furthermore, Pakistan has a relatively low level of income volatility and a large share of its population is reported as living above global poverty levels. Pakistan also scores exceptionally high on 'willingness to pay', as a large share of the population has experience buying on credit where kerosene – used here as a proxy for cost of alternatives to electricity – is relatively more expensive.

**Kenya received the highest score on 'willingness to pay' indicators among the 24 countries.** 73% of the Kenyan adult population has a mobile money account, and 37% have paid utility bills using their mobile phone in the past year. In addition, off-grid households in Kenya have significantly higher expenditures on lighting and mobile phone charging than in other countries, indicating relatively higher ability to pay.

Kenya however scores only 68/100 on 'ability to pay' indicators, as income volatility is estimated to be relatively high at 14% and GNI per capita is lower than for most countries in the sample, at USD 1,460.

**Uganda scores high on market size and 'willingness to pay', offsetting a slightly weaker score in ability to pay indicators.** While Uganda's population is relatively small with only 43 million

people, it has a large share of rural population (77%), and over 83% of the population live in medium density areas. In addition, 82% of the rural population are not connected to the grid.

Uganda scores high on 'willingness to pay', as more than 50% of the population have a mobile money account and 10% have already paid utility bills using a mobile phone in the past year. Uganda has a lower GNI per capita than most countries in the sample at USD 600.

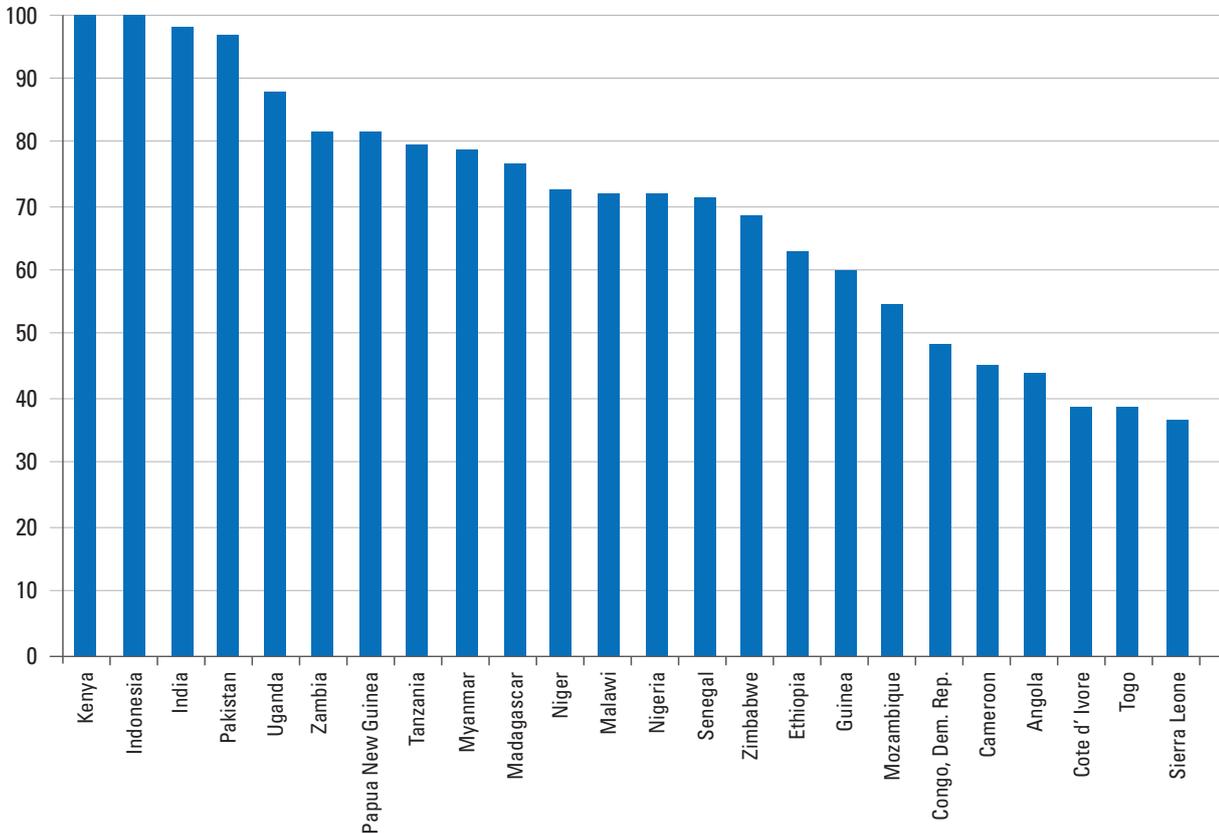
**At the other side of the spectrum, Zimbabwe, Guinea and Mozambique have the lowest score on the demand side pillar.** Zimbabwe has a relatively small addressable market, with a dispersed population (only 2% in 'medium' density areas, while 78% live in 'extremely low' density areas), and a low rate of population growth (2.2%).

Furthermore, it has a low GNI per capita (USD 1,170) and higher income volatility estimate than many countries in the sample (18%). Guinea scores low for indicators around willingness and ability to pay. In Mozambique, households have the lowest ability to pay. Only 33% of the population are classified above 'poor' income, and estimated income volatility is the highest of the sample, at 24%, which may pose a challenge in meeting the regular payments required from the PAYGo credit service.

**A large number of countries score similarly well on demand side indicators.** This result indicates that most countries score well in at least some sub-pillars, and that these country strengths are relatively well distributed on the demand side. The distribution of scores does not provide any information on the country variation in input data, as all indicators are normalized.

### 3.3 Supply pillar results

Figure 6 Kenya has the highest score on the supply pillar, Indonesia and India come second and third respectively



Note: The supply side pillar is composed of 4 sub-pillars: 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.

Source: PAYGo MAI 2019

**Under the default weights, Kenya scores highest on the supply-side pillar, followed by Indonesia.**

Kenya scores well on the supply side pillar, due to high scores across all sub-pillars. Kenya scores highest on human capital indicators, with strong scores on quality of graduate schools and quality of secondary education. A total of 33MW of total decentralized solar capacity installed (excluding mini grids) indicates higher decentralized solar uptake in Kenya to date than in most other countries in the sample. Kenya also has a strong and reliable high solar yield year-round.

**Indonesia scores well on indicators around access to finance, as financial services are affordable and there is a good availability of early stage equity.** In addition, long-term and short-term risks on financial markets in Indonesia are classified as the lowest among countries in the sample.

Indonesia is also exceptionally strong on human capital indicators, the quality of graduate schools and gross tertiary education enrolment rate, where it scores higher than all other countries in the sample. High scores on human capital indicators show that the local labor market can supply PAYGo companies with many of the skills needed to construct and utilize client and supply networks.

**India and Pakistan are also highly-ranked countries on the supply pillar.** India leads in the 'access to finance' and 'market penetration' sub-pillars, which means it has the highest combined score of indicators within these sub-pillars. However, India scores lower on operational considerations, as rural access is less developed than in comparison countries, and solar yield is lower in parts of the country. Pakistan similarly has high scores across three out of four sub-pillars on the supply side, but

market penetration is significantly lower as shown by low PAYGo sales. The PAYGo MAI does not provide insights on a sub-national level. For heterogenous countries like India, indicators on national level may not always be representative.

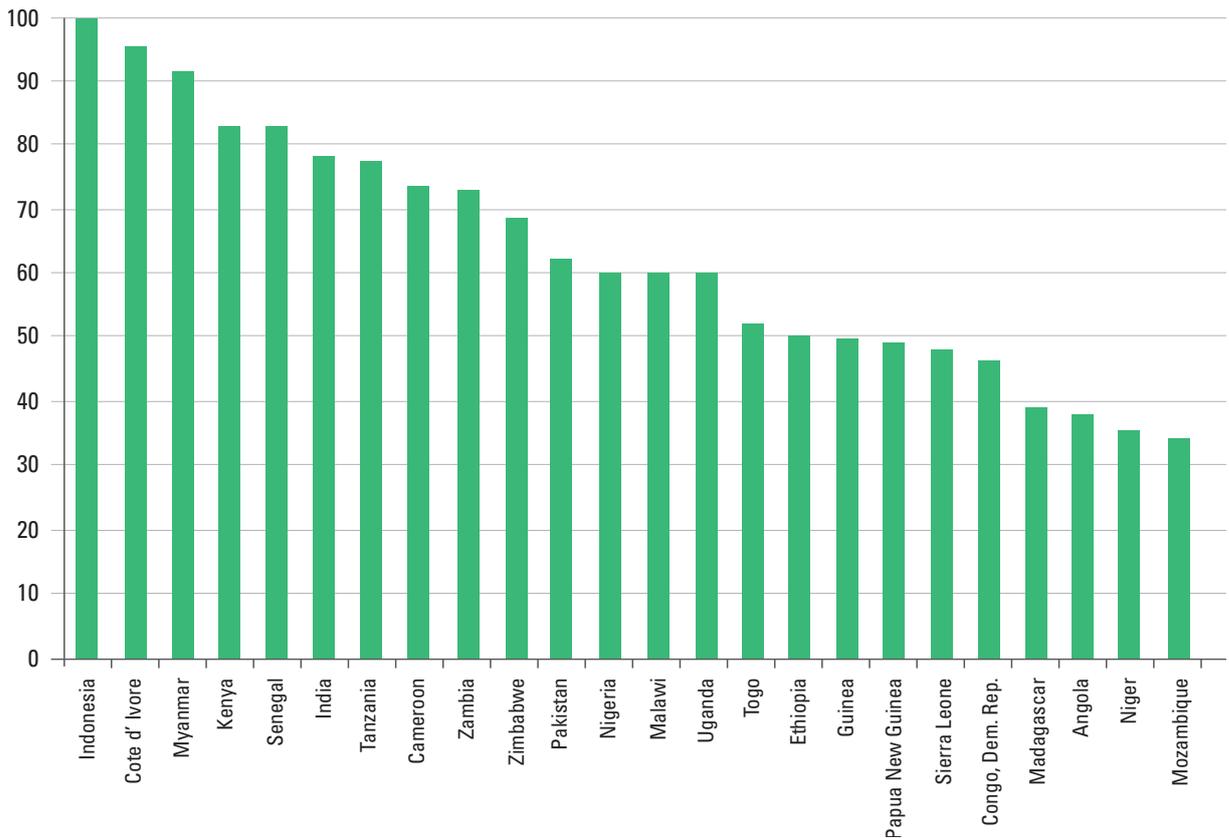
Sierra Leone faces a combination of low solar yield and barriers in access to finance, as 65% of firms in Sierra Leone identify access to finance as a major constraint, and economic risk on financial markets is classified as relatively high.

**At the bottom of the ranking, Cote d'Ivoire, Togo and Sierra Leone have the lowest supply side scores facing 'access to finance barriers', 'barriers to market penetration' and 'operational issues', respectively.** For Togo, the global database used (International Renewable Energy Association) does not report any decentralized solar capacity installed, and sales volumes of PAYGo products have only started to increase very recently.

**There is a large difference between the highest and lowest country scores on the supply pillar.** Countries on the low end of the distribution score considerably lower than the top countries in the sample on most sub-pillars, indicating that overarching barriers to market development may exist in these countries.

### 3.4 Enabling environment pillar results

Figure 7: Indonesia has the highest score on the enabling environment pillar, followed by Cote d'Ivoire and Myanmar



Note: Enabling Environment is composed of three sub-pillars: 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.

Source: PAYGo MAI 2019

**Indonesia has the top score on the enabling environment pillar, followed by Côte d'Ivoire.**

Indonesia clearly leads the country sample on 5 out of 6 indicators within the ICT sub-pillar. No other country within the index has higher shares of mobile broadband coverage (84%), SIM penetration (133%) or secure internet servers per capita. Furthermore, the country scores highly on trade and commerce indicators, with relatively lower corruption perception, low cost to start a business and high depth of credit information.

Côte d'Ivoire's high score results from high scores across the ICT sub-pillar, where the country scores high on percentage of individuals using the internet (44%) and SIM penetration (128%). The country is similarly strong on trade and commerce sub-pillars, with the lowest cost to start a business and high expected annual GDP growth (7.7%).

**Myanmar and Kenya also score relatively high on the enabling environment pillar, with particularly high scores on the legal and regulatory sub-pillar.**

Myanmar is the country with the largest number of fiscal incentives such as solar module subsidies and duty exemptions on equipment related to standalone solar systems in place.

Myanmar's ICT environment is above average, the country's trade and commerce landscape may however present difficulties to developers, as legal rights are reported as low and corruption perception is relatively high, signaling a challenging business environment.

Kenya, in contrast, scores well on both legal/regulatory aspects and trade and commerce, but low mobile cellular subscriptions (86%) and a low number of individuals using the internet (17%), among other ICT aspects, may hinder successful supply chains.

**Niger and Mozambique have the lowest score on supply side sub-pillars, scoring below average across all three.**

Mozambique has exceptionally low SIM penetration (47%) and a low number of mobile cellular subscriptions (40 per 100 people). It stands out, as there are only few measures in place to support developers.

Corruption perception is high, while strength of legal rights is classified as low. Niger, slightly stronger on commerce indicators and regulation, scores even lower across indicators within the ICT sub-pillar than Mozambique. Only 10% of individuals are using the internet in Niger and there are only 41 mobile cellular subscriptions per 100 people.

**Like the supply pillar, there is a large diversity of country scores within the enabling environment pillar.** The pillars under 'enabling environment' include a set of indicators to evaluate the regulatory frameworks in place. These indicators are binary (values can only be 0 or 1) to partially explain the varying differences in final scores.



## 4 CLOSING REMARKS

### 4.1 Overview summary of index results

The scores in the PAYGo MAI provide a high-level overview of relative market attractiveness of the 24 countries in the index.

Figure 8 shows the scores of each country in the index overall, and across the three main pillars, using a color coded scoring system, or “heat map”. Orange represents relatively poor scores, light-green mid-range scores, and dark green the highest scores within each pillar.

Figure 8: Heat map of country scores by pillar

	Demand	Supply	Enabling Environment
Angola	Light Green	Orange	Orange
Cameroon	Light Green	Orange	Light Green
Congo, Dem. Rep.	Light Green	Orange	Orange
Cote d'Ivoire	Light Green	Orange	Dark Green
Ethiopia	Light Green	Light Green	Orange
Guinea	Orange	Light Green	Orange
India	Light Green	Dark Green	Dark Green
Indonesia	Light Green	Dark Green	Dark Green
Kenya	Dark Green	Dark Green	Dark Green
Madagascar	Light Green	Dark Green	Orange
Malawi	Dark Green	Light Green	Light Green
Mozambique	Orange	Orange	Orange
Myanmar	Light Green	Dark Green	Dark Green
Niger	Light Green	Light Green	Orange
Nigeria	Dark Green	Light Green	Light Green
Pakistan	Dark Green	Dark Green	Light Green
Papua New Guinea	Light Green	Dark Green	Orange
Senegal	Light Green	Light Green	Dark Green
Sierra Leone	Light Green	Orange	Orange
Tanzania	Light Green	Dark Green	Dark Green
Togo	Light Green	Orange	Orange
Uganda	Dark Green	Dark Green	Light Green
Zambia	Light Green	Dark Green	Light Green
Zimbabwe	Orange	Light Green	Light Green

Source: PAYGo MAI 2019

**Indonesia leads the overall index score, but Kenya is the only country to be ‘dark green’ and scoring highly across all three pillars.** Pakistan, Uganda and India also score well across two of the three pillars, with medium scores on the remaining pillar. Tanzania and Myanmar both score high on the supply and enabling environment pillars but score low on the demand pillar.

**Five countries score at the low end of the spectrum across all three pillars.** They are Angola, Dem. Rep. Congo, Guinea, Mozambique and Sierra Leone.

**Figure 6 provides a more detailed comparison of the scores across each of the sub-pillars in the index.** Some sub-pillars have a comparable number of countries marked orange, light green and dark green respectively, while some sub-pillars show a more ‘clustered’ performance across countries. For example:

- Most countries have relatively low scores in the willingness to pay and ICT sub-pillars.** This is because one or more countries in the sample score particularly well on these sub-pillars. The index evaluates country performance against ‘potential performance’, as measured by the best performing country in the sample. Therefore, the index shows that on the ‘willingness to pay’ and ICT sub-pillars, there is large potential for improvements across the set of countries.
- Operational considerations have mostly relatively strong or relatively weak performers.** Achieving a ‘good’ score on operational considerations is almost a pre-requisite for the development of a PAYGo market at scale.

- **The ‘trade and commerce’ pillar shows many medium scores and only three countries score very low.** This indicates that, while there are a few countries that lack behind and some that do very well, most countries in the sample have a comparable trade and commerce landscape and this aspect is not expected to be a barrier to market development in most countries.
- **Kenya is the only country that scores mid-range or high across all sub-pillars.**

#### 4.2 Emerging trends between the 2019 and 2018 editions of the PAYGo MAI

**There have been several developments in key indicators between the 2019 PAYGo MAI and the 2018 edition.** These are explored in the paragraphs below.

**While the share of population in rural areas is falling, in absolute terms, rural populations are increasing and will remain a key market for off-grid solar PAYGo products.** All countries in the sample are experiencing growth in the share of urban population, with exception of Zimbabwe, where the share of urban population is decreasing very slightly.

However, population growth which outstrips the rate of urbanization means that in all countries except Indonesia, the size of the rural population is increasing in absolute terms. Countries that are experiencing the largest increase in total rural population are Niger (3.9% per year), Malawi (2.7% per year) and Uganda (2.6% per year). There is a large overlap between the set of countries with high absolute rural population growth and countries with low access to electricity of rural population (Dem. Rep. Congo, Guinea, Malawi, Mozambique, Sierra Leone, and Zambia).

**As urban populations continue to grow faster than rural populations, grid reliability continues to represent a challenge across a number of countries.** In particular Nigeria, Pakistan, and Papua New Guinea appear to score poorly on reliability of grid services, and the ‘under the grid’ market can represent an attractive customer base for off-grid solar PAYGo energy services, as these households are often in easy to reach, densely populated areas, with relatively high incomes, but are unserved or underserved by the main grid. The Nigeria country

focus study demonstrates how urban households with an unreliable grid connection can be a significant market for PAYGo companies.

**Access to and use of mobile money is increasing across all countries, but not at the same rate and is only widespread in a few locations.** On customers with a mobile money account, between 2015 and 2017, coverage increased in Cameroon from just 2% to 15%, and similarly in Guinea (1% to 14%), Malawi (4% to 20%), Senegal (6% to 32%) and Togo (1 to 21%).

The countries with the highest share of population using a mobile money account are Kenya (73%) and Uganda (51%). In Kenya, the population share using mobile money to pay utility bills has increased from 19% to 37%. Other countries where this share has increased significantly are Cote d’Ivoire, Senegal, Tanzania, Zambia and Zimbabwe.

**Alternative payment mechanisms and business models are emerging to the ‘classic’ mobile money approach that enabled development of markets in East Africa.** In Nigeria, PAYGo companies have formed partnerships with local banks to reach customers through their network of agents, and their provision of consumer credit. In India, access to bottom of pyramid consumers and provision of consumer credit has been achieved through partnership with micro-finance institutions (MFIs), rather than through direct sales of PAYGo-technology-enabled products.

In India, credit bureau coverage, has grown to 55% of population, and Indonesia has seen credit bureau coverage double from 18% to 38% in just one year between the 2018 and 2019 editions of the PAYGo MAI.

**Across the 24 countries, sales of PAYGo products increased 10% between the first and second halves of 2018.** In Cameroon, semi-annual product sales have grown from 2,000 units in H2 of 2017 to 55,000 in H2 2018. In Myanmar sales grew from 4,000 units, peaking at 72,000 units in H1 2018 before falling to 27,000 H2 2018. Semi-annual sales in Ethiopia, Pakistan, Togo and Zambia more than doubled over this time period, while sales significantly decreased in Congo, Madagascar, Malawi and Uganda. India registered the highest total units sold in H2 2018 at 1.2 million units, slightly below its sales levels in H1 2018.

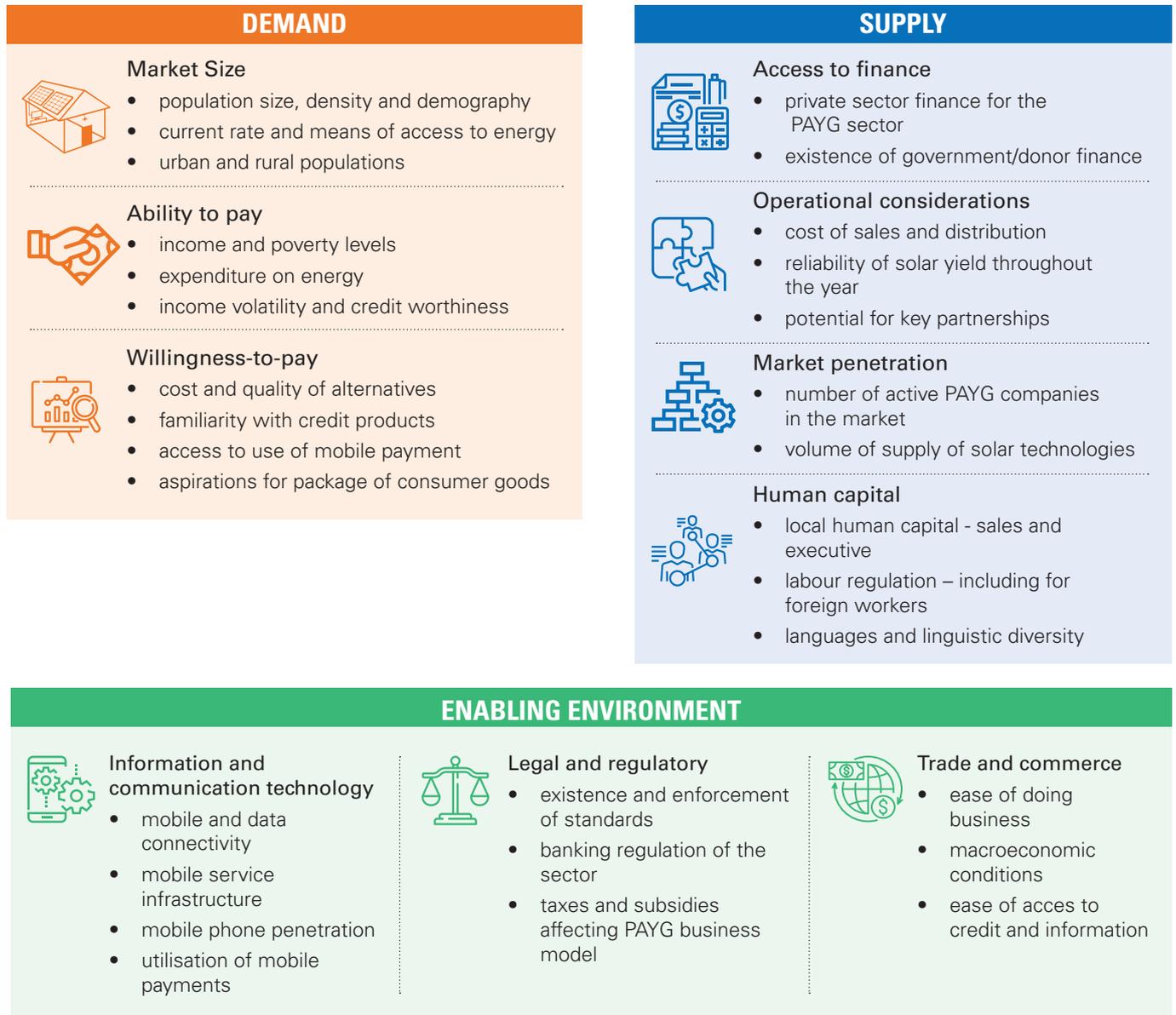
Figure 9 Heat map of country scores by sub-pillar



Source: PAYGo MAI 2019

## APPENDIX A – PAYGo MAI STRUCTURE

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



Source: Vivid Economics

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

- **demand:** size of the addressable market, ability of customers to pay, and willingness to pay for PAYGo products;
- **supply:** access to finance, operational considerations to provide PAYGo products, and potential partnership opportunities to support the PAYGo value chain, penetration of PAYGo and related products in the market, and access to human capital;
- **enabling environment:** broader conditions to support the development of PAYGo 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.

## Demand side

**For a market to develop or grow there must be a demand – with ability and willingness to pay for the services offered.** PAYGo 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

**In absolute terms, Sub-Saharan Africa (SSA) 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.<sup>3</sup> 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 urbanization and population growth, as well as income growth and purchasing power.** Rural customers are an important market segment for PAYGo 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.

PAYGo markets 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).<sup>4</sup> It is also important to note that PAYGo services are a platform that have the ability to transcend beyond lighting to agricultural products, household goods, and other new sectors. The opportunity lies not only in serving unelectrified population segments but in catalyzing new industries.



### Ability to pay

**Ability to pay will largely be determined by income levels and poverty distribution.** The proportion of people living in extreme poverty has declined from 17.8% in 2008 to just 9.9% of the global population in 2015. 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 PAYGo 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 PAYGo 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 PAYGo business model of regular repayment over time.

<sup>3</sup> Data from Global Tracking Framework, World Bank, 2017

<sup>4</sup> Medium consumption refers to appliances that range between 30W (e.g. a fan) to 100W (e.g. a fridge)



### Willingness to pay

**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 PAYGo 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.

**PAYGo 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 willingness to pay 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 PAYGo products.

**Leveraging established consumer confidence and awareness of financial services is an important facilitating mechanism for PAYGo operators.**

Consumers with credit or instalment-based payment history is limited in some countries, which may limit demand for PAYGo products since the ownership model is unfamiliar. PAYGo companies are often forced to play the role of mobile network operators and establish mobile money agents in the off-grid areas they operate, which can be a drain on resources. Financial inclusion is a key driver of PAYGo demand and may in turn also be supported by PAYGo market growth where this is naturally accompanied by improved access to financial services.

## 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 PAYGo market are organized 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 PAYGo agents and supporting services;



### Access to finance for PAYGo companies

**Access to finance for business operations is a strong determinant for growth of the PAYGo off-grid solar sector.**<sup>5</sup> PAYGo 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). PAYGo companies raised around USD 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 PAYGo 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.

<sup>5</sup> Importantly, this section relates to the ease and cost of PAYGo 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).

**PAYGo 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 PAYGo 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 PAYGo 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 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 the country or the region.

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

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



#### Market penetration and current levels of supply

**The rapid growth of the PAYGo markets has been characterized 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 PAYGo companies. While dominant market positions may dissuade new players, it is important to study the varying degrees of products and value propositions offered by existing competitors. Good opportunities continue to exist in these and in new, untapped markets

**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 PAYGo, Pico and solar lantern products as recorded by GOGLA 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 characterized by a large number of players increases competition but may also indicate a market that is growing and can support further entry / deepening.



### Conditions in the local labour market

**PAYGo 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 PAYGo 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 PAYGo companies, as well as being a principal cost item of their businesses.

## 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 PAYGo value chain and its customers. The PAYGo 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

**Growth in usage of mobile phones and availability of mobile payment platforms has gone hand in hand with the development of PAYGo markets.** The effectiveness of PAYGo 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 PAYGo 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 PAYGo solar operations, but this approach 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 PAYGo company in Nigeria after partnering with a mobile network operator (GSMA, 2017b).



### Legal and regulatory

**The legal and regulatory environment affects both the extent to which solar technologies are supported, and the business environment for PAYGo 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 PAYGo 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 PAYGo 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 program in Africa, ElectriFi, emphasizes 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 penalizing lower quality products, helping to build consumer confidence and can play a part in increasing customer willingness to pay (Bensch, Grimm, & Peters, 2015).



### 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 PAYGo 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 PAYGo businesses.

**Market transparency facilitates predictability and stability, lowering risk for investors and increasing financing available to PAYGo companies.**

Similarly, businesses prefer operating environments that are less prone to political and security risks. In the PAYGo context, such stability is particularly important, as PAYGo companies tend to both be newer and require high up-front investment (Dalberg Global Development Advisors & Lighting Global, 2018).

**For PAYGo companies, a favorable 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 PAYGo business model. An established credit ecosystem supports confidence in the availability of a long-term finance stream for PAYGo companies, which can evolve with the companies' needs.



# APPENDIX B – METHODOLOGY AND USER MANUAL

## Overview

**This technical annex provides a brief description of how to use and interpret the Excel based index.**

**The Pay-as-you-go Market Attractiveness Index (PAYGo MAI) is an Excel based index built for user-led comparison of country characteristics related to PAYGo market attractiveness.** It is designed for user flexibility and ease of use. The index 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. It provides an overview of the performance of a selected country, as well as the option to compare all countries across selected sub-pillars and indicators.

**The index comprises 71 indicators, organized under three pillars and ten 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 structure of the 71 indicators with sub-pillars and pillars in the index is shown in Figure 10.

**The 2019 edition of the index covers 24 countries across Sub-Saharan Africa and Asia.** These are Angola, Cameroon, Congo, Dem. Rep., Cote d’Ivoire, Ethiopia, Guinea, India, Indonesia, Kenya, Madagascar, Malawi, Mozambique, Myanmar, Niger, Nigeria, Pakistan, Papua New Guinea, Senegal, Sierra Leone, Tanzania, Togo, Uganda, Zambia and Zimbabwe.

Figure 10. Index structure and indicators included

DEMAND PILLAR	SUPPLY PILLAR	ENABLING ENVIRONMENT PILLAR
Market size	Access to finance	ICT
D_1 Population size	S_1 Firms who don't identify access to finance as a major constraint	EE_1 Mobile cellular subscriptions
D_2 National population density	S_2 Affordability of financial services	EE_2 Secure Internet servers
D_3 Population density distribution	S_3 Availability of early stage equity	EE_3 Individuals using the internet
D_4 Rural population	S_4 Financial Markets - Short Term Economic Risk	EE_4 SIM penetration
D_5 Population growth rate	S_5 Financial Markets - Long Term Economic Risk	EE_5 Mobile broadband use
D_6 Rate of Urbanisation		EE_6 Number of mobile connections per capita
D_7 Urban non-slum population	Operational considerations	Legal and regulatory
D_8 Unconnected rural population	S_6 Rural access index	EE_7 Do national programs to develop or support stand-alone systems exist?
D_9 Unconnected urban population	S_7 Number of months with less than five hours of sunshine per day	EE_8 Has the government adopted international quality standards for stand-alone systems?
D_10 Unreliable grid connections	S_8 Cumulative month hours below 5 hours of sunshine per day	EE_9 Are there environment regulations on disposal of solar devices and SHS components?
D_11 Number of electrical outages in a typical month	Market penetration	EE_10 Do subsidies exist for solar modules?
Ability to pay	S_9 Number of PAYGo players in market	EE_11 Do duty exemptions for solar modules exist?
D_12 GNI per capita	S_10 Total decentralised solar capacity installed excluding minigrids	EE_12 Do duty exemptions for other equipment related to stand-alone systems exist?
D_13 Annualised off-grid household expenditure on lighting	S_11 Most recent sales volume of PAYGo, PICO and SHS products	EE_13 Do subsidies exist for stand-alone systems?
D_14 Proportion of population above global poverty level	S_12 Cumulative sales volume of PAYGo, PICO and SHS products since 2014	EE_14 Do duty exemptions exist for stand-alone systems?
D_15 Income volatility	Human capital	EE_15 Do government incentives exist for renewable electricity?
Willingness to pay	S_13 Quality of management schools	EE_16 Do specific financing facilities exist for operators in energy access?
D_16 Borrowed from a store by buying on credit	S_14 Local availability of specialised training services	Willingness to pay
D_17 Cost of subsidised electricity consumption	S_15 Quality of the education system	EE_17 Depth of credit information index
D_18 Time to get connection	S_16 Gross tertiary education enrolment rate	EE_18 Strength of legal rights index
D_19 Average kerosene prices	S_17 Living languages count	EE_19 GDP (PPP and constant 2011 US\$)
D_20 Private credit bureau coverage	S_18 Linguistic diversity index	EE_20 Annual GDP growth
D_21 Public credit registry coverage	S_19 Availability of government certified training programmes for solar equipment installation	EE_21 Ease of doing business index (1 = easiest to 185 = most difficult)
D_22 Mobile money account (age 15+)		EE_22 Corruptions Perception Index
D_23 Paid utility bills; using a mobile phone (% paying utility bills, age 15+)		EE_23 Global Perception Index
D_24 Cheapest prepaid mobile voice product by country (in USD)		EE_24 Cost of import
D_25 Cost to get electricity (% of income per capita)		EE_25 Cost to enforce a contract
		EE_26 Cost to start a business
		EE_27 Minimum paid-in-capital required to start a business

Source: PAYGo MAI 2019

## Changes to the index between the 2018 and the 2019 editions

- **The 2019 edition of the index has been extended to cover 24 countries, compared to 14 in the 2018 edition of the index.** The addition of new countries affects some of the scores for the original 14 countries, as the normalized scores for each indicator are based relative to other countries in the index; therefore, adding more countries may affect the scores of existing countries in the index.
- **Variables with important outlier values for some countries in the index are normalized to adjust for the outlier.** This is to provide a balance between appropriately capturing variation between countries in the index, while preventing individual outliers to skew results. More detail is provided below.
- **Where data is missing, values are assigned, to preserve the score for each country based on indicators where it does have data available.** The 2018 edition of the index assigned values to missing data either by (i) expert judgement to fill the gap, or (ii) assigning a score equivalent to the lowest score among comparators in the index for which data was available. The 2019 index takes an updated approach, which aims to preserve the score of each country based only on the indicators for which data is available. More detail is provided below.
- **Data sources have changed for a small number of indicators to improve coverage across the extended range of countries in the 2019 index.** Where this is the case, the changes are highlighted in the variable description. Changes include:
  - D\_10, Unreliable grid connections: Afrobarometer has been replaced by World Bank Enterprise surveys, as the index now covers countries outside the regional (Africa) coverage of the original Afrobarometer source.
  - D\_13, Annualised off-grid household expenditure on lighting and mobile phone charging: International Renewable Energy Agency (IRENA) estimates are replaced by Bloomberg New Energy Finance (BNEF) estimates from an earlier year with larger country coverage. Both sources use a similar estimation method based on UNEP data, both datasets were published in the Off-Grid Solar Market Trends Report Series.
  - D\_24, Cheapest prepaid mobile voice product by country (in USD): Research ICT Africa is replaced by data from the 'International Telecommunications Union'.
  - S\_16, Gross tertiary education enrolment rate: The Global Competitiveness Report 2017 is replaced with World Development Indicators.
- **Some indicator descriptions have changed as a result of a change to the source data.** This is particularly the case for some indicators from the Global Competitiveness Report as detailed in Table 1.
- **All data in the index is the most recent data for the respective indicator available as of April 2019.** For every indicator, the year of data in the tool can be retrieved from the indicator tab.

Table 1 Updated variable descriptions between the 2018 MAI and the 2019 MAI

Indicator	2018 MAI variable description	2019 MAI variable description
S_2, Affordability of financial services	Answer to the question: In your country, to what extent does the cost of financial services (e.g. insurance, loans, trade finance) impede business activity? [1 = impedes business to a great extent; 7 = not at all]	Answer to the question: In your country, to what extent can small- and medium-sized enterprises (SMEs) access finance they need for their business operations through the financial sector? [1 = not at all; 7 = to a great extent]
S_13, Quality of management schools	Answer to the question: In your country, how do you assess the quality of business schools? [1 = extremely poor—among the worst in the world; 7 = excellent—among the best in the world]	Answer to the question: In your country, to what extent do graduating students possess the skills needed by businesses at the following levels: b. University-level (1 = Not at all; 7 = To a great extent)“
S_14, Local availability of specialized training services	Answer to the question: In your country, how available are high-quality, professional training services? [1 = not at all; 7 = to a great extent]	Answer to the question: In your country, to what extent do companies invest in training and employee development? [1 = not at all; 7 = to a great extent]
S_15, 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? [1 = Not at all; 7 = To a great extent]	Answer to the question: In your country, to what extent do graduating students possess the skills needed by businesses at the following levels: a. Secondary education [1 = Not at all; 7 = To a great extent]

Source: Vivid Economics

## Scoring and normalization

**Each indicator in the index is normalized on a scale of 0-100.** The ‘lowest’ performing country scores 0, the ‘highest’ performing country scores 100, with all remaining scores defined on a relative scale between 0-100. The default normalization

approach is a linear scaling with the maximum data value assigned a score of 100 and all values assigned scores proportional to their distance from the max (see examples in Box 2).

### BOX 2: EXAMPLE INDICATOR NORMALIZATION: RURAL POPULATION

- For rural population share (D\_4), the country with the highest share of rural population is Papua New Guinea, where 87% of the population are classified rural. Papua New Guinea therefore scores ‘100’ on this indicator. The lowest value registered across the 24 countries is for Angola, with only 35% of the population classified as rural. Angola therefore scores ‘0’ on this indicator.
- Countries receive a normalized score, based on their relative position between Papua New Guinea and Angola. For example, Myanmar has 70% of its population living in rural areas and therefore is assigned a score of ‘67’, while Cameroon has 44% of its population in rural areas, scoring ‘18’ on the scale.
- Specifically, the normalized score for Myanmar is calculated as:  $(70-35) / (87-35) * 100 = 67$

**For some indicators, there are one or two countries with large ‘outlier’ values, which may distort the scores of other countries.** Because normalization is carried out on the basis of a minimum and a maximum value (as explained in Box 2), for an indicator where the maximum value for a particular country is far greater than any other country in the index, this will result in a highly ‘skewed’ set of normalized scores. For example, for population size, India has over 1.3 billion people and would score ‘100’. The third largest country is Pakistan with 197 million people. However, Pakistan would score just ‘14’ on its normalized score, as it is in relative terms far smaller than the 1.3 billion market size in India. This would mean the 21 other countries with less population than Pakistan have a very small range in their normalized scores for this indicator and variation amongst countries would not be captured, except for that between the largest countries and the rest.

**‘Outlier’ indicators with potential for skewing scores across the sample are identified as those with fewer than three countries receiving a score of 25 or above on a normal max-min distribution.**

Most of these reflect indicators that relate to country size. For this selection of indicators, one of two approaches are taken:

- **For continuous variables with a large ‘unconstrained’ range, a log transformation is used.** The log transformation increases the scale of relative distribution of small values, while also preserving a relative distance between outliers and small values. This approach is selected for indicators D1, S10, EE2, EE19 and D18 (see Table 2 below).
- **For continuous variables which take only a limited range of values, the scores are normalized around median value.** All values below the median are normalized between 0 and the median (which scores 50), while values above the median are normalized between the median and 1. The consequence of this is a more equal distribution of values between 0 and 1, with exactly half of the values scoring above 50 points by definition. This approach is selected for indicators S11, S12, D21 and D23 (see Table 2 below).

Table 2 Outliers are accounted for in 10 variables in the index

Variable	Proposed solution	Rationale
D1. Population	Normalize – LOG	Continuous variable, large outliers at upper end of spectrum. Distribution fits natural log well to maintain variation but not ‘skew’ the distribution
S10. Total solar capacity installed	Normalize – LOG	As per above
S11. Total sum of solar units sold in latest half-year	Normalize – median	Continuous variable, but constrained, and most interesting to ‘center’ the distribution around a central sales volume across the countries in our sample
S12. Cumulative sales of solar units	Normalize - median	As per above
EE19. GDP	Normalize – LOG	Continuous variable as per above
EE2. internet servers per 1m people	Normalize – LOG	Continuous variable as per above
D18. Time to get grid connection	Normalize – LOG	Single outlier in continuous variable, apply logs as per above
D21. Public credit registry coverage	Normalize – median	Discrete constrained variable, most logical interpretation is around median
D23. Paid utility bills using a mobile phone	Normalize – median	Discrete constrained variable, most logical interpretation is around median

Source: Vivid Economics

**Where data is not available for all countries for an indicator, 'gaps' are filled to preserve the overall rankings of the countries in each sub-pillar.**

The index uses raw data from a range of sources for 71 indicators, and data is not available for all countries for all 71 indicators. The indicator tab of the tool highlights where data is missing, and where the missing data has been filled with an estimated datapoint. The reason data gaps are 'filled' is to make sure the index can be computed for all countries on a comparable basis.

**To fill these data gaps, data is interpolated at the sub-pillar level to preserve the score for each country as if it was not missing any data.**

The interpolation method ensures that the index can be viewed on a comparable basis for all countries for sub-pillars, pillars, and the overall index. To achieve this, any missing country data point for a particular indicator is replaced by the weighted average performance of the respective country across all other indicators in that respective sub-pillar. Country scores in sub-pillars and pillars are thereby not affected by missing data. Interpolation is required for only a small proportion of data points, with just 3% of indicator scores based on interpolation to fill data gaps.

## Pillars and sub-pillars

**The 10 sub-pillars are a weighted sum of individual indicator scores, following the index structure detailed in Figure 10.**

The range of each sub-pillar is again scaled so that the highest performing country scores 100. Each indicator is weighted based on: (i) the relative importance of the indicator, (ii) whether it is binary, discreet, or

continuous, (iii) the range of variation in the raw indicator scores across the 24 countries. In general, indicators that are considered more 'important' are given more weight in the index.

Furthermore, 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. Indicators with a wider range are assigned a higher weight for the same reason. This assessment is based on expert judgement and stakeholder engagement, used to provide a sensible calibration of the index. Critical indicators, such as the distribution of population density, are weighted highly. Box 3 provides an example of how indicators are weighted and aggregated up to the sub-pillar level.

**Each of the three main pillars is a weighted average of the 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. Box 4 provides an example of how sub-pillars are weighted and aggregated up to the pillar level.

**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. Weightings can be manually adjusted on the PAYGo MAI tab for each pillar, and for each sub-pillar.

### BOX 3: AGGREGATING INDICATORS TO SUB-PILLAR – WORKED EXAMPLE: INDIA

**India is the highest scoring country on the ‘Access to Finance’ sub-pillar (within the ‘supply’ pillar) with a normalized score of 100.**

**This box explains how the normalized sub-pillar scores are calculated, as a result of weighting and aggregation across the individual indicators it comprises.** This is important, as receiving the highest normalized score of 100 on a sub-pillar does not imply that a country performs best across all the individual component indicators.

- **The Access to Finance sub-pillar comprises five individual indicators:**
  - S1. Firms who do not identify access to finance as a major constraint
  - S2. Affordability of financial services
  - S3. Availability of early stage equity
  - S4. Financial markets – short term economic risk
  - S5. Financial markets – long term economic risk
- **India’s ‘raw’ score on the ‘Access to Finance’ sub-pillar is a result of the weighted average of its score on each indicator, multiplied by that indicators weight.** It is important to note that the score of an indicator is derived by looking at the value of that indicator across all countries and assigning a normalized score from 0 to 100. For example, the value for S2. Affordability of financial services was 4.8, which is the highest value for all 24 countries. Therefore, the score for S2. Affordability of financial services is equal to 100. The scores and weights for India are set out below:
  - S1. score of 82 multiplied by weight of 60%
  - S2. score of 100 multiplied by weight of 10%
  - S3. score of 100 multiplied by weight of 10%
  - S4. score of 85 multiplied by weight of 10%
  - S5. score of 85 multiplied by weight of 10%
- **The weights for each indicator are determined based on (i) its importance, (ii) its type (discreet or continuous), and (iii) the range of variation across countries.** In the ‘Access to Finance’ sub-pillar, following consultation with industry stakeholders it was clear that whether or not firms face constraints in access to finance was the most important indicator for the PAYGo context (S1. Firms who do not identify access to finance as a major constraint indicator), and therefore receives a weight of 60%. The remaining four indicators are less important and receive a weight of 10% each. In particular, S2 and S3 capture important information on the affordability of firm finance and availability of equity but are themselves already in index form from the Global Competitiveness Report, so receive a lower weight.
 

Similarly, S4 and S5 present information on short- and long-term economic risk, but with limited variation across both two indicators which are in the form of an index score from BMI. While S2 to S5 present information that may be valuable, they are less important than S1 which receives the largest weight.
- **The ‘raw’ score for the ‘Access to Finance’ sub-pillar is therefore 86, which is then readjusted to reflect its position as the highest scoring country in this sub-pillar.** In practice this means India’s raw score of 86 is scaled up by a factor of 1.16 to result in a normalized score in this sub-pillar of 100. The ‘raw’ scores of all other countries are also scaled up by the same factor so they maintain their relative position to India’s normalized score of 100.

#### BOX 4: AGGREGATING SUB-PILLARS TO PILLAR AND TO OVERALL INDEX – WORKED EXAMPLE: PAKISTAN

**Pakistan is the highest scoring country on the ‘demand’ pillar, with a normalized score of 100, followed by Kenya which scores 95.**

**This can appear counter-intuitive, as Pakistan does not score highest in any of the three sub-pillars within the demand pillar.** The following bullets set out how the process of weighting and aggregation at pillar level works, and the same process is then used to aggregate from the three main pillars to the overall index score.

- For the ‘market size’ sub-pillar, Malawi scores highest (100), while Pakistan scores 91
- For the ‘ability to pay’ sub-pillar, Indonesia scores highest (100), while Pakistan scores 68
- For the ‘willingness to pay’ sub-pillar, Kenya scores highest (100), while Pakistan scores 91

**Clearly, on any one of the sub-pillars, Pakistan is not the highest scoring country.** However, by virtue of the process of weighting these sub-pillars to arrive at the overall demand pillar score, Pakistan comes out on top. The default weights assigned to each of the sub-pillars 40%, 30% and 30% for market size, ability to pay, and willingness respectively. This places Pakistan first, and Kenya second in the demand pillar overall, as:

- **Pakistan’s ‘raw’ weighted score across all three sub-pillars is 84.** This is the sum of each sub-pillar score and its weights, i.e. market size (score of 91 \* weight of 40%), + ability to pay (score of 68 \* weight of 30%) + willingness to pay (score of 91 \* weight of 30%) = 84.
- **Kenya’s ‘raw’ weighted score across all three sub-pillars is 80.** Similarly, this is: market size (score of 73 \* weight of 40%), + ability to pay (score of 68 \* weight of 30%) + willingness to pay (score of 100 \* weight of 30%) = 80.

**These ‘raw’ pillar scores are then re-adjusted so that the top scoring country scores 100, and the remaining countries scores are adjusted accordingly.** Specifically, to re-adjust Pakistan’s score so that it receives 100 as the highest scoring country, its ‘raw’ score of 84 is multiplied by a factor of 1.2. Kenya’s ‘normalized’ score on the demand pillar is therefore its ‘raw’ score of 80, multiplied by the readjustment factor of 1.2, which gives Kenya a demand pillar score of 95.

### Using the index

**The PAYGo MAI is built for user-defined comparison of country characteristics related to PAYGo market attractiveness.** Five output tabs summarize index results by providing overall results for all countries in comparison (COUNTRY OVERVIEW and HEAT MAP tabs), country characteristics and relative performance (COUNTRY OVERVIEW and COUNTRY DEEP DIVE tabs), as well as indicator details and data (INDICATOR DETAIL TAB).

**User modifiable cells are highlighted with a yellow background, and orange text.** User selections are facilitated by 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. The user selection of weights on the PAYGo MAI tab will inform results shown on all subsequent tabs that show scores on the pillar level or overall scores (COUNTRY DEEP DIVE, HEAT MAP tabs). This is also highlighted in white textboxes on the respective tabs.

**There are five output tabs:**

- **The ‘PAYGo MAI’ tab**

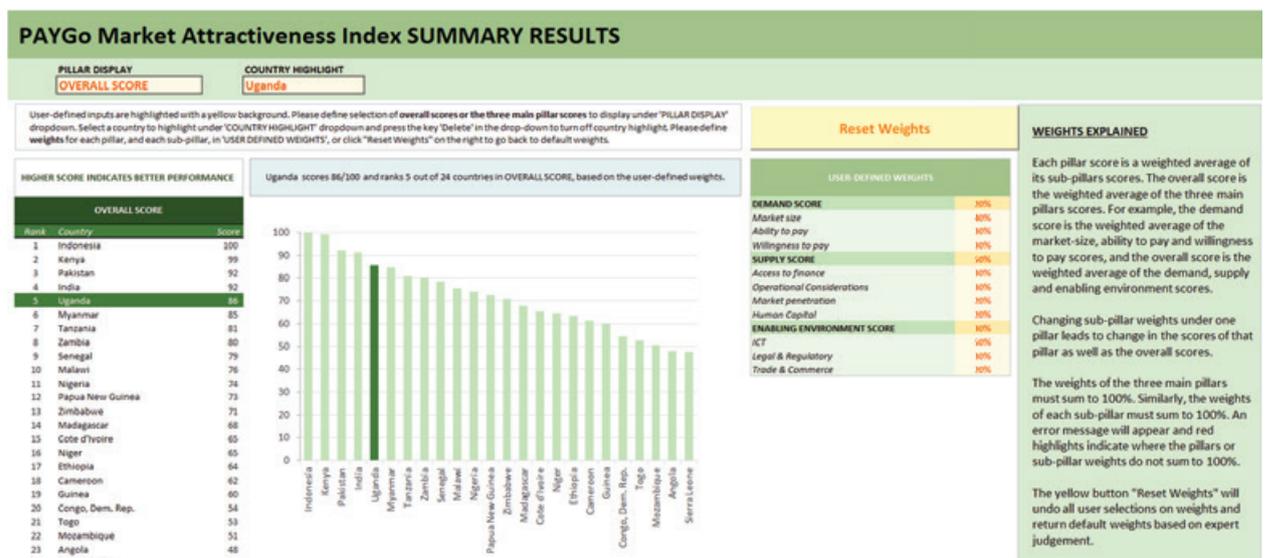
This is the main summary tab and presents overall index scores, as well as scores across the three main pillars. Users can select at the top of the tab which pillar they want to display, from a choice of the overall index, or each of the three main pillars of the index. The bar chart, country scores 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. The index results for the country of choice are summarised in a light blue text box.

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 each sum to 100%. An error message will appear in red if this is not the case. The index is presented with default weights based on market research and engagement. Clicking the ‘Reset Weights’ button will return the values of the pillar and sub-pillar weights to these default values.

Figure 11. ‘PAYGo MAI’ tab



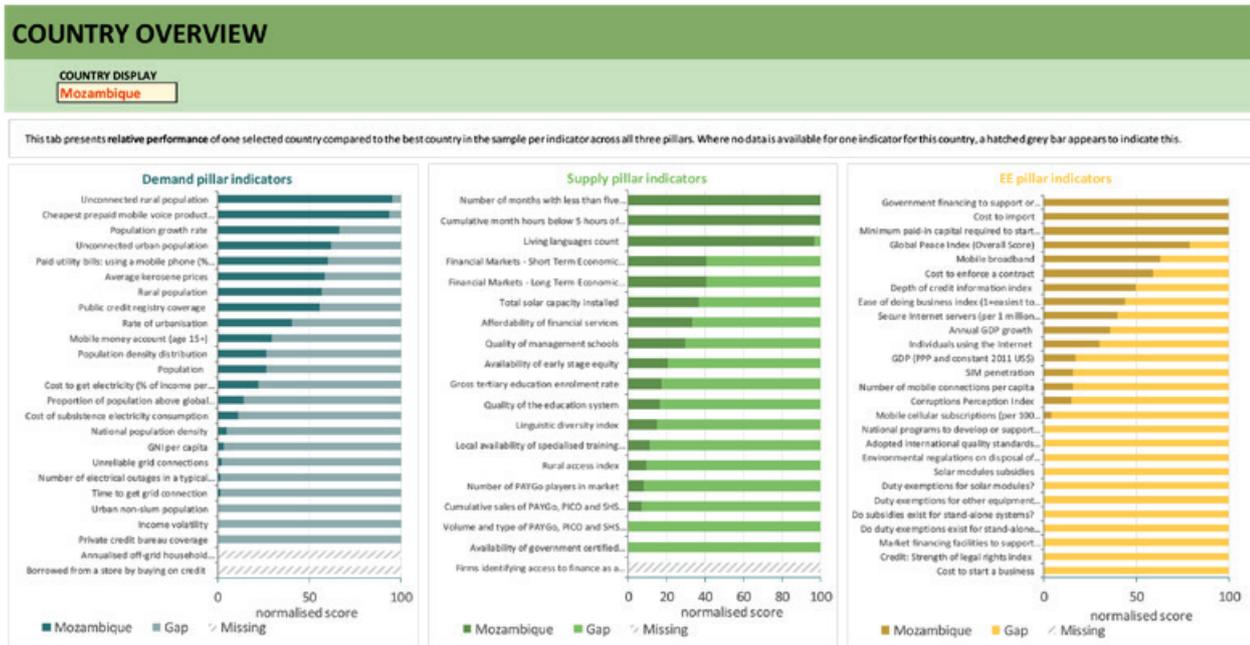
Source: PAYGo MAI, 2019 version

- **The ‘COUNTRY OVERVIEW’ tab**

This tab aims to clearly highlight strengths and weaknesses of a selected country across the three PAYGo MAI Pillars Supply, Demand and Enabling Environment. A country is selected in the “COUNTRY DISPLAY” field and the figures will update to reflect this country choice and indicators

in each figure are re-ordered based on normalized scores of the selected country is conducted. The indicator data is sorted from highest to lowest score within each pillar.

Figure 12. 'COUNTRY OVERVIEW' tab



Source: PAYGo MAI, 2019 version

• The 'COUNTRY DEEP DIVE' tab

This 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 score, 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). Note that overall scores and pillar scores in this tab are based on the current live selection of weights in the PAYGo MAI Tab.

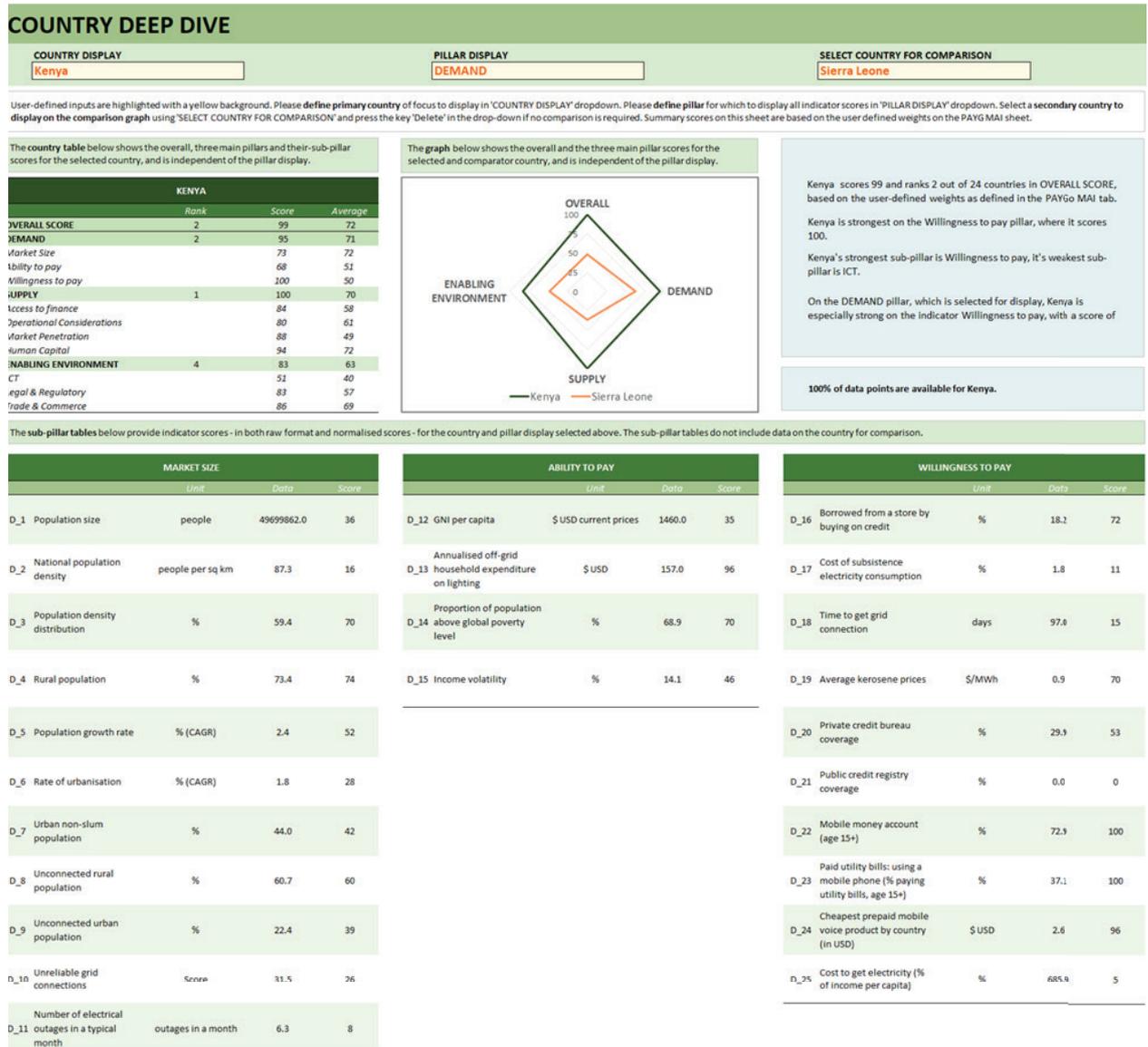
The bottom half of the page shows the indicator scores – in both raw format and for the normalized scores (between 0 – 100). These tables update to

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).

Figure 13. 'COUNTRY DEEP DIVE' tab



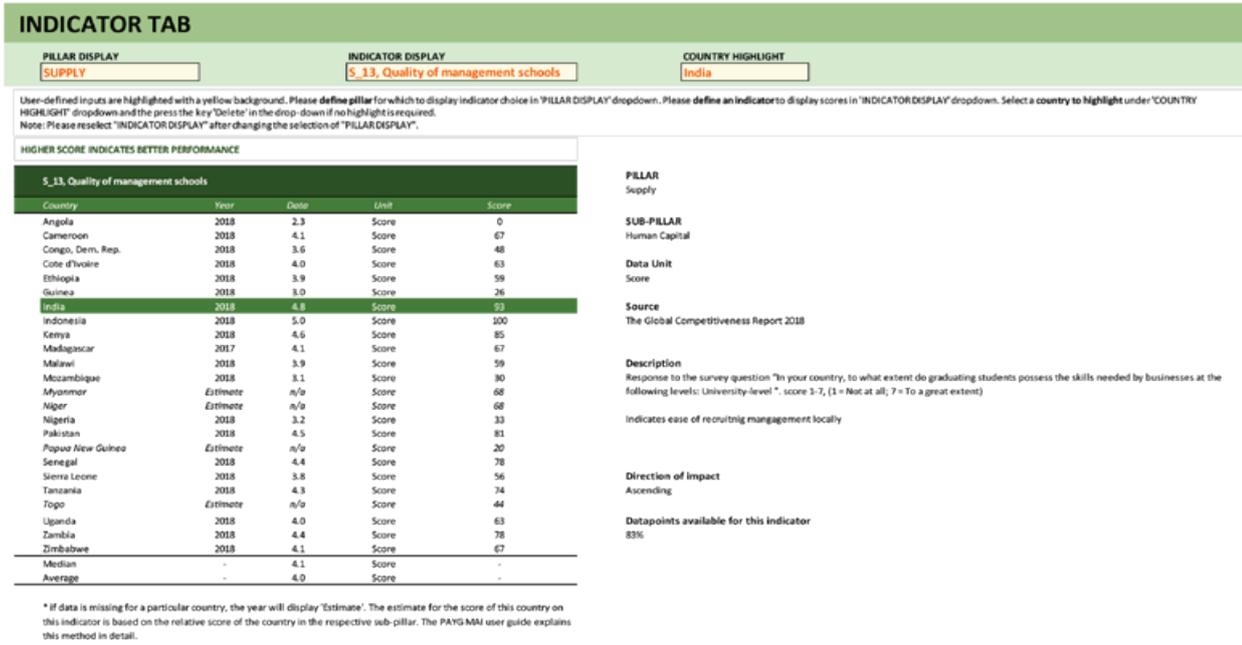
Source: PAYGo MAI, 2019 version

• The 'INDICATOR' tab

The indicator tab allows users to see the latest year of data, raw data and normalized scores by country for a single indicator. Next to the main results table, users find a selection of further summary details. These include the pillar and sub-pillar location of the selected indicator, the unit of measurement, source, a description of the indicator as well as the direction of impact. In addition, Median and Average values for the selected indicator are displayed. Where the indicator value is unavailable for a country, the "year" column will display "Estimate," and the data column will display "n/a."

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. Only when PILLAR DISPLAY and INDICATOR DISPLAY match, will the overview table display values.

Figure 14. 'INDICATOR' tab

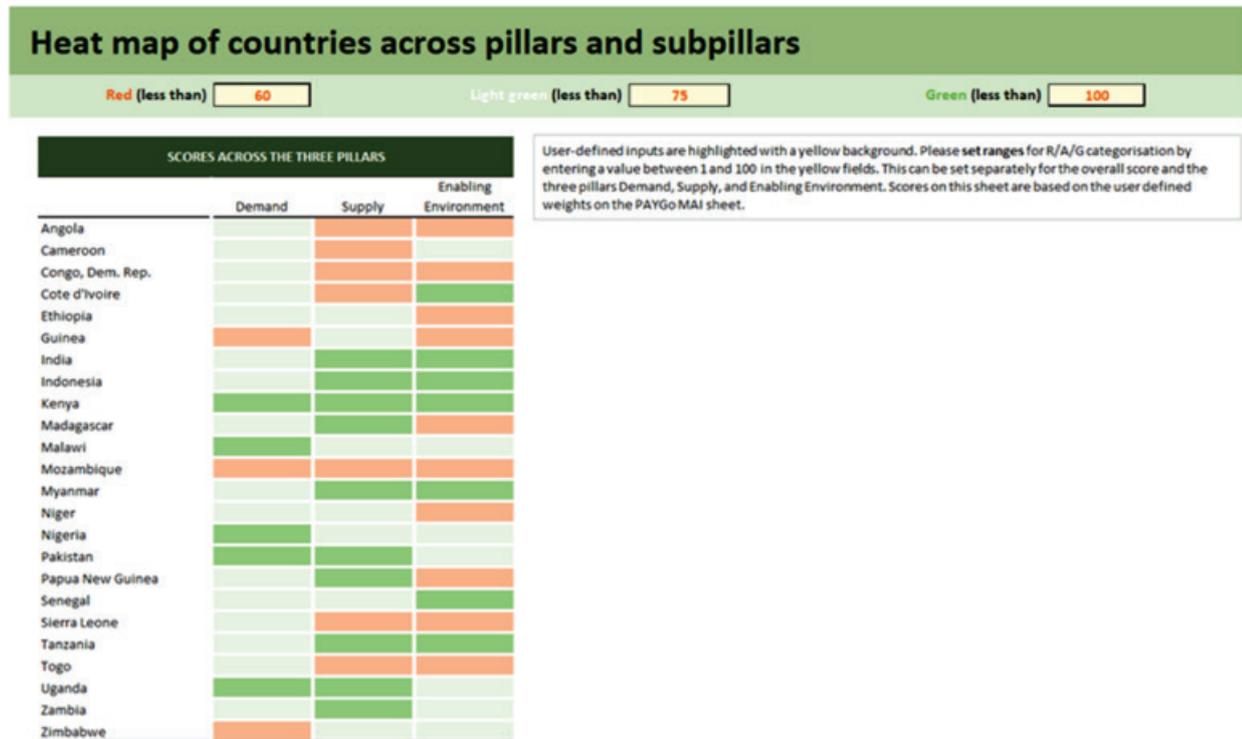


Source: PAYGo MAI, 2019 version

• The 'HEAT MAP' tab

Based on user selected definition of limits for "Orange," "Light Green" and "Dark Green," countries scores are displayed as heatmaps. Heatmaps facilitate quick comparison of countries across pillars and sub-pillars. Again, the displayed scores are based on user selected weights in the PAYGo MAI tab.

Figure 15 'HEAT MAP' tab





Source: PAYGo MAI, 2019 version

## COMPLETE LIST OF INDICATORS

### Demand side pillar indicators

Table 3. Market size indicators

#	Name	Description	Year	Source	Impact direction and rationale
D_1	Population size	Absolute population size	2017	WB World Development Indicators	Ascending - An indicator of absolute size of market
D_2	National population density	Average population density across country	2017	WB World Development Indicators	Ascending - Dense populations typically easier to reach
D_3	Population density distribution	Proportion of population that is "medium density", i.e. < 1000 pp / sq km and > 100 pp / sq km	2015	Vivid modelling, based on UN WPP density data	Ascending - Medium density population best target market for SHS style technologies
D_4	Rural population	Proportion of population not living in urban areas	2017	WB World Development Indicators	Ascending - Rural population an important market
D_5	Population growth rate	Rate of population growth between 2015 and 2025	prediction to 2025	WB World Development Indicators	Ascending - Indicator of future market size
D_6	Rate of urbanization	Rate of urbanization between 2015 and 2025	prediction to 2025	WB World Development Indicators	Descending - Indicator of increase in population living in urban centres – can be a driver of demand where grid is unreliable
D_7	Urban non-slum population	Proportion of urban homes not classified as slums	2014	WB World Development Indicators	Ascending - Slum populations typically less suited to technology solution which requires payback over a period of years
D_8	Unconnected rural population	Proportion of rural population with no access to electricity.	2016	WB World Development Indicators	Ascending - Indicator of relative market size in rural areas
D_9	Unconnected urban population	Proportion of urban population with no access to electricity	2016	WB World Development Indicators	Ascending - Indicator of relative market size in urban areas
D_10	Unreliable grid connections	Vivid calculations based on World Bank Enterprise surveys, "Percent of firms experiencing electrical outages"; "Number of power outages per month and average duration for all countries, reported by enterprises"; "If there were outages, average duration of a typical electrical outage (hours)"	2017	World Bank Enterprise surveys (this source changed from the first version of the PAYGo MAI, for better country coverage)	Ascending - Households with an unreliable grid connection may use OGS solutions as an alternative / back-up
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	2017	Enterprise Surveys, World Bank	Ascending - Households with an unreliable grid connection may use OGS solutions as an alternative / back-up

Source: PAYGo MAI 2019

Table 4. Ability to pay indicators

#	Name	Description	Year	Source	Impact direction and rationale
D_12	GNI per capita	Annual gross national income per capita (Atlas method). GNI per capita is the dollar value of a country's final income in a year, divided by its population. It reflects the average income of a country's citizens.	2017	World Development Indicators, World Bank Group	Ascending - Higher income indicates higher ability to pay
D_13	Annualized off-grid household expenditure on lighting and mobile phone charging	Estimated average annual lighting spend by the off-grid household (\$/year)	2012	Bloomberg New Energy Finance based on UNEP, published in Off-Grid Solar Market Trends Report 2016 (this source changed from the first version of the PAYGo MAI, for better country coverage)	Ascending - Current spending on energy products indicates ability and willingness to pay
D_14	Proportion of population above global poverty level	Proportion of population above global poverty level (2011 PPP \$2/day)	2017 (projection)	Vivid Economics projection to 2017 baseline scaled for expected shift between income categories in line with income growth, based 2011 World Bank data presented in Pew Research Center (2015)	Ascending - Indicates relative share of population above ability to pay threshold income
D_15	Income volatility	Weighted average volatility of crop yields for all major crop types (>5% of annual production)	2017	Analysis of FAO crop yield data 1990 – 2017	Descending - Income volatility can present a challenge to PAYGo, as presents a challenge to meet regular repayment schedules

Source: PAYGo MAI 2019

Table 5. Willingness to pay indicators

#	Name	Description	Year	Source	Impact direction and rationale
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. (age group 15+)	2014	Findex, World Bank	Ascending - Previous experience with buying on credit increases willingness to enter a credit-based contract
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	2015	RISE 2016, SE4ALL	Ascending - High cost of alternative electricity consumption increases willingness to pay
D_18	Time to get grid connection	Time required to get electricity (days)	2019	WB Doing Business	Ascending - High effort required for getting grid connection partly increases willingness to pay
D_19	Average kerosene prices	Average price in US\$ per one liter of kerosene	2016	Climatescope	Ascending - Kerosene is an important cooking and lighting fuel for unconnected households, high Kerosene prices increase willingness to pay for electricity
D_20	Private credit bureau coverage	Percentage of adults covered by private credit	2019	WB Doing Business	Ascending - Indicator for financial inclusion and willingness to engage in a credit model
D_21	Public credit registry coverage	Percentage of adults covered by public credit	2019	WB Doing Business	Ascending - Indicator for financial inclusion and willingness to engage in a credit model
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	Findex, World Bank	Ascending - Indicates share of population that could use mobile money based PAYGo payment mechanisms
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	Findex, World Bank	Ascending - Indicates share of population already using mobile money to pay for similar service
D_24	Cheapest prepaid mobile voice product by country (in USD)	Cheapest prepaid mobile voice product, 30 Calls / 100 SMS	2017	International Telecommunications Union 2017	Descending - Lower cost of mobile phone products raises prevalence of mobile based payment mechanisms
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 and paying a security deposit.	2019	Doing Business, World Bank	Ascending - High cost of setting up electricity connection increase willingness to pay for alternative. Given the focus on establishing the connection of a warehouse, this indicator reflects most closely the cost to get electricity for commercial use.

Source: PAYGo MAI 2019

## Supply side pillar indicators

Table 6. Access to finance indicators

#	Name	Description	Year	Source	Impact direction and rationale
S_1	Firms who don't identify access to finance as a major constraint	Percentage of firms that do not state they are identifying access to finance as a major constraint	various, latest 2017	Enterprise Surveys, World Bank	Ascending - PAYGo has high upfront capital requirements - only repaid over time of repayment from customers
S_2	Affordability of financial services	Answer to the question: In your country, to what extent can small- and medium-sized enterprises (SMEs) access finance they need for their business operations through the financial sector? [1 = not at all; 7 = to a great extent]	2018	The Global Competitiveness Report 2018	Ascending - Indicates access to finance for SMEs
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 = extremely easy]	2018	The Global Competitiveness Report 2018	Ascending - Indicates access to early stage equity for startup businesses
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. [0 to 100, 100 being the least risky]	2018	BMI Research, 2018	Ascending - Indicates ease of financial operations for businesses - PAYGo companies may need to work in different currencies / move capital with ease
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. [0 to 100, 100 being the least risky]	2018	BMI Research, 2018	Ascending - Indicates ease of financial operations for businesses - PAYGo companies may need to work in different currencies / move capital with ease

Source: PAYGo MAI 2019

Table 7. Supply side operational indicators

#	Name	Description	Year	Source	Impact direction and rationale
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. The RAI was developed in 2003 as a measure of transport connectivity using spatial data and techniques and comprising data on both road density and road condition.	various	Roberts, Peter; KC, Shyam; Rastogi, Cordula. 2006. Rural Access Index <sup>6</sup>	Ascending - Indicates ease of distributing OGS products to rural populations
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 5	2018	Vivid modelling based on various sources <sup>7</sup>	Descending - Indicates availability of solar resource to power technology
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 modelling based on various sources	Descending - Indicates availability of solar resource to power technology

Source: PAYGo MAI 2019

6 <https://openknowledge.worldbank.org/handle/10986/17414> License: CC BY 3.0 IGO

7 <http://fr.allmetsat.com/climat/tanzanie-rwanda-burundi.php?code=63844>

Table 8. Market penetration indicators

#	Name	Description	Year	Source	Impact direction and rationale
S_9	Number of PAYGo players in market	Number of active PAYGo companies in a market at the given time of research. Includes only companies that offer SHS in combination with consumer credit	2018	Dalberg 2018, own research	Ascending - Active existing market demonstrates feasible conditions
S_10	Total decentralised solar capacity installed excluding minigrids	Sum of decentralised solar capacity, excluding minigrids, installed in the country	2018	IRENA Decentralised Renewable Energy Dashboard	Ascending - Indicates broader penetration of similar decentralised solar products
S_11	Most recent sales volume of PAYGo, PICO and SHS products	The total sum of solar units sold in the second half of 2018.	2018	GONGLA	Ascending - Active market in most recent half-year of sales demonstrates feasible / attractive current conditions. Based on sales data collected from GONGLA members and Lighting Global associates.
S_12	Cumulative sales volumes of PAYGo, PICO and SHS since 2014	The cumulative sum of solar units sold since the second half of 2014.	2018	GONGLA	Ascending - Cumulative sales of OGS products indicates success in reaching consumer base

Source: PAYGo MAI 2019

Table 9. Human capital indicators

#	Name	Description	Year	Source	Impact direction and rationale
S_13	Quality of graduate schools	Response to the survey question "In your country, to what extent do graduating students possess the skills needed by businesses at the following levels: University-level " score 1-7, (1 = Not at all; 7 = To a great extent)	2018	The Global Competitiveness Report 2018	Ascending - Indicates ease of recruiting management locally
S_14	Local availability of specialized training services	Response to the survey question: "In your country, to what extent do companies invest in training and employee development?" score 1-7, (1 = not at all; 7 = to a great extent)	2018	The Global Competitiveness Report 2018	Ascending - Indicates climate for specialised training in the local labour market
S_15	Quality of secondary education	Response to the survey question "In your country, to what extent do graduating students possess the skills needed by businesses at the following levels: a. Secondary education" . score 1-7, (1 = Not at all; 7 = To a great extent)	2018	The Global Competitiveness Report 2018	Ascending - Indicates alignment of local education systems to business needs
S_16	Gross tertiary education enrolment rate	Gross enrolment ratio in tertiary education in % of relevant age group	2017	World Development Indicators (this source changed from the first version of the PAYGo MAI, for better country coverage)	Ascending - General indicator of availability of high-skill labour
S_17	Living languages count	Count of living languages	2017	Simons, Gary F. and Charles D. Fennig (eds.). 2018. Ethnologue: Languages of the World	Descending - Language diversity can pose challenges for operating distribution networks
S_18	Linguistic diversity index	Variation of local languages, index. Index score 0 - 1	2017	Simons, Gary F. and Charles D. Fennig (eds.). 2018. Ethnologue: Languages of the World	Descending - Language diversity can pose challenges for operating distribution networks
S_19	Availability of government certified training programmes for solar equipment installation	Response to the survey question: "Is there a government certified program for solar equipment installers?"	2015	RISE 2016, SE4ALL	Ascending - Indicates specific government supported training for skills required for solar sector

Source: PAYGo MAI 2019

## Enabling environment indicators

Table 10. Information and communications technology indicators

#	Name	Description	Year	Source	Impact direction and rationale
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.	2017	International Telecommunication Union, World Telecommunication/ICT Development Report and database	Ascending - Indicates favourable conditions for mobile / internet-based payment mechanisms
EE_2	Secure Internet servers	Secure servers are servers using encryption technology in Internet transactions	2018	World Development Indicators, from Netcraft	Ascending - Indicates favourable conditions for mobile / internet-based payment mechanisms
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. Annual weighted average of the percentage of the population	2017	World Bank Sustainable Development Goals, from International Telecommunication Union, World Telecommunication/ICT Development Report and database	Ascending - Indicates favourable conditions for mobile / internet-based payment mechanisms
EE_4	SIM penetration	Proportion of the population making use of a SIM	2018	GSMA intelligence Q4 2018	Ascending - Indicates favourable conditions for mobile / internet-based payment mechanisms
EE_5	Mobile broadband	Proportion of the population with mobile broadband use	2018	GSMA intelligence Q4 2018	Ascending - Indicates favourable conditions for mobile / internet-based payment mechanisms
EE_6	Number of mobile connections per capita	Ratio of number of mobile connections to total population, connections per capita	2018	World Bank population data 2017, and GSMA data on total mobile connections	Ascending - Indicates favourable conditions for mobile / internet-based payment mechanisms

Source: PAYGo MAI 2019

Table 11. Legal and regulatory indicators

#	Name	Description	Year	Source	Impact direction and rationale
EE_7	Do national programs to develop or support stand-alone systems exist?	Response to the question: Do national programs to develop or support stand-alone systems exist?	2017	RISE 2018, SE4ALL	Ascending - Indicates favourable regulatory environment for OGS technology solutions
EE_8	Has the government adopted international quality standards for standalone systems?	Response to the question: Has the government adopted international quality standards for standalone systems?	2017	RISE 2018, SE4ALL	Ascending - Indicates favourable regulatory environment for OGS technology solutions
EE_9	Are there environmental regulations on disposal of solar devices and SHS components?	Response to the question: Are there environmental regulations on disposal of solar devices and SHS components?	2017	RISE 2018, SE4ALL	Ascending - Indicates favourable regulatory environment for OGS technology solutions
EE_10	Do subsidies exist for solar modules?	Response to the question: Do solar modules subsidies exist?	2015	RISE 2016, SE4ALL	Ascending - Indicates favourable regulatory environment for OGS technology solutions
EE_11	Do duty exemptions for solar modules exist?	Response to the question: Do duty exemptions for solar modules exist?	2015	RISE 2016, SE4ALL	Ascending - Indicates favourable regulatory environment for OGS technology solutions
EE_12	Do duty exemptions for other equipment related to stand-alone systems exist?	Response to the question: Do duty exemptions for other equipment related to stand-alone systems exist?	2015	RISE 2016, SE4ALL	Ascending - Indicates favourable regulatory environment for OGS technology solutions
EE_13	Do subsidies exist for stand-alone systems?	Response to the question : Do subsidies exist for stand-alone systems?	2015	RISE 2016, SE4ALL	Ascending - Indicates favourable regulatory environment for OGS technology solutions
EE_14	Do duty exemptions exist for stand-alone systems?	Response to the question: Do duty exemptions exist for stand-alone systems?	2015	RISE 2016, SE4ALL	Ascending - Indicates favourable regulatory environment for OGS technology solutions
EE_15	Do government incentives exist for renewable electricity?	Does the government offer other direct fiscal incentives for renewable electricity (e.g. capital subsidies, grants or rebates, investment tax credits, tax reductions, production tax credits, FITs for large producers?)	2017	RISE 2018, SE4ALL	Ascending - Indicates favourable regulatory environment for OGS technology solutions
EE_16	Do specific financing facilities exist for operators in energy access?	Are there specific financing facilities (access to credit etc.) available to support operators (of tandalone home systems)?	2017	RISE 2018, SE4ALL	Ascending - Indicates favourable regulatory environment for OGS technology solutions

Source: PAYGo MAI 2019

Table 12. Trade and commerce indicators

#	Name	Description	Year	Source	Impact direction and rationale
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. (0=low to 8=high)	2017	World Bank, Doing Business project	Ascending - Indicates availability of information on credit for consumers and companies
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. (0=weak to 12=strong)	2017	World Bank, Doing Business project	Ascending - Indicates strength of legal rights and contracts for financial services
EE_19	GDP (PPP and constant 2011 US\$)	GDP in purchasing power parity, constant US 2011 prices	2015	World Development Indicators	Ascending - Indicator of general economic conditions
EE_20	Annual GDP growth	Expected GDP growth rate 2015 - 2025	2016	World Development Indicators	Ascending - Indicates expected growth and improved economic conditions
EE_21	Ease of doing business index (1=easiest to 185=most difficult)	Ease of doing business, from the World Bank Doing Business project. (1=easiest to do business, 185 most difficult)	2017	World Bank, Doing Business	Descending - Indicates ease of business operations
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 (scale of 0 to 100, where 0 is highly corrupt and 100 is very clean)	2017	Transparency International	Ascending - Indicates perception of corruption
EE_23	Global Peace Index	Ranks 163 independent states and territories according to their level of peacefulness. (1-5, 1 being very peaceful)	2017	Visions of Humanity	Descending - Indicates peaceful environment to conduct business
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	World Bank, Doing Business project	Descending - Indicates cost of import (general) - which will typically be required for OGS products
EE_25	Cost to enforce a contract	Cost as a percentage of total claim	2017	World Bank, Doing Business project	Descending - Indicates cost of enforcing contract
EE_26	Cost to start a business	Cost as a percentage of income per capita	2017	World Bank, Doing Business project	Descending - Indicates cost to start new business operations
EE_27	Minimum paid-in capital required to start a business	Paid in capital as a percentage of income per capita	2017	World Bank, Doing Business project	Descending - Indicates capital constraints to starting new business operations

Source: PAYGo MAI 2019

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