A decentralized approach for assessing energy access at the household level to monitor and maximize the impact of inclusive finance towards SDG7

Dr.-Ing. Natalia Realpe Carrillo (natalia@hedera.online)
Colombian
HEDERA & Institute for Energy Engineering, TU Berlin
Hardenbergstr. 38, 10623, Berlin, Germany

Dr. Lilo Wagner (lilo@hedera.online)
German
HEDERA
Hardenbergstr. 38, 10623, Berlin, Germany

Ing. Alberto Diaz-Durana (alberto@hedera.online)
Colombian
HEDERA & Institute for Energy Engineering, TU Berlin
Hardenbergstr. 38, 10623, Berlin, Germany

Dr. Alfonso Caiazzo (alfonso@hedera.online)
Italian
HEDERA
Hardenbergstr. 38, 10623, Berlin, Germany

Abstract

Assessing the progress towards SDG7 requires a detailed analysis of energy needs and energy access at the individual household level. This paper examines the effectiveness of the application of the Multi-Tier Framework (introduced by The World Bank), in combination with mobile data collection tools optimized for the microfinance industry, for such assessment. Decentralized data collection is commonly used for internal evaluation purposes. It is possible to integrate these procedures into the acquisition of information related to clients' energy needs, as well as report the impact on SDG7 based on the collected data, using the latest standard indicators. This innovative approach is discussed in terms of cost reduction, feasibility, and quality of information, as well as its potential for large scale implementation, based on preliminary test implementation in Latin America and Africa.

Keywords: Energy access; Multi-Tier Framework; Data Collection; Impact Assessment.

Introduction

The Sustainable Development Goals (SDGs) provide a framework to encourage the synchronization of initiatives and increase available funds and tools in order to meet the goals and "not leave anyone behind". Although the public sector has acknowledged an increasing commitment towards these targets, active collaboration with the private sector is urgently needed. The time is right for this; more and more investors are being sensitized to sustainability issues, and, thus, capital is not the main concern. Especially in Africa, untapped investment opportunities and the growth of financial and technological innovations can be harnessed to support the implementation of the SDGs [SDGC/A, 2019]. However, the monitoring of progress, still carried out voluntarily, remains incomplete. In this constellation, it is imperative to establish functional tools and good practices to set a common language regarding the specific goals and track the progress towards these targets.

Financing energy access, whether through green microfinance or pay as you go (PAYG) mechanisms,

has demonstrated that overcoming financial barriers to energy access is possible. However, inclusive financial institutions are rarely aware of the energy needs of their customers. For this reason, these institutions are far away from fully exploiting their potential to offer, in addition to financial services, modern energy services that enhance energy inclusion (Realpe Carrillo et al., 2015). This suggests that a better and more detailed data and impact management system could play a decisive role in assisting financial institutions and other inclusive finance stakeholders in efficiently addressing their triple bottom line, combining social, financial, and environmental goals. Moreover, efficient tools, in combination with detailed and comprehensive methodologies, are needed to assess the outcome of these programs in a standardized manner and, eventually, mobilize more public and private investment.

This article focuses on innovative approaches to assessing, monitoring, and reporting the impact of inclusive finance towards SDG7. Currently, the commonly used metrics for reporting impact are insufficient because they only track data on an institutional level (e.g. number of systems sold, carbon dioxide emissions reduction through the accountability of systems, etc.). This can only provide limited insight into clients' needs and progress. Moreover, despite the existence of multiple indices developed to evaluate green microfinance (Pierantozzi et al., 2015), neither has the impact of these programs on the microfinance clientele's energy access been measured, nor has an index to measure and track the deprivation of access to modern energy services been specifically developed for the microfinance industry.

SDG 7 dictates "ensuring affordable and reliable energy access" for all, thereby recognizing the expected quality of such access and the crucial role of energy access in development. The goal is subdivided into three sub-targets to be reached by 2030: 7.1 Ensure universal access to affordable, reliable, and modern energy services; 7.2 Substantially increase the share of renewable energy in the global energy mix; and 7.3 Double the global rate of improvement in energy efficiency. Wykes et al. (2015) claim that the indicators for target 7.1 should at least include the attribute of safety, so as to avoid potential conflicts between the overall energy SDG and other climate and health-related targets. In order to ensure significant change, progress towards the SDGs should be tracked through clear milestones with specific indicators aligned with definitions and methodologies in the sector. However, several methods for measuring energy access significantly underestimate the scale of the challenge (Global Tracking Framework, 2015).

For instance, counting connections to the grid is an insufficient measure of energy poverty [Practical Action, 2013; IEA/WB, 2014]. Such *binary* metrics ignore the progress made by decentralized energy technologies, which provide energy to households in off-grid areas. This means that, as of today, since the baseline energy access criterion is the percentage of people living on and off the grid respectively [SER4ALL 2019], decentralized energy technologies are not accounted for in measuring progress towards the SE4ALL goal.

The World Bank's Energy Sector Management Assistance Program (ESMAP), with the support of more than thirty international organizations, has developed a framework for measuring energy access [Banerjee et al., 2013], heralded as a "new milestone" in energy measurement. The Multi-Tier Framework (MTF), introduced by ESMAP in 2013 (Bensch, 2013), assesses energy access based on several attributes (e.g. reliability, affordability, etc.), measured either by binary indicators or along a graded scale. The performance of a combination of these individual attributes determines the assignment of a specific tier, which in turn reflects the level of electricity access.

The purpose of this article is, first, to investigate the applicability and practicability of the usage of the MTF framework for tracking the progress of energy access at the household level, for microfinance clients. Second, it investigates the potential of digitization, and its main hurdles, in the context of impact reporting. Third, it seeks to identify the missing links that would enable the framework to be used on a large scale. Based on the application of the developed toolkits for data collection, the article shows and discusses the results of practical implementation of the application in the field. Finally, the paper proposes steps on how to fill these missing gaps in data collection, analysis, and reporting.

Research Objectives

The main goal of this paper is to introduce an innovative, efficient method for measuring financial institutions' impact on improvement in energy access at the household level. This method combines the latest standards and modern digital tools to efficiently measure the impact of microfinance institutions on enhancing the energy access of their clients.

To this end, the first objective of the article is to introduce the latest quantitative approaches to evaluating green microfinance initiatives. In particular, we will focus on the recently introduced MTF and discuss its main characteristics, as well as possible opportunities for improvement and variants proposed in the literature, such as the Progress out of Energy Poverty Index (PEPI) (Realpe Carrillo, 2017). We aim to demonstrate how organizations can track progress towards SDG7 using the MTF approach to measuring energy access at the household level. Furthermore, we investigate how the MTF can be used to measure progress over time, rather than just depicting the status quo at a given point in time by applying the PEPI methodology. The second objective of this research is to assess the feasibility of decentralized approaches in household energy surveys, where the data collection is executed by the staff of the financial institution using a mobile app. Smooth implementation and good data quality are crucial aspects for evaluating the potential of the proposed approach. In particular, we investigate and discuss the technical requirements and relevant features for mobile data collection, based on the results of implementation in the field. The third objective is to present a collection of baseline data from field-level implementation in Peru, Mozambique and Mexico and, based on the data collection experiences, identify and describe the challenges in large-scale implementation.

Methodology

To meet the objectives outlined above, we will use a mix of different methodologies: literature reviews, our own theoretical considerations, the integration of feedback from major inclusive finance stakeholders, and case studies that demonstrate the feasibility and challenges of decentralized approaches.

The Multi-Tier Framework

The methodology for the analysis of energy access entails the application of the World Bank/ESMAP MTF (Bhatia and Angelou, 2015) in order to identify the missing links in present energy service supply that keep households from attaining higher tier levels.
Aiming to capture a dataset that can provide detailed insights and identify the most relevant indicators for the tier-ranking, the MTF assesses energy supply at the level of households, productive activities, and community infrastructure. The six tier levels (with 0 being the lowest performing and 5 being the highest) reflect the diverse energy access spectrum and the ability to provide meaningful differentiation between energy access attributes. The tiers are defined independently from the technology, which is key for energy access measurement (Bazilian et al., 2010). As originally released, the multi-tier standards, with binary and gradual indicators for the attributes associated with household electricity supply and cooking facilities, are complemented by two separate multi-tier frameworks for access to electricity services and electricity supply (we refer to Bhatia and Angelou, 2015 for details). These two frameworks are required because, despite the fact that the electricity services and supply frameworks are quite aligned, supply metrics are only indicative, due to the diversity of appliances a household might be able to use, as well as the potential use of energy efficient appliances not necessarily reflected in the estimated thresholds.

This study examines household energy access. The article will thus focus solely on electricity access (supply, consumption, and services) and cooking solutions, excluding the frameworks for productive and community uses. Analysis of results provides insights for possible future interventions, through the investigation of deficiencies in energy supply performance and the potential roles microfinance stakeholders could play to bridge the gap.

The Progress out of Energy Poverty Index

Following MTF, PEPI was developed with the aim of providing a framework for rating the progress with respect to energy access quality against different tiers of performance (Realpe Carrillo, 2017). In PEPI, the MTF attributes are grouped in wider dimensions, measuring specifically the indicators assigned for each

sub-target of SDG7: Reliability, Affordability, and Safety (concerning access to electricity) and Availability, Safety, and Affordability (access to modern cooking solutions).

The PEPI also takes into account a series of modifications of the MTF, incorporating several suggestions from Groh et al., (2016), expanding the attributes of reliability, affordability, and legality to enable tracking of improvements in interventions, and separating the attributes of health and safety, considering health hazards, injuries, and diseases that might be caused by the energy supply or fuel. Finally, instead of requiring laboratory testing of cooking stoves, health and safety are assessed on a more empirical level, according to the level of ventilation, the cooking place, and the level of hazards the household is exposed to through the cooking fuel or stove. We refer to Realpe Carrillo, (2017) for details.

Household data collection

The data collection was implemented using **HEDERA collect**, a mobile survey app developed by HEDERA[1]. The mobile survey is based on an optimized version of the ESMAP questionnaire[2] and has been extensively tested in the framework of this research project.

Case Studies

This paper discusses the results obtained in three case studies implemented with different institutions. The scope of these studies was to assess, in addition to the results related to the energy access of microfinance clients, the adaptation of the different microfinance institutions (MFIs) to the digital tools.

Fondesurco (Region of Arequipa, Peru) The HEDERA collect tool was tested March 5-April 16, 2019 by the Peruvian MFI Fondesurco, which has a decade of experience in disbursing green loans. Fondesurco has a relatively low degree of digitization of internal processes. The energy survey was implemented for new clients only, in five different offices. The data collection process consisted of two steps. First, the loan officers (eight in total) recorded the Global Positioning System (GPS) of each client during the first visit. Subsequently, upon approbation of the loan, the full energy survey was conducted by phone from the main office. During the first three weeks, regular meetings (remotely, once a week) were organized between HEDERA and the institution, whereas in the last three weeks, the data collection process did not require any external support.

Microbanco Confiança (Region of Maputo, Mozambique) The HEDERA collect tool was tested March 8-April 15, 2019 by the Mozambique microfinance institution Microbanco. So far, the MFI has not had any experience distributing or financing decentralized energy technologies; however, it has previously identified energy access as a major need of its clients. Although client assessment and analysis is mainly paper-based, Microbanco is currently assessing different tools for digitizing its processes. The application of the tool included the digitization of its own forms used to assess the credit worthiness and risk of its potential clients. The data collection (access to electricity) was directly conducted by the loan officers in the field in multiple locations.

Te Creemos (Mexico) The HEDERA collect tool was tested July 12-24, 2019 by Te Creemos, a large Mexican microfinance institution with more than 800,000 clients in rural, peri-urban, and urban areas across the country. Te Creemos has already implemented several measures for the digitization of their financial and internal processes. For the case study, HEDERA trained the coordinator of the technical team of the microfinance institution, who then communicated with eighty loan officers in different locations, performing the installation completely remotely. More than 500 data points were collected within two weeks.

Results

Our results show that the MTF is well suited to provide a detailed picture of each household's level of energy access. Besides the standardized ranking in different tiers, which enables identification of the major issues of each client, the implemented energy survey

[1] www.hedera.online

[2] See, e.g., the household questionnaire used for the country assessment in Rwanda, available at https://datacatalog.worldbank.org/dataset/rwanda-multi-tier-framework-mtf-survey-2018

provides financial institutions with additional information on their clients' most urgent needs. Integrating additional client information and analyzing the energy access status with respect to other socio-economic data can help institutions deliver appropriate, targeted credit products to their customers. On the other hand, the MTF presents a framework for computing a baseline, and, in order to measure and monitor the impact of dedicated credit products, data collection needs to be regularly implemented.

Practical Aspects

From the practical point of view, the case study demonstrated that the data collection process via the HEDERA collect app could be easily done in the three institutions.

Installation, Training, & Usability In all cases, minimal training was required, and data collection proceeded without any major issues throughout the entire implementation period. None of the institutions reported major problems concerning the usage of the mobile app.

Interview Duration & Scalability In the case of Fondesurco and Te Creemos, where both electricity access and cooking solutions were analyzed, the implementation demonstrated that the survey can be completed in less than fifteen minutes per household on average. Moreover, our data revealed that interview time decreases over time, indicating that practicing the application of the mobile survey eventually leads to faster implementation.

Fondesurco

The survey of 137 clients revealed that, although the vast majority of clients are connected to the grid (all but two households), several households reported lower rankings in energy affordability, legality, and reliability (Figure 1).

Concerning access to cooking solutions, the majority of households have liquefied petroleum gas (LPG) stoves, although about 30% also use a secondary (firewood) stove. Households using primarily solid fuel (firewood or biomass) ranked in the lowest tiers, while clients using LPG mainly reported safety or affordability issues (Figures 2 & 3).

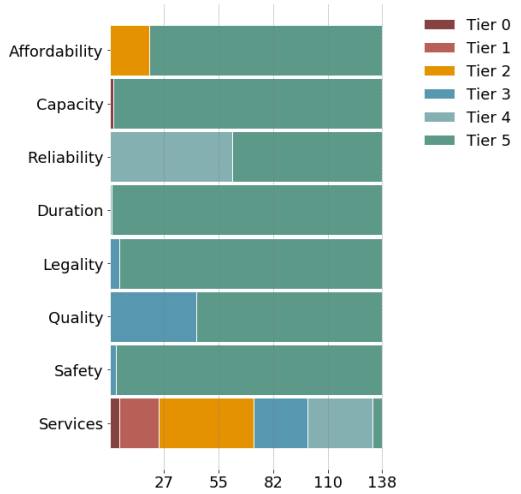


Figure 1: MTF Attributes (access to electricity) for Fondesurco clients

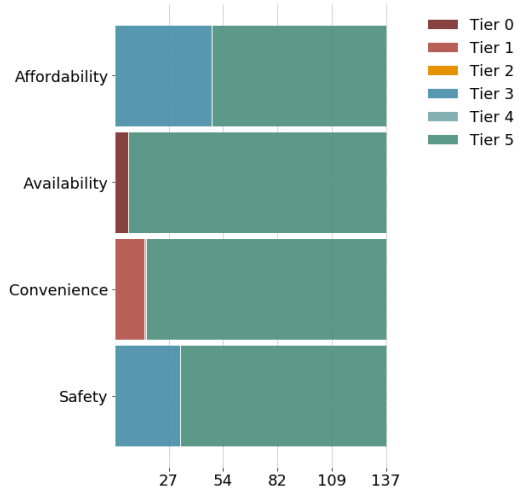


Figure 2: MTF Attributes (access to modern cooking solutions) for Fondesurco clients

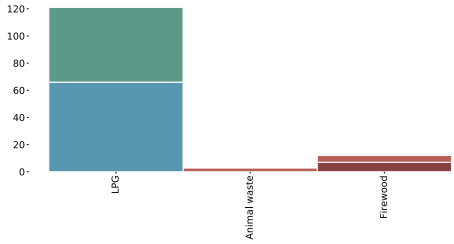


Figure 3: Tier ranking (cooking solutions) depending on the primary cooking fuel (Fondesurco)

Microbanco

Two loan officers from Microbanco interviewed 28 clients, focusing on their access to electricity. The results show that, although the majority (75%) are connected to the grid, tier ranking is extremely low due to the low quality and reliability of the service.

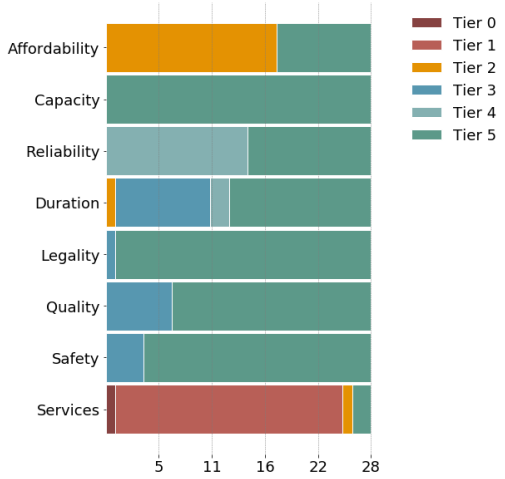


Figure 4: Attributes characterizing the access to electricity (Microbanco)

The lack of a grid connection is the main cause of the low ranking concerning access to electricity services. Affordability (60% ranked in Tier 2) and reliability (50% in Tier 4) were also reported as major issues (Figure 4). In particular, Figure 5 shows that only about 10% of connected households have been ranked in the highest Tier.

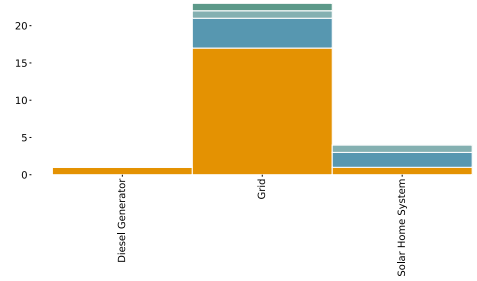


Figure 5: Tier ranking depending on the primary electricity source (Microbanco)

Te Creemos

In about two weeks, 561 household interviews were carried out by 70 loan officers in different branches of the institutions. Concerning electricity sources, the vast majority (90%) of clients are connected to the national grid. Nonetheless, only about 20% achieved the highest ranking (Tier 5), confirming the inability of binary metrics to capture the dimensionality of energy access. Among the different attributes, duration and safety (see Figure 6) are those where major issues have been reported.

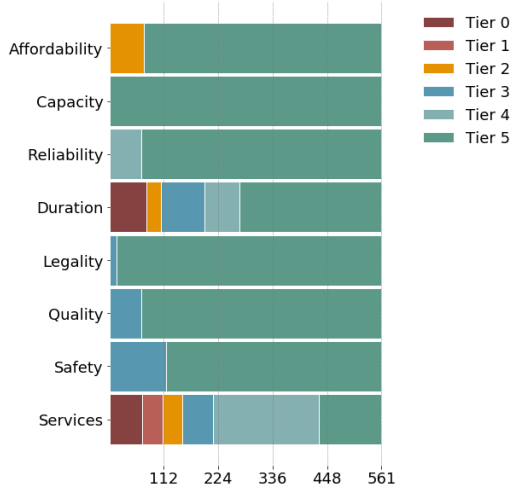


Figure 6: Attributes characterizing the access to electricity (Te Creemos)

About 75% of households primarily use LPG for cooking. The remainder rely mainly on natural gas (5%) and firewood (9%). Figure 7 shows that affordability of fuel and perception of risk were the principal reasons for reducing the ranking of households. Moreover, more than 90% of the households cooking with biomass reported the issue of limited convenience (long acquisition and preparation time) of the fuel.

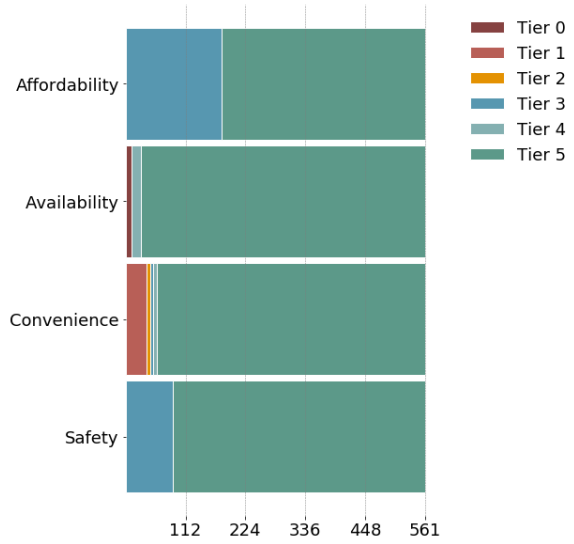


Figure 7: Attributes characterizing the access to modern cooking solutions (Te Creemos)

Discussion

Energy access has a multidimensional nature, and its assessment requires a framework in which various attributes are captured. In this article, we discuss how a baseline for the SDG7 can be accurately measured at the household level, based on the recently introduced Multi-Tier Framework.

The primary objective of this article is to discuss the potential of large-scale MTF application in microfinance. One major barrier to its implementation is related to the high costs involved in conducting household surveys (survey time and required technical knowledge). To address this challenge, we investigate the application of the MTF in combination with HEDERA collect, which integrates an optimized version of the MTF energy survey. The implemented case studies demonstrated that this decentralized approach drastically reduces the costs of data collection & analysis and can be integrated into existing client surveys with minimal training and additional effort.

The adoption of MTF (and related indices) enables institutions to understand the realities of the on-grid and off-grid populations they are serving, as well as those cooking with solid and non-solid fuels. Our results demonstrate that binary metrics (e.g. whether a household is connected or not connected to the grid) do not provide meaningful insights into households' energy needs.

The proposed decentralized approach also has significant potential for scale-up. Our study considered only a limited sample of clients in the three microfinance institutions. The interviewed households were selected by the institutions purely based on practical criteria (new clients, routine visits, etc.). Our goal is to ensure that – with the use of digitization and decentralization - baseline and progress assessment can be and is done with all clients of an MFI, integrating impact management practices into routine client visits and thus going far beyond an assessment based on a statistical sample. Moreover, by using data integration methods, such massive data collection concerning energy needs could be combined with available social and financial indicators (e.g. for credit assessment). This aspect, together with the integration of further SDG assessments (Clean Water & Sanitation, Education, and Gender Equality) are currently topics of ongoing research.

References

Allet, M. (2014) The Green Index, an Innovative Tool to Assess the Environmental Performance of MFIs. Technical Report, European Microfinance Platform.

Bhatia, M. and Angelou, N. (2015). Beyond Connections: Energy Access Redefined. ESMAP Technical Report 008/15, Washington. USA: The World Bank Group.

Banerjee S., Bhatia M., Azuela GE., Jacques I., Sarkar A., Portale E., Bushueva I., Angelou N., and Inon J.G. Global Tracking Framework (vol. 3). Working Paper 77889, World Bank, Washington, DC. May 2013.

Bensch, G. (2013) Inside the metrics: An empirical comparison of energy poverty indices for Sub-Saharan countries, Ruhr Economic Papers, No. 464.

Bensch, G. (2014) Tracking the Energy Poor. Empirical Insights on Energy Poverty Measurement Approaches. Technical report, International Association for Energy Economics.

Groh, S., Pachauri, S., and Narasimha, R. (2016). What are we measuring? An empirical analysis of household electricity access metrics in rural Bangladesh. Energy for Sustainable Development, 30:21-31.

Pierantozzi, A., Allet, M., Forcella, D., Huybrechts, F., Mauro, A., Realpe Carrillo, N., Spaggiari, L., and Shuite, G. (2015). Assessing green microfinance qualitative and quantitative indicators for measuring environmental performance. Technical report, Mix Market.

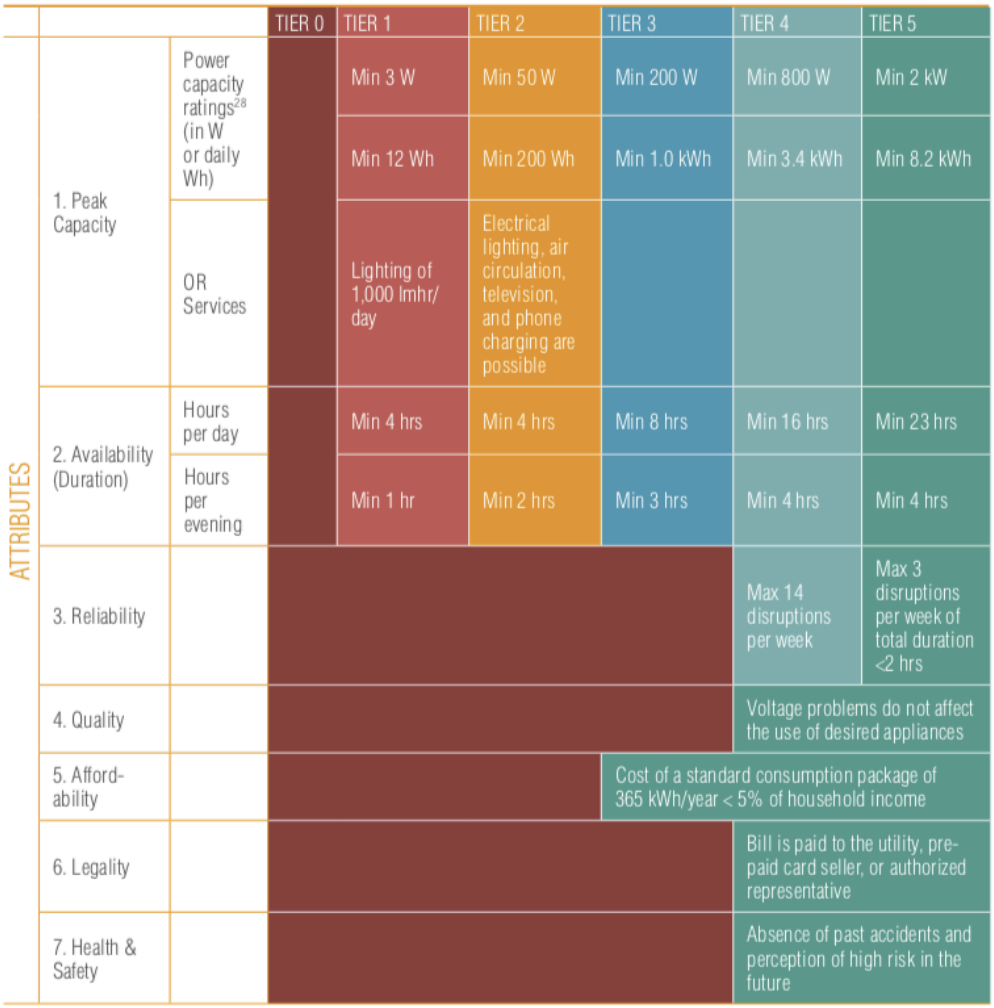
Realpe Carrillo, N. (2017) Measuring Energy Access at the Household Level: The Progress out of Energy Poverty Index (PEPI) Toolkit for the Microfinance Sector. PhD Dissertation. TU Berlin. Feb. 2017

SDGC/A (2019) Sustainable Development Goals Center for Africa, SDG Index and Dashboard Report, 2019.

Wykes, S., Stevens, L., and Singer, S. (2015). Measuring what matters in the SDG. Practical Action Publication.

Appendix: Multi-tier Framework Matrices

1 Multi-Tier Matrix: Electricity Supply Assessment at Household Level



ATTRIBUTES			TIER 0	TIER 1	TIER 2	TIER 3	TIER 4	TIER 5
	1. Peak Capacity	Power capacity ratings[28] (in W or daily Wh)		Min 3 W	Min 50 W	Min 200 W	Min 800 W	Min 2 kW
				Min 12 Wh	Min 200 Wh	Min 1.0 kWh	Min 3.4 kWh	Min 8.2 kWh
		OR Services		Lighting of 1,000 lmhr/ day	Electrical lighting, air circulation, television, and phone charging are possible			
	2. Availability (Duration)	Hours per day		Min 4 hrs	Min 4 hrs	Min 8 hrs	Min 16 hrs	Min 23 hrs
		Hours per evening		Min 1 hr	Min 2 hrs	Min 3 hrs	Min 4 hrs	Min 4 hrs
	3. Reliability						Max 14 disruptions per week	Max 3 disruptions per week of total duration <2 hrs
	4. Quality						Voltage problems do not affect the use of desired appliances	
	5. Afford-ability					Cost of a standard consumption package of 365 kWh/year < 5% of household income		
	6. Legality						Bill is paid to the utility, pre-paid card seller, or authorized representative	
	7. Health & Safety						Absence of past accidents and perception of high risk in the future	

2 Multi-Tier Matrix: Electricity Services Assessment at Household Level

	TIER 0	TIER 1	TIER 2	TIER 3	TIER 4	TIER 5
Tier criteria		Task lighting AND Phone charging	General lighting AND Phone Charging AND Television AND Fan (if needed)	Tier 2 AND Any medium-power appliances	Tier 3 AND Any high-power appliances	Tier 2 AND Any very high-power appliances

3 Multi-Tier Matrix: Energy Access Assessment At Household Level For Cooking Solutions

ATTRIBUTES			LEVEL 0	LEVEL 1	LEVEL 2	LEVEL 3	LEVEL 4	LEVEL 5
	1. Indoor Air Quality	$PM_{2.5}$ ($\mu g/m^3$)		[To be specified by a competent agency, such as WHO, based on health risks]	[To be specified by a competent agency, such as WHO, based on health risks]	[To be specified by a competent agency, such as WHO, based on health risks]	< 35 (WHO IT-1)	< 10 (WHO guideline)
		CO (mg/m^3)					< 7 (WHO guideline)	
	2. Cookstove Efficiency (not to be applied if cooking solution is also used for space heating)			Primary solution meets Tier 1 efficiency require-ments [to be specified by a competent agency consistent with local cooking conditions]	Primary solution meets Tier 2 efficiency require-ments [to be specified by a competent agency consistent with local cooking conditions]	Primary solution meets Tier 3 efficiency require-ments [to be specified by a competent agency consistent with local cooking conditions]	Primary solution meets Tier 4 efficiency require-ments [to be specified by a competent agency consistent with local cooking conditions]	
	3. Convenience: Fuel acquisition and preparation time (hrs/week)				< 7	< 3	< 1.5	< 0.5
	Stove preparation time (min/meal)				< 15	< 10	< 5	< 2
	4. Safety of Primary Cookstove	IWA safety tiers		Primary so-lution meets (provisional) IWA Tier 1 for Safety	Primary so-lution meets (provisional) IWA Tier 2	Primary so-lution meets (provisional) IWA Tier 3	Primary solution meets (provisional) IWA Tier 4	
		OR Past accidents (burns and unintended fires)					No accidents over the past year that required profes-sional medical attention	
	5. Affordability						Levelized cost of cooking solution (inc. cookstove and fuel) < 5% of house-hold income	
	6. Quality of Primary Fuel: variations in heat rate due to fuel quality that affects ease of cooking						No major effect	
	7. Availability of Primary Fuel						Primary fuel is readily available for at least 80% of the year	Primary fuel is readily available through-out the year