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IMPACT ASSESSMENT FRAMEWORK

JULY 2022

TVs

CONTEXT

The Framework for TVs is one of four Frameworks that aims to facilitate the reporting and shared measurement of impact evidence for a variety of stakeholders (e.g., distributors, developers, funders, appliance users and researchers). Ultimately, this project seeks to contribute to the creation of an industry-wide consensus for the assessment, reporting, and measurement of the impact of high-performing appliances.

This Framework was developed by Rural Senses, SVT, CLASP, and Energy Saving Trust as part of the Low Energy Inclusive Appliances programme, Efficiency for Access' foundational initiative. Efficiency for Access is a catalyst for change, accelerating the growth of off-grid appliance markets to boost incomes, reduce carbon emissions, improve quality of life and support sustainable development.

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The framework was authored by Yau Ben-Or, Ramit Debnath, Richa Goyal, Stephanie Hirmer, Makena Ireri, Thalia Konaris, Sara Olsen, David Pritchard, and Josephine Tumwesige.

The framework was developed using the best available evidence. Nevertheless, users of the framework should be aware of the limitations and caveats below. Given these limitations as well as changes that will occur over time, it is likely that when reviewing and using the Framework users may find one or many of the following apply:

- some indicators are no longer important to stakeholders
- the calculation of the indicator is not accurate
- data needed to calculate the indicator are impossible to obtain
- new evidence suggests improvements to the indicators or the creation of new indicators

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ABBREVIATIONS

*See the section Framework at a Glance for abbreviations for the variables used in the indicators. Please refer to the tables for input variables and standard variables, as well as the list of IDs used for indicators.

FAO	Food and Agriculture Organisation (UN)
FTE	Full-time equivalent
IRENA	International Renewable Energy Agency
MCDA	Multi-Criteria Decision Analysis
NGOs	Non-governmental organisations
NREL	(US) National Renewable Energy Laboratory
OPEX	Operational expenditure per litre over the lifetime of a technology
PV	Photovoltaic
RS-SVT	Rural Senses and SVT Group
SDG	Sustainable Development Goal
SHS	Solar home system

DEFINITIONS

Confidence level	The confidence level was assessed for each value for 'standard variables'. Three stars (***) indicate that a study is 'up to date' (i.e., conducted within five years of the assessment) and has, at the same time, a 'large sample size' (meaning that the data came from one study with 500+ samples or several studies with a total of 500+ samples). Two stars (**) indicate that studies are either 'up to date' or have a 'large sample size', and one star (*) indicates that the studies are not up to date and have a small sample size.
Degree of urbanisation	Description of territories or countries within three different categories of urbanisation as follows: (a) cities (densely populated areas); (b) towns and suburbs (intermediate density areas); (c) rural areas (thinly populated areas) (Eurostat, 2021).
End-user	People who use the appliances.
Formula	The specific data points necessary to calculate a given impact metric or indicator, and how they should be combined to arrive at the impact indicators result.
High-performing appliances	High-quality and efficient off- and weak grid appliances that are intentionally designed for end-users living in an energy-constrained environment and advertised for use primarily with a PV module or a solar home system.[1]
Indicator	The means by which an impact can be gauged.
Input variables	Variables that the framework user needs to provide data for.
Multi-criteria decision analysis	A process used to help make a decision or choice by explicitly evaluating multiple criteria that may be in conflict with each other to choose the best option.
Multi-criteria decision score	Potential indicators were given a score of 0, 1, or 2 depending on how well they satisfied several criteria that are desired of impact indicators. See section below on Multi-Criteria Decision Analysis and Appendix 1.
PAYGo	The Pay-As-You-Go (PAYGo) business model is an innovative financial mechanism that enables off-grid customers to pay for high-quality solar products in a 'rent-to-own' system. The innovation that emerged to address the energy access challenge and to provide electricity generated from renewable energy sources at affordable prices, with payments facilitated by technologies and mobile phone credit.[2]
Pipeline variables	Variables that are of interest but where data is not yet available. While there is no set plan for these pipeline variables, we invite people to undertake research to close the existing data gap.
Standard variables	Variables provided within the Framework based on existing evidence.
The Framework	The Impact Assessment Framework for off- and weak-grid high performing appliances. The Framework describes metrics, indicators and formula that are to be used to assess the social, environmental, and economic impacts of the four types of appliances. The Framework consists of Objective 1 from the original Efficiency for Access Request for Proposals: 'Suggested metrics for industry use to report impact' (the 'impact metrics'), and Objective 2: "Formula for impact indicators that the industry may be unable to report on but are nevertheless important to develop to provide a framework that could capture holistic impact" (the "impact indicators").
User	Those that use the Framework.
User-perceived value	This term applies to the appliance users and refers to "the benefits, concerns, feelings and underlying drivers that vary in importance and act as the main motivators in the lives of the people—as perceived and defined by the [people] themselves at a given time".[3]
Value	The regard that something is held to deserve; the importance, worth, or usefulness of something. Specifically with respect to impact assessment, value or social value is the quantification of the relative importance that people place on the changes they experience in their lives. Some, but not all of this value is captured in market prices. (Impact Management Project, N/A)
Variables	A quantity which, during the calculation of a formula, is assumed to vary or be capable of varying in value. (Oxford Languages, N/A)
Off- and weak-grid	A place that is not connected to the main electricity grid, or a system that suffers from frequent brown / blackouts and voltage fluctuations / instabilities.

1 Efficiency for Access, 'The State of the Off-Grid Appliance Market (2019) https://storage.googleapis.com/e4a-website-assets/Clasp-SOGAM-Report-final.pdf

2 Energypedia, Pay-as-you-go Approaches (2021), https://energypedia.info/wiki/Pay-as-you-go_Approaches_(PAYGO)

3 Stephanie Hirmer, Alycia Leonard, Josephine Tumwesige, and Constanza Conforti, Building Representative Corpora from Illiterate Communities: A Review of Challenges and Mitigation Strategies for Developing Countries,in Proceedings of the 16th Conference of the European Chapter of the Association for Computational Linguistics: Main Volume, (2021), no. iii, pp. 2176–2189, doi: 10.18653/v1/2021.eacl-main.186.

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Purpose and Context

This report outlines the Impact Assessment Framework for TVs used in off- and weak-grid settings. This Framework was developed in 2020–2022 in consultation with end-users, investors, donors, the Efficiency for Access Secretariat, and GOGLA Impact Working Group together with external partners, Rural Senses and SVT Group. You can read more about the development process here. This Framework for TVs is one of four standard Impact Assessment Framework for off- and weak-grid high performing appliances. The others frameworks are for fans, refrigerators and solar water pumps.

Purpose of the Framework

The framework aims to facilitate the shared measurement and reporting of the impacts of TVs for a variety of stakeholders (e.g., distributors, developers, funders, appliance users and researchers) through the development of evidence-based social, environmental, and economic impact indicators. Ultimately, this work seeks to contribute to the creation of an industry-wide consensus for the assessment, reporting and measurement of the impact of TVs. For more information on how this and the other three frameworks were developed, you are encouraged to consult the methodology report.

This report harmonises existing evidence from a wide range of studies into an easy to use and robust set of impact indicators for TVs. The report specifically captures impacts for TVs used for the first time, in a rural setting with recent access to electricity. Some of the suggested indicators can be used now to report impacts, while others are not yet ready, mainly due to a data gap. Indicators that are not yet ready are nevertheless important to develop to provide a framework that captures a holistic set of impacts.

Context

A holistic understanding of the impacts of high-performing appliances is important because they have been used increasingly over the years. GOGLA's report, Global Off-Grid Solar Market Report Semi-Annual Sales and Impact Data, recorded sales of 470,000 off-grid solar appliances between July and December 2020. While recorded global sales were less than anticipated due to the impacts of COVID-19, the easing of some countries' lockdown restrictions in the second half of the year may have contributed to increased sales for this period. This is despite the additional constraints on cash flows, and shows how high-performing appliances play a crucial role in providing homes and businesses with essential services.

The report further highlights solid growth for appliances in East and West Africa, with the TV as the most commonly sold high-performing appliance. The popularity of TVs can be attributed to the demand for entertainment and the maturity of the technology. The latter has resulted in the availability of inexpensive and more efficient TVs that do not require a large solar panel.[4] Further, having access to 'communication' appliances such as TVs has become an important tool in providing end-users with up to date, public health information (e.g., COVID-19). Such appliances are used to inform people about the pandemic and communicate preventative measure announcements, and as an educational tool. (Power Africa, 2020; World Bank, 2020).

A number of manufacturers and distributors are responding to customers' demand for TVs by bundling them with solar home systems or upselling to existing customers. The indicators listed in this report build on impact metrics released by GOGLA in partnership with Efficiency for Access[5], providing more metrics to estimate the impacts created by off-grid, high-performing TVs in a consistent, clear and coherent manner. Therefore, they complement, and do not substitute the indicators previously developed and published in a report by Efficiency for Access and GOGLA. Some indicators appear in both reports (e.g., A-ENV). These are the indicators that apply to all four appliances, and we repeated these metrics to help ensure that the Impact Assessment Framework was complete.

Use of the Framework

The primary use cases of this framework are the following:

- enable organisations assess the holistic impact they create by distributing TVs
- support funding decision making with regards to TVs
- inform mitigation strategies for the unintended negative impacts of TVs
- guide further research

To use the framework to estimate the impact of TVs and/or their distribution, users should follow these steps:

1. Choose the indicators you wish to use based on the type of impact you wish to estimate from the summary tables in Section 3 (or the spreadsheet).
2. Once you have identified the indicators in the summary table, please consult the associated table in Section 4; you can identify them by their indicator ID. Please note that easy navigation is possible through the Excel version of the Framework.

4 GOGLA, Global Off-Grid Solar Market Report: Semi-Annual Sales and Impact Data, July - December 2021 (2021) https://www.gogla.org/sites/default/files/resource_docs/gogla_sales-andimpact-reporth2-2021_def2.pdf

5 Efficiency for Access and GOGLA, Standardised Impact Metrics for High-Performing Appliances : Fans and TVs. (2020) https://www.gogla.org/sites/default/files/resource_docs/gogla_impactmetrics-appliances_paper2020_def_0.pdf

3. Consult the detailed table to check that the list of assumptions associated with the specific indicator that you have chosen is valid in your specific use-case. Only use the provided indicator if the assumptions are suitable for your use-case.
4. Calculate the impact by applying the input variables and standard variables:
   - Input variables are marked as 'Input by user'; these are variables that the user of the framework needs to provide values for based on the impact being assessed.
   - Standard variables[6] are 'plug and play' values based on existing evidence. It is important to check the detailed information about each standard variable, as the most appropriate value may depend on the specific geography and degree of urbanisation of your product and customers. You can use the detailed information to ensure that the value you choose matches the specific context of your product or service.
5. Where the value for the standard variable is given as a percentage (e.g., 3%) when used in the indicator formula it will need to be input in its decimal equivalent e.g. 0.003
6. You can describe the impact using the language of the specified Impact statement and the results of your calculation. For example: "100 people below the poverty line gained access to high-performing TVs".

How to challenge the Framework

We invite users, researchers, sceptics, appliance users and others to challenge the framework and identify opportunities for improvement. For example, you may find:

- the framework uses indicators that are no longer important to stakeholders
- the calculation of the indicator is not accurate
- data needed are difficult to obtain
- new evidence suggests improvements to the indicators or the creation of new ones

Please share with us evidence that could challenge or improve the metrics, variables, assumptions and data used in the framework by completing this form.

6 Values for the 'standard variables' may be given in ranges, because of specific context (i.e. geography and degree of urbanisation). Refer to the specific variable sheet for more information.

The Framework at a Glance

IMPORTANT: For easy navigation, we recommend that you use the spreadsheet version of the Framework.

The Framework consists of:

1. A table summarising the current indicators and formulae that were developed and comprise the framework for TVs.
2. A table of the agreed variables (standard variables) to be used in the metrics, as well as input variables that require the Framework users' input.

The table below summarises the framework for TVs. The tables show the ID for each of the indicators defined under the 'Indicator' column, which can be used to link to a more detailed table on each indicator. For each appliance, the ID starts with the letter of the appliance: in this case TV for TV. When the ID starts with an 'A', the indicator applies to TVs and other appliances. This is followed by the indicator category: ENV for environmental, ECO for economic, and SOC for social.

The formula to measure the impact, which can be positive or negative, is then given next. The variables are described in the tables that follow.

The Multi-Criteria Decision Analysis (MCDA) Score refers to the sum of the scores given to each indicator according to how well they each compare against desired characteristics, namely widely applicable, comparable, robust, relevant, time-bound/timely, specific and dynamic (refer to the general report for more details). The maximum sum for the scores is 14.

The readiness level, or status, of the different indicators is indicated in the summary tables using a traffic-light system. A green dot means that the indicator is ready to use, an orange dot means that parts of the indicator can be used, and a red dot means that the indicator is not yet ready.

Indicators can have a positive, negative, or positive/negative impact. This is indicated using the following signs: +, –, +/–. Indicators are also elaborated individually; please refer to the corresponding tables for more information.

Table 1: TV Framework

ID	INDICATOR	FORMULA	MCDA SCORE	STATUS	IMPACT
ENVIRONMENTAL					
Emissions					
A-ENV1	**Tonnes of CO_2 emissions avoided**	(S × (1 – DL) × DR-GHG × PL × G) / 1000	13	🟢	⊕
E-waste					
A-ENV2a	**Annual tonnes of electric waste added**	S × WS / 1000	14	🟢	⊖
A-ENV2b	**Annual tonnes of electric waste avoided**	S × WS × WRP / 1000	12	🟢	⊕
ECONOMIC					
Expenditure					
A-ECO1	**USD savings in fuel costs (solar-powered appliance replacing a non-solar-powered appliance)**	S × (1 – DL) × DR-GHG × PL × OPEXD	12	🟢	⊕
Job opportunity					
A-ECO2	**Number of new jobs created**	S × EF × EFa	13	🟢	⊕
SOCIAL					
Access and inclusion					
A-SOC 1	**Number of people who gained access to an off-grid appliance for the first time**	S × (1 – DL) × (1 – DR-Access)	12	🟢	⊕
A-SOC 2	**Number of customers currently accessing off-grid appliances through flexible financing**	SL-PAYGo × (1 – DL) × (1 – DR-Access)	12	🟢	⊕
A-SOC3	**Number of people below the poverty line with access to an appliance**	S × (1 – DL) × (1 – DR-Access) × RPL	11	🟢	⊕
Ownership					
A-SOC4	**Affordability of monthly repayments**	(PAYGoMC / IMAC) × 100	14	🟢	⊕

ID	INDICATOR	FORMULA	MCDA SCORE	STATUS	IMPACT
Health and wellbeing					
TV-SOC1a	**Number of people who are experiencing improved indoor air quality**	SL × (1 – DL) × H × PTST	13	●	⊖
TV-SOC1b	**Number of people who perceived a reduction in carriers of vector-borne diseases, e.g., mosquitos**	SL × (1 – DL) × (1 – DR-Access) × PRSL	14	●	⊕
TV-SOC1c	**Number of people who perceived improved health**	SL × (1 – DL) × PR × PEVP	10	●	⊖
TV-SOC2a	**Number of people spending more time together due to owning a TV**	SL × (1 – DL) × H × PSTT	12	●	⊕
TV-SOC2b	**Number of people who perceive improved quality of life due to owning a TV**	SL × (1 – DL) × (1 – DR-Access) × H × PQL	13	●	⊕
Information access & learning					
TV-SOC3a	**Number of people accessing information through a TV**	S × (1 – DL) × (1 – DR-Access) × H × PIW	12	●	⊕
TV-SOC3b	**Number of children accessing education programmes through a TV**	S × (1 – DL) × (1 – DR-Access) × PR × PLTTV	12	●	⊕

Variables

Below is a summary of the variables that are used in the formulae used to calculate the indicator. These are separated into 'input variables', which need to be entered by the user of the Framework, and 'standard variables', which are provided with the Framework. The latter are based on existing evidence and end-user research conducted as part of this project.

Input variables

List of the variables where the user of the Framework needs to enter the value.

VARIABLES	DEFINITION
IMAC	Average monthly income of the customer base (USD or equivalent)
PAYGoMC	Average monthly PAYGo commitment (USD or equivalent)
SL-PAYGO	Number of units sold through flexible financing currently in use (number of units)
PL	Estimated product lifespan (minimum of 1.5 × financing period, or 1.5 × warranty period in cash payments) (years)
RPL	Percentage of people who are below the World Bank's international Poverty line when they gain access to the appliance. The poverty line is determined as half of the median household income.[7] Regional values for the average (or median) Household Income by country can be found in the World Population Review
S	Number of units sold (cumulative, i.e. ever) (number of units)
SL	Number of units sold which are estimated to currently be in use (based on the products estimated lifespan being 1.5 × financing period, or 1.5 × warranty period in cash payments) (number of units)
WRP	Proportional weight of each appliance that will be recycled (percentage)
WS	Weight of solar-powered appliance (kg)

7 OECD, In It Together: Why Less Inequality Benefits All (2015)OECD Publishing, Paris, https://doi.org/10.1787/9789264235120-en

Standard variables

Standard variables are those for which a reasonably reliable estimate was found in the literature review and 'end-user' research conducted as part of this project. These values are included with the framework, and the values for some standard variables are given as ranges. Users should consult each specific variable sheet for information on the local context, such as geography and the degree of urbanisation[8], to decide which value is most appropriate for their products, as well as the confidence rating[9] of each value. For more information, please consult the standard variables section.

VARIABLES	DEFINITION	TV
DL	Discount for loss: products not working or not in use, excluding loss in supply chain (%)	**3%**
DR-Access	Discount for repeat sales for estimating new access to solar powered appliance (including different companies) (%)	**16%**
DR-GHG	Ratio capturing sales replacing a diesel genset-powered appliance (%)	**16%**
EF	Employment factor (jobs / item sold)	**0.0082**
EFa	Proportion of employment factor relevant to each appliance	**60%**
G	Average amount of greenhouse gases avoided per appliance, due to diesel displacement (kg CO_2 / year)	**59**
H	Household size (number of people)	**5.5**
OPEXD	Annual operational fuel cost of a diesel-powered appliance (USD / year)	**18–23.214**
PEVP	Percentage of people who associate exposure to violence and any other undesired content to a TV (%)	**27%**
PIW	Percentage of people associating TV use with improved access to information (%)	**86%**
PLTTV	Percentage of children under the age of 18 with access to a TV who relate it to learning (%)	**60%**
PQL	Percentage of people associating the appliance with improved quality of life (%)	**10-49%**
PR	Multiplier for the number of children under 18 in a household accessing the appliance (ratio)	**2.3-2.8**
PRSL	Percentage of people associating reduction in stress levels and relaxation with using the TV (%)	**76%**
PSTT	Percentage of people associating the appliance with spending time with family and community (%)	**76%**
PTST	Percentage of people reporting watching the TV for more than two hours (%)	**95%**

8 The degree of urbanisation describes territories or countries within three different categories of urbanisation as follows: (a) Cities (densely populated areas); (b) Towns and suburbs (intermediate density areas); (c) Rural areas (thinly populated areas) (Eurostat, 2021).

9 The confidence level was assessed for each value for 'standard variables'. Three stars (***) indicate that a study is 'up to date' (i.e. were conducted within 5 years of the assessment) and has, at the same time, a 'large sample size' (meaning that the data came from one study with 500+ samples or several studies with a total of 500+ samples). Two stars (**) indicate that studies are either 'up to date' or have a 'large sample size', and one star (*) indicates that the studies are not up to date and have small sample size.

Impact Indicators

Here we give a detailed description of the evidence for the indicators and values that we have proposed for TVs.

The following tables provide an overview of the indicators and the following information for each indicator:

- the formula and agreed values of the different variables
- a paragraph describing the different data sources that informed the values, including insights from literature, end-user research, and stakeholder input
- a discussion of the data gaps and limitations, with special attention to limitations in terms of context (rural/urban, East Asia/East Africa)
- notes on indicators that were considered but not included in the final version

More detailed information about the values can be found in the respective tables for the variables.

Table 2: Environment
A-ENV1: Tonnes of CO_2 emissions avoided

METRIC	TONNES OF CO_2 EMISSIONS AVOIDED		
ID	A-ENV1		
Appliance name	All		
Unit of measurement	Tonnes CO_2e / year		
Definition	CO_2 emissions saved during operation, for households or businesses replacing a diesel-powered appliance with a solar powered one		
Usefulness of metric	Quantifying the benefit of replacing diesel-powered appliances with solar appliances in terms of CO_2 emissions		
Impact statement	X tonnes of CO_2 emissions were saved through the distribution of [appliance name] since [start date of distribution]		
Calculation	(S × (1 – DL) × DR-GHG × PL × G) / 1000		
Variables	**VARIABLES**	**DEFINITION**	**VALUE**
	S	Number of units sold (cumulative, i.e., ever) (number of units)	This variable is to be inserted by the user
	DL	Discount for loss: products not working or not in use, excluding loss in the supply chain (%)	3%
	DR-GHG	Ratio capturing sales replacing a diesel genset-powered appliance (%)	16%
	PL	Estimated product lifespan (minimum of 1.5 × financing period, or 1.5 × warranty period in cash payments) (years)	This variable is to be inserted by the user
	G	Average amount of greenhouse gases avoided per appliance, due to diesel displacement (kg CO_2 / year)	59
Assumptions	• The operational CO_2 emissions of a solar appliance are assumed to be zero. • Nonetheless, the US National Renewable Energy Laboratory (NREL) conducted a harmonisation study on all published lifecycle analyses of residential and utility-scale solar PV systems, harmonising the lifecycle emissions of PVs at 40gCO_2e / kWh (Stages, 2012), with operational emissions estimated at 8.4 – 10.4gCO_2e / kWh.		
Supporting literature	The International Renewable Energy Agency (IRENA) estimates that the accelerated deployment of solar PV alone can lead to significant emission reductions of 4.9 gigatonnes of carbon dioxide (Gt CO_2) in 2050 [10]		
Data gaps	• Addressing more accurate usage pathways of appliances and especially solar water pumps • The percentage of cases that a solar powered appliance is used in addition to the diesel-powered appliance. • Identifying lifecycle emissions reduction, also considering production, transportation, maintenance and replacement of solar appliances.		
Usage notes	Impact insights from other resource-constrained regions, especially Sub-Saharan Africa. Impact insights broken down by different appliance access use cases: gender access, actual access level (period), extent of functionality, impact insights broken down into differences of geography, seasonality or differences in time-use		

10 IRENA, Future of Solar Photovoltaic: Deployment, investment, technology, grid integration and socio-economic aspects. (A Global Energy Transformation: paper, 2019), International Renewable Energy Agency, Abu Dhabi

Table 3: Environment
A-ENV2a: Annual tonnes of electric waste added

METRIC	ANNUAL TONNES OF ELECTRIC WASTE ADDED		
ID	A-ENV2a		
Appliance name	All		
Unit of measurement	Tonnes		
Definition	Tonnes of electronic waste added annually due to the ownership and disposal of an off-grid appliance by households or businesses.		
Usefulness of metric	Quantifying the electronic waste added to the environment when off-grid appliances are disposed of in the absence of a disposal plan.		
Impact statement	Since [start date of distribution], X tonnes of electronic waste were added to the environment due to the distribution of off-grid appliances, in the absence of a recycling or reuse plan.		
Calculation	S × WS / 1000		
Variables	**VARIABLES**	**DEFINITION**	**VALUE**
	S	Number of units sold (cumulative, i.e. ever) (number of units)	This variable is to be inserted by the user
	WS	Weight of solar appliance (kg)	This variable is to be inserted by the user
Assumptions	• It is assumed that the entire appliance, whether solar powered or non-solar powered, will be disposed of in full, in the absence of recycling or reuse. • The indicator does not address the difference in environmental impact of different mass elements (all kgs are equal).		
Supporting literature	• E-waste is defined as: "all types of electrical and electronic equipment that have been discarded"). For our purposes, we include all parts in the appliance including all electrical components, as well as metal and plastic fractions, and excluding packaging and external power source. • Appliances that include a majority of mechanical components (such as solar water pumps) are also considered e-waste as described in Psomopoulos, Barkas, & Ioannidis.[11] • "The expected quantity of e-waste going to landfill as a result of using solar appliances is 78 million tonnes by 2050.[12] No appliance-specific data currently exists. • The global sales of small-scale solar devices, including PV-based solar lanterns, solar water pumps, solar refrigerators, and solar home systems, was predicted to double between 2010– 2022. Sales reached 130 million units between 2010 –2017, and were to increase up to 250 million units between 2017 –2022.[13] These sales were concentrated geographically in developing countries located in Sub-Saharan Africa , especially in East Africa, and to a lesser extent in South Asia and Latin America. • Recent research shone a light on on an 'emerging disposal problem' associated with the exponential rise in sales of small-scale and off-grid solar devices.[14] The World Bank estimated that of the 130 million off-grid solar devices sold, around 26 million off-grid solar devices went out of use in 2017.[15] Estimates show that solar e-waste represented less than 0.5% of the overall e-waste stream in 14 Sub-Saharan African countries in 2014. In 2014, an estimated 2,500 tonnes of off-grid solar products came onto the market of which 800 tonnes were in the waste stream. The disposal of solar e-waste was expected to increase up to 10,000 tonnes by 2020 with Kenya leading the share with 3,800 tonnes, followed by Nigeria (530 tonnes,) and Rwanda (350 tonnes).[16] • The International Renewable Energy Agency estimated that by 2050, cumulative global volumes of solar e-waste could reach 78 million metric tonnes.[17]		
Data gaps	Addressing different components according to their environmental impact (e.g. battery vs cables).		
Usage notes	• WS includes only the appliance and built-in battery. This excludes packaging and the external power source, but includes any other part of the appliance. • Only use WC in case of a replacement of an existing appliance, otherwise the value should be 0.		

11 Constantinos Psomopoulos, The Recycling Potential of Submersible Sewage Pumps in the EU (2018) Recycling. MDPI AG, 3(2), p. 14. doi: 10.3390/recycling3020014

12 Stephanie Weckend, Andreas Wade and Garvin Heath, End of life management: solar photovoltaic panels" (No.NREL/TP-6A20-73852, 2018). National Renewable Energy Lab.(NREL), Golden, CO (United States).

13 Lighting Global, Off-grid solar market trend report 2018 (No. 4; p. 24, 2018). International Finance Corporation. https://www.lightingglobal.org/wp-content/uploads/2018/02/2018_Off_Grid_Solar_Market_Trends_Report_Summary.pdf

14 Gunther Bensch, Jorg Peters, and Maximiliene Sievert 2017, The lighting transition in rural Africa—From kerosene to battery-powered LED and the emerging disposal problem (2017) Energy for Sustainable Development,39, 13-20.

15 Lighting Global, Off-grid solar market trend report 2018, (No. 4; p. 24, 2018). International Finance Corporation. https://www.lightingglobal.org/wp-content/uploads/2018/02/2018_Off_Grid_Solar_Market_Trends_Report_Summary.pdf

16 Federico Magalini, Deepali Sinha Khetriwal, David Rochat and Jaco Huisman, Electronic Waste (E-waste) Impacts and Mitigation Options in the Off-grid Renewable Energy Sector" (p. 62, 2016). UK Department for International Development (DFID). https://www.gov.uk/research-for-development-outputs/electronic-waste-e-waste-impacts-and-mitigation-options-in-the-off-grid-renewable-energy-sector

17 IRENA, End-of-life management: Solar Photovoltaic Panels. (2016) International Renewable Energy Agency. https://irena.org/publications/2016/Jun/End-of-life-management-Solar-Photovoltaic-Panels

Table 4: Environment
A-ENV2b: Annual tonnes of electric waste avoided

METRIC	ANNUAL TONNES OF ELECTRIC WASTE ADDED		
ID	A-ENV2b		
Appliance name	All		
Unit of measurement	Tonnes		
Definition	Tonnes of electronic waste avoided annually due to the existence of a recycling plan		
Usefulness of metric	This metric rewards organisations that promote recycling and raise awareness of e-waste recycling		
Impact statement	Since [start date of distribution], X tonnes of electronic waste was avoided thanks to recycling plans		
Calculation	S × WS × WRP / 1000		
Variables	**VARIABLES**	**DEFINITION**	**VALUE**
	S	Number of units sold (cumulative, i.e. ever) (number of units)	This variable is to be inserted by the user
	WS	Weight of solar-powered appliance (kg)	This variable is to be inserted by the user
	WRP	Proportional weight of each appliances that will be recycled (%)	This variable is to be inserted by the user
Assumptions	• It is assumed that the entire appliance, whether solar powered or non-solar powered, will be disposed of in full, in the absence of recycling or reuse plans. • The indicator does not address the difference in environmental impact of different mass elements (all kgs are equal).		
Supporting literature	See A-ENV2a		
Input from stakeholders	Input from people / investors / donors		
Data gaps	• Solar appliance recycling potential in East Africa and Asia • Including the e-waste saved through using reused materials in the manufacturing process		
Usage notes	• WS includes only the appliance and inbuilt battery. It excludes packaging and external power source, but includes any other part of the appliance • WRP is determined during the project/intervention depending on the recycling/reuse plan available • The above indicator could be improved or added to in order to incorporate reduction in e-waste		

Table 5: Economic
A-ECO1: USD savings in fuel costs

METRIC	USD SAVINGS IN FUEL COSTS (SOLAR-POWERED APPLIANCE REPLACING A NON-SOLAR-POWERED APPLIANCE)		
ID	A-ECO1		
Appliance name	All		
Unit of measurement	USD		
Definition	Total USD saved in fuel-related operational costs for households or businesses replacing a diesel-powered appliance with a solar-powered appliance, throughout the lifetime of the solar appliance		
Usefulness of metric	The indicator provides the business case for solar appliances by highlighting the amount of operational costs that a household or business saves throughout throughout the solar-powered appliance's lifetime		
Impact statement	Since [start date of distribution], people saved x USD in operational costs due to moving from diesel-powered [appliance name] to a solar powered appliance		
Calculation	S × (1 – DL) × DR-GHG × PL × OPEXD		
Variables	**VARIABLES**	**DEFINITION**	**VALUE**
	S	Number of units sold (cumulative, i.e. ever) (number of units)	This variable is to be inserted by the user
	DL	Discount for loss: products not working or not in use, excluding loss in the supply chain (%)	3%
	DR-GHG	Ratio capturing sales replacing a diesel genset-powered appliance (%)	16%
	PL	Estimated product lifespan (minimum of 1.5 × financing period, or 1.5 × warranty period in cash payments) (years)	This variable is to be inserted by the user
	OPEXD	Annual operational fuel cost of a diesel-powered appliance (USD / year)	18–23.214
Assumptions	• The annual operational expenditure of a solar appliance is assumed to be zero. • Only fuel cost reduction is accounted for i.e. costs like seeds, fertiliser, and labour are not considered.		
Supporting literature	The supporting literature does not relate to TVs. Refer to the literature on each specific variable.		
Data gaps	• Include other expenses that are not fuel. • Magnitude of the replacement market for solar appliances. • The operating costs for solar appliances.		
Usage notes	• Values for OPEXD vary depending on the geography. • To find the most suitable value, please refer to the elaborated variable sheet (click on the variable name).		

Table 6: Economic
A-ECO2: Number of new jobs created

METRIC	NUMBER OF NEW JOBS CREATED		
ID	A-ECO2		
Appliance name	All		
Unit of measurement	Number of jobs		
Definition	Increase in job opportunities within the business (manufacturing, assembly, distribution).		
Usefulness of metric	Enables demonstration of the contribution of the high-performing appliance supply chain to the local job market.		
Impact statement	A total x jobs have been created in local markets through the high-performing appliance supply chain.		
Calculation	S × EF × EFA		
Variables	**VARIABLES**	**DEFINITION**	**VALUE**
	S	Number of units sold (cumulative, i.e. ever) (number of units)	This variable is to be inserted by the user
	EF	Employment factor (jobs / item sold)	0.0082
	EFA	Proportion of employment factor relevant to each appliance	60%
Assumptions	The jobs are created within the geographical area being served.		
Supporting literature	The values for EF and EFA are taken from the Power for All report "Powering Jobs Census 2019".[18] Evidence from the same publication and others suggests that the off-grid solar value chain could generate up to 1.3 million full-time equivalent (FTE) jobs by 2022, excluding manufacturing.[19,20] For further details, we recommend consulting the original report.		
Data gaps	Explore indirect jobs from upstream sectors and potential job displacement from traditional energy sectors.		
Usage notes	• The above indicators would be applied to a specific geographical region that is the area of interest. • The jobs being counted are those generated within that geographical region. • The formula should not be used for appliances sold as a bundle with SHS.		

18 Power for All, Powering Jobs Census 2019: The Energy Access Workforce. (2019) https://www.powerforall.org/resources/reports/powering-jobs-census-2019-energy-access-workforce
19 Lighting Global, Off-grid solar market trend report 2018 (No. 4; p. 24, 2018). International Finance Corporation. https://www.lightingglobal.org/wp-content/uploads/2018/02/2018_Off_Grid_Solar_Market_Trends_Report_Summary.pdf
20 Power for All, Powering Jobs Census 2019: The Energy Access Workforce. (2019) https://www.powerforall.org/resources/reports/powering-jobs-census-2019-energy-access-workforce

Table 7: Social / Health Impact

A-SOC1: Number of people who gained access to an off-grid appliance for the first time

METRIC	NUMBER OF PEOPLE WHO GAINED ACCESS TO AN OFF-GRID APPLIANCE FOR THE FIRST TIME		
ID	A-SOC1		
Appliance name	All		
Unit of measurement	Number of people		
Definition	The number of people engaging and benefiting from the off-grid market due to access to a high-performing [appliance name].		
Usefulness of metric	Enables demonstration of the number of people who have benefited from clean energy using appliances.		
Impact statement	High-performing appliances are enabling an estimated x people to access and use clean energy. This will allow them to build up assets which could help them to access more products and services in the future.		
Calculation	S × (1 – DL) × (1 – DR-Access) × H		
Variables	**VARIABLES**	**DEFINITION**	**VALUE**
	S	Number of units sold (cumulative, i.e. ever) (number of units)	This variable is to be inserted by the user
	DL	Discount for loss: products not working or not in use, excluding loss in supply chain (%)	0.03%
	H	Household size (number of people)	5.5
	DR-Access	Discount for repeat sales for estimating new access to solar appliance (including different companies) (%)	16%
Assumptions	We assume that the majority of the customers are first-time appliance owners, and the appliance is not only allowing them to benefit from its functionality, but also enable them to become more financially included.		
Supporting literature	• The "Powering Opportunity" report in South Asia found that 39% of respondents (SHS owners) had their first experience of access to clean, modern power.[21] • "M-KOPA's 'Pay-As-You-Go' solar model has helped open up exciting new consumer markets. As off-grid energy connections increase, we are seeing millions of new consumers with greater financial stability and, for the first time, access to power".[22] • Efficiency for Access and 60 Decibels' study on Kenya, Rwanda, Tanzania, and Uganda found that 80% of the customers surveyed reported that that was their first time accessing a TV.[23]		
Data gaps	• Explore the impacts of access on financial inclusion and further engagement in the appliance market (e.g. customer upgrades, use of PAYGo to purchase other products and services). • Disaggregate this indicator for gender and income levels.		

21 ALTAI and GOGLA, Powering Opportunity in East Africa:Proving Off-Grid Solar is a Power Tool for Change. (2019) https://www.gogla.org/sites/default/files/resource_docs/powering_opportunity_in_east_africa.pdf

22 M-KOPA, Tuned In: Television and Civic Engagement in Off-Grid Society. (2019) Sun Connect News https://sun-connect-news.org/fileadmin/DATEIEN/Dateien/New/TUNED_IN.pdf

23 Efficiency for Access and 60_Decibels, Use & Impact of Solar TVs: Lean Data Insights from Kenya, Rwanda, Tanzania, Uganda. (202) https://storage.googleapis.com/e4a-website-assets/Solar-TVReport__-FINAL.pdf

Table 8: Social / Health Impact

A-SOC2: Number of people currently accessing off-grid appliances through flexible financing

METRIC	NUMBER OF CUSTOMERS CURRENTLY ACCESSING OFF-GRID APPLIANCES THROUGH FLEXIBLE FINANCING		
ID	A-SOC2		
Appliance name	All		
Unit of measurement	Number of people		
Definition	Number of people with current access to high-performing, clean energy appliances through financing.		
Usefulness of metric	Enables demonstration of the number of people who have benefited from high-performing, clean energy appliance financing through flexible financing.		
Impact statement	PAYGo appliance financing is enabling an estimated x people access to high-performing, clean energy appliances financing. This will allow them to build up a credit history, which could help them access more products and services in the future.		
Calculation	SL-PAYGO × (1 – DL) × (1 – DR-Access)		
Variables	**VARIABLES**	**DEFINITION**	**VALUE**
	S	Number of units sold (cumulative, i.e. ever) (number of units)	This variable is to be inserted by the user
	DL	Discount for loss: products not working or not in use, excluding loss in supply chains (%)	3%
	DR-Access	Discount for repeat sales for estimating new access to solar appliance (including different companies) (%)	16%
Assumptions	• Currently most of the information about flexible financing comes from PAYGo systems and excludes other micro financing options. • The majority of PAYGo customers are unlikely to have a strong credit history and, as such, PAYGo financing is not only providing more affordable high-performing appliances, but enabling them to become more financially included. • Most sales are PAYGo and therefore, the discount for loss is approximately equal to the discount for loss for all sold appliances.		
Supporting literature	The "Powering Opportunity in South Asia" report found that 39% of respondents, the SHS owners, had their first experience of access to clean, modern power. [24]		
Data gaps	• Explore the impacts of access on financial inclusion and further engagement in the appliance market (e.g., customer upgrades, use of PAYGo to purchase other products and services). • Disaggregate this indicator for gender and income levels. • Gather data about number of customers with access to flexible financing beyond PAYGo.		
Usage notes	• This metric is equal to the number of people currently financing their appliance through PAYGo. • The number does not include those who may have purchased a product previously through PAYGo financing and have already benefited from this level of financial inclusion.		

24 ALTAI and GOGLA, Powering Opportunity in East Africa: Proving Off-Grid Solar is a Power Tool for Change (2019) https://www.gogla.org/sites/default/files/resource_docs/powering_opportunity_in_east_africa.pdf

Table 9: Social / Health Impact

A-SOC3: Number of people below the poverty line with access to an appliance

METRIC	NUMBER OF PEOPLE BELOW THE POVERTY LINE WITH ACCESS TO AN APPLIANCE		
ID	A-SOC3		
Appliance name	All		
Unit of measurement	Number of people		
Definition	The number of people who live under the World Bank's International Poverty Line for the specific region and have access to a high performing appliance.		
Usefulness of metric	• Increasing the inclusivity of high-performing appliances among marginalised groups is essential for realising their positive impact. • This metric rewards organisations that reach low- income end-users and allows them to monitor the progress of the sector as a whole.		
Impact statement	X people under the poverty line gained access to high-performing [appliance name].		
Calculation	S × (1 – DL) × (1 – DR-Access) × H × RPL		
Variables	**VARIABLES**	**DEFINITION**	**VALUE**
	S	Number of units sold (cumulative, i.e. ever) (number of units)	This variable is to be inserted by the user
	DL	Discount for loss: products not working or not in use, excluding loss in supply chains (%)	3%
	DR-Access	Discount for repeat sales for estimating new access to solar appliance (including different companies) (%)	16%
	H	Household size (number of people)	5.5
	RPL	Percentage of people who are under World Bank's International Poverty Line when gaining access to the appliance. The poverty line is determined as half of the median household income.[25] Regional values for the average (or median) Household Income by country can be found in the World Population Review	This variable is to be inserted by the user
Assumptions	This formula does not include an increase in income post-purchase.		
Supporting literature	• In 2018, over 40% of the Sub-Sahran African population was under the World Bank's International Poverty Line. In East Asia, the same rates reached over 15% in 2014. The WHO dimension in the Impact Management Project recommends identifying how underserved the stakeholders of the intended impact are when measuring impact (Impact Managenment Project).[26] • The Efficiency for Access and 60 Decibels' research from Kenya, Rwanda, Tanzania, and Uganda found that 30% of customers surveyed live in poverty.[27]		
Data gaps	• Improving the mapping of income level at the day of purchase. • Disaggregate this indicator for gender.		

25 OECD, In It Together: Why Less Inequality Benefits All. (2015) OECD Publishing, Paris, https://doi.org/10.1787/9789264235120-en

26 Impact Management Project, Who. (2021) Impact Management Project. https://impactmanagementproject.com/impact-management/impact-management-norms/who/

27 Efficiency for Access and 60_Decibels, Use & Impact of Solar TVs: Lean Data Insights from Kenya, Rwanda, Tanzania, Uganda. (2020) https://storage.googleapis.com/e4a-website-assets/Solar-TVReport__-FINAL.pdf

Table 10: Social / Health Impact
A-SCO4: Affordability of monthly repayments

METRIC	AFFORDABILITY OF MONTHLY REPAYMENTS		
ID	A-SOC4		
Appliance name	All		
Unit of measurement	Percentage		
Definition	The affordability of the monthly instalments		
Usefulness of metric	Enables understanding of the affordability of high-performing appliances for the end-user.		
Impact statement	At [point in time] the average monthly payment for [appliance name] is X percent of the average monthly income of our target customers.		
Calculation	(PAYGoMC / IMAC) × 100		
Variables	**VARIABLES**	**DEFINITION**	**VALUE**
	PAYGoMC	Average Monthly PAYGo commitment (USD or equivalent)	This variable is to be inserted by the user
	IMAC	Average monthly income of the customer base (USD or equivalent	This variable is to be inserted by the user
Assumptions	The majority of PAYGo customers struggle to meet the monthly PAYGo repayments. This implies that access to high-performing appliances presents an 'unreasonable burden' to the individual or household.		
Supporting literature	• ALTAI & GOGLA (2019's report) "Powering Opportunity in East Africa: Proving Off-Grid Solar is a Power Tool for Change" found that 4% of respondents reported negative effects with the most common being feeling more stressed, likely related to repayments. • For example, with regards to solar TVs, Efficiency for Access and 60 Decibels' survey on the use and impact of the appliances found that 61% of respondents reported that they had to make unacceptable sacrifices to make repayments. 2% had to reduce appliance use to make repayments.[28]		
Data gaps	• More work on how to include changes in income post purchase in the case of productive use of energy (e.g., irrigation). • Including the income increase post-purchase. • Measure the default rates of appliances as a more accurate proxy to affordability. • Disaggregate this indicator for gender.		
Usage notes	• This metric is simply defining and measuring the affordability to a household, using the payment method which is based on the ratio of the payment for a particular commodity to a household's total resources. • In case IMAC is not available, users can use national household surveys, or the FAO estimates available here, or other data services such as https://fraym.io/analysis/ • PAYGoMC includes everything that is included in the monthly payment, including anything in the bundle. • IMAC is calculated as yearly income divided by 12 recognising that there is a seasonal effect in monthly incomes. • In case and for PAYG payments are not monthly, or not equal every month, PAYGoMC is calculated as the monthly equivalent.		

28 Efficiency for Access and 60_Decibels, Use & Impact of Solar TVs: Lean Data Insights from Kenya, Rwanda, Tanzania, Uganda. (2020) https://storage.googleapis.com/e4a-website-assets/Solar-TVReport__-FINAL.pdf

Table 11: Social / Health Impact

TV-SOC1a: Number of people exhibiting an increase in sedentary behaviour

METRIC	NUMBER OF PEOPLE EXHIBITING AN INCREASE IN SEDENTARY BEHAVIOUR		
			STATUS
ID	TV-SOC1a		●
			IMPACT
Appliance name	TV		⊖
Unit of measurement	Number of people		
Definition	Number of people currently watching a high-performing TV for more than the recommended two hours per day.		
Usefulness of metric	Enables quantification of the impact of access to a high-performing TV to an increase in sedentary behaviours and physical inactivity.		
Impact statement	High-performing TVs increase sedentary behaviours and physical inactivity in an estimated x people.		
Calculation	SL × (1 – DL) × H × PTST		
Variables	**VARIABLES**	**DEFINITION**	**VALUE**
	SL	Number of units sold which are estimated to currently be in use (based on the products' estimated lifespan being 1.5 × financing period, or 1.5 × warranty period in cash payments) (number of units)	This variable is to be inserted by the user
	DL	Discount for loss: products not working or not in use, excluding loss in supply chain (%)	3%
	H	Household size (number of people)	5.5
	PTST	The percentage of people reporting watching TV for more than two hours (%)	95%
Assumptions	• The appliance is used in the home, and every household member benefits or has access to the appliance. • The appliance maintains its functionality over its lifetime. • Issues of unreliable signals, disconnection due to electricity availability, payment and other factors are not taken into consideration. • The indicator is used as a surrogate measure of how sedentary a person's lifestyle is. It is assumed that the act of watching TV in itself does not result in poor health, instead it is the lack of movement while watching TV that results in poor health.[29]		
Supporting literature	• Rural Senses' study of 116 off-grid appliance users in Uganda and 96 in India found that 58% and 45% of respondents respectively, reported watching TV between 3 to 5 hours a day.[30] • The MKOPA (2017) study of its customers found that three hours per day is the average time spent watching a new solar TV (MKOPA, 2017).[31] • The Azimoh study of the impact of South African SHS programmes found that the daily usage pattern for a TV is five hours.[32]		
Data gaps	• The impact of using high-performing off-grid TVs on the increase of sedentary behaviours, physical inactivity and associated risks. Existing literature has a strong Global North and higher income groups focus. • Impact insights broken down by different appliance access use cases: gender access, actual watching time with different energy systems.		
Usage notes	• Data are mainly collected from the Sub-Saharan African region, particularly East Africa. Although some data from India (South Asia) have been used to derive an average for default values (PTST = 98%), the formula outcome will potentially be more accurate for East African countries. • We take into account the end-user's perceived value of the appliance by quantifying their subjective responses to derive at the default value, PTST. • This has a negative impact. • The indicator does not account for having a TV on in the background. It also does not account for the fact that watching TV may replace other sedentary activities. • There is limited literature on the threshold; the literature that exists has a Global North and high income group focus.		

29 Hamish M.E. Foster, Frederick K Ho, Naveed Sattar, Paul Welsh, Jill P Pell, Jason M R Gill, Stuart R Gray, Carlos A Celis-Morales, Understanding How Much TV is Too Much: A Nonlinear Analysis of the Association Between Television Viewing Time and Adverse Health Outcomes (2020) Mayo Clin. Proc., vol. 95, no. 11, pp. 2429–2441, https://doi: 10.1016/j.mayocp.2020.04.035

30 Rural Senses, Impact Assessment Framework End-User Research in Uganda & India." (End-User research unpublished, 2021).

31 M-KOPA, Tuned In: Television and Civic Engagement in Off-Grid Society. (2017) Sun Connect News https://sun-connect-news.org/fileadmin/DATEIEN/Dateien/New/TUNED_IN.pdf

32 Chukwuma Leonard Azimoh, Sustainability and Development Impacts of Off-Grid Electrification in Developing Countries: an Assessment of South Africa's Rural Electrification Program." (Västerås: Mälardalen University, 2016), http://urn.kb.se/resolve?urn=urn:nbn:se:mdh:diva-30762

Table 12: Social / Health Impact

TV-SOC1b: Number of people who experience reduced stress levels

METRIC	NUMBER OF PEOPLE WHO EXPERIENCE REDUCED STRESS LEVELS		
			STATUS
ID	TV-SOC1b		●
			IMPACT
Appliance name	TV		⊕
Unit of measurement	Number of people		
Definition	Number of people who are currently using a high-performing TV to reduce stress levels		
Usefulness of metric	Enables an estimation of the functionality and usefulness of a TV to reduce stress levels as perceived by the end-users.		
Impact statement	High-performing TVs are helping x end-users to reduce their stress levels.		
Calculation	SL × (1 – DL) × (1 – DR-Access) × H × PRSL		
Variables	**VARIABLES**	**DEFINITION**	**VALUE**
	SL	Number of units sold which are estimated to currently be in use (based on the products' estimated lifespan being 1.5 × financing period, or 1.5 × warranty period in cash payments) (number of units)	This variable is to be inserted by the user
	DL	Discount for loss: products not working or not in use, excluding loss in supply chain (%)	3%
	DR-Access	Discount for repeat sales for estimating new access to solar powered appliances (including different companies) (%)	16%
	H	Household size (number of people)	5.5
	PRSL	The percentage of people associating reduction in stress levels and relaxation with using their TV (%)	75.6%
Assumptions	• The appliance is used in the home, and every household member benefits or has access to the appliance. • The appliance maintains its functionality over its lifetime. • Issues of unreliable signals, disconnection due to the availability of electricity, payment and other factors are not taken into consideration.		
Supporting literature	• The Rural Senses survey[33] of TV end-users in Uganda and India found that 78.7% and 71.6%, respondents respectively, associated TV use with relaxation and less boredom. The most frequently mentioned reason for reduced stress was higher educational attainment, improved mental health and togetherness. • The findings of Efficiency for Access & 60 Decibels' report[34] from the off-grid TV sector in East Africa based on 3,920 phone interviews conducted in Kenya, Rwanda, Tanzania and Uganda between June 2018 and June 2019 reported that 79% of respondents felt that their stress levels had reduced since they started using the solar TV, and 83% said that their family was better connected. The most frequently mentioned reason for reduced stress was less boredom and better entertainment (25%). Other common responses were more time spent on relaxation and reducing stress (24%) and increased happiness within the family (21%).		
Data gaps	More evidence about the impact of TV on mental health.		

33 Rural Senses, Impact Assessment Framework End-User Research in Uganda & India (End-User research unpublished, 2021)

34 Efficiency for Access and 60_Decibels, Use & Impact of Solar TVs: Lean Data Insights from Kenya, Rwanda, Tanzania, Uganda. (2020) https://storage.googleapis.com/e4a-website-assets/Solar-TVReport__-FINAL.pdf

Table 13: Social / Health Impact

TV-SOC1c: Number of children with increased exposure to violent and other undesired content

METRIC	NUMBER OF CHILDREN THAT ARE PERCEIVED TO BE MORE EXPOSED TO VIOLENT AND OTHER UNDESIRED CONTENT		
			STATUS
ID	TV-SOC1c		●
			IMPACT
Appliance name	TV		⊖
Unit of measurement	Number of people		
Definition	Number of people exposed to violence and other undesired content through the use of a high-performing TV		
Usefulness of metric	Enables estimation of the negative impact of access to a high-performing TV as perceived by the end-users.		
Impact statement	High-performing TV access exposes x people to violence and other undesired content.		
Calculation	SL × (1 – DL) × PR × PEVP		
Variables	**VARIABLES**	**DEFINITION**	**VALUE**
	SL	Number of units sold which are estimated to currently be in use (based on the products' estimated lifespan being 1.5 × financing period, or 1.5 × warranty period in cash payments) (number of units)	This variable is to be inserted by the user
	DL	Discount for loss: products not working or not in use, excluding loss in supply chain (%)	3%
	PR	Multiplier for the number of children under the age of 18 in a household who are accessing the appliance (ratio)	2.3–2.8
	PEVP	The percentage of people who associate exposure to violence and any other undesired content to a TV (%)	27%
Assumptions	• The appliance is used in the home, and every household member benefits or is negatively impacted by access to the appliance. • The appliance maintains its functionality over its lifetime. • Issues of unreliable signals, disconnection due to electricity availability, payment and other factors are not taken into consideration.		
Supporting literature	A survey by Rural Senses of TV users in Uganda and India found that 27.0% and 9.1% of respondents respectively, associated TV use with exposure to violence and other undesired content especially among children and teenagers.[35]		
Data gaps	It is unknown if the TV suppliers offer any form of appliance use training that educates users on control measures that can be used to regulate the exposure of household members to violent and other undesired content.		
Usage notes	• The data are not conclusive and the formula heavily relies on the perceptions of the end-user. • We take into account the end-user's perceived impact of the appliance by quantifying their subjective responses to derive the default value, PEVP=0.27.		

35 Rural Senses, Impact Assessment Framework End-User Research in Uganda & India (End-User research unpublished, 2021)

Table 14: Social / Health Impact

TV-SOC2a: Number of people spending more time together due to owning a TV

METRIC	NUMBER OF PEOPLE SPENDING MORE TIME TOGETHER DUE TO OWNING A TV		
			STATUS
ID	TV-SOC2a		●
			IMPACT
Appliance name	TV		⊕
Unit of measurement	Number of people		
Definition	Number of people spending more time together as a result of accessing a high-performing TV		
Usefulness of metric	Enables estimation of the functionality and usefulness of a TV in helping people to spend more time together.		
Impact statement	The high-performing TV industry is helping x people to spend more time together.		
Calculation	SL × (1 – DL) × (1-DR-Access) × H × PSTT		
Variables	**VARIABLES**	**DEFINITION**	**VALUE**
	SL	Number of units sold which are estimated to currently be in use (based on the products estimated lifespan being 1.5 × financing period, or 1.5 × warranty period in cash payments) (number of units)	This variable is to be inserted by the user
	DL	Discount for loss: products not working or not in use, excluding loss in supply chain (%)	3%
	H	Household size (number of people)	5.5
	PSTT	The percentage of people associating the appliance with spending time with family and community (%)	76%
Assumptions	• The appliance is used in the home, and every household member benefits or has access to the appliance. • Families and friends congregate to watch TV together.		
Supporting literature	• The Rural Senses survey of TV users in Uganda and India[36] found that 77.5% and 71.6% of respondents, respectively, associated TV use with spending more time together. • MKOPA's study of new television owners in off-grid homes in Kenya found that 8% of respondents perceived that the television improved their quality of life because family members could spend more time together.[37] • The insights of Efficiency for Access and 60 Decibels from Kenya, Rwanda, Uganda, and Tanzania revealed that 83% of participants said that their family was more connected as a result of accessing a TV.[38]		
Data gaps	• It should be noted that all studies with the exception of one have been entirely conducted in Africa. • Given that this evidence was used to derive the default constant PSTT= 65%, the formula outcome may potentially be less accurate for Asian countries.		
Usage notes	• Impact insights from other Global South regions, especially Sub-Saharan Africa. • Impact insights broken down by different appliance access use cases: gender access and age. • Impact insights broken down into differences of geography, seasonality or differences in time-use.		

36 Rural Senses, Impact Assessment Framework End-User Research in Uganda & India." (End-User research unpublished, 2021)

37 M-KOPA, Tuned In: Television and Civic Engagement in Off-Grid Society. (2017) Sun Connect News https://sun-connect-news.org/fileadmin/DATEIEN/Dateien/New/TUNED_IN.pdf

38 Efficiency for Access and 60_Decibels, Use & Impact of Solar TVs: Lean Data Insights from Kenya, Rwanda, Tanzania, Uganda. (2020) https://storage.googleapis.com/e4a-website-assets/Solar-TVReport__-FINAL.pdf

Table 15: Social / Health Impact

TV-SOC2b: Number of people who perceive improved quality of life due to owning a TV

METRIC	NUMBER OF PEOPLE SPENDING MORE TIME TOGETHER DUE TO OWNING A TV		
			STATUS
ID	TV-SOC2b		●
			IMPACT
Appliance name	TV		⊕
Unit of measurement	Number of people		
Definition	Number of people who currently perceive that using a high-performing TV is improving their quality of life		
Usefulness of metric	Enables estimation of the functionality and usefulness of a TV to improve quality of life as perceived by the people using it.		
Impact statement	X people accessing a high-performing TV perceive that it is improving their quality of life.		
Calculation	SL × (1 – DL) × (1 – DR-Access) × H × PQL		
Variables	**VARIABLES**	**DEFINITION**	**VALUE**
	SL	Number of units sold which are estimated to currently be in use (based on the products' estimated lifespan being 1.5 × financing period, or 1.5 × warranty period in cash payments) (number of units)	This variable is to be inserted by the user
	DL	Discount for loss: products not working or not in use, excluding loss in supply chain (%)	3%
	DR-Access	Discount for repeat sales for estimating new access to solar-powered appliances (including different companies) (%)	16%
	H	Household size (number of people)	5.5
	PQL	The percentage of people associating the appliance with improved quality of life (%)	10–49%
Assumptions	• The appliance is used in the home, and every household member benefits or has access to the appliance. • The appliance maintains its functionality over its lifetime. • Issues of unreliable signals, disconnection due to electricity availability, payment and other factors are not taken into consideration.		
Supporting literature	• The Rural Senses survey of TV users in Uganda and India found that 78.7% and 71.6 % of respondents respectively, associated TV use with improved quality of life; with positive sentiment for mental health, family, and entertainment.[39] • MKOPA's study of new television owners in off-grid homes in Kenya found that customers perceived that the television improved their quality of life because families could spend more time together (8%); their social status in the community had changed (9%); the TV brought home entertainment (42%); and they felt better informed about current affairs and politics (70%).[40] • Efficiency for Access and 60 Decibels' report from Kenya, Rwanda, Uganda, and Tanzania reported that 50% of customers said that their quality of life had very much improved as a result of the TV. They spoke mostly about having improved well-being including joy and family connection.[41]		
Data gaps	• More accurate definition of quality of life with regards to TV. • Gender-disaggregated data.		
Usage notes	• The data supporting this metric have mainly been collected from the East African region. Therefore, the formula outcome may potentially be more accurate for East African countries. • PQL is a range as values change significantly per geography, consult the PQL elaborated sheet (click on variable name) to find the most accurate value.		

39 Rural Senses, Impact Assessment Framework End-User Research in Uganda & India." (End-User research unpublished, 2021)

40 M-KOPA, Tuned In: Television and Civic Engagement in Off-Grid Society. (2017) Sun Connect News https://sun-connect-news.org/fileadmin/DATEIEN/Dateien/New/TUNED_IN.pdf

41 Efficiency for Access and 60_Decibels, Use & Impact of Solar TVs: Lean Data Insights from Kenya, Rwanda, Tanzania, Uganda. (2020) https://storage.googleapis.com/e4a-website-assets/Solar-TVReport__-FINAL.pdf

Table 16: Social / Health Impact

TV-SOC3a: Number of people accessing information through a TV

METRIC	NUMBER OF PEOPLE ACCESSING INFORMATION THROUGH TV		
			STATUS
ID	TV-SOC3a		●
			IMPACT
Appliance name	TV		⊕
Unit of measurement	Number of people		
Definition	Number of people accessing information (such as news, current affairs etc.) through a high performing TV		
Usefulness of metric	Enables estimation of the number of people using a TV as their source of information.		
Impact statement	X people have gained improved access to information thanks to a high-performing TV.		
Calculation	S × (1 – DL) × (1 – DR-Access) × H × PIW		
Variables	**VARIABLES**	**DEFINITION**	**VALUE**
	SL	Number of units sold which are estimated to currently be in use (based on the products' estimated lifespan being 1.5 × financing period, or 1.5 × warranty period in cash payments) (number of units)	This variable is to be inserted by the user
	DL	Discount for loss: products not working or not in use, excluding loss in supply chain (%)	3%
	DR-Access	Discount for repeat sales for estimating new access to solar powered appliances (including different companies) (%)	16%
	H	Household size (number of people)	5.5
	PIW	The percentage of people associating a TV with improved access to information (%)	86%
Assumptions	The entire household becomes aware of the information gained from the TV, either by watching it or by being informed by other household members.		
Supporting literature	• "We are always informed due to watching television which makes me feel like I am one of these rich people since I get access to the same information they do." — Daniel, a 35-year-old carpenter and bricklayer, Western Kenya.[42] • 79.8 % and 89.8 % of TV users in Uganda and India respectively associated use of a TV with access to information.[43] • 98% of Azuri customers with a solar powered TV reported that they felt more aware of local and international affairs and that children felt more confident in discussing current affairs in school.[44] • ~90% of respondents in the Efficiency for Access and 60 Decibels study on the use and impact of solar TVs felt that their knowledge or awareness of current affairs, politics, and general knowledge had improved as a result of owning the solar powered TV.[45] • MKOPA's study of its new solar TV customers found that 70% of respondents felt the TV had improved their quality of life because they felt better informed about current affairs and politics.[46]		
Data gaps	More evidence regarding the value of the information accessed via a TV.		
Usage notes	• Most studies on TV use and impact in the off-grid market are done in Sub-Saharan Africa. • Therefore, the formula output may strongly hold true for this particular region, but not others.		

42 ALTAI and GOGLA, Powering Opportunity in East Africa: Proving Off-Grid Solar is a Power Tool for Change. (2019) https://www.gogla.org/sites/default/files/resource_docs/powering_opportunity_in_east_africa.pdf

43 Rural Senses, Impact Assessment Framework End-User Research in Uganda & India." (End-User research unpublished, 2021)

44 Cambridge Network, Azuri Survey Shows That Solar TV Is Helping to Improve Education and Communication Skills. (2018) https://www.cambridgenetwork.co.uk/node/521575

45 Efficiency for Access and 60_decibels, Use & Impact of Solar TVs: Lean Data Insights from Kenya, Rwanda, Tanzania, Uganda. (2020) https://storage.googleapis.com/e4a-website-assets/Solar-TVReport__-FINAL.pdf

46 M-KOPA, Tuned In: Television and Civic Engagement in Off-Grid Society. (2017) Sun Connect News https://sun-connect-news.org/fileadmin/DATEIEN/Dateien/New/TUNED_IN.pdf

Table 17: Social / Health Impact

TV-SOC3b: Number of people accessing education programmes through a TV

METRIC	NUMBER OF CHILDREN ACCESSING EDUCATION PROGRAMMES THROUGH A TV		
			STATUS
ID	TV-SOC3b		●
			IMPACT
Appliance name	TV		⊕
Unit of measurement	Number of people		
Definition	Number of people learning by using a high-performing TV		
Usefulness of metric	Enables estimation of the number of people who have used a TV for educational purposes.		
Impact statement	X people have improved educational outcomes as a result of access to a high-performing TV.		
Calculation	S × (1 – DL) × (1 – DR-Access) × PR × PLTTV		
Variables	**VARIABLES**	**DEFINITION**	**VALUE**
	S	Number of units sold (cumulative, i.e. ever) (number of units)	This variable is to be inserted by the user
	DL	Discount for loss: products not working or not in use, excluding loss in supply chain (%)	3%
	DR-Access	Discount for repeat sales for estimating new access to solar powered appliances (including different companies) (%)	16%
	PR	Multiplier for number of children under the age of 18 in a household accessing the appliance (ratio)	2.3–2.8
	PLTTV	The percentage of children under 18 with access to a TV appliance that relate it to learning (%)	60%
Assumptions	Learning or skills attainment, although beneficial to the entire household, can only target specific members of the household. For example, formal school subjects, business programmes, farming programmes, and so on. Therefore, we use the ratio for the number of people per household rather than the entire household size.		
Supporting literature	• 46.1% and 30.7% of TV users in Uganda and India respectively associated TV use with attainment of knowledge, skills and personal development.[47] • 92% of customers in Azuri's customer study said that watching TV had improved their communications skills.[48] • 60% of Azuri's TV customers with school-age children reported that their children had improved in their reading, writing, and speaking skills since installing a solar TV system.[49]		
Data gaps	Evidence from TV-enabled remote learning during the COVID pandemic.		
Usage notes	Most studies on TV use and impact in the off-grid market are done in Sub-Saharan Africa. Therefore, the formula output may strongly hold true for this particular region but not others.		

47 Rural Senses, Impact Assessment Framework End-User Research in Uganda & India." (End-User research unpublished, 2021)

48 Cambridge Network, Azuri Survey Shows That Solar TV Is Helping to Improve Education and Communication Skills. (2018) https://www.cambridgenetwork.co.uk/node/521575

49 Ibid

Standard Variables – Elaborated

This section provides a detailed description of the evidence for the values proposed for the standard variables.

The tables provide the values, geography, and degree of urbanisation for which the values are applicable; a summary of the evidence for the values; a score for the level of confidence users can have in the value based on the quality of the evidence; and limitations and potential biases with the evidence and hence values.

In the section of the table related to applicability, for each variable the 'degree of urbanisation' factor indicates which of three different categories of urbanisation the variable is appropriate for: (a) cities (densely populated areas), (b) towns and suburbs (intermediate density areas) and (c) rural areas (thinly populated areas).[50]

The confidence level was assessed for each value for 'standard variables'. Three stars (***) indicate that a study is 'up to date' (i.e. it was conducted within five years of the assessment) and has, at the same time, a 'large sample size' (meaning that the data came from one study with 500+ samples or several studies with a total of 500+ samples). Two stars (**) indicate that studies are either 'up to date' or have a 'large sample size', and one star (*) indicates that the studies are not up to date and have small sample sizes.

Table 18: DL (Discount for loss) – products not working or not in use, excluding loss in supply chain

DL	DISCOUNT FOR LOSS: PRODUCTS NOT WORKING OR NOT IN USE, EXCLUDING LOSS IN SUPPLY CHAIN (%)			
Unit	%			
Appliance	TV			
Applicability	**GEOGRAPHY**	**DEGREE OF URBANISATION**	**CONFIDENCE**	**VALUE**
	East Africa	Rural	***	3%
Assumptions	It is assumed that the off-grid use data are collected from a rural setting if it is not explicitly stated otherwise.			
Supporting literature	• GOGLA member companies reported that 3.5% of MKOPA TV customers in Kenya returned their device for a myriad of reasons and did not receive a replacement unit. • 2% of BBOXX customers in Kenya and Rwanda reported not using their systems mainly due to battery issues / customer service issues; 5% of BBOXX customers in the Democratic Republic of Congo (DRC) reported problems with the system, of which 15% indicated that it was a problem with the TV. • Efficiency for Access and 60 Decibels' report on the Use and Impact of Solar TVs for 2,370 participants in East Africa found that 34% of respondents reported challenges with using their solar TV, of whom 24% identified the appliance as the challenge.[51]			
Limitations / biases	The data are self-reported by GOGLA member companies and through customer phone calls; it is therefore prone to response and observer biases.			

50 Eurostat. Applying the Degree of Urbanisation. (2021) OECD. https://doi.org/10.1787/4bc1c502-en

51 Efficiency for Access and 60_Decibels. Use & Impact of Solar TVs: Lean Data Insights from Kenya, Rwanda, Tanzania, Uganda. (2020) https://storage.googleapis.com/e4a-website-assets/Solar-TVReport__-FINAL.pdf

Table 19: DR-Access – discount for repeat sales for estimating new access to solar appliances

DR-ACCESS	DISCOUNT FOR REPEAT SALES FOR ESTIMATING NEW ACCESS TO SOLAR-POWERED APPLIANCES (INCLUDING DIFFERENT COMPANIES) (%)			
Unit	%			
Appliance	TV			
Applicability	**GEOGRAPHY**	**DEGREE OF URBANISATION**	**CONFIDENCE**	**VALUE**
	East Africa	Rural	***	16%
Supporting literature	Efficiency for Access & 60 Decibels' study on the "Use and Impact of Solar TVs" found that 20% of respondents had owned a TV before buying a solar-powered TV.[52] Of the 20%, 4% had owned a solar-powered TV previously. 16% were also supported by the Efficiency for Access TV Working Group.			
Limitations / biases	Besides response biases that are common with telephone interviews, the data were not aggregated to the level of ascertaining whether the previously owned TV was still in use and if the new purchase was an additional TV or if it had been discarded and the new purchase was the only usable TV appliance. Therefore, to account for that uncertainty, the final value was reduced to 16%.			

Table 20: DR-GHG: Ratio capturing sales replacing a diesel genset-powered appliance

DR-GHG	RATIO CAPTURING SALES REPLACING A DIESEL GENSET-POWERED APPLIANCE (%)			
Unit	%			
Appliance	TV			
Applicability	**GEOGRAPHY**	**DEGREE OF URBANISATION**	**CONFIDENCE**	**VALUE**
	East Africa	Rural	***	16%
Supporting literature	Efficiency for Access and 60 Decibels' study on "The Use and Impacts of Solar TVs" found that 20% of the 2,355 respondents had previously owned a TV, with 4% having owned a Solar TV before.[53]			
Limitations / biases	• The 20% of respondents reported in the above study included an unknown percentage of unusable assets that had not been discarded due to status / prestige enhancing aspects of TV ownership. • An assumption is made that besides the 4% of respondents who owned solar powered TVs, the other 16% owned a diesel genset-powered TV. The variation of the coefficient established value across geographies is not studied.			

52 Efficiency for Access and 60_Decibels, Use & Impact of Solar TVs: Lean Data Insights from Kenya, Rwanda, Tanzania, Uganda. (2020) https://storage.googleapis.com/e4a-website-assets/Solar-TVReport__-FINAL.pdf

53 ibid

Table 21: EF – Employment factor

EF	EMPLOYMENT FACTOR (JOBS / ITEM SOLD)			
Unit	%			
Appliance	TV			
Applicability	**GEOGRAPHY**	**DEGREE OF URBANISATION**	**CONFIDENCE**	**VALUE**
	Nigeria	Nationwide	**	0.0188
	Kenya	Nationwide	**	0.0082
	India	Nationwide	**	0.0137
Assumptions	TVs are included in SHS packages, and that a SHS is able to support a TV.			
Supporting literature	• According to Power for All's "Powering Jobs Census 2019", the employment factor for pico solar appliances and SHS in Nigeria, Kenya and India for 2017–2018 were 18.8 jobs, 8.2 jobs and 13.7 jobs per 1,000 items sold respectively.[54] • The information is based on a survey carried out across 150 companies in India, Kenya and Nigeria. • These companies were surveyed across the decentralised renewable energy (DRE) technology spectrum, and the survey covers the supply chain, from manufacturing and wholesale imports to sales, installation and operations. • This included DRE companies working in off-grid, weak-grid, or on-grid contexts.[55]			
Limitations / biases	• The data are not segregated for each solar product, such as solar TV, fan, water pumps and refrigerators but rather given as an aggregated value for pico solar appliances and SHS systems. • This may result in overestimation of the actual contribution by each solar product.			

Table 22: EFA – Proportion of employment factor relevant to each appliance

EFA	PROPORTION OF EMPLOYMENT FACTOR RELEVANT TO EACH APPLIANCE			
Unit	%			
Appliance	TV			
Applicability	**GEOGRAPHY**	**DEGREE OF URBANISATION**	**CONFIDENCE**	**VALUE**
	Global	Nationwide	**	60%
Supporting literature	According to the "Powering Jobs Census 2019" , discount ratios are assigned based on the average appliance-to-total-SHS-cost ratios from VeraSol database.[56] These values equate to 60% for TVs.			
Limitations / biases	The above figures relate to SHSs as a whole, and we make an assumption that in East Africa, these SHS packages include a TV. There is no specific reference to jobs created by the TV market.			
Data gaps	Job creation along off-grid appliance supply chain disaggregated by appliance.			

54 Power for All, Powering Jobs Census 2019: The Energy Access Workforce. (2019) https://www.powerforall.org/resources/reports/powering-jobs-census-2019-energy-access-workforce
55 ibid
56 ibid

Table 23: G – average amount of greenhouse gases avoided per appliance, due to diesel displacement

G	AVERAGE AMOUNT OF GREENHOUSE GASES AVOIDED PER APPLIANCE, DUE TO DIESEL DISPLACEMENT (KG CO_2 / YEAR)			
Unit	kg CO_2e / year			
Appliance	TV			
Applicability	**GEOGRAPHY**	**DEGREE OF URBANISATION**	**CONFIDENCE**	**VALUE**
	Internationally	N/A	***	59
Supporting literature	Assuming that the solar equivalent appliance will have zero end-use emissions, the emissions of a single appliance equal: [57] • (Required energy / 10^12) × Emissions Factor of a Diesel Generator. Where the required energy equals: • (Delivered Energy × 3600 × 1 / Generator efficiency). Assuming a generator efficiency of 25% and the following: • Run-time of three hours / day. • Daily energy consumption of 0.15 kWh / day. • Annual operating days of 365. Then the required annual Delivered Energy is 55 kWh / year, and the annual Required Energy is 0.000788 TJ / year. As such, CO_2e emissions saved from using a solar powered TV equal 59 kgCO_2e / year. Diesel Emission Factor: 74100 kgCO_2 / TJ.[58]			
Limitations / biases	The above figures assume that a TV runs for three hours daily for 365 days per year. However, this will vary depending on various parameters including household size.			

57 Efficiency for Access and GOGLA, Standardised Impact Metrics for High-Performing Appliances : Fans and TVs. (2020) https://www.gogla.org/sites/default/files/resource_docs/gogla_impactmetrics-appliances_paper2020_def_0.pdf

58 ibid

Table 24: H – Household size

H	HOUSEHOLD SIZE (NUMBER OF PEOPLE)			
Unit	Number of people			
Appliance	All			
Applicability	**GEOGRAPHY**	**DEGREE OF URBANISATION**	**CONFIDENCE**	**VALUE**
	South Asia	General	***	5.5
	West Africa	Urban	***	6
	West Africa	Rural	***	8
	East Africa	Urban	***	5.3
	East Africa	Rural	***	5.5
Supporting literature	• 60 Decibels interviewed 25,497 individuals in its study on "Why Off-Grid Energy Matters" in East Africa (61%), West Africa (16%), and South Asia (14%), and recorded an average household size of 5.9.[59] • Efficiency for Access' report "Socio-Economic Impacts of Super-Efficient Off-Grid Fans in Bangladesh" reported an average household size of 5.3 people. with two-thirds having between two-six people per household.[60] Similarly, ALTAI & GOGLA in their report "Powering Opportunity in East Africa: Proving Off-Grid Solar is a Power Tool for Change" recorded an average household size of 5.7.[61] • ALTAI & GOGLA in the "Powering Opportunity in West Africa: Improving Lives, Powering Livelihoods with Off-Grid Solar" report highlighted that "while the average household size was seven across the research, urban households tend to be closer to six members while rural households are closer to eight members".[62] In South Asia, ALTAI & GOGLA in "Powering Opportunity in South Asia: From Work to Well-being", the Important Role of Small Scale Solar, the average household size among pre-purchase interviewees was 6.9.[63] • United Nation's Household Size and Composition Around the World 2017 reported an average household size of 4.8 in India and 6.8 in Pakistan.[64]			
Limitations / biases	Off-grid household data shows larger household sizes than the national averages, this needs to be further investigated.			

59 Kat Harrison, Shahnaz Khan, Tom Adams and Sasha Dichter, Why off-grid energy matters. An Impact Performance Report. (2020) https://60decibels.com/user/pages/energy-report/60%20Decibels%20-%20Why%20Off-Grid%20Energy%20Matters.pdf

60 Efficiency for Access, The Socio-Economic Impact of Super-Efficient Off-Grid Fans in Bangladesh. (2020) https://www.clasp.ngo/research/all/the-socio-economic-impact-of-super-efficient-fans-inbangladesh/

61 ALTAI and GOGLA. Powering Opportunity in East Africa:Proving Off-Grid Solar is a Power Tool for Change. (2019) https://www.gogla.org/sites/default/files/resource_docs/powering_opportunity_in_east_africa.pdf

62 ALTAI and GOGLA, Powering Opportunity in West Africa. Improving Lives, Powering Livelihoods with Off-Grid Solar. (2019) https://www.gogla.org/resources/powering-opportunity-in-west-africaimproving-lives-powering-livelihoods-with-off-grid

63 ALTAI and GOGLA, Powering Opportunity in South Asia: From Work to Well-being, the Important Role of Small Scale Solar (2020) https://www.gogla.org/resources/powering-opportunity-in-southasia-from-work-to-well-being-the-important-role-of-small

64 United Nations. Household size and composition around the world.(2017) Data Booklet. https://www.un.org/en/development/desa/population/publications/pdf/ageing/household_size_and_composition_around_the_world_2017_data_booklet.pdf

Table 25: OPEXD – Annual operational fuel cost of a diesel-powered appliance

OPEXD	ANNUAL OPERATIONAL FUEL COST OF A DIESEL-POWERED APPLIANCE (USD / YEAR)			
Unit	USD / year			
Appliance	TV			
Applicability	**GEOGRAPHY**	**DEGREE OF URBANISATION**	**CONFIDENCE**	**VALUE**
	East Africa	Nationwide	**	23.214
	India	Nationwide	**	18.25
Supporting literature	According to articles published in Renewable Energy World, the average cost of 1 kWh generated by diesel generators is USD 0.25 and USD 0.318 for India and East Africa respectively. Therefore, the expenditure on fuel for powering a 24-inch, 50 watt LCD TV for four hours every day is calculated as follows: ((50 × 4 × 365) / 1000) × (0.25 / 0.318). The coefficient established value excludes the cost of the generator.[65,66]			
Limitations / biases	The cost of fuel is volatile and the sizes, technology and power consumption of TV appliances varies from one customer to another. An assumption is made that a 24-inch LCD TV is the most common.			

Table 26: PEVP – Percentage of people who associate exposure to violence and any other undesired content with a TV

PEVP	PERCENTAGE OF PEOPLE WHO ASSOCIATE EXPOSURE TO VIOLENCE AND ANY OTHER UNDESIRED CONTENT TO A TV (%)			
Unit	%			
Appliance	TV			
Applicability	**GEOGRAPHY**	**DEGREE OF URBANISATION**	**CONFIDENCE**	**VALUE**
	East Africa	Rural	**	27%
	India	Rural	**	9%
Supporting literature	A survey of TV users in India and Uganda found that 27.0% of the respondents (in India) and 9.1% (in Uganda) associated TV use with exposure to violence and other undesired content especially among children and teenagers.[67] In addition to this study, there are more studies on this topic from other countries. e.g, "The Influence of Media Violence on Youth".[68]			
Limitations / biases	The formula heavily relies on the perception of the people and is prone to participant, response and social desirability biases.			

65 Anthony Mburu, Solar + battery energy storage VS diesel in East Africa. Renewable Energy World. (2020) https://www.renewableenergyworld.com/solar/solar-battery-energy-storage-vs-diesel-ineast-africa/#gref

66 B. Trivedi, Solar Power Becomes Cheaper than Diesel in India, Renewable Energy World (2011). https://www.renewableenergyworld.com/solar/solar-power-becomes-cheaper-than-diesel-inindia/#gref

67 Rural Senses, Impact Assessment Framework End-User Research in Uganda & India." (End-User research unpublished, 2021).

68 Craig A. Anderson, Leonard Berkowitz, Edward Donnerstein, L. Rowell Huesmann, James D. Johnson, Daniel Linz, Neil M. Malamuth, Ellen Wartella, The Influence of Media Violence on Youth. (2003) Psychological Science in the Public Interest, Volume: 4 issue: 3, page(s): 81-110 doi: https://doi.org/10.1111%2Fj.1529-1006.2003.pspi_1433.x

Table 27: PIW – Percentage of people associating TV with improved access to information

PIW	PERCENTAGE OF PEOPLE ASSOCIATING A TV WITH IMPROVED ACCESS TO INFORMATION (%)			
Unit	%			
Appliance	TV			
Applicability	**GEOGRAPHY**	**DEGREE OF URBANISATION**	**CONFIDENCE**	**VALUE**
	East Africa	Rural	***	89%
Supporting literature	98% of Azuri customers with a solar TV said they feel more aware of local and international affairs and that children feel more confident in discussing current affairs in school.[69] Similarly, around 90% of participants in the Efficiency for Access and 60 Decibels study on the use and impact of solar TVs felt that their knowledge or awareness of current affairs, politics, and general knowledge had improved given their ownership of the solar TV. [70] MKOPA's study of its new solar TV customers found that 70% of respondents felt the TV had improved their quality of life because they were better informed about current affairs and politics.[71] GOGLA's report "Powering Opportunity in West Africa: Improving Lives, Powering Livelihoods" reported that 97% of households felt that their quality of life had improved since purchasing the SHS:[72] among them 67% attributed this to access to information.[73] Another study by GOGLA – "Powering Opportunity in South Asia: From Work to Well-being, the Important Role of Small-Scale Solar" reports that 94% of households interviewed felt that owning a SHS helped improve their quality of life.[74] 8% of respondents attributed this to access to information.[75] 79.8% and 89.8% of TV users in Uganda and India respectively associated their use of a TV with access to information.[76]			
Assumptions	Unless explicitly stated, the off-grid studies are assumed to have been conducted in a rural setting.			
Limitations / biases	The data points are derived from subjective responses from the end-users. This implies the data are prone to response and selection biases. Two data points from the GOGLA & ALTAI studies [77,78,79] were not used to derive the standard value because we cannot attribute access to information to only TVs, as SHS are also sold with radios. However, the data points further support the impact metric.			
Data gaps	Breakdown of what information the end-user has access to and if the impact is positive or negative.			

69 Cambridge Network, Azuri Survey Shows That Solar TV Is Helping to Improve Education and Communication Skills. (2018) Cambridge Network. https://www.cambridgenetwork.co.uk/node/521575

70 Efficiency for Access and 60_Decibels, Use & Impact of Solar TVs: Lean Data Insights from Kenya, Rwanda, Tanzania, Uganda. (2020) https://storage.googleapis.com/e4a-website-assets/Solar-TVReport__-FINAL.pdf

71 M-KOPA, Tuned In: Television and Civic Engagement in Off-Grid Society. (2017) Sun Connect News https://sun-connect-news.org/fileadmin/DATEIEN/Dateien/New/TUNED_IN.pdf

72 ALTAI and GOGLA, Powering Opportunity in West Africa. Improving Lives, Powering Livelihoods with Off-Grid Solar. (2019) https://www.gogla.org/resources/powering-opportunity-in-west-africaimproving-lives-powering-livelihoods-with-off-grid

73 ALTAI and GOGLA, Powering Opportunity in East Africa: Proving Off-Grid Solar is a Power Tool for Change. (2019) https://www.gogla.org/sites/default/files/resource_docs/powering_opportunity_in_east_africa.pdf

74 ALTAI and GOGLA, Powering Opportunity in South Asia: From Work to Well-being, the Important Role of Small Scale Solar (2020) https://www.gogla.org/resources/powering-opportunity-in-southasia-from-work-to-well-being-the-important-role-of-small

75 ibid

76 Rural Senses, Impact Assessment Framework End-User Research in Uganda & India." (End-User research unpublished, 2021)

77 ALTAI and GOGLA. Powering Opportunity in East Africa:Proving Off-Grid Solar is a Power Tool for Change. (2019) https://www.gogla.org/sites/default/files/resource_docs/powering_opportunity_in_east_africa.pdf

78 ALTAI and GOGLA, Powering Opportunity in West Africa. Improving Lives, Powering Livelihoods with Off-Grid Solar. (2019) https://www.gogla.org/resources/powering-opportunity-in-west-africaimproving-lives-powering-livelihoods-with-off-grid

79 ALTAI and GOGLA, Powering Opportunity in South Asia: From Work to Well-being, the Important Role of Small Scale Solar (2020) https://www.gogla.org/resources/powering-opportunity-in-southasia-from-work-to-well-being-the-important-role-of-small

Table 28: PLTTV – Percentage of children under the age of 18 with access to a TV who relate it to learning

PLTTV	PERCENTAGE OF CHILDREN UNDER THE AGE OF 18 WITH ACCESS TO A TV WHO RELATE IT TO LEARNING (%)			
Unit	%			
Appliance	TV			
Applicability	**GEOGRAPHY**	**DEGREE OF URBANISATION**	**CONFIDENCE**	**VALUE**
	East Africa	Rural	**	60%
Supporting literature	46.1% and 30.7% of TV users in Uganda and India respectively associated TV use with attainment of knowledge, skills and personal development.[80] 92% of Azuri's customers said that watching TV had improved their communications skills.[81] 60% of Azuri's TV customers with school-age children reported that their children had improved their reading, writing and speaking skills since installing a solar TV system.[82] Azuri also reported in 2020 that their solar TV is helping off-grid children across Kenya to continue education while schools remain closed during the COVID-19 lockdown.[83] As this variable aims to capture children only, only the 60% value is considered.			
Limitations / biases	Since the standard value is derived from two data points from the same data set, to be conservative, we used the lower value that represents learning improvements for school-aged children. As other subjective responses, the data are prone to selection and response biases.			
Data gaps	More data points and secondary data are needed to support the development of this metric.			

80 Rural Senses, Impact Assessment Framework End-User Research in Uganda & India." (End-User research unpublished, 2021).

81 Cambridge Network, Azuri Survey Shows That Solar TV Is Helping to Improve Education and Communication Skills, Cambridge Network (2018). https://www.cambridgenetwork.co.uk/node/521575

82 ibid

83 Azuri, Azuri Technologies Is Helping to Off-Grid Children across Kenya to Continue Education While Schools Remain Closed, (2020) Azuri (blog), 3 April 2020, https://www.azuri-group.com/azurihelping-off-grid-children-across-kenya-to-continue-education-while-schools-closed/

Table 29: PQL – Percentage of people associating the appliance with improved quality of life

PQL	PERCENTAGE OF PEOPLE ASSOCIATING THE APPLIANCE WITH IMPROVED QUALITY OF LIFE (%)			
Unit	%			
Appliance	TV			
Applicability	**GEOGRAPHY**	**DEGREE OF URBANISATION**	**CONFIDENCE**	**VALUE**
	East Africa	Rural	**	60%
	South Asia	Rural	**	10%
Supporting literature	• The Rural Senses survey of TV users in Uganda and India found that 78.7% and 71.6% of respondents, respectively, associated TV use with improved quality of life; with positive sentiment for mental health, family and entertainment.[84] • MKOPA's study of 250 new TV owners in off-grid homes in Kenya found customers perceived that the TV had improved their quality of life because families could spend more time together (8%); their social status in the community had changed (9%); the TV brought home entertainment (42%); and they felt better informed about current affairs and politics (70%).[85] • The insights of Efficiency for Access and 60 Decibels from Kenya, Rwanda, Uganda, and Tanzania reported that 50% of customers said their quality of life had very much improved as a result of using the TV. The respondents mostly talked about having improved wellbeing, including joy and family connection.[86] • A 2018 Lean Data study of 270 Azuri clients found that 97% of respondents reported improved quality of life.[87] • GOGLA's report "Powering Opportunity in East Africa: Proving Off-Grid Solar is a Power Tool for Change" found that 94% of households reported that the SHS had improved their quality of life, of which 34% of 1,419 attributed the improvement to the ability to watch TV.[88] • GOGLA's study titled "Powering Opportunity in South Asia: From Work to Well-being, the Important Role of Small-Scale Solar'' reports that 94% of households reported that the SHS had helped improve their quality of life. Among them, 3% attributed this to access to a TV.[89]			
Limitations / biases	The standard value is derived from the subjective responses of the end-user that are prone to response bias and any other limitation of the respective studies. Regarding the MKOPA data point, we used the percentage attributed to being more informed because the percentages reported in the study did not add up to 100%. We understand that people would have reported more than one reason for the improved quality of life however, this could not be ascertained. For South Asia, only two data points were used with relatively small sample sizes and this calls for caution when applying this value. It can be improved with more data points and secondary data.			

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85 M-KOPA, Tuned In: Television and Civic Engagement in Off-Grid Society. (2017) Sun Connect News https://sun-connect-news.org/fileadmin/DATEIEN/Dateien/New/TUNED_IN.pdf

86 Efficiency for Access and 60_Decibels. 2020. "Use & Impact of Solar TVs: Lean Data Insights from Kenya, Rwanda, Tanzania, Uganda." https://storage.googleapis.com/e4a-website-assets/Solar-TV-Report__-FINAL.pdf

87 Global Partnership, Partner Profile: Azuri (November 2020) https://globalpartnerships.org/wp-content/uploads/bsk-pdf-manager/all/Partner-Profile-Azuri.pdf

88 ALTAI and GOGLA, Powering Opportunity in East Africa: Proving Off-Grid Solar is a Power Tool for Change. (2019) https://www.gogla.org/sites/default/files/resource_docs/powering_opportunity_in_east_africa.pdf

89 ALTAI and GOGLA, Powering Opportunity in South Asia: From Work to Well-being, the Important Role of Small Scale Solar (2020) https://www.gogla.org/resources/powering-opportunity-in-southasia-from-work-to-well-being-the-important-role-of-small

Table 30: PR – Multiplier for number of children under the age of 18 in a household accessing the appliance

PR	MULTIPLIER FOR NUMBER OF CHILDREN UNDER 18 IN A HOUSEHOLD ACCESSING THE APPLIANCE (RATIO)			
Unit	Ratio			
Appliance	TV			
Applicability	**GEOGRAPHY**	**DEGREE OF URBANISATION**	**CONFIDENCE**	**VALUE**
	Sub-Saharan Africa	N/A	**	2.8
	Asia	N/A	**	2.3
Assumptions	It is assumed that children benefit most from the use of a TV through educational programming.			
Supporting literature	Bongaarts' study of household size and composition in the developing world using household surveys in 43 developing countries found that the average number of children per household in sub-Saharan Africa is 2.8.[90] Near East / North Africa, this is 2.7, and in Asia 2.3. Children are defined as members of the household who are below 18 years of age, excluding individuals under the age of 18 who are identified as head of a household or spouse.			
Limitations / biases	Data are not recent and this number could have changed. It is also not sourced from off-grid customer data, and may not not be an accurate estimate of off-grid household composition.			

Table 31: PRSL – Percentage of people associating reduction in stress levels and relaxation with using the TV

PRSL	PERCENTAGE OF PEOPLE ASSOCIATING REDUCTION IN STRESS LEVELS AND RELAXATION WITH USING A TV (%)			
Unit	%			
Appliance	TV			
Applicability	**GEOGRAPHY**	**DEGREE OF URBANISATION**	**CONFIDENCE**	**VALUE**
	East Africa	Rural	**	75.6%
Supporting literature	The Rural Senses survey of TV users in Uganda and India found that 78.7% and 71.6% of respondents, respectively, associated TV use with relaxation and reduced boredom.[91] The most frequently mentioned reason for reduced stress was better entertainment, improved mental health and togetherness. MKOPA's study of 250 new TV owners in off-grid homes in Kenya found that 42% of respondents perceived that the TV improved their quality of life because it provided home entertainment.[92] The findings of Efficiency for Access and 60 Decibels on the off-grid TV sector in East Africa based on 3,920 phone interviews conducted in Kenya, Rwanda, Tanzania and Uganda between June 2018 and June 2019 reported that 79% of respondents felt that their stress levels had reduced since using the solar TV, and 83% said that their family was more connected.[93] The most frequently mentioned reason for reduced stress was less boredom and better entertainment (25%). Other common responses were more time spent on relaxation and reducing stress (24%) and increased happiness within the family (21%).			
Limitations / biases	The standard value derived is a weighted average of the percentages of people from two data points that perceived that the use of a solar powered TV had reduced their stress levels. This is subjective, prone to response bias, and may vary for different representative samples or communities.			

90 John Bongaarts, Household size and composition in the developing world. (2001) Population Council. https://doi.org/10.31899/pgy6.1045

91 Rural Senses, Impact Assessment Framework End-User Research in Uganda & India." (End-User research unpublished, 2021)

92 M-KOPA, Tuned In: Television and Civic Engagement in Off-Grid Society. (2017) Sun Connect News https://sun-connect-news.org/fileadmin/DATEIEN/Dateien/New/TUNED_IN.pdf

93 Efficiency for Access and 60_Decibels, Use & Impact of Solar TVs: Lean Data Insights from Kenya, Rwanda, Tanzania, Uganda. (2020) https://storage.googleapis.com/e4a-website-assets/Solar-TVReport__-FINAL.pdf

Table 32: PSTT – Percentage of customers associating appliance use with spending time with family and community

PSTT	PERCENTAGE OF CUSTOMERS ASSOCIATING APPLIANCE WITH SPENDING TIME WITH FAMILY AND COMMUNITY (%)			
Unit	%			
Appliance	TV			
Applicability	**GEOGRAPHY**	**DEGREE OF URBANISATION**	**CONFIDENCE**	**VALUE**
	East Africa	Rural	**	75.9%
Supporting literature	MKOPA's study of new TV owners in off-grid homes in Kenya found that 8% perceived that the TV had improved their quality of life because families could spend more time together.[94] Efficiency for Access and 60 Decibels' insights from Kenya, Rwanda, Uganda, and Tanzania revealed that 83% of respondents had said that their family was better connected as a result of access to a TV.[95] The Rural Senses survey of TV owners in Uganda and India found that 77.5% and 71.6% of respondents, respectively, associated TV use with spending more time together.[96]			
Limitations / biases	The measure is subjective and therefore prone to response bias. It can also vary depending on the representative sample being assessed.			

Table 33: PTST – Percentage of people reporting watching TV for more than two hours per day

PTST	PERCENTAGE OF PEOPLE REPORTING WATCHING TV FOR MORE THAN TWO HOURS (%)			
Unit[97][98][99][100][101]	%			
Appliance	TV			
Applicability	**GEOGRAPHY**	**DEGREE OF URBANISATION**	**CONFIDENCE**	**VALUE**
	Sub-Saharan Africa	Rural	**	95%
Supporting literature	Research shows that limiting TV time to two hours per day could minimise health risks from TV.[97] A MKOPA study of its customers found that three hours per day is the average time spent watching a new solar TV.[98] An Azuri study revealed that, on average, customers watched five hours of TV per day.[99] An Azimoh study of the impact of the South African and Namibian SHS programmes found that the daily usage pattern shows that the TV was used for five hours.[100] Rural Senses' study of 116 off-grid appliance users in Uganda and 96 in India found that 58% and 45% of respondents respectively, reported watching TV between 3–5 hours a day.[101]			
Limitations / biases	All the data from people indicate an hour or more of TV use that exceeded the two-hour recommended time. We took the lower limit after adding a standard error of + / - 5. The literature that informed the two-hour threshold focuses on the Global North and high-income groups. No study for the case study context of this work could be identified.			

94 M-KOPA, Tuned In: Television and Civic Engagement in Off-Grid Society. (2017) Sun Connect News https://sun-connect-news.org/fileadmin/DATEIEN/Dateien/New/TUNED_IN.pdf

95 Efficiency for Access and 60_decibels, Use & Impact of Solar TVs: Lean Data Insights from Kenya, Rwanda, Tanzania, Uganda (2020) https://storage.googleapis.com/e4a-website-assets/Solar-TVReport__-FINAL.pdf

96 Rural Senses, Impact Assessment Framework End-User Research in Uganda & India." (End-User research unpublished, 2021)

97 Ali Howard and Elizabeth McMeekin, Limiting TV Time to 2 Hours per Day Could Minimise Health Risks from TV (Thesis, United Kingdom, University of Glasgow, 2020), https://www.gla.ac.uk/news/archiveofnews/2020/july/headline_731141_en.html

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100 Chukwuma Leonard Azimoh, Sustainability and Development Impacts of Off-Grid Electrification in Developing Countries: an Assessment of South Africa's Rural Electrification Program." (Västerås: Mälardalen University, 2016), http://urn.kb.se/resolve?urn=urn:nbn:se:mdh:diva-30762

101 Rural Senses, Impact Assessment Framework End-User Research in Uganda & India." (End-User research unpublished, 2021)

Table 34: WC – Weight of the non-solar powered appliance

WC	WEIGHT OF NON-SOLAR POWERED APPLIANCE (KG)			
Unit	kg			
Appliance	TV			
Applicability	**GEOGRAPHY**	**DEGREE OF URBANISATION**	**CONFIDENCE**	**VALUE**
	Global	N/A	**	12.4
Supporting literature	The weight of a TV varies depending on the size and type of materials used. It can weigh from a few pounds to 100 pounds (45 kg) and more. For instance, a standard 32-inch flat screen LCD TV can weigh somewhere between 25 –30 pounds (11–14 kg). A 50-inch TV can weigh about 28–55 pounds (15–25 kg). Older Cathode Ray Tube TVs are quite heavy. A 25-inch CRT TV could weigh up to 100 pounds (45 kg).[102,103] According to findings from Eutelsat's 2019 study, the need for HD is rising in Sub-Saharan Africa with a growing demand for HD content. The number of HDTV enabled households rises year on year and already has an influence in major Sub-Saharan countries.[104]			
Limitations / biases	The weight of a TV varies depending on the size and type of materials used.			

102 Yulia Kalmykova, João Patrício, Leonardo Rosado, Ber and P. EO, Out with the old, out with the new – The effect of transitions in TVs and monitors technology on consumption and WEEE generation in Sweden 1996–2014.(2015) Waste Management, 29. https://doi.org/10.1016/j.wasman.2015.08.034

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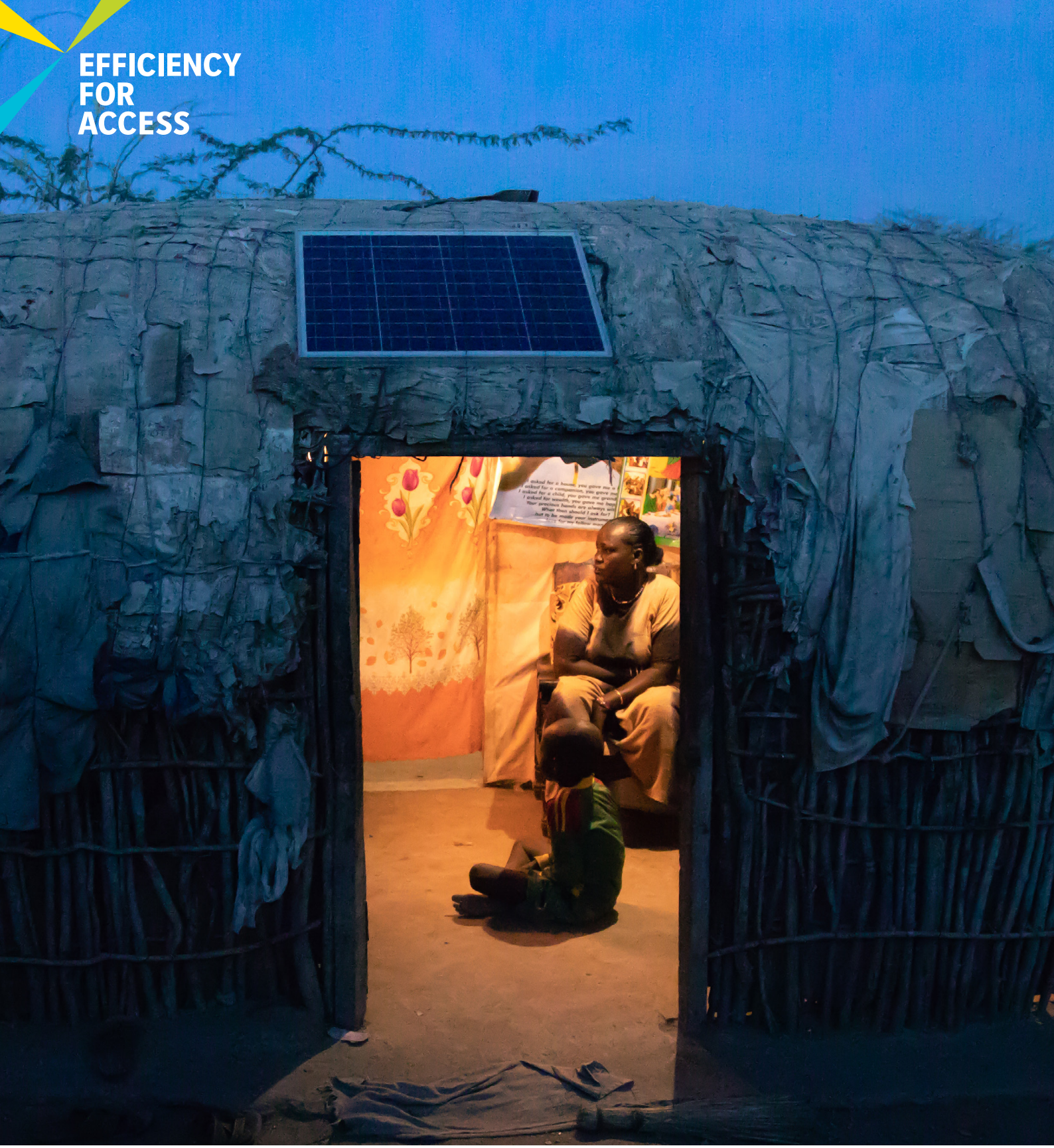

CONTACT US

efficiencyforaccess.org
info@efficiencyforaccess.org
@EforA_Coalition