GOGLA

The Voice of the Off-Grid Solar Energy Industry

Standardised Impact Metrics for High-Performing Appliances: Fans and TVs

October 2020

EFFICIENCY FOR ACCESS

About

Efficiency for Access Coalition

Efficiency for Access is a global coalition working to promote high-performing appliances that enable access to clean energy for the world's poorest people. It is a catalyst for change, accelerating the growth of appliance markets to boost incomes, reduce carbon emissions, improve quality of life and support sustainable development.

Efficiency for Access consists of 15 Donor Roundtable Members, 10 Programme Partners, and more than 30 Investor Network members. Current Efficiency for Access Coalition members have programmes and initiatives spanning 44 countries and 22 key technologies.

The Efficiency for Access Coalition is coordinated jointly by CLASP, an international appliance energy efficiency and market development specialist not-for-profit organisation, and UK's Energy Saving Trust, which specialises in energy efficiency product verification, data and insight, advice and research.
www.efficiencyforaccess.org.

The Low Energy Inclusive Appliances (LEIA) programme is the flagship programme of Efficiency for Access. Funded by the UK's Foreign and Commonwealth Development Office and the IKEA Foundation, LEIA is a research & innovation programme that aims to accelerate the availability, affordability, efficiency, and performance of a range of low energy inclusive appliances particularly suited to developing country contexts.

GOGLA

GOGLA is the global association for the off-grid solar energy industry. Established in 2012, GOGLA now represents over 180 members as a neutral, independent, not-for-profit industry association. Its mission is to help its members build sustainable markets, delivering quality, affordable products and services to as many households, businesses and communities as possible across the developing world. The products and solutions that GOGLA members sell transform lives. They improve health and education, create jobs and income opportunities and help consumers save money.

To find out more, go to www.gogla.org

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UKaid from the British people

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Introduction

Why Impact Metrics Matter

Affordable high-performing appliances[1] can deliver significant economic, health, education and quality of life benefits for households worldwide. They can also reduce greenhouse gas emissions and help communities adapt to the effects of climate change. To ensure that energy access decision-makers understand the transformative impact of high-performing appliances, a standardised framework for impact measurement is needed.

The Efficiency for Access Coalition and the GOGLA Impact Working Group have joined forces to propose the standardised approach presented in this publication. It provides a harmonised industry standard for measuring social impact, designed to attract investment, working capital, and regulatory support for the high-performing appliances sector. The metrics help build the evidence base for the many benefits that high-performing appliances unlock for people previously living in energy poverty. These include improved quality of life, and using the appliance to work, study or spend time with family.

Individual organisations can use these metrics to estimate the impact of their products, services or market support activities. The LEIA Programme will use these metrics to support high-performing appliance companies and members of the Efficiency for Access Donor Coalition in their impact reporting. GOGLA will also use the metrics to calculate the impact of those members, IFC Lighting Global Associates and companies engaging with the LEIA Programme, that are participating twice yearly in the off-grid solar sales and impact data collection. This will help demonstrate the impact of high-performing appliances to key decisionmakers.

Background

High-performing appliances help rural communities in off- and weak-grid areas to enjoy improved quality of life and the benefits associated with access to modern energy services. Appliances have the potential to help accelerate progress towards many of the Sustainable Development Goals (SDGs) as shown in Figure 1.

Figure 1. SDGs Impact by High-performing Appliances (Efficiency for Access Coalition)

High-Performing Appliances Help Achieve the UN Sustainable Development Goals

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1 High-quality and efficient off-grid appliances that are intentionally designed for end-users living in energy-constrained environment and advertised for use with a PV module or a solar home system. Efficiency for Access Coalition (2019). State of the off-grid appliance market.

Introduction

Since 2018, the partnership between GOGLA and the Efficiency for Access Coalition has allowed sales data to be collected for a range of key high-performing appliances as part of the Global Off-Grid Solar Market Data Collection process. Along with reporting unit volumes and revenues generated by the sale of products, a high value is also placed on communicating the estimated impact that these products make throughout their serviceable lifetimes. For lighting products (including solar home systems or SHS), the GOGLA 'Standardised Impact Metrics for the Off-Grid Solar Energy Sector'[2] have been in place since 2015 widely adopted across the sector as the accepted measure for estimating the social, economic and environmental impact of off-grid solar lighting products consistently and comparably. **Each impact estimate, updated in the Global Off-Grid Solar reporting that takes place each half-year, is based on a calculation using the number of products sold or deployed to end-users.**

As part of a broader impact framework, the creation of similar impact metrics for appliances will provide a valuable and cost-effective opportunity to create global impact estimates that can help engage relevant policymakers, investors and development stakeholders. At the same time, the incorporation of impact measurements into the sales data reporting process would increase the value of participation to reporting companies by providing them with a third-party generated measure of impacts which showcases their work and efforts to their investors and other stakeholders.

The Impact Metrics for Appliances Project

The focus of this project is the development of a set of standardised impact metrics that capture the impacts that high-performing appliances have on end-users. This set aims to encompass metrics for each of the following identified impact areas unlocked by the appliances: appliance access, economic activity, environmental sustainability and social impact. Metrics are defined for each specific appliance category, subject to the availability of reliable research and robust data. The focus of the first metric development effort, outlined in this document, are fans and TV appliances. These are developed with the support (and through the mechanism) of the GOGLA Impact Working Group (WG),[3] where companies, academic observers and other relevant stakeholders partake in discussions and approve the metrics. For the WG to represent the different target companies and company profiles, for whom the framework is intended, a number of appliance companies from the LEIA network have joined to partake in the discussions and the metric development.

The target users of these metrics are appliance companies (manufacturers/distributors), investors and financiers, as well as advocacy groups and development partners involved in the sector and working with government and policymakers.

2 GOGLA (2020). Standardised Impact Metrics for the Off-Grid Solar Energy Sector, version 4.

3 The GOGLA Impact WG has as primary objective to revise and expand the standardised impact metrics for the off-grid solar sector. It also aims to improve the adoption of these metrics as well as gather evidence on social impact. The WG usually consists of GOGLA Members, academic observers and development partners.

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Limitations when using the metrics

Specific metrics or coefficients apply to specific appliances. Each appliance type has its own set of metrics and variables. Only use those metrics or variables that relate to the relevant appliance/product(s). For example, a certain metric or variable might be specific to elements of TV use, while different metrics and variables should be used for measuring the impact of fan use. Please ensure you review the metrics carefully and only use those metrics or variables that relate to the relevant appliance/product(s).

These metrics apply to high-performing appliances. The metrics have been created using data and evidence from high-performing appliances products. As such, it is advised that these metrics should only be used to calculate the impact of companies or organisations selling products that adhere to the eligibility criteria outlined in the section above.

The metrics apply to high-performing appliances sold in off- and weak-grid environments in a developing countries context. Therefore, only off-grid solar products sold in the developing world should be included when using the metrics to measure impact. It should be noted that while the appliances framework applies to weak and off-grid environments, it is agnostic to the associated energy supply source.

Results calculated using these metrics should be described as estimates. It is important to note that, while these metrics have been created using the best available data, results created using the metrics should always be referred to as estimates as the data represents insights from research done with specific companies or organisations. As such, these estimates may not be representative for specific contexts that other companies (outside of the datasets from considered research) operate in. Additionally, most data is self-reported. Please see details of the limitations for each metric's variables for specific limitations and/or details on each metric for more information on how these should be used and described.

Metrics should not be used when it is clear that specific products and services do not have the estimated impact. While applicable in most cases, there may be instances where a specific product type, location or use-case may not lead to a commonly observed impact. For example, a company selling appliances specifically to households powered by a (weak) grid, should not use the current metric to estimate the amount of

Eligibility criteria for TVs and fans to use metrics suggested in this report

The following criteria, shown in Table 1, have been selected and adopted as a minimum standard, set up to be applicable and consistent across appliances. The selection is based on preliminary criteria that would not require testing and are focused on consumer protection.

The rationale for keeping the selected criteria limited to access to warranty and user manual is that including appliance performance criteria would lead us into the work field of establishing a full quality assurance framework for all different types of appliances, which at present is too early for the impact framework. All companies should be able to use the impact framework as long as the consumer protection criteria shown in Table 1 are met and limitations below are taken into account.

Table 1. Selected criteria to products for which metrics are applied

Aspect	Requirements
Warranty (one year)	Warranty is accurately specified and consumer-facing, with a minimum coverage of one year
Availability of User Manual	The user manual must present instructions for use and basic electrical safety

Introduction

GHG emissions offset since that pertains only to the replacement of diesel generators. Another example is that a fridge developed and sold for vaccine storage is not likely to lead to household access or avoidance of food waste. A common-sense approach should be taken to use and apply the impact metrics.

Guidance on using the Metrics

The high-performing appliances sector is still at a nascent stage, and the availability of research, particularly socio-economic impact research is limited. This initial framework of measuring impact in the high-performing appliances sector, and the metrics within it, present the first effort of its kind. We have fully taken the utmost care to use the available data as effectively as possible, while still keeping a conservative approach. Please be mindful that this is an iterative approach, as new research projects are commissioned and more data and evidence become available, a revision to these metrics will be made available.

Funding and support is needed to carry out new research and obtain more data. If you would like to help us uncover other data and research useful for impact metric development and improve assumption accuracy, you can:[4]

- share relevant data
- (co) fund research
- join the impact working group

The overview of formulas and variables in the tables at the beginning of each appliance section summarizes the harmonized framework detailed in the rest of this document. **Red** coefficients are to be inputted by users of the metrics (e.g. companies) whilst **Blue** coefficients have default values that have been established through this work. Defaults should be used where appropriate, unless companies or other users have more accurate and specific inputs from their own, robust and reviewed, research.

Please note that the primary basis used for counting and scaling estimates of social impact is the number of products sold or deployed to end-users (product specifications are also used for certain metrics). In some cases, it makes sense to count all products ever sold [S], while in others the estimated number of currently operating systems [S_L] (i.e., within the lifetime of the product) is a more appropriate basis.

The values of the default coefficients are based on three different types of sources:

- Company information – direct input from companies active in the sector, via the GOGLA Impact Working Group
- Primary research
- Secondary research/literature

Where possible, data sets have been averaged and where input and/or outcome took the form of a possible data-range, the most conservative value was adopted. When company information was a leading input, a particularly conservative approach has been adopted for validating and establishing the coefficient. In the sections that detail each coefficient, Sections 4 and 5, the sources are described, referenced and are available upon request.

For sales and deployment estimates, sales numbers should be discounted by a channel loss discount factor [D_L] that is the fraction of products that are damaged or lost and never reach end-users.

Structure of the document

In the remainder of this document, the formally adopted metrics for TVs and fans are defined and described in detail per appliance in their respective chapters, segmenting between TVs and fans. In addition, the impact subcategories which could not be populated owing to limited availability of data are listed in these chapters as well, to highlight the metrics the Efficiency for Access Coalition and Impact Working Group will prioritise for future development. The data and research needs that have been identified to populate these metrics are outlined under the 'Future Developments' section and will feed into recommendations for future research plans.

4 Please contact the Efficiency for Access Coalition at info@efficiencyforaccess.org and GOGLA at info@gogla.org

At a Glance

Impact Metrics – Overview of Formulas

Metric		Appliance Type	Formula
1. Appliance Access/Household Access			
1a	Number of people benefitting from high-performing appliances, cumulatively	Fan TV	$S \times (1 - D_{R\text{-}Access}) \times (1 - D_L) \times H$
1b	Number of people benefitting from high-performing appliances, currently	Fan TV	$S_L \times (1 - D_{R\text{-}Access}) \times (1 - D_L) \times H$
2. Economic Activity			
2a	Number of People using their appliances to support enterprise	Fan TV	$S_L \times (1 - D_L) \times E$
2b	Number of People generating additional income	TV only	$S_L \times (1 - D_L) \times IG$
3. Environmental Sustainability			
3a	Metric tons of CO_2e emissions avoided, from diesel displacement	Fan TV	$S \times D_{R\text{-}GHG} \times (1 - D_L) \times G \times P_L$

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At a Glance

Impact Metrics – Overview of Coefficients

Variables (input by user)		Fan	TV
S	Number of units sold (cumulative i.e. ever)		
S_L	Number of units sold which are estimated to currently be in use (based on the products estimated lifespan being [1.5 x warranty] period)		
P_L	Estimated product lifespan (1.5 x warranty)		

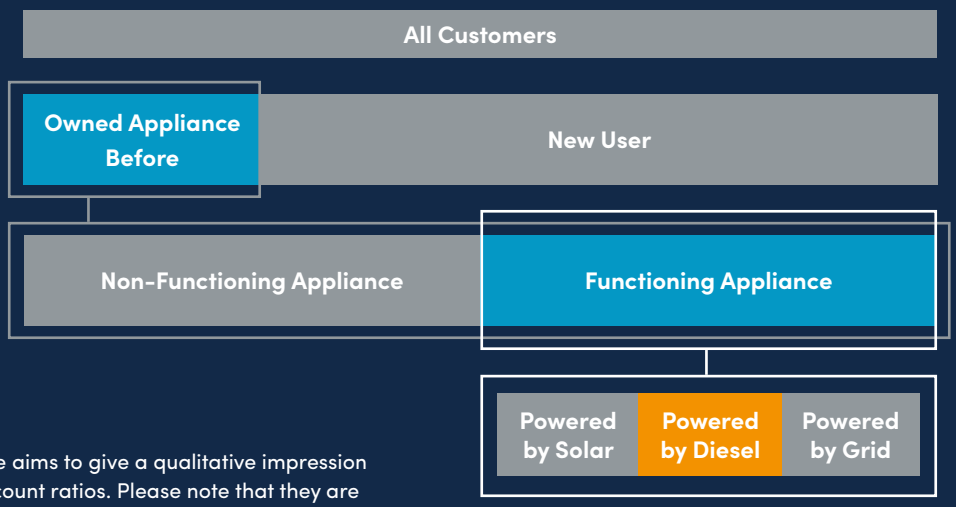
Variables (standard value)		Fan	TV
$D_{R\text{-}Access}$	Discount for repeat sales for estimating new access impact	5%	16%
$D_{R\text{-}GHG}$	Ratio capturing sales replacing a diesel genset powered appliance for estimating GHG emissions	3%	6%
D_L	Discount for loss: products not working or not in use, excluding loss in supply chain	3%	7%
H	Household Size	5.5	5.5
E	The percentage of customers using products to support enterprise (including those that have opened a new business)	3%	9%
IG	Percentage of customers/households creating additional income	-	4%
G	Average amount of greenhouse gases avoided per appliance, in kg CO_2e/year,[5] due to diesel displacement	84	59

Details on literature, definitions, assumptions and limitations for standard variables values can be found in Section 4 for fans, and Section 5 for TVs.

A note on $D_{R\text{-}Access}$ and $D_{R\text{-}GHG}$

For correctly estimating impact of those who have new access to an appliance, we should only take into account new users, or those whose TV was not functional. This means that the discount ratio $D_{R\text{-}Access}$ specifically accounts for those who owned a working appliance before.

For correctly estimating environmental impact, we should only look at replacement of working TVs in regular use, powered by diesel generators. This means that the discount ratio $D_{R\text{-}GHG}$ specifically accounts for those who used diesel generator as power source to power their appliance.



The image aims to give a qualitative impression of the discount ratios. Please note that they are not representative of actual numbers.

5 CO_2-equivalent (CO_2e) emissions include the Kyoto gases carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), but exclude fluorinated gases. CO_2e emissions are calculated based on 100-year Global Warming Potential (GWP_{100}) values from the IPCC Second Assessment Report (CO_2 = 1, CH_4 = 25, N_2O = 298).

Impact Metrics

Impact Metrics

Impact Metrics Formulas - Details

For each established metric, the following section outlines the definition, impact statement, calculation and assumptions behind each of the Appliance impact metrics. Where appliance specific information or annotations are required, a differentiation has been made between fans and TVs.

Inputting sales units, and other information relating to the off-grid solar product, into each metric formula will estimate impact. The assumptions and calculations for coefficients that constitute the metric formulas are outlined in the section below.

1. Appliance Access/household access

Metric	1a - Number of people benefitting from high-performing appliances, cumulatively
Unit of measurement	Number of people
Definition	Cumulative number of people who have ever lived in a house with a high-performing *[insert type of]* appliance
Usefulness of metric	Enables us to estimate the number of people that have benefited from using high-performing appliances
Impact Statement	The high-performing appliances industry has helped to improve *[insert type of appliance]* access for an estimated X number of people
Calculation	$S \times (1 - D_{R\text{-}Access}) \times (1 - D_L) \times H$ Number of products sold (S) x discount for loss (D_L) x discount for repeat sales ($D_{R\text{-}Access}$) x household size (H)
Assumptions	• The appliance is used in the home, and every household member benefits or has access to the appliance • Appliance access and use is reported as an average. For example, seasonality or differences in time-use (who benefits most, uses the appliance most) are not taken into regard
Future improvements	• Impact insights broken down by different appliance (fan, TV) sizes and types • Impact insights broken down by different appliance access use cases: gender access, actual access levels (e.g. neighbours and wider family/relatives benefitting from the fan or TV), business access, primary user access, usage throughout the year • Impact insights broken down into differences of geography, seasonality or differences in time-use

Impact Metrics

Metric	1b. Number of people benefitting from high-performing appliances, currently
Unit of measurement	Number of people
Definition	Number of people who currently live in a house with a high-performing *[insert type of]* appliance
Usefulness of metric	Enables us to estimate the number of people using high-performing appliances
Impact Statement	The high-performing appliances industry is helping to improve *[insert type of appliance]* access for an estimated X number of people
Calculation	S_L x (1 - $D_{R\text{-}Access}$) x (1 – D_L) x H Number of products sold that are still in lifetime (S_L) x discount for loss (D_L) x discount for repeat sales ($D_{R\text{-}Access}$) x household size (H) Number of products still in lifetime = sold within last [1.5 x warranty] years
Assumptions	• The appliance is used in the home, and every household member benefits or has access to the appliance • Appliance access and use are reported as an average. For example, seasonality or differences in time-use (who benefits most, uses the appliance most) are not taken into regard
Future improvements	• Impact insights broken down by different appliance (fan, TV) sizes and types • Impact insights broken down by different appliance access use cases: gender access, actual access levels (e.g. neighbours and wider family/relatives benefitting from the fan or TV), business access, primary user access, usage throughout the year • Impact insights broken down into differences of geography, seasonality or differences in time-use

2. Economic Activity

Metric	2a. Number of people using high-performing appliances to support enterprise
Unit of measurement	Number of people
Definition	Number of people who are using their high-performing appliance to support an enterprise, or income generating activities (e.g. showing TV for a fee, or using their fan to improve the temperature within an office or shop to improve working conditions/attract customers)
Usefulness of metric	Enables us to estimate the number of people directly using their high-performing *[insert type of]* appliance product to support enterprise
Impact Statement	High-performing appliances products and services are used by an estimated X people to support enterprise
Calculation	S_L x (1 – D_L) x E Number of products sold that are still in lifetime (S_L) x discount for loss (D_L) x proportion of people using products to support enterprise or income generating activities in the home (E)
Assumptions	• That impact is stable/no change over time
Notes	• This metric is focused on the enterprise being supported due to the ownership of an high-performing appliance. The strong majority of businesses supported are individual or micro-enterprises such as small stalls, shops or restaurants. • This metric excludes all enterprise created by the industry rather than the products e.g. it does not include agents selling appliances products
Future improvements	• Impact insights into how this may change over time • Impact insights broken down into differences pertaining to geography or seasonality • Obtain additional evidence in the long term, exploring change over time. Eventual appliance ownership saturation could potentially decrease the economic activity that can be undertaken

Impact Metrics

Metric	2b. Number of people generating additional income
Unit of measurement	Number of people
Definition	Number of people that are generating additional income as a result of using their high-performing appliance (for example to open a business or to charge a fee for use of the appliance)
Usefulness of metric	Enables us to estimate how many people have been able to create additional income as a result of using a high-performing appliance
Impact Statement	High-performing *[insert type of]* appliance products and services are estimated to be enabling X number of people to generate additional income
Calculation	S_L x (1 – D_L) x IG Number of products sold that are still in lifetime (S_L) x discount for loss (D_L) x proportion of people generating additional income (IG)
Assumptions	• That impact is stable/no change over time • The impact created in rural and urban environments is assumed to be equal
Notes - fans	• This metric is currently **not** available for fans
Future improvements - fans	• Gather sufficient data to establishing this metric for fans
Future improvements - TV	• Impact insights into how this may change over time • Impact insights broken down into differences pertaining to geography or seasonality • Obtain additional evidence in the long term, exploring change over time. Eventual appliance ownership saturation could potentially decrease the economic activity that can be undertaken

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Impact Metrics

3. Environmental Sustainability

Metric	3a. Metric tons of CO_2e emissions avoided from diesel displacement
Unit of measurement	Metric tons of carbon dioxide equivalent (CO_2e).[5]
Definition	Metric tons of CO_2e averted due to estimated reduction in diesel generator emissions of CO_2, CH_4 and N_2O, per off-grid high-performing appliance; over expected lifetime of the product
Usefulness of metric	Enables us to highlight the estimated environmental benefits of (off-grid) energy efficient appliances by capturing the immediate effects of reductions in several major climate altering greenhouse gases including carbon dioxide. Reductions are seen due to the replacement of appliances previously used that were powered by diesel generation sets.
Impact Statement	The high-performing *[insert type of]* appliances industry has helped to avert an estimated X metric tons of CO_2e (not including embodied emissions)
Calculation	$S \times D_{R\text{-}GHG} \times (1 - D_L) \times G \times P_L$ Number of products sold (S) x ratio capturing number of sales replacing a diesel genset powered appliance ($D_{R\text{-}GHG}$) x discount for loss (D_L) x annual CO_2e emissions avoided (G) x estimated lifespan of appliance product (P_L) Conversion: 1 metric tons = 1000 kg
Assumptions	• That appliances and energy sources replaced (e.g. appliances powered by diesel generation sets) were functioning and commonly used at an average estimated rate
Notes	• Use of the following standardized footnote is strongly recommended when calculating and reporting CO_2e emissions avoided: *CO_2-equivalent (CO_2e) emissions include the Kyoto gases carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), but exclude fluorinated gases. CO_2e emissions are calculated based on 100-year Global Warming Potential (GWP_{100}) values from the IPCC Second Assessment Report* • Applies where newly purchased high-performing appliances are solar-powered and are replacing previously used appliances that were powered by a diesel generator • Does not include embodied energy from manufacturing and transporting products
Future improvements	• Take into account variations in baseline e.g. maybe some replacement of fans or TVs powered by weak-grid • Explore embodied energy from manufacturing

Social Impact

At this point in time, there are no social impact metrics ready to be put forth for either fans or TVs.

It is widely accepted that users and companies perceive considerable social impacts through the use of high-performing appliances (such as an improved quality of life, health improvements, contributing to gender equality or education – to name a few). In most cases, the impact evidence for these is anecdotal and self-reported, and further research is required to identify more quantifiable impacts and the degree of causal linkages, which is outlined in the "Future Developments" section, on page 34.

Fans Coefficients Calculations and Values

Fans Coefficients Calculations and Values

This section contains the impact metrics variable details for fans. The below tables outline the definitions, assumptions and default values for the variables for high-performing fans that make up the metric formulas.

The types of sources underlying each coefficient can be identified through the following color coding:

- Green for company input
- Blue for primary research
- Gray for secondary research

Standard Coefficients with Default Values

Coefficient	$D_{R\text{-}Access}$: Discount for repeat sales for estimating new access impact
Definition	The percentage of units sold that are repeated sales to a household with the same appliance, due to the replacement or additional purchases, while the first product is still functioning and in use. The intention is to avoid double-counting within the number of people impacted
Default Value	5%
Justification	• Conservative estimate by companies involved in the supply chain in off-grid and weak-grid environments • Validated by SHS data (sold with appliance included) and by data on households who report powering a fan with grid electricity
Limitations	• This variable is calculated based on data from South Asia. Applying this variable to other regions may be inaccurate. • This variable is not validated by secondary data. Conservative assumptions were used to reduce the risk of overestimating impact. • Currently does not distinguish between appliances sold alone, or sold as part of a SHS kit, nor between business models through which the appliance (kit) is sold (e.g. both cash sales and PAYGo[6] are included) • At this point in time, no differentiation between fan types is made
Sources	• GOGLA Impact WG Members / GOGLA Member companies / Efficiency for Access network companies • CLASP (2020). Socio-Economic Impacts of Super-Efficient Off-Grid fans in Bangladesh • GOGLA (2020). Standardised Impact Metrics for the Off-Grid Solar Energy Sector, version 4
Relevant Metrics where coefficient is used	1a, 1b
Future Improvements	• Collect better data from companies and identify third-party research source for establishing $D_{R\text{-}Access}$ • Obtain data from different regions/geographies • Distinguish between business models through which the appliance is sold (cash or PAYGo), as well as sales of an independent appliance vs appliance + SHS kit • Impact insights broken down by different fan sizes and types

6 Pay-As-You-Go (PAYGo): refers to a business model that allows users to pay for their product via consumer financing over time. A PAYGo company will typically offer a solar product for which a customer makes a down payment, followed by regular payments for a term ranging from 6 months to 8 years. In most cases, the repayment period is close to 24 months.

Fans Coefficients Calculations and Values

Coefficient	$D_{R\text{-}GHG}$: Ratio capturing sales replacing a diesel genset powered appliance for estimating GHG emissions
Definition	The percentage of units sold to a household where the new purchase is replacing a similar type of appliance, diesel powered.
Default Value	3%
Justification	• Conservative estimate by companies involved in the supply chain in off-grid and weak-grid environments
Limitations	• This variable is validated based on data from South Asia. Applying this variable to other regions may be inaccurate. • This variable is calculated using a relatively small and limited data sample. Conservative assumptions were used to reduce the risk of overestimating impact.
Sources	• GOGLA Impact WG Members / GOGLA Member companies / Efficiency for Access network companies • CLASP (2020). Socio-Economic Impacts of Super-Efficient Off-Grid fans in Bangladesh • GOGLA (2020). Standardised Impact Metrics for the Off-Grid Solar Energy Sector, version 4
Relevant Metrics where coefficient is used	3a
Future Improvements	• Collect better data from companies or identify third-party research source for establishing $D_{R\text{-}GHG}$ • Obtain data from different regions/geographies • Distinguish between business models through which the appliance is sold (cash or PAYGo), as well as sales of an independent appliance vs appliance + SHS kit • Impact insights broken down by different fan sizes and types

Coefficient	D_L: discount for loss
Definition	The percentage of appliance products (fans) sold that do not end up in customer homes, due to theft, damage, loss, non-adoption etc.
Default Value	3%
Justification	• Conservative estimate by companies involved in the supply chain in off-grid and weak-grid environments • Supported by primary research focusing on fans • Validated by SHS data (sold with appliance included) where the D_L is set at 3%
Limitations	• This variable is calculated based on data from South Asia. Applying this variable to other regions may be inaccurate. • This variable is calculated using a relatively small and limited data sample. Conservative assumptions were used to reduce the risk of overestimating impact. • Currently does not distinguish between appliances sold alone, or sold as part of a SHS kit, nor between business models through which the appliance (kit) is sold (e.g. both cash sales and PAYGo are included) • At this point in time, no differentiation between fan types is made
Sources	• GOGLA Impact WG Members / GOGLA Member companies / Efficiency for Access network companies • CLASP (2020). Socio-Economic Impacts of Super-Efficient Off-Grid fans in Bangladesh • GOGLA (2020). Standardised Impact Metrics for the Off-Grid Solar Energy Sector, version 4
Relevant Metrics where coefficient is used	1a, 1b, 2a, 2b, 3a
Future Improvements	• Collect more data from member companies and identify third-party research source for establishing D_L • Obtain data from different regions/geographies • Distinguish between business models through which the appliance is sold (cash or PAYGo), as well as sales of an independent appliance vs appliance + SHS kit • Impact insights broken down by different fan sizes and types

Fans Coefficients Calculations and Values

Coefficient	H: Household Size
Definition	The number of people living in a household
Default Value	5.5
Justification	• High-quality external sources, as well as primary research
Limitations	• Off-grid household data can show larger household sizes. However, we advise using a consistent value of 5.5 people per household all categories to maintain a standard and conservative approach to estimating household size. • It should be noted that the average household size includes all age ranges, while in reality not all ages would experience the same benefits. An assumption is made that this is averaged out by remaining conservative in the established average household size.
Sources	• 60 Decibels (2020), Why off-grid energy matters • CLASP (2020). Socio-Economic Impacts of Super-Efficient Off-Grid fans in Bangladesh • GOGLA (2019). Powering Opportunity in East Africa: Proving Off-Grid Solar is a Power Tool for Change • GOGLA (2019). Powering Opportunity in West Africa: Improving Lives, Powering Livelihoods with Off-Grid Solar • GOGLA (2020). Powering Opportunity in South Asia: From Work to Well-being, the Important Role of Small-Scale Solar • UN DESA Population Division (2017). Population Facts. • UNEP / GEF en.lighten initiative (2013). Off-Grid Country Lighting Assessments
Relevant Metrics where coefficient is used	1a, 1b
Future Improvements	• Coefficient to be reviewed should significantly more off-grid specific household size data become available • Explore the differences in household size between rural, urban and peri-urban locations

Coefficient	E: percentage of customers using products to support enterprise
Definition	The percentage of off-grid solar customers using their appliance product (fan) to support an enterprise, or for income-generating activities in the home
Default Value	3%
Justification	• High-quality data source and primary research, including interviews with off-grid customers • Supported by anecdotal evidence from companies involved in the supply chain • Customers have reported that purchase or ownership of a fan has led to the specific effect noted (e.g. using their fan to improve the temperature within an office or shop to improve working conditions/attract customers)
Limitations	• This variable is calculated based on data from South Asia. Applying this variable to other regions may be inaccurate. • This variable is calculated using a relatively small and limited data sample. Conservative assumptions were used to reduce the risk of overestimating impact. • This research that this variable is based on has a disproportionate gender bias towards males, and might not accurately capture the impact on the wider user group. • At this point in time, no differentiation between fan sizes or types is made
Sources	• CLASP (2020). Socio-Economic Impacts of Super-Efficient Off-Grid fans in Bangladesh
Relevant Metrics where coefficient is used	2a
Future Improvements	• Work with research partners to better align data sets • Impact insights broken down by different fan sized and types • Obtain more data, from different regions as well as from more gender diverse respondent groups

Fans Coefficients Calculations and Values

Coefficient	G: average amount of greenhouse gases avoided per appliance, in kg CO_2e/year
Definition	The average amount of greenhouse gases (carbon dioxide, methane and nitrous oxide) averted due to estimated reduction in diesel generator use, measured in metric tons CO_2e, emitted annually, per appliance unit
Default Value	84 kg CO_2e/year
Justification	• Highest-quality external source data available • Current default value is established with a number of assumptions regarding daily run time, annual operation days and daily energy consumption
Limitations	• Emissions offset are estimates of the replacement of diesel generator powered appliances, and do not take into account appliances powered by grid or through any other method. See Annex 1 for more details on the methodology • At this point in time, no differentiation between fan sizes or types is made
Sources	• Calculation method developed by CLASP and LEIA, with the support of Schatz Energy Research Center • See Annex 1 for more details on the methodology and the calculation of G
Relevant Metrics where coefficient is used	3a
Future Improvements	• Inclusion of estimated CO_2e avoided through replacement of grid-powered fan appliances • Differentiate emissions factors between fan sizes and types based on relative energy consumption

Coefficient Values to be Inputted by Organizations

Coefficient	S: number of units sold
Definition	The number of high-performing appliances sold This coefficient aims to record the number of high-performing appliances sold since a company/organisation's sales began
Guidance	• As the metrics are designed to estimate the impact of good quality high-performing appliances (fans) on households and communities in the developing world, this variable should only include the number of appliances sold in the developing world • In addition, this variable should only be used to highlight the number of appliances that fulfill the eligibility criteria outlined on page 6
Notes	• Please note that this number should not include products lost in the supply chain or products that never enter a customer's home e.g. used for marketing or display
Relevant Metrics where coefficient is used	1a, 3a

Fans Coefficients Calculations and Values

Coefficient	S_L: number of units sold within the lifespan of product (1.5 x warranty period)
Definition	The number of high-performing appliances that are still in use
Guidance	• This coefficient aims to estimate the number of appliances still in working order/use, and so conservatively calculates the lifetime of the product as 1.5 x the product's warranty period • As for S, since the metrics are designed to estimate the impact of good quality high-performing appliances (fans) on households and communities in the developing world, this variable should only include the number of appliances sold in the developing world • In addition, this variable should only be used to highlight the number of appliances that fulfil the eligibility criteria outlined on page 6
Notes	• Please note that this number should not include products lost in the supply chain or products that never enter a customer's home e.g. used for marketing or display
Relevant Metrics where coefficient is used	1b, 2a

Coefficient	P_L: estimated solar product lifespan (1.5 x warranty)
Definition	The estimated lifetime of the high-performing appliance product
Guidance	• This coefficient aims to estimate the number of appliances still in working order/use, and so conservatively calculates the lifetime of the product as: 1.5 x the product's warranty period
Notes	• Please note that this number should not include products lost in the supply chain or products that never enter a customer's home e.g. used for marketing or display
Relevant Metrics where coefficient is used	Definition needed for establishing S_L 3a
Future Improvements	Introduce P_L for independent appliances

TVs Coefficients Calculations and Values

TVs Coefficients Calculations and Values

This section contains the impact metrics coefficient details for TVs. The below tables outline the definitions, assumptions and default values for coefficients for high-performing TVs that make up the metric formulas.

The types of sources underlying each coefficient can be identified through the following color coding:

- Green for company input
- Blue for primary research
- Gray for secondary research

Standard variables with default values

Coefficient	$D_{R\text{-}Access}$: Discount for repeat sales for estimating new access impact
Definition	The percentage of units sold that are repeated sales to a household with the same appliance, due to their replacement or additional purchases, while the first product is still functioning and in use. The intention is to avoid double-counting within the number of people impacted
Default Value	16%
Justification	• Conservative estimate by companies involved in the supply chain in off-grid and weak-grid environments • Based partially on primary data, with a particularly conservative approach regarding the ratio of functioning products (of all customers previously owning a TV powered by diesel or grid, 50% of those TVs are assumed to be functioning, whereas the other 50% are non-functioning, for example a broken appliance used as prestige asset, or technically working but without access to power).
Limitations	• This variable is calculated based on data from East Africa. Applying this variable to other regions may be inaccurate • This variable is calculated using a relatively small and limited data sample. Conservative assumptions were used to reduce the risk of overestimating impact • Currently does not distinguish between appliances sold alone, or sold as part of a SHS kit, nor between business models through which the appliance (kit) is sold (e.g. both cash sales and PAYGo are included) • No differentiation between TV sizes is made
Sources	• GOGLA Impact WG Members / GOGLA Member companies / Efficiency for Access network companies • 60 Decibels, Efficiency for Access (2020). Use & Impact of Solar TVs – Lean Data insights from Kenya, Rwanda, Tanzania, Uganda • GOGLA (2020). Standardised Impact Metrics for the Off-Grid Solar Energy Sector, version 4
Relevant Metrics where coefficient is used	1a, 1b
Future Improvements	• Collect better data from companies or identify third-party research source for establishing $D_{R\text{-}Access}$ in particular focusing on functioning vs non-functioning TVs • Distinguish between business models through which the appliance is sold (cash or PAYGo), as well as sales of an independent appliance vs appliance + SHS kit • Obtain data from different regions/geographies • Impact insights broken down by different TV categories and sizes

TVs Coefficients Calculations and Values

Coefficient	$D_{R\text{-}GHG}$: Ratio capturing sales replacing a diesel genset powered appliance for estimating GHG emissions
Definition	The percentage of units sold to a household where the new purchase is replacing a similar type of appliance, diesel powered.
Default Value	6%
Justification	• Conservative estimate by companies involved in the supply chain in off-grid and weak-grid environments • Based partially on primary data, with a particularly conservative approach regarding the ratio of functioning products (of all customers with a functioning TV previously, 2/3rd are powered by diesel and 1/3rd by grid).
Limitations	• This variable is calculated based on data from East Africa. Applying this variable to other regions may be inaccurate. • This variable is calculated using a relatively small and limited data sample. Conservative assumptions were used to reduce the risk of overestimating impact. • Currently does not distinguish between appliances sold alone, or sold as part of a SHS kit, nor between business models through which the appliance (kit) is sold (e.g. both cash sales and PAYGo are included) • No differentiation between TV sizes is made
Sources	• GOGLA Impact WG Members / GOGLA Member companies / Efficiency for Access network companies • 60 Decibels, Efficiency for Access (2020). Use & Impact of Solar TVs – Lean Data insights from Kenya, Rwanda, Tanzania, Uganda • GOGLA (2020). Standardised Impact Metrics for the Off-Grid Solar Energy Sector, version 4
Relevant Metrics where coefficient is used	3a
Future Improvements	• Collect better data from companies or identify third-party research source for establishing $D_{R\text{-}GHG}$, in particular, focusing on working vs non-working TVs, as well as the previous power source • Distinguish between business models through which the appliance is sold (cash or PAYGo), as well as sales of an independent appliance vs appliance + SHS kit • Obtain data from different regions/geographies • Impact insights broken down by different TV categories and sizes

TVs Coefficients Calculations and Values

Coefficient	D_L: discount for loss
Definition	The percentage of appliance products (TVs) sold that do not end up being used in customer homes, due to theft, damage, loss, non-adoption etc.
Default Value	7%
Justification	• Conservative estimate by companies involved in the supply chain • Validated by SHS data (sold with appliance included) for D_L as well as data for TV appliance malfunctioning (independently of the SHS) • Supported by the rate of replacement due to defect for AC TVs
Limitations	• This variable is calculated based on data from East Africa. Applying this variable to other regions may be inaccurate • This variable is calculated using a relatively small and limited data sample. Conservative assumptions were used to reduce the risk of overestimating the impact • Currently does not distinguish between appliances sold alone, or sold as part of a SHS kit, nor between business models through which the appliance (kit) is sold (e.g. both cash sales and PAYGo are included) • No differentiation between TV sizes is made
Sources	• GOGLA Impact WG Members / GOGLA Member companies / Efficiency for Access network companies • 60 Decibels, Efficiency for Access (2020). Use & Impact of Solar TVs – Lean Data insights from Kenya, Rwanda, Tanzania, Uganda; (unpublished results) • Efficiency for Access Coalition, longitudinal impact of off-grid appliances (unpublished data). Final report expected in 2022 • GOGLA (2020). Standardised Impact Metrics for the Off-Grid Solar Energy Sector, version 4 • Einfluss der Nutzungsdauer von Produkten auf ihre Umweltwirkung: Schaffung einer Informationsgrundlage und Entwicklung von Strategien gegen „Obsoleszenz", Prakash et al.
Relevant Metrics where coefficient is used	1a, 1b, 2a, 2b, 3a
Future Improvements	• Collect better data from companies or identify third-party research source for establishing D_L • Distinguish between business models through which the appliance is sold (cash or PAYGo), as well as sales of an independent appliance vs appliance + SHS kit • Obtain data from different regions/geographies • Impact insights broken down by different TV sizes and types

TVs Coefficients Calculations and Values

Coefficient	H: Household Size
Definition	The number of people living in a household
Default Value	5.5
Justification	• High-quality external sources, as well as primary research
Limitations	• Off-grid household data can show larger household sizes. However, we advise using a consistent value of 5.5 people per household in all categories to maintain a standard and conservative approach to estimating household size. • It should be noted that the average household size includes all age ranges, while in reality, not all ages would experience the same benefits. An assumption is made that this is averaged out by remaining conservative in the established average household size.
Sources	• 60 Decibels (2020), Why off-grid energy matters • 60 Decibels, Efficiency for Access (2020). Use & Impact of Solar TVs – Lean Data insights from Kenya, Rwanda, Tanzania, Uganda • GOGLA (2019). Powering Opportunity in East Africa: Proving Off-Grid Solar is a Power Tool for Change • GOGLA (2019). Powering Opportunity in West Africa: Improving Lives, Powering Livelihoods with Off-Grid Solar • GOGLA (2020). Powering Opportunity in South Asia: From Work to Well-being, the Important Role of Small Scale Solar • UN DESA Population Division (2017). Population Facts. • UNEP / GEF en.lighten initiative (2013). Off-Grid Country Lighting Assessments
Relevant Metrics where coefficient is used	1a, 1b
Future Improvements	• Coefficient to be reviewed should significantly more recent (off-grid specific) household size data become available • Explore the differences in household size between rural, urban and peri-urban locations

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TVs Coefficients Calculations and Values

Coefficient	E: percentage of customers using products to support enterprise
Definition	The percentage of off-grid solar customers using their TV to support an enterprise or income-generating activities (for example showing TV in a restaurant to attract more customers)
Default Value	9%
Justification	• High-quality data sources and primary research • Supported by anecdotal evidence from companies involved in the supply chain • Customers have reported that purchase or ownership of a TV has led to the specific effect noted, for example generating additional income by placing a TV in their restaurant or bar
Limitations	• This variable is calculated based on data from East Africa. Applying this variable to other regions may be inaccurate • This variable is calculated using a relatively small and limited data sample. Conservative assumptions were used to reduce the risk of overestimating the impact • No differentiation between TV sizes is made
Sources	• 60 Decibels, Efficiency for Access (2020). Use & Impact of Solar TVs – Lean Data insights from Kenya, Rwanda, Tanzania, Uganda; (unpublished results) • GOGLA (2019). Powering Opportunity in East Africa: Proving Off-Grid Solar is a Power Tool for Change. Data gathered reanalyzed by Altai to extract data specifically on TVs • GOGLA (2018). Powering Opportunity, The Economic Impact of Off-Grid Solar
Relevant Metrics where coefficient is used	2a
Future Improvements	• Work with research partners to better align data sets • Impact insights broken down by different TV categories and sizes • Obtain data from different regions/geographies

Coefficient	IG: percentage of customers generating additional income
Definition	Number of people that are generating additional income as a result of TV ownership (for example by showing TV for a fee)
Default Value	4%
Justification	• High-quality data sources and primary research • Supported by anecdotal evidence from companies involved in the supply chain • Customers have reported that purchase or ownership of a TV has led to the specific effect noted
Limitations	• This variable is calculated based on data from East Africa. Applying this variable to other regions may be inaccurate • This variable is calculated using a relatively small and limited data sample. Conservative assumptions were used to reduce the risk of overestimating impact • No differentiation between TV sizes is made
Sources	• 60 Decibels, Efficiency for Access (2020). Use & Impact of Solar TVs – Lean Data insights from Kenya, Rwanda, Tanzania, Uganda; (unpublished results) • GOGLA (2019). Powering Opportunity in East Africa: Proving Off-Grid Solar is a Power Tool for Change. Data gathered reanalyzed by Altai to extract data specifically on TVs
Relevant Metrics where coefficient is used	2b
Future Improvements	• Work with research partners to better align data sets • Impact insights broken down by different TV categories and sizes • Obtain data from different regions

TVs Coefficients Calculations and Values

Coefficient	G: average amount of greenhouse gases avoided per appliance, in kg CO_2e/year
Definition	The average amount of greenhouse gases (carbon dioxide, methane and nitrous oxide) averted due to estimated reduction in diesel generator use, measured in metric tons CO_2e, emitted annually, per appliance unit
Default Value	59 kg CO_2e/year (TVs)
Justification	• Highest-quality external source data available • Current default value is established with a number of assumptions regarding daily run time, annual operation days and daily energy consumption
Limitations	• Emissions offset are estimates of the replacement of diesel generator powered appliances and do not take into account appliances powered by grid or through any other method. See Annex 1 for more details on the methodology • No differentiation between TV sizes is made
Sources	• Calculation method developed CLASP and LEIA • See Annex 1 for more details on the methodology and the calculation of G
Relevant Metrics where coefficient is used	3a
Future Improvements	• Inclusion of estimated CO_2e avoided through replacement of grid-powered TV appliances • Differentiate emissions factors between TV categories based on relative energy consumption

Coefficient Values to be Inputted by Organizations

Coefficient	S: number of units sold
Definition	The number of high-performing appliances sold This coefficient aims to record the number of high-performing appliances sold since a company/organisation's sales began
Guidance	• As the metrics are designed to estimate the impact of good quality high-performing appliances (TVs) on households and communities in the developing world, world, this variable should only include the number of appliances sold in the developing world • In addition, this variable should only be used to highlight the number of appliances that fulfil the eligibility criteria outlined on page 6
Notes	• Please note that this metric should not include products lost in the supply chain or products that never enter a customer's home e.g. used for marketing or display
Relevant Metrics where coefficient is used	1a, 3a

TVs Coefficients Calculations and Values

Coefficient	S_L: number of units sold within the lifespan of product (1.5 x warranty period)
Definition	The number of high-performing appliances that are still in use
Guidance	• This coefficient aims to estimate the number of high-performing appliances still in working order/use, and so conservatively calculates the lifetime of the product as: 1.5 x the product's warranty period • As for S, since the metrics are designed to estimate the impact of good quality high-performing appliances (TVs) on households and communities in the developing world, this variable should only include the number of appliances sold in the developing world • In addition, this variable should only be used to highlight the number of appliances that fulfil the eligibility criteria outlined on page 6
Notes	Please note that this metric should not include products lost in the supply chain or products that never enter a customer's home e.g. used for marketing or display
Relevant Metrics where coefficient is used	1b, 2a, 2b

Coefficient	P_L: estimated solar product lifespan (1.5 x warranty)
Definition	The estimated lifetime of the high-performing appliance
Guidance	This coefficient aims to estimate the number of appliances still in working order/use, and so conservatively calculates the lifetime of the product as: 1.5 x the product's warranty period
Notes	Please note that this metric should not include products lost in the supply chain or products that never enter a customer's home e.g. used for marketing or display
Relevant Metrics where coefficient is used	Definition needed for establishing S_L 3a
Future Improvement	Introduce P_L for independent appliances

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Future Developments

Future Developments

The overall process of literature review, company consultation, Working Group discussions and metric development has not only resulted in the first set of established metrics and variables for fans and TVs, it has also brought to light a number of research and data gaps for potential future metric refinements and development. In this section, priority impact areas for which there is not yet enough data to formulate metrics and coefficients have been identified. These are listed below in Tables 2 and 3, per appliance type and impact category/sub-category. For each sub-category, details of the data and research gaps that must be addressed to create new or enhance current metrics have been outlined. This analysis will feed into recommendations for future research.

Fans

Table 2. Mapping of data and research needs currently identified for fans. Please note that this overview is not meant to be exhaustive, but rather a starting point for further exploration.

Impact Category	Subcategory	Identified Data and Research gaps
Appliance Access	**Actual Access** The total number of people benefitting from the appliance (fan). This would include friends and neighbors joining or gathering around in an area/room with fan to be comfortable	• Additional data from customers on the number of people that join them to benefit from cooling (on average) • Better understanding of the correlation between volume of air that fans are capable of cooling and how many people can derive sufficient benefit from a fan
	Business/Productive Access The total number of people benefitting from an appliance when it is placed in a business. For example, if the appliance (fan) is used at an office and enables office staff to work longer hours, or if it is used in a bar/restaurant and benefits are felt by several customers	• Additional data from purchasers that use their appliance (fan) in their place of business e.g. restaurant, looking at average number of customers over a defined time unit • Additional data on the number of people using their appliance in a place of business who report that they, or their colleagues, are able to work more hours. (A first data set[7] on this topic is available)
	Hours of Use/Access* Average runtime and usage of different appliances, to explore the amount of time that customers receive the benefits, and how much productive time is gained in for example business use	• Additional data from customers on the runtime of fans in different circumstances, and if/how that's limited by the power source • Additional data from customers on how the fan improves their time spent being productive, and how much time on average that amounts to Potential structure of metric would be similar to $S \times (1 - D_L) \times EA \times$ variable with nr of hours • Additional data on the use of a fan increases time spent in social gatherings or quality social time
	First-time Access vs Moving up Tiers[8] Number of people who gain first-time access vs number of people who are moving up the Tiers of energy access due to appliance ownership. (These insights would help to create a picture of the 'energy journey' customers go on after their first high-performing appliance purchase)	• Additional data from customers on previous system ownership, energy-mix and appliance access
	Different Use Cases Seasonality: Frequency of use of the high-performing appliance varies throughout the year/seasons. Use of fans can be very seasonal, with less to no use in 'winter' months for example	• Additional data on days/months of use, and how this varies across regions (influenced by harsher dryer climates, or more hot and humid climates)

* It should be noted that the different use case focusing on Time Use has a large Social Impact aspect and should also be considered as part of that impact category.

7 CLASP (2020). Socio-Economic Impacts of Super-Efficient Off-Grid fans in Bangladesh

8 The level of access to household electricity services is defined through the multitier framework for measuring energy access. This framework was developed by the World Bank's Energy Sector Management Assistance Program (ESMAP) under the Sustainable Energy for All initiative. Full report: https://www.esmap.org/node/55526

Future Developments

Impact Category	Subcategory	Identified Data and Research gaps
Appliance Access	**Different Use Cases** Different impact of different fan types: Different types and sizes of a high-performing appliance can benefit a different number of people, in a different manner. A Ceiling fan would benefit a different number of people than a Table fan, for example	• Research and data segregated on fan type and size • Introduce a number of people benefitting per household ratio, based on the different fan types
	Different Use Cases Off-Grid vs Weak-Grid vs Grid Use Off-grid users are users that have no access to grid electricity. Weak-grid users are ones that have unreliable or intermittent grid connection that on average provides electricity to the customer for <50% of the day	• Appliances sold independently could be powered by sources that are not a 100% renewable energy based e.g. diesel generator or utility grid. Collecting disaggregated sales data by energy source will help with measuring impact related to GHG savings more accurately
Economic Activity	**Income Generation** The number of people generating income through the use of fans in their business/ workplace or within their homes	• Additional data on the number of users using the appliance to generate income Potential structure of metric would be similar to $S \times (1 - D_L) \times IG$ • Insights on *how* the fan is used in a business
	Additional Income Generated The total amount of additional income generated through ownership of the high-performing appliance	• Additional data from those users indicating they use the system to generate income, on how much income specifically is generated (per time unit), and how the system is applied Potential structure of metric would be similar to $S \times (1 - D_L) \times IG \times AI \times P_L$
Environmental Sustainability	• Avoided Battery Toxicity • Building products that last • Avoided E-waste • GHG emissions savings from: - use of high-performing appliances - use of cleaner fuel - efficiencies in transport - use of BLDC motors	• Identification of cleaner chemistries of batteries and estimation of mass balance of hazardous waste from different battery technologies • Potential metric will be 'avoided disposal of hazardous battery waste' after being adjusted for a discount rate for appropriate recycling[9] • Development of a model estimating savings from the use of high-performing appliances is currently in progress by Schatz and CLASP and is expected to be incorporated in the next iteration of the metrics
Social Impact	**Quality of Life** Number of people that feel their quality of life has improved due to ownership of the high-performing fan	• Additional data around people reporting their quality of life has improved due to ownership of the fan, and what the specific reasons for this life quality improvement are
	Health Number of people that feel their health has improved, due to ownership of the high-performing fan. There's a number of health-related subcategories that have been identified: • Reduction of insects in the house • Alleviated heat stress • Number of people sleeping better • Less dust/indoor pollution/improved ventilation • Less dehydration, sweat less	• Additional data around people reporting their health has improved due to ownership of a high-performing fan, and what the specific reasons for this health improvement are • Explore secondary data sources to feed into metric or base metric. For example geographic data information on humidity or average temperature for looking into heat stress
	Gender Number of women who purchase/own a high-performing appliance, and different impacts felt by men, women and children (if any)	• Additional data on ownership, by gender • Additional data on how/if appliances have a different impact on women men and children
	Education Increase in time spent studying, either at home or at school, facilitated by a high-performing fan	• Additional data and research on how a high-performing fan is applied in the household or classroom environment, and if that is of influence on study hours, skills and/or capacity increase

9 According to estimates by Hinckley Recycling Nigeria, 20% of E-waste is recycled responsibly in Africa

Future Developments

TVs

Table 3. Mapping of data and research needs currently identified for TVs. Please note that this overview is not meant to be exhaustive, but rather a starting point for further exploration.

Impact Category	Subcategory	Identified Data and Research gaps
Appliance Access	**Actual Access** Total number of people benefitting from the appliance (TV). This would include friends and neighbors joining or gathering around in an area/room (joining to benefit from TV)	• Additional data from customers on number of people on average joining to watch
	Business Access The total number of people benefitting from an appliance when it is placed in a business. For example in a bar or a restaurant and benefits are felt by several customers, or setting up a business specifically for people to join and watch TV (cinema, video hall)	• Additional data from purchasers on use of their appliance (TV) in their place of business; e.g. restaurant, looking at average number of customers over a defined time unit
	Hours of Use/Access* Average runtime and usage of different appliances, to explore the amount of time that customers receive the benefits, and how much productive time is gained in for example business use	• Additional data from customers on runtime of TVs in different circumstances, and if/how that's limited by the power source • Additional data from customers on how the TV improves their time spent being productive, or less productive, and how much time on average that amounts to Potential structure of metric would be similar to: $S \times (1 - D_L) \times EA \times$ variable with nr of hours • Additional data on use of a TV increases time spent in social gatherings or quality social time
	First-time Access vs Moving up Tiers Number of people who gain first-time access vs number of people who are moving up the Tiers of energy access due to appliance ownership. (These insights would help to create a picture of the 'energy journey' customers go on after their first high-performing appliance purchase)	• Additional data from customers on previous system ownership, energy-mix and appliance access
	Different Use Cases Different impact of different TV sizes: Different sizes of a high-performing appliance (TV) can benefit a different number of people, in a different manner. For example, a larger size TV can attract more customers in a TV hall	• Research and data segregated on TV size • Introduce a number of people benefitting per household ratio, based on the different TV sizes
Economic Activity	**Savings on Expenditures** Enables to demonstrate the estimated financial benefit of, for example, not having to pay for use of a TV elsewhere. Conversely, it might also provide more insights on potential over-indebtedness of customers	• Additional information on average expenditures on the activity before and after owning the appliance • Explore total energy expenditure (including transportation and other costs) both before and after purchase
	Additional Income Generated Enables to estimate how much additional income has been created by households using the appliance (TV) either at home or in their place of business, to generate income	• Additional data from those users indicating they use the system to generate income, on how much income specifically is generated per time unit, and how the system is applied • Potential structure of metric would be similar to $S \times (1 - D_L) \times IG \times AI \times P_L$

* It should be noted that the Different Use Case focusing on time use has a large Social Impact aspect and should also be considered as part of that impact category.

Future Developments

Impact Category	Subcategory	Identified Data and Research gaps
Environmental Sustainability	• Avoided Battery Toxicity • Building products that last • Avoided E-waste • GHG emissions savings from: – use of high-performing appliances – use of cleaner fuel – efficiencies in transport	• Identification of cleaner chemistries of batteries and estimation of mass balance of hazardous waste from different battery technologies • Potential metric will be 'avoided disposal of hazardous battery waste' after being adjusted for a discount rate for appropriate recycling[9] • Development of a model estimating savings from the use of high-performing appliances is currently in progress by SERC and CLASP and is expected to be incorporated in the next iteration of the metrics
Social Impact[10]	**Quality of Life** Number of people that feel their quality of life has improved due to ownership of the high-performing TV	• Additional data around people reporting their quality of life has improved due to ownership of the TV, and what the specific reasons for this life quality improvement are
	Health Number of people that feel their health has improved, due to ownership of the high-performing TV. There's a number of health-related subcategories that have been identified: • Increase in entertainment • Reduction in stress	• Additional data around people reporting their health has improved due to ownership of a high-performing TV, and what the specific reasons for this health improvement are
	Gender Number of women who purchase/own a high-performing appliance (TV), and different impacts felt by men, women and children (if any). Several categories could be: • Gender role in income-generating activities • Family planning (reduction in son preference, lower fertility) • Role of TV in improved gender equality	• Additional data on ownership, by gender • Additional data on how/if appliances have a different impact on women men and children • Additional data on the role of gender for starting or supporting economic activity • Additional data on how urban values, brought into rural households through TV programs, have an impact on gender equality (reduction in domestic violence, increased participation in the household decision making)
	Education Increase of skills and/or capacity because of having access to a TV, and if/how this impacts study behavior	• Additional data and research on how a high-performing TV is applied in the household or classroom environment, and if that enables children access to educational programs • Additional data if time spent in front of the TV detracts from time spent studying
	Access to News, Information and Entertainment Enables to measure how information broadcasted on TV impacts a household or personal mindset. There's a number of information-related subcategories that have been identified: • Exposure to urban values and attitudes • Entrepreneurial inspiration	• Additional data on customer viewing behavior and subsequent types of knowledge implemented • Additional data on TV inspired business expansion, success rate, etc. • Additional data on engagement in local/national news and politics

10 60 Decibels have published insightful publications that focus among others on the social impact of TV appliances: 60 Decibels (2020). Why Off-Grid Energy Matters; and 60 Decibels, Efficiency for Access (2020). Use & Impact of Solar TVs – Lean Data insights from Kenya, Rwanda, Tanzania, Uganda

Standardised Guidelines

In addition to the standardised metrics above, companies are often requested to report on sector-specific parameters, such as transport emissions. Standardised guidelines are developed to encourage companies, investors and stakeholders within the sector to take a common approach to reporting on those impact areas where it's not yet feasible to create metrics.

Transport Emissions

One component of the embodied energy of a high-performing appliance is the number of emissions that stem from the transport of the product. The below is a simplified approach to model the transport emissions involved in shipping appliances from manufacturer to market, developed by the LEIA M&E team, EST and GOGLA. This indicator might be used in two different ways: to showcase avoided emissions when manufacturing locally; or for companies calculating their actual transport-related emissions.[11]

Company consultations showed that the main production location is in China; and that transport is nearly always done via cargo shipping, in 20 feet containers, to three main regional markets: South Asia, East Africa and West Africa.

Based on that knowledge, three standardised shipping routes have been defined (see Table 4), starting at Guangzhou, China, and arriving at the main port of each of the three main markets. Although there are multiple ports in China from where products are shipped, we opted for Guangzhou/Shenzhen as reference port since products are most frequently shipped from there. A similar reasoning is applied when selecting the reference port in the destination regions, going for the most popular route and port.

From the selected ports onwards to their final destination, goods are assumed to be transported over land. Transport over land has been left out of the approach.

The CO_2e footprint per product unit for each route is dependent on the number of appliances units of a certain kind that can fit into a 20ft container. Table 5 provides a quick reference matrix which can be used to determine how much kg CO_2e emissions can be assigned per product unit. Estimated CO_2e emissions for the journey have been calculated with an online tool developed by EcoTransIT.[13]

Table 4. Overview of distances (in nautical miles) for the three standardised shipping routes.

Route	Distance (nm)[12]
1. Guangzhou (CN) – Dakar (SE)	9968
2. Guangzhou (CN) – Mombasa (KE)	5528
3. Guangzhou (CN) – Mumbai (IN)	3978

Note that For Guangzhou (CN) - Dakar (SE) the shortest route through the Suez Canal has been selected.

11 Both use cases have a different definition of a conservative estimate: for the local manufacturing use-case, the shortest route is most conservative; while for estimating emissions made, the longest route is most conservative. The approach described herein is taking a middle ground, based on most popular routes and ports. Companies are advised to produce their own estimates as outlined in this section should a precise number be needed.

12 Nautical miles were determined using the following online tool: https://sea-distances.org/

13 Estimated CO2e emissions were calculated using the following online tool: https://www.ecotransit.org/

Standardised Guidelines

Table 5. Quick reference matrixt table to determine how much kg CO_2e of transport emissions can be assigned per product unit, on a specific route. (Estimates given in kg CO_2e emissions/unit).

Nr of units in a 20 ft container	Route 1 China to West Africa	Route 2 China to East Africa	Route 3 China to India
1500	0.989	0.548	0.466
1200	1.237	0.685	0.582
1000	1.484	0.822	0.699
900	1.649	0.913	0.776
800	1.855	1.027	0.874
700	2.120	1.174	0.998
600	2.474	1.369	1.165
500	2.968	1.643	1.398
400	3.711	2.054	1.747

Assumptions: One container is filled with product units of a similar kind. During the transport journey, no in-between stops are made. Transport over land has been left out of the approach.

Calculating Transport Emissions

If you need to calculate your CO_2e transport emissions in more detail, the online tool developed by EcoTransIT[13] will help you produce your own estimates. We advise using the standard calculation method for one 20ft container (1 TEU), selecting only sea ship to ensure you cover marine transport. The total Well-to-Wheel (WTW) provides you with the most accurate CO_2e estimate in tonnes. The following formula will then provide you with the estimated kg CO_2e emissions per unit:

$$\frac{\text{Emissions output}}{\text{nr of appliances in 1 TEU}} \text{ *1000 = kg } CO_2e \text{ emissions per unit}$$

Contributors

These metrics were developed through the mechanism of the GOGLA Impact Working Group, a body of industry practitioners from the lighting and high-performing appliances sector, and academic observers. The development was led by the Working Group Chairs, GOGLA's Outreach and Impact Manager and EST's Senior Insight Manager. GOGLA and Efficiency for Access Coalition would like to express its thanks to the Working Group Chairs, peer-reviewers and contributing members and observers noted below.

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Nabeela leads on Impact for Energy Access and Efficiency within CDC Group, the UK government's development finance institute. It is a major investor in energy infrastructure, including distributed energy, on the continent. She joined CDC to design and execute the Impact Accelerator, a direct investment fund focusing on businesses with challenging risk-return profiles to prepare them towards commercial investors. Over the last three years, Nabeela has helped steer the GOGLA Impact Working Group, bringing with her years of experience in impact investment, measurement and reporting.

Working Group Co-Chair: Yomi Jegede, Greenlight Planet, December 2019 – present
Yomi Jegede is Operations Manager for Greenlight Planet in Nigeria. He joined as co-chair of the Working Group at the end of 2019. He brings with him over four years' operational experience and knows first-hand of the challenges consumers and agents face, and how their solar products create impact.

Research Design: The broader impact assessment framework for appliances, under development by the Efficiency for Access Coalition, encompasses the development of the metrics. We would like to take this opportunity to kindly acknowledge the work and people involved. Key literature review was performed by Gillian Davies, E Feng Tan Loh, Bex Paffard and James Wakelin at Energy Saving Trust and Makena Ireri at CLASP. Richa Goyal, Joseph Thomas, Gillian Davies and E Feng Tan Loh at Energy Saving Trust have worked on creating the transport emissions guideline. Yau Ben Or and Josephine Tumwesige at Rural Senses have supported and advised on reviewing data to make the proposed assumptions and values more rigorous. Dr. Nick Lam, Research Scientist, and Eli Wallach, Research Engineer and Data Scientist at the Schatz Energy Research Center have kindly reviewed and advised on the GHG emission approach, which is based on the GHG model developed by Yuanda Wang and Asif Hassan at CLASP. Special thanks go out to Richa Goyal at Energy Saving Trust and Dr. Eveline Jansen at GOGLA, for playing a key role in all of the above-mentioned activities.

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This section provides useful resources and links to sources used to inform the Appliances Impact Metrics.

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Annex

1. Avoided Emissions from replacement of diesel generator sets

Annual energy consumed by a single appliance to perform its intended service (Del.Energy) is estimated by multiplying the rated power of the appliance by the assumed annual operation days and runtime, shown in Table 6.

Equation 1.

$$Del.Energy\left(\frac{Wh}{Year}\right) = RatedPower\ (Watts) * Runtime\left(\frac{Hours}{Day}\right) * Annual\ Operation\ Days$$

The corresponding required energy (Req.Energy) for powering the appliance is estimated by dividing the delivered energy by an assumed generator efficiency (Eff.) of 25%.[14]

Equation 2.

$$Req.Energy\left(\frac{Joules}{Year}\right) = Del.Energy\left(\frac{Wh}{Year}\right) * 3600\left(\frac{Joules}{Wh}\right) * \frac{1}{Eff}$$

The annual carbon dioxide equivalent (CO_2e) emissions from operating a diesel generator to power the appliance are estimated by multiplying the required energy estimate by energy-based pollutant emission factors (EF) for diesel generators. CO_2e emissions include the Kyoto gases – carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), but exclude fluorinated gases. The default emission factors for diesel generators used in the calculation are 74,100 kg_{CO_2}/TJ, 10 kg_{CH_4}/TJ and 0.6 kg_{N_2O}/TJ.[15]

CO_2e emissions are calculated based on 100-year Global Warming Potential (GWP_{100}) values from the IPCC Second Assessment Report (CO_2 = 1, CH_4 = 25, N_2O = 298).[16] Based on these values, the calculated EF for diesel generator is 74,529 $kgCO_2e$/TJ.

It is assumed that 100% of these appliance emissions would be avoided with solar replacements, which have zero end-use emissions. This emissions value is for a single appliance and can be multiplied by unit sales to estimate total averted emissions.

Equation 3.

$$Emissions\left(\frac{kgCO_2e}{Year}\right) = \frac{Req.Energy}{10^{12}}\left(\frac{Terajoules}{Year}\right) * EF_{Diesel\ Generator}$$

Where $EF_{Diesel\ Generator}$ is:

$$\left[EF_{CO_2}\left(\frac{kg_{CO_2}}{Terajoule}\right) * GWP_{CO_2}(1) + EF_{CH_4}\left(\frac{kg_{CH_4}}{Terajoule}\right) * GWP_{CH_4}(25) + EF_{N_2O}\left(\frac{kg_{N_2O}}{Terajoule}\right) * GWP_{N_2O}(298)\right]$$

14 IFC (2019) The dirty footprint of the broken grid: The impact of fossil fuel back-up generators in developing countries.

15 IPCC (2006) 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Prepared by the National Greenhouse Gas Inventories Programme, Eggleston H.S., Buendia L., Miwa K., Ngara T. and Tanabe K. (eds). IGES, Japan

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Table 6 outlines the assumptions used for the various appliance types, with the table values informed by the Efficiency for Access Equip data[17] as well as the resulting emission factor (G) in kg CO_2e/year.

Table 6. Overview of assumptions used for the various appliance types, and the resulting value for G

Type	Power Rating (W)	Run Time (hours/day)	Daily Energy Consumption (kWh/day)	Annual Operation Days*	G: Emission factor ($kgCO_2e$/year)
TVs	50	3	0.15	365	59
Fans	41	8	0.33	240	84

* Note: TVs are assumed to be used on a daily basis all throughout the year, whereas fans are assumed to be in use on a daily basis only during warm periods (approximately 8 months per year). Future improvements include better insight into average operation days or downtime of the appliance, either through software data from companies or through consumer research.

2. Creating the Metrics - Methodology

This document contains proposed metrics for the appliance technologies of fan and TV appliances, separated in two chapters. The metrics in both chapters were developed by following the following interlinked steps below:

- Prioritization Exercise
- Desk Research (into available data)
- Working Group (discussion and adoption)

Prioritization Exercise

To get an understanding of what kind of metrics would best serve or be most appreciated by companies active in the manufacturing or distribution of these high-performing appliances (as they constitute what is arguably the most important target group for adoption of these metrics). Working group participants provide input and feedback on different impact categories and subcategories via a prioritization survey (See Table 7 for an overview).

The categories and subcategories were pre-selected and included based on initial work performed within the LEIA program and previous experience of the team. In the survey, companies were asked to rank the different impact categories according to their perceived importance, as well as with regard to which specific areas were of most interest. Priority was assigned by the companies on a scale from 1-3 (1 = low priority, 2 = medium priority, 3 = high priority). Participants were given the opportunity to list additional (sub)categories that they felt were missing but yet important. This measure was introduced in order to negate the potential bias that might have been created by preselecting the impact (sub)categories.

A total of 16 companies took part in the survey. There were no impact categories or subcategories that were "deemed neutral or unimportant" (have a ranking lower than 2). In Table 7 the categories and subcategories are ranked in order of priority.

17 Based on Efficiency for Access Equip Data (or called VeraSol now).

Annex

Table 7. Priority ranking of subcategories, ordered within each impact category. First row indicates highest ranked subcategory, with the following rows indicating ranking lower on the scale.

High

Appliance Access	Economic Activity	Environmental Sustainability	Social Impact
Number of people with access • Household Access • Actual Access, e.g. neighbours benefitting • Business Use • Hours of use /access	People generating more income because of ownership of the product	Building products that last • Durability • Repairability • Upgradeability	People improving their level of education through use of the appliance • Skills and capacity increase
Capturing the impact of first-time access vs impact of moving up tiers	People undertaking more economic activity because of owning the appliance	Battery Toxicity • Low toxicity at disposal • Battery chemistry profile	People improving their level of health and wellbeing through use of the appliance • Alleviated heat stress • Fewer mosquitos in the house • Number of people sleeping better • Less dust/indoor pollution/ improved ventilation • Less dehydration, sweat less
	Using information from TV to expand trade or business	E-waste • Reusability • Recoverability	Gender • Differentiate between gender for access, economical and environmental impact estimates • Specify gender impacts for certain benefits
	Savings on expenditures by not watching TV for a fee	Reduction in GHG emissions • Emissions savings from the use of BLDC motors (fans only) • Emissions savings from the use of cleaner fuel • Reduced emissions from energy efficiency • Transport emissions	Improved access to news, information and entertainment through use of the appliance (TV only)
		Other material efficiencies • Proportion of recycled material content	Time•Use • Increase in social gatherings or quality social time • Productive use of time due to appliance

Low

Desk Research

The prioritized impact categories listed in Table 1 were then evaluated through relevant academic literature and research to assess whether sufficient data was available to begin creating a relevant metric. This included reviewing some initial metrics developed for the LEIA programme monitoring and evaluation (M&E). Based on this, a shortlist of impact categories in which metric formulas and accompanying values for coefficients could be proposed.

Working Group

A shortlist of feasible metrics and coefficients, identified from the prioritization exercise and literature evaluation, was then put forward to the GOGLA Impact Working Group for discussion and feedback. This took the following format: An initial discussion with companies and organisations working with a specific appliance was held on the metric areas, to gather input and insights from their practical experience, and to receive feedback on whether any other aspects should be taken into account. In a subsequent call, the metrics were further discussed. Those metrics that the working group feels comfortable proceeding with were agreed and adopted, the others being sent back to the drawing table or are parked for a future iteration. A final document summarizing all agreements and established metrics was shared back with the group and formally adopted.

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