

Measuring Energy Access With A Multi-tier Approach







Definition Of Energy Access - Current vs New

CURRENT DEFINITION

'Having electricity or not having electricity'
'Cooking with non-solid fuels or cooking with solid fuels'

New Definition

Access to energy is the ability to avail energy that is Adequate, Available when needed, Reliable, of good Quality, Convenient, Affordable, Legal, Healthy & Safe, for all required energy services across Household, Productive and Community uses





Multi-tier Framework – Access To Household Electricity Supply

| | | | Tier-0 | Tier-1 | Tier-2 | Tier-3 | Tier-4 | Tier-5 | |
|-------|--------------------|-------------------|-------------|---|-----------------------|---|------------------------------------|---------------|----------|
| | 1. Peak | Power | No | V. Low Power Min 1 W | Low Power Min 50 W | Medium Power Min 200 W | High F Min | Power 2 kW | |
| | capacity | Daily capacity | Electricity | Min 4 Wh | Min 200 Wh | Min 1.6 KWh | Min 4 | KWh | Tier-rat |
| | 2 Duration | Hours per day | < 4 hrs | Mir | n 4 hrs | Min 8 hrs | Min 16 hrs | Min 23 hrs | for th |
| | 2. Duration | Hours per evening | < 2 hrs | Mi | n 2 hrs | Min 2 hrs | Min 4 hrs | Min 4 hrs | |
| | | | | | | Max 3 | Max 7 | Max 3 | househ |
| | | | | | | disruptions | disruptions | disruptions | is |
| S | 3. Reliability | | liability | | | per day | per week | per week | 10 |
| oute | | | | | | | | of total | calcula |
| ttrik | | | | | | | | < 2 hours | by apply |
| ◄ | | 4. Quality | | Voltage problems do not prevent the use of | | | | the low | |
| | 4. Quanty | | | | | des | ired appliances | 5 | |
| | 5 Affordabil | 5. Affordability | | Cost of a standard consumption package of 365 kWh per | | | | | or the t |
| | J. Anordabii | | | annum is less than 10% of household income | | | | | rating |
| | 6. Legality | 5. Legality | | | | Bill is paid to the utility / pre-paid card | | | 201066 |
| | 0. <u>-</u> 00unty | | | | | | seller / authorized representative | | |
| | 7. Health an | d Safety | afety | | | Absence of past accidents and perception | | | attribut |
| | | , | | | | of high | h risk in the fut | ure | |

Index of Access to Energy ∑(P_i x K)

 P_i = Proportion of households at the kth tier K = Tier number {0,1,2,3,4,5}

- Can be aggregated across geographies (Village, district, province, country or region)
 - Can be tracked over time •



Pilot - Kinshasa City

Household energy survey done in Aug-Sept, 2013

Covered all four districts : Lukunga, Funa, Mont Amba, Tshangu

Sample of 2505 Households

Data used for multi-tier analysis

Data also used to prepare a draft Energy Access Diagnostic Report

Binary Measurement



Multi-tier Measurement Of Access To Electricity Supply



Map of Kinshasa City



Multi-tier Measurement of Access to Electricity Appliances





SUSTAINABLE ENERGY FOR ALL

Access to Household Electricity: Attributes Summary Sheet by District



| erruptions | | | | | Legality | |
|--------------------------|--|--|--|--|--|--|
| • | Low Voltage Problems | | Cost of 30 kWh < 5% of | | Based on Bill Payment | |
| (mins) | | | | Monthly Income | | |
| | г | | Г | | Г | |
| 19% 8 <mark>%</mark> 6% | Tshangu | 88% | Tshangu 2 <mark>%</mark> | | Tshangu 2 <mark>%</mark> | |
| | - | | _ | | - | |
| <mark>% 7%</mark> 3% | 5. Mont Amba | 90% | Mont Amba 3 <mark>%</mark> | 97% | Mont Amba 1 <mark>%</mark> | 99% |
| | - | | - | | - | |
| 56% 17% | <mark>6 !</mark> Lukunga | 83% | Lukunga 0 <mark>%</mark> | 100% | Lukunga <mark>5%</mark> | 95% |
| | _ 1 | | - | | | |
| 3% 1 <mark>1% 6</mark> % | Funa | 79% | Funa 1 <mark>%</mark> | 99% | Funa 0% | 100% |
| | L | | | | | |
| 0 mins 🔲 <10 mi | n: 🗖 Lo | w Voltage 🛛 🗖 Good volta | Not Afford | lable 🔲 Afforda | b Not | Legal 🗖 Legal |
| | 19% 8% 6% % 7%3% 56% 17% 3% 11% 6% 0 mins <10 mi | 19% 8% 6% Tshangu % 7%3% 5: Mont Amba 56% 17% ! Lukunga 3% 11% 6% Funa 0 mins <10 min: | 19% 8% 6% Tshangu 88% % 7%3% 5; Mont Amba 90% 56% 17% ! Lukunga 83% 3% 11% 6% Funa 79% 0 mins <10 min: | Monthly Inc 19% 8% 6% Tshangu 88% Tshangu 2% % 7%3% 5; Mont Amba 90% Mont Amba 3% 56% 17% Lukunga 83% Lukunga 6% Funa 79% Funa 1% 0 mins <10 min: Low Voltage Good volta; Not Afford | Monthly Income Monthly Income Monthly Income Monthly Income Stangu Stangu % Tshangu Tshangu % Tshangu Mont Amba 90% Mont Amba 90% Mont Amba 97% 56% 17% ! Lukunga 83% Lukunga 97% 3% 11% 6% Funa 79% Funa 99% 0 mins <10 min: Low Voltage Good volta; Not Affordable Afforda | Monthly Income 19% 8% 6% Tshangu 88% Tshangu 2% % 7%3% 5; Mont Amba 90% Mont Amba 3% 97% Mont Amba % 56% 17% Lukunga 83% Lukunga 0% 100% Lukunga 5% 3% 11% 6% Funa 79% Funa 1% 99% Funa % 0 mins <10 min: Low Voltage Good voltaj Not Affordable Affordable Affordable Not I |

Problem of lack of grid-connectivity is most acute in Tshangu district where almost 17% of the households do not have a grid-connection, compared to about 7% in the other districts.

Problem in duration of supply is also acute in Tshangu where 70% of households have less than 8 hours of supply per day. In general Tshangu and Mont Amba districts receive less supply during the day as also in the evening compared to Lukunga and Funa districts.

Problem of reliability is most acute in Mont Amba district, even though other districts also do not fare well.

Problem of poor voltage is equally intense in all districts and affects the regular use of appliances.



Electricity – Gap Analysis and Interventions



Technical Assistance Package

As part of this effort, ESMAP will provide support for:

- 1. Theoretical framework: providing concept frameworks, multi-tier definition and measurement methodology
- 2. Implementation of household energy surveys: providing a standardized household energy questionnaires, and assistance with survey administration and data cleaning.
- **3. Energy access diagnostic assessment:** by applying the multi-tier measurement of energy access to household, productive, and community uses of energy. The diagnostic report will include gap analysis, highlighting deficiencies in energy supply performance and possible interventions.



Questionnaire:

Contains core questions for the tier calculation related to:

- 1. Electricity: => capacity, quality, duration, reliability, affordability, legality
- 2. Electricity services => usage of electricity appliances
- 3. Lighting => no electricity sources and details on solar applications (SHS, Solar lantern...)
- 4. Cooking solutions => room ventilation, primary stove and fuel, secondary stove an fuel, convenience, capacity, affordability, availability
- 5. Productive use of energy=> capacity, quality, duration, reliability, affordability, legality
- 6. Community use of energy=> capacity, quality, duration, reliability, affordability, legality

Time: around 45-60 minutes

INTRODUCTION AND GENERAL INFORMATION

Core-questions, relevant for the calculation of the multi-tier index (questions in red are optional).

Introduction

"Hello, my name is ______. I am a representative of the [COMPINY NAME]. We are conducting a survey on behalf of the [INSTITUTION/GOVERNMENT NAME]. This survey is part of a study aimed to measure the access to energy in [COUNTRY NAME]. We would like to ask you few questions which will take about 30-40min. All the answers that you provide will be kept anonymous- only members of the survey team will have access to this information. You can stop the interview at any time, ask me to clarify any question, or ask me to repeat something if you don't understand. Your cooperation is greatly appreciated."

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Additional Information





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A New Approach

Universal access to modern energy services by 2030 is one of the primary goals of the Sustainable Energy for All [[[111]] initiative, and essential for ending poverty and boosting shared prosperity. Achieving this goal, however, will require a concerted international effort, substantial new investment, the deployment of new technologies, and a wide range of interventions targeted to the needs and potential of the countries in gues-

The success of such interventions depends, to a great estent, on the ability to assess the level of energy access in a selected area-both at the initial stage of investment planning, and later, for monitoring and evaluation purposes. Detailed baseline data can help facilitate policy formulation, investment strategies, and project design. Similarly, data can be used to evaluate the impact of projects, and assess the linkages between energy access, poverty, and other factors. such as gender equality.

EFFECTIVE MEASUREMENT OF ENERGY ACCESS

But what does 'access to modern energy services' Seamin 7

Will the goal be achieved if every household had electric lighting? Are four hours per day of electricity supply sufficient or is access defined by round-theclock nower? Chewton, what would qualify a household as having access to modern spoking solutions? Should every household cook with liguefied petroleum gas (LPG) or electricity? What about improved cookstoves using solid fuels (such as charcoal or **Sibdow**

Up until now, access to electricity has been measured as having a connection or by use of electric lighting. while access to modern cooking solutions has been measured based on the use of non-solid fuels. However er, these binary metrics fail to capture the multifaceted nature of energy access, and may not reflect the impact that many interventions have on improving



To help address these shortcomings, CIMAP is developing a new approach to measuring energy access, using a multi-tier framework. This method was first proposed in the Global Tracking Framework report, the baseline report for the SE4AUL goals, released in May 2013. Under this approach, energy access is assessed through a combination of quantity of energy, as well as quality, duration, reliability, legality, affordability, conven lence, and health and safety.

The objective of the new approach is to reflect all aspects of energy supply in the measurement of access. All common types THE WORLD BANK

THE BOTTOM LINE

The multi-tier approach to measuring energy access proposed in the SE4ALL Global Tracking Framework of 2013 introduces a five-tier measurement methodology based on various energy attributes, such as quantity, quality, affordability, and duration of supply. The approach makes it possible to compute a weighted index of access to energy for a given geographical area. Separate notes focusing on multi-tier measurement of energy access for households, productive enterprises, and community institutions will extend the application of the new approach



Vewire___ A KNOWLEDGE NOTE SERIES FOR THE ENERGY PRACTICE

Capturing the Multi-Dimensionality of Energy Access

Why is this issue important?

Rapid expansion of access to energy requires both accurate assessment and tracking of progress

Access to energy has gained significant interest from governments and development agencies, particularly since the call for Sustainable Energy for All (SE4ALL) by the Secretary General of the United Nations in 2012. One of the key goals of SE4ALL is to achieve "universal access to modern energy services by 2030" (SE4ALL 2012). Achieving that goal will require a concerted international effort, substantial new investment, the deployment of new technologies, and a wide range of interventions targeted on underserved populations.

The success of such interventions depends in part on the ability to assess the level of access to energy-both planning and investment, and, later, for monitoring of progress. Detailed baseline data can help support policy formulation, investment strategies, and project design, as well as better exante estimation of the likely impact of projects on access. For example, baseline data may reveal that a high proportion of the population in an area has 24 hours per day of electricity but suffers from frequent unscheduled outages; or that most households use liquefied propane gas (LPG) as their primary cooking fuel, but often use charcoal because of frequent shortages of LPG cylinders.

Regular and sustained data collection can also be used to evaluate how well a given project has done in improving energy access. It can help utilities to become more accountable and transparent by comparing household survey data with utility data, for example,

in terms of unscheduled outages or voltage levels. In addition, comprehensive data may lead to a better assessment of the linkages between energy access and energy poverty¹ by evaluating, for example, the impact of a solar home system project on the rate of access to information and entertainment through television

What does access to energy mean?

A full definition of energy access must be multi-dimensional

There are two initial challenges in defining and measuring energy access: the absence of a universal definition of energy access and the difficulty of measuring any definition in an accurate manner. Such difficulty lies within the multi-dimensional nature of access to energy. For example, multiple sources of energy, delivered through a range of diverse technologies, across grid-based and off-grid systems. need to be captured (IEA 2012). Also, energy is used in a wide spectrum of applications, ranging from lighting to communication and entertainment, air circulation, refrigeration, cooking, heating, and so on. The practice of "fuel stacking"-the parallel use of multiple fuels, particularly for cooking-complicates data capture because it goes beyond the simple concept of an "energy ladder" and because data on simultaneous use of multiple energy sources are scarce (Davis 1998; Heltberg 2004; Masera, Diaz, and Berrueta 2005). Finally, energy is not only needed at the household level but is also essential

Energy powerty is defined here as being deprived of certain energy services that fulfill ic human needs in a healthy, convenient, and efficient manner.



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by round-the-clock power, or are four hours per day of electricity sufficient? Likewise, what would qualify a household as having access to modern cooking solutions? Should every house hold be cooking with nonsolid fuels such as LPG or electricity? What about improved cookstoves that use solid fuels and that are as clean and efficient as those using nonsolid fuels? Is any amount of time and effort involved in collecting fuel considered acceptable? How do tariffs figure in the equation? In other words, does energy have to meet an affordability standard before being counted toward universal access? How



Thank you

For any further questions, please contact:

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Annexes

Multi-tier Framework – Access To Household Cooking Solutions

| | | | | Level-0 | Level-1 | Level-2 | Level-3 | Level-4 | Level-5 |
|------|-----------------------------------|-------------------------------------|-----------------|---------|---------|---------|---------|-------------|---------|
| | 1. Health (| Indoor | PM2.5 (μg/m3) | | <350 | <250 | <100 | <35 | <10 |
| | Air Quality | /) | CO (mg/m3) | | <70 | <50 | <20 | <7 | <7 |
| | 2. Conveni | ience | | | | | | | |
| | • Fuel Coll | ection Ti | me (Hrs / week) | | | < 7 | < | 3 | < 1 |
| | • Stove Pre | epn Time | e (Min/meal) | | | < 15 | < 2 | 15 | < 5 |
| | • Ease of C | Cooking | | | | | ۱ | / | V |
| | 3. Safety | IWA Sa | fety Tiers | | | Tier-1 | Tier-2 | Tier-3 | Tier-4 |
| | of | OR, Pa | st Accidents | | | | None | | None |
| tes | Primary | & Perceived Future Risk | | | | | Yes | | None |
| ibu | 4. Afforda | bility | | <10% of | | | of HH | of HH <5% a | |
| ∖ttr | | | | | | Inco | ome | Inco | ome |
| 1 | 5. Quality | of Prima | ry | | | No | No | | |
| | Variations | Variations in heat rate due to fuel | | | | | Major | Affect | |
| | quality that | at affects | cooking | | | | | Affect | |
| | 6. Capacity of Primary | | | Mino | | | | | None |
| | Use of secondary due to number of | | | | | | | | |
| | burners or | burners or flame Size of primary | | | | | | | |
| | 7. Availabi | lity of Pr | imary | | | | | Minor | None |
| | Use of sec | ondary c | lue to non- | | | | | | |
| | availability | / of prim | ary | | | | | | |

Tier-rating for the household is calculated by applying the lowest of the tier-ratings across all attributes.



Multi-tier Framework – Access To Energy For Productive Uses

| | | | Tier-0 | Tier-1 | Tier-2 | Tier-3 | Tier-4 | Tier-5 |
|------|------------------------|----------------------|---------------------------------------|--------------------------|---------------------------|--|----------------------|-------------|
| | 1. Capacity | Electricity (Watts) | <1W | 1-50W | 50-200W | 200W-2kW | 2-10kW | >10kW |
| | | (Wh) | <2Wh | 2-200Wh | 200-1.2kWh | >1.2kWh | - | - |
| | | RM&T (% of needs) | <25% | 25% | -75% | 75%- | 100% | 100% |
| | 2. Duration (% o | f needs) | <25% | 25%-50% | 50%-75% | 75%- | 100% | 100%+ |
| | 3. Reliability | | | scups with so | voro import | Reliability issues with | | No issue or |
| es | | | Reliability issues with severe impact | | moderate impact | | no impact | |
| out | 4. Quality | | Quality issues with sovere impact | | | Quality issues with | | No issue or |
| tril | | | Quality issues with severe impact | | | moderate impact | | no impact |
| At | 5. Affordability | | > 2 times grid tariff | | | \leq 2 times grid tariff \leq grid t | | |
| | 6. Legality /Formality | | No | | | Yes | | |
| | 7. Convenience | | No | | | | Ye | es |
| | 8. Health & Safety | | Non-BLEN wi | ithout smoke | Non-BLEN wi | th smoke | BLEN solution | S |
| | | | extraction | | extraction or outside use | | Not likely to cause | |
| | | Likely to caus | se severe | Likely to cause moderate | | significant damage/injury | | |
| | | | health dama | ge/injury | damage/injury | | | |

Tier-rating for the productive use is calculated by calculating Tier-ratings for all relevant applications and applying the lowest.



Multi-tier Framework - Access To Energy For Community Uses: Health Facilities; Education Facilities; Public & Community Buildings

| | | | Tier-0 | Tier-1 | Tier-2 | Tier-3 | Tier-4 | Tier-5 |
|--|---|------------------------|---|--|--------------------------|--|--------------------------|-------------------------------------|
| | 1. Capacity | Electricity | No Electricity | Very Low Power | Low Power | Medium Power | High F | Power |
| | | Heating (if needed) | No heating (0%) | Capacity partially covers needs (1%-49%) | | Capacity largely covers needs (50%-99%) | | Capacity totally covers needs |
| | 2. Duration | Electricity | No electricity/ | Less than ¼ of | Less than ½ | More than ½ | More than ¾ | All the time |
| tes | | Heating (if needed) | heating (0%) | the time (1-24%) | of the time (25%-49%) | of the time (50%-74%) | of the time (75%-99%) | (100%) |
| rib u | 3. Reliability Electricity Heating (if needed) | | | | | No significant unscheduled | | |
| Attı | | | Sigr | nificant unsched | interruptions | | | |
| | 4. Quality | Electricity | | | | | | |
| | | Heating (if needed) | Quali | ality is not satisfactory Quality is satisfactor | | | ory | |
| | 5. Health & Safety | Electricity | | | | | | |
| Heating Health & Safety i (if needed) | | | is not satisfactory Health & Safety is satisfac | | | is satisfactory | | |

Tier-rating for the household's access to energy at each community institution is calculated by applying the lowest of the tier-ratings across all attributes.



How Is Energy Access Measured – Indices By Dimensions Of Energy Use





Piloting Of Multi-tier Framework – Status & Strategy

| Survey Status | Country | Area | Dimensions |
|--------------------|------------|---------------------|---|
| Completed | DRC | Kinshasa area | Household cooking, Household electricity |
| Completed | Uganda | National | Household Cooking |
| Completed | Ethiopia | Amhara Region | Household cooking, Household electricity |
| Completed | India | Bihar – 6 districts | Household cooking, Household electricity |
| Ongoing | Guinea | National | Household cooking, Household electricity, Productive uses, Community uses |
| Pipeline | Mali | National | Household cooking, Household electricity, Productive uses, Community uses |
| Pipeline candidate | Burundi | | |
| Pipeline candidate | Liberia | | |
| Pipeline candidate | Mozambique | | |
| Pipeline candidate | Senegal | | |



Electricity - Attributes Summary Sheet

| Electricity Source | Capacity | Duration | Duration |
|--|-------------------|--|---|
| Source | Wattage | Out of 24 Hours | Evening Supply |
| NO SHS 2% 10% OTHER 1% GRID 87% | >2000 W 87% | 16h- 22h 9% 6% <4h 23% 8h-16h 23% 4h-8h 39% | <1h 9% >4h 41% 1h-2h 18% 2h-4h 32% |

| Reliability | Quality | Affordability | Legality |
|--|---|--|------------------------------------|
| Duration of Interruptions (mins) | Low Voltage Problems | Cost of 30 kWh < 5% of Monthly | Based on Bill Payment |
| | | Income | |
| None >30 38% mins 46% <10 mins 10-30 5% mins 11% | Good voltage 15% Low Voltage 85% | Not Afforda ble 2% Afforda ble 98% | Not Legal 2% Legal 98% |

Less than 8 hours per day for 62% of the household

Unscheduled interruptions are longer than 30 minutes for more than 57% of the household

Almost 85% of the household experienced low voltage



Electricity - Tiers Summary Sheet



Electricity Services – Summary sheet





Observations: Most household can afford to own energy appliances but they cannot use them properly due to poor electricity supply

