Defining and Measuring Access to Energy

SREP Pilot Country Meeting | May 28-30, 2013

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Session Roadmap

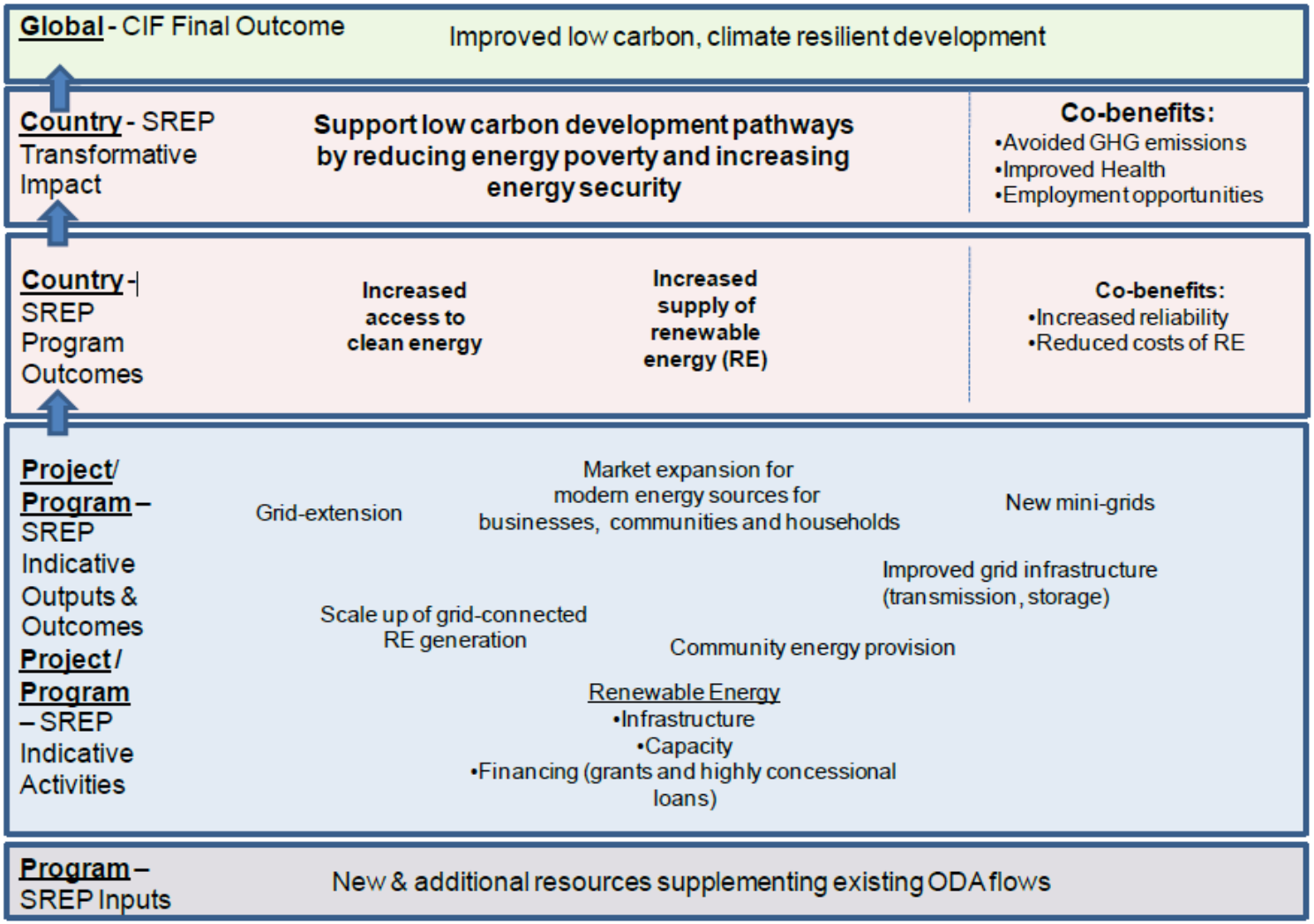
1.	Introduction	20 min
2.	SE4ALL Global Tracking Framework	20 min
3.	Energy Results Chain	20 min
4.	Measuring Household Electricity Access	30 min
5.	Measuring Household Cooking Access	30 min
6.	Access Impact of Generation Projects	30 min
7.	HH Energy Surveys	30 min

Introduction

Context

- Scaling-up Renewable Energy Program + Other CIF
- Sustainable Energy for All (SE4ALL)
  - Universal Access to Energy
  - Doubling the share of renewable energy
  - Doubling the rate of increase of energy efficiency
- ACCES
- GACC
- Lighting Africa
- Lighting Asia, Lighting India
- Energy +
- EnDev
- Multilateral Projects

Revised SREP Results Chain

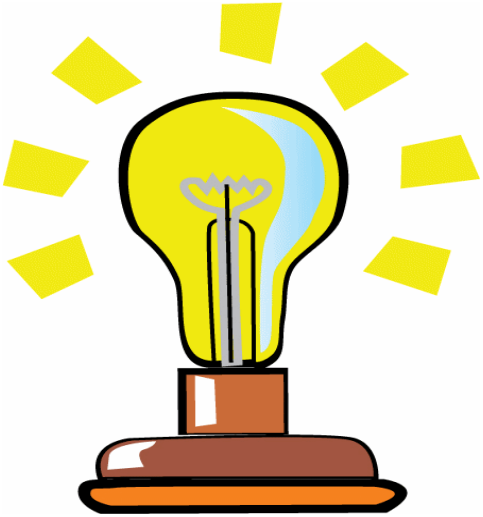


Revised SREP Results Framework

BASIC PRINCIPLES

a) Living document
b) Field testing
c) National M&E systems + MDBs MfDR.
d) Flexible and pragmatic approach
e) Data collection and reporting standards

	Results	Indicators
SREP Transformative Impact	Support low carbon development pathways by reducing energy poverty and/or increasing energy security	Annual electricity output from RE in GWh (for the country as a whole)
		National measure of "energy poverty" such as the Multi-dimensional Energy Poverty Index (MEPI), or some equivalent mutually agreed measure
		Increased public and private investments ($) in targeted subsector(s) per country per year
SREP Program Outcomes	Increased supply of renewable energy	Annual electricity output from RE as a result of SREP interventions (GWh)
	Increased access to modern energy services	Number of women and men, businesses and community services benefiting from improved access to electricity and fuels as a result of SREP interventions



A Short Quiz on Energy access

A Short Quiz on Energy access

Q1: As of 2013, Lighting Africa initiative is active in how many countries ?

a. 2
b. 11
c. 4
d. 6

Ethiopia, Ghana, Kenya, Nigeria, Senegal and Tanzania

Q2: What are ACCES and GACC?

a. Fancy acronyms
b. Global heating initiatives
c. Clean cooking initiatives
d. Types of cookstoves

ACCES: Africa Clean Cooking Energy Solutions
GACC: Global Alliance for Clean Cookstoves

Q3: Is Kerosene a modern fuel and a clean fuel?

a. Modern - Yes, Clean - Yes
b. Modern - No, Clean - Yes
c. Modern - No, Clean - No
d. Modern - Yes, Clean – No

Nearly 80% households in Africa use kerosene for lighting, though it causes health problems.

Source: SE4ALL Global Tracking Framework Report

Q4: What is the electricity access rate, installed capacity and peak demand in Nepal?

a. 71 %, 560 MW, ~500 MW
b. 76 %, 946 MW, ~700 MW
c. 63 %, 250 MW, ~ 300 MW
d. 89 %, 1200 MW, ~900 MW

Source: NEA Annual Report 2011 and Internet

A Short Quiz on Energy access

Q5: Where does it take the longest to get an electricity connection for a business?

a. Liberia

b. Nepal

c. Rwanda

d. Vietnam

Liberia (465 days), Nepal (70 days), Rwanda (30 days), Vietnam (115)

Q6: How does the installed generation capacity in Sub-Saharan Africa (minus S.Africa) compare with that in Spain?

a. Three times that in Spain

b. Double of that in Spain

c. Half of that in Spain

d. One-third of that in Spain

In 2009, power capacity in Spain was about 93 GW, while that in SSA (minus South Africa) was 28 GW.

Q7: To provide universal access to energy, by 2030, what percentage of the global investment ($890 billion) would be needed in Sub-Saharan Africa?

a. 52 %

b. 17 %

c. 30 %

d. 60%

Q8: How many people are served in health clinics in Sub-Saharan Africa, that are without access to electricity?

a. 255 million

b. 20 million

c. 3 million

d. 150 million

Source: Poor people's energy outlook, Practical Action, 2013

A Short Quiz

Q9: How many deaths each year that can be attributed to indoor air pollution?

a. 200,000
b. 1,500,000
c. 3,500,000
d. 20,000,000

Source: Global Burden of Disease Study

Q10: What is access to electricity?

a. An electric pole in the village
b. A light bulb in the house
c. A wire connection to the house
d. 24-hour uninterrupted grid supply
e. > 1 kWh per person per month
f. Any of the above

Q11: Do generation and transmission projects help expand energy access?

a. No, These are upstream projects
b. Yes – in all cases
c. Only in case of micro-grids
d. Only when new connections result
e. Sometimes – only if connections increase or supply quality improves

Q12: Do energy policy, laws, institutions, markets, regulators etc help access?

a. No, These are unrelated
b. Only electrification policy/Laws
c. Only when new connections result
d. Sometimes – only if connections increase or quality improves. They provide the ecosystem.

Difficulties in Measuring Energy Access

- **Multiple Dimensions of Energy Use:** Households, Productive Enterprises, Community Institutions
- **Multiple Uses (Applications)**: Lighting, Cooking, Air-Circulation, Refrigeration, Entertainment, Communication, Mechanical loads etc.
- **Multiple Sources (carriers):** Off-Grid/Mini-grid/Grid Electricity, Solid/Liquid/ Gaseous Fuels.
- **What is Access:** Access to Energy Sources vs. Energy Applications (Services) vs. Actual Use (Consumption)
- **Defining Minimum Standards of Access** – the binary split
- **Quality of Supply** – Energy Attributes: Connectivity, Availability, Quality, Convenience, Safety, Health Impact, Reliability, Affordability etc.
- **Accounting for Upstream Investments** in Generation, Transmission, Distribution, Gas Pipelines etc.
- **Institutional Capabilities, Policy, Regulation and Market**
- **Constraints in Data Availability** – Utility Data, Project Data and Household Surveys

How should Energy Access be measured:

- Cover ***all dimensions***
- ***Technology-neutral*** approach
- Based on ***usability*** for availing Energy Services
- Reflective of ***attributes***
- Separate measurement of ***actual use*** (also consumption)

Past Approaches for Measuring Energy Access

Methodology	Name	Objective	Author	Date
Single indicator	Energy Poverty Line	Define a threshold point at which households consume a bare minimum level of energy	Barnes	2011
Dashboard of indicators	Energy Indicators for Sustainable Development	Measure of the social, economic and environmental impact of energy	IAEA	2005
	Energy access situation in developing countries	Penetration rate of modern energy	UNDP/WHO	2009
Composite index	Energy Development Index	Penetration rate of modern energy and levels of energy consumption	IEA	2004
	Multi-dimensional Energy Poverty Index	Measure of deprivation of energy services through ownership of appliances	UNIDO	2011
	Total Energy Access	Minimum access standards for five energy services	Practical Action	2010
Multi-tier	Energy Supply Index	Multi-dimensional measure of the quality of energy supply		
	Incremental levels of access to energy services	Level of access to energy services through energy usage (kWh/per capita)	AGECC	2010
	Minimum levels and priorities of access to energy services	Minimum access to basic energy needs in terms of quantity, quality and affordability	EnDev	2011
	Multi-tier standards for cookstoves	Establish standards for cookstoves in terms of efficiency, safety and emissions	GACC/PCIA	2012

Defining and Measuring Energy Access

- ESMAP funded activity
- Collaborative effort with experts from many partner agencies
- Practical Action as Consultants
- Timely effort to feed into the SE4All Tracking Framework Report
- May also feed into other programs such as Energy+, Endev, Lighting Africa, Clean Cooking Initiative etc.

Core Consultation Group draws experts from:

- World Bank
- Practical Action
- WHO
- GIZ, kfw
- DfID
- UNDP
- UNIDO
- GACC
- NORAD
- IEA

2012 INTERNATIONAL YEAR OF SUSTAINABLE ENERGY FOR ALL

SE4ALL
Global Tracking Framework

COORDINATORS

ESMAP

THE WORLD BANK

iea International Energy Agency

IIASA

peec International Partnership for Energy Efficiency Co-operation

PRACTICAL ACTION Technology challenging poverty

IRENA International Renewable Energy Agency

REN21 Renewable Energy Policy Network for the 21st Century

UNDP

UNEP

UNIDO

UN-Energy

UNITED NATIONS FOUNDATION

WORLD ENERGY COUNCIL CONSEIL MONDIAL DE L'ÉNERGIE For sustainable energy.

World Health Organization

GLOBAL ALLIANCE FOR CLEAN COOKSTOVES

SE4ALL Goals for 2030

- **Energy access**
  - Ensure universal access to modern energy services
- **Renewable energy**
  - Double the share of renewable energy in the global energy mix
- **Energy efficiency**
  - Double the global rate of improvement in energy efficiency

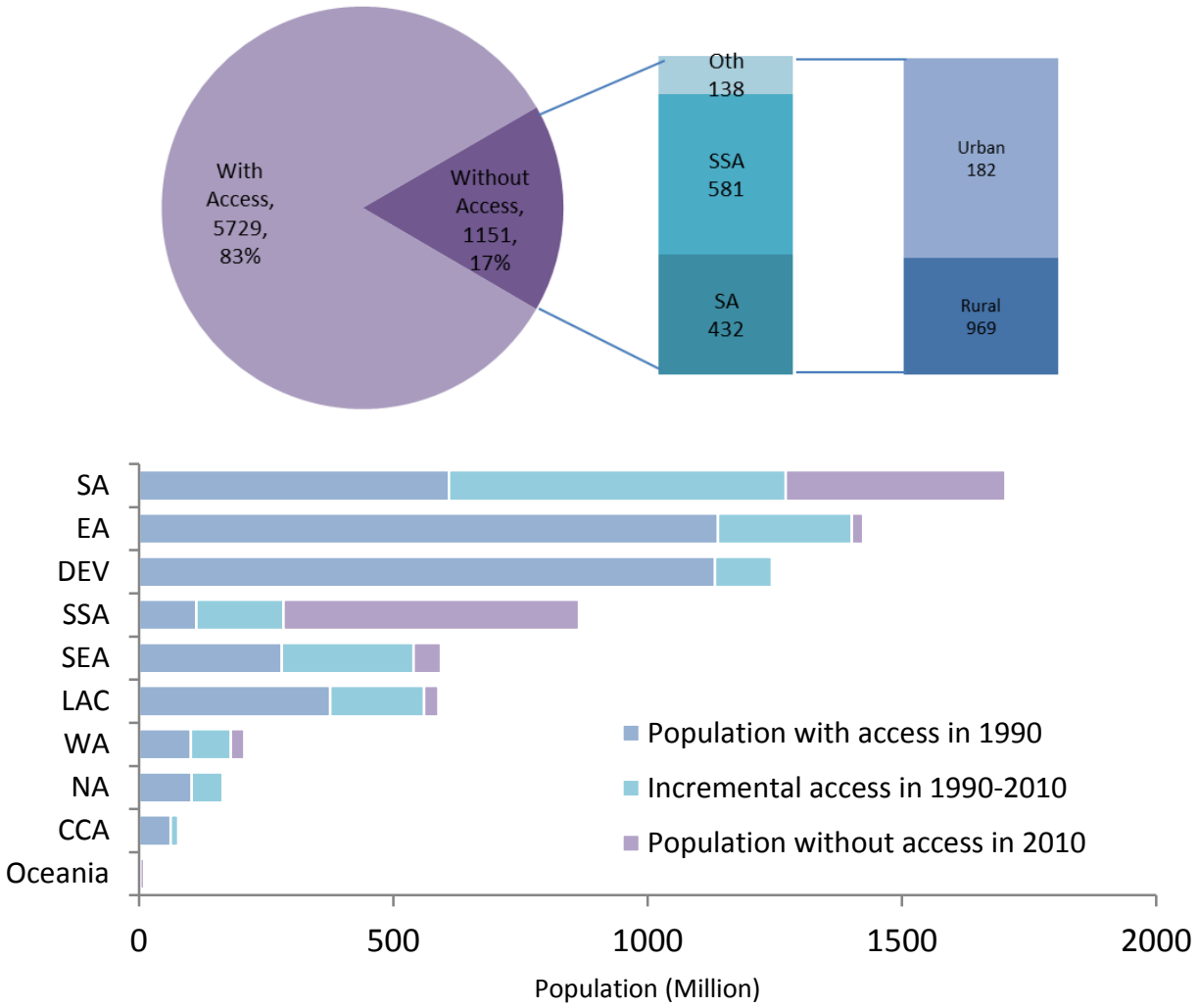
A Phased and Differentiated Approach

	Immediate	Medium term
Global tracking	Which indicator is ready to go for global tracking with all data needs (past, present, and future) already fully met?	Which indicator is highly desirable for global tracking, but would require a feasible incremental investment in global energy data systems over the next five years?
Country level tracking	Na.	Which indicator is ideal for tracking, and although too ambitious for global tracking, could be very suitable for country level tracking under SE4ALL?

Available data allows coverage of over 180 countries

	Data Sources	Country Coverage (% global popn.)
Electrification	Global omnibus and national household surveys plus some censuses	212 (99.8%)
Cooking	Household surveys Global omnibus and national household surveys plus some censuses	190 (99.8%)
Renewable Energy	IEA (plus UN) for Energy Balances REN 21, IRENA, BNEF for complementary indicators	181 (98%)
Energy Efficiency	IEA (plus UN) for Energy Balances WDI for GDP and sectoral value added	181 (98%)

Global Snapshot of Electricity Access



Definition in SE4All Tracking Framework Report:

Based on data from omnibus surveys. Access to electricity is defined as a binary metric:

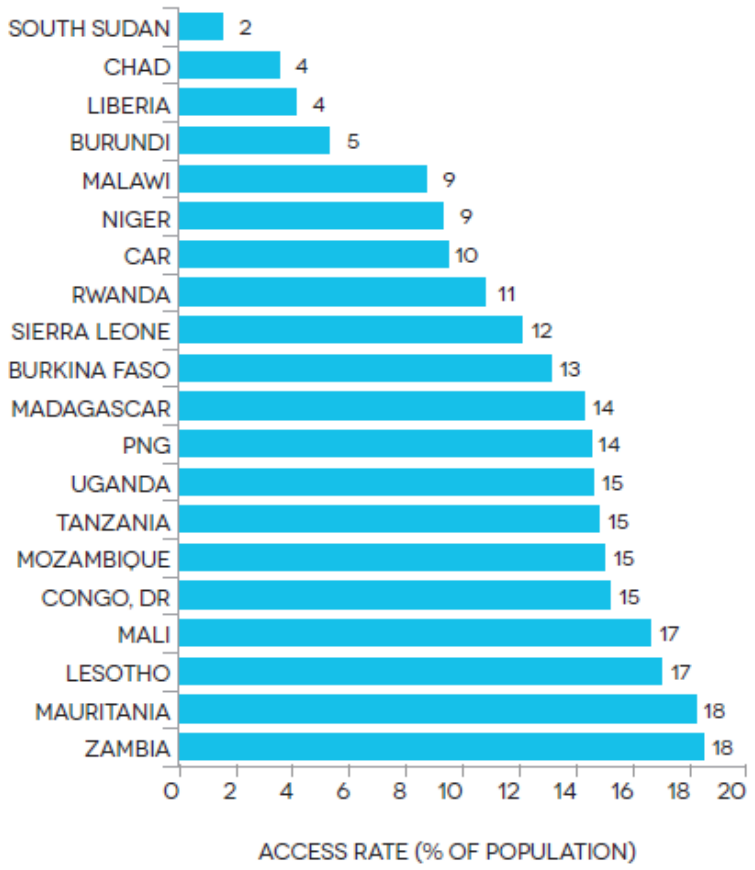
DHS: The household has an electricity connection

LSMS: The household uses electricity as primary source of lighting (LSMS)

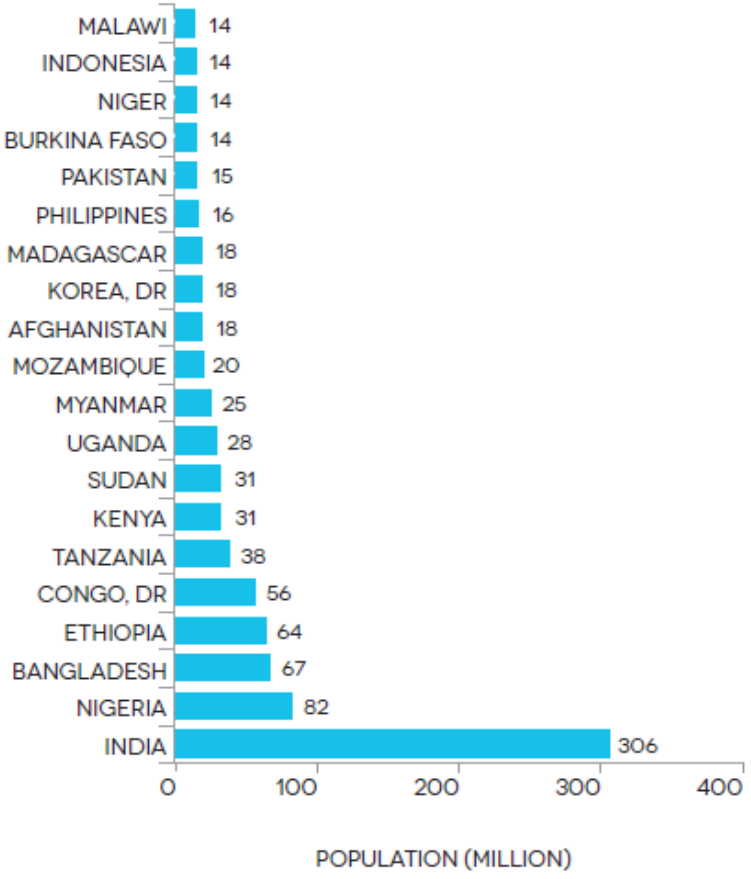
Data constraints imply that:

- Not reflective of usability attributes of supply
- Does not capture off-grid solutions
- Ambiguity about illegal and secondary connections

Top 20 Countries Lacking Electricity Access

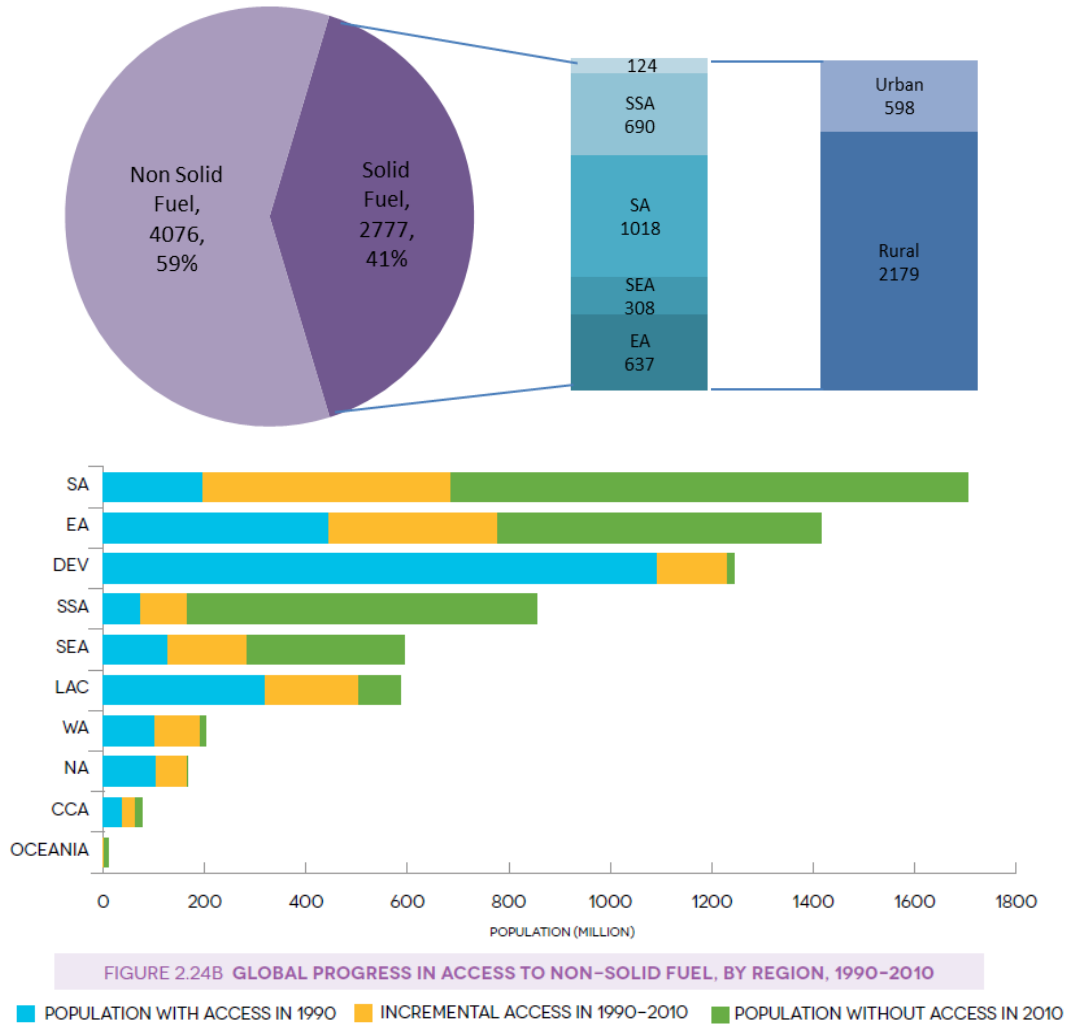


Top 20 countries with lowest access rates



Top 20 countries with largest access deficits

Global Snapshot of Cooking Solutions Access



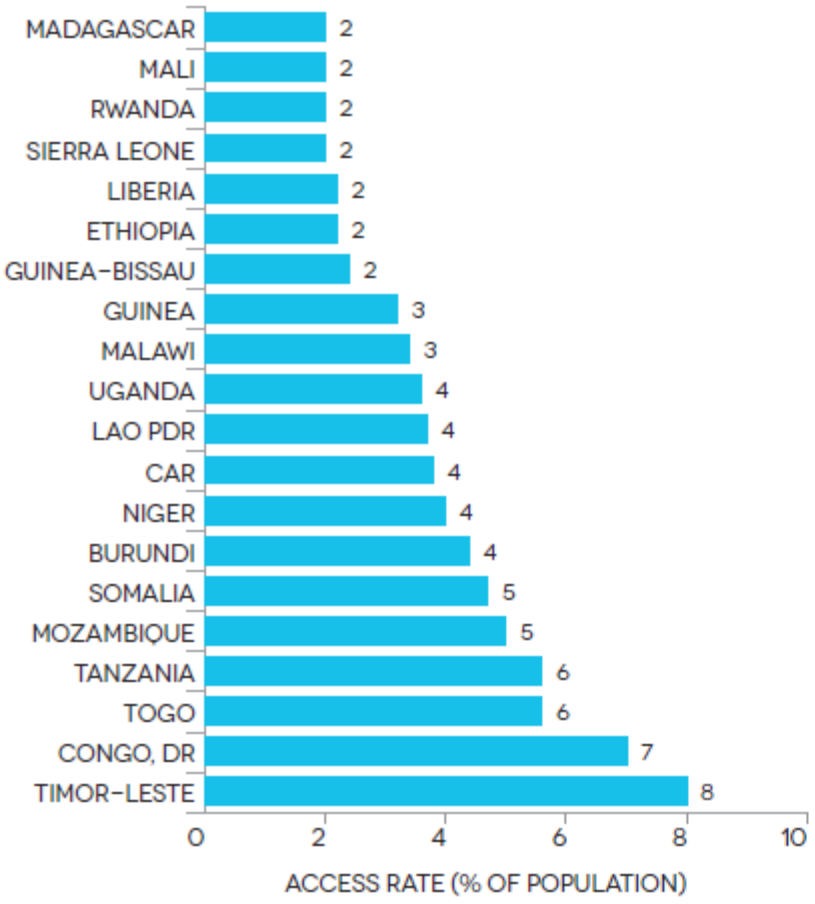
Definition in SE4All Tracking Framework Report:

Based on data from omnibus surveys. Access to cooking is defined as a binary metric:
DHS: Fuel that the household mainly uses for cooking
LSMS: Main source of energy for cooking

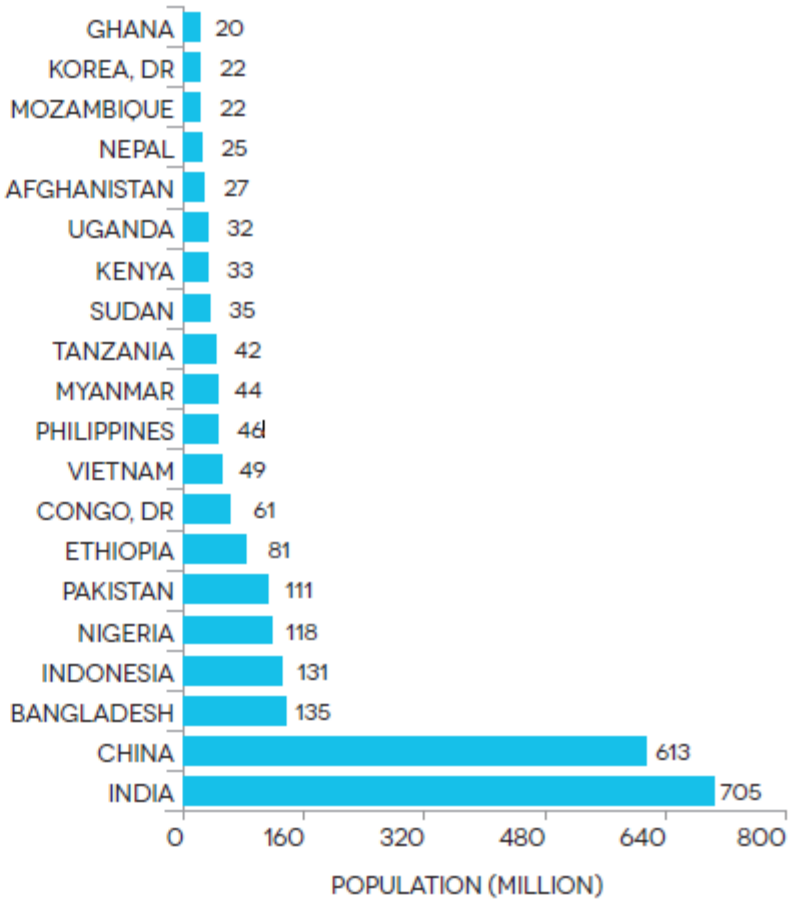
Data constraints imply that:

- Not reflective of fuel-stacking phenomenon.
- Not reflective of use of improved cookstoves
- Includes Kerosene as modern fuel
- Not reflective of issues of convenience

Top 20 Countries Lacking Cooking Access

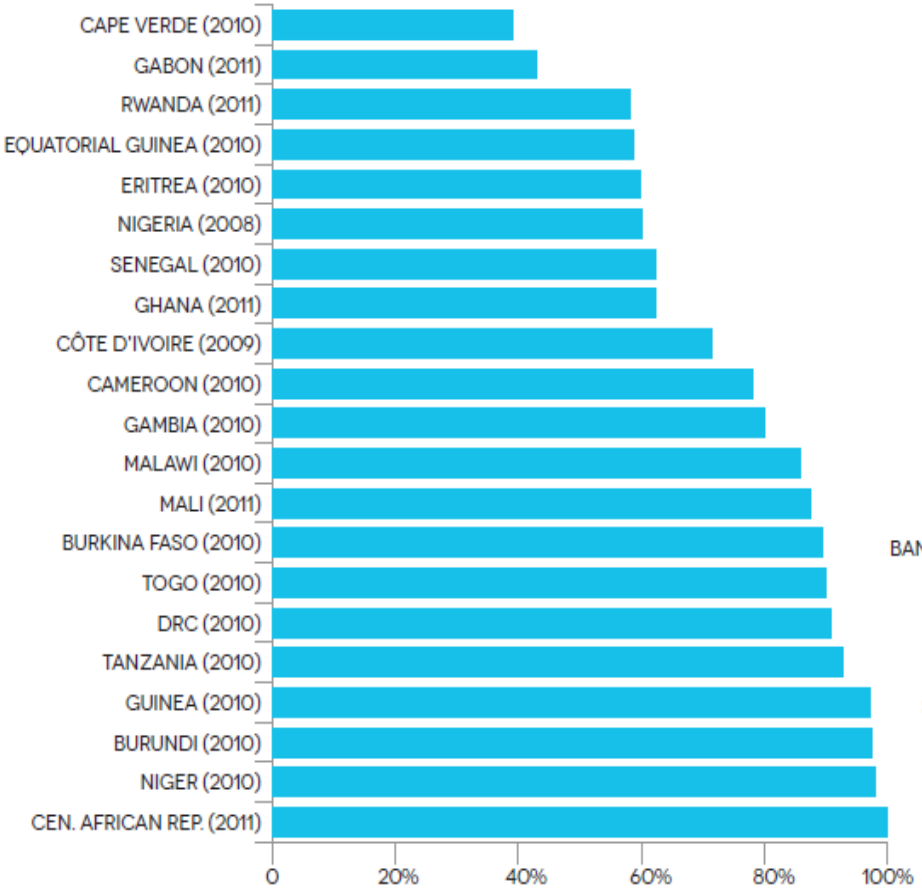


Top 20 countries with lowest access rates

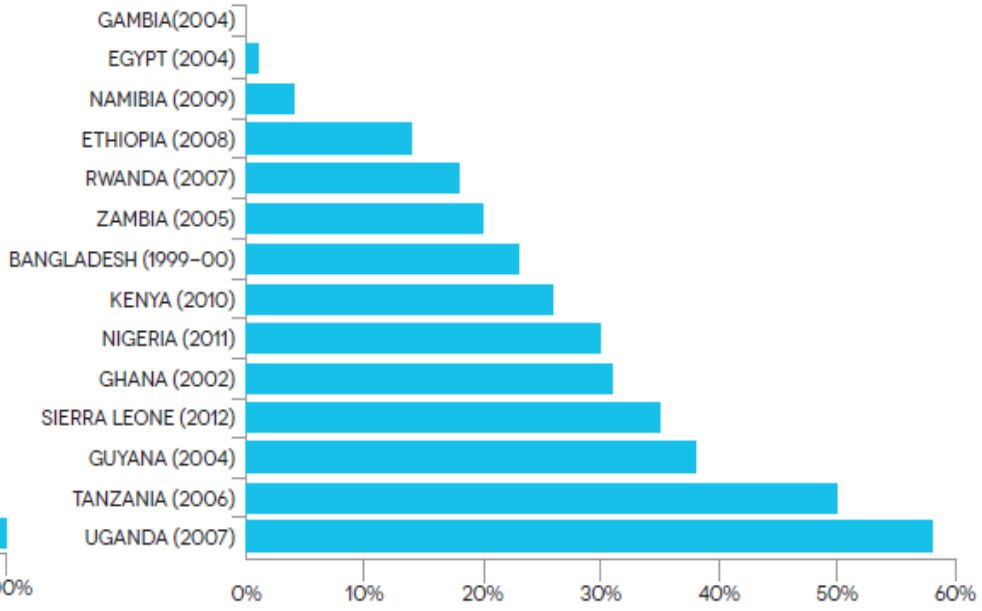


Top 20 countries with largest access deficits

Electricity Access in Community Institutions



Public Primary Schools without Electricity



Health Clinics without Electricity

Defining and Measuring Access to Energy
SREP Pilot Country Meet, May 28-30, 2013, Maldives

Addressing Methodological challenges

Challenge	Approach for Global Tracking	Approach for Country Tracking
Off-grid, mini-grid, and grid solutions	Two-threshold measurement to reflect access to electricity for lighting and for more advanced applications on a technology-neutral basis.	Technology-neutral multi-tier measurement based on attributes of supply and covering grid and off-grid solutions.
Quality of supply	Not reflected. Quality of supply cannot be measured without detailed household surveys or reliable utility data.	Quality of supply aspects are reflected through detailed household surveys using the multi-tier framework.
Access to electricity supply versus electricity services	Electricity supply and services overlap across the two-threshold measurement.	Both electricity services and electricity supply are measured through separate multi-tier frameworks.
Productive and community uses	New methodologies to be developed.	New methodologies to be developed.

Addressing Methodological challenges

Challenge	Approach for Global Tracking	Approach for Country Tracking
Heating	New methodologies to be developed.	New methodologies to be developed.
Improved solid fuel cookstoves	Two-threshold measurement to reflect the use of manufactured non-BLEN cookstoves and BLEN cookstoves (based on direct observation).	Technology-neutral multi-tier framework reflects the wide range of technical performance of non-BLEN cookstoves, along with the associated CCA attributes.
Stacking of stoves and fuels	Only the primary cooking solution is reflected.	Multi-tier framework reflects fuel stacking through the adequacy attribute.
Convenience and conformity	Not reflected. BLEN cookstoves may be assumed to be convenient and conforming.	Multi-tier framework reflects all actual use attributes.

Energy Results Chain

Why is Energy Access Important?

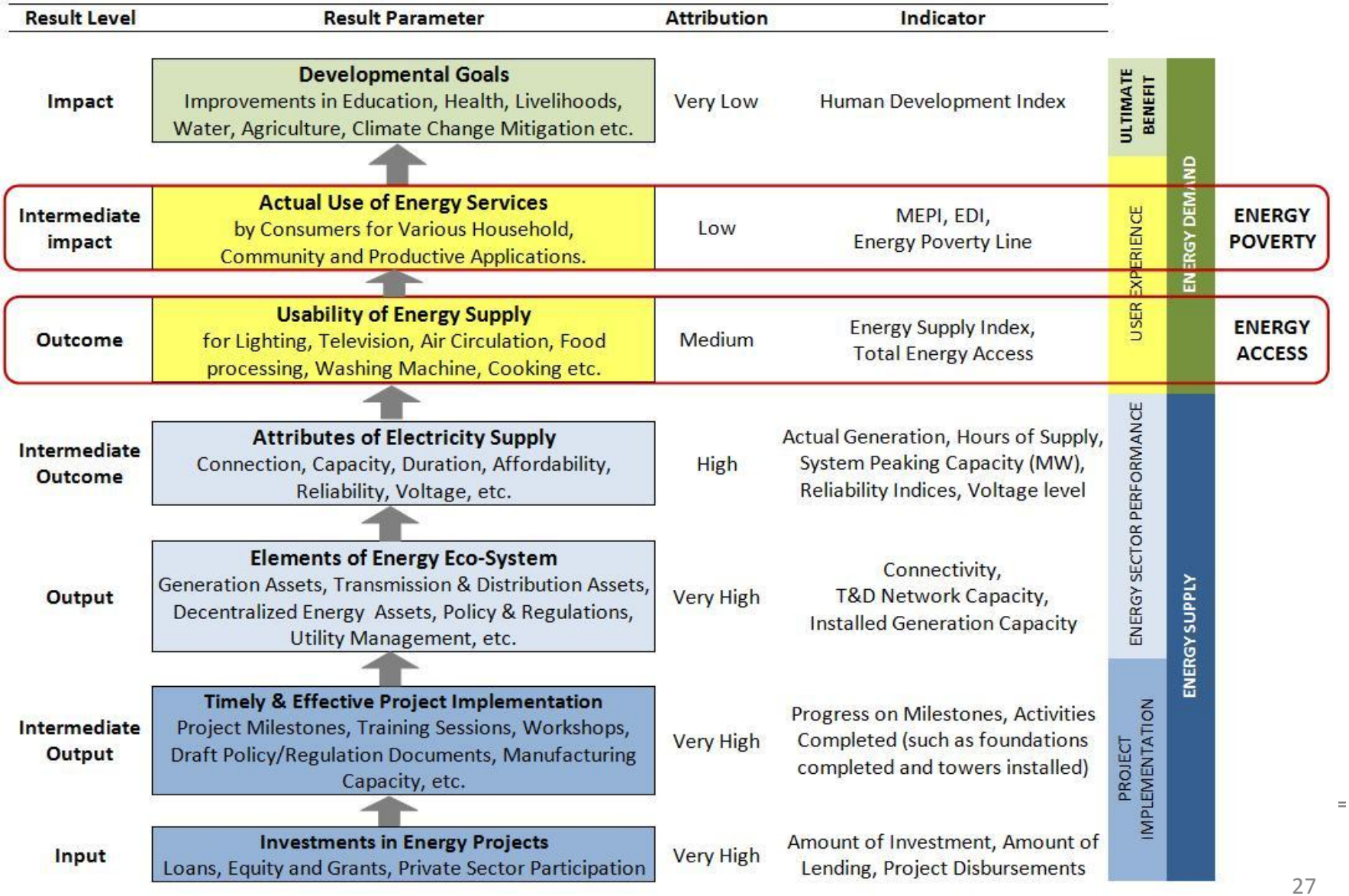
Benefits of Energy

- Lighting – extended hours of day
- Communication, Information and Entertainment
- Food Preservation - Refrigerators
- Reduction of drudgery at home
- Climate Control – Fans, Coolers, Air Conditioners
- Health – at home and at health clinics
- Education – in schools and at home
- Economic development
- Agriculture
- Social development
- Gender equity
- Security – Street Lighting

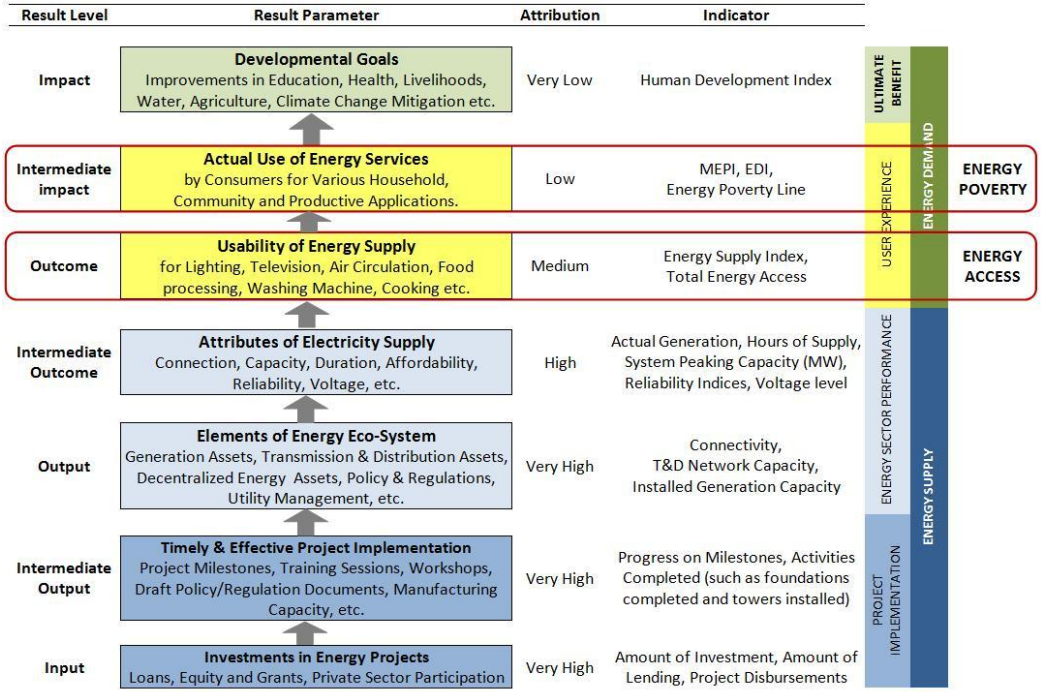
Dimensions of Energy Access

1. Household
   - Electrification
   - Cooking & Heating
2. Productive Enterprises
   - Agriculture
   - Micro-mini-small and medium enterprises
   - Large enterprises
3. Community Institutions
   - Health Clinics
   - Schools
   - Local Government
   - Water Supply
   - Community Buildings

Energy Results Chain



Energy Results Chain



Key Concepts:

1. Attributes of Energy
2. Energy Supply vs. Energy Services vs. Energy Consumption
3. Usability of Supply vs. Actual Use of Energy Services
4. Energy Access vs. Energy Poverty

Measuring Household Electricity Access

Attributes of Electricity Supply

1.
2.
3.
4.
5.
6.
7.
8.
9.
10.

Attributes of Electricity Access

1. **Peak available capacity**
   Less than a watt for LED lighting to several kilowatts for space heating.
2. **Duration of supply**
   Few hours of grid supply (and off-grid) in many countries to 24 x 7 supply.
3. **Evening supply**
   Many grid-connected houses do not get evening supply when it is most useful.
4. **Affordability of supply**
   Complex parameter – involves quantity, cost, income and consumer preferences.
5. **Legality of connection**
   Illegal connections are a drain on the system and subject to being disconnected.
6. **Quality of supply (voltage)**
   Low or fluctuating voltage makes power non-usable and damages equipment.
7. **Reliability of supply**

   Poor reliability disrupts people's schedules and forces the use of costly backups.

Proposed Multi-tier Framework

Supply side: Tiers based on attributes of electricity supply

ATTRIBUTES	Tier-0	Tier-1	Tier-2	Tier-3	Tier-4	Tier-5
Peak Available Capacity (W_{eq})	-	>1	>50	>500	>2000	>2000
Duration (Hrs)	-	≥4	≥4	≥8	≥16	≥22
Evening Supply (Hrs)	-	≥2	≥2	≥2	≥4	≥4
Affordability	-	-	√	√	√	√
Formality (Legality)	-	-	-	√	√	√
Quality (Voltage)	-	-	-	√	√	√
Global Tracking for SE4All	No	Basic	Advanced			

Service side: Tiers based on regular use of appliances

Tier-0	Tier-1	Tier-2	Tier-3	Tier-4	Tier-5
-	Task Lighting AND Phone Charging	General Lighting AND Television AND Fan	Tier-2 AND any low-power appliances	Tier-3 AND any medium-power appliances	Tier-4 AND any high-power appliances

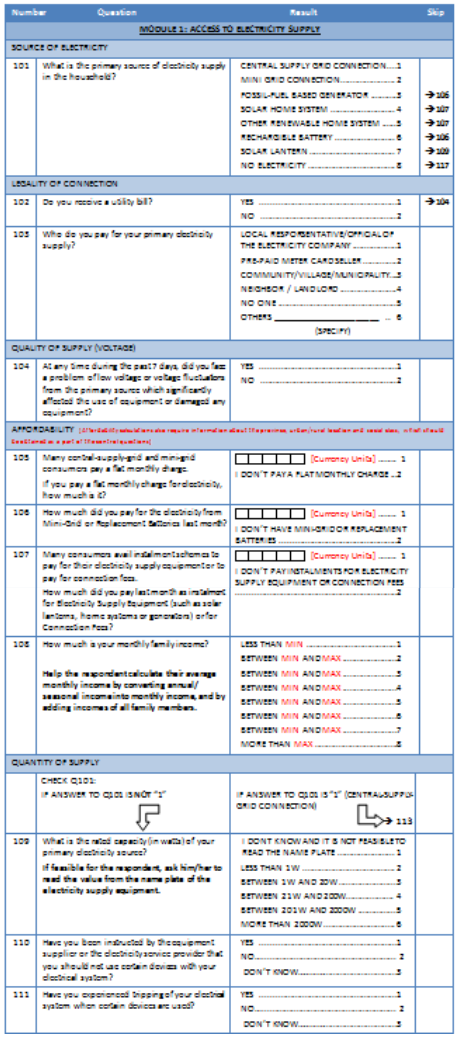
Access to Electricity Supply

- Technology Neutral
- Based on natural break-points in supply technologies as well as electricity services
- Gives minimum requirements for attributes of supply

Access to Electricity Services

- Based on ownership and regular use of appliances
- Tier design based on increasing requirements of energy attributes
- Regular use of at least electric lighting, radio television and electric fan considered as Advanced Access

Core Survey Questionnaire



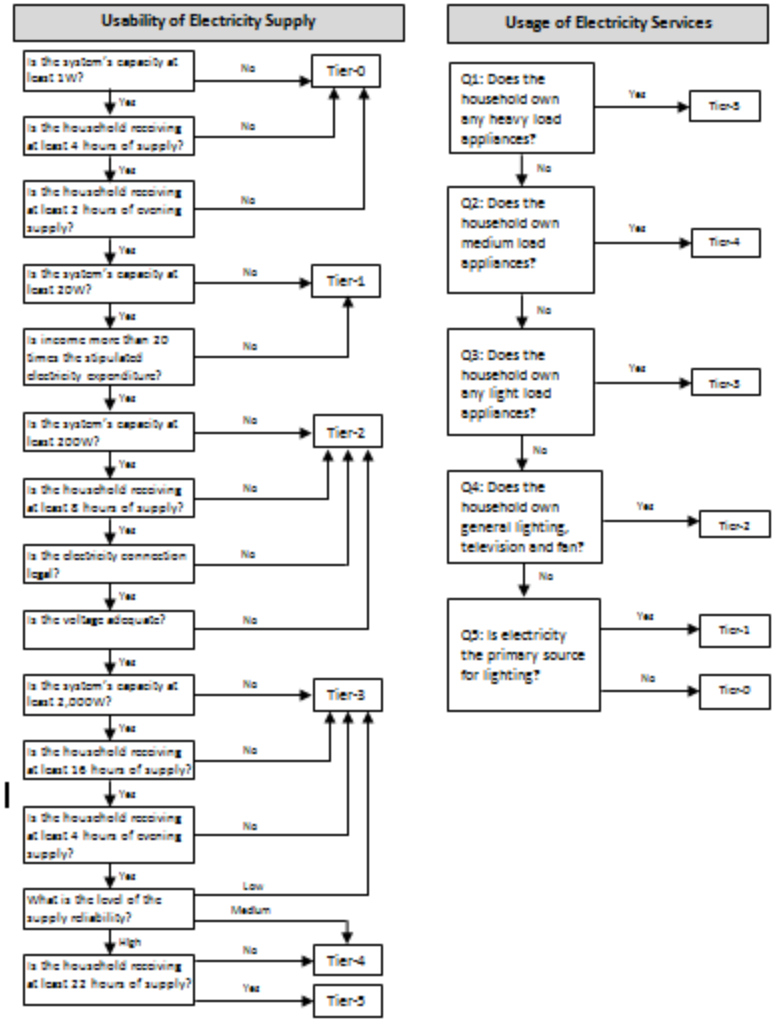
Number	Question	Result	Skip
	MODULE 1: ACCESS TO ELECTRICITY SUPPLY		
	SOURCE OF ELECTRICITY		
101	What is the primary source of electricity supply in the household?	CENTRAL SUPPLY GRID CONNECTION....1 MINI GRID CONNECTION....2 FOSSIL-FUEL BASED GENERATOR....3 SOLAR HOME SYSTEM....4 OTHER RENEWABLE HOME SYSTEM....5 RECHARGEABLE BATTERY....6 SOLAR LANTERN....7 NO ELECTRICITY....8	→106 →107 →107 →106 →109 →117
	LEGALITY OF CONNECTION		
102	Do you receive a utility bill?	YES....1 NO....2	→104
103	Who do you pay for your primary electricity supply?	LOCAL REPRESENTATIVE/OFFICIAL OF THE ELECTRICITY COMPANY....1 PRE-PAID METER CARDSELLER....2 COMMUNITY/VILLAGE/MUNICIPALITY....3 NEIGHBOR / LANDLORD....4 NO ONE....5 OTHERS _____ (SPECIFY)....6	
	QUALITY OF SUPPLY (VOLTAGE)		
104	At any time during the past 7 days, did you face a problem of low voltage or voltage fluctuations from the primary source which significantly affected the use of equipment or damaged any equipment?	YES....1 NO....2	
	AFFORDABILITY (Affordability questions require information about the previous criteria level and need also, in full should be obtained as a part of the enterprise questions)		
105	Many central-supply-grid and mini-grid consumers pay a flat monthly charge. If you pay a flat monthly charge for electricity, how much is it?	[ ][ ][ ][ ][ ][ ] [Currency Units]....1 I DON'T PAY A FLAT MONTHLY CHARGE....2	
106	How much did you pay for the electricity from Mini-Grid or Replacement batteries last month?	[ ][ ][ ][ ][ ][ ] [Currency Units]....1 I DON'T HAVE MINI-GRID OR REPLACEMENT BATTERIES....2	
107	Many consumers avail installment schemes to pay for their electricity supply equipment or to pay for connection fees. How much did you pay last month as installment for electricity Supply Equipment (such as solar lanterns, home systems or generators) or for Connection Fees?	[ ][ ][ ][ ][ ][ ] [Currency Units]....1 I DON'T PAY INSTALMENTS FOR ELECTRICITY SUPPLY EQUIPMENT OR CONNECTION FEES....2	
108	How much is your monthly family income? **Help the respondent calculate their average monthly income by converting annual/ seasonal income into monthly income, and by adding incomes of all family members.**	LESS THAN MIN....1 BETWEEN MIN AND MAX....2 BETWEEN MIN AND MAX....3 BETWEEN MIN AND MAX....4 BETWEEN MIN AND MAX....5 BETWEEN MIN AND MAX....6 BETWEEN MIN AND MAX....7 MORE THAN MAX....8	
	QUANTITY OF SUPPLY		
	CHECK Q101: IF ANSWER TO Q101 IS NOT "1"	IF ANSWER TO Q101 IS "1" (CENTRAL-SUPPLY-GRID CONNECTION)	→113
109	What is the rated capacity (in watts) of your primary electricity source? **If feasible for the respondent, ask him/her to read the value from the name plate of the electricity supply equipment.**	I DON'T KNOW AND IT IS NOT FEASIBLE TO READ THE NAME PLATE....1 LESS THAN 1W....2 BETWEEN 1W AND 20W....3 BETWEEN 21W AND 200W....4 BETWEEN 201W AND 2000W....5 MORE THAN 2000W....6	
110	Have you been instructed by the equipment supplier or the electricity service provider that you should not use certain devices with your electrical system?	YES....1 NO....2 DON'T KNOW....3	
111	Have you experienced tripping of your electrical system when certain devices are used?	YES....1 NO....2 DON'T KNOW....3	

	CHECK Q110 AND Q111: IF ANSWER TO ANY OF THE QUESTIONS IS "1" (YES)	IF ANSWER TO BOTH QUESTIONS IS "2" (NO)			→113
112	Has any of the following equipment caused tripping or have you been advised not to use them with your electricity supply system?	Yes	No	Don't Know	
	1. Television / Electric Fan	1	2	3	
	2. Air Cooler (Evaporative Cooling) / Food Processor / Rice Cooker / Washing Machine	1	2	3	
	3. Water Pump / Refrigeration / Electric Iron / Microwave Oven / Water Heater / Electric Toaster / Hair Drier / Air Conditioner / Space Heater / Electric Cooking Range	1	2	3	
	DURATION OF SUPPLY				
113	Over the past 7 days, on an average how many hours of electricity supply did you receive from your primary electricity source each day?	LESS THAN 4 HOURS....1 BETWEEN 4 AND 8 HOURS....2 BETWEEN 8 AND 16 HOURS....3 BETWEEN 16 AND 22 HOURS....4 MORE THAN 22 HOURS....5			
	EVENING SUPPLY				
114	Over the past 7 days, on an average how many hours of electricity supply did you receive during the evening time (from TT:TT to TT:TT) from your primary source? [Evening time to be specified based on country context before the survey is conducted. A span of minimum 4 hours is to be specified]	LESS THAN 2 HOURS....1 BETWEEN 2 AND 4 HOURS....2 4 HOURS OR MORE....3			
	RELIABILITY OF SUPPLY				
	CHECK Q101: IF ANSWER TO Q101 IS "1" OR "2" (CENTRAL-SUPPLY-GRID OR MINI-GRID)	IF ANSWER TO Q101 IS NOT "1" OR "2"			→117
115	Over the past 7 days, on an average how many times did you face unscheduled supply interruptions from the electricity source? **Unscheduled interruptions refer to interruptions that had not been announced by the electricity provider in advance.**	0-1 PER DAY....1 1-5 PER DAY....2 MORE THAN 5 PER DAY....3			
116	On an average how long was each unscheduled supply interruption?	NO UNSCHEDULED INTERRUPTIONS....1 LESS THAN 10 MINUTES....2 10-30 MINUTES....3 MORE THAN 30 MINUTES....4			
	MODULE 2: ACCESS TO ELECTRICITY SERVICES				
	SOURCE OF ELECTRICITY				
117	For each of the following devices, please confirm whether you have them at your house	Yes	No		
01	Electric Light in at least One Room	1	2		
02	Electric Radio	1	2		
03	Phone Charger	1	2		
04	Electric Light in Every Room	1	2		
05	Television	1	2		
06	Electric Fan	1	2		
07	Computer	1	2		
08	Printer	1	2		
09	Air Cooler (Evaporative Cooling)	1	2		
10	Electric Food Processor (or Mixie)	1	2		
11	Rice Cooker	1	2		
12	Washing Machine	1	2		
13	Water Pump	1	2		
14	Refrigerator	1	2		
15	Electric Iron	1	2		
16	Electric Hair Dryer	1	2		
17	Microwave Oven	1	2		
18	Electric Toaster	1	2		
19	Water Heater	1	2		
20	Air Conditioner	1	2		
21	Electric Space Heater	1	2		
22	Electric Cooking System	1	2		

Features:

- Obtain all the necessary information about attributes of supply and use of electricity services.
- Can be integrated with global omnibus surveys such as LSMS and DHS.
- May also be conducted as a standalone 'household energy survey".
- Can be supplemented by non-core and background questions.

Determining Access Tiers



Decision flow-charts to explain how tiers for access to energy supply and access to energy services should be determined using survey data.

Indices of Access to Electricity Supply and Services

Index of Access to Electricity Supply = $\sum(P_i \times K)$

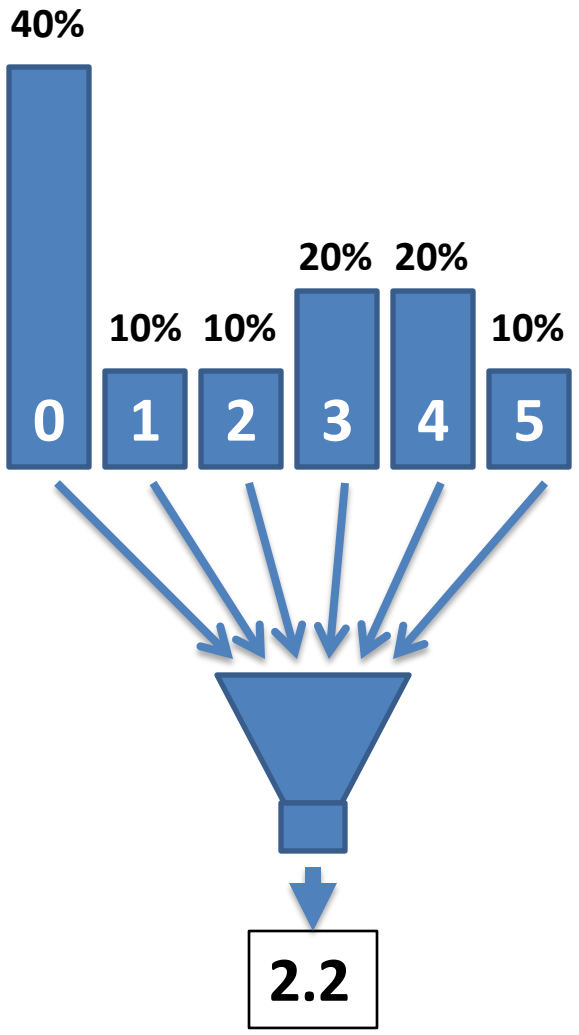
where, P_i = Proportion of households at the k^{th} tier in terms of electricity supply

K = Tier number {0,1,2,3,4,5}

Index of Access to Electricity Services = $\sum(P_i \times K)$

where, P_i = Proportion of households at the k^{th} tier in terms of electricity services

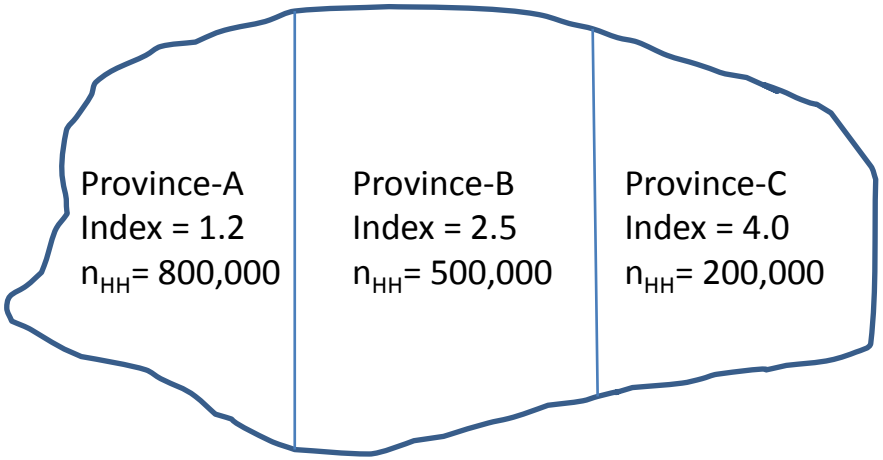
K = Tier number {0,1,2,3,4,5}



Features:

- Each index varies from 0 to 5
- Can be aggregated across geographies :
  Village, cluster, district, province, country or region
- Indices can be tracked across geographies and over time.
- Indices of Supply and Services may be different.
  - Ownership of appliances without adequate supply
  - Availability of supply without having appliances.

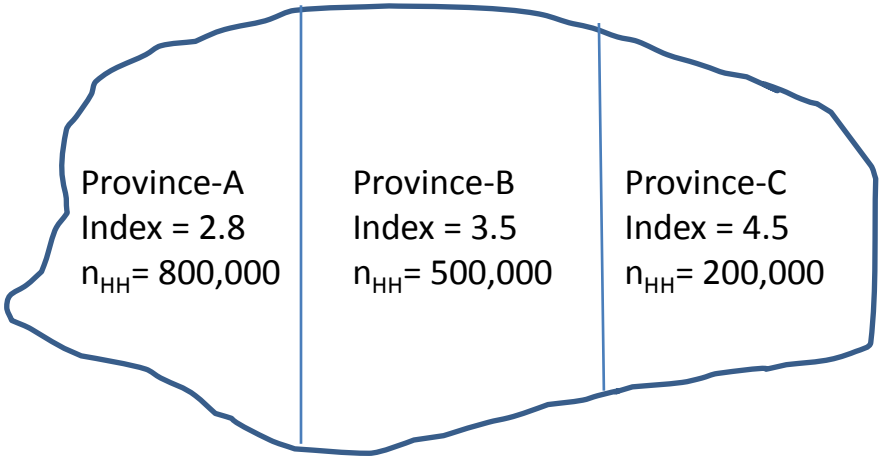
Example of an Imaginary Country "**Accessistan**"



2012 Overall Index for *Accessistan* = 2.00

Projects between 2012 & 2015

- Connections program in 'A'.
- Improved quantity of supply from new generation plant in 'B'.
- Better reliability and evening supply through improved system management in 'C'



2015 Overall Index for *Accessistan* = 3.26

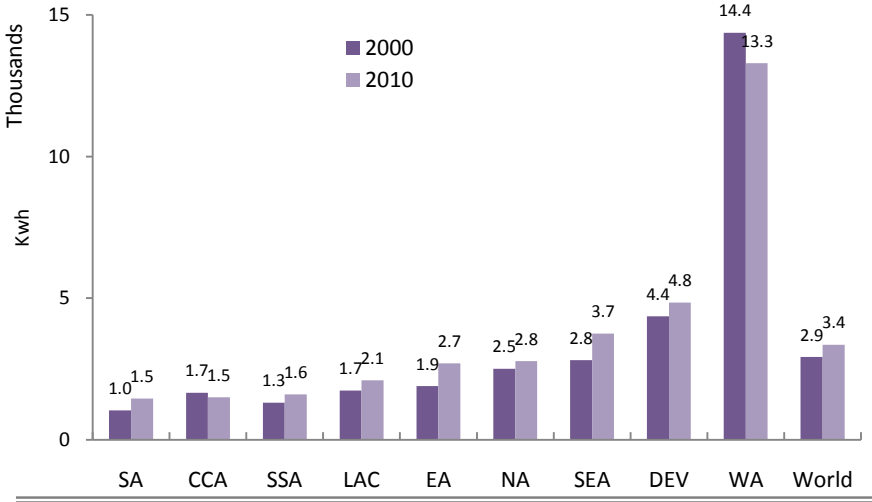
Disaggregate Analysis:

- Number of new connections.
- Amount of additional generation.
- Improvement in hours of supply.
- Improvement in reliability.
- Availability of power in evening.

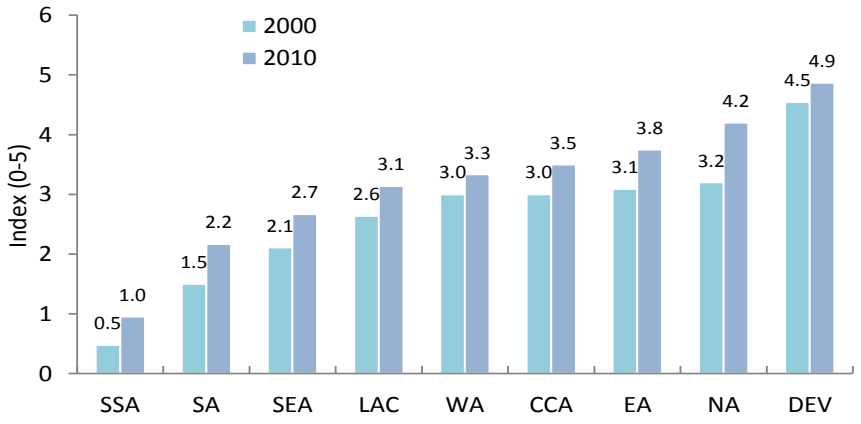
Multi-tier access index can be approximated using data on average residential electricity consumption

	Tier-0	Tier-1	Tier-2	Tier-3	Tier-4	Tier-5
Indicative Electricity Services	-	Radio, Cellphone Charging, Task Light	General Lighting AND Television AND Fan	Tier-2 AND any low-power appliances	Tier-3 AND any medium-power appliances	Tier-4 AND any high-power appliances
Consumption (kWh) per hh per year	**<3**	**3-66**	**66-321**	**321-1,317**	**1,317-2,120**	**>2,120**

Average residential electricity consumption per household (1,000 Kwh) - (IEA 2010)



Simplified energy access index based on average consumption



How Energy Projects Improve Access

Project Type	Grid Connections	Legality	Peak Capacity (W)	Duration (Hrs)	Evening Supply	Quality (Voltage)	Reliability (Outages)	Affordability
Grid Electrification	↑	↑	↑	↑				↑
Mini-Grid Electrification	↑		↑	↑	↑	↑	↑	↑
Off-Grid & Solar Lanterns			↑	↑	↑		↑	↑
Generation & X-Border T/M	↑			↑	↑	↑	↑	↑
Transmission & Distribution	↑	↑				↑	↑	↑
Rural Feeder Segregation		↑		↑	↑	↑	↑	↑
Energy Efficiency			↑	↑	↑			↑
Regulations & Market Reform	↑	↑	↑	↑	↑	↑	↑	↑

Defining and Measuring Access to Energy
SREP Pilot Country Meet, May 28-30, 2013, Maldives

Measuring Household Cooking Access

Attributes of Household Cooking Solutions

1.
2.
3.
4.
5.
6.
7.
8.
9.
10.

Attributes of Household Cooking Access

TECHNICAL PERFORMANCE	USE ATTRIBUTES
1. Efficiency *What is the cookstove efficiency + how much fuel does it consume?* • High-power thermal efficiency • Low-power specific consumption	**5. Conformity** *Are use and maintenance requirements adhered?* • *Use of Skirts, Hoods etc.* • *Timely maintenance*
2. Indoor Air Pollution *How much indoor air pollution is caused?* • *Carbon Mono-oxide* • *Particulate Matter*	**6. Convenience** *How much time and effort is involved?* • *In Fuel collection and processing* • *In Cookstove preparation and cooking*
3. Overall Pollution *How much overall pollution is caused?* • *High-power CO , Low-power CO* • *High-power PM, Low-power PM*	**7. Adequacy** *Why is a secondary solution needed?* • *Availability* • *Affordability* • *Cultural Fit* • *Number of Burners* • *Aspirational secondary*
4. Safety *How safe is the cookstove design?* • *IOWA Protocol*	

Technical Performance Evaluation

STEP-1

Low Grade	Medium Grade	High Grade
Self-made cookstove	Manufactured non-BLEN cookstove	BLEN cookstove

STEP-2

	Low Grade	Medium Grade			High Grade
	Grade-E	Grade-D	Grade-C	Grade-B	Grade-A
Efficiency	Self-made cookstove	Uncertified non-BLEN manufactured cookstove			BLEN cookstove
Indoor Pollution					
Overall Pollution					
Safety					

Certified Non-BLEN Cookstoves

IWA Technical Standards by GACC, ISO & WHO

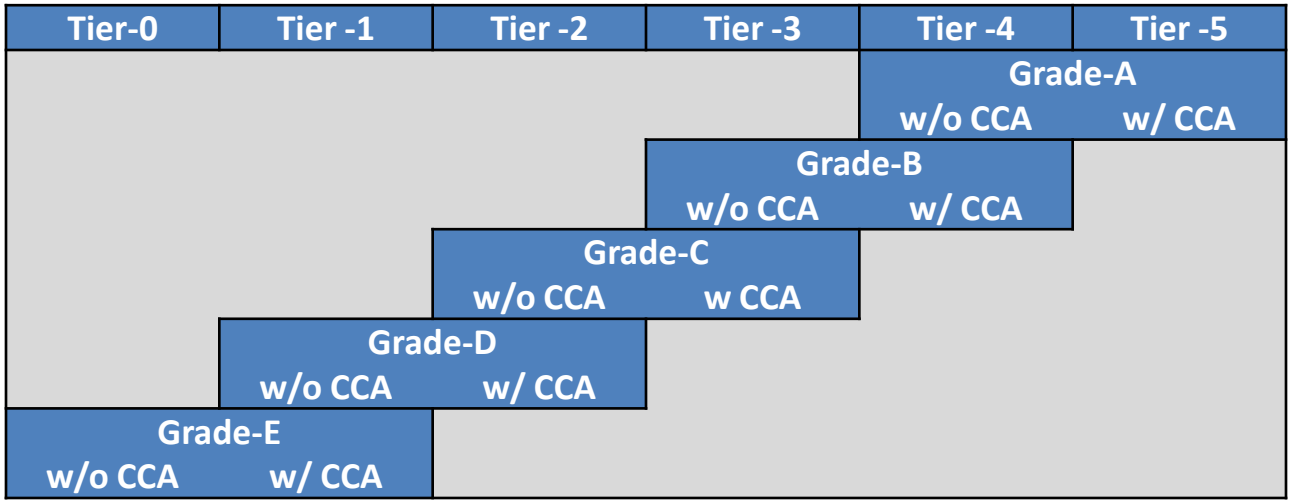
Technical attributes		Tier-0	Tier-1	Tier-2	Tier-3	Tier-4
Efficiency	HPTE[1] (%)	<15	<15	>25	>35	>45
	LPSC[2] (MJ/min/L)	>0.05	<0.05	<0.039	<0.028	<0.017
Indoor pollution	CO (g/min)	>0.97	<097	<0.62	<0.49	<0.42
	PM (g/min)	>40	<40	<17	<8	<2
Overall pollution	HPCO[3] (g/ML_d)	>16	<16	<11	<9	<8
	LPCO[4] (g/min/L)	>0.2	<0.2	<0.13	<0.1	<0.09
	HPPM[5] (mg/MJd)	>979	<979	<386	<168	<41
	LPPM[6] (mg/min/L)	>8	<8	<4	<2	<1
Safety	Iowa protocol	<45	>45	>75	>88	>95

Source: The Global Alliance for Clean Cookstoves.

Note:[1] high-power thermal efficiency; [2] low-power specific consumption; [3] high-power CO; [4] low-power CO; [5] high-power PM; [6] low-power PM; CO = carbon monoxide; PM = particulate matter.

Adjustment of Tiers for CCA Attributes

Conformity	• Chimney/hood/ pot skirt used (as required) • Stove regularly cleaned and maintained (as required)
Convenience	• Household spends less than 12 hrs/week on fuel collection/preparation • Household spends less than 15 min/meal for stove preparation • Ease of cooking is satisfactory
Adequacy (fuel stacking)	• Primary stove fulfils most cooking needs of the household, and it is not constrained by availability or affordability of fuel, cultural fit, or no. of burners • If multiple cooking solutions are used (stacking), other stoves are not a lower technical grade



Core Survey Questionnaire

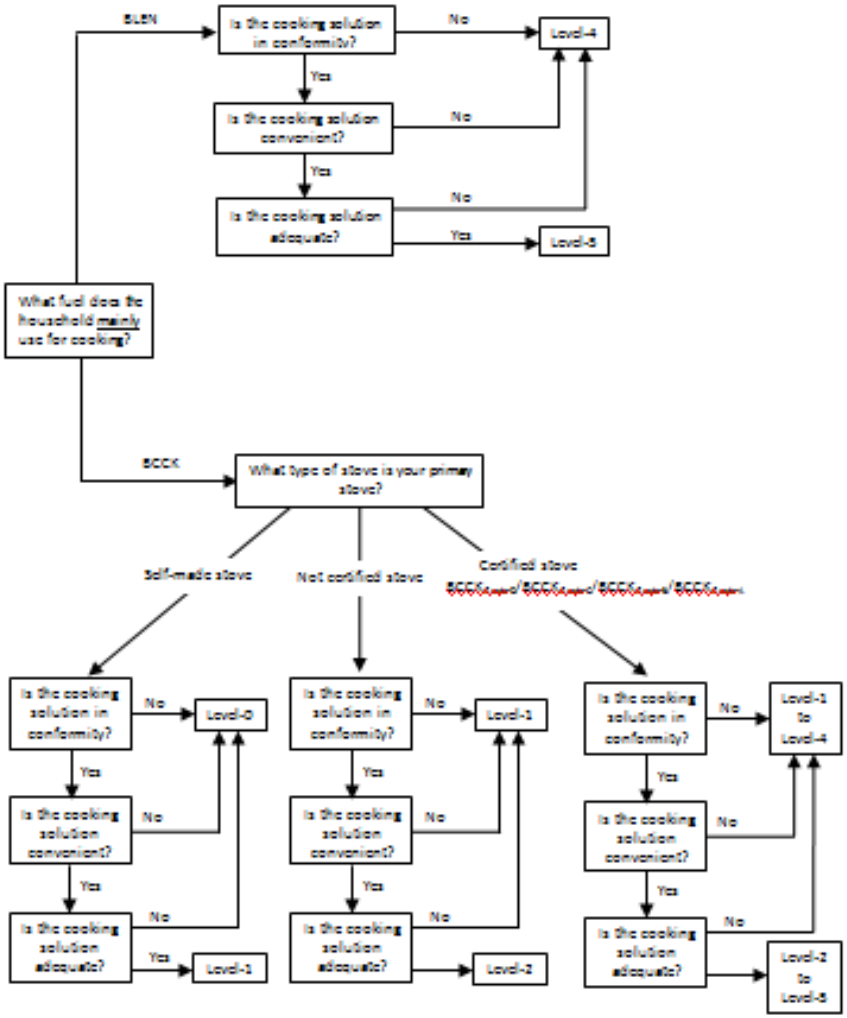
	COOKING LOCATION			
18	Where do you normally cook?	IN HOUSE IN A SEPARATE KITCHEN IN A SHARED ROOM THAT ALSO ACTS AS A KITCHEN IN A SEPARATE BUILDING OUTDOORS OTHER (SPECIFY)	1 2 3 4 5	
	PRIMARY COOKING SOLUTION			
19	What stove does the household mainly use for cooking?	SELF-MADE STOVE MANUFACTURED COOKSTOVE UNBRANDED SOLID FUEL COOKSTOVE BRANDED SOLID FUEL STOVE-A BRANDED SOLID FUEL STOVE-B BRANDED SOLID FUEL STOVE-C BRANDED SOLID FUEL STOVE-D BRANDED SOLID FUEL STOVE-E BRANDED SOLID FUEL STOVE-F BRANDED SOLID FUEL STOVE-G BRANDED SOLID FUEL STOVE-H BRANDED SOLID FUEL STOVE-OTHER BIOGAS / LPG/ NATURAL GAS STOVE ELECTRIC STOVE OTHER (SPECIFY)	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15	
20	What type of fuel does your household mainly use for cooking?	ELECTRICITY LIQUEFIED PETROLEUM GAS (LPG) NATURAL GAS BIOGAS KEROSENE COAL / LIGNITE CHARCOAL WOOD STRAW / SHRUBS / GRASS ANIMAL DUNG AGRICULTURAL CROP RESIDUE NO FOOD COOKED IN HOUSEHOLD OTHER (SPECIFY)	1 2 3 4 5 6 7 8 9 10 11 12 13	
21	For most part of the year, how much time do you spend per week for collecting the fuel that you need to use in the above cook stove?	LESS THAN 12 HOURS MORE THAN 12 HOURS OTHER (SPECIFY)	1 2 3	
22	How much time do you spend in preparing the above stove & fuel for each meal?	LESS THAN 15 MINUTES MORE THAN 15 MINUTES	1 2	
23	Does your stove require additional parts and if yes do you use them? (e.g. chimney, hood, skirt, etc.)	NOT REQUIRED REQUIRED AND USED (ALL OF THEM) REQUIRED BUT ONLY PART OF THEM USED OTHER (SPECIFY)	1 2 3 4	
24	Is the cleaning & maintenance done as required?	NOT REQUIRED REQUIRED AND DONE REQUIRED AND NOT DONE OTHER (SPECIFY)	1 2 3 4	

	SECONDARY COOKING SOLUTION			
25	Do you use a secondary cooking solution?	YES NO	1 2	=>136
26	What stove does the household use for cooking apart from the one specified above?	SELF-MADE STOVE MANUFACTURED COOKSTOVE UNBRANDED SOLID FUEL COOKSTOVE BRANDED SOLID FUEL STOVE-A BRANDED SOLID FUEL STOVE-B BRANDED SOLID FUEL STOVE-C BRANDED SOLID FUEL STOVE-D BRANDED SOLID FUEL STOVE-E BRANDED SOLID FUEL STOVE-F BRANDED SOLID FUEL STOVE-G BRANDED SOLID FUEL STOVE-H BRANDED SOLID FUEL STOVE-OTHER BIOGAS / LPG/ NATURAL GAS STOVE ELECTRIC STOVE OTHER (SPECIFY)	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15	
27	What type of fuel does your household use for cooking apart from the one specified above?	ELECTRICITY LIQUEFIED PETROLEUM GAS (LPG) NATURAL GAS BIOGAS KEROSENE COAL / LIGNITE CHARCOAL WOOD STRAW / SHRUBS / GRASS ANIMAL DUNG AGRICULTURAL CROP RESIDUE NO FOOD COOKED IN HOUSEHOLD OTHER (SPECIFY)	1 2 3 4 5 6 7 8 9 10 11 12 13	
28	What is the most important reason because of which you use the secondary cook stove?	FUEL FOR THE PRIMARY SOLUTION IS NOT AVAILABLE FUEL FOR THE PRIMARY SOLUTION IS NOT ALWAYS AFFORDABLE CERTAIN TYPES OF COOKING / HEATING ARE NOT FEASIBLE ON THE PRIMARY SOLUTION PRIMARY STOVE DOES NOT HAVE ADEQUATE NUMBER OF BURNERS SECONDARY SOLUTION IS PREFERABLE BUT IT IS OUT OF REACH AS A PRIMARY ONE OTHER (SPECIFY)	1 2 3 4 5 6	

Features:

- Obtain all the necessary information about attributes of supply and use of electricity services.
- Can be integrated with global omnibus surveys such as LSMS and DHS.
- May also be conducted as a standalone ‘household energy survey”.
- Can be supplemented by non-core and background questions.

Determining Access Tiers



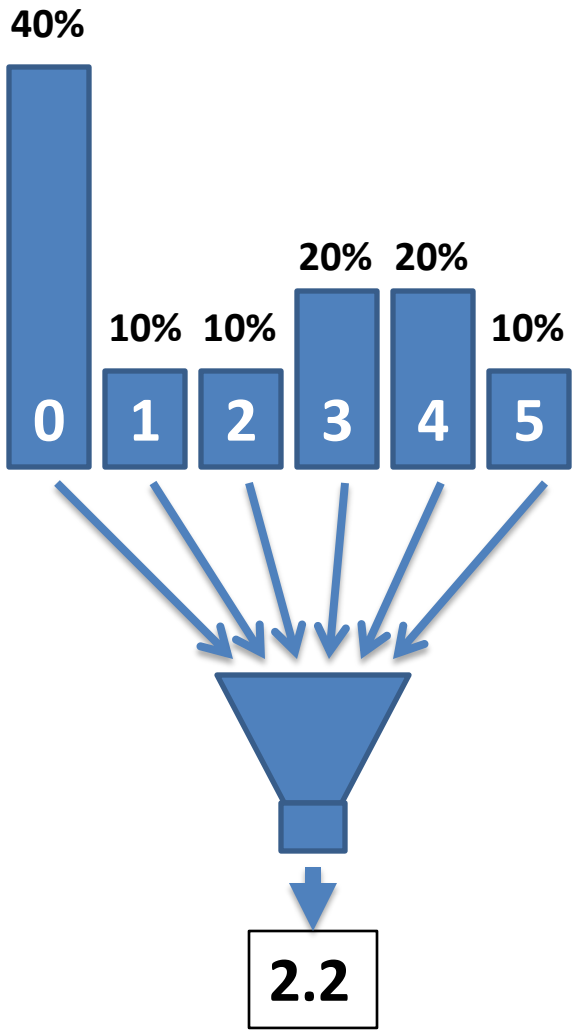
Decision flow-charts to explain how tiers for access to energy supply and access to energy services should be determined using survey data.

Indices of Access to Cooking Solutions

Index of Access to Cooking Solutions = $\sum(P_i \times K)$

where, P_i = Proportion of households at the k^{th} tier in terms of cooking access

K = Tier number {0,1,2,3,4,5}



Features:

- Each index varies from 0 to 5
- Can be aggregated across geographies : Village, cluster, district, province, country or region
- Indices can be tracked across geographies and over time.

Access Impact of Generation and Transmission Projects

Generation Projects under SREP

Country	Project	Technology	MW
Ethiopia	Aluto Langano	Geothermal	75.0
	Assela	Wind	100.0
Honduras	Grid Connected RE Development		60.0
	Sustainable Rural Energization		??
Kenya	Memengai Geothermal Phase-A	Geothermal	200.0
	Hybrid Mini-Grid Systems	Hybrid	3.0
Maldives	ASPIRE		20.0
	POISED		2.0
	Thilafushi	Waste-to-energy	4.0
Mali	Solar PV IPP	Solar PV	20.0
	Rural Electrification Hybrid Systems	Hybrid	4.5
	PDM - Hydro	Mini-micro hydro	14.6
Nepal	Small Hydropower Development	Small hydro	50.0
	Mini-micro Initiatives	Mini-micro hydro	30.0
	Mini-micro Initiatives	Solar PV	10.0
	Waste to Energy Project	Waste-to-energy	

How can we estimate the access impact of generation and transmission projects?

Two complementary approaches:

1) Quick Estimation at Project Commencement
2) Actual Measurement after Implementation

Quick Estimation

Case Study

ABC Geothermal Project in Accessistan

How would you estimate the electricity access impact of ABC Geothermal Project?

Quick Estimation

Key factors in arriving at a quick estimate:

- Amount of additional energy available
- Distribution area
- Transmission and Distribution Losses
- Share of household consumption
- Increase in consumption by existing consumers
- Improvement in access for new and existing consumers
- Allocation of energy access benefit across Generation, Transmission and Distribution Investments
- Calculation of Index of Energy Consumption

Quick Estimation

Case Study

ABC Geothermal Project in Accessistan

Calculation Sheet

Quick Estimation

Case Study

ABC Geothermal Project in Accessistan

Discussion and Feedback

Going Forward

Need for Enhanced Energy Surveys

Tracking Progress under SE4All:

- To capture off-grid and mini-grid based access
- Reflect attributes of energy supply from grid
- Capture illegal and secondary connections
- Obtain information about cooking and heating
- Socio-economic impact of access or the lack of it
- Capture productive uses and community applications of energy

Broader role for energy survey data

- Tracking under SE4All
- As a basis for policy and program design in the country
- Efficient allocation of resources for projects based on deeper assessment of state of access
- Establish socio-economic developmental linkages with access to energy
- Feed into regulatory processes as a means to strengthen utility accountability
- Foster political accountability for the state of energy access
- Facilitate donor interventions

Technical Assistance Facility

Proposal:

Set-up a support team at the World Bank Energy Anchor to facilitate household energy surveys

Objective:

- Support the roll-out of SE4ALL GTF
- Provide information for better informed decision-making on policies, regulations, and investment strategies

Scope:

- Assist project teams in carrying out household energy surveys.
- Assist in testing the survey questionnaires and validating the survey methodology for replication.
- Assist the project teams and survey agencies in sanitizing the data.
- Analyze the collected data using the methodologies for multi-tier analysis for access to energy.
- Analyze the data using the disaggregate approaches to provide important insights into the current status of energy access, energy use patterns, consumer preferences, affordability aspects, benefits of energy access and costs of lack of energy access.
- Host data on an internet based platform for use by a wide cross-section of stakeholders.

Survey Questionnaire

Core Questions	Non-Core Questions	Background Questions
• Key data needed for multi-tier analysis • Attributes of supply • Ownership and use of electricity appliances • Data also used with non-core and background questions for disaggregate analysis	• Support core questions by adding details and controls. • Additional information on: – Energy use – Coping costs of lack of access to energy – Household perception of energy aspects – Socio-economic impact of energy use	• Standard survey questions for analysis of core and non-core data. • Demographic , Economic, Social and Geographical characteristics as well as information • Data on housing facilities and physical features of dwelling units.

Survey Logistics

- **Enhance of Global Omnibus Surveys to include core questions**
- **National level household energy surveys**
- **Periodicity**: Every 2 or 3 years
- **Sample Size**: About 5,000-10,000 households
- **Implementation Plan**
  - *Pilot Phase*: 8-10 pilot countries over next 1-2 years
  - *Expansion Phase*: Cover all opt-in countries over next 2-3 years
  - *Sustenance Phase*: Regular tracking of progress every 2-3 years
- **Possible Funding Options:**
  - Component under SE4All Technical Assistance
  - Project-based support from development agencies
  - International Programs: ESMAP, SREP, Endev, Energy+, Lighting Africa etc.
  - Donor Agencies: Positive Indications from Germany and Norway
  - Create a Global Energy Survey Fund.

Questions

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