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Global Survey for Comprehensive Measurement of Energy Access Using Multi-tier Approaches

ESMAP
Energy Sector Management Assistance Program

SUSTAINABLE ENERGY FOR ALL

WHAT is Multi-tier Measurement?

Definition Of Energy Access - Current vs New

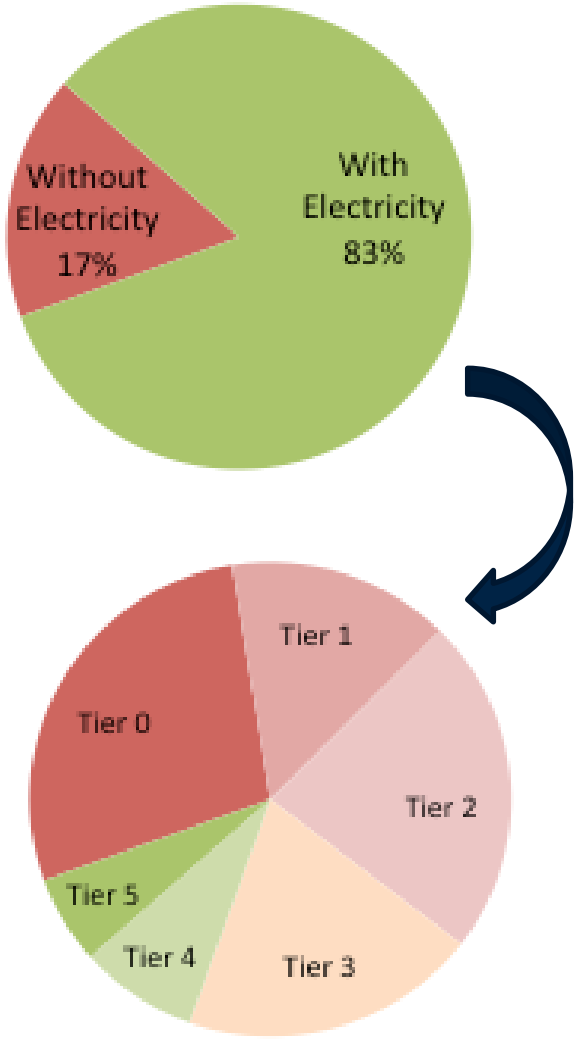
CURRENT DEFINITION

'*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*



Why the new definition of Energy Access?

Shortfalls of Binary Approaches	Remedies using Multi-tier Framework
• Equal weightage to all sources of electricity – grid and off-grid • Quality of supply issues not reflected • Energy for productive and community uses not reflected • Illegal connections not reflected • No weightage for use of improved cook-stoves • Fuel / cook-stove stacking not reflected • Linkages with socio-economic development not evident • No insights about ways of augmenting energy access • Only select interventions are related to expansion of energy access • Country-wise targets difficult to define	• Technology neutral approach • Weighted assimilation of various supply solutions based on attributes • Quality of supply issues are reflected • Energy for productive and community uses also reflected • Improved cook-stoves can be reflected • Fuel/cook-stove stacking is properly reflected • Linkages established with socio-economic development through use of energy • Gap analysis provides insights about ways of augmenting energy access • Most energy sector interventions can be linked to expansion of access • Countries can set own targets

Access To Household Electricity Supply

			Tier-0	Tier-1	Tier-2	Tier-3	Tier-4	Tier-5
Attributes	1. Peak capacity	Power	No Electricity	V. Low Power Min 1 W	Low Power Min 50 W	Medium Power Min 200 W	High Power Min 2 kW	
		Daily capacity		Min 4 Wh	Min 200 Wh	Min 1.6 KWh	Min 4 KWh	
	2. Duration	Hours per day	< 4 hrs	Min 4 hrs		Min 8 hrs	Min 16 hrs	Min 23 hrs
		Hours per evening	< 2 hrs	Min 2 hrs		Min 2 hrs	Min 4 hrs	Min 4 hrs
	3. Reliability					Max 3 disruptions **per day**	Max 7 disruptions per week	Max 3 disruptions **per week** of total duration < 2 hours
	4. Quality					Voltage problems do not prevent the use of desired appliances		
	5. Affordability				Cost of a standard consumption package of 365 kWh per annum is less than 10% of household income			
	6. Legality					Bill is paid to the utility / pre-paid card seller / authorized representative		
	7. Health and Safety					Absence of past accidents and perception of high risk in the future		

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

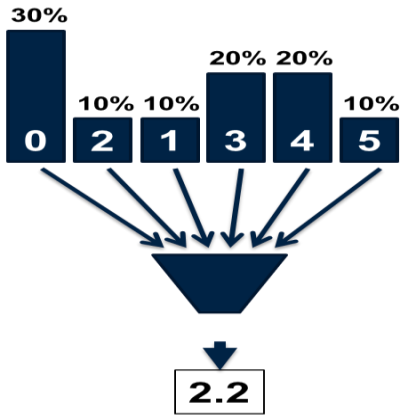
Index of Access to Electricity = $\sum(P_i \times K)$

P_i = Proportion of households at the k^{th} tier

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

The Index can be aggregated across geographies.

It can be compared across geographies and over time



Access To Household Cooking Solutions

		Level					
		0	**1**	**2**	**3**	**4**	**5**
1. Health (Indoor Air Quality in Kitchen)	$PM_{2.5}$ ($\mu g/m^3$)		< 400 (???)	< 275 (???)	< 125 (???)	**< 35**	**< 10**
	CO (mg/m^3)		< 70 (???)	< 50 (???)	< 20 (???)	**< 7**	**< 7**
	Or, Primary Cookstove Performance	Three-stone fire, home-made stove, Mud/earthen ring	Tested primary solution that is visually identifiable for meeting Agreed Cookstove Performance Standard corresponding to IAQ Level-1 OR Potentially improved cookstoves that are either untested or cannot be visually identified	Tested primary solution that is visually identifiable for meeting Agreed Cookstove Performance Standard corresponding to IAQ Level-2	Tested primary solution that is visually identifiable for meeting Agreed Cookstove Performance Standard corresponding to IAQ Level-3	Tested primary solution that is visually identifiable for meeting Agreed Cookstove Performance Standard corresponding to IAQ Level-4 OR Biogas, LPG, Natural Gas, Ethanol used.	Tested primary solution that is visually identifiable for meeting Agreed Cookstove Performance Standard corresponding to IAQ Level-5 OR Electric, Solar Stove
			AND, For both tested and untested primary stoves, any inferior secondary solutions used for less than 20% of the time. Else shift one Level below.				Only BLEENS used.

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Access To Household Cooking Solutions

		Level					
		0	**1**	**2**	**3**	**4**	**5**
2. Convenience • Fuel Collection (hrs/wk) • Stove Prepn (min/meal)				<10.5 <15	<3.5 <10	<1.5 <10	<0.5 <5
3. Safety of Primary Solution	IWA Safety Tiers		IWA Tier-1	IWA Tier-2	IWA Tier-3	IWA Tier-4	
	Or, Past Accidents					No accidents in last one year that required professional medical attention	
4. Efficiency of Primary Solution			IWA Efficiency Tier-1	IWA Efficiency Tier-2	IWA Efficiency Tier-3	IWA Efficiency Tier-4	
5. Affordability						Levelized cost of cooking solutions <10% of HH Income	
6. Quality of Primary Fuel						No major affect of fuel quality on ease of cooking	
7. Availability of Primary Fuel					Primary Fuel available for 75% time	Primary Fuel is readily available throughout the year	

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

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Access To Energy For Productive Uses

			Tier-0	Tier-1	Tier-2	Tier-3	Tier-4	Tier-5
Attributes	1. Capacity	Electricity (Watts) (Wh)	<1W <2Wh	1-50W 2-200Wh	50-200W 200-1.2kWh	200W-2kW >1.2kWh	2-10kW -	>10kW -
		RM&T (% of needs)	<25%	25%-75%		75%-100%		100%
	2. Duration (% of needs)		<25%	25%-50%	50%-75%	75%-100%		100%+
	3. Reliability		Reliability issues with severe impact			Reliability issues with moderate impact		No issue or no impact
	4. Quality		Quality issues with severe impact			Quality issues with moderate impact		No issue or no impact
	5. Affordability		> 2 times grid tariff			≤ 2 times grid tariff		≤ grid tariff
	6. Legality /Formality		No			Yes		
	7. Convenience		No				Yes	
	8. Health & Safety		Non-BLEN without smoke extraction Likely to cause severe health damage/injury		Non-BLEN with smoke extraction or outside use Likely to cause moderate damage/injury		BLEN solutions Not likely to cause significant damage/injury	

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

Access To Energy For Community Uses

Health Facilities; Education Facilities; Public & Community Buildings

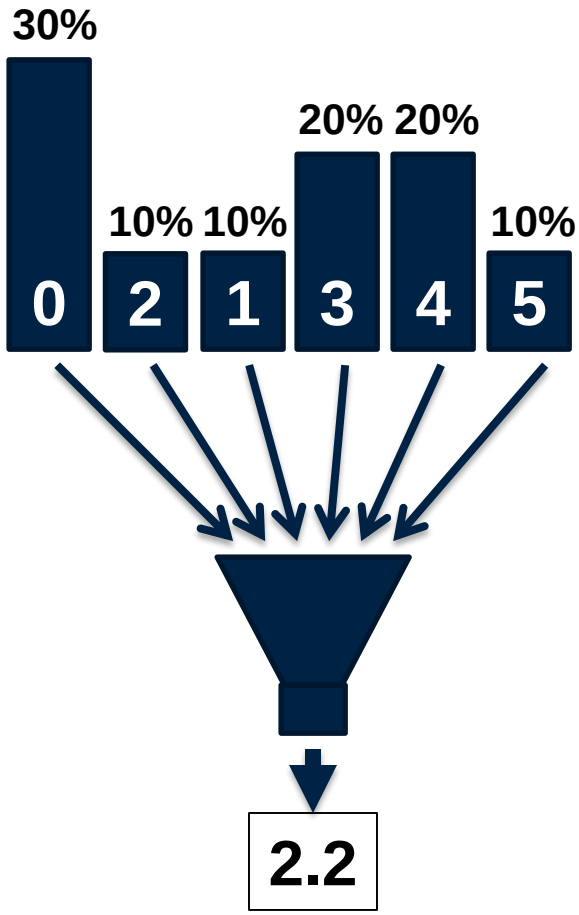
			Tier-0	Tier-1	Tier-2	Tier-3	Tier-4	Tier-5
Attributes	1. Capacity	Electricity	No Electricity	Very Low Power	Low Power	Medium Power	High Power	
		Heating (if needed)	No heating (0%)	Capacity partially covers needs (1%-49%)		Capacity largely covers needs (50%-99%)		Capacity totally covers needs
	2. Duration	Electricity	No electricity/ heating (0%)	Less than ¼ of the time (1-24%)	Less than ½ of the time (25%-49%)	More than ½ of the time (50%-74%)	More than ¾ of the time (75%-99%)	All the time (100%)
		Heating (if needed)						
	3. Reliability	Electricity	Significant unscheduled interruptions				No significant unscheduled interruptions	
		Heating (if needed)						
	4. Quality	Electricity	Quality is not satisfactory			Quality is satisfactory		
		Heating (if needed)						
	5. Health & Safety	Electricity	Health & Safety is not satisfactory				Health & Safety is satisfactory	
		Heating (if needed)						

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 –
Index of Energy Access

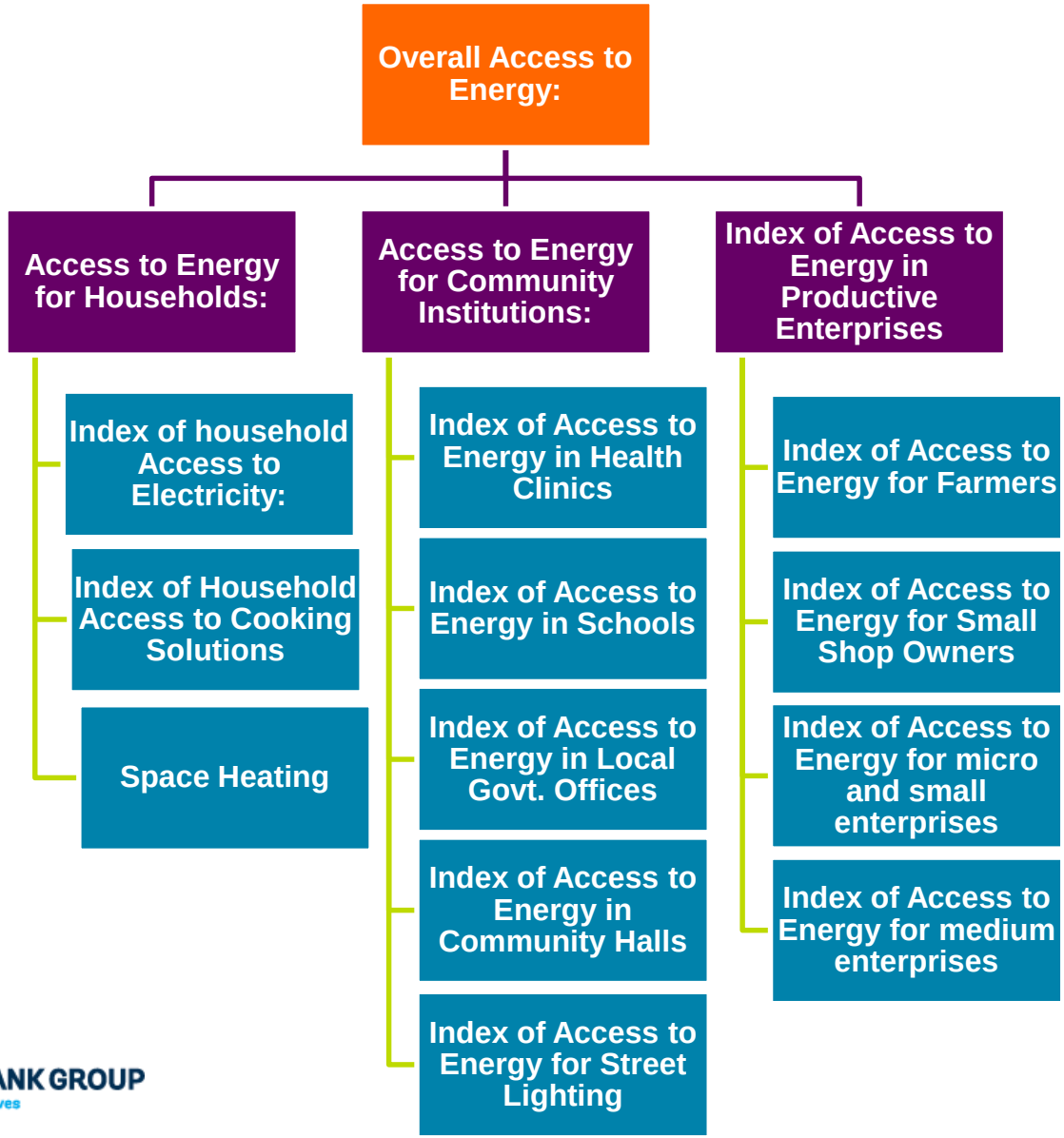
Index of Access to Energy
$= \sum(P_i \times K)$

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



- Can be aggregated across geographies - village, district, province, country, region or the whole world.
- Can be tracked over time.

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



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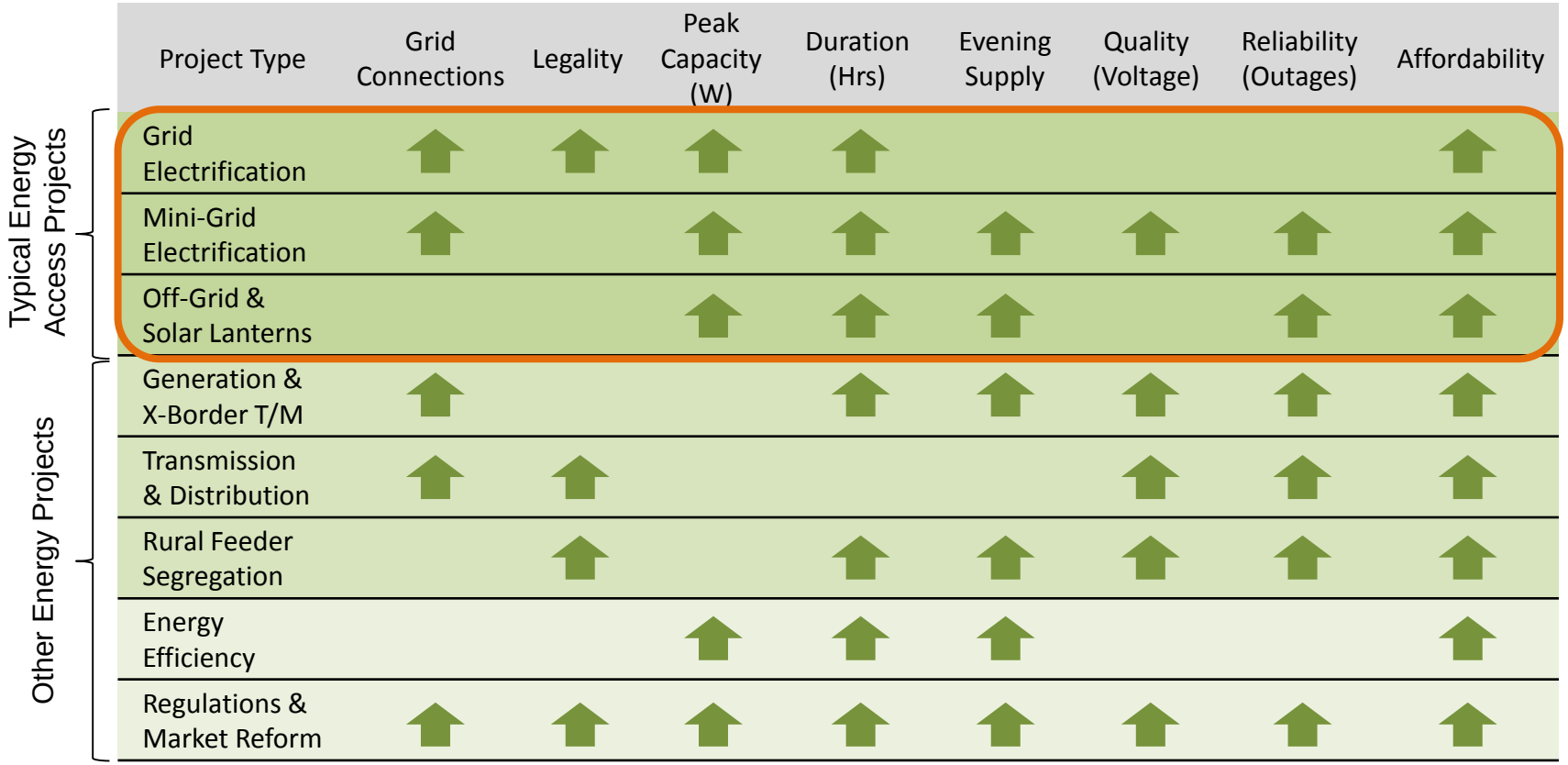
HOW do energy interventions enhance access?

How Energy Interventions Influence Energy Access - All Energy Interventions Can Improve Energy Access



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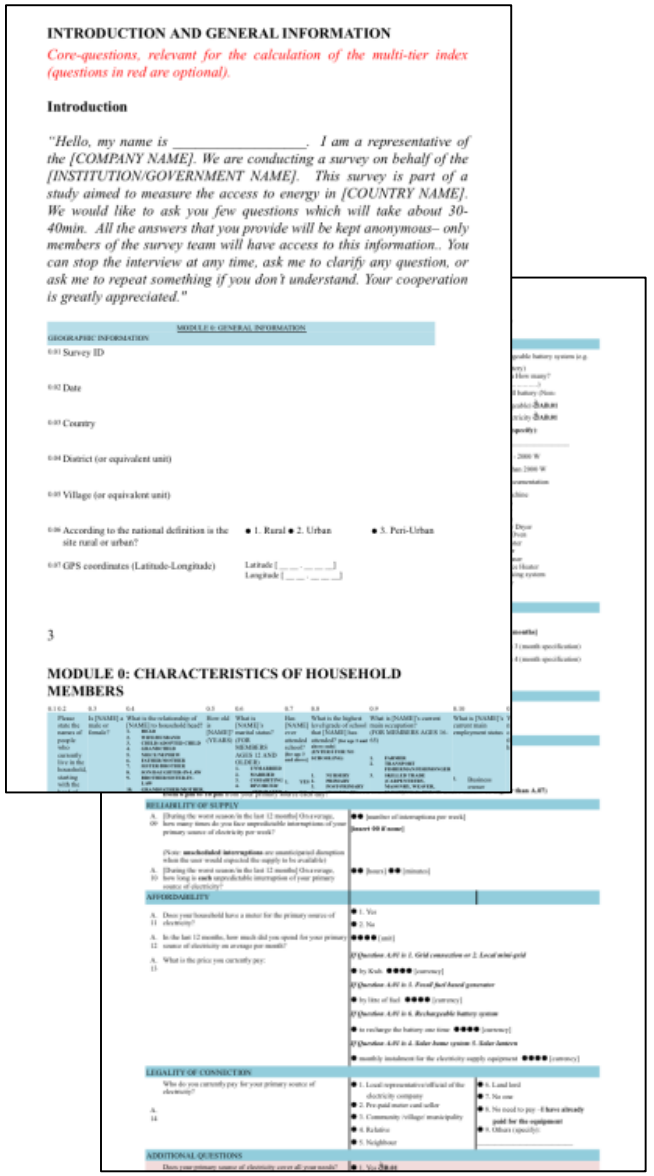
Questionnaire:

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



Piloting Of Multi-tier Framework – Status & Strategy

Survey Status	Country	Area	Locales
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
Completed	Malawi	Small Sample	All Locales
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		

Pilot - Kinshasa City

Household energy survey done in Aug-Sept, 2013

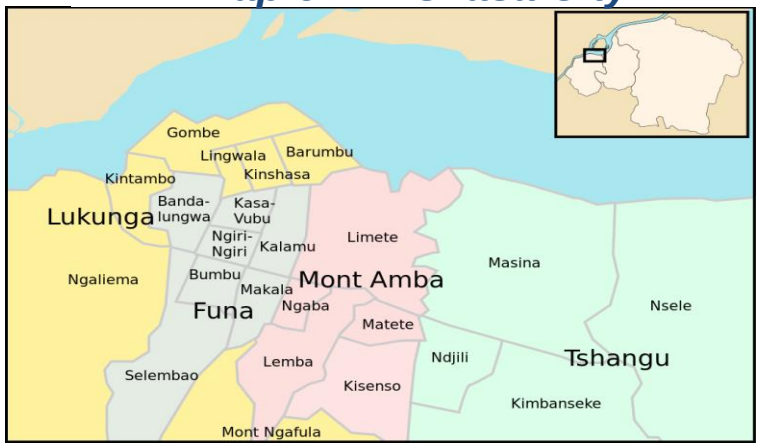
Covered all four districts : Lukunga, Funa, Mont Amba, Tshangu

Sample of 2505 Households

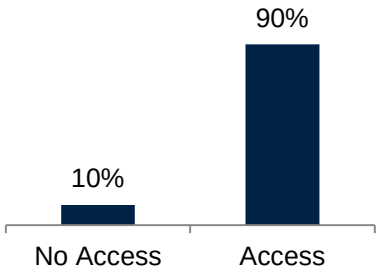
Data used for multi-tier analysis

Data also used to prepare a draft Energy Access Diagnostic Report

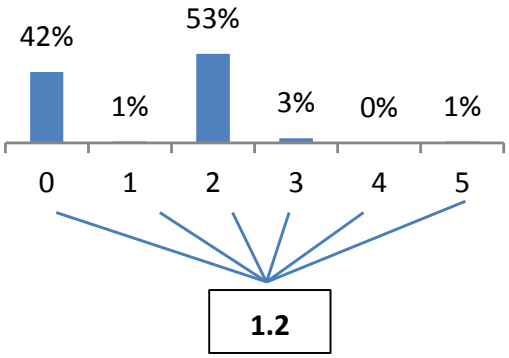
Map of Kinshasa City



Binary Measurement

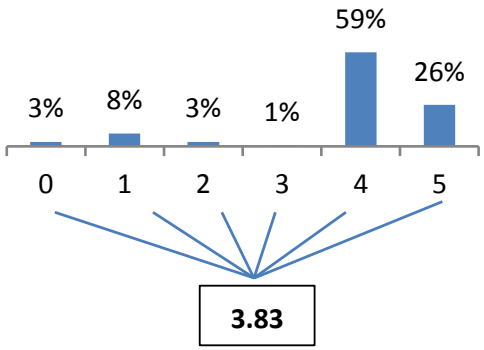


Multi-tier Measurement Of Access To Electricity Supply



Index of Electricity Access

Multi-tier Measurement of Access to Electricity Appliances



Index of Access to Appliances

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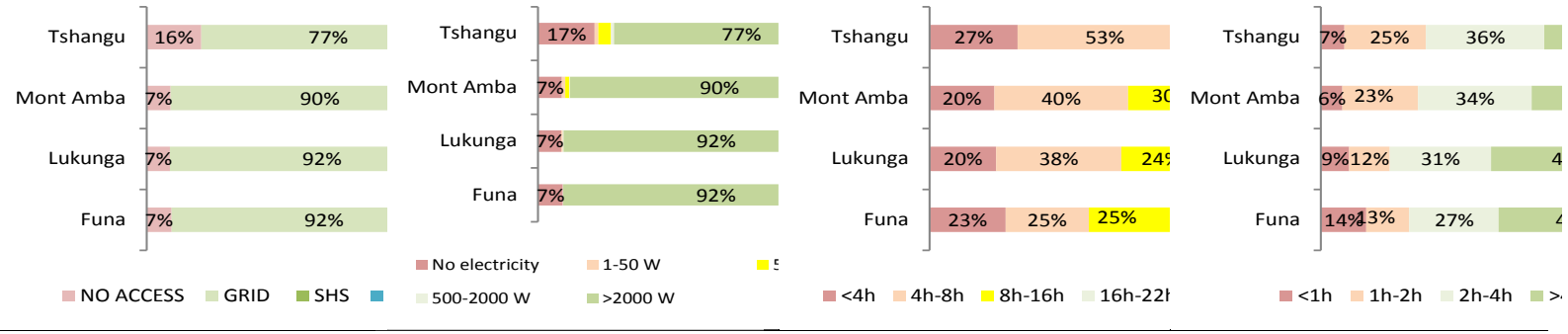
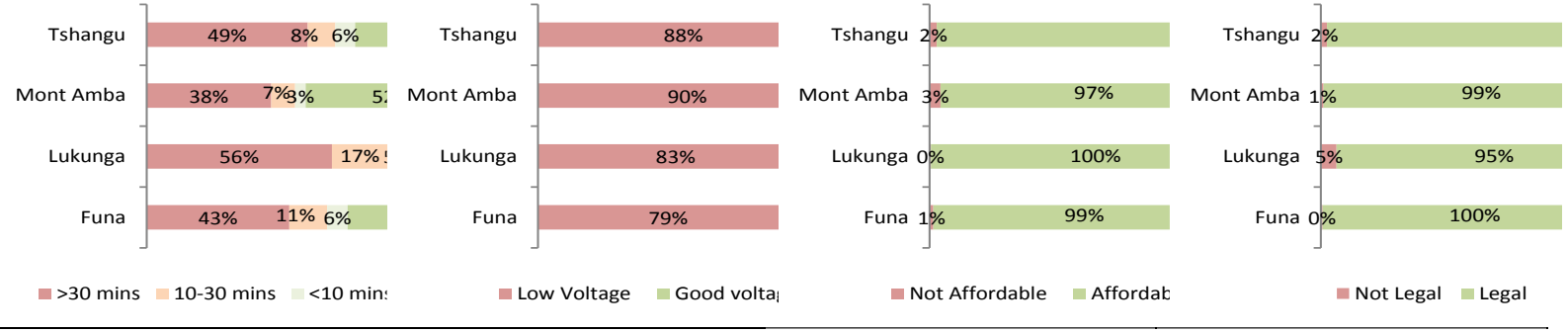
Access to Household Electricity: Attributes Summary Sheet by District

Electricity Source	Capacity	Duration	Duration
Source	Wattage	Out of 24 Hours	Evening Supply



Reliability	Quality	Affordability	Legality
Duration of Interruptions (mins)	Low Voltage Problems	Cost of 30 kWh < 5% of Monthly Income	Based on Bill Payment



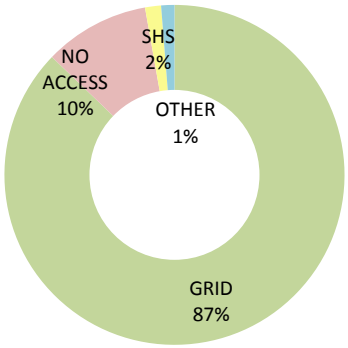
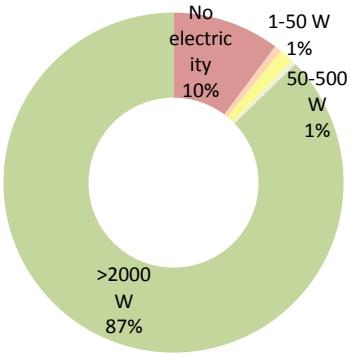
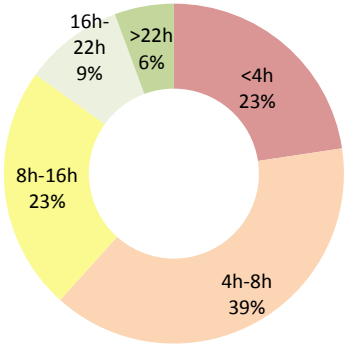
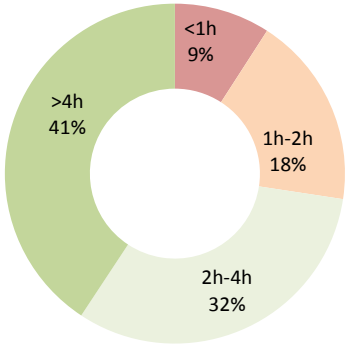
Problem of lack of grid-connectivity is most acute in Tshangu district where almost 17% of the households do not have a grid-connection, compared to about 7% in the other districts.

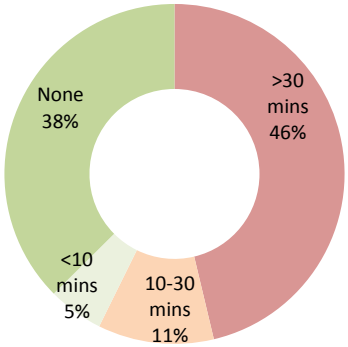
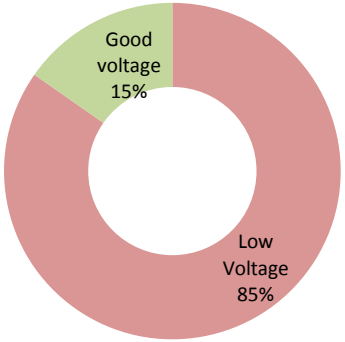
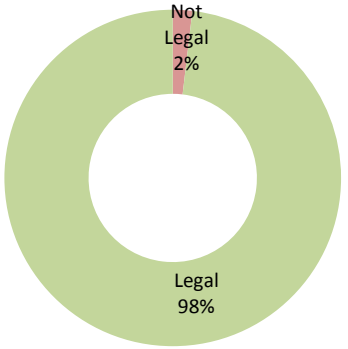
Problem in duration of supply is also acute in Tshangu where 70% of households have less than 8 hours of supply per day. In general Tshangu and Mont Amba districts receive less supply during the day as also in the evening compared to Lukunga and Funa districts.

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 - Attributes Summary Sheet

Electricity Source	Capacity	Duration	Duration
Source	**Wattage**	**Out of 24 Hours**	**Evening Supply**
			

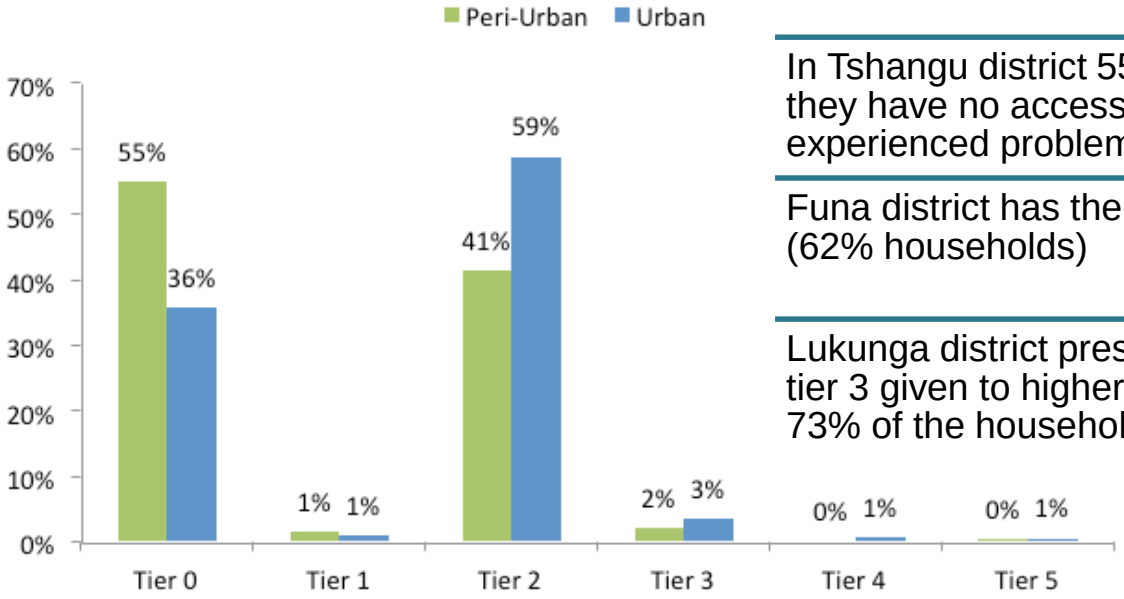
Reliability	Quality	Affordability	Legality
Duration of Interruptions (mins)	**Low Voltage Problems**	**Cost of 30 kWh < 5% of Monthly Income**	**Based on Bill Payment**
			

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

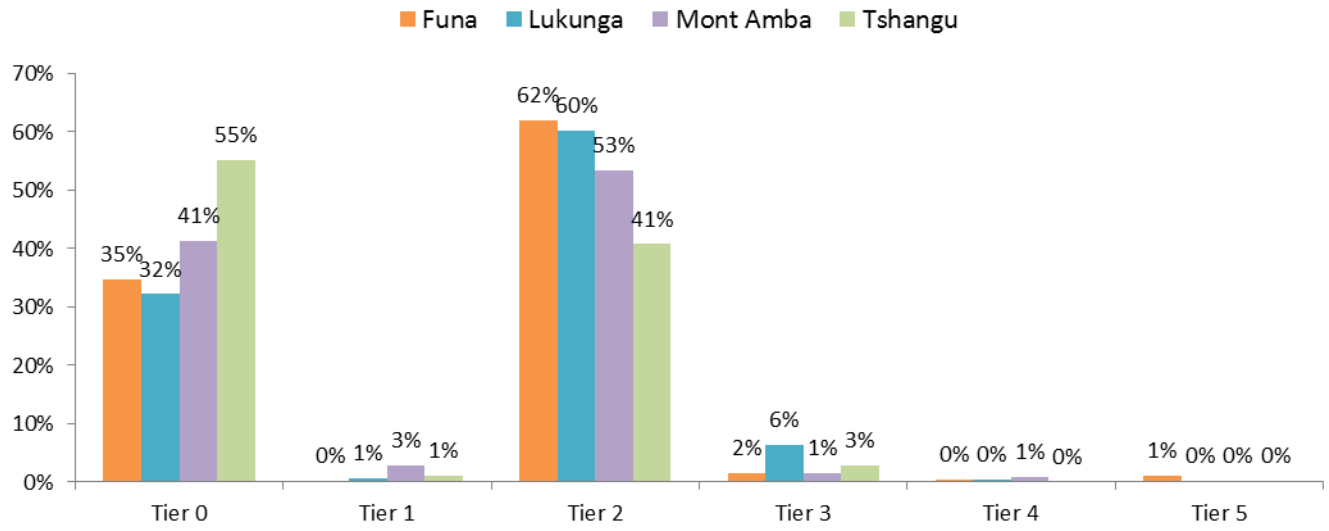
Electricity - Tiers Summary Sheet



In Tshangu district 55% of the households are in tier 0: they have no access to any form of electricity or experienced problems in duration of supply

Funa district has the higher rate of household in tier 2 (62% households)

Lukunga district presents the highest number of people in tier 3 given to higher rate of duration of interruption for 73% of the households



Area	Index
Urban	1.3
Peri-Urban	0.9
Funa	1.4
Lukunga	1.4
Mont Amba	1.2
Tshangu	0.9
Total	1.2

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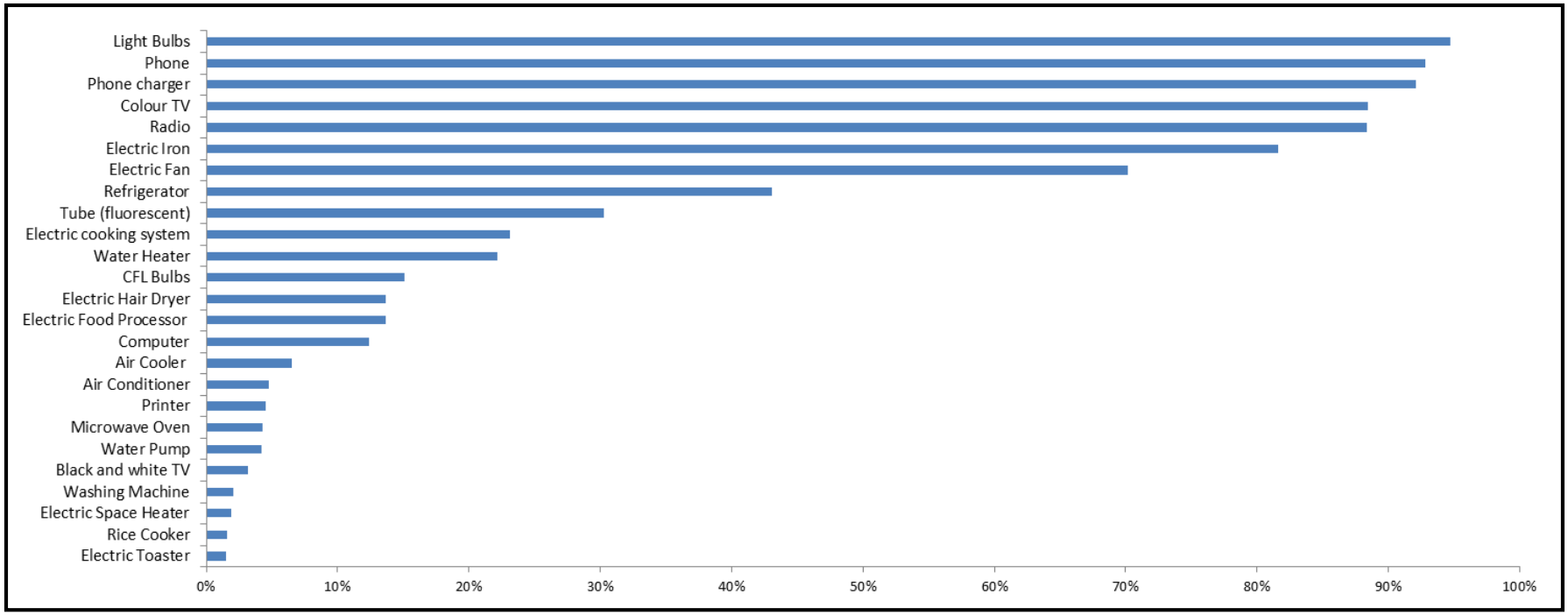
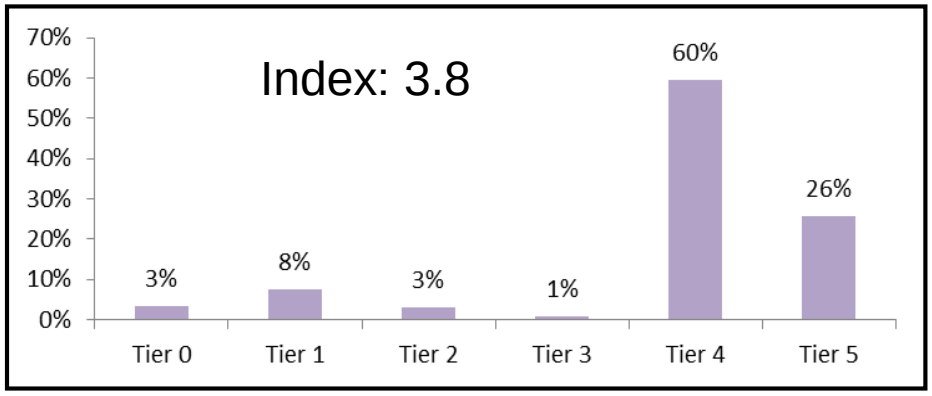
Electricity Services – Summary sheet

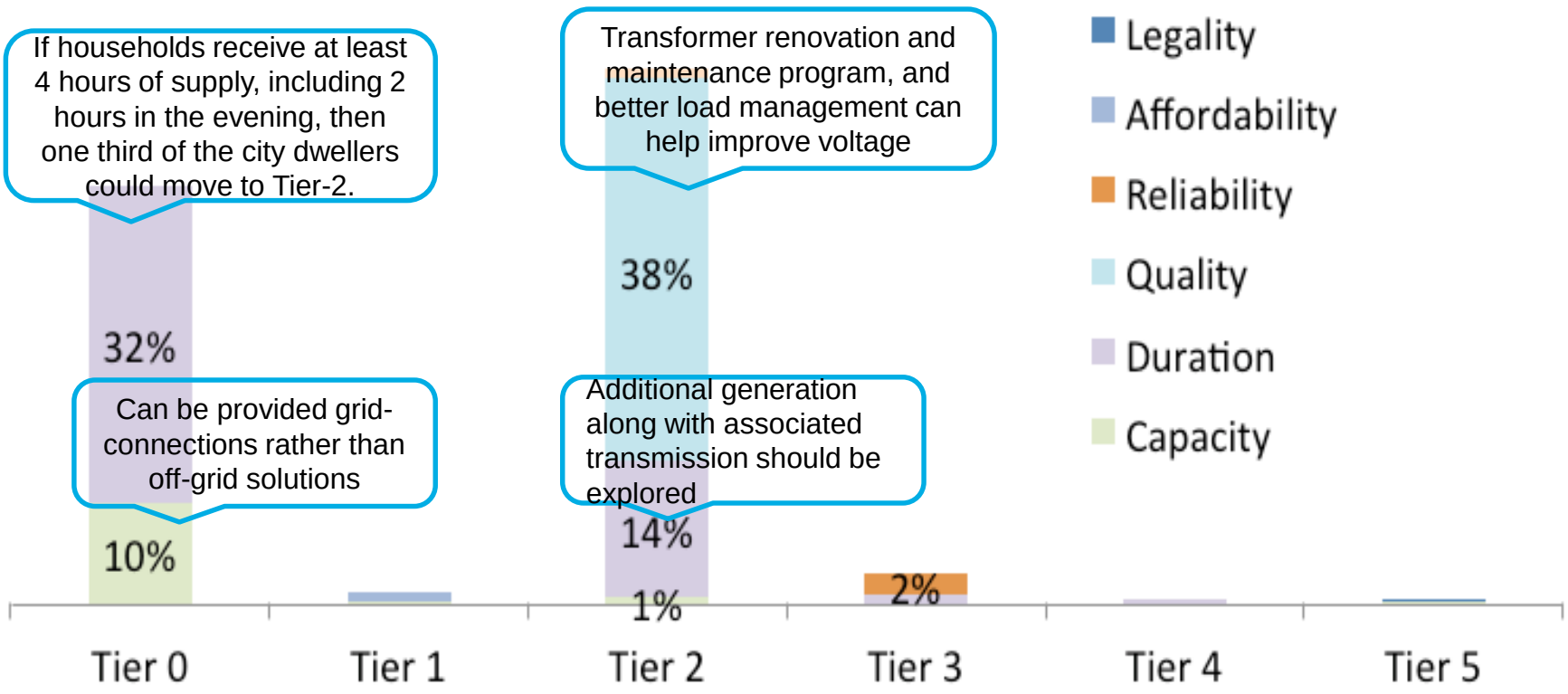




Observations:

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

Electricity – Gap Analysis and Interventions



Gap analysis at Glance:

32% of people in tier 0 had less than 4 hours during the day or less than one hour in the evening) and 10% of them do not have electricity

Tier 1 represents people with some affordability problems

In tier 2 most of the people (38%) experienced low voltage problems in the last year and 14% of them have less than 8 hours of supply during the day or less than 4 in the evening.

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Implementation of Multi-tier Frameworks

A THREE STEP STRATEGY

	Description	Components	Status
Step-1	Develop conceptual underpinnings	Detailed Conceptual Frameworks, including - Household Power, Lighting, Cooking & Space Heating - Productive Engagements - Community Infrastructure Draft Report on Defining and Measuring Energy Access Survey Questionnaire Guidance on data analysis to calculate tiers & indices Review by all stakeholders Final Report	Done Underway Done Done Underway Feb 2015
Step-2	Conduct Pilots to Refine and Validate	Early pilots to validate approach for: • Households • Productive and Community Uses Develop the format for Energy Access Diagnostic Report Advanced pilots to generate full Diagnostic Reports	 Done Underway Underway In Pipeline
Step-3	Scale-up	Global Energy Access Survey – Baseline Study Periodic Global Surveys for Tracking Progress WHO's SARA Surveys for Health Facilities	In Pipeline ??? Underway

Proposed Global Household Energy Survey

Target Countries:

- Survey of about 30-40 key countries that represent about 70-80% of grid unconnected households.
- In addition, the list also includes countries that together account for about 60-70% of households dependent on solid fuels for cooking.

Survey Tools:

- Household Energy Survey Instrument developed under ESMAP funded activity
- Multi-tier framework for measuring access to energy
- Energy Access Diagnostic Report format

Survey Timing:

- Q3-Q4 of 2015

Survey Approach:

- Appoint 4-5 survey agencies that would covered the desired 30-40 countries with sample sizes of about 3000-5000.
- Larger sample sizes needed in India and China

SREP Countries

- **Proposal:** Leverage up to USD 80-100,000 per country (with connection deficit of more than 10 million households) for household energy surveys.

Thank you

For any further questions, please contact:

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