

# Does Quality of Electricity Supply Matter for Development?

An Evaluation of Service Level Benefits in Nepal?

ESMAP MTF Insights Seminar Series

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# Outline of Talk

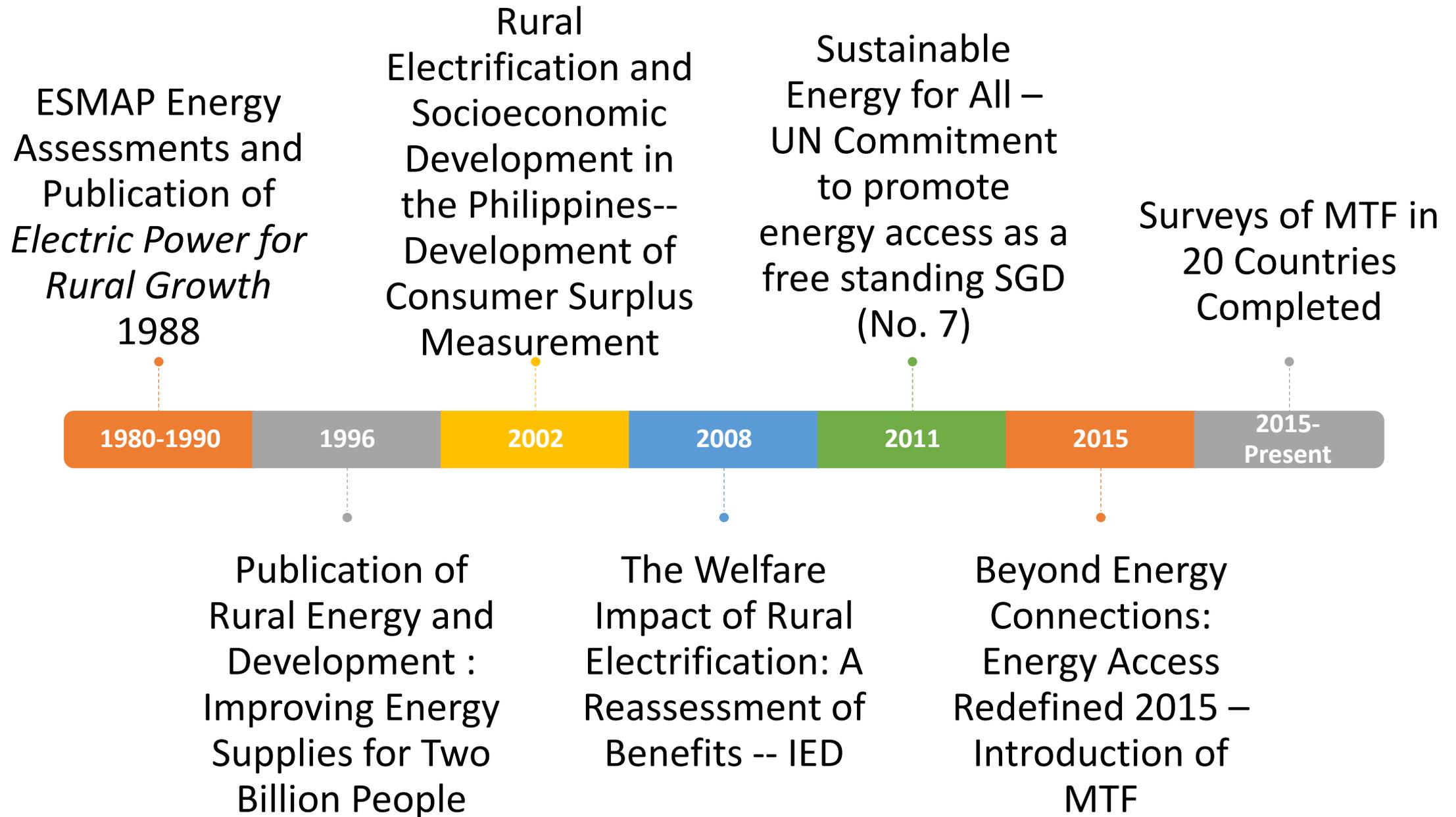
The Access Chronology

Evolution of Rural Electrification  
Benefits Assessment

Does the MTF Provide a Better/Practical  
Approach to Monitor Electricity Access?

Conclusions

# The Access Chronology

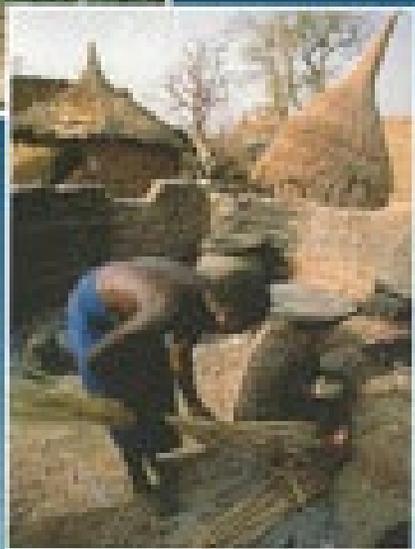
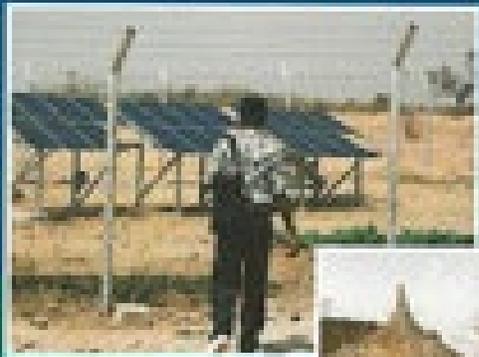


DEVELOPMENT IN PRACTICE

# Rural Energy and Development

Improving Energy Supplies

for Two Billion People



A WORLD BANK  
PUBLICATION

Rural Energy and Development,  
1996

Issue: Energy Access not getting  
enough attention in World Bank

Only 112 Pages but ahead of its  
time and had a long-term large  
impact

Main Focus: Electricity Access,  
Cooking fuels, and Renewable  
Energy

## Context of Early Days:

## Extent of Rural Electrification by Region, 1971

**Table 1.1 Extent of Rural Electrification in Developing Countries by Region, 1971**

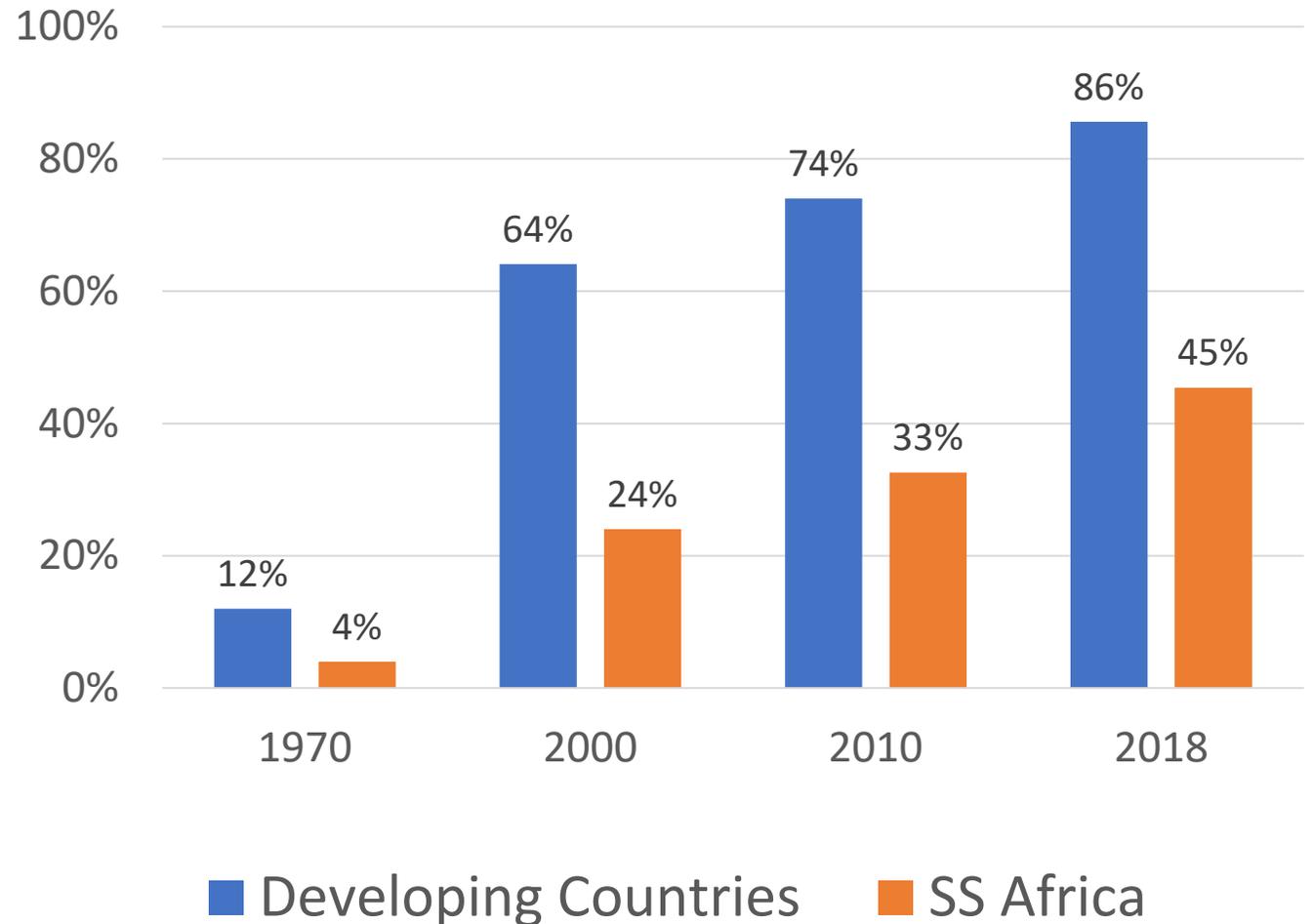
Region	Population			Electricity access	
	Total (million)	Rural (million)	Rural population (%)	Rural	Rural
				(million)	Population (%)
Latin America	282	140	50	32	23
Asia	934	700	75	105	15
Africa	182	165	91	7	4
Other	143	87	61	45	15
<b>Total</b>	<b>1,541</b>	<b>1,092</b>	<b>71</b>	<b>189</b>	<b>12</b>

*Source:* World Bank 1975.

*Note:* An update of these historical figures is provided in table 9.1.

- % Electricity Access 2010-2018
- Much progress since 1970 (from 12% to 86%)
- SS Africa still lags behind. Only 1 in 4 in rural areas with electricity

## % Electricity Access 1970-2018 and Urban and Rural 2018



# Worldwide Numbers 2021

- 34% decline in those without electricity, but questions over reliability
- Only 7% decline in those using solid cooking fuels

	INDICATOR	2010	LATEST YEAR
	7.1.1 Proportion of population with access to electricity	<b>1.1 billion</b> people without access to electricity	<b>675 million</b> people without access to electricity (2021)
	7.1.2 Proportion of population with primary reliance on clean fuels and technology for cooking	<b>2.9 billion</b> people without access to clean cooking	<b>2.3 billion</b> people without access to clean cooking (2021)

# Evolution of Rural Electrification Benefits Assessment

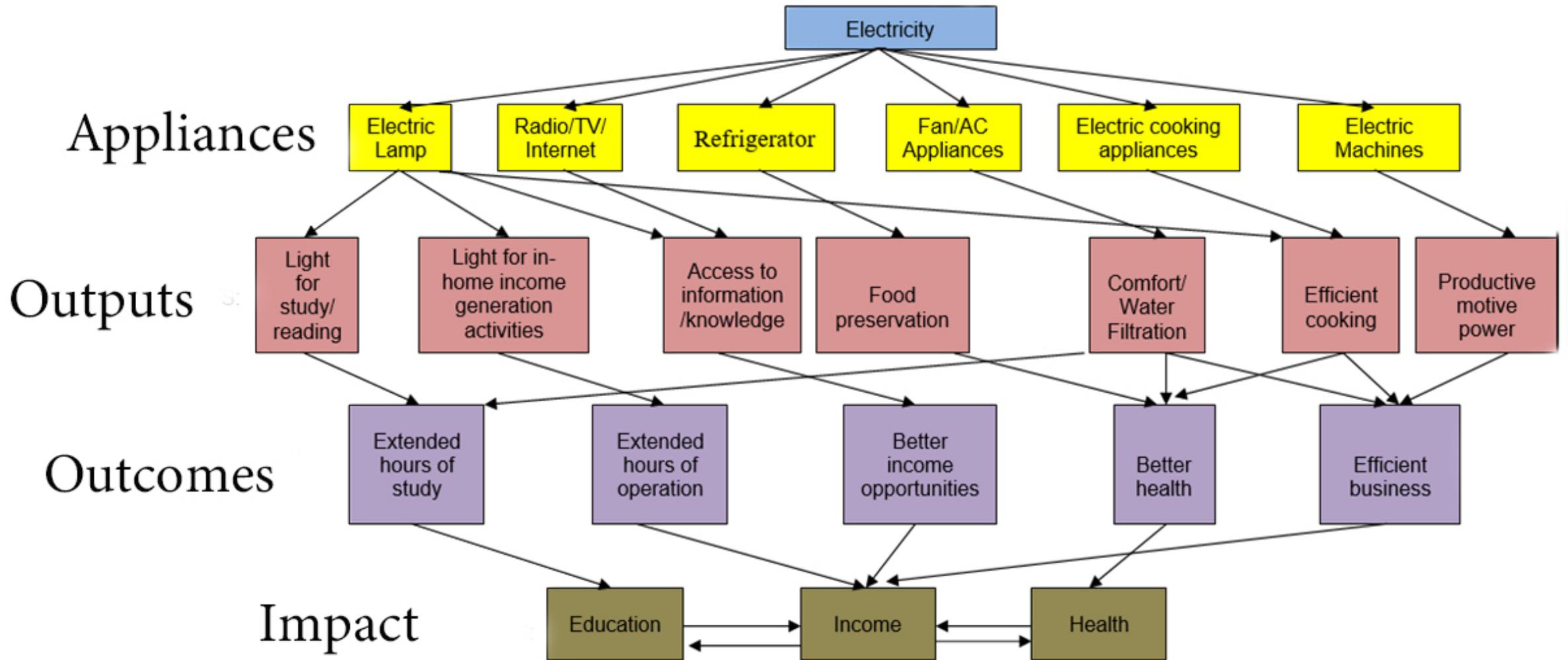
# Consumer Surplus Estimates - Peru:

Electricity Provides Greater Light at Less Cost: Peru Rural Energy Survey 2004



## Light in Kilolumen Hours per Month Rural Peru 2004

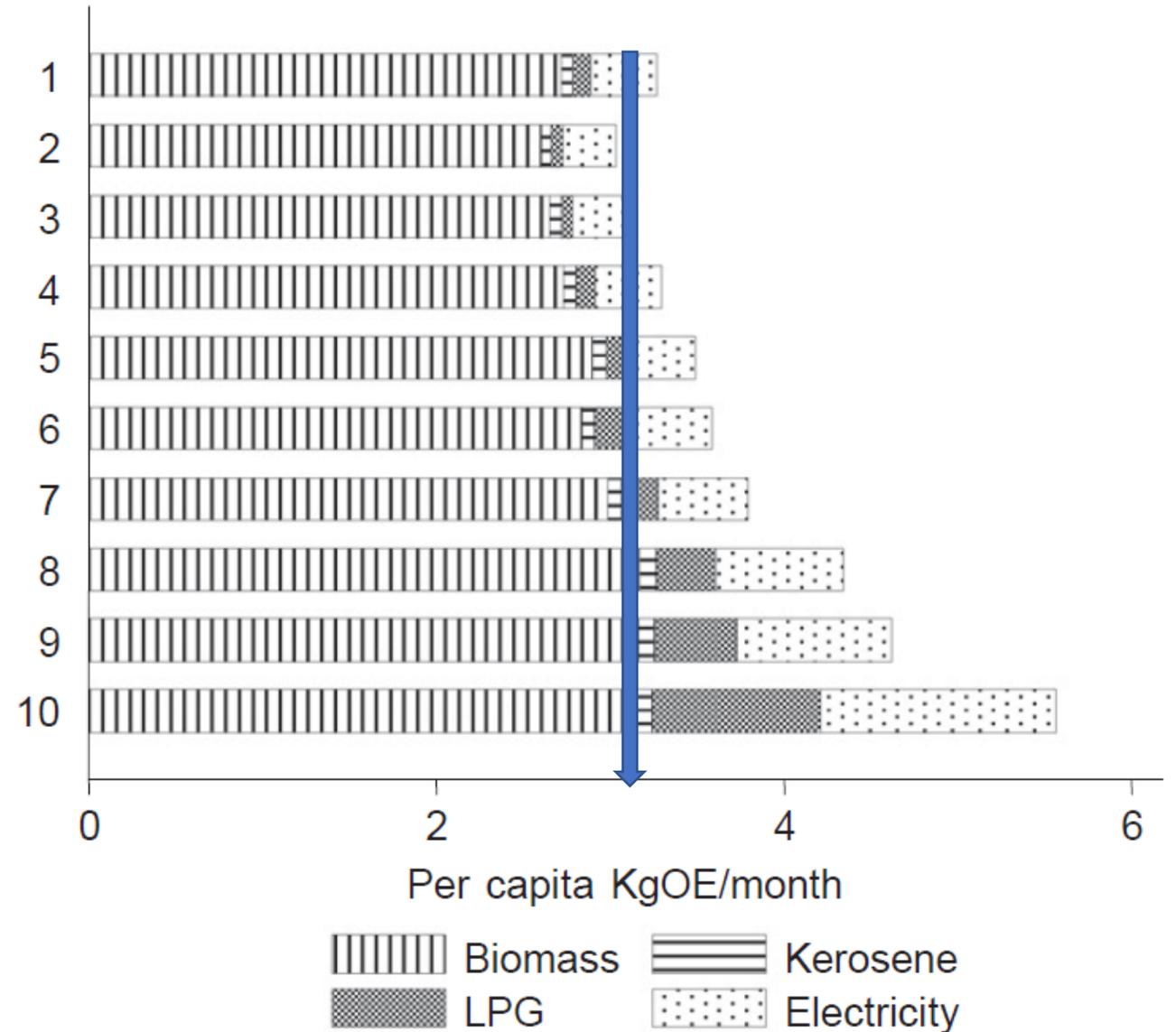




Pathways of impact of Electricity for Education, Income and Health

# Energy Poverty Line Index:

India (IHDS),  
2005, Rural  
End Use  
Energy per  
capita per  
Month





## Sustainable Energy for All Program

- Launched by UN in 2011 but now an independent organization supported by various government donors.
- “Sustainable Energy for All (SEforALL) is an international organization working ... achieve [Sustainable Development Goal 7](#) (SDG7), (universal access to sustainable energy) by 2030), and the Paris Agreement, (reducing greenhouse gas emissions to limit climate warming to below 2° Celsius.”)
- **To track progress, ESMAP launched the Multitier Framework for assessing energy access in 2015.**

Does the MTF Provide a  
Better/Practical Approach  
to Monitor Value of  
Electricity Access?

The Case of Nepal 2017



# Methods: It Was Complicated!

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- Comparison of simple access versus MTF tiers requires use of two different estimate methods – Binary and MTF
- Causality issues was addressed by using instrumental variables (external factors such as distance from pole) to predict electricity adoption.
- Nepal has wide variety of generation sources that differ in capacity and reliability
- Impact of electricity on development is assessed through a variety of factors (quality of service, access)
- Many interesting findings in the report!

# Components of MTF Measure by Attributes

Index Score		Zero	One	Two	Three	Four	Five
Attributes		Tier 0	Tier 1	Tier 2	Tier 3	Tier 4	Tier 5
<b>Capacity</b> <i>(Power Capacity ratings)</i>		< 3W	3W-49W	50W-199W	200W-799W	800W-1999W	≥ 2kW
<b>Availability</b>	<b>Day</b>	< 4 hrs	4-8 hrs		8-16 hrs	16-22 hrs	≥23 hrs
	<b>Evening</b>	< 1 hr	1-2 hrs	2-3 hrs	3-4 hrs	4 hrs	
<b>Reliability</b>	<i>(Frequency of disruptions per week)</i>	> 14				4-14	≤ 3
	<i>(Duration of disruptions per week)</i>					≥ 2 hrs (if frequency ≤ 3)	< 2 hrs
<b>Quality</b> <i>(Voltage problems affect the use of desired appliances)</i>		Yes				No	
<b>Affordability</b> <i>(Cost of a standard consumption package of 365 kWh/year)</i>		≥ 5% of household expenditure(income)			< 5% of household expenditure(income)		
<b>Formality</b> <i>(Bill is paid to the utility, pre-paid card seller, or authorized representative)</i>		No				Yes	
<b>Health and Safety</b> <i>(Having past accidents and perception of high risk in the future)</i>		Yes				No	

MTF HH Scoring Method:  
 HH is assigned lowest score of all attributes

Attribute and Tier	Tier 0	Tier 1	Tier 2	Tier 3	Tier 4	Tier 5
Capacity (LT 3W to GT 2kW)	0	1	2	3	4	5
Availability (0 to 24 hrs)	0	2	2	3	4	5
Availability (6-10 pm)	0	1	2	3	5	5
Reliability Frequency (Outtages/Week)	3	3	3	3	4	5
Reliability (Duration during Week)	3	3	3	3	4	5
Votalge Quality (Yes = 3, No = 5)	3	3	3	3	5	5
Affordability (GT or less than 5% income)	2	2	2	5	5	5
Formality (No = 3, Yes = 5)	3	3	3	3	5	5
Health and Saftey (No = 3, Yes = 5)	3	3	3	3	5	5

# Distribution of households by Tier and Source of Electricity, Nepal, 2017.

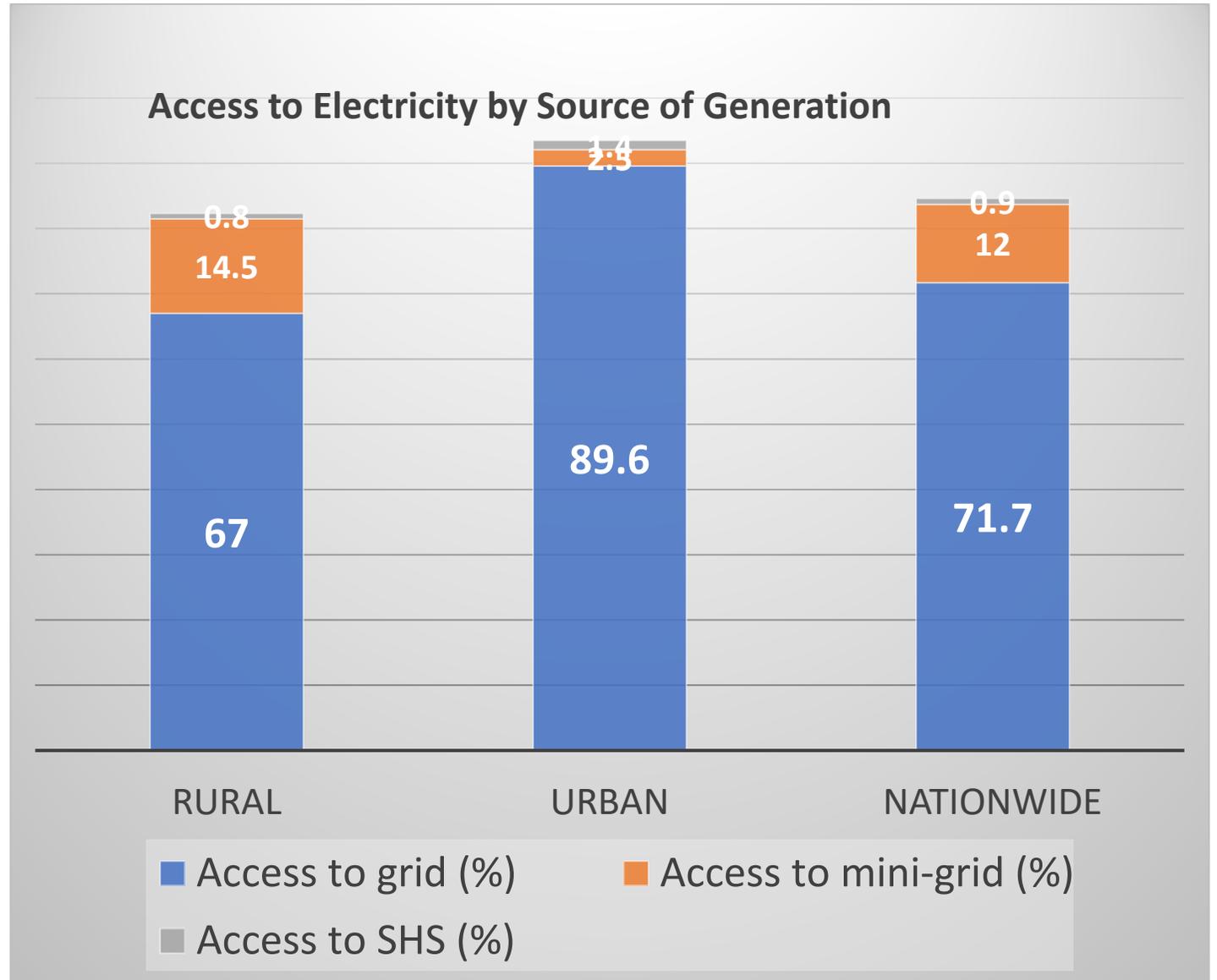
**Table 2.3 Share of Households by Sources of Electricity in Each MTF Tier**

<b>Tier</b>	<b>Grid (%)</b>	<b>Mini-grid (%)</b>	<b>SHS (%)</b>	<b>Other sources<sup>a</sup> (%)</b>	<b>No sources (%)</b>	<b>Grid consumption (kWh/month)<sup>b</sup></b>	<b>N</b>
0	0.5	0	0	16.4	83.1	n.a.	426
1	6.5	29.9	1.2	62.4	0	35.7	1,001
2	81.7	15.6	2.7	0	0	35.9	475
3	87.2	12.8	0	0	0	54.2	1,728
4	93.5	6.5	0	0	0	52.7	1,139
5	97.8	2.2	0	0	0	72.3	1,231
All households	71.7	12.0	0.5	10.6	5.2	57.5	6,000

Source: Nepal MTF household survey 2017.

Note: n.a. = not applicable.

Household access to electrification by major sources: Grid and Mini-Grids Dominate



# Main Findings: Causality Issue Means Statistical Methods Complicated (but Possible)



Having electricity has an impact, but the impact of having high quality electricity service is even greater.



MTF tiers for Nepal are mainly related to capacity and reliability



Education, clean cooking and expenditures (income) are positively impacted by electricity

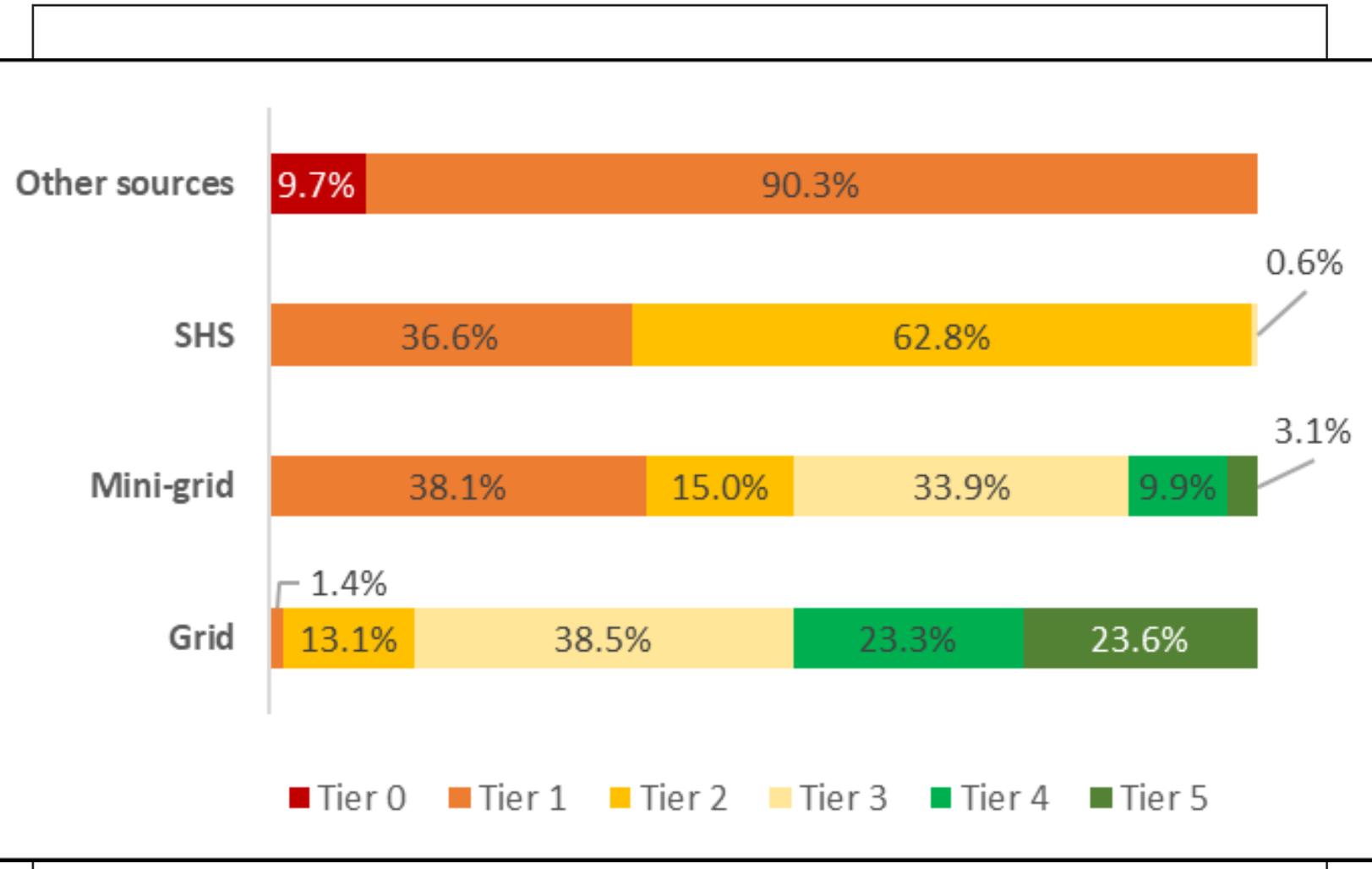


Impact also varies with kWh consumption, meaning more appliances have greater impact.



Households with electricity use cleaner methods of cooking and save cooking time.

Household MTF tiers of electrification by main source of electricity



# Key Drivers of Electricity Access

(% Change in Probability of Adopting Electricity from Grid, Mini Grid or Solar Systems: Table 3.2)



HH completion of secondary (6.4%) and post secondary education (5.5%)



Reliability of service (1 hour outage decrease = probable 1.6% increase)



Price of electricity (higher price means lower adoption)



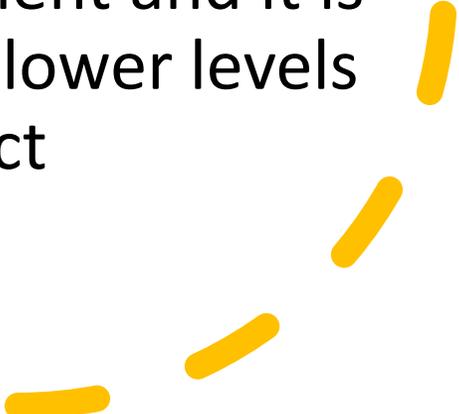
Urban location (Urban dwellers = 2.6% probable increase)



Community has market (1.6% probable increase)

*Note: The % change in probability of adopting grid electricity is even higher for education 10.8% and 13.2% (Table 3.3)*

Impacts of  
Electricity  
Tiers  
Statistical  
Analysis  
Controlling for  
Other  
Variables

- Increase food and non-food expenditures (mainly Tier 5)
  - Reduces cooking and food preparation time perhaps through clean cooking adoption (mostly LPG)
  - Reduces fuel collection time and kerosene expenditure
  - Increase women's farm sector employment
  - Mixed impact on men's employment and it is mostly limited to Tier 5 meaning lower levels of service don't have much impact
  - See Tables 4.4A, 4.4B and 4.5
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# Outcomes by Electricity Tiers -- Cross Section



	<b>Tier 0</b>	<b>Tier 1</b>	<b>Tier 2</b>	<b>Tier 3</b>	<b>Tier 4</b>	<b>Tier 5</b>
<b>Non-Food Expenditures (Rs/Month)</b>	<b>2,368</b>	<b>2,160</b>	<b>3,867</b>	<b>3,622</b>	<b>3,229</b>	<b>4,107</b>
<b>Fuel Preparation and Cooking time (hours/week)</b>	<b>3.6</b>	<b>2.5</b>	<b>1.6</b>	<b>1.5</b>	<b>1.2</b>	<b>1.0</b>
<b>Increase in Women's Farm Employment (Hours/Month)</b>	<b>37</b>	<b>82</b>	<b>52</b>	<b>45</b>	<b>57</b>	<b>25</b>
<b>Mixed Impact on Men's Employment (Hours per Month)</b>	<b>159</b>	<b>150</b>	<b>139</b>	<b>142</b>	<b>173</b>	<b>142</b>
<b>Reduces Kerosene Expenditure (Liters per month)</b>	<b>2.3</b>	<b>0.1</b>	<b>0.6</b>	<b>0.6</b>	<b>0.3</b>	<b>0.2</b>
<b>Households that Use Clean Cookstoves (Percent of Households)</b>	<b>2</b>	<b>8</b>	<b>34</b>	<b>43</b>	<b>46</b>	<b>61</b>

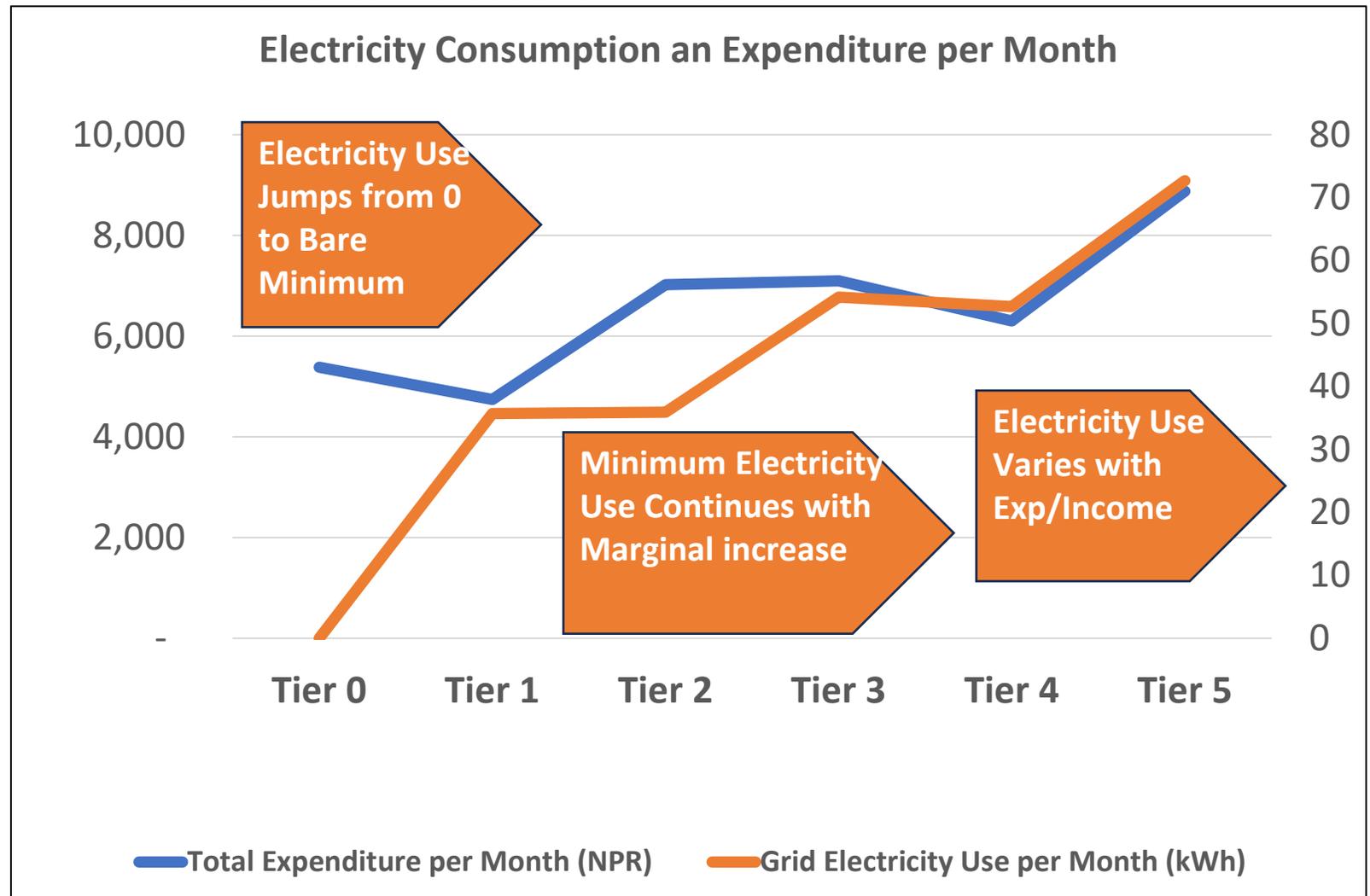
# Grid Electricity Consumption and Expenditure by Tiers

Electricity use rises to bare minimum and then rises marginally until Tier 4

Then electricity use and expenditures are elastic after Tier 4 (% increase for each is same)

Simple access leads to bare minimum electricity use with substantial benefits.

The benefits remain fairly flat until you reach Tier 5. Then benefits increase with income.





# How electricity consumption matters

- Electricity consumption increase from 35kWh per month in Tier 1 to only 72 kWh per month in Tier 5
- It is through quantity consumed and diversity of consumption (appliances) that benefits accumulate.
- Survey data show that electricity is positively correlated with MTF tiers but high impacts are in Tier 0-1 and in Tier 4-5.

# Electricity Consumption Raises Income and Reduces Poverty

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Electricity access, MTF tiers and consumption affect expenditures and poverty levels.

A 10% rise in electricity consumption can raise per capita expenditure by 0.9% but after Tier 4 it is larger.

The increase in expenditures has the potential to lift households that are in poverty above the poverty line.

The expenditure benefits due to a 10% increase in electricity consumption can lower poverty by one-sixth.

Raising electricity consumption of all grid-connected HHs to the level of Tier-5 consumption can lower poverty by almost one-third,

By raising the consumption all HHs (not just grid HHs) to same level can lower poverty by more than half.

# Do HHs consume enough electricity?



- HH consumption of electricity from grid is very low.
- Even the consumption of Tier-5 HHs (72.3 kWh/month) is much lower than country's aspirational consumption goal of 260 kWh/month, which the government wants to achieve by 2030.
- HHs now spend only 1.3% of their expenditure on grid electricity. Thus, they can raise use without squeezing out other necessary expenditures.

# Can MTF Be Simplified

- In Nepal all 8 attributes are not necessary in because the last 3 all have the same score and can be dropped.
- Studies in more countries may reveal similar or different patterns. We don't know!
- In Nepal, for impact evaluation:
  - Moving from Tiers 0-1 have a big impact.
  - Tiers 1-4 have no or moderate impact and can be combined.
  - Tier 5 of developed country level of service has a big impact.



# Conclusions

# Take-home messages

Both demand- and supply-side factors determine grid-connectivity and MTF tiers.

Both gaining access to electricity and attaining higher tiers has a significant impact on household welfare.

In Nepal, additional benefits are possible by providing more households with Tier-5 levels of service and Productive Use programs.

The electricity benefits are channeled through higher levels of electricity consumption (kWh per month) via appliance use.

# Practical Policy recommendations

01

Keep expanding access to electricity until universal coverage is reached.

02

Provide a higher quality of electricity supply to existing customers to enhance the socioeconomic impacts for households in Nepal.

03

Beyond lighting, appliance ownership is the path through which electricity provides benefits, so encourage greater appliance adoption.