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The role of energy in development processes

*Energy poverty and demand modeling for the case
of Arequipa (Peru)*

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 1. Energy Poverty
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- What is energy poverty?

Mostly used:

- Mere access to electricity & dependency on biomass (IEA 2010, 2012); ext: intermittent electricity supply
- Development of energy access criteria: ranking DCs in their progress toward modern energy access – EDI (IEA 2011):
 1. Per capita commercial energy consumption
 2. Per capita electricity consumption in the residential sector
 3. Share of modern fuels in total residential sector energy use
 4. Share of population with access to electricity



Energy Poverty (2)

Mostly used:

- definition of a basic energy need minimum / an energy poverty line over amount of energy consumed (Practical Action 2010)
- energy expenditures as a proportion of total income bigger than 10% (Barnes 2005)
- threshold point at which energy consumption begins to rise with increases in household income (Khandker et al. 2012)

Energy Poverty (3)



Scientific Paper

Energy service	Minimum standard
1 Lighting	300 lumens at household level
2 Cooking and water heating	<p>1 kg woodfuel or 0.3 kg charcoal or 0.04 kg LPG or 0.2 litres of kerosene or ethanol per person per day, taking less than 30 minutes per household per day to obtain</p> <p>Minimum efficiency of improved wood and charcoal stoves to be 40% greater than a three-stone fire in terms of fuel use</p> <p>Annual mean concentrations of particulate matter ($PM_{2.5}$) $< 10 \mu\text{g}/\text{m}^3$ in households, with interim goals of $15 \mu\text{g}/\text{m}^3$, $25 \mu\text{g}/\text{m}^3$ and $35 \mu\text{g}/\text{m}^3$</p>
3 Space heating	Minimum daytime indoor air temperature of 12°C
4 Cooling	<p>Food processors, retailers and householders have facilities to extend life of perishable products by a minimum of 50% over that allowed by ambient storage</p> <p>All health facilities have refrigeration adequate for the blood, vaccine and medicinal needs of local populations</p> <p>Maximum indoor air temperature of 30°C</p>
5 Information and communications	<p>People can communicate electronic information beyond the locality in which they live</p> <p>People can access electronic media relevant to their lives and livelihoods</p>
6 Earning a living	<p>Access to energy is sufficient for the start up of any enterprise</p> <p>The proportion of operating costs for energy consumption in energy-efficient enterprises is financially sustainable.</p>

Reproduced from Practical Action, 2010, p. 33.



Concept of Energy Poverty Penalty

- Approach over *service quality*

Quality is defined over the characteristics of a product or service that bear on its ability to satisfy stated or implied needs [ASQ 2013].

Poor energy service quality =

- ✓ insufficiencies,
- ✓ unreliability,
- ✓ dangers in usage,
- ✓ low durability,
- ✓ unfitness,
- ✓ lack of after-sales service
- ✓ non-affordability, in the sense of poor financial

services.



Concept of Energy Poverty Penalty (2)

- Hypothesis

The existence of an energy poverty penalty implies that poorer people tend to spend more on energy services in relation to their total income than comparatively richer people for a lower service quality.



trapped in high cost



Concept of Energy Poverty Penalty (3)

Potential reasons:

- urban bias: limited choice/ access (capabilities)
- no affordability
- higher cost of decentralized technologies vs. centralized technologies
- less production potential (controversial)
- lack of energy literacy (not addressed)



Causality? Income <-> Energy
Use



Method

- sample with 342 rural households/ micro-businesses in Arequipa
- clustering over mobile phone coverage
- asset indexing
- descriptive and regression analysis



Findings

- evidence found for the existence of an energy poverty penalty
- mobile phone coverage insignificant for energy expenditure
- only about 40% spent on electricity
- sample percentage of dependency on biomass (43%) doubles the total Arequipan average

Table 13: Regression outputs for (relative) energy expenditure determinants

VARIABLES	(1) OLS rel en exp inc	(2) OLS2 rel en exp inc	(3) OLS3 tot en exp mix	(4) OLS3 tot en exp mix
z_assetind_100			21.54*** (4.950)	22.11*** (5.015)
Credit	-0.00147 (0.00163)	-0.00153 (0.00164)	10.10 (12.10)	10.08 (12.23)
Elec	-0.00959*** (0.00287)	-0.00955*** (0.00266)	-21.37 (22.75)	-21.94 (23.34)
Cay			-40.39** (19.09)	-35.90** (14.76)
Cas	-0.00522*** (0.00187)	-0.00519*** (0.00178)	-49.97*** (16.25)	-47.75*** (12.76)
Lau			-62.48*** (18.93)	-65.77*** (15.60)
Arq			-7.616 (25.98)	
Microbus	-0.00129 (0.00178)	-0.00133 (0.00175)	19.85** (10.07)	19.95** (9.992)
mob_cov	-7.88e-05 (0.000816)		8.192 (6.073)	7.805 (5.827)
Distance	0.00148 (0.00139)	0.00149 (0.00137)	-7.953 (14.53)	
tech_adap	-0.000866** (0.000433)	-0.000867* (0.000446)		
produc_pot	0.000948* (0.000526)	0.000931* (0.000522)		
energy_lit	-8.65e-05 (0.000416)			
Constant	1.010*** (0.00494)	1.009*** (0.00364)	-2,050*** (496.7)	-2,116*** (501.3)
Observations	261	261	269	269
R-squared	0.118	0.118	0.131	0.130

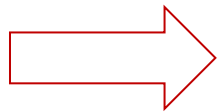
Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1



Policy implications

- Reduce EPP impact causing a trap prohibiting/ delaying (?) people's development
- Support financial institutions serving low-income people in business case identification



Support effective energy inclusion measures

Energy inclusion may be defined as a process of improving energy service quality for vulnerable and low-income groups



Future Research Needs

- causality between energy use and development
- productive use of energy in terms of a catalyst for development
- temporarily off-grid sector as a potential market for energy service improvements



Thanks a lot for your attention.

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