

Econ 366

Fall 2012

Residential Sector Fuel Poverty

Information Sources

- Textbook – Chapter 22
- Murray and Mills (2011) "An Application of Dichotomous and Polytomous Item Response Theory Models For Scoring Energy Insecurity"
 - http://www.cox.smu.edu/c/document_library/get_file?p_l_id=749502&folderId=990301&name=DLFE-5144.ppt
- Holm (2010) "Renewable Energy Future for the Developing World"
 - <http://whitepaper.ises.org/ISES-WP-600DV.pdf>

Fuel Poverty

- In some regions, major problems relate to lighting and cooking and the impact of using biomass instead of ‘modern fuels’ in the home
- In other regions, major impacts concern the health implications of inadequate heating and cooling system operation
- Major issues: access to and affordability of clean fuels (and the technologies needed to transform the fuels into light, heat and ‘work’)

Analysing Fuel Poverty

- Can be useful to apply general framework of Chapter 3 in textbook
- Multi-stage process whereby each individual decides:
 - (i) whether to purchase energy commercially
 - (ii) what type of equipment to use
 - (iii) how intensely / often to use the equipment (household capital stock)

Residential Consumers (in Developing Countries): Stage (i)

- (a) Low income may lead to increased use of in-kind transactions (bartering) → less likely to buy fuels commercially
- (b) Low income leads to credit constraints → difficult to invest in clean technologies (if switch to a commercially provided fuel like propane to cook, also need to replace equipment)
- (a) and (b) can lead to a preference for 'non-commercial' access to fuels (firewood, biomass) that require minimal monetary transactions

Policy Implications of “Stage (i)”

- Suitable / versatile clean energy sources needed
- Either minimal need for cash transactions (low cost) or increased cash incomes of which some can be used to purchase clean energy

Residential Consumers in Developing Countries: Stage (ii)

- Appliances have long lives, and initial costs are high relative to income → replace appliances less frequently → very strong path dependence
- To make purchase of new cooker, for example, economically viable, need a low initial price (possibly through subsidies) and/or quick pay-off in terms of benefits and/or will need to use it for a long time (net present value calculations)
- May consider new technologies risky

Residential Consumers (in Developing Countries): Stage (iii)

- Vulnerable to price changes / market fluctuations (role of subsidies?)
- Utilisation will depend on availability / access (for example, can use biomass cooker during a power outage, but not an electric cooker)

Access to Electricity by Region: A (Textbook)

Table 22.1 Level of electrification in various regions

Region	Population without electricity (Millions)	Electrification rate (%)		
		Overall	Urban	Rural
North Africa	2	98.9	99.6	98.2
Sub-Saharan Africa	587	28.5	57.5	11.9
Africa	589	40.0	66.8	22.7
China and East Asia	195	90.2	96.2	85.5
South Asia	614	60.2	88.4	48.4
Developing Asia	809	77.2	93.5	67.2
Middle East	21	89.1	98.5	70.6
Developing Countries	1453	72.0	90.0	58.4
Transition economies and OECD	3	99.8	100.0	99.5
Global total	1456	78.2	93.4	63.2

Source: WEO (2009)

Access to Electricity by Region: B (Textbook)

Table 22.2 Major concentration of population with access to electricity

Country	Rank in terms of population	Population without electricity access (Million)	Share of population without access (%)		
			Urban	Rural	Total
India	2	404.5	6.9	47.5	35.5
Bangladesh	7	94.9	24	72	59
Indonesia	4	81.1	6	48	35.5
Nigeria	8	80.6	31	74	53.2
Pakistan	6	70.4	22	54	42.4
Ethiopia	15	68.7	20	98	84.7
DR Congo	19	57	75	96	88.9
Myanmar	24	42.8	81	90	87
Tanzania	30	36.6	61	98	88.5
Kenya	32	32.8	48.7	95	85
Uganda	37	29.1	57.5	96	91
Afghanistan	44	23.3	78	88	85.6

Source: WEO (2009)

Biomass Cooking Fuel (Textbook)

Table 22.3 Reliance on biomass for cooking energy needs in 2004

Region	Total population		Rural		Urban	
	%	Million	%	Million	%	Million
Sub-Saharan Africa	76	575	93	413	58	162
North Africa	3	4	6	4	0.2	0.2
India	69	740	87	663	25	77
China	37	480	55	428	10	52
Indonesia	72	156	95	110	45	46
Rest of Asia	65	489	93	455	35	34
Brazil	13	23	53	16	5	8
Rest of Latin America	23	60	62	59	9	3
Total	52	2528	83	2147	23	461

Source: WEO (2006)

Biomass as a Household Energy Source: Some Implications (Holm)

- Rural households may spend several hours per day engaged in the collection of fuelwood
- Sometimes carrying loads weighing > 20kg
- Time and energy expended often has health consequences (disproportionately for women): respiratory, blindness, heart
- “Reducing women’s drudgery by providing improved access to energy services for lighting, cooking and productive activities should have a significant positive effect on women’s education, literacy, nutrition, health, economic opportunities, and involvement in community affairs which, in turn, will benefit all family members.”

Implications Continued

- Combustion, often using inefficient equipment → air pollution and health hazards with as much of 20% of fuel converted to products of incomplete combustion
- Similar hazards apply to household use of coal due to particulate matter
- Liquid and gas based cook stoves are usually much more efficient and fuel quality is better
- Solar cookers and solar water heaters are starting to make some inroads

Potential of Improved Technology (Holm)

Kenya Ceramic Jiko (Improved Charcoal Cookstove)

The Kenya Ceramic Jiko (KCJ) is one of the most successful African stove projects. It is made up of a metal cladding with a wide base and a ceramic liner. At least 25 percent of the liner base is perforated with holes of 15mm diameter to form the grate. The stove has three pot rests, two handles, three legs and a door controlling the airflow. The standard model weighs about 6kg, which means it can be carried around easily (KENGO, 1991; Karekezi and Kithyoma, 2002).

This stove is used for cooking and space heating. The KCJ directs 20 to 40 percent of the heat from the fire to the cooking pot, replacing stoves with only 10 - 20 percent efficiency. Open cooking fires, yield efficiencies as low as 10 percent (Kammen, 1995). The cost of the stove is about US\$ 2, which makes it accessible to the majority of the urban population in Kenya, although this cost does not include fuel costs (charcoal).

Fuel Poverty

- Not limited to developing countries
- Energy consumption increases with income (→ low-income households purchase less energy)
- Human Development Index* increases with energy use

*"Human Development Index (HDI): A composite index measuring average achievement in three basic dimensions of human development—a long and healthy life, knowledge and a decent standard of living" (http://hdr.undp.org/en/media/HDR_2011_EN_Table1.pdf)

How Can Fuel Poverty be Measured?

- Energy poverty line
- Access to energy
- Engineering measures of minimum needs
- Index based on answers to household surveys
(Murray and Mills)

Poverty Line Approach

- Poverty Line: Income cut-offs (based on household size) determine which households are living in poverty
- Among those who are living in poverty, what % of household income is devoted to the purchase of energy
- If a household spends more than a certain % of income on energy, considered to be “fuel poor”

Factors that affect Poverty Line Measure of Fuel Poverty

- Fuel mix
- Market prices
- Energy Efficiency of Appliances
- Household composition (for example, families with young children tend to keep houses warmer at night → larger energy expenditures)

Engineering Approach

- What are the basic needs of a household (lighting, appliances, heating/cooling)?
- How much energy is required to provide for these basic requirements given current technologies? (which technologies will the poorest households have access to?)
- Does a household have access to sufficient energy to meet these needs?

Access to Services

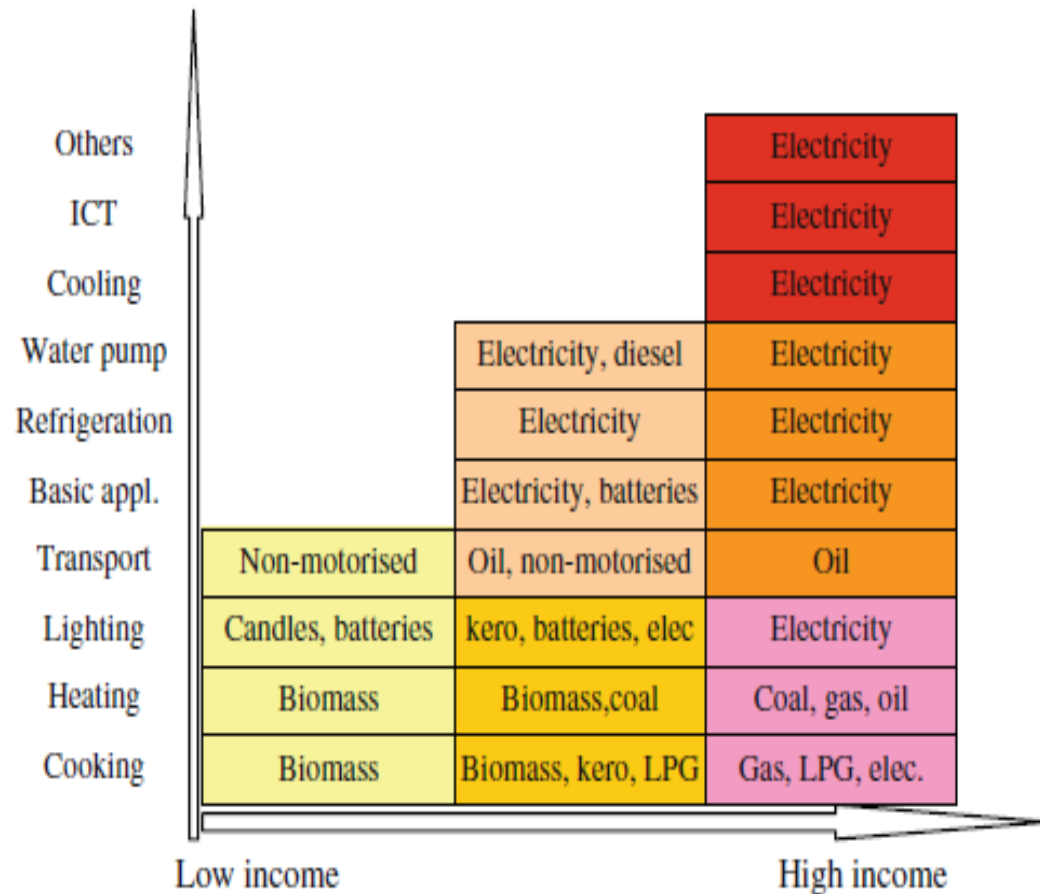
- Is physical access feasible for the household?
- Poorer households will face more constraints in terms of access to technologies and fuel types (and may have to resort to non-market access, especially in developing countries)
- Energy Development Index (counterpart to HDI) has been developed

Energy Development Index (National Measure)

- Factors considered:
 - Per capita commercial energy consumption
 - Share of commercial energy in final energy use
 - Share of population with access to electricity
- Implicitly assumes:
 - Biomass use is a characteristic of underdevelopment
 - Connection to ‘the grid’ is essential for development

Energy Ladder

Fig. 22.1 Energy ladder example. *Source* WEO (2002)



Measuring Fuel Poverty – based on household surveys

- See Murray and Mills
- US conducts a Residential Energy Consumption Survey every 4 years.
 - Collects information on energy consumption from all respondents
 - Some questions only asked to very poor households (with incomes at least 150% under the poverty line) who are eligible for Low Income Home Energy Assistance Program (LIHEAP) benefits
 - These additional questions delve further into household energy use and household behaviour

Supplemental Questions

		<u>Almost Every Month</u>	<u>Some Months</u>	<u>Only 1 or 2 Months</u>	<u>Never</u>
K-1a	SCALEA Did you worry that you wouldn't be able to pay your home energy bill?	1	2	3	4
K-1b	SCALEB Did you reduce your expenses for what you consider to be basic household necessities?	1	2	3	4
K-1c	SCALEC Did you need to borrow from a friend or relative to pay your home energy bill?.....	1	2	3	4
K-1d	SCALED Did you skip paying your home energy bill or pay less than your whole home energy bill?.....	1	2	3	4
K-1e	SCALEE Did you have a supplier of your electric or home heating service threaten to disconnect your electricity or home heating fuel service, or discontinue making fuel deliveries?	1	2	3	4
K-1f	SCALEF Did you close off part of your home because you could not afford to heat or cool it?.....	1	2	3	4
K-1g	SCALEG Did you keep your home at a temperature that you felt was unsafe or unhealthy at any time of the year?	1	2	3	4
K-1h	SCALEH Did you leave your home for part of the day because it was too hot or too cold?	1	2	3	4
K-1i	SCALEI Did you use your kitchen stove or oven to provide heat?.....	1	2	3	4

Using Survey Questions

- Murray and Mills try various ways of combining the responses of these questions into a single 'reliable/usable' index of energy insecurity and then determining the characteristics of energy insecure households (→ get useful information on who to target?)
- Preliminary results
 - Current set of questions may need to be tweaked
 - Households that are the most energy insecure more likely to be headed by a single female, household head more likely to be young, more likely to be black, likely to be spending a relatively high proportion of income on energy, likely to be accessing some form of government assistance