PESD Cookstove Research

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Energy@Stanford
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Low-Income Energy Research Platform

Research Question
What kinds of institutional arrangements (enterprises, business models, markets, policies, and laws/regulations) can allow delivery of modern energy services to the poor at scale and in a durable way?

Methods
Structured case studies
Qualitative surveys
Quantitative surveys
Econometric modeling
The Energy Transition

- 1.6 billion people without electricity

- 2.4 billion without “modern” fuels
Harms of Status Quo

• Lack of energy directly impedes development
  – No lighting for education
  – No electricity for productive activities
  – Time spent on biomass collection (esp. by women)

• Serious climate impacts
• Negative health consequences of biomass burning
Energy for the Poor: Health Impact

Estimated deaths from cooking-related indoor air pollution:
1.6 million/year (> malaria)

Improved biomass cookstoves could significantly reduce
Are Health Benefits Valued?

Insecticide-Treated Bednets (175 articles)

% of articles reporting that factor is:
not significant ↔ significant
-20% -10% 0% 10% 20% 30% 40% 50% 60%

Comfort/Convenience
HEALTH
Taste/Aesthetics
Socio-Cultural Norms

Point-of-Use Water Treatment (28 articles)

% of articles reporting that factor is:
not significant ↔ significant
-20% -10% 0% 10% 20% 30% 40% 50% 60%

Comfort/Convenience
HEALTH
Socio-Cultural Norms
Taste/Aesthetics

Improved Biomass Cookstoves (7 articles)

% of articles reporting that factor is:
not significant ↔ significant
-40% -10% 0% 10% 20% 30% 40% 50% 60%

Comfort/Convenience
HEALTH
Taste/Aesthetics
Socio-Cultural Norms

Systematic review of factors affecting adoption of health-improving technologies

Thurber, Warner, Platt, Slaski, and Miller
Cookstove Dissemination Research

Top-down: “Business models” for distribution

Bottom-up: Factors affecting household cooking choices
Cookstove Dissemination Research

Top-down: “Business models” for distribution

Bottom-up: Factors affecting household cooking choices
Survey of Cookstove Sellers in India

<table>
<thead>
<tr>
<th>Organization</th>
<th>Years in stoves business</th>
<th>Approx. # of direct employees in stoves</th>
<th>Est. total # of stoves sold in India (as of June 2010)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>B</td>
<td>40</td>
<td>300</td>
<td>0 (sold 150,000 in Africa)</td>
</tr>
<tr>
<td>C</td>
<td>2</td>
<td>60</td>
<td>120,000</td>
</tr>
<tr>
<td>D</td>
<td>4</td>
<td>21</td>
<td>450,000</td>
</tr>
<tr>
<td>E</td>
<td>11</td>
<td>2</td>
<td>450</td>
</tr>
<tr>
<td>F</td>
<td>1</td>
<td>Unknown</td>
<td>1000</td>
</tr>
<tr>
<td>G</td>
<td>2</td>
<td>5</td>
<td>5000</td>
</tr>
<tr>
<td>H</td>
<td>5</td>
<td>10</td>
<td>25,000</td>
</tr>
<tr>
<td>I</td>
<td>1</td>
<td>5</td>
<td>40</td>
</tr>
<tr>
<td>J</td>
<td>10</td>
<td>20–50</td>
<td>7000</td>
</tr>
</tbody>
</table>

How have business model factors affected ability to scale and to sustain business?
Two Stove Companies That Have Scaled

First Energy

• ~450,000 stoves sold
• Retrenchment period following detachment from BP in 2009
• Major challenge due to price increases in raw materials for biomass pellet fuel
• Increased pellet price in 2009

Envirofit

• ~150,000 stoves sold
• Business appears to be growing
Business Model Factor #1: Technology/Design

First Energy

**OOJA**

Uses gasifier technology, to burn more efficiently.

Uses pellets made from agricultural waste.

A small fan delivers air to the burning pellets.

**Source:** Wall Street Journal / First Energy

Envirofit

**ENVIROFIT**

Burns 3 times more efficiently than regular wood fire, so very little smoke is created.

Source: Envirofit

Radical Innovation / Complex

Incremental Innovation / Simple
### Business Model Factor #2: Customer Targeting

<table>
<thead>
<tr>
<th></th>
<th>First Energy</th>
<th>Envirosol</th>
</tr>
</thead>
<tbody>
<tr>
<td>Household Location</td>
<td>Rural/Urban</td>
<td>Rural</td>
</tr>
<tr>
<td>Household Income</td>
<td>$2-8/day</td>
<td>&gt;$7/day</td>
</tr>
<tr>
<td>Stove Price</td>
<td>$20-35</td>
<td>$20-30</td>
</tr>
<tr>
<td>Competing Fuels</td>
<td>Biomass / LPG</td>
<td>Biomass</td>
</tr>
</tbody>
</table>
Business Model Factor #3: Enterprise Financing

First Energy

2006-2009
BP Emerging Consumer Markets

2009-
First Energy

Envirofit

Shell Foundation

Substantial seed funding

Envirofit International

Staff salaries

Colorado State Univ
Business Model Factor #4: Sales Channel – Women Entrepreneurs

First Energy

Envirofit

Source: Envirofit

Photo by Mark Thurber
Business Model Factor #4: Sales Channel – Store Fronts

First Energy

Envirofit

Photo by Mark Thurber

Source: Envirofit
Business Model Factor #5: Management Experience – Technology

Source: Shrimali, Slaski, Thurber, and Zerriffi (2011), Energy Policy
Business Model Factor #5: Management Experience – Operations

Source: Shrimali, Slaski, Thurber, and Zerriffi (2011), *Energy Policy*
Business Model Factor #5: Management Experience – Marketing

Source: Shrimali, Slaski, Thurber, and Zerriffi (2011), Energy Policy
Cookstove Dissemination Research

Top-down: “Business models” for distribution

Bottom-up: Factors affecting household cooking choices
## 1000-Household Survey of Cooking Habits in Maharashtra and Karnataka

<table>
<thead>
<tr>
<th>Villages in Maharashtra</th>
<th>Villages in Karnataka</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pune</strong></td>
<td><strong>Belgaum</strong></td>
</tr>
<tr>
<td>Thopatewadi</td>
<td>Hanabar Hatti</td>
</tr>
<tr>
<td>Dhamani</td>
<td>Tarihal</td>
</tr>
<tr>
<td>Rajgurunagar (Khed) (CT)</td>
<td>Raybag (TP)</td>
</tr>
<tr>
<td><strong>Satara</strong></td>
<td><strong>Bail Hongal (TMC)</strong></td>
</tr>
<tr>
<td>Hol</td>
<td>Betadur</td>
</tr>
<tr>
<td>Pande</td>
<td><strong>Dharwad</strong></td>
</tr>
<tr>
<td><strong>Jalna</strong></td>
<td><strong>Bagalkot</strong></td>
</tr>
<tr>
<td>Sukhapuri</td>
<td>Bhandiward</td>
</tr>
<tr>
<td>Ambad (M Cl)</td>
<td>Hubli</td>
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<tr>
<td><strong>Latur</strong></td>
<td><strong>Kakanur</strong></td>
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<tr>
<td>Patharwadi</td>
<td><strong>Kerur (TP)</strong></td>
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<tr>
<td>Dhamangaon</td>
<td></td>
</tr>
<tr>
<td><strong>Nashik</strong></td>
<td><strong>Haveri</strong></td>
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<tr>
<td>Bramhan Wade</td>
<td>Hulgur</td>
</tr>
<tr>
<td>Nilgavhan</td>
<td></td>
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<tr>
<td>Satana (M Cl)</td>
<td></td>
</tr>
<tr>
<td><strong>Sangli</strong></td>
<td></td>
</tr>
<tr>
<td>Bhilwadi</td>
<td></td>
</tr>
<tr>
<td>Takali</td>
<td></td>
</tr>
<tr>
<td>Madhavnagar (CT)</td>
<td></td>
</tr>
</tbody>
</table>
Information Collected by Survey

Usage of different kinds of stoves
Perceived attributes of different kinds of stoves
Stove costs
Fuel costs
Ease of fuel procurement
Perceived health impacts of indoor smoke from stoves
Awareness of improved biomass stoves
Purchase/use of improved biomass stoves
Research Questions to Address

• How do perceived health effects of smoke affect choice of cooking mode?
• Which attributes of a stove are most valued?
• What demographic factors drive uptake and ongoing use of different types of stoves?
• What is the diffusion process for a particular improved biomass stove (Oorja)?
• How do fuel availability factors affect choice of cooking mode?
Survey Conducted March-May 2011

Traditional stove

Oorja

Photos by Himani Phadke
Initial Data Analysis:
Income and Use of Traditional Chulha

Average Monthly Income (Rs)

Time Spent Cooking on Traditional Chulha

<10% 10-20% 20-30% 30-40% 40-50% 50-60% 60-70% 70-80% 80-90% >90%
Initial Data Analysis:
Education and Use of Traditional Chulha

![Chart showing the relationship between time spent cooking on traditional chulha and the average level of highest educational attainment. The x-axis represents the percentage of time spent cooking, ranging from <10% to >90%, while the y-axis shows the average level of highest educational attainment. The chart indicates a trend where higher educational attainment is associated with more time spent cooking on traditional chulha.]
Thank you.

Questions?
Mark Thurber
mthurber@stanford.edu
## Business Model Factors

<table>
<thead>
<tr>
<th>Organization</th>
<th>Selected independent variables</th>
<th>External enterprise funding</th>
<th>Channel involvement</th>
<th>Management experience (operations and marketing)</th>
<th>Scale</th>
<th>Sustainability (if current trends continue)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A C</td>
<td>Incremental</td>
<td>Household</td>
<td>Private</td>
<td>Unknown</td>
<td>Limited</td>
<td>TBD</td>
</tr>
<tr>
<td></td>
<td>Incremental ( &gt;$7/day)</td>
<td>Donor</td>
<td>Significant</td>
<td>Significant</td>
<td>High</td>
<td>Likely</td>
</tr>
<tr>
<td>D^h</td>
<td>Radical</td>
<td>Household ($2–8/day)</td>
<td>Private</td>
<td>Limited</td>
<td>High</td>
<td>Unlikely</td>
</tr>
<tr>
<td>D^{h,c}</td>
<td>Radical</td>
<td>Household ($2–8/day); commercial</td>
<td>Private</td>
<td>Significant</td>
<td>High</td>
<td>Likely</td>
</tr>
<tr>
<td>E</td>
<td>Radical</td>
<td>Commercial</td>
<td>Limited</td>
<td>Limited</td>
<td>Low</td>
<td>Proven</td>
</tr>
<tr>
<td>F</td>
<td>Unknown</td>
<td>Household ($3–7/day)</td>
<td>Private</td>
<td>Unknown</td>
<td>TBD</td>
<td>Unknown</td>
</tr>
<tr>
<td>G</td>
<td>Incremental</td>
<td>Household; commercial</td>
<td>Limited</td>
<td>Limited</td>
<td>Moderate</td>
<td>Possible</td>
</tr>
<tr>
<td>H</td>
<td>Incremental</td>
<td>Household ( &gt;$3/day)</td>
<td>Limited</td>
<td>Limited</td>
<td>Moderate</td>
<td>Possible</td>
</tr>
<tr>
<td>I J</td>
<td>Incremental</td>
<td>Commercial</td>
<td>Limited</td>
<td>Unknown</td>
<td>TBD</td>
<td>Moderate</td>
</tr>
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</table>

Source: Shrimali, Slaski, Thurber, and Zerriffi (2011), *Energy Policy*
Manufacturing: Mass Production

First Energy

Photo by Mark Thurber

Source: Envirofit
Marketing: Attractive Packaging

First Energy

Envirofit

Photo by Mark Thurber

Source: Envirofit
Marketing: Product Demonstrations

First Energy

Source: First Energy

Envirofit

Source: Envirofit
Marketing: Advertisements

First Energy

Source: First Energy

Envirofit

Source: Envirofit