CLEAN HOUSEHOLD ENERGY & INDOOR AIR POLLUTION

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High social costs of traditional biomass use

- Drudgery of biomass collection
- Time consuming cooking
- Indoor and outdoor air pollution
- Diversion of time of women and children from more productive activities
- Physical and mental health problems
- Gender disparity
- Forest and soil degradation
Cooking, Indoor Air Pollution & Health

India Traditional Stove Near Bangalore
Indoor Air Pollution: Periurban Bangladesh
Collection Time and Drudgery
Venting Smoke: Improved Stove
Guatemala
Fuel Substitution: Kerosene and LPG
Cooking Urban India

Kerosene  LPG
How are measurements taken?
Lighting & Cooking Rural India
General Issues: Indoor Air Pollution (IAP) from solid fuels is a major health threat

- A leading cause of illness and death, according to World Health Report-2002 (WHO):
  - 8th top health risk worldwide
  - 4th top health risk in developing countries with high child mortality
  - 3rd top health risk in India, after malnutrition and water-borne diseases

- Particularly affects young children and women
  - Kills 1.6 million infants, young children and women worldwide each year
  - 420,000 or over 25% of these deaths happen in India, mainly in rural areas

- An important factor for achieving Millennium Development Goals (MDG) of halving child mortality and improving maternal health
Burden of Disease attributable to 10 top risk factors (plus urban air pollution) in India, 2000

- Underweight
- Unsafe water, sanitation & hygiene
- Indoor smoke from solid fuels
- Unsafe sex
- Iron deficiency
- Tobacco
- Blood pressure
- Cholesterol
- Zinc deficiency
- Low fruit & vegetable intake
- Urban air pollution

Attributable DALYs, % of total DALYs
Are these estimates of health impacts believable? Yes…

- For example, 70% of India’s households use traditional biomass as the primary cooking fuel, and people spend most of their time indoors, especially women, young children, and elderly.

- Indoor concentrations and exposures to particulate matter and other harmful air pollutants in rural households using unprocessed solid fuels exceed those in the world’s most polluted cities, and are much higher than outdoor air quality health-based standards.

- While highest in colder climate areas with high heating demand, exposure levels also significantly exceed health-based standards for “cooking only” households, even when cooking takes place outdoors.

- In sum, a very large number of people are exposed to a very high level of air pollution inside their homes on a daily basis while strong scientific evidence links exposure to particulate matter and some other air pollutants to health effects.
Key health effects linked to IAP

- ARI/ALRI (young children)
- Chronic bronchitis and COPD
- Lung cancer (coal only)
- Cataract - In India cataracts are highest among women
- Asthma
- Tuberculosis

Consistent evidence from:
- A large body of outdoor air pollution studies
- Environmental tobacco smoke studies
- A rapidly increasing number of solid fuels/IAP studies in rural areas with largely consistent findings
- Cumulative evidence is sufficient to acknowledge the problem and justify action
Household Energy, Indoor Air Pollution and Health

- **India Study (Kseniya Lvovsky SASES)**
  - Rural Andhra Pradesh 412 Households stratified by kitchen configuration (indoor outdoor etc.)
  - 270 HH using wood, 97 wood and dung, 34 LPG or biogas, 11 kerosene
  - PM4 or Respiratory Suspended Particulate Mater (RSPM) was measured

- **Bangladesh Study (Susmita Dasgupta DECRG)**
  - Indoor air quality (PM10) was monitored for a stratified sample of 236 households in Dhaka and Narayanganj using filters
  - PM2.5 was monitored for a subsample of 85 households using constant monitoring technique.
India Study: IAP mitigation impact of kitchen configuration

![Graph showing 24 Hour Kitchen and Living Area RSPM Concentrations for Different Kitchen Configurations in rural AP](graph.png)
India Study IAP mitigation impact of switching to gaseous fuels

24 Hour Exposure of different household members: solid fuel versus gas, AP, India

- Female Cooks (16-60)
- Female Non-cooks (16-60)
- Male (16-60)
- Children under 5

24 hour average exposure, ug/m3

Solid Fuel Using Households
Gas Using Households
Bangladesh Study

Cooking location: Inside (I) vs. Outside (O)
Building material: Mud (M) vs. Other (O)
Space: Kitchen (K) vs. Living room (L)

Bar chart showing mean PM-10 levels:
- IMK: 498
- IML: 475
- OMK: 638
- IOK: 267
- OML: 293
- IOL: 250
- OOK: 210
- OOL: 165
Fuel | Biomass (B) | Clean (CLN)
---|---|---
Cooking location | Inside (I) | Outside (O)
Building material | Mud (M) | Other (O)
Space | Kitchen (K) | Living room (L)

Mean PM-10 (ug/m³)

<table>
<thead>
<tr>
<th>Fuel</th>
<th>Inside</th>
<th>Outside</th>
<th>Mud</th>
<th>Other</th>
<th>Kitchen</th>
<th>Living room</th>
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## Bangladesh: Pollution Factors and PM10 Concentrations: All Fuels

<table>
<thead>
<tr>
<th>Fuel</th>
<th>Cooking Location</th>
<th>Building Material</th>
<th>Space</th>
<th>Abbrev.</th>
<th>Mean PM$_{10}$</th>
<th>Median PM$_{10}$</th>
<th>Houses</th>
<th>Difference in Mean (From BIOL)</th>
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<td>231</td>
<td>187</td>
<td>493</td>
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</tbody>
</table>
Bangladesh: PM$_{10}$ concentrations in 4 houses: kitchens and living rooms.

1. 

2. 

3. 

4.
India: Emissions Along the Household Energy Ladder

Grams Per Meal

- Dung
- Crop Residues
- Wood
- Kerosene
- Gas
- Electricity

- CO
- PM10
India Income Effect:
LPG Use vs. per capita expenditure

Cumulative LPG consumption vs. Per capita expenditure decile:
- Rural
- Urban
- National
- Equal consumption distribution

Deciles range from 0% to 100% cumulative LPG consumption.
Some findings

- **Fully switching** to liquid and especially gaseous fuels is the most effective way to reduce IAP to safe levels.
  
  More prevalent partial switching while continuing to use biomass does not have the same result!!!

- **Cooking outside** reduces levels but does not reduce exposure to safe levels.

- A wide range of exposure levels in solid fuel using households with relatively low levels recorded in some households.

- Factors affecting exposure are complex and need to be better understood.
Switching to Clean Household Fuels: what we learnt

- **Barriers to clean fuel switching**
  - high start-up cost (cylinder deposit fee, stove purchase)
  - high and volatile fuel prices; “lumpy” fuel purchase payments (example: LPG),
  - difficult delivery logistics or lack of supply reliability

- **Problems with designing effective targeted subsidy:**
  - Low budget priority among the poor as long as free or cheap biomass options are available
  - Attractive for higher-income households and other uses (vehicles)

- **Need to focus on:**
  - Income generating alternatives to time spent on biomass collection
  - Raising awareness of health and other benefits of clean fuels and technologies
  - Designing rural energy programs that identify, meet and help sustain demand from users
Conclusion: Barriers to Overcome
What can be done? A menu of options...

Solutions:
- Behavioral change
- Better Housing
  - Windows
  - Kitchen configuration
- Better Stoves
  - Chimneys & hoods
  - Fuel & combustion efficiency
- Better Fuels
  - “Clean” solids
  - Gases and liquids

Examples of interventions:
- Raising awareness of health effects and mitigation options
- Housing programs
- Improved stove programs
- Clean fuel promotion programs

Cross-cutting themes:
- Improving household economic status
- Income opportunities for women
- Female education
- Level-paying field for private sector/rural entrepreneurs
Final Thought: Actual Filters from Bangladesh Study