Agricultural Biomass in China

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Renewable Energy Structure in China in Recent Years

- Hydro and wind power: 30%
- Solar, geo and ocean energy: 9%
- Modern BioEnergy: 2%
- Household stove fuel: 59%

Why Biomass and Biomass Assessment
BioEnergy (M tce) and Its Structure in 2006

Why Biomass and Biomass Assessment

- Bioethanol, 1.95, 1%
- Biogas, 4.5, 2%
- Bioelectricity, 1.05, 0%
- Household stove fuel, 259, 97%
Biomass Assessment-Sampling

Two levels of sampling:
Random sampling of households in the randomly selected villages and towns, to guarantee enough samples.

Taking a district of a city as an example, firstly 53 villages were selected and then 525 households were selected in these villages.
Biomass Assessment-Questionnaire

Household questionnaire
- family members
- economic status
- energy consumption
- heating and cooking
- altitude to energy

Village and town
- natural resources and biomass resources
- Economy status
- Biomass/agricultural development strategy and plan

Some data could be derived from the internet and from governmental strategies
Ground Stove for Heating
Chinese Kang

Indoor air temperature increased by 4-5°C
Household semi-gasifiers
High efficiency biomass stove and biogas stove
Coal stoves for heating / cooking
New Semi-gasifier
Energy consumption scenario in countryside

- Energy structure is affected by economy. More coal is consumed in richer region. The less development region uses more biomass as fuel.

- About 22% of the household annual income is spent to buy energy. As a comparison, the ratio in US is about 5% in 2004 and 5-6% in Beijing City in 2005.

- Farmers houses poor thermal insulation and lower stove efficiency are main factors for more heating energy consumed.
Willingness to invest by farmers

About 60% of farmers are willing to invest 30% of the total budget

About 30% of farmers are willing to invest 50%
Biomass Technologies

- Direct combustion
  - stove combustion
  - boilers/burners
  - Briquetting
  - garbage combustion

- Physical conversion technology
  - wood carbonization
  - Gasification by hydrogenation
  - oil by hydrogenation (BTL)

- Chemical conversion technology
  - landfill and composting
  - biogas fermentation
  - ethanol technology
  - oil from energy-plants

- Feed/Fertilizer

- Industrial purposes
Household IAQ monitoring

CO monitoring devices

- HOBO CO Logger
- Chinese national standard

PM2.5 monitoring devices

SO2/NH3 monitoring devices

- Spectra monitor
- QC—1 gas sampling
Stoves impact on Indoor Air Quality (IAQ)

A typical family in Western China

Old style of efficient biomass stove with 7.5 kg daily consumption of biomass

New efficient biomass stove with 2.5 kg daily consumption of biomass
Kitchen ventilation on IAQ

![Graph showing CO concentration over time under different ventilation conditions.]

- Door/window open
- Door O/window C
- Standard
- Outside

Different ventilation conditions' CO concentration
Fuels Impact on IAQ

- Plant residue
- Coal
- Biogas
- LPG

![Bar chart showing emissions of CO, PM$_{2.5}$, and SO$_2$ for different fuels.](chart)
A typical family in Western China

CO浓度 (mg/m³)

Coal

Biogas
Fuel/Stove impact on SO2 Concentration

![Graph showing SO2 concentration for different stages and regions.](image)
Fuel/stove impact on PM2.5

Different places/regions

PM$_{2.5}$ concentrations (μg/m$^3$)

Pro-  Post-  US EPA?
Stove emission monitoring
Proposed Collaboration: Clean Household Stove Center

- Stoves collection (worldwide)
- Stove technical innovation
  - Convenient  Fast  Efficient
  - Clean (low emission)  Beautiful  Affordable
  - Transferable / Portable
- Indoor Air Quality monitoring
- Close links with stove manufacturers and consumers
  - e.g.: CAREI: Chinese Association of Rural Energy Industries
- Close collaborations among all of us here
Forum of Renewable Energy Promotion in Developing Countries
Economic analyses on rural energy technologies for household application

<table>
<thead>
<tr>
<th>Rural Energy Construction/Household</th>
<th>Investment for improvement/RMB</th>
<th>Energy saved/%</th>
<th>Period/a</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solar house</td>
<td>4500</td>
<td>50–70%</td>
<td>5 to 6</td>
</tr>
<tr>
<td>Chinese Kang</td>
<td>1500</td>
<td>40%</td>
<td>2 to 3</td>
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<tr>
<td>Stoves for cooking</td>
<td>200</td>
<td>40%</td>
<td>1 to 2</td>
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<tr>
<td>Heating system</td>
<td>1000–2000</td>
<td>40%</td>
<td>2 to 4</td>
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<tr>
<td>Solar house + Chinese Kang</td>
<td>6000</td>
<td></td>
<td>6 to 7</td>
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<tr>
<td>Solar house + Chinese Kang + Stoves for heating</td>
<td>7000–8000</td>
<td></td>
<td>6 to 8</td>
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<tr>
<td>Chinese Kang + Stoves for Cooking</td>
<td>1700</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>Chinese Kang + Stoves for cooking and heating</td>
<td>2700–3700</td>
<td></td>
<td>3 to 4</td>
</tr>
</tbody>
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