Access to energy is not a right to all

**An issue of QUANTITY**

- **Low income countries**
  - 1.2 billions no access to electricity

- **Middle Income Country**
  - 2.6 billions rely on traditional biomass for domestic need
  - 90% in informal suburbs
  - 80% in rural area
  - 95% in LIE

- **High Income Country**
  - 1 billion, no access to reliable electric grid, regular provision of EE
  - 15% efficiency
  - 4 million deaths /y
  - 5-15% annual outages

**An issue of QUALITY**

- Affordable (energy may cost 10 times EU standard), reliable, safe and clean...
BIO-ENERGIES, ENVIRONMENT AND DEVELOPMENT,
a question of supply chains...

- Arab «Springs» and more, an issue to sort out
- Overcoming biomass for domestic use
- Valorizing biomass for energy empowerment
Bioenergy, the heart of the energy mix for Africa

- **Bioenergy use** – mainly fuelwood and charcoal – outweighs demand for all other forms of energy combined, a **picture that changes only gradually even as incomes rise**
- **4/5 of five people** in SSA rely on the traditional use of solid biomass
- A **40% rise in demand for bioenergy to 2040 exacerbates strains on the forestry stock**, with efforts to promote more sustainable wood production hindered by the operation of much of the fuelwood and charcoal supply chain outside the formal economy.
- Promotion of more **efficient biomass cookstoves** reduces the health effects of pollution

650 million people – more than 1/3 of an expanding population **still cook with biomass in an inefficient and hazardous way in 2040.**
Biomass for domestic uses
Technologies for cooking
Alternatives to traditional devices

Three Stones - traditional cooking systems (TCS)

• Strong impact on land degradation
• Strong impact on local health
• Strong impact on social development

Cooking Alternatives

1. Promoting Improved Cooked Stoves (ICS) using non commercial biomass
   >>> longer term
2. Shift to Modern Energies gas, electricity, kerosene or II gen biomass
   >>> shorter term
Technologies for cooking

Impact of traditional devices

Three Stones - traditional cooking systems (TCS)

• Strong impact on **local health**

Millions of deaths

- MNUMERO OGGI è a 4.5 milioni di morti non 1.5

- Unsustainability
  - For human health
  - For environment
    - land degradation
    - deforestation
Technologies for cooking

Impact of traditional devices

Three Stones

traditional cooking systems (TCS)

• Strong impact on land degradation

Three Stones

traditional cooking systems (TCS)

• Strong impact on social development
Technologies for cooking

Literature Review: Village Characterisation

Selected criteria

- **Season: dry/wet hot/cold**: dependence on climate conditions
- **Family size**: scale effect link to the number of people in the family
- **Ease of Wood Access**: presence of forest and accessibility
- **Rural/peri-urban**: location of the village/area
- **Grid connection and fuel alternatives**: presence of infrastructure and access to other modern fuels
- **Economic Dev/local condition**: presence of other activity then subsistence: energy may be used not only for basic needs but also for agriculture and rural industry
- **Wood/Charcoal (efficiency)**: shifting to Charcoal increase the quantity of biomass used (sometimes the information may be double-accounted in the criterion Rural/Urban)
- **Nutritional Habit**: this is one of the key elements and has a cultural and social origin
Technologies for cooking
Classification based on fuel typology

1. Solid (traditional) fuels
   - Wood
   - Charcoal
   - Coal
   - Agricultural Residue
   - Dung

2. Modern Fuels
   - **Solar** Energy
   - **Electricity**
   - **Gas** → LPG, Natural Gas & Biogas
   - **Liquid** → kerosene, Ethanol, Methanol
Technologies for cooking

Classification based on fuel typology

Stoves can be classified on the basis of feeding fuel.

The strong and negative impact generated by the use of the three-stone fire stoves can be mitigated through the use of alternative cooking technologies and/or the shift to modern fuels (gas, electricity, biofuels, sun).

Traditional cook stoves
- Mud stoves
- Metal stoves
- Clay stoves

Improved Cook Stoves
- Rocket wood stoves
- Gasifiers

Modern Energy Stoves
- Gas stoves
- Liquid stoves
- Electric stove

Efficiency
Pollutant emissions
Cooking Stoves

Classification based on performances

Stoves performances: qualitative evaluation

<table>
<thead>
<tr>
<th></th>
<th>Traditional Wood stoves</th>
<th>Traditional Charcoal stoves</th>
<th>Rocket wood stoves</th>
<th>Gasifiers</th>
<th>Liquid/electric/gas stoves</th>
</tr>
</thead>
<tbody>
<tr>
<td>Efficiency</td>
<td>★★★★★</td>
<td>★★★★★</td>
<td>★★★★</td>
<td>★★★★</td>
<td>★★★★★</td>
</tr>
<tr>
<td>CO emissions</td>
<td>★★★★★</td>
<td>★★★★</td>
<td>★★★★</td>
<td>★★★★</td>
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<td>PM emissions</td>
<td>★★★★</td>
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</tbody>
</table>

Optimum and long term solution
Power from Biomass
Biomass indicates different sources

Refers to the biodegradable fraction of organic products and residuals:
- agriculture, forestry, industrial activities dealing with organic matter.
- organic fraction of urban waste

A number of thermo-chemical processes exist:
- Biomass gasification is suitable for low generation capacities
- Biogas reactors are mainly suitable for cooking purposes

ASSESSMENT: Biomass assessment is not easy

Biomass resources assessment is very complex:
- a comprehensive analysis of the biomass production chain is always required
- biomass drivers and barriers need to include competition with other resources
- studies about biomass resources potentials refer to large areas
- very little or no information is available for specific sites in DCs
  - GIS-based remote techniques can provide appropriate information
### Assessment: Biomass assessment is not easy

<table>
<thead>
<tr>
<th>Forest residue</th>
<th>Agricultural residue</th>
<th>Agro-processing residue</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forest pruning</td>
<td>Paddy straw</td>
<td>Rice husk</td>
</tr>
<tr>
<td>Wood from plantations</td>
<td>Wheat straw</td>
<td>Cashew nut shells</td>
</tr>
<tr>
<td>Wood from marginal lands</td>
<td>Maize stalks</td>
<td>Oil seed shells</td>
</tr>
<tr>
<td>Grasses and bushes</td>
<td>Cotton stalks</td>
<td>Oil cakes</td>
</tr>
<tr>
<td>Wood pulp</td>
<td>Maize cobs</td>
<td>Coconut shells and fibre</td>
</tr>
<tr>
<td>Saw dust</td>
<td>Mustard stalks</td>
<td>Coffee and tea waste</td>
</tr>
<tr>
<td>Bamboo</td>
<td>Millet straw</td>
<td>Bagasse</td>
</tr>
</tbody>
</table>

*Different types of biomass.*
Biomass gasifier power station

TECHNOLOGY OVERVIEW

The gasification process
- takes place in the gasification reactor, a closed vessel, normally cylindrical in shape
- biomass is subjected to partial combustion with limited supply of air
- the ultimate product is a combustible gas mixture known as producer gas: carbon monoxide, hydrogen, nitrogen, carbon dioxide and methane
- thermal value depends on the type of biomass used: range 3800-6300kJ/Nm³

Gasification of biomass takes place in four distinct stages
- drying, pyrolysis, oxidation/combustion and reduction
- gasifiers are classified in 3 categories: fixed bed, fluidised bed, entrained flow

There are three types of fixed bed gasifiers:
- In downdraft gasifiers the gases and solids flows in a descending packed bed.
- In updraft gasifiers, the gases and solids have counter-current flow.
- In crossdraft gasifier, solid fuel moves down and the airflow moves horizontally

Gas contains a high level of tar and organic condensable and requires cleaning
Electrification and Distributed Generation

Biomass gasifier power station

TECHNOLOGY OVERVIEW

1. Moving or Fixed Bed Gasifiers
   - Updraft Gasifiers
   - Downdraft Gasifiers
   - Crossdraft Gasifier
Electrification and Distributed Generation

Biomass gasifier power station
Electrification and Distributed Generation

Biomass gasifier power station

TECHNOLOGY CONSTRAINTS

Biomass gasification is not suitable for home-based applications:
- minimum size plant is around 7-8kW electric power
- with a power generation efficiency in the range 10-20%.

Management of supply chain

Is crucial in order to assure the overall sustainability

Operation and Maintenance requires local capacity

To keep the plant operating safely and under security.
Electrification and Distributed Generation

Biomass gasifier power station

ECONOMICS and ENVIRONMENTAL IMPACT in a glance

Capital cost for gasifier varies

• for small installation **10-35 kWe** : 850-2200 $/kWe
• for medium-large **50-2000 kWe** : 1200-7600 $/kWe

The Levelized Cost of Energy (LCOE)

• is **0.08-0.14 $/kWh**.

Greenhouse gas (GHG) emissions,

• When the supply chain is managed in a proper way, CO2 emissions from combustion are compensated by the growth of new biomass
• other emissions: fuel supply, power station construction and maintenance are considered.
• This consideration leads to a range from **63-70 g CO2/kWh** (only CO2 is taken into consideration and non CO2-equivalent emission)