BIOMASS GASIFICATION FOR OFF-GRID ELECTRIFICATION OF SOUTH-SAHARAN AFRICA

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Pôle Goundi Project

Chad condition:
- Poverty index of 55%
- 97.8% of Chadian households without access to electricity
- Absence of an electrical infrastructure

Aim: Provide the infrastructures needed to stimulate the technical, economical and social activity in Goundi.

Construction of an **hybrid electricity generation system** (photovoltaic, solar thermal and biomass gasification technologies) and **small transmission network**
Initial stage of the project

**TARGET:** Install and operate 25 kVA generation system in order to demonstrate project’s viability.

**Technology:** **BIOMASS GASIFICATION**

**Advantages**
- Stimulation the local economy
- Increased availability of food
- Use of agricultural waste to generate electricity
- Reduction of unemployment rates

**Drawbacks**
- Maintenance of facilities
- Availability of spare parts
Biomass gasification

Food purposes

Energy purposes

Power Pallet (20 kW):
- GEK Hot TOTTI gasifier
- Spark ignition engine
- Electricity generator
- PCU (Process Control Unit)
System description

Multi-stage gasifier GEK Hot TOTTI:

- Subatmospheric pressure operation
- Innovative design with several heat exchanges which transform waste heat into useful heat inputs.
- Downdraft gasifier
- Physical separation between the drying and the pyrolysis zones
- Syngas cleaning: cyclone and packed bed filter
- Start-up system
System model (1)

- The model simulates the **entire system** in order to:
  - Analyze the operating parameters and the performance of the system.
  - Facilitate the design of other gasification equipment which would extend the power capacity of the generation plant.
System model (2)

- **Gasification process model (Cycle-Tempo®)**
  - Based on thermodynamic equilibrium
  - Simulated through several reactors with intermediate separations of certain components in order to achieve closer results to reality.

- **Spark ignition engine model (Matlab®/Simulink®)**
  - Estimation of the engine’s power curve when operating with syngas.
  - Dynamic model.

- **Electrical system model (Matlab®/Simulink®)**
  - Simulated with blocks from the toolbox SimPowerSystems®
Results and discussions

• Gasification process model has allowed the analysis of the steady state behaviour of the system and the characteristics of the syngas obtained from two types of biomass: corn cob hearts and corn stalk.

• The power curve of the engine has been calculated with the LHV of syngas.

• Two disturbances have been simulated with the dynamic model of Simulink®:
  - Switch on of the centrifugal pump
  - Momentary reduction of the heating value of the syngas.
Conclusions

• Biomass gasification is suitable for small-scale electricity production.

• Pôle Goundi project will have noticeable social and economical impact in Goundi.

• Advanced simulation tool has been developed.

• Power Pallet® system is currently being tested before its shipment to Chad
  – Get further information about its operation
  – Enable the validation of the model and the adjustment of simulation parameters to obtain simulation results as close as possible to reality.
Thank you for your attention

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