Combination of renewable energy systems for rural electrification: the case of Biogas and wind turbines in Bamdzeng Village in Bui Division North West Region of Cameroon.

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Presentation

- Introduction
- Renewable energy research/outreach at the university of Dschang
- Case study: Presentation of Bamdzeng village Kumbo
- The biogas digester
- The wind turbine
- Socio environmental impact of the project
- Conclusions
- Acknowledgements

Introduction

- The importance of energy for the wellbeing of mankind cannot be overemphasised
- Man needs energy for cooking, heating, lighting, shaving and powering machines for agriculture etc.
- Mans daily energy consumption indicates his standard of living
- Energy is supplied mostly as electricity from carbon, petroleum and natural gas
- These conventional sources account for over 80% of world energy production and use.

Energy Situation in Cameroon

Aging plants, increase in population and seasonal fluctuation in the volume of rivers used for electricity generation has brought about energy crises

No Improvement after privatisation and installation of thermal plants

Electrified areas experience erratic power affects business and social activities

Poor roads state affects distribution of petroleum products.

For example in the extreme North Region of Cameroon only 0.2% of the population has access to cooking gas.

Problems with conventional Sources

- Supply and prices controlled by world politics
- Global warming. By 2100 world temperature would have increased by 3.5°C causing irreversible changes in world climate
  - This means the disappearance of many coastal cities around the world
- Many oil wells will dry up before 2050 because consumption is faster than formation
- Increased international regulation affecting the consumption of fossil fuels (allocation of carbon credits)

Problems with conventional sources cont.

- Cost of exploitation is on the rise due to emerging challenges such as too much water to handle and international regulation on environmental management.

- Not too wise to have everybody connected on one grid line. A problem for one becomes a problem for all.

- Many roads in developing countries where available are seasonal and do not permit the smooth distribution of petroleum products.

Therefore: Renewable Energies

Energy gotten from renewable resources which are naturally replenished like sunlight, wind, rain, geothermal, hydro and biomass

Advantages

- Cleaner and available almost everywhere
- Inexhaustible if sustainably harnessed.
- Environmentally friendly.
- Checks global warming.
- No need for long distance transportation.
- Source of income through carbon credits.
- Relatively cheaper in the long run.

Hence our interest in renewable energies at the Renewable Energy Laboratory University of Dschang

Products of the Laboratory to date

- Wind Turbines (0.5 -7 kW)
- Micro hydro systems(1-10 kW)
- Biogas Digesters
- Solar thermal and electrical systems
- Producer gas
- Energy efficient lighting units and buildings

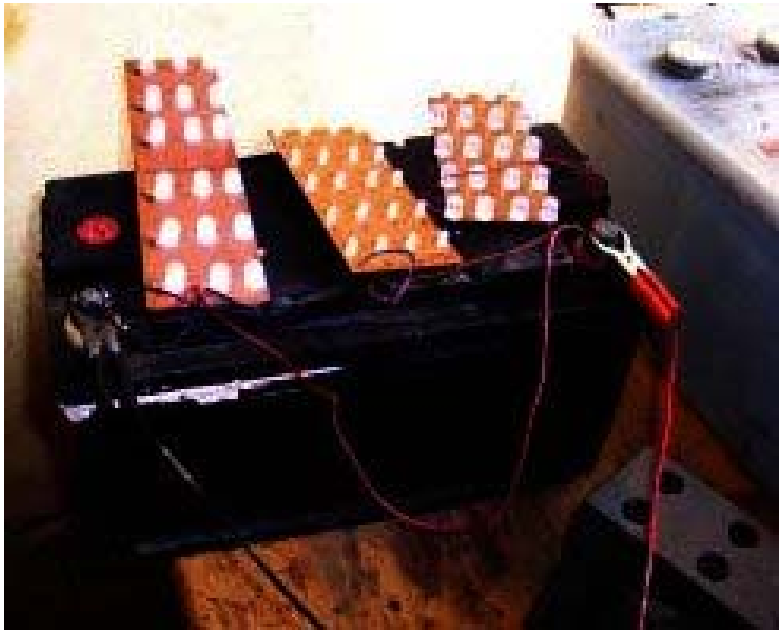
Some wind installations

Micro wind energy systems ≤ 10kW

Winding of permanent magnet type wind generator

Series production of wind turbine blades and stators

LED Lighting systems 12 volts and 230 volts



Intermittent absorption solar refrigeration system

Solar dryers for Agricultural produce

Solar dryers for agricultural Produce Cont.

Products from solar dryers

Red pepper dried in solar dryer and outside the drier

Cabbage dried in the solar dryer and outside the dryer

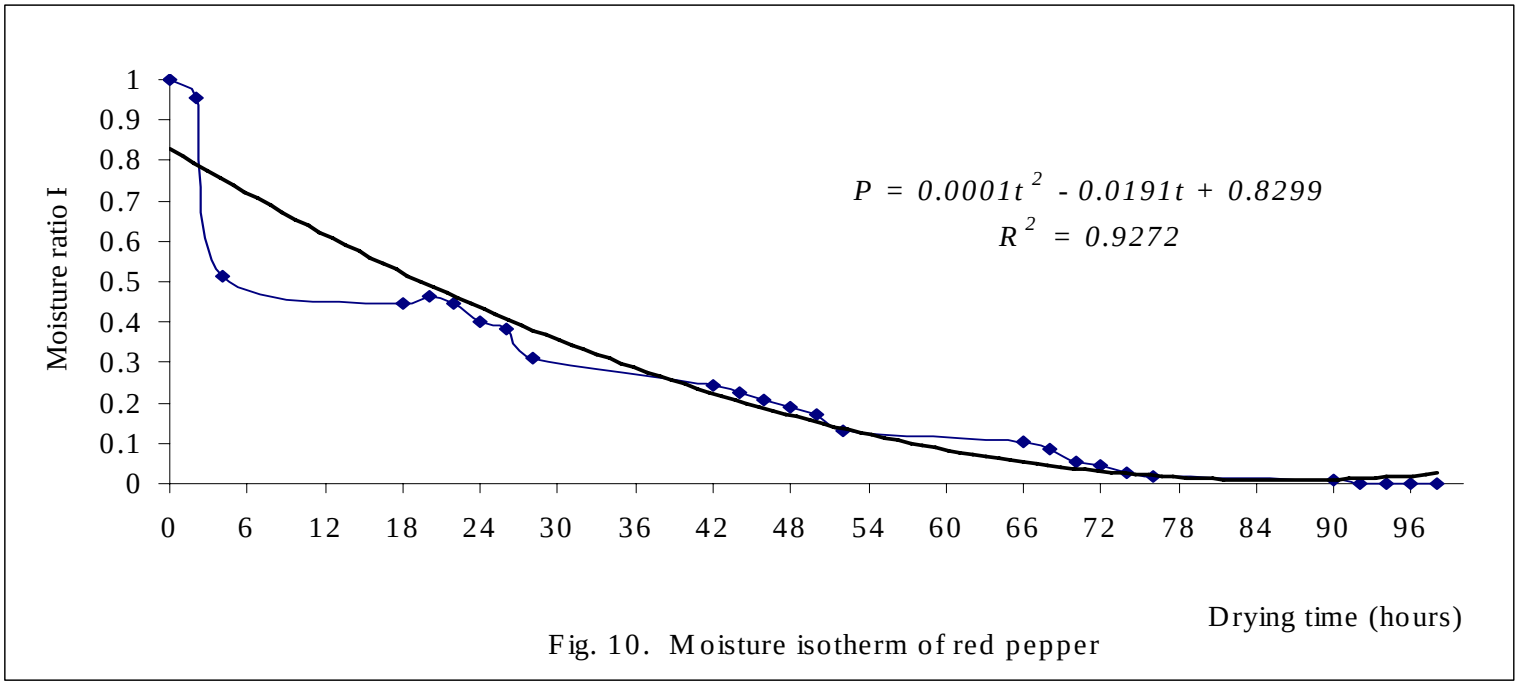
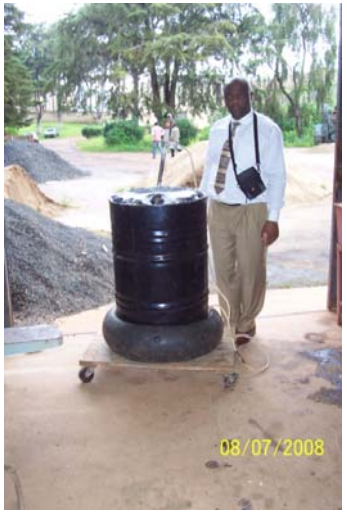


Fig. 10. Moisture isotherm of red pepper

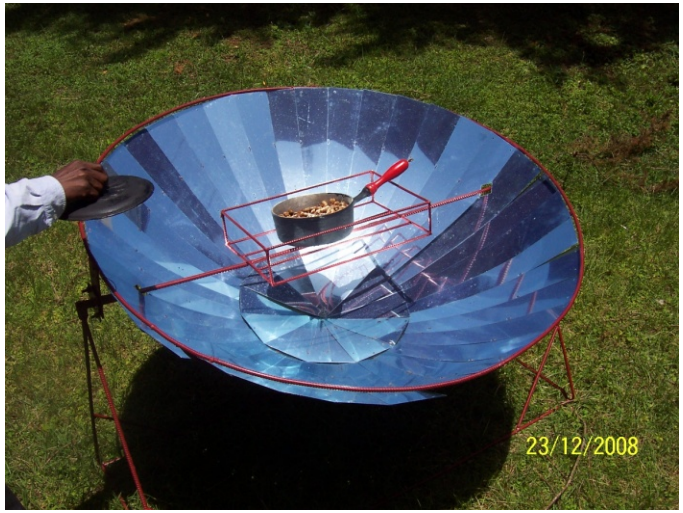
Drying on the highway produces poor quality products

Solar still for water purification

Small and industrial scale biogas digesters for cooking gas and electricity generation



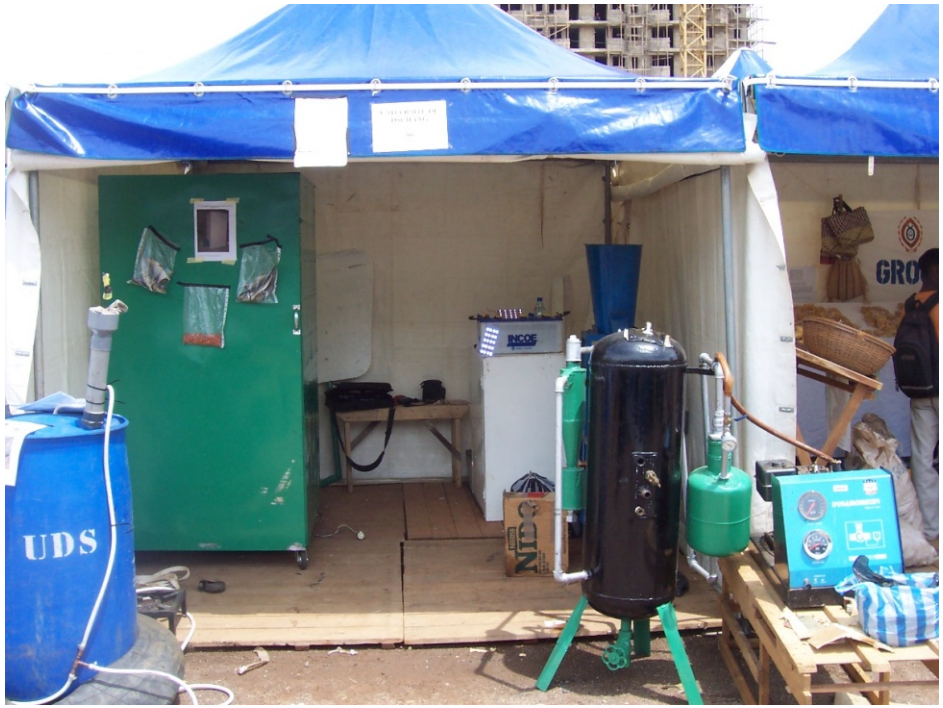
Solar cookers



Biogas systems continued (Fix dome burnt bricks)

Biogas systems continued

Producer gas plants

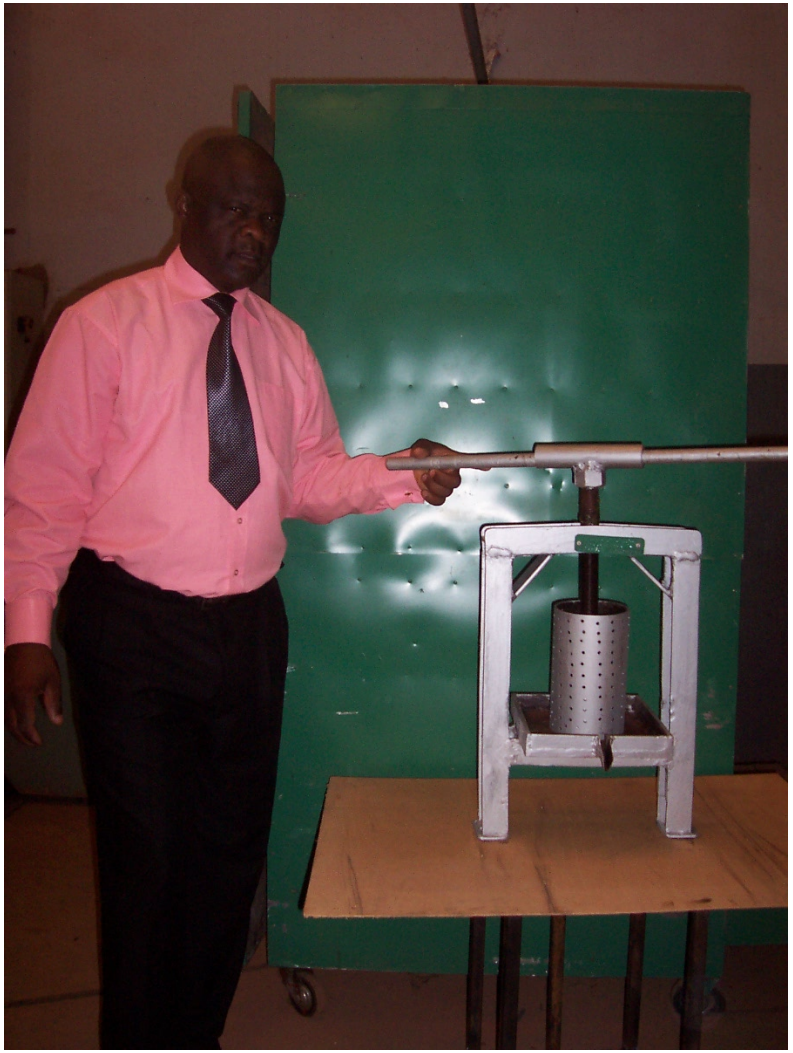


Case study: Biogas and wind energy technology installed in Bamdzeng village

Villagers are nomadic grazers

Village accessible through a seasonal track suitable only for high performing four-wheel drive vehicles

Assorted oil presses for vegetable oil extraction



Jatropha press and oil utilisation

Soap making using jatropha by rural women

Presentation of Bamdzeng cont.

- About 10 km from Kumbo town or from national electricity grid line
- Village population estimated at about 1000
- The village experiences relatively high wind speeds with averages of up to 10m/sec
- Two weekly trips to Kumbo town recharge cell phones or to have a hair cut.
- Main source of energy in the village was firewood from the wild
- Activities of the villagers threaten 3 H2O catchments for neighbouring villages causing serious environmental issues
- The village obtained funding for a small community college of Organic Agriculture but electricity was the main problem threatening the running of this project.
- Grid extension estimated at 400 million FCFA (excluding road construction).

Average temperatures in Kumbo:

Month	2007	2008	Average
January	23,9	21,4	22,65
February	22,1	22,9	22,5
March	23,1	24,0	23,55
April	24,8	23,5	24,15
May	22,1	22,8	22,45
June	22,5	23,1	22,8
July	22,2	**21,8**	22
August	22	21,8	21,9
Septembre	21,5	23,6	22,55
October	22,7	23,4	23,05
November	**20**	23,6	**21,8**
Decembre	21,8	25,1	23,45
Average	22,6	23,1	**22,85**

Source : Annual Report of the Delegation of Agriculture and Rural Development Kumbo for 2007and 2008.
Values for Bamdzeng lacking but night temperatures of 13°C are not uncommon

Energy solution proposed and executed

- Biogas digester for the production of methane (biogas) from cow dung since the area is grazing land and the school has some 50 cows already.

- Wind turbine for the generation of electricity for lighting, refrigeration and running of computer equipment.

- Jatropha cultivation along hedges to provide fuel for generator

Design of the Digester

- $Q_g = nq_m$ m^3 per day
- Where Q_g = Quantity of gas to be produced m^3
- n = number of people to benefit from the gas
- q_m = daily percapita gas requirement which is estimated by GTZ (1989) Kuria et Maringa (2008) to be between 0,42m^3 and 0,5m^3
-

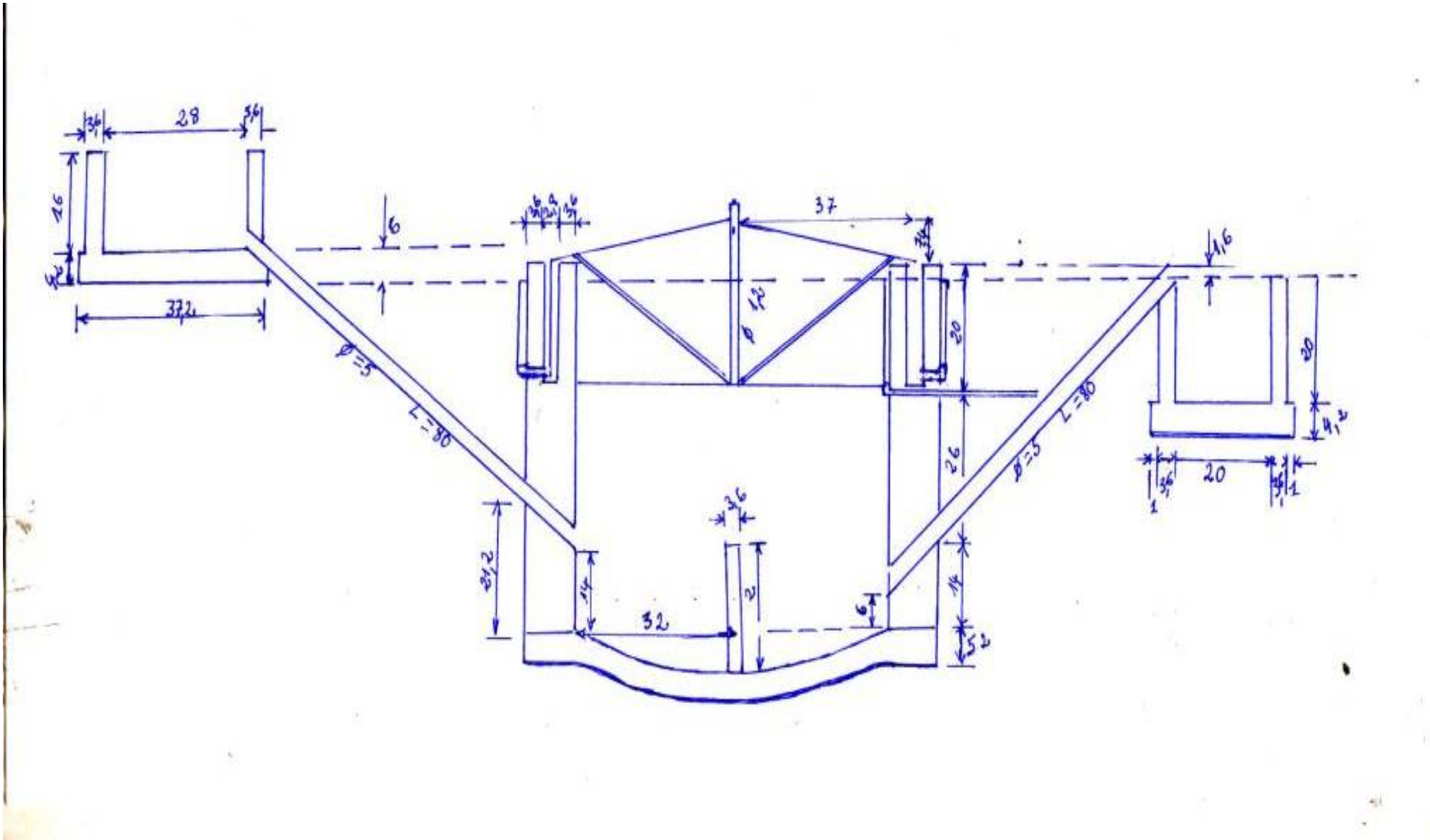
- Estimation of the volume
- 6.2 kg of cattle dung produces 340 l of biogas daily
- 1kg should be diluted with 1.5 kg of water
- Volumetric flow rate =0.82 m^3 per day
- Digester volume = Retention time x daily flow rate = 0.82 x 30 = estimated at 25 m^3

Estimation of the volume of the gas reservoir

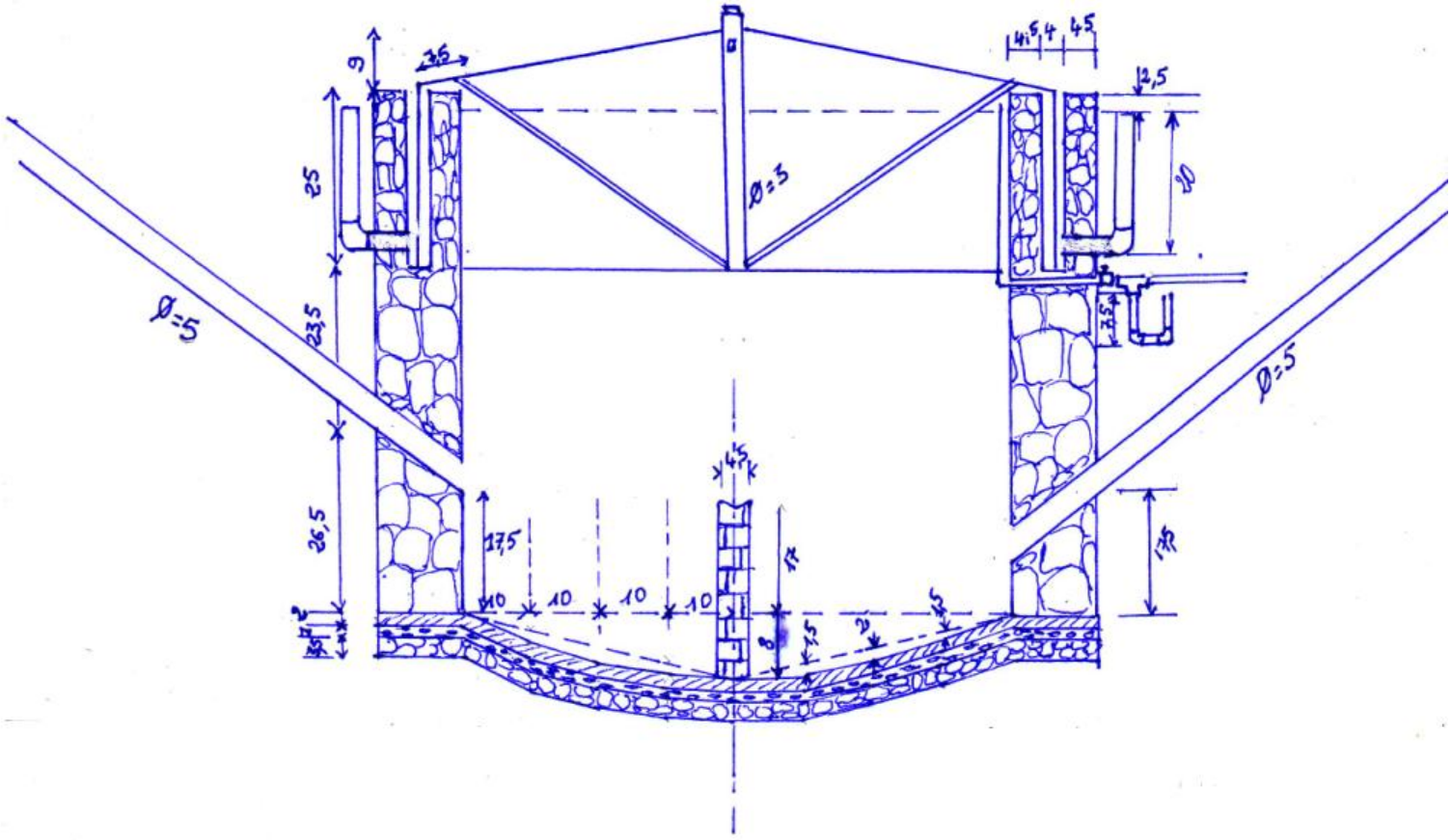
- Daily gas consumption, Q_{cmh}= daily gas production Q_g / total time used in consumption T in m^3 per hour

- Other parameters taken into consideration
  - Volume of pre-treatment tank, volume of exhaust tank
  - Delivery and exhaust pipe diameters
  - Effluent flow characteristics

Digester lay out



Digester plans



Construction

Foundation and building

Construction cont.

The gas holder

Construction of the gas reservoir

Piping to the Kitchen and to the poultry

Gas production

Digester before gas production

Digester filled with gas

Gas consumption

Clean burning flame

Pot on fire

Heating the poultry unit

Tableau 1: Cost of construction of the digester.

Item	Volume (m^3)	Coût financier (FCFA)	Coût moyen (FCFA/m^3)
Digester	25	813.050	32.522
Pre-treatment reservoir	1,23	33.785	27.467
Discharge reservoir	2	31. 920	15.950
Gas holder	10,8	383.700	38.994
Total (FCFA)			**1.262.455**
Cost per FCFA/ m^3 of digester)			**50.498**

Results of economic analysis

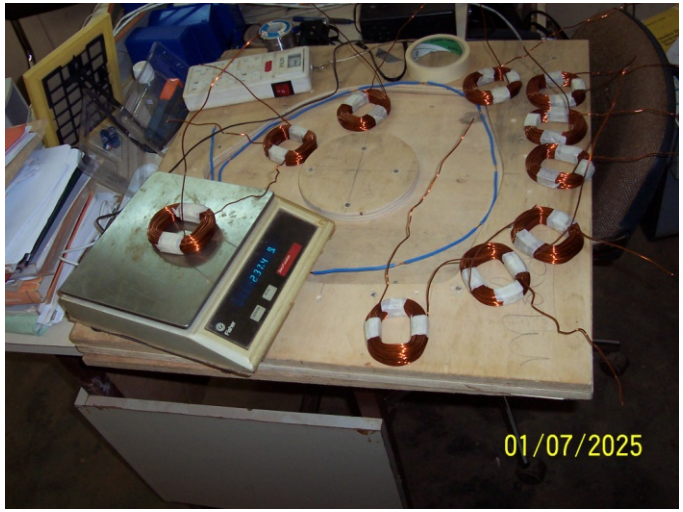
- Gas production is 9.48 m^3 perday
- Pay back period is 16 months
- Digester substitutes 32.85 tonnes of wood per year which in Kumbo would cost up to 3 285 000 frs CFA

Wind Turbine designed for the project

- The permanent magnet ND 40 obtained
- The rotor was made from local wood species carved to produce aerodynamic lift when wind passes through the bade. The plan proposed by Hugh Piggot 2003 was used to carve the blades.
- The power was determined by $P= 0.5 \dot{\rho} AV^3$

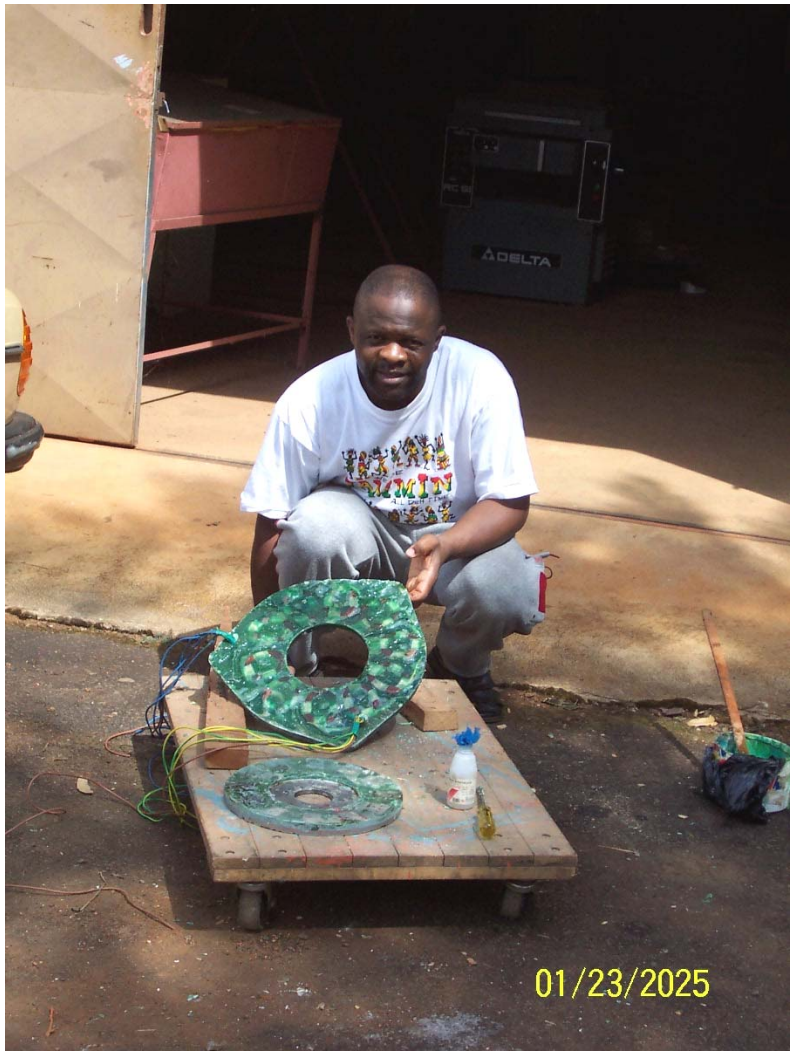
  Where P= power rating in watts, $\dot{\rho}$=density of air kg/m^3, A = cross sectional area swept by wind turbine blades and V= wind speed in m/sec
- The minimum cut in speed = 3m/sec
- German furling system for protection
- The wind generator is made of ten sets of 180 turn coil
- The coil arrangement sand which the 2 magnetic discs which rotate with the rotor cutting the strong magnetic filed and creating electricity.

Winding of the generator



Fabrication of the magnetic discs

Casting of coils in polyester resin



Casted stator is ready for mounting

Fabrication of the stator

Completed parts of the generator

Antirust protects parts from rust

Assembled wind generator

Carving of propeller blades

Wind turbine parts Two rotors and a stator

Propellers are protected from adverse whether conditions

Assembled propellers

Field tests at the university wind Farm

Machine ready for transport to Kumbo

Installation and tests at the organic college

Installation of wind machine cont.

Socio-economic impact of the project

- Huge annual savings to the community college. No more burning of diesel for electricity generation
- No more cutting of fuel wood from the wild.
- Villagers no longer have to trek for 10km to charge their cell phones.
- Standard of living at the college has improved with purchase of computers and refrigerators
- Continuous electricity for the whole year due to strong winds

Conclusions

- The solution to Cameroons energy crises does not only lie in the provision of multibillion dollar energy projects but in small off grid sustainable energy projects that can keep communities independent.

- Many of such projects might provide energy surplus without grid expansion

Special thanks

- To the organisers of this event and to the entire team of the