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Innovative Solutions for Sustainability

Challenges to monitor energy output of biogas projects (AMS-I.C.)

Practitioners Workshop

on enhancing the usability of CDM methodologies for household cooking energy supply

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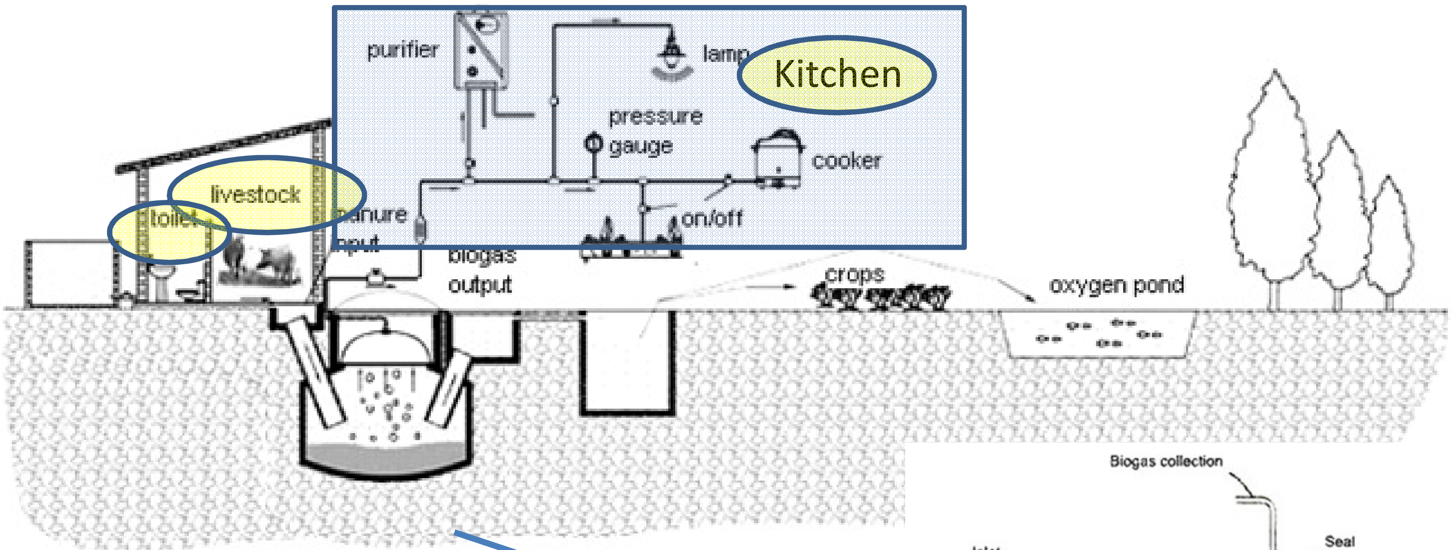
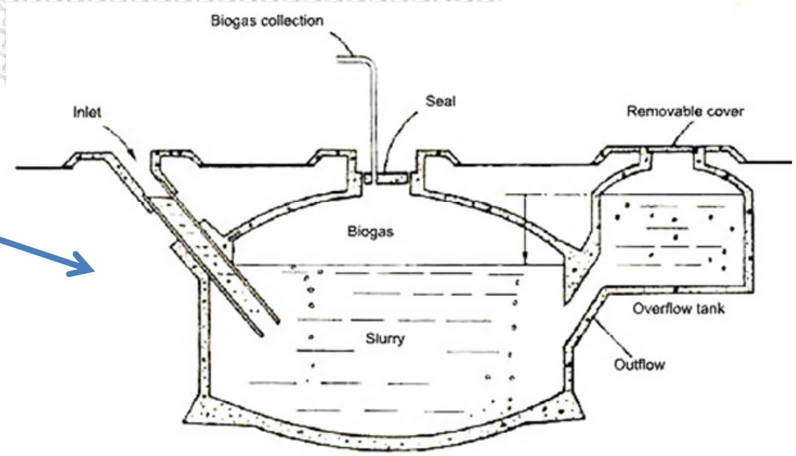
Case example:
Three improvements biogas digester plant





Fossil thermal energy; honeycomb coal

Figure 1. Biogas digester site

Figure 3. Honeycomb coal storages in retail shop and in the house

Figure 2. A honeycomb coal briquette and coal stoves

Baseline emissions

- The simplified baseline is the fuel consumption of the technologies that would have been used in the absence of the project activity times an emission factor for the fossil fuel displaced
- For household or commercial applications/systems, whose maximum output capacity is less than 45 kW thermal and where it can be demonstrated that the metering of thermal energy output is not plausible, as in the case of cooking stoves, gasifiers, driers, water heaters etc., **efficiency** of the baseline units shall be determined by adopting one of the following criteria:
  - (a) Highest measured operational efficiency over the full range of operating conditions of a representative sample of units with similar specifications, using baseline fuel. The efficiency tests shall be conducted following the guidance provided in relevant national / international standards;
  - (b) Highest of the efficiency values provided by two or more manufacturers for units with similar specifications using the baseline fuel;
  - (c) Highest efficiency from referenced literature values or default efficiency of 100%.

Project emissions and emission reductions

Project emissions

- Any significant emissions associated with project activity within the project boundary;
- Leakage

Emission reductions

- $ER_y = BE_y - PE_y - LE_y$

Where:

- ER_y Emission reductions in year *y* (tCO_2e)
- BE_y Baseline emissions in year *y* (tCO_2e)
- PE_y Project emissions in year *y* (tCO_2)
- LE_y Leakage emissions in year *y* (tCO_2)

Monitoring (1/2)

- 30 (a) Metering the energy produced by a sample of the systems where the simplified baseline is based on the energy produced multiplied by an emission coefficient;
- 30 (b) Metering the thermal and/or electrical energy produced;
  - (i) In the case of heat energy (e.g., hot air, hot water), direct measurement of flow and temperature is required.
  - (ii) In the case of steam energy, direct measurement of flow, temperature, pressure is required to determine enthalpy of the steam.
- **30 (c) If the emissions reduction per system is less than 5 tonnes of CO_2e a year:**
  - **(i) Recording annually the number of systems operating (evidence of continuing operation, such as on-going rental/lease payments could be a substitute), if necessary using survey methods;**
  - **(ii) Estimating the annual hours of operation of an average system, if necessary using survey methods. Annual hours of operation can be estimated from total output (e.g., tonnes of grain dried) and output per hour if an accurate value of output per hour is available.**

Monitoring (2/2)

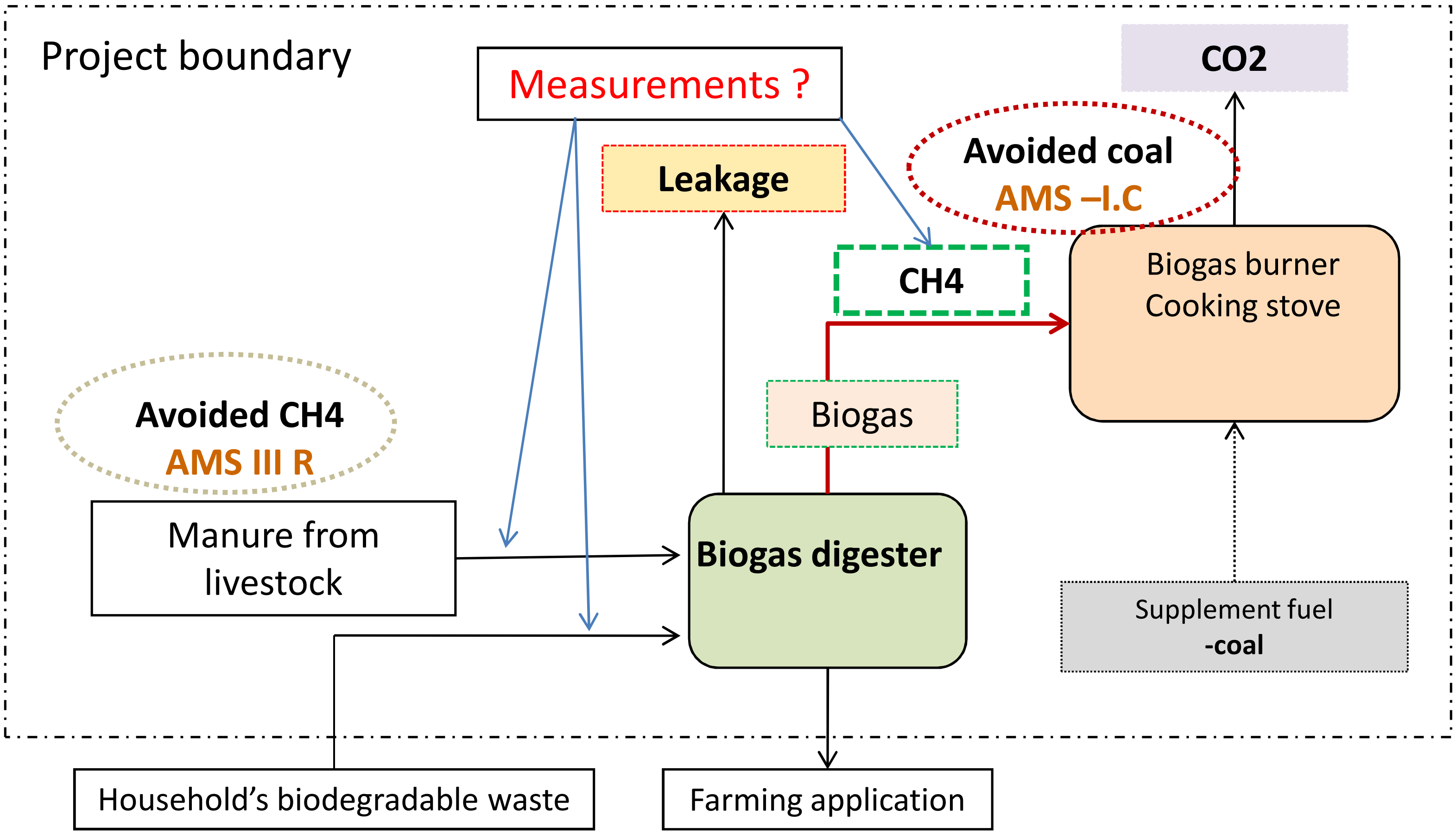
- **30 (d) For household or commercial applications/systems, whose maximum output capacity is less than 45 kW thermal and where it can be demonstrated that the metering of thermal energy output is not plausible, as in the case of biomass stoves, gasifiers, driers, water heaters etc, the project output energy shall be estimated based on consumption of the biomass (in terms of energy quantity) times the efficiency of the project equipment. The equation below shall be used**

$$BE_y = [HG_{PJ,y} / \eta_{BL}] * EF_{FF,CO2}$$

$$= \{[B_{biomass,PJ,y} * NCV_{biomass} * \eta_{PJ}] / \eta_{BL}\} * EF_{FF,CO2}$$

BE_y	The baseline emissions from thermal energy displaced by the project activity using renewable biomass during the year *y* in tCO_2
$HG_{PJ,y}$	The net quantity of thermal energy supplied by the project activity using renewable biomass during the year *y* in TJ
η_{BL}	Efficiency of the baseline equipment being replaced (determined as per paragraph 18 or19)
η_{PJ}	Efficiency of the project equipment measured using representative sampling methods or based on referenced literature values. The efficiency tests shall be conducted following the guidance provided in the relevant national / international standards.
$EF_{FF,CO2}$	The CO_2 emission factor of the fossil fuel that would have been used in the baseline in tCO_2/TJ
$B_{biomass,PJ,y}$	The net quantity of the biomass consumed in year *y* in tons
$NCV_{biomass}$	The net calorific value of the biomass in TJ/tons

Emission sources and emission reductions



Monitoring options

HOW TO ACCURATELY ESTIMATE PROJECT'S OUTPUT ENERGY ?

- Measure the flow of biogas and methane content in the biogas on a sample basis (90/10 precision)
  - Complicated and expensive for example in case of POA (> 100 000 systems)
- Thermal capacity and operating hours of the biogas stove => the total thermal energy production/biogas production based on the operational data and rated capacity
  - How the operating hours can be accurately recorded ?
- Monitoring the consumption of each type of feedstock fed into the digester =>quantity of biogas produced
  - Accurate data difficult to monitor
- Recording annually the number of systems operating & operating hours (emissions reduction per system is less than 5 tonnes of CO_2e)
  - Is this enough ? Should be based on baseline emissions and estimation of energy output in each system ? Energy output based on biodigester volume ?
- Any chances to monitor the consumption reduction of coal?

Estimated biogas production v.v. surveyed biogas production (10 m^3 digester)

$$MPS = (VS \times 365) \times B_0 \times S$$

MPS	*methane generated by one biogas digester from swine manure only, m^3CH_4*
VS	*daily volatile solids by swine, 0.3 $kg_{dry\ matter}$/swine/day (IPCC 2006 Guidelines Volume 4, Chapter 10, Table 10A-7)*
B_0	*maximum methane producing capacity for manure, 0.29 m^3CH_4 /kg_{VS} (IPCC 2006 Guidelines Volume 4, Chapter 10, Table 10A-7)*
S_{iy}	*average number of swine in farm in the beginning of year y*

Biogas generation

Typically 4 swines in a household:

Calculated; Annually*127 m^3CH_4 => 254 m^3 biogas, 50 % CH_4*

Survey[1]; *Biogas generated annually in normal conditions varies between 360-400 m^3 having methane (CH4) content of 50-60 %*

[1] Greenhouse gas reduction and CDM analysis on countryside biogas engineering; Liu Shangyu, Luo Zhigang, Zhao Daiqing; University of Science and Technology (Hefei)/Chinese Academy of Science (Guangzhou); Acta Energiae Solaris Sinica, Vol. 27, No. 7, July 2006.