CDM Monitoring of Biogas Plants

A comprehensive overview on the requirements of the CDM

CDM Monitoring of Biogas Plants

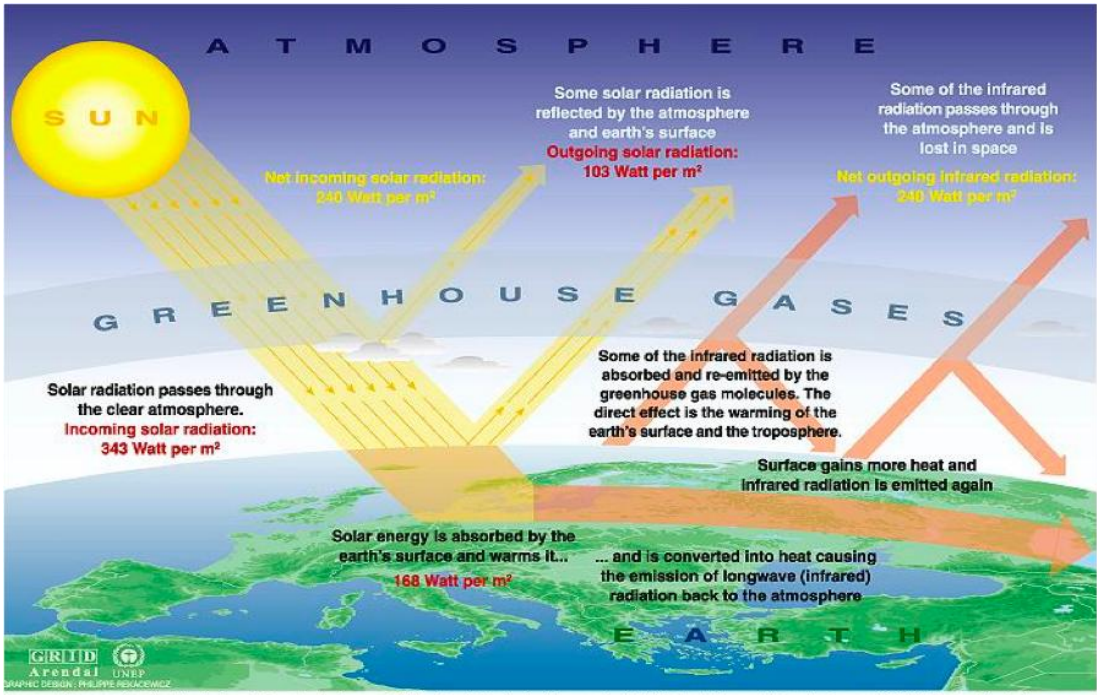
The Clean Development Mechanism (CDM)

Requirements of the CDM

Meters & Calibration

Monitoring Report

The Greenhouse-Effect



Sources: Okanagan university college in Canada, Department of geography, University of Oxford, school of geography; United States Environmental Protection Agency (EPA), Washington; Climate change 1995, The science of climate change, contribution of working group 1 to the second assessment report of the intergovernmental panel on climate change, UNEP and WMO, Cambridge university press, 1996.

Greenhouse - Gases	CO_2	CH_4	N_xO	PFC	HFCs	SF_6
GWP	1	21	210-310	9.200	11,700	23,900

The Kyoto Protocol

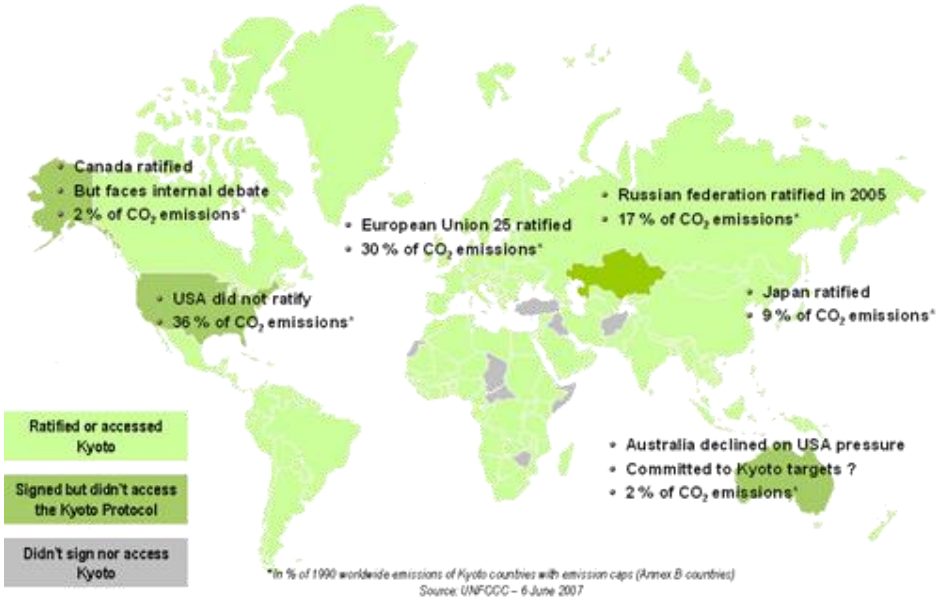
- The United Nations Framework Convention on Climate Change (UNFCCC)

  Adopted by the UN in 1992 (in force since 1994)

  Annex I countries (industrial countries) to “aim” to reduce their emissions

  “... stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system ...”

  (Article 2)



- Emission reduction targets quantified in the Kyoto Protocol 1997
- 2005 Kyoto Protocol came into force (16.02.2005)
- On average 5.2% during the period 2008 - 2012 (as compared to 1990)

The principle of CDM

Sponsor **Host**

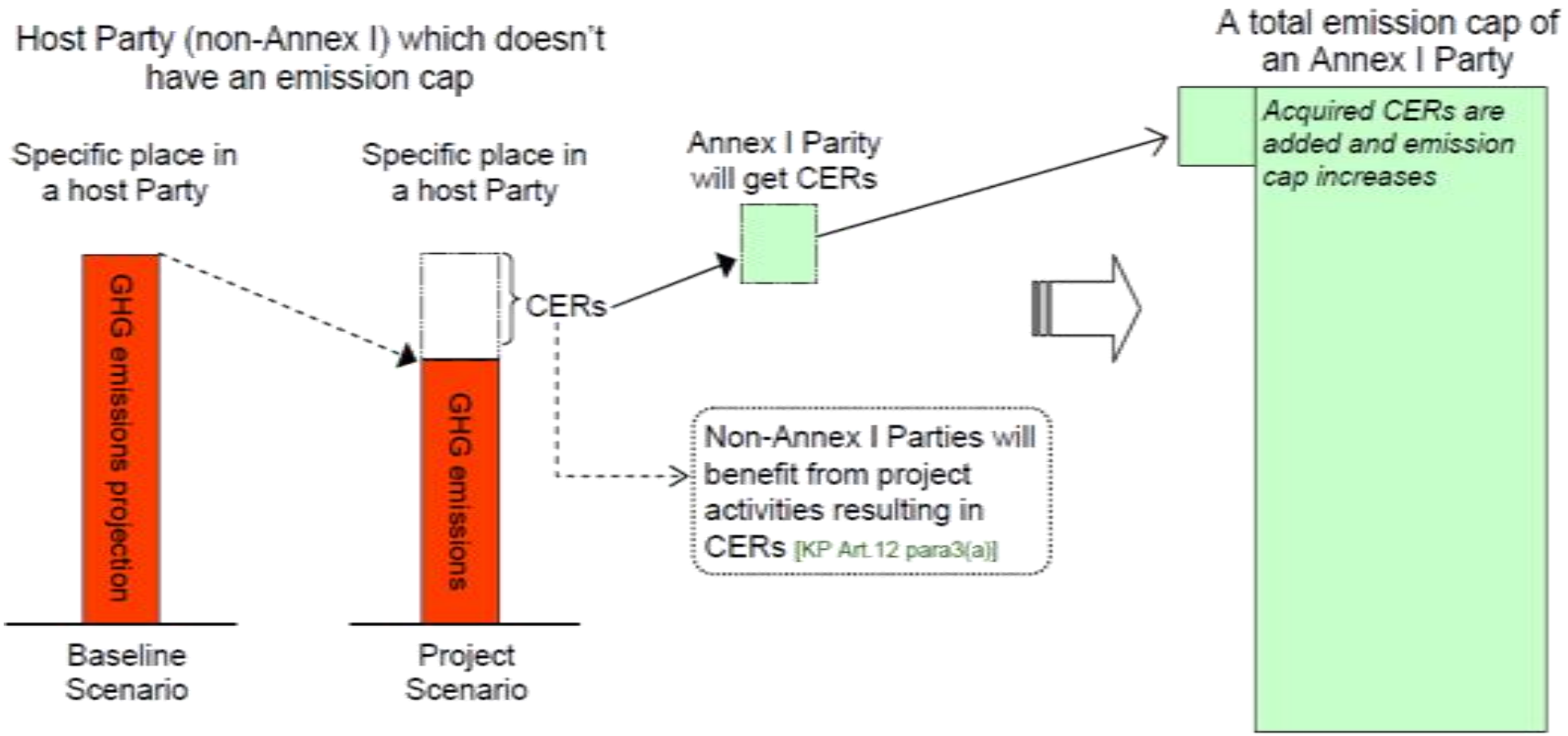
Technology transfer and investment

CER for fulfilling commitment

Need for “Certified Emission Reductions” (CER) in Annex I countries

Need for sustainable development, especially in the energy sector, in non-Annex I countries

CDM mode of operation



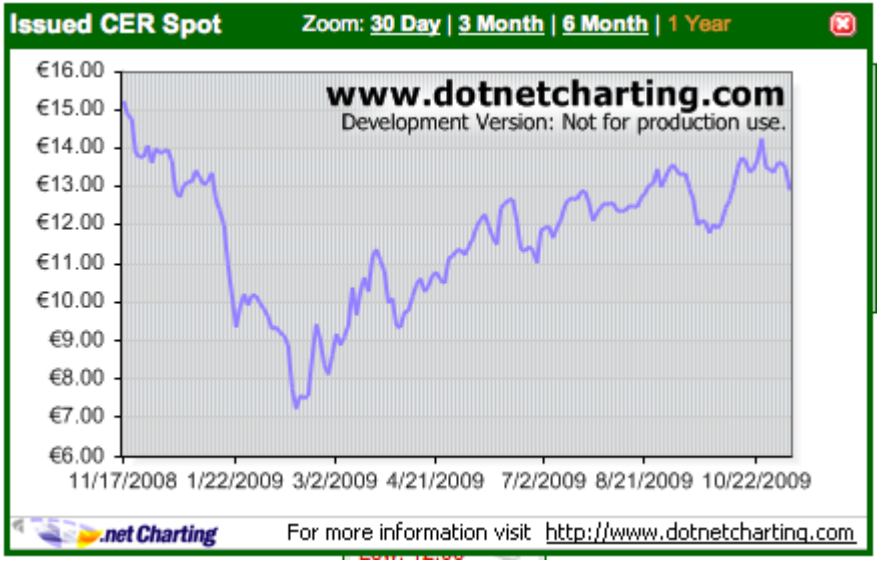
Flexible Mechanisms

- Emission Trading (ET)
  - Stock like trade of emisions certificates
- Joint Implementation (JI)
  - Emission reduction in developed countries
- Clean Development Mechanism (CDM)
  - Emission reduction in developing countries

➔ Worldwide self-preserving stable market for emission reductions

CDM Revenues

- 66 m^3 CH_4 destroyed will result in one CER
- Predictions on CER price are difficult
- With recovering economies it will rise
- Predictions by major banks between 20 € and 35 €



Source: http://www.co2e.com

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The CDM project cycle (1/2)

Planning
- Consideration of all related condition
- Providing of all required documents

PDD Writing
- Describing the technical aspects of the project
- Describing emission reductions

Getting Approvals
- Written approvals of countries involved

Validation
- Document review and on-site evaluation by third party
- Evaluation report according to standard procedure

The CDM project cycle (2/2)

Registration
- Registration by the CDM Executive Board
- Standard procedures, registration fees

Monitoring
- Strict requirements to all involved personnel and technology
- Data taking and storage according to standards

Verification
- Review of monitoring documents and on-site evaluation by third party
- Issuance request according to standard procedure

Issuance
- Verified amount of certificates will be issued by executive board
- Tax will be raised by Chinese government, 2% for Methane projects

Distribution
- Distribution (sales) of CERs shall exclusively be taken by project participants
- Current price: ~150 RMB

Ex ante calculation of emission reduction

$$ER_{CH4} = BE_y - PE_y$$

ER_{CH4}	Emission reduction
BE_y	Baseline emission
PE_y	Project emission

Baseline emission (1/2)

$$BE_y = GWP_{CH4} \cdot D_{CH_4} \cdot UF_b \cdot \sum_{j,LT} MCF_j \cdot B_{0,LT} \cdot N_{LT,y} \cdot VS_{LT,y} \cdot MS\%_{LT,j}$$

BE_{-y}	Baseline emission in year “y” (tCO_{2e})
GWP_{CH4}	Global Warming Potential of CH_4 (21)
D_{CH4}	CH_4 density (0.00067 t/m^3 at 20 °C and 1 atm)
LT	Index of all types of livestock
j	Index of animal waste management system
MCF_j	Annual methane conversion factor (MCF) for the baseline animal waste management system “j”
$B_{0,LT}$	Maximum methane producing potential of the volatile solid generated for animal type “LT”(m^3 CH_4/kg dry matter)
$N_{LT,y}$	Annual average number of animal of type “LT” in year “y” (numbers)
$VS_{LT,y}$	Volatile solids for livestock “LT” entering the animal manure management system in year “y” (on a dry matter weight basis, kg dm/animal/year)
$MS\%_{BL.j}$	Fraction of manure handled in baseline animal manure management system “j”
UF_b	Model correction factor to account for model uncertainties(0.94)

Baseline emission (2/2)

$$E_{bl} = EP_{BIO} \cdot EF_{grid}$$

E_{bl}	Baseline electricity generation emissions (tCO_2/year)
EP_{BIO}	Electricity produced by biogas generator unit for grid electricity replacement (MWh)
EF_{gird}	Baseline emission efficient of East China Power Grid (kg CO2e/kwh).The calculation of EF_{gird} is provided in a separate spreadsheet in Annex 3- Baseline information.

Project Emission

$$PE_y = PE_{PL,y} + PE_{flare,y} + PE_{power,y}$$

PE_y	Project emission in year “y” (tCO_2e)
$PE_{PL,y}$	Emission due to physical leakage of biogas in year “y” (tCO_2e)
$PE_{flare,y}$	Emission from flaring or combustion of the gas stream in year “y” (tCO_2e)
$PE_{power,y}$	Emissions from the use of fossil fuels or electricity for the operation of all the installed facilities

Example: Biogas plant in Shanghai

- Dairy farm with 10,000 cows of Western Europe genetic origin
- Baseline scenario: open lagoon
- Installation of a biogas plant and a grid connected 1 MW gas engine
- Emission reduction by destruction of methane in baseline and by production of electricity from renewable energy

Baseline emission from AMMS

GWP_{CH4}	21
D_{CH4}	0.00067 (t/m^3)
LT	1
j	1
MCF_j	0.73 for an uncovered lagoon and an annual mean temperature of 14° C
$B_{0,LT}$	0.24 (m^3 CH_4/kg dry matter) for dairy cows of Western Europe genetic origin
$N_{LT,y}$	10,000
$VS_{LT,y}$	1861.5 (kg/head/year) for dairy cows of Western Europe genetic origin
$MS\%_{BL,j}$	1
UF_b	0.94
PE_y	**43,135 tCO_2e**

Baseline emission from grid electricity production

EP_{BIO}	7884 MWh
EF_{gird}	0.78255 tCO_2/MWh
E_{bl}	6,169 tCO_2e/year

Project emission from leakage

$PE_{PL,y}$	6,286 (tCO_2e)
$PE_{power,y}$	0
$PE_{power,y}$	556 (tCO_2e)
PE_y	**6,842 (tCO_2e)**

Estimated emission reduction

- Overall annual emission reduction of this project: 42,461 tCO_2e
- If the project gets registered and the monitoring is carried out according to the requirements, 42,461 CERs will be issued and can be sold annually.

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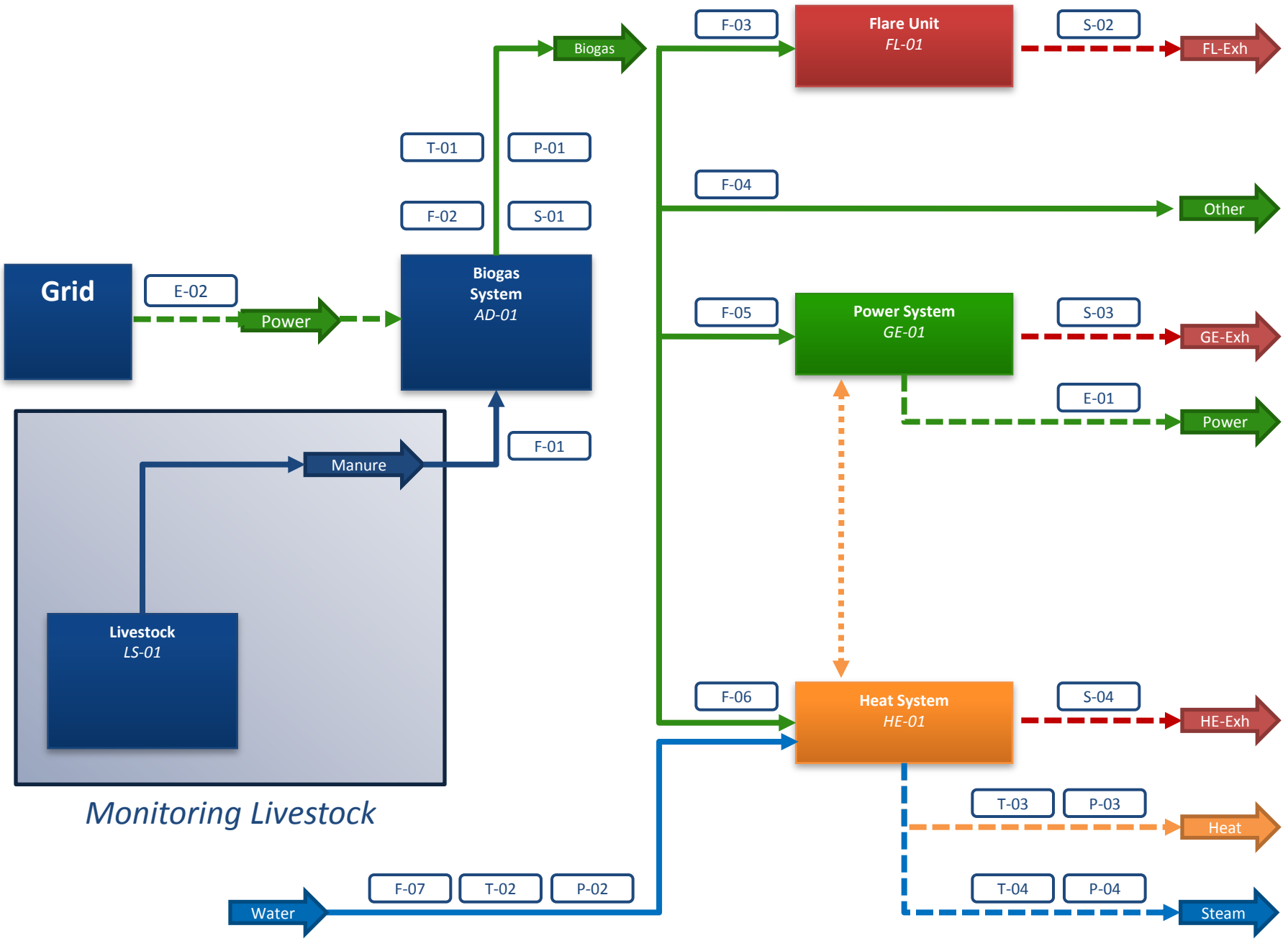
Meters & Calibration

Monitoring Report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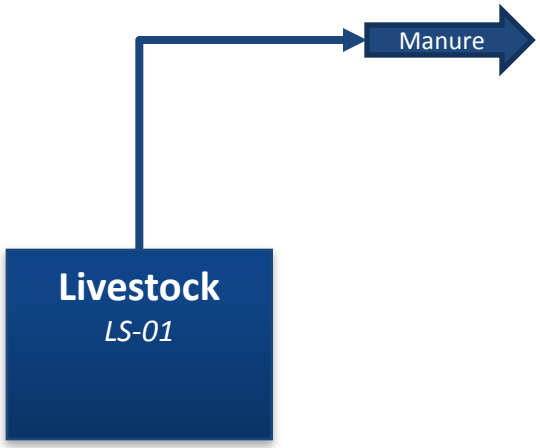
Livestock



Monitoring Livestock

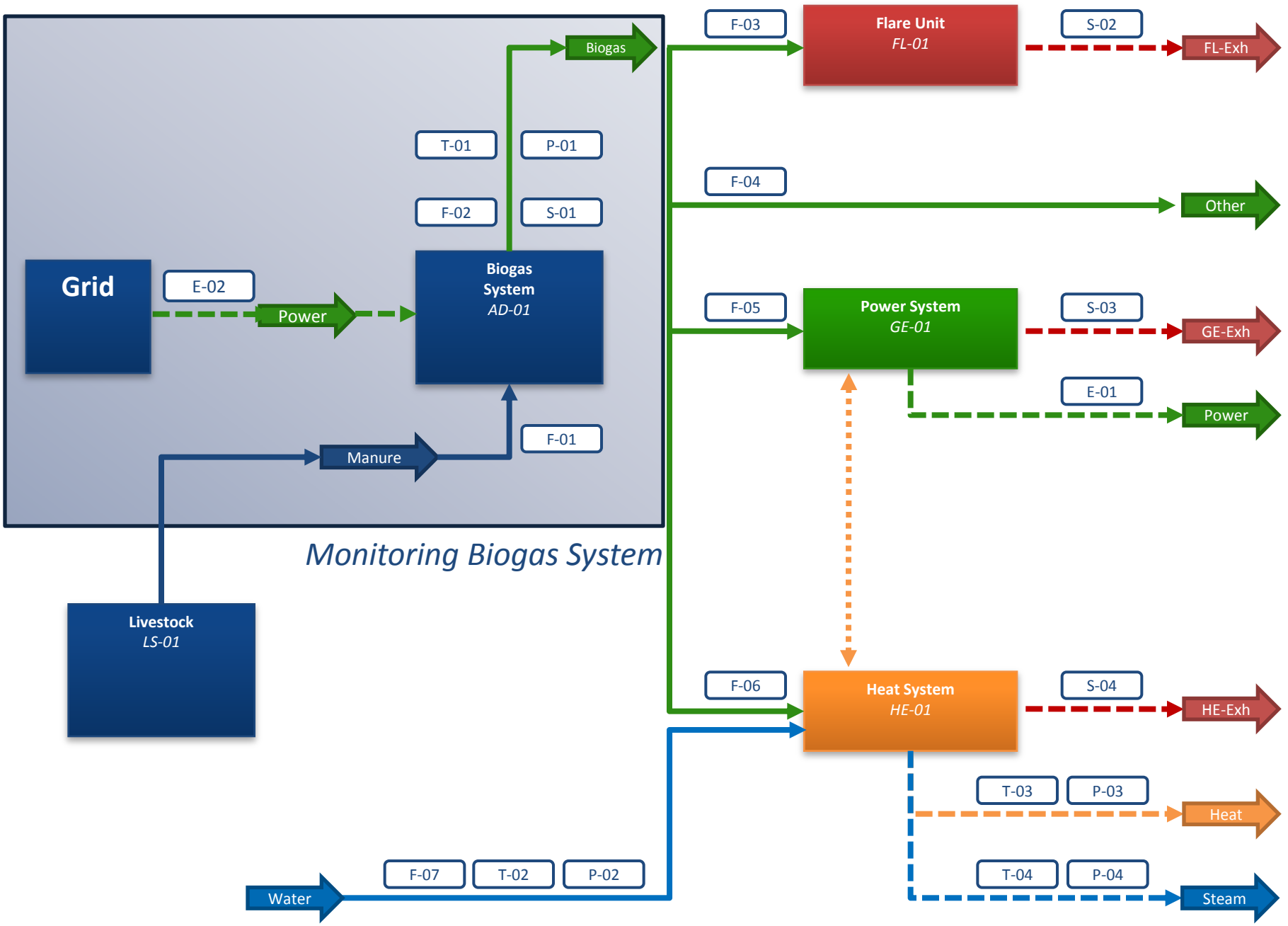
nd_y: The number of days that the animal manure management system capturing methane and flaring/combusting or gainfully using methane was operational

$MS\%_{i,y}$: The fraction of manure handled in the manure management system

W_{site}: The average weight of the livestock

$N_{LT,y}$: The livestock population

The consistency between these values and indirect information (records of sales, records of food purchases) shall be assessed. Significant changes in livestock population and average weight shall be explained.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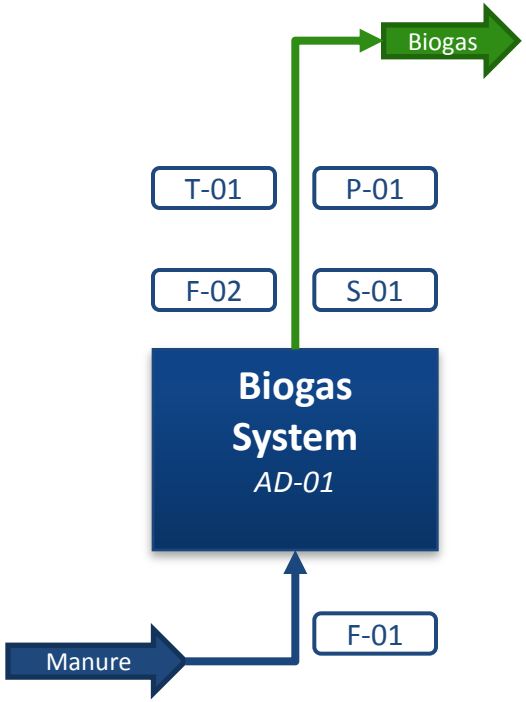
Biogas System



F-01

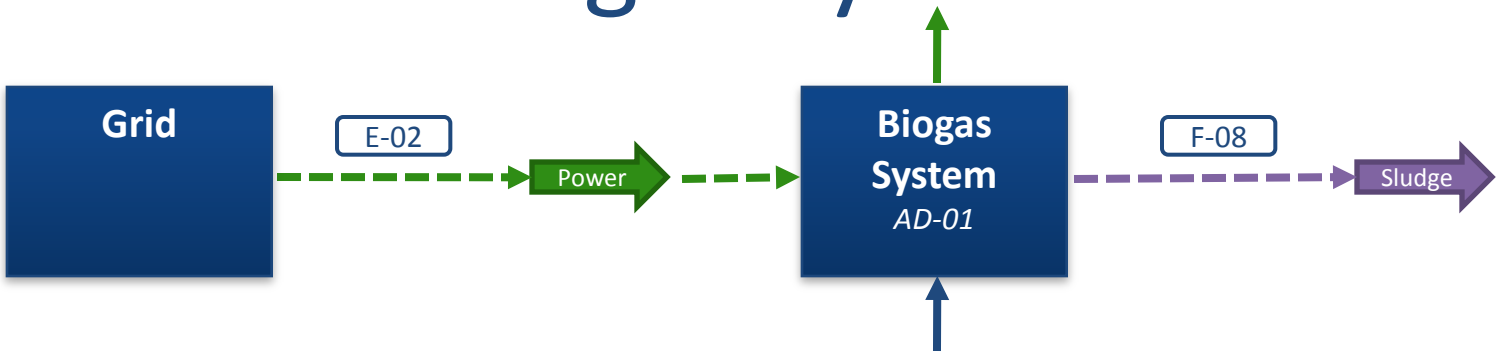
The VS of the manure is usually checked quarterly to ensure 100% of manure enters the digester.

P-01
T-01
S-01
F-02

Continuous measurement of pressure/temperature and sampling of the methane concentration is required to determine the methane density and mass flow

The fraction of methane in the biogas should be measured with a continuous analyzer or, alternatively, with periodical measurements at a 95% confidence level

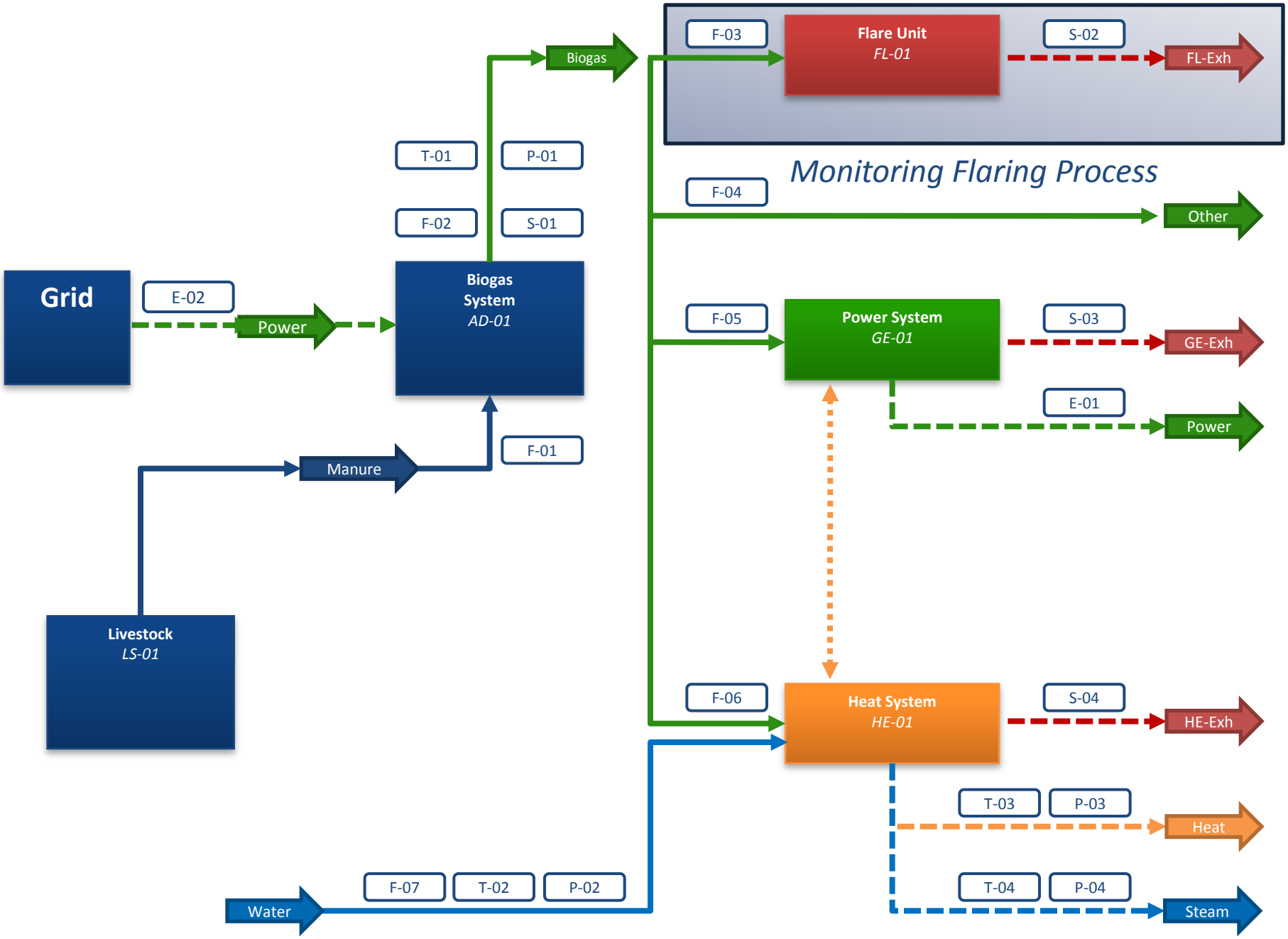
Biogas System



E-02 The annual fossil fuel or electricity used to operate the facility or power auxiliary equipment shall be monitored

Alternatively it shall be assumed that all relevant electrical equipment operate at full rated capacity, plus 10% to account for distribution losses, for 8760 hours per annum.

F-08 The proper soil application (not resulting in methane emissions) of the final sludge must be ensured.


Monitoring Flaring Process
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P-02

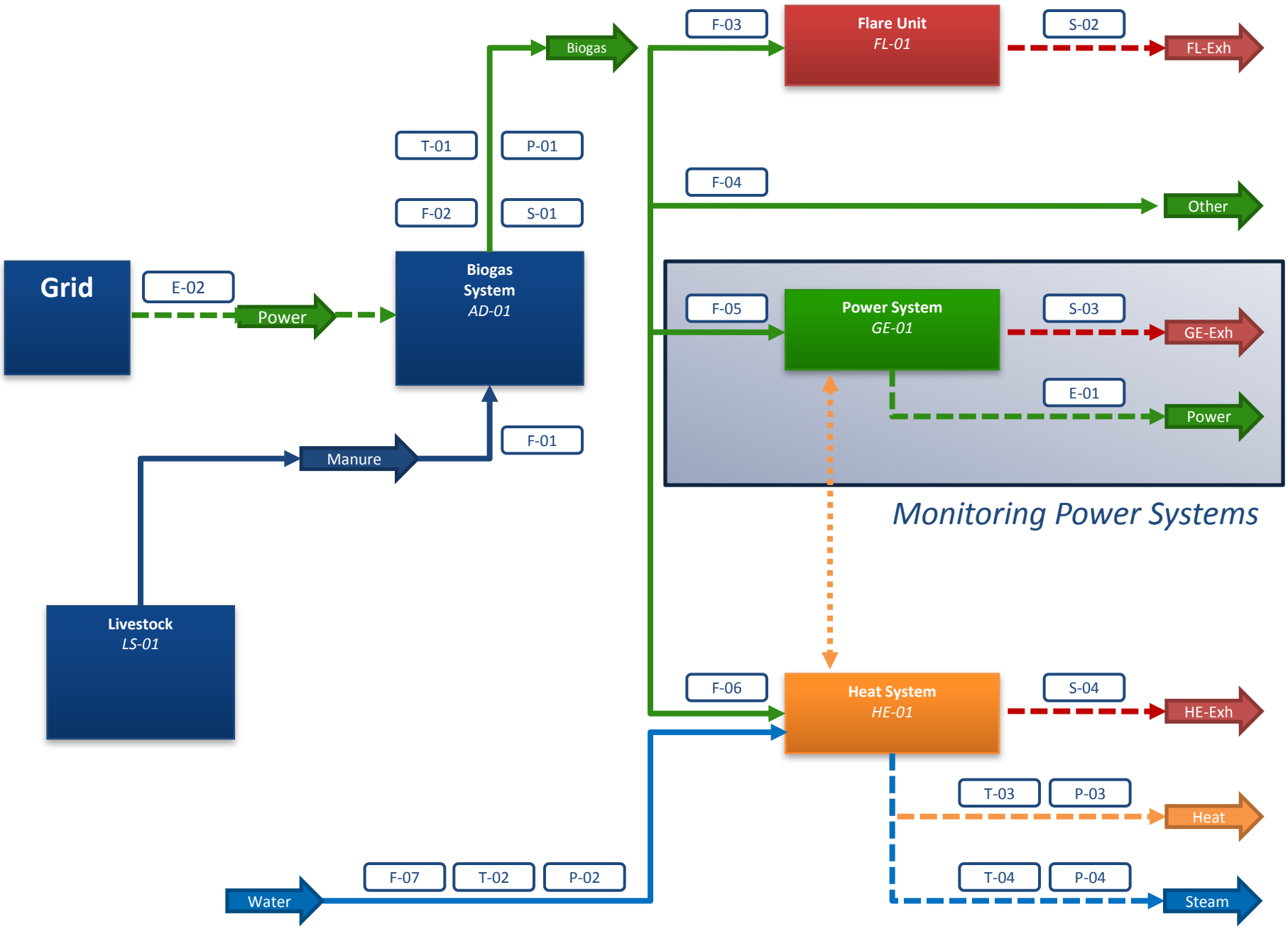
Flaring Process

Monitoring Flaring Process

F-03 Amount of biogas flared

S-02 Methane content in exhaust gas for determination of the efficiency of the flaring process and emissions from flaring of biogas. This will usually be done by measuring temperature and applying a standard value.

- Voluntarily continuous monitoring of flaring efficiency (eff. of flaring process multiplied by fraction of time in which the gas is flared
- Alternatively 90% standard. If this option is chosen, continuous check of compliance with the manufacturer‘s specification (Temperature, Biogas Flow) is required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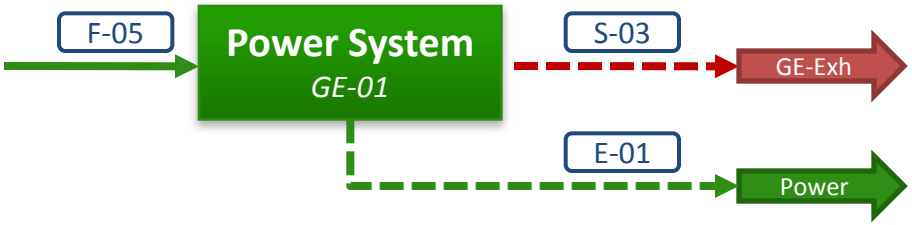
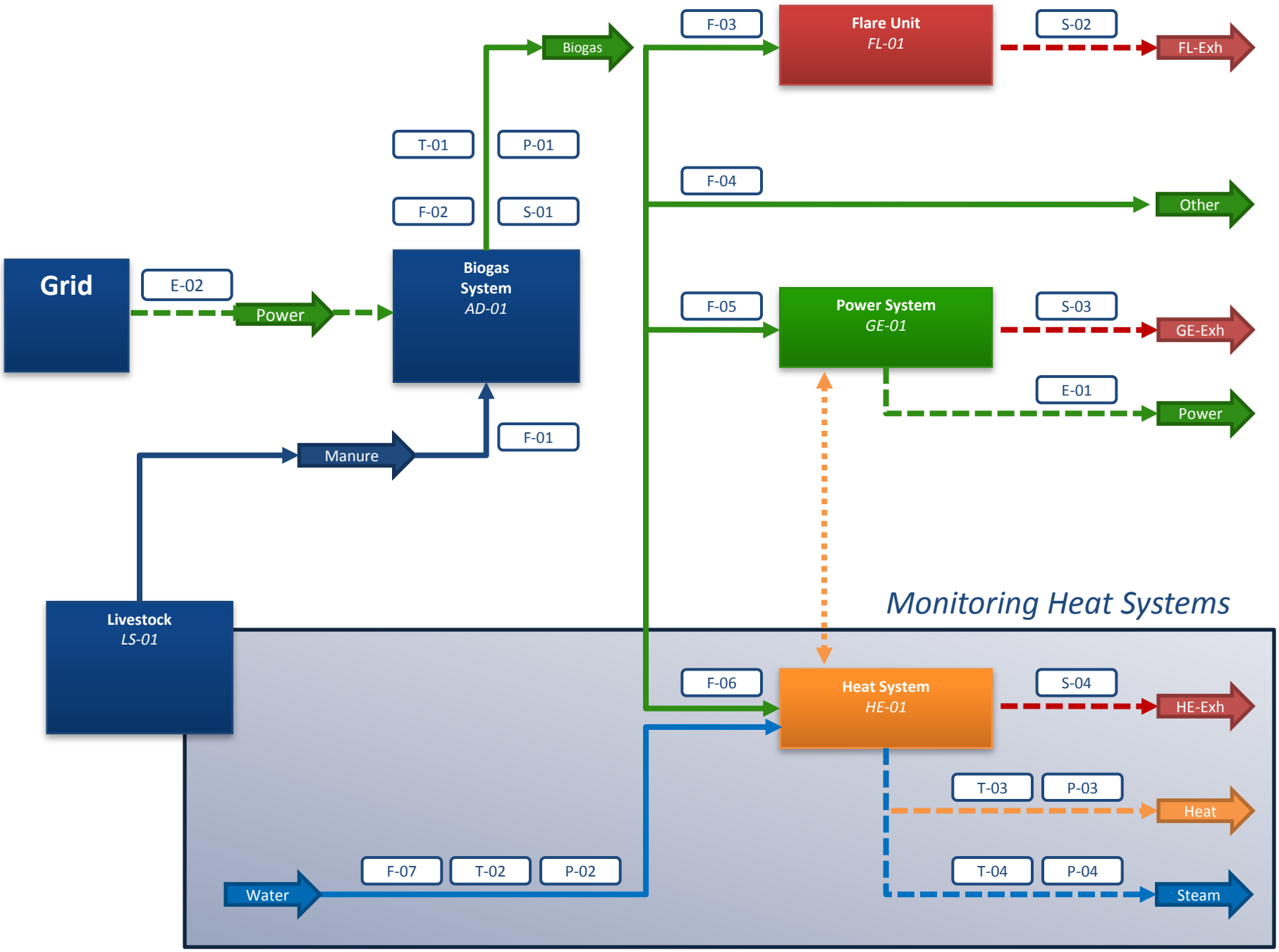
Power System



F-05 Amount of biogas utilized for electrical energy generation

S-03 Sampling of exhaust gas composition to monitor the fraction of methane combusted. This is not required by CDM. The engine efficiency can be assumed to be 1.

E-01 The electricity produced and fed into the grid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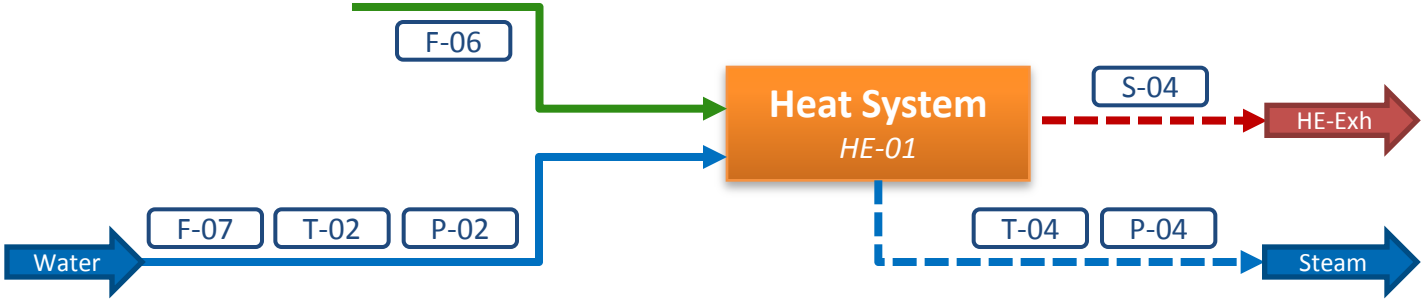
Heat Utilization (Steam)

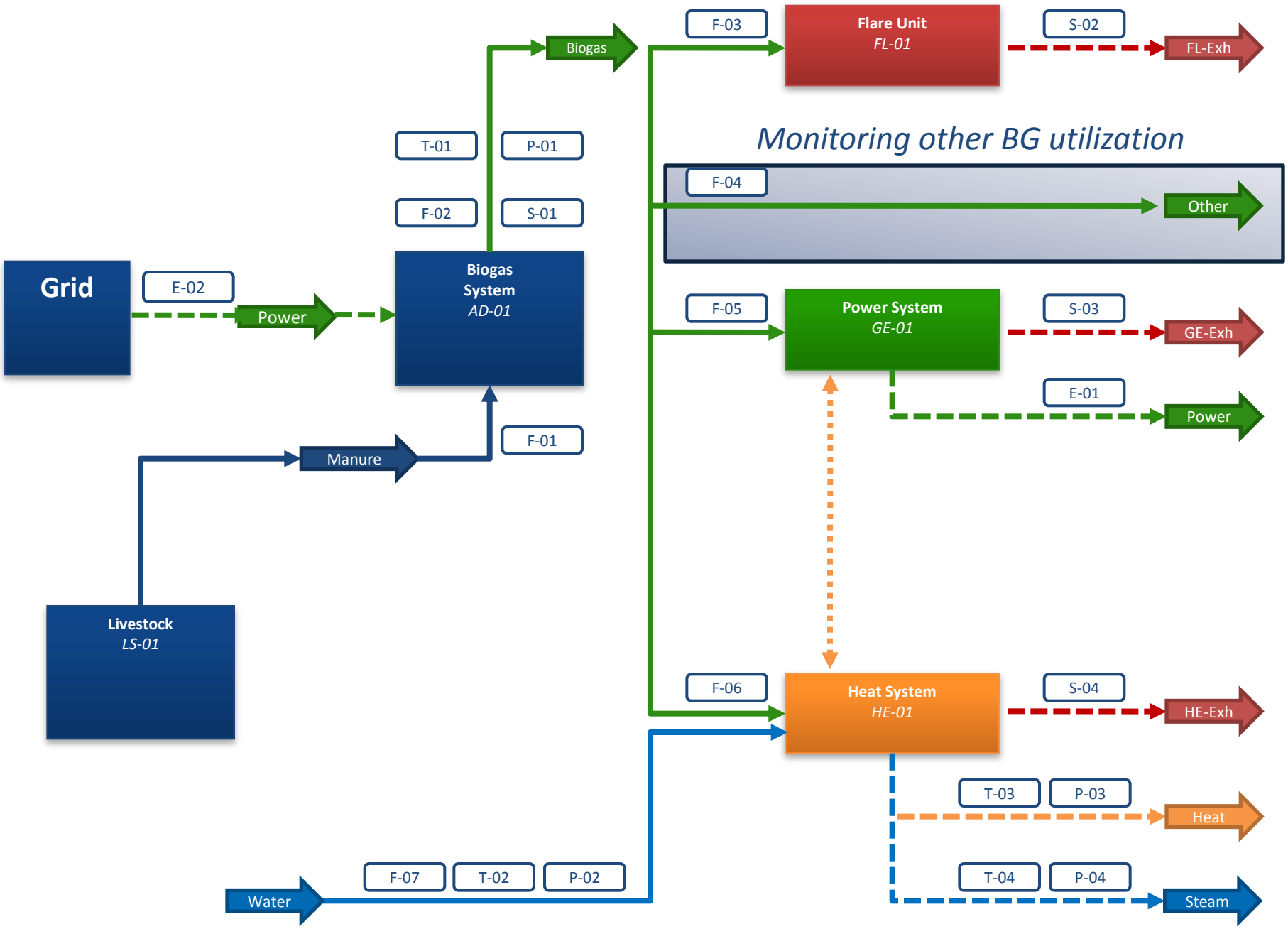


F-06 Amount of biogas utilized for electrical energy generation

F-07
T-02
P-02
T-04
P-04

Continuous measurement of pressure/temperature/flow to determine the amount of energy that was transferred to the water.

S-03 Sampling of exhaust gas composition to monitor the fraction of methane combusted. This is not required by CDM. The engine efficiency can be assumed to be 1.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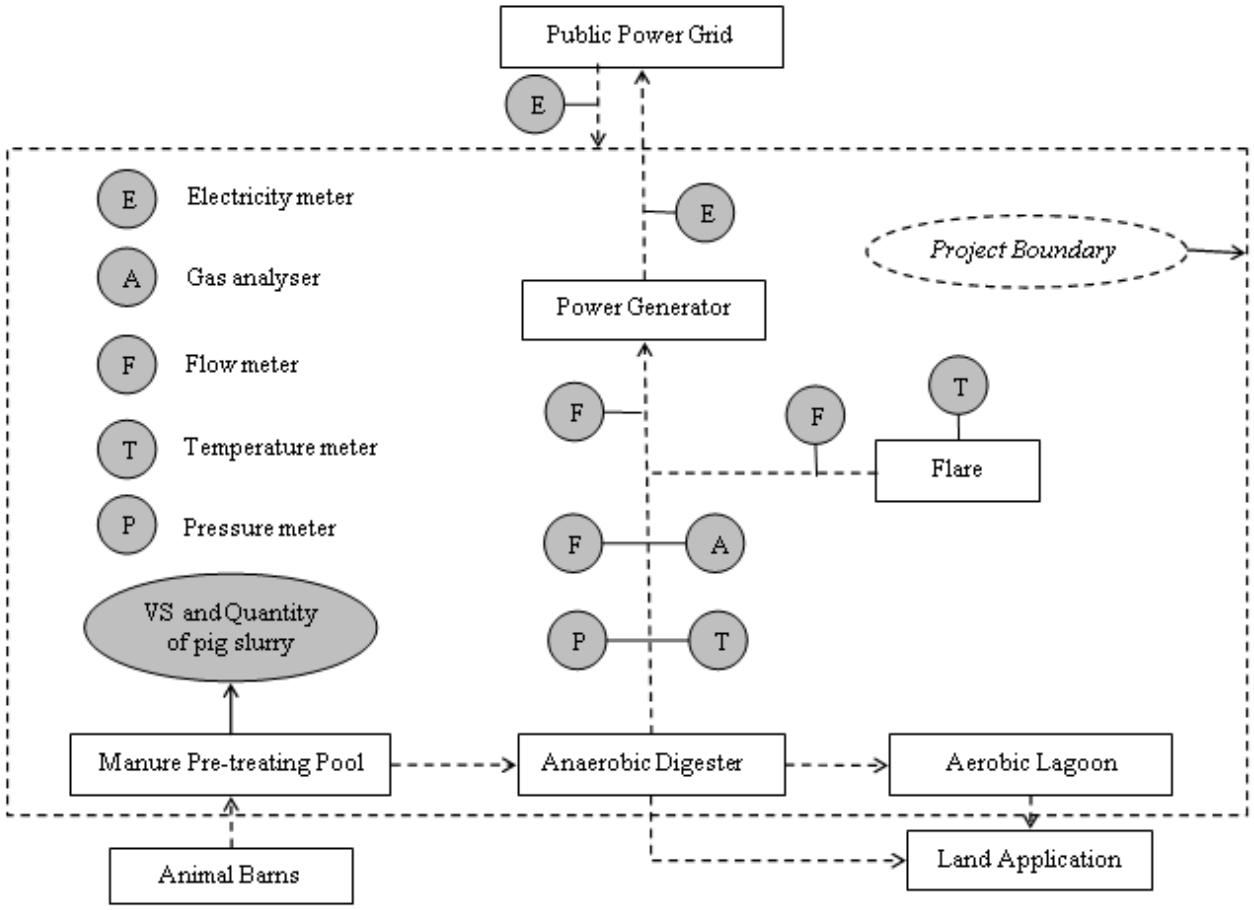
Other Application

The recovered methane may also be utilised for other applications instead of flaring or combustion, e.g. Bottling of upgraded biogas or upgrading and distribution in piped networks to groups of other end users or into natural gas distribution

F-04

Continuous measurement of the amount of biogas used for various (n-application) purposes in the project activity: e.g., heat, electricity, flare, injection into natural gas distribution grid, etc. The difference is considered as loss due to physical leakage and deducted from the emission reductions.

Example: Electricity production



List of parameters

Parameter	Measurement Frequency	Accuracy
Electricity delivery to the public grid	Daily	99.8% or according to the national standard
Electricity input for operation of biogas plant	Daily	99.8% or according to the national standard
Volatile solid (VS) content of animal slurry that entering the digester	common practice: four times a year to make sure 100% of manure is treated in biogas plant.	Test at the qualified labs or testing centers at the city level
Quantity of animal slurry that entering the digester	Daily	95% according to methodology
Biogas flow	Measured continuously, recorded daily	95% according to methodology
Biogas pressure	Measured continuously, recorded daily	95% according to methodology
Biogas temperature	Measured continuously, recorded daily	95% according to methodology
Methane fraction in biogas	Measured continuously, recorded daily	95% according to methodology
Temperature in the exhaust gas of the flare	Measured when flaring biogas	95% according to methodology

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Meters & Calibration

Monitoring Report

Monitoring & Reporting

- The whole project will be inspected by a third party to confirm the accordance with the CDM requirements
- All relevant parameters have to be provided, measured or calculated
- All meters have to be calibrated by an authorized technician or institute according to manufacturers requirements
- Meter accuracies have to be in line with national standards
- A monitoring manual has to be compiled for the local staff

Yearly Project Verification

- Yearly (or half-yearly/quarterly) report on actual emission reduction has to be compiled and submitted to a DOE
- On-site verification by DOE to ensure correctness of all data and information
- After successful verification issuance can be requested
- Issued CERs can be sold with spot prices on stock markets

Thank you for you attention

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