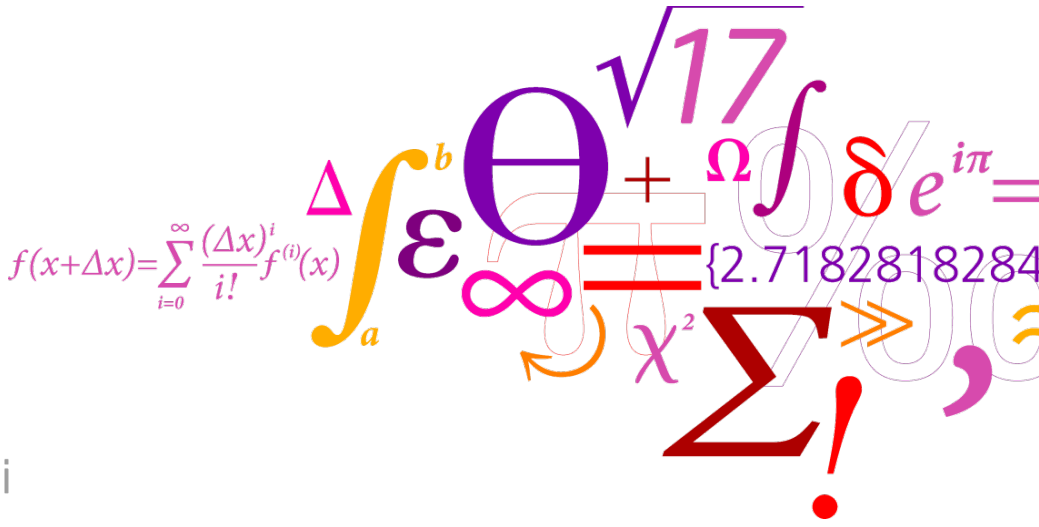
WP 1: Value Chain Optimisation of Biogas Production

Ida Græsted Jensen
Department of Management Engineering

e-mail: idje@dtu.dk



Risø DTU
Nationallaboratoriet for Bæredygtig Energi

Introduction

Main objective:

- Ensure economic feasibility for all partners in a biogas project

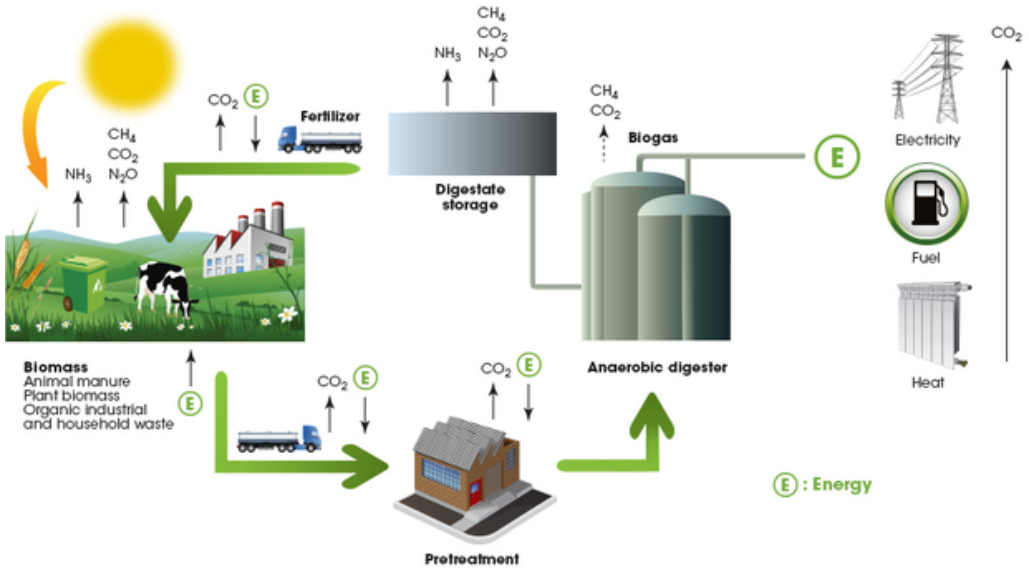
This will be done by developing mathematical optimisation models:

- Plant level model
- National level model
- Implementation of biogas in Balmorel

The plant level model

Objective:

- Optimise the production of biogas while ensuring economic feasibility for all partners



The model will be able to:

- Plan the production of biogas for each time period (more about this tomorrow)

Solution method

Stochastic programming:

- Optimisation method for solving problems with uncertainties

It is defined by:

- An objective function: what do we want to optimise? In this case the overall profit combined with the profit for each partner
- A number of constraints: what limits our solution? E.g. the amount of input available, the capacity of the plant, or the demand for electricity at time t
- A set of decision variables: what is the optimal setting? E.g. amount of input used for production at time t, or the share of production used for electricity at time t

Example of a "simple" mathematical model

$$\min \sum_{i\in\mathcal{I}}\sum_{a\in\mathcal{A}} c_{ia}x_{ia} + \sum_{n\in\mathcal{N}} \gamma_n y_n + \sum_{k\in\mathcal{K}} \beta z_k + \sum_{p\in\mathcal{P}}\sum_{r\in\mathcal{R}(p)} c_{pr}\rho_{pr}$$

$$\text{s.t.} \quad \sum_{a\in\delta^-(v)} x_{ia} - \sum_{a\in\delta^+(v)} x_{ia} = d_{iv} \qquad \forall i \in \mathcal{I},\ v \in \mathcal{V}$$

$$\sum_{i\in\mathcal{I}}\sum_{a\in\alpha_n} x_{ia} + y_n = 1 \qquad \forall n \in \mathcal{N}$$

$$\sum_{a\in\alpha_{T_{k,1}}} x_{ia} - \sum_{a\in\alpha_{T_{k,2}}} x_{ia} - z_k \leq 0 \qquad \forall k \in \mathcal{K},\ i \in \mathcal{I}$$

$$\sum_{a\in\alpha_{T_{k,1}}} x_{ia} - \sum_{a\in\alpha_{T_{k,2}}} x_{ia} + z_k \geq 0 \qquad \forall k \in \mathcal{K},\ i \in \mathcal{I}$$

$$\sum_{r\in\mathcal{R}(p)} \rho_{pr} \geq n_p \qquad \forall p \in \mathcal{P}$$

$$\sum_{p\in\mathcal{P}}\sum_{r\in\mathcal{R}(p)} \varphi_{fr}\rho_{pr} \leq \sum_{i\in I} x_{if} q_i \qquad \forall f \in \mathcal{F}$$

$$x_{ia} \in \{0,1\} \qquad \forall i \in \mathcal{I},\ a \in \mathcal{A}$$

$$y_n \in \{0,1\} \qquad \forall n \in \mathcal{N}$$

$$z_k \in \{0,1\} \qquad \forall k \in \mathcal{K}$$

$$\rho_{pr} \in \{0,1\} \qquad \forall p \in \mathcal{P},\ r \in \mathcal{R}(p)$$

The national level model

Objective:

- Optimise the biogas production of a biogas plant on a national level

What is new:

- Taking existing biogas plants into account

Method:

- Extension of the plant level model - stochastic programming

Implementation of biogas in Balmorel

Objective:

- Include biogas production in Balmorel

Balmorel:

- is an energy systems model
- is used for analysing the electricity and combined heat and power sectors in different regions
- will be able to evaluate the competitiveness of biogas

Method:

- Change of the national level model to accommodate the specific features of Balmorel