Optimising waste treatment and energy systems - focusing on spatial and temporal issues

Pizarro Alonso, Amalia Rosa; Münster, Marie; Ravn, H.

Publication date:
2014

Optimising waste treatment and energy systems - focusing on spatial and temporal issues

Authors: A. R. Pizarro, M. Münster & H. Ravn

Aim

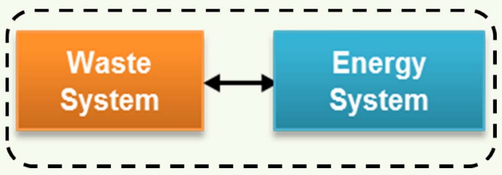
The aim of the TOPWASTE project is to evaluate current and future optimal treatment of waste fractions in terms of economy and the environment, with a focus on recycling versus Waste-to-Energy technologies.

What´s the optimal use of waste, as a resource for recycling and/or energy recovery?

After optimization of the waste management system, results must be analysed so as to identify drivers and barriers that efficient waste utilization in Denmark is facing and discuss the economic and/or environmental benefits that might arise from a change of the current waste management system.

1. Introduction

Optimal performance of waste treatment strategies often depends more on the impacts on the surrounding systems, such as the energy system, than on the waste technologies themselves.



Holistic approach required

Which energy production is actually affected by incineration or biogas plants (Waste-to-Energy)?

Heat supplied to the District Heating grid is constrained by heat demand, i.e. during summer time, where excess heat might be generated.

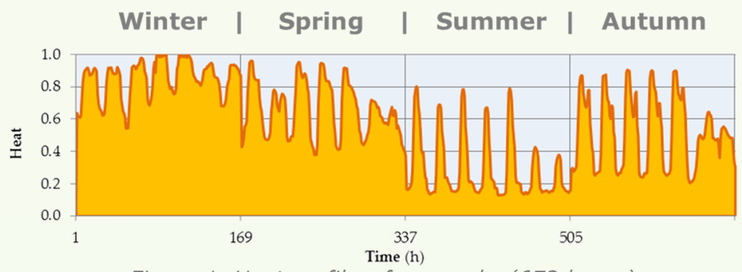


Figure 1. Heat profile - four weeks (672 hours)

Geography & Time resolution

Electricity demand will increasingly depend on fluctuating sources, and thereby its value, depending on the need of dispatchable power.

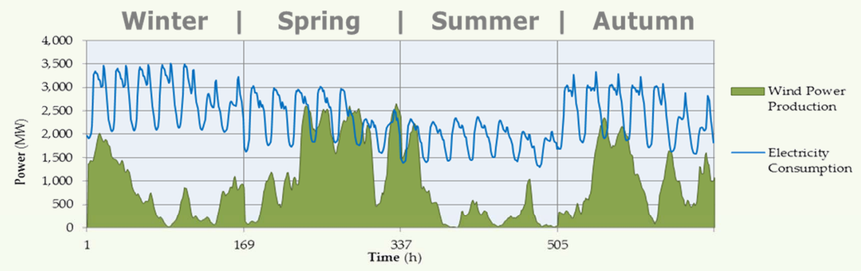


Figure 2. Electricity profile - four weeks (672 hours)

2. Methodology

Description of the waste management processes through a network model of processes and flows, OptiWaste, using **linear programming models**, which are solved through optimization from economic and environmental perspectives.

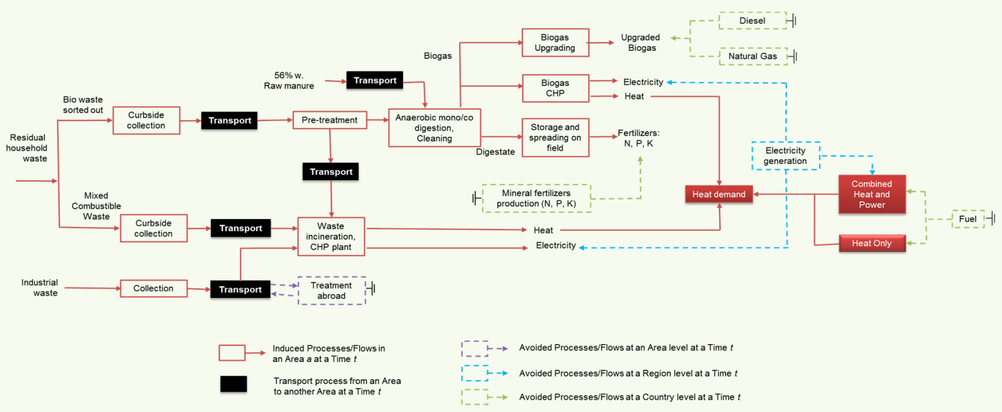
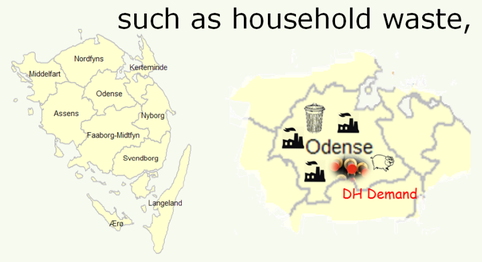


Figure 3. Simplified waste management system modelled as a network model

Optimization Strategy

Minimization of the total socioeconomic cost of the energy and waste system (mixed combustible waste+biowaste) for a **case study in Funen**; assuring that all the waste undergoes a treatment process and that all the District Heating demand is covered. Two scenarios are analysed: no obligation to separate the organic fraction (OF) from the mixed combustible waste and sorting 50% of the OF to Anaerobic Digestion (AD). The optimization model provides a systematic and quantitative way to allocate resources; such as household waste, manure or money.



- Waste and manure generation distributed geographically and temporally
- District Heating demand according to spatial and temporal profiles
- Energy Plants distributed geographically

3. Results

Incineration of biowaste is favoured over AD, unless specific recycling targets are set.

Total GHG emissions, when segregating the OF decrease. However, emissions from fossil origin increase, as less heat is provided from WtE technologies and it has to be supplied by other means (marginal technology).

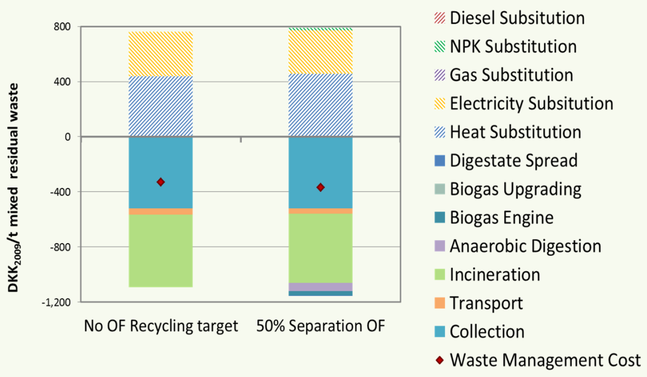


Figure 4. Monetary flows from waste management (costs denoted as negatives and earnings as positive)

Figure 5. Heat production profile - one day (24 hours)

Conclusions

Waste management implies expenses; however, some of them can be covered by providing energy to the system and resources for reuse. Geographical and temporal resolution is needed to quantify the avoided energy production, the gains from reuse and the cost and emissions associated.

Optimal operation of WtE technologies depend on the area where they are located and the competing technologies for providing district heating.

Further work

- Analysis and optimization of collection and sorting systems, including new technologies, such as REnescience.
- Modelling of investments with a special focus on economy of scale.
- Full integration with the energy system.
- Analysis of waste and energy scenarios to outline the path to follow to treat waste optimally in a future 100% renewable energy system.

DTU Management Engineering
Department of Management Engineering

Energy Systems Analysis Group

Research assistant A.R. Pizarro: aroal@dtu.dk,

Project Leader - Senior Researcher M. Münster: maem@dtu.dk