Multifonctionality issue regarding LCA of bioenergy plants

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Introduction

In the context of energy transitions, anaerobic digestion proposes an interesting alternative to fossil fuels by producing energy, thanks to the biogas production from organic residues digestion. However, as centralized bioenergy plants generate co-products, they can be considered as multifunctional systems. **Those functions arise some methodological issues for assessing their environmental interest throughout Life Cycle Assessment** (LCA).

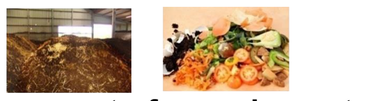

Fig.1 : The main functions provided by a bioenergy plant

Objectives

The aim of this study is to **analyse tendencies of LCA results depending on the main function of a centralized bioenergy plant.**

The concrete case of a bioenergy plant establishment within a local authority located in Western France is studied. After a territorial systemic analysis, the two main functions relevant pertaining to its urban and industrial context are: **(i) the management of organic waste** and **(ii) the production of energy via a gaseous fuel.**

Two comparatives LCAs are then carried out by considering those two functions.

Method

Whatever the choice of the main function, a centralized bioenergy plant remains a multifunctional system and fulfils **secondary functions**. In this study, secondary functions are managed by the **substitution method**:

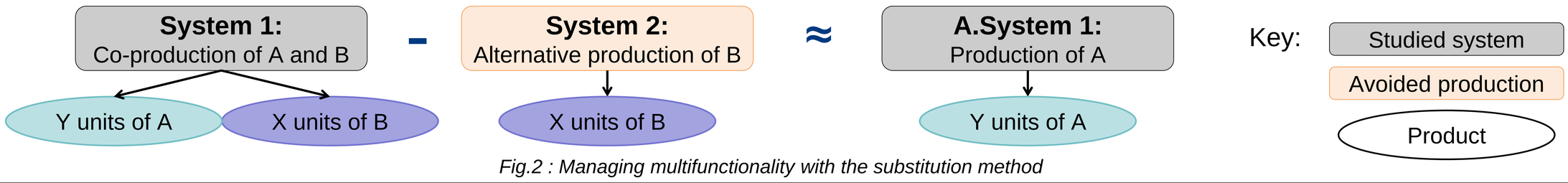

Fig.2 : Managing multifunctionality with the substitution method

Scenarios analysed

Function (i) : Management of organic waste

W.Reference: Incineration, composting and classical manure management system

- 20 050 MWh — Energy production avoided from wood boiler and FEM
- 35 t f. — Mineral fertilizers production avoided

14 640 t owm.

W.Metha

- 16 400 MWh — Energy production avoided from natural gas combustion
- 310 t f. — Mineral fertilizers production avoided

Function (ii) : Production of energy via a gaseous fuel

16 400 MWh

E.Metha

- 14 640 t owm. — Incineration and classical manure management system avoided
- 22 970 MWh — Energy production avoided from wood boiler and FEM
- 310 t f. — Mineral fertilizers production avoided

E.Reference: Combustion of the French natural gas mix

t owm.: tons of organic waste managed
t f.: tons of fertilizers as N, P_2O_5 and K_2O
FEM: French Electricity Mix

Fig.3 : Centralized bioenergy system (Metha) fulfilling function (i) or (ii), reference scenarios and their respective avoided productions

Results

Table 1 : Comparison of scenarios fulfilling function (i)

Impact category CML 2013	**W.Metha VS W.Reference** w/o substitution	Would co-function change conclusion ?		IF results are aggregated
		Energy production co-function	Fertilizer production co-function	
Acidif.		No	No	
Eutroph.		No	No	
ADP		Yes	Yes	
GWP (w)		Yes	No	
GWP (w/o)		Yes	Yes	
POCP		Yes	Yes	

Key: Metha has lower impacts than Reference | No significant difference (less than 20%) | Metha has higher impacts than Reference

Table 2 : Comparison of scenarios fulfilling function (ii)

Impact category CML 2013	**E.Metha VS E.Reference** w/o substitution	Would co-function change conclusion ?		IF results are aggregated
		Waste management co-function	Fertilizer production co-function	
Acidif.		No	No	
Eutroph.		No	No	
ADP		No	No	
GWP (w)		No	No	
GWP (w/o)		Yes	Yes	
POCP		Yes	Yes	

ADP: Abiotic Depletion Potential (CML 2007); GWP (w) or (w/o): Global Warming Potential with or without accounting biogenic carbon emissions; POCP: Photochemical Ozone Creation Potential.

Conclusion

Regardless of the choice of the main function, taking avoided impacts into account does not affect results on **local impact categories** (acidification and eutrophication potential) but it leads to **different conclusions on categories like GWP and POCP**. Depending on the main function, avoided impact has different consequences on ADP.

This study shows that the environmental interest of centralized bioenergy plants relies in their inherent multifunctionality. Therefore, making the identification of the main function and the account of co-functions more robust and more relevant are real issues. Those uncertainties for such a multifunctional system were here reduced by **involving local stakeholders**.

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