Environmental assessment of alternative treatments for wastewater and domestic organic waste

L. Lijó*, M.T. Moreira*, E. Katsou**, S. Malamis*** and S. González-García*

* Department of Chemical Engineering, University of Santiago de Compostela

**Department of Mechanical, Aerospace and Civil Engineering, Brunel Univeristy

***Department [illegible]sources and Environmental Engineering, School of Civil

[illegible]nical University of Athens

Wastewater treatment schemes

Centralised WWT

Decentralised WWT

✓ Criteria for selection of the most suitable approach:

- Cost effectiveness
- Feasibility of the management system
- Specific conditions of the target area

Wastewater treatment technologies

Treatment

- UASB at ambient temperature as the core technology

Advantages	Disadvantages
High efficiency	Low pathogen removal
Flexibility	Low nutrient removal
Low space requirements	Long start-up
Low energy consumption	Possible bad odours
Low sludge production	Necessity of post-treatment
Low chemicals requirement	High dissolved methane at ambient temperature

Post-treatment

- Anaerobic membrane → low energy requirements
- Sequencing batch reactor → nutrient removal of water reuse

Objective

Objective:
Environmental evaluation of two integrated schemes for the co-treatment of domestic wastewater and DOW in a decentralised community of 2,000 PE.

Wastewater →

Domestic organic waste (DOW) →

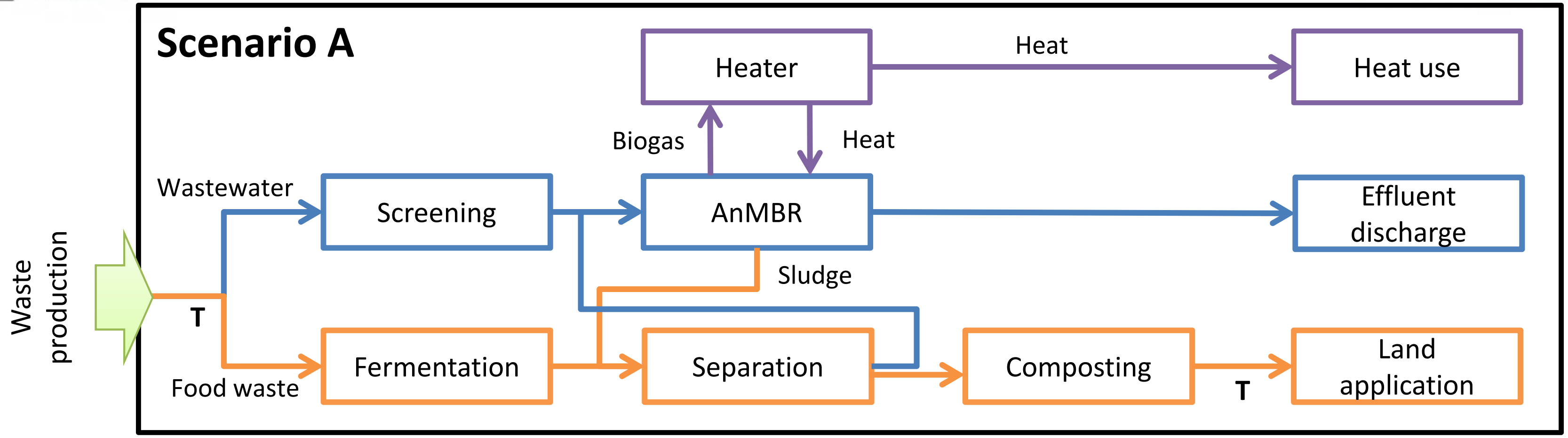
Integrated treatment scheme

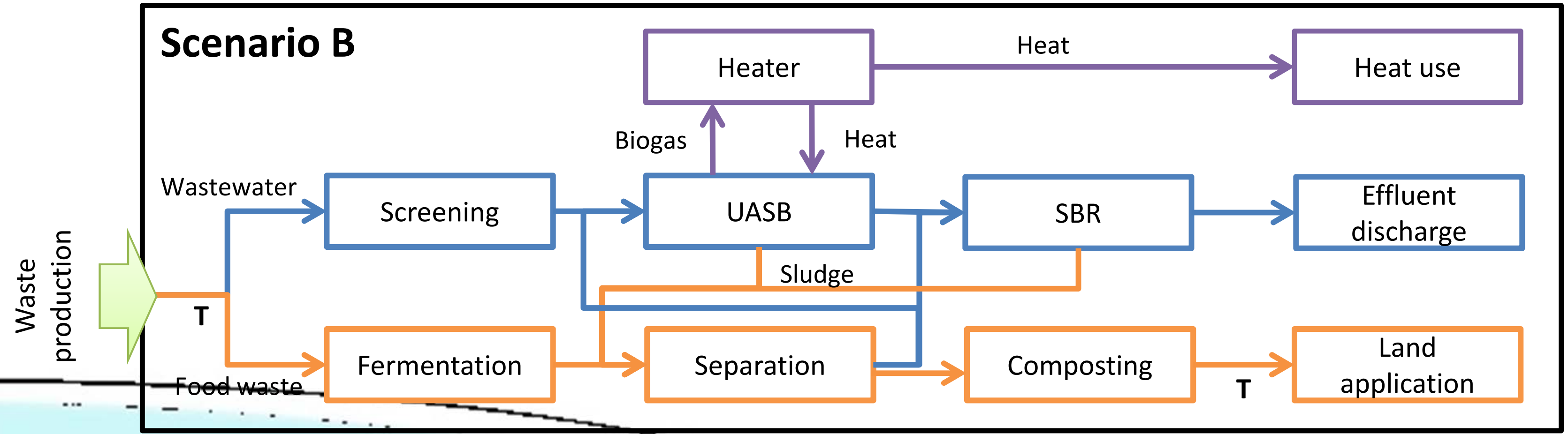
→ Biogas

→ Effluent

→ Compost

Case study


Scenario A
Heater
Heat
Heat use
Biogas
Heat
Wastewater
Screening
AnMBR
Effluent discharge
Sludge
Waste production
T
Food waste
Fermentation
Separation
Composting
T
Land application


Scenario B
Heater
Heat
Heat use
Biogas
Heat
Wastewater
Screening
UASB
SBR
Effluent discharge
Sludge
Waste production
T
Food waste
Fermentation
Separation
Composting
T
Land application

Life Cycle Assessment (LCA)

Goal and scope definition

Inventory data collection

Inputs from Technosphere		
Electricity	1000	kWh
Outputs to Environment		
CH_4	60	kg
N_2O	0.1	kg

Impact assessment

Environmental results			
Impact categories	A	B	C
Climate change	10	60	-1
Acidification	5	15	-5
Eutrophication	0.8	1	0

Interpretation

Conclusions
Recommendations
Improvement options

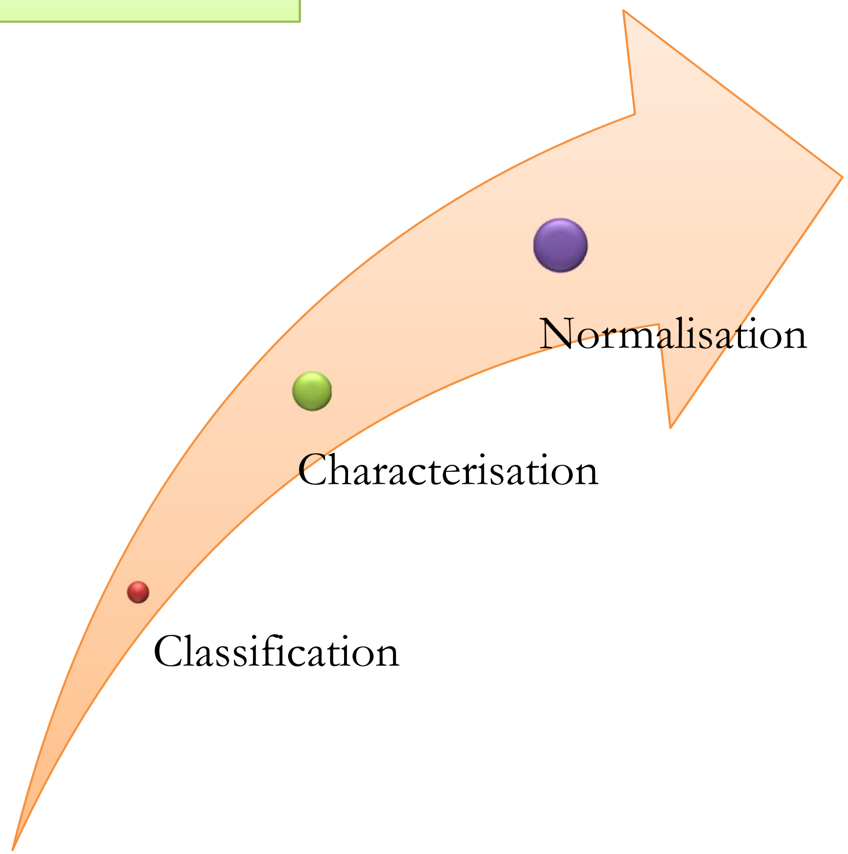
Life Cycle Assessment (LCA)

FU: Management of the wastewater and DOW produced by 2,000 inhabitants per day

ReCiPe Midpoint and Endpoint Methodologies

Characterisation results

- Climate change (CC)
- Ozone depletion (OD)
- Photochemical oxidant formation (POF)
- Fossil depletion (FD)
- Water depletion (WD)
- Terrestrial acidification (TA)
- Freshwater eutrophication (FE)
- Marine eutrophication (ME)

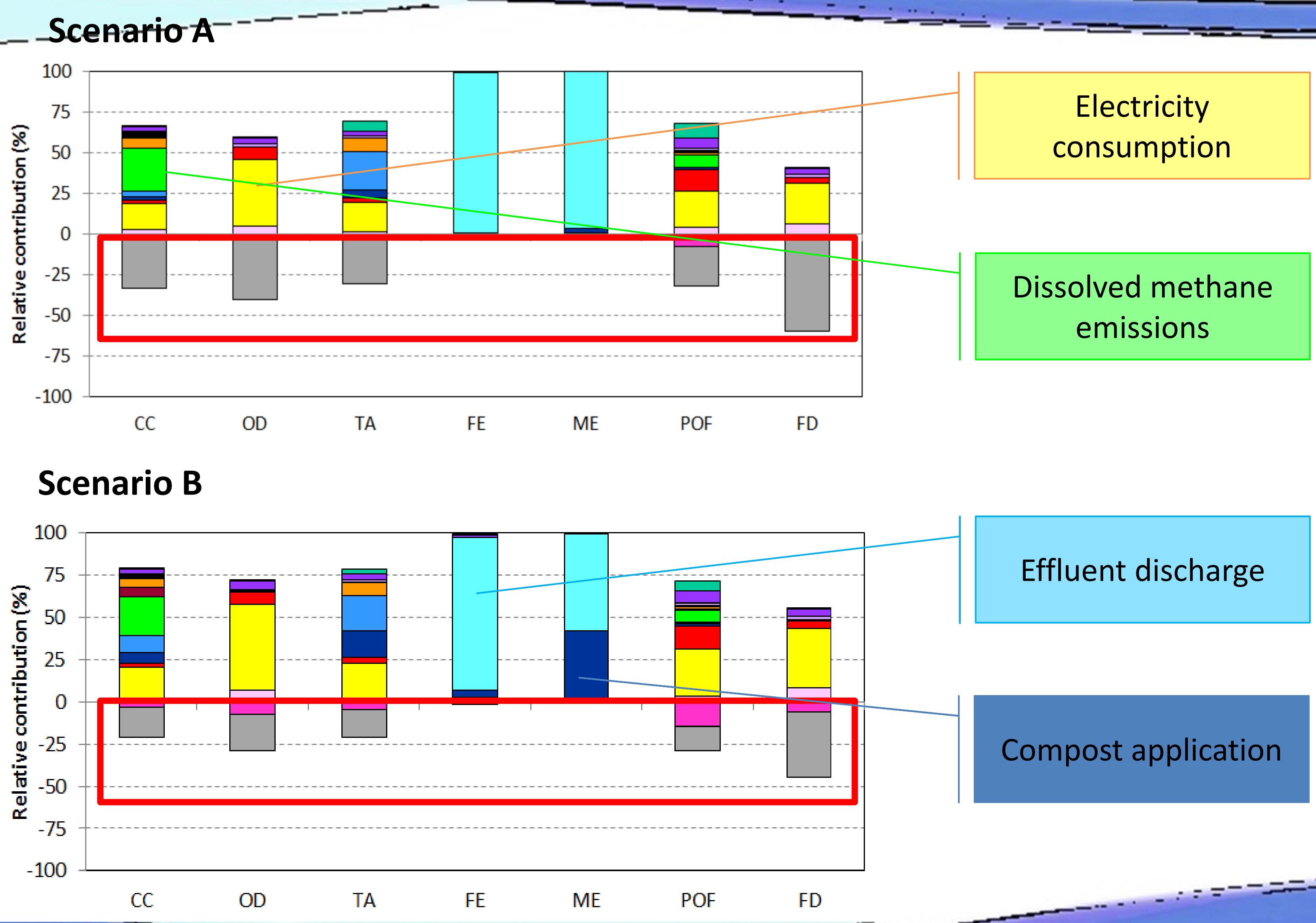


Main parameters

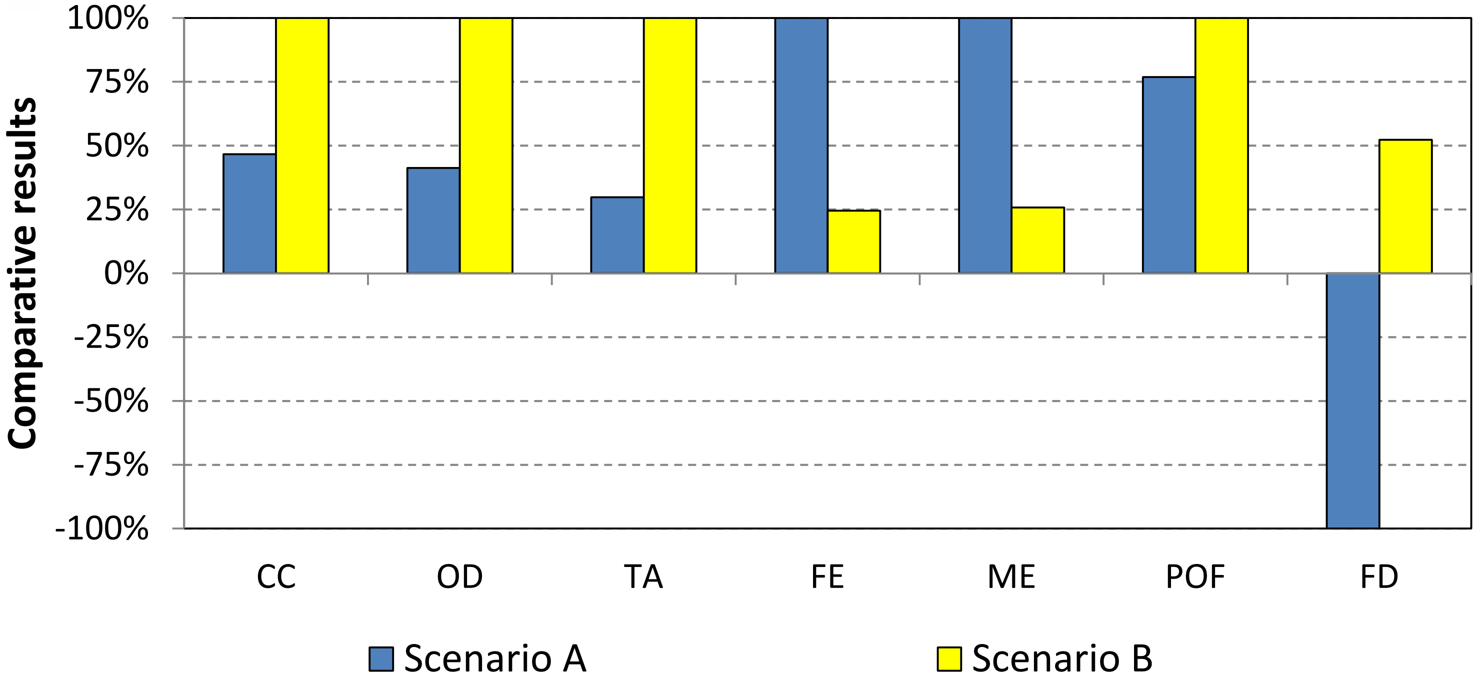
Input flow	Units	Wastewater	DOW
Input	m^3/d	400	
	kg/d		500
COD	mg/L	600	1200
N	mg/L	60	25
P	mg/L	9	3

Parameter	Unit	Scenario A	Scenario B
Methane production	m^3/d	96	61
Heat production	kWh/d	897	570
Final effluent			
· **Flow**	m^3/d	402	401
· **TS**	mg/L	0	26
· **COD**	mg/L	80	41
· **N**	mg/L	63	9.6
· **P**	mg/L	8.5	1.95
Compost production	kg/d	300	616

Impact assessment – Scenario A and B



Impact assessment – Comparative analysis



Normalisation results	
Scenario A	Scenario B
10.86	**2.83**

Conclusions

- **Environmental hotspots** of the proposed treatment scheme:
  - Electricity production → energy related categories
  - Emissions derived form the dissolved methane in the anaerobic effluent
  - Discharge of the effluent → eutrophication related categories
- Specific **environmental advantages** → valuable products production
  - Heat from biogas → avoided fossil-based heat
  - Compost production → avoid the use of peat as soil conditioner
- Scenario B achieved better results in **eutrophication related categories**
  - Implementation of biological nutrient removal
- Scenario B achieved worse results in **energy related categories and TA**
  - Nutrient removal requires high energy requirements and sludge production
- **Both treatment scenarios achieve discharge limits; however, only Scenario B achieves reuse requirements.**

Acknowledgements

This research was supported by the **BBVA programme "2015 edition of the BBVA Foundation Grants for Researchers and Cultural Creators"** (2015-PO027) and by the UE project **LIVE-WASTE** (LIFE 12 ENV/CY/000544).

LIVEWASTE

Ayudas Fundación BBVA
a Investigadores y
Creadores Culturales

Environmental assessment of alternative treatments for wastewater and domestic organic waste

L. Lijó*, M.T. Moreira *, E. Katsou**, S. Malamis*** and S. González-García *

* Department of Chemical Engineering, University of Santiago de Compostela
**[illegible] ace and Civil Engineering, Brunel Univeristy
[illegible] and Environmental Engineering, School of Civil
[illegible], National Technical University of Athens