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LIFE Zero Waste Water: exploring the joint management of bio-waste and wastewater

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LIFE ZERO WASTE WATER - LIFE19 ENV/ES/000631
With the contribution of the LIFE Programme of the European Commission

INTRODUCTION

Our Research Team

Chemical Engineering

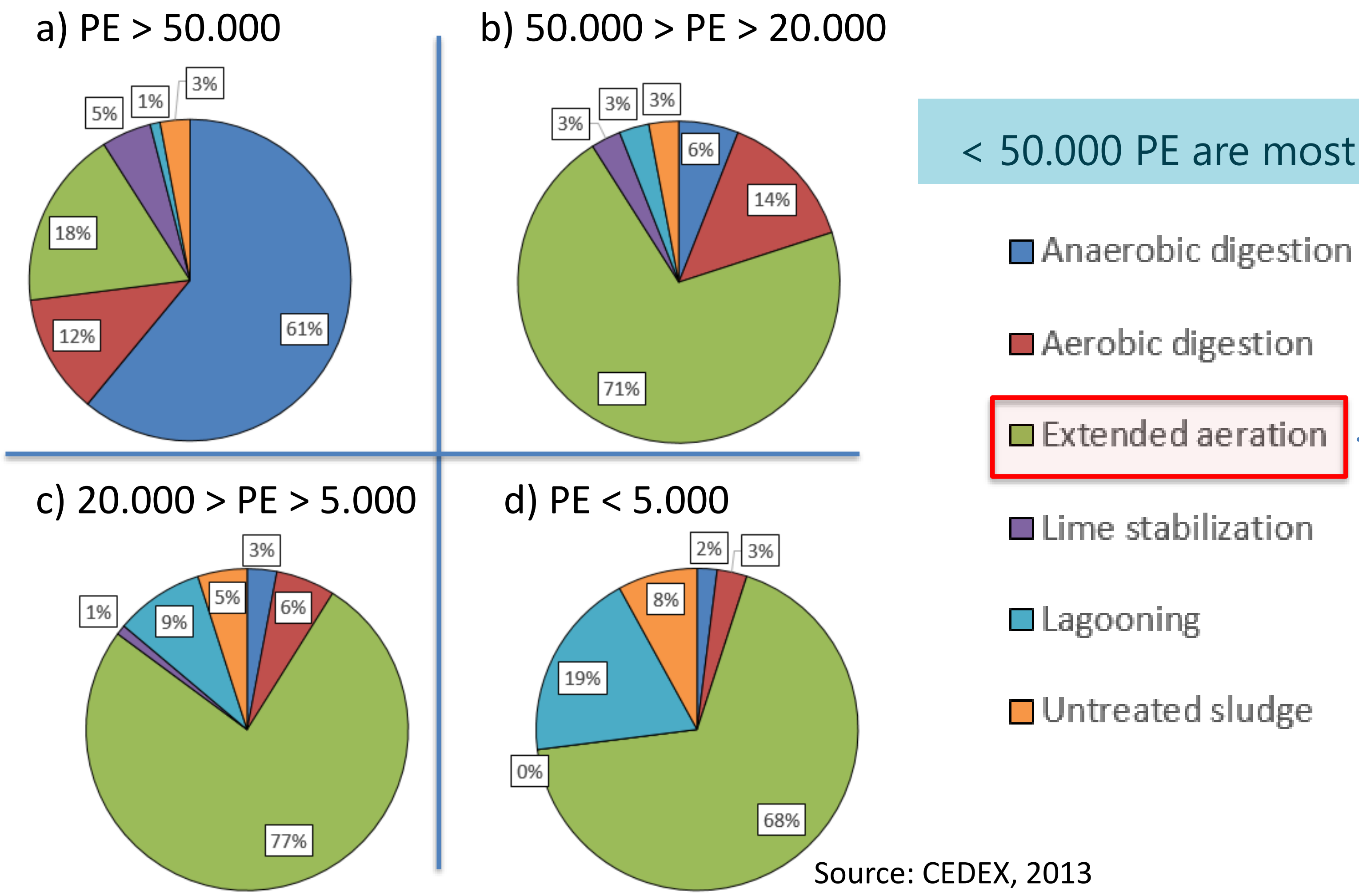
Water and Environmental Eng.

Urban wastewater can be fully treated **anaerobically** with **AnMBR** plants

WWTPs can become WRRFs with net energy production

INTRODUCTION

- **Current WWTP facilities by plant size and type of process (Spain)**



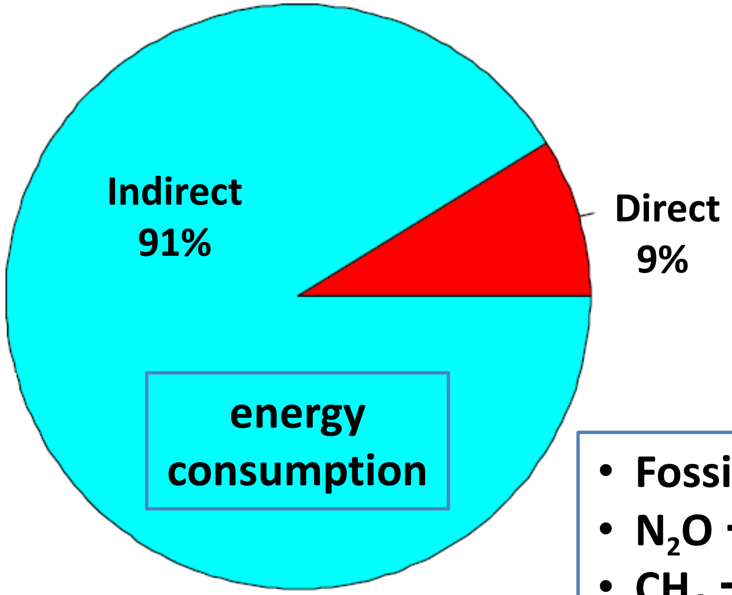
< 50.000 PE are mostly **aerobic based**

Extended aeration:
- Energy demand
- GHG emissions

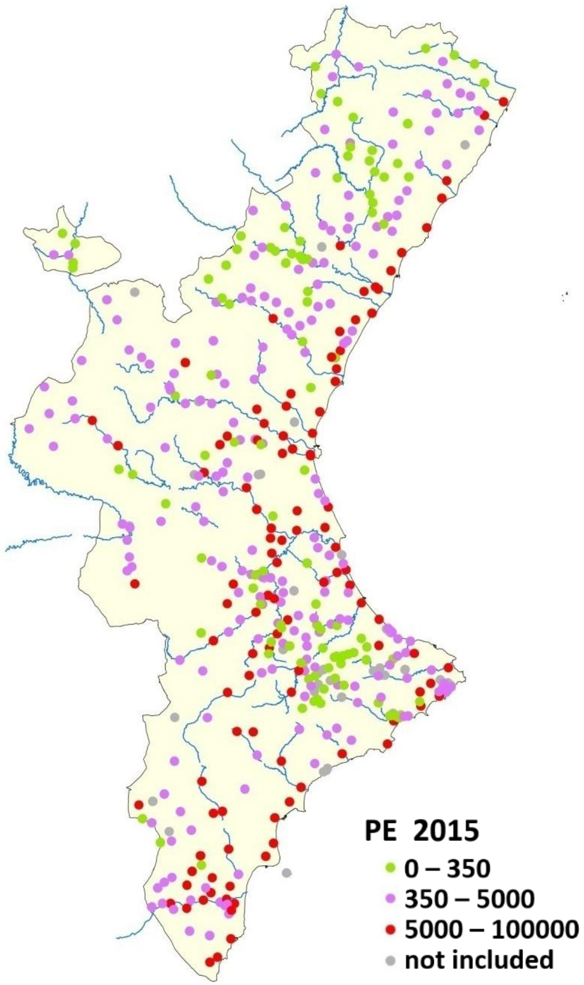
Source: CEDEX, 2013

Carbon foot-print of WWTP in the Region of Valencia

- 91% GHG emissions associated to energy consumption



- Fossil fuel consumption
- N_2O → N/DN process
- CH_4 → Anaerobic w/o CH_4 capture

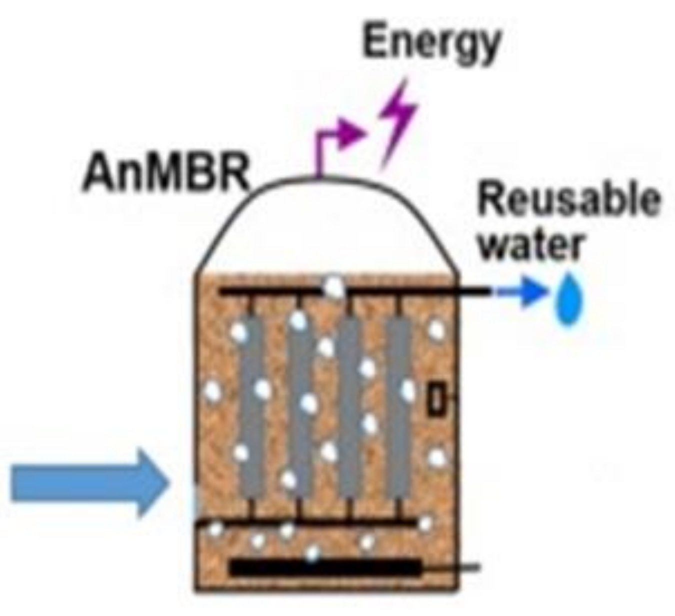


Source: EPSAR (2016), Period 2010-2015

INTRODUCTION

We need a shift towards more sustainable technologies

Anaerobic Membrane BioReactor (AnMBR)



- **Anaerobic** treatment can be used in small WWTP (aerobic water treatment can be avoided)

BENEFITS:

IMPACT REDUCTION
- Low energy demand
- Low GHG emissions
- Low sludge productions

RECYCLING & VALORIZATION
- High quality water (ultra-filtered, pathogen free, nutrient rich effluent)
- Organic matter → Biogas / Biomethane
- Nutrients & compostable sludge

AnMBRs allow **decentralisation**, which facilitates recycling of water and nutrients.

AnMBR applied to low strenght UWW

First study at pilot plant scale located in Valencia (Spain) in 2008

Reaction volume
2.2 m^3

2 membrane tanks
PURON®, KMS ultrafiltration
31 m^2 filtration area/module

Design flow-rate
25 m^3/d

Influent characteristics

Variable		Media ± SD*
SST	(mg SS·l^{-1})	186 ± 61
SSV	(mg SS·l^{-1})	150 ± 54
DQO_T	(mg DQO·l^{-1})	388 ± 95
DQO_S	(mg DQO·l^{-1})	79 ± 25
AGV	(mg DQO·l^{-1})	11 ± 7
$S\text{-}SO_4$	(mg S·l^{-1})	99 ± 18
$N\text{-}NH_4$	(mg N·l^{-1})	27,0 ± 8,1
$P\text{-}PO_4$	(mg P·l^{-1})	2,7 ± 0,9
Alk.	(mg $CaCO_3$·l^{-1})	292,5 ± 37,2

Low COD concentration

Significant sulfate concentration

Unidad Mixta UV-UPV

Grant CTM2008-06809-C02-01 and CTM2008-06809-C02-02
funded by the Spanish National Science Foundation (CICYT)

Case study of industrial prototype (Alcázar de San Juan WWTP) in 2014

3 membrane tanks 0.8 m^3/tank (0.7 + 0.1)

PURON®, KMS, Ultrafiltration (0.03 µm)

41 m^2 filtration area/module

Anaerobic reactor

40 m^3 (35 + 5)

Design flow-rate

60 m^3/d

http://www.life-memory.eu

AnMBR applied to low strenght UWW

Case study of industrial prototype (Alcázar de San Juan WWTP)

Energy demand (technology comparison)

Scenario	Energy Consumption (kWhm³)	Energy Recovery (kWh/m³)	Net Energy Consumption (kWh/m³)
CAS w/o energy recovery	0.42	-	0.42
CAS with energy recovery	0.44	0.16	0.28
AeMBR w/o energy recovery	0.50	-	0.50
AeMBR with energy recovery	0.54	0.13	0.41
AnMBR with energy recovery	0.59	0.65	-0.07

↑ organic matter (COD) in the influent → ↑ benefits

memory
http://www.life-memory.eu

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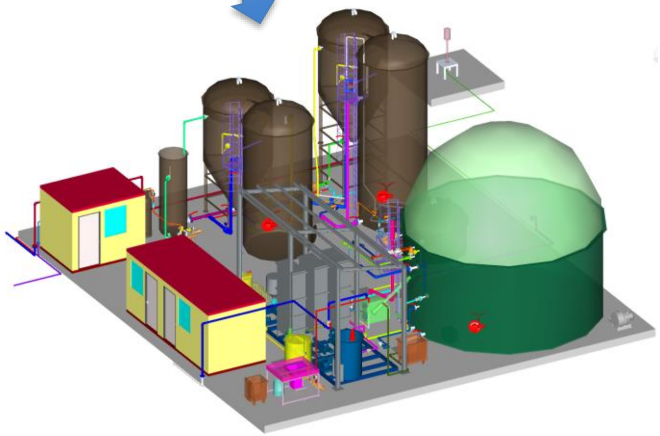
ZERO WASTE WATER

LIFE ZERO WASTE WATER

Integrated management of Urban Wastewater (**UWW**) and the Organic Fraction of Municipal Solid Waste (**OFMSW**) for populations of **less than 50.000 inhabitants**

http://www.lifezerowastewater.com



PROJECT LOCATION: **Valdebebas WWTP, Madrid (Spain)**

BUDGET INFO:
- **Total amount: 2.464.520 €**
- **% EC Co-funding: 55%**

DURATION: Start: 01/09/2020 - End: 31/08/2024

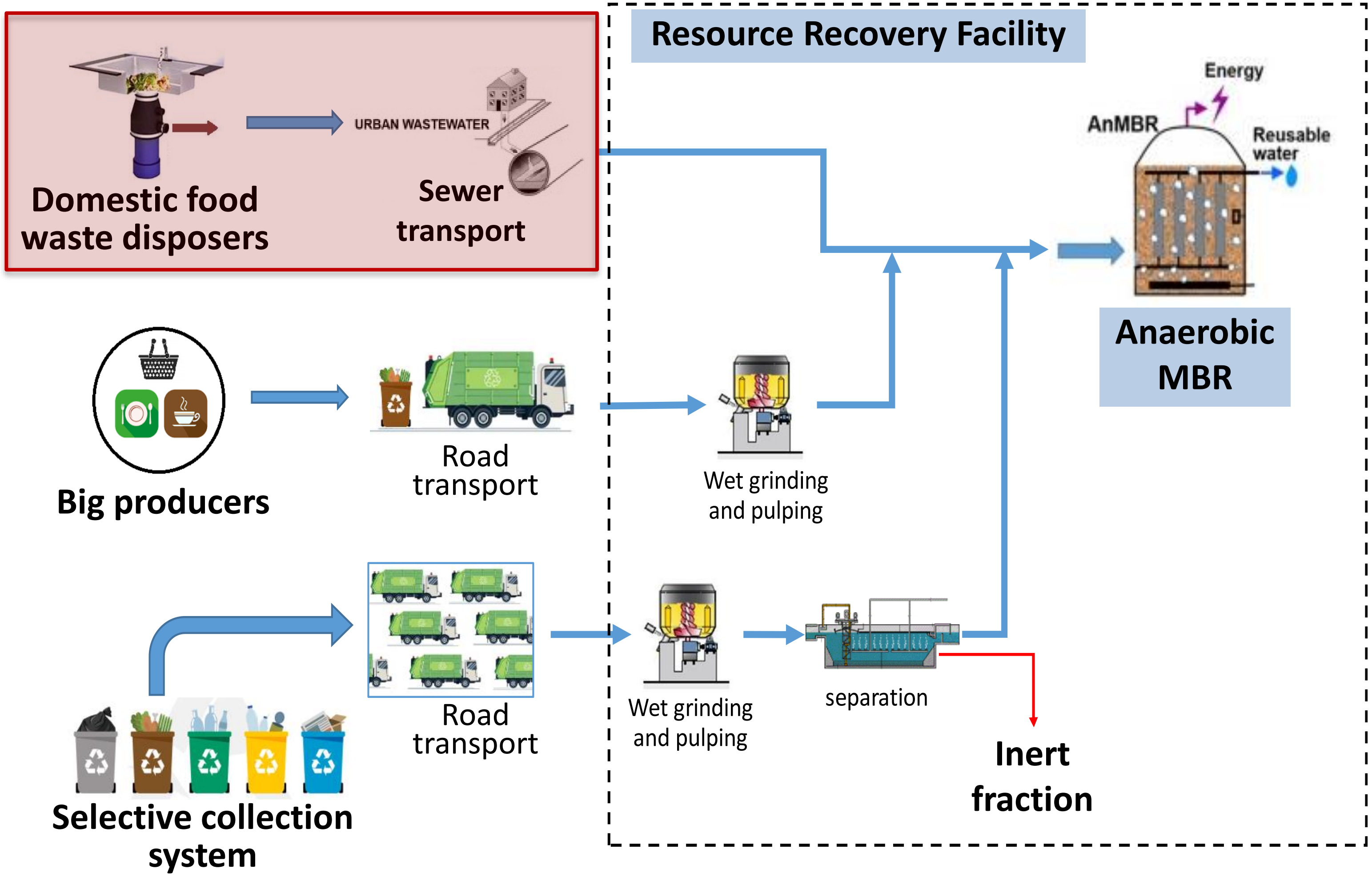
PROJECT'S IMPLEMENTORS:

aqualia, Canal de Isabel II, simbiente, USC Universidade de Santiago de Compostela, Vniversitat de València, VWM Solutions

Different integration options to be analysed in the project

Gravity driven transport

Only food waste is treated



The AnMBR Plant

Anaerobic digester and 3 types of membrane modules

Design flows:

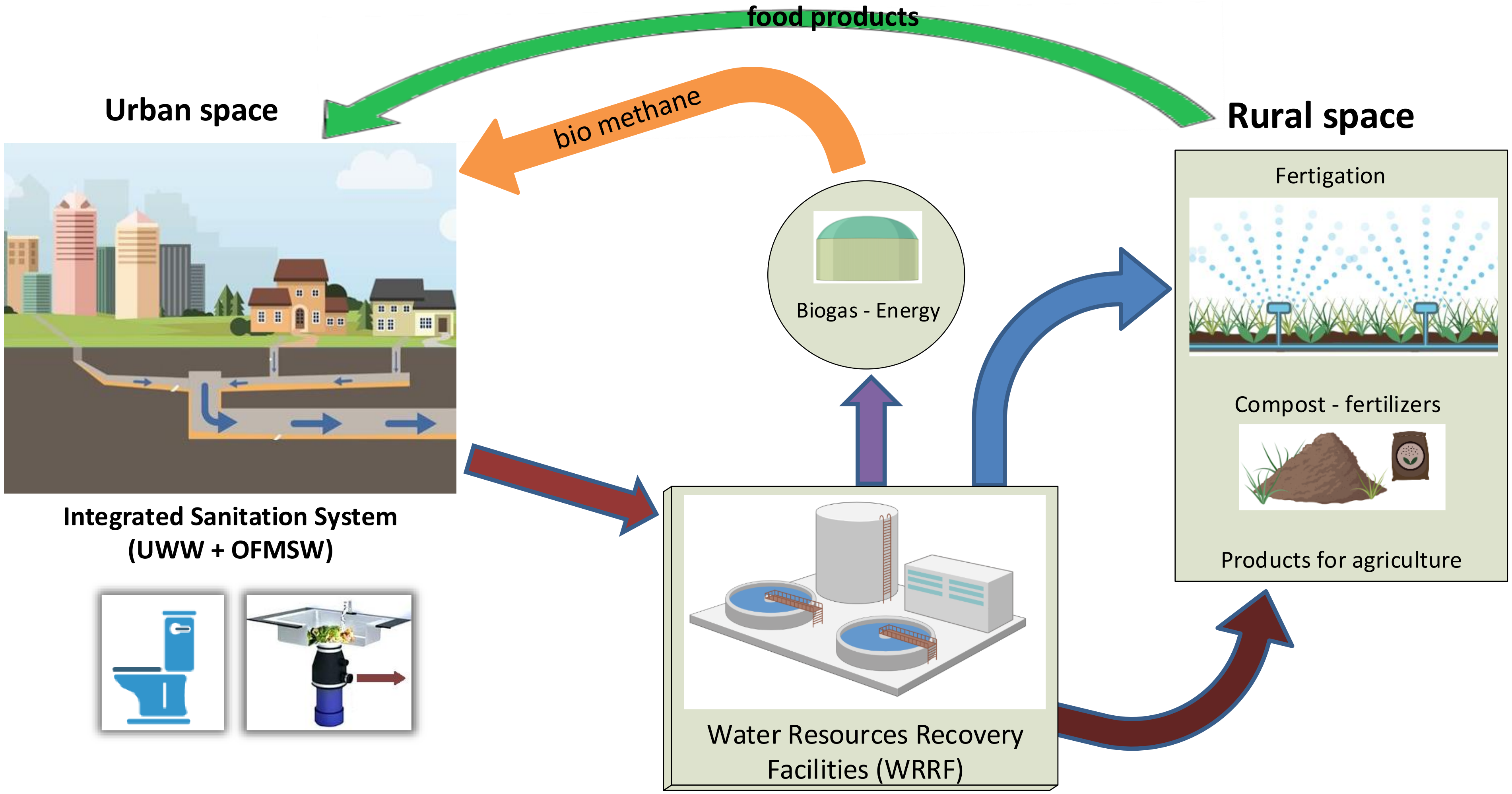
50 m^3/d UWW

125 kg/d OFMSW

(~ 300 PE with 70% PF)

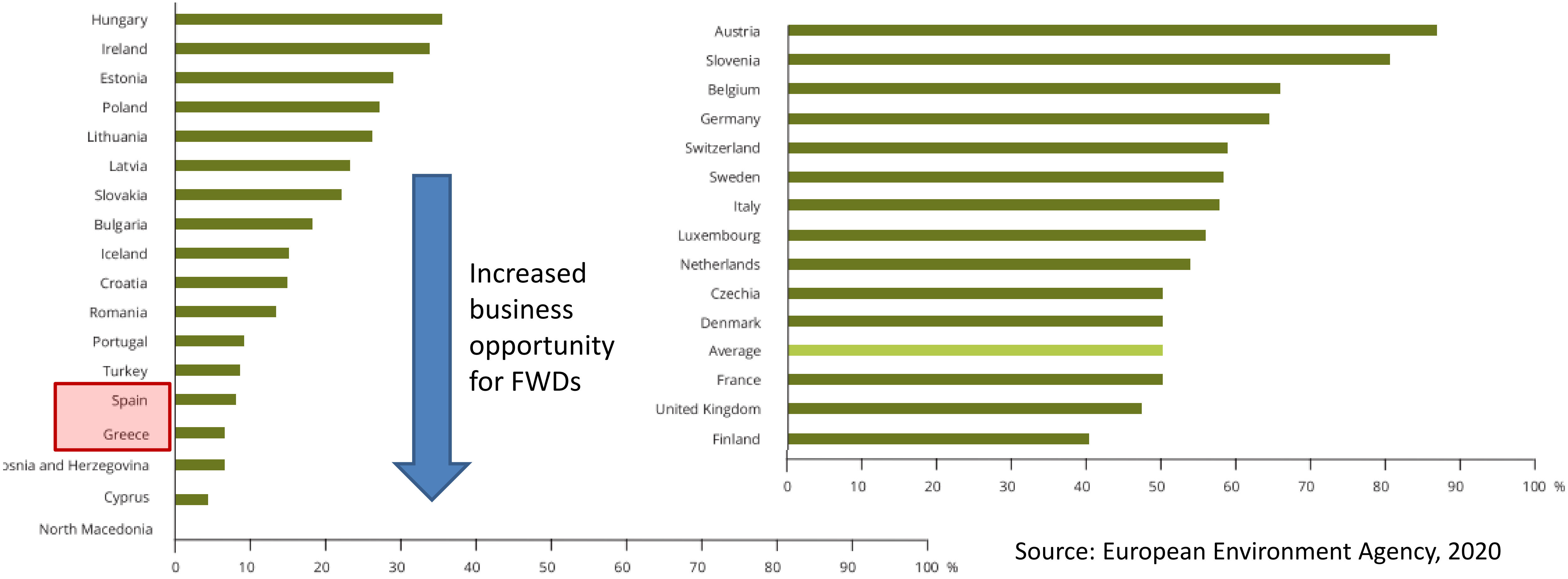
The LIFE ZWW project concept

- **Circular economy in the urban sanitation sector**



Management of the OFMSW in the EU

- **Bio-waste "capture rate"** (BW collected as a share of BW generated)



Increased business opportunity for FWDs

Source: European Environment Agency, 2020

Management of the OFMSW in the EU

- **Separate collection of Bio-waste** must be implemented to fulfill the Waste Framework Directive (EU 2018/851) and the Landfill Directive (EU 2018/850)
  - It is **crucial for bio-waste recycling** (high quality compost, less inert/toxic materials)
- So far, **door-to-door** and **street containers** are the most extended systems
- But, for many cities, it is not easy to implement in few years:
  - It requires careful planning, design, and citizen engagement.
  - Achieving high bio-waste quality and "capture rates" can take many years, even with awareness campaigns.
  - Impurities can be reduced, but can still exceed 15% in street containers.
- Separate collection is now being implemented is Spain by legal requirements, but in most cases it is **inefficient** and **expensive** for citizens.

The combination of FWDs with AnMBR-based RRFs can promote effective bio-waste recycling.

Advantages for MSW management: citizen engagement

- FWDs simplify the separation of bio-waste to citizens at home:

Source: Insinkerator®

- No special bin is required for organic waste separation.
- The use of compostable/plastic bags is avoided.
- The **effort of citizens** is significantly reduced.
- Easy solutions enhance engagement and BW capture rates.

- Citizen engagement relies on FWD installation (Penetration Factor).
- A high PF means less organics in the mixed waste street container.

- Less OM will end up in a landfill.

Use of FWDs with AnMBR systems

Advantages for MSW management: road transport reduction

- Significant reduction in collection and transport requirements:

On demand collection can be applied

Fermentable waste

High collection frequency required (warm climates)

- It reduces **cost** and **environmental impact** of MSW collection
- Reduction in truck traffic, noise, air pollution, etc.

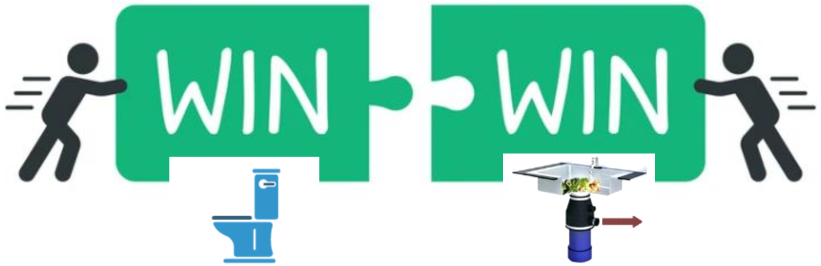
CONCLUSIONS

- **Main benefits of the solution proposed in the LIFE ZWW project:**
  - It promotes Circular Economy in urban sanitation at the local level.
  - It allows anaerobic treatments being implemented in small and decentralised WWTPs.
  - It allows a fast increase of bio-waste capture rates (only FWD installation required)
  - FWDs ensure the quality of bio-waste, avoiding improper materials.
  - Once the AnMBR plant is built, PF can rise without additional membrane upgrades.
  - The more bio-waste, the greater the benefits (biogas, nutrients, compost...)

- The AnMBR system enables a paradigm shift in urban sanitation:

"More OM in the influent means more benefits"

- The integrated sanitation system facilitates MSW management and increases the benefits of RRFs.



Integrated sanitation system

ZERO WASTE WATER

http://www.lifezerowastewater.com

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Ευχαριστώ

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