Workshop Effisludge

"Life-ANADRY" project has received funding from the European financial instrument for the Environment (LIFE+) programme (LIFE14 ENV/ES/000524).

Life ANADRY

(LIFE14 ENV/ES/00524)

General aspects

- Time: 01/09/2015 – 28/02/2019 (42 months)
- Coordinator : Depuración de Aguas del mediterráneo (DAM)
- Budget: 1,54 M€
- Partners:

DAM

ceit IK4 Research Alliance

esamur

The Regional Entity of sanitation and wastewater in Murcia

INDEREN

SEMIDE EMWIS

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Introduction

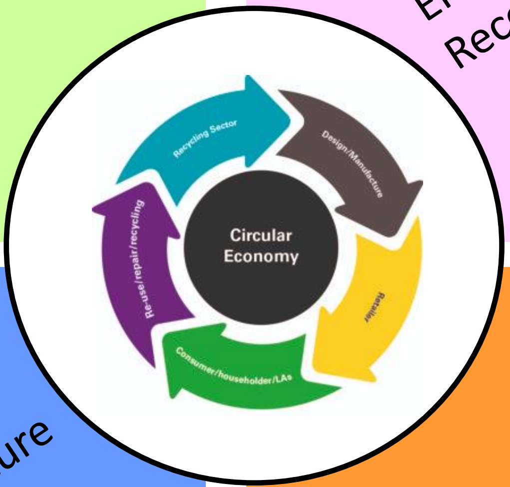
AD of sewage sludge is a process for the stabilization of the sludge and the conversion of an important part of the organic matter into biogas.

GHG/CO_2

Climate change

Energy Recovery

Biogas
Upgrading
Methane
CO_2



Stabilization
Hygienitation

Digestate
Farmers

Agriculture

Resource efficiency

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Introduction

Spain

- Direct disposal in agriculture — 80,2 %
- Composting
- Incineration — 9,5 %
- Drying
- Landfill — 10,3 %

Europe

9.050.181 t DM /year

Fuente: WRC and RPA for the European Comision 2010

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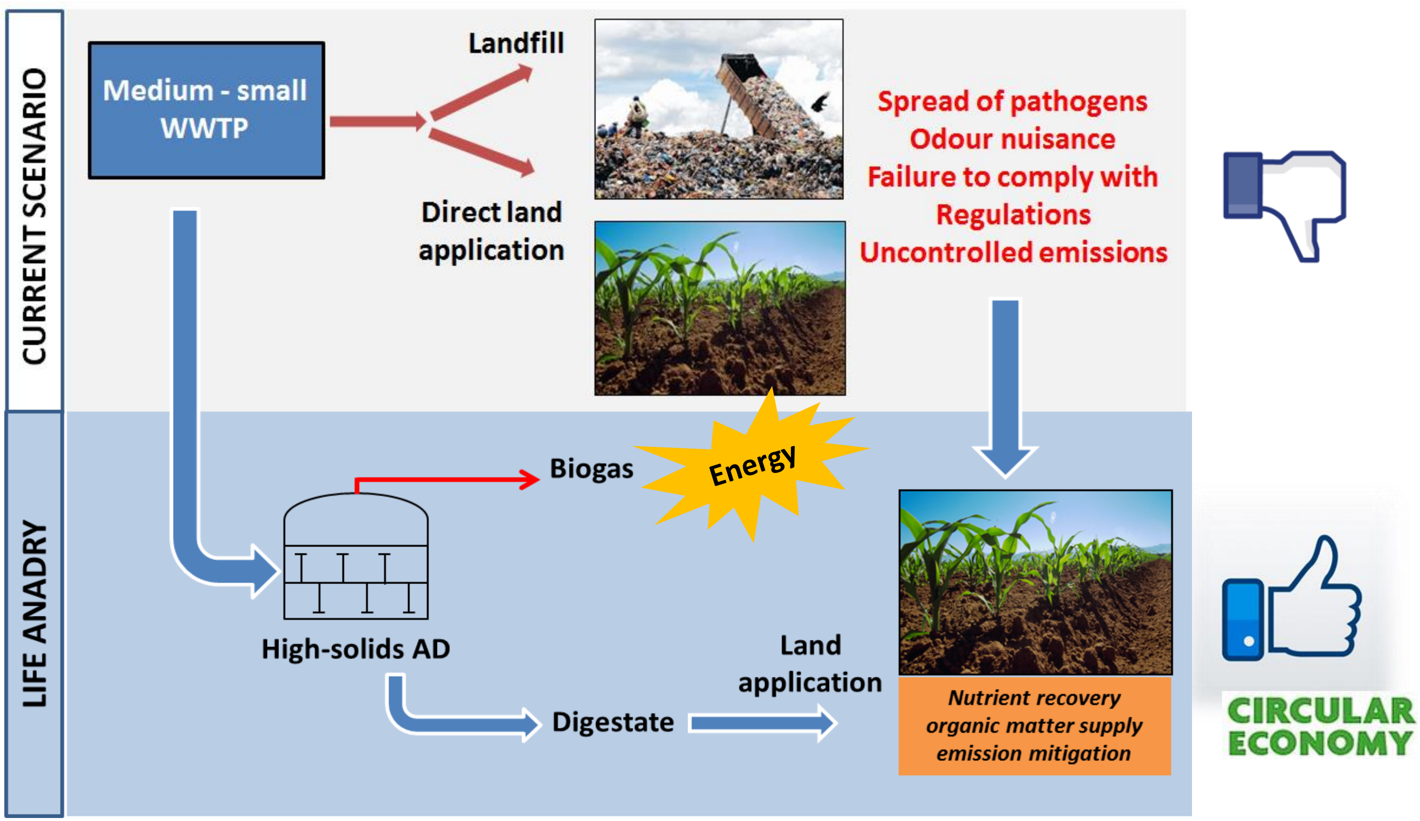
Introduction



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Main objective

To demonstrate the **technical, economic and environmental feasibility of the correct environmental management of sludge** in medium to small size urban wastewater treatment plants (WWTPs), which do not have anaerobic digestion.

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Specific objectives

- Demonstrating the technical-economic viability of dry AD technology .
- Design and construction of 20m^3 the dry anaerobic prototype.
- Implementation of the prototype in thermophilic and mesophilic conditions.
- Improving the quality of the sludge produced in WWTP.
- Reducing GHG gas emissions due to the reduction sludge minimization and the dry AD.
- Promoting the inorganic fertilizers substitution due to the use of sludge recycled in agriculture.

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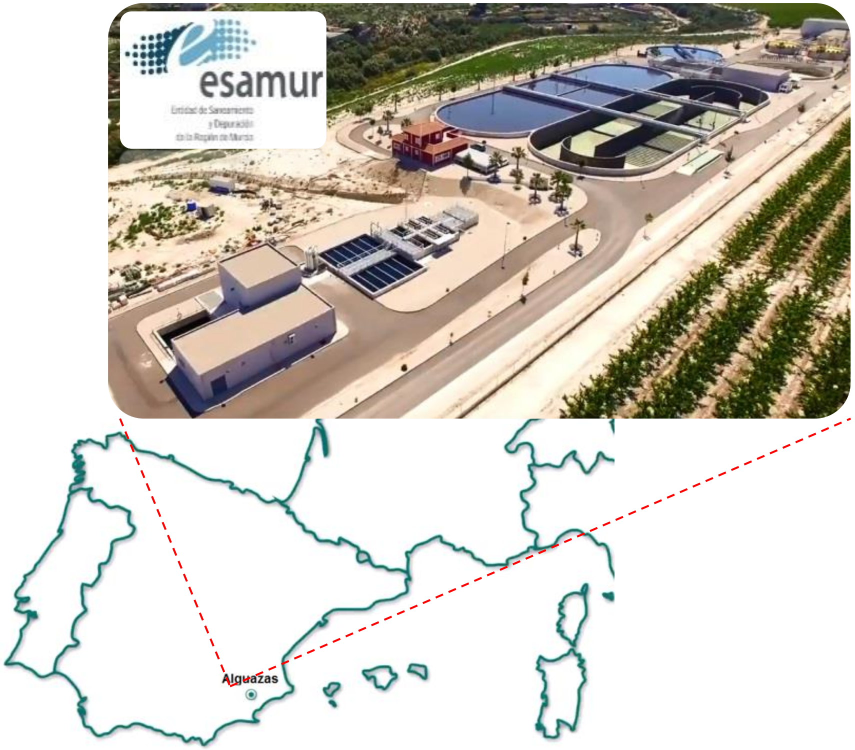
Location of the project

- Alguazas WWTP (Murcia, Spain).
- Urban WWTP small/medium size.
- Flow aprox : 3500 m^3/d.
- Population: 60,000 inhab.
- Sewage sludge production: 10 t/d.
- Configuration: Extended aeration/carrousel reactors.



Alguazas WWTP is a small/medium sized urban plant that has not anaerobic digestion

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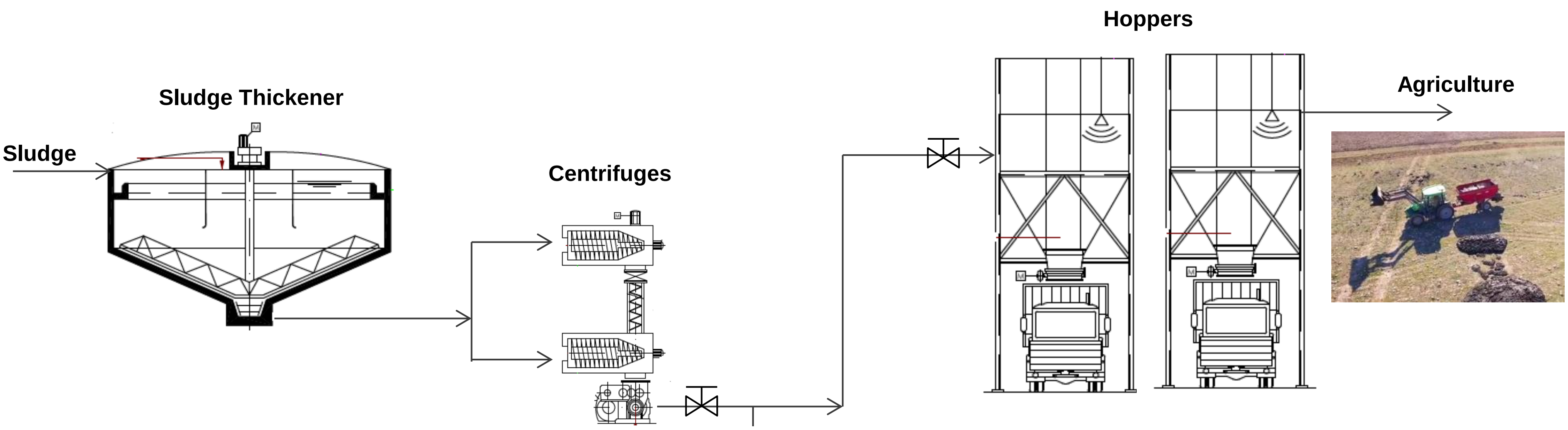
Current scheme in the Alguazas WWTP



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Technical progress

B1 – Design of the dry anaerobic digestion technology and control algorithm.

B2 – Construction, validation and transport of the prototype.

B3 – Start-up of the prototype at Alguazas WWTP.

B4 – Implementation of thermophilic conditions in the prototype .

B5 – Implementation of mesophilic conditions in the prototype.

B6-B7 – Technical and economic feasibility studies / Transferability study

Implementation actions

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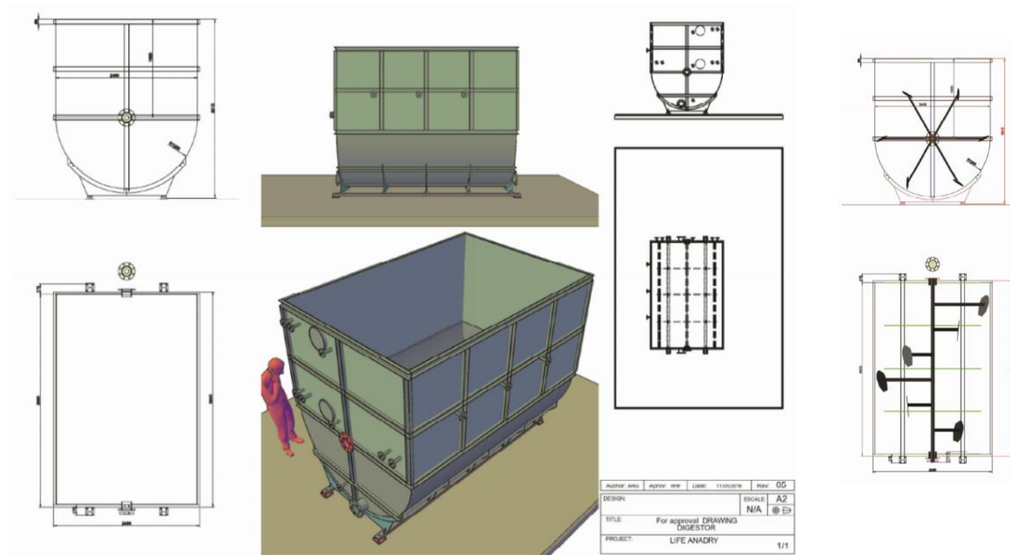
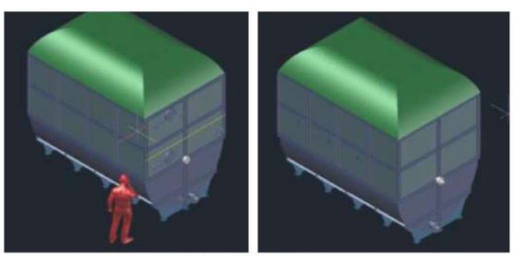
Technical progress

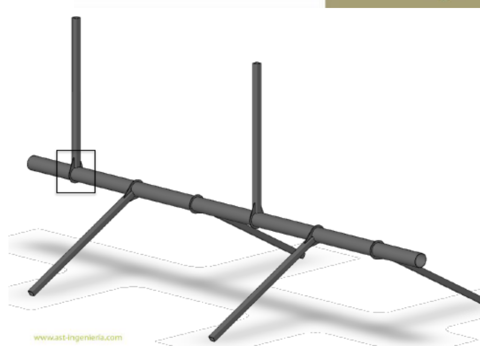
B1

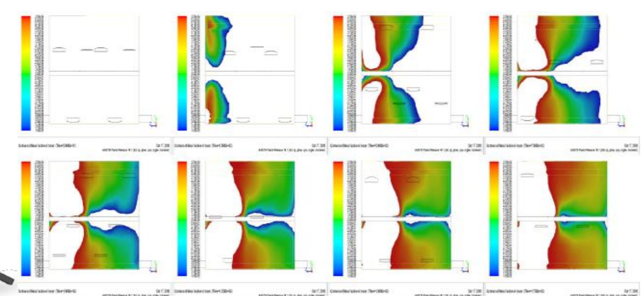
Design of the dry anaerobic digestion technology and control algorithm.





Design of the reactor





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Technical progress

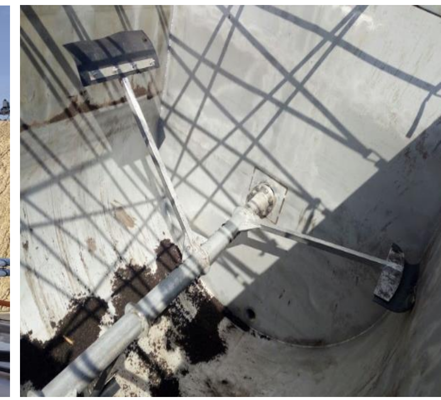
B2

Construction, validation and transport of the prototype.

Feeding System

Digester

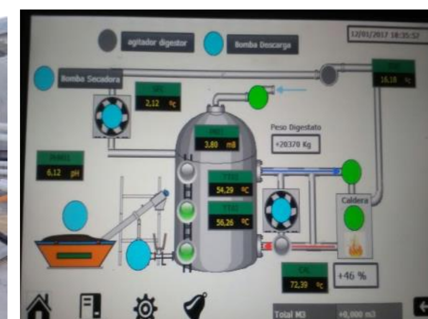
Agitation system



Effluent Tank

Heating system

Control system



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Technical progress

B2

Construction, validation and transport of the prototype.

Video

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Technical progress

B3

Start-up of the prototype at Alguazas WWTP.

- Thermophilic biomass by organic fraction of municipal solid waste (OFMSW) treatment plant (Botarrell).
- Volume=20 m^3
- HRT= 20d
- Flow rate: 1000 kg/day

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Technical progress

Analysis of the influent

B3

Start-up of the prototype at Alguazas WWTP.

Influent	
COD t (mg/l)	70225 ± 8435
DM(%)	15.5±1.2
VS (%)	76.5 ± 11.9
TKN (%)	3.2 ± 2.6
TAN (mgN/l)	2808 ± 574.7
pH	7.1 ± 0.5
Salmonella sp..	*existence*
E.coli CFU/100ml	*7.5 x 10-3*

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Technical progress

B3

Start-up of the prototype at Alguazas WWTP.

Best parameters to control AD:

- Volatile fatty acid (VFA)
- Alkalinity (ALK)
- Dry matter (DM)
- Volatile matter (VM)
- Biogas (CH_4, CO_2, H_2S, O_2)
- pH

Allows checking of the AD process state plus predicting and avoiding process disturbances (acidification, inhibition..)

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Technical progress

B4

Implementation of thermophilic conditions in the prototype .

- Temperature: 55°C
- Hydraulic Retention Time (HRT): 40-30-20-15 days
- Yield in terms of:
  - Volatile solid destruction
  - Hygienization: *E.coli* and *Sallmonela spp*.
  - Biogas production
  - Stability of the process

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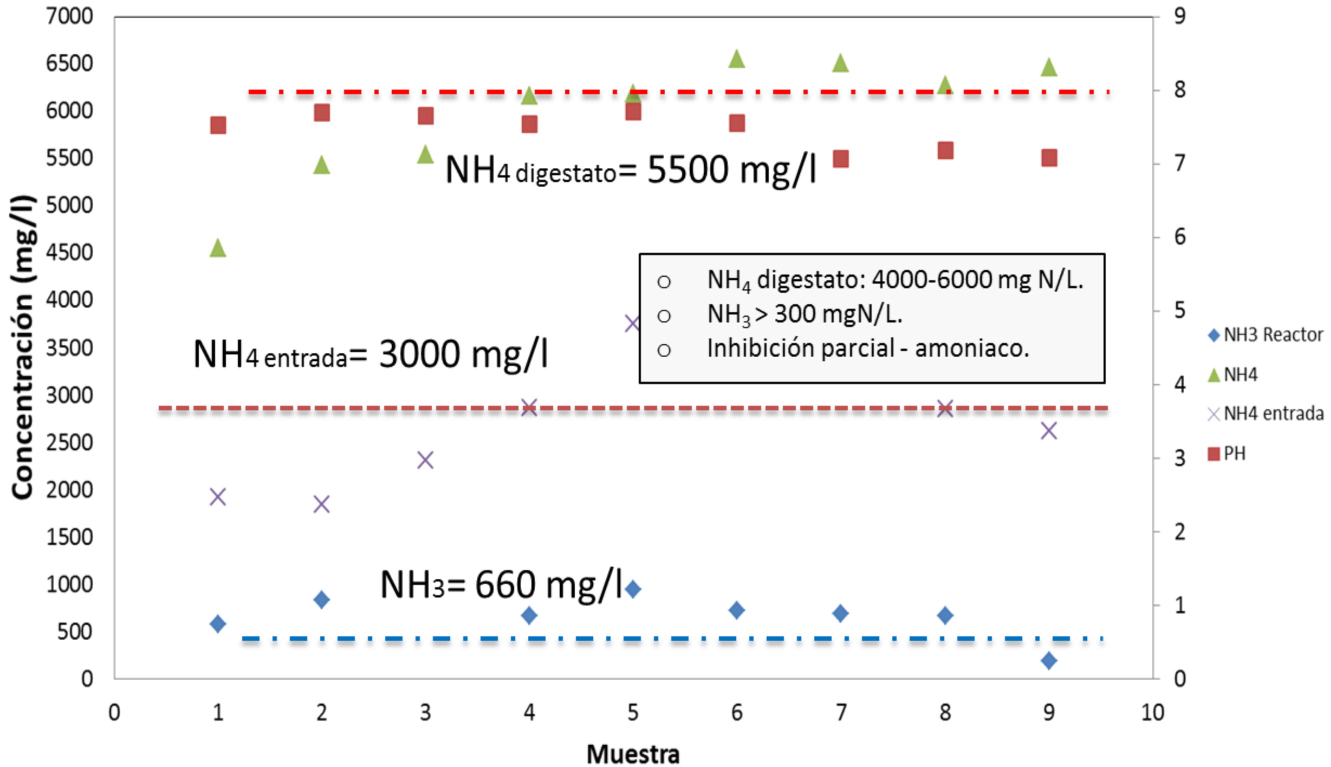
Technical progress

B4

Implementation of thermophilic conditions in the prototype .



Higher than 250mg/l of free ammonia cause an partial inhibition of methanogenic activity (Rajagopal *et al.*,2013; Yenigün *et al.*,2013)

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Technical progress

Biomethane Potential test (BMP)

B4

Implementation of thermophilic conditions in the prototype .

T= 55ºC ; pH= 7,5 - 8,0

-Ammonium Nitrogen < 2500 mg/l
-Co-digestion, COD/N (Corns Silage, rice straw, other)

Influence on the metanogenic stage
60% Methane

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Life ANADRY

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Technical progress

B4

Implementation of thermophilic conditions in the prototype .

Sulphide control

- Fe(0H) microstructural
- Load= 3 Kg/d
- Removal: 10,000 ppm.

MICRONOX BIOX

La siguiente tabla ilustra los beneficios de utilizar Mircronox Biox en lugar de los métodos alternativos de desulfurización de biogás:

	Micronox ON16	Cloruro de hierro	Desulfurización biológica
Corrosividad	★ ★ ★	★ ★ ★	★ ★
Sustancias nocivas	★ ★ ★	★ ★ ★	★ ★ ★
Concentración de metano	★ ★ ★	★ ★ ★	★ ★
Manipulación	★ ★ ★	★ ★ ★	★ ★
Biología del reactor de fermentación	★ ★ ★	★ ★	★ ★
Efectividad	★ ★ ★	★ ★ ★	★ ★
Riesgo de explosión	★ ★ ★	★ ★ ★	★
Velocidad de reacción	★ ★	★ ★ ★	★
Efecto "Buffer"	★ ★	★ ★ ★	★ ★ ★
Subproducto de reacción no deseado	Ninguno	Ácido clorhídrico	Ácido sulfúrico

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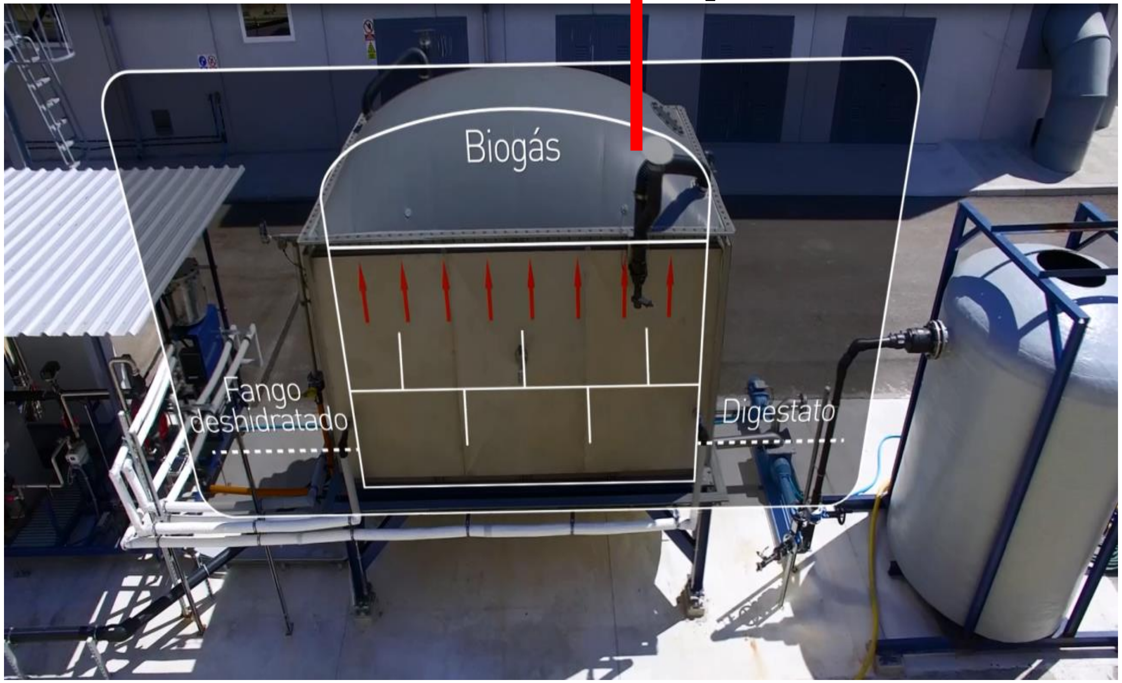
Technical progress

Biogas
CH_4= 30-40%
CO_2=60-70%
H_2S<1000ppm

Digester
HRT=40-30-20-15d
pH= 7,5-8,0
T= 55 °C
V agitation= 5-10 rpm



INFLUENT
Q= 500 -1300 kg /day
%MS=14-17
%MV=75,0
E. Coli = $6,9x10^4$
Salmonella= Presencia

EFFLUENT
%MS=12
%MV=60,0
E. Coli = < 10
Salmonella= Ausencia

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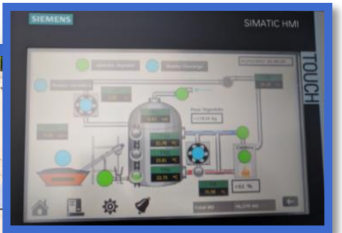
Technical progress

- Inoculation: January 2018 , 9 m^3 biomass Wet AD WWTP Alzira
- **Ratio:** 50%-50% (dehydrated sludge/Inoculum)
- HRT: 30-20-15-12 d

B5

Implementation of mesophilic conditions in the prototype.



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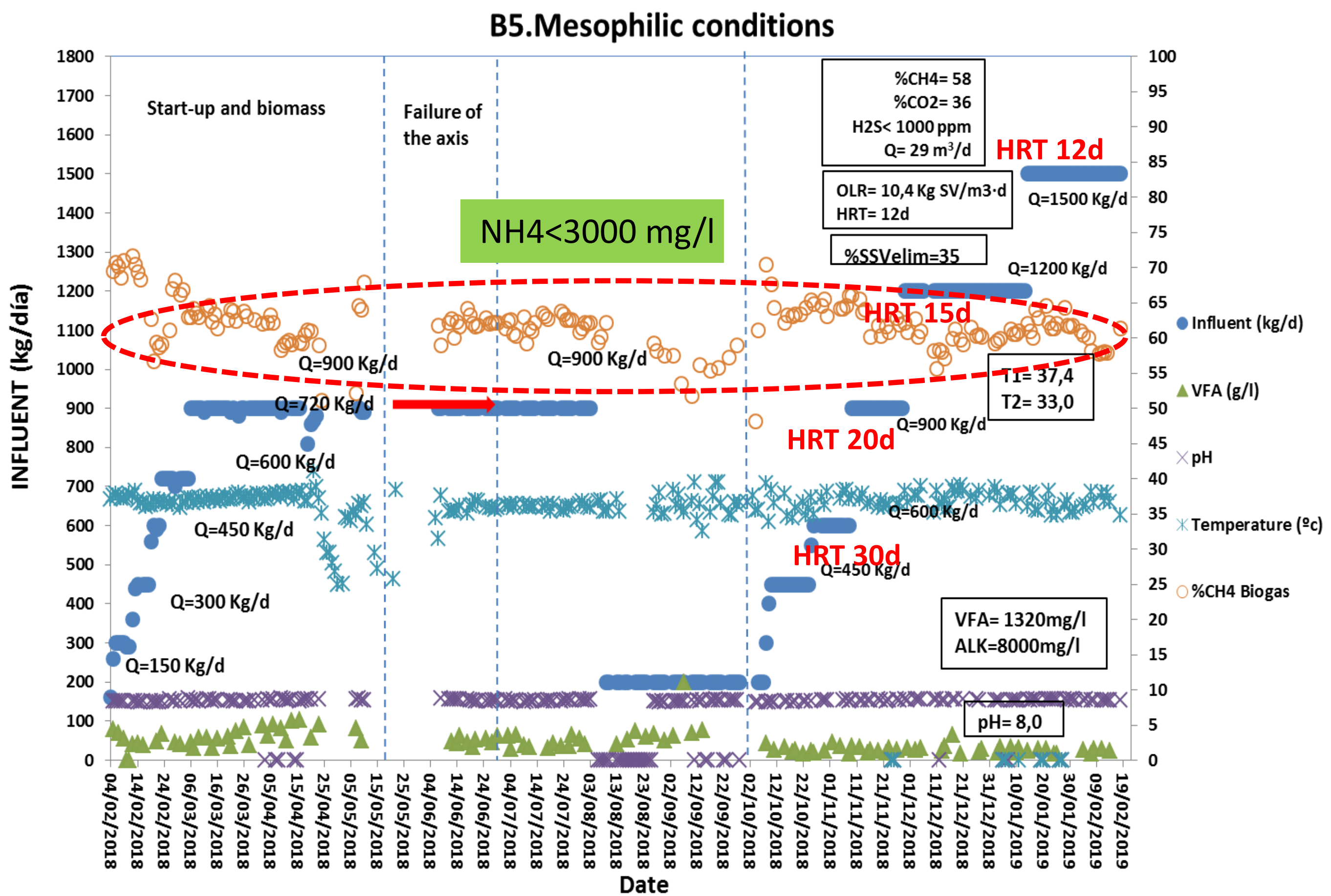
Technical progress

B5

Implementation of mesophilic conditions in the prototype.



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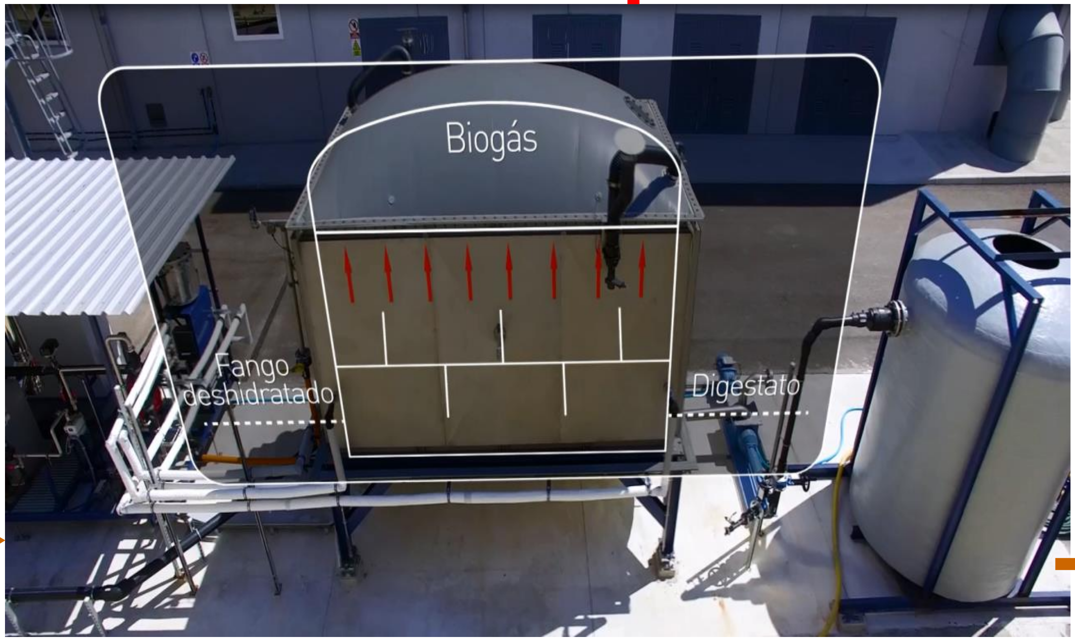
Technical progress

B5

Digester
HRT=30-20-15-12 d
pH>8,0
T= 35 °C
V agitation= 5 rpm

Biogas
CH_4=61%
CO_2=35%
H_2S <500 ppm
Q= 20-25 m^3/d

INFLUENT
Q= 500 -1300 kg /day
%MS=14,5
%MV=77
E. Coli = $2,5x10^3$
Salmonella= Presencia



EFFLUENT
%MS=10,7
%MV=72
E. Coli = 4x10^1
Salmonella= Ausencia
VSD= 30-35%
VFA= 1500 mg/l
NH4= 3000 mg/l

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General conclusions

Thermophilic (55ºC)	Mesophilic (35ºC)

Thermophilic (55ºC)

- Complete higienization (E.coli and Salmonella).
- Low biogas (partial inhibition /aclimatation) at HRT 40-30-20d.
- High free ammonia, instability.
- Control Sulphide with FeOH (H_2S<500ppm)

Mesophilic (35ºC)

- Complete higienization (>90% E coli and salmonella).
- Stable operation at HRT of 30, 20 15 and 12d
- High production biogas (Q≈ 25 m3/d ; CH_4 >60%).
- Higher performance (hig, stab, and biogas).
- Control Sulphide with FeOH (H_2S<500ppm)

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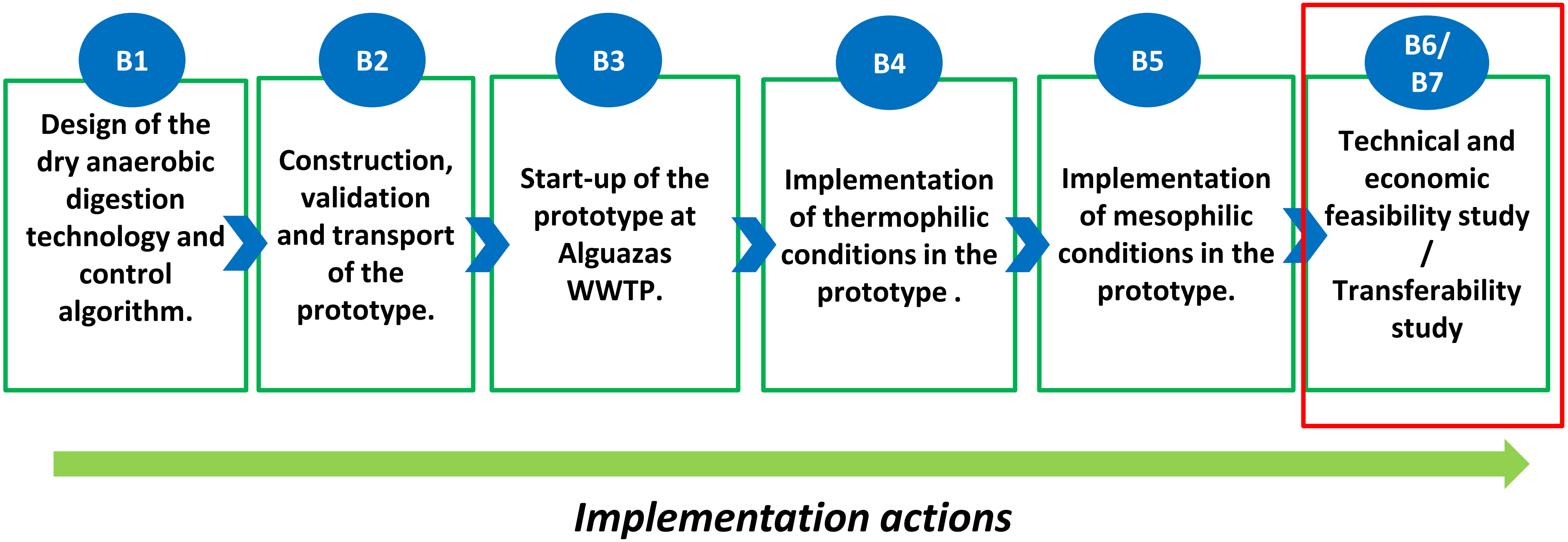
Technical progress



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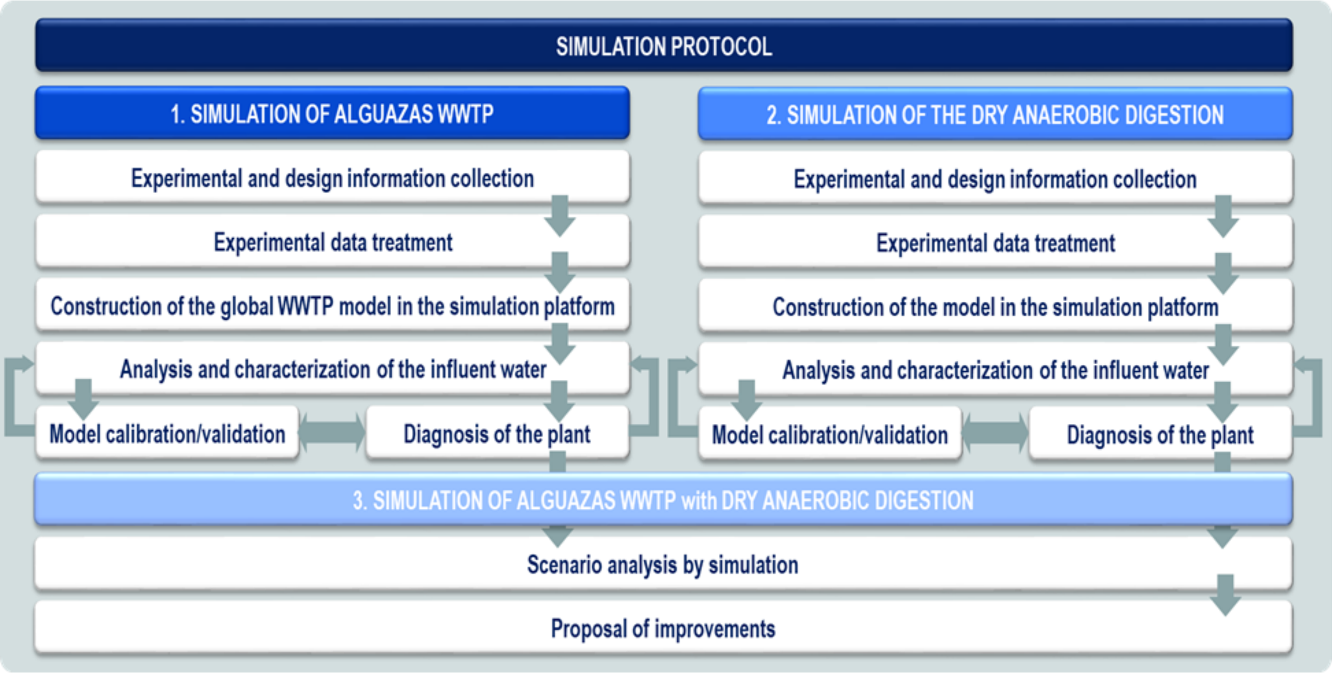
Technical progress

- **Simulation protocol: WEST software**

B6

Technical and economic feasibility studies in Alguazas WWTP. (Ceit-IK4)



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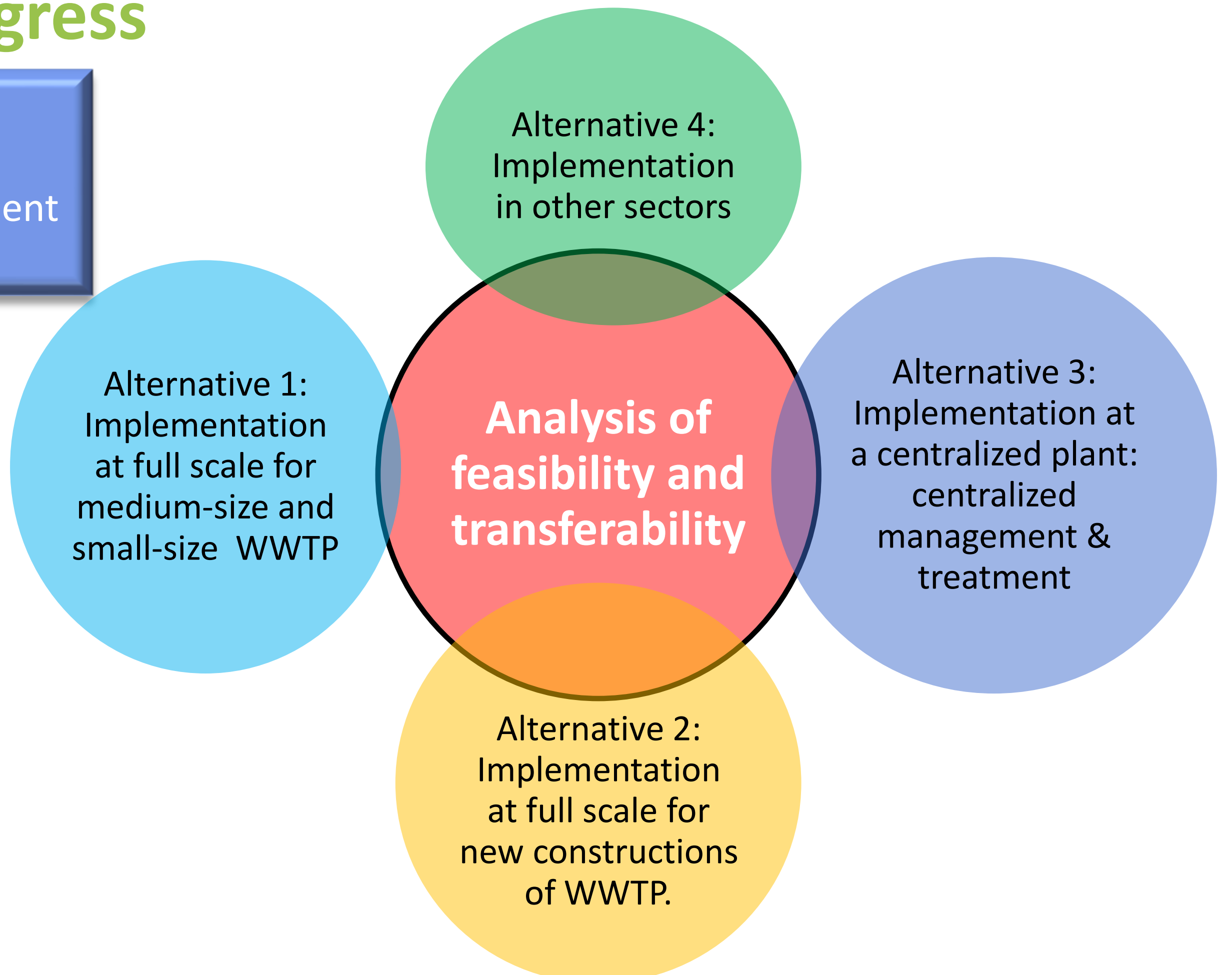
Technical progress

- 4 Alternatives
- Economic study
- Environmental assessment
- Transferability action



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Technical progress

Alternative 1. Existing small or medium capacity WWTP without anaerobic.

- Small WWTP (Extended aireation; Q>2000 m3/d; <10.000 inhab-eq)
- Medium WWTP(Convencional; Q= 2000-15000m3/d; 10.000-50.000 inhab-eq).

Alternative 2. Implementation at full scale for new constructions of WWTP.

- New constructions WWTP (Convencional >100.000 inhab-eq)

Alternative 3. Implementation at a centralized plant.

- Selection of WWTP based on distance (100-150 km), in order to determine in which area the implementation of this technology is economically viable.

Alternative 4. Implementation in other sectors.

- Information collected from various companies in order to determine the characteristics of the influent. Companies in the area, canneries, bibliography, etc.

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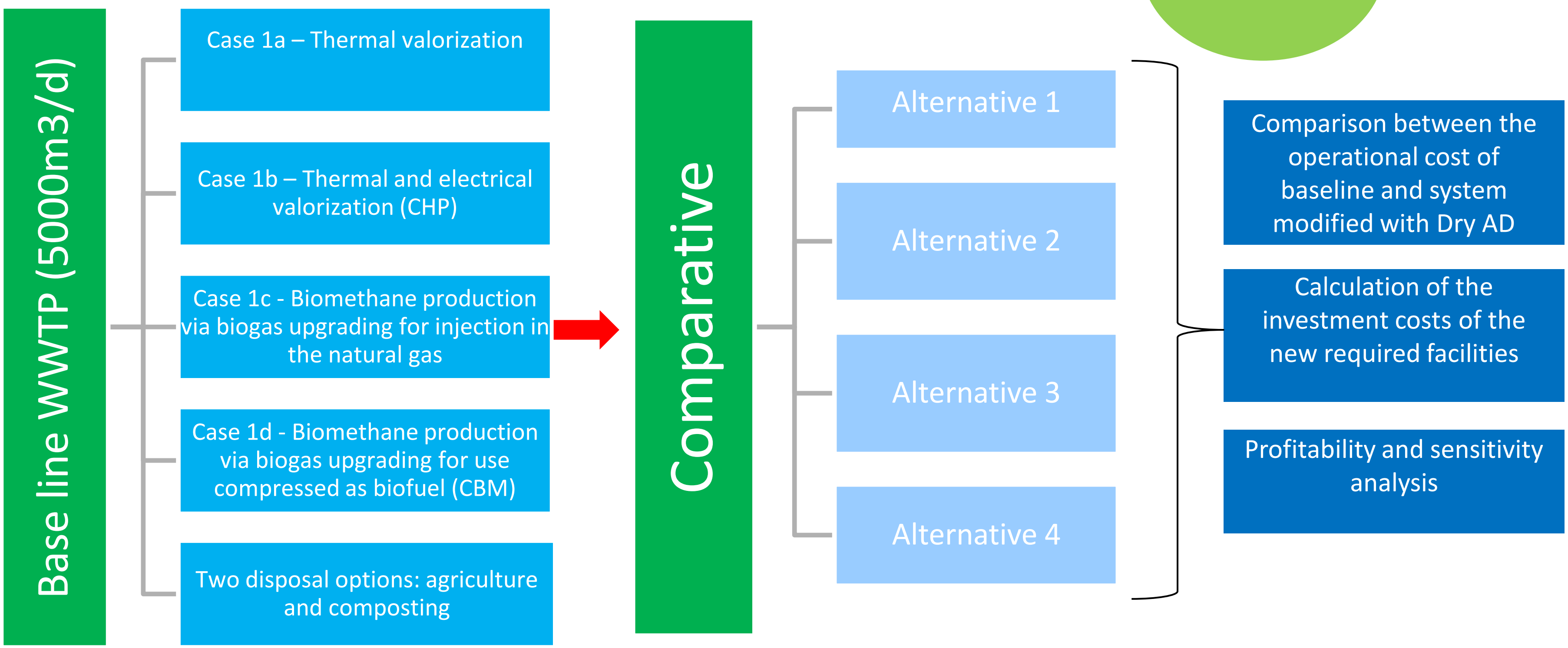
Technical progress

✓ Economic study

For the cost study development, the next work structure is followed:

Total = 72 scenarios



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Technical progress

✓ Economic study: conlusions

Conclusions

Alternative 1 – WWTP existing

➡ The best option in mesophilic conditions is the valorization of biogas via dual engine (diesel-biogas). Undigested sludge were removed at a cost of 35 €/ton for example, an IRR of 17.3% and a return period of 7.1 years would be obtained.

Alternative 2 – New construction

➡ The best option Electrical valorization (CHP)) is the most advantageous, since it would allow obtaining a IRR of 21.5% and an investment return time of 5.7 years if the non-digested sludge was managed.

Alternative 3 – Centralized plant

➡ The best option is a centralized plant to treat the sludge produced in several WWTPs, all adding a treatment capacity of 125,000 m3/d of wastewater, and valorizing the produced biogas in a cogeneration engine. That system offers a 25.2% IRR and 4.6 years of investment return time.

Alternative 4 – Other sectors

➡ The best performance is the 4'a, which corresponds to the DAD system with co-digestion of organic waste under mesophilic conditions and valorization of the biogas in the boiler.

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Thank you for your attention!

For further information:

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