LIFE iMPETUS

Monitorização e controlo de fármacos em ETAR

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Workshop I&Di AdA, UALG - Campus da Penha, Faro
9 outubro 2019

LIFE14 ENV/PT/000739
Improving current barriers for controlling pharmaceutical compounds in urban wastewater treatment plants
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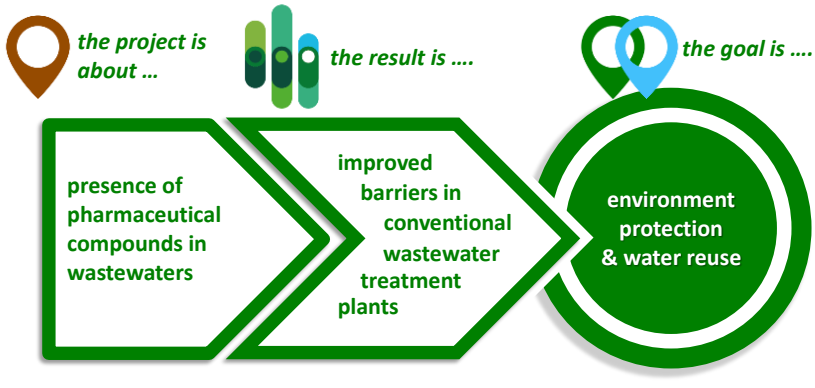
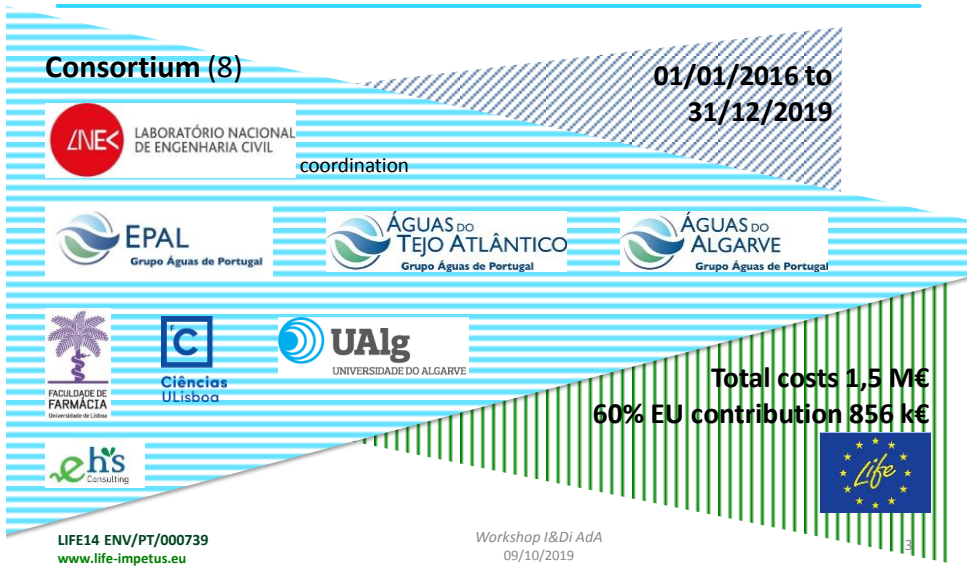
LIFE Impetus rationale

LIFE iMPETUS

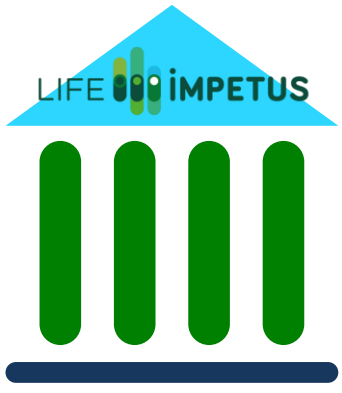
Improving current barriers for controlling pharmaceutical compounds in urban wastewater treatment plants



About the project

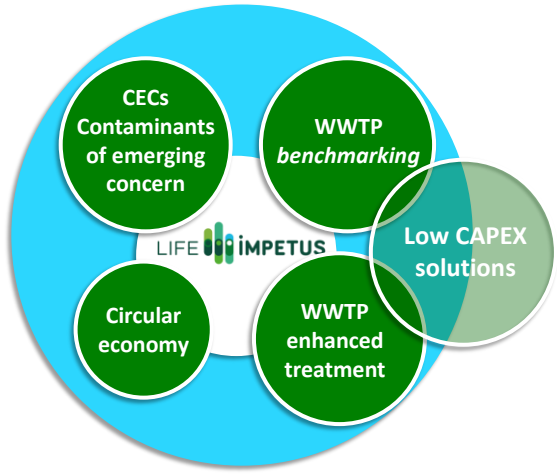


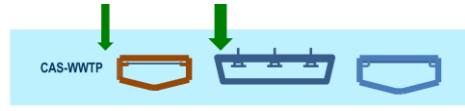
LIFE Impetus research pillars



1. monitoring
2. benchmarking
3. enhanced treatment
4. stakeholders' involvement

LIFE Impetus context in 2014

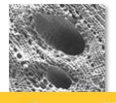




enhanced treatment
Low CAPEX

a) OPERATIONAL MEASURES
b) ECO-FRIENDLY ADSORBENTS AND COAGULANTS

Operational improvement of the current barriers using benchmarking tools (KPIs, indices)

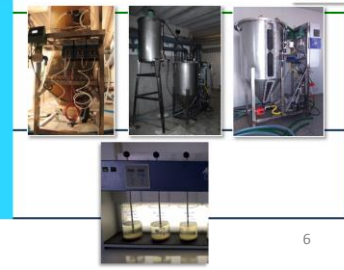


Chemical enhancement of clarification barriers by adding commercial vs **new adsorbents** from (local) wastes and biopolymer coagulants

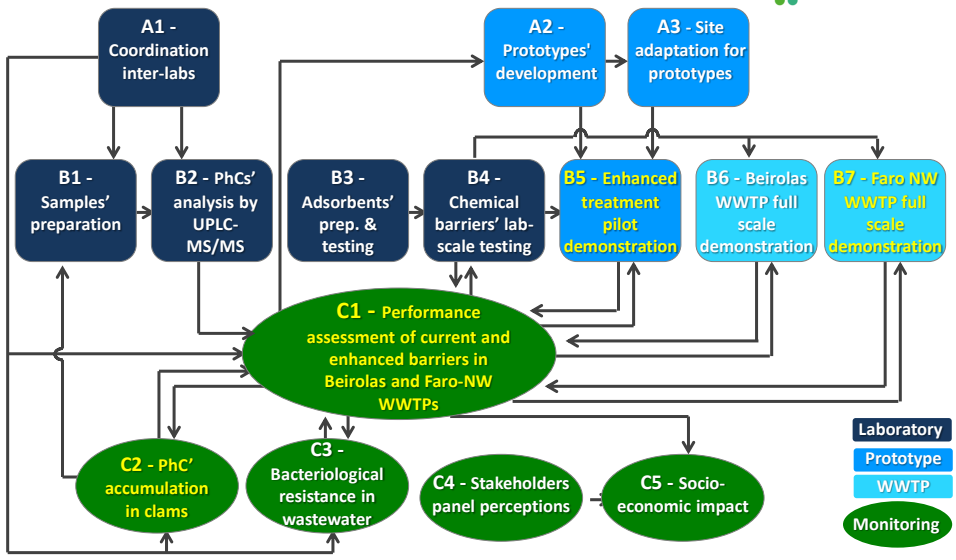
Full scale
2 Portuguese urban WWTPs, conventional activated sludge

Pilot scale
3 coagulation/flocculation/ /sedimentation pilot prototypes

Lab scale
jar-tests



Interdependencies of 15 + 5 actions



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António Martins

O projeto LIFE IMPETUS na Águas do Algarve, SA - Faro NW WWTP

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Workshop I&Di AdA
09/10/2019

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Faro NW WWTP

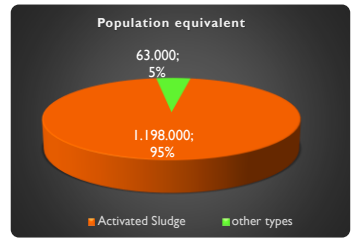
FARO NOROESTE Subsystem

- 1 WWTP
- 2 WW Pumping stations
- 24,31 km sewer system
- Hospital Particular do Algarve – Gambelas (180 beds)

Faro NW WWTP

- Why Faro NW WWTP ?

95% of the p.e. is served by activated sludge systems



- Discharge of treated effluent into sensitive zone (shellfish activity)
- WWTP with the most restrictive discharge limit regarding microbiological parameters
- Potential for water reuse

- **Discharge limits:**
  - 25 mg/L BOD_5
  - 125 mg/L COD
  - 35 mg/L TSS
  - 300 CFU/100 mL Fecal coliforms

Faro NW WWTP

	Operational Data 2018	Project data
Population equivalente (p.e.)	25.101	44.530
Daily flowrate (m^3/day)	4.700	13.221
Organic load (kg BOD_5/d)	1.506	2.696
Treatment capacity (%) (one treatment line)	112	-
Sludge Production (tons w.b.)	2.630	-
Specific Sludge Production (kg/m^3)	1,5	-

Extended aeration activated sludge system
selector + oxidation ditch, UV disinfection:

> 14 h HRT; 8-14 days SRT; 4 g/L MLSS

Faro NW WWTP

AdA to-do in articulation with LNEC

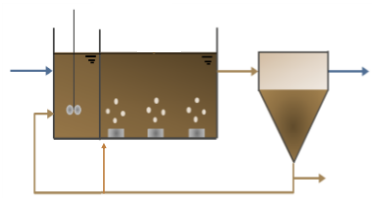
- Site adaptation for prototype FNW PT2 installation
- Provide technical assistance to FNW PT2
- Wastewater and sludge sampling at the WWTP and FNW PT2
- Performing analyzes in the AdA's Lab to the regular analytical parameters foreseen in the project
- Site adaptation for full scale trials
- Participation in full-scale PAC trials
- Change of operating parameters of treatment process control
- Operational data collection for WWTP performance assessment
- Execution of energy consumption measurement campaigns at the WWTP

Faro NW WWTP

Faro NW WWTP

Faro NW WWTP

selector + oxidation ditch



Variable control in the biological treatment process:

- Aeration: DO, redox potential
- SRT: excess sludge flow

Faro NW WWTP energy campaigns

Dedicated short-term campaigns for measuring energy consumption
(improvement measures from action C1)

Campaign	Date	Oxidation ditch			
		DO (mg/L)		TSS (g/L)	SRT (days)
		Aerator 1	Aerator 2		
2	26-27 Sept. 2017	0.6	0.7	3.2	12
3	10-11 Oct. 2017	0.6	0.7	3.9	**20 (↑)**
4	24-25 Oct. 2017	**0.3 (↓)**	**0.6 (↓)**	3.9	12

Faro NW WWTP energy campaigns

- **energy use baseline** obtained for assessing the improvement measures for both temperature scenarios (campaign 1 - lower temp; campaign 2 - higher temp)
- **higher SRT** (20 vs. 12 days - campaign 3 vs. 2) may help promoting the PhC control and did not compromise the energy performance
- **lower DO** (campaign 4 vs. 2) in the oxidation ditch was associated with lower energy consumption in aeration in kWh/m^3, though not with total kWh/kg BOD_5 removed

PhC reduction (%) in WWTPs
Beirolas & Faro NW

- **APAP & CAF** highest concentrations, highly reduced (> 99.9%)
- **IBU & NPX** the 2nd more abundant (< 1/10 APAP & CAF), highly reduced (> 98%)
- **SDZ** & **fluoxetine** & **estriol**, **cortisone**, **testosterone** also occur (in ng/L) and Cout < LOD
- **CFA** and the **other hormones** < LOD in & out
- **ERY**, **SMX**, **SPD** & **ATN**, **MTPL**, **PPNL**, **BZF** intermediate (~30-80%), variable reductions
  SRT > 20 d, more reliable ERY reduction
- **CBZ** & **DCF** (0.6, 1.5 ug/L median in) are (almost) not removed

→ **Pilot tests** focused on CBZ, DCF, SMX

Tests at pilot scale. FNW PT2

Tests at pilot scale. FNW PT2

Tests at pilot scale. FNW PT2

Example. **carbamazepin**

Commercial renewable-source PAC, 2-10 h

- **< 10 mg/L PAC** reaches **50-70% CBZ** reduction, lacks reliability
- **18-25 mg/L PAC**, **65-89% CBZ** reduction, low reliability
- **> 30 mg/L PAC**, **> 80% CBZ** reduction, reliable

20 mg/L new PAC surrogate
(commercial non-renewable source PAC)
↓
further 12-21% reduction for CBZ, DCF, SMX

PAC dosing at full-scale
Faro NW WWTP

PAC dosing at full-scale
Faro NW WWTP

PAC dosing at full-scale
Faro NW WWTP

	PAC test 1		PAC test 2	
	Initial PAC overdosing	Continuous PAC dosing	Initial PAC overdosing	Continuous PAC dosing
Test starting date	25/03/2019	25/03/2019	02/04/2019	02/04/2019
Test end date	25/03/2019	02/04/2019	02/04/2019	12/04/2019
PAC dosing duration	3-5 h	**8 days**	7 h	**10 days**
Fresh PAC concentration	-	9-11 mg/L (C1)	-	**22-29 mg/L (C2)**
Total mass of PAC dosed	**750 kg**	**360 kg**	**1140 kg**	**1125 kg**
Sampling for PhC analysis (day 1 of 24-h composite)	-	28/03 & 01/04/2019	-	08/04 & 11/04/2019

Commercial renewable-source PAC

→ 3,4 ton

- Full-scale and pilot results are coherent and corroborate each other
- Overall, both PAC doses achieved similar effluent concentrations for the poorly-not removed PhCs in CAS-WWTPs, but the higher dose yielded always more reliable and usually lower concentrations
- For the **recalcitrant CBZ** and **DCF**, disregarding the different time-scales of the 2 scenarios (2.5 years w/ no PAC, 51 data points) vs. 3 weeks w/ PAC (4 data points for each dose), **median effluent conc.** were

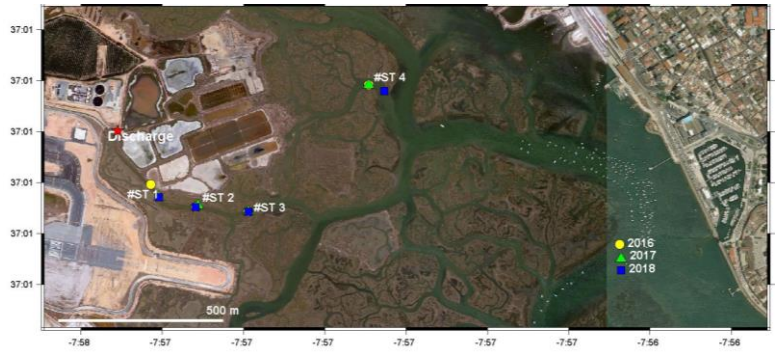
  1739 ug/L DCF, 592 ug/L CBZ vs. 620 ug/L DCF, 205 ug/L CBZ (C1) **vs. 501 ug/L DCF, 89 ug/L CBZ (C2)**

  65% DCF / 64% CBZ reduction (C1) **71% DCF / 85% CBZ reduction (C2)**
- The new PAC should produce better results, i.e. same PAC dose, higher PhC reduction, or lower dose for similar reduction

Assessment of PhC accumulation in clams in Ria Formosa

Alexandra Cravo - Universidade do Algarve
in collaboration with AdA and FFUL/EPAL

Clams' exposure experiments



3 field exposure campaigns 2016, 2017 & 2018, along 1 month (Jun/Jul)

- **Clams' control**
  Olhão clam bed in 2016 & 2018; Faro clam bed in 2017
- ~1-1.5 kg clams exposed at the 4 sites (> 100 clams)
  - **#ST1,** 200-250 m from the WWTP discharge point
  - **#ST2,** 400 m
  - **#ST3,** 600 m
  - **#ST4,** ~1.5 km

- **Environmental characterization**
  - *in situ* with multiparametric probe YSI 6820
    temperature, salinity, pH, dissolved oxygen
  - water samples for determination of
    SS, chlorophyll a, nutrients, PhCs
- **Clams & water samples for PhC analysis at FFUL and EPAL**

Clams' exposure experiments

In clams, CAF and APAP…

… were the most bioavailable for clams, regardless the concentrations and dominance of PhCs in the water samples from the exposure sites.

PhC uptake & bioaccumulation depend on:

- ✓ physical-chemical properties of the PhCs/Horm (polarity, solubility)
- ✓ abiotic factors (temperature, salinity, pH, dissolved oxygen)
- ✓ size and weight, condition index, sexual stage, lipid content, metabolic processes among other variables.

FINAL REMARKS

Maria João Rosa

3-level innovation…

1. **Practices/products** for improved PhC control in 2 **CAS-WWTPs** variants: A2O and oxidation ditch
2. **Analytical methods for PhC** in wastewaters, sludge and clams
3. **Cost-benefit analysis** strongly supported by long-term data and with an innovative approach integrating the **stakeholders'** input for evaluating intangible cost and benefits

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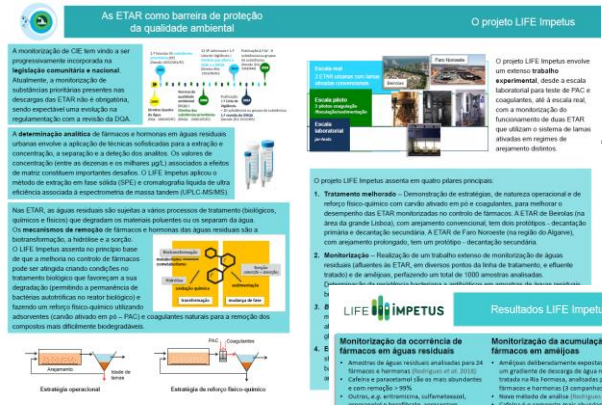
Science technology/new knowledge

& innovation/policy

& marketable products



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interim version

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5 December 2019

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Thank you for your attention!