5th Water Efficiency Conference 2018
6-7 Set 2018
Aveiro, Portugal

Optimization of a water supply system using genetic algorithms

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ABOUT ISQ

ISQ HEADQUARTERS

With more than 50 years of existence

headquarters in **Portugal**

Founded in 1965

30 + SUBSIDIARIES

250 + SPECIALIZED SERVICES

- ENNGINEERING & CONSULTANCY
- VERIFICATION & REGULATORY
- TESTING
- INSPECTION
- TRAINING
- R&D + I

CUSTOMIZED SOLUTIONS

16 accredited laboratories

145 000 + trainees

13 500 + training courses

Promote **R&D**

400 + R&D international projects

1.200 + partners

1.400 employees

800 in Portugal

55% + with degrees

ABOUT ISQ

ISQ HEADQUARTERS

SECTORS

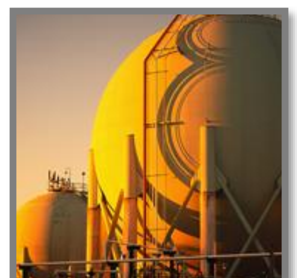
AERONAUTICAL & AEROSPACE

AUTOMOTIVE

CONSTRUCTION & INFRASTRUCTURES

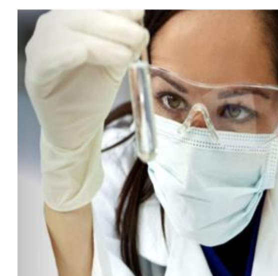
AGRO FOOD

ENERGY & POWER GENERATION



OIL & GAS

PROCESS INDUSTRIES



HEALTHCARE & MEDICAL

ABOUT SIC

SUSTAINABLE INNOVATION CENTRE

TECHNICAL EXCELLENCE

APPLIED RESEARCH

INDUSTRY PARNER

PROJECT COORDINATION

Applied R&D UNIT

20 years of R&D

60 +
R&D projects promoting Sustainability

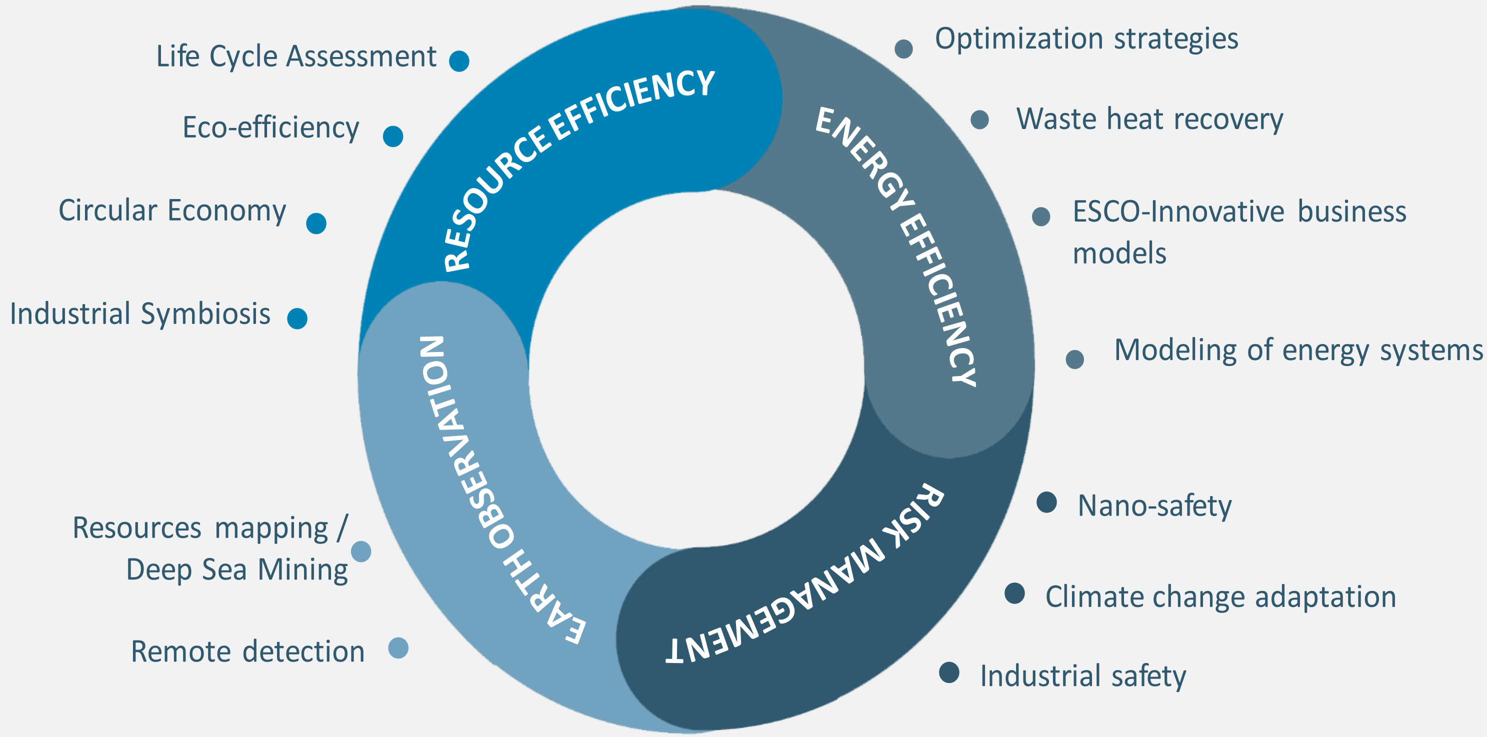
12
financial instruments

500 + partners from 30 + countries

300 + scientific publications

Sustainable Innovation Centre

ABOUT SIC



ISQ's Sustainable Innovation Centre
provide **technical and scientific support to Industry**
within a **large range of multisectorial competences**
aiming to achieve improved **industrial competitivitness and sustainability**

Creating Value

Water challenge

UN Conference Rio+20 *The Future We Want*, recognized that 'water is at the core of sustainable development', with tremendous impacts on several sectors.

SUSTAINABLE DEVELOPMENT GOALS

Improve wastewater treatment

Efficiency

Nexus water-energy

Circular economy

Reduce consumption

Reduce environmental impacts

Energy consumption in water systems

- **Water systems are present in all economic sectors offering an important range of services, being indispensable to sustainable development.**
- **The energy consumption of the water sector worldwide was 120 Mtoe in 2014.**
- **A majority of this is in the form of electricity, corresponding to 4% of total global electricity consumption**

The electricity consumed for water, around 40% is used to extract water, 25% for wastewater treatment and 20% for water distribution.

The electricity consumed for industrial water circuits, namely pumping corresponds to 20%

Therefore, it is crucial to optimise water management systems within the context of nexus water-energy.

SMART WATER SUPPLY SYSTEMS

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SUPPLY
SYSTEMS

Motivation

Water supply systems are systems used to treat and transport water over vast geographical areas to consumers.

- Complex systems and large infrastructures
- Intensive energy users
- Old infrastructures
- Leaks
- Inefficient control strategy
- Need for support in decision-making

How can water management be optimized for increased efficiency, minimized environmental impact, and minimized costs?

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Project LIFE SWSS

Smart Water Supply Systems

Name : Smart Water Supply Systems

Funding Programme : LIFE financial instrument of the European Union

http://life-swss.eu/en/

Start of project: April 2015
End of project: March 2018

Budget: 1,4Million Euros

Partnership:

ISQ, HIDROMOD, TÉCNICO LISBOA, ÁGUAS DE PORTUGAL, EPAL Grupo Águas de Portugal, ÁGUAS DO ALGARVE Grupo Águas de Portugal

SMART WATER SUPPLY SYSTEMS

Main objectives

Smart Water Supply Systems

1

Create an innovative management and decision support platform (SWSS)

2

Demonstrate SWSS platform on **three demonstration** systems

3

Reduce the **energy** consumption, **GHG** emissions and **water leakage**

Demonstration systems

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The SWSS platform will be implemented in three industrial scale demonstration sites, which are **Águas do Algarve**, **EPAL's Centre**, **EPAL's West**

- 24 pumping stations
- Water supply: 40 Mm^3 /year
- Water losses: 620 000 m^3 /year
- Energy use:
  17 GWh/year.
  1,6 Million euros

General targets:

- Reduction of 15 % in the energy consumption
- Reduction of 15% in CO_2 emissions
- Reduction of the average water losses

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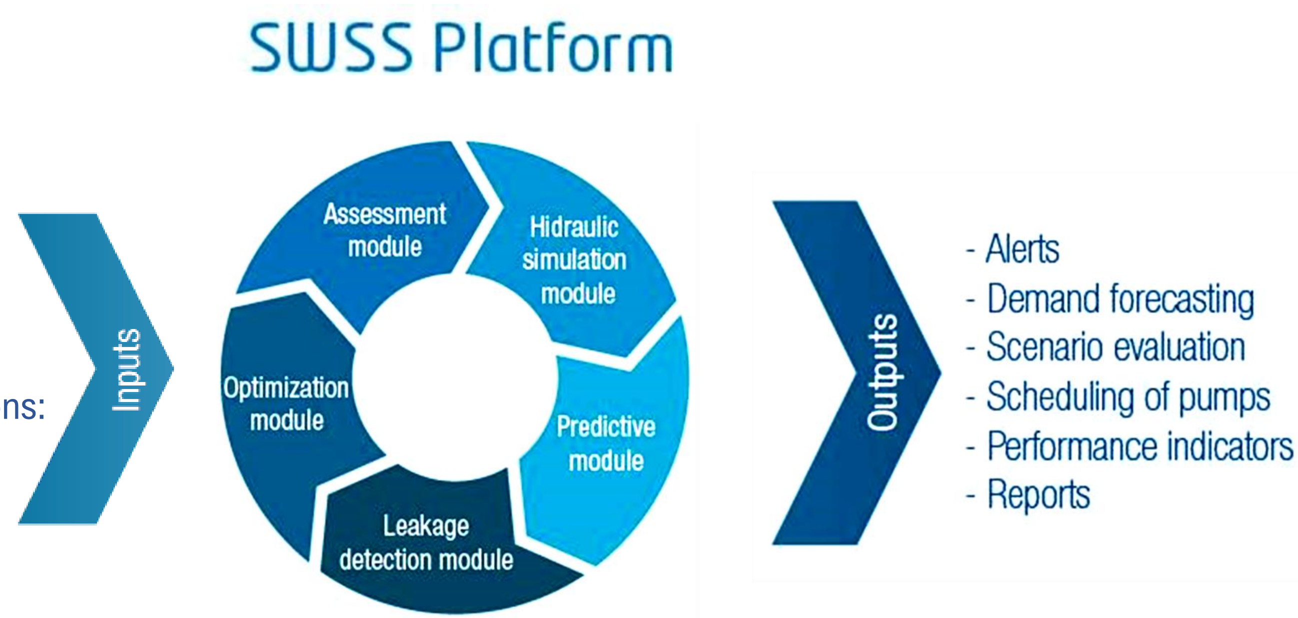
Digital platform

The **SWSS platform** will be composed of 5 modules:
Predictive, Hydraulic simulation, Assessment, Leakage, and Optimization, which together will support the water companies in their efforts to improve energy efficiency and water efficiency.

- SCADA and GIS
- General system characteristics
- Operational conditions: Survey

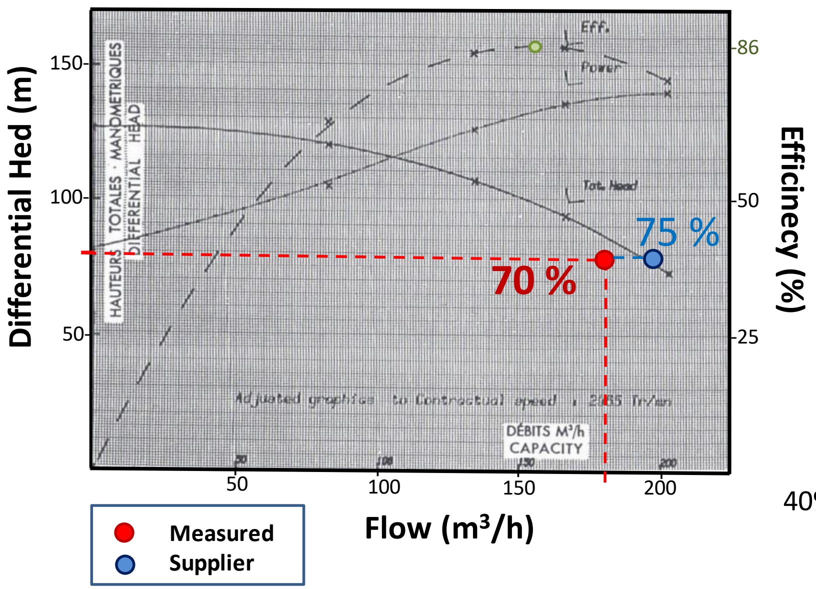


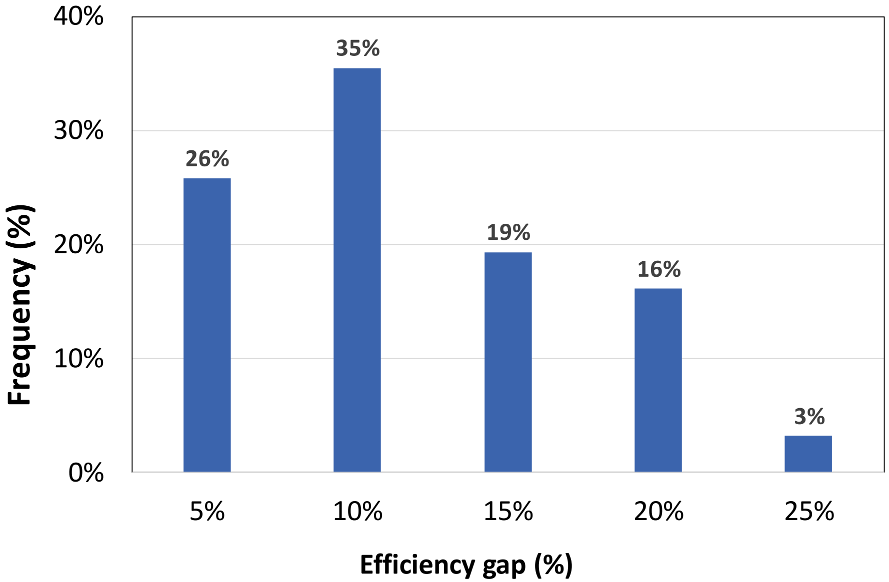
Off-line component Planning & Decision Support	**On-line component** Operational Management

Approach

SMART WATER SUPPLY SYSTEMS

1. Survey of the systems





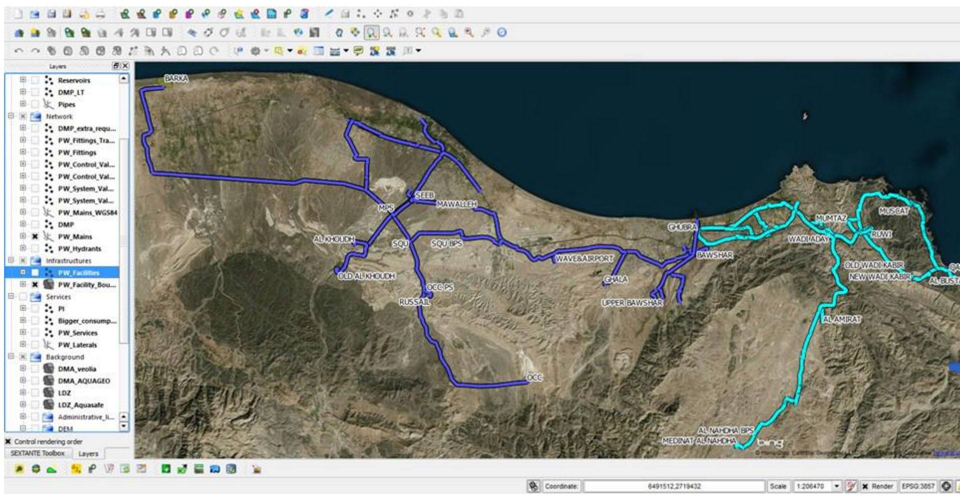
- *The baseline conditions must be stablished first*
- *Pump inefficiencies are usually diagnosed*

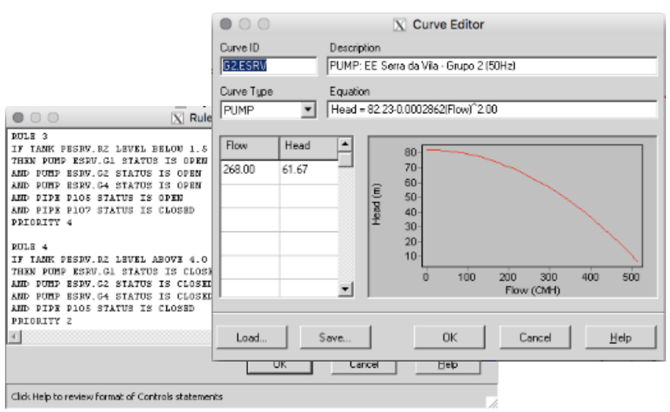
Approach

SMART WATER SUPPLY SYSTEMS

2. Mathematical modelling

Hydraulic Simulation (**EPANET**) – Using real data, the model of the system was developed. System modelling allows to test and evaluate operation scenarios





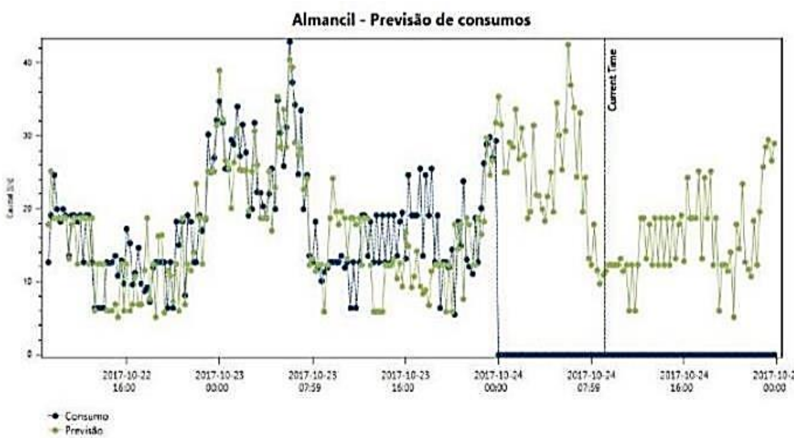
SMART WATER SUPPLY SYSTEMS

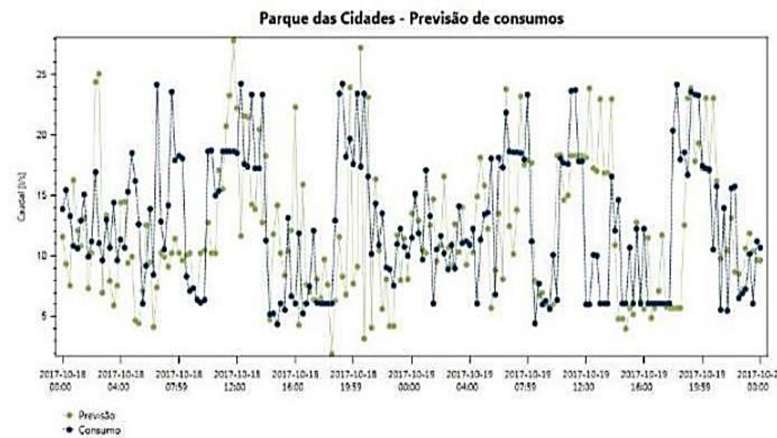
LIFE SWSS Smart Water Supply Systems

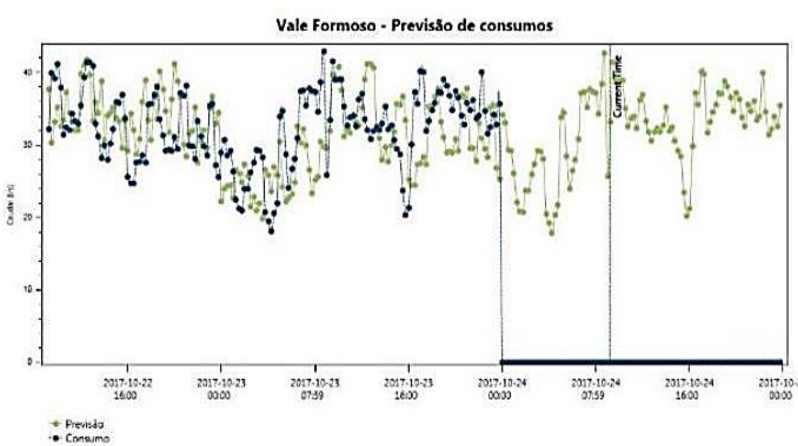
Approach

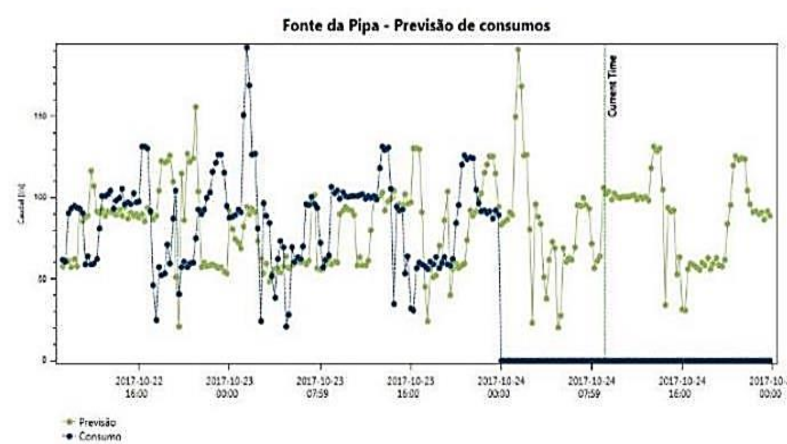
3. Water demand - Forecasting Models

A predictive algorithm was developed to forecast the water demand for the next 24h, based on historical data









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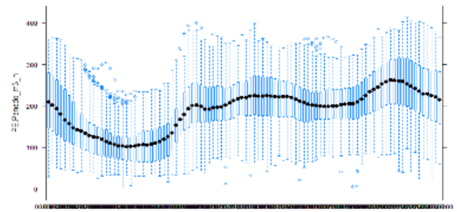
Approach

4. Optimization

Water demand prediction



Optimal strategy to operate the system for the next 24 hours

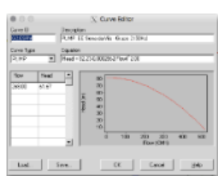
Real Water system

Pumping schedule optimization

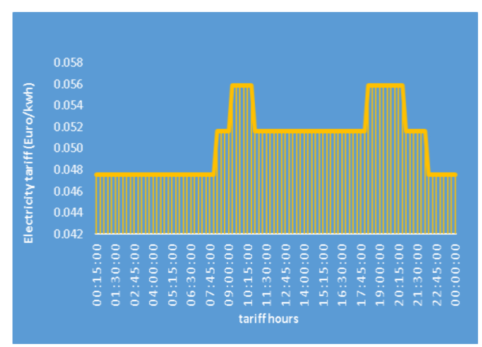
Goal: *minimize the cost of the pumping operation*

Water system model (EPANET) + **Electricity tariff**

Pumping/Tank characteristics



Water network



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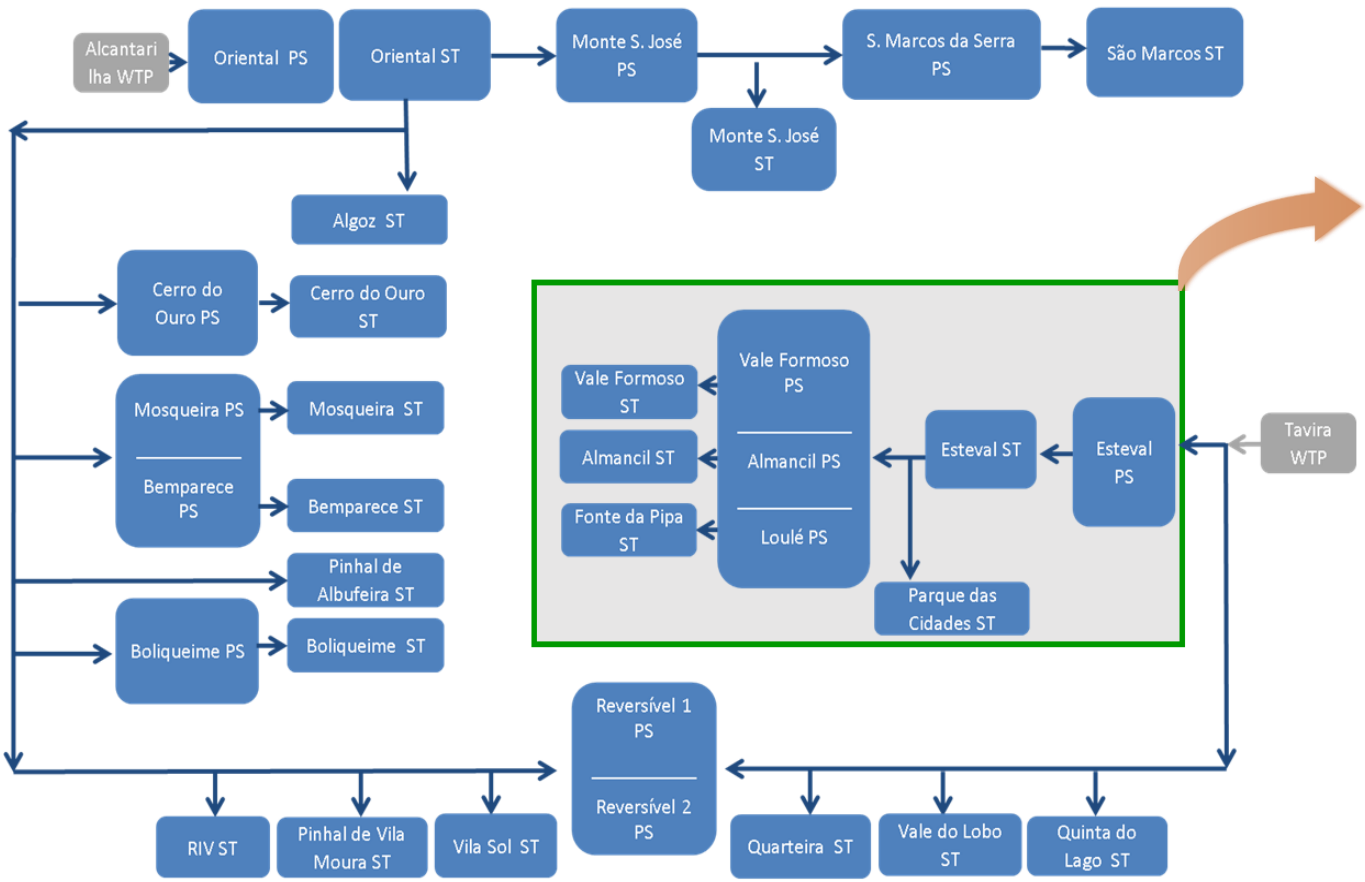
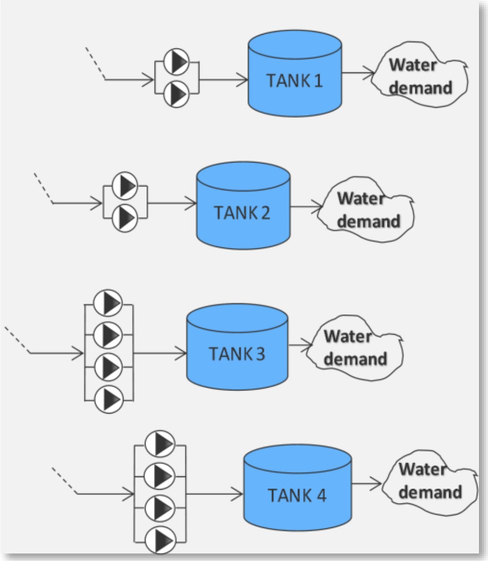
Case Study results

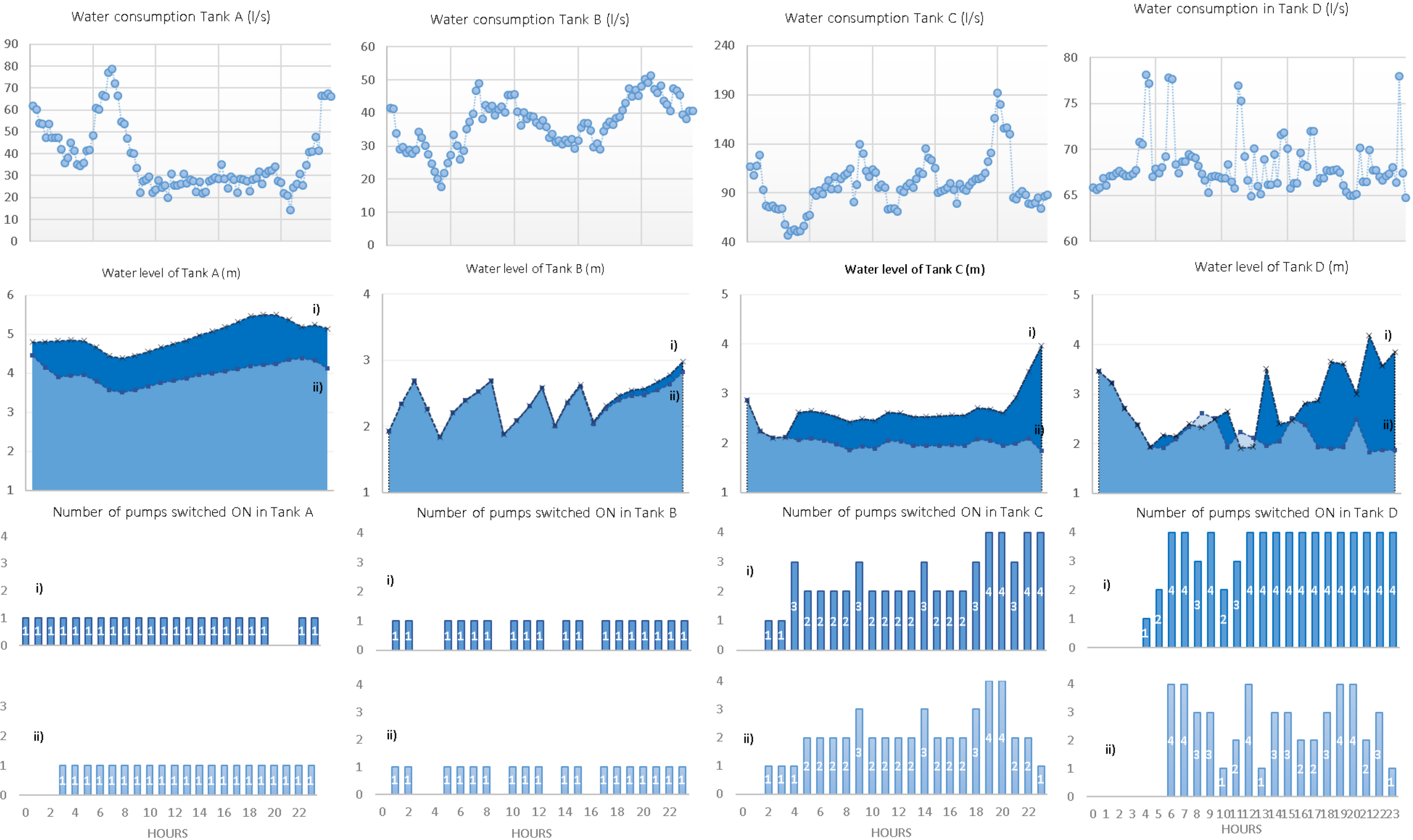
AdA – Aguas do Algarve 12 Pumps | 4 Tanks





Case Study results

AdA – Aguas do Algarve 12 Pumps | 4 Tanks

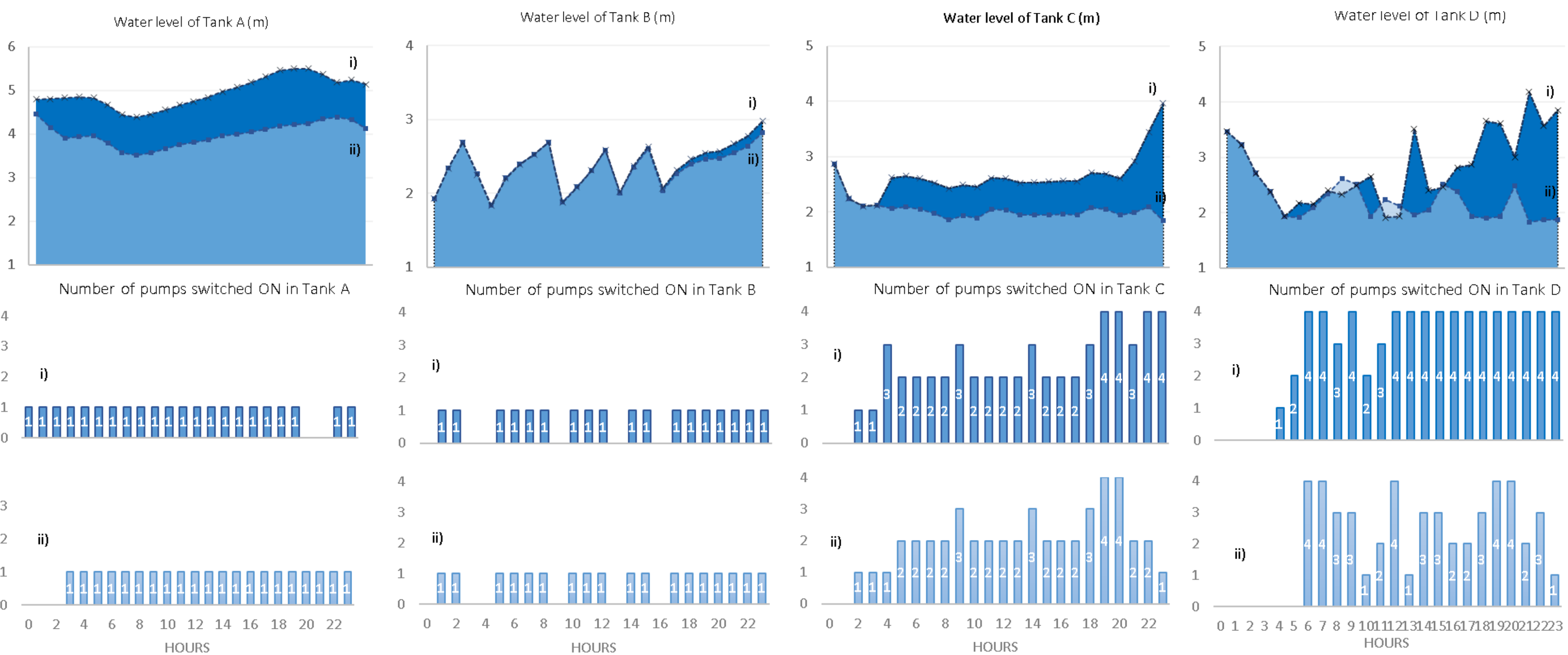


Case Study results

AdA – Aguas do Algarve 12 Pumps | 4 Tanks

Solution i) is water level-driven - **Min COST** and **Min Δlevel**

Solution ii) is solely cost-driven - **Min COST** -> more storage risk but -8% the cost and -3% pumping

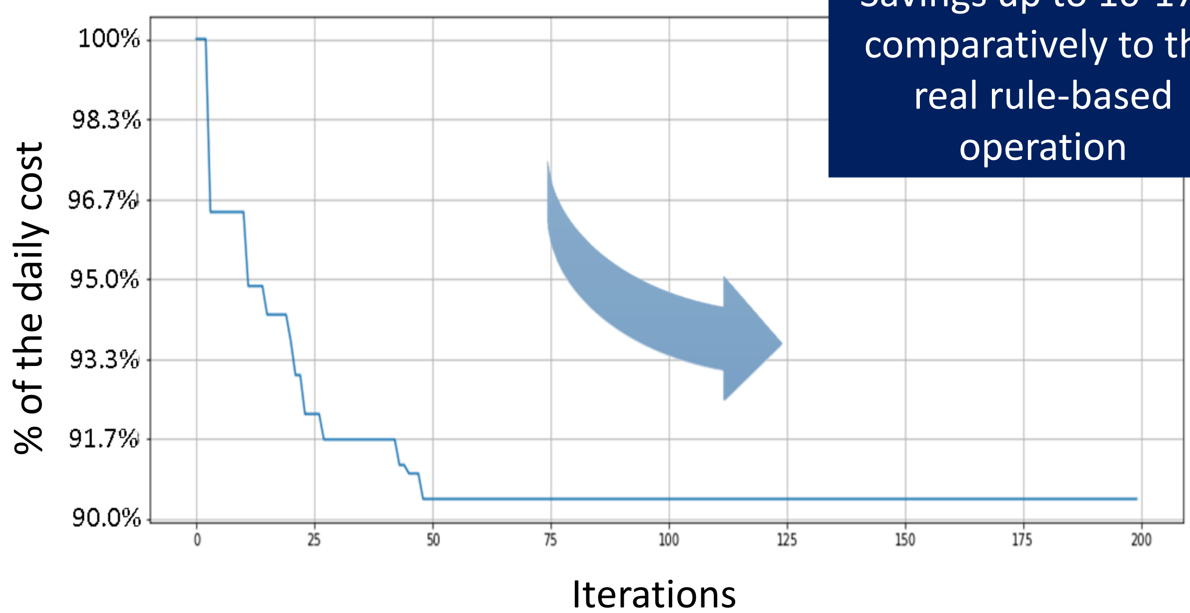


Case Study results

SMART WATER SUPPLY SYSTEMS

Smart Water Supply Systems

AdA – Aguas do Algarve 12 Pumps | 4 Tanks



Savings up to 10-17% comparatively to the real rule-based operation

Main restrictions:

- Tolerance VS risk levels in tanks
- Availability of water in the network
- Daily water consumption

Conclusions

Water systems improvement can lead to significant energy efficiency increases, and the reduction of costs, water losses, and environmental impact

To improve it is necessary to know the current situation - baseline

Digital solutions / technologies allow:

- Identify technological and management opportunities
- Develop models that effectively support integrated decision-making
- Optimize the system with minimal investment or physical intervention




THANK YOU

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