FIWARE 4 WATER

FIWARE for the Next generation Internet Services for the WATER sector

Intelligent Control for Wastewater Treatment Plant

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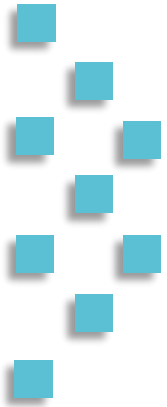


waternet
regional public water authority
amstel gooi en vecht
city of amsterdam

KWR

Fiware for Water

- 14 partners: water utilities, universities, research institutes, companies, NGO
- Period: 01/06/2019 - 31/05/2022
- Member of:
  - EU ICT4Water cluster
  - EU Synergy Group DigitalWater2020

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 821036.

FIWARE 4 WATER

Demo Case #1 • Greece

Athens • Water Supply System
real time operational managment

Demo Case #2 • France

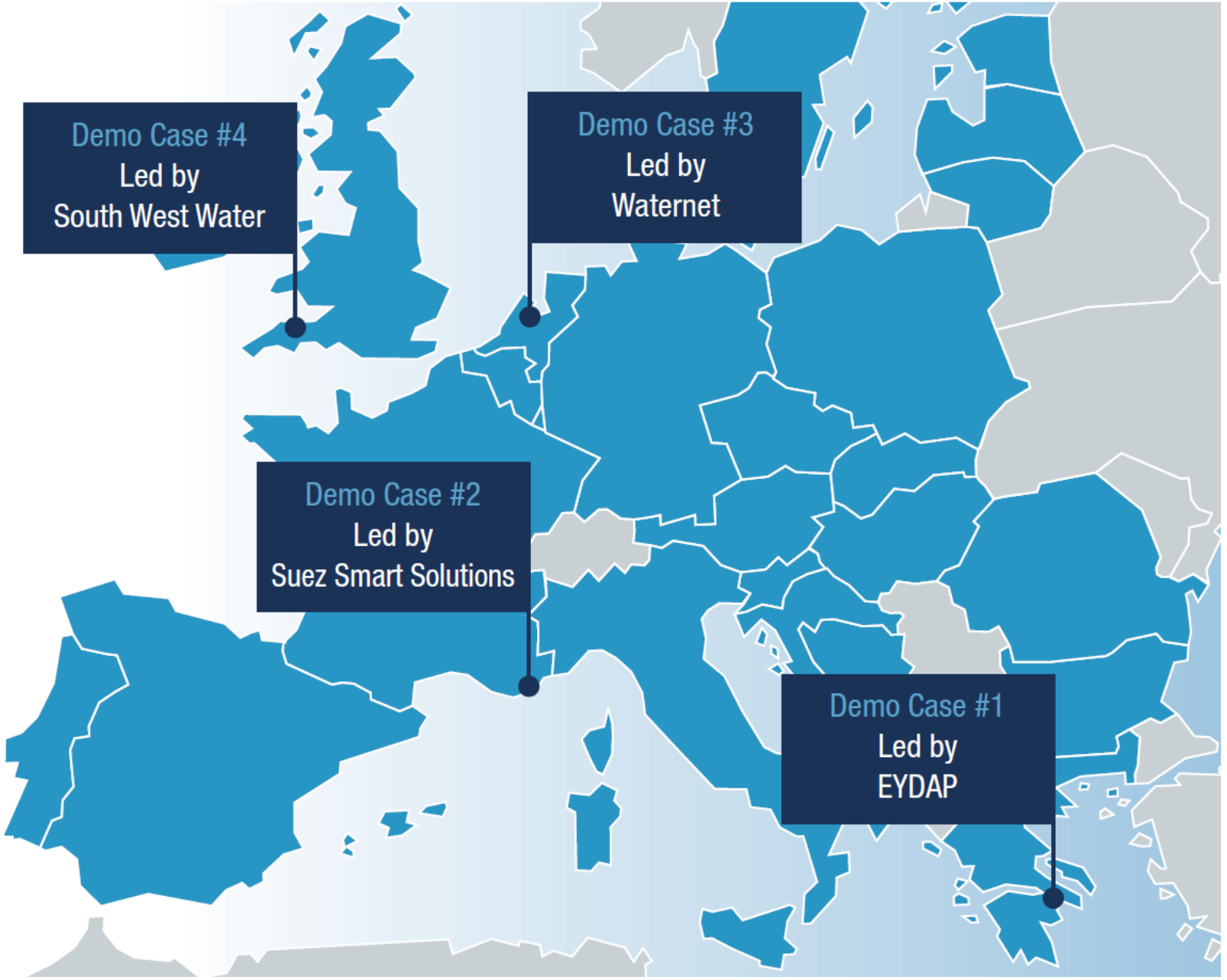
Cannes • Improving the Water
Supply System

Demo Case #3 • Netherlands

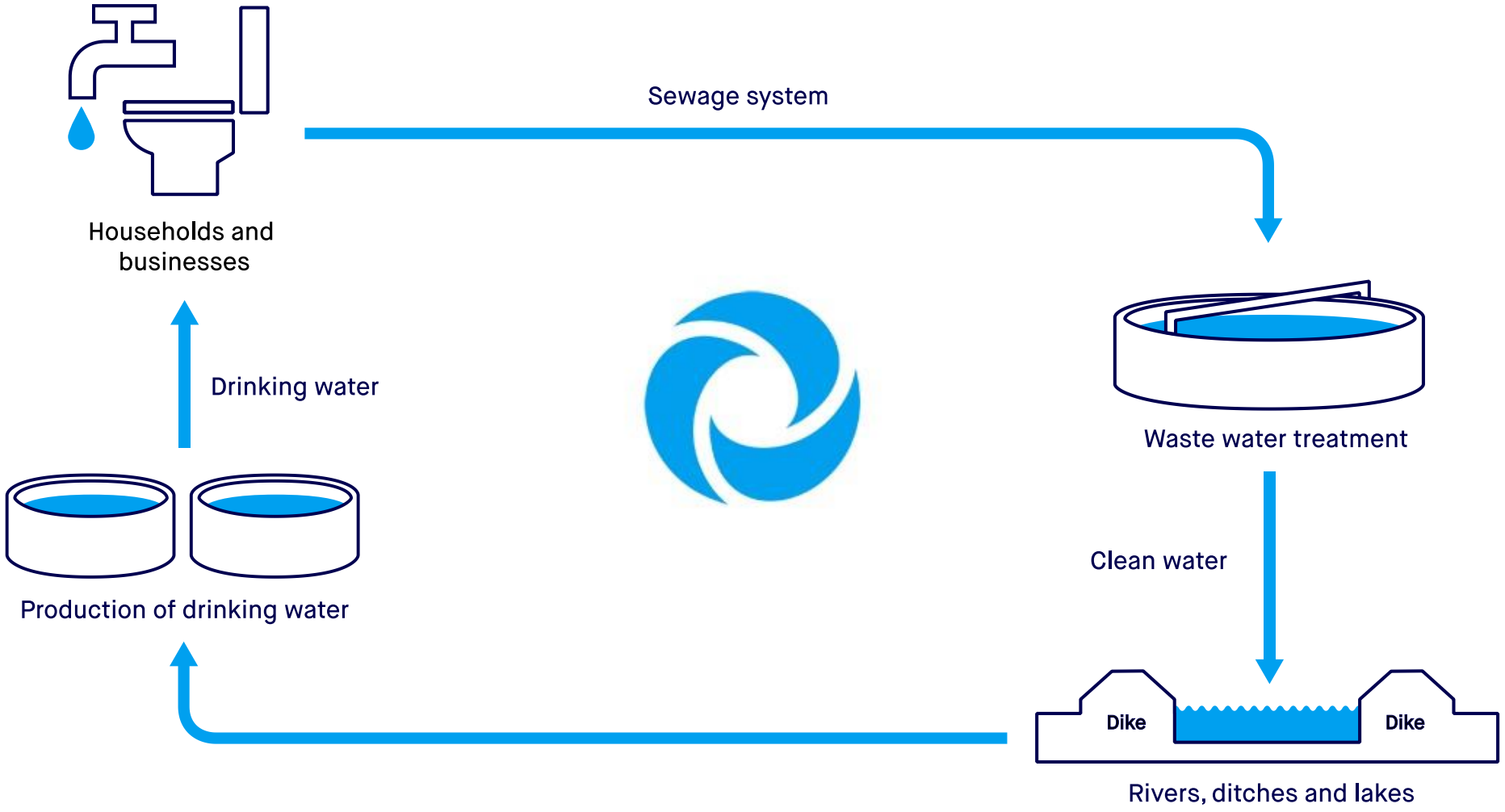
Amsterdam • Intelligent control
for wastewater treatment

Demo Case #4 • United Kingdom

Great Torrington • Smart Meters
and Customers



Waternet water cycle utility of Amsterdam

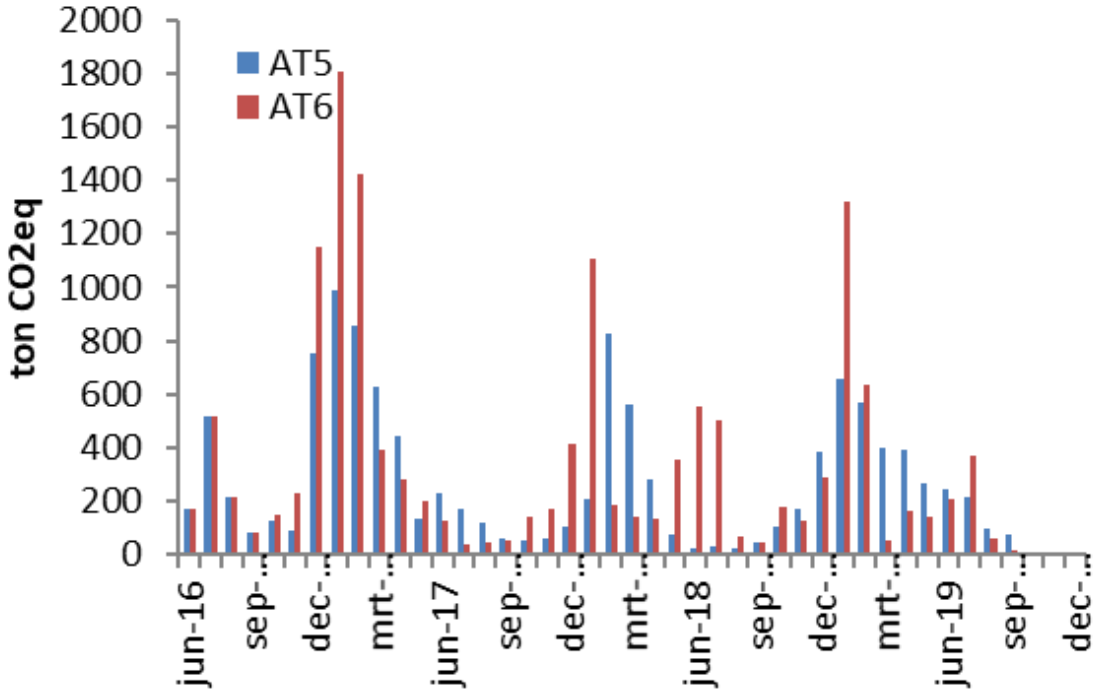


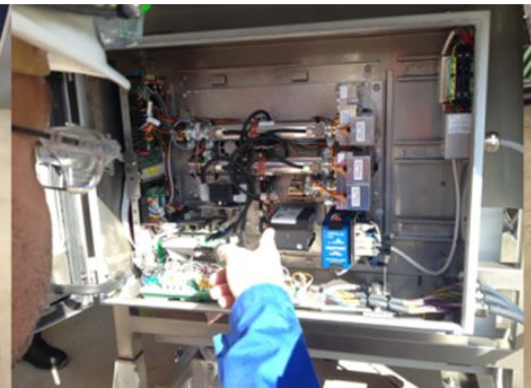
Wastewater treatment plant Amsterdam West

Nitrous oxide (N2O) gas emissions

Real-time measurement in off-gas aeration tanks (ATs) of WWTP Amsterdam West starting 2016:

15 – 28 kton/year CO_2-eq



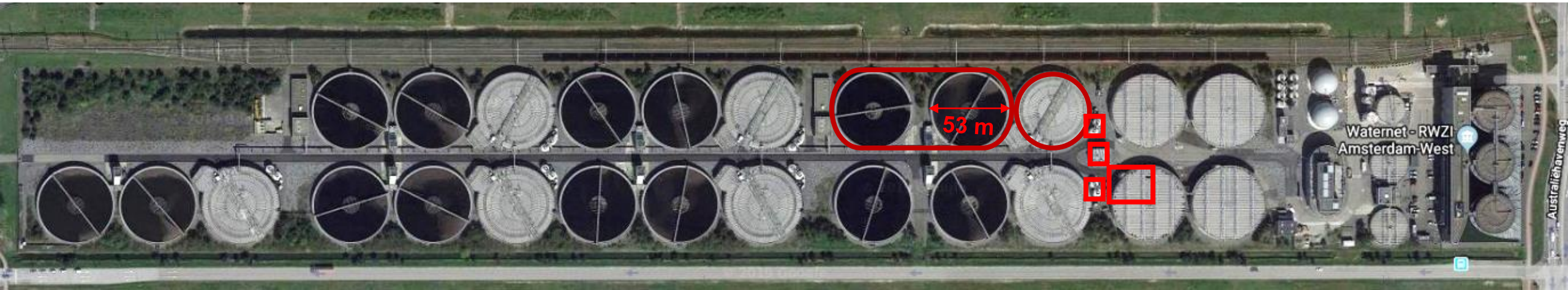


Full-scale research lane

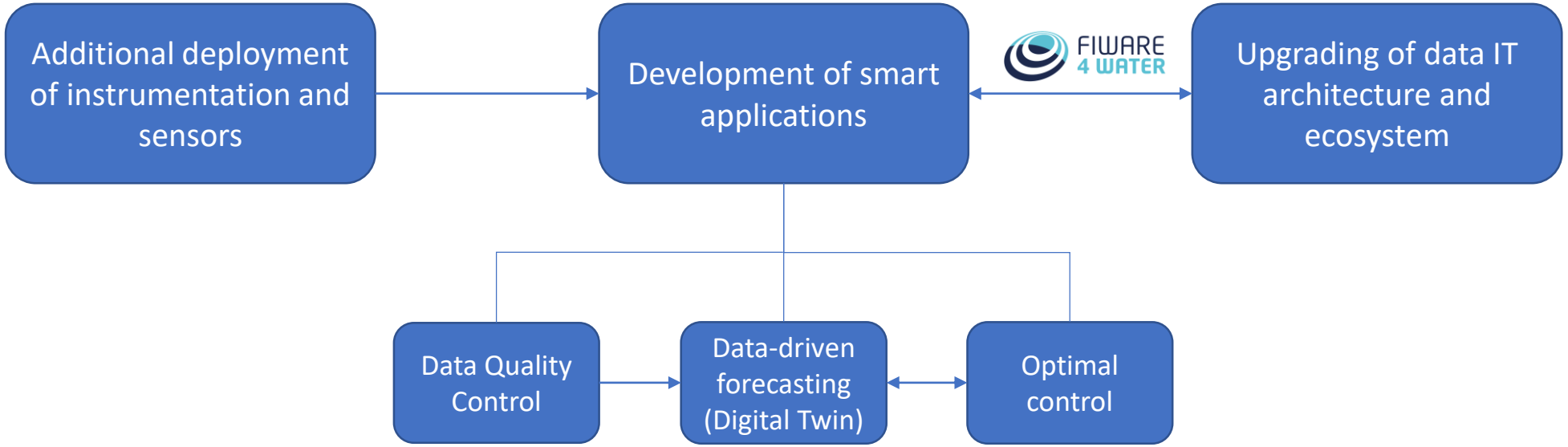
Objective: Reduction of nitrous oxide emission and electricity use aeration

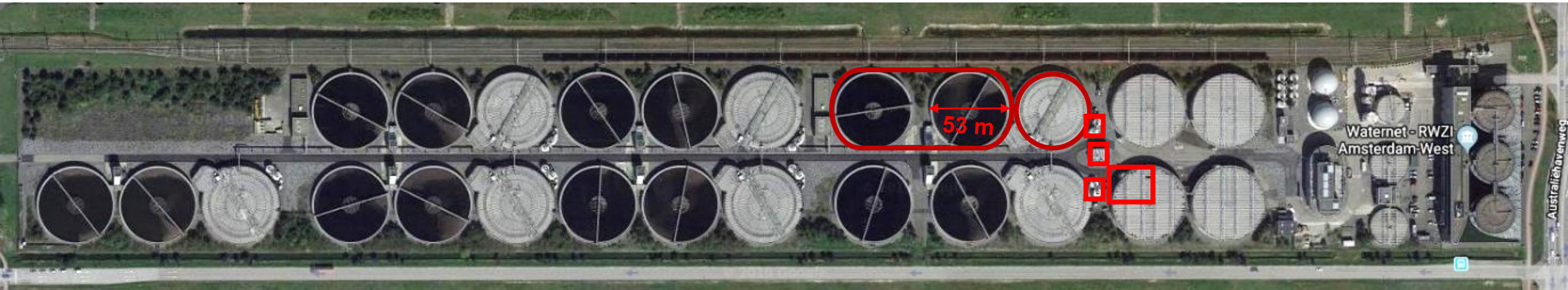
Installing additional sensors

Treatment optimisation with Artificial Intelligence

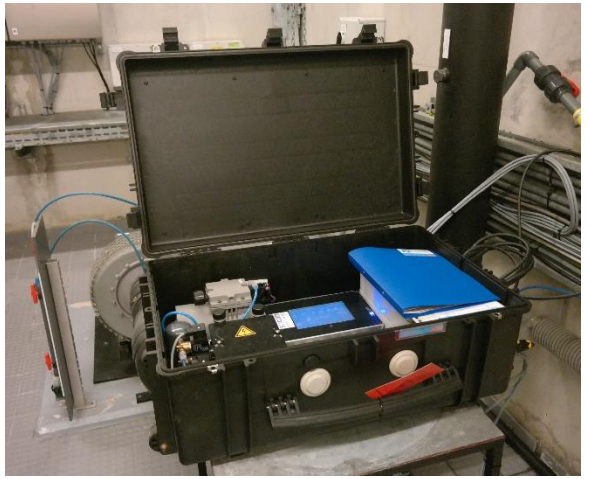


Building Blocks for Digitalization of WWTP

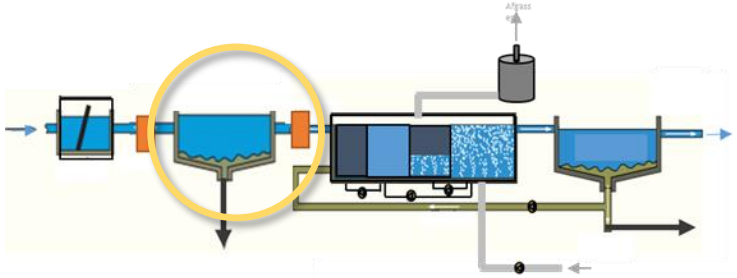


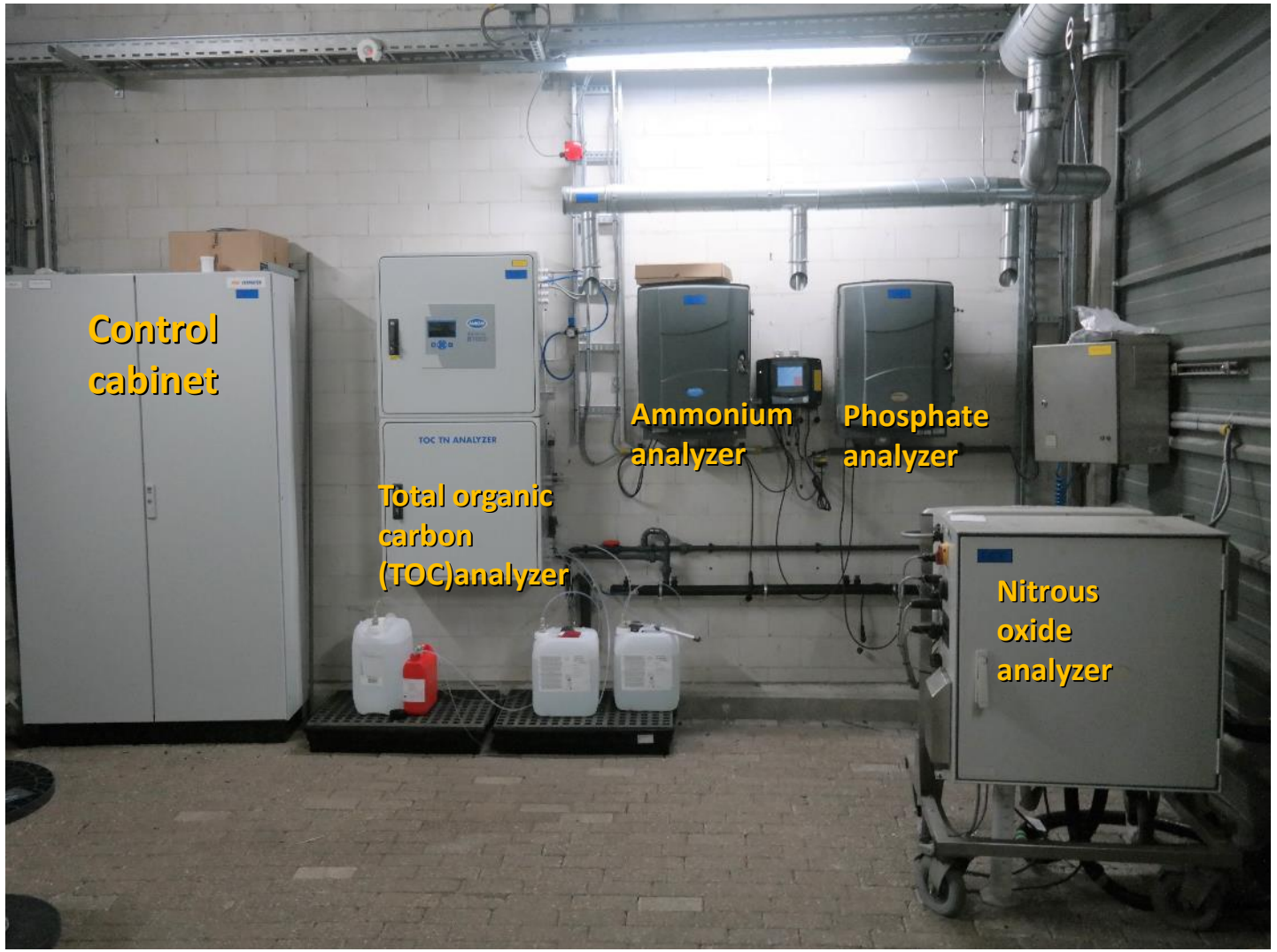


Sensor deployment and research facility



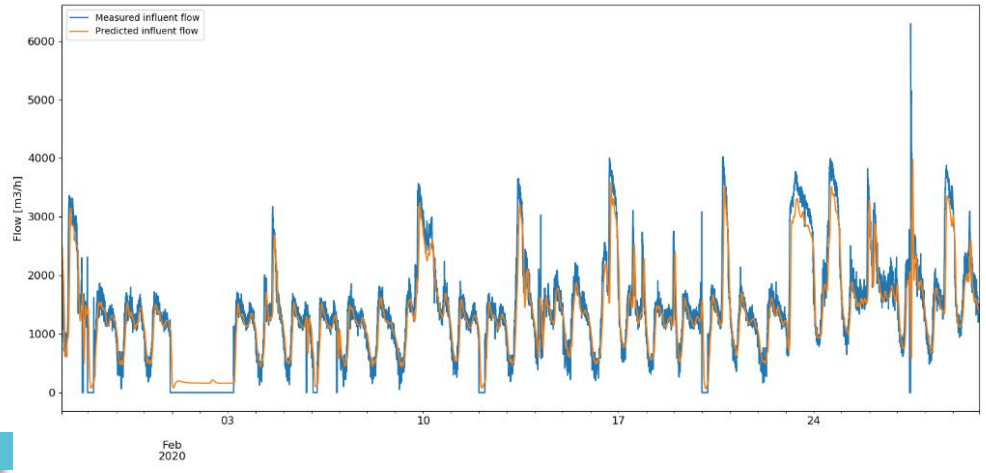
Primary settler



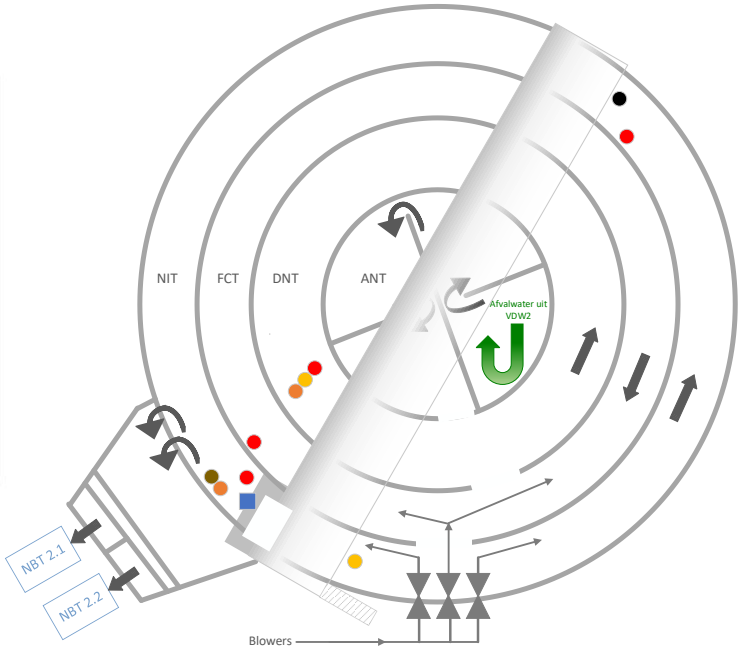


AI models for aeration optimisation

Influent model
"How much wastewater is coming?"



Digital twin model
"What happens if …?"



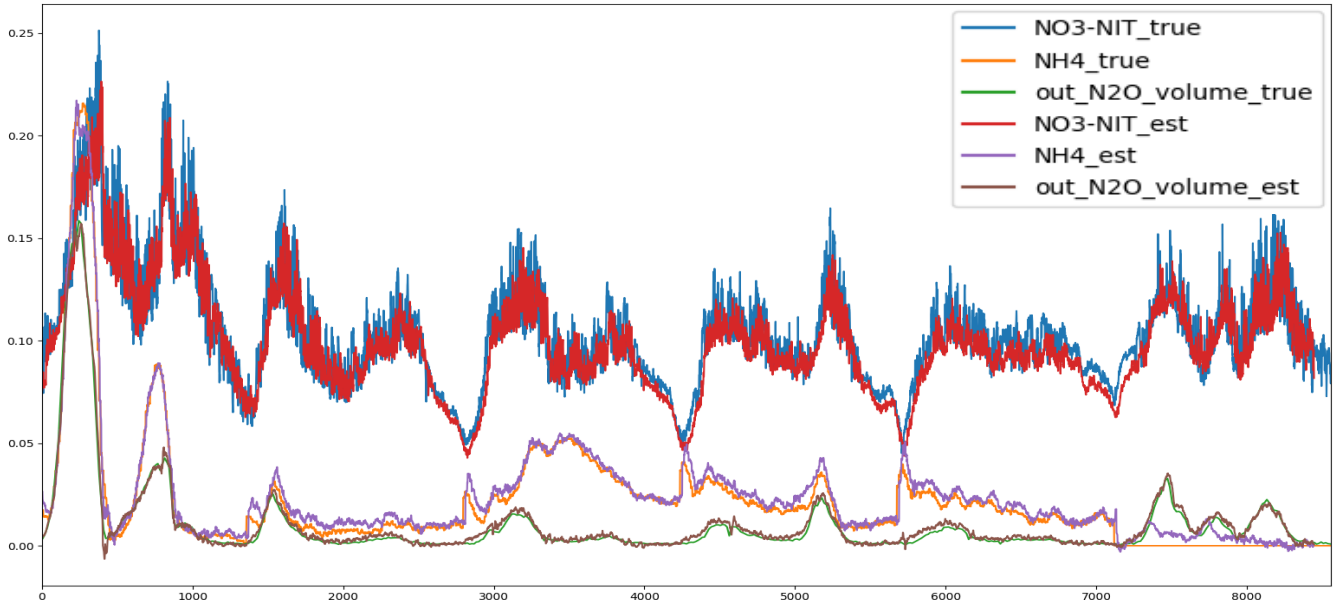
Control model
"What is the best action?"

Objective:
- Low N_2O
- Low kWh

20+ Soft-sensors
"What is the value of this quantity we don't or can't measure?"

Data driven AI digital twin model

Inputs				
Influent	Energy	O_2	Recirc-C	Ctrl-recirc-C
Influent-terrain	Valves-NIT	NH_4	DS-surplus-drain	out-N_2O-volume
Effluent	Valves-FCT	DS	Setpoint-O_2	
Blowers	NO_3-NIT	Recirc-A	Ctrl-recirc-A	
Pressure	NO_3-DNT	Recirc-B	Ctrl-recirc-B	



$[x_1^{t0}, x_2^{t0}, \ldots, x_n^{t0}]$
$[x_1^{t-1}, x_2^{t-1}, \ldots, x_n^{t-1}]$
…
$[x_1^{t-95}, x_2^{t-95}, \ldots, x_n^{t-95}]$

Deep Q-Learning Model

$[y_1^{t+1}, y_2^{t+1}, \ldots, y_n^{t+1}]$

A reinforcement learning agent

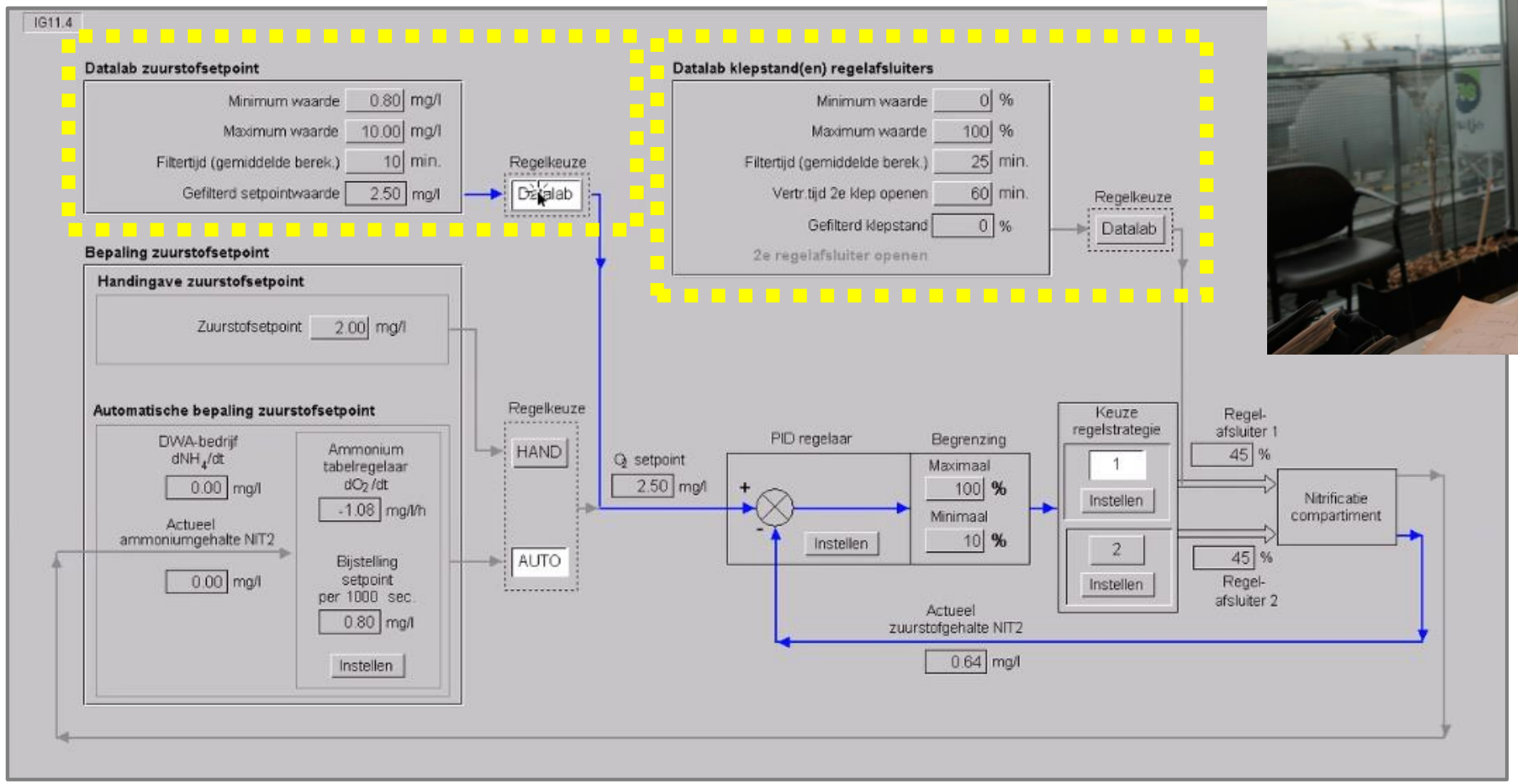
Simulator (environment)

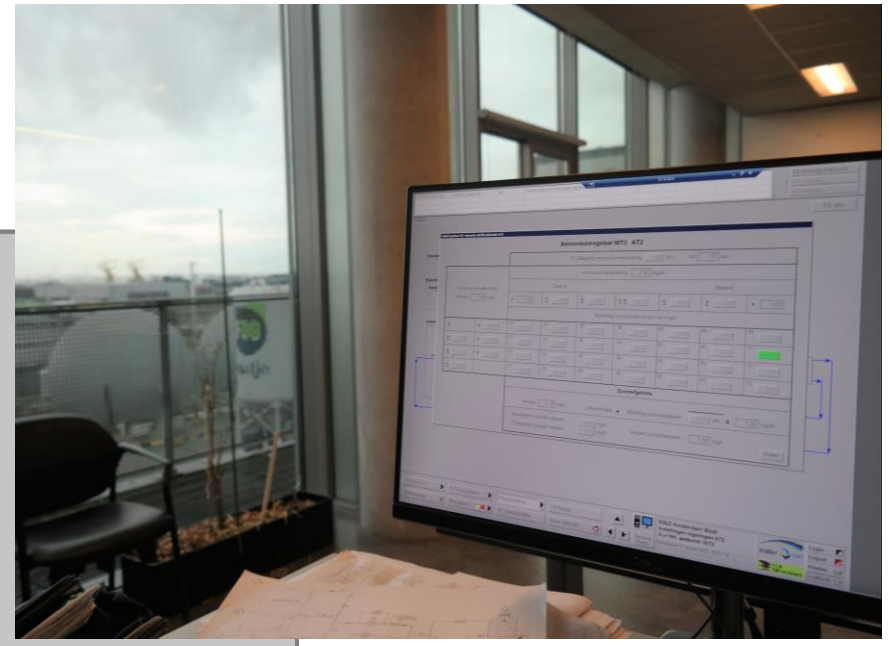
Actions
(control signals)

Observations
+
Reward

Agent

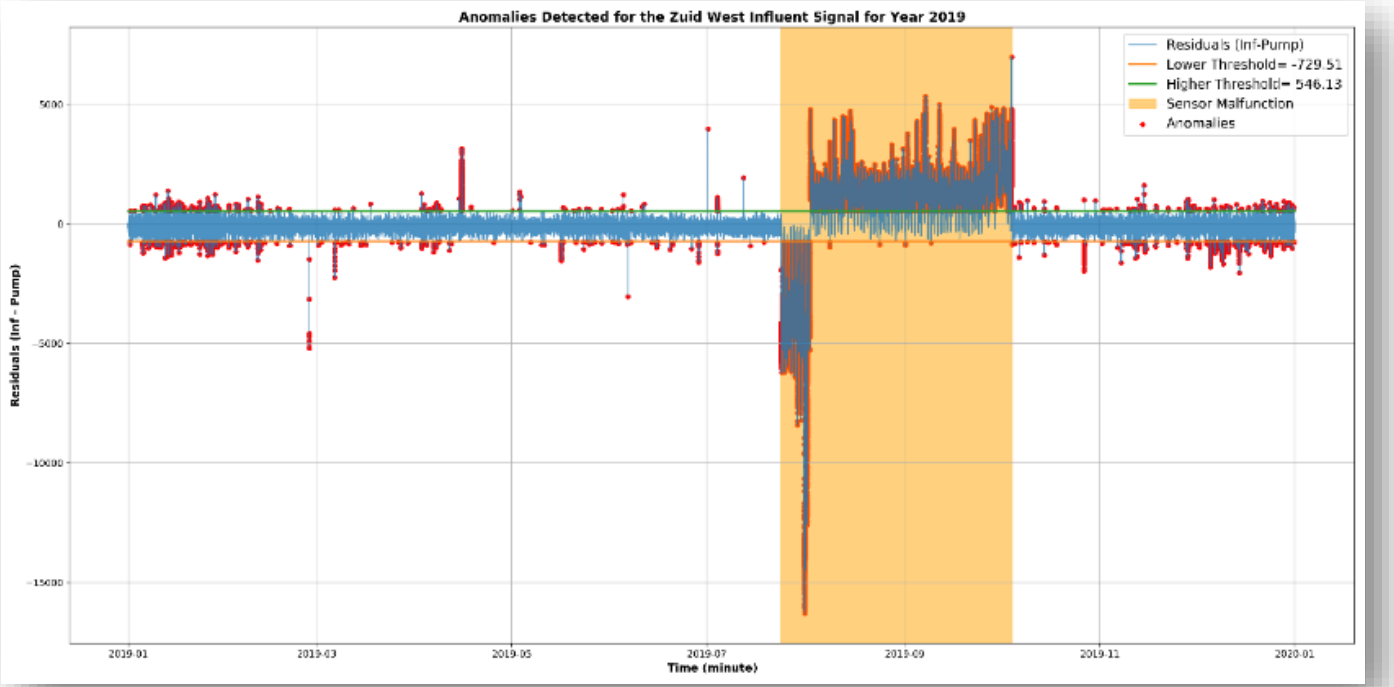
AI control implementation





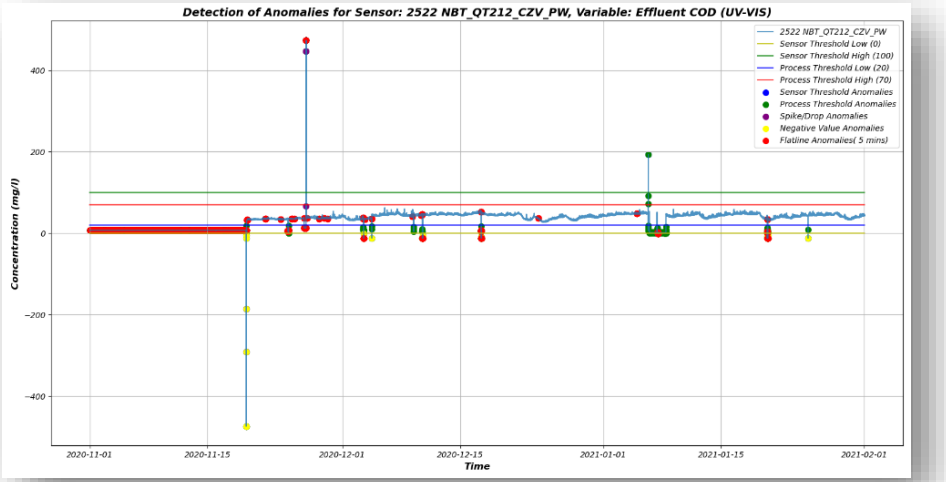
Automatic Data Validation and Data Quality Control

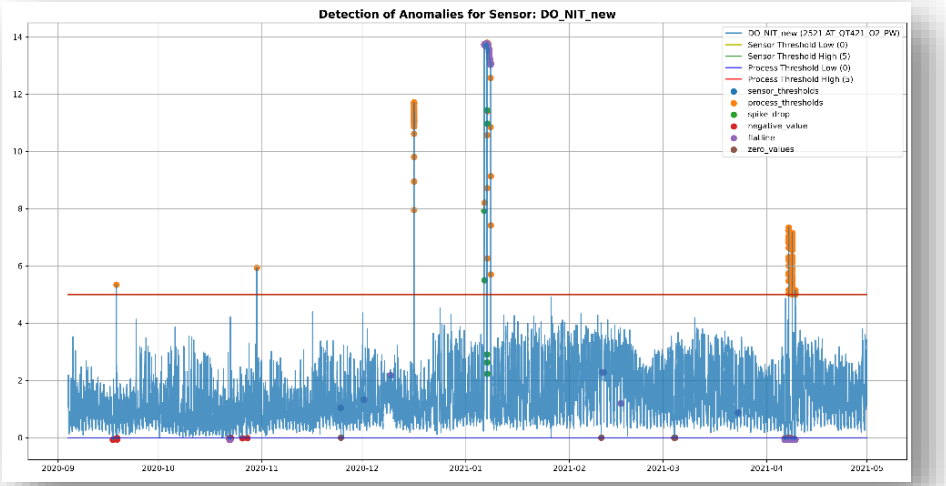
- Data quality can be impacted by sensor faults, (sensor) calibration issues, fouling, connectivity problems during transfer of data between the sensors/actuators and PIMS.
- Manual detection and correction can be labour intensive, particularly for signals used for simulation by AI models.
- Development of an automated data validation framework to screen raw data signals prior to model simulations and visualization.



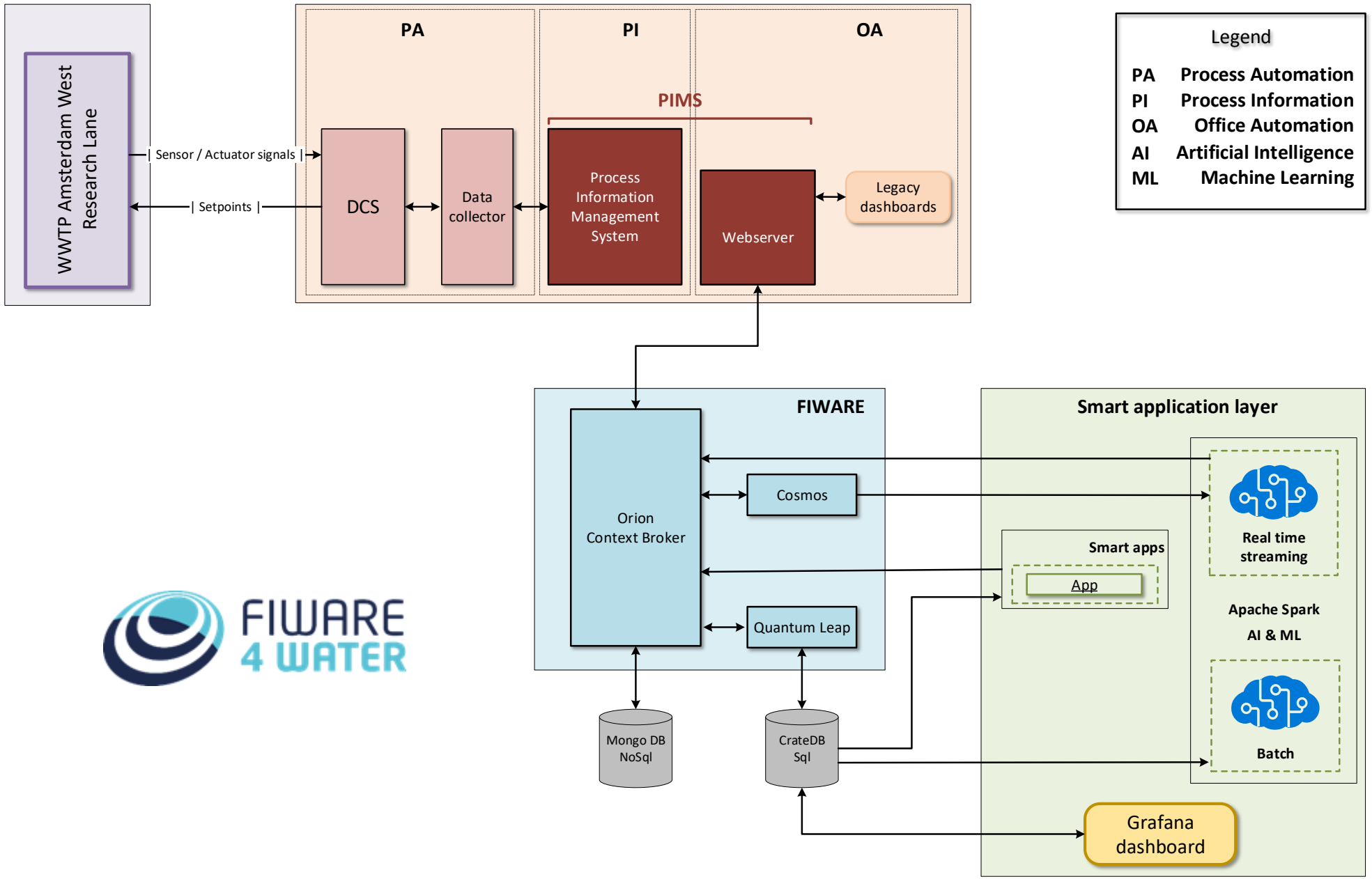
Automatic Data Validation and Data Quality Control

- Simple statistical methods to detect gross sensor anomalies due to sensor failures.
- Involves the collection of crucial metadata on sensors and guidance from process technologists.
- Detection of contextual anomalies using model-based detection.
- Development of soft sensors for crucial parameters (such as NH4 in aerobic tank) for data reconciliation.
- Conduct a (near) real-time data validation process using Fiware.





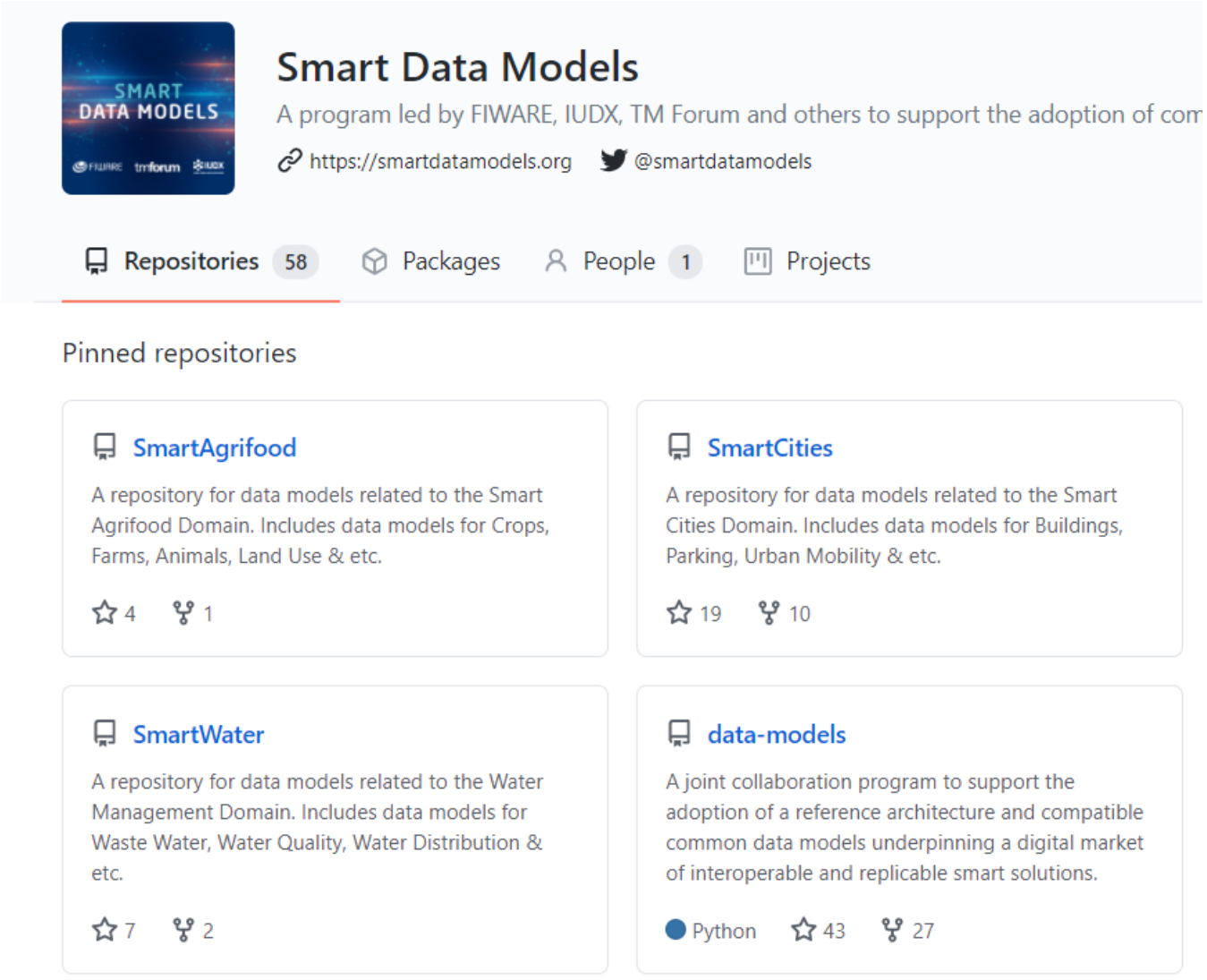
Integration of FIWARE To Legacy System



Data Integration Layer

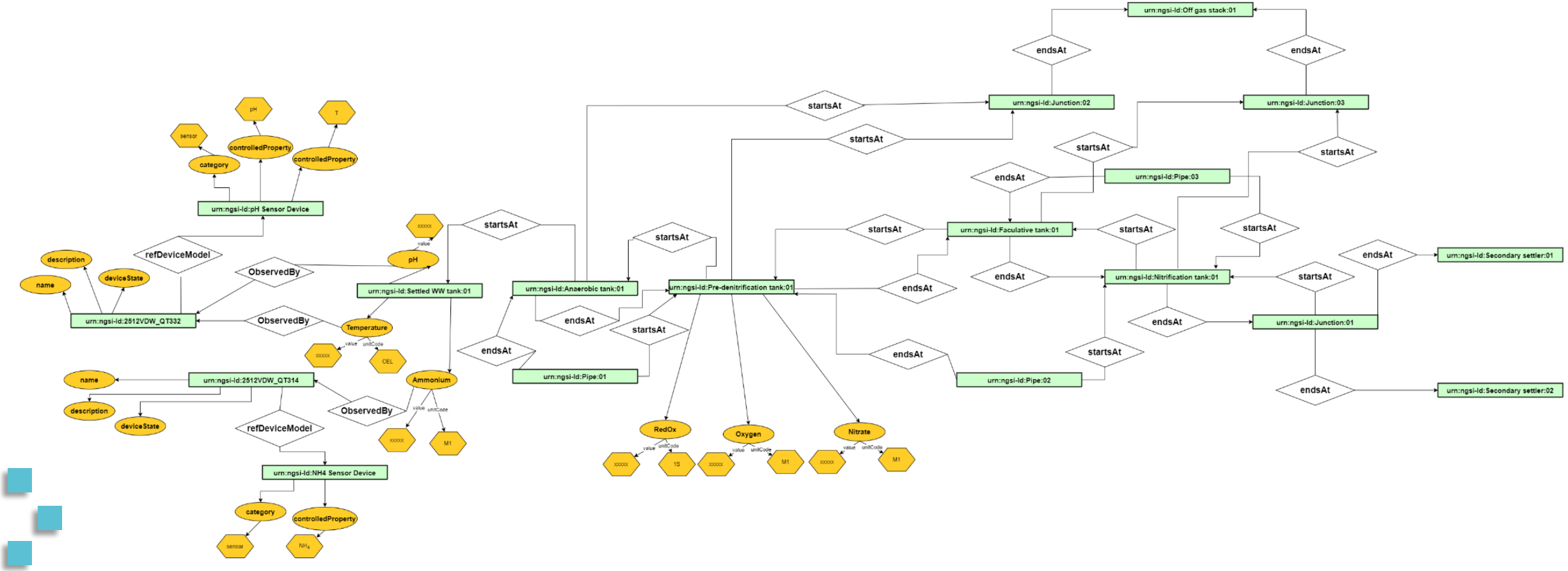
NGSI-LD Data Models Describing the ‘As-built’ Digital Twin

- Development of common information data models in NGSI-LD for the wastewater domain.
- Ensure interoperability for wastewater treatment systems.
- Using existing definitions by the Fiware/TM Forum/IUDX to promote a standardised approach and ensure interoperability across domains.



Data Integration Layer

NGSI-LD Data Models Describing the ‘As-built’ Digital Twin



Data Integration Layer

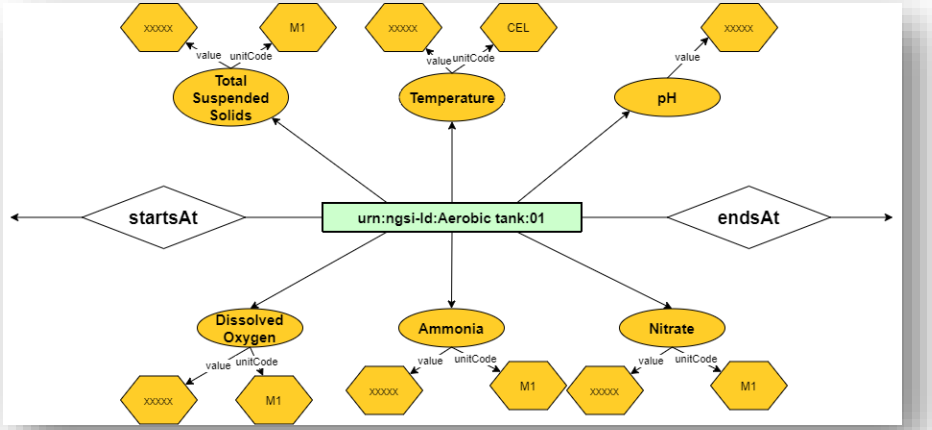
WasteWaterTreatment Data Models

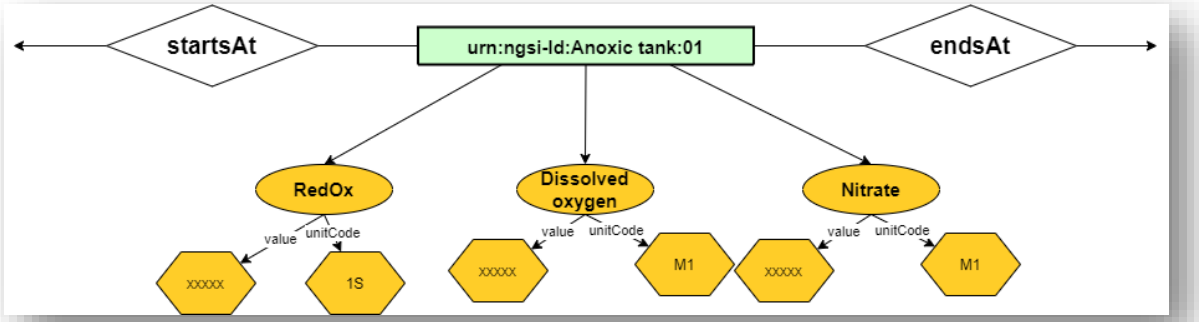
- Following entity types have been developed:
  - WasteWaterTank
  - WasteWaterJunction
  - Blower
  - OffGasStack

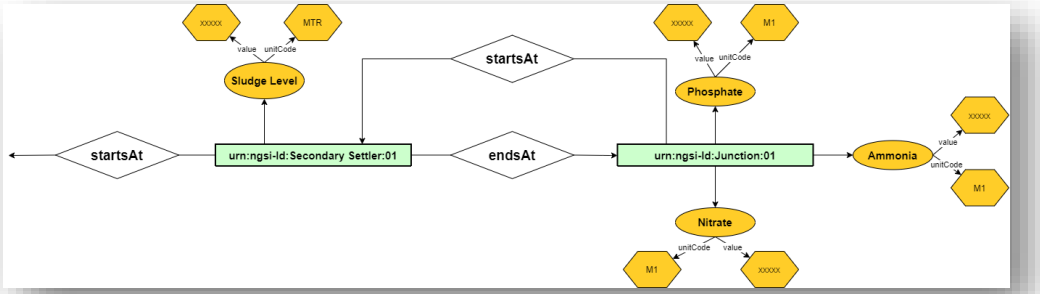
- Models can be found here - *https://github.com/smart-data-models/dataModel.WasteWater*

- Extension of these models based on the use case requirements.

- Further models applicable to WWTPs in development.







Thank you

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This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 821036.