

# SPRINT4.0

*STRATEGIC PARTNERSHIP FOR INDUSTRY 4.0 INNOVATION  
ADVANCED TRAINING*

**Testing the use-case format for SPRINT4.0 using a real case as testbed.**

"An innovative Waste-management system based on the acquisition of biogas data"

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AGENZIA  
NAZIONALE  
INDIRE

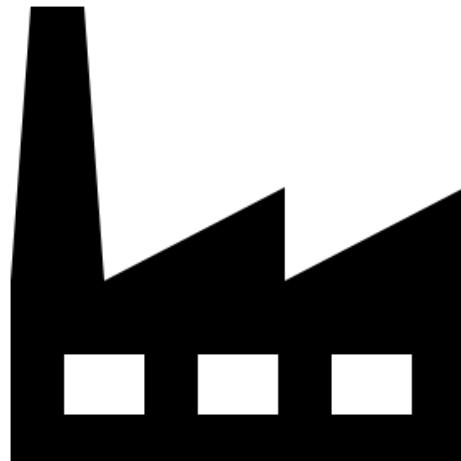
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- 1. Company**
- 2. Context description**
- 3. Problem to be solved**
- 4. Solution**

## COMPANY DESCRIPTION

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**SPRINT4.0**



Very short description of the company:  
Who is it and what it produce?  
Which is it its value proposition to the market?  
Dimension: is it a start-up or a big company?  
Which are its strengths and weaknesses?

# COMPANY DESCRIPTION

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**Name:** REA IMPIANTI Srl

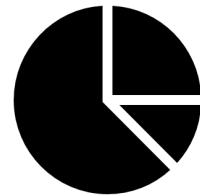
**Description:** Rea Impianti is a 100% company of the Municipality of Rosignano Marittimo (Tuscany) that deals with the management and maintenance of various landfills of organic waste and plants for the production of electricity.

**Value proposition to the market:** "La Fabbrica del Futuro" ("The Factory of the Future")

**Dimension:** one of the biggest waste management company in Tuscany with around 100 employees and around 40M in revenue

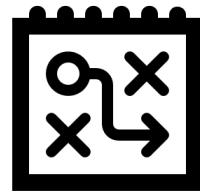
**Strengths:** optimal place for a landfill, openness to the use of new technologies

**Weaknesses:** adoption of innovative technologies slowed down by too much bureaucracy



- MARKET

Describe the market in which the company operates:  
number and type of actors, barriers, competitors

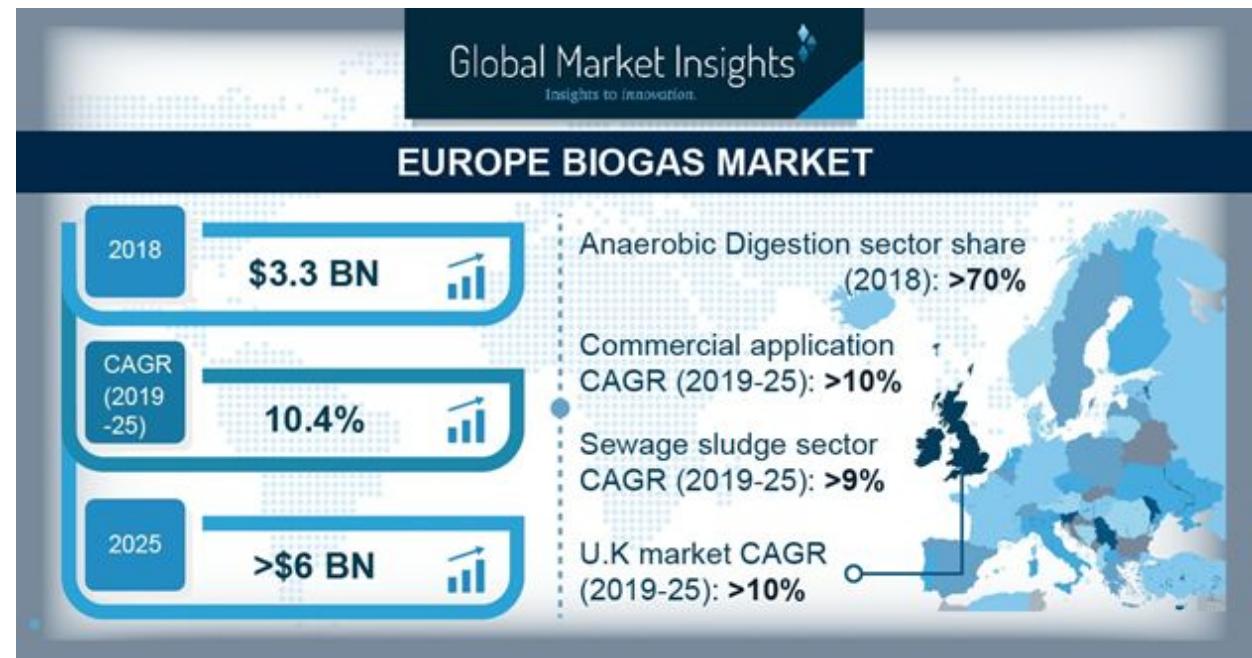
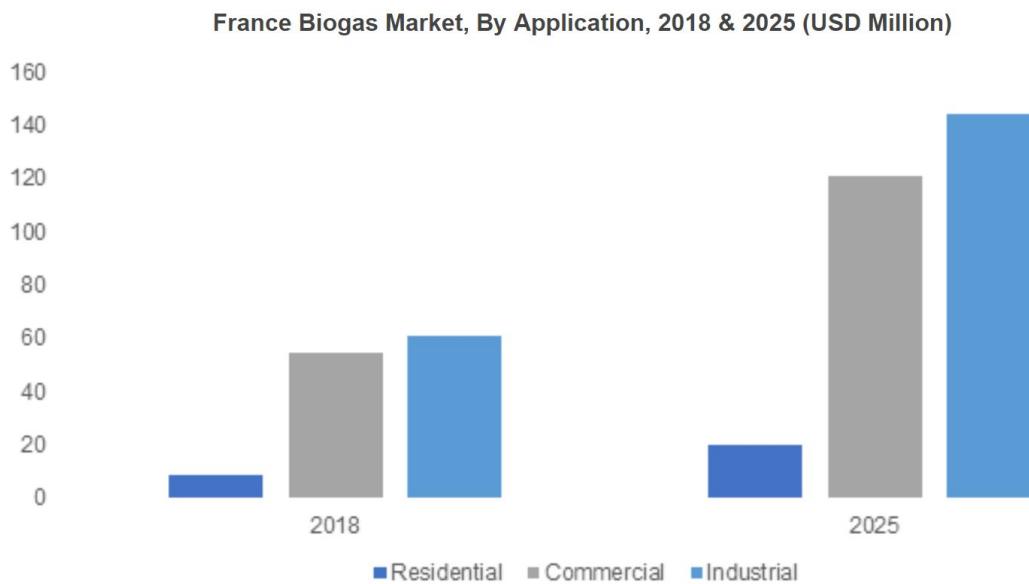


- VALUE CHAIN

Describe relevant aspects of company/market value  
chain: logistics, distribution channels, operations, etc. - if  
any -

## CONTEXT DESCRIPTION - MARKET

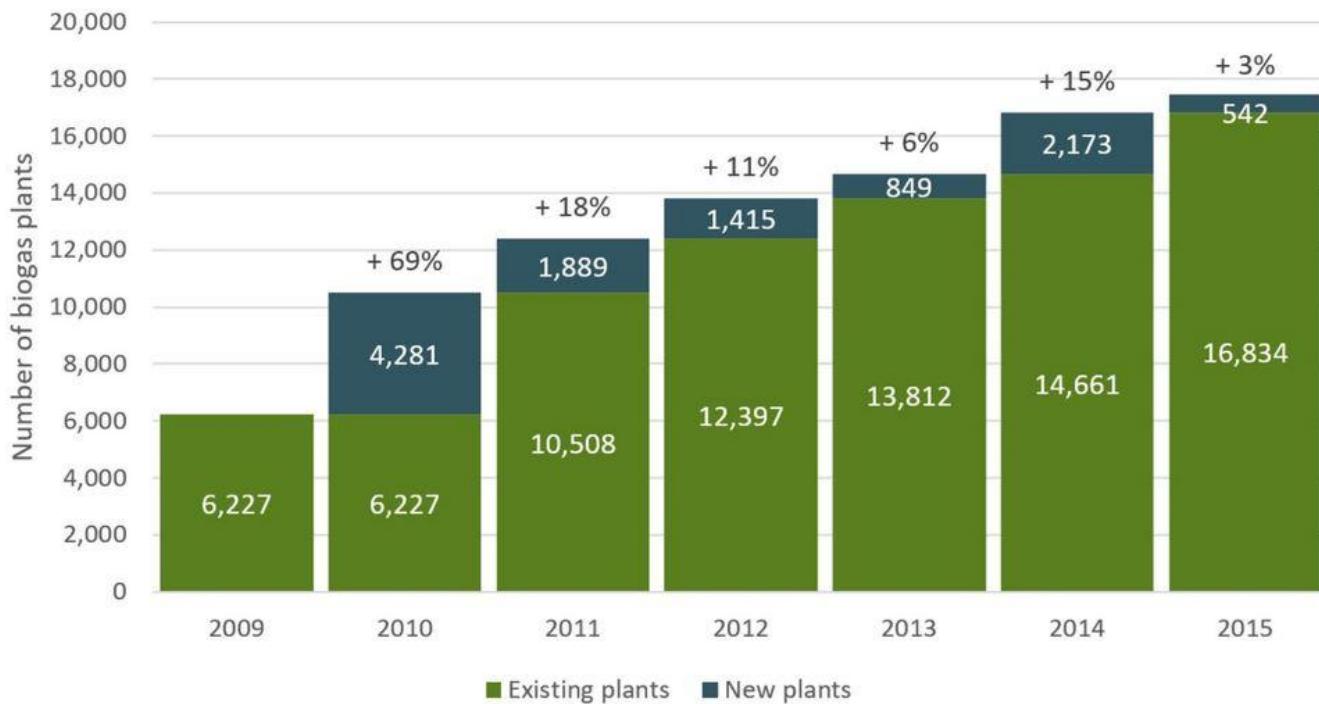
Europe Biogas Market to surpass \$6 billion by 2025 (Global Market Insights, Inc.)



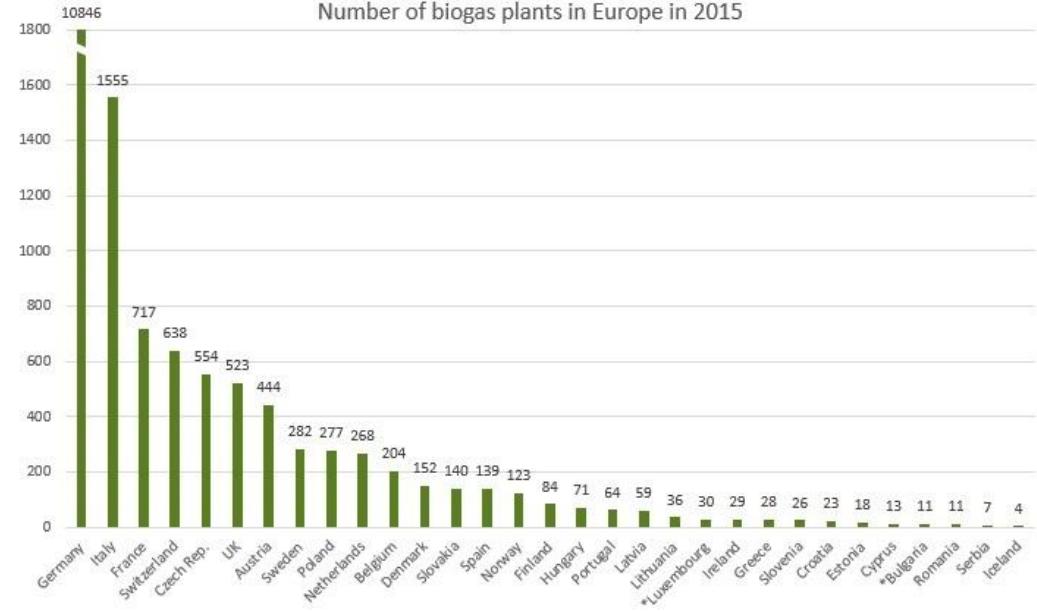
# CONTEXT DESCRIPTION - MARKET

European Biogas Association reports 17,376 biogas plants in EU

Evolution of the number of biogas plants in Europe



Number of biogas plants in Europe in 2015



# PROBLEM TO BE SOLVED

SPRINT4.0

- PROBLEM

Outline the problem to be solved and how it was addressed before the innovation process.



- INVOLVED PROCESSES

Which internal and external processes are involved?



- INVOLVED STAKEHOLDERS

Which stakeholders are involved in the process? How are they impacted?



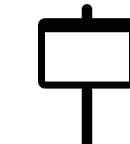
- MAIN OBSTACLES

What are the main obstacles to the problem resolution?



- STATE OF THE ART

There is any solution already on the market? How have other companies, in the same or in different sectors solved this issue ?



## PROBLEM TO BE SOLVED - OVERVIEW

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REA Impianti needed to **improve the monitoring and management process** of the biogas generated from a waste management plant.

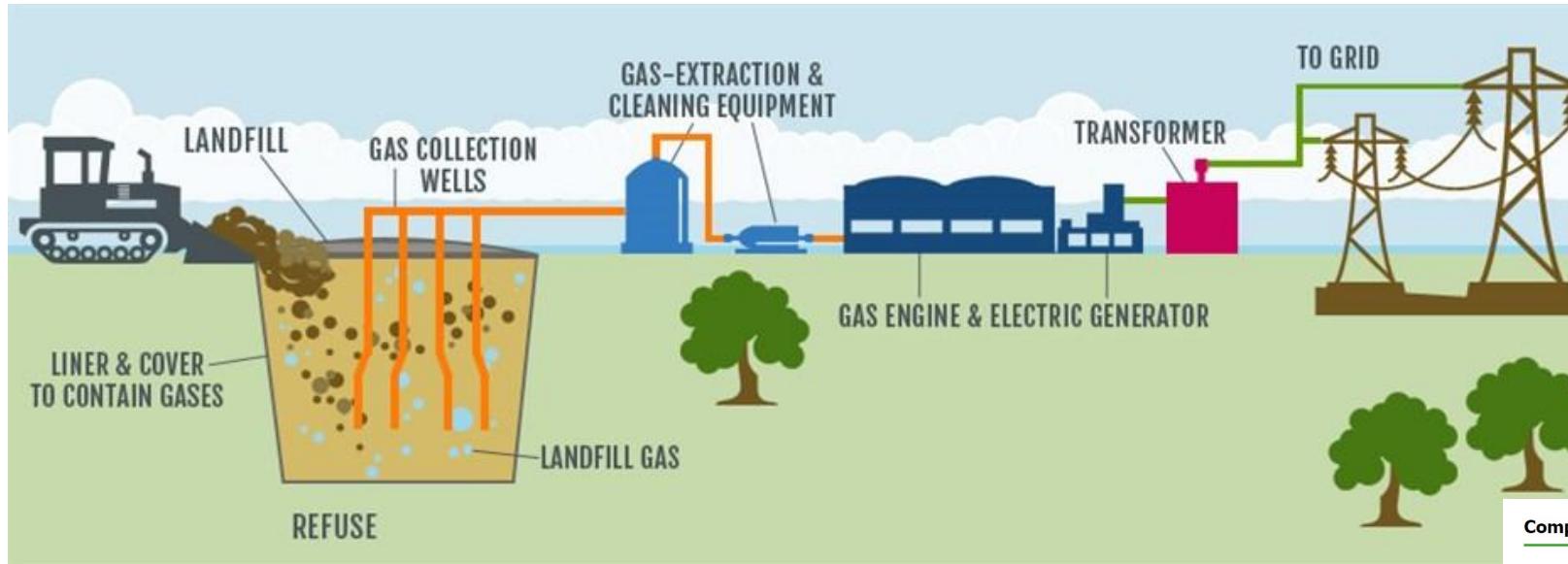
In particular, **replacing the manual check-up of the working parameters of the biogas wells spread along the plant, in order to reduce costs and increase efficiency and safety.**



# PROBLEM TO BE SOLVED - INVOLVED PROCESSES



## How a Landfill works



### Composition of biogas

Methane ( $\text{CH}_4$ )	35-60%
Carbon Dioxide ( $\text{CO}_2$ )	30-60%
Oxygen ( $\text{O}_2$ )	0-2%
Water ( $\text{H}_2\text{O}$ )	2-5%
Other gases: Hydrogen sulphide ( $\text{H}_2\text{S}$ ); Hydrogen ( $\text{H}_2$ ); Nitrogen ( $\text{N}_2$ ); Trace amounts of other compounds (mercaptans, ammonia,...)	2-5%

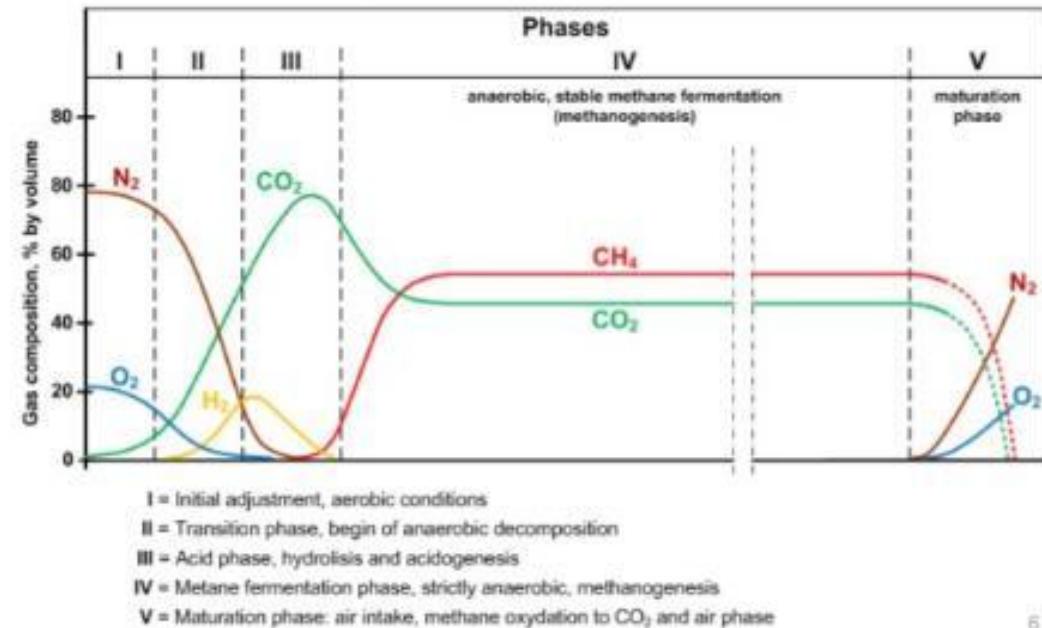
# PROBLEM TO BE SOLVED - INVOLVED PROCESSES



## Goals of a landfill manager:

1. **Maximize the amount of biogas extracted**
  - a) Increase the energy production
  - b) Reduce the amount of gas released in the atmosphere
    - Reduction of smell
    - Reduction of greenhouse gasses emission
2. **Maximize the percentage of methane in the Biogas**
  - a) Improve performances of the generator engine
3. **Minimize the percentage of oxygen in the Biogas**
  - a) Reduction of flammability risk
  - b) Better combustion in the generator engine

The 5 phases of Landfills life



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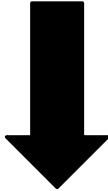
**So we have Data-driven goals! Ideally, we just need to get this data but...**

## PROBLEM TO BE SOLVED - MAIN OBSTACLES

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Up to now, biogas plants planned their settings and adjustments of resources on a monthly basis. This is generally done manually, based on experience and intuition of the operators.



**NO REAL-TIME DATA FROM WELLS**

- OVERALL APPROACH IN PROBLEM RESOLUTION

Describe how did you approached the problem: how did you analysed the problem? On what did you focus at first in the innovation process?



- SELECTED TECHNOLOGY

Which technology did you choose? Why? How did you select it?



- LEVEL OF INNOVATION PROVIDED

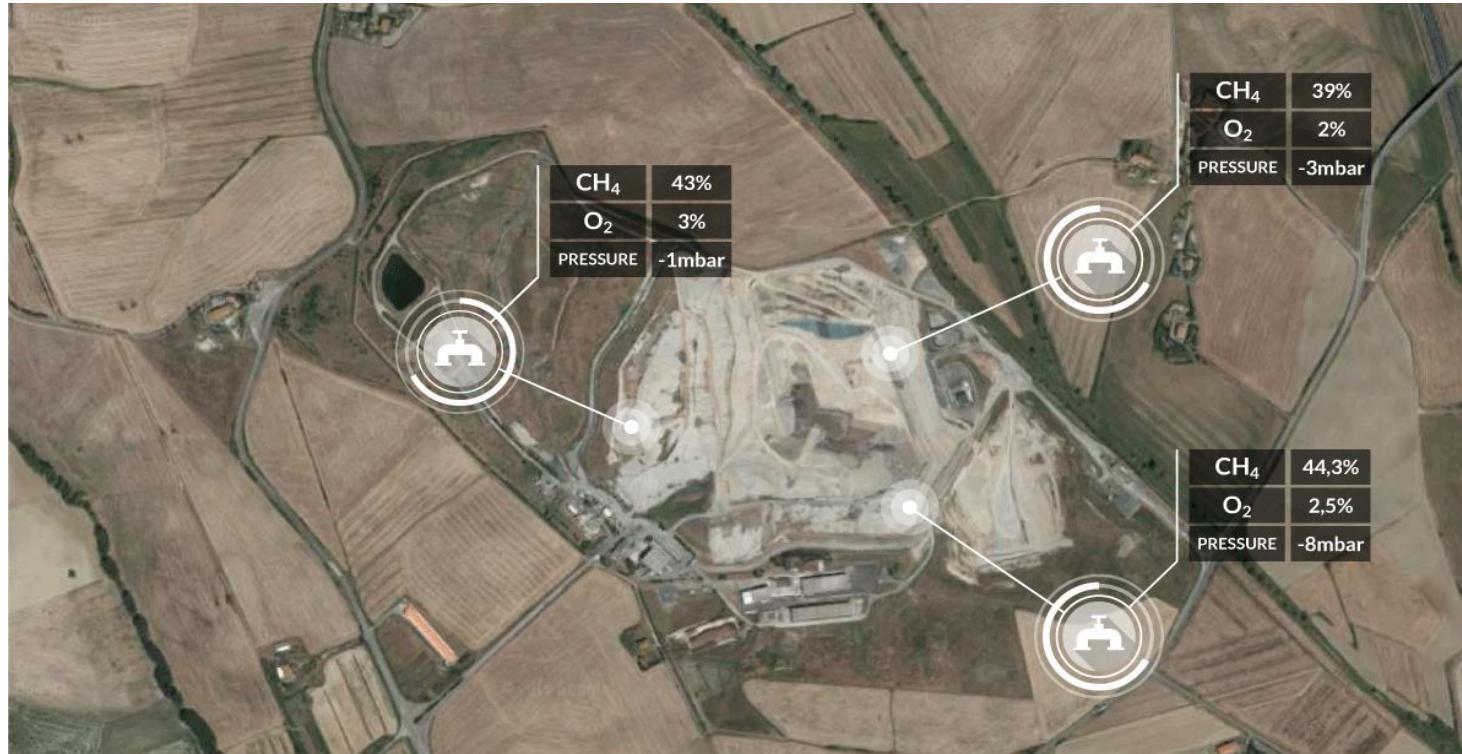
Why and how the new solution provided a improved level of technology?



# SOLUTION - OVERVIEW



## IoT biogas monitoring System



### Technical Challenges:

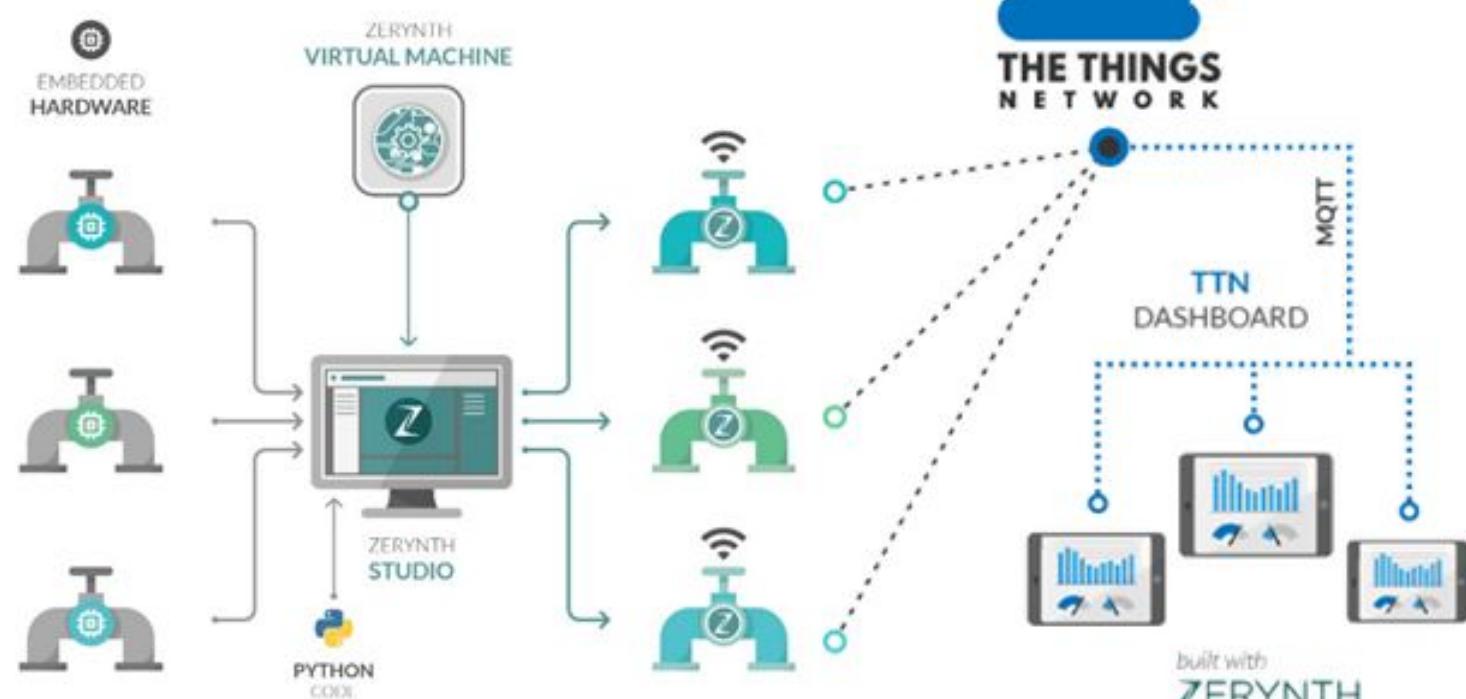
- No WiFi coverage (landfill has 2Km of radius)
- No GSM coverage (landfill is distant from repeaters)
- Very challenging environment (flammable system)
- No power supply

# SOLUTION - SELECTED TECHNOLOGY



## MAIN TECHNOLOGIES

- 4ZeroBox: Python programmable low-power microcontroller
- CH4, O2, pressure, temperature and humidity sensors
- LoRa + The Things Network
- Custom Dashboards



## SOLUTION - SELECTED TECHNOLOGY



### 4zeroplatform

TOI provides **4ZeroPlatform**: a plug-and-play data gathering, processing, and reporting solution for small and large enterprises who need to achieve full **visibility** and **optimization** of Industrial Processes.



4zerobox

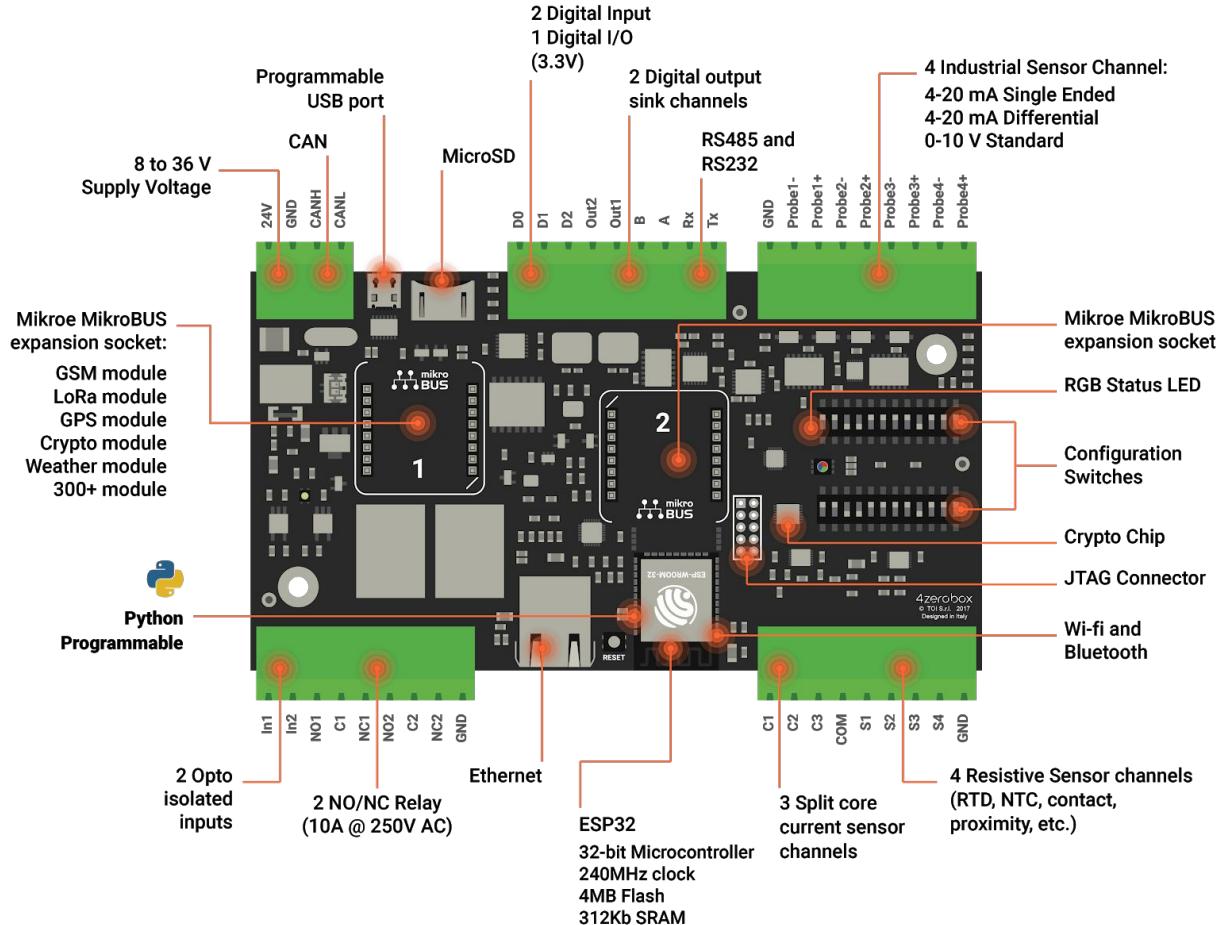


4zeromanager

# SOLUTION - SELECTED TECHNOLOGY



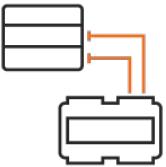
4zero**box**



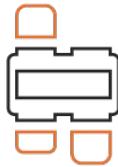
# SOLUTION - SELECTED TECHNOLOGY



## 4zero<sup>box</sup>



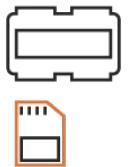
Analog and digital ports for connection to industrial sensors and PLC



Modular hardware with infinite configuration



Multi-connectivity:  
GSM, WiFi, Bluetooth,  
LoRa, Ethernet



Can retain and store data locally when disconnected



Secure hardware encryption and Blockchain-Ready



Python-Programmable thanks to Zerynth technology

## SOLUTION - SELECTED TECHNOLOGY

### 4zero manager



Secure and scalable  
device provisioning



Remote device  
management



Remote device  
diagnostics



Firmware Over-The  
-Air updates



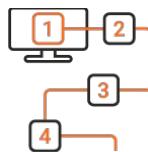
Secure  
connectivity



Enterprise software  
integrations



Modern user interface  
with MQTT Consoles



Step by Step  
configuration  
tools



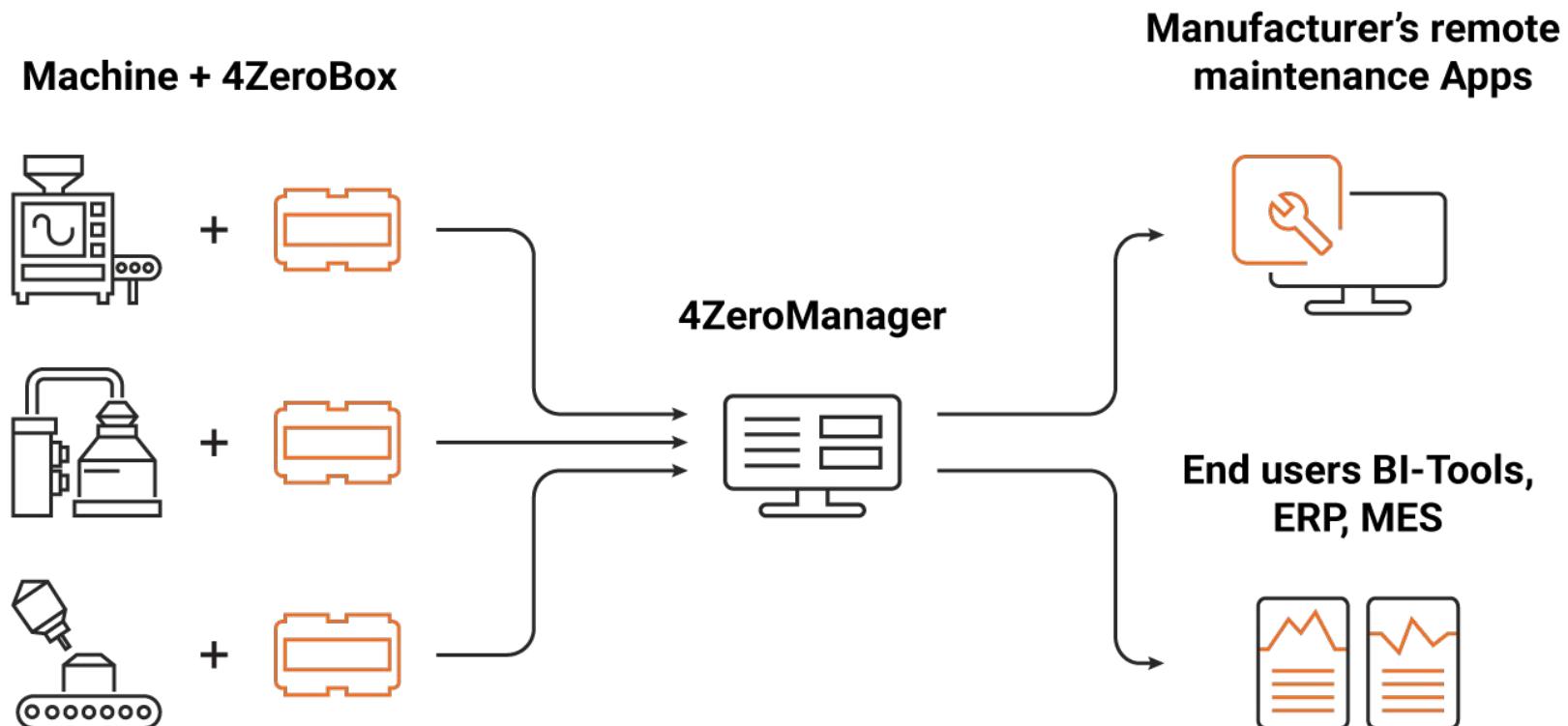
Development  
tools



Cloud or on-premises  
deployment

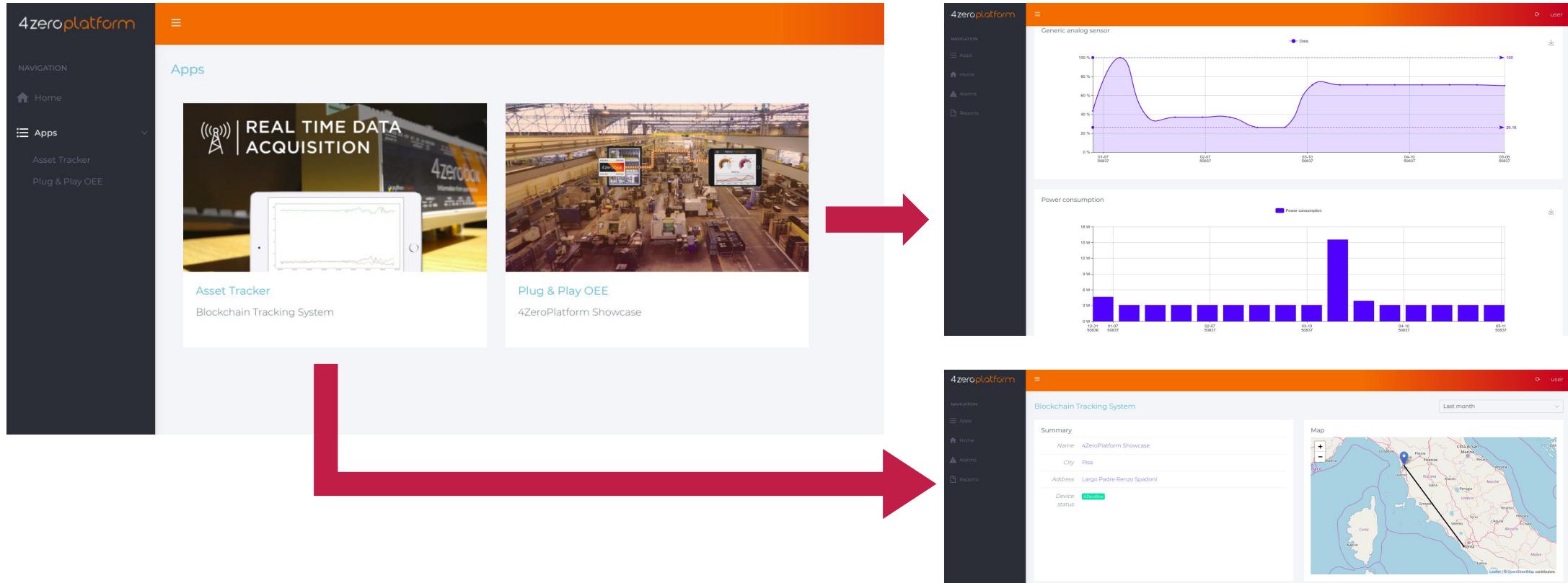
# SOLUTION - SELECTED TECHNOLOGY

A versatile Solution that adapts to any industrial context



# SOLUTION - SELECTED TECHNOLOGY

## 4ZeroManager - Custom Apps integration

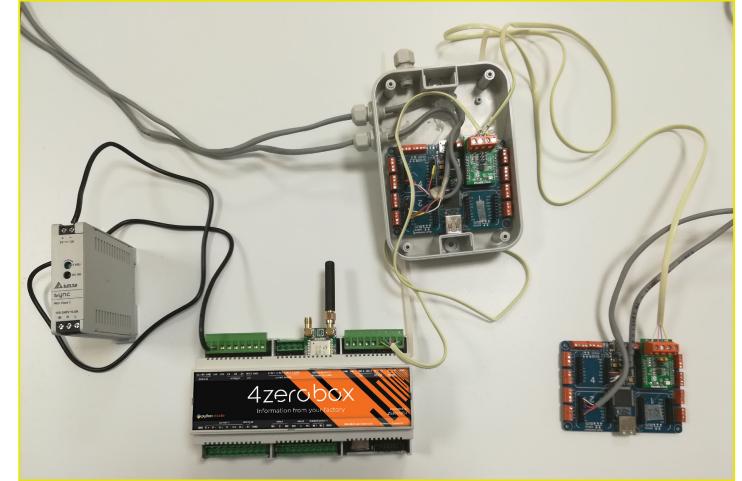
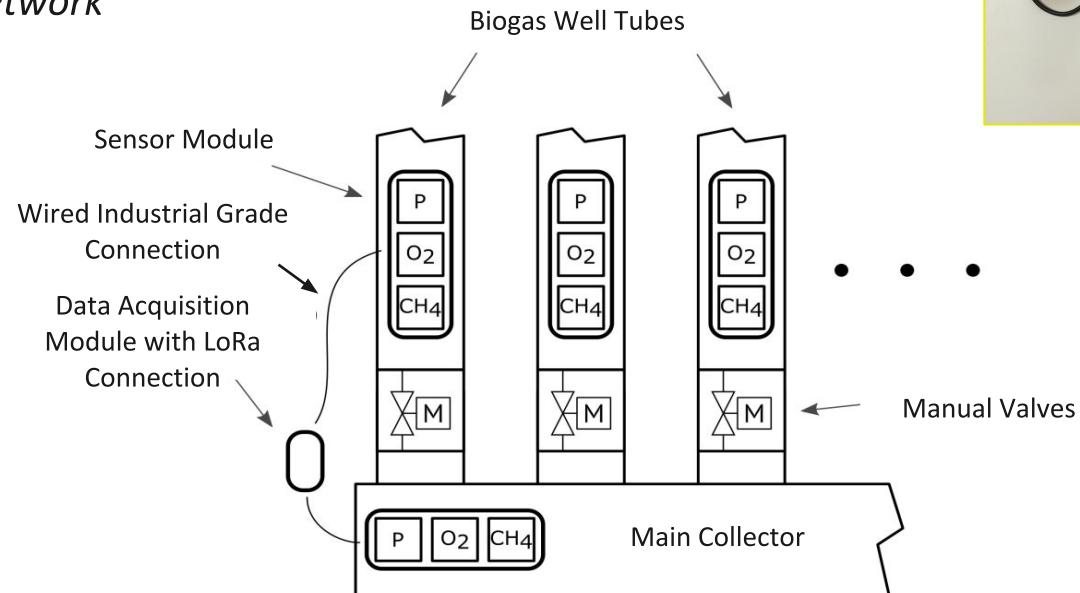


# SOLUTION - LEVEL OF INNOVATION PROVIDED



## INNOVATIVE ARCHITECTURE

- Modular and Scalable
  - 1 data collector per sub-station
  - up to 20 sensor modules per sub-station
  - Low bandwidth long range network
- Industrial Grade:
  - Waterproof IP68
  - Certifiable (CE and Atex)
- Edge Computing
  - Local Processing
  - Local Storage



# SOLUTION - LEVEL OF INNOVATION PROVIDED



## CUSTOM DASHBOARDS

CSV Data Export

Visual Alarms

Monitoraggio biogas

Mappa

Interactive Charts

ZERYNTH®  
Your Ideas. Embedded

The dashboard features a map titled 'Mappa' showing an industrial facility with various tanks and structures. Several black dots represent monitoring points, with one red dot and one green dot highlighted. Above the map are five buttons: 'Aggiorna', 'Esporta dati', 'LOG dati', 'LOG tempo', and 'Esporta .db'. To the right of the map is a chart titled 'Stato collettori' comparing Methane (CH4) and Oxygen (O2) levels. The Y-axis represents concentration in % vol, ranging from 0 to 45. The X-axis represents time or collector number from 1 to 10. Red vertical bars indicate CH4 levels, with a major spike at collector 3 reaching nearly 45%. Blue vertical bars indicate O2 levels, with a minor spike at collector 3 reaching approximately 4%.

Collector	CH4 [% vol]	O2 [% vol]
1	~32	~0.5
2	~33	~0.5
3	~45	~4
4	~34	~0.5
5	~35	~0.5
6	~36	~0.5
7	~37	~0.5
8	~38	~0.5
9	~39	~0.5
10	~40	~0.5

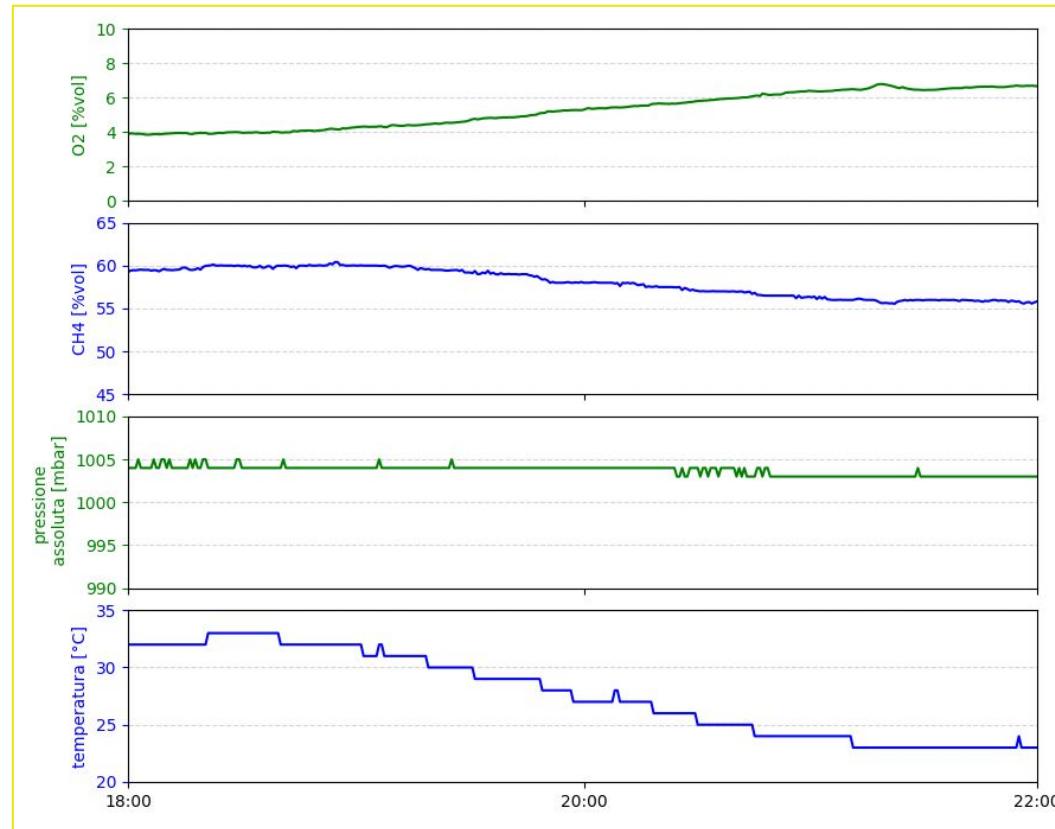
# SOLUTION - LEVEL OF INNOVATION PROVIDED



## AUTOMATED ALARMING AND REPORTING

### Alarms:

- CH4 concentration < 40%
- O2 concentration > 4%
- Well pressure  $\geq$  Env. Pressure
- Collector Pressure > 900 mbar
- Gas Temperature < 10 °C



# SOLUTION - LEVEL OF INNOVATION PROVIDED



## IMPROVING PROCESSES VISIBILITY

### Temperature Effects in Anaerobic Digestion Modeling

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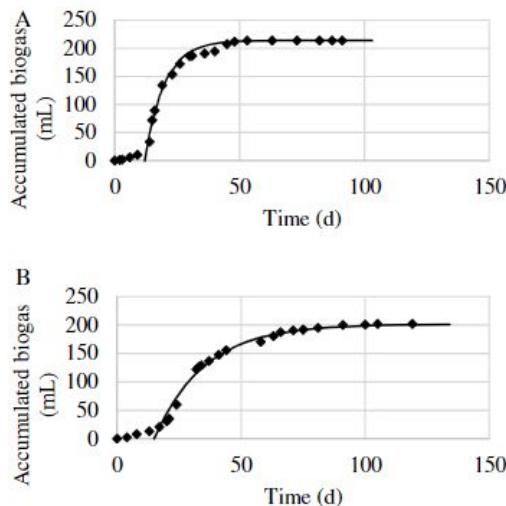
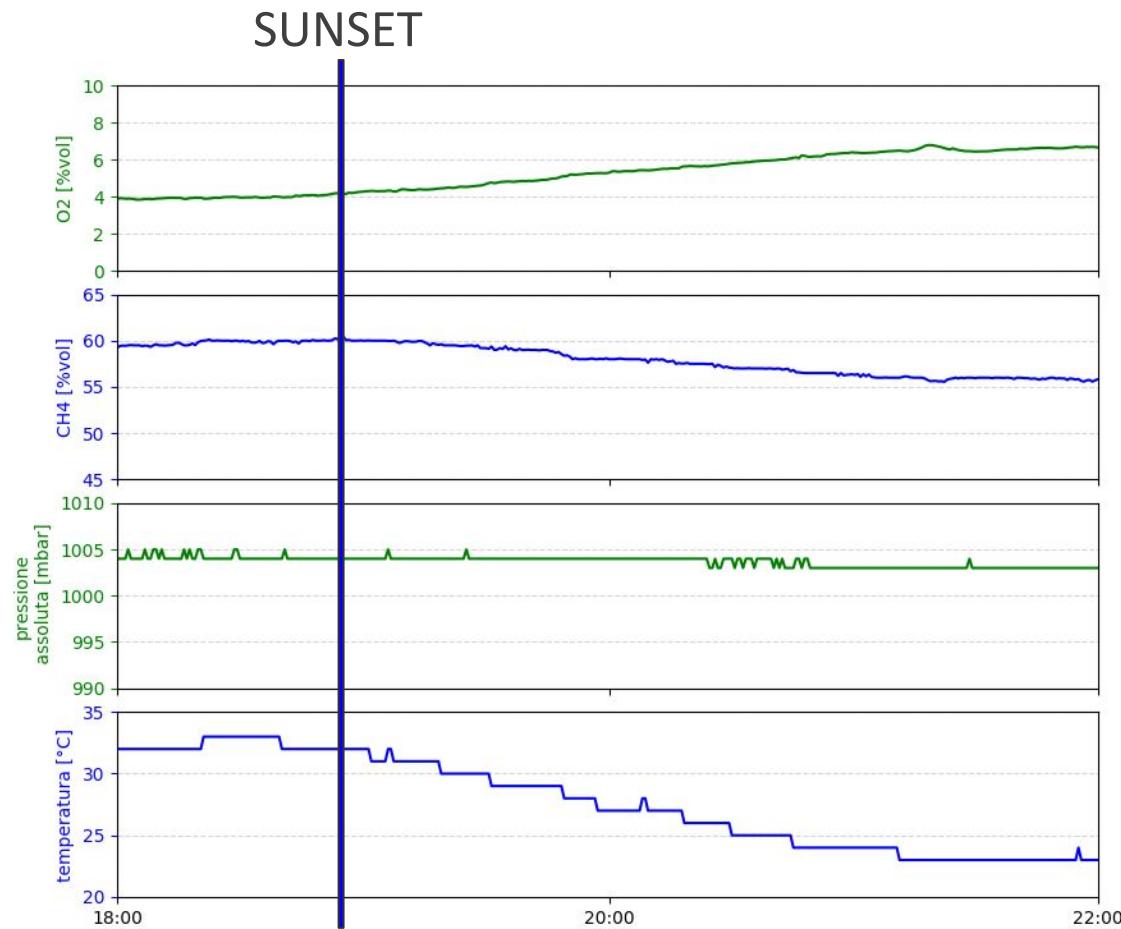


Figure 3. Batch test data and fitted line for 35 °C (A) and 23 °C (B) used to calculate  $k_{hyd}$ .



- ACCOMPLISHED OUTCOMES

What has been the outcome of the solution, from an economical, technical and performance standpoint?



- IMPACT

What are the main benefit generated by the solution and for which stakeholders?



- COST AND BENEFIT ANALYSIS

Were the benefit for the company higher than the sustained cost?

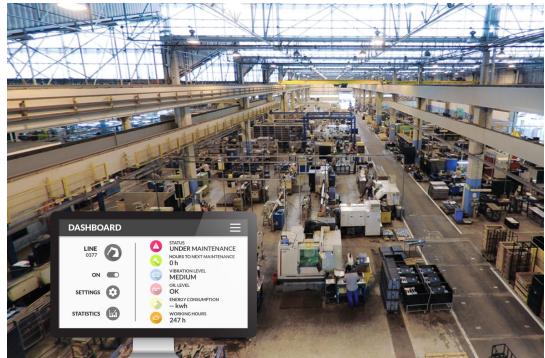


# IMPACT



Process Parameters/Actions	Before	After
Gas analysis	Every two weeks	Continuous (1 sample/minute)
Alarms	Not available	Available - Event driven
Tube Failure Detection	Not available	Available - Event driven
Analytics	Not available	Automatically generated daily reports
Valves Adjustment	Every two weeks on the basis of current measure	Event driven

# OTHER USE CASES



## Manufacturing Industry

**New and legacy machines in different manufacturing sectors.**

- Real-time sensor data acquisition and processing of anomalies and deviations
- Integrated in cloud or on-premises solutions

### 4.0 OUTCOMES

- Efficiency: real-time production data and OEE measuring
- Maintenance: failures detection improvement
- Productivity: integration with ERP-MES tools



## Process Industry

**Biogas production monitoring for efficiency improvement.**

- Pressure, Temperature, Humidity, CH<sub>4</sub> and O<sub>2</sub> data acquisition and local computing
- LoRa connection to local servers

### 4.0 OUTCOMES

- Efficiency: less time and more precision for wells regulation
- Visibility: awareness of unknown biogas cyclic dynamics



## Industrial Refrigeration

**Industrial refrigerators monitoring for efficiency and regulatory purposes.**

- Temperature, humidity, doors and energy data for real-time monitoring, recording and COP
- Wi-fi and GSM connectivity

### 4.0 OUTCOMES

- Efficiency: reduction of Maintenance costs and energy
- Quality: cold chain monitoring meeting HACCP regulation