

# ZERYNTH

Your Ideas. Embedded



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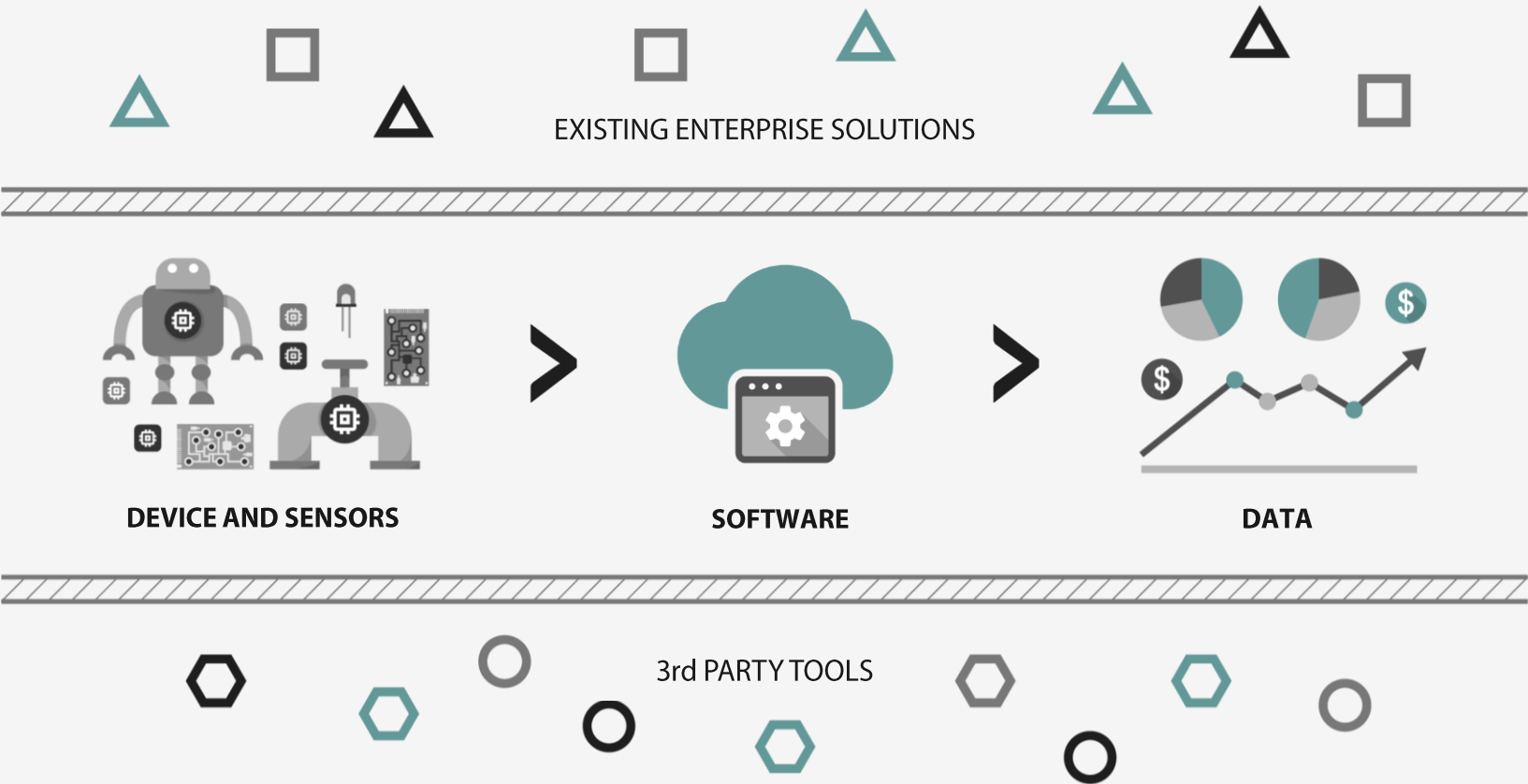
[@zerynth](https://twitter.com/zerynth)

# 4.0 LANDFILL

**Smart monitoring solution for waste management**

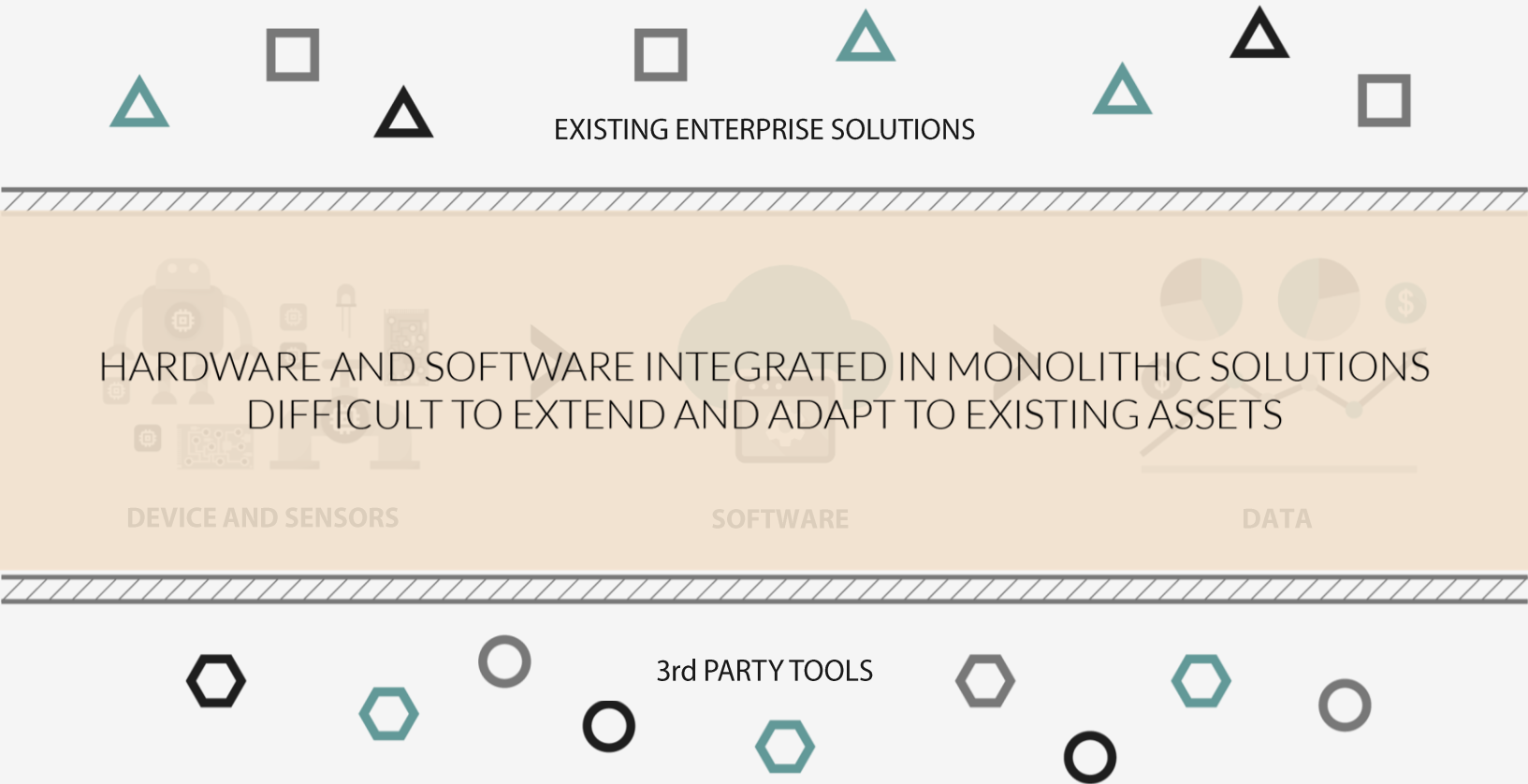


# THE TYPICAL IOT PLATFORMS APPROACH





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# INTRODUCING ZERYNTH

**ZERYNTH**  
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Zerynth is the first set of tools for designing embedded applications and IoT connected devices using any 32bit microcontroller and cloud architecture.

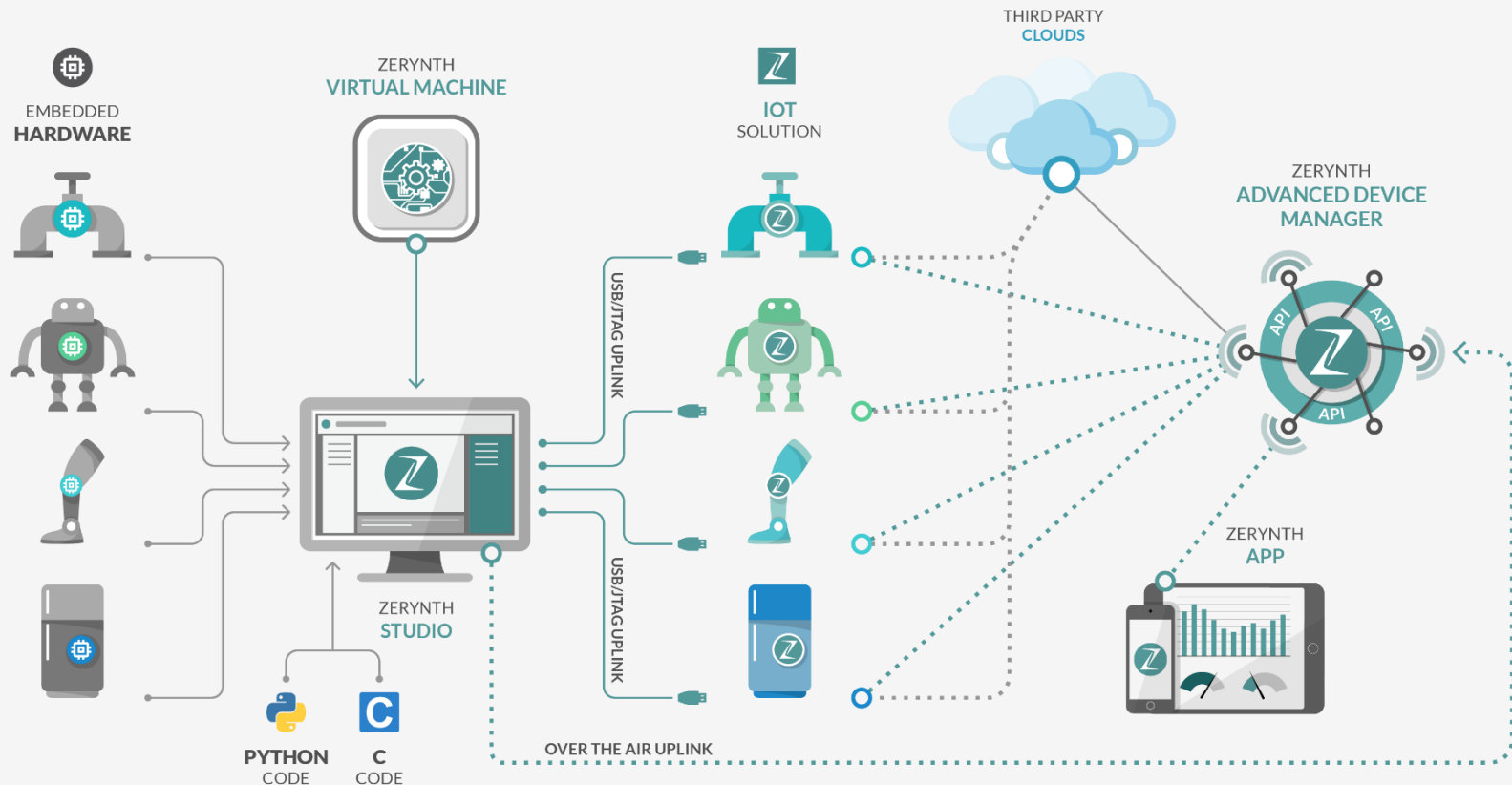
All in Python language.





# ZERYNTH STACK

Zerynth features a full stack solution going from embedded hardware cross-platform programming to cloud data visualization, analytics and mobile integration





# ZERYNTH UNIQUENESS



## TIME TO MARKET REDUCTION

Zerynth reduces the development and industrialization time thanks to faster coding and ready-to-use features



## FLEXIBILITY

Zerynth allows the generation of multiple IoT solutions with different hardware and cloud architectures



## SCALABILITY

The Zerynth-powered IoT solutions grow with your needs, thanks to code transferring and over-the-air updates



# New Tools for New Paradigms





# 4zerobox

The Modular Way to Smart Data



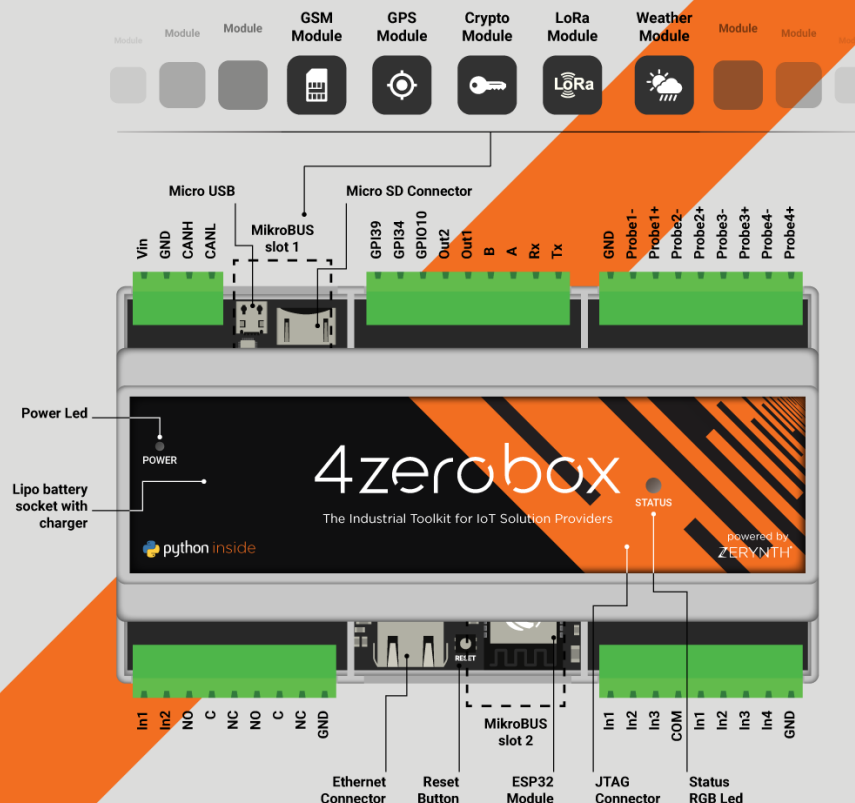


# TECHNICAL SPECIFICATIONS

## FEATURES

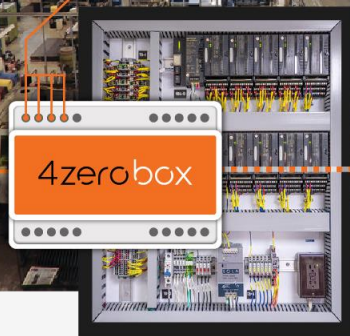
- DIN-rail mountable (9 slots)
- 5V Supply voltage
- 8 analog input channels:
  - Two 4-20mA single-ended channels
  - Two 4-20mA differential channels
  - Four 0-10V / RTD channels
- 3 non-invasive current sensor channels
- 2 opto-isolated digital inputs
- Connectivity:
  - WiFi (Client and AP mode supported)
  - Bluetooth Low Energy
  - Ethernet
- RS485 and RS232
- MicroSD card slot
- 5 Digital I/O
- 2 NO/NC Relay (10A @ 250V AC)
- 2 on-board Mikrobus-click sockets (more than 300 expansion module available)
- 12-pin AUX connector with I2C and GPIOs for 4zerobox and third parties expansion modules
- LiPo battery support with on board charging unit
- 32bit Microcontroller (240MHz, 4Mb Flash, 312Kb SRAM) Python-Programmable thanks to Zerynth technology

More than **300 MikroBUS** expansion modules available!



compatible with

# HOW IT WORKS

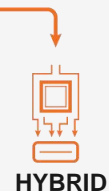


Android and iOS  
control App available



## INSTALLATION OPTIONS

## INFORMATION MANAGEMENT



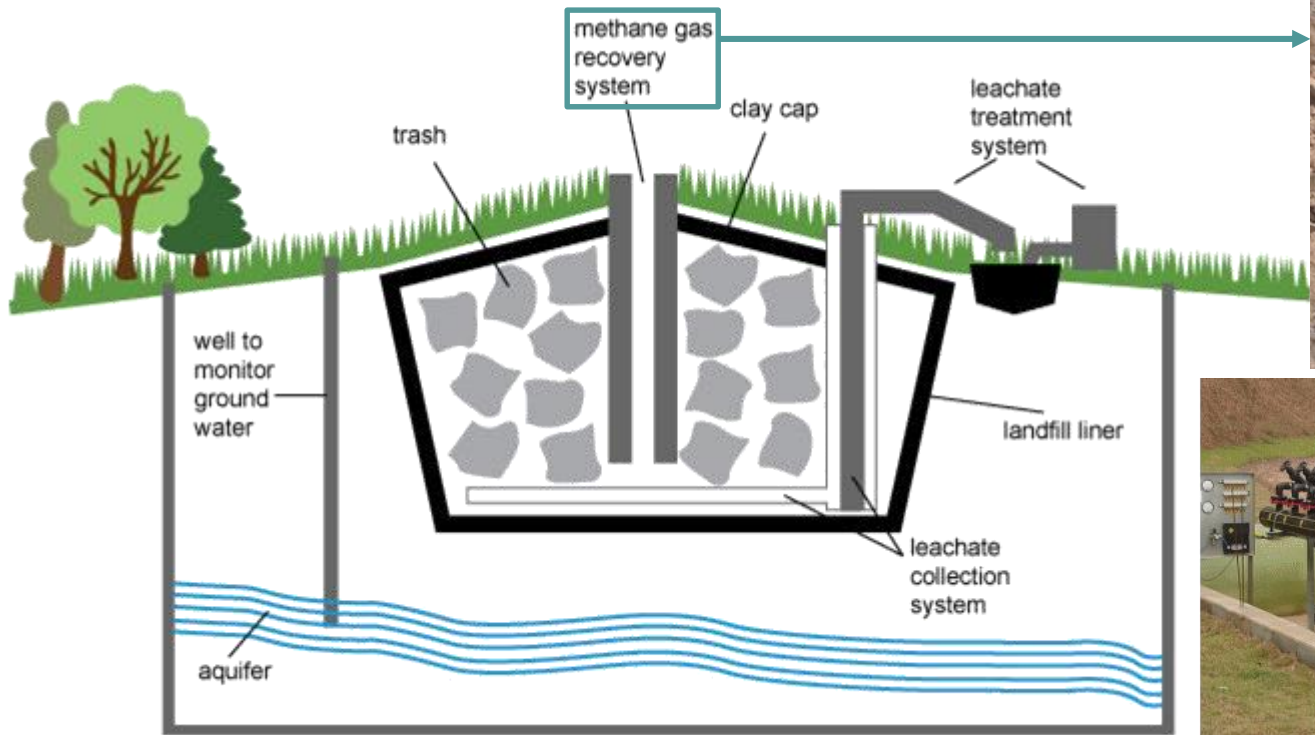


# The Challenge

*Optimization of Biogas Production in Landfill*



# Biogas Production in Landfill



Source: Adapted from National Energy Education Development Project (public domain)



# Production Control

## 1. Maximize the amount of biogas extracted

- Increase the energy production
- 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

- Improve performances of the generator engine

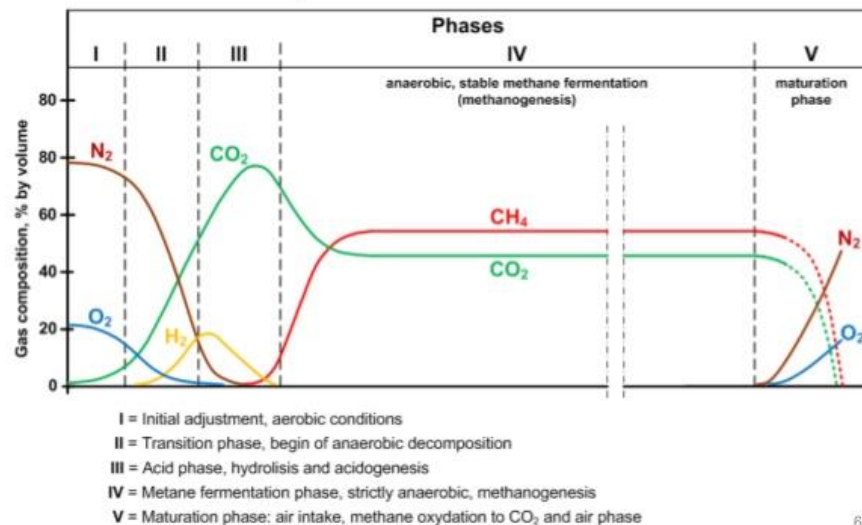
## 3. Minimize the percentage of oxygen in the Biogas

- Reduction of flammability risk
- Better combustion in the generator engine

## Generation of LFG

HOFSTETTER  
GASTECHNIK AG

### The 5 phases of Landfills life







# Production Control

## The Process is influenced by:

- Rain
- Barometric Pressure
- Environmental Temperature and Humidity
- Sun Light / Clouds
- Seasons





# Production Control

## Operator based control:

- Only one operator trained
- Gas sampling and valves adjustment every two weeks
- Obsolete pressure measurement instrument
- Manual adjustment of valves
- Very high inertia -> no real-time feedback!





# The Solution

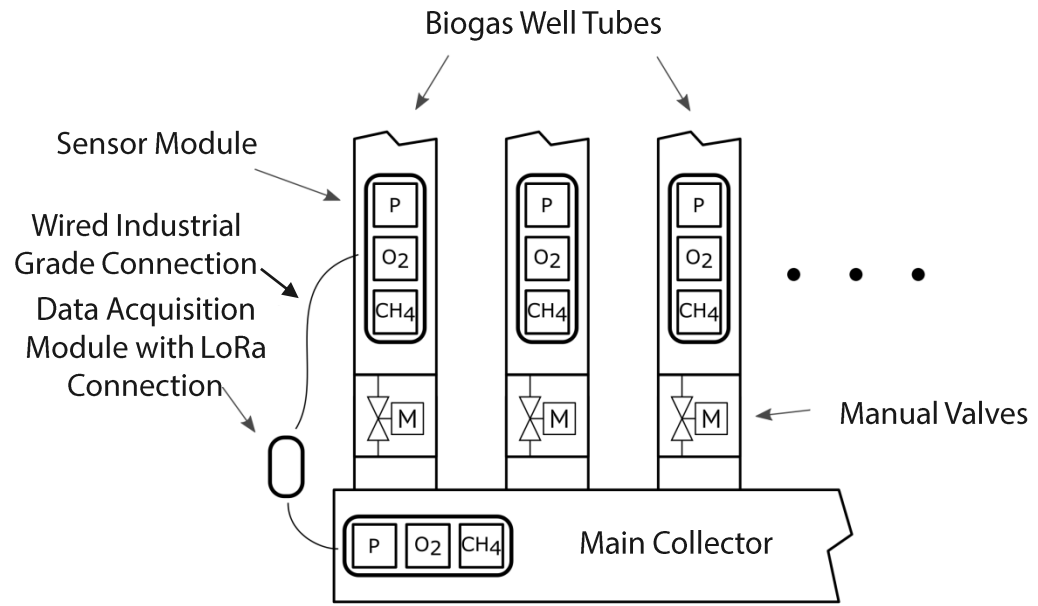
*LoRa Based Biogas Monitoring System (proof of concept)*



# Requirements and Proposed Architecture

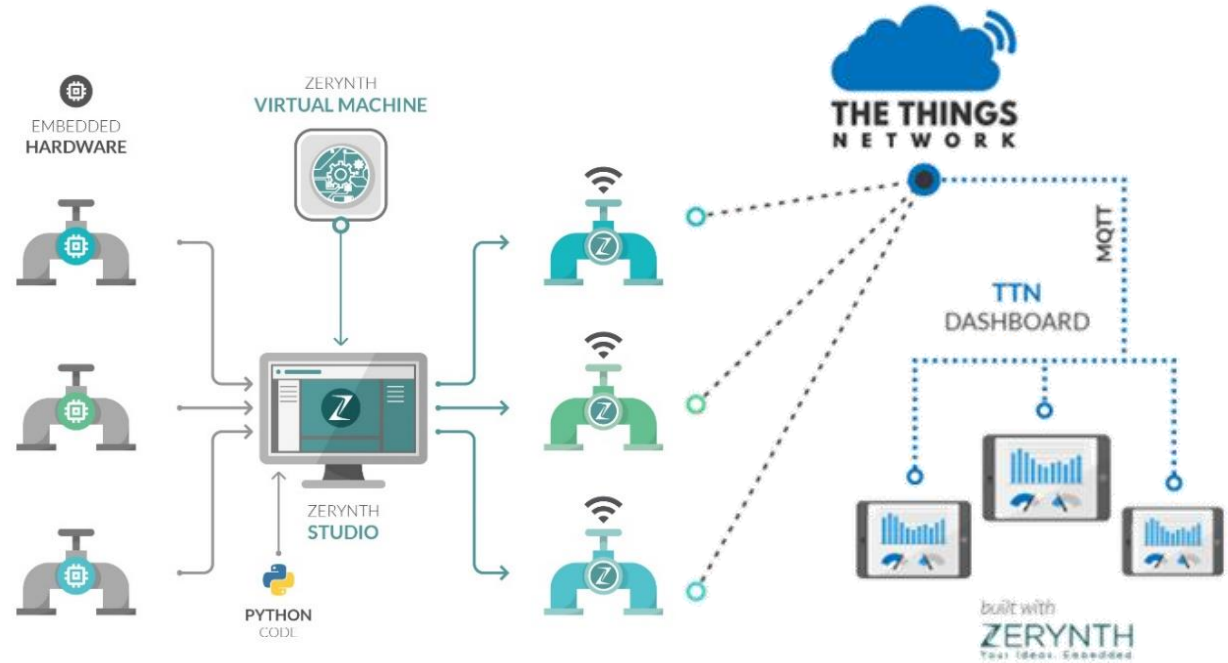
## Requirements:

- Modular and Scalable
  - 1 data collector per sub-station with LoRa modem
  - up to 20 sensor modules per sub-station
- LoRa Network (1 or 2 Gateways)
- Industrial Grade:
  - Waterproof IP68
  - Certifiable (CE and Atex)
- Connection uptime not guaranteed
  - Local Processing
  - Local Storage



# Network Architecture

- Multitech Gateway
- The Things Network
- MQTT
- Custom Dashboard





# Network Test



- Hexiwear Control Unit with Display
- Microchip RN2483 LoRa module
- Hornet GPS nano module





# First Hardware Prototype

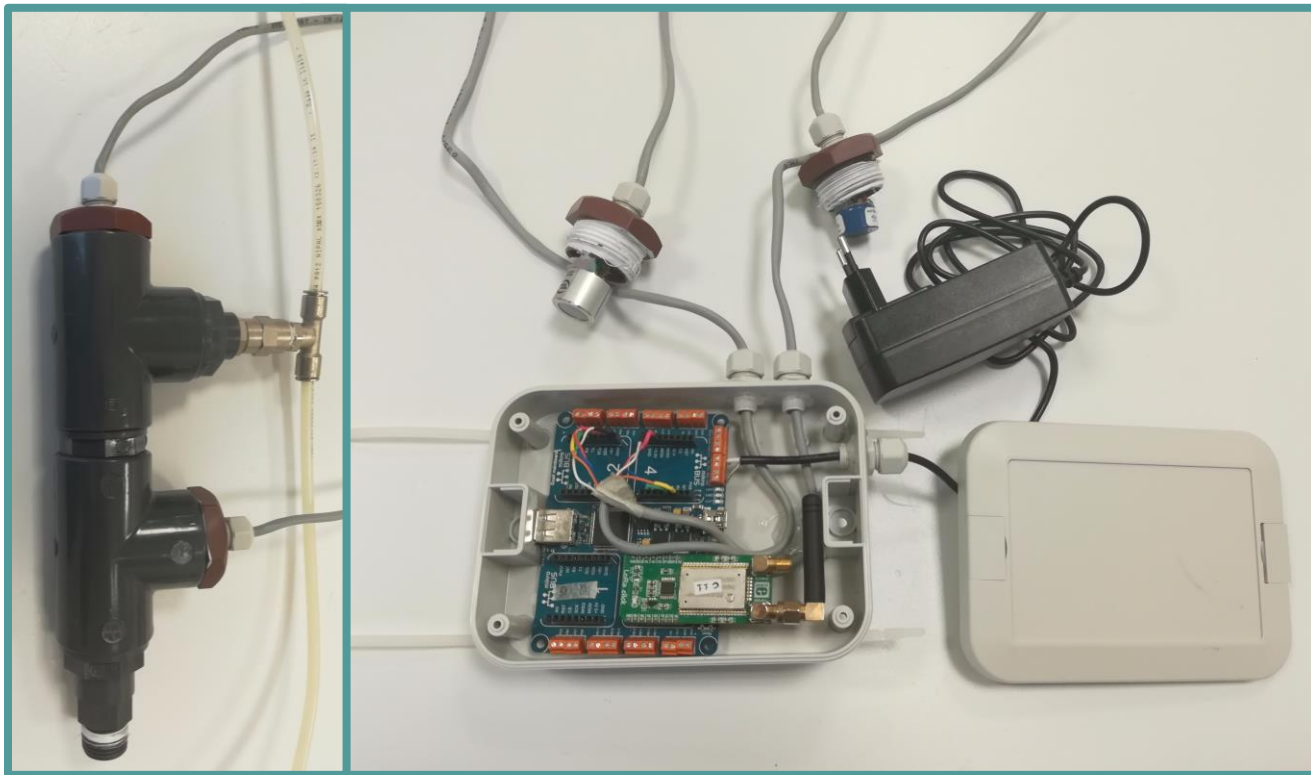
## Standalone sensor module

### Sensors:

- LuminOx Optical Oxygen Sensors
- Euro-Gas Methane CH4 M4-V Infrared Gas Transmitter

### Control Unit:

- Mikroe Quail (STM32-F4)
- Microchip RN2483 LoRa module



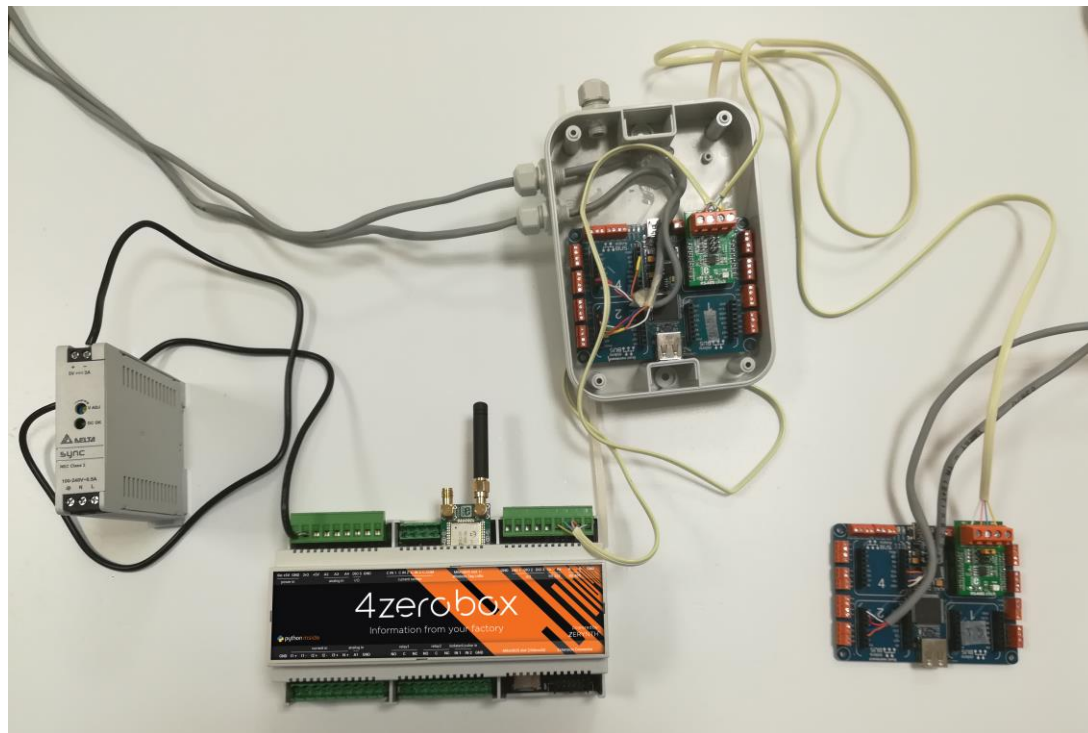


# Final Hardware Configuration

## RS485 sensor module with data collection unit

### 1 data collector per sub-station

- 4ZeroBox as data acquisition module (based on ESP32 by Espressif)
- RS485 connection between sensor modules and 4ZeroBox
- LoRa modem on 4ZeroBox only
- DIN bar 5V – 3A power supply





# On The Field



**Well Sensor Unit**



**Collector Sensor Unit**



**Sensor Module's Control Units**



# DASHBOARD PROTOTYPE



## Monitoraggio biogas



Aggiorna

Esporta dati

LOG dati

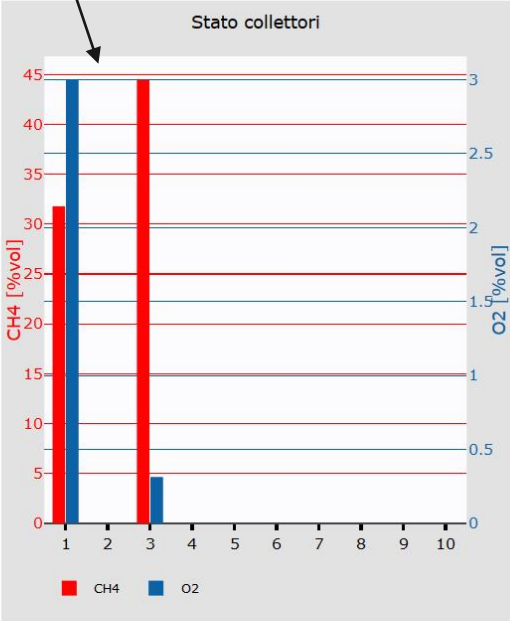
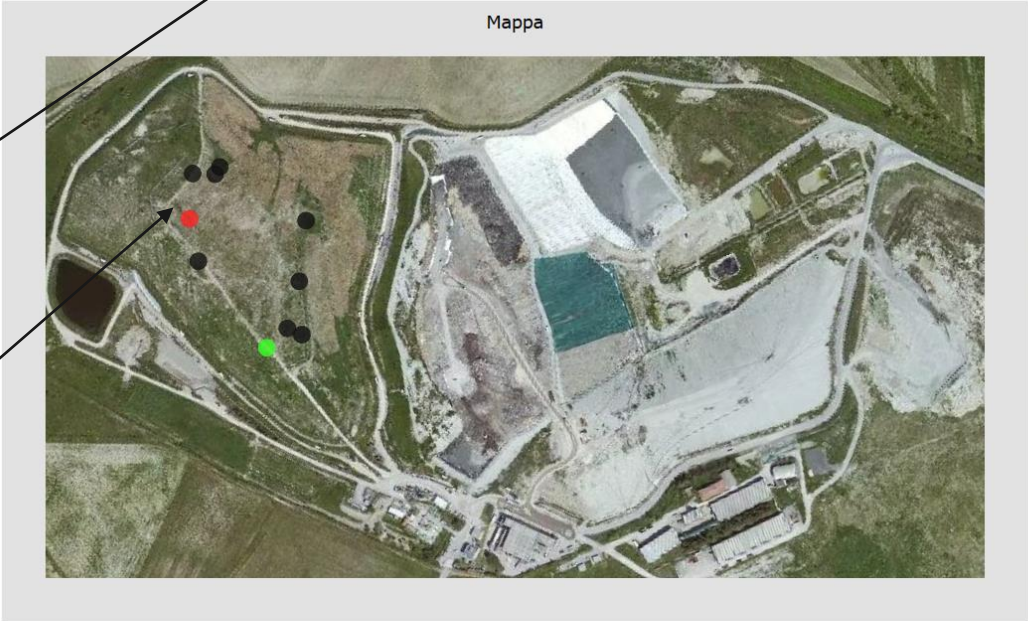
LOG tempo

Esporta .db

### Interactive Charts

CSV Data Export

Visual Alarms



Dettaglio Stazione PG 0.01

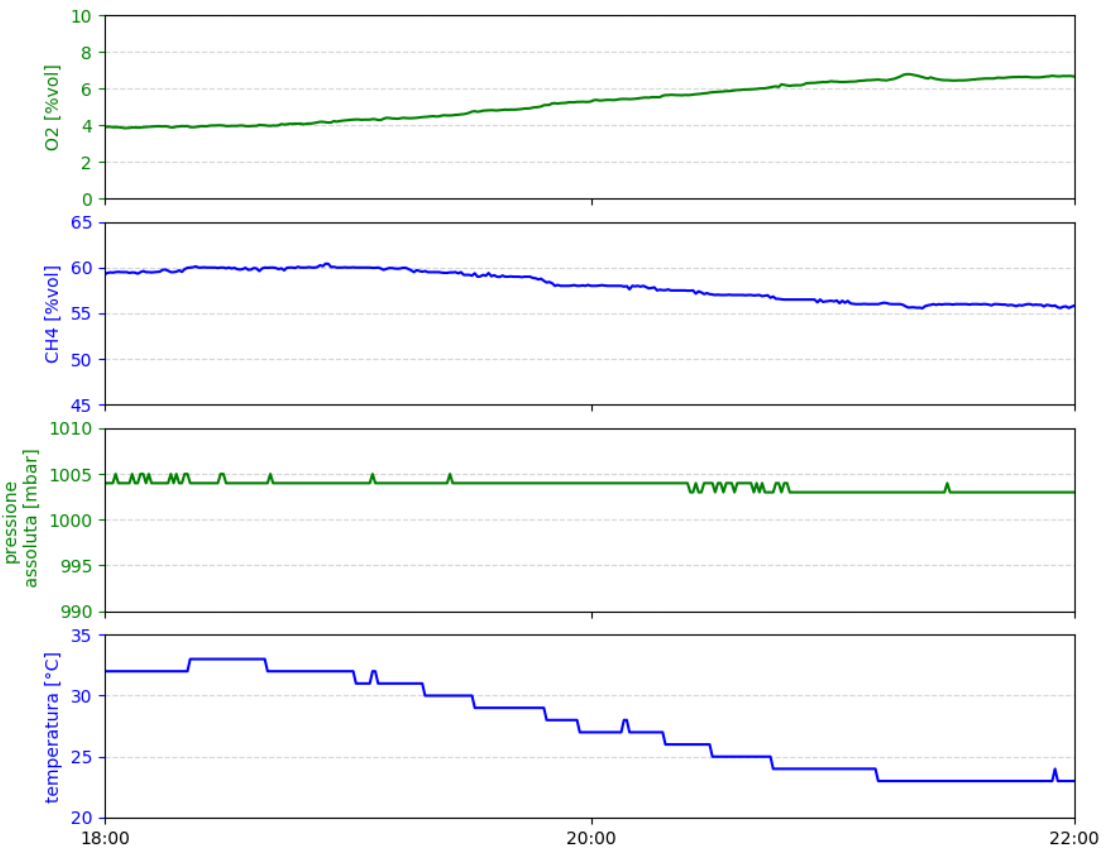




# DASHBOARD PROTOTYPE

**Alarms:**

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





# Production Control – Process Improvements

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



# Conclusions

- POC designed, implemented and tested in 2 months thanks to Zerynth and The Things Network ready to use solutions
- Disruptive production control paradigm change
- Scalable solution extendable also to leachate monitoring
- LPWAN and LoRa technologies can bring disruptive innovation in industrial plants
- *Technology isn't enough... a change of mindset is required*

# ZERYNTH

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