Digital Twins for Optimizing Energy Efficiency in Manufacturing

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Energy Efficiency in Manufacturing
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Company Overview

High-Tech Areas

- Internet of Things
- Artificial Intelligence
- Hyper connectivity
- Extended Reality

Domains

- Environment
- Utilities & Civil Infrastructure
- Production & Manufacturing
- Service sectors (Health, etc.).

Technology

Devices (IoT) – Edge Intelligence

Telco, Cloud, Big Data

AI – Powered Mechanisms

- Decision Support Systems
- Machine Learning
- Data Analysis
- Digital Twins

Visualization/ Dashboards

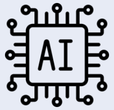
WINGS can help in 3 challenges /opportunities

A. Make Energy Visible

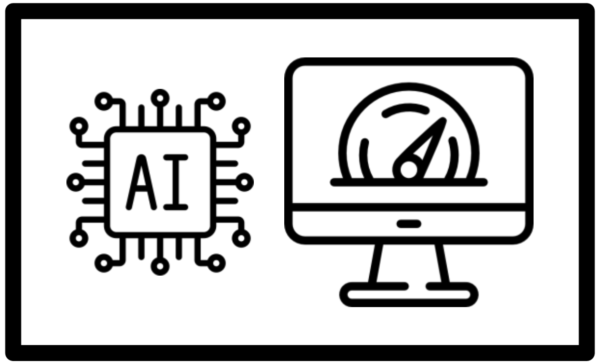
B. Optimization

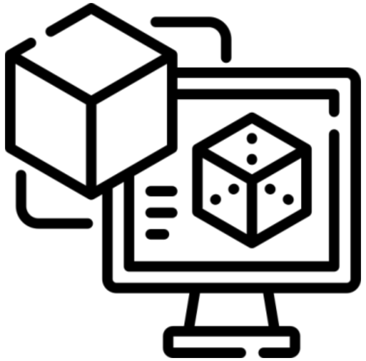
C. Digital Twin

Technology Direction

Tech	Rationale
	IoT (devices) to Measure, Actuate
 …	Networks: Speed, Robustness, Security
 	“Big Data” for handling / exploiting sheer amounts of data
	“AI” **video** / other streams; understand, decide, learn
	XR for empowering humans; Human in the Center / in Control
	Digital Twins (DTs) for **experimenting** in the digital world, building confidence / trust, integrating **technologies** and **human** perspective
Legacy	Adopt best practices / experience, fight inertia

WINGS Approach to Manufacturing





A. Monitoring / Metering

Data ingestion and control:

- Sensors. Location, Air, …
- Actuators. Robotics, …
- Manufacturing Elements. Boilers, Heat Exchangers, Tanks, …
- Vehicles. Forklifts, Trucks, Cranes, …

B. AI / Optimizations

Monitoring – Metering +
Optimizations for

- Warehouses.
- Freight Transfer.
- Manufacturing Plant.

3. Digital Twinning

AI / optimizations +

- **Simulations.**
- **What-If scenarios.**
- 3D Visualization (XR)

AI & IOT POWERED PLATFORM

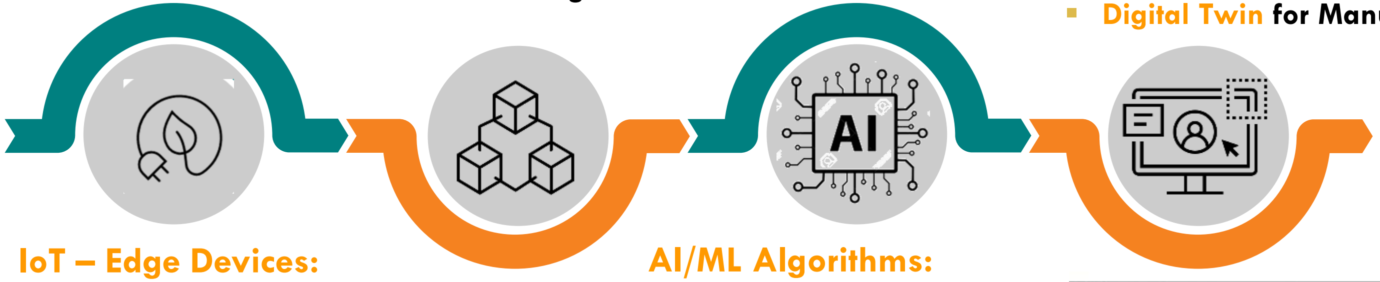
Leveraging Artificial Intelligence (AI) & IoT Powered Platform for Energy Efficiency Management.

Scope - Monitoring:

- **Energy consumption**
- **Fault identification**
- **Outages**
- **Remote Management**

Dashboard capabilities:

- **ESG reporting**
- **Predictive Analytics**
- **Geospatial Data Visualization**
- **Alerts**
- **Digital Twin for Manufacturing**



IoT – Edge Devices:

- **Smart Meters**
- **Energy Sensors**
- **Controllers**
- **Smart Appliances**
- **Tanks, Sources**
- **Renewables**
- **WINGS Gateway**

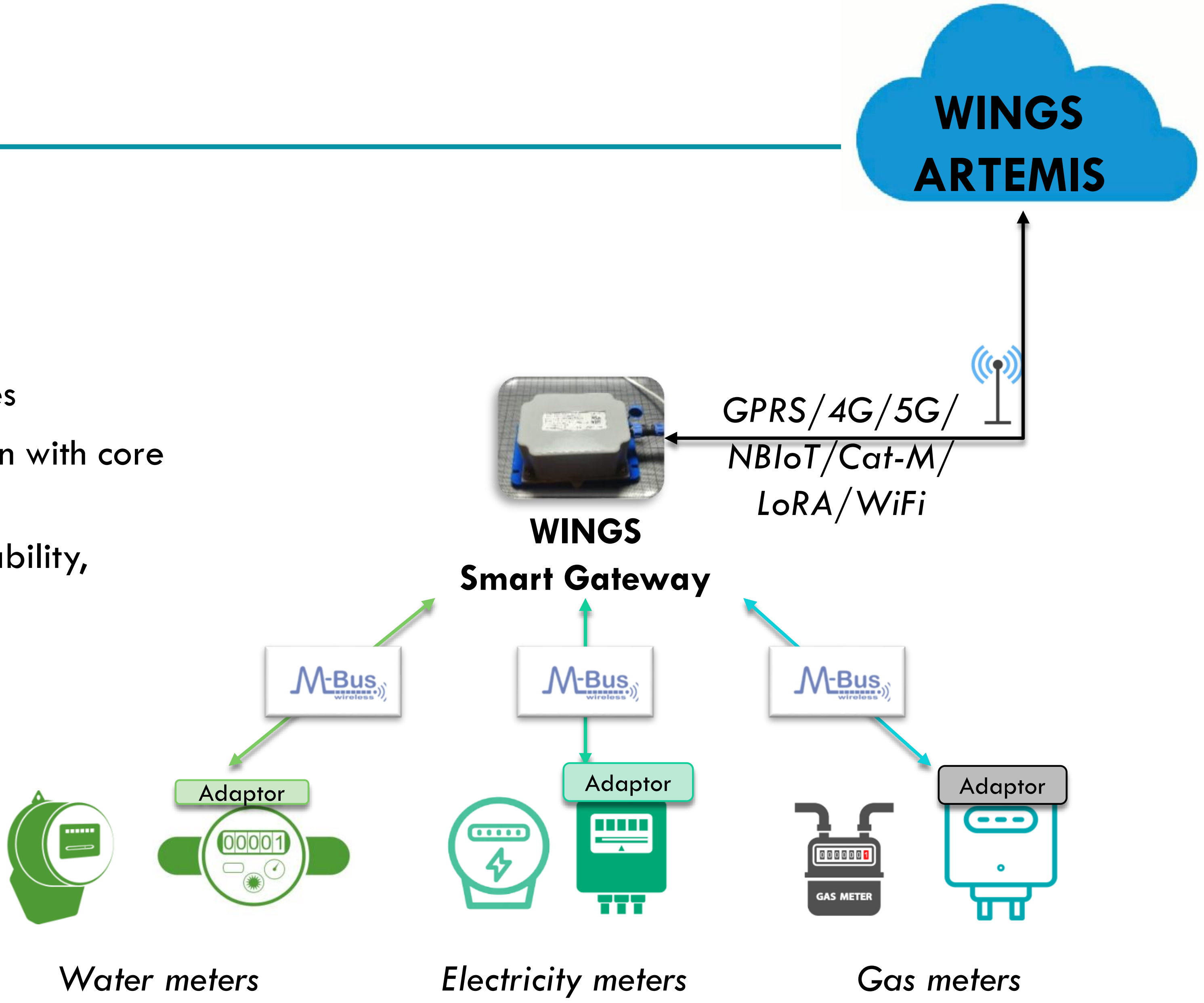
AI/ML Algorithms:

1. **Consumption Prediction**
2. **Consumption Optimisation**
3. **RES/Storage Planning**
4. **Capability Prediction**
5. **Outage Prediction**
6. **Energy Use Optimization**
7. **Faulty Meter** Identification
8. **Leakage** Localization
9. **Gas** Analysis & Prediction
10. **Non-technical energy loss**
11. **Process Optimisation**

A. Metering

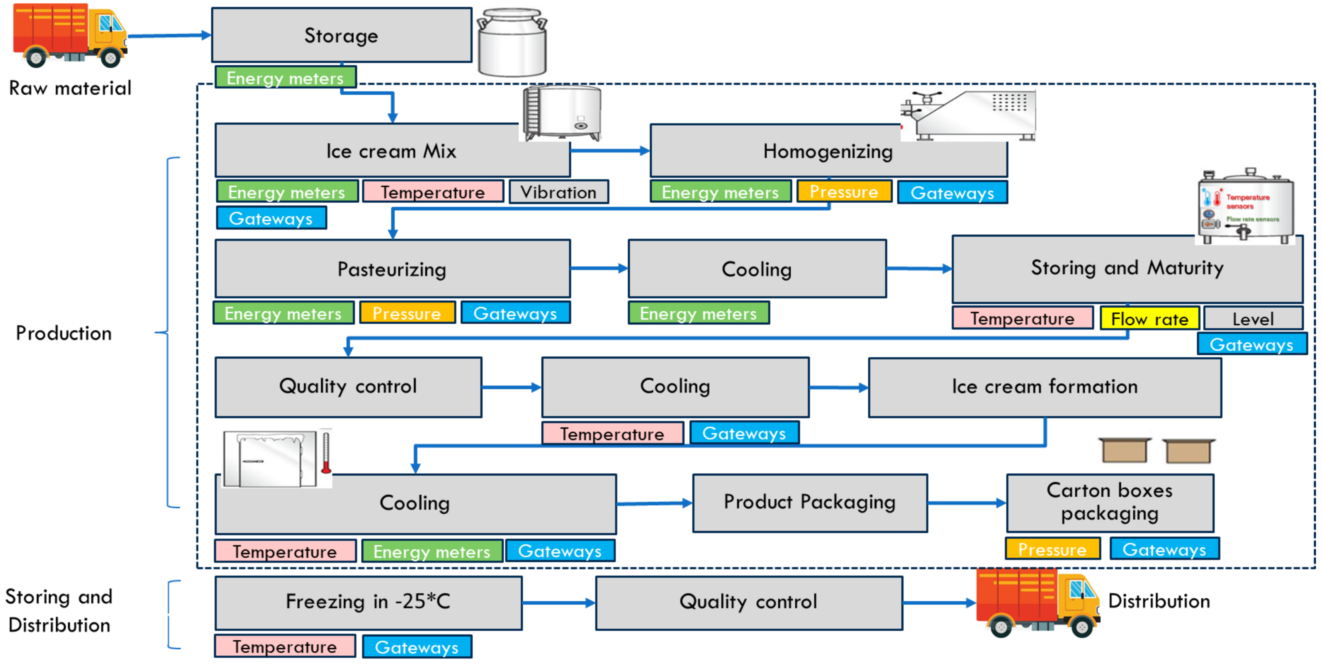
WINGS Smart Gateway example:

- Energy, Gas, Water meters
- Communicating directly or through adaptor
- Local intelligence – edge computing capabilities
- Diverse network capabilities and communication with core cloud, big data and AI infrastructure
- **Benefits**: efficiency, economy of scale, controllability, extensibility, scalability



A. Application example: monitor energy end-to-end

Features:
Dairy Products;
Monitoring



Phases of production

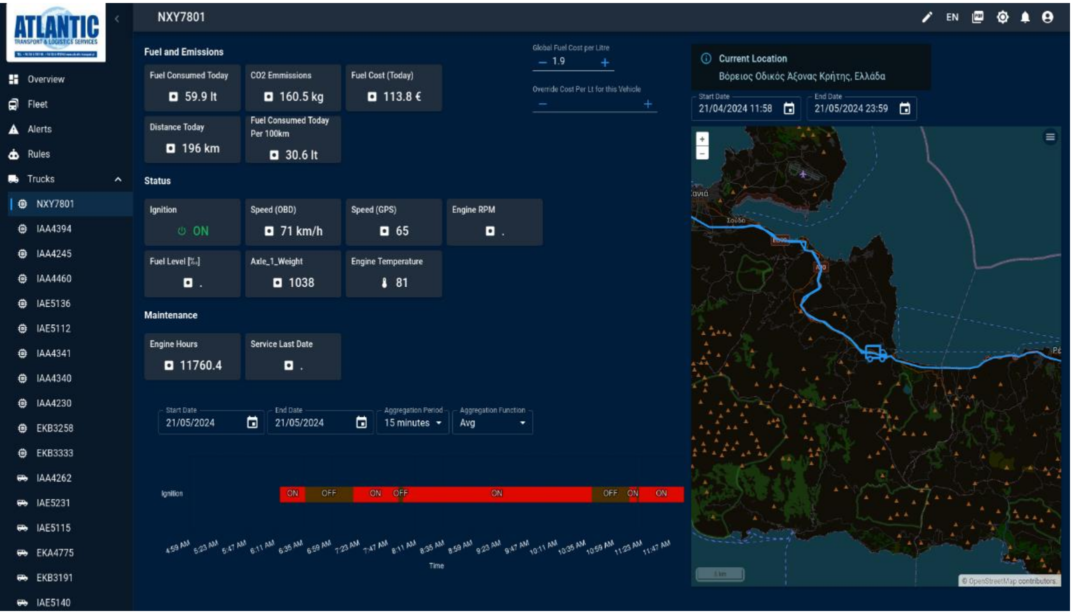
Features

- Monitoring of **energy** consumption throughout production
- Monitoring of **pressure** at various stages of production
- Monitoring of **temperatures** at all stages of production
- Monitor the **operation** of the mixer
- Monitoring temperature, **flow** and **level** in maturity tanks
- Automation of **transport** in the cold storage area
- Product **packaging**
- Monitoring the good operation of **charging** of refrigeration trucks
- Detection of **ammonia** in the production area

Similar cases:
Food, Pharma industries.

24/7 Monitoring, >10% cost reductions

A. Application example: Freight Transfer



Freight Transfer

- Remote condition monitoring & control
- Dynamic delivery route optimisation based on real-time data

Vehicle Monitoring

- Vehicle Performance and Status (location, fuel, etc.)
- Predictive fleet maintenance
- Carbon footprint calculation
- Vehicle TCO calculation

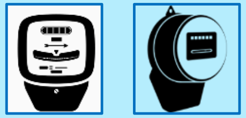
Driver Assistance

- Remote monitoring & communication
- Green driving assistance

24/7 monitoring; Product safety; Routing optimization; Driver Safety; Sustainability (CO2 reductions)

B. Optimizations: Predict Demand & Recommendations

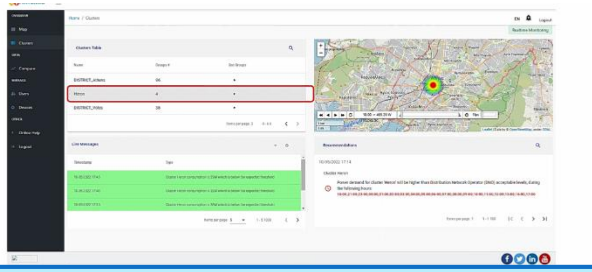
- **45% reduction in CO_2**
- **30% cost reduction**



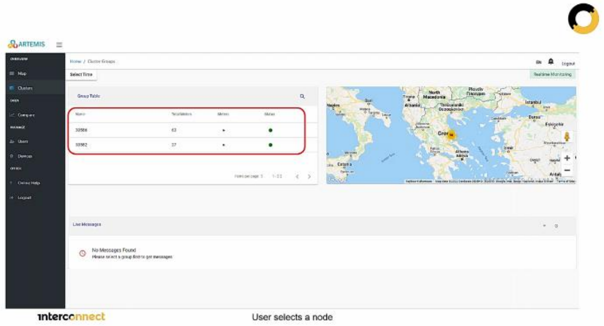
Sensors / Metering

Sensors (smart lamps, plugs, switches etc.)

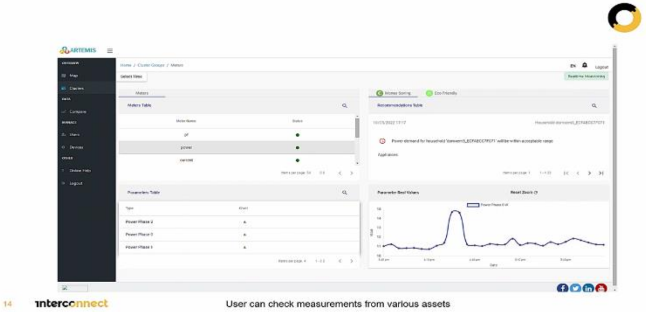
Data ingestion from buildings



Selecting areas

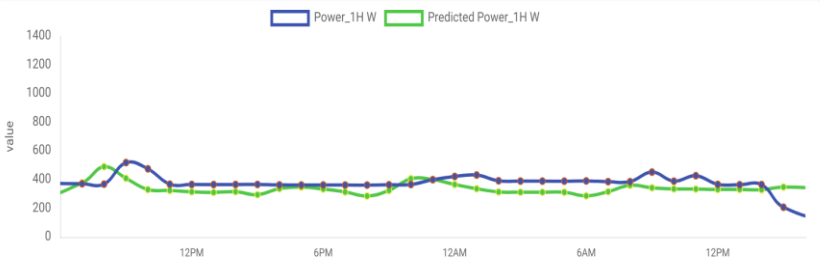


Selecting buildings

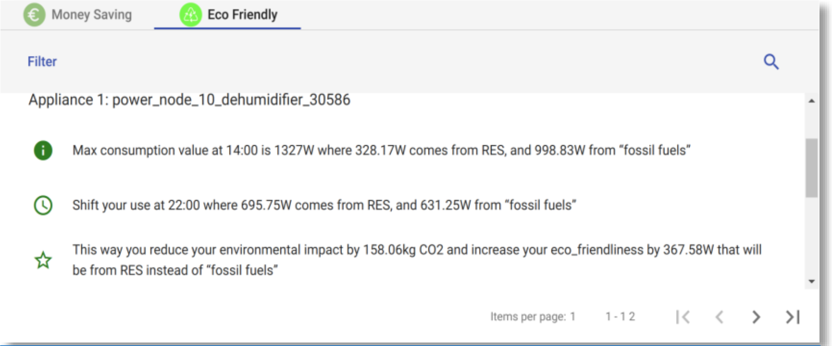


Selecting meters / sensors

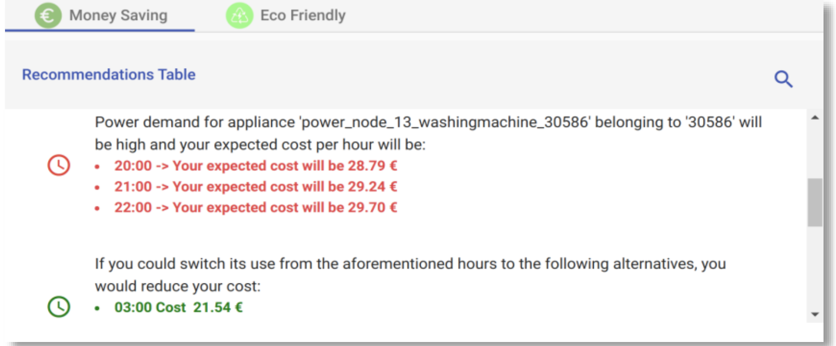
Data analysis / results



Predicting demand



Recommendations: Eco-friendliness



Recommendations: Cost savings

B. Power Consumption Forecasting

- **Improved Energy Management**

Hourly energy predictions allow utilities and energy providers to better manage their energy supply and demand.

- **Renewable Energy Integration**

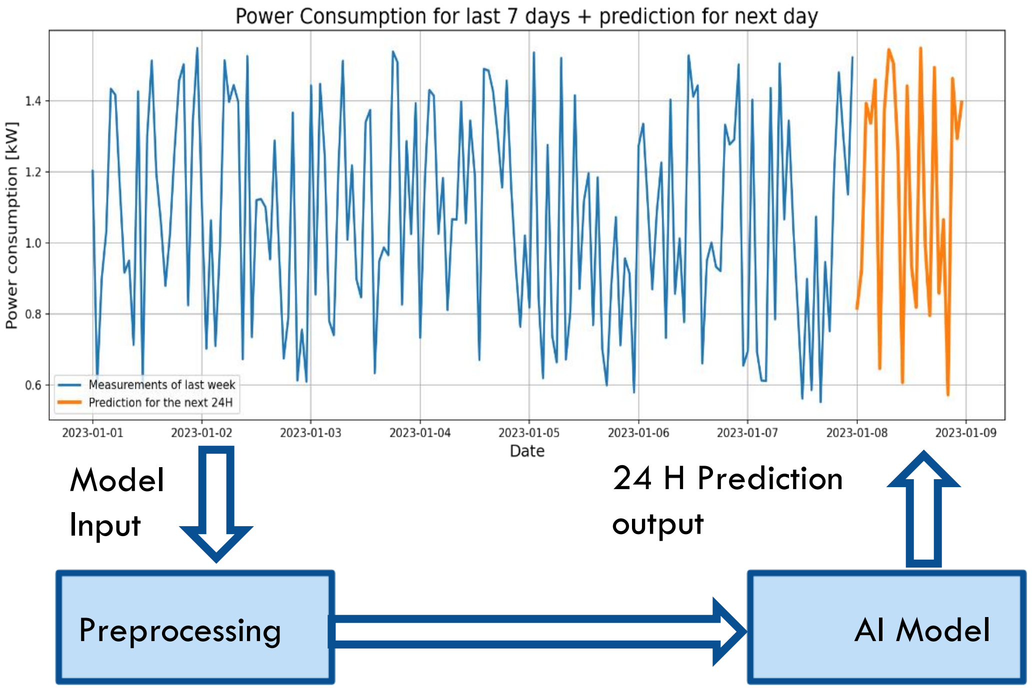
With the increasing use of renewable energy sources like solar and wind, hourly energy predictions can help energy providers optimize the use of these resources.

- **Improved Customer Service**

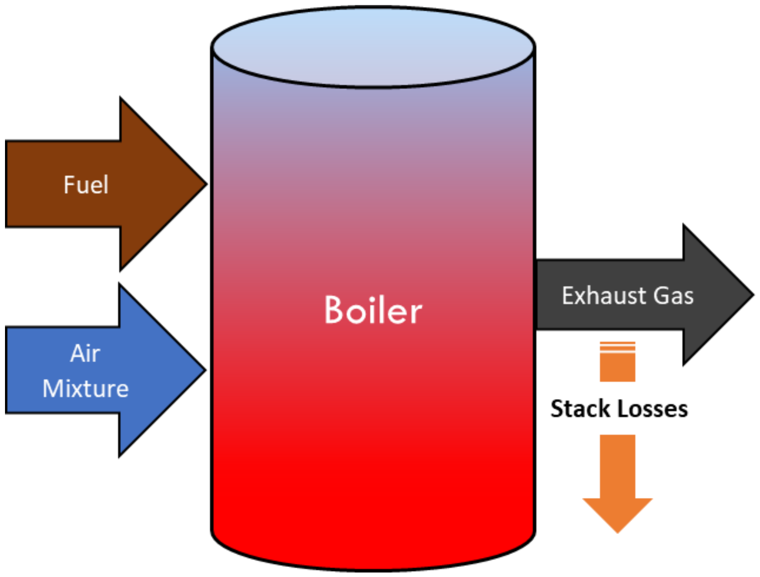
Hourly energy predictions can help energy providers to provide better customer service by giving customers more accurate information about their energy usage and costs.

- **Environmental Benefits**

By improving energy management and reducing costs, hourly energy predictions can also have environmental benefits by reducing greenhouse gas emissions.

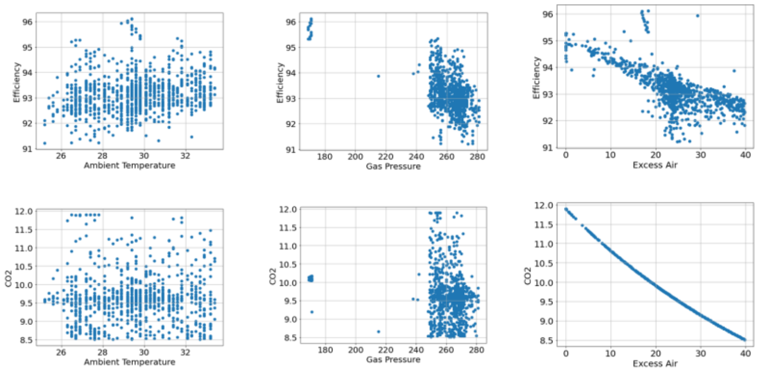


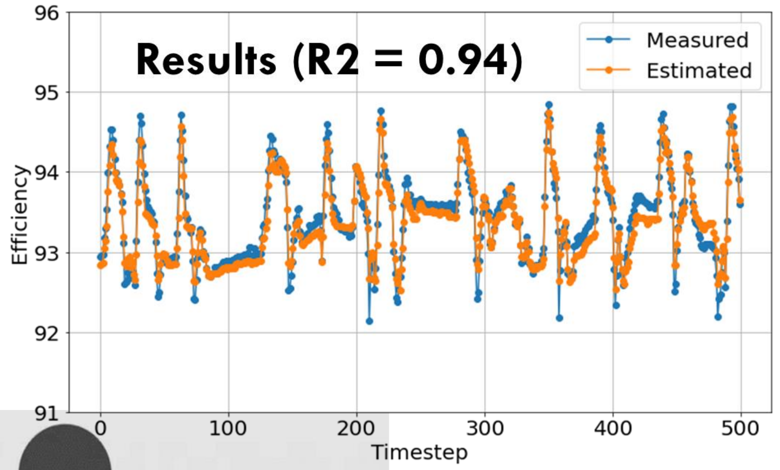
B. Process Optimizations for energy efficiency



Boiler Combustion Efficiency

- Data driven Model build on historic data (monitored parameters)
- Prediction of the **combustion efficiency** for each combination of:
  - Air flow and Pressure
  - Fuel flow and Pressure
  - Ambient temperature
- Utilization of the AI model for optimizing the boiler efficiency

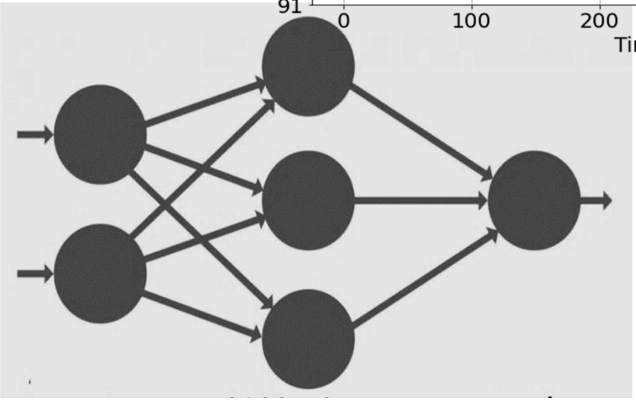




Optimum selection of Fuel to Air Ratio:

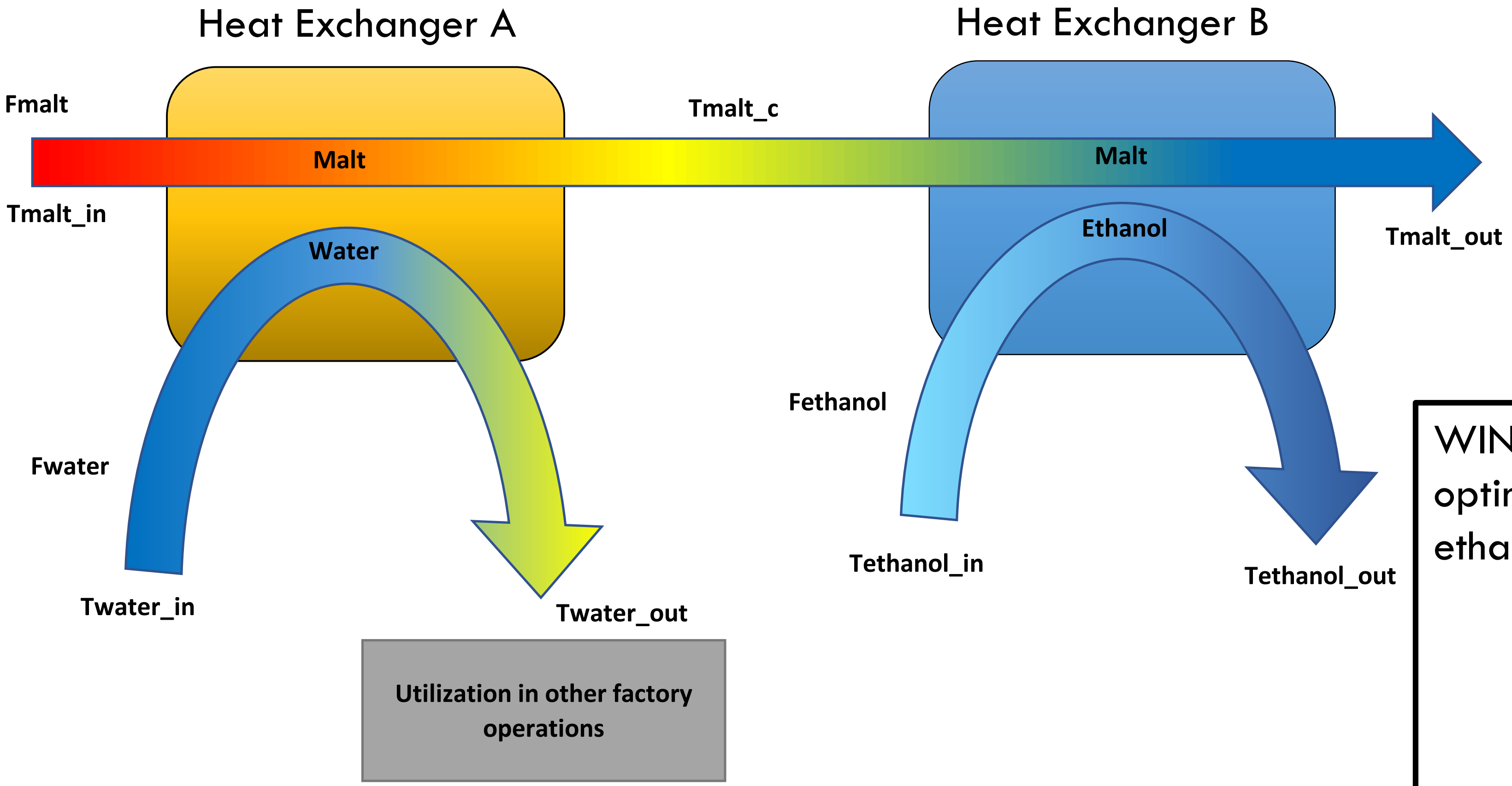
- Reduce head losses by maximizing the combustion efficiency
- Reduce boiler's fuel consumption
- Reduce CO emissions
- **Gains of 8-23%**

- T : **Ambient Temperature**
- P: **Pressure**
- Fa: **Air flow**
- Ta : **Air Temperature**
- Pa : **Air Pressure**
- Fg : **Gas flow**
- Tg : **Gas Temperature**
- Tp: **Gas Pressure**
- L: **Thermal load (water liters)**



- Eff: **Combustion efficiency**
- Te: **exhaust gas temperature**
- 02: **Exhaust O_2 concentration**
- CO2: **CO_2 concentration**

B. Optimizations, Factories



- Heat exchangers are usually coupled in a circuit to achieve higher cooling (or heating) capacity
- Optimize flow rates (water and ethanol) to the heat exchangers to minimize: (i) the energy consumption for cooling the Ethanol; (ii) the water consumption

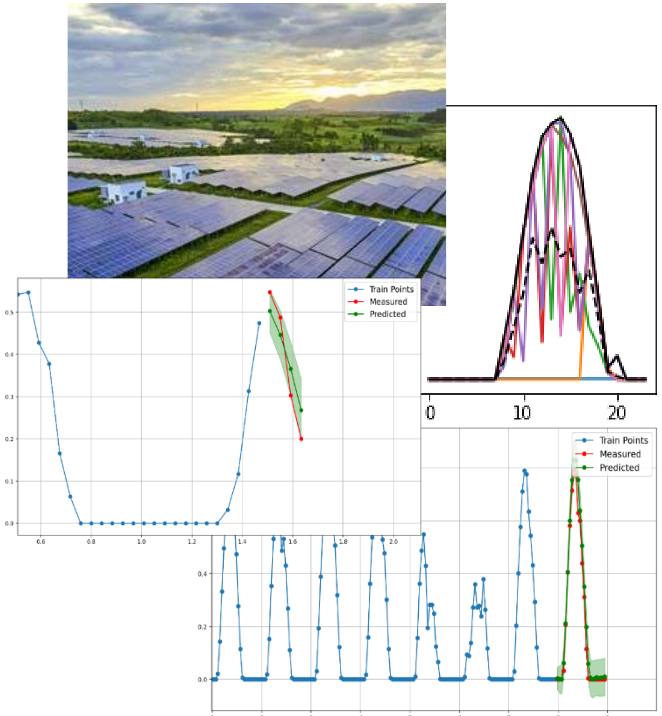
WINGS developed multi-objective optimization of **input flow rates** (water and ethanol to be used) that lead to:

- Higher heat exchange coefficient (higher efficiency);
- Reduced energy consumption for cooling (or heating) the working fluids;
- Higher water reuse.

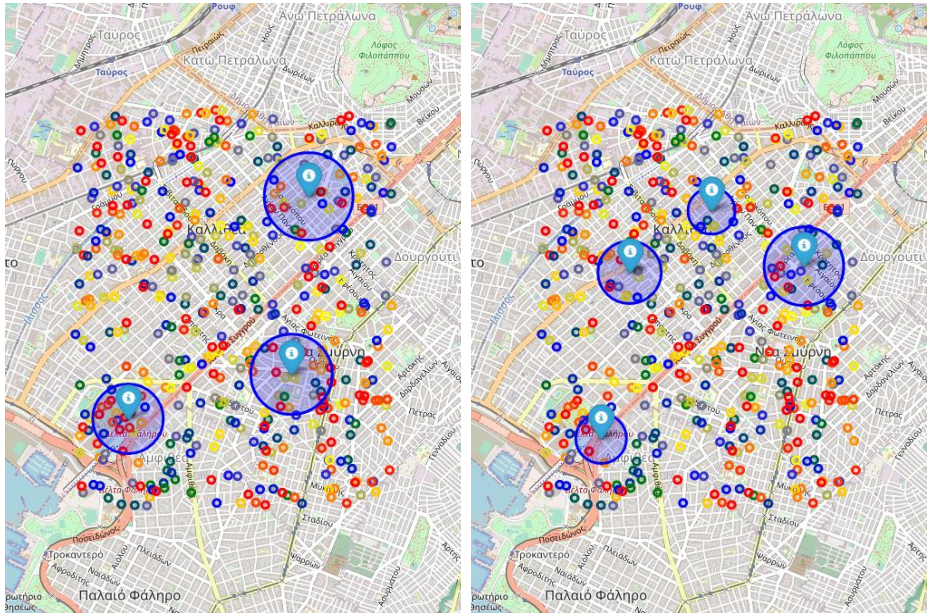
- Gains at the range of 10% in certain demanding scenarios

B. Optimizations for RES – Decision Support Tools

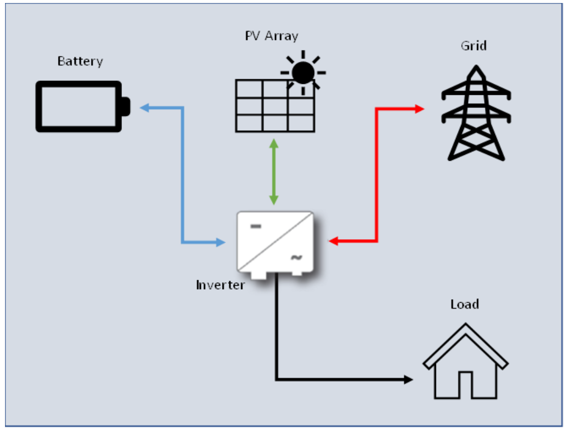
Optimize RES Deployment



Optimize RES Operations



Optimize RES Storage



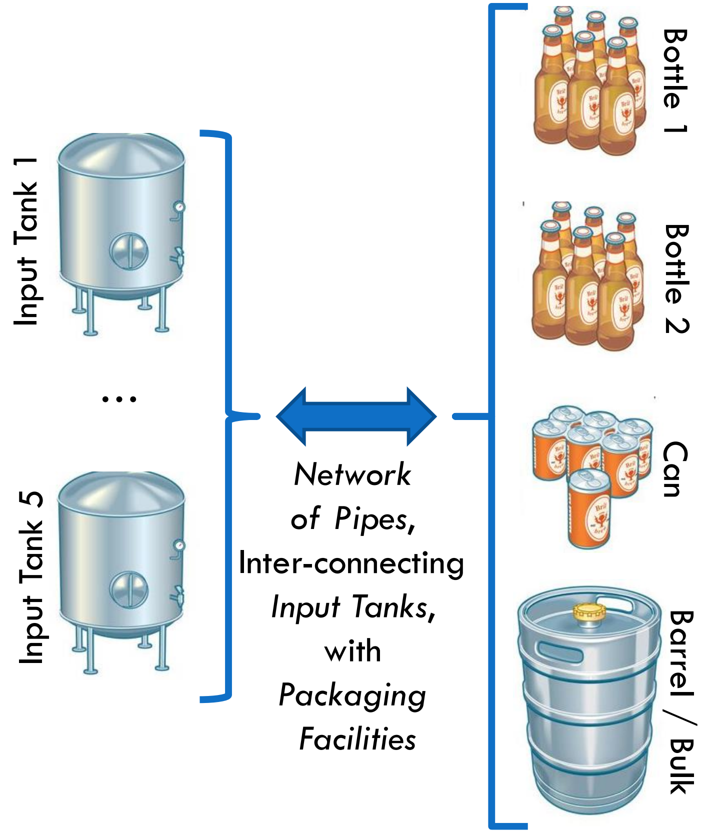
- PV Power Generation Analytics & Forecasting
  - Meteorological Parameters (Temperature, Solar Radiation, Rain)
  - PV module parameters (Capacity, Nominal Power)
- Analytical Modeling for Validating and Evaluating Power Generation

- Optimize the charge rate of a battery storage under different production/demand conditions.

B. Optimizations for Production Scheduling - Energy

Features:
Food industry;
AI-optimization

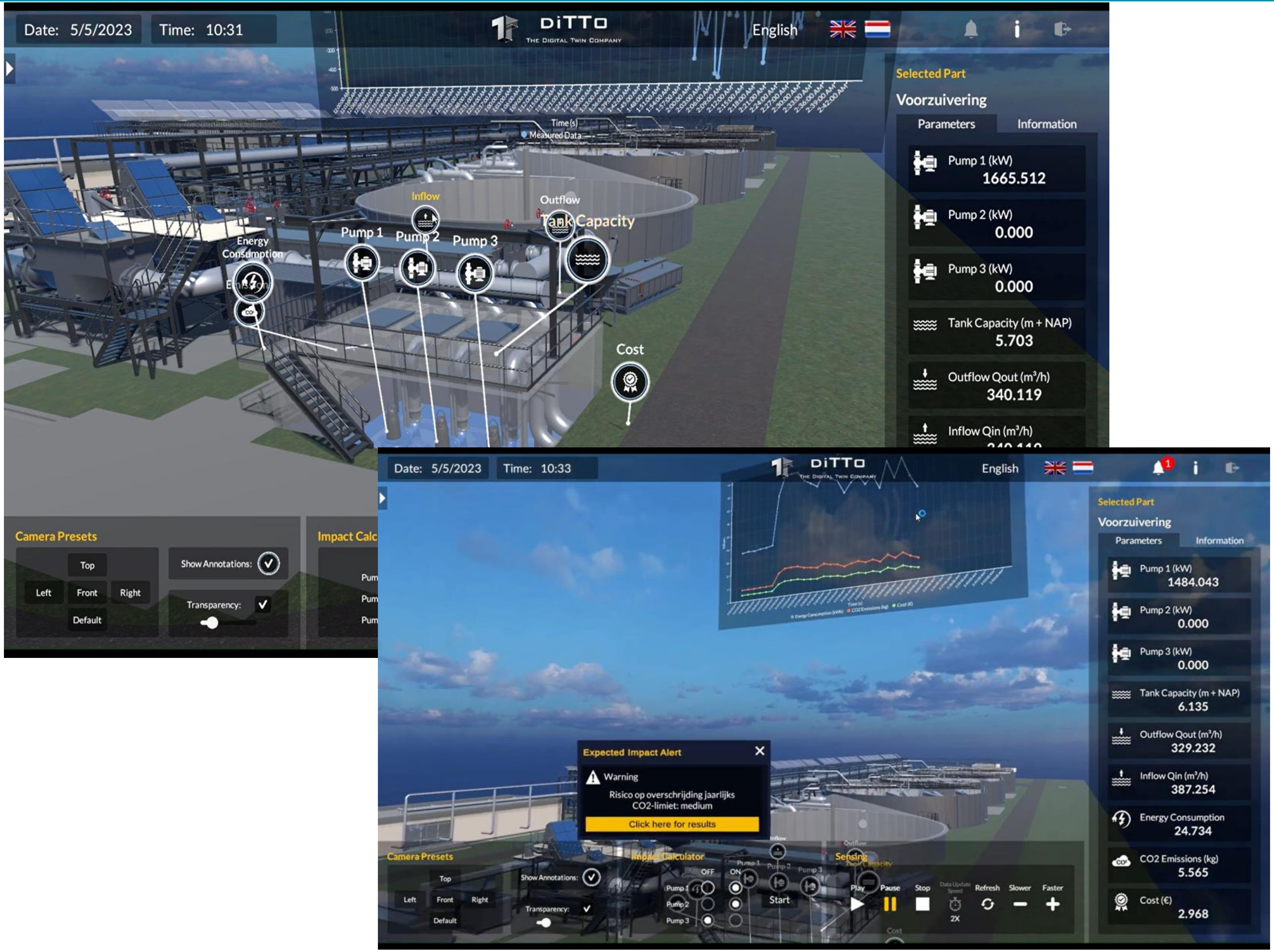
Objective: Time minimization
Hard-constraints: Task realization; Time available.



>15% productivity gain

C. Digital Twin for Factories

- Management of data related to the energy consumption, maintenance and operation of the factory
- Data analysis for forecasting, anomaly detection, early warnings, scenario simulation for calculation of impact of different actions (e.g. switching on additional pump), alerts
- Visualisation of data and insights on dashboard



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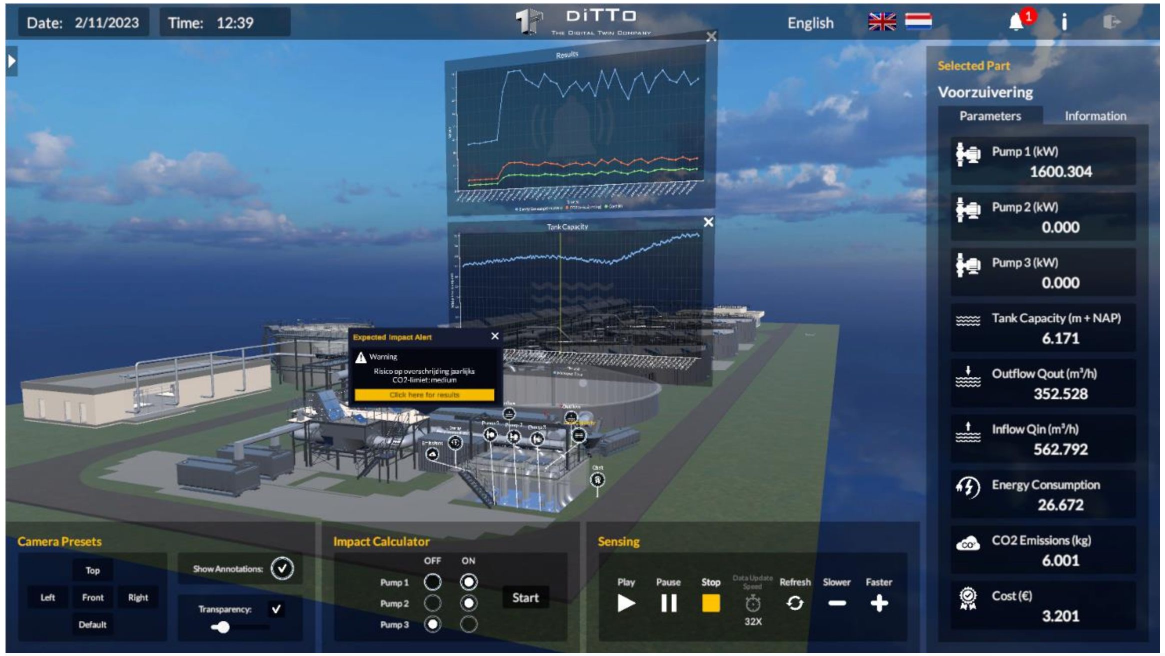

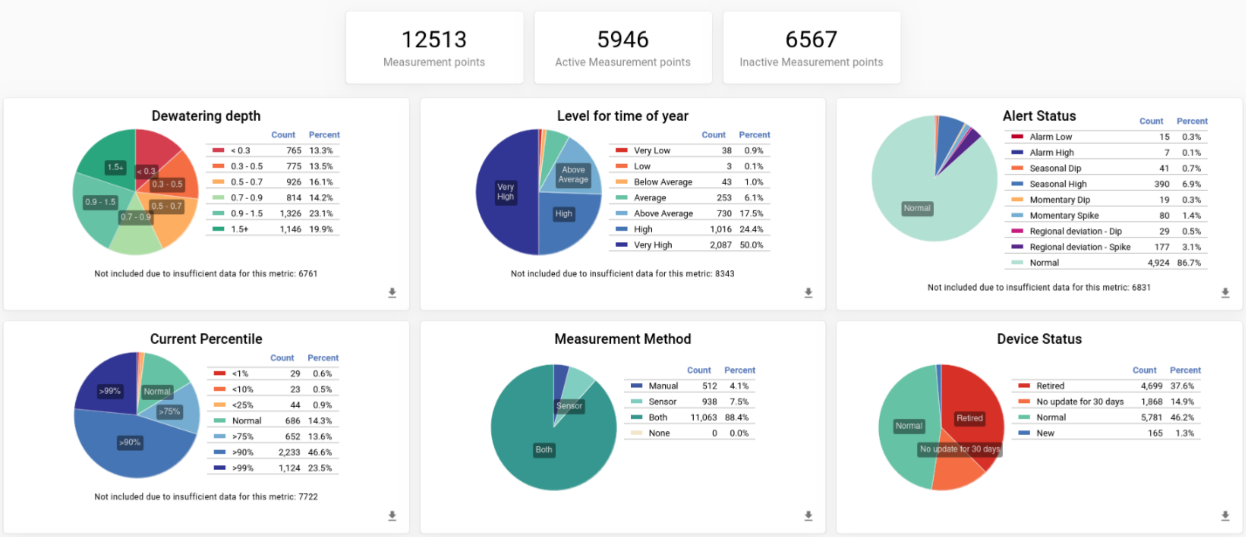

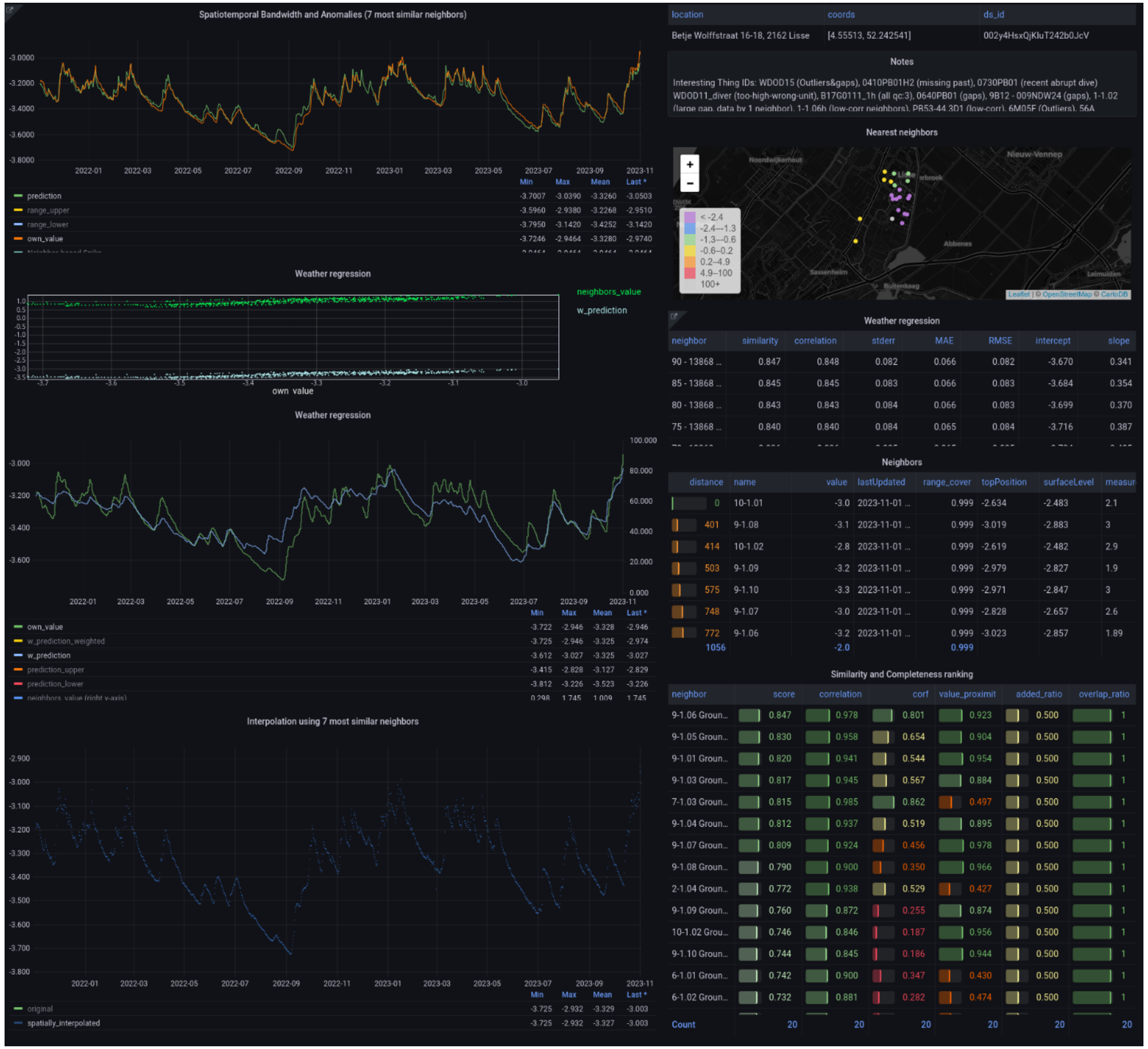

WINGS your ICT partner in 5G, IoT & AI in Manufacturing

- Partnerships for Digital Transformation
  - Technologies, R&D
  - Understanding of application sectors
- Flexibility
  - Business and delivery models
  - Vertical areas addressed, technologies
- Significant volume and high quality of human resources

Contact Information

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