Platform-ZERO

ACHIEVING ZERO DEFECT MANUFACTURING

FOR THE PHOTOVOLTAIC INDUSTRY

The Manufacturing Partnership Days – 7-8/05/2024

Davide Quaggiotto – R2M Solution

Co-funded by
the European Union
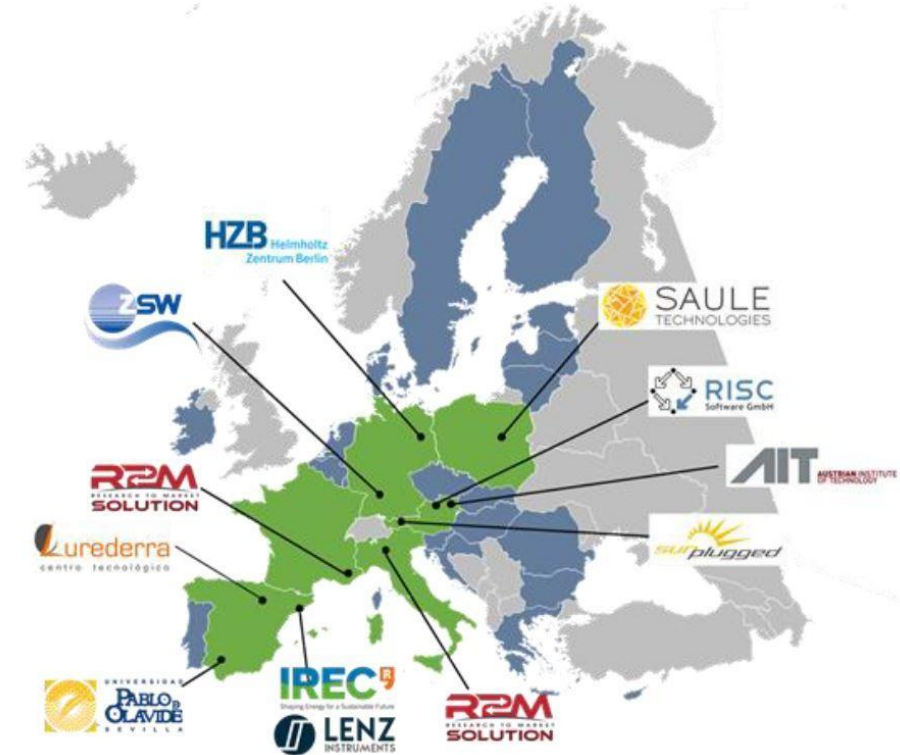
Meet the Consortium

12 European Partners :

12M meeting Hagenberg, Austria (11-12th January 2024)

1. **Four research centers** and **one university** with knowledge in the development of spectroscopic methodologies (IREC, HZB), imaging (AIT), device optoelectronic assessment (UPO), AI analysis (AIT, IREC, RISC) and data management (RISC).

2. **Two research centers** with know-how in advanced PV technologies and with industrial pilot lines to validate concepts (two demo-sites) based on CIGS devices (ZSW) and nano-based surface processes and coatings (Lurederra).

3. **Metrology SME with strong know-how** in the implementation of industrial process monitoring applications (LENZ) and by **two third-generation PV manufacturing SMEs** (SUNPLUGGED and SAULE), both providing their production lines for demonstrating the Platform-ZERO technology (two demo-sites). Additionally, **two other partners**, R2M Solution France and R2M Solution SRL Italy, **for dissemination, exploitation and communication actions**.

THE CONSORTIUM

CONTEXT

● Solar photovoltaic (PV) provides an important contribution to the European energy mix. It was equal to 3.1% of EU-28 gross electricity generation in 2020 (source: Eurostat).

● Furthermore, solar energy has the potential to meet 20% of the EU electricity demand in 2040 (source: BloombergNEF).

● The latest generation of PV technologies combine high performance with a strong flexibility for integration in buildings, vehicles, agrivoltaics and internet-of-things devices.

However, the high complexity of the latest generation of PV devices makes them prone to the appearance of critical defects, leading to significant production waste

Platform-ZERO addresses this challenge aiming at reaching zero defect manufacturing for the photovoltaic industry

In-line process monitoring, control and artificial intelligence strategies are key technologies:
- to allow early detection, correction and/or prevention of pre-critical production faults
- to substantially reduce production costs for industry in the photovoltaic sector

These strategies will be tested in four different PV industrial pilot plants throughout Europe

ABOUT THE PROJECT

OVERALL OBJECTIVES

Overall goal

To develop a modular in-line process monitoring and control solution for the third-generation PV industry

Sensor Stations

To develop sensor stations compatible with sensor arrays for morphological, physicochemical and optoelectronic in-line inspection of PV devices

AI System

To develop an AI-based prediction and decision-making system along with methodologies compatible with different data, real-time monitoring, and process control

Data Management

To develop a big data infrastructure, control unit and GUI software for managing the large amount of data generated by the platform

Monitoring Platform

To implement and install a process monitoring platform in 4 PV manufacturing lines across Europe
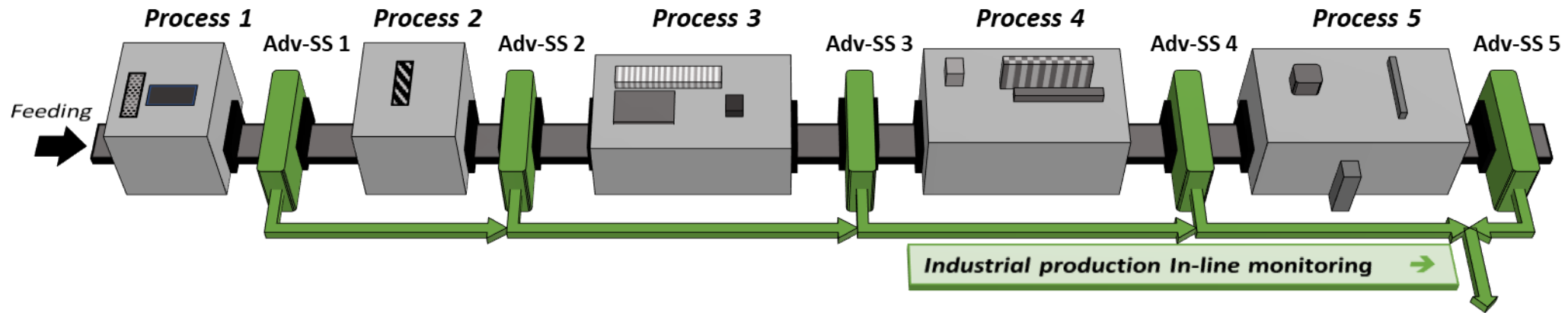
Photovoltaic Devices

To optimize PV manufacturing by validating the process monitoring and control platform developed to minimize production defects

PROCESS MONITORING PLATFORM

Platform-ZERO develops a new customizable in-line process monitoring platform, supported by Artificial Intelligence, for achieving zero-defect manufacturing of the PV Industry with:
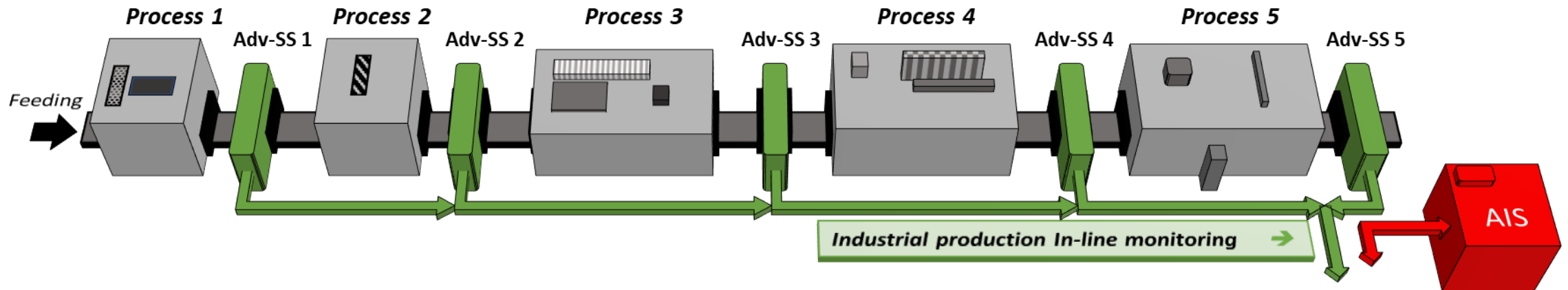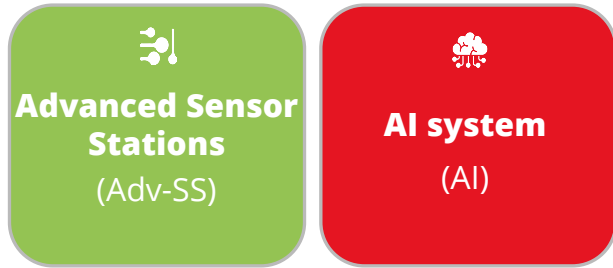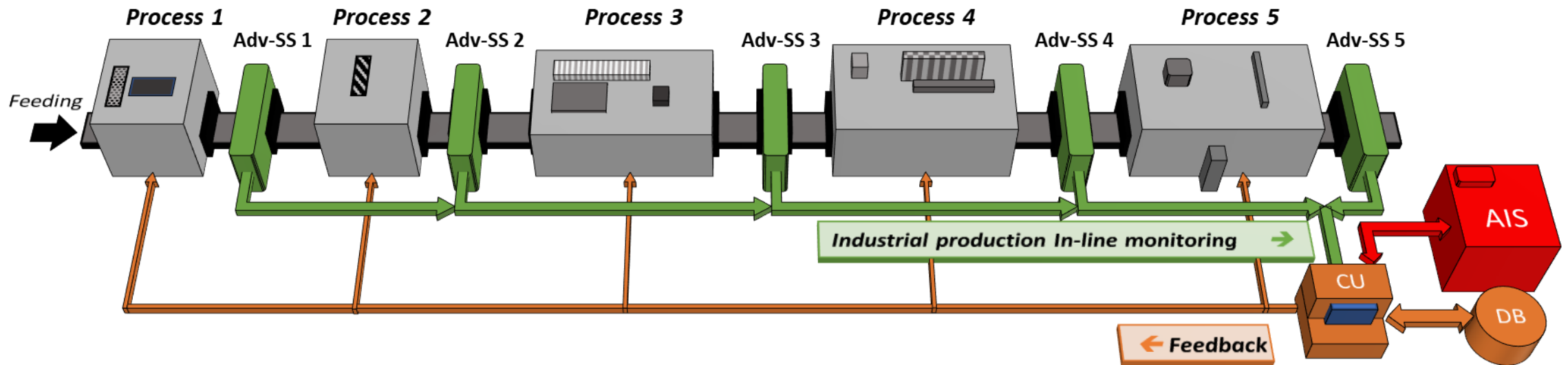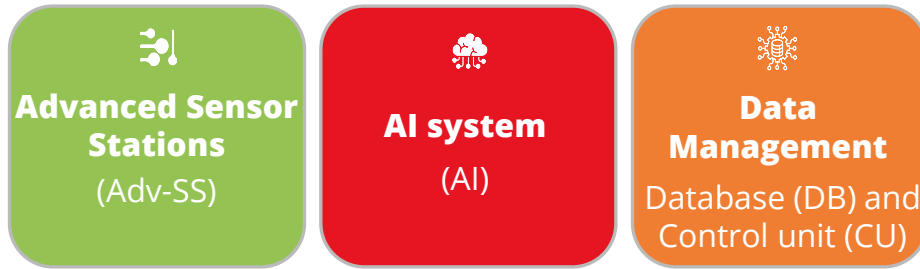
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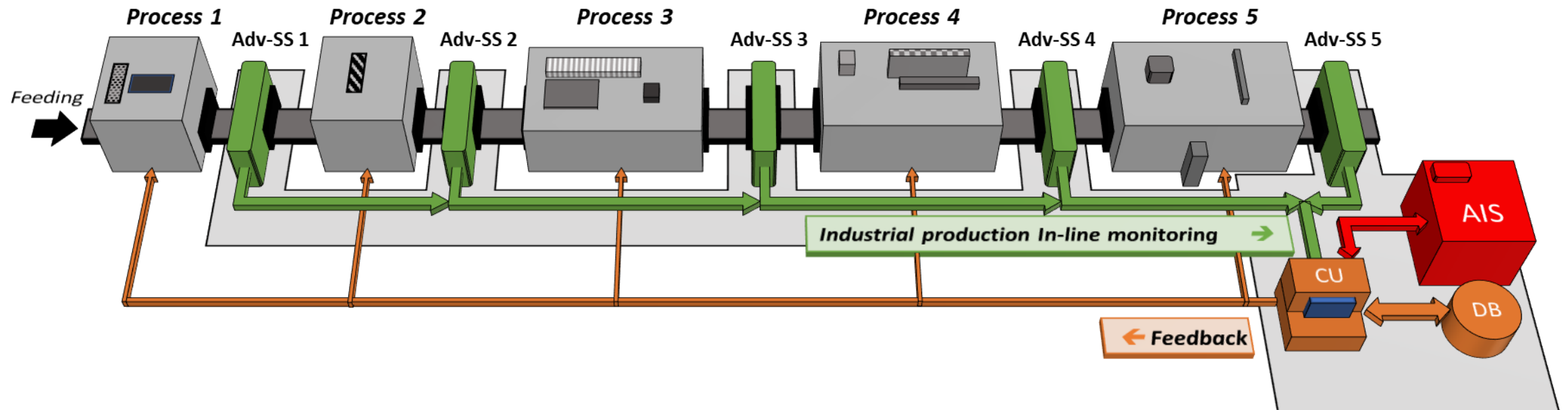
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Advanced Sensor Stations
(Adv-SS)

AI system
(AI)

Data Management
Database (DB) and Control unit (CU)
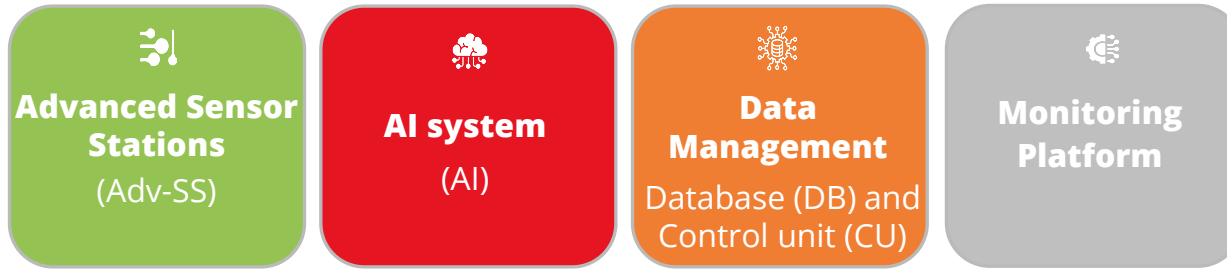
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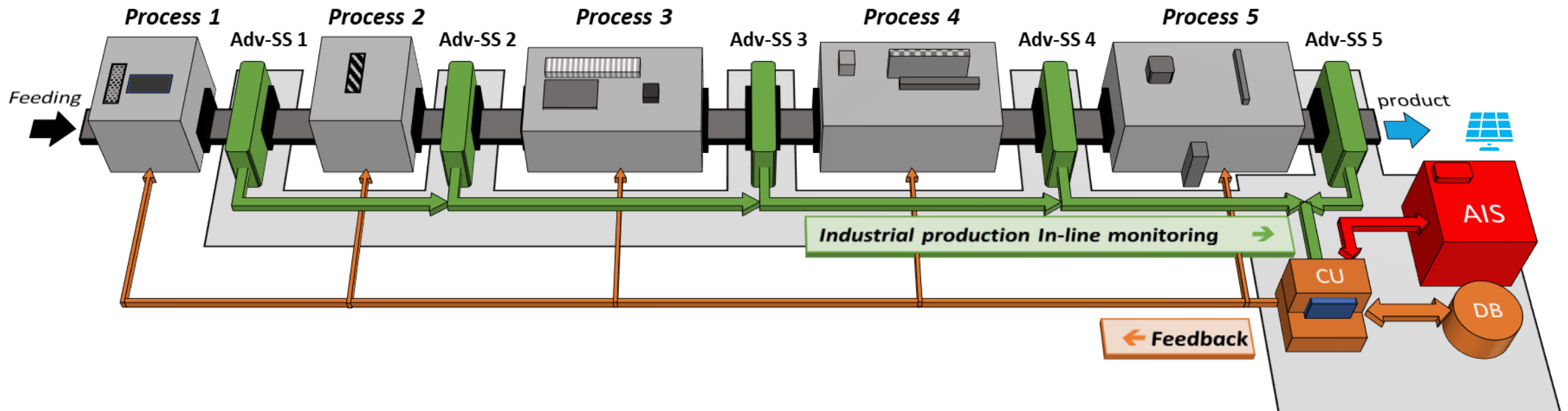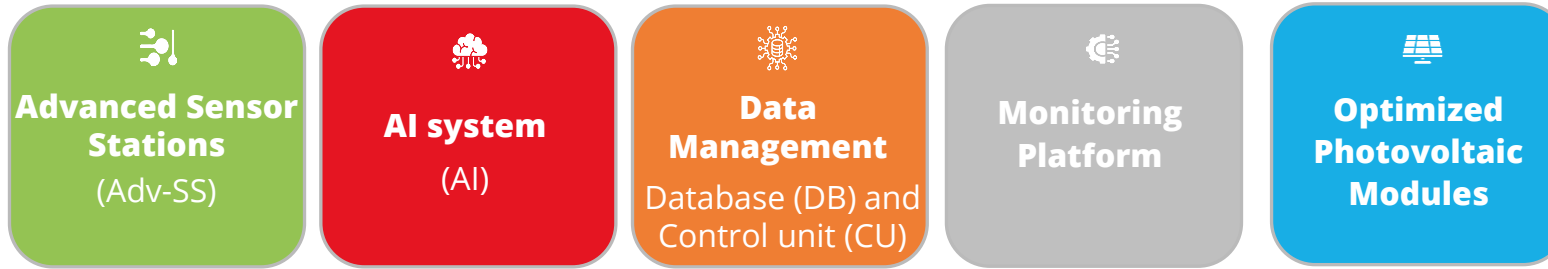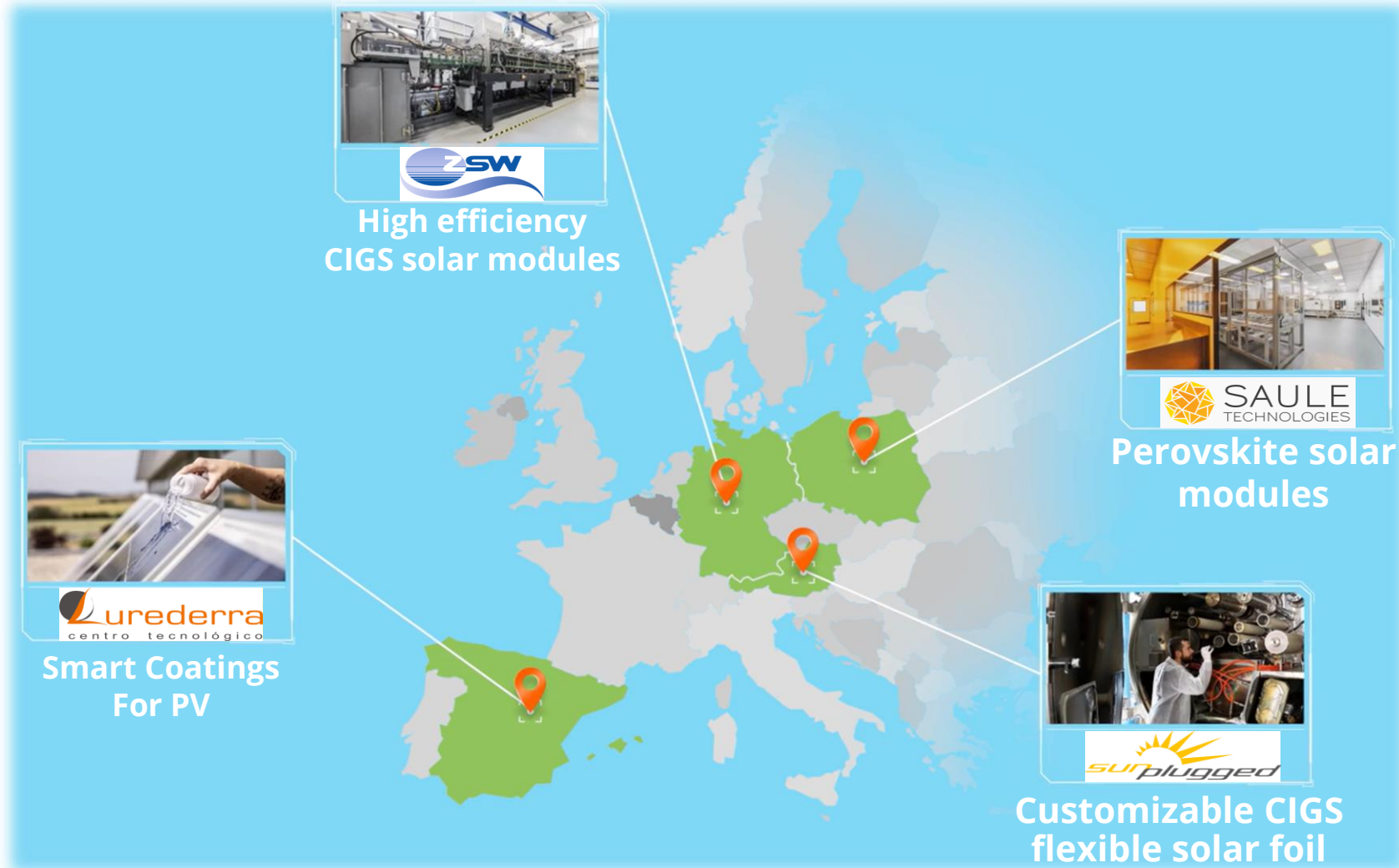
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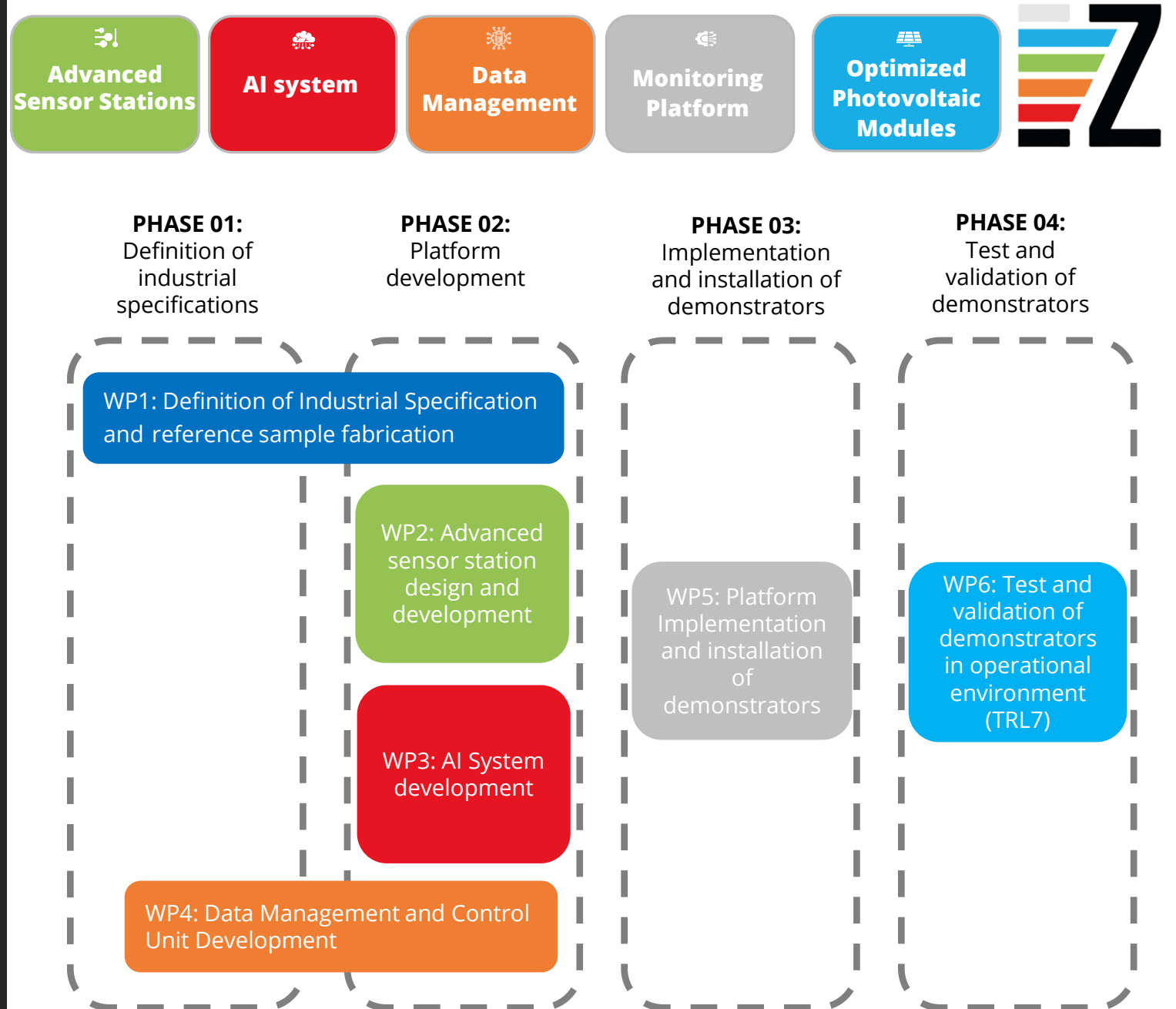
| Advanced Sensor Stations (Adv-SS) | AI system (AI) | Data Management — Database (DB) and Control unit (CU) | Monitoring Platform | Optimized Photovoltaic Modules |

DEMONSTRATORS

Platform-ZERO innovations will be tested in 4 PV industrial pilot plants throughout Europe: Spain, Germany, Poland and Austria
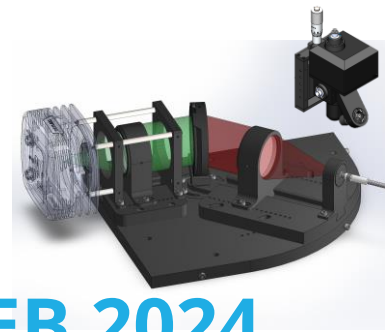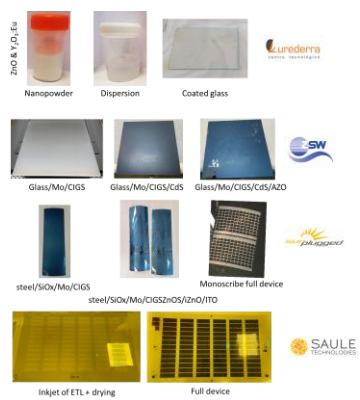

High efficiency CIGS solar modules

Perovskite solar modules

Smart Coatings For PV

Customizable CIGS flexible solar foil

METHODOLOGY & WORK PLAN

4M approach

- Mapping (year 1)
- Manufacturing (year 2)
- Making (year 3)
- Monitoring (year 4)

| Advanced Sensor Stations | AI system | Data Management | Monitoring Platform | Optimized Photovoltaic Modules |

PHASE 01: Definition of industrial specifications

PHASE 02: Platform development

PHASE 03: Implementation and installation of demonstrators

PHASE 04: Test and validation of demonstrators

WP1: Definition of Industrial Specification and reference sample fabrication

WP2: Advanced sensor station design and development

WP3: AI System development

WP4: Data Management and Control Unit Development

WP5: Platform Implementation and installation of demonstrators

WP6: Test and validation of demonstrators in operational environment (TRL7)

JUNE 2023

- FABRICATION OF **1ST REFERENCE OF PV SAMPLES** REPRESENTATIVE OF THE OPTIMUM PRODUCTION CONDITIONS AND WITH A WIDE RANGE OF CONTROLLED DEVIATIONS

- CREATION OF **1ST GENERATION DATA MANAGEMENT INFRASTRUCTURE** FOR COLLECTING SENSOR DATA INTO DATABASES AND FOR THE DEVELOPMENT OF THE AI SYSTEM

FEB 2024

- DESIGN OF **SEMI-AUTOMATIZED MODULAR SENSOR PROTOTYPES** COMPATIBLE WITH IN-LINE INSPECTION

MAI 2024

- DESIGN **OF SENSORS FOR ADVANCED SENSING STATIONS**

- 1ST **GENERATION AI SYSTEM IMPLEMENTATION** CONSIDERING 1ST GENERATION DATABASE ACQUIRED USING LABORATORY CHARACTERIZATION SYSTEMS AS TRAINING INPUT

- CREATION OF **1ST GENERATION DATABASE** CHARACTERIZING THE 1ST SET OF REFERENCE SAMPLES

SEPT 2023

- FABRICATION OF **2ND SET OF PV REFERENCE SAMPLES**

MARCH 2024

TIMELINE

JUNE 2024

- DEVELOPMENT OF **2ND GENERATION DATABASE** USING THE COMBINED DATA FROM THE 1ST AND 2ND SETS OF SAMPLES EMPLOYING THE SEMI-AUTOMATIZED ADV-SS PROTOTYPES FOR ACQUISITION

MARCH 2025

- DESIGN OF **ALGORITHMS FOR CONTROL, SENSORS SELF-CALIBRATION AND DATA CONDITIONING**

AUGUST 2025

- **AI-BASED CONTROL UNIT** IN PLACE, WHICH WILL CONTROL THE TRANSMISSION OF INFORMATION FROM/TO THE DIFFERENT COMPONENTS OF THE PLATFORM, CONTROLLING ITS WHOLE OPERATION

- **2ND GENERATION AI SYSTEM IMPLEMENTATION**, USING THE 1ST GENERATION AI SYSTEM ARCHITECTURE AND THE 1ST AND 2ND GENERATION DATABASES

OCT 2024

- **DESIGN OF HOLISTIC PROCESS MONITORING PLATFORM** READY FOR THE DIFFERENT MANUFACTURING LINES
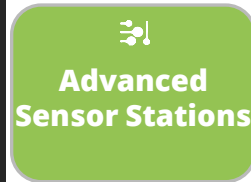
JUNE 2025

TIMELINE

1. Increase of sustainable PV production through improved control systems and non-destructive inspection methods

2. Tools to prevent the generation of defects at different production stages and propagation of the prevention to the final product level

3. Diagnostic methodologies for in-line monitoring of industrial PV production

4. Increase of efficient use of materials and reduced PV modules production costs

Expected impacts:

● 10% increase in productivity of the EU's PV industry

● 10% decrease in high-value raw materials required for the production of PV devices

PROJECT OUTCOMES & EXPECTED IMPACTS

PROJECT OUTPUT AND KPIs

Advanced Sensor Stations	AI system	Data Management	Monitoring Platform	Optimized Photovoltaic Modules

1) Sensors sensitivity to deviations of the critical parameters at a certain process step >5%

2) Implementation of AI-based algorithms library

3) Implementation of data management and control algorithms library

4) Implementation of GUI software for monitoring, data visualization and decision-making advising

5) Implementation of fully operational platform demonstrators compatible with a real-time industrial process monitoring

6) Detection of process deviations thanks to the process monitoring platform

THANK YOU , GET IN TOUCH

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