



**SUSTAINABLE
PLACES 2025**

8-10 October 2025

Milano



R2M
RESEARCH TO MARKET
SOLUTION

Sustainable Manufacturing WORKSHOP

From Resilient Factories to Sustainable Places



RARE²

RESTORE



**MULTI
MOLD**

Manufacturing the Future



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**SUSTAINABLE
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Sustainable Manufacturing WORKSHOP

Opening & Framing the Challenge *(Rubén Alonso)*

Pitches from Contributing Projects

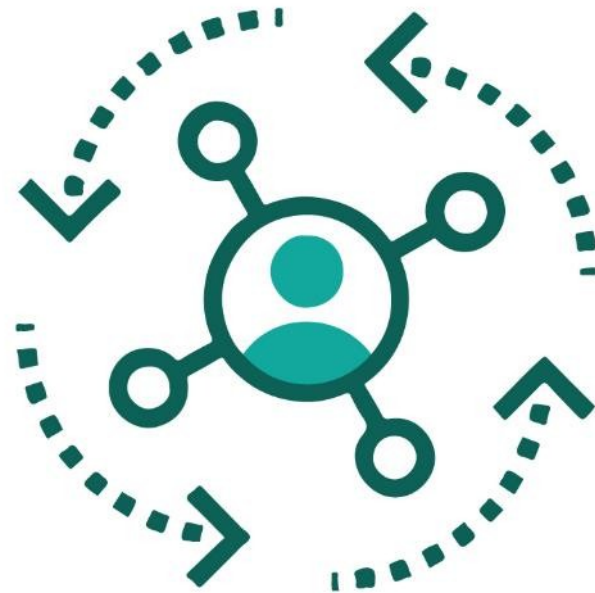
- **RaRe2** – People-Centered Resilience in Factories *(Alexander Dementyev, Domenico Perfido, Alessandra Sala)*
- **RESTORE** – Sustainable Remanufacturing Solutions *(Diana Rodrigues)*
- **MULTIMOLD** – Advanced Injection Molding for Complex Products *(Jacopo Cassina)*
- **openZDM** – From Waste to Zero Defects: Digital, Human-Centric Manufacturing *(Vangelis Lakkas)*
- **Platform-Zero** – Achieving Zero Defect Manufacturing for the Photovoltaic Industry *(Raphael Pickl)*

Interactive Session: Co-Design & Real-Life Impacts *(Martina Di Gallo)*

Key Takeaways & Closing *(Rubén Alonso)*



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RARE²

Human-centred Rapid Reconfiguration of Production
and Value Chain in Fast Changing Scenarios

A short introduction

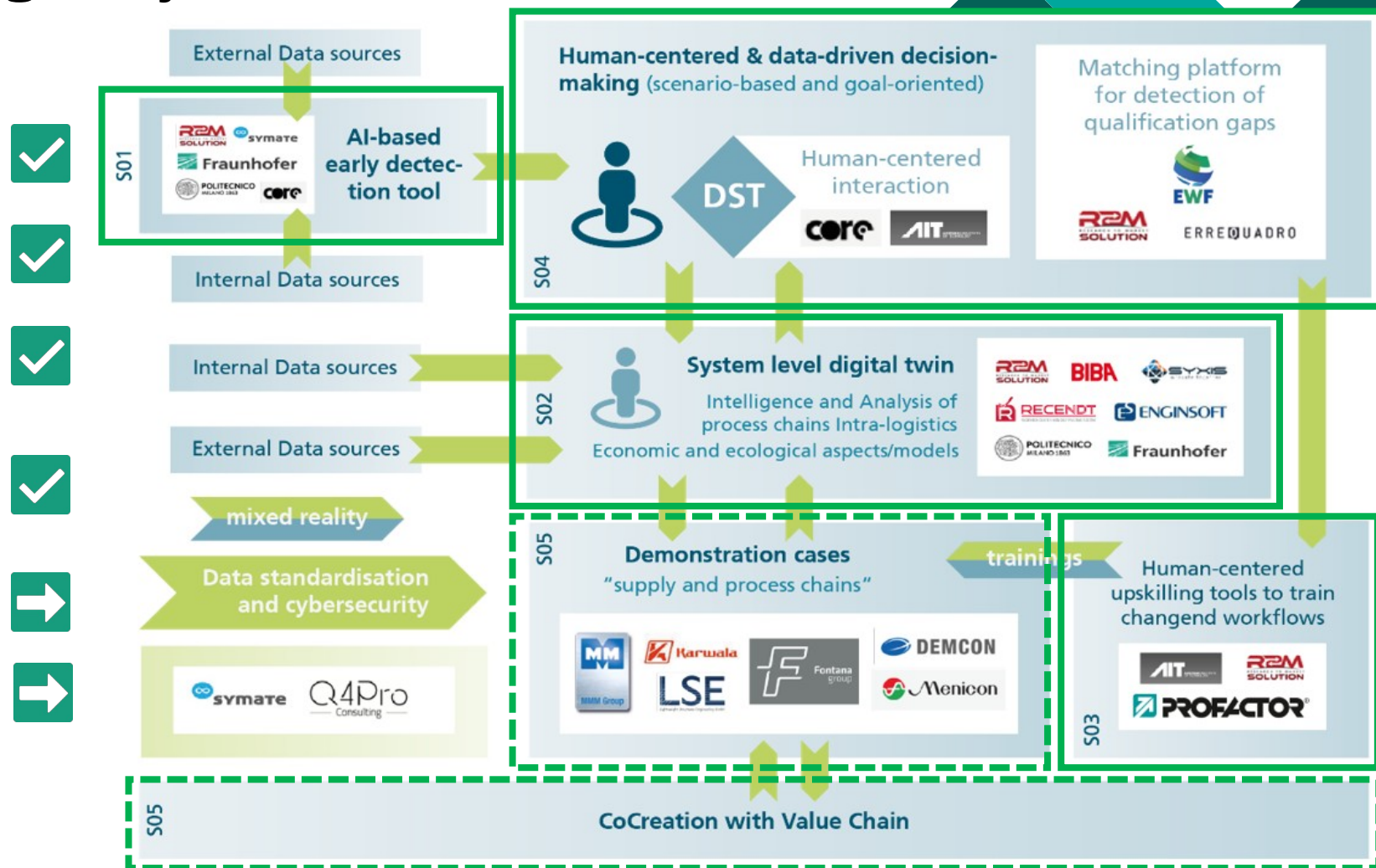
From resilient factories to sustainable places

Sustainable Places 2025, October 9, 2025, Milan

ALEXANDER DEMENTYEV (FHG)

Main topics and strategic objectives of RaRe²

- Early detection tool ✓
- System level digital twin ✓
- Human-centered upskilling tools to train changed workflows ✓
- Human-centred & data-driven decision making ✓
- Demonstration Cases →
- CoCreation with value chain →

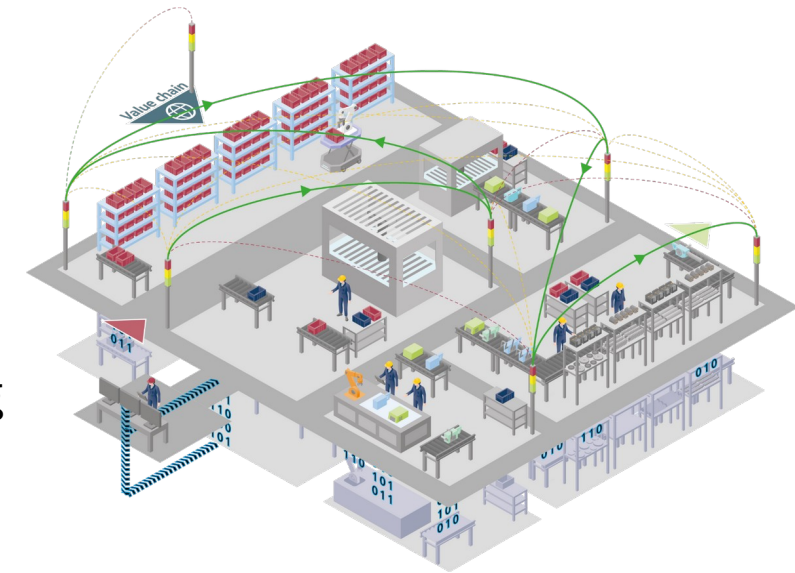


Vision and Lessons learnt:

The Holistic Ecosystem Platform based on [the Holistic Methodology Framework \(HMF\)](#) will enable the generation of a green wave through value chains of European manufacturers.

Lessons learnt:

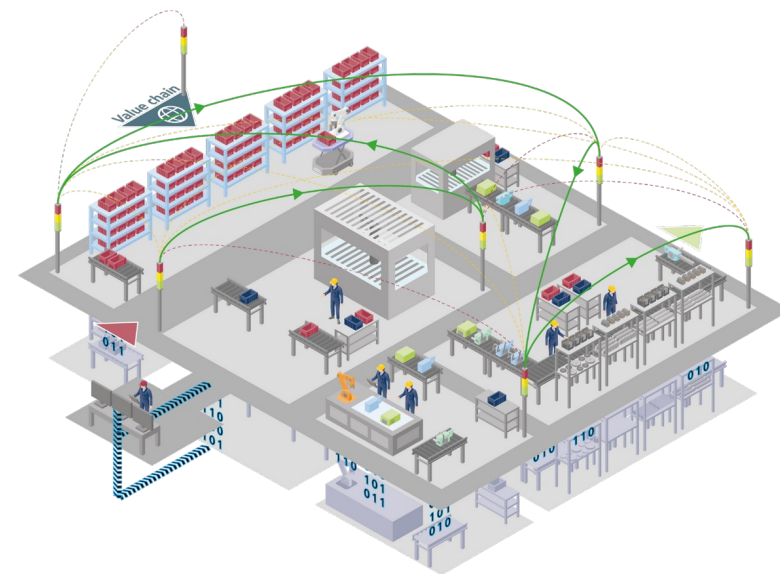
- Decentralized architectures offer greater flexibility for integration with legacy systems and partner-specific infrastructures, compared to fully unified platforms.
- Early stakeholder engagement during user story development significantly improves tool relevance and pilot adoption.
- The alignment of semantic models, data structures and user-facing dashboards is critical for ensuring practical usability and acceptance by operators and planners.



From resilient factories to sustainable places

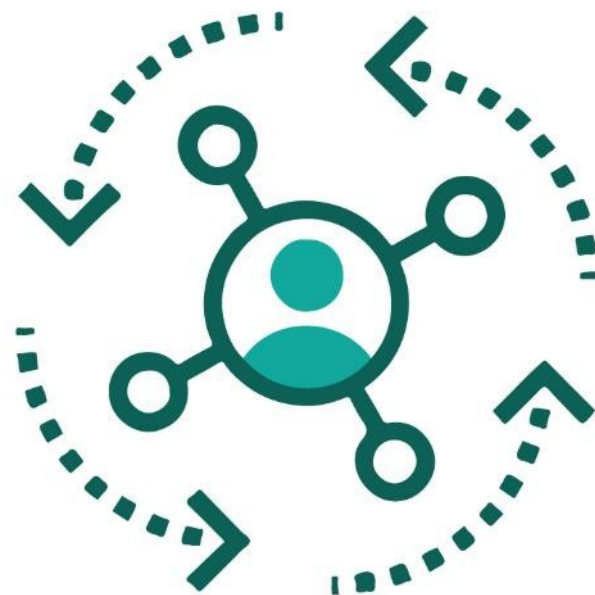
RaRe² contributes to improving the resilience and sustainability of urban areas by providing innovative approaches to problem-solving and resource utilization in manufacturing area:

- Flexibility and Resilience: By developing flexible and adaptable production processes, cities can respond more quickly to changes in the market or environment.
- Efficient Resource Use: Innovative digital solutions enable more efficient use of resources, leading to a reduction in the ecological footprint.
- Early Problem Detection: The early detection system for issues can help cities proactively manage crises such as natural disasters or economic disruptions.
- Sustainable Production Methods: RaRe² promotes the development of environmentally friendly production methods that can be implemented in urban settings to enhance sustainability.



Our partners





RARE²

Human-centred Rapid Reconfiguration of Production
and Value Chain in Fast Changing Scenarios

Upskilling and Participatory approaches. Human – Centered process

From resilient factories to sustainable places

Sustainable Places 2025, October 9, 2025, Milan

DOMENICO PERFIDO (R2M)

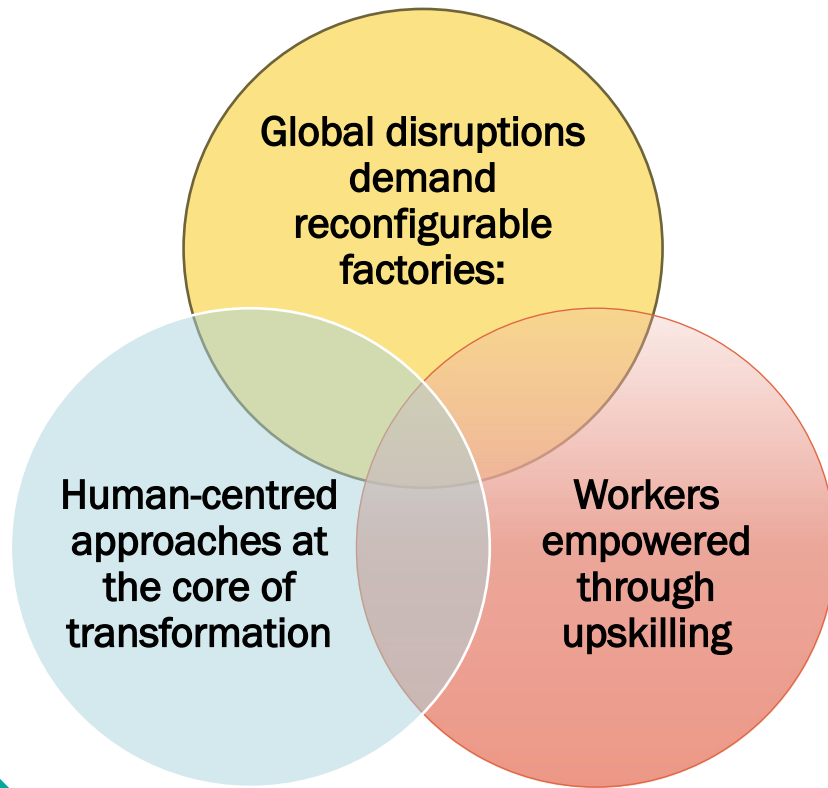
RaRe2 _ Building Human-Centred Resilient Factories

- Emerging technologies, even those driven by AI, must remain tools that serve people rather than replace them. In the industrial sector—where automation often takes the spotlight—the real innovation lies in empowering human capabilities, not eliminating them.

Human-centered design ensures that technology amplifies expertise, creativity, and safety, creating smarter and more resilient workplaces.



RaRe2 _ Building Human-Centred Resilient Factories



In a world of global disruptions and constant change, industries must evolve towards **reconfigurable factories** — agile systems capable of adapting to new demands, technologies, and crises.

But flexibility is not only about machines; it's about people.

Empowering workers through continuous upskilling ensures that human expertise remains the engine of innovation and resilience.

At the core of this transformation lie **human-centred approaches**, where technology enhances human creativity, safety, and well-being — building workplaces that are not just efficient, but also sustainable and inclusive

RaRe2 _ Pilots in Action

Factories adapting quickly to shocks.
Flexible production lines adapting to demand shifts.

AI-driven planning supporting human decision-making.

Upskilling workers for digital and green transition

Participatory approaches:
operators in design & decision-making

efficiency improvements,
reduced downtime,
higher worker satisfaction



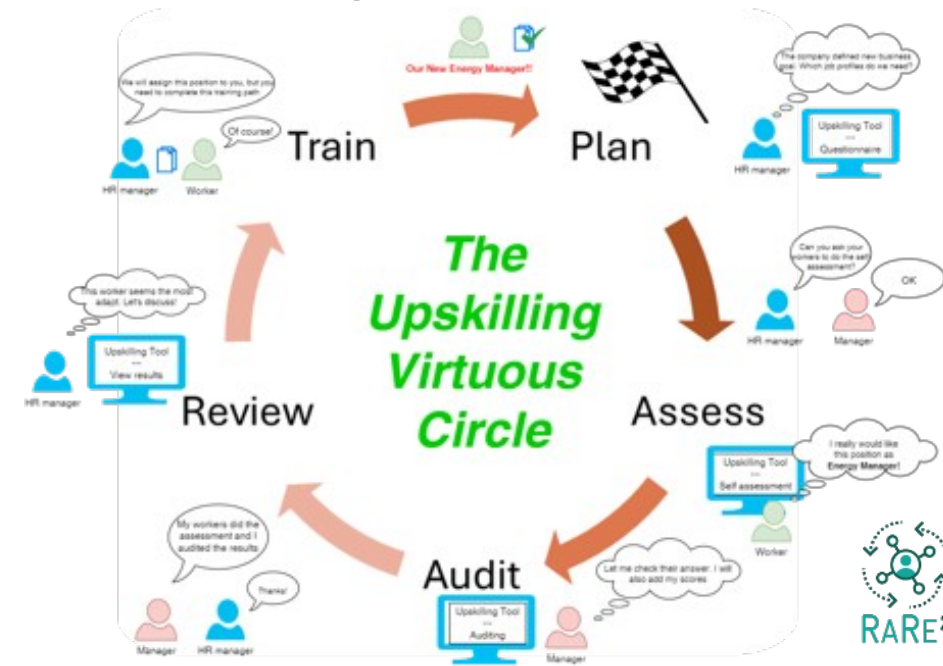
RaRe2 _ Human Centered Tools

Today's companies face a dual challenge: not only to **keep up with rapid technological change**, but to ensure their **people evolve with it**.

The real competitive advantage lies in aligning **human capabilities with emerging business needs**.

The Skill GAP Detection Tool, developed within the Horizon Europe RaRe² project, tackles this by identifying skill gaps early and supporting organizations in deciding whether to **upskill existing workers or recruit new talent**.

This proactive, human-centered approach transforms technological disruption into an opportunity for sustainable growth.



RaRe2 _ SKILL GAP DETECTION TOOL

Supports HR to convert business goals into needed profiles



Helps managers and workers into upskilling/reskilling process

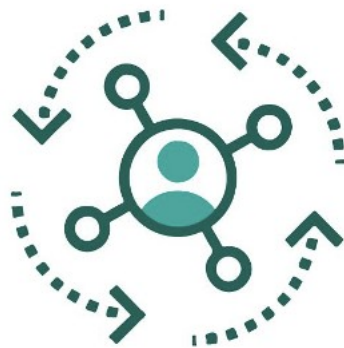


Assesses hard/soft skill of worker & their digital gaps



RaRe2 _ PARTECIPATORY APPROACHES

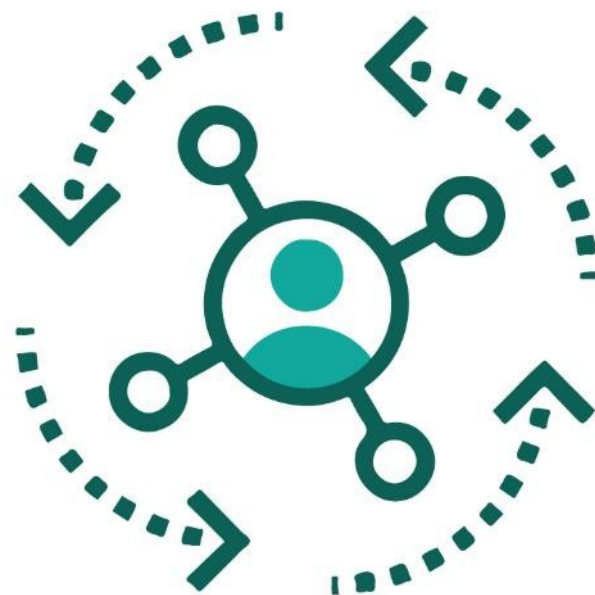
- Workers, managers, and stakeholders co-design solutions
- Shared responsibility and innovation
- Collaboration across the value chain
- Empowering people and enable Sustainable Industry 5.0



RARE²

Human-centred Rapid Reconfiguration of Production
and Value Chain in Fast Changing Scenarios





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Human-centred Rapid Reconfiguration of Production
and Value Chain in Fast Changing Scenarios

Real Example of participatory approaches, co-creation and collaboration in the value chain – Kartu

From resilient factories to sustainable places

Sustainable Places 2025, October 9, 2025, Milan

ALESSANDRA SALA (SYX)

KARTU – DEMO5

Kartu is a co-creation and matchmaking platform developed specifically to use within Demo5.

- It is designed to *support companies* and solution providers in the context of rapid reconfiguration needs. It enables companies to quickly find solution when facing urgent changes in their production system or supply chain.
- It's a *collaborative environment* that empowers participants to share ideas, propose solutions, and configure new production setups—all in response to emerging and unexpected needs.
- It helps participants *find others in the value chain*, adjust configurations, optimize flows, and minimize investments, all in a single space.

KARTU – DEMO5

DEMO 5 starts from an important concept: co-creation (collaborative creation).

KARTU supports multiple phases of the co-creation process:

- Co-Ideation: In the initial stage, KARTU helps gather ideas, challenges, issues, and opportunities from different stakeholders. This is essential for understanding what needs to be addressed in the value chain.
- Co-Design:
 1. KARTU enables collaborative solution building, bringing together diverse actors to co-create potential responses to the identified challenges.
 2. KARTU helps draw conclusions and consolidate contributions into actionable outcomes.

Why is this important for Demo 5?

Because **co-creating the value chain** means building it together — with partners, inputs, and shared understanding. KARTU makes this possible by guiding from ideation to design, all in one space.

KARTU – DEMO5

KARTU is a software platform designed to manage collaborative projects and activities within virtual rooms, with different levels of access and specific functionalities based on user roles.

The system features three main types of users:

- Admin: The platform administrator, responsible for creating and managing projects, assigning Room Managers (RM), archiving rooms and projects, and configuring categories.
- Room Manager (RM): A user responsible for creating and managing project rooms, including enabling/disabling features and managing participants.
- Participant: A user who participates in activities within the rooms they have been invited to, with permissions defined by the RM.

OBJECTIVES & HOW KARTU WORKS

Objectives of KARTU

- Facilitate collaboration between service providers and clients.
- Support Open Calls (OC) for rapid solution identification.
- Enable rapid reconfiguration in production and supply chains.

Create an account

First Name*	Last name*
First name	Last name
E-mail*	Confirm email*
Email	Confirm e-mail
Password**	Confirm password**
Password	Confirm password
Company	
Company	

*Required field
**Choose at least 8 characters, including at least one number, one capital letter and/or one special character

☐ I declare that I have read the **privacy policy** in accordance with Articles 13 and 14 of Regulation (EU) 2016/679*

☐ I agree with the **terms and conditions** of the platform

☐ I'm not a robot 

[Create an account](#)

[Go to login page](#)

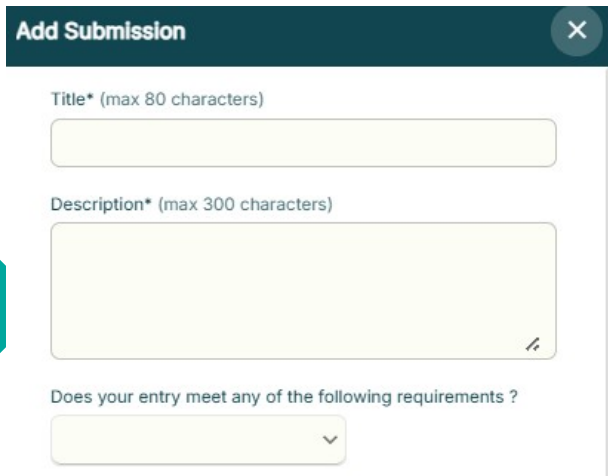
How it Works

- Each partner registers and receives a confirmation link.
- Upon login, they access a dedicated room where they can create one or more submissions.
- A submission represents a tool, service, or consultancy that supports reconfiguration.

MAIN FUNCTIONALITIES OF KARTU

1. Create Submission

Partners can easily create and manage detailed submissions describing their tools, services, or consultancies. Each submission includes all the essential information (title, description, attachments, and useful links)solutions



The screenshot shows a modal window titled 'Add Submission' with a close button (X). It contains three input fields: 'Title* (max 80 characters)', 'Description* (max 300 characters)', and a dropdown menu labeled 'Does your entry meet any of the following requirements?'. The description field has a small icon in the bottom right corner.

2. Select & Match

Clients can search, filter, and compare available submissions to identify the most suitable solutions for their specific needs.

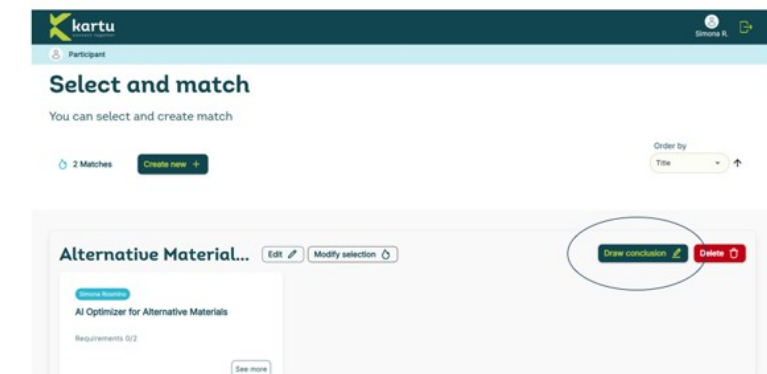
The system uses keywords to facilitate and accelerate the matching process, helping users quickly find what best fits their requirements.



The screenshot shows a modal window titled 'Create new match' with a close button (X). It contains a 'Match title' label and a text input field with the placeholder 'Match title (max 80 characters)'. At the bottom, there are 'Cancel' and 'Create' buttons with a checkmark.

3. Draw Conclusion

After identifying relevant matches, clients can review and reflect on selected solutions directly within the platform. They can group and annotate their findings and write short reflections for each match.



The screenshot shows the 'Select and match' interface. At the top, there's a header with the KARTU logo and a 'Participant' label. Below it, the text 'You can select and create match' is displayed. There's a '2 Matches' indicator and a 'Create new' button. A dropdown menu shows 'Order by' with 'Title' selected. The main content area shows a match titled 'Alternative Material...' with 'Edit' and 'Modify selection' buttons. At the bottom right, there are 'Draw conclusion' and 'Delete' buttons, with 'Draw conclusion' circled in red.

KARTU – DEMO5

The KARTU platform enables collaborative innovation and rapid reconfiguration across partners.

- Through shared rooms, structured submissions, and open interaction, users can *co-create* efficient solutions.
- The demo highlights how KARTU *turns ideas* into practical matches, supporting flexibility and resilience in industrial ecosystems.
- KARTU is not just a tool — it's a community for smart collaboration,



RARE²

Thank you

Contact:

Alexander.Dementyev@iwu.fraunhofer.de



RESTORE

Sustainable remanufacturing solution



Sustainable Places 2025

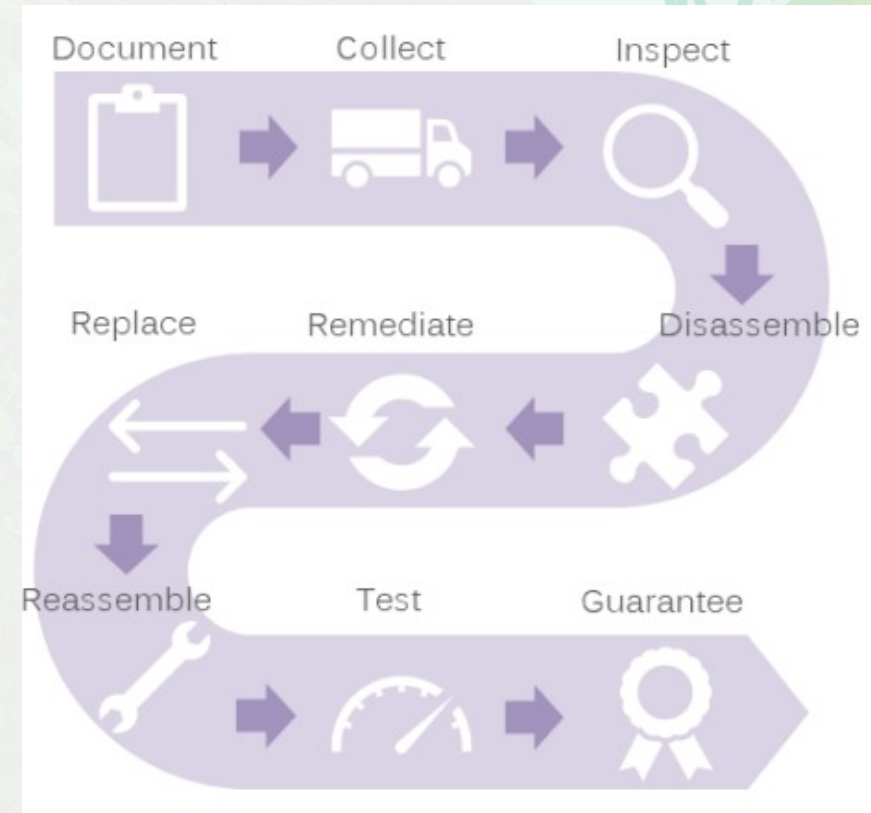
Milan / 09.10.2025



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Remanufacturing

With roots in the early 20th century, remanufacturing has been quietly adopted into the life-cycle of complex and expensive machinery: at first, into military equipment, and later - after World War II - into consumer products such as cars. In our technology-driven world, the scope for remanufacturing has increased so that now ICT, medical equipment, tyres, renewables technologies and many other types of product can be successfully remanufactured.



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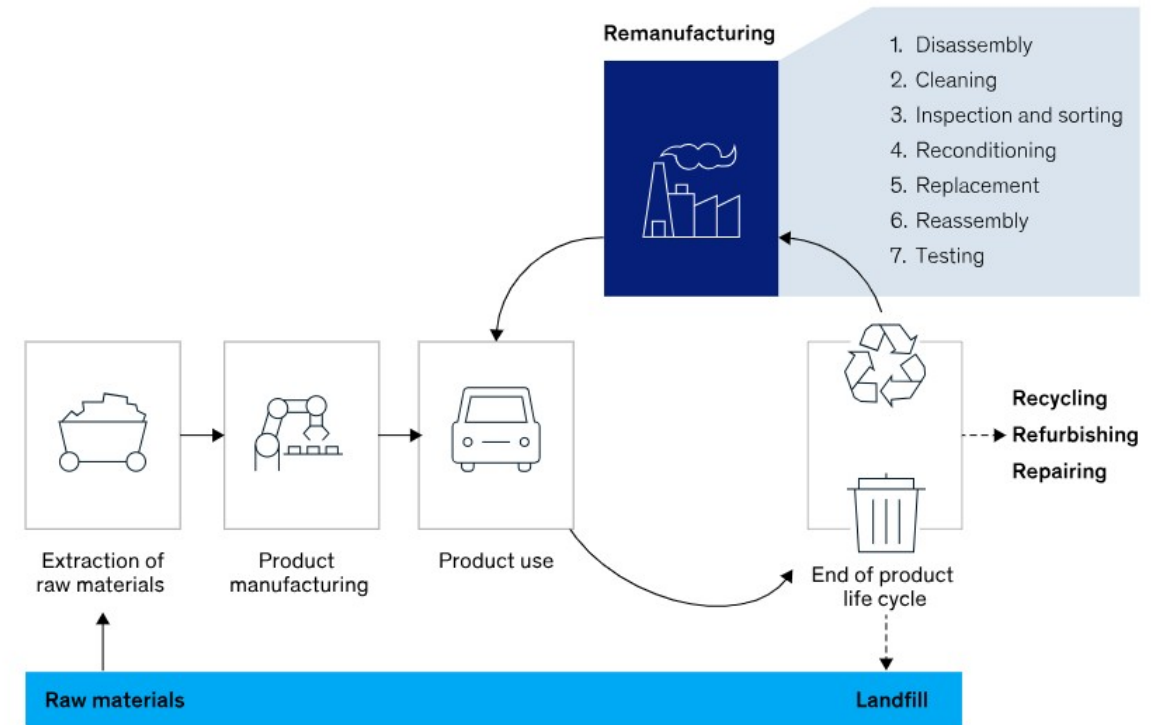
remancoucil.eu

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Sustainable remanufacturing solution

Remanufacturing

The essential process steps include: **disassembly, cleaning, repair/replacement of damaged components, reassembly and testing**, although the emphasis on each step will vary by product. The must-have feature for a remanufactured product is the assurance that the quality and performance of the item is like that of a new product. This is where it differs from repair: in repair, only the apparent fault is rectified while in remanufacturing the whole product performance is guaranteed – for a new life.

Product value chain



McKinsey & Company



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Project Summary

In the pursuit of a **Circular Economy**, **RESTORE** seeks to revolutionize remanufacturing practices by introducing **sustainable processes, materials, and digital tools**. The project addresses the challenges of remanufacturing implementation by developing advanced cladding technologies, zero-waste materials, and a comprehensive digital platform.

- **Call and Topic/Activity:**
HORIZON-CL4-2023-TWIN-TRANSITION-01-04 – Factory-level and value chain approaches for remanufacturing (Made in Europe Partnership) (IA).
- **GA Number:** 101138775.
- **Type of action:** IA (Innovation Action).
- **Duration:** 48 months, 2024-2028.



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Sustainable remanufacturing solution

Our Partners



aerobase



intellegens

IREPA LASER
INSTITUT CARNOT MICA



STELLANTIS



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RESTORE
Sustainable remanufacturing solution

Overview of the project, scientific objectives and achievements for the period, deliverables & milestones achieved



SO1: Develop a sustainable cladding process and consumables

SO2: Develop digital tools for increased automation

SO3: Develop a RESTORE platform for remanufacturing

SO4: Scale business model innovation for remanufacturing

SO5: Demonstrate RESTORE remanufacturing technology solution and platform



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RESTORE
Sustainable remanufacturing solution

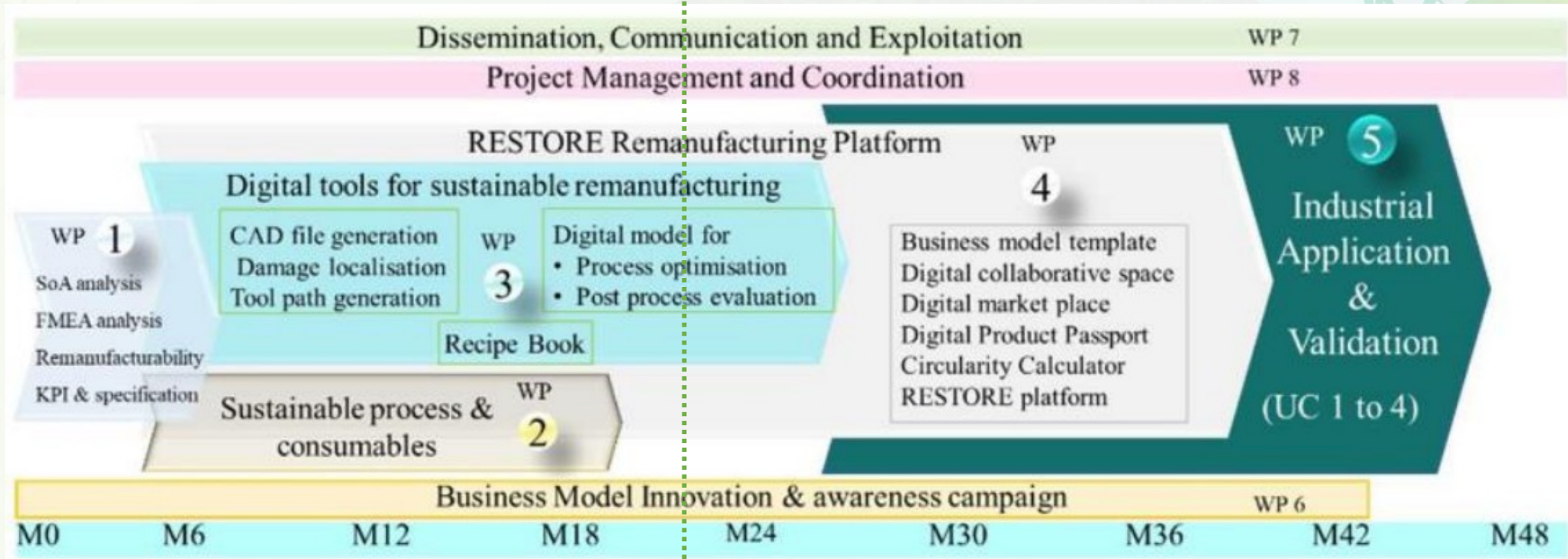
Overview of the project, scientific objectives and achievements for the period, deliverables & milestones achieved – Use Cases



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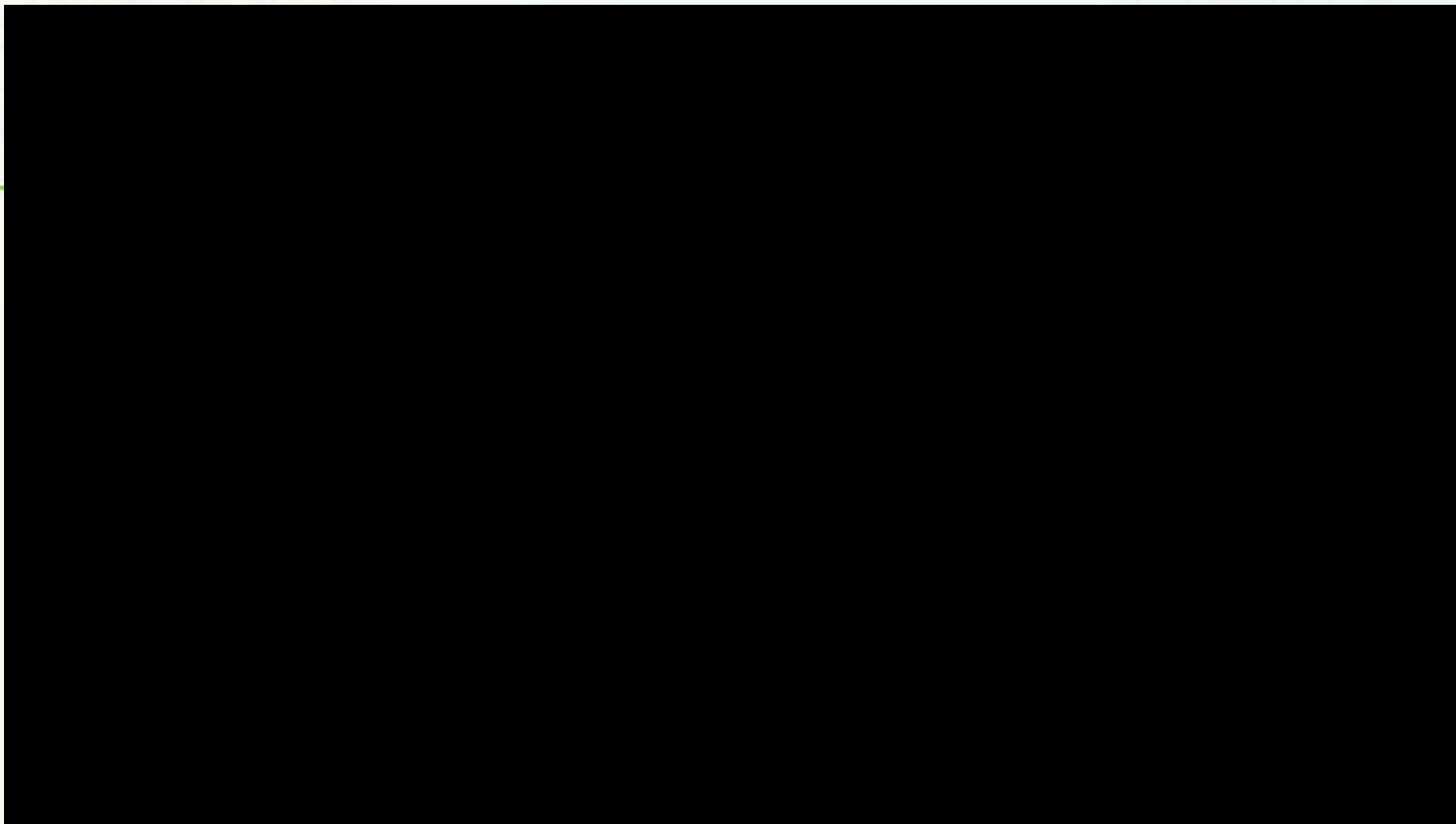
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Sustainable remanufacturing solution

Project Summary



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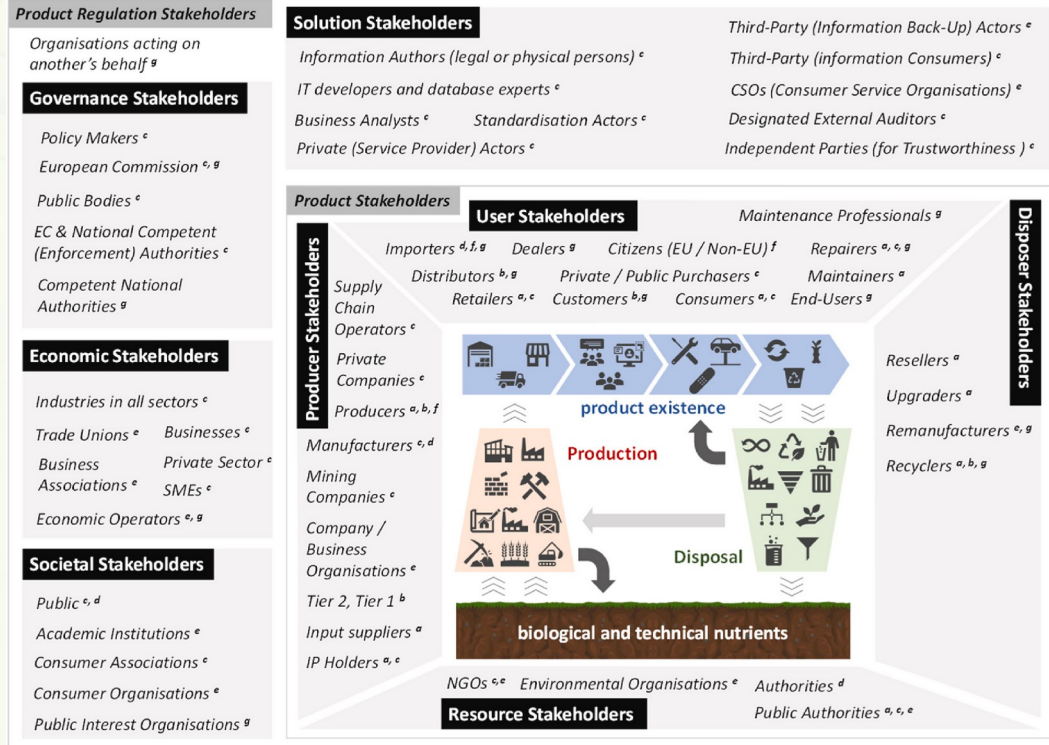
RESTORE
Sustainable remanufacturing solution



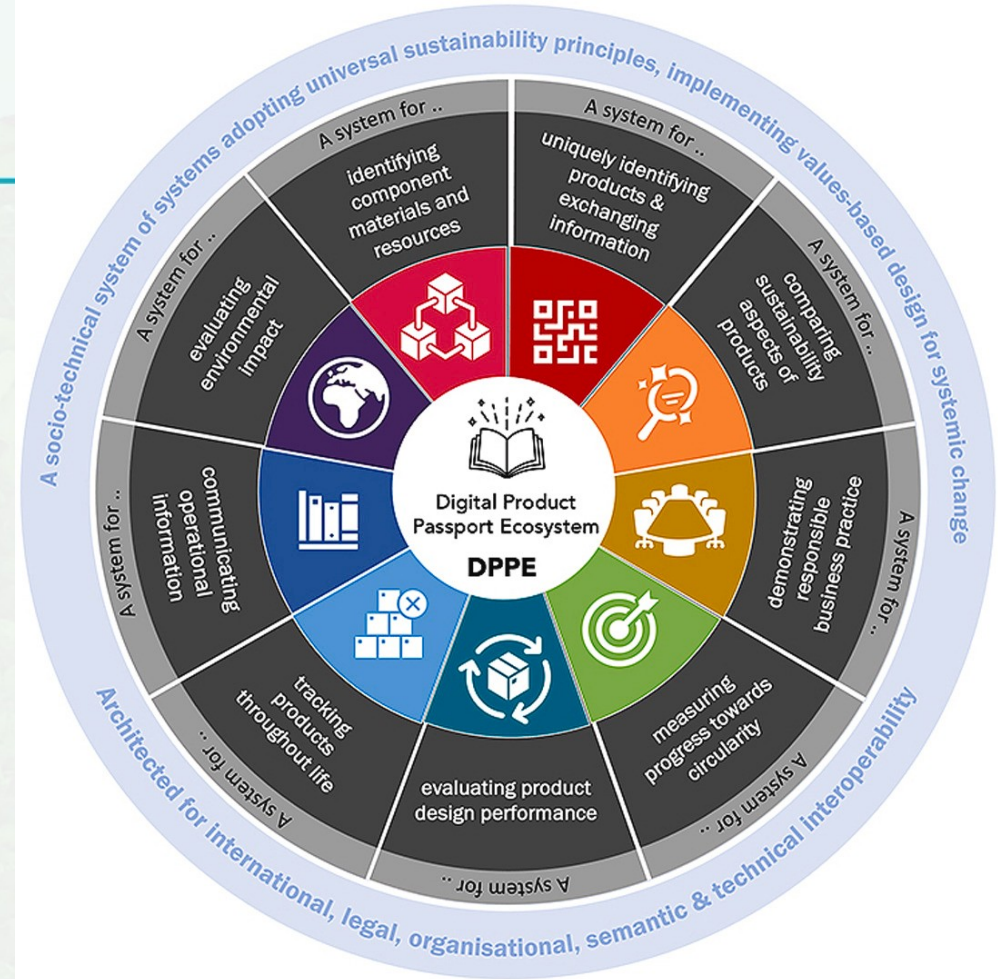
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DPP Ecosystem Services



(a) Annex 18, Table 99 (b) Annex 18, Figure 1 (c) Annex 18, 'Potential stakeholders' benefits, pg 592-596 (d) Annex 18, 'Roles', Table 101
(e) Annex 18, pg 617-621 (f) Feedback Organisations (to Impact Assessment, Open Public Consultation) (g) COM(2022)142 Ch.III



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RESTORE
Sustainable remanufacturing solution

RESTORE Social Awareness Campaign

The **RESTORE - Sustainable Remanufacturing** Surveys are live, running from **September 1st, 2025, to March 31st, 2026**, the surveys will collect valuable insights across Europe.



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CALL FOR RESPONDENTS!

Remanufacturing Readiness in Europe

Remanufacturing is a key enabler of the Circular Economy, yet its integration into existing industrial value chains remains complex. Your insights will help shape the development of targeted support tools and strategies that meet the real needs of European manufacturers.



THANK YOU FOR PARTICIPATING!

RESTORE
restoreeuproject.eu



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HORIZON-CL4-2023-TWIN-TRANSITION-01

Product as a Service (PaaS)

Product-as-a-Service (PaaS) is a business model where a provider retains ownership of a product and sells its usage or the outcome it provides, rather than the product itself. Customers typically pay a recurring fee through a subscription or pay-per-use model for access to the product and associated services. This model fosters a circular economy by emphasizing maintenance, upgrades, and end-of-life recycling, benefiting both providers with predictable revenue and customers with convenient access to value without the burden of ownership.

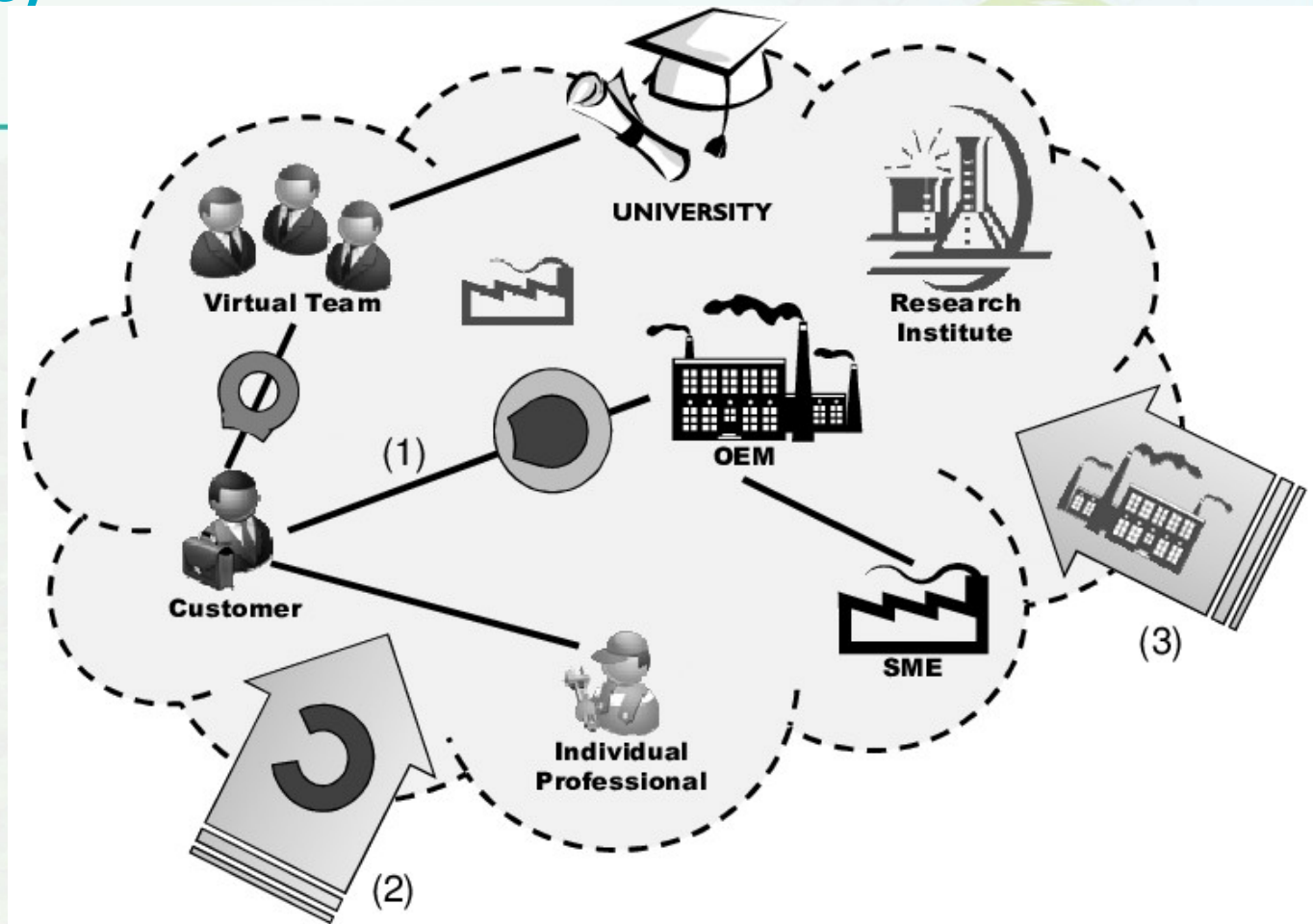


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Sustainable remanufacturing solution

Manufacturing as a Service (MaaS)

Manufacturing-as-a-Service (MaaS) is a digital-driven business model where companies access and utilize a shared network of manufacturing capabilities and services on a pay-per-use or subscription basis, rather than owning their own facilities. Leveraging platforms and technologies like cloud computing, AI, and digital twins, MaaS provides on-demand access to prototyping, custom fabrication, and large-scale production to increase flexibility, reduce costs, and enable agile, scalable operations.



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Sustainable remanufacturing solution

RESTORE Social Awareness Campaign



- How do products as a service, manufacturing as a service or components as a service support both economically viable products and circularity business to increase refurbished, remanufactured, or repurposed value creation?
- What incentive structures allow more participation in the circular models and more business creation in localized environments to expand the opportunities for remanufacturing?



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RESTORE Social Awareness Campaign

<https://forms.office.com/e/jT21dCMvmu>



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Sustainable Places 2025 - RESTORE



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Any Question?

"If there are any questions or if something needs further explanation, please, don't hesitate to ask!"



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Speaker

Jacopo Cassina

Jacopo.cassina@syxis.eu

Organisation

Syxis, VŠI

Date

MULTIMOLD

Multi-functional-in-mold-electronics

Sustainable Places 2025



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SYXIS



SYXIS



SYXIS, VŠĮ

Who we are:

- A Lithuanian non-profit organisation that **supports innovation** through digital, sustainable, and collaborative solutions.
- A Digital Sustainable company that connects SMEs, organizations, and research centers across Europe to generate and foster innovation.
- SYXIS, VŠĮ establishes and facilitates new relationships among companies operating in the field of funded research and innovation, assisting them with methods, operations, and technologies. This enables them to embrace and develop new strategies focuses on themes such as **digitalization, circular economy, and networking.**

Our expertise:

- Innovation in **circular and digital transformation.**
- Design of **data-driven platforms** and lifecycle monitoring tools.
- Promotion of **cross-sector ecosystems** for sustainable growth.
- Support in **bringing research results closer to market.**



DIGITAL SOLUTION

We create technological platforms based on the power and importance of data to improve the digital transformation



CIRCULAR ECONOMY ECOSYSTEM

all our activities aim to provide sustainable solutions for the future of the environment, the economy and the people



NETWORKING

We connect SMEs, find partners and promote collaboration among entities, encouraging the co-creation model as a new business strategy

Project name: Multi-functional In-Mold Electronics

Project acronym: MULTIMOLD

Type of action: HORIZON Innovation Actions

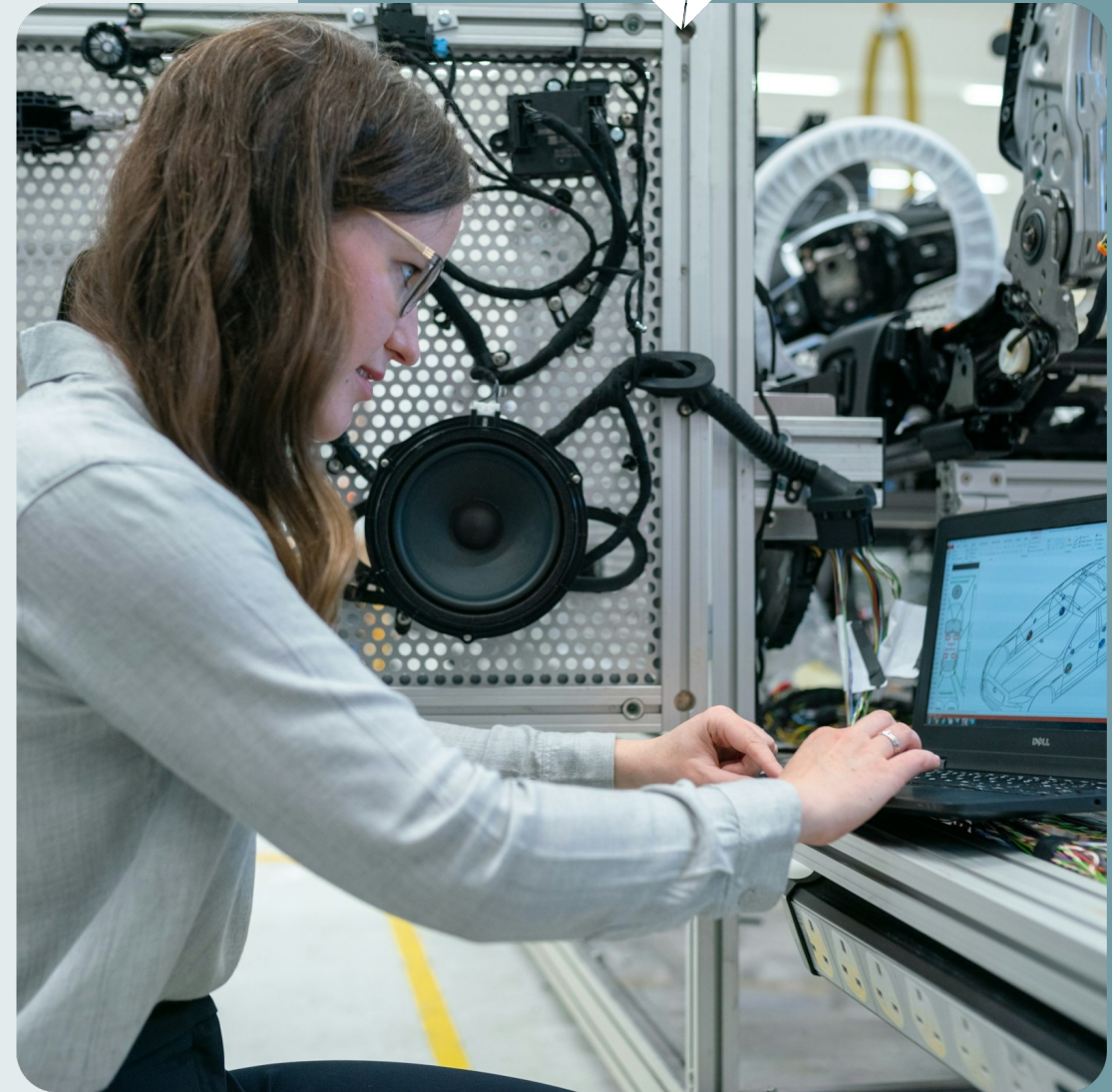
Starting date: 1 January 2024

End date: 31 December 2027

Duration: 48 months

Max grant amount: 5 760 076.77

Objective: To develop the next generation manufacturing process for **products with complex geometries** based on **in-mold electronics** with a robust, weather-resistant material concept that provides **inherent recyclability by design**

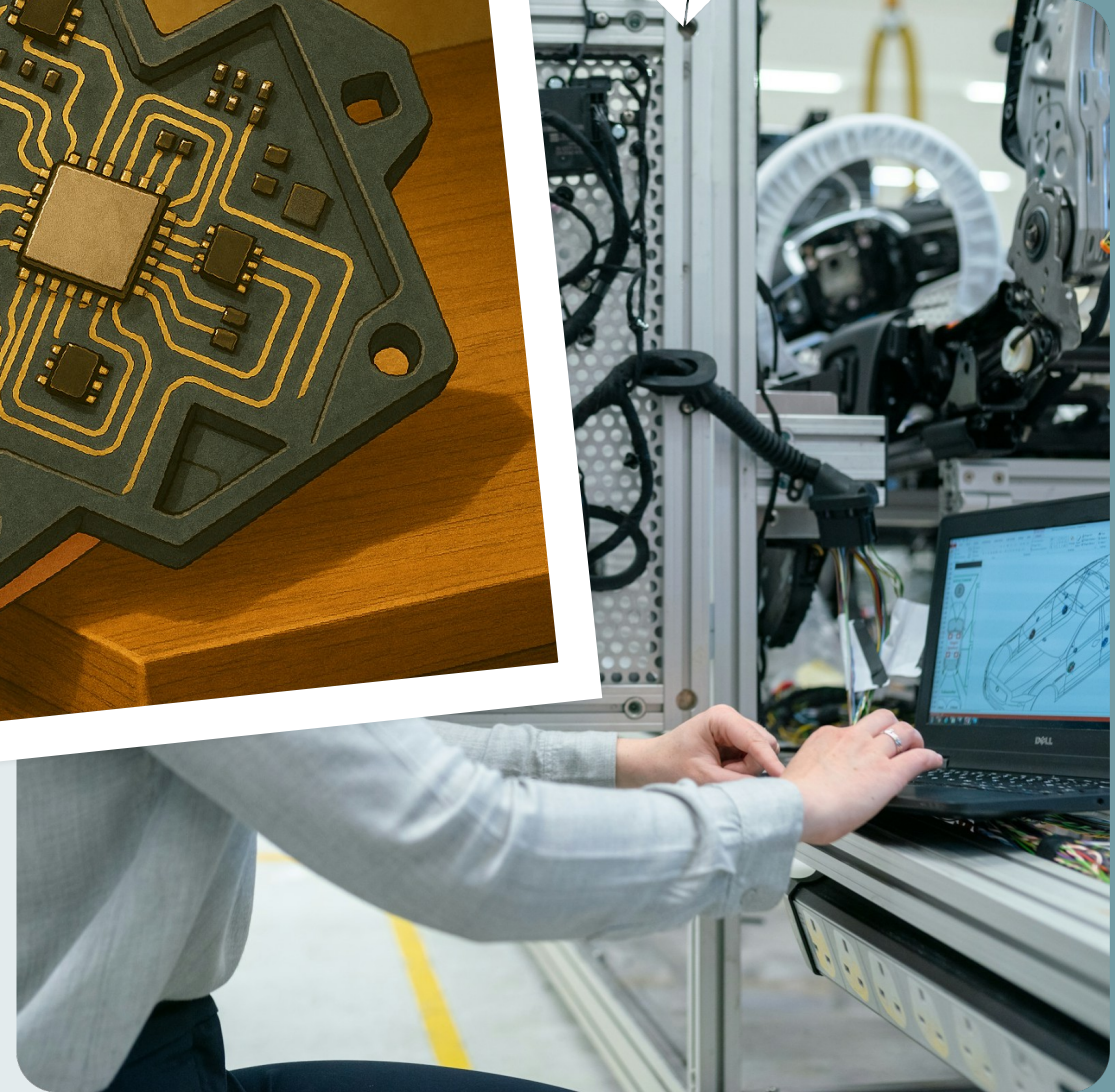
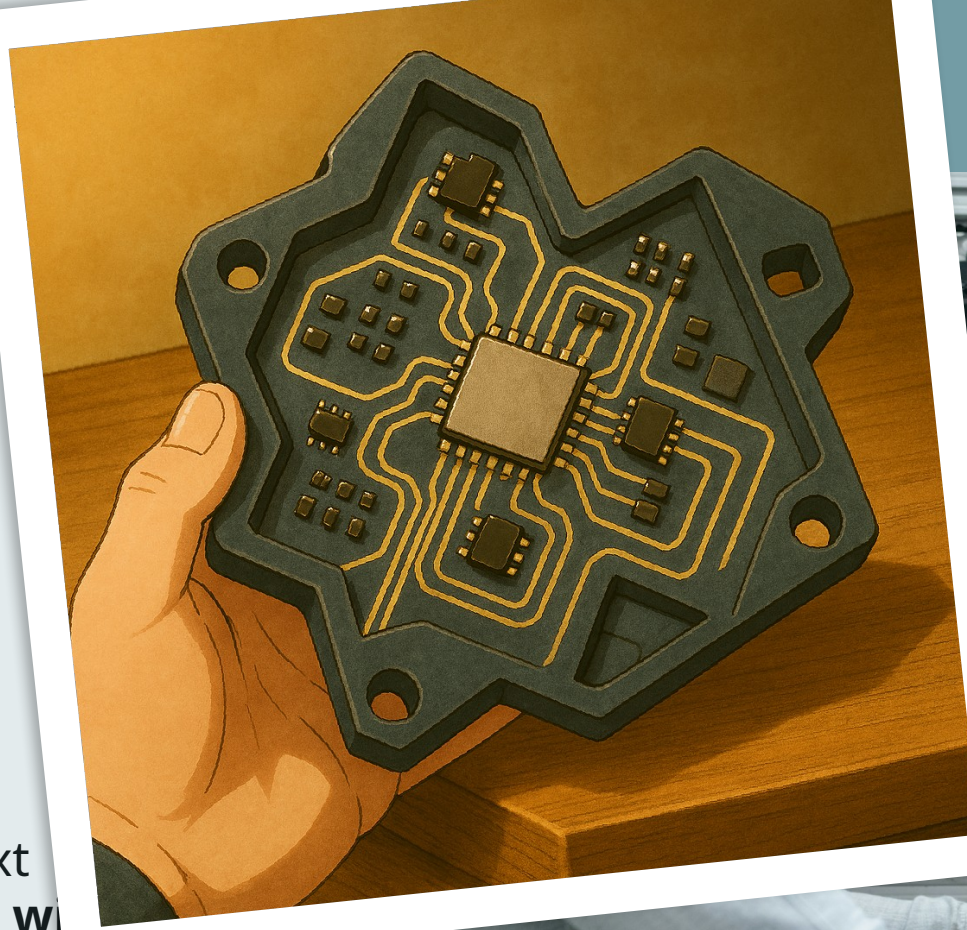


Project name: Multi-functional In-Mold
Project acronym: MULTIMOLD
Type of action: HORIZON Innovation Action

Starting date: 1 January 2024
End date: 31 December 2027
Duration: 48 months

Max grant amount: 5 760 076.77

Objective: To develop the next manufacturing process for **products with complex geometries** based on **in-mold electronics** with a robust, weather-resistant material concept that provides **inherent recyclability by design**

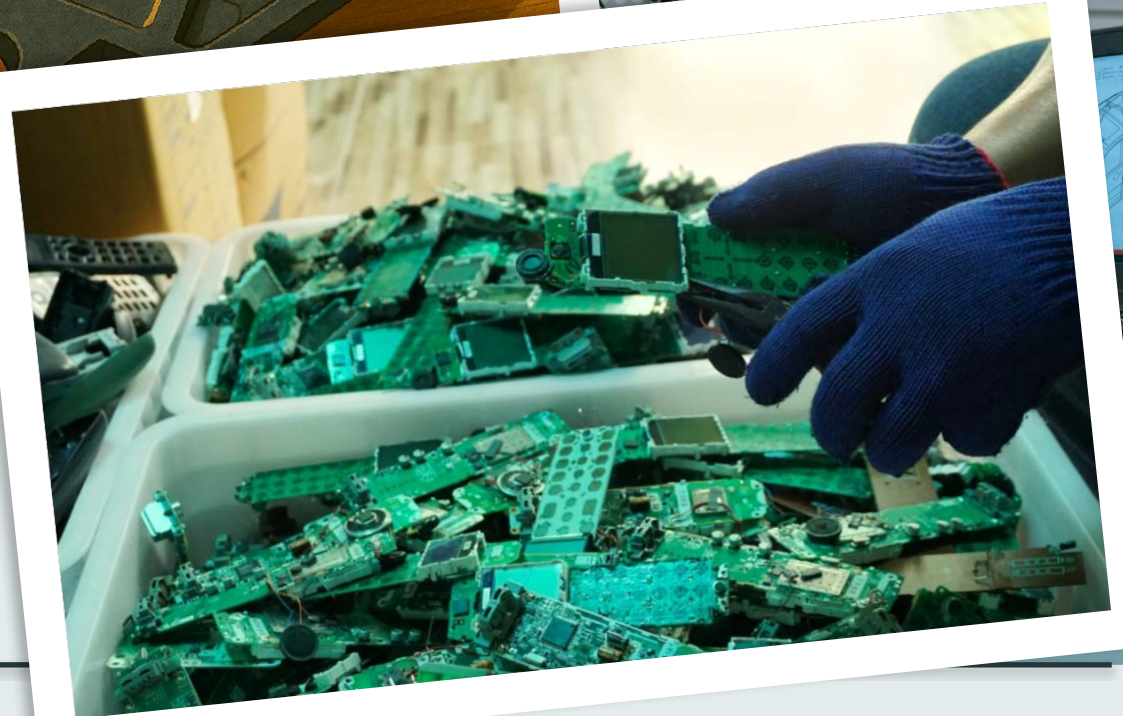
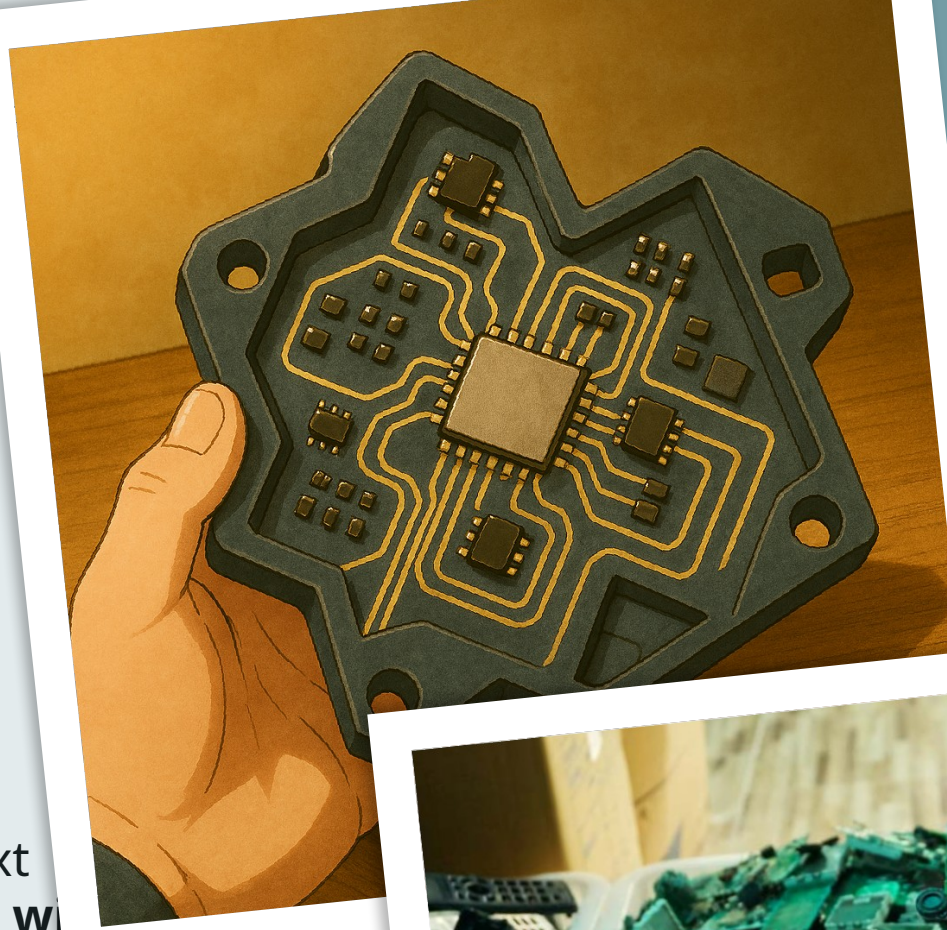


Project name: Multi-functional In-Mold
Project acronym: MULTIMOLD
Type of action: HORIZON Innovation Action

Starting date: 1 January 2024
End date: 31 December 2027
Duration: 48 months

Max grant amount: 5 760 076.77

Objective: To develop the next manufacturing process for **products with geometries** based on **in-mold electronics** with a robust, weather-resistant material concept that provides **inherent recyclability by design**



Partners

1

Joanneum Research (Coordinator)



2

SYXIS, VŠI



3

R2M Solution



4

IMEC - Interuniversitair Micro-Electronica Centrum



5

Montanuniversitaet Leoben



6

Standex Engraving Moldtech



Partners



7

Nanogate



8

Schneider Electric industries sas



9

Eologix Ping



10

Fraunhofer IZM and Fraunhofer IV



11

Htp high tech plastics gmbh

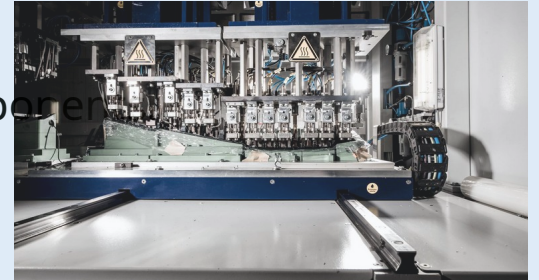


Click to edit Master text styles

Pilot 1: HTP High Tech Plastics

Who they are:

- A company **specializing in advanced injection molding** and high-precision plastic components.
- They work in industries such as **automotive and electronics**.
- Experts in 3D forming, over-molding, and integrating electronics into plastic parts.



What they do in MULTIMOLD:

- Develop and **manufacture demonstrator** components using In-Mold Electronics (IME) and In-Mold Labeling (IML).
- Lead the over-molding process of 3D-formed films with printed electronics.
- Collaborate on material selection, surface finishing, and component testing.

Goals:

- 1) Develop a **scalable injection molding process for electronics-integrated components**.
- 2) Ensure **tactile functionality and surface durability**.
- 3) Apply **circular-by-design principles** (separation, recyclability).
- 4) Use digital **tools and data to improve production** quality and efficiency.

Expected outcomes:

- Functional prototypes ready for industrial testing.
- Clear guidelines for industrial adoption of MULTIMOLD technologies.

The 1st MULTIMOLD use case
Industrial Control Panel (IOI).

In the first 18 months of the project
An industrial HMI was also created,
combining haptic feedback with a 3D-
formed flexible PCB. This allowed for
a compact design with high
integration of LEDs and piezoelectric
sensing in limited space.

Pilot 2: Pilot: Schneider Electric

Who they are:

- A global leader in energy management and industrial automation.
- They provide **smart solutions for factories, buildings, and infrastructure.**

What they do in MULTIMOLD:

- Act as an industrial end-user, testing **MULTIMOLD operator interface panels.**
- Help develop advanced **control panels** with **touch features and durable surfaces.**
- Provide real-world requirements and feedback for final products.



Their goals:

- 1) Validate functional and **industrial design of IME-based interfaces.**
- 2) Ensure reliability in **harsh conditions** (wet, dusty, frequent use).
- 3) Test disassembly and **recyclability** of components.
- 4) Support **scalability** and industrial use of the technology.

Expected outcomes:

- Smart, sustainable operator interfaces.
- Real-life feedback for improved product design and usability.

The 2nd MULTIMOLD use case:
Automotive HMI.

In the first 18 months of the project an automotive HMI prototype was developed with integrated piezoelectric sensors and illuminated touch buttons, ensuring reliable user interaction even outside the car and in high humidity conditions.

Pilot 3: Eologix-Ping

Who they are:

- An innovative **SME** focused on **sensor technology for wind turbines and smart structures**
- Their systems help **monitor turbine condition and improve maintenance strategies.**



What they do in MULTIMOLD:

- Use MULTIMOLD to **embed sensors directly into wind turbine blades** during production.
- Develop and test **miniature smart sensors for temperature, vibrations, and stress.**
- **Validate sensor performance in real environmental conditions.**

Their goals:

- 1) Demonstrate that **sensors can be embedded** using IME technology.
- 2) Enable **real-time, non-invasive monitoring of turbine blades.**
- 3) Improve **safety and maintenance efficiency of wind turbines.**
- 4) Prove sensors can work in **extreme weather conditions.**

Expected outcomes:

- **Smart wind blades** with built-in monitoring.
- Progress toward **predictive maintenance** in renewable energy.

The 3rd MULTIMOLD use case: **Wind Turbine Sensor Unit.**

A first-generation condition monitoring demonstrator successfully showed the overmolding of sensitive electronics, such as solar cells and batteries. The system withstood both lab and field testing under the harsh environmental conditions found on a wind turbine blade.

SYXIS in MULTIMOLD

Role and main objectives:

- **Responsible for data management and the project's digital communication infrastructure**
- To ensure **interoperability, traceability, and reusability** of all innovations developed within the project.

Key responsibilities :

- Development and continuous update of the Data Management Plan.
- Ensure that all project outcomes comply with the FAIR principles: Findable, Accessible, Interoperable, Reusable.
- Development of **rEUse platform = A Scalable Platform for Circular Data Management**
- Leadership of WP6, focused on creating communication interfaces with Manufacturing Execution Systems (MES).

rEUse platform:

Cloud-based, multi-sided platform, designed for data-driven circular economy practices.

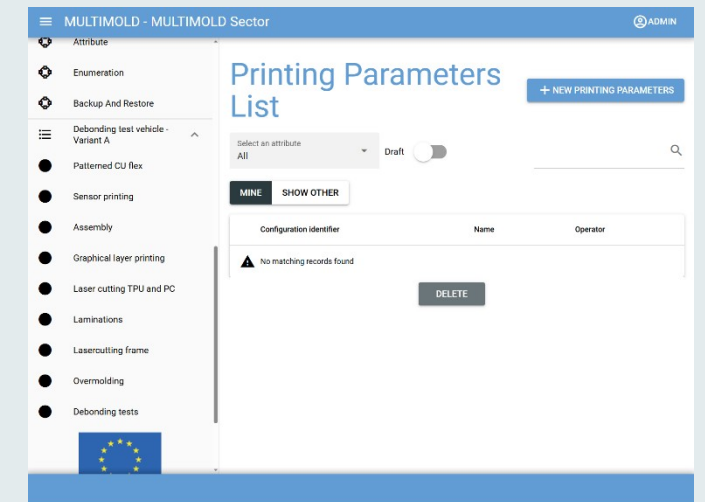
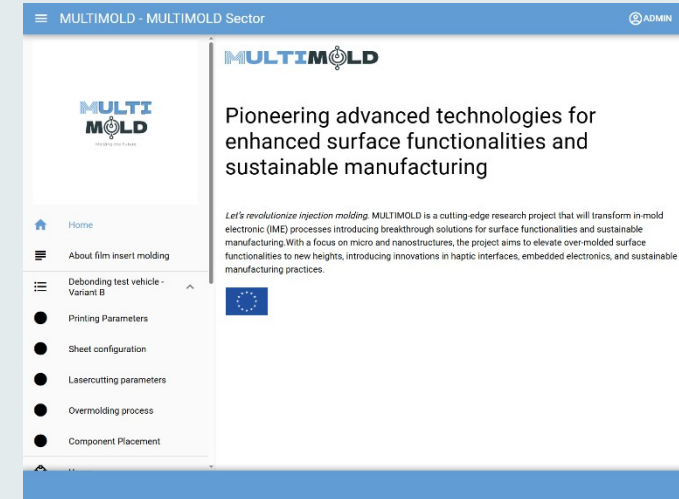
It supports the management of: Materials, Components, Products, and Waste streams

- No-code interface – easy to use, no programming needed
- Multi-user networking – connects actors across the value chain
- Integration-ready – supports MES, Digital Product Passport (DPP), and REST APIs
 - Supports technical documents – e.g. CAD, design files
- Advanced security – includes tools like Keycloak authentication

SYXIS in MULTIMOLD

rEUse platform: why we chose rEUse for the MULTIMOLD project

- Enables traceable, circular production
- Replaces outdated tools like Excel
- Drives collaboration across industries
- Facilitates reuse, recycling, repurposing, and remanufacturing
- Supports sustainability and regulatory compliance



Expected key impacts

- 1) Increased production efficiency through improved over-molding processes and digital control.
- 2) Enhanced product functionality with smart surfaces, sensors, and advanced user interfaces.
- 3) Support for circular economy via recyclable designs and material traceability.
- 4) Robust digital infrastructure enabling data interoperability and integration with digital tools.
- 5) Reduced costs and faster development through innovative manufacturing techniques.
- 6) Stronger EU industry with cross-sector applications and sustainable innovation.



Improved user experience
and surface functionalities



Sustainability



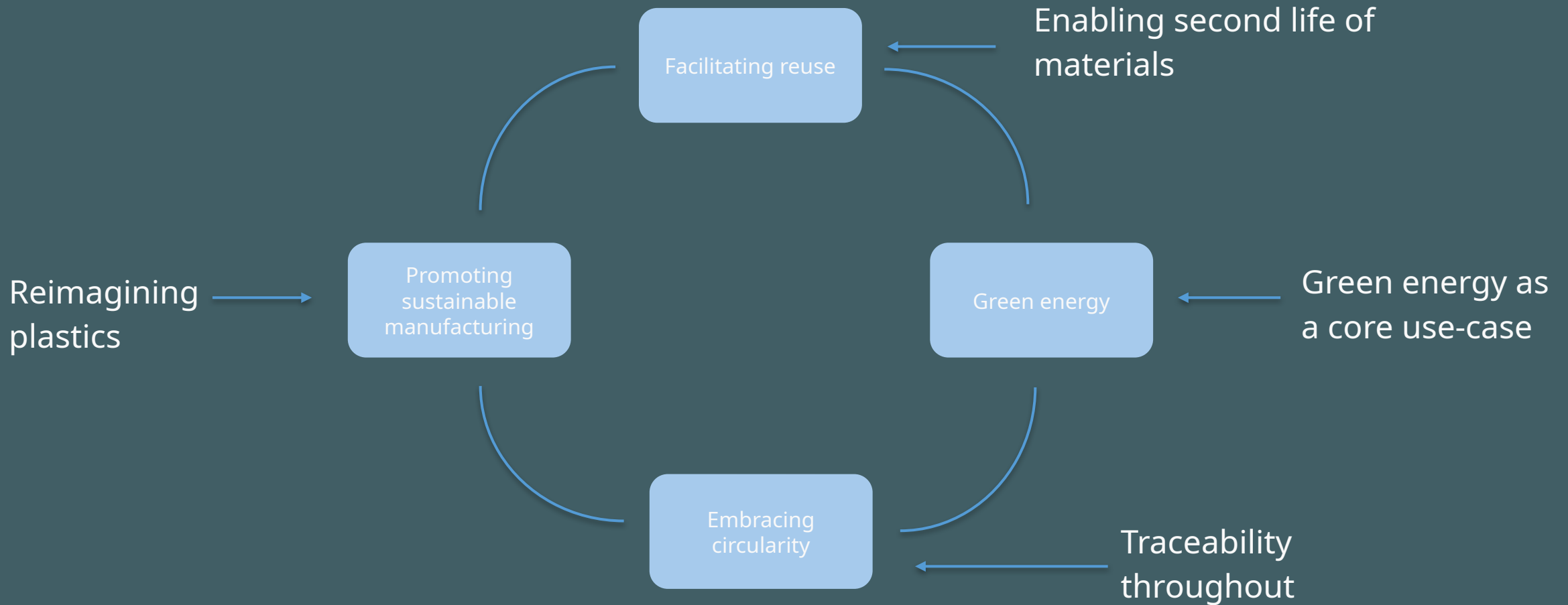
Boosting efficiency and
revenues



Circular - by - Design

Expected key impacts

Impacts to workers, communities, urban life



Thank you for your attention!

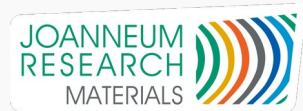
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Phone
number:



Fraunhofer
IVV



Fraunhofer
IZM

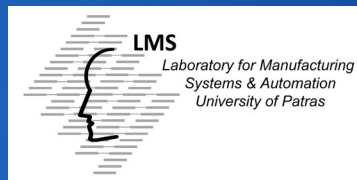


Funded by
the European Union

Linkedin **MULTIMOLD EU Project**

Email multimold@joanneum.at

From Waste to Zero Defects: Digital, Human-Centric Manufacturing



Angelis Lakkas-Pyknis

Sustainable Places 2025,
09.10.2025,
Milano, Italy

- Industrial context
- Problem definition
- The openZDM approach
- Real-world application of openZDM
- The openZDM impact so far
- Conclusions & value proposition
- Acknowledgement
- Questions

Contents

Sustainable places 2025

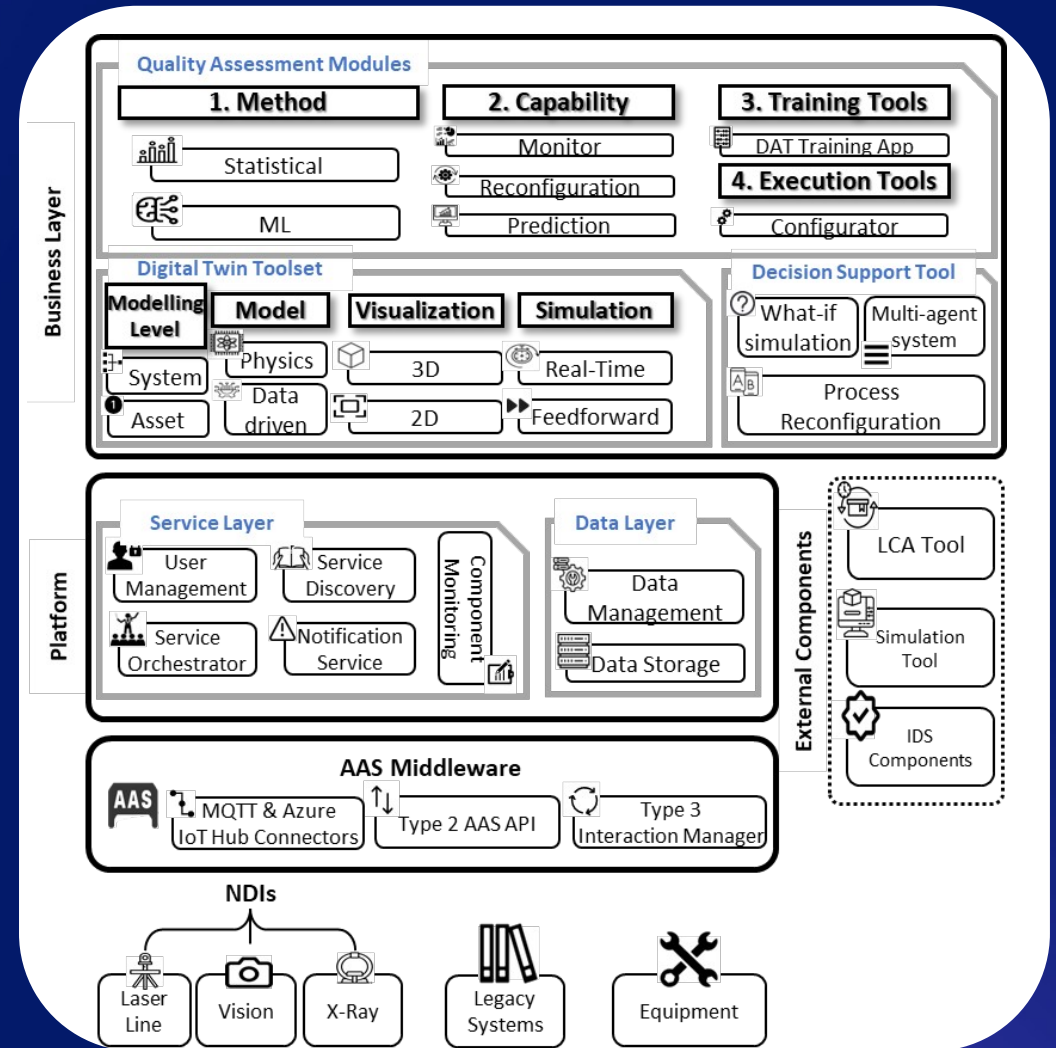
- Modern manufacturing operates with
 - ❖ Shorter lead times
 - ❖ Tight quality margins
 - ❖ Increased automation adoption
- The ZDM philosophy aims to
 - ❖ Enable environmental & economic sustainability
 - ❖ Ensure human-in-the-loop decision

making
Industrial context

- Traditionally quality control is a manual process
- Defects are identified after their generation leading to
 - ❖ **Worsen sustainability**
 - ❖ **Reduced customer satisfaction**
 - ❖ **Limited reconfiguration capacity**
- Human-centricity has
 - ❖ **Been gradually replaced by automation**

Problem definition

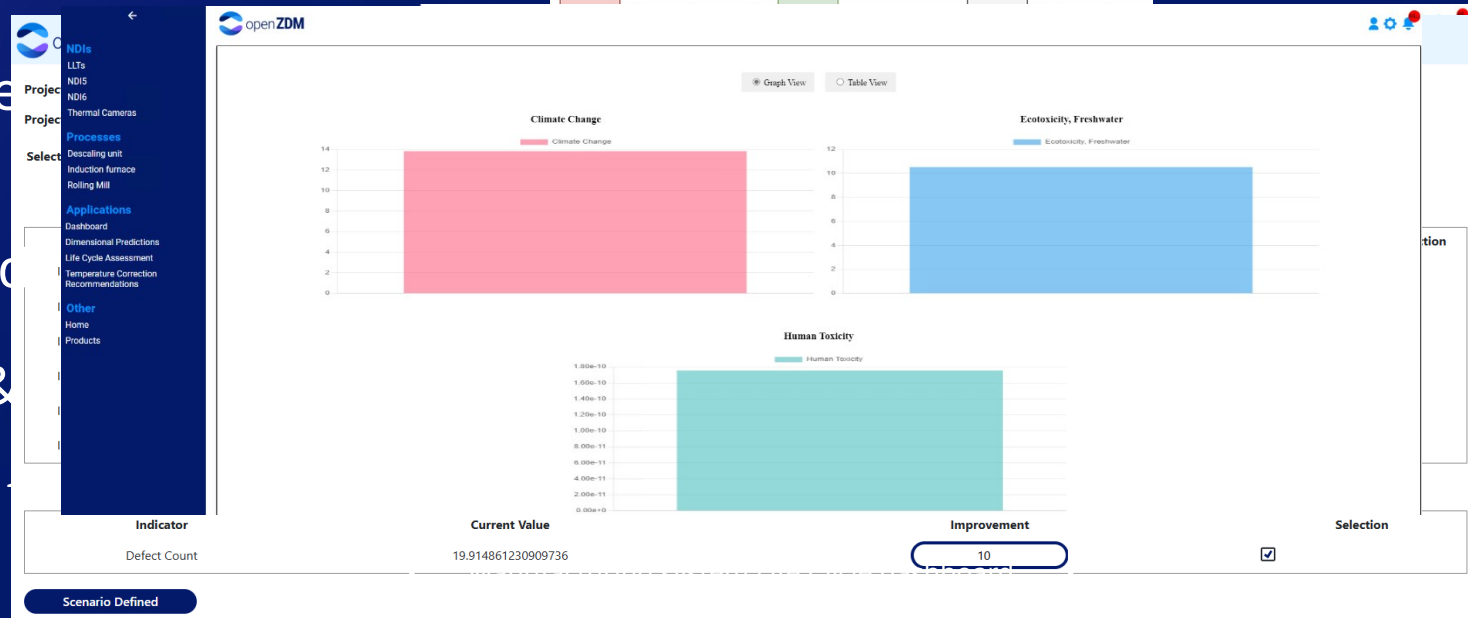
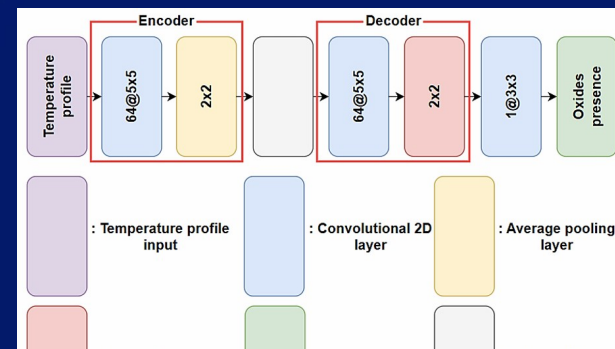
- An AAS-based open platform with integrated
 - ❖ Non-destructive inspection (NDI) systems
 - ❖ Digital twins for system simulation
 - ❖ AI-based quality assessment modules
 - ❖ A decision-support system for process adaptation
 - ❖ LCA for inline environmental assessment
 - ❖ eXplainable AI (XAI) for human-centric decision-making



The openZDM approach – High level representation

Step 1 – Data acquisition & reconfiguration Step 2 – Process configuration Step 3 – Quantification & defect evaluation

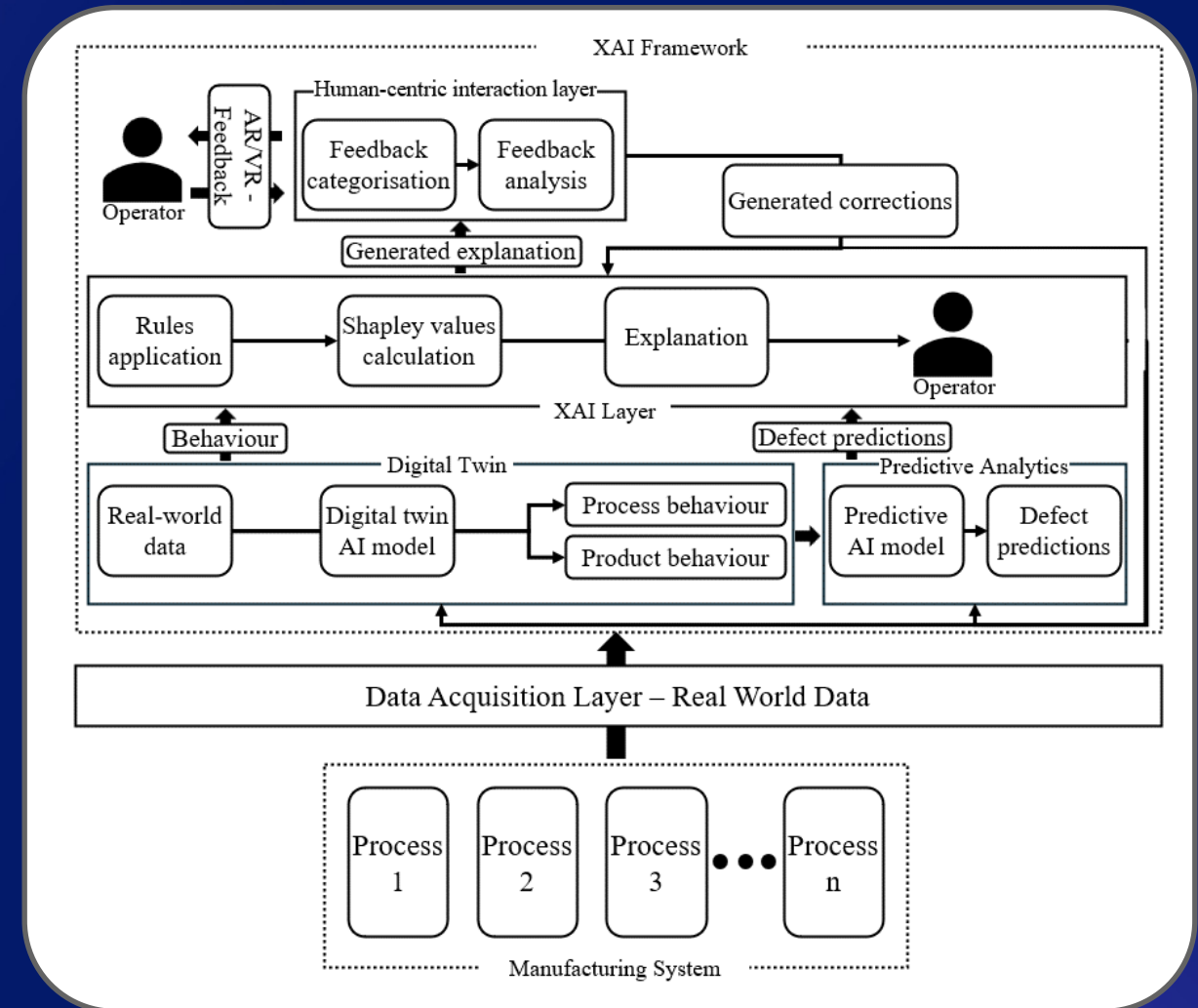
- Sustainability is understood as early identification of defects
- Using inline LCAs
 - ❖ Digital twins provide the system
 - ❖ Environmental impact is quantified
 - ❖ Two types of NDIs for inline product
 - ❖ Raw material properties, consumptions & A decision support system
 - ❖ Configuration process is highly integrated
 - ❖ AI-based quality assessment modules
- minimizing defect generation probability



IR-based NDI capturing a product's temperature profile during hot forming

The openZDM approach – Achieving sustainability

- Human-centricity is ensured via XAI-enabled feedback provision
 - ❖ XAI explains quality assessment modules & digital twin outcomes
 - ❖ Humans can provide feedback to the system & override decisions
- ✓ **Improves the system performance**



The openZDM approach – Human feedback integration

openZDM is applied into 5 industrial pilots



VDL Weweler
Trailing arm
production
process
demonstrator



Volkswagen
Autoeuropa
Vehicle body
shop and
final
assembly
demonstrato
r



VIDRALA
Bottle
manufacturin
g
demonstrator



SONAE
ARAUCO
Decorative
board
manufacturin
g
demonstrato
r



APTIV
EV battery
production
demonstrato
r

Real-world application of openZDM

The demonstrated impact of openZDM so far includes



Reduction in battery welding defects by 17%



Improvement of cost of poor quality on revenue in specific pilots by 5%



Reduction of costs due to parts misalignment by 8%



Reduction of time needed for products inspection by 5%



During experiments, more than 80% of operators deem explainability

The openZDM impact so far

Conclusions

- ZDM can act as an enabler of sustainability by
 - ❖ Integrating NDI and AI-based solutions in manufacturing lines
 - ❖ Ensuring that process adaptation is automated while remaining human-centric

Value proposition

- ✓ Continuous defect identification and process reconfiguration resulting in defect reduction & sustainability improvement
- ✓ Human-centric system with human-feedback in the loop for continuous improvement

Conclusions & value proposition

Scope

openZDM is an initiative funded by the European Commission under the Horizon Europe programme

Aim

to provide an innovative state-of-the-art integrated open platform that will combine advanced ICT solutions and innovative non-destructive testing, to support production networks' zero-defect processes.

Objectives:

To develop and deploy an **open platform** based on RAMI4.0 and AAS standards.

To develop and deploy **Digital Twins** for online process evaluation and adaptation.

To define **AI-based data-driven** quality assessment approaches.

To develop and integrate **NDTs for zero defects.**

To test and validate the integrated solution to **five industrial pilot cases.**



www.openzdm.eu



www.linkedin.com/company/openzdm



www.twitter.com/open_zdm

Acknowledgment

Sustainable Places 2025, Milan, Italy



Questions?

Sustainable Places 2025, Milan, Italy

Thank you!



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Platform-ZERO

**ACHIEVING ZERO DEFECT MANUFACTURING
FOR THE PHOTOVOLTAIC INDUSTRY**

SUSTAINABLE PLACES 25 - 09/10/2025

RAPHAEL PICKL



Co-funded by
the European Union



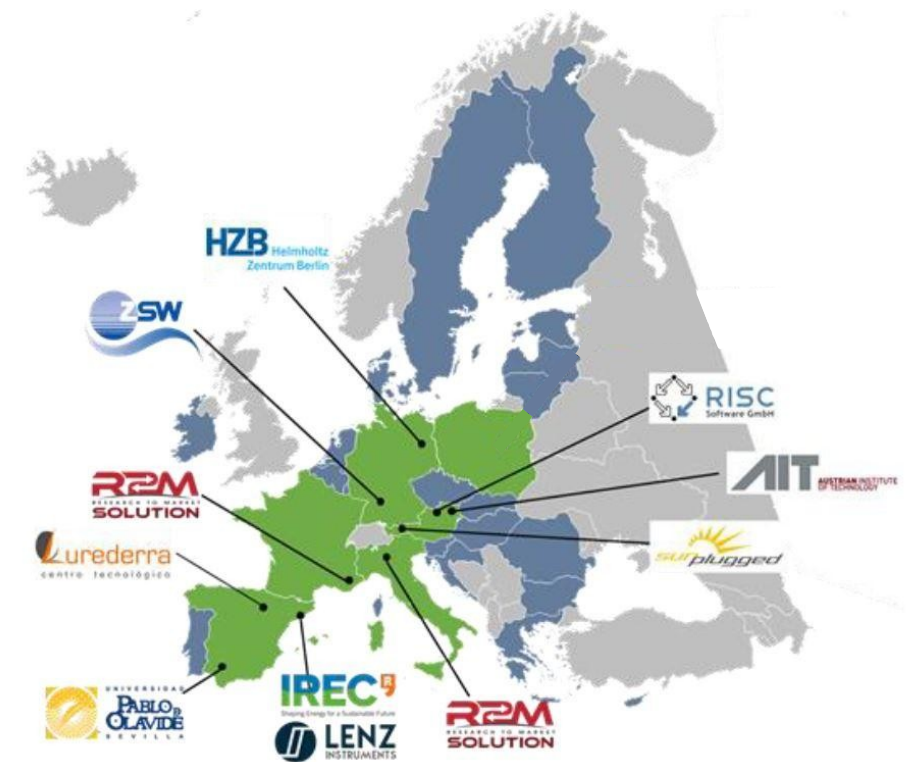
ABOUT THE PROJECT



- Platform-ZERO develops a new customizable in-line process monitoring platform, supported by Artificial Intelligence, for achieving zero-defect manufacturing for the PV Industry
- Project innovations will be tested in several industrial pilot plants across Europe
- The project aims to:
 - ✓ Substantially lower PV fabrication costs
 - ✓ Improve production quality of PV devices

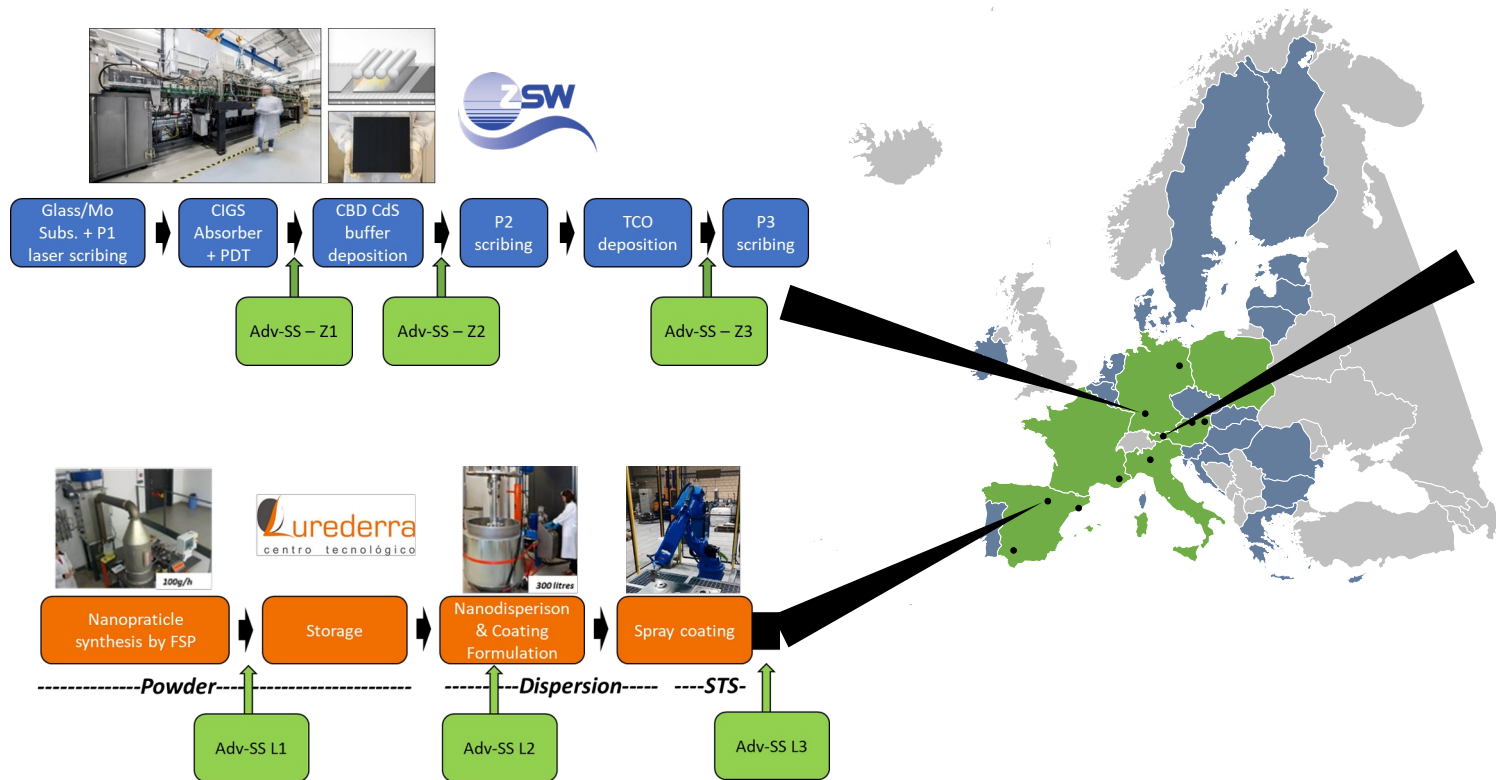


- **Four research centers** and **one university** with a strong knowledge in the development of spectroscopic methodologies, imaging, artificial intelligence and data management
- **Two research centers** with strong know-how in advanced PV technologies and with industrial pilot line facilities
- **A Metrology SME** with strong know-how in the implementation of industrial process monitoring applications
- **Two SMEs** in charge of dissemination, exploitation and communication actions

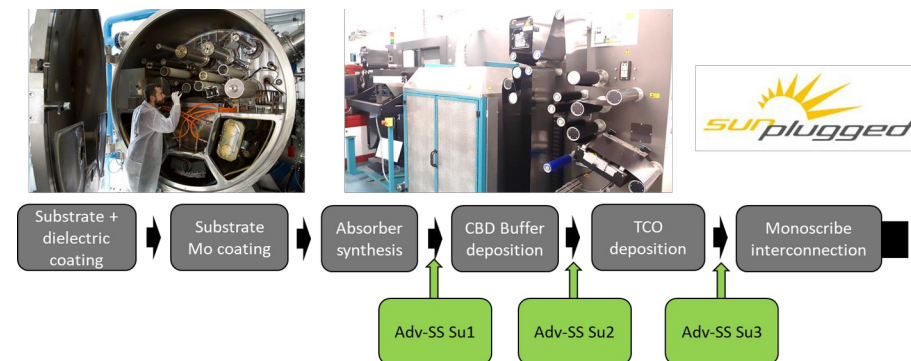


THE CONSORTIUM

Preindustrial environment



R&D Industrial environment





OBJECTIVES

1) Development of advanced sensor stations



2) AI system for autonomous monitoring and control



3) Implementation of a big data management infrastructure and control system



4) Implementation and installation of functional process monitoring platforms



5) PV manufacturing optimization





OBJECTIVES

1) Development of advanced sensor stations



2) AI system for autonomous monitoring and control



3) Implementation of a big data management infrastructure and control system

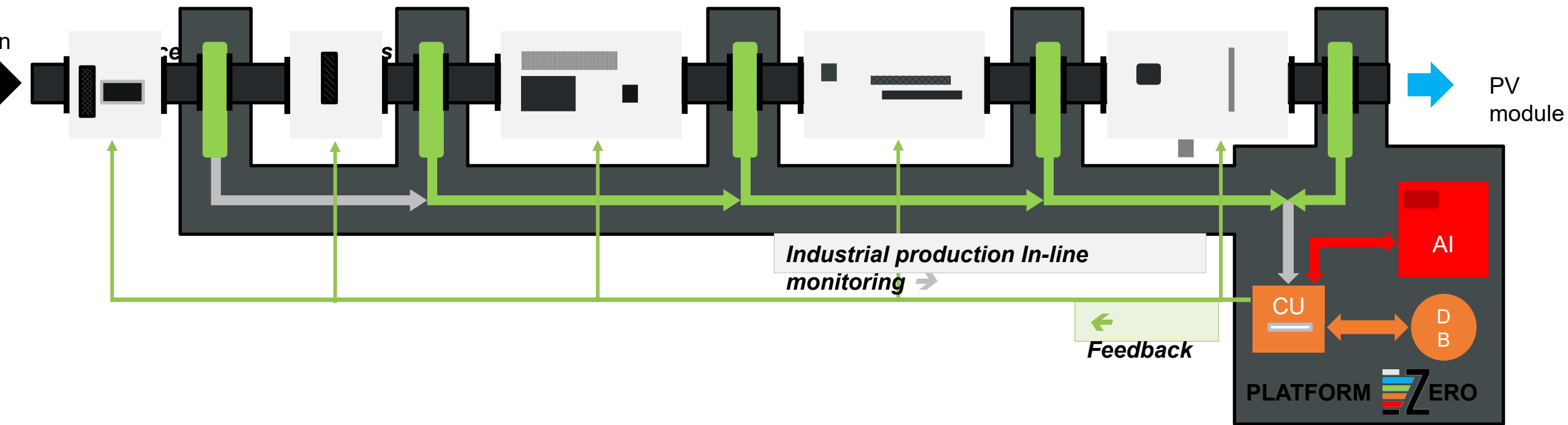


4) Implementation and installation of functional process monitoring platforms

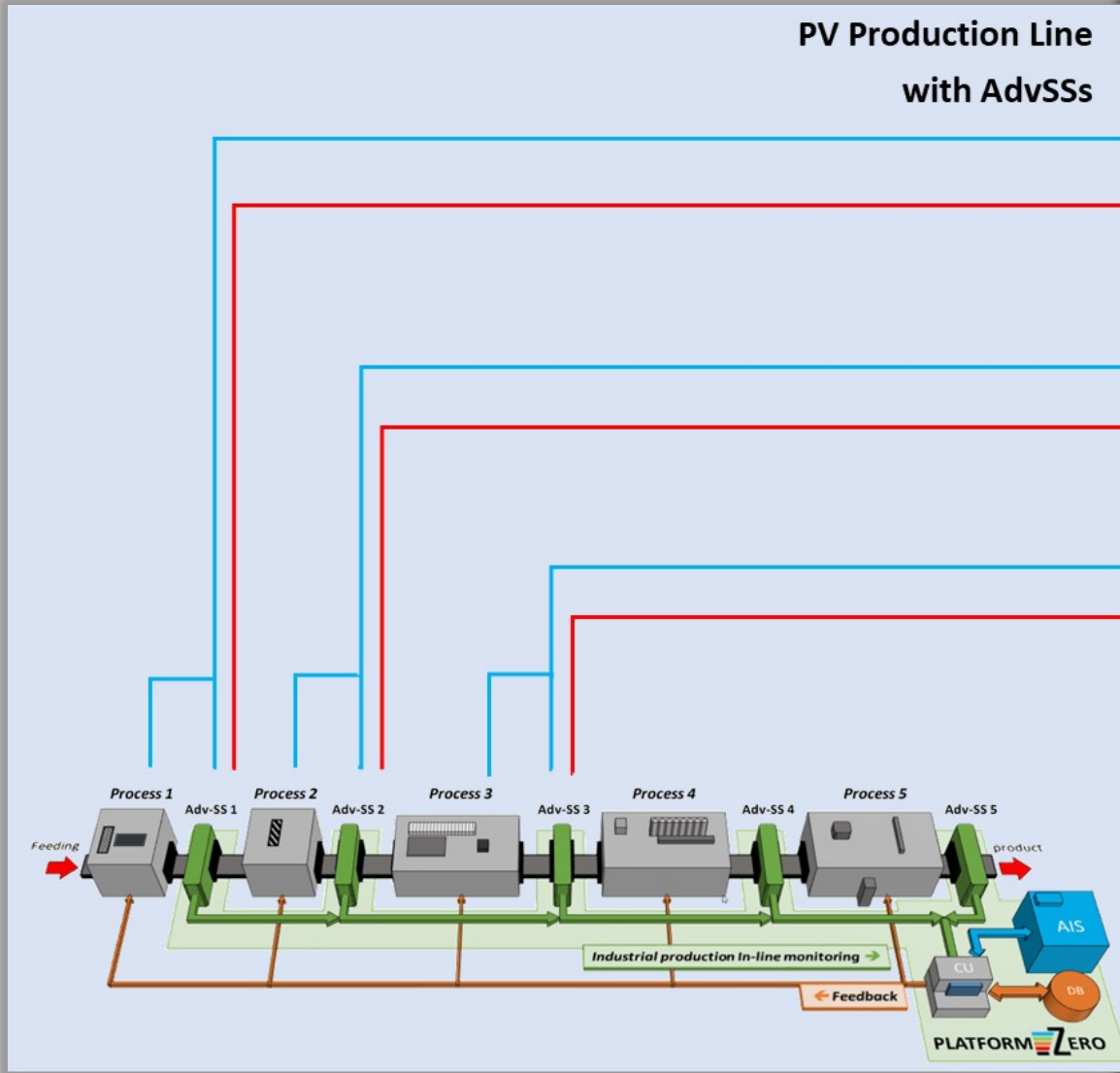


5) PV manufacturing optimization





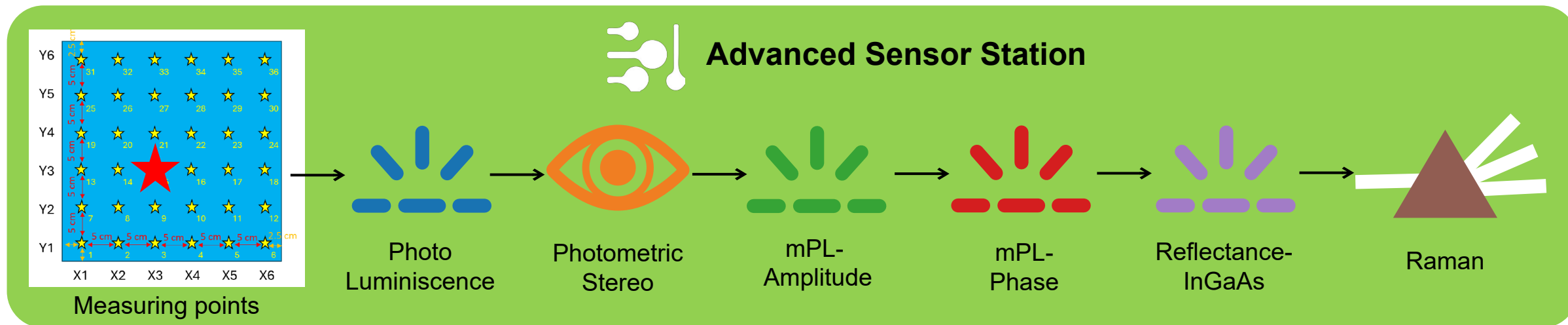
Data acquisition table



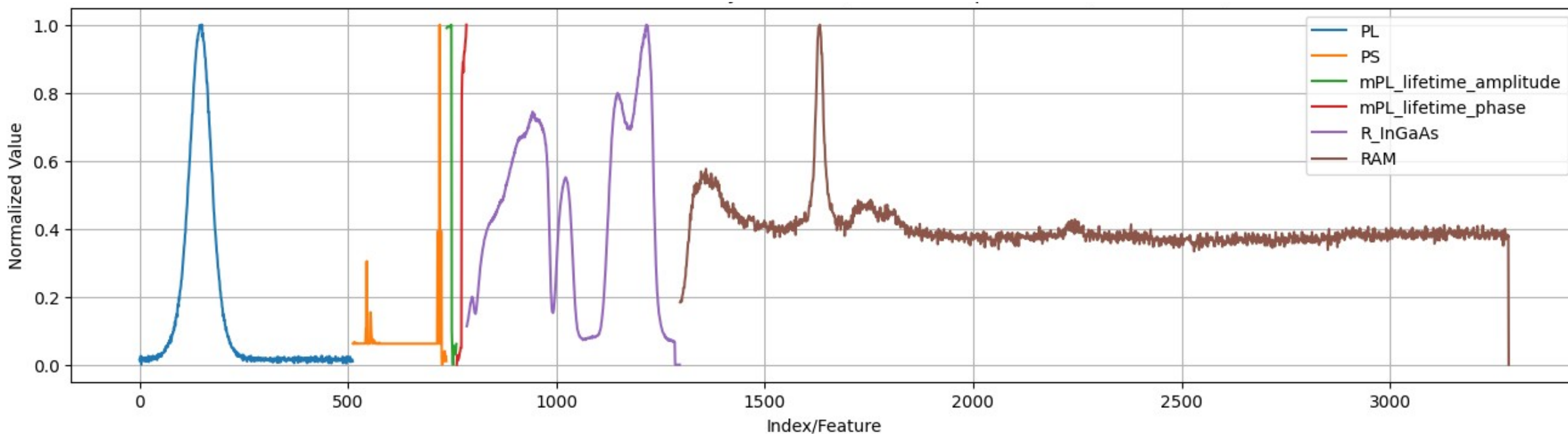
„Cloud“	Sample ID	Adv-SS ID	Sensor #	Parameters	Raw Data
	1	1	1	Acq. Speed=xx [m/s] Illumination = xx [W] Temperature = xx [°C]	Image 1 Image 2 Image 3
	1	1	2	Acq. Speed=xx [m/s] Energy= xx [mJ] Temperature = xx [°C]	Raman 532nm
	1	1	3	Acq. Speed=xx [m/s] Energy= xx [mJ] Temperature = xx [°C]	PL 405 PL 633
	1	2	1	Acq. Speed=xx [m/s] Illumination = xx [W] Temperature = xx [°C]	Image 1 Image 2 Image 3
	1	2	2	Acq. Speed=xx [m/s] Energy= xx [mJ] Temperature = xx [°C]	Raman 532nm
	1	2	3	Acq. Speed=xx [m/s] Energy= xx [mJ] Temperature = xx [°C]	PL 405 PL 633
	⋮				
					
	2	1	1	Acq. Speed=xx [m/s] Illumination = xx [W] Temperature = xx [°C]	Image 1 Image 2 Image 3
	2	1	2	Acq. Speed=xx [m/s] Energy= xx [mJ] Temperature = xx [°C]	Raman 532nm
	2	1	3	Acq. Speed=xx [m/s] Energy= xx [mJ] Temperature = xx [°C]	PL 405 PL 633
	⋮				



Modular Data-Fusion



Visualization of fused vector for all sensors at position X3Y3



Method:

- **Algorithm:** Linear Discriminant Analysis (LDA)
- **Labels:** Standard / Deviation + / Deviation – (± 2 % process variation)
- **Samples:** < 1000 sample points
- **Split:** 20 % train / 80 % test

Results:

- ≈ 90 % accuracy distinguishing standard vs. deviation samples
- Demonstrates system robustness and effective data fusion

Key Takeaways:

- Different sensors more applicable for different stages
- Flexible sensor integration confirmed
- Modular, scalable architecture validated

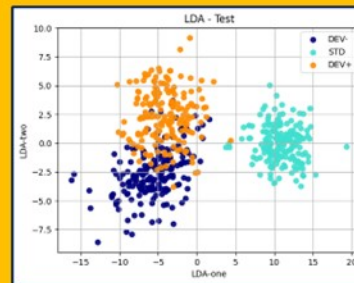
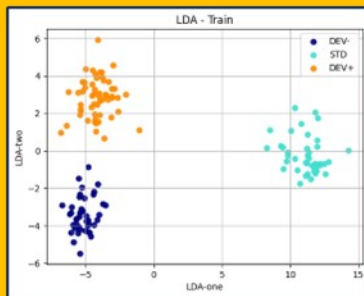
Results of LDA

Saule SAU3

S622 -2%

S615 STD

S620 +2%



Train 20% : Acc. = 1.0

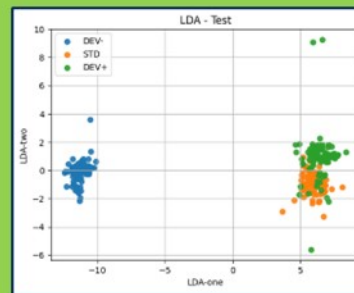
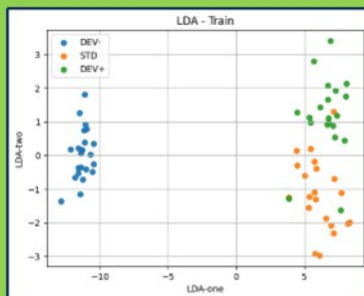
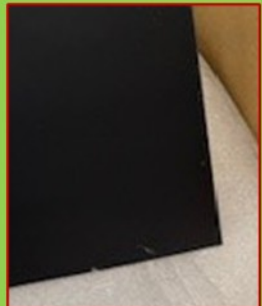
Test 80% : Acc. = 0.912

ZSW Z1

10137254: +2.5%

10137211: STD

10137190: -2,5%



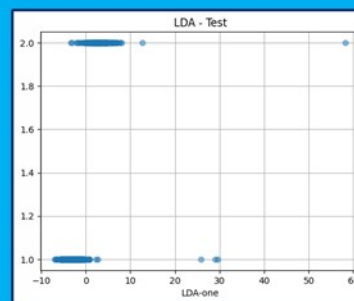
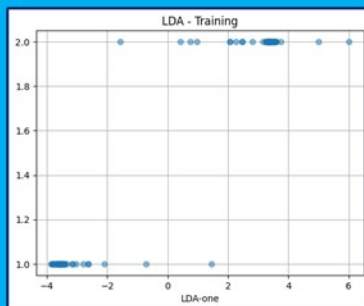
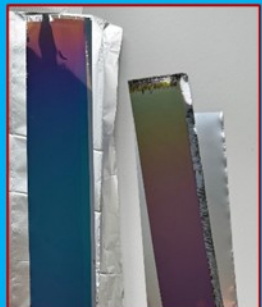
Train 20% : Acc. = 0.953

Test 80% : Acc. = 0.9117

Sunplugged SUN3

PZC4-ug1-1: STD

PZC4-ug1-2: thick



Train 20% : Acc. = 0.979

Test 80% : Acc. = 0.935



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THANK YOU, GET IN TOUCH!



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