D2.2 Challenges and proposal selection framework and performance KPIs_M17

30/04/2026

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ABBREVIATIONS & ACRONYMS

AI	ARTIFICIAL INTELLIGENCE
BAU	BUSINESS AS USUAL
COP	COMMUNITY OF PRACTICE
D	DELIVERABLE
DMP	DATA MANAGEMENT PLAN
DOA	DESCRIPTION OF ACTION
DOE	DESIGN OF EXPERIMENTS
DT	DIGITAL TWIN
D&C	DISSEMINATION AND COMMUNICATION
GA	GRANT AGREEMENT
HW	HARDWARE
KER	KEY EXPLOITABLE RESULT
KPI	KEY PERFORMANCE INDICATOR
L	LEAD
LCA	LIFE CYCLE ASSESSMENT
LCC	LIFE CYCLE COSTING
M	MONTH
ML	MACHINE LEARNING
MS	MILESTONE
O	OBJECTIVE
OC	OPEN CALL
P	PARTICIPANT
RP	REPORTING PERIOD
SME	SMALL AND MEDIUM-sized Enterprise
SO	SPECIFIC OUTCOME
SW	SOFTWARE
T	TASK
TRL	TECHNOLOGY READINESS LEVEL

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UC	USE CASE
WP	WORK PACKAGE
W.R.T	WITH RESPECT TO
FSTP	FINANCIAL SUPPORT TO THIRD PARTIES
RGB	RED, GREEN, BLUE
IRT	INFRARED THERMOGRAPHY
QA	QUALITY INSURANCE
EOL	END OF LIFE
NIR	NEAR-INFRARED
VIS	VISIBLE RANGE
O&M	OPERATION AND MAINTENANCE
FAQ	FREQUENTLY ASK QUESTION

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Executive Summary

The AID4SME project aims to advance Artificial Intelligence (AI) and Data-driven solutions tailored for Small and Medium-sized Enterprises (SMEs) and startups, fostering innovation and accelerating digital transformation. The project's approach is structured around four key pillars that encompass the full lifecycle of AI and Data Technologies: (1) data collection, (2) creation of insights, (3) decision support, and (4) automation. These pillars are supported by carefully selected high-TRL playgrounds (industrial sectors) and low-TRL playgrounds (academic and research settings), chosen based on two guiding principles: alignment with Green Deal objectives and strong market potential. The low- and high-TRL playgrounds will provide opportunities for SMEs to test and validate approaches and solutions, together with the AID4SME consortium to address challenges related to the Green Deal.

AID4SME provides a platform for SMEs and startups to demonstrate, validate, and scale their AI-driven solutions. Beyond technical validation, the project actively fosters knowledge exchange and ecosystem building through AI & Data events, networking opportunities, and educational programs through the formation of a Community of Practice (CoP). The CoP will guide SMEs and startups during the development, demonstration, and marketing of the challenge solutions, offering expert knowledge, firsthand market intelligence, and independent testing and validation facilities provided by the academic partners, where the SMEs and startups can safely exchange data and test and validate their low TRL solutions.

1 Introduction

In the previous deliverable 2.1 Challenges and proposal selection framework and performance, the report provided a comprehensive overview of the open challenge concept, the identified challenges, and the evaluation framework for selecting SME proposals and assessing solution performance through Key Performance Indicators (KPIs).

In the current deliverable 2.2 Challenges and proposal selection framework and performance, the report focuses on the learning form open call 1 and provides recommendations for open call 2.

This report aims to provide a comprehensive overview of the Open Call 2 challenges, which, building on the lessons learned from the first Open Call, introduce a fine-tuned, clearer, and more impactful set of challenges. The updated challenge framework reflects the experience gained during the definition, selection process and execution of Open Call 1 and translates these insights into concrete improvements in challenge structure, clarity, feasibility, and alignment with project objectives.

Key highlights include:

- The **integration of learnings from Open Call 1**, ensuring that the challenges are more precise, better structured, and more understandable for applicant SMEs, while addressing previously identified gaps and ambiguities.
- A **refined challenge definition framework for Open Call 2**, designed to enhance relevance, feasibility, and attractiveness,
- The **strengthening of environmental and sustainability considerations**, ensuring that the challenges adequately reflect Green Deal

2 Methodology

The methodology applied for the definition and consolidation of the Open Call 2 (OC2) challenges builds on a structured, evidence-based and participatory process, ensuring continuity from Open Call 1 (OC1) while incorporating improvements aligned with the observations and recommendations from the project.

The process started with the collection and consolidation of learnings from OC1, focusing on both the challenge definition and the execution of the open call. Inputs were gathered under Task 4.4, with contributions from LEITAT and I2M, capturing practical feedback related to clarity, feasibility, challenge structure and implementation aspects. These lessons learned constituted the primary evidence base for refining and strengthening the OC2 challenge design.

In parallel, a systematic integration of environmental and European Green Deal Key Performance Indicators (KPIs) was carried out to ensure that OC2 challenges adequately addressed sustainability and environmental impact requirements. Inputs provided by ISQ, based on a dedicated Green Deal KPIs framework, were reviewed and mapped against the proposed challenges to ensure consistent coverage of environmental objectives and alignment with policy priorities.

To reinforce SME inclusiveness and European coverage, a collaborative review process was implemented involving LEITAT, GreeneDIH, LTH, I2M and other partners. Challenges were assessed against SME needs in terms of technological maturity, sectoral diversity and geographical balance. Partner feedback was collected through a common template and consolidated by LEITAT to ensure coherence and comparability across inputs.

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Additionally, the attractiveness and market fit of the challenges were reviewed to maximise SME engagement. Contributions from F6S focused on improving wording, readability, clarity of scope and expectations, supported by applicant-oriented guidance and platform experience.

As task leader, LEITAT coordinated the overall consolidation process, leading the refinement of challenges through structured exchanges with partners. A series of targeted online meetings was organised to jointly review each challenge, validate requirements, and define relevant KPIs and parameters for solution performance assessment. This collaborative approach enabled the systematic collection and validation of partner inputs, ensuring that the final challenge set is robust, well-defined and measurable. The outcome of this process is formalised in Deliverable D2.2, which presents the final OC2 challenges, the proposal evaluation framework and the solution performance KPIs.

For further reference, Deliverable D2.1 provides a comprehensive description of the program framework and underlying concepts. It includes detailed information on the overall approach and objectives, the structure and implementation of the Open Calls, the defined technical domains, the configuration of Low-TRL and High-TRL playgrounds, and the established Key Performance Indicators. In addition, D2.1 describes the setup and operation of the Community of Practice, the technical support mechanisms, training activities, Open Call coordination processes, as well as the associated education programs and mentoring actions.

3 Observations

This section summarises the main observations arising from the implementation of the project activities. It is based on information collected during project execution, including monitoring results, feedback from participants and stakeholders, and practical experience gained throughout the different actions. The purpose of this section is to highlight key findings, recurring patterns, and relevant issues identified during the process, providing a clear and factual overview of what has been observed.

3.1 Challenge Attractiveness and Market Fit (F6S)

The “core dissemination funnel” worked well (website + webinars + social media).

- The OC1 webpage performed well (7,844 visits; 1,992 downloads of the Guidelines).
- The webinars were delivered without major issues and with effective Q&A sessions.
- The recordings achieved good view counts (e.g. 300 and 107 views).
- Social media and web articles: “good” performance, with partners actively reposting/resharing.

Applicant support and practical guidance: gaps identified

- F6S suggests including more practical examples/use cases in webinars and allocating more time to Q&A or a follow-up session.
- The purpose and intended audience of press releases were not always clear.

Visibility and outreach through events: current situation

- OC1 was promoted at four events, reaching more than 500 participants.

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- Partners explicitly recommend increasing participation in events during the OC2 application phase, with contributions from all partners.

3.2 Inclusiveness & European coverage (GreeneDIH / I2M / LOGI / LTH)

Widening Countries: pan-European openness, but no explicit widening measures

- GreeneDIH observes that the OC1 documentation did not include incentives or specific measures explicitly targeting Widening Countries. It recommends adding explicit wording and dedicated actions (regional webinars / info sessions).
- LOGI perceives a “well-balanced geographical distribution” and proposes maintaining the same communication strategy (dissemination via clusters; replicate in OC2).

Applicant support: generic, not region-differentiated

- GreeneDIH indicates that support mechanisms existed (helpdesk, webinars, mentoring, etc.), but no specific support was apparent for Eastern or Southern Europe.
- Dedicated Q&A sessions, proposal-writing webinars, and optional 1:1 support are recommended for Widening Countries.

Gender and diversity: not operationalised in evaluation

- Gender balance and diversity were not included as evaluation criteria.
- No structured reporting on gender or diversity aspects was implemented.
- This resulted in limited visibility and traceability of these aspects across partners.

Sectoral coverage and SME maturity: clear industrial focus, but no balance monitoring

The call focused clearly on industrial sectors (manufacturing, energy, batteries, white goods, logistics).

- Agriculture and other traditional sectors were not explicitly targeted.
- No monitoring of sectoral balance during evaluation was evident.
- SMEs and start-ups were eligible, but evaluation criteria were not adapted to maturity level.
- Low-TRL / high-TRL approaches and general mentoring existed, but without specific support for less mature SMEs.

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3.3 OC1 Learnings Impacting OC2 Design

Learnings related to challenge definition

- The overall scope of challenges was not sufficiently comprehensive.
- Several challenges planned at proposal stage were not launched in OC1.
- Challenge definition was largely treated as a one-off exercise.
- The innovation journey between low-TRL and high-TRL playgrounds was not always clear for applicants.
- KPIs related to resource optimisation, Green Deal impact and social impact were not consistently interpreted, with frequent confusion between technical and impact KPIs.
- A mismatch was observed between expected challenge scope and actual applications received.

Learnings related to annexes and evaluation framework

- Screening and pre-selection mechanisms were insufficient.
- Q&A handling became complex due to a high volume of repetitive questions.
- IP rules were not sufficiently clear in the annexes.
- Ethical aspects were not explicitly addressed in technical annexes.
- Rejection letters did not sufficiently highlight future opportunities within the project.

Learnings related to call execution and dissemination

- The very high number of applications put strong pressure on evaluation and management processes. The OC1 timeline was not suited for high application volume.
- Communication was not sufficiently targeted towards EU countries with participation gaps.
- Partners lacked real-time visibility on call status, leading to frequent ad hoc follow-ups.
- Dissemination of selected third parties is insufficient on time and content.
- Long gaps between submission deadlines and webinars reduced applicant momentum.

Learnings related to Action Plan preparation

- Many KPIs proposed by SMEs were: vague, not measurable, lacking data owners, or not verifiable within the project duration.
- This creates a risk of sustainability reporting becoming purely qualitative.
- Mentors were not systematically included when SMEs were informed of their selection.
- The link between milestones and payments was often unclear.

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- IP aspects remained insufficiently understood during the Action Plan phase.

Cross-cutting governance and coordination lessons

- Better internal coordination tools are needed to ensure transparency across partners.
- Regular status updates and shared monitoring tools would reduce fragmentation and duplication of efforts.

4 Recommendations

Based on the observations presented above, this section proposes a set of recommendations aimed at improving Open Call 2 (OC2) and maximising the overall project impact. These recommendations reflect the lessons learned and good practices identified during the project and Open Call 1 (OC1) and translate them into concrete and actionable suggestions for the design, dissemination, and implementation of OC2.

Recommendation 1. Maintain what works in "attractiveness" (and scale it)

Attractiveness is a key success factor in engaging SMEs and maximising the reach and quality of applications. The aim is to increase visibility, improve clarity, and further amplify outreach during Open Call 2 by reinforcing proven communication channels, formats, and tools, while ensuring consistency and efficiency across partners.

- Reuse the OC1 website structure for OC2 (same content architecture and CTAs). (Owner: F6S + I2M)
- More practical webinars: include concrete examples / use cases and more Q&A time or a follow-up session. (Owner: Green eDIH + F6S)
- Publish recordings immediately and amplify them through social media and the newsletter. (Owner: F6S + I2M)
- Improve LinkedIn performance to drive newsletter reach (impressions / reach). (Owner: F6S + I2M)
- More events during the OC2 application phase: set a minimum outreach target per partner. (Owner: All partners)
- Clarify the objective of the press release (promotional vs. media-oriented) and define the target audience. (Owner: I2M)
- Update the flyer and, if relevant, add event materials (roll-up, etc.) (Owner: F6S + I2M)

Recommendation 2. Making "Inclusiveness" measurable and explicit.

This recommendation therefore focuses on making inclusiveness explicit and measurable for Open Call 2, by translating project values and policy objectives into clear guidance, targeted support measures, and trackable indicators.

- Add explicit wording in the Guide for Applicants encouraging SMEs from Widening Countries, including a clear definition/list and a specific call-to-action (CTA). (Owner: LEITAT, with input from GreeneDIH and I2M)
- Dedicated widening actions: regional webinars, targeted Q&A sessions, and optional 1:1 support / proposal clinics. (Owner: I2M and GreeneDIH)
- Structured dissemination plan by partners, defining roles, regional targets, and minimum outreach actions. (Owner: LEITAT and I2M)
- Gender/diversity: introduce a reference within the “Impact” criterion (not necessarily as a hard requirement), include optional reporting, and add a self-declaration on equality/diversity policies. (Owner: LEITAT and I2M, with input from GreeneDIH)
- Internal monitoring: track the distribution of applications and selected projects by geography, sector, and SME type to identify gaps (including analysis of non-selected applicants). (Owner: LEITAT and I2M)

Recommendation 3. Strengthen OC2 Design Based on OC1 Learnings

This recommendation therefore focuses on translating OC1 learnings into concrete design improvements for Open Call 2, strengthening the coherence between challenge scope, evaluation criteria, KPIs, and implementation mechanisms.

- Apply an iterative challenge definition process for OC2.
- Open the challenges not launched in OC1 and refine or reduce others to ensure balance.
- Clarify low-TRL and high-TRL playground roles and transition points.
- Introduce mandatory KPI dimensions at challenge definition and selection stages.
- Strengthen screening and pre-selection mechanisms to address the high number of applications (Owner: F6S).
- Improve Q&A handling through structured FAQs and involvement of challenge owners.
- Reinforce Action Plan preparation with early KPI validation, clearer IP guidance, mentor involvement, and alignment between milestones and payments.
- Elaborate a roadmap as living document, therefore the partners are updated about the status of the OC2 (Owner: F6S)

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5 Challenges

The challenges addressed by this project are crucial for tackling climate change, enhancing resource efficiency, and promoting social cohesion. These efforts are vital for spreading innovation across Europe's regions and are central to the EU's twin transitions towards a sustainable and digital economy, which are essential for maintaining EU competitiveness.

SMEs play a pivotal role in bringing innovative solutions to these challenges. AID4SME provides the necessary infrastructure and learning environment to empower SMEs to tackle these challenges.

The 11 challenges for the open call 2 are listed in the table 1. The project offers both low- and high-TRL playgrounds, providing SMEs opportunities to test and validate their approaches and solutions. This collaborative effort with the AID4SME consortium aims to address challenges related to the Green Deal.

TABLE1. OPEN CALL 2 CHALLENGES

CHALLENGE IDENTIFIER	CHALLENGE NAME
CHALLENGE 1.1	AUGMENTED SENSING SOLUTION
CHALLENGE 2.1	PRODUCT-PRODUCTION DIGITAL TWINS
CHALLENGE 2.2	AUTOMATED MONITORING HYGIENE INSPECTION FOR REFURBISHMENT
CHALLENGE 2.3	ENERGY SYSTEM DIGITAL TWIN DECISION SUPPORT TOOL
CHALLENGE 2.4	AUTOMATED MACHINE SELECTION FOR PARTS PRODUCTION
CHALLENGE 2.5	BATTERY PRODUCTION DIGITAL WORK INSTRUCTIONS AND SKILL CAPTURING
CHALLENGE 2.6	DIGITAL TWIN BASED LIFESPAN ANALYSIS TOOL
CHALLENGE 3.2	AUTOMATED WAREHOUSE AND INTERNAL LOGISTICS MANAGEMENT
CHALLENGE 4.1	AUTOMATED ENERGY MANAGEMENT FOR PARTS PRODUCTION
CHALLENGE 4.3	SEMI-AUTOMATED EV BATTERY DISASSEMBLY FOR RECYCLING: INTRODUCTING DIGITAL WORK INSTRUCTIONS
CHALLENGE 4.4	CO-BOT REFRIGERATOR DOOR ASSEMBLY SOLUTIONS

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5.1 Challenge 1.1 - Augmented sensing solution

Challenge and context

Forces, stress, torques, and power are direct indicators of a system's well-being. However, these quantities are typically expensive, difficult, and intrusive to measure. Digital twins approach within AID4SME can help alleviate these hurdles for use cases inside and outside the consortium. Digital twins offer a paradigm shift where computational models of various complexities are merged in a coherent framework and linked to online measurement data available on a physical system. This paradigm allows for a hyper-realistic representation of process behaviour, enabling novel engineering applications and process improvements, such as virtual or augmented sensors. Augmented sensing uses cheap, readily available, non-intrusive, and robust physical sensors to collect data from the real asset component in a digital twin. The desired, yet unknown, quantities are estimated, resulting in a real-time/online virtual sensor fed with real measurement data enriched with physical insights.

Use case and expected solution

Within the consortium, Arçelik requires an augmented sensing solution for its refrigerator production facility, which undergoes approximately 120 mold changes per month. Each change necessitates manual, iterative adjustments, causing about 60 tons of polyurethane waste and about 60 minutes of facility downtime per mold change. This results in approximately 5 million euros in annual costs due to production capacity loss. The solution will enable accurate monitoring of forces, stresses, or other relevant physical quantities during plastic mold changes in the refrigerator production line. It will provide real-time feedback and predictive insights to reduce manual intervention and iterative adjustments during mold changes, minimize polyurethane waste, and reduce facility downtime. For this industrial high TRL application, Arçelik has foreseen the following Key Performance Indicators (KPIs): (i) First time-right adjustment of the mold; (ii) Reduce facility downtime by 15%; (iii) Decrease annual waste by 30 tons; (iv) reduction in energy consumption per mold change. These KPIs are initial indicative numbers and may evolve during the execution of the projects. Besides this high-TRL application, KU Leuven has technology blocks available at TRL 4 and low-TRL playgrounds to develop and test augmented sensing solutions, specifically for mecha(tro)nic system level dynamics, and model-based augmented sensing in electro-thermo-mechanical applications in the manufacturing industry. For application on the low-TRL research lab playgrounds, the focus will be on the technological development of the augmented sensing solution together with the SME.

Specification for use case

SMEs are invited to propose a use case leveraging their own technology or solving their problems at hand, which will be further elaborated together with the consortium partners. Inspirational examples can be based on system identification, parameter estimation, force estimation, etc. The consortium offers low-TRL research lab playgrounds as well as one high-TRL industrial application (as detailed above). SMEs applying for this challenge should specify which TRL level they would like to target. For the industrial application, three consortium partners will support SMEs in developing an augmented sensing solution to optimize the mold adjustment phase, targeting difficult-to-measure quantities and ensuring a comprehensive understanding of the manufacturing process. The data will be fed to an AI-based digital twin decision support tool, enabling first-time-right adjustment of the mold by the operator.

Key Performance Indicators

Key Performance Indicators (KPIs) should be defined as clear, objective criteria that demonstrate the relevance and impact of the proposed solution, covering at least two of the following dimensions—resource optimisation, Green Deal objectives, and social impact—and must be SMART (Specific, Measurable, Achievable, Relevant and Time bound), ensuring they remain quantifiable throughout the project

Green Deal impact
Examples of KPIs adequate for measuring the Green Deal alignment of previous proposals for this challenge:
- First-time-right adjustment of the mold
- Reduce facility downtime by X%
- Decrease annual waste by X tons.
- Product life extension - Increase in mean time between product replacements
- Energy saved - Energy otherwise wasted in start/stop cycles & idling
- Material footprint intensity - Reduction in combined material use
- CO2e avoided - Greenhouse-gas savings

Examples of KPIs not adequate for measuring Green Deal alignment of previous proposals for this challenge:
- GDPR compliance - Handling of user data under GDPR and clinical standards
- Quality Certification - Compliance with EU compost standards.

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5.2 Challenge 2.1 - Product-production Digital Twins

Challenge and context

Traditional design cycle paradigms in manufacturing have been optimised to their limits, and further gains are expected from cross-stage optimisation through combined AI and Data solutions. Digital information is becoming available in large amounts during different stages of product design, manufacturing, useful life, and recycling. Digital twins enable the collection and comprehensive management of all digital information linked to a unique product asset, exploiting it for added value creation within the same stage at which the data was collected. Leveraging these technologies, the manufacturing industry is on the verge of fully reaching Industry 4.0's digitalization potential, where digital twins play a central role at both the product level and at the production level. Manufacturers are striving to reduce their ecological footprints by minimising energy consumption, material use, and waste. AID4SME is committed to overcoming these challenges for use case owners both inside and outside the consortium.

Use case and expected solution

Inside the consortium, Arçelik operates extruder processes to blend virgin plastic material with plastic scrap. Flaws in the mixing rate can lead to discolouration and cracking, generally caused by high ratios of recycled material. Arçelik seeks a product-production digital twin solution to optimise material mixing ratios based on real-time measurement of visual and mechanical properties of the different plastic source materials. This aims to increase the ratio of recycled plastic, enhancing sustainability while maintaining quality and reducing scrap. Additionally, Arçelik's consumer electronics refurbishing factory, which refurbishes over 50000 products annually, seeks to reduce the amount of refurbished products by combining augmented sensing (cf. challenge 1.1) and a product-production Digital Twin to optimise End-of-Life Product Refurbishment processes by assessing the health and predicting the remaining lifespan of components. For this industrial high-TRL application, Arçelik has foreseen the following activities/Key Performance Indicators (KPIs): (i) improvement of existing sensors and integration of new ones in the extruder machine; (ii) integration of visual, dimensional (width, length, thickness) and mechanical quality control systems into the existing extruder machine; (iii) creation of a digital twin of the developed system; (iv) determination and control of optimal process parameters (screw, speed, mold and barrel temperatures, gear pump pressure, cooling water temperatures, material mixing ratios, etc.) using AI and data analysis; (v) reduction in maintenance costs, waste rates, and energy consumption; (vi) 5% increase (1200 tons) in recycled plastic content in Arçelik refrigerator products; (vii) resolving 95% of quality control issues; (viii) reduction in virgin material usage. This list is not exhaustive but rather indicative. Additional KPIs will be studied and can be integrated to ensure quality outcomes. Besides this high-TRL application, KU Leuven has technology blocks available at TRL 4 and low-TRL playgrounds, namely a fully equipped injection moulding laboratory facility, to develop and test related solutions. This allows to link the manufacturing process to product quality in mecha(tro)nic applications. For application on the low-TRL research lab playgrounds, the focus will be on the technological development of a dedicated product-production simulation framework for injection moulding manufacturing processes.

Specification for use case

SMEs are invited to propose a use case leveraging their own technology or solving their problems at hand, which will be further elaborated together with the consortium partners. Inspirational examples can be based on system identification, quality control, process parameter optimisation, etc. The consortium offers low-TRL research lab playgrounds as well as one high-TRL industrial application (as detailed above). SMEs applying for this challenge should specify which TRL level they would like to target. For the industrial application, the consortium partners will guide and mentor SMEs to deploy a straight-through digitalization (STD) approach in the challenges. More specifically for this challenge, a product-production digital twin for their extruder processes for blending virgin and regrind plastic and masterbatch materials will be developed and demonstrated at TRL 6 at the high-TRL playground of Arçelik.

Key Performance Indicators

Key Performance Indicators (KPIs) should be defined as clear, objective criteria that demonstrate the relevance and impact of the proposed solution, covering at least two of the following dimensions—resource optimisation, Green Deal objectives, and social impact—and must be SMART (Specific, Measurable, Achievable, Relevant and Time-bound), ensuring they remain quantifiable throughout the project

Green Deal impact

Examples of KPIs adequate for measuring the Green Deal alignment of previous proposals for this challenge:

- % increase in recycled plastic content in X product
- Reduction in waste rate
- Reduction in energy consumption
- Recycled content in final parts
- Scrap Rate with High PCR Content

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5.3 Challenge 2.2 - Automated monitoring hygiene inspection for refurbishment

Challenge and context

Currently, within the consortium, Arçelik handles approximately 70,000 returned or rejected products per year. These products are processed through an automated sorting system in which each unit is scanned via a QR code, providing access to its complete historical documentation and traceability information, including an initial assessment of its refurbishment potential. For products identified as suitable for refurbishment, cleanliness and surface condition are assessed individually using swab tests and ATP detectors, requiring approximately 30 minutes per product. Although effective, this approach is time-consuming, provides limited spatial information, and does not support predictive or scalable, data-driven decision-making.The main challenge, therefore, lies in improving how cleanliness, sanitation, and surface condition are assessed in manufacturing and refurbishment processes, while reducing inspection time and supporting objective refurbishment decisions

Use case and expected solution

This use case focuses on the development of an AI-based decision-making model to objectively determine the cleanliness status and surface condition of manufacturing equipment and parts. The proposed solution combines AI with optical sensing technologies to enable contactless, scalable, and industrially applicable cleanliness monitoring.

Multispectral and hyperspectral vision, together with infrared thermography, can be used for the early assessment of cleanliness and hygiene conditions in manufacturing and refurbishment environments. Hyperspectral imaging (HSI) enables the capture of objective, spatially resolved information on surface contamination, including organic residues (e.g. proteins, fats, and sugars), moisture, and cleaning-agent residues, over large areas and without physical contact. Infrared thermography (IRT) complements this capability by identifying temperature anomalies associated with residual moisture, improper cleaning, or incomplete drying processes. Compared to conventional RGB imaging, multispectral and hyperspectral data provide significantly richer spectral information, enabling more reliable discrimination of surface conditions and contamination types. Currently, LEITAT has the HSI and IRT systems available under laboratory conditions to develop a proof of concept of an AI-based predictive model for cleanliness assessment at TRL 4. Arçelik will provide the industrial playground, contributing real manufacturing equipment and parts to train the models and supporting their validation under real industrial operating conditions

Specification for use case

SMEs are invited to propose a use case that contributes to the development of an AI-based predictive model and demonstrates the capability to integrate and validate HSI- and/or IRT-based decision-making models in industrial environments, bridging laboratory developments and production-line implementation. In particular, the consortium is interested in engaging SMEs capable of providing and deploying multi/hyper-spectral imaging (HSI) cameras or proposed optical sensing technologies for testing and validation under real industrial operating conditions.The consortium offers a low-playground, provided by LEITAT, where optical sensing technologies and AI-based decision-making models can be developed and validated under laboratory conditions, and a high-playground, provided by Arçelik, where the developed solutions can be tested, integrated, and validated under real industrial operating conditions

Expected solution

AI-based, contactless inspection system that assesses the cleanliness and surface condition of manufacturing equipment and refurbished products by combining hyperspectral imaging (HSI) and, where applicable, infrared thermography (IRT). The system will generate objective, spatially resolved cleanliness indicators by detecting organic residues, contamination, moisture, and cleaning-agent residues over large surface areas, supporting automated and data-driven refurbishment decisions. Developed initially as a proof of concept under laboratory conditions at LEITAT (TRL 4), the solution will be integrated and validated in real industrial environments at Arçelik, enabling scalable deployment in manufacturing and refurbishment processes while reducing inspection time, costs, and waste

Key Performance Indicators

Key Performance Indicators (KPIs) should be defined as clear, objective criteria that demonstrate the relevance and impact of the proposed solution, covering at least two of the following dimensions—resource optimisation, Green Deal objectives, and social impact—and must be SMART (Specific, Measurable, Achievable, Relevant and Time bound), ensuring they remain quantifiable throughout the project

Resource optimisation

-Inspection time per day: Reduced from ~2hours (ATP/swabs) to minutes using AI based optical inspection
-Labour efficiency: ~126,000 labour hours saved per year (based on 70,000 units)
-Spare part recovery efficiency: Increase to 90% for refurbishment eligible products
-Annual cost savings: Approx. €13.6 million/year (avg. product value €130)

Green Deal impact

-Impact: Returned products reused~70,000 units/year refurbished instead of discarded
-Material savings: Approx. 7,000 tonnes of material saved/year (≈100 kg per unit)
-Reduction in consumables: Decrease in swabs, reagents, water, and cleaning chemicals
-Carbon footprint reduction: Lower emissions due to reduced new manufacturing and logistics

Social impact

-Worker safety & ergonomics: Reduced repetitive manual inspections via contactless sensing
-Workforce upskilling: Introduction of AI based inspection and decision support tools
-Job quality: Shift from manual inspection tasks to higher value supervisory roles

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5.4 Challenge 2.3 - Energy system Digital Twin decision support tool

Challenge and context

Grid operators increasingly face grid balancing challenges due to rising energy demand and the growing share of decentralized renewable energy production. To balance power generation and demand, a portfolio of energy storage technologies can be deployed, including electrochemical storage (e.g., batteries, hydrogen technologies) and thermal energy storage. Thermal storage can play a significant role by shifting heating or cooling loads, improving sector coupling, and reducing peak electricity demand. Moreover, with the advances in thermophotovoltaic (TPV) technology that provides conversion from heat to electricity, thermal storage enables output of both electricity and heat.

However, energy conversion and storage equipment, including both electrical and thermal systems, incur capital and operational expenditures that ultimately affect the final price of delivered energy. Optimal sizing and integration of local renewable generation, electrical storage, and thermal energy storage are therefore essential to achieving an economically efficient and flexible energy system.

Due to numerous variables, such as time-dependent profiles of energy consumption (electric and thermal), renewable generation, storage state dynamics, and dynamic pricing signals, and their nonlinear interdependencies, optimal system configurations cannot be derived analytically. This challenge calls for AI and data-driven solutions to optimally size, coordinate, and control distributed energy resources, including microgrids with integrated thermal and electrical storage.

Use case and expected solution

A Digital Twin (simulation model) of local energy systems and real-life measurements of energy consumption will represent a core of the playground. The provided Digital Twin enables simulation of thermal and electrical energy balance over a desired time and observing economic results as a function of equipment sizes and prices. The digital twin will be used to experiment and test microgrid control algorithms for different pricing scenarios. The main focus of the scenarios will be on inclusion of novel thermal energy storage solutions and provision of ancillary grid services.

Specification for use case

The selected third party is expected to have experience with provision of ancillary (grid) services and is expected to contribute with the following:

- Develop an optimization algorithm for optimal sizing of a microgrid components using a microgrid Digital Twin
- Develop a microgrid grid energy control algorithms using predictions of heat and electricity needs
- Implement and test the developed solutions in a digital environment with real world data and for different scenarios
- Demonstrate operational scenario of ancillary grid services together with the use of thermal storage solution

Key Performance Indicators

Key Performance Indicators (KPIs) should be defined as clear, objective criteria that demonstrate the relevance and impact of the proposed solution, covering at least two of the following dimensions—resource optimisation, Green Deal objectives, and social impact—and must be SMART (Specific, Measurable, Achievable, Relevant and Time bound), ensuring they remain quantifiable throughout the project

Resource optimisation

• Decrease of investment for energy storage system for the reference scenario (% reduction in CAPEX for energy storage),

• Decrease costs of electricity and heat for the reference scenario utilizing predictive energy storage and smart energy management,

Green Deal impact

Examples of KPIs adequate for measuring the Green Deal alignment of previous proposals for this challenge:

- Improve local consumption of renewable energy (% increase in renewable energy self-consumption),

- Ancillary service fulfillment rate (%), share of requested ancillary service energy/power that is successfully delivered. (Delivered service / Requested service) × 100

- Ancillary service activation success rate (%), percentage of service requests that are activated correctly and on time

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5.5 Challenge 2.4 - Automated machine selection for parts production

Challenge and context

Many complex production processes are still partially controlled by operators with highly specialized, tacit knowledge that is difficult to formalize and document, posing risks to product quality, process reliability, and long-term industrial competitiveness if lost. At the same time, shopfloor operations often rely on simple but repetitive manual tasks, such as pick-and-place activities involving movement between workstations, which require coordinated perception, manipulation, and locomotion but are rarely described in a way that enables direct automation. The challenge is therefore twofold: to capture and structure human instructions and operator know-how, and to translate them into executable actions for robotic systems operating in dynamic production environments. In this context, adaptive DWI are essential, as they enable instructions to be both human- and machine-readable and adaptable to operational conditions.

The AID4SME framework provides a foundation for addressing these challenges through AI-driven decision support, knowledge representation, and cyber-physical systems. As a representative use case, the project focuses on enabling a humanoid robot to learn and execute a simple pick-and-place task with locomotion between workstations based on human-provided instructions. This use case represents the execution layer of decision support, where high-level decisions—such as machine selection for parts production—are translated into actionable instructions and physically carried out on the shopfloor by the robot. In this way, the project demonstrates a practical pathway for bridging human expertise, AI-based decision-making, and autonomous robotic execution in real production environments.

Use case and expected solution

The challenge addresses the need to formalize and digitalize operator knowledge and translate it into actionable instructions for robotic systems. Capturing and representing this knowledge requires combining structured knowledge capture methodologies with AI-based approaches capable of linking human actions with process context. The use case focuses on a practical and demonstrable scenario, where a humanoid robot learns and executes a simple pick-and-place task involving locomotion between workstations based on human-provided instructions.

The proposed solution leverages imitation learning and reinforcement learning to enable the robot to learn from demonstrations and structured DWI, transforming human-readable instructions into robot-executable workflows. The approach is supported by theoretical and methodological developments, including knowledge representation, instruction modelling, and AI-based learning strategies.

The resulting system will demonstrate that a humanoid robot can reliably execute a defined task in an industrial setting, enabling improved process consistency, reduced dependency on manual execution, and a scalable pathway for integrating human-centric AI and humanoid robotics into smart manufacturing systems.

Specification for use case

The use case focuses on enabling a humanoid robot to autonomously perform a simple pick-and-place task involving locomotion between two or more workstations in a production environment at LTH Castings. The humanoid robot is to be provided by the solution provider and is not part of the playground infrastructure. The task includes object detection, grasping, transportation, and precise placement, while navigating safely between predefined locations on the shopfloor.

The system shall support the following functional specifications:

• Task definition and execution: Pick an object from a defined source location (e.g., bin or fixture), Walk to a target workstation using predefined or dynamically generated paths, Place the object at a designated position with sufficient accuracy and repeatability

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• Instruction handling: Input provided as human-readable instructions (text and/or video-based demonstrations), Transformation of instructions into structured DWI, Conversion of DWI into robot-executable action sequences
• Learning and adaptation: Use of imitation learning for initial task acquisition, Use of reinforcement learning for optimisation and robustness, Ability to adapt execution based on environment conditions (e.g., object position variability)
• Perception and navigation: Multi-modal perception using stereo vision (≥3 cameras) and LiDAR, Object detection and localisation, Environment mapping and safe navigation between workstations
• Development approach: Initial validation in simulation environment (digital twin of workspace), Gradual transition to real-world deployment (Sim2Real), Use of virtual sensors and synthetic data where applicable. The use case focuses on enabling a humanoid robot to autonomously perform a simple pick-and-place task involving locomotion between two or more workstations in a production environment at LTH Castings. The humanoid robot is to be provided by the solution provider and is not part of the playground infrastructure. The task includes object detection, grasping, transportation, and precise placement, while navigating safely between predefined locations on the shopfloor.

The system shall support the following functional specifications:
• Task definition and execution: Pick an object from a defined source location (e.g., bin or fixture), Walk to a target workstation using predefined or dynamically generated paths, Place the object at a designated position with sufficient accuracy and repeatability
• Instruction handling: Input provided as human-readable instructions (text and/or video-based demonstrations), Transformation of instructions into structured DWI, Conversion of DWI into robot-executable action sequences
• Learning and adaptation: Use of imitation learning for initial task acquisition, Use of reinforcement learning for optimisation and robustness, Ability to adapt execution based on environment conditions (e.g., object position variability)
• Perception and navigation: Multi-modal perception using stereo vision (≥3 cameras) and LiDAR, Object detection and localisation, Environment mapping and safe navigation between workstations
• Development approach: Initial validation in simulation environment (digital twin of workspace), Gradual transition to real-world deployment (Sim2Real), Use of virtual sensors and synthetic data where applicable.

Expected solution

The resulting system will demonstrate that a humanoid robot can reliably execute a defined task in an industrial setting, enabling improved process consistency, reduced dependency on manual execution, and a scalable pathway for integrating human-centric AI and humanoid robotics into smart manufacturing systems.

Key Performance Indicators

Key Performance Indicators (KPIs) should be defined as clear, objective criteria that demonstrate the relevance and impact of the proposed solution, covering at least two of the following dimensions—resource optimisation, Green Deal objectives, and social impact—and must be SMART (Specific, Measurable, Achievable, Relevant and Time bound), ensuring they remain quantifiable throughout the project

Resource optimisation

• Successful execution of the full pick–transport–place cycle
• Task execution speed reaching at least 50% of human baseline performance
• Instruction-to-execution setup time ≤ 4 hours
• Reliable operation across multiple repetitions with consistent results

Green Deal impact

Examples of KPIs adequate for measuring the Green Deal alignment of a proposal for this challenge:
- Part damage or scrap rate during automated pick–transport–place operations (%)
- Energy consumption per successfully completed handling cycle (Wh/cycle or kWh/100 cycles)

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5.6 Challenge 2.5 - Battery production digital work instructions and skill capturing

Challenge and context

Battery manufacturing processes combine automated inspection systems with human decision-making in critical steps such as electrode coating and quality control. In such contexts, inspection systems (e.g. camera-based solutions) can be used to detect defects during production, but detecting a defect is only the first step: Operators must determine which actions should be taken to correct the issue or prevent its recurrence, such as checking machine parameters or investigating upstream causes. In current production practice, the corresponding corrective actions remain dependent on operator expertise. These decisions rely heavily on operator expertise, which is often tacit, experience-based, and not systematically captured. At the same time, industrial initiatives such as electronic workstations (eWS) aim to centralize documentation and ensure compliance, but do not capture how experienced operators respond to specific production situations, such as defect occurrences.
As a result, knowledge related to defect handling and process adjustments remains largely tacit, leading to variability in decision-making across operators and shifts. This impacts product quality, process stability, and scalability, particularly in fast-growing environments such as gigafactories.
The challenge is therefore to capture, structure, and formalize operator knowledge related to defect handling and decision-making, and to integrate it into adaptive DWI that complement existing eWS systems by providing context-aware, actionable guidance to operators during production.

Use case and expected solution

The use case focuses on defect detection and operator intervention recommendation in battery production, particularly in electrode coating process where identified anomalies require human decision-making. When a defect is detected, operators must decide which machine parameters to verify, which corrective actions to perform, or whether upstream processes are the root cause.
The expected solution aims to capture (vision-based or sensor-based approaches) and formalize expert knowledge associated with defect handling and translate it into adaptive digital work instructions integrated with workstation-level systems. This includes:

- Linking detected defects to recommended corrective actions or parameter checks
- Providing context-aware guidance based on process conditions and operational context
- Supporting operators with relevant documentation, alerts, and task-specific instructions
- Ensuring traceability between defect detection, decisions taken, and outcomes

The proposed approach combines knowledge representation methods with AI-based techniques capable of modelling relationships between defect patterns, process conditions, and operator decisions/solutions for resolving the production problems. The solution should extend existing documentation systems (e.g., eWS) by enabling dynamic, situation-aware guidance rather than static instructions.
The resulting system will demonstrate improved process consistency, reduced variability in defect handling, and enhanced operational efficiency, contributing to more robust and scalable battery manufacturing processes.

Specification for use case

The use case focuses on supporting operator decision-making in response to defects detected by inspection systems, while integrating with existing workstation-level documentation systems.
The system shall support the following functional specifications:

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- Defect-driven guidance:

Identification of defect types from inspection systems and mapping to recommended corrective actions or parameter checks

- Instruction handling and integration:

Transformation of expert knowledge into structured Digital Work Instructions
Integration with existing documentation systems (e.g., work instructions, checklists, safety procedures)
Delivery of alerts and updates when instructions or process conditions change

- Skill and context awareness:

Consideration of operator qualifications (e.g., training, certification) when delivering guidance
Adaptation of instruction detail based on operator experience level

- Knowledge capturing and modelling:

Extraction and formalisation of expert decision-making practices
Linking operator actions with process conditions and outcomes

- Traceability and monitoring:

Recording of actions taken and checks performed (e.g., process controls before/during manufacturing)
Monitoring of compliance with required procedures

- Development approach:

Initial validation in a controlled lab environment (low TRL)
Progressive integration and demonstration in an industrial pilot environment (TRL7) The use case focuses on supporting operator decision-making in response to defects detected by inspection systems, while integrating with existing workstation-level documentation systems.
The system shall support the following functional specifications:

- Defect-driven guidance:

Identification of defect types from inspection systems and mapping to recommended corrective actions or parameter checks

- Instruction handling and integration:

Transformation of expert knowledge into structured Digital Work Instructions
Integration with existing documentation systems (e.g., work instructions, checklists, safety procedures)
Delivery of alerts and updates when instructions or process conditions change

- Skill and context awareness:

Consideration of operator qualifications (e.g., training, certification) when delivering guidance
Adaptation of instruction detail based on operator experience level

- Knowledge capturing and modelling:

Extraction and formalisation of expert decision-making practices
Linking operator actions with process conditions and outcomes

- Traceability and monitoring:

Recording of actions taken and checks performed (e.g., process controls before/during manufacturing)
Monitoring of compliance with required procedures

- Development approach:

Initial validation in a controlled lab environment (low TRL)
Progressive integration and demonstration in an industrial pilot environment (TRL7)

Expected solution

The resulting solution will demonstrate improved process consistency, reduced variability in defect handling, and enhanced operational efficiency, contributing to more robust and scalable battery manufacturing processes.

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Key Performance Indicators

Key Performance Indicators (KPIs) should be defined as clear, objective criteria that demonstrate the relevance and impact of the proposed solution, covering at least two of the following dimensions—resource optimisation, Green Deal objectives, and social impact—and must be SMART (Specific, Measurable, Achievable, Relevant and Time-bound), ensuring they remain quantifiable throughout the project

Resource optimisation

• Reduction in scrap rate associated with defect handling
• Improved consistency of operator decisions across shifts and teams
• Reduction in defect recurrence due to improved corrective actions
• Reduction in response time to detected defects
• Improved compliance with procedures and execution of required process controls

Green Deal impact

Please ensure that KPIs are measurable throughout the project duration and avoid vague, indirect, purely technical/performance oriented or non-quantifiable indicators. These KPIs should highlight how your proposal advances one area (or several) within the Green Deal scope and objectives.

Examples of KPIs adequate for measuring the Green Deal alignment of a proposal for this challenge:
- Reduction in scrap rate associated with defect handling (%)
- Reduction in material waste per battery cell or electrode (kg/unit)
- Reduction in energy consumption linked to rework and repeated inspections (%)

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5.7 Challenge 2.6 - Digital Twin based lifespan analysis tool

Challenge and context

Manufacturers are striving to reduce ecological footprints by minimizing energy consumption, material use, and waste. ARC operates two relevant processes: (1) an extruder process blending virgin plastic with plastic scrap, where flaws in mixing ratios cause discoloration, cracking and scrap parts; and (2) a consumer electronics refurbishing factory processing over 50,000 products annually, where the health and remaining lifespan of components cannot be systematically assessed, limiting the repurposing of parts and the accuracy of warranty and pricing decisions.

Use case and expected solution

Leveraging Digital Twin technology combined with AI and Data solutions, ARC seeks a product-production Digital Twin to: (1) optimize material mixing ratios in its extrusion process based on real-time measurement of visual and mechanical properties of plastic source materials, increasing the ratio of recycled plastic while maintaining quality; and (2) assess the health and predict the remaining lifespan of components in its refurbishment operations. The solution will be demonstrated at TRL 6, building on technology blocks available at TRL 4 within KUL's Digital Twin Experience Centre (DTEC).

Specification for use case

A Digital Twin-based lifespan analysis tool (KER4) will be developed and demonstrated at TRL 6 for ARC. The tool implements a straight-through digitalization (STD) approach, digitally connecting product design, manufacturing, useful life, and recycling stages in a closed loop. KUL, supported by LOGI, will guide and mentor SMEs in deploying STD. The tool will determine the remaining life of products and parts, enabling optimized refurbishment decisions, adjusted warranty periods and pricing, and responsible management of end-of-life products. A Digital Twin-based lifespan analysis tool (KER4) will be developed and demonstrated at TRL 6 for ARC. The tool implements a straight-through digitalization (STD) approach, digitally connecting product design, manufacturing, useful life, and recycling stages in a closed loop. KUL, supported by LOGI, will guide and mentor SMEs in deploying STD. The tool will determine the remaining life of products and parts, enabling optimized refurbishment decisions, adjusted warranty periods and pricing, and responsible management of end-of-life products.

Expected solution

Leveraging Digital Twin technology combined with AI and Data solutions, ARC seeks a product-production Digital Twin to: (1) optimize material mixing ratios in its extrusion process based on real-time measurement of visual and mechanical properties of plastic source materials, increasing the ratio of recycled plastic while maintaining quality; and (2) assess the health and predict the remaining lifespan of components in its refurbishment operations. The solution will be demonstrated at TRL 6, building on technology blocks available at TRL 4 within KUL's Digital Twin Experience Centre (DTEC).

Key Performance Indicators

Key Performance Indicators (KPIs) should be defined as clear, objective criteria that demonstrate the relevance and impact of the proposed solution, covering at least two of the following dimensions—resource optimisation, Green Deal objectives, and social impact—and must be SMART (Specific,

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Measurable, Achievable, Relevant and Time-bound), ensuring they remain quantifiable throughout the project

Resource optimisation

- Reduction in waste generated during refurbishment due to optimized part reuse
- Reduction in warranty-related costs due to data-driven lifespan predictions
- Increased ratio of parts repurposed as spare parts from discarded products

Green Deal impact

-Increased share of recycled plastic material used in extrusion processes
- Reduction in scrap produced during extrusion and refurbishment operations
- Contribution to circular economy through extended product and component lifecycles

Social impact

- Contribution to sustainable manufacturing practices benefiting local communities and supply chains
- Support for responsible and resourceful management of end-of-life products

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5.8 Challenge 3.2 - Automated warehouse and internal logistics management

Challenge and context

Manufacturing companies increasingly operate highly automated and complex production environments, in which internal logistics such as buffer warehouses management, pallet flows, automated forklifts operations, and the deployment of AMRs have a direct impact on production continuity, energy consumption, and overall operational efficiency. This is particularly relevant in metal-part production settings, where production rhythms can be variable, intermediate buffers are often constrained, and disturbances can rapidly propagate across the shop floor.
Despite the increasing levels of automation in production equipment, the execution and coordination of internal logistics are still frequently governed by fixed rules, manually triggered actions, or dispatcher-based decision-making. As a result, logistics resources are often used sub-optimally, leading to inefficient fleet utilization, unnecessary transport movements, delayed machine supply, increased operator effort, and avoidable production interruptions. In such environments, the lack of real-time coordination between production needs and logistics execution becomes a major barrier to both efficiency and resilience.

Typical inefficiencies include:
- delayed response to machine-originated transport requests;
- poor prioritization of urgent logistics tasks;
- unnecessary empty movements and excessive transport distances;
- low fleet utilization due to unbalanced task allocation;
- weak coordination between conventional forklifts and AMRs;
- reduced resilience under disturbances such as machine stoppages, variable cycle times, and temporary congestion.

Digital Twin based control and decision-support frameworks address these limitations by enabling a more integrated, event-driven, and adaptive approach to internal logistics management. By combining real-time machine signals, logistics state information, and operational context, such frameworks can support dynamic task generation, prioritization, fleet allocation, and routing decisions. This is especially relevant in industrial contexts characterized by heterogeneous equipment, variable demand patterns, and frequent disturbances. However, effective deployment remains challenging due to the complexity of the underlying decision architectures, the need to integrate smoothly with existing machines, forklifts, AMRs, and IT systems, and the requirement to ensure practical usability in real production environments. AID4SME is flexible to overcome these challenges for use case owners inside and outside the consortium. Inside the AID4SME consortium, LTH would like to develop a smart planning tool for their automated buffer warehouse and internal logistics system. This digital twin-based tool should enable them to optimise internal workflows for the automated transporting the around 200 pallets on the shop floor.

Use case and expected solution

The expected outcome is a smart, dynamic, AI-optimized fleet management engine that uses machine-triggered inputs (KLICI s stroja) as operational events, dynamically assigns transport tasks, optimizes resource use within the agreed scope, and provides an operator-facing communication layer for forklift operators and AMRs. The solution requirements are as follows:

1. Data availability and event inputs

For challenge preparation and low-TRL research activities, partners will work with pre-provided historical data samples and clearly documented data schemas by LTH. These are expected to include data such as, where available:

- machine-triggered inputs;
- machine and line status signals;
- warehouse and buffer status;
- pallet and material flow data;
- forklift task logs and localisation data;
- AMR mission and execution data;
- operator interaction logs; and
- production planning and order context.

Live data ingestion, system integration, and validation against the industrial environment are led by the selected SME together with LTH in the higher-TRL playground. LTH will clarify which data are directly available, which are only available as historical samples, and which indicators would need to be derived by the SME.

Data and developed solutions should be made available for non-commercial (research) purposes to consortium members beyond the project duration, and a dual-licensing approach allows consortium members, especially LTH, to use the solution after project completion.

2. route and fleet management

The core decision-support logic should assign tasks to available resources on the basis of constraints such as fleet availability; capability constraints; expected travel time and execution time; route constraints. The primary objective is to develop and validate an internal route and fleet management solution that interprets machine-triggered logistics inputs and supports prioritization and task allocation across conventional forklifts and one AMR demonstrator (AMR to be provided by solution provider). The selected SME may combine optimisation methods, scheduling algorithms with AI-based approaches.

3. Operator and system communication

The solution should include an operator-facing dispatch and feedback interface through which tasks are communicated to operators. This may take the form of an operator terminal, mobile interface, dashboard, or another practical dispatching mechanism proposed by the SME together with LTH in the higher-TRL playground. The interface should support actions such as:

- task notification;
- task acknowledgement or acceptance;
- completion feedback;
- exception handling; and
- reassignment of urgent machine-linked requests.

Specification for use case

The goal of this challenge is to move beyond static or reactive dispatching practices towards a data-driven solution of internal transport resources capable of improving responsiveness, reducing inefficiencies, and supporting more robust and sustainable production operations. The solution will be validated at TRL 6 in the LTH industrial environment through a pilot demonstration on the selected production line. The solution includes one AMR demonstrator provided by solution provider. Validation will assess technical feasibility, operational robustness, and measurable logistics improvement under realistic factory conditions. For external SME use cases, transferable results and deployment concepts will be evaluated up to TRL 7.

Expected solution

The primary objective is to develop and validate a solution enabling LTH to optimize efficiency, reduce logistics energy consumption, and production stops.

Key Performance Indicators

Key Performance Indicators (KPIs) should be defined as clear, objective criteria that demonstrate the relevance and impact of the proposed solution, covering at least two of the following dimensions—resource optimisation, Green Deal objectives, and social impact—and must be SMART (Specific, Measurable, Achievable, Relevant and Time-bound), ensuring they remain quantifiable throughout the project

Resource optimisation

1. Improvement in fleet utilization, measured as the proportion of productive transport time relative to total fleet availability for forklifts and AMRs.
2. Reduction in empty travel distance, measured as non-productive distance per vehicle per shift.
3. Decrease in production stops caused by logistics delays, measured as the number and duration of machine stoppages caused by missing material, delayed pickup, or unavailable transport.
4. Reduction in response time to machine calls, measured from event generation to task assignment and task completion.
5. Improvement in warehouse and buffer space utilisation efficiency, measured through occupancy patterns, dwell time, and turnover efficiency.
6. Task completion reliability, measured as the percentage of logistics tasks completed within the required service window.

Green Deal impact

Examples of KPIs adequate for measuring the Green Deal alignment of a proposal for this challenge:
1. Reduction in internal logistics energy consumption, measured per shift and normalised per manufactured product unit.
2. Reduction in empty travel distance, measured as non-productive distance per vehicle per shift.

Social impact

1. Reduction in manual operator interventions, measured as the decrease in manually dispatched or manually corrected transport tasks per shift.
2. Reduction in operator time spent on logistics coordination, measured in minutes per shift or per production batch.

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5.9 Challenge 4.1 - Automated energy management for parts production

Challenge and context

In high-volume and energy-intensive industrial parts production, a significant share of energy losses occurs during unplanned machine downtime, such as micro-stoppages, quality control stops, disruptions caused by tool malfunctions, or other unexpected interruptions. Unlike planned non-production periods, these events are often unmanaged from an energy perspective, leading to machines and auxiliary systems remaining in fully powered states while no value-adding operations take place.
This challenge focuses on industrial production cells for parts manufacturing, where machines operate in cyclical modes and rely heavily on auxiliary and spatially distributed energy consumers, such as tool tempering units and compressed air systems. These subsystems remain in standby and continue to consume energy even when production cycles have stopped unexpectedly, resulting in unnecessary energy use, increased operational costs, and higher environmental impact.
LTH currently operates several production cells where machine cycle information is available at PLC or sensor level; however, automated energy-aware control of auxiliary energy consumers during unplanned downtime is not yet implemented. Operators intervene manually or not at all, and auxiliary systems often remain in full operation during downtime.
The challenge addresses the need to automatically detect machine cycles, identify unplanned downtime events in real time, determine appropriate energy mitigation strategies and dynamically transition machines and auxiliary equipment into appropriate standby or off modes. On the other hand, the estimated preparation time to continue production should be predicted and orchestrated control of auxiliary systems should be performed at process startup, without compromising production readiness or product quality once production resumes.

Use case and expected solution

The expected solution should provide an automated energy management system that continuously monitors machine cycle signals, production states, and energy consumption within an industrial production cell and provides an orchestrated control of most significant consumers linked to the observed operation. The solution shall include a smart tool tempering unit for aluminium diecasting process capable of individual monitoring and control of each tempering circuit within the diecasting tool and integration capability for real-time measurement, visualization and regulation with aim to intgrate it within the demonstrated system.

Specification for use case

the system shall:
1. Automatically detect machine cycle starts, normal cycle operation, cycle interruptions, and unplanned downtime events using realtime data.
2. Distinguish between short microstoppages and longer unplanned downtime to select appropriate energy saving strategies.
3. Dynamically control machine operation states (e.g. run, standby, offmode) during unplanned downtime.
4. Specifically optimize the operation of energy intensive auxiliary systems, with focus on Tool tempering unit (TTU) and Air Management System (AMS).

The solution will use data driven methods, combining rule-based logic with AI or machine learning

techniques, to learn normal cycle behavior, automatically detect deviations, and continuously improve downtime classification and energy saving decisions. Moreover, it should provide a reliable indicator of the estimated time needed for re-activation of the auxiliary systems.
The developed solution should be demonstrated in the industrial environment, where communication with the auxiliary systems should be resolved using standard communication protocols (OPC-UA, MODBUS, etc.). Finally, the control of auxiliary services (TTUs and AMS) shall operate autonomously, without reliance on manual operator input, while remaining fully compatible with production control systems, safety constraints, and quality requirements.

Expected solution

· Machine cycle detection from PLC signals, sensors, or energy signatures.
· Realtime identification of unplanned downtime events.
· Integration of monitoring and automated control of compressed air pressure and airflow, including supply of IoT-enabled AMS.
· Integration of automated control of TTU and supply of suitable TTU for the pilot.
· Energy aware control interfaces for production cell supporting standby and off modes.
· Orchestrated and on-time management of startup phases.

Demonstration and validation under real production conditions with varying unplanned downtime scenarios.

Key Performance Indicators

Key Performance Indicators (KPIs) should be defined as clear, objective criteria that demonstrate the relevance and impact of the proposed solution, covering at least two of the following dimensions—resource optimisation, Green Deal objectives, and social impact—and must be SMART (Specific, Measurable, Achievable, Relevant and Time-bound), ensuring they remain quantifiable throughout the project

Resource optimisation

The demonstrated solution will enable LTH to significantly reduce nonproductive energy consumption in parts production cells while maintaining production flexibility and responsiveness.
The impact of the developed solution will evaluate changes compared to the baseline conditions (operation without the energy management system):
· Percentual reduction of energy consumption during unplanned downtime for managed machines and linked auxiliary systems.
· Percentual reduction in compressed air flow during unplanned downtime.
· Percentual increase in production recovery time, measuring the delay between cycle restart and stable production.

Green Deal impact

Examples of KPIs adequate for measuring the Green Deal alignment of a proposal for this challenge:
- Percentual reduction of energy consumption during unplanned downtime for managed machines and linked auxiliary systems.
- Percentual reduction in compressed air flow during unplanned downtime.
- Percentual increase in production recovery time, measuring the delay between cycle restart and stable production.

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Examples of KPIs not adequate for measuring Green Deal alignment of previous proposals for this challenge (they do not translate a direct quantifiable benefit in terms of the Green Deal):
- Accuracy of energy consumption forecasts - Measures the accuracy of the digital twin's energy consumption predictions against actual measured values. (%)
- Production schedule adherence - Tracks any deviation from the planned production schedule caused by the AI control system, ensuring optimization does not impact output. (% deviation)

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5.10 Challenge 4.3 - Semi-automated EV battery disassembly for recycling: introducting digital work instructions

Challenge and context

Complex assemblies, such as EV batteries and motors, across manufacturers and vehicle models vary significantly. E.g., virtually each battery type has its own type of cables, bus bars, battery modules, and different types of cells. This variability makes the automation of EV drivetrain components dismantling for recycling challenging. Additionally, current EV batteries subjected to recycling are mainly Li-ion based, posing a multitude of hazards for recycling processes. Automating each process for each battery type is time-consuming and costly, if at all possible. Given the end-of-life state of such assemblies, there is often little to no reliable information on their internal composition, condition, or hazards. Therefore, battery recycling companies are (sub)consciously building a mental, written, or digital catalog of product-specific datapoints, based on the operator's experience.
Capturing both operator actions and hazardous components (whether mechanical, electrical, chemical, or thermal) and subsequently registering them uniformly for each product type/variant would allow, on one hand, a more efficient manual disassembly for recurring models by integrating digital work instructions, and on the other hand, the opportunity to, where possible, automate specific hazardous, unergonomic, or repetitive tasks.

Use case and expected solution

A consortium partner has a laboratory for EV motor and battery dismantling available, with an industrial robot at TRL 4, specifically focusing on developing flexible human-machine collaborative demanufacturing processes. This partner has several technology blocks at TRL 4, leveraging computer vision and AI technologies from other areas, enabling the development of dismantling operations for different products without requiring specific robot programming for each. Another partner has significant knowledge and experience regarding, specifically, battery-related hazards and the required safety precautions.
A missing key element is an operator interface that enables structured recording of manual operations, hazards, and status feedback, based on which the system can later present product-specific work instructions to the operator. All relevant product and process data should be logged in the Digital Product Passport (DPP), which can then be utilized to base future robotic/manual work instructions on.
The consortium partners will support the selected SME by providing the following contributions:
• A suitable lab environment for the final demonstration, including a workbench setup with product clamping, a top frame for a projector and cameras, tool mounting, and demo case study products, including a dummy EV battery assembly and EV motors.
• A draft DPP data structure. The partner will demonstrate the use of the registered data in the DPP by the robotic disassembly system.
• In-depth knowledge and guidance in battery-related safety hazards.

Specification for use case

The consortium partners will guide and mentor SMEs to develop the operator's interface for a robot cell for semi-automatic dismantling of various EV component types, extending to overall mechatronic system demanufacturing approaches. In this solution, a human operator manually records operations on newly encountered products, of which some will later be performed by industrial robots and some, which a robot cannot perform, will still be performed by the operator, although supported by digital work instructions. • Position accuracy of the recorded locations: The position accuracy of the recorded locations and operations should be at least ±10mm and ±10°.

• Reduction in teaching time for new product types: Increase the speed at which a new product type can be taught for robotic disassembly by a minimum of 50%, comparing manual data logging versus the implemented technologies.

• Improvement of operator workload and usability: Demonstrate a measurable reduction in mental and physical workload associated with manual disassembly by implementing projected digital work instructions. This should be evaluated by comparing a limited guided approach (e.g. with printed paper instructions) with the proposed system, in a manner similar to [1], using a structured assessment method such as the NASA Task Load Index [2]. Evaluation should consider mental demand, physical demand, temporal demand, effort, frustration and perceived performance, while maintaining at least the same task success rate.

• Reduction in time for supporting and intermediate actions: Achieve a minimal time reduction of 50% for supporting and intermediate disassembly actions, such as tool switching, picking and placing components in designated bins, cutting cables, or repositioning the product. These improvements should be measured separately from primary disassembly actions (e.g., unscrewing or prying), which are not expected to be significantly impacted by digital work instructions.

• Completeness of hazard logging and visualization: Log and clearly display all relevant hazard warnings on component/location level.

[1] W. Mahy, D. Gors, B. Van Doninck, H. Qin and J. R. Peeters, "Projection-Based Augmented Reality to Support Human Intervention in Robotic Disassembly: A Case Study for Bike Batteries," 2026.

[2] S. G. Hart and L. E. Staveland, "Development of NASA-TLX (Task Load Index): Results of empirical and theoretical research," 1988.

Expected solution

• Detection and logging of manual operations and hazards

Detect and evaluate the manually performed operations, using common/smart hand tools (e.g., screwdrivers, pliers, cutters) and hand tracking (e.g., component pickup and component drop off), also incorporating hazard logging.

• Storage of manual operations and product data in a Digital Product Passport (DPP)

All relevant parameters (such as fastener locations and types, and relevant hazards) should be saved in a standardized digital format so that they can later be used to perform human-robot cooperative disassembly tasks on the same model type. All disassembly operations should be registered in such a way that a reusable (chrono)logical disassembly sequence is compiled.

• Digital work instruction visualization

Intuitively display digital work instructions by projecting them on the workbench (2m width and 1,2 m depth) and on the product itself to reduce mental overload and to align instructions directly with the product and setup. To allow for the projection of markers and instructions on the complex geometries of the case study products, 3D mapping and multi-angle projection are required.

• Hazard warning and monitoring visualization

Clearly display relevant operator safety instructions during manual disassembly. For example, highlight electrical contacts of battery modules that may still hold a charge, sharp objects, unknown chemical substances, warm surfaces, and other potential hazards. Use clear and unambiguous pictograms to reduce language dependence and support a safer working environment. In addition, proposals that include complementary monitoring systems are encouraged. This may include the integration of thermal vision systems, not only to detect potential thermal runaway events and trigger both local (work cell) and plant-wide safety alarms, but also to support monitoring, testing, and validation activities during disassembly operations.

Key Performance Indicators

Key Performance Indicators (KPIs) should be defined as clear, objective criteria that demonstrate the relevance and impact of the proposed solution, covering at least two of the following dimensions—resource optimisation, Green Deal objectives, and social impact—and must be SMART (Specific, Measurable, Achievable, Relevant and Time-bound), ensuring they remain quantifiable throughout the project

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5.11 Challenge 4.4 - Co-bot refrigerator door assembly solutions

Challenge and context

The development of new automation technologies for the manufacturing industry directly contributes to efficiency, safety, and human factors. Modular, reconfigurable, energy-efficient, and collaborative robots can enable industries to optimize their operations, reduce waste, lower their environmental impact, and improve human operator job attractiveness. The white goods factory of a partner is one area where collaborative robots can make a significant difference. This partner will provide a use case for their refrigerator production line, where refrigerator gaskets of different shapes and sizes are installed on refrigerator doors. Manual installation of the refrigerator gaskets poses ergonomic challenges, resulting in inefficiencies and potential product rejections. Partial (co-bot) automation of gasket installation, particularly flexible elastomer gaskets, presents unique challenges that require the integration of collaborative robotics and AI to optimize the installation process. This ensures precision, safety, and adaptability to the deformable nature of elastomers, as the co-bot must apply the right force on the flexible material without causing deformation. The partner seeks a co-bot solution to overcome these challenges while aligning with the Green Deal's focus on promoting worker well-being and safety.

Use case and expected solution

Another partner has a catalogue of developed technologies validated
in the lab (TRL 4), building on results from previously funded EU projects related to collaborative assembly. These technologies will be combined with 2D/3D video analysis technology blocks. The partner has several low-TRL playgrounds based on these technologies. The solution enables to improve efficiency, operator ergonomics, and inclusiveness, and reduce waste. This will result in more efficient production processes, better utilization of machinery, and enhanced overall operational efficiency. The expected solution will advance the catalogue of technologies and apply them in a working solution for the gasket installation use-case at TRL6. This will enable to improve efficiency, operator ergonomics, and inclusiveness, and reduce waste. This will result in more efficient production processes, better utilization of machinery, and enhanced overall operational efficiency. It will be demonstrated at TRL 6 and will offer the means to be advanced to even higher TRL, including with all safety requirements for factory deployment. The AID4SME solutions will foster a sustainable and inclusive digital transition that benefits both manufacturing companies and society at large.

Specification for use case

The consortium partner will guide and mentor SMEs to further develop the technology bricks using their low-TRL playground and adapt these technologies for deployment in other industry sectors. For the “bring your own use-case” challenges, co-bot solutions will be demonstrated at TRL 5-6. This will enable improved efficiency, operator ergonomics, and inclusiveness, decrease waste, and increase the longevity of refrigerator doors through enhanced stability of gasket installation quality.

Instruction handling and integration:

- Transformation of expert knowledge into structured Digital Work Instructions
- Integration with existing documentation systems (e.g., work instructions, checklists, safety procedures)
- Delivery of alerts and updates when instructions or process conditions change.

Skill and context awareness:

- Consideration of operator qualifications (e.g., training, certification) when delivering guidance.

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- Adaptation of instruction detail based on operator experience level.
Knowledge capturing and modelling:
- Extraction and formalisation of expert decision-making practices
- Linking operator actions with process conditions and outcomes.
Traceability and monitoring:
- Recording of actions taken and checks performed (e.g., process controls before/during manufacturing)
- Monitoring of compliance with required procedures
Development approach:
- Initial validation in a controlled lab environment (low TRL)
- Progressive integration and demonstration in an industrial pilot environment (TRL7)

Expected solution

The selected third party is expected to contribute with the following: 1. Develop a co-bot-assisted gasket installation solution 2. Integrate AI-based perception and control systems to allow the co-bot to adapt to different gasket shapes and models. 3. Ensure compliance with safety and ergonomic standards, by reducing physical strain on human workers and improving workplace safety with co-bot working 4. Demonstrate human-robot collaboration capabilities, where the co-bot supports rather than replaces the human operator, ensuring intuitive interaction and task sharing.

Key Performance Indicators

Key Performance Indicators (KPIs) should be defined as clear, objective criteria that demonstrate the relevance and impact of the proposed solution, covering at least two of the following dimensions—resource optimisation, Green Deal objectives, and social impact—and must be SMART (Specific, Measurable, Achievable, Relevant and Time-bound), ensuring they remain quantifiable throughout the project

Resource optimisation

- Demonstrate effective and flexible autonomous processes (% 10 increase in assembly precision).
-Increase quality: robotized processes can more easily detect errors in production during the process itself (%10 reduction in installation errors).
- %5 reduction in waste due to assembly defects

Green Deal impact

Examples of KPIs adequate for measuring the Green Deal alignment of a proposal for this challenge:
- %5 reduction in waste due to assembly defects

Social impact

-Ensure the safety of workers in the vicinity.
- Improved efficiency: reduce the number of workers required at the production line (%50 reducing labour for gasket assy).
- Operator ergonomics: reduce operator/worker effort, as they will be able to focus on other tasks.
- Percentage of operators trained in safe procedures

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6 Conclusions

This report provides a consolidated framework for the definition of challenges, the selection of proposals, and the assessment of solution performance within the AID4SME project. Building on the experience gained during Open Call 1, it translates operational learnings into a refined and coherent approach designed to support the effective implementation of Open Call 2.

The defined challenges are structured across the full AI and data value chain—ranging from data collection to automation—and are explicitly anchored in both low-TRL and high-TRL playgrounds. This dual-playground approach ensures that selected SMEs can validate their solutions in controlled research environments while progressing towards industrial-scale demonstration and deployment. By maintaining a strong link between technological ambition, industrial relevance, and Green Deal objectives, the challenge framework supports solutions with clear market potential and societal impact.

In parallel, the proposal evaluation framework establishes a transparent and robust basis for assessing submissions. The alignment between challenge objectives, evaluation criteria, and Key Performance Indicators ensures consistency throughout the Open Call lifecycle—from challenge definition and proposal selection to monitoring of funded solutions. The KPIs defined across resource optimisation, environmental impact, and social impact provide a common reference for evaluating performance while allowing flexibility to accommodate diverse SME profiles and solution maturity levels.

Finally, the recommendations formulated in this report consolidate good practices identified during Open Call 1 and address areas for improvement related to attractiveness, inclusiveness, and call design. Together, these measures strengthen the overall coherence, accessibility, and effectiveness of Open Call 2, contributing to a more balanced participation of SMEs across regions, sectors, and maturity levels. Overall, this deliverable establishes a solid operational foundation for the successful execution of Open Call 2 and for maximising the impact of AID4SME's cascade funding mechanisms.

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