TNO innovation for life

ERP Annual Plan 2027

TNO Exploratory Research Programme



TNO Public ⟩ 2026 S 028
21 oktober 2026

Strategy
www.tno.nl
+31 88 866 00 00
info@tno.nl

2026 S 028 – 21 oktober 2026

ERP Annual Plan 2027

TNO Exploratory Research Programme

Auteurs	Ir. A.W.J.C. (Joëlle) van den Broek, Dr. L. (Lorijn) van der Spek
Rubricering rapport	TNO Public
Titel	ERP Annual Plan 2027
Rapporttekst	TNO Public
Aantal pagina's	35 (excl. voor- en achterblad)
Aantal bijlagen	0

Alle rechten voorbehouden
Niets uit deze uitgave mag worden verveelvoudigd en/of openbaar gemaakt door middel van druk, fotokopie, microfilm of op welke andere wijze dan ook zonder voorafgaande schriftelijke toestemming van TNO.

© 2026 TNO

Executive Summary

- The Exploratory Research Programmes (ERPs) are a cornerstone of TNO's exploratory research initiatives, representing EUR 30M of TNO's institutional grant in 2027. These programmes are designed to build new robust technology positions and address societal challenges, creating new propositions to strengthen the Dutch economy. The ERP programme is the only part of TNO's portfolio that is not directly steered by stakeholders, including clients, 'Topsectors', ministries, and various governmental bodies.
- ERPs are strategic projects aimed at establishing knowledge and positions in emerging research and technology areas, with the goal of generating economic and social value for the Dutch society. Despite the inherent unpredictability of exploratory research, TNO mitigates its exploratory research along two main axes: right-to-play for TNO and market attractiveness.
- In 2024, TNO introduced 'impact pathways' to guide exploratory research projects, ensuring they plan not only scientific activities but also outcomes that reduce risks and enhance value.
- In 2025, TNO renewed its portfolio process, rebranding the ERP as "Exploratory Research Programme" with a more selective, competitive and impactful funnel.
- In 2025, TNO also realised an ERP Toolbox to empower its research teams with tools and workshops on impact pathways, market analyses, IP and valorisation strategies, and further topics.
- In 2026, as a consequence of its renewed portfolio process, TNO executed its Series B selection process for the first time. Here, four series B ERPs were selected by a selection committee comprising of Directors of Science & Technology as well as representatives of TNO Ventures and TNO Vector, aided by input from Market Office.
- In 2026 TNO also introduced 'Short Seed ERPs', seedERPs with a 5 month lead time instead of 8 month to provide input before selection on the aforementioned axes of 'right to play' and a first scan on market attractiveness. Two selection rounds per year shorten the path from initial idea to a decision on ERP readiness.
- During the selection of series A and B proposals, TNO concluded that the quality of the Series A (new process) proposals was higher than series B (old ERP process) proposals due to the coaching the teams received on elaborating the potential value of their topic, measured along the progress on their impact pathway, right to play analysis and market attractiveness.
- In the new ERP process, TNO aimed for a more dynamic portfolio, with more seeds at start and a more selective funnel. In 2027 TNO will realise the full impact from this new process for the first time.
- For 2027, TNO has selected 11 new 2-year ERPs Series A, 4 2-year ERPs Series B, and will select 20 single-year Seed ERPs in November and March. The overall quality and relevance of proposals were high, necessitating a distinction between 'good' and 'even better'. The eleven selected ERPs Series A are EcoChip, RE-SMART, Affordable healthcare, STRIKE, New2DM, METAL, AID-PATH, AccuRATE, SNCI, Enabling Transitions, and TAPAS. The four selected ERPs Series B are BioAlert, Industrial Ethylene Electrolysis, Future proof smart logistic, and Hi-sensitive and hi-selective optical gas sensing. These projects were chosen for their scientific challenges and societal relevance.

- In 2027, TNO realizes two ‘Whole of TNO Challenges’ for the first time. This is an experiment in which TNO wants to use TNO-technologies and ideas to solve a concrete urgent societal challenge, in a short-cycle and impact-driven fashion.
- In 2027, the ERP portfolio will consist of 26 ERPs (Series A and B) in various stages and about 20 Seed ERPs, with a total budget of EUR 30M. Each ERP Series A runs for 2 years, potentially followed by an ERP Series B for another 2 years. The ERPs are well-distributed among TNO’s 6 units and cover a variety of Key Enabling Technologies (KETs) as well as Key Enabling Methodologies (KEMs).
- In March 2027, TNO will organise the third edition of its ERP Day, in which ERP teams can showcase their output to management, market directors and business developers, with the goal of lively discussions around the valorisation of the new knowledge.

Table of Contents

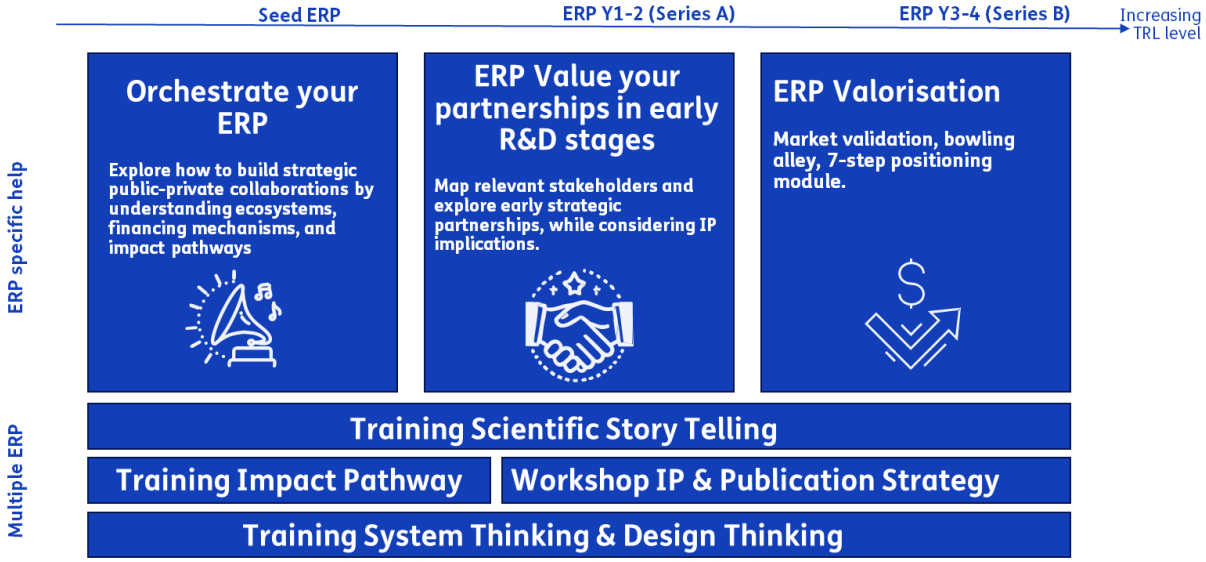
Executive Summary 3
Table of Contents 5
Introduction 6
TNO's Exploratory Research Programmes 6
Portfolio Characteristics 8
1 A Scalable Technology platform for Resilience and Intelligent monitoring in KEy transport corridors and urban structures (STRIKE) 10
2 Affordable Healthcare: solutions for obesity pandemic 11
3 AI-Driven PATHology detection system (AID-PATH) 12
4 Biogenic Epoxy and Additive Manufacturing for Eco-Friendly Chip Packaging (ECOCHIP) 13
5 Minimal Execution through AI-generated Logic (METAL) 14
6 Novel electronics with 2D materials (NEW2DM) 15
7 Rapid Repair with Memory Steel (Re-SMART) 16
8 Trustworthy Agents for Personalized Assistance in Social decision making (TAPAS) 17
9 SNCI – Sensor Networks for Critical Infrastructure 18
10 Ultrasound-Based & AI-powered Early Battery Failure Detection (AccuRATE) 19
11 Enabling transitions: from strategic ambition to collective action 20
12 Women's Health: Muscle Matters 21
13 Large-Scale Agent-based Simulation (LABS) – first use case Electrification in Mobility 22
14 Greenhouse gas recycling for semicon 23
15 System-level Platform for Adversarial Robustness Testing and Analysis 24
16 Orchestrating Alternative Compute Platforms 25
17 Agile AI Anomaly Detection 26
18 Hybrid Power Plant Digital Twin for Resilient Health-Aware Operation & Maintenance 27
19 Industrial ethylene electrosynthesis 28
20 BioAlert - Innovative early warning system through biomarkers 29
21 Future proof smart logistics 30
22 Highly sensitive optical gas sensing 31
23 Asphalt rejuvenation using micro-algae (CARMA) 32
24 Atmospheric models for optical solutions 33
25 Empowering citizen collectives 34
26 Sustainable ICT 35

Introduction

TNO's Exploratory Research Programmes

The Exploratory Research Programmes (ERPs) constitute TNO's exploratory research activities. Through these programmes, TNO establishes robust technological positions and collaborates with knowledge partners and stakeholders to address societal challenges and create new propositions to strengthen the Dutch economy. In 2027, the ERPs account for approximately EUR 30M of TNO's institutional grant, while the remaining budget is directed by TNO's stakeholders, including industrial and public clients, 'Topsectors', ministries and governmental bodies (via consultation and/or task financing).

ERP projects are strategic endeavours where TNO aims to develop expertise and positions for the Netherlands in emerging research and technology areas, addressing gaps and fostering economic and social value for Dutch society. Despite the iterative nature and unpredictability of exploratory research, TNO focuses on mitigating risks along two primary axes: right-to-play for TNO regarding scientific and technological risks to establish a competitive position within international innovation ecosystems, and market attractiveness to enhance the applicability and impact of new technologies and methodologies. In 2024, TNO introduced 'impact pathways' to guide exploratory research projects, ensuring comprehensive planning of both scientific activities and outcomes, thereby reducing risks and maximizing economic and social value. In 2025, TNO introduced the ERP Toolbox to empower our research teams with tools and workshops on impact pathways, market analyses, scientific storytelling, IP and valorisation strategies, and further topics.



Figuur 1.1: A schematic overview of the new ERP Toolbox that empowers ERP teams towards achieving impact.

In 2025, the ERP funnel was redesigned to increase competition, selectivity and impact. In 2026 the positive effects of the redesigned process became visible – a more dynamic portfolio, higher quality proposals, and more attention and reflection from the teams on valorisation and impact of their projects. Further transition to this new way of managing the ERP portfolio will also be important in 2027.

This document outlines the ERP portfolio plans for 2027, summarising the anticipated outcomes of ongoing projects.



Figure 1.2: TNO's Exploratory Research Programmes serve as the incubator for innovative technologies and methodologies, driving value for Dutch society and the economy. In March 2027, TNO will organise the third edition of its ERP Day, in which ERP teams can showcase their output to management, market directors and business developers, with the goal of lively discussions around the valorisation of the new knowledge.

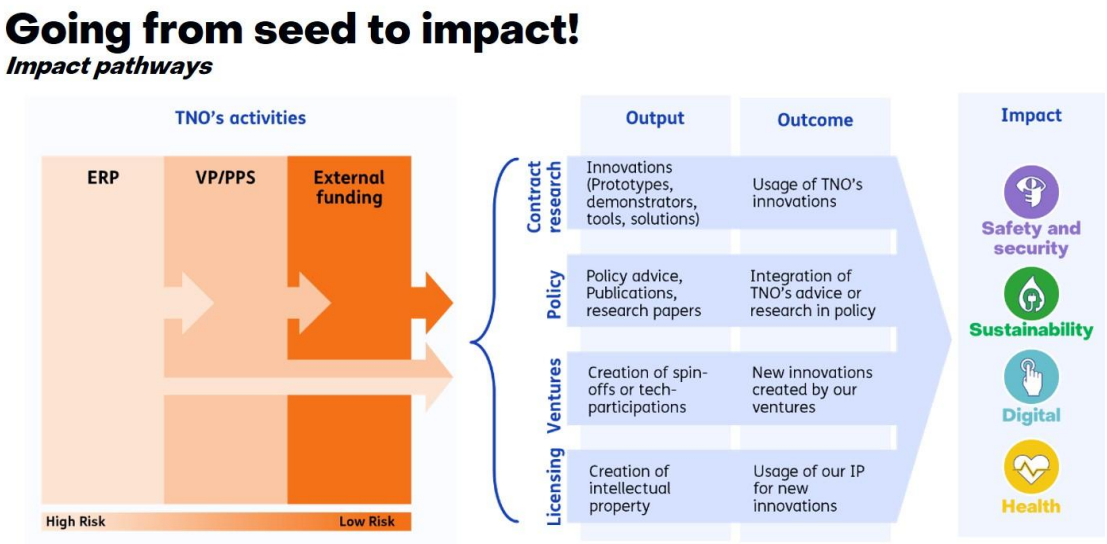


Figure 1.3: A visualisation of how TNO's Exploratory Research Programmes contribute to valorisation.

Portfolio Characteristics

The ERP portfolio acts as an incubator for innovative technologies and methodologies, driving value for Dutch society and the economy. In this section, TNO presents the main characteristics of the ERP portfolio management, highlighting our strategic approach and key initiatives for the upcoming years.

- For the upcoming Seed ERPs, ERPs Series A 2027, and ERPs Series B 2027, TNO proactively considers the new strategic period in our decision-making process, aligning with both international and national priorities such as the National Technology Strategy.
- ERPs are driven by specific use-cases and have well-defined research objectives. ERPs contribute to multiple TNO innovation areas; they are often cross-unit projects that share common needs for lower-TRL technology breakthroughs. The results from the ERPs are then transitioned to higher TRL shared innovation programmes, contract research, and start-up initiatives.
- ERPs seek to amplify impact through collaboration with knowledge partners, including universities and companies, and by securing co-investments from both public and private sources.
- ERPs Series A are well-funded, with each having a budget of 600 – 800k EUR per year, and they typically span a duration of two years.
- The first collection of ERPs Series B has been selected from the ERPs Series A in 2026, with a typical budget between 900k EUR – 1.3M EUR per year and spanning a duration of two years.
- ERPs Series A are typically preceded by one-year Seed ERPs that assess the feasibility of the topic, validate the expected impact, and establish necessary partnerships, thereby shaping the ERP program.
- From Seed onward, business development is engaging with the project. By running market and technological developments parallel, the opportunities for a successful application are increased.
- ERP funnel management is implemented to monitor progress and make necessary adjustments and resource reallocations. This process involves reviews by the TNO Science & Technology Office and the board of TNO's Science Directors.
- In collaboration with our Ministry of Economic Affairs and Climate Policy (EZK), TNO keeps the Topsectors and ministries informed about our ERP portfolio, aiming to engage companies and other stakeholders early in public-private cooperation.
- In 2027, TNO realizes two 'Whole of TNO Challenges' for the first time. This is an experiment in which TNO wants to use TNO-technologies and ideas to solve a concrete urgent societal challenge, in a short-cycle and impact-driven fashion. The challenges are "From Cyber Threats to Cyber Resilience" and "Automated QS for regional bridges".
- In 2026, TNO selected 11 new 2-year ERP Series A to commence in 2027, and 4 2-year ERP Series B. Additionally, a selection of 20 single-year Seed ERPs to be executed in 2027 will be finalized by April 2027. TNO considers a success rate of roughly 50% for Seed ERPs transitioning to Series A ERPs as optimal, balancing quality promotion and minimising wasted proposal efforts. The overall quality and relevance of proposals this year were high, requiring us to differentiate between 'good' and 'even better.'
- The selected new ERPs Series A are ECOCHIP, RE-SMART, Affordable healthcare, STRIKE, New2DM, METAL, AID-PATH, AccuRATE, SNCI, Enabling Transitions, and TAPAS. All these concern domains with clear scientific challenges and high societal and economic relevance. The topics were selected out of the Seed ERPs of 2026.
- The selected new ERPs Series B are BioAlert, Industrial Ethylene Electrolysis, Future proof smart logistic, and Hi-sensitive and hi-selective optical gas sensing. All these concern domains with high societal and economic relevance. The topics were selected out of the Series A topics that had been going on for 2 years.

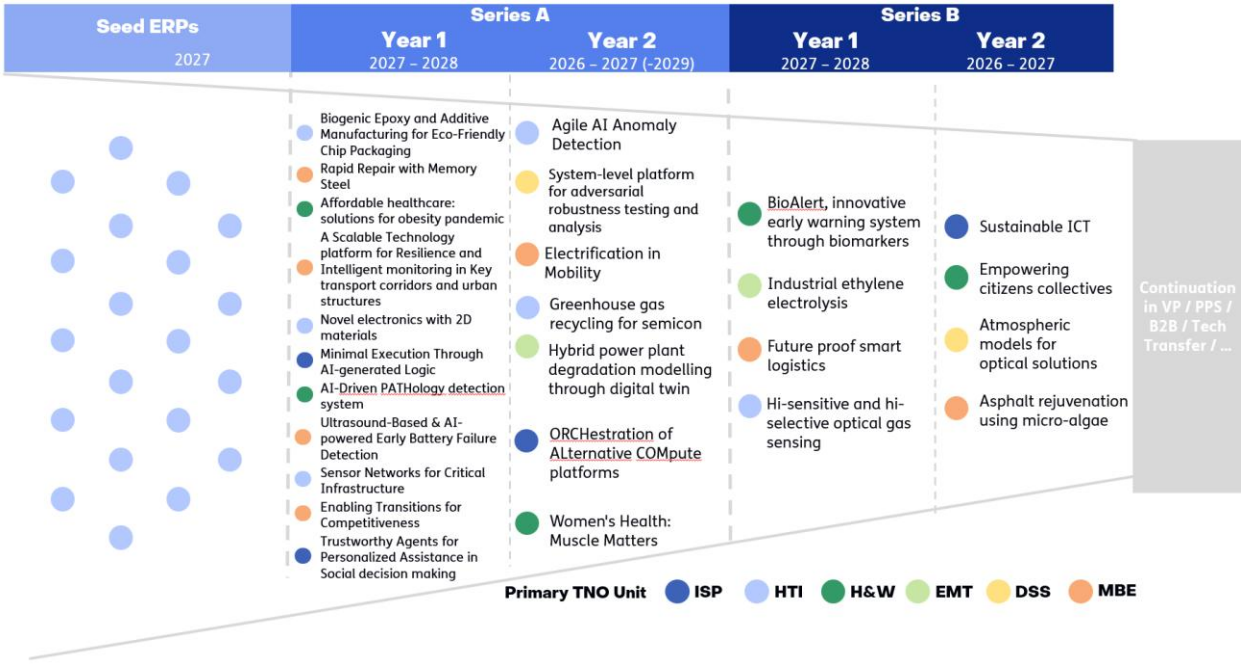


Figure 1.3. The funnel of 'Exploratory Research Programmes' colour-coded through the TNO units: ICT, Strategy and Policy (ISP), High Tech Industry (HTI), Healthy Living and Work (H&W), Energy and Materials Transition (EMT), Defence, Safety & Security (DSS), Mobility and Built Environment (MBE).

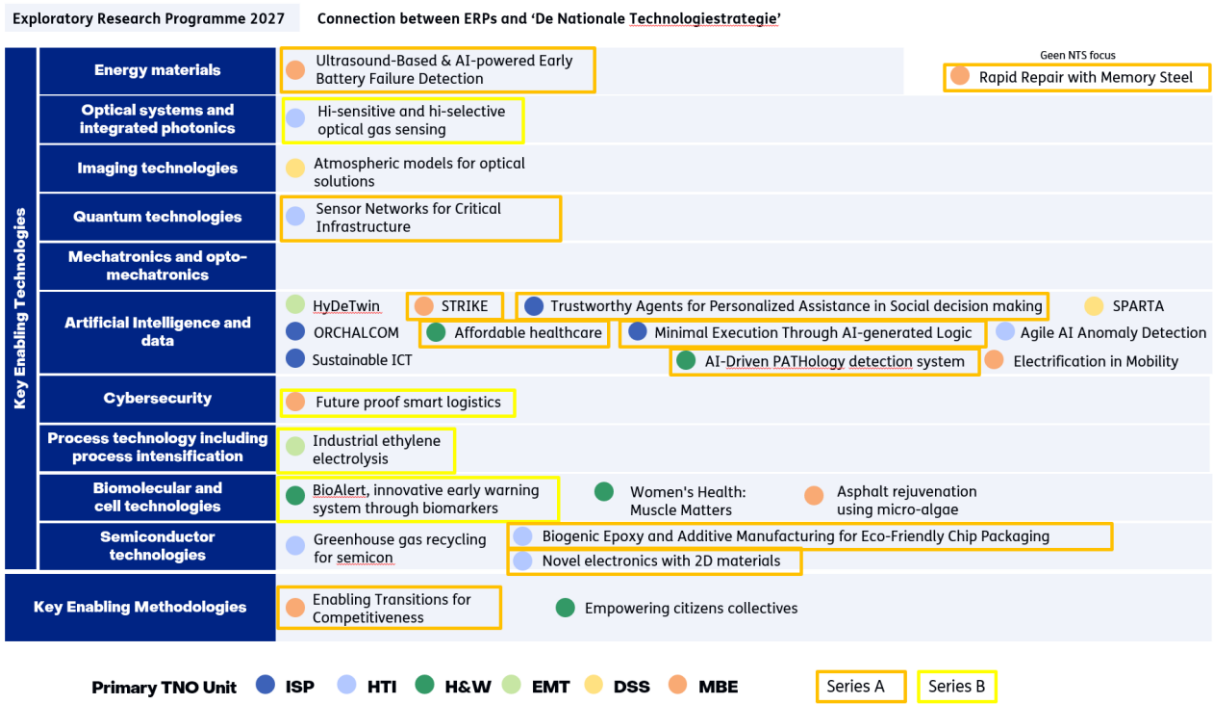


Figure 1.4: The 'Exploratory Research Programmes' mapped to the key enabling technologies of the 'Nationale Technologiestrategie'. The ERPs are colour-coded by the TNO units: ICT, Strategy and Policy (ISP), High Tech Industry (HTI), Health and Work (H&W), Energy and Materials Transition (EMT), Defence, Safety & Security (DSS), Mobility and Built Environment (MBE).

1 A Scalable Technology platform for Resilience and Intelligent monitoring in KEy transport corridors and urban structures (STRIKE)

- **Ambition.** STRIKE aims to develop scalable approaches for monitoring the condition and resilience of transport infrastructure. By bringing together different sources of information and advanced modelling approaches, the project seeks to provide infrastructure managers with timely and reliable insights that support effective maintenance and management of infrastructure networks.
- **Impact.** STRIKE will contribute to safer, more resilient and more sustainable infrastructure networks. Better and more scalable insight into infrastructure condition can support earlier identification of potential issues, more effective maintenance and investment decisions, improved infrastructure availability, and longer asset lifetimes.
- MBE, DSS, EMT
- 1st year in 2027. ERP Series A running 2027 – 2028.

Plans 2027

In 2027, STRIKE will develop and integrate the core methods needed for scalable infrastructure monitoring and assessment. The project will investigate how different sources of information can be combined with advanced modelling approaches to provide reliable insights into infrastructure condition and resilience. The developed methods will be evaluated using representative infrastructure cases, alongside engagement with infrastructure owners, knowledge partners and industry to assess their practical applicability and opportunities for further development.

Impact Pathway



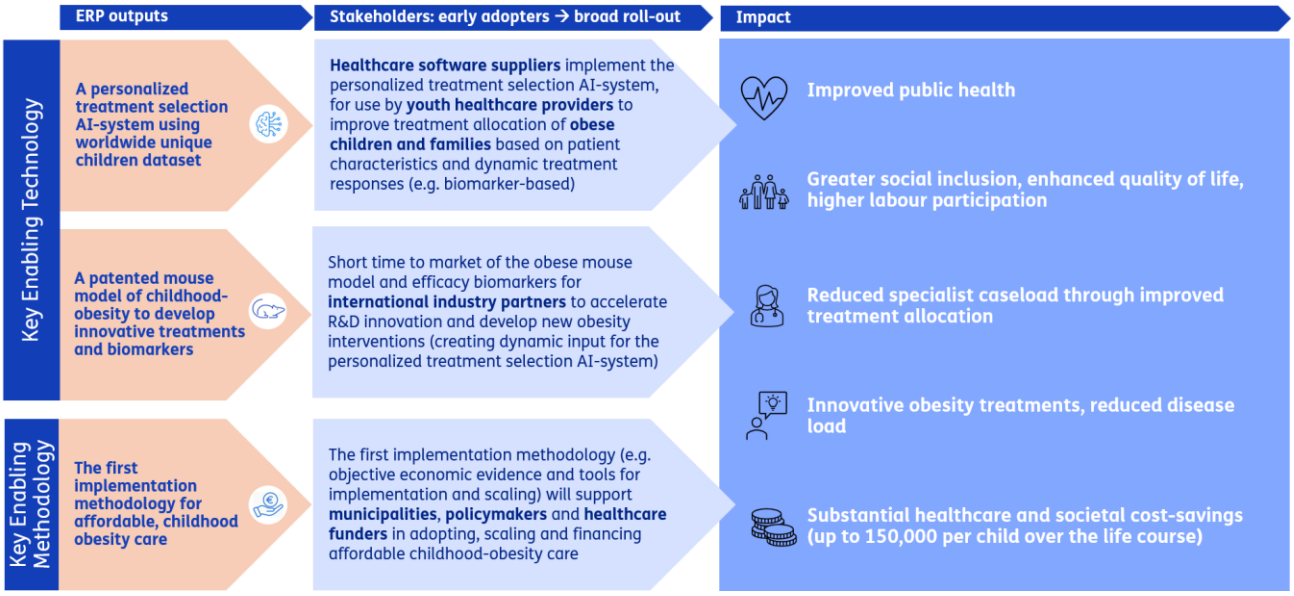
2 Affordable Healthcare: solutions for obesity pandemic

- **Ambition.** The project aims to 1) to develop technologies and methodologies for effective treatment of childhood-obesity and 2) to deliver real-world evidence for implementation and upscaling of affordable childhood-obesity care.
- **Impact.** lower overall care costs, reduced specialist caseloads, improved access to care, lower chronic disease prevalence, and innovative obesity treatments for children.
- H&W, ISP, DSS
- 1st year in 2027. ERP Series A running 2027 – 2028.

Plans 2027

Key activities focus on establishing the scientific and implementation foundations for affordable childhood-obesity care. The project will prepare and analyse unique longitudinal datasets, develop an initial AI-based treatment selection system, create a prototype childhood-obesity mouse model, identify and validate biomarkers for treatment monitoring, and investigate how community-based obesity care can be implemented and scaled. In parallel, stakeholders such as municipalities, healthcare providers, insurers and policymakers will be engaged to define implementation requirements and develop early cost-benefit projections. The main outcome of Year 1 is a portfolio of validated prototypes, datasets, biomarkers and implementation insights.

Impact Pathway



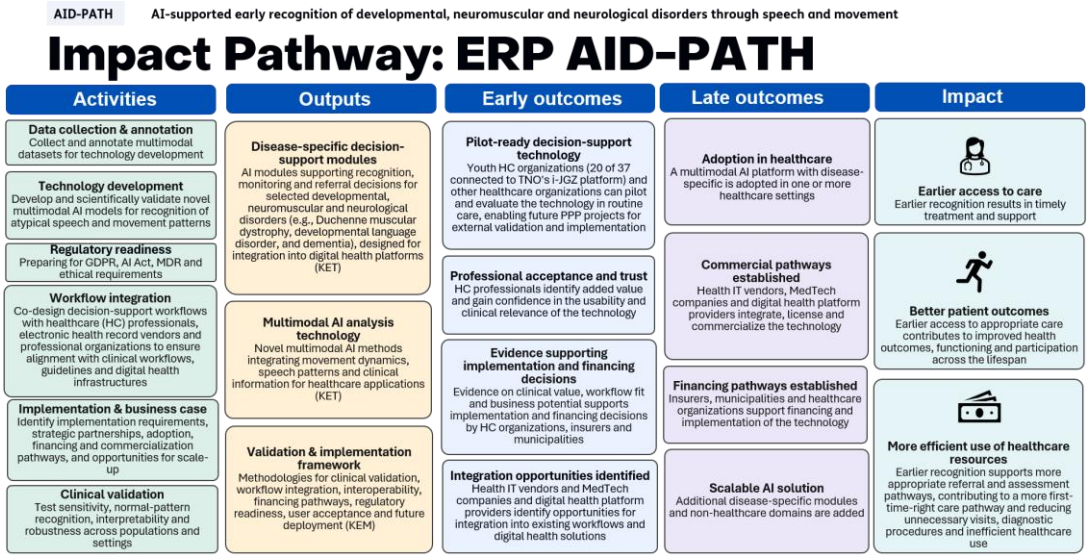
3 AI-Driven PATHology detection system (AID-PATH)

- **Ambition.** AID-PATH seeks to transform video and audio data into trusted clinical intelligence, enabling healthcare professionals to recognize disorders earlier, make better-informed decisions, and ultimately improve access to timely care through scalable AI-driven decision support.
- **Impact.** AID-PATH aims to deliver multimodal AI technology and disease-specific decision-support modules that support healthcare professionals in recognizing developmental, neuromuscular and neurological disorders earlier and more objectively. By combining technological innovation with clinical validation, workflow integration and implementation readiness, the project lays the foundation for future adoption in healthcare. In the longer term, this contributes to earlier access to appropriate care, better patient outcomes and more efficient use of healthcare resources through more targeted monitoring, referral and assessment pathways, reducing unnecessary visits and diagnostic procedures.
- H&W, DSS, ISP
- 1st year in 2027. ERP Series A running 2027 – 2028.

Plans 2027

In 2027, AID-PATH will collect, annotate and harmonise multimodal video, movement and speech datasets for developmental, neuromuscular and neurological disorders, using protocols that safeguard data quality and representativeness. The team will develop and optimise AI models combining pose estimation, vision-language methods and speech analysis, and test effective ways to fuse these modalities. Initial validation will assess model robustness across populations and care settings. By year-end, the project will deliver annotated datasets, multimodal AI models, disease-specific decision-support modules and performance evaluations.

Impact Pathway



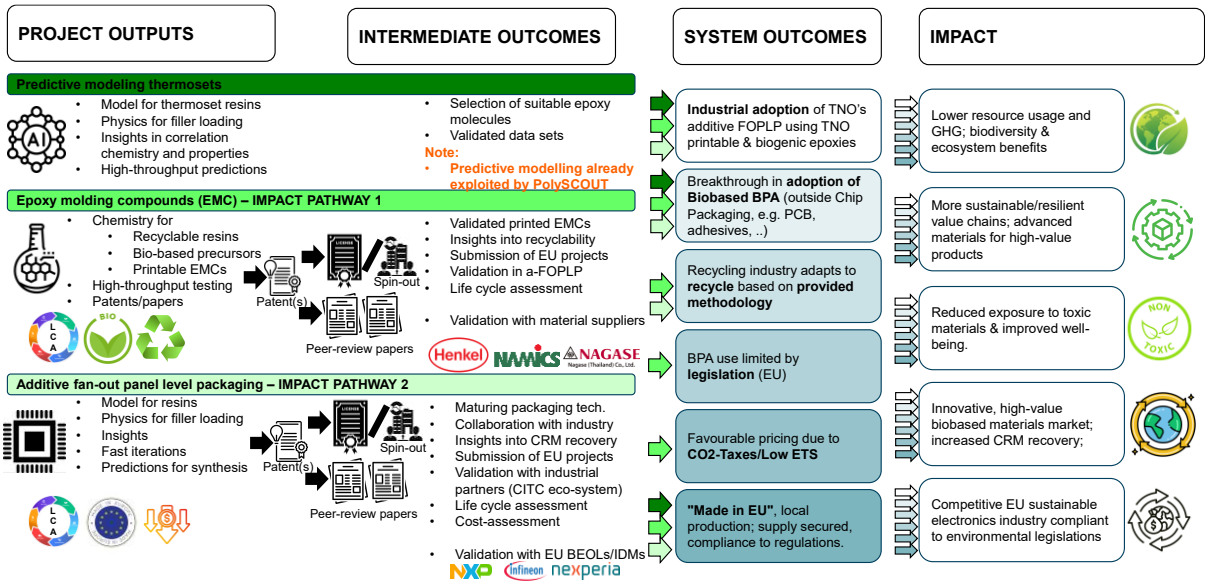
4 Biogenic Epoxy and Additive Manufacturing for Eco-Friendly Chip Packaging (ECOCHIP)

- **Ambition.** ECOCHIP aims to develop printable epoxy moulding compounds for additive fan-out panel-level packaging. Using AI-guided material design, novel epoxy synthesis and experimental validation, the project will enable reliable chip packages while improving circularity, reducing dependence on bisphenol-A and supporting European semiconductor sovereignty
- **Impact.** ECOCHIP will enable cost-effective European chip packaging, reduce material and energy use, avoid Pb-, PFAS- and wet-chemical processing, and improve recovery of critical and strategic raw materials. The resulting proprietary material portfolio can support licensing to European integrated device manufacturers and material suppliers.
- HTI, EMT
- 1st year in 2027. ERP Series A running 2027 – 2028.

Plans 2027

In 2027, ECOCHIP will develop and benchmark printable epoxy moulding compounds for additive fan-out panel-level packaging. The team will extend predictive modelling and materials screening, establish a high-performance reference formulation, and develop promising biogenic and circular-by-design variants. Selected materials will be integrated into functional chip-package demonstrators and evaluated against industry-relevant requirements for printability, electrical and mechanical performance, reliability, cost and sustainability. In parallel, engagement with integrated device manufacturers and material suppliers will validate specifications, application opportunities and routes towards joint development, licensing and further scale-up.

Impact Pathway



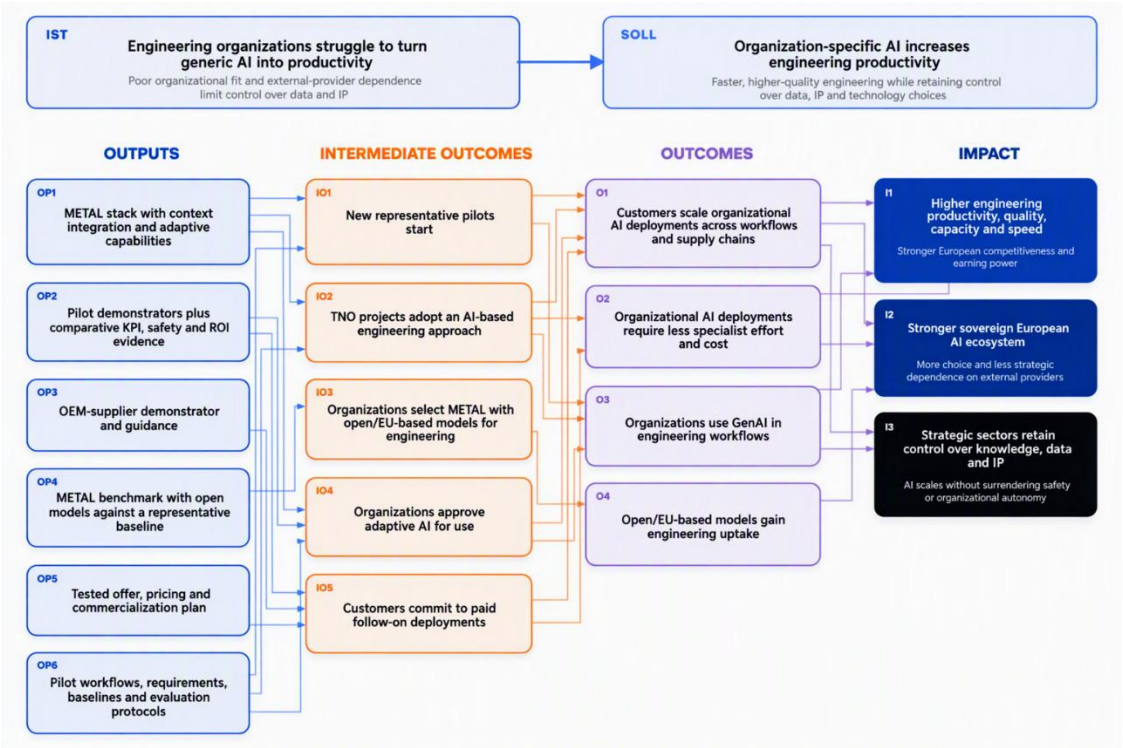
5 Minimal Execution through AI-generated Logic (METAL)

- **Ambition.** METAL will develop a sovereign, model-independent AI harness that aligns generative AI with an organisation's tools, workflows, standards and knowledge. It will enable organisations to use and share AI functionality while retaining control over sensitive data, intellectual property and technical choices.
- **Impact.** METAL aims to increase engineering productivity, lower AI-integration costs and reduce dependence on proprietary US and Chinese platforms. It will strengthen European technological sovereignty and enable AI-supported collaboration across representative supply chains. External pilots will provide evidence on performance, ROI, transferability and willingness to pay.
- ISP, DSS, HTI
- 1st year in 2027. ERP Series A running 2027 – 2028.

Plans 2027

In 2027, METAL will design and develop a first AI-harness prototype. The team will establish methods for aligning AI with organizational context and requirements. Representative pilots will define baseline performance and test organisational fit, productivity and IP protection. In parallel, METAL will conduct customer discovery, competitor monitoring and ROI analysis, develop a preliminary value proposition and pricing model, and assess Tech Transfer and spin-off valorisation routes.

Impact pathway



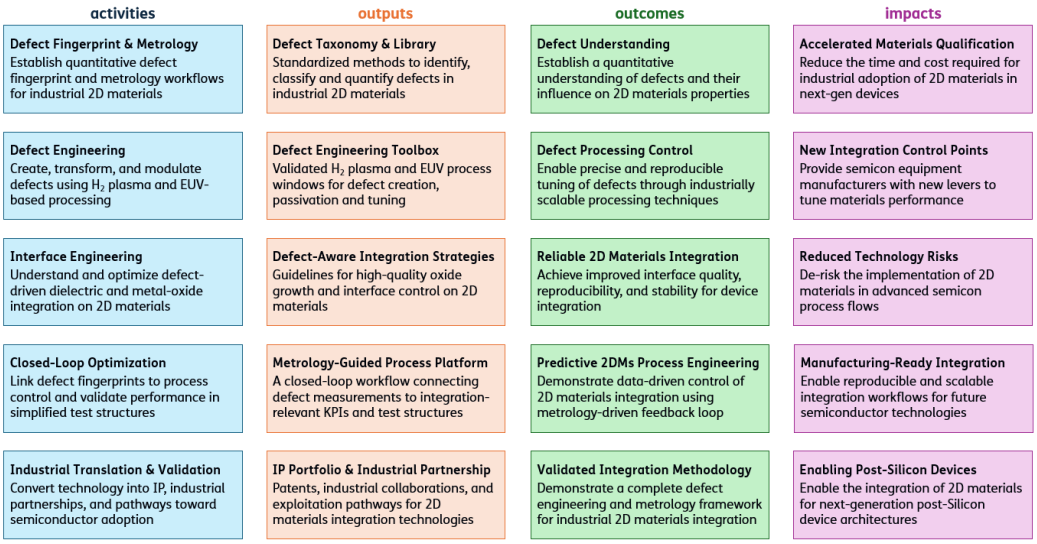
6 Novel electronics with 2D materials (NEW2DM)

- **Ambition.** NEW2DM aims to accelerate the integration of two-dimensional materials into semiconductor manufacturing by developing a closed-loop defect-engineering and metrology framework. By deliberately creating, characterising and controlling defects—and linking them to material properties and performance in simplified test structures—the project will transform defects from an uncontrolled source of variability into a design parameter for reliable next-generation electronics.
- **Impact.** NEW2DM will reduce the risks, time and cost associated with industrial adoption of 2D materials by creating new control points for semiconductor manufacturing and enabling reproducible, manufacturing-ready integration workflows. This will support more powerful and energy-efficient post-silicon devices, strengthen Europe's semiconductor position and create opportunities for industrial collaboration, licensing and contract research.
- HTI, EMT
- 1st year in 2027. ERP Series A running 2027 – 2028.

Plans 2027

In 2027, NEW2DM will establish the building blocks for a closed-loop defect-engineering framework for two-dimensional materials. The team will select a focused material and device use case, develop methods to deliberately create and modulate defects, and apply advanced metrology to relate defect type, density and distribution to material properties. Simplified test structures will be designed and fabricated to evaluate how these defects affect device and integration performance. The resulting data will be used to optimise processing conditions and demonstrate feedback-driven control of defects. In parallel, the project will engage semiconductor manufacturers and equipment and materials suppliers to validate industrial requirements and prepare pathways towards further technology maturation and adoption.

Impact pathway



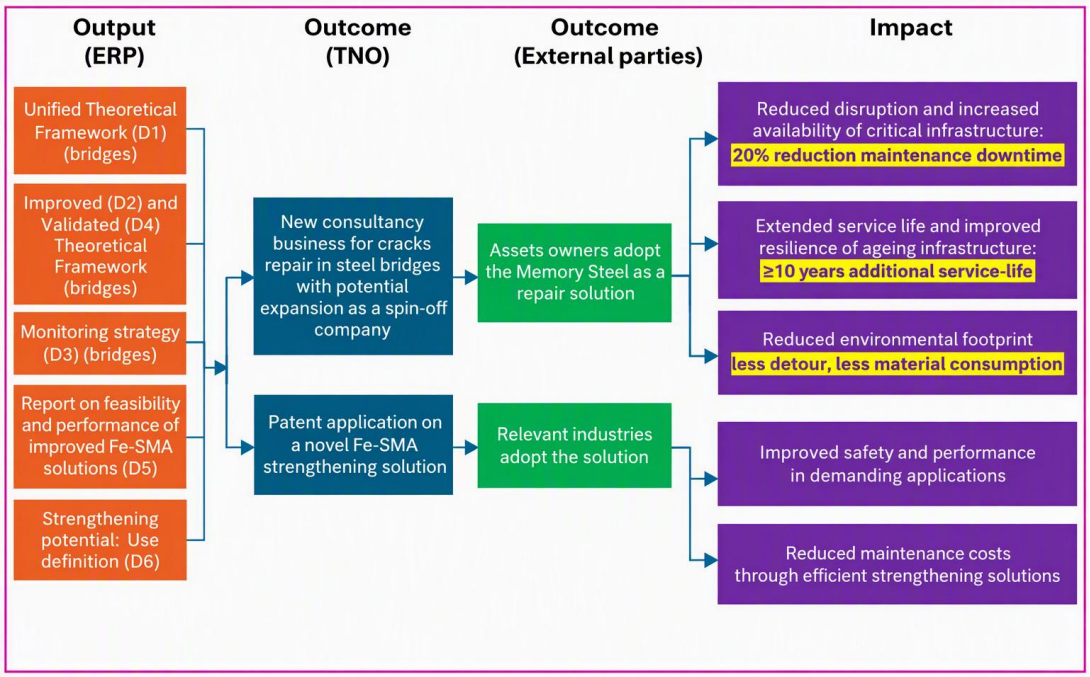
7 Rapid Repair with Memory Steel (Re-SMART)

- **Ambition.** RE-SMART aims to develop practical, robust methods for designing and applying iron-based shape memory alloy (Fe-SMA) prestressing to e.g. steel bridges. By accounting for uncertainties in material behaviour, activation, attachment, manufacturing and operational conditions, the project will enable tailored solutions that e.g. extend bridge lifetime.
- **Impact.** RE-SMART will support safer and more resilient infrastructure, reduce disruption, replacement costs and environmental impact, and improve safety in demanding applications. Through validated design methods, monitoring solutions, demonstrations and contributions to Dutch and European standards, the project will accelerate adoption by infrastructure owners, engineering companies, contractors and relevant industries, while creating opportunities for consulting services, contract research and a potential spin-off.
- MBE, DSS
- 1st year in 2027. ERP Series A running 2027 – 2028.

Plans 2027

In 2027, RE-SMART will establish the quantitative and probabilistic design framework for Fe-SMA strengthening solutions. The team will characterise uncertainties in material behaviour, activation, attachment and operational conditions through laboratory testing and finite-element simulations and develop monitoring methods for temperature and prestress. The framework will be applied to steel-bridge and other use cases, supported by component and real-scale validation tests. In parallel, the project will engage infrastructure owners, other relevant public-sector stakeholders, manufacturers and suppliers to define implementation requirements, strengthen the Dutch and European supply chain, and prepare pathways towards demonstration, standardisation and market adoption.

Impact pathway



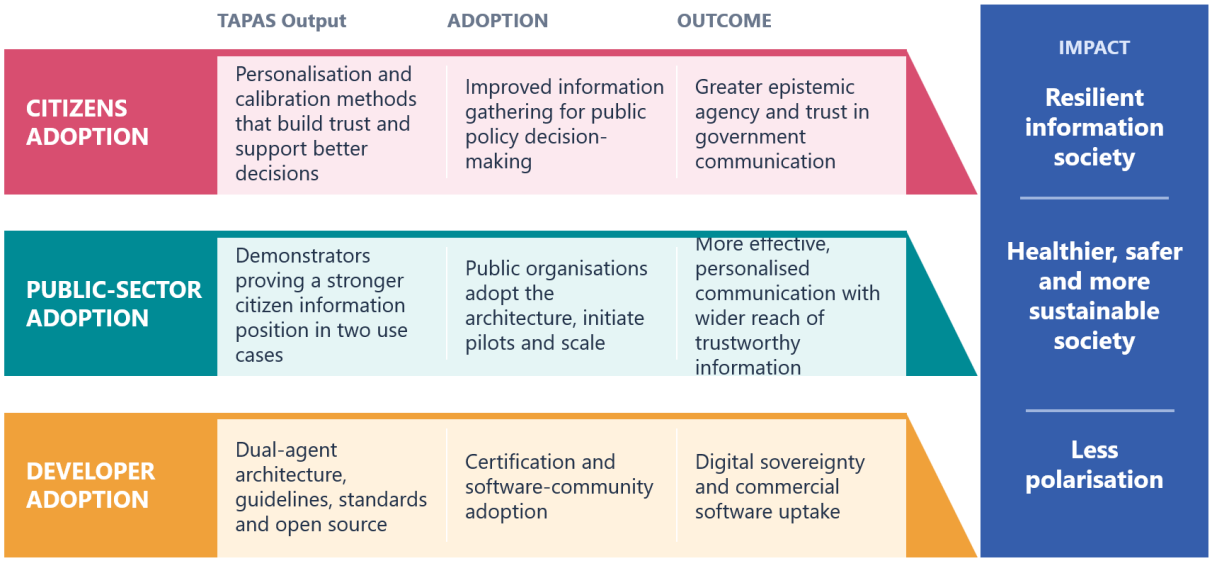
8 Trustworthy Agents for Personalized Assistance in Social decision making (TAPAS)

- **Ambition.** TAPAS aims to develop trustworthy, sovereign AI agents that help citizens make well-informed decisions on complex public issues. Its dual-agent architecture combines personalised proxy agents, which reflect citizens' needs, abilities and values, with expert agents that provide grounded public-sector information without steering or manipulating choices. The ambition is to establish a scalable foundation for trustworthy public AI services in the Netherlands and Europe.
- **Impact.** TAPAS will improve citizens' access to reliable, personalised public information, strengthen resilience against misinformation and support trust in public organisations. For public-sector organisations, it will enable more effective communication with diverse populations; for technology providers, it will deliver validated architectures, design principles, governance frameworks and implementation guidance. Valorisation routes include public-private partnerships, contract research, standardisation, adoption by technology providers and a potential spin-off.
- ISP, H&W, DSS
- 1st year in 2027. ERP Series A running 2027 – 2028.

Plans 2027

In 2027, TAPAS will develop and evaluate its dual-agent architecture, combining personalised proxy agents with public-sector expert agents. The team will define design principles for trustworthy personalisation, domain grounding and governance. Vaccination and security demonstrators will test informed decision-making, trust and evidence-based communication across citizen profiles. In parallel, public-sector organisations and technology providers will help validate implementation requirements and prepare further development and adoption.

Impact pathway



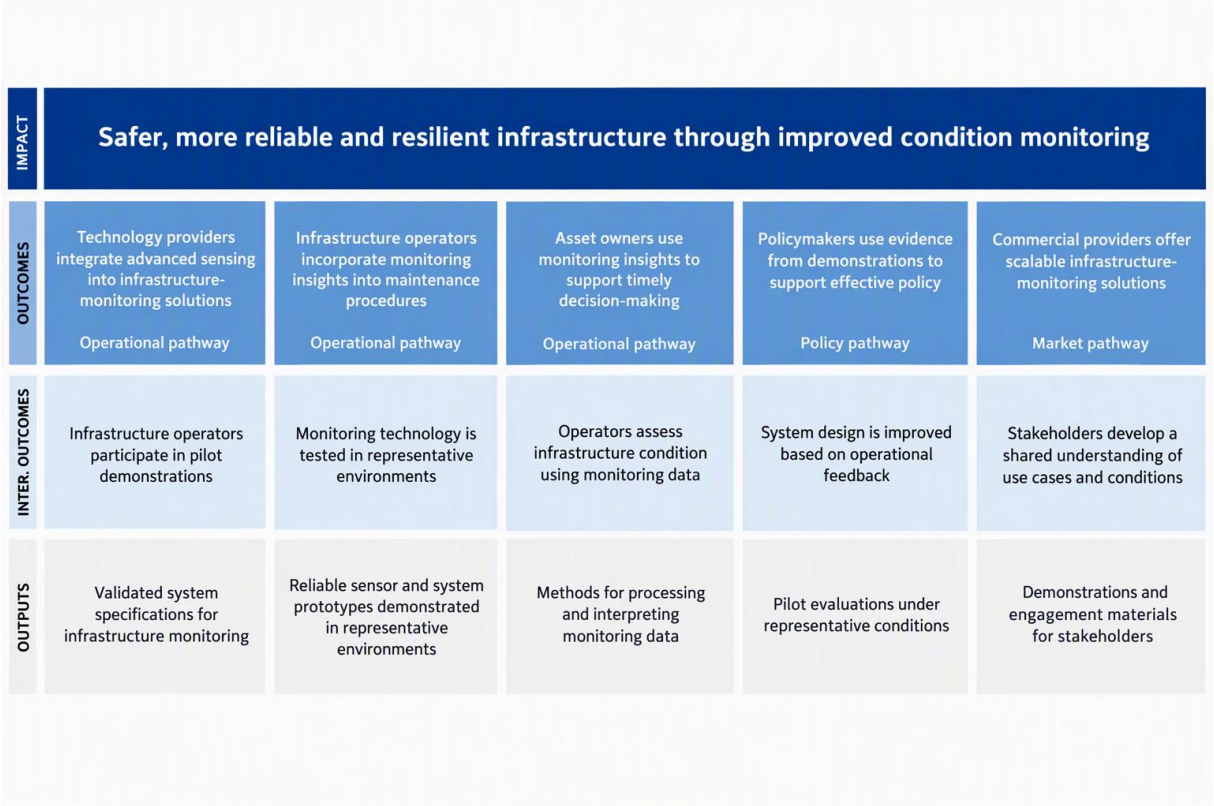
9 SNCI – Sensor Networks for Critical Infrastructure

- **Ambition.** SNCI aims to develop a scalable infrastructure-monitoring platform based on advanced sensing technology. By providing continuous and distributed monitoring, the project will address monitoring needs in complex environments. It will validate the platform for infrastructure monitoring, demonstrating its applicability across different domains.
- **Impact.** SNCI will enable earlier detection of anomalies and infrastructure degradation, reducing safety, environmental and operational risks. By involving end users, infrastructure operators and industrial partners in validation and development planning, the project will accelerate adoption. Results can be valorised through licensing, joint development, contract research or venture creation and provide the basis for further demonstrations in Series B.
- HTI, DSS
- 1st year in 2027. ERP Series A running 2027 – 2028.

Plans 2027

In 2027, SNCI will develop a first prototype based on advanced sensing technology. The team will define requirements and develop and assess core system components and data processing methods. Proofs of concept for infrastructure monitoring will evaluate performance under representative conditions. In parallel, end users, technology providers and other relevant partners will support market validation, development planning and preparations towards further demonstrations.

Impact Pathway



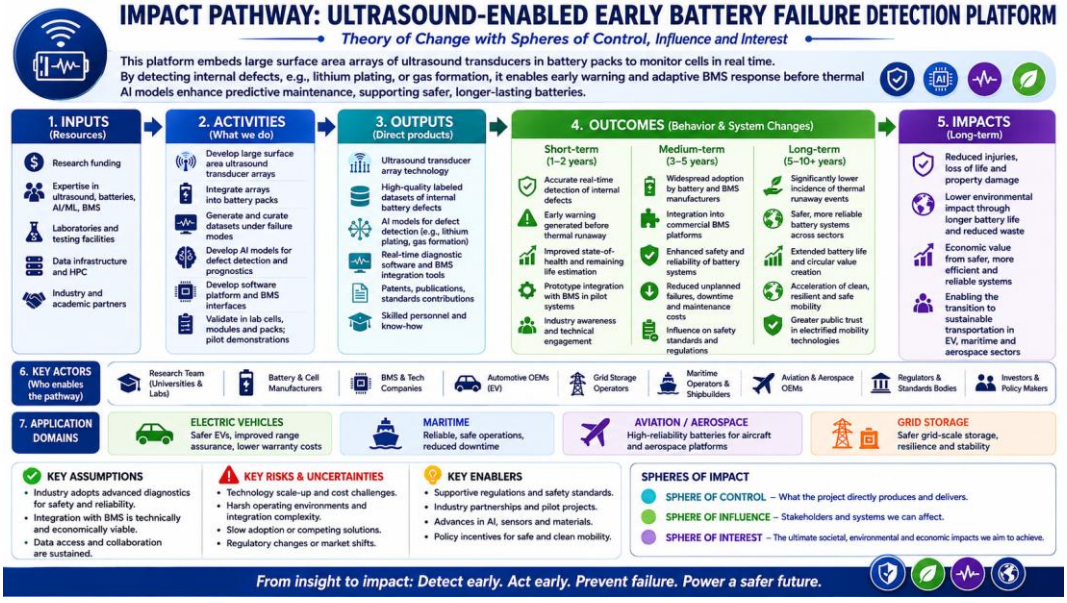
10 Ultrasound-Based & AI-powered Early Battery Failure Detection (AccuRATE)

- **Ambition.** AccuRATE aims to enable continuous, direct monitoring of internal battery degradation by combining ultrasound sensing with AI-driven interpretation. The project will detect failure mechanisms that remain invisible to conventional battery-management systems and demonstrate a scalable, low-cost early-warning solution for cylindrical and prismatic cells.
- **Impact.** AccuRATE will improve battery safety, extend battery lifetime and reduce premature replacement, supporting safer electrification and more efficient use of critical raw materials. Initial applications target aviation and grid storage, followed by maritime uses. Valorisation routes include contract research, licensing of sensor and signal-processing IP, public-private partnerships and contributions to certification frameworks.
- MBE, HTI, DSS, ISP, EMT
- 1st year in 2027. ERP Series A running 2027 – 2028.

Plans 2027

In 2027, AccuRATE plans to launch its two-year ERP Series A programme, building on the 2026 proof of principle for ultrasound-based early detection of battery failure. The first year will establish aviation and grid-storage requirements with industrial partners, select target cells and failure precursors, reproduce the initial results, and assess ultrasound measurement methods for cylindrical and prismatic cells. By year-end, the programme aims to deliver a validated transducer specification, demonstrate at least one failure precursor earlier than conventional battery monitoring, and establish methods for AI signal interpretation that compensate for temperature and state of charge. Alongside this research, the team will pursue two patent filings, agree partner data and IP arrangements, and develop the business case and follow-up funding plan, preparing for prototype construction and industrial demonstrations in 2028.

Impact Pathway



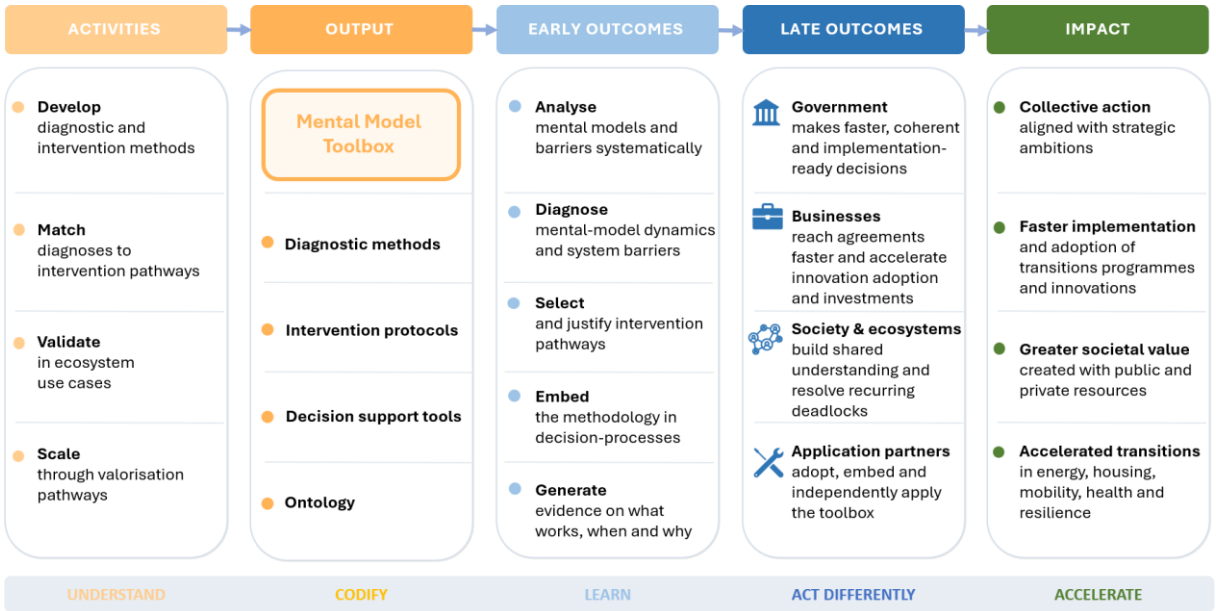
11 Enabling transitions: from strategic ambition to collective action

- **Ambition.** Enabling Transitions aims to develop and validate a science-based Mental Model Toolbox that helps multi-actor ecosystems translate strategic ambitions into coordinated action. The toolbox will integrate methods for eliciting and diagnosing mental models, selecting context-specific interventions, and supporting coherent collective decision-making across organisations, governance levels and interconnected transitions. The toolbox can be applied to various transition challenges including energy, mobility, housing, resilience and health.
- **Impact.** The project will help governments, businesses and ecosystem partners identify the root causes of decision-making deadlocks, target interventions and investments more effectively, and improve implementation readiness and transition outcomes. The toolbox will be validated in Brainport and other transition contexts and valorised through contract research, public-private programmes, deployment within TNO propositions and exploration of licensable AI-supported tools.
- MBE, ISP, EMT, DSS, H&W
- 1st year in 2027. ERP Series A running 2027 – 2028.

Plans 2027

In 2027, Enabling Transitions will inventory and operationalise methods for eliciting, analysing and influencing mental models in multi-actor ecosystems. The team will develop diagnostic methods, intervention pathways and decision-support tools, including responsible AI-supported prototypes. These will be applied in the Brainport ecosystem, addressing interconnected challenges in housing, energy, mobility, economic development and social cohesion. Validation with stakeholders will assess contextual effectiveness, implementation readiness and opportunities for deployment within TNO propositions.

Impact pathway



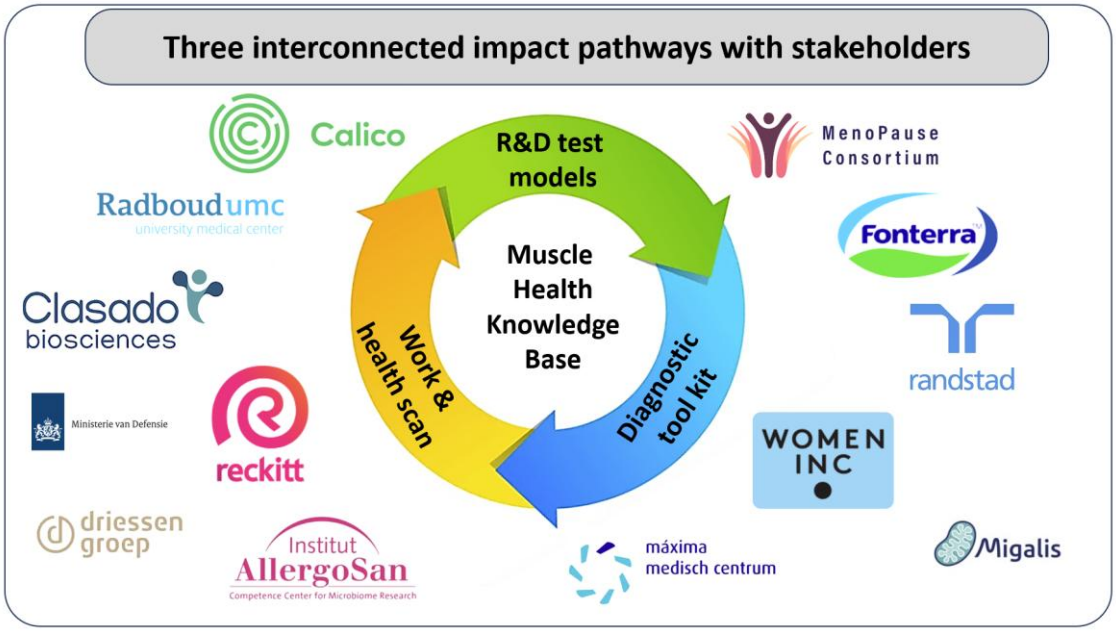
12 Women's Health: Muscle Matters

- **Ambition.** ERP Muscle Matters aims to improve women's muscle health, performance, employability and healthy ageing through a unique combination of biological, technological and societal innovation. Building on the three pillars of knowledge generation, diagnostic technologies and interventions, the programme will develop sex-specific insights, tools and solutions that address muscle health across different life stages. Ultimately, Muscle Matters seeks to translate scientific knowledge into impactful applications for healthcare, industry, employers and society.
- **Impact.** Muscle Matters will contribute to healthier ageing, improved quality of life and sustainable labour participation for women. By generating evidence on female-specific muscle health and translating this into diagnostics, wearables, interventions and guidelines, the programme addresses an important and currently underserved societal need. The programme also creates opportunities for innovation through co-development of products and technologies, while supporting healthcare, employers and policy makers with evidence-based solutions to improve female health and performance.
- H&W, DSS, HTI
- 2nd year in 2027. ERP Series A running 2026 – 2027.

Plans 2027

In 2027, Muscle Matters will focus on translating initial scientific findings into scalable research, innovation and valorisation opportunities. Key activities include establishing a menopause-related PPP around muscle biopsies, preparing legal and ethical frameworks for the Care for Women dataset, advancing ageing and menopause disease models and defining a PPP for a muscle wearable. Go/no-go decisions will be made for strategic work packages, while promising lines will be prepared for follow-up funding, PPPs and implementation in years 3 and 4.

Impact pathway



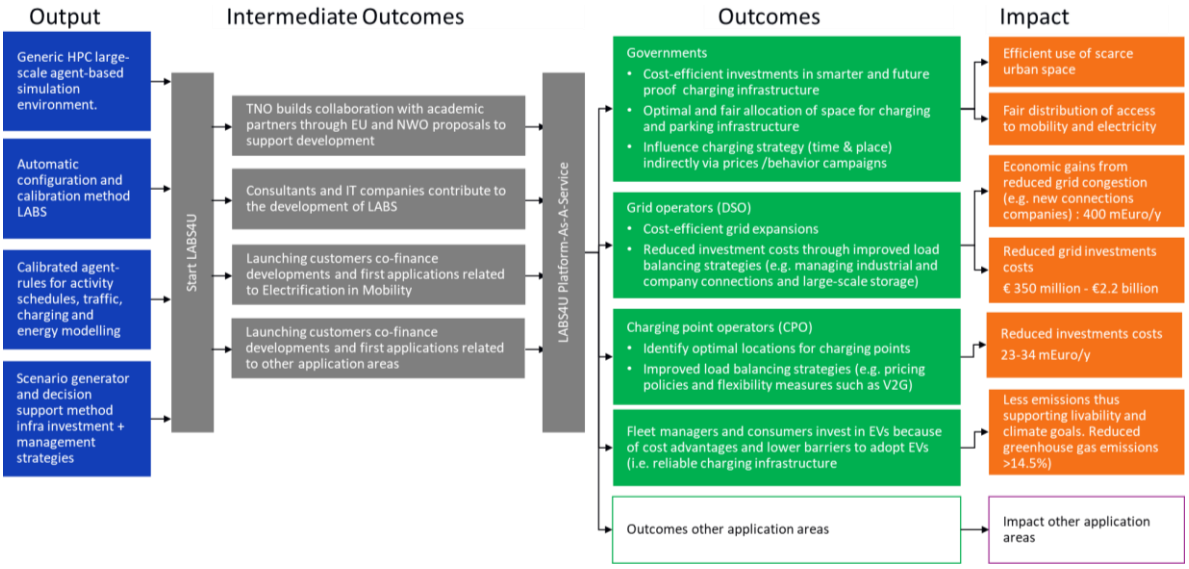
13 Large-Scale Agent-based Simulation (LABS) – first use case Electrification in Mobility

- **Ambition.** Pioneers the development of a world-class, high-performance Large-scale Agent-Based Simulation platform (LABS), enabling stakeholders in the mobility and energy domains to make model-based, cost-effective investment decisions. Establish a well-aligned ecosystem (LABS4U) that brings together currently fragmented agent-based modelling initiatives, strengthening collaboration and positioning TNO at the forefront of agent-based decision-making and innovation.
- **Impact**. LABS accelerates the mobility and energy transition, leading to reduced congestion, reduced nitrogen deposition, improved air quality, public health benefits, reduced healthcare costs, improved use of space and reduction of greenhouse gas emissions.
- MBE, EMT, ISP
- 2nd year in 2027. ERP Series A running 2026-2027

Plans 2027

In 2027, the goal is to deliver an advanced version of LABS, including an optimized data architecture, agent core designed for parallel GPU computing, automated calibration procedure and scenario generator and decision support dashboard to evaluate and compare a large number of what-if scenarios for different application areas. Adaptors to open-source agent-based modelling frameworks will be made to integrate well-established agent-rules (i.e. behaviour) needed for different application areas. A use case will be executed to demo the added value of LABS. The LABS4U ecosystem will be officially launched, starting with core partners and a dedicated partner board.

Impact Pathway



Example focussed on first application area “electrification in mobility”. Other application areas are being explored in parallel.

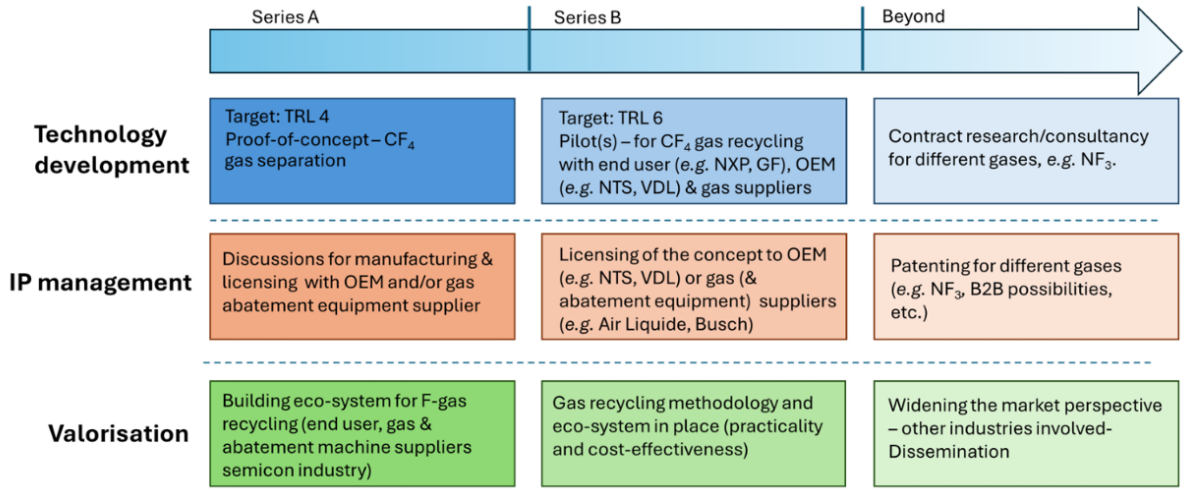
14 Greenhouse gas recycling for semicon

- **Ambition.** The project aims to develop and demonstrate a breakthrough technology for capturing and recycling fluorinated greenhouse gases (F-gases) from semiconductor manufacturing processes. By leveraging state-of-the-art separation technologies, the goal is to drastically reduce the direct emissions of potent F-gases, particularly CF_4 , and enable their reuse, supporting the semiconductor industry in meeting stringent EU sustainability targets.
- **Impact**. The expected impact is an 80% reduction in F-gas emissions, a 70% reduction in F-gas waste, and the reuse of approximately 73% of CF_4 compared to current state-of-the-art abatement methods. This technology will help the semiconductor industry achieve both sustainability and growth targets, potentially reducing European F-gas emissions by ~4 Mton CO_2eq annually and saving an estimated €300 million per year in emission costs.
- HTI, EMT
- 2nd year in 2027. ERP Series A running 2026-2027

Plans 2027

Key activities include: lab experiments proving condensation of high GWP gases from a binary mixture (WP1, M1), a design update enabling liquid-gas phase separation (WP 2, D2) and lab experiments with this design proving separation (WP2, M2). By building an ecosystem for technology dissemination through strong partnerships with European end-users, OEMs and abatement manufacturers, preparation for broader market adaption is ensured (WP 4).

Impact Pathway



15 System-level Platform for Adversarial Robustness Testing and Analysis

- **Ambition.** SPARTA aims to advance the testing of autonomous systems by developing a virtual test platform. This platform supports systematic evaluation under a broad range of conditions, complementing traditional testing approaches.. The ambition is to strengthen TNO's position in AI operationalization and safety assurance, supporting the development of trustworthy autonomous systems across different application domains.
- **Impact.** SPARTA will enhance the safety and resilience of autonomous systems by improving methods for identifying and assessing operating conditions. The approach supports industry adoption, regulatory standardization, and public trust in automation while strengthening TNO's position in trustworthy AI and safety assurance.
- DSS, MBE, ISP
- 2nd year in 2027. ERP Series A running 2026 – 2027.

Plans 2027

In 2026, we focused on developing and integrating technological pieces that would allow a minimal working example of the SPARTA vision. In 2027, we will focus on demonstrations that connect with customer needs. Now that we can show our customers what SPARTA is about and what could be achieved with further technological developments, a central point of 2027 will be stakeholder engagement and the definition of a clear path for valorization. Further development of the technology is still much needed, and this will be done in consultation with key external stakeholders to ensure real-world relevance and applicability.

Impact Pathway



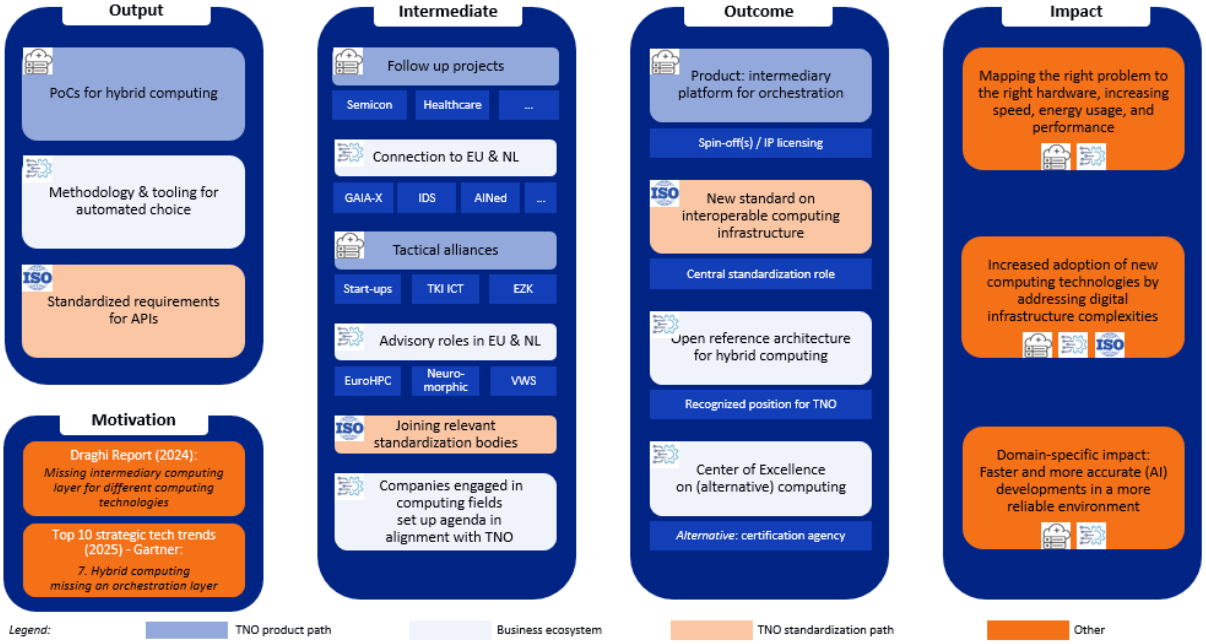
16 Orchestrating Alternative Compute Platforms

- **Ambition.** ORCHALCOM aims to address fragmentation and interoperability barriers between high-performance, quantum and neuromorphic computing. The project explores an application-aware middleware framework for decomposing computational problems, selecting the most suitable computing infrastructures and automatic orchestrating of workloads across them. The intended result is to lower the expertise barrier for users and contribute to an open, vendor-neutral foundation for hybrid/heterogeneous computing in Europe.
- **Impact.** ORCHALCOM seeks to improve access to advanced computing for researchers, SMEs and industry by exploring hybrid solutions in areas such as new drug development and low-energy remote patient monitoring. Through an open and neutral approach, the project intends to contribute to European technological autonomy and sovereign technological stack, and to strengthen TNO's role in interoperable computing
- ISP, HTI, H&W
- 2nd year of ERP Series A running 2026 – 2027.

Plans 2027

In 2027, ORCHALCOM plans to further implement, integrate and validate selected first-year results. Activities are expected to include implementing and testing automated workload placement according to the elaborated middleware architecture, developing neuromorphic and quantum-classical integration demonstrators, and progressing healthcare use cases and the hybrid-computing testbed design. The project will also continue partner engagement, explore establishment of a computing community between its isolated branches, contribute to standardisation and intellectual-property activities, and investigate suitable follow-up funding opportunities.

Impact Pathway



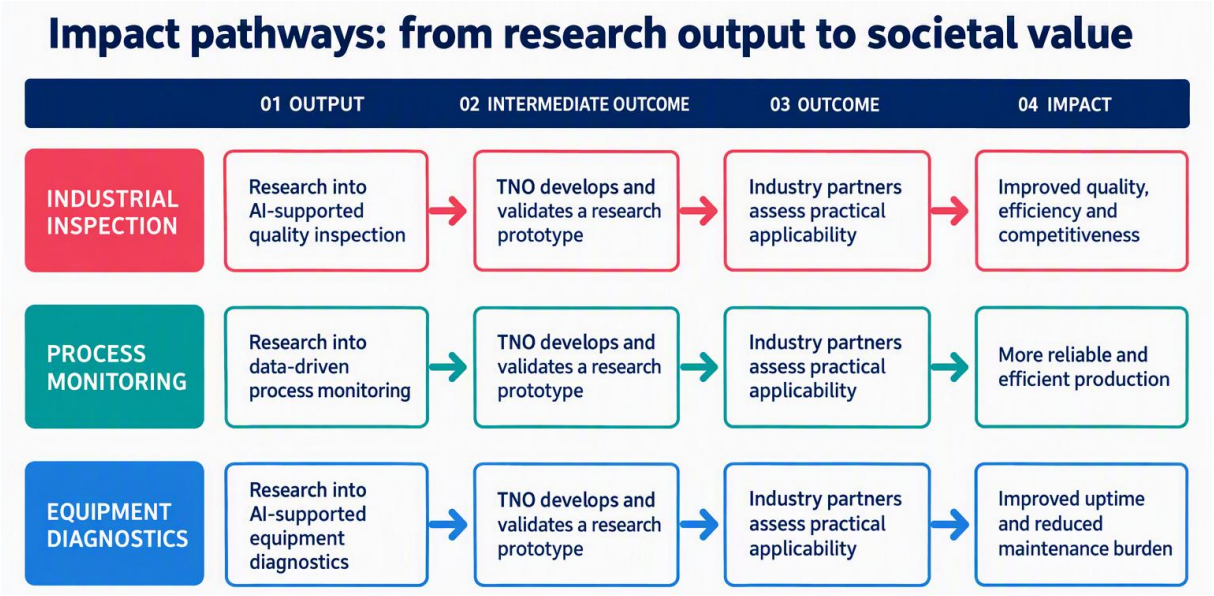
17 Agile AI Anomaly Detection

- **Ambition.** The project aims to advance AI-based anomaly detection for complex systems where traditional methods fall short. Its ambition is to reduce the amount of labelled data required for effective AI training by combining data-driven approaches with domain knowledge. This approach targets sectors such as industrial inspection and medical screening, making advanced anomaly detection more accessible and cost-effective.
- **Impact.** AAAD is expected to enhance TNO's capabilities in AI-based inspection and diagnostics by developing methods that transform sensor data into actionable information. This can support manufacturing with in-line quality assurance and productivity gains. The project also aims to generate broadly accessible intellectual property, benefiting multiple customers and strengthening TNO's market position in high-tech industries.
- HTI, DSS, ISP
- 2nd year of ERP Series A running 2026 – 2027.

Plans 2027

In 2027, the project will focus on further developing and validating methods that reduce the need for costly labelled data. Key activities include gathering requirements and datasets, developing prototypes, validating methodologies and comparing these to alternatives. Collaboration with industry partners is included to ensure solutions meet real-world needs. This year's milestones will involve delivering research reports, prototypes and informing stakeholders.

Impact Pathway



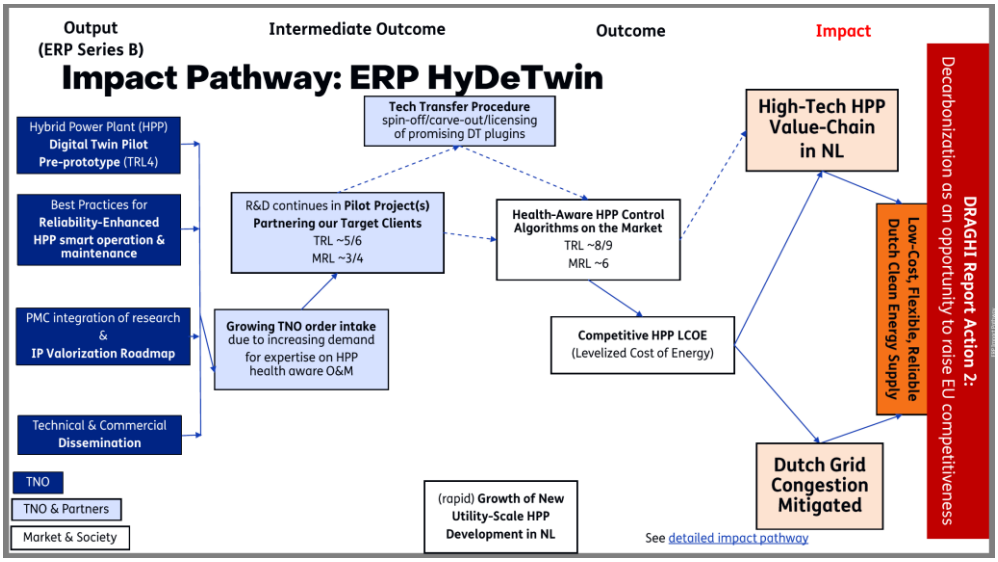
18 Hybrid Power Plant Digital Twin for Resilient Health-Aware Operation & Maintenance

- **Ambition.** ERP HyDeTwin Series A aims to enhance Hybrid Power Plant (HPP) resilience and lifetime profitability by informing operational scheduling decisions with long-term asset degradation and system reliability (i.e. health-aware operation), thanks to advanced reliability modelling and optimization algorithms integrated into a versatile digital twin architecture. HyDeTwin Series A also aims to design a tailored experimental campaign in TNO's SWITCH field lab (Wind Energy group) and Faraday lab as well as the corresponding database (STIP group) to validate the developed algorithms (the execution of these experiments is planned for the Series B ERP).
- **Impact.** This project will develop knowledge and a TRL-4 digital twin pre-prototype for health-aware HPP operation and maintenance decision support. By integrating asset degradation and system reliability into operational scheduling, it can help HPP operators and energy management system providers reduce OPEX, extend component lifetime, and lower HPP LCoE. This approach is expected to enable cost-saving of up to 16%, and to lead to more flexible, reliable renewable energy supply, reduction of grid congestion, and a more resilient Dutch energy system.
- EMT, ISP, MBE
- 2nd year of ERP Series A running 2026 – 2027.

Plans 2027

In 2027 the project delivers a Hybrid Power Plant Digital Twin software prototype (TRL 3), containing all developed models for degradation, reliability and setpoint optimisation, workflows, and connectors. Secondly, the design of accelerated degradation experiments is delivered, and the designed experimental campaign in the SWITCH field lab is approved by the SWITCH lab management team. Thirdly, valorisation is pursued by consulting market parties for their interest in our research and (future) collaboration.

Impact Pathway



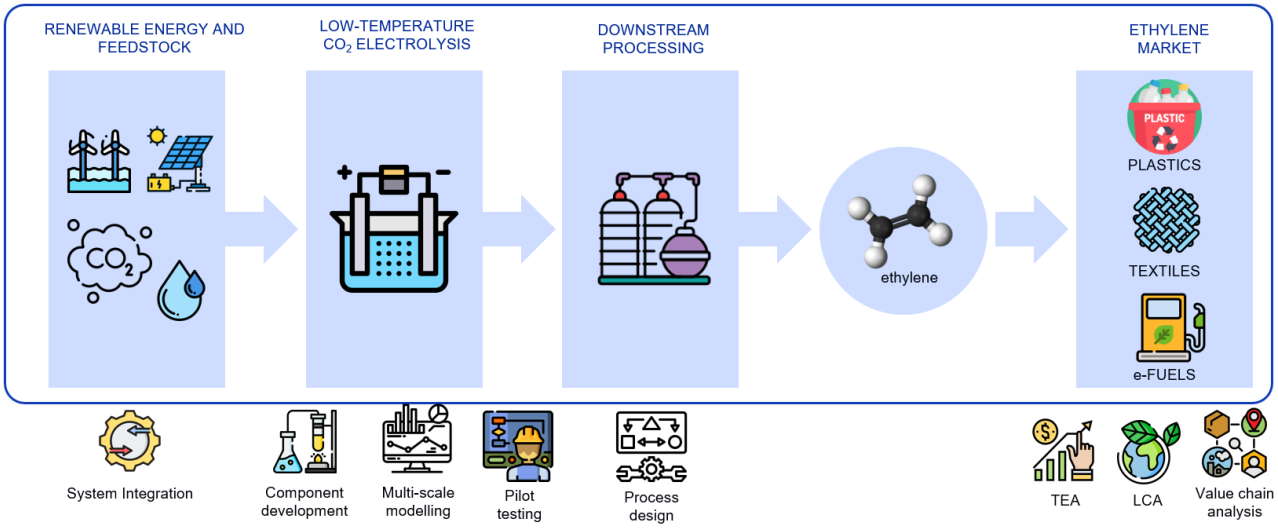
19 Industrial ethylene electrosynthesis

- **Ambition.** Industrial Ethylene Electrosynthesis aims to position TNO as a global leader in industrialising electrochemical CO_2 conversion. By integrating electrocatalysis, scalable material production, multiscale modelling, reactor engineering and process design, the project will progress towards a world-first multi-kW demonstration of direct CO_2-to-ethylene conversion.
- **Impact.** The project will de-risk industrial scale-up of green ethylene production for carbon-neutral plastics, textiles and fuels. It will strengthen TNO's position as Europe's independent validation and scale-up partner and create opportunities for licensing, contract research, consultancy, joint ventures and a Shared Research Programme.
- EMT
- 3rd year in 2027. ERP Series A running 2025 – 2026, ERP Series B 2027 – 2028.

Plans 2027

In 2027, the project will integrate multiscale modelling, scalable catalyst and electrode manufacturing, reactor development and automated pilot testing. Long-duration experiments will assess efficiency, stability and reproducibility, while conceptual plant design, techno-economic analysis and life-cycle assessment will guide system integration and downstream processing. The team will scope a Shared Research Programme, engage sixteen industrial partners and target at least four commitments, while developing licensable knowledge, contract-research services and an industrial implementation roadmap.

Impact Pathway



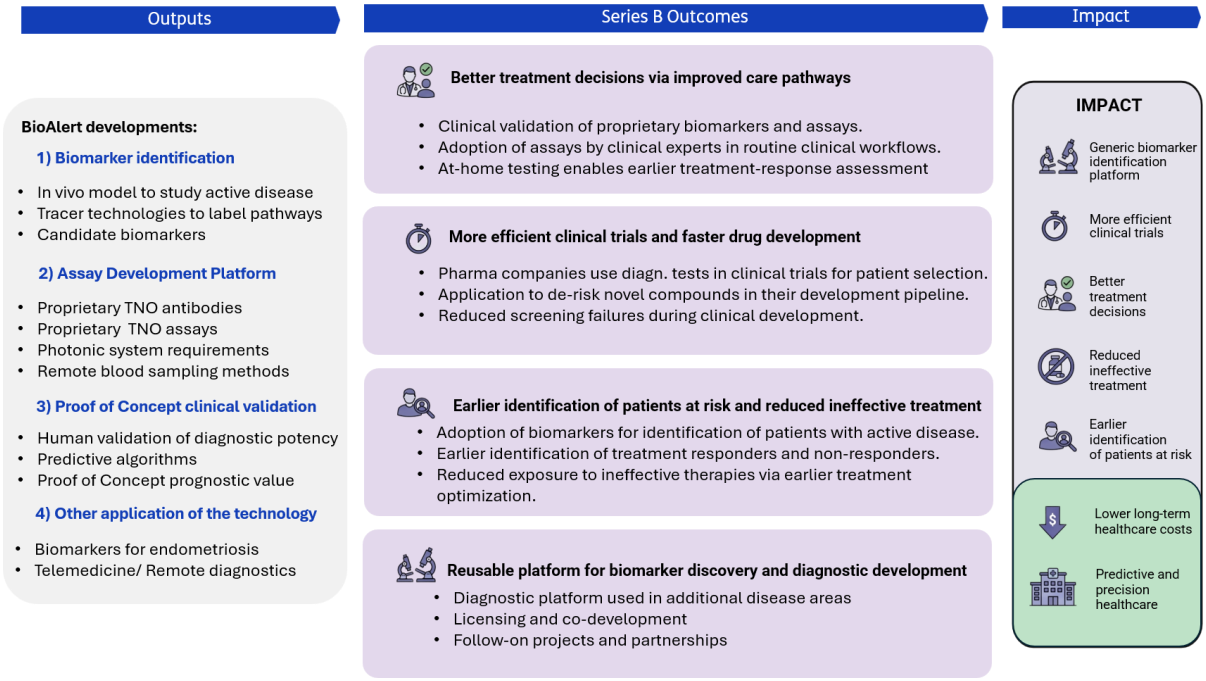
20 BioAlert - Innovative early warning system through biomarkers

- **Ambition.** BioAlert aims to develop a widely applicable diagnostic platform that translates active disease biology into actionable information. Building on Series A, the project will validate mechanism-based biomarkers and next-generation photonic sensing for patient selection and early treatment-response monitoring, initially focusing on liver fibrosis and subsequently other chronic diseases.
- **Impact.** BioAlert will enable earlier and more effective treatment decisions, reduce screening failures in clinical trials and improve the use of expensive therapies. It will create value for pharmaceutical, diagnostic and healthcare organisations through IP-protected biomarkers, antibodies, assays, predictive algorithms and photonic sensing, with valorisation through licensing, contract research and public-private partnerships.
- H&W, HTI
- 3rd year in 2027. ERP Series A running 2025 – 2026, ERP Series B 2027 – 2028.

Plans 2027

In 2027, BioAlert will deliver biomarkers that identify patients at risk of disease progression and monitor early treatment responses. This will enable validated diagnostic applications for liver fibrosis. The team will validate prognostic signatures and patient-selection algorithms in longitudinal clinical cohorts, assess treatment-response biomarkers using clinical-trial samples, and benchmark results against current standards of care. In parallel, immunoassays and a compact photonic sensing platform will be developed, while health-economic modelling, stakeholder engagement and target product profiles will guide regulatory, licensing and commercialisation routes.

Impact Pathway



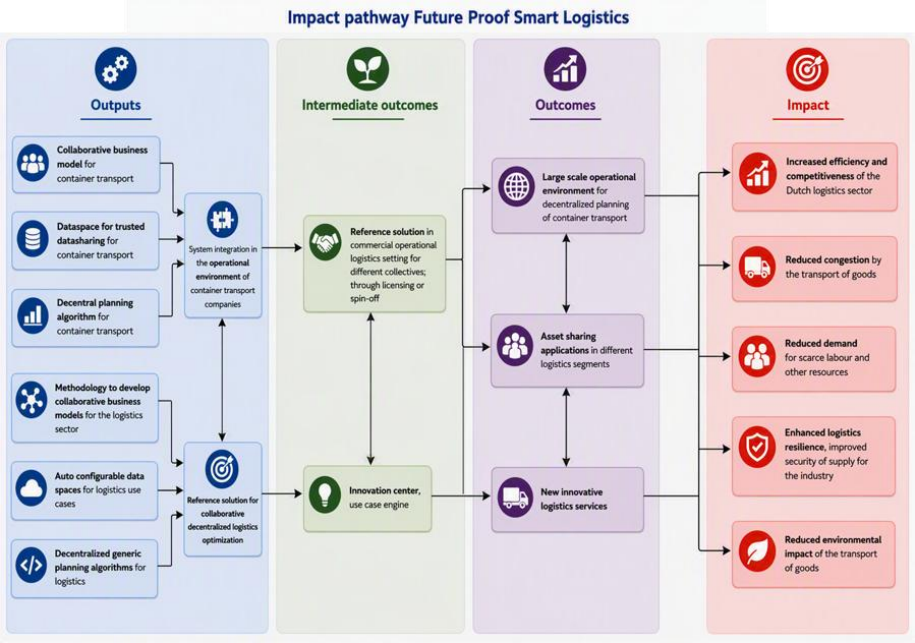
21 Future proof smart logistics

- **Ambition.** Future Proof Smart Logistics aims to enable large-scale collaboration between autonomous logistics organisations by integrating scalable collaborative business models, trusted data-sharing technologies and decentralised asset-sharing algorithms. Building on the Series A reference solution, Series B will validate this integrated approach in operational environments, enable replication across logistics domains and accelerate the transition towards the Physical Internet.
- **Impact.** FPSL will reduce empty transport movements and costs, increase asset and labour productivity, improve security of supply and strengthen the resilience and sustainability of logistics networks. The project will translate the validated solution into market adoption through a spin-off or licensing route and establish the foundation for an innovation centre that supports implementation and scaling across sectors.
- MBE, ISP, DSS
- 3rd year in 2027. ERP Series A running 2025 – 2026, ERP Series B 2027 – 2028.

Plans 2027

In 2027, FPSL will further develop and validate its integrated reference solution for collaborative logistics in operational environments. The team will scale trusted data sharing, collaborative business models and decentralised asset-sharing algorithms, quantify participant-level value as networks grow, and extend validation beyond container logistics to applications including horticulture and logistics. In parallel, FPSL and TNO Tech Transfer will validate the preferred spin-off or licensing route, launch implementation projects with logistics hubs and industry partners, and prepare the governance, funding and coalition for an innovation centre that can replicate the approach across new domains.

Impact Pathway



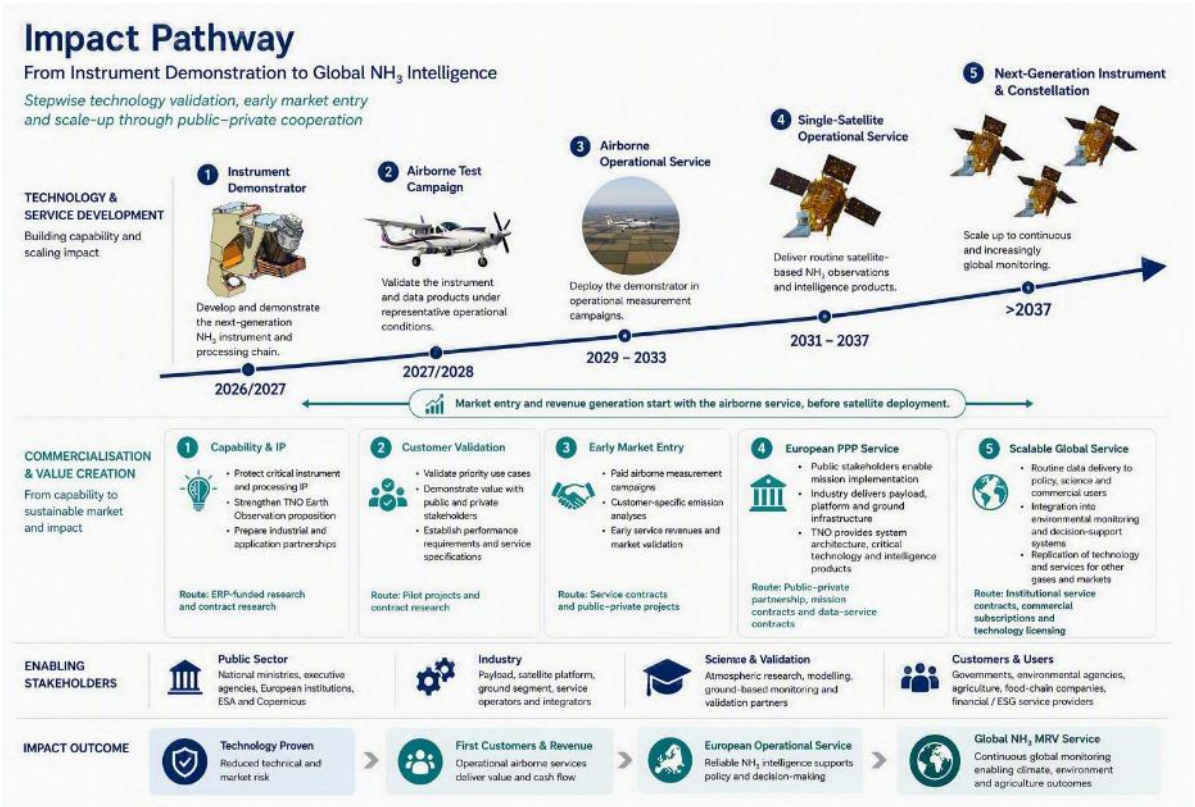
22 Highly sensitive optical gas sensing

- **Ambition.** HISENSE aims to create a validated, measurement-driven capability that converts Earth Observation data into locally actionable ammonia-emission information. Building on Series A, the project will mature the OFFIR thermal-infrared instrument, end-to-end simulation and retrieval tools, and atmospheric inversion methods into an integrated airborne demonstrator and a credible pathway towards operational satellite monitoring.
- **Impact.** HISENSE will provide more reliable evidence for nitrogen policy, permitting and emission-reduction measures by detecting distributed agricultural ammonia sources that current satellite systems miss. Series B will deliver an offerable airborne monitoring service, reduce technical and market risks for a future European satellite mission, and strengthen the position of TNO and the Dutch space sector in thermal-infrared Earth Observation.
- HTI, EMT
- 3rd year in 2027. ERP Series A running 2025 – 2026, ERP Series B 2027 – 2028.

Plans 2027

In 2027, HISENSE will refine user requirements and application-readiness criteria, validate the end-to-end modelling, retrieval and emission-inversion chain, and quantify uncertainties and added value compared with existing monitoring approaches. The team will complete laboratory testing of the OFFIR concepts, select the airborne configuration, procure and integrate the required thermal-infrared components, and build and qualify a functional instrument demonstrator. In parallel, stakeholders will be engaged to select a credible commissioning and funding route, while preparations begin for airborne campaigns and a future space mission.

Impact Pathway



23 Asphalt rejuvenation using micro-algae (CARMA)

- **Ambition.** CARMA aims to develop a circular, fit-for-purpose asphalt rejuvenator based on wastewater-grown microalgae at an industrial scale. By combining cost- and resource-efficient algae cultivation, scalable biorefining and a tailored formulation that improves asphalt durability, the programme seeks to enable repeated high-value recycling of asphalt surface layers and establish a viable new biobased value chain for climate-neutral road maintenance.
- **Impact.** CARMA can reduce the use of new bitumen, make asphalt last longer, and support the high-quality reuse of road surfaces. This will reduce the climate impact and the use of raw materials in road maintenance, creating a road maintenance solution that fits within the planetary boundaries. CARMA will also help build a strong technical and economic basis for a microalgae-based rejuvenator, support cooperation across the value chain, and prepare the way for future investment, approval, and wider market use.
- MBE, EMT
- 4th year in 2027. Running 2024 – 2027.

Plans 2027

In 2027, CARMA will develop the main elements needed for a follow-up pilot: optimized algae cultivation protocol, a process description of the biorefining process for pilot scale production of the rejuvenator, and an approach for dosage and application method for the rejuvenator in asphalt. HSE risks, environmental impacts, and economic feasibility will also be assessed together with algae producers, biorefineries, contractors, and road authorities. Together with future stakeholders a joint proposal for a pilot for the production of the rejuvenator, including full scale application in a pavement will be prepared. This proposal will be submitted for RVO funding under the EKOO industry call. The demonstration is expected to secure commitments for the required investments for production and implementation.

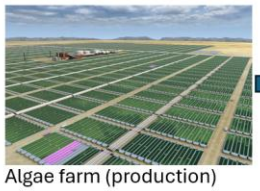
Impact Pathway



Waste water (nutrients)

Activities: Development of fit for purpose asphalt rejuvenator to enable effective recycling of asphalt

Outputs 2027: A validated algae-based rejuvenator and asphalt application method, ready for further scale-up and use in sustainable road maintenance.



Algae farm (production)



Biorefinery (processing)

Outcomes:

- The Dutch pavement sector has a validated biobased recycling option paving the way for zero emssion asphalt.
- A new more local biobased value chain has been initiated for the production of bio-oil products.

Impact: A high quality road network for freight and people while sticking to climate goals



Asphalt (processing)



Asphalt production

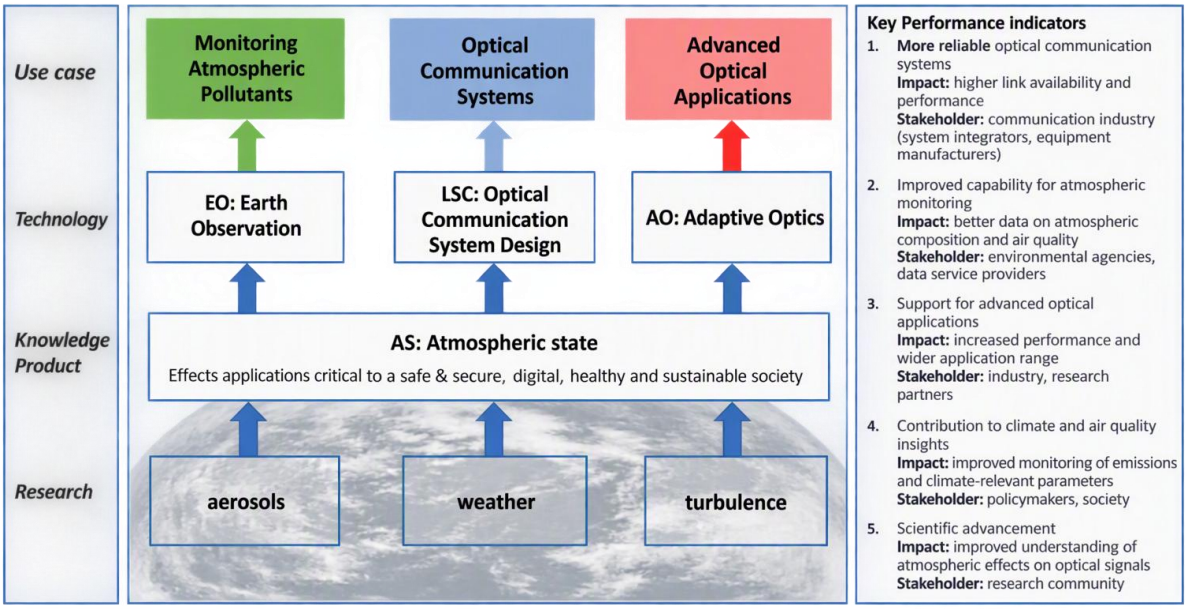
24 Atmospheric models for optical solutions

- **Ambition.** To improve understanding of the impact of the dynamic atmospheric state on the quality of an (optical) signal after propagation through the atmosphere, thereby strengthening TNO's market position in optical communication and atmospheric monitoring. ATMOS results feed into key technologies, contributing to the development and performance assessment of optical systems and earth observation by a new generation of satellites.
- **Impact.** We enable highly reliable optical communication. Our improvement to extremely accurate monitoring of climate and pollution will help improve verification of the Paris Agreement.
- DSS, HTI, EMT
- 4th year in 2027. Running 2024-2027

Plans 2027

In the final year of ATMOS, the team will consolidate the knowledge development achieved in ATMOS and finalize the implementation of that knowledge in selected application areas. In the continuing impact and valorization efforts, the team aims to develop an "ATMOS inside" approach, allowing additional and novel use cases to benefit from ATMOS expertise, thereby establishing a generic pathway towards including knowledge of the atmospheric state to the benefit of both internal and external customers.

Impact Pathway



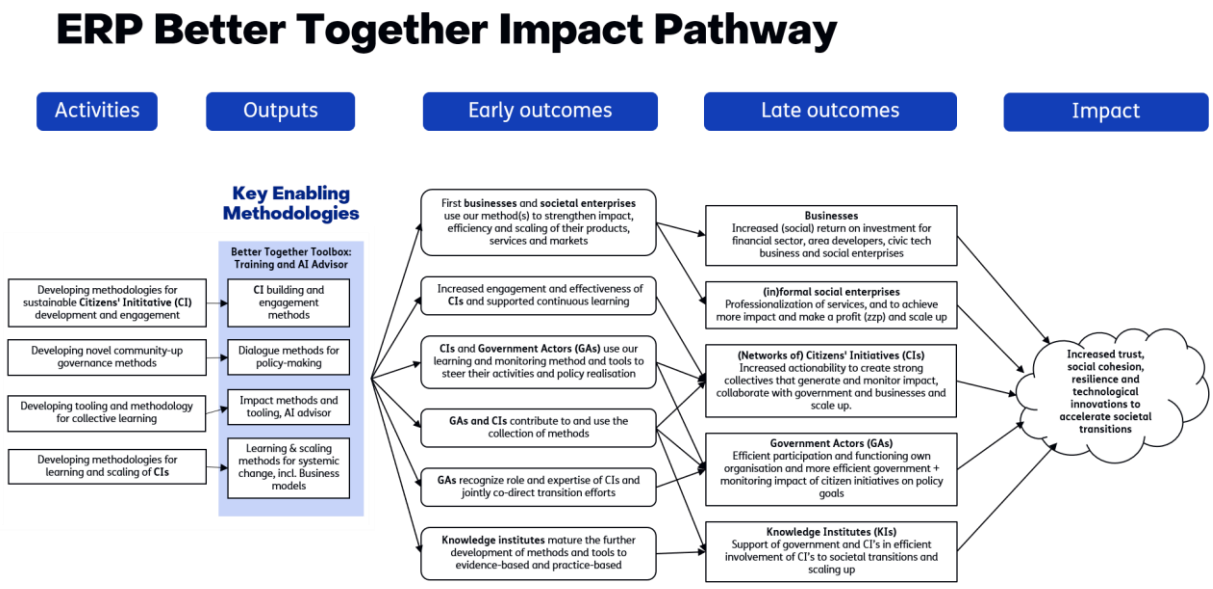
25 Empowering citizen collectives

- **Ambition.** Our ambition is to empower citizen collectives as essential partners in accelerating societal transitions. We will develop and validate an integrated toolbox of key enabling methodologies for community engagement, transformative governance, impact monitoring, collective learning and scaling. By connecting citizens, governments, businesses and knowledge organizations, we aim to create sustainable public-private-civic ecosystems in which local initiatives can flourish and contribute to systemic change.
- **Impact.** The toolbox enhances the agency of citizens' initiatives at neighbourhood level, and strengthens participatory policy making and collaborative action in public-civic-private partnerships at national and local level. The improved agency will lead to increased social cohesion and social justice, ultimately fostering increased trust. Engaging citizens – particularly those that have lost trust in government policy – is essential for the success of urgent transitions. By doing so, this ERP accelerates the local adoption of socio-technical innovations, shaping societal transitions.
- H&W, Vector
- 4th year in 2027. Running 2024-2027.

Plans 2027

In 2027 we will focus on finalizing the Better Together Toolbox, which includes training modules (milestone 1) and a Better Together advisor (milestone 2). The aim is to sustain the Better Together Toolbox and underlying knowledge through exploring various valorization pathways (milestone 3), such as paid training and consultancy assignments, and possibilities for licensing the Better Together advisor. Furthermore, we will disseminate our knowledge and increase communication in order to achieve the desired impact (milestone 4).

Impact Pathway



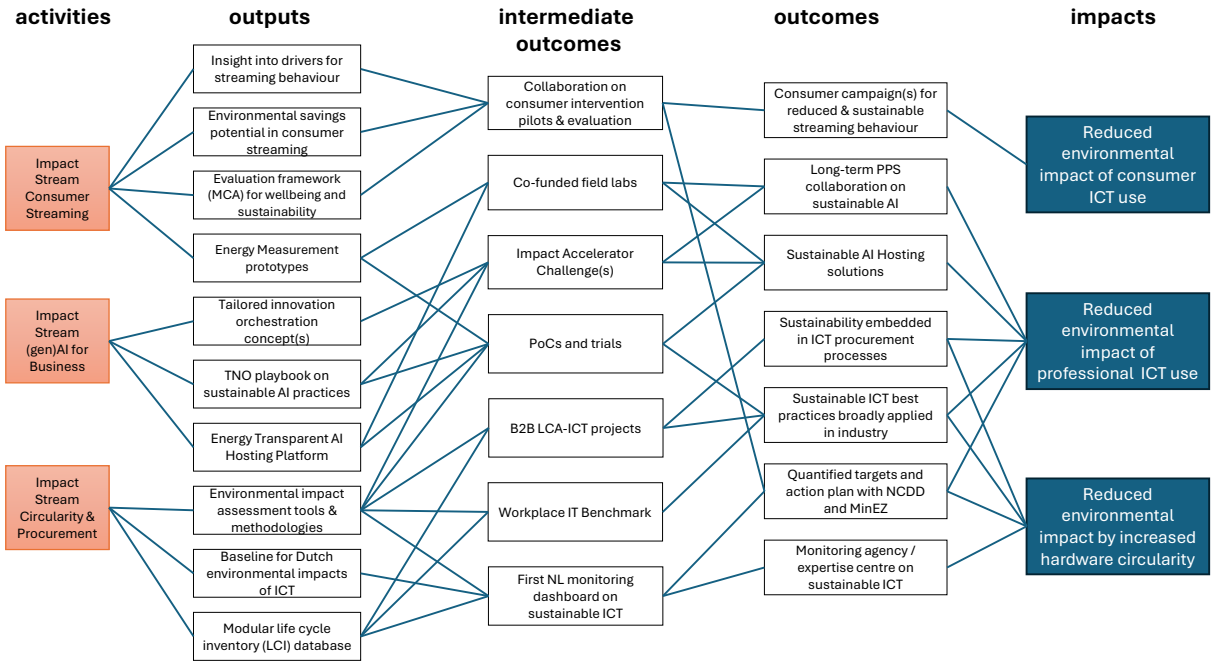
26 Sustainable ICT

- **Ambition.** The ambition is to enable policy makers and large organisations to comprehend the environmental impact of the ICT domain. This includes identifying hotspots with the highest impact and modelling interventions and their impact to identify opportunities for interventions and supporting actions. The main use cases are consumer video streaming and social media use, workplace IT, datacentres and AI use in professional work environments.
- **Impact.** The main impact is to reduce the environmental impact of the ICT domain. In the consumer market the focus is on reduced use linked to reduced wellbeing, with the government as the main actor. At the country level, the focus is on stimulating collective action through transparency on impacts. At an organisational level, the focus is on benchmarking, and for (gen)AI use, on decision support leading to more responsible and sufficient use.
- ISP, EMT, TNO Vector
- 4th year in 2027. Running 2024 – 2027.

Plans 2027

In the final phase of the ERP, the focus is on finishing the research, on validation and dissemination and on building out the existing collaborations. Our main partners are Platform EnergieBewustzijn and Trimbos (for streaming and social media use), LeafCloud, Resilio and Interact (for our LCA work) and the NCDD and a range of financial institutes and government organisations (for our genAI work). The goal is that our output enables ongoing collaborations in these areas to ensure our insights and methodologies find their way to the market.

Impact Pathway



Strategy

Anna van Buerenplein 1
2595 DA Den Haag
www.tno.nl

TNO innovation for life