# The Future of Advanced Materials Research and Innovation in Europe

iAM-i
INNOVATIVE
ADVANCED MATERIALS
INITIATIVE

VISION
2040

# Foreword

Every technology that will shape Europe's future — clean energy, mobility, health, the digital economy — depends on advanced materials. Whoever develops and scales these advanced materials first sets the terms everyone else lives by. This is not a niche of science; it is a question of sovereignty.

The decisive factor for competitiveness is the toolbox. Europe mostly still develops advanced materials the 20th - century way — one step at a time, in separate silos, barely tapping what the digital world now offers. The road from idea to product is fragmented, slow and expensive: ten to twenty years, and the reward is too often captured elsewhere. As applications grow more complex and competition turns global, that way of working can no longer keep pace.

This Vision is about a new toolbox — a 21st-century way to bring advanced materials from lab to market, faster. Its building blocks are already taking shape across Europe: self-driving labs running day and night, a shared European data space, large research facilities, and pilot lines that turn a promising advanced material into a product. Alone, they change little; connected into one system, they become the HOW. Building those connections — the data, standards and methods — and proving them on real, strategically important advanced materials is the work of the partnership we propose for Horizon Europe 2028–2034, turning each project into a reusable blueprint. Material and method advance together. IAM-I is the community driving this; IAM4EU⁺ is the instrument that delivers it.

Our aspiration is concrete: to roughly halve the time to market — from ten-to-twenty years toward five-to-ten.

And because the HOW is transversal, it works with and for Europe's value-chain partnerships, in chips, batteries, hydrogen and beyond. Most funding for advanced materials sits with them and stays there; together we choose which advanced materials to take on, so the toolbox is built on real industrial need. A toolbox is only proven by using it.

The timing is rare. Horizon Europe 2028–2034, the new European Competitiveness Fund and the coming Advanced Materials Act are taking shape at the same moment — an alignment that comes maybe once in a decade. We are not starting from a blank page: through IAM-I the community is already here, more than 300 members across industry and research in some thirty countries. What is missing is the decision to run the connected system as one, at European scale.

**No country can build this alone, and the market will not deliver it — it takes the European Commission, the Member States and partners across the ecosystem, pulling the same way. Endorse this Vision, and build it with us. The people are in place, the instruments are aligning, and the moment is now.**

Fabrice Stassin
IAM-I Chair
Umicore

Eva-Kathrin Schillinger
Secretary General
IAM-I

# Executive Summary

## THE OBSERVATION

Advanced materials are the foundation of Europe's industry, present across the entire value chain, from the advanced material itself to the market-ready product. Europe is strong in research and development — but slow to turn it into products.

## THE CORE PROBLEM: EUROPE IS TOO SLOW

Bringing a new advanced material to market takes 10 to 20 years. Today this work is done one step at a time, in separate silos — research, development, scale-up and first industrial deployment handed from one to the next rather than run as one connected system. The whole journey is slow, fragmented and expensive. Europe still develops its advanced materials with 20th-century methods.

## WHY NOW

Europe's competitors are not standing still. The United States and China are building complete advanced materials value chains, and bringing them to market faster than Europe can match with short-term, fragmented responses. Europe is losing the competition — not because its research is weak, but because it is too slow to industrialise it.

This is the moment to change it. Horizon Europe 2028–2034 (HE 2028–2034) is taking shape alongside the new European Competitiveness Fund (ECF) and the Advanced Materials Act, and together they are a once-in-a-decade opportunity to reshape how Europe develops advanced materials. If Europe uses this chance, it can build a faster system; if it does not, the same problems return for another cycle, and European research keeps being turned into products elsewhere.

## THE SOLUTION: A NEW WAY OF WORKING - THE "HOW"

The answer is not more money alone. It is a new way of working: a single connected system that links data, infrastructure and people, and carries an advanced material from first idea to industrial use without breaking the chain. At its heart is a simple loop — plan, synthesise, characterise — repeated again and again, with shared data and results from each round guiding the next. It is driven by the researchers and engineers who direct the work, their expertise is amplified by the tools.

**No country can build such a system by itself, and the market will not deliver it either. It is a task for Europe.**

## IAM4EU+: BOOSTING EUROPE'S ADVANCED MATERIALS ECOSYSTEM

The Commission's support for IAM4EU as the advanced materials partnership under the current Horizon Europe framework programme, FP9, was an important first step — one that now needs to be built on. Through IAM-I, the private side of IAM4EU[1], the community and the expertise are already in place: a network of 300+ members across industry and research.

**IAM4EU+ is the proposed HE 2028–2034 partnership to change how Europe develops advanced materials — from slow and fragmented work to a fast, connected process driven by shared data.**

This change calls for a new generation of connected infrastructures:

- **A network of self-driving labs** — robots and AI running experiments around the clock, so that discovery and optimisation which once took a year can take weeks. Where such labs are joined with modelling, simulation and AI into a single closed loop across the innovation cycle, they form materials acceleration platforms (MAPs).
- **A shared European data space (Materials Commons)** — where advanced materials data is exchanged safely, without giving up ownership, so that the labs and AI have the trusted data they need.
- **Europe's large research facilities** — synchrotrons, ion-beam and similar facilities that produce high-quality data no simulation can replace.
- **Fast prototyping** — pilot lines, test beds and digital innovation hubs that develop, validate and demonstrate advanced materials on the way from a laboratory result to a first industrial product.

These four building blocks are already being developed under other FP9 scopes. IAM4EU+ brings them together, at European scale, developing the methods and blueprints that make them work as one system — a 21st-century approach to advanced materials R&I.

[1] IAM-I represents the private side of IAM4EU, the co-programmed partnership on advanced materials under Horizon Europe.

## 1. Advanced materials: the foundation of Europe's competitiveness

**Advanced materials are materials designed or engineered to deliver new or enhanced properties and structural features for improved functionality and/or specific applications.** They span the full range, from traditional advanced materials and their enhanced variants to the latest emerging materials. They drive technological innovation and are critical to Europe's industrial competitiveness, resilience, sustainability, circularity and open strategic autonomy.

Advanced materials are used in nearly every sector — among them mobility, energy, electronics, construction and health — and shape how well products perform, how efficient and how sustainable. Because they cut across every sector, they are a transversal enabler: progress in one benefits several industries at once. They are not just inputs; they are the backbone of Europe's competitiveness and of its transition to a green, digital economy.

This is increasingly reflected in EU policy. The Chips Act 2.0,[2] the Biotech Act[3], the Critical Raw Materials Act[4], the Net-Zero Industry Act[5] and the Industrial Accelerator Act[6] all aim to secure supply, scale up manufacturing and speed up industrial deployment — and the coming Advanced Materials Act[7] will strengthen this further. Because the same advanced materials, and the methods used to make and test them, often serve both civilian and defence uses (see Annex I), advanced materials are also a strategic asset for Europe's security and technological sovereignty.

## 2. The challenge: Europe is too slow

Today, bringing a new advanced material to market takes 10 to 20 years[8] — too long, too costly and too uncertain. Figure 1 shows what this means in money: years of spending before any return, with the risk that the return is often captured outside Europe. Every year saved matters — the sooner an advanced material reaches the market, the sooner it starts to pay back, and the stronger Europe's industrial position.

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[2] Chips Act 2.0 — proposed June 2026 — digital-strategy.ec.europa.eu/en/library/proposal-chips-act-20

[3] Biotech Act — proposed December 2025 — health.ec.europa.eu/biotechnology/european-biotech-act_en

[4] Critical Raw Materials Act — single-market-economy.ec.europa.eu/sectors/raw-materials … /critical-raw-materials-act_en

[5] Net-Zero Industry Act — single-market-economy.ec.europa.eu/industry/sustainability/net-zero-industry-act_en

[6] Industrial Accelerator Act (Industrial Decarbonisation Accelerator Act) — single-market-economy.ec.europa.eu/publications/industrial-accelerator-act_en

[7] Towards an Advanced Materials Act — research-and-innovation.ec.europa.eu … /towards-advanced-materials-act_en

[8] The 10–20-year discovery-to-market range is the established baseline for advanced materials; see e.g. the Materials 2030 Manifesto (AMI2030).

Generic example advanced material develpment

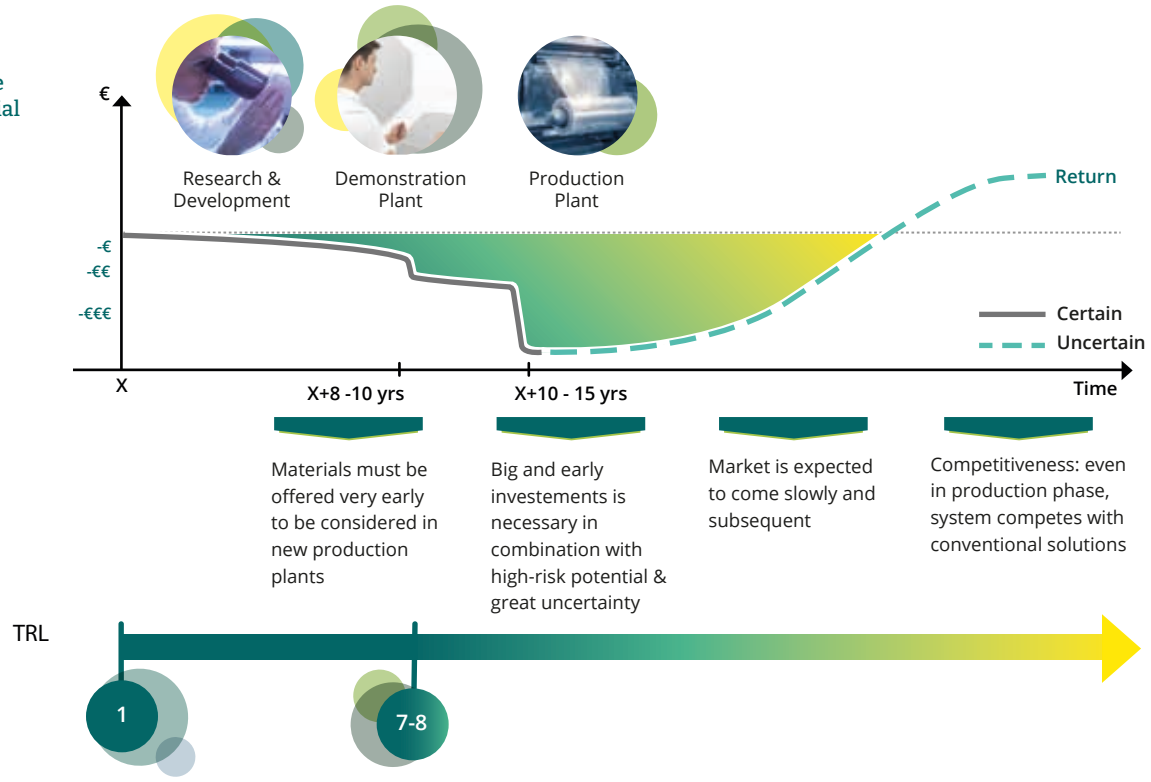



*Figure1: The cash-cost curve of a typical advanced material development — long timelines mean high cost, late returns and high uncertainty.*[9]

The core problem is not a shortage of good research and development capacities; it is that Europe is slow to turn it into industrial strength. Most advanced materials are still discovered, developed and brought to market one experiment at a time, in disconnected steps — the methods of the last century. The United States and China are moving faster, building complete value chains and backing them with both public and private money — the widening competitiveness gap the Draghi report set out in full.[10]

Europe is slow for structural reasons — there is no single cause. The biggest is fragmentation: research, data, testing facilities and industrial routes are not connected enough across Member States, research and innovation disciplines and value chains. Fragmentation is made worse by weak demand signals, by funding that is poorly matched across technology readiness levels (TRLs), by too little financing for scale-up, and by standards and rules that move more slowly than the technology. Together, these create four bottlenecks:

[9] IAM-I, Advanced Materials Act position paper and call to action (Jan 2026) — https://www.iam-i.eu/2026/01/08/advanced-materials-act-iam-i-position-paper-and-call-to-action/

[10] The future of European competitiveness (Draghi report, September 2024) — commission.europa.eu/topics/competitiveness/draghi-report_en

- **a broken lab-to-fab pathway,** where research, testing, validation and first deployment are run as separate steps rather than one connected pathway, so promising advanced materials stall between the laboratory and a first product;

- **disconnected value chains and weak demand,** so an advanced material does not pass smoothly from producer to component manufacturer to final product, and too little industrial demand pulls it through to market ("market pull");

- **too little scale-up infrastructure and finance,** so the facilities to test and scale are fragmented and hard to reach, and there is not enough investment to carry a validated result through to first industrial production; and

- **framework conditions that lag innovation,** as standards, certification and regulation move more slowly than the technology

This is the European paradox: world-class research that too rarely becomes industrial leadership. The four bottlenecks reinforce one another, so none can be solved on its own — and not by money alone. Establishing the free movement of research, innovation and knowledge across Europe — the "fifth freedom" of the Single Market, and the object of the forthcoming European Research Area Act — is the political counterpart to what this Vision describes technically.[11]

What it takes is a change in HOW research is organised, scaled and brought to market, supported by the right funding and instruments (see Annex II).

[11] European Research Area (ERA) Act — research-and-innovation.ec.europa.eu … /european-research-area-era-act_en.

The "fifth freedom", the free movement of research, innovation and knowledge, was set out in the Letta report (2024); the Commission proposal is expected in Q3 2026.

## 3. The vision: a 21st-century way of working

IAM-I's vision is a connected, data-driven European system for advanced materials — built on shared infrastructure, value chains that work as one, and early testing in real industrial conditions — that moves an advanced material from first idea to industrial use at speed and at competitive cost. Because this infrastructure is shared, it is open to all players, not only the largest: it gives SMEs and start-ups access to labs, data and facilities they could not build or afford alone.

Figure 2 shows the two states side by side: today's fragmented and sequential landscape on one side, and on the other the connected system Europe should reach by 2040.

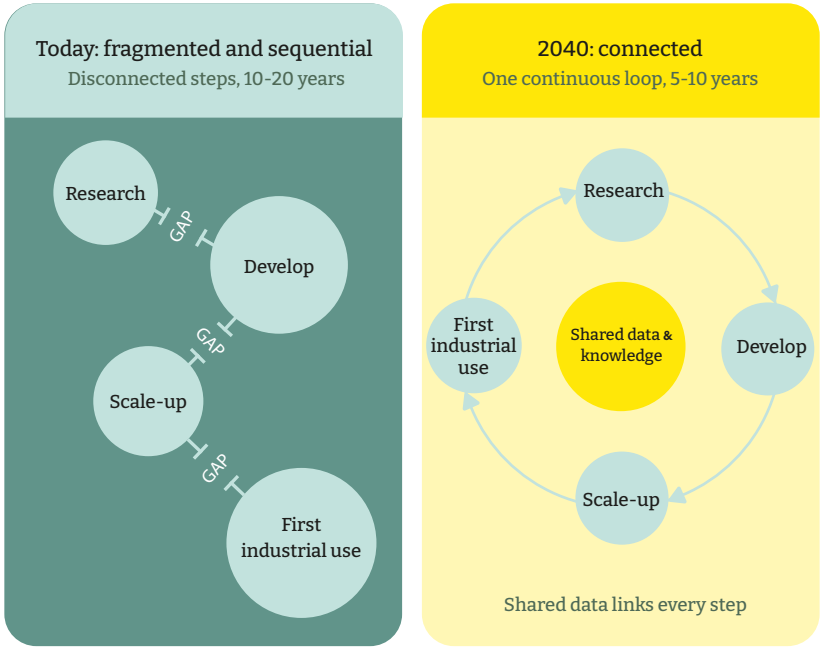



*Figure 2: Europe's advanced materials system — today (fragmented and sequential) versus 2040 (connected).*

At the heart of the approach is a new way of working — the HOW: in place of today's one-step-at-a-time practice, advanced materials are developed in a continuous, connected loop (Figure 3).

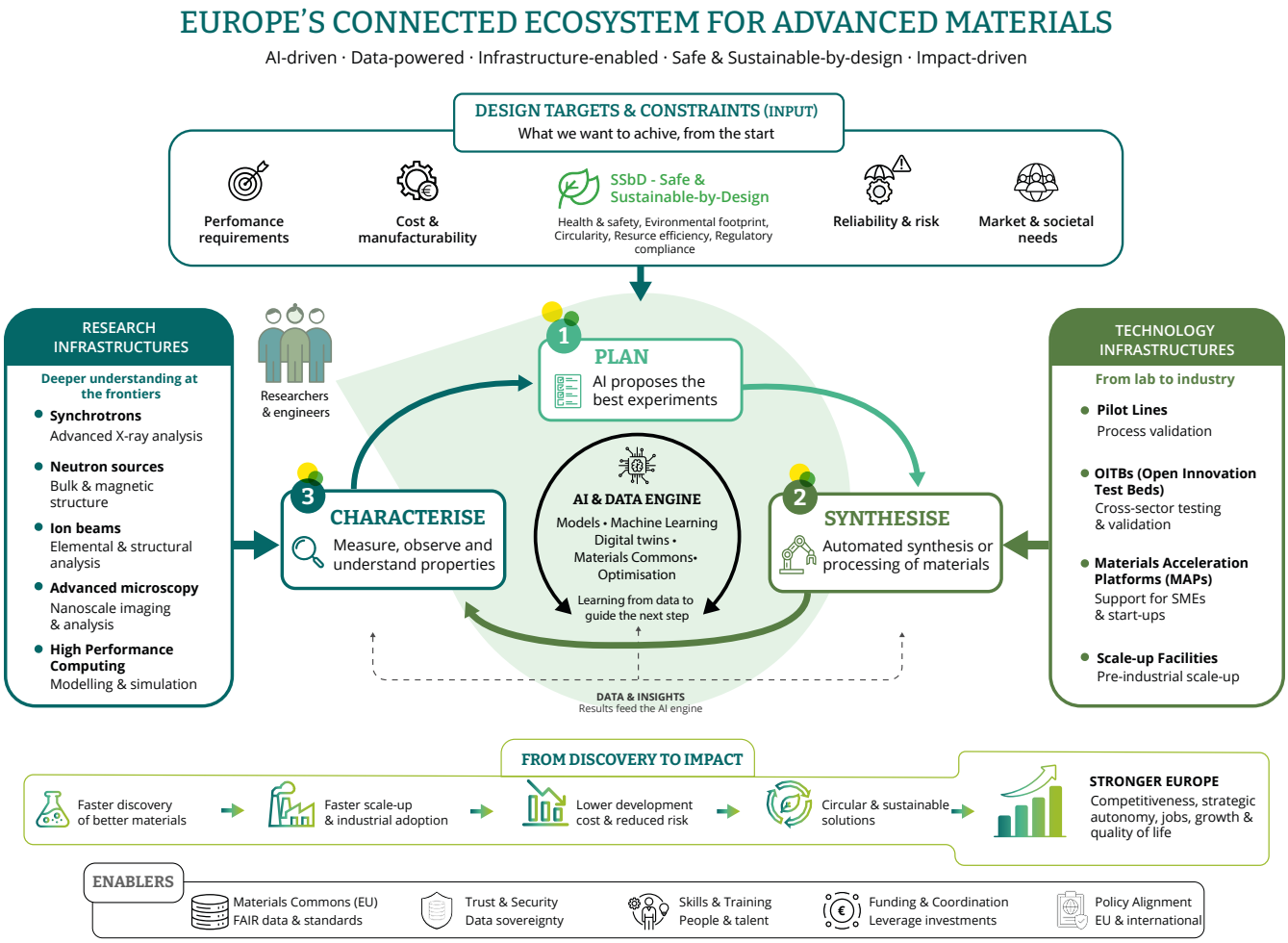



*Figure 3: Europe's interconnected ecosystem for advanced materials research and innovation.*

Figure 3 brings the whole approach together. At its centre is the loop — plan, synthesise, characterise — turning around a shared AI and data engine of models, machine learning, digital twins and simulation: AI proposes the most promising experiments, self-driving labs make and process the advanced materials, and high-quality measurement and monitoring reveals what was really made. Every result flows back into the engine and sharpens the next round, so the system learns as it goes. This loop does not run in isolation. On one side it draws on Europe's large research infrastructures — synchrotrons, neutron and ion-beam sources, advanced microscopy and high-performance computing — for the deep understanding that no shortcut can replace; on the other, it connects to the technology infrastructures — pilot lines, test beds, digital innovation hubs and scale-up facilities — that take part in iterative process development, validation and demonstration, and carry results through to early testing under real industrial conditions.

Two principles run through all of it: 1) targets are set from the very start, including Safe and Sustainable-by-Design (SSbD), applied as a design principle that runs at loop speed rather than a downstream gate; and 2) shared data, trusted and openly governed through Materials Commons.

The different tools per se (AI, self-driving labs, measurement capabilities) are only part of the answer; on their own, they change little. What makes the real difference is connection — the skilled researchers and engineers, infrastructures and value chains behind each step joined up and pulling in the same direction, on shared methods, common data and agreed standards, so that data, knowledge and advanced materials move without a break from one step to the next. The point is the methodology that brings advanced materials to industry faster, as the enabling technology Europe's key sectors are built on. The result is the HOW in full: faster discovery, faster scale-up, lower cost and risk, and more circular, sustainable solutions — together, a stronger Europe.

None of this is new. The building blocks already exist or are within reach: the pharmaceutical industry has used fast, largely automated discovery for years,[12] and the first self-driving labs for advanced materials have already been demonstrated.[13, 14] What is missing is not the capability but the framework to run these pieces as one system, at European scale.

**No single instrument delivers this vision on its own: it takes several, working in concert — and IAM4EU⁺ is the one that builds the HOW.**

[12] High-throughput screening — robotic, automated testing of very large compound libraries — has been standard in pharmaceutical drug discovery for decades; see reviews of laboratory automation and high-throughput screening in drug discovery.

[13] Demonstrations: B. Burger, A. I. Cooper et al., "A mobile robotic chemist", Nature 583, 237–241 (2020); N. J. Szymanski et al., "An autonomous laboratory for the accelerated synthesis of novel materials", Nature 624, 86–91 (2023). Review: G. Tom et al., "Self-driving laboratories for chemistry and materials science", Chem. Rev. 124, 9633–9732 (2024). Typical acceleration factors: A. D. Adesiji et al., "Benchmarking self-driving labs" (2025). Self-driving labs are now moving into industrial R&D — e.g. Atinary's Self-Driving Labs facility, Boston, opened February 2026.

[14] RAISE (Resource for AI Science in Europe) — a Commission flagship under the European Strategy for AI in Science, pilot launched November 2025, €107M under Horizon Europe (2026–2027). Materials science is among its most developed lines, spanning networks of excellence, foundation models for materials, and automated ("self-driving") labs — including the Automated Scientific Discovery call (HORIZON-RAISE-2027-01-01, €29M, materials-first, opening September 2026). research-and-innovation.ec.europa.eu/strategy/…/raise-resource-ai-science-europe_en

## 3.1 The instrument for the HOW: IAM4EU+

IAM4EU+ does not build or operate the physical infrastructure, and it is not the instrument that funds scale-up. So what is it? Delivering the HOW takes a whole new toolbox — the physical infrastructure together with the tools, shared standards, data environments and methods that connect it into one system. IAM4EU+ develops and integrates that connecting part of the toolbox, turning fragmented assets into a coherent European system for advanced materials. Physical infrastructure and partnership develop in parallel and build on each other — each making the other work.

This is the gap IAM4EU+ fills: under the partnership, project consortia work on advanced materials that are essential to strategic technologies (see Annex III), chosen as the prime cases for building the method. In doing so, they produce the blueprints for HOW Europe develops advanced materials on these connected infrastructures — methodologies and approaches that others can reuse, turning a single case into a repeatable way of working. Material and method advance together.

Take high-efficiency thermoelectrics, materials that turn waste heat into electricity, where the possible compositions run far beyond what any team could test by hand. A project sets the target properties; models and machine learning propose candidates; self-driving labs make and measure them; results feed back into the shared data space to guide the next round; the best are confirmed at a large research facility — and the whole route is captured as a blueprint others can reuse.

Working this way, researchers narrowed 16,206 compositions to 80 syntheses and found three new high-entropy chalcogenides above zT 2 (see example box). That method — connected, evidence-driven, value-chain-oriented, with design, synthesis, characterisation, modelling, validation, manufacturability and sustainability built in from the start — is the HOW. And the method, not any single facility, is what accelerates the work.

The same approach applies across Europe's strategic technologies — covering a range from batteries to chips to quantum (see Section 4).

IAM4EU+ anchors the HOW: Figure 4 shows the direction of travel — the HOW feeds the strategic technologies (the WHAT: chips, batteries, hydrogen, quantum and others; see Annex III) — it is transversal by nature — and these in turn feed the system integrators that serve industry (the WHAT FOR).

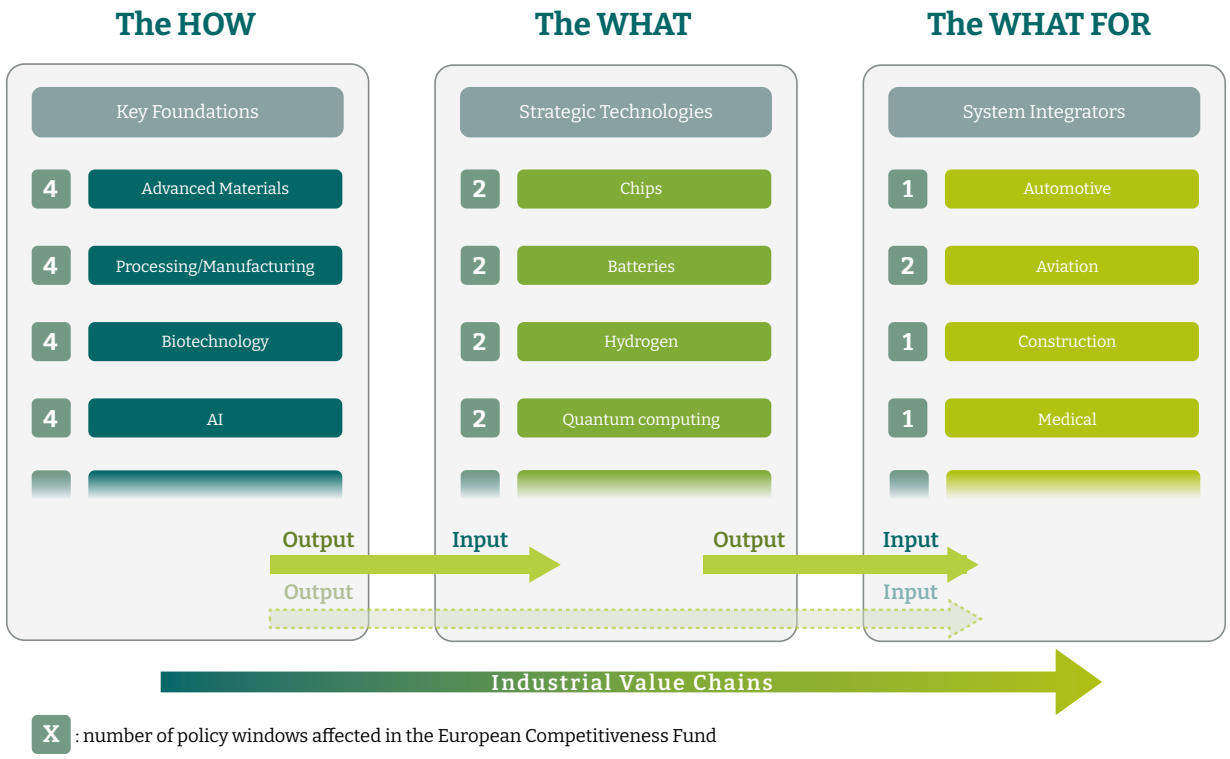



*Figure 4: Directionality of advanced materials R&I — the HOW feeds strategic technologies, which feed system integrators –all stages feed the ECF's four policy windows.*

Each step is built to feed the next, keeping R&I pointed at results industry can take up — tested and de-risked enough to move into production.

**Its place in the European funding landscape.** The place of IAM4EU⁺ in the European funding landscape is clear and complementary. IAM-I brings the ecosystem; IAM4EU⁺, as the partnership, brings the HOW and a structured pipeline of projects that turns both into industrial impact:

- **Pillar I (the European Research Council and Marie Skłodowska-Curie Actions)** produces the basic knowledge that feeds the pipeline at the start.

- **Pillar II is its home:** as a transversal, cross-sectoral partnership, IAM4EU⁺ sits at the middle technology-readiness levels (mid-TRL), linked directly to the priorities of the ECF and its four policy windows — Clean Transition and Industrial Decarbonisation; Health, Biotech, Agriculture and Bioeconomy; Digital Leadership; and Resilience, Security, Defence Industry and Space. The shared European data space (Materials Commons) is funded under the current programme (Cluster 4 of FP9). Within Pillar II, IAM4EU⁺ is the HE 2028-2034 partnership for HOW advanced materials R&I is done.

- **Pillar III (the European Innovation Council, EIC)** connects both ways: Pathfinder supports high-risk research, proof of concept and prototyping, including advanced-materials challenges; downstream, the IAM4EU⁺ portfolio opens opportunities that EIC-backed deep-tech ventures can build on.

- **Pillar IV (research and technology infrastructures)** builds the physical infrastructure — self-driving labs and materials acceleration platforms, pilot lines, test beds, digital innovation hubs, and scale-up lines — which the projects of IAM4EU⁺ bring to life, funding the access and use their work requires.

Close cooperation with the Advanced Materials Academy — Europe's training and capacity-building initiative for the field — will make sure its engineers and researchers have the skills to use these data-driven tools and connected infrastructures. Europe has the talent; what it needs are the new skills to work this way — which is what the Academy provides.

Strategic direction is set by a dedicated body — the Technology Council for Advanced Materials (TCAM), established in 2024 — which defines Europe's priorities for advanced materials, keeps HE 2028–2034 and the ECF aligned, and brings together industry, research, the Member States and the Commission. IAM4EU⁺ delivers against those priorities through its projects, and helps shape the work programme and thematic calls that bring the infrastructure to life across the pillars.

**In short:** HE 2028–2034 funds the collaborative research and innovation, the Advanced Materials Act sets the (regulatory) framework, the ECF turns proven results into industrial reality — and IAM4EU⁺ is the connective tissue between them.

## 3.2 The road to 2040

The path from today to 2040 is not a single leap but four phases, each building on the one before and each tied to the wider timeline — IAM4EU running today under the current programme (FP9), HE 2028–2034 opening in 2028, the first project results from the IAM4EU⁺ portfolio expected from 2032. Step by step, the journey from discovery to first industrial use grows shorter — the shift from today's 10 to 20 years toward 5 to 10 years traced along the foot of the roadmap.

Across these phases, what IAM4EU⁺ itself builds is not the infrastructure but the methods that make it usable. Underpinning all of them is one way of handling materials data — shared formats, ontologies and FAIR practices for data and workflows — so that a result from any lab or facility is directly comparable and reusable. On that foundation, activities launched and coordinated through IAM4EU⁺ will develop, validate and refine approaches to the bottlenecks set out in Section 2:

- **Closed-loop discovery-to-validation blueprint** — the plan–synthesise–characterise loop, run across AI, self-driving labs and shared data as a reusable protocol for a whole material class, with SSbD targets set from the first round. This addresses the broken lab-to-fab pathway.

- **Value-chain co-design methodology** — working methods that bring advanced materials producers, component makers and end-users into the loop from the start, so an advanced material is developed against real downstream demand rather than in isolation. This addresses disconnected value chains and weak market pull.

- **Lab-to-fab scale-up blueprint** — repeatable ways to carry a validated result through test beds and pilot lines into first industrial conditions, de-risking the step investors find hardest. This addresses the shortage of accessible scale-up infrastructure and finance.

- **Accelerated qualification and pre-normative standards methodology** — shared validation protocols, reference data and standards work that compress the slowest downstream step. This addresses framework conditions that move more slowly than the technology.

By 2040, these capabilities should come together into one connected European system that breaks down national silos. Reaching it takes deliberate, coordinated investment at European level, guided by the Technology Council for Advanced Materials and delivered through the right HE 2028-2034 instruments — with IAM-I mobilising the ecosystem and IAM4EU⁺ steering a portfolio of initiatives that generates, tests and consolidates proven, de-risked blueprints and methods for advanced materials R&I.

## The road to 2040

Four phases, each building on the one before - and the journey from discovery to industry growing shorter.

**1 · 2025 - 2027 · FP9**

### Lay the foundations

IAM4EU under FP9; community and shared agenda (SRIA); Materials Commons started.

**2 · 2028 - 2031**

### Launch IAM4EU⁺

HE 2028–2034 begins; IAMI4EU⁺ launched as the partnership for the "HOW"; first calls and projects begin.

**3 · 2032 - 2037**

### Prove and scale

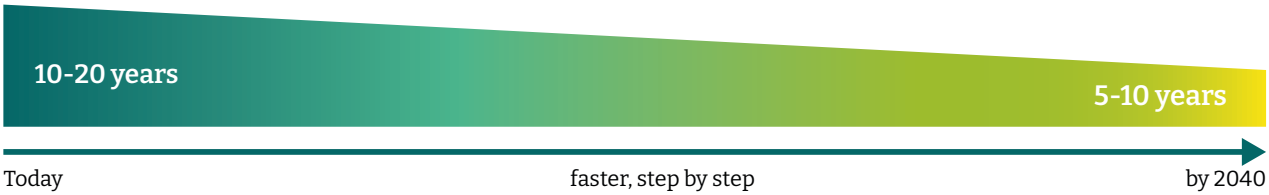
First results; discovery-to-validation measurably faster. Proven tranferability of blueprints across sectors.

**4 · 2038- 2040**

### System at scale

The connected system becomes the default across Europe for advanced materials.

**Time from discovery to first industrial use**




Progress towards the full system is tracked at two levels. Along the way, a few markers show the system is being built and is working: the methods in real use across the connected toolbox; a growing pipeline of validated, reusable blueprints; and — the measure that matters most — the time from discovery to first industrial use falling, case by case.

| Phase | Horizon | What is built, deployed and proven | How we´ll know |
|---|---|---|---|
| 1 · Lay the foundations | 2025–2027 FP9 | Community and shared agenda in place; Materials Commons and the first projects prepared under existing FP9 scopes; first blueprints drafted. | HE 2028–2034 partnership agreed; first blueprints drafted. |
| 2 · Launch IAM4EU⁺ | 2028–2031 | IAM4EU⁺ is launched; self-driving labs, Materials Commons, research facilities and pilot lines connected into one working chain; first projects develop methods on strategic-technology cases. | Toolbox connected and in use; first projects running. |
| 3 · Prove and scale | 2032–2037 | First project results; reusable blueprints; qualification and standards work; proven transferability of blueprints across sectors. | First validated blueprints; demonstrated time savings. |
| 4 · System at scale | 2038–2040 | The connected European system operating across sectors; methods reused widely; national silos broken down. | Discovery-to-industry timeline moving toward 5–10 years. |

## 4. Impact by 2040

By 2040, a successful IAM4EU+ will have brought about a real, measurable shift in how Europe develops advanced materials — above all in speed, which finally decides whether European R&D turns into industrial leadership. What follows sets out what that shift delivers: faster, cheaper and more certain routes to the advanced materials Europe's strategic technologies depend on, and a system that turns its own discoveries into industry at home.

### What the evidence shows

This target is not speculative. The United States set it in 2011 with its Materials Genome Initiative: cut the 10-to-20-year development cycle, and its cost, by half.[15] It pursued this with the same connected way of working described in Section 3. These methods help most in the research and innovation part of the cycle — discovery, design, synthesis, characterisation and optimisation — where they have made work several times faster, and on some tasks ten times faster or more.

Even on a cautious reading, this part of the cycle can be shortened by about half to two-thirds. The later stages — scale-up, qualification and first industrial use — are harder to shorten, and longer still in some domains, such as health, where they are also more heavily regulated. Yet they do not stand still: faster characterisation and qualification, together with the right conditions, help here too (see Annex II). No single figure is claimed for the whole cycle. But gains of this kind, connected end to end and applied across Europe, bring a 10-to-20-year journey within reach of the Materials Genome Initiative's target of 5 to 10 years.

| ~50% | 1/2 – 2/3 | 10-20 → 5-10 |
|---|---|---|
| cut to the whole development circle | shorter research-and-innovation segment | years, to first industrial deployment |

[15] US Materials Genome Initiative (MGI), launched 2011 — a US federal multi-agency initiative to discover, develop and deploy advanced materials "twice as fast, at a fraction of the cost". mgi.gov

## What this means in practice

Acceleration is not abstract: it means faster routes to the advanced materials Europe's strategic technologies depend on. The examples below are illustrative, drawn from across the strategic technologies.

### Illustrative examples of advanced materials development acceleration

**High-efficiency thermoelectrics** (energy, electronics, mobility). Thermoelectric materials turn waste heat into electricity and manage heat in electronics and vehicles, but the compositional space of high-entropy alloys is far too large to test by hand. Researchers paired rapid synthesis with active learning: 80 targeted syntheses, selected from 16, 206 possible combinations, identified three new high-entropy chalcogenides with thermoelectric performance above zT 2.

*— "Active Learning-Guided Accelerated Discovery of Ultra-Efficient High-Entropy Thermoelectrics," Advanced Materials, DOI 10.1002/adma.202515054 (published online 2025; issue 10/2026).*

**Lead-free piezoelectrics** (electronics, health, energy). Piezoelectric materials turn pressure into signal and back — the heart of medical ultrasound, of sensors and actuators in electronics, and of energy harvesting — and the field is working to replace lead-based versions. Testing compositions one at a time is slow. With combinatorial synthesis, a whole spread of compositions is made in a single run and characterised rapidly, so a large slice of the design space is explored in one experiment instead of dozens.

*— "High-throughput combinatorial approach expedites the synthesis of a lead-free relaxor ferroelectric system" (BCT–BZT), Zhang et al.; medical-imaging use in "Lead-free piezoelectric materials and ultrasonic transducers for medical imaging," J. Advanced Dielectrics.*

**Low-carbon concrete** (construction, energy). Finding a good concrete recipe normally means testing many mixes one by one, which is slow. With AI suggesting the mixes, researchers found a lower-carbon concrete that passed lab tests and was then used to build a real structure — cutting the built environment's carbon, and first deployed in data-centre construction.

*— "Accelerated Design and Deployment of Low-Carbon Concrete for Data Centers," arXiv:2204.05397 (2022);Meta Engineering, "Using AI to make lower-carbon, faster-curing concrete" (2025).*

**Qualification standards for metal additive manufacturing** (mobility, health, energy, construction). A 3D-printed metal part — an aircraft bracket, a medical implant, an energy component, a structural node — must at least meet the same requirements as a conventionally made one, and proving that is normally the slowest, costliest step, done differently by each firm. Shared international standards give everyone the same benchmarks, so results are reproducible and comparable and the qualification phase moves faster instead of being re-invented part by part. European industry and European research infrastructures have helped drive these standards for that reason.

*— "A review on qualification and certification for metal additive manufacturing," Virtual and Physical Prototyping 17 (2022); ISO/ASTM 52900 series.*

*— ISO/ASTM TR 52905:2023, "Additive manufacturing of metals — Non-destructive testing and evaluation — Defect detection in parts."*

*— CEN/TS 18094 (2024), "Non-destructive testing — Test method for determining residual stresses by synchrotron X-ray diffraction," developed in the EU-funded EASI-STRESS project.*

**A common language for materials data** (all application areas). Results from different laboratories and instruments could not easily be compared or reused, because everyone documented characterisation differently. A European pre-standardisation agreement — one of several interoperability efforts — now fixes shared concepts, metadata and terminology for materials characterisation, both human-readable and machine-processable, so a measurement made anywhere in Europe can be understood, compared and reused everywhere else. This is the connective tissue that makes shared data and connected infrastructures work at all — and it is one of the aims Materials Commons is now taking forward.

*— CWA 17815:2025, "Materials characterisation — Terminology and structured documentation" (CEN-CENELEC, open access), developed under the EU-funded NanoMECommons project; built on the CHADA documentation model and the CHAMEO ontology.*

The advanced materials this system develops and validates will feed every major application field — mobility, energy, construction, health, electronics. Taken together, the effect is a Europe faster at innovating, stronger at industrialising, and more sovereign in the advanced materials that matter most — with IAM4EU⁺ holding the architecture together.

## 5. Conclusion

The pressure on Europe is real and growing — the widening competitiveness gap set out earlier. The United States and China are investing on a scale Europe has not matched — through major national programmes for semiconductors, advanced materials and clean technology [16,17] — building complete value chains and setting the terms on supply and standards, while Europe's world-class research too often ends up industrialised elsewhere. This is not a gap that closes on its own; left alone, it widens.

Europe has the research and the talent. What it has lacked is the will to turn them into industrial leadership at speed — and the moment to act is now. HE 2028–2034, the ECF and the Advanced Materials Act together create a unique opportunity to reshape how Europe acts across the full innovation chain, from research and laboratory validation to scale-up, industrial deployment and market uptake: this window will not stay open, and it will not come again soon. Either Europe uses it to build a faster system for advanced materials, or it spends the next decade depending on the choices of others. IAM-I, with its 300+ members across industry and research, stands ready to build that system — with the European Commission, the Member States and partners across the wider ecosystem.[18]

[16] E.g. the US CHIPS and Science Act (2022), close to $280 billion for semiconductor research and manufacturing; subsequent measures (e.g. the SEMI Investment Act) extend support to upstream advanced materials.

[17] US–China Economic and Security Review Commission, Made in China 2025: Evaluating China's Performance (2025): state-led investment exceeding $150 billion; China now the world's largest producer of mid-range carbon fibre (~43% of global production).Realising this vision also depends on enabling conditions e.g. a fair, level playing field for European industry and predictable, innovation-aligned framework conditions.

[18] Realising this vision also depends on enabling conditions e.g. a fair, level playing field for European industry and predictable, innovation-aligned framework conditions.

# About IAM-I

The Innovative Advanced Materials Initiative (IAM-I) is the voice of European R&I in advanced materials. With our **more than 300 stakeholders** across sectors, we build a cross-disciplinary research and innovation ecosystem that accelerates research, development, industrial deployment and market uptake of advanced materials.

IAM-I supports the EU's goals for technological sovereignty and industrial leadership and operates the co-programmed partnership Innovative Advanced Materials for Europe (IAM4EU).

## CONTACT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