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Operationalising Transformative Change in Research and Innovation Policy Evaluation: The TIME Framework

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What to find in this Policy Brief

- This Policy Brief introduces the 'TIME' (**T**ransformative **I**nnovation **M**onitoring and **E**valuation) framework – developed to support policy-makers, funding agencies, and evaluators in the field of research and innovation (R&I) policy. The framework helps develop relevant indicators for transformative effects and is applicable to both top-down and bottom-up R&I interventions, regardless of whether transformative change is an explicit objective.
- The TIME framework provides a means to operationalise the concept of transformative change and thereby assess how R&I interventions help to accelerate, broaden, or deepen processes of change. It offers both an analytical model and a practical template for developing context-specific indicators.
- Instead of prescribing a fixed set of indicators, the TIME framework provides a structured process for deriving context-specific ones. This openness is particularly valuable when combined with artificial intelligence (AI), as it enables the rapid generation of tailored indicators instead of generic sets. The framework thus offers the structure needed to ensure that AI-supported indicator development remains targeted, consistent, and transparent.

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How the TIME framework can complement existing monitoring and evaluation frameworks

- Conventional indicators used in the monitoring and evaluation of R&I policies typically focus on growth effects (e.g. publications, R&D staff, patents) and the direction of change (e.g. toward green or inclusive innovation). The TIME framework complements these approaches by supporting the identification of indicators that capture how policies *accelerate*, *deepen*, or *broaden* change toward societal goals.
- Recognising and assessing the transformative effects of R&I policies enhances the legitimacy, learning, and communication functions of monitoring and evaluation. It helps make visible the value of interventions whose effects are often systemic, long-term, or indirect.
- Measuring transformative effects does not necessarily require creating a long list of new indicators. A useful first step is to systematically examine the potential of existing indicators and available data. With the TIME framework as a conceptual basis, AI can support this process by assessing how well current indicators capture transformative effects and by identifying opportunities for further development.

Contents

1 | Why assessing the transformative effects of R&I policies?

Many of today's societal, environmental, and technological challenges – such as structural industrial change, climate change, social inequality, and digitalisation – are urgent, deep-rooted, and wide-ranging. Addressing them requires new responses that go beyond isolated innovations or adjustments within current structures. Transformative change is essential to meeting these challenges, involving shifts not only through technologies but also by reconfiguring organisational practices, cultural values, and institutional frameworks. Such change is needed at various scales – from organisations and everyday life to infrastructures and entire sectors such as mobility, energy, and food. Research and innovation (R&I) policy plays a crucial role in enabling and supporting these transformations.

What is new about monitoring and evaluating transformative effects?

Traditional approaches to monitoring and evaluating R&I policy primarily focus on growth and systemic effects. These include metrics such as the number of publications, patents, and citations; increases in R&D personnel or funding; and the development of innovation infrastructures and networks. Such indicators reflect the long-standing emphasis on strengthening innovation systems and improving their performance – objectives that remain important and continue to shape much of R&I policy.

In recent years, however, there has been growing recognition of the need to guide innovation towards broader societal goals. This shift is reflected in emerging indicator frameworks that seek to align R&I activities with global challenges such as those defined in the Sustainable Development Goals (SDGs). While these frameworks incorporate a directional perspective, they still tend to focus on *what* changes, rather than *how* change unfolds (Kofler et al., 2025).

This is where the assessment of transformative effects provides a new perspective. Transformative change is not just about the thematic alignment of R&I with societal goals; it is also about the dynamics and quality of change. Moreover, transformative change involves developments across multiple stages: from emergence, through diffusion, to reconfiguration (Victor et al., 2019). Transformative change thus means not only creating new alternatives, but also challenging and destabilising existing dominant systems. In focusing on the new and its expansion, traditional approaches to monitoring and evaluation provide little indications whether relevant systems are being transformed.

How assessing transformative effects can support policy legitimacy, learning and communication

Accounting for the transformative effects of R&I policies can strengthen key functions of monitoring and evaluation frameworks. The following table provides an overview of the added value in relation to policy legitimacy, learning, and communication.

Legitimacy demonstrating long-term public value	Learning improving strategic reflexivity and adaptive design	Communication & Engagement fostering shared understanding and motivation
▪ Makes indirect and long-term effects of R&I policies visible and assessable ▪ Helps justify the relevance of exploratory, enabling, or experimental interventions ▪ Provides evidence to defend policy continuity in the absence of short-term impact	▪ Enables structured comparison across interventions (e.g. by depth, speed, breadth) ▪ Reveals which types of change are triggered in which domains (science, industry, policy) ▪ Supports more targeted and context-sensitive programme design and adjustment	▪ Helps translate abstract goals into visible progress ▪ Strengthens motivation among stakeholders by highlighting significant achievements (as opposed to low-hanging fruits and easy wins)

2 | Transformative change: definition and dimensions

Interest in the notion of transformative change has grown significantly, as more attention is given to how deep and lasting changes can be achieved across different sectors. This growing interest is reflected in the increasing use of the concept in key policy documents, including those related to the European Green Deal and the European AI Strategy. However, the term transformative change remains somewhat ambiguous, which may explain its broad appeal in both scientific and political discussions (Lidskog & Sundqvist, 2022).

While there is general agreement among researchers that transformative change involves significant or substantial shifts, there is less consensus on how exactly these changes occur. Some experts emphasise that transformative change is disruptive and involves clear breaks from the past, while others argue that incremental changes in the form of small, gradual adjustments can also lead to transformative outcomes (Göpel, 2016; Termeer et al., 2017).

The TIME-framework is based on a broad definition of transformative change that recognises that it can both be disruptive or incremental. What makes the concept of transformation distinct is its focus on qualitative changes: the way something fundamentally alters in form or function, rather than just quantitative growth or improvement (Hölscher et al., 2018). This focus on qualitative change means that transformative change can be understood in various ways, depending on what is changing and how it changes.

One effective way to understand and compare different types of transformative change is by looking at its speed, depth, and breadth (Andersen et al., 2023; Evans et al., 2023; Fazey et al., 2018; Termeer et al., 2024). These dimensions help clarify how different changes occur, whether quickly or slowly, at a small scale or across entire systems, and whether they involve deep structural shifts or more surface-level adjustments:

- Speed refers to how quickly change occurs, whether through gradual, incremental shifts or more rapid, disruptive transformations. Faster change can seize windows of opportunity and create early advantages. The speed at which change happens can be influenced by factors such as available resources, strong networks, cost reductions, and shared long-term goals. Also alignments and synergies may accelerate change. For instance, the rapid global uptake of digital communication platforms during the COVID-19 pandemic compressed years of technological and behavioural change into mere months, illustrating how urgent need, supportive infrastructure, and aligned incentives can accelerate a systemic shift.
- Depth refers to how profound or fundamental the change is. It is about whether the change alters the core structures of a system, such as technologies, infrastructure, and societal norms. Deeper changes often have long-lasting, wide-reaching impacts because they reshape the underlying foundations that drive behaviours and systems. For instance, a shift toward renewable energy involves not just the adoption of new technologies but also the transformation of energy infrastructures, policy frameworks, and societal values around sustainability.
- Breadth describes the range or scope of change – how widely it spreads across different sectors or systems. Broad change means that a wide variety of entities, such as industries, communities, or governance structures, are involved. It also refers to the diversity of change across different dimensions, whether technological, social, or governance-related, and how well these changes are integrated across different sectors.

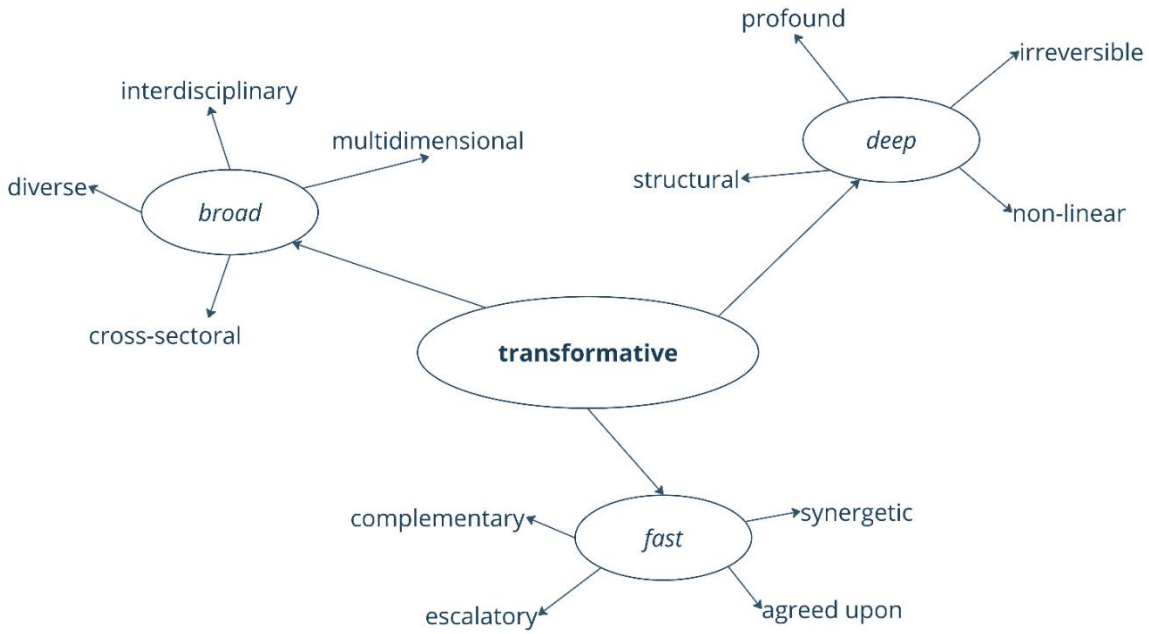


Figure 1 | Exemplary expressions of transformative change

Source: own elaboration

As shown in Figure 1, transformative change can express itself in various ways. Qualities as diverse as 'structural', 'cross-sectoral', or 'synergetic' can all be indications of transformative change. It is important to recognise that there can be both synergies and trade-offs between different types of transformative change, and that it may be difficult to achieve all of them simultaneously (Andersen et al., 2023). For example, Termeer et al. (2024) suggest that each type of transformative change may require different forms of intervention and governance. The kinds of changes expected from an intervention, therefore, need to be defined on a case-by-case basis. To ensure relevance across different types of R&I policies, this Policy Brief adopts a broad definition of transformative change and proposes a wide range of potential catalysts (see Section 4). In evaluation practice, however, less may be more.

3 | The TIME framework: how to develop R&I indicators of transformative change

The TIME framework offers a structured but flexible process for identifying and developing relevant indicators of transformative change. It is designed for policy-makers, funding bodies, and evaluators who seek to assess whether and how R&I interventions contribute to transformative change in science, technology, industry, or society.

Importantly, the framework does not impose a predefined theory of change or list of indicators. Instead, it starts from the specific logic of the initiative under evaluation – whether derived from policy goals, stakeholder input, or academic literature. The framework supports users in linking this logic to the kinds of mechanisms that are known to drive or enable transformation.

The development of indicators unfolds in two key steps:

- Selecting relevant transformation catalysts: These are mechanisms or drivers that can trigger transformative change (e.g. shifts in capital flows, new planning cultures, changes in institutional routines). Since not all policy outcomes are transformative, this step helps users identify which kinds of change matter most in the context of the initiative. A comprehensive matrix supports this selection by providing a structured set of transformation catalysts across science and technology, industry and organisation, as well as culture and policy.
- Developing context-specific indicators: For each selected catalyst, users are guided to define expected outcomes, identify where change would be observable, and formulate appropriate qualitative or quantitative indicators. A dedicated template supports this process and helps translate abstract mechanisms into recognisable or measurable indicators.

This section presents the methodology in three parts:

- Section 3.1 explains how to select relevant catalysts;
- Section 3.2 outlines the steps for developing tailored indicators;
- Section 3.3 provides guidance on how to combine the TIME framework with AI for efficient indicator development;
- Section 3.4 provides a practical example of how to apply the approach.

3.1 | Identifying drivers of transformative change: the matrix of catalysts

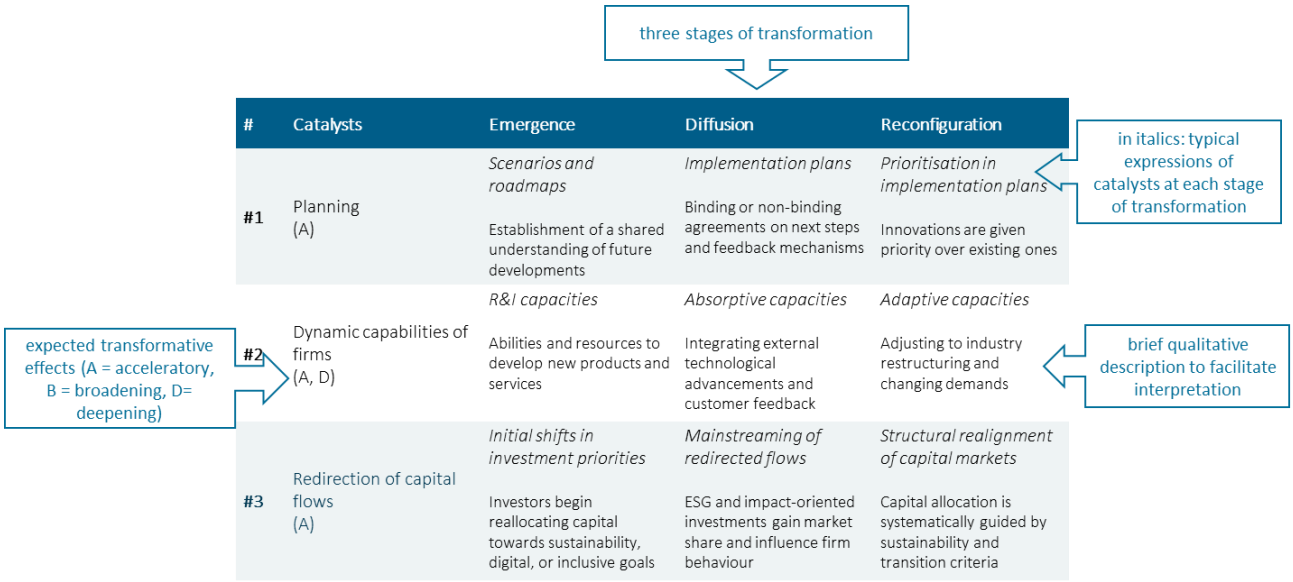
Transformative change in R&I policy does not follow a linear path. It can take shape through many different mechanisms, affect various societal and economic systems, and unfold across diverse stages – from early experimentation to deep structural reconfiguration. To help practitioners, programme managers and evaluators navigate this complexity, the TIME framework introduces a systematic set of 'transformation catalysts'.

Definition and purpose of catalysts

Transformation catalysts are mechanisms or drivers that can spark or support transformative change. They are not the ultimate societal outcomes of R&I policy, but they can themselves be important intermediate results. They represent shifts in structures, behaviours, or capabilities that help create the conditions for deeper, faster, and/or broader change. In this sense, they are both observable outcomes and enablers of transformation. For instance, a shift in capital allocation toward sustainability goals or the creation of shared roadmaps may be measurable outcomes of a specific policy instrument.

Importantly, catalysts are not tied to a specific policy theory or a fixed causal model. Instead, they provide orientation: they highlight relevant transformation mechanisms that can be observed, supported, or measured in a given R&I context.

Structure of the matrix



#	Catalysts	Emergence	Diffusion	Reconfiguration
#1	Planning (A)	*Scenarios and roadmaps* Establishment of a shared understanding of future developments	*Implementation plans* Binding or non-binding agreements on next steps and feedback mechanisms	*Prioritisation in implementation plans* Innovations are given priority over existing ones
#2	Dynamic capabilities of firms (A, D)	*R&I capacities* Abilities and resources to develop new products and services	*Absorptive capacities* Integrating external technological advancements and customer feedback	*Adaptive capacities* Adjusting to industry restructuring and changing demands
#3	Redirection of capital flows (A)	*Initial shifts in investment priorities* Investors begin reallocating capital towards sustainability, digital, or inclusive goals	*Mainstreaming of redirected flows* ESG and impact-oriented investments gain market share and influence firm behaviour	*Structural realignment of capital markets* Capital allocation is systematically guided by sustainability and transition criteria

Figure 2 | Structure and components of the catalyst matrix

Source: own elaboration

The TIME-framework identifies 48 transformation catalysts, each of which is systematically classified along two main axes:

1. **Three transformation dimensions**[1]:
   - **Science and Technology**: This dimension addresses the technologies, materials, and novel approaches required, their integration into system-level technical solutions, and the ways in which these solutions can be made available.
   - **Industry and Organisation**: This dimension focuses on the organisational structures, business models, and infrastructures needed to effectively integrate technological innovations, and on shaping value chains that support sustainable and resilient systems.
   - **Culture and Policy**: This dimension considers the societal and institutional changes necessary to enable acceptance and implementation of innovations, and how transition processes can be designed to achieve balance across the overall system and its subsystems.
2. **Three stages of transformation processes**[2]:
   - **Emergence**: Early-stage developments that have transformative potential, such as exploratory R&I activities, pilot programmes, or the creation of new ideas and approaches. This stage is often characterised by niche experimentation and limited uptake.

[1] The dimensions are rooted in the concept of sociotechnical systems and have been identified in an internal document prepared by the Austrian Federal Ministry of Innovation, Mobility, and Infrastructure (Meyer & Koch, 2024). The dimensions were adopted in the TIME framework to align indicator development with the Ministry's domains of interest.

[2] The distinction between emergence, diffusion, and reconfiguration is widely used in transformation research and builds on conceptualisations of socio-technical change (see Victor et al., 2019). These stages provide a heuristic for tracing how change mechanisms evolve over time, while recognising that in practice transitions are often non-linear and overlapping.

- **Diffusion**: Mid-stage transformation processes where innovations begin to spread and influence broader systems, either through adoption by additional actors or integration into organisational routines or markets.
- **Reconfiguration**: A late-stage transformation, in which existing systems – such as policy regimes, markets, infrastructures, or regulatory settings – are fundamentally reshaped to accommodate and normalise new practices.

Each catalyst in the matrix is described across all three stages, allowing users to trace how a mechanism might evolve or be supported over time (see Figure 2). For example, the catalyst "Redirection of capital flows" might begin with early shifts in investor priorities (Emergence), become more widespread through shared guidelines on impact investments (Diffusion), and eventually be reflected in a realignment of capital markets (Reconfiguration).

> **Can R&I policies induce transformative changes in the stages of diffusion and reconfiguration?**
>
> At this stage of the selection process, it is important not to prematurely rule out potentially relevant areas where R&I interventions may have transformative effects. A widespread misconception is that the stages of diffusion and reconfiguration lie beyond the reach of R&I policies. This view is rooted in a linear understanding of innovation, according to which knowledge production and the development of new solutions occur only at the early stages of a product or service life cycle. Later phases are then thought to involve merely the adoption or rejection of innovations by users.
>
> By contrast, innovation research demonstrates that knowledge development and experimentation are not confined to the early stages. Transformative innovation can also occur at the system level, encompassing regulatory changes, shifts in infrastructures, or the reorientation of institutional practices. R&I policies can therefore, in principle, contribute to catalysts across all stages of transformation, including diffusion and reconfiguration.
>
> For this reason, it is essential to adopt a broad conception of innovation when applying the matrix. By focusing on general spheres of interest, rather than limiting attention to immediate and expected spheres of influence, evaluators can identify transformative effects that may not have been foreseen at the outset. In this sense, the catalyst matrix serves a formative function in indicator development: it not only guides structured reflection but also helps reveal new and unexpected pathways to impact.

Understanding the type of transformative change

To further enhance its usefulness, the matrix includes coded labels in brackets next to each catalyst, which denote the type of transformative effect that the catalyst can be expected to foster:

- (A) Acceleratory: Catalysts that help speed up transformation dynamics, e.g. by removing bottlenecks or creating efficiencies.
- (B) Broadening: Catalysts that support the replication, scaling, or diffusion of transformative practices to new settings or actor groups.
- (D) Deepening: Catalysts that stabilise and embed emerging innovations, helping them gain resilience within established systems.

These categories reflect insights from transformation research (see Section 2) and help practitioners formulate more nuanced evaluation questions regarding the type of effects a policy intervention may produce. For example, is the measure primarily accelerating an ongoing shift, or is it broadening and diversifying experimentation?

3.2 | Developing context-specific R&I indicators: methodological steps and tools

Step 1: How to select relevant transformation catalysts

To identify the potentially transformative effects of an intervention, the catalyst matrix serves as the central reference tool. The process begins with defining an intervention's **sphere of interest**, which encompasses all targeted and non-targeted domains, actors, and systems where the intervention is expected to generate direct or indirect effects. Strategic policy objectives often provide a natural starting point for delineating this sphere. However, these objectives may not always explicitly articulate a transformative ambition. In such cases, evaluators may choose to adopt a broader perspective, which allows consideration of unintended or emergent results.

Once the sphere of interest has been clarified, the selection boxes in the second column of the matrix can be used to compile an **initial long list** of catalysts. This pre-selection includes all transformation mechanisms that plausibly fall within the intervention's domain of influence or interest. Inevitably, this first list may still be quite comprehensive and potentially impractical for evaluation or monitoring purposes.

Once relevant transformation catalysts have been identified, the next step is to translate them into context-specific indicators that allow for systematic monitoring and evaluation. This translation is crucial, as catalysts remain abstract mechanisms unless they are operationalised into observable outcomes. The **indicator development template** (see below) is designed to support this process. Developed together with evaluators, it provides a neutral framing that does not prescribe the use of exclusively quantitative or qualitative approaches. Instead, it allows for a mix of methods according to the needs of the intervention and the availability of data.

The template is to be completed for each selected catalyst. Depending on the desired level of detail, multiple indicators can be developed per catalyst. Because the translation of catalysts into indicators can be resource-intensive, it is rarely feasible to develop indicators for all entries on the long list. Before applying the indicator template, evaluators should therefore prioritise which catalysts will be taken forward, based on criteria such as policy relevance, methodological feasibility, and data availability. This prioritisation ensures that the final set of indicators is both meaningful and manageable in practice.

Step 2: Define expected outcomes across the transformation stages

In a first step, users are invited to consider the expected contributions of the intervention to the catalyst across all three stages of transformation (emergence, diffusion, reconfiguration). Stages / rows where no contributions are expected, or where no indicators are required, can simply be left empty.

The crucial shift here is from the sphere of interest (the wider range of potentially relevant transformative effects) to the sphere of influence (those outcomes that are both relevant and realistically attributable to the intervention) (see Figure 3). This shift ensures that monitoring and evaluation of transformative effects focus on achievable policy results.

To make sure that monitoring and evaluation results capture outcomes that are not only relevant but also realistic, indicator development should be grounded in a solid understanding of the intervention's **theory of change**. In relation to transformative effects, we are particularly interested in likely or expected

policy outcomes – observable changes in the groups, organisations, or systems directly targeted by an intervention. Because these occur within the immediate sphere of influence, they can be regarded as achievable policy results.

A well-articulated theory of change helps evaluators to:

- Differentiate policy outcomes from outputs (activities, services delivered) and impacts (long-term, systemic effects).
- Clarify how intervention activities are expected to lead to observable changes in practices, behaviours, or decisions.
- Identify where transformative results may realistically be expected and measured, including types of transformative change that might be initially unexpected or structurally underexposed.
- Understand interdependencies among different transformative outcomes.

Where a formal theory of change is lacking, outcome mapping (Earl et al., 2001) may provide a useful methodology. Outcome mapping helps identify relevant outcomes based on overarching policy objectives and distinguishes outcomes from inputs and impacts. This approach is particularly valuable in R&I policy contexts, where transformative change often involves diffuse and indirect processes.

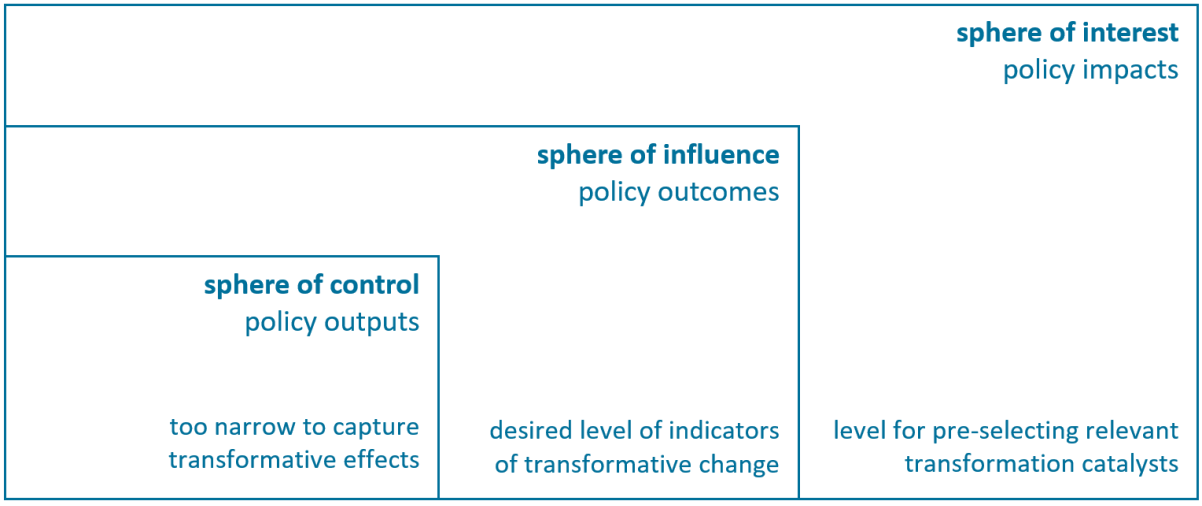


Figure 3 | Levels of analysis and their relevance for developing indicators of transformative change

Source: own elaboration, adapted from Ofir & Schwandt (2012)

Having described the expected outcomes for each selected catalyst, the next task is to translate these generic expectations into more concrete, observable elements. This is achieved by working through the remaining columns of the template in a structured sequence.

Step 3: Identifying observable points of change

The second column of the template invites evaluators to specify where the expected outcomes would become visible. This step shifts attention from abstract change processes to concrete sites of intervention:

- Actors: e.g. research teams, firms, regulators, or user groups whose behaviour may change.
- Organisations: e.g. research institutions, companies, or ministries that may adopt new practices.
- Networks/sectors: e.g. professional associations, value chains, or clusters that may reflect the diffusion of practices.

- Documents/artefacts: e.g. funding calls, strategy papers, investment portfolios, standards, or media narratives.

By identifying such points of intervention, evaluators create a map of potential evidence sources for later data collection.

Step 4: Defining what would indicate that change has taken place

The third column asks: "What would indicate that the expected change has taken place?" This step is about making the change observable and recognisable. It involves defining signs of transformation that signal that an outcome has materialised.

- Quantitative indicators could include measurable uptake (e.g. number of firms integrating new sustainability standards, amount of redirected capital, frequency of cross-sector partnerships).
- Qualitative indicators might capture new routines, practices, or discourses (e.g. evidence of altered decision-making processes, changes in professional norms, emergence of new policy framings).

At this stage, it is important to keep the focus on outcomes (changes in behaviour, routines, practices, or decisions), not on outputs (e.g. number of workshops held).

Step 5: Linking indicators to data sources and methods

The fourth column addresses the question: "How should the expected change be observed. Here, users can specify the methods and data sources that will allow changes to be assessed.

- Potential data sources: surveys, interviews, case studies, administrative or financial data, bibliometric data, media analysis, policy documents.
- Observation methods: statistical monitoring, content analysis, stakeholder consultation, expert scoring, or mixed-method approaches.

When linking indicators to data sources, users should balance ambition with feasibility. Not all desirable indicators will be measurable with available data, and choices must therefore be guided by criteria of relevance, practicality, and data availability. Both qualitative and quantitative data sources are valid, provided they capture observable changes within the intervention's sphere of influence.

The last column can be used to suggest formulations of indicators, using precise phrasing that captures how indicators are linked to data sources and methods.

Indicator development template

Name of catalyst: _____

Stages of transformation	Which concrete changes related to this catalyst can be expected as a result of the intervention? Focus on outcome-level changes (e.g. altered behaviour, routines, practices, decisions) within the intervention's sphere of influence.	Where are the expected changes observable? Consider actors (e.g. grantees, users), organisations, networks, sectors, or documents that could reflect the change.	What would indicate that the expected change has taken place? Consider both qualitative and quantitative forms of change.	How should the expected change be observed? Suggest potential sources of data and methods.	Indicators Suggest formulations for the indicators.
Emergence					
Diffusion					
Reconfiguration					

3.3 | Combining the TIME framework and AI for developing context-specific indicators

The TIME framework provides a structured process for developing context-specific indicators of transformative change. Its core idea is not to prescribe a definitive set of indicators but to provide an analytical and methodological structure that evaluators can adapt to their context. Artificial Intelligence (AI) can enhance this process – both in the initial selection of relevant catalysts and in the subsequent development of indicators – provided its use is carefully aligned with the logic of the TIME framework.

Using AI to select relevant catalysts

The starting point in applying the TIME framework is to identify the potentially transformative effects of an intervention. The catalyst matrix serves as the central reference tool, but the process begins with defining the intervention's sphere of interest: all targeted and non-targeted domains, actors, and systems where the intervention is expected to generate direct or indirect effects.

Here, AI can be used to:

- Map policy objectives to catalysts: by comparing programme documents with the catalyst matrix, AI can suggest a list of catalysts likely to fall within the intervention's sphere of interest.
- Broaden the perspective: by prompting AI to identify catalysts that might reflect unintended or emergent effects, users can avoid relying solely on stated policy objectives.
- Support prioritisation: when the long list of catalysts is too broad, AI can help cluster and rank catalysts according to relevance, feasibility, and expected explanatory power.

To make best use of AI in this step, users should:

- Provide AI with the programme's strategic objectives and target groups,
- Specify that it must return catalysts from the TIME matrix only, and
- Require suggestions for priority catalysts across the different transformation types (accelerating, deepening, broadening).

Using AI to develop context-specific indicators

Once priority catalysts are selected, the next task is to translate them into observable and measurable indicators. AI can be employed in two main ways:

- Step-by-step prompting: guiding AI through the process of (a) defining expected outcomes, (b) identifying observation points, and (c) formulating indicators. This allows users to validate each step against the TIME methodology but requires more interactions.
- Full-template prompting: providing AI with the entire indicator template (catalyst → outcomes → observation points → data collection and measurement → indicators) and instructing it to generate draft entries. This is efficient and ensures internal consistency, but requires precise prompting to prevent vague or generic outputs.

The best results emerge when AI is used to produce structured drafts (long lists of catalysts, template entries for indicators) while users ensure methodological discipline: clarifying the sphere of interest, narrowing to the sphere of influence, and validating outputs against theories of change.

3.4 | Illustration of the TIME framework: Accounting for the transformative effects of the R&I programme 'Mobility of the Future'

To illustrate how the TIME framework can be applied in practice, this section demonstrates the development of indicators for transformative change using the Austrian R&I programme *Mobility of the Future*. Launched by the Federal Government, the programme aimed to foster sustainable solutions across multiple domains, including personal mobility, freight transport, transport infrastructure, vehicle technologies, the railway system, and automation.

Between 2013 and 2021, *Mobility of the Future* supported 288 R&I projects, complemented by networking activities, consultation services, and a platform for disseminating results. An interim evaluation (Fischl et al., 2018) examined preliminary results and their alignment with the programme's strategic objectives on societal, environmental, and economic impacts.

For the ex-post evaluation (2025–2026), the evaluation team sought to go beyond conventional measures and systematically assess the programme's transformative effects. The ambition was to derive lessons for the design of contemporary R&I policies that explicitly pursue transformative change (Ecker et al. 2023).

A central evaluation objective was to assess the programme's additionality in the behaviour of funded organisations. Key guiding questions included:

- Did enterprises and research organisations change their innovation processes as a result of participation?
- Were these processes merely strengthened, or redefined for greater transformative impact?

The following subsections illustrate how the TIME framework was applied to structure this analysis, beginning with the identification of relevant catalysts and the subsequent development of context-specific indicators.

3.4.1 | Selection of relevant transformation catalysts

To identify potential drivers of transformative change activated by the programme, the matrix of catalysts was related to the evaluation's defined sphere of interest. A theory-based evaluation approach was adopted: the sphere of interest was derived from the technological innovation systems framework (Bergek et al., 2008; Hekkert et al., 2007), which specifies seven generic functions of innovation systems that R&I policies may seek to strengthen or redefine.

The evaluation sought to examine whether, and in which ways, the programme contributed to these functions. The programme's intervention logic (BMVIT, 2015) articulated three intended modes of influence:

- Initiating change
- Re-orienting change
- Accelerating change

When mapped against the three dimensions of transformative change described in Section 2 – speed, depth, and breadth – this intervention logic reflected only a limited transformative ambition. A conventional indicator framework of behavioural additionality restricted to initiation, reorientation, and acceleration (cf. Gök & Edler, 2012), would thus provide only partial insights into the programme's transformative effects.

To capture a broader range of transformative mechanisms, the evaluation team drew on the TIME framework and introduced two additional categories of change that were not considered in the programme's intervention logic:

- Deepening change
- Broadening change

The evaluation therefore articulated a two-dimensional sphere of interest encompassing both various functions of innovations systems and types of change. Because the evaluation aimed to measure transformative changes across all seven system functions and relied on a questionnaire survey with participating organisations, practical constraints had to be taken into account in order not to overburden respondents. For each function, only one indicator per type of change could be developed and measured. It was therefore crucial to prioritise catalysts considered most relevant. The labels provided in the TIME matrix, denoting the types of transformative effects associated with each catalyst, were used to guide this prioritisation process.

Table 1 | Pre-selected transformation catalysts for indicator development

Impact domains	Long-list All catalysts relevant to the impact domain	Short-list Selected catalysts for indicator development
Entrepreneurial activities	▪ #2 market penetration ▪ #10 real-world testing and embedding ▪ #22 business model change ▪ #23 changes in organisational strategy ▪ #24 alternative ownership models ▪ #28 entry of disruptive market actors ▪ #31 diversification of demand	▪ #2 market penetration → acceleration change ▪ #22 business model change → deepening change ▪ #31 diversification of demand → broadening change
Mobilisation of financial resources	Direct financial catalysts: ▪ #18 Redirection of capital flows (shifts in investment priorities) ▪ #19 New financing instruments (development of alternative funding models) ▪ #42 Public finance ▪ #46 Public procurement Indirect catalysts (non-financial, but indicative of mobilised resources): ▪ #2 Market penetration ▪ #12 Infrastructure ▪ #14 Reskilling and labour shifts ▪ #17 Dynamic capabilities of firms	▪ #2 Investments for faster market penetration → accelerating change ▪ #17 Investments to build dynamic capabilities → accelerating/deepening change ▪ #14 Investments for reskilling and labour → deepening/broadening change

For illustrative purposes, the case study presented here focuses on two functions (impact domains): **entrepreneurial activities** and the **mobilisation of financial resources**. The table above shows the pre-selected catalysts from the TIME matrix that were identified as relevant for indicator development in these domains. With respect to the mobilisation of financial resources, two potential pathways were

considered in light of the programme's objectives: catalysts linked to the development or use of financing instruments, and catalysts reflecting the mobilisation of investment resources among the programme's target groups.

3.4.2 | Development of context-specific R&I indicators

The transformation catalysts can be translated into observable R&I indicators using the indicator development template. The two templates presented below summarise our entries for the impact domains entrepreneurial activities and mobilisation of financial resources.

At this stage, the key challenge was to ensure that abstract catalysts were translated into indicators that are empirically tractable and meaningful. Multiple issues were particularly important in the application:

- Sphere of influence: Indicators were anchored in the behaviours and practices of funded organisations, not in broad systemic impacts. This ensured that the evaluation captured results that fall within the realistic reach of the programme.
- Specification of points of observation: For the impact domain entrepreneurial activities, the analysis was narrowed to enterprises only. While the programme also funded research organisations, the selected catalysts (e.g. market penetration, business model change, diversification of demand) primarily reflect outcomes observable in firms.
- Operationalisation through survey items: For comparability across diverse organisations, the indicators were expressed as survey questions with a standardised Likert scale. This allows both quantitative aggregation (e.g. share of enterprises reporting change) and differentiation across types of change (acceleration, deepening, broadening, destabilisation).
- Catalysts linked to multiple dimensions of transformative change: Some catalysts can point to different transformation logics, depending on how they materialise in practice. For instance, investments in training could reflect deepening (specialising and embedding new routines) or broadening (opening up to new fields) effects. It was therefore important to make explicit choices in indicator development. For example, to reflect broadening change, indicators related to reskilling and labour were phrased in terms of "new research or business fields".

Taken together, the templates demonstrate how the TIME framework supports users in bridging the gap between conceptual catalysts and practical indicators, while making transparent decisions about scope, interpretation, and the types of transformative change being measured.

Indicator development template

Indicators for transformative changes to enterpreneurial activities

Transformation catalysts	Which concrete changes related to this catalyst can be expected as a result of the intervention? Focus on outcome-level changes (e.g. altered behaviour, routines, practices, decisions) within the intervention's sphere of influence.	Where are the expected changes observable? Consider actors (e.g. grantees, users), organisations, networks, sectors, or documents that could reflect the change.	What would indicate that the expected change has taken place? Consider both qualitative and quantitative forms of change.	How should the expected change be observed? Suggest potential sources of data and methods.	Indicators Suggest specific formulations of the indicators.
Market penetration – time-to-market (emergence and accelerating change)	Acceleration of research and development processes due to funded R&I projects	R&I processes of funding recipients – *enterprises* only	Less time to market introduction	Enterprises' self-assessments using questionnaire survey and a five-point Likert scale (0=no change to 4=large programme contribution)	1. % of funded enterprises reporting shortened time-to-market to which the programme contributed 2. Average programme contribution score (1–4) for shortened time-to-market
Business model change – introduction of alternative business logics (emergence and deepening change)	Development of suitable business models for sustainable mobility solutions	R&I processes of funding recipients – *enterprises* only	More intensive engagement with the development of suitable business models	Enterprises' self-assessments using questionnaire survey and a five-point Likert scale (0=no change to 4=large programme contribution)	1. % of funded enterprises reporting intensified work on sustainable business models to which the programme contributed 2. Average programme contribution score (1–4) for intensified business model development
Diversification of demand – engagement with new user segments (emergence and broadening change)	Development of mobility solutions for new markets or user segments	R&I processes of funding recipients – *enterprises* only	Intensified experimentation of mobility solutions in new markets or new customer segments	Enterprises' self-assessments using questionnaire survey and a five-point Likert scale (0=no change to 4=large programme contribution)	1. % of funded enterprises reporting intensified experimentation in new markets or customer segments to which the programme contributed 2. Average programme contribution score (1–4) for intensified experimentation in new markets or segments

Indicator development template

Indicators for transformative changes to the mobilisation of financial resources

Transformation catalysts	Which concrete changes related to this catalyst can be expected as a result of the intervention? Focus on outcome-level changes (e.g. altered behaviour, routines, practices, decisions) within the intervention's sphere of influence.	Where are the expected changes observable? Consider actors (e.g. grantees, users), organisations, networks, sectors, or documents that could reflect the change.	What would indicate that the expected change has taken place? Consider both qualitative and quantitative forms of change.	How should the expected change be observed? Suggest potential sources of data and methods.	Indicators Suggest specific formulations of the indicators.
Market penetration – time-to-market (emergence and accelerating change)	Earlier mobilisation of financial resources to accelerate market introduction of sustainable mobility solutions	Investment behaviour of funded organisations	Earlier-than-planned investments directed at R&D and market introduction	Organisations' self-assessments using questionnaire survey and a five-point Likert scale (0=no change to 4=large programme contribution)	1. % of funded enterprises reporting earlier investments to which the programme contributed 2. Average programme contribution score (1–4) for earlier investments in market introduction
Dynamic capabilities – R&I capacities (emergence and deepening change)	Investments in R&D infrastructure	R&D facilities, equipment, and production infrastructure of funded organisations	Upgraded or newly acquired R&D infrastructure and equipment	Organisations' self-assessments using questionnaire survey and a five-point Likert scale (0=no change to 4=large programme contribution)	1. % of funded enterprises reporting upgraded R&D infrastructure to which the programme contributed 2. Average programme contribution score (1–4) for upgrading R&D infrastructure
Reskilling and labour shifts – growing reskilling efforts (diffusion and broadening change)	Investment in training and capacity building to access new research or business fields and broaden organisational scope	HR development and training activities of funded enterprises	Training/qualification activities in fields new to the organisation	Organisations' self-assessments using questionnaire survey and a five-point Likert scale (0=no change to 4=large programme contribution)	1. % of funded enterprises reporting training investments in new research or business fields to which the programme contributed 2. Average programme contribution score (1–4) for training investments enabling broader organisational scope

4 | The matrix of catalysts of transformative change

Table 2 | Science and technology catalysts

#	Selection	Catalyst	Emergence	Diffusion	Reconfiguration
			Stabilisation of a dominant design	*Formulation of industry standards*	*Solidification of a dominant design*
#1	☐	**Dominant design** (A, D)	A widely recognised core architecture emerges, serving as a reference point for future developments	Industry-wide norms or protocols are agreed upon, ensuring compatibility and guiding competition	Competing designs lose relevance or are phased out, with the dominant design solidifying as the default standard
			Time-to-Market	*Time-to-Adoption*	*Time-to-Critical Mass*
#2	☐	**Market penetration** (A)	The speed and efficiency from concept to initial commercial availability	The time required to achieve a specified market share or user adoption rate post-launch	The time it takes for an innovation to reach a self-sustaining tipping point, driven by network effects and organic growth
			Successful demonstrations	*Significant price-performance improvements*	*Significant process-performance improvements*
#3	☐	**Technological progress** (A)	Innovations showcasing readiness for commercial deployment	Noticeable gains in cost-efficiency and product capabilities, attracting mainstream users	Major enhancements in automation, service innovation, or production processes that reshape value chains
			Interoperability potential discovered	*Interoperable systems*	*Industry-wide adoption of standards*
#4	☐	**Interoperability of systems** (B, D)	Distinct systems identified as technically compatible, setting the stage for integrated solutions	Common protocols or APIs enable structured data exchange and joint functionalities across platforms	Sector-wide acceptance of shared protocols, creating an ecosystem-level integration
			Designing for interoperability	*Development of complementary products*	*Products become fully interoperable*
#5	☐	**Interoperability of products** (B, D)	Products begin to include open interfaces, enabling potential future connections across products	Ecosystem of interlinked goods or services grows, increasing combined value and synergy	Different product lines integrate seamlessly, forming a cohesive user experience or solution set

#	Selection	Catalyst	Emergence	Diffusion	Reconfiguration
			Early application of research outputs	*Diffusion of applied knowledge*	*Shifts in know-how*
#6	☐	**Applied knowledge** (A)	Initial translation of scientific findings into prototypes, tools, or methods that demonstrate practical relevance beyond the research context.	Widespread uptake of research outputs in commercial or public-sector settings, supported by knowledge-transfer mechanisms	Industries develop advanced tacit skills while discarding outdated practices and assumptions
			Early recognition in scientific community	*Early industry recognition*	*Institutionalised recognition*
#7	☐	**Recognition** (A)	Growing citations in papers, patents, and scientific forums indicating initial validation	Firms, investors, and sectoral bodies acknowledge potential, supporting collaborations and uptake	The innovation attains established standing as a key driver in research and development ecosystems
			Users modify solutions to address gaps	*Users share innovations through networks*	*Users advocate systemic change*
#8	☐	**User innovation** (B, D)	Advanced or niche users experiment with prototypes and provide feedback for improvements	Grassroots or community-driven diffusion via informal and formal channels (e.g., online communities, meetups)	Organised user groups influence policy, standards, and R&D priorities, shaping industry-wide benchmarks
			Anticipated scalability	*Technical optimisation for scaling*	*Scalable system architectures*
#9	☐	**Technological scalability** (A)	Laboratory and pilot studies demonstrate that the technological principles can be generalised and replicated beyond niche settings.	Technological advances allow the innovation to be reproduced at larger volumes or higher complexity while retaining reliability, efficiency, and quality.	Technological architectures and infrastructures are reconfigured to embed scalability as a core property, enabling sustained and extensible expansion.
			Real-world testing with early users	*Iterative adaptation under real-world conditions*	*Consolidation of operational know-how*
#10	☐	**Real world implementation and embedding** (A, B)	Prototypes undergo trials in realistic conditions to validate performance and identify context-specific technical challenges.	Successive cycles of technical adjustment refine robustness, interoperability, and safety across diverse use environments.	Technical routines, maintenance procedures, and best practices become stabilised, enabling consistent and reliable use across real-world environments.

#	Selection	Catalyst	Emergence	Diffusion	Reconfiguration
			Transdisciplinary co-creation of knowledge	*Institutionalised research–technology collaborations*	*Persistent collaborative R&D ecosystems*
#11	☐	**Collaborative knowledge production** (B, D)	Initial research collaborations bring together scientists, engineers, and stakeholders from different fields to jointly frame problems and generate novel knowledge.	Structured consortia, shared laboratories, and research infrastructures facilitate sustained co-production of scientific and technological knowledge across disciplines and sectors.	Long-term knowledge production systems (e.g. technology platforms, centres of excellence, open science infrastructures) become embedded as default modes of advancing science and technology.
			Infrastructural needs identified	*Designing and prototyping infrastructures*	*Full-scale infrastructure implementation*
#12	☐	**Infrastructure** (A, D)	Assessments reveal the physical, digital, or organizational infrastructure required to support the innovation	Concrete planning and pilot implementation of necessary infrastructure adaptations or new builds	New or adapted infrastructures become widely adopted and promoted by key stakeholders.
			Initial questioning of assumptions	*Collective reframing of knowledge and design logics*	*Changes in education and training*
#13	☐	**Second-order learning** (D)	Early adopters and researchers recognise limits of existing knowledge frameworks, triggering reflection on alternative technical principles or problem framings.	Research and engineering communities systematically revise underlying assumptions, leading to new conceptual models, heuristics, and methodological approaches.	Educational systems, training programmes, and research curricula embed revised conceptual frameworks.
			Early recognition of skill gaps	*Growing reskilling efforts*	*Reskilling embedded in education and workforce systems*
#14	☐	**Reskilling and labour shifts** (B, D)	Stakeholders recognize emerging skill gaps and discuss the need for retraining.	Coordinated upskilling and retraining programmes expand to meet the innovation's labour requirements.	Policies and institutions systematically align training and workforce development with new industry needs.

#	Selection	Catalyst	Emergence	Diffusion	Reconfiguration
			Recognition of limitations in existing solutions	*Growing destabilisation of incumbents*	*Systemic phase-out of outdated technologies*
#15	☐	**Destabilisation of incumbent technologies** (D)	Scientific evidence highlights the inefficiency, risks, or obsolescence of existing technologies, fuelling exploration of alternatives.	Competing innovations demonstrate superior technical performance, creating scientific and technical pressure on incumbent solutions through benchmarking, comparative studies, and field trials.	Technical standards, design practices, and research agendas converge around superior alternatives, rendering incumbents scientifically obsolete and structurally unsupported in R&D and technical communities.

Note: A = acceleratory, B = broadening, D = deepening

Table 3 | Industrial and organisational catalysts

#	Selection	Catalyst	Emergence	Diffusion	Reconfiguration
#16	☐	**Planning** (A)	*Scenarios and roadmaps* Establishment of a shared understanding of future developments	*Implementation plans* Binding or non-binding agreements on next steps and feedback mechanisms	*Prioritisation in implementation plans* Innovations are given priority over existing ones
#17	☐	**Dynamic capabilities of firms** (A, D)	*R&I capacities* Abilities and resources to develop new products and services	*Absorptive capacities* Integrating external technological advancements and customer feedback	*Adaptive capacities* Adjusting to industry restructuring and changing demands
#18	☐	**Redirection of capital flows** (A, D)	*Initial shifts in investment priorities* Investors begin reallocating capital towards sustainability, digital, or inclusive goals.	*Mainstreaming of redirected flows* ESG and impact-oriented investments gain market share and influence firm behaviour.	*Structural realignment of capital markets* Capital allocation is systematically guided by sustainability and transition criteria.
#19	☐	**New financing instruments** (A, B)	*Development of alternative funding models* Green bonds, transition funds, and blended finance are introduced to support long-term innovation.	*Wider uptake by public and private actors* Innovative instruments are adopted across sectors and embedded in financial portfolios.	*Institutionalisation of new finance mechanisms* Non-traditional instruments are supported by regulation and financial infrastructure.
#20	☐	**Stakeholder coordination** (A)	*Initial collaborative efforts* Informal partnerships and ad-hoc initiatives among key stakeholders explore common goals and test joint action.	*Structured multi-stakeholder collaboration* Partnerships evolve into regular alliances, platforms, and consortia, developing shared rules and coordination routines.	*Systemic coordination architectures* Stakeholder coordination becomes embedded in overarching governance frameworks that shape long-term trajectories of innovation and transition.

#	Selection	Catalyst	Emergence	Diffusion	Reconfiguration
#21	☐	**Support of dominant actors** (A)	*Initial buy-in from leading firms or institutions* Early interest and preliminary engagement	*Active sponsorship and resource allocation* Dominant actors invest and champion new solutions	*Full adoption and advocacy* Dominant actors integrate new solutions into core strategies
#22	☐	**Business model change** (D)	*Introduction of alternative business logics* Firms adopt new ways of creating and capturing value that challenge established models.	*Uptake across firms and networks* New business models are adopted by competitors, suppliers, or partners and adapted to new contexts	*Business models restructure industries* New business models actively reshape value chains and competitive dynamics, displacing incumbent models.
#23	☐	**Changes in organisational strategy** (D)	*Strategic goal-setting for transitions* Organisations add transition-related objectives alongside existing strategies, opening new directions without abandoning prior logics.	*Strategic integration across the organisation* Transition-related goals are embedded into planning, KPIs, and risk management.	*Prioritisation of transition strategies* Transition-oriented objectives become dominant in strategic agendas, displacing previous priorities and guiding long-term decision-making.)
#24	☐	**Alternative ownership models** (D)	*New ownership forms introduced* Firms adopt mission-driven, cooperative, or public-private structures to align governance with long-term goals.	*Expansion of ownership diversity* Alternative models spread across sectors, influencing investment and decision-making norms.	*Institutionalisation of ownership change* Legal frameworks and financial tools support non-traditional ownership at scale.
#25	☐	**Industry integration and restructuring** (D)	*Restructuring of industry boundaries* Mergers or alliances redefine roles across the value chain.	*New integrated architectures* Standardisation and shared platforms support coordination and innovation.	*Stabilisation of new industry structures* Reconfigured chains become dominant in shaping competition and governance.

#	Selection	Catalyst	Emergence	Diffusion	Reconfiguration
#26	☐	**Collaborative supplier–customer relationships** (B, D)	*Trust-based collaboration* Early pilots build confidence through joint problem-solving, shared risks, and longer-term engagement with selected partners.	*Expansion of co-innovation practices* Collaborative contracts, joint R&D, and shared investment structures spread, embedding innovation into supplier–customer interactions.	*Shifting supplier–customer constellations* Firms reconfigure their networks by building new, collaborative ties with different customers and suppliers, while previously established relationships diminish in importance.
#27	☐	**Strategic innovation ecosystems** (A, B)	*Emergence of collaborative platforms* New alliances and ecosystems form across sectors and disciplines.	*Expansion and structuring of ecosystems* Ecosystems develop coordination mechanisms and shared innovation infrastructure.	*Reconfiguration of innovation ecosystems* New ecosystems with different actor constellations and governance logics replace or supersede established ones.
#28	☐	**Entry of disruptive market actors** (B, D)	*Emergence of non-traditional players* New entrants challenge incumbents with alternative models or values.	*Growth and legitimisation of disruptors* Disruptive actors gain credibility, market share, and influence.	*Integration of new actor types* Disruptors become essential players in markets and value networks.
#29	☐	**Workforce diversity and inclusion** (B)	*Diverse hiring and inclusive culture initiatives* Organisations take active steps to broaden representation and participation.	*Embedding diversity in organisational systems* Diversity becomes part of team composition, leadership, and HR strategy.	*Structural commitment to inclusion* Inclusion is formalised through governance, incentives, and long-term planning
#30	☐	**Distributed innovation practices** (B)	*Innovation beyond R&D units* Firms empower multiple departments to contribute to innovation processes	*Organisational diffusion of innovation practices* Cross-functional teams and open platforms facilitate collaboration	*Innovation as an organisational capability* Innovation is institutionalised across functions and tied to incentives and metrics

#	Selection	Catalyst	Emergence	Diffusion	Reconfiguration
			Engagement with new user segments	*Demand shaping across industries*	*Market diversification as standard practice*
#31	☐	**Diversification of demand** (B)	Organisations address underserved or emerging markets	New client needs influence design, marketing, and business models	Serving diverse client groups becomes central to competitiveness and resilience
			Introduction of inclusive governance models	*Expansion of multi-voice structures*	*Institutionalised pluralism*
#32	☐	**Pluralistic decision-making structures** (B)	Firms pilot stakeholder advisory boards or participatory mechanisms	Stakeholder engagement becomes integrated into major decisions	Diverse interests are formally represented in boards, policies, and governance structures
			Involvement of new innovation actors	*Multi-stakeholder innovation becomes routine*	*Institutionalised actor diversity*
#33	☐	**Actor diversity in innovation systems** (B)	Cities, NGOs, and communities join traditional innovation processes	Diverse actors regularly collaborate in funding, experimentation, and scaling	Innovation systems structurally include multiple actor types as co-creators
			Formation of community-led pilots	*Replication and adaptation*	*Institutional recognition and scaling*
#34	☐	**Grassroots and communities** (B, D)	Local groups initiate small-scale experiments that address unmet needs or embody alternative ways of living.	Other communities adopt or adapt grassroots models, leading to regional or national networks.	Grassroots practices influence mainstream policy, funding, or infrastructure through formal integration.

Note: A = acceleratory, B = broadening, D = deepening

Table 4 | Cultural and political catalysts

#	Selection	Catalyst	Emergence	Diffusion	Reconfiguration
			Development of shared visions	*Wider adoption of visions*	*Changing visions*
#35	☐	**Visions** (A)	Formulation of a collective stakeholder vision about the innovation	Visions adopted across society and stakeholders	Innovation vision replaces dominant visions and is integrated into policy and societal norms
			Problem articulation	*Awareness campaigns*	*Shared consciousness*
#36	☐	**Public awareness** (A, D)	Early actors publicly highlight a societal problem and present the innovation as a potential response, sparking first recognition.	Organised efforts (e.g. campaigns, policy consultations, advocacy) spread knowledge about the innovation and its implications, creating broader public understanding.	Awareness evolves into a widely shared understanding that actively shapes choices, expectations, and evaluations of options in public life, making ignorance of the innovation's implications untenable.
			Narrative framing	*Media amplification*	*Narrative dominance*
#37	☐	**Public discourse** (A, B, D)	Stakeholders introduce new framings and build initial coalitions to promote specific interpretations of the innovation.	Expanding public and media debates multiply competing narratives, shaping how different groups perceive opportunities and risks.	One or more framings become dominant, institutionalised in policy language, cultural narratives, and professional vocabularies, marginalising alternatives..
			Introduction of enabling policies	*Establishment of favourable conditions*	*Reduced support for incumbent systems*
#38	☐	**Policy support** (A, D)	First formal policies or regulations create space for innovation through legal or financial mechanisms.	Regulations and incentives explicitly support widespread adoption of the innovation.	Policy explicitly shifts resources toward the innovation.

#	Selection	Catalyst	Emergence	Diffusion	Reconfiguration
#39	☐	**Organisational values** (D)	*Articulation of new value frameworks* Leaders or internal advocates promote alternative values (e.g. sustainability, equity) as guiding principles.	*Organisational alignment and engagement* New values are integrated into internal communications, HR practices, and leadership narratives.	*Embedding values in governance and accountability* Values are formalised in decision-making structures, codes of conduct, and stakeholder commitments.
#40	☐	**Indicators of success** (A, D)	*Adoption of new performance metrics* Organisations begin using alternative indicators (e.g. ESG, stakeholder impact, resilience) alongside financial ones.	*Internalisation and benchmarking* Non-financial indicators are linked to internal targets and compared across peers or industry benchmarks.	*Redefinition of value and accountability* Success is measured through impact-oriented metrics that shape incentives, reporting, and governance.
#41	☐	**Social acceptance** (A, D)	*Niche community acceptance* Early adopters embrace the innovation within specific subcultures or communities.	*Mainstream cultural resonance* The innovation aligns with broader cultural narratives and public sentiment.	*Deep societal integration* The innovation becomes part of collective identity, values, and traditions.
#42	☐	**Public finance** (A)	*Deployment of public funding* Governments or public banks allocate funds to specific innovation programs or demonstration projects.	*Scaled investment and risk sharing* Governments and institutions increase financial support to enable widespread adoption.	*Structural financial realignment* Long-term public finance and subsidies are restructured to support the innovation.
#43	☐	**Power structures** (D)	*Emerging challengers* Marginal actors or movements begin to contest incumbent dominance.	*Shifting alliances* Alliances shift and new actors gain influence over decision-making.	*Institutional transformation* Structures of authority and governance are reshaped in line with the innovation.
#44	☐	**Policy strategies and plans** (A, B, D)	*Initial strategic adoption* The innovation is explicitly included in official R&I strategies and planning documents by relevant public institutions.	*Sectoral strategy alignment* Sectoral strategies in domains such as energy, transport, or health integrate the innovation into their plans, creating cross-sectoral coherence.	*Comprehensive policy planning* Long-term, system-wide planning frameworks embed the innovation across government and governance, providing durable strategic orientation.

#	Selection	Catalyst	Emergence	Diffusion	Reconfiguration
#45	☐	**Behavioural change** (A, D)	*Experimental practices* Individuals or groups trial new behaviours aligned with the innovation.	*Routines* Innovations become part of everyday routines.	*Social practices* Innovations are integrated in widely shared and accepted social practices.
#46	☐	**Public procurement** (A)	*Targeted early procurement* Public institutions procure innovation-aligned products or services through pilot tenders or frameworks.	*Procurement scaling* Public agencies adopt procurement criteria that support wider uptake of the innovation.	*Shifting procurement standards* Procurement processes are fully reoriented to support transformative outcomes.
#47	☐	**Policy integration** (A, B, D)	*Early coordination activities* First consultations, guidance, or inter-ministerial initiatives begin to connect R&I policy with one or two sectoral domains (e.g. energy, mobility).	*Expansion across sectors* Multiple sectoral ministries and agencies adopt aligned objectives and instruments, creating cross-sectoral consistency and reducing fragmentation..	*System-wide policy coherence* Core economic, social, and environmental policy frameworks are deliberately harmonised, producing durable cross-government integration around the innovation.
#48	☐	**Legal frameworks** (A, D)	*Legal validation* New legal concepts, rights, or instruments are introduced through pilot laws, strategic litigation, or experimental regulation.	*Expansion and legal harmonisation* Innovative legal approaches are adopted by additional jurisdictions or aligned across legal systems.	*Redefinition of legal foundations* Core legal principles, rights, or doctrines are redefined to support the transformed system.

Note: A = acceleratory, B = broadening, D = deepening

5 | How the TIME framework was developed

The development of the TIME framework was funded by the Austrian Energy and Climate Fund and was carried out under the "Austrian Climate Research Programme implementation" (ACRPi KC407968). The process combined desk research, workshops, and expert interviews, and was carried out in multiple steps (see Figure 4).

The development took place between October 2024 and July 2025 and engaged numerous experts from R&I policy and evaluation through a series of workshops. The Austrian Platform for Research and Technology Policy Evaluation (fteval) supported the organisation of a workshop at the REvaluation conference 2024. We are especially grateful to Michael Dinges and Anahi Montalvo-Rojo (both Austrian Institute of Technology), Brigitte Tiefenthaler (Technopolis Group) and Peter Kaufmann (Austrian Institute for SME Research) for their valuable contributions to the design of the indicator development template. We would also like to express our gratitude to the Austrian Federal Ministry of Innovation, Mobility, and Infrastructure (BMIMI) for providing early conceptual input on system innovations and feedback at an earlier stage of development.

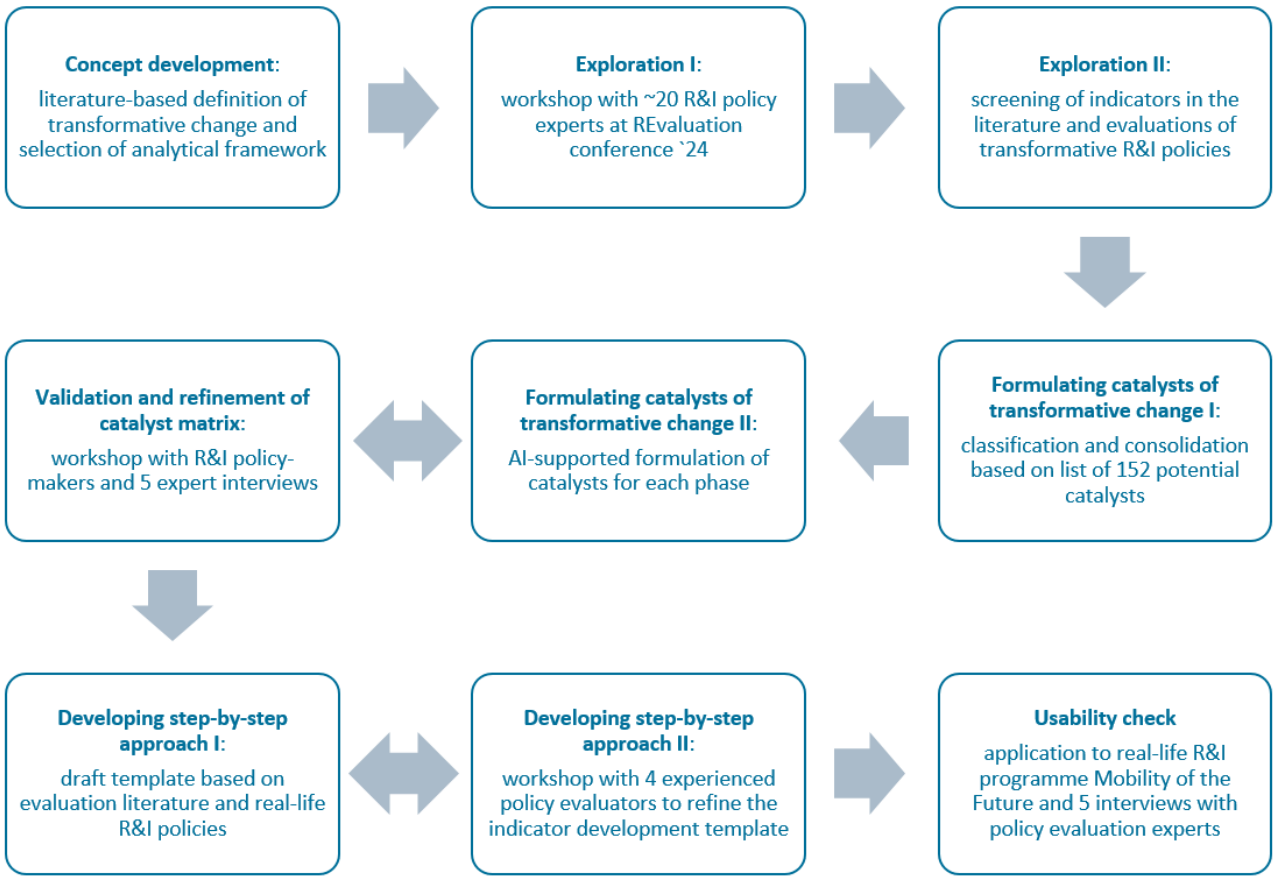


Figure 4 | Stepwise development of the TIME framework

Source: own elaboration

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