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FASTER, DEEPER, BROADER: CAPTURING RTI-POLICY CONTRIBUTIONS TO SUSTAINABLE TRANSFORMATION PROCESSES

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ABSTRACT

This article summarises the results of an fteval working group on the impact measurement of research, technology, and innovation (RTI) contributions to sustainable transformation processes. Existing approaches in Austria are presented, additional approaches from the literature are discussed, and, based on this, possibilities are shown for further developing indicators and monitoring. This is intended to lay the first foundation for how monitoring and evaluation can more comprehensively capture and thus better support sustainable transformation in Austria.

1. SUSTAINABILITY AND TRANSFORMATION IN MONITORING, EVALUATION, AND LEARNING (MEL)

Research, Technology, and Innovation Policy (RTI policy) plays a central role in shaping and accompanying sustainable transformation processes. With the increasing urgency and importance of profound changes in the economy and society, RTI policy is increasingly expected to make concrete contributions to societal challenges such as combating climate change, biodiversity loss, pandemics, or poverty (Schot & Steinmueller, 2018). The Austrian federal government has responded to this new demands by redesigning parts of the RTI policy portfolio adopting a transformative approach policy': New RTI initiatives have been launched, new funding instruments developed, and new forms of collaboration in public administration established (Ecker et al., 2023).

With the new ambitions of a transformative innovation policy come many challenges for the design and implementation of monitoring processes and evaluations. Effectively supporting transformation processes requires a sound understanding of the application context and the possible impact contributions of RTI policy instruments, as well as timely feedback on achieved and unachieved impacts. To provide this, existing processes for collecting and processing information must be fundamentally rethought. This also affects the 'core' of monitoring and evaluation: the indicators and measurement procedures used to capture specific outputs, activities, or impacts.

This article examines existing RTI indicators for capturing impacts on sustainable transformation. Although the approach of transformative innovation policy entered national and international RTI policy several years ago, there is still considerable need for catch-up in impact measurement (Biggeri & Ferrannini, 2020; Brodnik & Dinges, 2022). Brodnik and Dinges note about current indicators:

"The existing sets of indicators [...] embrace the concept of transformative innovation policy only to a very limited extent. While there are examples and initiatives of indicators that aim to systematically measure the influence of R&I activities on the realisation of overarching societal goals (such as the SDGs or Agenda 2030[1]), they are currently not well established. There is either a conceptual ambiguity or the data is currently neither available nor systematically collected"
(Brodnik & Dinges, 2022: 36f).

1 https://sdgs.un.org/goals

Issues of impact measurement are of cross-institutional interest, concerning both internal monitoring processes and external analyses by evaluators or accompanying bodies. Against this background, fteval – the Austrian Platform for Research and Technology Policy Evaluation – established a working group to assess the status quo and need for action regarding the measurement of RTI contributions to sustainable transformation processes. Experts from administration (Federal Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology - BMK), funding agencies (Research Promotion Agency – FFG, Austrian Science Fund – FWF, Vienna Business Agency), universities (Alliance of Sustainable Universities, University of Natural Resources and Life Sciences), and evaluation (Austrian Institute for SME Research, WPZ Research, Centre for Social Innovation, fteval) participated in the group.

The exchange in the working group showed how differently the terms sustainability and transformation have been interpreted so far. The joint engagement with the requirements of the respective organisations also highlighted the challenges of translating established concepts and approaches from transformation research into practical, real-world applications. Approaches that have already been successfully applied in evaluation practice (e.g., Dinges et al., 2022; Janssen, 2019) elicited little resonance among participants. Many indicators discussed in the literature are derived from high-level transformation theories (e.g., the transformative Outcomes approach, see Ghosh et al., 2021), which lack sufficient flexibility for adaptation to diverse application contexts.

We take a different approach in this article: rather than relying on abstract concepts, we begin with what already exists in the Austrian context and use this as a basis to determine additional requirements for effective impact measurement. We use a simple subdivision of four dimensions of sustainable transformation as orientation: the sustainability, depth, breadth, and speed of change processes. Using this framework, it becomes clear which focuses have been set so far in monitoring and evaluation concerning impact measurement and which aspects of sustainable transformation existing indicators can only insufficiently capture. It is particularly evident that while steps have been taken to measure ecological, social, and economic impacts in terms of a comprehensive understanding of sustainability, existing indicators provide little guidance regarding the three other qualities of transformative change. It thus remains largely unclear whether and to what extent RTI policy measures contribute to profound, broad, and accelerated change.

To create an overview of impact measurement in Austrian RTI policy from the perspective of sustainable transformation, we address the following questions

in the next sections:

- How are RTI contributions to sustainability and transformation processes captured in Austria? Which impact measurement approaches are pursued?
- Which specific gaps in existing analytical frameworks require the use of new or additional indicators to adequately capture to the diverse impacts of RTI initiatives on sustainable transformation?

2. TRANSFORMATIVE INNOVATION POLICY IN AUSTRIA

The implementation of a transformative innovation policy in Austria builds on a long-standing tradition of thematic RTI programmes that have supported research projects, network activities, and capacity building in areas of sustainable development for more than two decades (Weber & Kubeczko, 2023). Especially in the field of ecological sustainability, many programmes have been geared toward achieving positive contributions to environmental and climate protection (Wieser et al., 2021). Examples where research and innovation have provided direction include programmes such as "Mobilität der Zukunft (Mobility of the Future)"[2] or "Vorzeigeregion Energie (Flagship Region Energy)"[3] (Weber & Kubeczko, 2023).

Transformation, however, involves more than setting or changing direction. In contrast to sustainability (as a principle), transformation does not describe *why* a change should happen, but *how* it can happen (as a process). Transformative change often involves adjustments in the following three dimensions (e.g., Andersen et al., 2023):

- **Depth**: Refers to systemic and structural changes in institutions, rules, and infrastructures that maintain the status quo, considering both innovation and exnovation.
- **Breath**: Accounts for the diversity of solutions for different (local) problems and the various target groups that need to be reached and involved, including interdependencies between different systems (e.g., energy and mobility), and considers both technological and social innovations.

2 https://www.ffg.at/mobilitaetderzukunft

3 https://www.ffg.at/vorzeigeregionenergie

- **Speed**: Concerns the temporal dynamics of change processes, particularly opportunities for acceleration.

To trigger transformative change, measures beyond determining the direction of development are required; they must act structurally, consider context-specific requirements, and provide impulses to accelerate change processes. In recent years, some new instruments have been introduced in Austrian RTI policy in this context, such as innovation labs, regulatory sandboxes, or public-public collaborations (as detailed in the section on transformative innovation policy in the *Austrian Research and Technology Report 2023*, Ecker et al., 2023). Complementary measures – such as joint learning (i.e., knowledge and experience exchange between science, business, and other stakeholders) and the targeted inclusion of previously less involved actor groups (e.g., citizens and NGOs) – are also crucial. Short feedback loops are needed, for example, through regular monitoring or accompanying evaluations, as ex-post evaluation feedback often comes too late in dynamic transformation processes.

In Austria, several institutions implement transformative innovation policy. Their initiatives and programmes aim to support systemic changes in the economy and society, such as the energy transition or mobility transformation, to tackle central societal challenges like climate change and sustainability. The main actors in Austrian RTI policy and their initiatives and programmes are described below:

- *Federal Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology (BMK):* Leads the development and implementation of transformative innovation policy in Austria. Four explicitly transformative RTI initiatives have been defined in recent years: Mobility Transition, Energy Transition, Circular Economy and Production Technologies, and Climate-Neutral City.
- *Klima- und Energiefonds (Climate and Energy Fund):* The Climate and Energy Fund supports several RTI initiatives that promote sustainable transformation. One example was the programme "Flagship Region Energy", which supported model regions in developing and implementing innovative technologies and solutions in the field of renewable energy and energy efficiency. The aim was to pave the way for a sustainable energy future through pilot projects and best practices. The new "RTI Initiative for the Transformation of Industry", launched in 2023 as part of the federal Climate and Transformation Offensive, is intended to support industry in achieving climate neutrality by bundling RTI and investment funding. Furthermore, the

2024 programme "Lighthouses of the Heating Transition" is emerging as a transformative programme that covers RTI, demonstration, implementation, as well as qualification, diversity, and equal opportunities.

- *Federal Ministry of Education, Science and Research (BMBWF)*: The BMBWF plays a central role in coordinating the EU Missions in Austria. These missions are part of the 9th EU Framework Programme for Research and Innovation "Horizon Europe" and aim to tackle major societal challenges such as climate change adaptation and the transition to sustainable agriculture and land use through concrete, solution-oriented actions. The BMBWF supports the implementation of the missions through research funding, coordination, and networking of involved actors.
- *Funding Agencies: These policies are implemented through Austria's national research funding agencies*: aws, CDG, FFG, FWF, LBG, and ÖAW[4]. In addition to cooperation with the aforementioned ministries and the Climate and Energy Fund, resources from the national foundation "Fonds Zukunft Österreich"[5] can also be accessed. The foundation allocates resources competitively based on the Austrian RTI strategy and the recommendations of the Austrian Council for Sciences, Technology and Innovation (FORWIT)[6].

The following section outlines how different actors in Austrian RTI policy have so far attempted to capture sustainability and transformation in their respective monitoring approaches.

4 Austria Wirtschaftsservice (https://www.aws.at/), Christian Doppler Forschungsgesellschaft (https://www.cdg.ac.at/), Öst. Forschungsförderungsgesellschaft (https://www.ffg.at/), FWF Der Wissenschaftsfonds (https://www.fwf.ac.at/de/), Ludwig Boltzmann Gesellschaft (http://www.lbg.ac.at/de), Öst. Akademie der Wissenschaften (http://www.oeaw.ac.at/).

5 https://www.stiftung-fte.at/

6 https://forwit.at/

3. CURRENT IMPLEMENTATION STATUS

The following presents the approaches pursued to date by the institutions represented in the fteval Platform's working group. The presentation does not claim to be exhaustive but reflects the approaches discussed in the group and the contributions of its participants.

3.1 BMK

INNOVATION & TECHNOLOGY DEPARTMENT: COMPREHENSIVE MONITORING SYSTEM

The Innovation and Technology Department of the BMK is responsible for promoting technological innovation and research to strengthen Austria's competitiveness and advance the green and digital transformation. It is currently (as of 2024) further developing the monitoring system for the budgets and activities of applied research within its remit. This development is based on a dedicated preliminary study (Warta et al., 2023).

The monitoring system relates to the three impact objectives for the Innovation and Technology Department (BVA UG 34):

1. Increasing the RTI intensity of the Austrian business sector.
2. Developing modern, efficient, high-performing and safe technologies and innovations to address major societal challenges, such as climate change and resource scarcity.
3. Increasing employment in the field of research, technology, and innovation with particular emphasis to increasing the proportion of women.

Each objective includes indicators aligned with an intervention logic from activities to outputs, outcomes, and impacts. The further development of the monitoring system aims for indicators not to relate to individual programmes or initiatives but to the total budgets for funding and basic financing of non-university research institutions. Activities towards sustainable transformation arise not only from top-down funding programmes, but also from thematically open, bottom-up support. The monitoring system is intended to provide an overarching view of sustainable transformation initiated through technology and innovation.

Table 1 below shows sample indicators for Objective 2: Addressing climate change and resource scarcity.

Table 1 Indicators for Goal 2: Addressing Climate Change and Resource Scarcity

Level	Indicator	Source	Point in time
Input	Share of the planned UG34 budget with intended climate impact (Score 2) or indirect impact (Score 1)	Green Budgeting for UG34[7]	Annually, during budget planning
Output	Share of mentions from FFG-funded projects aiming to contribute to SDGs 7, 11, 12 and/or 13	FFG and AWS data	Annually, as reported at application
Output	System innovation (indicator still in development)		
Output	Share of projects involving implementation partners, users, or other stakeholders	FFG data	Annually
Outcome	Share of funded projects whose results show high potential for or actual contributions to environmental dimensions of the EU Taxonomy	FFG Impact Monitoring	Annually, four years post-project
Impact	Patent publications for environmental technologies	Austrian Patent Office	Annually
Impact	Share of the R&D sector in environmentally related production value	Environmental Goods and Services Sector (Statistik Austria)	Annually

7 Created on the basis of the Green Budgeting method of Austria Green Budgeting Methode des Bundes (bmf.gv.at)

Various approaches are currently being tested and partially implemented within the Department. It is important to note that these are located at different levels (department, programme, innovation) and are tailored to various contexts. What is already implemented is the capture of contributions to EU sustainability goals, based on the positively framed and slightly adapted "Do No Significant Harm" (DNSH) criteria of the EU Taxonomy. The data is gathered via the FFG's impact monitoring, which handles most of the department's R&D funding. The FFG's impact monitoring is based on a survey of project participants four years after project completion. This timing allows effects that often emerge with delay in R&D projects to be assessed once they have occurred. Thus, the approach does not rely on ex-ante impact estimations. However, it only captures *whether*, in the opinion of the project implementers, a contribution was made to the six aspects of the EU Taxonomy – not *how* or *to what extent*.

The Department also uses information on the assessment of sustainability criteria during the selection process for monitoring purposes. Since the evaluation methodology has changed in recent years, a joint evaluation of the sustainability criterion was conducted in 2024 with the BMAW (The Ministry of Labour and Economy; Seus et al., 2025). Furthermore, the department is developing indicators to capture projects dealing with and advancing system innovations. Two approaches developed for the RTI priorities „Climate-Neutral City" and „Mobility Transition" are being used:

SYSTEM READINESS APPROACH FROM THE RTI INITIATIVE "CLIMATE-NEUTRAL CITY"

For the RTI initiative "Climate-Neutral City", a model was developed to assess the maturity level of system innovations[8] in urban contexts. The approach expands on the established Technology Readiness Levels (TRLs) by including additional dimensions, such as regulatory readiness or infrastructure availability. The model can be integrated into monitoring processes to track progress in the development of system innovations. A pilot of this system innovation monitoring is planned for 2025.

8 https://smartcities.at/projects/system-readiness/

NAVIGATION SYSTEM APPROACH FROM THE RTI INITIATIVE „MOBILITY TRANSITION“

Within the RTI initiative “Mobility Transition”, a navigation system was developed to track project contributions to the development and implementation of system innovations. This approach builds on a process-oriented understanding of transformation, drawing from the multi-level perspective (Geels, 2002), and captures impacts across 17 fields of action. Notably, progress is measured not at the project level but in relation to a concrete system innovation. Multiple projects may contribute to one innovation, and information is aggregated accordingly. The monitoring also includes structured learning processes between project implementers and stakeholders involved in the innovation. A pilot is ongoing (as of 2025).

This monitoring is mainly based on qualitative information – hence the emphasis on “fields of action” rather than traditional indicators. The fields of action are grouped into three levels (Kofler & Wieser, 2023):

CAPACITY BUILDING AND SOLUTION DEVELOPMENT

- A clear and comprehensible problem definition is available.
- A consensus has emerged around one or more solution approaches within expert circles.
- The positive and negative effects of the solution component can be assessed.
- The solution has proven itself in a controlled test environment.
- A sufficiently large community has been established.
- Shared visions and narratives have been developed.

DIFFUSION AND SCALING

- Practical experience has been gained in user environments.
- User expectations were considered in development.
- An institution is promoting diffusion or scaling.
- A discourse on regulatory frameworks has been initiated.
- New application contexts have been explored.
- The solution has gained public recognition.
- Decision-makers have the necessary evidence available.

IMPLEMENTATION AND ANCHORING

- Required infrastructures are in place.
- Relevant laws and standards have been implemented.
- The solution has high social and cultural acceptance.
- Sustainable financing for scaling and deployment has been secured.

3.2 FFG – AUSTRIAN RESEARCH PROMOTION AGENCY

As a conceptual basis for capturing sustainability impacts, the FFG uses the United Nations' Sustainable Development Goals (SDGs). These provide 17 broadly legitimised goals with 169 targets. The SDGs have been integrated into the existing programme monitoring and controlling system. Impacts are recorded at project level by asking applicants during the submission process to estimate their contribution to the SDGs. This estimate can be supplemented by qualitative details. The information is gathered based on a selection of SDG targets relevant to R&D. In the final project report, the contribution to these goals is queried again, allowing for reassessment at a stage when the project's implementation and impacts are more advanced and thus easier to assess. The comparison over time also makes it possible to evaluate how accurately project applicants are able to anticipate their contributions in advance.

The FFG does not yet use explicit indicators for transformation, but there are internal discussions and initiatives underway. At the level of transformative programmes (e.g. "Expedition Zukunft" or "Impact Innovation") and in individual teams (e.g. Business Development), increasing attention is being paid to monitoring and evaluating transformation.

3.3 FWF – AUSTRIAN SCIENCE FUND

In their value statement[9], the Austrian Science Fund (FWF) affirm their commitment to climate-friendly, ecological and social sustainability across all areas of activity. The FWF also advocates for framework conditions that enable researchers to conduct projects in a sustainable and climate-conscious manner[10]. In addition to open-topic funding programmes – through which all dimensions of sustainability can be explored – there are also specific thematic calls (e.g. Zero Emissions Award of the alpha+ Foundation). The FWF also aims to operate its administrative office as sustainably as possible. There is ongoing

9 https://www.fwf.ac.at/ueber-uns/werte

10 https://www.fwf.ac.at/ueber-uns/aufgaben-und-aktivitaeten/nachhaltigkeit

exchange with (inter)national funding organisations on these issues. Since late 2024, the FWF has been developing a comprehensive sustainability strategy for both its administrative operations and funding activities, in close coordination with relevant stakeholders. This strategy is oriented towards the legally defined tasks set out in the Research and Technology Funding Act. Monitoring particularly focuses on aspects of diversity, especially gender. As the FWF funds basic research in a bottom-up and thematically open manner, an explicit orientation towards "societal transformation" is not a programmatic priority.

3.4 UNIVERSITIES

There are various university networks dealing with sustainability monitoring, such as the Alliance of Sustainable Universities in Austria[11] and the Sustainable Universities Network[12]. These networks generally pursue a "Whole Institution Approach"[13], which aims to align various dimensions and aspects of sustainability within an institution under a coherent guiding principle. The idea is for the university as a whole to act as a multiplier within society.

A research project conducted by the University of Natural Resources and Life Sciences Vienna (BOKU) and the University of Graz (2022/23) on "Knowledge Balance and Sustainability"[14] examined evaluation systems for sustainability-related research and teaching, as well as approaches to assessing and presenting the sustainability impact of academic activities.

The project also explored the nature of transformative research. It included (1) a review of international rankings that consider sustainability indicators and impact, (2) examples of sustainability evaluation approaches, and (3) methods for impact assessment in sustainability science.

Based on these inputs, the project developed additional criteria for assessing sustainability in research and teaching at the institutional level. These are intended to enable more differentiated analysis and reporting. The goals are: (1) to describe the structural conditions and frameworks that universities themselves create to enable and promote sustainability-focused research and teaching, and (2) to provide a foundation for comparative university reporting

11 https://nachhaltigeuniversitaeten.at/

12 https://www.nachhaltige-hochschulen.at/

13 https://www.unesco.de/node/6100

14 https://boku.ac.at/nachhaltigkeit/nachhaltigkeit-in-der-forschung/wissensbilanzierung-und-nachhaltigkeit-projektergebnisse

and knowledge balance in the context of sustainability efforts and impacts. Additionally, reflection frameworks for sustainability in both research and teaching were developed to help identify the depth of sustainability integration in academic activities.

3.5 VIENNA BUSINESS AGENCY

As part of a portfolio restructuring, the Vienna Business Agency introduced a systematic monitoring of sustainability criteria. These measures currently focus on the project selection stage. Fundamentally, no project is allowed to violate the "Do No Significant Harm" (DNSH) criteria. For this purpose, the DNSH definition was adapted from EU standards to fit the specific context.

At present, there are two programmes specifically targeting climate protection and one focused on the SDGs. Applicants must demonstrate the relevance of their project to climate protection and the SDGs. This criterion is treated as a knockout requirement in the assessment. It is queried at both the company and project level, although only the project-level information is considered in the evaluation.

3.6 INTERIM CONCLUSION

This overview shows that several actors within Austria's innovation system have already implemented approaches to measuring ecological sustainability contributions. However, methods that explicitly capture contributions to sustainable transformation remain limited to individual funding programmes and are still in the pilot phase. While the goals of RTI policy in terms of achieving transformative change have become more ambitious, the monitoring approaches still have some way to go. This gap between the implementation of transformative innovation policy and the knowledge production and application processes required for its realisation is observable internationally, and no satisfactory solution has yet been found (Kattel & Mazzucato, 2023).

The approaches used in Austria currently focus primarily on determining whether funding recipients are making a sustainable contribution – and what kind of contribution – guided by sustainability frameworks developed by the European Commission or the United Nations. However, to fully capture the process towards an ecologically sustainable economy and society – the transformation itself – this is insufficient. The next section introduces selected approaches from the literature before concluding with a perspective on further development.

4. APPROACHES TO CAPTURING TRANSFORMATIVE RTI IMPACTS FROM THE LITERATURE

In recent years, the literature has developed several analytical frameworks that could be used to assess transformative RTI impacts. Some of these frameworks have already been applied in evaluation practice. Below, we briefly introduce three of them:

- The **technological innovation systems** approach (e.g. Janssen, 2019) distinguishes seven key functions that an innovation system should fulfil in order to operate effectively: direction of research, knowledge development, knowledge exchange, entrepreneurial experimentation, resource mobilisation, legitimisation/opposition management, and market formation.
- The **transformative outcomes approach** (e.g. Boni et al., 2022) builds on the understanding that transformations result from interactions between different levels: innovations emerge in niches (which need protection) and must compete with and challenge dominant structures and rules (which need to be destabilised). To measure "transformative outcomes", Brodnik and Dinges (2022) derived a list of possible indicators (see Table 3 in the appendix).
- The **intervention points** approach (e.g. Kanger, 2020) is based on the same theories of socio-technical transitions but identifies six key intervention areas, providing guidance on where policy can intervene to achieve transformative effects. Table 2 provides an overview of these intervention points:

Tabelle 2 Political intervention points to foster socio-technical transition

1.	**STIMULATING DIVERSE NICHE INNOVATIONS**
	▪ Supporting R&D projects ▪ Creating spaces for experimentation ▪ Facilitating information exchange and knowledge transfer
2.	**SCALING UP NICHE INNOVATIONS**
	▪ Creating regulatory incentives ▪ Public procurement of innovations ▪ Securing financing ▪ Supporting diffusion via networks and platforms
3.	**DESTABILISING DOMINANT RULES AND STRUCTURES**
	▪ Regulatory interventions for phasing out outdated systems ▪ Adjusting incentive structures ▪ Divestment strategies
4.	**MITIGATING THE SOCIAL AND ECONOMIC CONSEQUENCES OF TRANSITIONS**
	▪ Regional development policies ▪ Qualification and training measures ▪ Financial compensation
5.	**COORDINATING AND ALIGNING DIFFERENT SYSTEMS**
	▪ Developing national strategies and visions ▪ Establishing cross-sectoral programmes ▪ Platforms for coordination and data exchange
6.	**ADJUSTING SOCIETAL FRAMEWORK CONDITIONS**
	▪ - International agreements ▪ - Political goals and narratives

Sources: Kanger et al. (2020), Kivimaa et al. (2023)

5. REFLECTIONS ON AN INDICATOR FRAMEWORK FOR TRANSFORMATIVE RTI IMPACTS

In the working group, we discussed existing analytical foundations from the literature and concluded that they are best suited for evaluating policy bundles or „policy mixes“ (e.g. as part of an evaluation of national RTI policy). However, we also observed that these frameworks require substantial adaptation to be applicable to individual initiatives. From the perspective of concrete RTI initiatives, there is often a large gap between the impacts that can reasonably be expected and the kinds of impacts that are demanded by frameworks that operate at the level of system transformation.

Brodnik & Dinges (2022) took a first step toward bridging this gap by linking analytical categories with specific indicators from other domains such as the SDGs and Responsible Research & Innovation (RRI). In our view, it seems more promising to develop indicators based directly on the concept of transformative change rather than predefined theories of transformation. Depending on the context, different transformation processes are initiated, and intervention logics differ significantly between RTI initiatives.

Transformative change can occur at different levels and take different forms – deep, broad, and fast (see Section 2). Indicators for transformative impacts can therefore be more flexibly applied to diverse contexts and, alongside depth – which existing frameworks tend to emphasise – also account for other dimensions such as breadth and speed. Both breadth and speed are critical in many areas. This expanded concept of transformation aligns with the idea that monitoring frameworks should not prescribe specific pathways, but rather remain open-ended and stimulate debate (Rafols & Stirling, 2020).

6. OUTLOOK

With this report, the working group aims to initiate a discussion on further developing and consolidating a transformative indicator framework within the Austrian RTI system. The research project TIME: Transformative Innovation Monitoring and Evaluation Framework (10/2024–06/2025) builds upon the group's findings and will develop them further into a comprehensive indicator set in collaboration with interested stakeholders. The project is funded by the Climate and Energy Fund.

The planned development steps include: first, refining the conceptual framework for the indicator set, screening existing indicators from academic and grey literature, and defining quality criteria. In addition, indicators will be collected and discussed with international experts during a workshop at the REvaluation conference. The project team will then select and further develop suitable indicators. In a subsequent workshop, these will be reviewed with policy practitioners from BMK and the Climate and Energy Fund for their practical relevance and generalisability. Finally, evaluators will validate the applicability of the indicators in a second workshop before the final indicator set is completed and a user guide for its application is prepared.

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ANNEX

Table 3 Suggestions for categories of indicators for "transformative outcomes" (from „Table 1. Indicator Categories for Transformative Outcomes", in Brodnik & Dinges, 2022)

Process	Transformative Outcome	Indicator Categories	Example of Indicators for Some of the Categories [unit]
Building and nurturing niches	Shielding: protecting new and more sustainable practices from external influences and helping them grow.	▪ R&D budget and subsidies for niche innovation. ▪ Fiscal support for niches (e.g., taxation). ▪ Public/Collective purchasing and procurement of niche innovations. ▪ Voluntary agreements with niche actors. ▪ Supportive regulation for niches. ▪ Experiments aimed at changing framework conditions (e.g., regulatory sandboxes).	▪ Business and government expenditures in R&D (euros). ▪ Subsidies and tax credits (euros). ▪ Procurement contracts (euros). ▪ The stringency of the regulation (qual.). ▪ The number of experiments (count). ▪ The number of agreements (count).
	Learning providing regular opportunities for discussing experiences, obstacles, and needs related to a new practice as well as challenging related values and assumptions that people might have.	Analytical descriptive knowledge about the current system and associated sustainability problems: ▪ Different types of system maps (e.g., policy landscape, project portfolios, etc.). ▪ Scientific publications (including conference papers or discussion papers). ▪ Grey literature. ▪ Datasets and databases of environmental or problem-related data. Normative knowledge about sustainability goals and desirable system states: ▪ Visions. ▪ Problem framings. ▪ Scenarios (qualitative, quantitative, or mixed). ▪ Capacities to develop effective sustainability interventions: ▪ Stakeholder track record in deploying sustainability initiatives. ▪ Existence of spin-offs/follow-up projects.	Network maps (qual./visual). ▪ The number of publications per year. ▪ Types of framing technologies, publication venues. ▪ The number of projects (count). ▪ The number of routines and strategies (count). ▪ The number of coalitions (count).

		Practical skills and knowledge that incorporate sustainability in routine actions: ▪ Evidence that sustainability has been anchored in routines beyond intervention. ▪ Evidence that sustainability has been anchored in strategies beyond intervention ▪ Interpersonal skills for developing coalitions and alliances. ▪ New networks and coalitions that are maintained beyond the project/intervention.	
	Networking: protecting and progressing new practises by gaining the interest of more people and creating connections between them.	Champions / Individuals: ▪ The number of champions. ▪ Type of champions (individual, organisational, etc.). ▪ Position/embeddedness of champions in a network. Actors' networks: ▪ Degree of formalisation of networks (from loosely ▪ connected individuals to formal networks). ▪ Autonomy and resources of networks. ▪ Heterogeneity of network. ▪ Inclusiveness of network. Intermediaries: ▪ Presence and number of intermediaries. ▪ Changes in the type of intermediary (individual, organisation, etc.). ▪ Roles of intermediaries (niche-, regime-, process-, systemic intermediary). ▪ Position/embeddedness of intermediaries in a network. ▪ System aggregation level at which intermediaries operate (local, regional, national, international).	▪ The number of champions (count.). ▪ Network metrics (indexes/quant.). ▪ Number [count.] and type of intermediaries (qual.).

	Navigating expectations: navigating and converging expectations of different actors the legitimacy of new practises is developed, and their potential explored.	Narratives: ▪ Presence of a new narrative or signs of an emerging narrative in different outlets (e.g., media, scientific, political, industry publications). ▪ Framing of solutions to sustainability issues widens (from a narrow problem-solution to a wider meaning). ▪ Changes to advocating narrative/counter-narrative. ▪ Coalitions around particular framings and narratives. Visions: ▪ Directionality of existing visions/new visions. ▪ Increase in reach/buy-in of visions. ▪ 'Quality' of vision (e.g., co-developed, widely shared, transformational aspirations, etc.)	▪ The number of newspaper articles (count.). ▪ The number of parliamentary discussions (count.). ▪ Opinion polls (qual.-quant.). ▪ Semantic metrics for narratives (qual.-quant.) ▪ The number of different coalitions (qual.).
Process	**Transformative Outcome**	**Indicator Categories**	**Example of Indicators for Some of the Categories [unit]**
Expanding and mainstreaming niches	Upscaling: conducting deliberate action to get more users involved in new and more sustainable practises.	Scaling: ▪ The number of stakeholders/stakeholder groups that engage with new practise. ▪ Changes in the number of practises adopted in a specific area/sector and at a certain level (local, national, transnational). ▪ Changes in the speed of adoption of practise in a specific area/sector and at a certain level (local, national, transnational). Scalable potential: ▪ Cost for an additional application of practise. ▪ Valorisation of practise by stakeholders	▪ Demand size for a niche (euros). ▪ Cost estimate for niche practise adoption (euros).

	Replicating: transferring the new and more sustainable practises to another location.	Replicating: ▪ Practise is applied in different settings/ circumstances. Replication potential: ▪ Independence of practise from cultural (e.g., user preferences) or structural (e.g., governance arrangements) particularities.	Number of different geographical markets for niches (count.).
	Circulating: exchanging knowledge, ideas, and resources between multiple related alternative practises.	▪ Knowledge and experience collection and synthesis. ▪ External knowledge and experience accessibility. ▪ Knowledge and experience sharing among stakeholders.	▪ The number of accesses to a website (count.). ▪ The number of attendees in a workshop (count.). ▪ The number of recipients of newsletters (count.).
	Institutionalising: turning new and more sustainable practises into more permanent and more widely available ones.	▪ Guidelines for best practises are developed. ▪ New standards are developed. ▪ Existing standards are adapted. ▪ New laws are developed. ▪ Existing laws are adapted. ▪ Practise features in emerging/dominant discourse.	The number of guidelines, standards, laws, etc. (count.).
Process	**Transformative Outcome**	**Indicator Categories**	**Example of Indicators for Some of the Categories [unit]**
Opening-up and unlocking regimes	De-aligning and destabilising regimes: disrupting and weakening dominant practises. This can be done by changing one of the dominant dimensions for example through the introduction of new policies.	Top-down: ▪ Phase-out policies. ▪ Bans on entrenched practises. ▪ Removal of subsidies of entrenched practises. ▪ Targeted financial incentives for alternative practises. Bottom-up: ▪ Public demonstrations, rallies, or marches. ▪ Boycotts. ▪ Petitions. ▪ Media campaigns. ▪ Public debates. ▪ Emerging discourses and metaphors.	▪ Number and stringency of policies (count. and qualitative). ▪ The number of grassroot events (count.). ▪ Opinion polls (qual.-quant.).

	Unlearning and deep learning in regimes: dominant actors question their assumptions and change their view on the potential of new and more sustainable practises and the ability of the dominant practise to respond to threats and opportunities, such as climate change and digitalisation.	▪ Evidence that new problem framings are being adopted by regime actors, e.g., in regime publications and advertisement campaigns. ▪ Evidence of changes in the direction of routine (r&i) search processes (i.e., moving into previously unexplored areas of knowledge); ▪ Existence of re-skilling, retrofitting, and repurposing programmes.	▪ Types of media and marketing ▪ campaigns (qual.). ▪ The number of patents (beyond ▪ regimes core area) (count.). ▪ The number of programmes ▪ (count.).
	Strengthening regime-niche interactions: frequency and quality of interactions between empowered actors from the niche and the regime on a non-competitive basis.	▪ Establishment of partnerships and collaborations between regimes and niches. ▪ Corporate venture capital initiatives for niche innovations. ▪ Merges and acquisitions (m&a) between the regime and niche actors (e.g., firms).	▪ The number of partnerships (count.) size of venture capital funds (euros). ▪ Number and size of m&a (count. / euros).
	Changing perceptions of landscape pressures: dominant actors to reach the point of view that immediate action is warranted, and new emerging more sustainable narratives need to be promoted.	▪ New regime discourses and narratives (framing) around a landscape trend (e.g., climate change). ▪ Announcement of new strategies, products, or services that seek to address a pressure or benefit from an opportunity at the landscape level.	▪ Semantic metrics (qual.-quant.). ▪ The number of announcements ▪ (count.).