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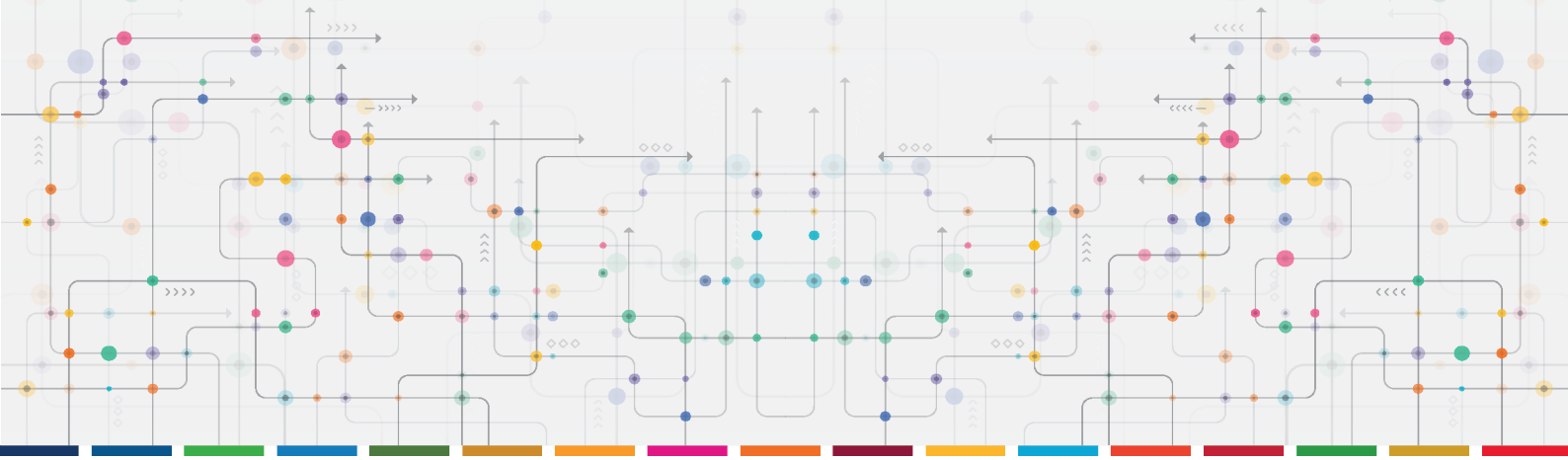
Accelerating innovation for sustainable socio-technical transformations



Navigating the challenges and opportunities for innovation-led sustainable transformations

ETIN Action Forum Policy Paper

ETIN UN-ECE TRANSFORMATIVE INNOVATION NETWORK

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Abbreviations

AI	artificial intelligence
BMBF	German Federal Ministry of Education and Research
CDI	challenge-driven innovation
DG RTD	Directorate-General for Research and Innovation
EC	European Commission
GDP	gross domestic product
HTS	German High-Tech Strategy
IoT	Internet of Things
JRC	Joint Research Centre, European Commission
ODP	open discovery process
PSO	public sector organization
RCN	Research Council Norway
R&D	research and development
R&I	research and innovation
SDGs	Sustainable Development Goals
TIP	transformative innovation policy

Acknowledgements

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[1] This event took place on 1–3 October 2024 in Brussels, Belgium.

Main Messages

Transformative innovation is needed at an accelerating scale to achieve sustainable and inclusive growth of economies and societies across the UNECE region.

Transformative innovation is not only about new products, services, processes and methodologies. It involves many complementary innovations that support and accelerate larger transformations in and of society at large, including changes in behaviours and mindsets.

This will require a more targeted, proactive and strategic approach to policymaking, creating and reinforcing policies and measures that enable and stimulate innovation for sustainable transformations.[a]

Policies and measures for transformative innovation begin with **Directionality** to identify and guide widespread activities towards sustainability transformations, ensuring that innovations achieve the intended positive impact.

Policies and measures for transformative innovation require **Coordination** and governance arrangements to encourage synergies and spillover effects, and enable seamless interaction between different actors.

Policies and measures for transformative innovation are designed to encourage **Experimentation and Strategic learning** to deal with the inherent unpredictability of complex adaptive systems (e.g. markets, societies, the natural environment) and the associated radical uncertainty concerning how policy interventions contribute to socio-technical changes.

Policies and measures for transformative innovation need **Capacitation** to build the right skills (capacities and capabilities), institutions, processes and incentivesto design, try out, learn, and continuously improve implement transformative innovation policies and measures effectively.

Putting these ambitions for innovation-led transformations into practice is one of the most complex challenges, making it essential to encourage the sharing practical experiences and exploring diverse approaches to innovation-led transformations. Networks like ETIN create a foundation for mutual learning and support, that through demand-driven activities and open exchanges helps stakeholders assess and apply strategies suited to their specific contexts.

Source: UNECE.

[a] Transformative innovation policy (TIP) is often perceived as a distinct set of targeted policies designed to support sustainable transformations. However, the approach under the ETIN framework suggests that policies for innovation-led sustainable transformations should not be treated as a separate or isolated policy category. Instead, transformative innovation is seen as a cross-cutting element that needs to be integrated across various policy areas, influencing a broader spectrum of initiatives. This holistic approach ensures that the principles of transformation are embedded in multiple sectors, fostering systemic change and enabling sustainable development across the entire economy.

1 General Introduction – Innovation for sustainable transformations

The transition to a sustainable societies, in line with the United Nations Agenda 2030 for Sustainable Development and the Sustainable Development Goals (SDGs), is one of the most significant and challenging socioeconomic endeavours of our generation. Considering the increasingly complex structural challenges and uncertainty arising from pandemics, poverty, rapid technology developments and war, along with the consequences of climate change, air pollution and biodiversity loss, there is a growing awareness of the need for more systemic transformations of our economies and societies. This will not only require that consumption and production patterns become more sustainable (SDG 12), but also that these efforts are somehow coordinated to reinforce one another, leveraging emerging opportunities, while at the same time mitigating and addressing potential socioeconomic risks and challenges.

Addressing these increasingly complex challenges will require innovation (SDG 9) at an unprecedented scale, including the much broader and more systematic experimentation with ideas. More importantly, it will require **transformative innovation**. Transformative innovation is not only about developing new products, services, processes and methodologies for everyday challenges. It is also expected to support and accelerate larger transformations in and of society at large, including changes in behaviours and mindsets, and this constitutes a new dimension to our understanding of innovation itself.

Supporting transformative innovation requires not only the design of better policies, but also changes in habits, institutions, and processes. Traditional approaches focus on technology development and innovation management to address competitiveness and growth at regional and national levels. Transformative innovation requires a more targeted, proactive and strategic approach to policymaking to reconfigure technologies, business models, infrastructure and markets, and to influence the cultures, mindsets and institutions that shape human behaviour around production and consumption to enable societal transformation. It also requires a broader scope, encompassing the global as well as the national and regional levels, as many sustainability challenges are global in nature. This implies developing supporting framework conditions, and new and appropriate incentives, along with allocating resources and using capacities and capabilities in both the public and private sectors and civil society.

There is a growing need for concerted and structured dialogues on these issues. How does this ambition to transform entire systems change the way we understand and promote innovation? What new policies and measures are needed to spur transformative innovation that accelerates a sustainable transition of our societies in line with UN Agenda 2030 and the SDGs? What are the opportunities and challenges in this process? What types of integrated learning processes and frameworks, enabling evaluation of past experiences while simultaneously pursuing foresight activities, can support experimentation that accelerates societal transformation in a complex and radically uncertain environment?

Responding to this need for concerted, structured dialogue, tools and joint initiatives, the UN-ECE Transformative Innovation Network (ETIN) has jointly organized the **Transformative Innovation Action Forum**, together with the United Nations Economic Commission for Europe (UNECE), the Joint Research Centre (JRC) of the European Commission and the Directorate-General for Research and Innovation (DG RTD) of the European Commission. The ambition of the Forum was to gain a better understanding of how key dynamics operate in this new context of transformative innovation, including the following:

- **Directionality** as an important first element in identifying and orienting our activities towards sustainability transformations
- **Experimentation and strategic learning** as an approach to deal with the inherent unpredictability of complex adaptive systems (e.g. markets, societies) and the associated radical uncertainty concerning how policy interventions contribute to socio-technical changes
- **Coordination** and governance arrangements to encourage synergies and spillover effects and enable seamless interaction between different actors involved in transformative innovation
- **Capacitation** to build the right skills (capacities and capabilities) to design and implement transformative innovation

This document brings together a collection of insights on these key dynamics, reflecting emerging thinking and practical experience from ETIN, DG RTD and JRC. It fed into the discussions at the Forum, and is a culmination of a portfolio of ETIN activities, including dedicated Task Forces on Circular Platforms, on Strategic Learning and on Innovation-Enhancing Procurement.

The document also offers reflections on how the contexts in which transformative innovation is carried out, such as digitalization, altered and emerging energy needs, and fluctuating political priorities for competitiveness versus sustainability, influence the conditions for innovation-driven sustainability transformations. It concludes with an overview of how the ETIN network can support its members in addressing the challenges and leverage the opportunities for sustainable transformations outlined in this document.

Accelerating transformative innovation is crucial not only for developed economies but also for transition economies, especially those in post-Soviet regions. It enables them to overcome unique structural and economic challenges and adopt new, inclusive growth strategies that leverage human potential and address social disparities, while building sustainable, resilient growth. Transition economies often face issues like outdated infrastructure, dependence on a limited range of industries, and lingering institutional barriers. By fostering transformative innovation, these countries can diversify their economies, improve competitiveness, and address pressing environmental and social issues. Moreover, transformative innovation can drive sustainable, inclusive development by creating opportunities across various sectors, which is essential for equitable economic progress. As global markets increasingly prioritize sustainable solutions, accelerating innovation helps transition economies integrate into these markets, creating pathways for economic growth and international cooperation.

Engaging transition countries in international dialogue, open exchanges, and peer learning is essential to facilitate the implementation of transformative innovations, ensuring that these nations can effectively transition to sustainable, competitive economies while contributing to broader global sustainability efforts. By fostering collaboration and knowledge sharing, ETIN provides a valuable platform for stakeholders and experts in these regions to harness their growth potential, ultimately leading to a more resilient and integrated pan-European economic landscape.

These discussions under ETIN, particularly at the Action Forum, are timely as there is an increased need to accelerate and scale up innovation-led growth to address global and complex challenges. They contribute to ensuring further progress not only towards SDG 9 (Industry, innovation and infrastructure) and SDG 12 (Responsible consumption and production), but also SDG 8 (Decent work and economic growth), SDG 10 (Reduced inequalities), SDG 11 (Sustainable cites and communities), SDG 13 (Climate action), SDG 17 (Partnerships), among others. They also strongly align with the Pact of the Future, recently adopted by UN member States, and the ambitions of the 2024 United Nations Climate Change Conference (COP29) in Baku, Azerbaijan.

2 Directionality to guide innovation-led activities for sustainable transformations

Main Messages

Directionality for sustainable transformations includes the **strategic alignment of goals and actions** to address societal challenges like climate change, energy transitions, and social well-being through a **systemic approach that engages diverse stakeholders**.

Directionality guides policy by **prioritizing sustainability and competitiveness**, moving beyond traditional market-driven innovation to phase out harmful technologies and support new, more adaptive governance models.

Tools like open discovery processes and mission-oriented approaches **help foster collaboration, co-creation, and a shared vision, ensuring that public policies are inclusive, clear, and aligned across different governance levels** to drive sustainable, long-term change.

Source: UNECE.

2.1 Introduction to directionality

Kjell-Håkan Närfelt, Chair of UNECE Team of Specialists on Innovation and Competitiveness Policies (ToS-ICP), Chief Strategy Officer, Vinnova

Innovation policy has traditionally used market and system failures as rationales for government intervention. What innovations should be developed was seen as a matter for the market to decide.

As societal challenges related to poverty, climate, health and well-being, pollution and energy, among others, has come to the forefront of the political agenda governments faced a new situation: traditional policy approaches and the institutions, incentives, and processes tasked with putting them into practice seemed poorly prepared. New approaches were needed to prioritize different innovative solutions.

Research and innovation (R&I) policy has become an important governmental means to address these challenges and stimulate knowledge, technologies and innovations that contributed to solving the challenges.[2,3,4]

[2] ERA (2009), "The Lund Declaration", Federal Ministry of Education, Science and Research, Republic of Austria, Available at https://era.gv.at/era/societal-challenges/the-lund-declaration/ - :~:text="Europe must focus on the,and public stakeholder-driven approach.

[3] United Nations (2015), "The 17 goals", Available at https://sdgs.un.org/goals

[4] Mazzucato, M. (2018), "Mission-oriented research & innovation in the European Union", Publications Office of the European Union, Luxembourg

An important consequence and objective of R&I policy is the need to proactively engage in giving R&I efforts directionality. Through directionality, innovation policy addresses the following aspects:

- How to set direction for R&I efforts and mobilize actors in that direction;
- How to phase out harmful technologies, products, practices, policies and power structures;
- How to stimulate and drive demand that supports the desired directionality; and
- How to make institutional changes that support the desired directionality.

2.2 Directionality towards sustainable transformations

Dimitrios Pontikakis, Scientific and Technical Project Officer, and Ramojus Reimeris, Economic and Policy Analyst, Joint Research Centre, European Commission

What is directionality?

Directionality can be understood as the shared understanding and alignment of goals, objectives and strategies among individuals or organizations. Directionality focused on a shared challenge, such as climate change mitigation and adaptation, can act as an organizing principle for cooperation and investment in complex and fragmented decision-making structures. It promotes resource collaboration and continuous improvement through shared learning and coordinated efforts.

Why do we need directionality?

We are living through exceptional times, witnessing once-in-a-century transformations in energy and mobility systems, when emerging technologies are likely to redefine the nature of work and when old geopolitical certainties can no longer be taken for granted. Traditionally, public policy in support of economic development, including innovation policy, has been wary of interventions that might distort prices, by say prioritizing a specific technology or industrial sector over others. However, to tackle climate change in time to avoid bleak scenarios, our societies need to move away from some established technologies and sectors.

For the European Union (EU), economic prosperity can no longer be conceived in isolation from other strategic objectives, including sustainability and open strategic autonomy.[5] Transforming current production and consumption systems within defined time frames inevitably requires setting a clear direction. An important reason for directionality at the present time is therefore that effectiveness in addressing urgent societal problems takes precedence over economic efficiency considerations.

But there are also good reasons to believe that, during a period of deep and pervasive transitions, directional interventions in fundamental human support systems for energy, food, housing, mobility and waste can be more efficient than relying on market forces alone.[6] For example, directional interventions in regulation, fiscal policy, skills and innovation will

[5] European Parliament (2023). "What if open strategic autonomy could break the cycle of recurring crises?", available at: https://www.europarl.europa.eu/stoa/en/document/EPRS_ATA(2023)747420.
[6] Pontikakis, D. et al. (2022), "Partnerships for regional innovation – Playbook - Concepts and rationales", EUR 31064 EN, Publications Office of the European Union, Luxembourg, JRC129327

largely determine how quickly markets for sustainable growth and services grow in a territory and how globally competitive its companies are likely to be.

How to promote greater directionality?

Directionality in policy does not emerge naturally. Safeguarding the public interest in this controversial and highly contested process is a fundamental role of government that requires new capacities to set legitimate directions and to engage effectively with stakeholders.[7]

Setting directionality begins by engaging with stakeholders and working backwards from societal problems to agree on a shared vision.[8] Once directionality on a shared problem has emerged and begins to enjoy broad societal backing, it can act as an organizing principle for cooperation in complex decision-making structures. Working backwards from a goal can allow a broad portfolio of actions to emerge, which can potentially cascade upwards (in higher levels of governance) and sideways (to other territories). Framing the problem sets the perimeter of what parts of our societies and economies need to change. The process ought to engage stakeholders, including citizens and disadvantaged groups, and needs to be backed by credible scientific evidence. The framing of the challenge should be clear and easily understood by all parties. Potential challenges that citizens may help address include social integration of marginalized groups, worker futures in sunset industries, or business and employment opportunities in markets for sustainable goods and services. In each case, the challenge will have to be adapted and expressed in terms that are sensitive to locally prevalent values.

Setting directionality does not mean that public policy ought to outsmart the market. On the contrary, as long as there is clarity about what would constitute an acceptable solution to any given societal challenge (e.g. agreeing on "net zero" to address climate change), a key duty of government is to safeguard openness about the way of getting there – where possible, spreading risk across several possible solutions.

Public policy can play a key role in setting a directionality by providing orientation (e.g. highlighting positive visions and proposing strategies such as the European Green Deal), providing the public good of objective evidence about the costs and benefits of particular courses of action and orchestrating continuous dialogue with stakeholders.

Examples of directionality: Open discovery process and missions

An example of a tool to foster directionality is the open discovery process (ODP). ODP serves as a platform of collective thinking, which fosters engagement and co-creation among various stakeholders, promoting a collective approach to addressing societal challenges. Governments at multiple levels and stakeholders can work together in designing and coordinating activities. ODP is a process that enables engagement, deliberation and co-creation of paths with different sets of stakeholders. It involves collective deliberation to develop a shared understanding of the directionality of the societal challenges and of ways in which they can be addressed before developing shared agendas. A goal of ODP is to encourage additional voluntary actions that help achieve the goal beyond planned actions.[9]

[7] Janssen, M. et al. (2023), "Capacities for transformative innovation in public administrations and governance systems: Evidence from pioneering policy practice", Publications Office of the European Union, Luxembourg, JRC131490

[8] Bianchi, G. et al. (2024), "Innovation for place-based transformations. ACTIONbook to build partnerships for fair green and digital transitions", Publications Office of the European Union, Luxembourg, 2024, JRC135826

[9] Laranja, M. and Reimeris, R. (2024), "Discovery-oriented innovation and industrial policies: insights from five regions about open discovery processes", Publications Office of the European Union, Luxembourg, JRC138135

Another instrument for achieving directionality is missions.[10] Mission-oriented innovation policy can support directionality by focusing on specific, well-defined goals that require innovation to address them. By setting mutually shared objectives and creating a plan with roles in it, missions can guide many different activities. The mission-oriented approach serves as an organizing principle that extends beyond research and development (R&D) efforts, to include actions in regulation, skills development, business investment, consumption subsidies and enhancement of physical and digital infrastructure.

This approach allows different levels and parts of governance to work together, creating a more inclusive and aligned policy framework. The challenge of implementing a mission-oriented approach at the regional level involves not just providing directionality to current regional innovation policies, but also developing new governance models. These models should adopt a multi-actor, multi-scale perspective, involving various stakeholders. Generally, directionality is important not only for solving complex societal goals, but also for any policy intervention to be impactful and to result in sustainable change.

[10] Kivimaa, P. et al. (2023), "Directionality for transformation: Analytical dimensions and illustrations of selected policy tools", European Commission, Seville, JRC134822

3 Coordination and governance for synergies and spillover

Leonard Kelleher, Research Associate, Institute for Manufacturing, University of Cambridge

Main Messages

System transformations rely on the **coordination of multiple parallel innovation processes across different sectors and levels of governance**.

Effective multilevel governance requires **breaking down policy silos and ensuring alignment between local, regional, and national initiatives** to drive transformative innovation.

Place-based innovation focuses on leveraging local strengths, resources, and stakeholders to address **specific regional challenges**, ensuring that solutions are tailored to diverse territorial needs.

Digital and circular platforms can serve as key coordinators, enabling scalable, sustainable practices by aligning market demand, connecting stakeholders, and fostering innovation.

Source: UNECE.

3.1 Introduction to coordination for sustainable transformations

In practice, system transformations are rarely brought on by a single disruptive innovation but rather by the combination and orchestration of several parallel experimental innovation processes undertaken and adjusted over lengthy time periods.

This fact highlights the need for coordination and alignment to encourage synergies and spillover effects and to enable seamless interaction between the different actors involved in transformative innovation. This includes cross-government horizontal coordination with other policy domains, vertical coordination between different levels of government (local, regional, national and supranational) and coordination between public and private (and other) sectors.[11]

Owing to the complex adaptive properties of systems, this coordination is complicated. As most can attest, the imperative for coordination often leads to too much or the wrong kind of coordination and deviates valuable resources towards documenting compliance with a large number of criteria. It needs to be accomplished in conditions of uncertainty, where individuals cooperate to combine knowledge as a contribution to a group outcome, but where the value of knowledge is only revealed afterward.

[11] Schot, J. and Steinmueller, E. (2018), "Three frames for innovation policy: R&D, systems of innovation and transformative change", Research Policy, 47(9), 1554–1567

The contributions in this chapter provide examples of developments and emerging approaches to coordination by governments in areas such as (1) the European Union's approach to multilevel governance for transformative innovation at national levels and (2) the coordination of transformative and place-based innovation policy at subnational levels. Recognizing that other modes of coordination are also possible, section 3.4 discusses the use of circular platforms as an example of coordination by markets.

3.2 Governance at the national level: Multilevel governance in transformative innovation policy

Bianca Cavicchi, Policy Officer, DG RTD, European Commission and Igor Oliveira, Independent Consultant

What is multilevel governance?

Unlike traditional research and innovation (R&I) policies, transformative innovation policy (TIP) emphasizes systemic change, directionality and inclusivity, with the goal to reorient socio-technical systems towards more sustainable pathways. In order to effectively achieve these systemic changes, multilevel governance is essential. Coordination across levels of governments and governmental departments helps with building synergies, considering different needs and designing policies that are more coherent and effective to deliver solutions for societal challenges.

The European Commission's approach to multilevel governance

From a European perspective, the European Commission translates the concept of multilevel governance into the whole of government approach[12] for R&I. Its key components:

- Integration of R&I policies in a policy mix with other key policy areas involved in systemic change, as for instance, climate, energy and mobility policies. This integration ensures that innovation initiatives contribute to broader transformative goals.
- Promotion of synergies between different government ministries and agencies, breaking down traditional policy silos (horizontal coordination), and better alignment of local, regional and national policies to ensure coordinated actions across multiple sectors and more efficient resource use (vertical integration).
- Engagement of a wide range of stakeholders, including the private sector, academia, civil society and local communities. This broad engagement is essential for building the shared views and the support needed to drive transformative changes.

Examples of the whole of government approach in different countries are shown in Table 1.

Table 1 | Country examples for whole of government approach

German High-tech Strategy (HTS) 2025	Launched in 2006, HTS 2025 has progressively expanded its scope from a multiyear strategy focused on science and technology to one that includes societal challenges and specific missions. Its governance structures include the German Government's interministerial committee at the more operational level and the round table of state secretaries on the HTS 2025 at the overall policymaking level. The president of the

[12] DG RTD (2023), "Mutual learning exercise on the whole of government approach in research and innovation – First thematic report – Introduction and overview of the whole of government approaches in research and innovation", Publications Office of the European Union, Luxembourg

	Fraunhofer Gesellschaft and the state secretary of the German Federal Ministry of Education and Research co-chair the High Tech Forum, which includes stakeholders from academia, industry and society in a strategic advisory capacity.
Norwegian Research Council Norway (RCN)	RCN is an umbrella agency for all research domains, involving multiple ministries in a coordinating role to translate policy issues into relevant research themes. This is embedded in the governance structure of Norway, where there is no coordinating ministry with a central priority-setting mechanism for R&I. Although RCN offers several benefits for coordination of sector-policy level research, its umbrella role is costly and hard work in terms of coordination. In addition, it is more difficult to introduce new and disruptive initiatives in the absence of a top-level referee.
Swedish Challenge-Driven Innovation Programme	Sweden's Challenge-Driven Innovation (CDI) Programme, managed by Vinnova, supports projects that address societal challenges through broad collaboration across sectors and levels of government. This program is driven by the country's commitment to the 2030 Agenda for Sustainable Development and exemplifies how WGA can be used to align innovation efforts with broader societal goals.

Source: DG RTD, Cavicchi, B. et al. (2023), "The transformative nature of the European framework programme for research and innovation – Analysis of its evolution between 2002–2023", Publications Office of the European Union, Luxembourg.

Challenges and opportunities

Even when a policy portfolio appears coherent and well aligned with the goals of TIP, the realities of implementation often reveal underlying misalignments. These challenges can arise from various mechanisms and interests that were not fully anticipated during the policy design phase. To navigate these challenges, it is essential to design policies with flexibility and adaptability, allowing for adjustments that keep the portfolio aligned with TIP goals over time.

One key challenge is the resistance to change inherent in established institutions. This resistance can lead to selective implementation or slow adoption of new policies. Encouraging dialogue and collaboration among public, private and societal stakeholders can help bridge gaps, reduce resistance and ensure that institutional inertia does not stifle innovation.[13]

Political interests affect policy coherence. Groups close to power may push for changes that would align policies with their agendas, fragmenting the original portfolio during implementation. To avoid this, it is crucial to ensure early institutional and political alignment, securing commitment to transformative goals and managing shifting priorities.

Evaluating the success of TIP initiatives is particularly challenging because of the long-term and systemic nature of the changes involved. Traditional evaluation frameworks fall short in capturing the transformative impacts of these policies. Therefore, investing in monitoring and evaluation systems that are capable of assessing long-term outcomes and systemic shifts, using new indicators and methodologies tailored to the unique demands of TIP, is essential for making informed adjustments to maintain the transformative trajectory.[14]

[13] DG RTD, Cavicchi, B. et al. (2023), "The transformative nature of the European framework programme for research and innovation – Analysis of its evolution between 2002–2023", Publications Office of the European Union, Luxembourg

[14] Idem

Potential role that ETIN can play in addressing challenges for sustainable transformations

ETIN can play a crucial role in addressing these challenges by fostering an environment of open dialogue and peer learning. Through exchanges of experiences, including sharing failures and misalignments encountered during implementation, ETIN allows its members to reflect on real-world challenges and learn from one another. This collaborative approach supports flexible policy experimentation and adaptation, helping members fine-tune their strategies in response to political, institutional, or market pressures. By leveraging peer feedback and expert insights, ETIN facilitates the continuous alignment of policies with transformative innovation goals, ensuring long-term, systemic change while navigating shifting priorities and institutional inertia.

Source: UNECE.

3.3 Governance at the subnational level: Innovation for place-based transformation

Karel Haegeman, Scientific Policy Officer, JRC, European Commission

Why do we subnational governance for complex challenges?

Addressing such complex challenges as biodiversity loss and rising inequalities requires different tools, mindsets and approaches to the ones traditionally used. Focusing on one is no longer sufficient, and understanding these problems' interlinkages and feedback effects is essential. Innovation alone cannot help tackle such problems or achieve the transformations needed. Policies must satisfy two important prerequisites:

Place-based: Places around the world are affected differently by global challenges, requiring a territorial translation into specific opportunities and solutions, drawing on territorial strengths, weaknesses and ambitions; this also means that local and regional stakeholders, including individuals, businesses, knowledge institutions and local authorities, must be meaningfully involved.	**Transformative**: Policy must strive for system-level innovation to enable and accelerate the required transformations. Interterritorial collaboration, network governance and coordinated policy and action mixes enable efforts at local, regional and national levels that achieve long-term societal well-being and climate-resilient development (IPCC, 2023).[15] Building partnerships is therefore not only a desired objective, but also a prerequisite to move towards societal well-being. Stated differently, it is not just about budget sizes and policies, but also the way they are spent and coordinated.

A new approach to subnational public governance: six key dimensions

Building on a pilot co-creation exercise with 74 territories, JRC developed a new approach to public governance, centered on six dimensions (Figure 1). These may not provide all the

[15] IPCC (2023), "Climate change 2023: Synthesis report. Contribution of working groups I, II and III to the sixth assessment report of the intergovernmental panel on climate change" [Core Writing Team, H. Lee and J. Romero (eds.)], IPCC, Geneva, pp. 35–115

answers, but may enable users to find them together, through partnerships. The six dimensions and their activities are modular and can be initiated separately depending on the specific goal.

Orchestration at the heart

Orchestration is the process of considering how we can identify and take on board all relevant powers to make change happen. The main aspects of orchestrating include agreeing on how to increase ownership of the transformation required and setting up tailored governance structures. Investment in effective orchestration makes it possible to increase the power to act, widens the scope of policies beyond innovation policies (including supply- and demand-side policies), diversifies budgets that can be leveraged and accelerates place-based transformation. It involves vertical and horizontal coordination, interterritorial coordination and setting of the agenda to drive this coordination. Building ownership and trust is essential to incentivize others to act on (and invest in) the collective transformation agenda. As trust builds, continued investment in orchestration is critical.

Figure 1 | Six dimensions for place-based transformation

Source: Bianchi, G. et al. (2024), "Innovation for place-based transformations. ACTIONbook to build partnerships for fair green and digital transitions", Publications Office of the European Union, Luxembourg, JRC135826.

Challenges and opportunities

The approach sets the overall agenda for a new way of conducting public governance, based on initial experimentation. [16] Scaling up practices and advancing knowledge on implementation of all dimensions and activities in different contexts is very much needed and requires a collective effort. Territories across the European Union and around the globe are invited to experiment and share experiences and learnings, while helping address the urgent societal issues at hand.

[16] JRC, Erdős, K. et al. (2023), "The square – Putting place-based innovation policy for sustainability at the centre of policymaking", Serger, S., Soete, L. and Stierna, J. (eds), Publications Office of the European Union, Luxembourg

3.4 Exploring the potential of platforms for transformation towards the circular economy

Immanuela Badde, Associate Economic Affairs Officer, Transformative Innovation Network (ETIN), Economic Cooperation and Trade, UNECE

What is the circular economy?

One prominent example of sustainable transformations is the transition towards the circular economy, featured in policy measures such as the EU Green Deal.[17] The processes and activities required to facilitate and accelerate this transition present new challenges and dynamics that necessitate a shift away from traditional, linear "take-make-dispose" models and towards more circular and sustainable production and consumption patterns across global value chains. To enable these transformations, innovation must target the essential activities, dynamics and behavioral changes required for scaling circular economy initiatives and accelerating socio-technical transformation.[18]

While awareness of and level of ambition for the circular economy transition are increasing, progress has been scarce as falling resource use per unit of output has been dwarfed by economic growth and poverty reduction –by some measures circularity overall is decreasing.[19] What is needed is policy experimentation to enable and encourage innovation around market creation and stimulation, business models, and ideas for turning physical products into services through platform intermediation or full replacement with, for instance, digital applications – already, smart phones have replaced almost fully the need for everything from newspapers, calendars, tickets, and alarm clocks to televisions.

Although new technologies for the circular economy are emerging, the markets for many secondary raw materials are underperforming, for several reasons: pricing challenges, supply stability, small market size, and lack of trust, information and monitoring. This calls for new activities and processes to strengthen and scale circular marketplaces that can facilitate the reuse, refurbishment and recycling of materials, extending their life cycle and minimizing their environmental impact.[20] Moreover, moving away from linearity raises new questions regarding the very process of innovation, calling also for new types of processes and coordination.

How can we enable coordination? The potential role of platform intermediations and circular platforms

While there are various potential coordinators for these transformations, one that stands out is the largely unexplored potential of the market itself. Markets can efficiently connect various stakeholders (e.g. producers, recyclers, consumers) and aggregate supply and demand, thereby reducing transaction costs and uncertainty and enhancing resource recovery.[21] They can also foster price discovery, which, in turn, can encourage investments in circular activities.[22] Through these processes, they not only mitigate the depletion of natural resources, but also drive innovation and growth by promoting new business

[17] European Commission (2024), "The European Green Deal", available at https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal_en
[18] EEA (2023), "Accelerating the circular economy in Europe. State and outlook 2024", EEA report 13/2023, Publications Office of the European Union, Luxembourg
[19] Circle Economy Foundation (2024), "The circularity gap report 2024"
[20] Lingaitiene, O. and Burinskiene, A. (2024), "Development of trade in recyclable raw materials: Transition to a circular economy", Economies, 12(2), 48
[21] Geissdoerfer, M. et al. (2017), "The circular economy – A new sustainability paradigm?", Journal of Cleaner Production, 143, 757–768
[22] Stahel, W. (2016), "The circular economy", Nature, 531(7595), 435–438

opportunities, including in the remanufacturing and recycling sectors. Looking to the market as a coordinator, leveraged by governments through market shaping, shines a new light on how we regard innovation, even creating new types of innovation models, whereby innovation takes place in a more distributed and decentralized manner.

Digital platforms demonstrate significant potential in facilitating the coordination of these new processes for circular marketplaces. [23] One of the main advantages of digital platforms as a business model is that they can address several challenges in the circular transformation process: (1) accelerating the scaling up of activities, (2) strengthening disruption and crisis resilience, and (3) incorporating the demand side to a much larger extent than traditional companies.[24] This is achieved by aligning supply and demand; connecting and coordinating various stakeholders along the value chain; enabling the efficient exchange of information, products and services; and establishing the essential digital infrastructure for ensuring transparency and traceability.[25] Some also foster the sharing economy, promoting product-as-a-service models. It is these characteristics that have led to the success of various online platforms, such as Amazon, Alibaba, Airbnb and Uber. However, many of these platforms still support linear value chains, and more needs to be done to explore their potential in facilitating circularity.

Circular platforms play a crucial role in establishing competitive marketplaces for material reuse, recycling and recovery. They promote sustainable practices and efficient resource use, driving innovation and fostering growth in the business sector. [26] Unlike many other stakeholders, circular platforms excel in connecting suppliers, buyers and consumers of secondary materials, second-hand goods and refurbished products, facilitating the commodification of excess capacity. Circular platforms can also help reach policy targets, for example, as outlined in the Extended Producer Responsibility (EPR) regulations.[27] They can also more easily reach consumers who are paying more attention to the environmental sustainability of their purchases.[28]

Challenges and opportunities

Scaling circular platforms presents various opportunities and challenges that need to be addressed. Opportunities include rapid technological innovations, including advances in blockchain, the Internet of Things, machine learning and artificial intelligence (AI), that transform our capacity to monitor, trace and optimize the use of resources. This can help circular platforms scale across global supply chains, further optimizing resource use and

[23] UNECE (2021), "Building back better: using platforms to enable sharing and progress towards the circular economy", 14th Session of the Committee on Innovation, Competitiveness and Public-Private Partnerships, ECE/CECI/2021/4; Innovation Matters Episode 1, "Platform economy – revolutionizing how we produce, consume and progress towards a circular economy". https://unece.org/eci/icp/innovation-matters-podcast#accordion_0; IPO Discussion Series – Innovation in Eastern Europe and South Caucasus - Episode 2 – "Tomorrow 3.0: How the platform economy can transform the world with Prof Michael Munger". https://www.youtube.com/watch?v=namSFvpJp2k&t=1s.

[24] Evans, P. (2023), "Seminar on platforms, circular economy, and transformative innovation: A cross-industry comparison", ETIN Seminar, available at https://unece.org/sites/default/files/2023-03/Presentation%20Peter%20Evans.pdf

[25] Munger, M. (2020), "The platform economy --An essential avenue towards sustainable production & consumption? --The circular economy transition?", UNECE Seminar, available at https://unece.org/fileadmin/DAM/ceci/documents/2020/TOS-ICP/Presentations/UN_Presentation_Michael_Munger_Platform_economy.pdf.

[26] Evans, P. (2023), "Circular platforms: Findings from a multi-client study", McFadyen Digital, available at https://content.mcfadyen.com/circular-platforms-survey-pdf

[27] European Union (2022), "Parliamentary question | Implementation of the extended producer responsibility scheme by Member States", E-000123/2022, European Parliament, available at https://www.europarl.europa.eu/doceo/document/E-9-2022-000123_EN.html

[28] Statista (2023), "Evolution of sustainable shopping worldwide 2022", available at https://www.statista.com/statistics/1377869/global-shift-to-buying-sustainable-products/

tracing, and supporting exchanges across borders. One main challenge is the type of support that circular platforms will need to facilitate their scaling – a question that is currently being explored by the ETIN Task Force on Circular Platforms for Transformation. This challenge raises several questions concerning what the role the State should play; what types of policies, standards and actions encourage expansion; and what effects are likely on consumer behaviour.

4 Experimentation and learning to navigate the complexities and uncertainties in sustainable transformations

Main Messages

Transformative innovation policy embraces experimentation and strategic learning as essential tools to address complex societal and environmental challenges, **shifting away from rigid, predictive methods toward adaptive, iterative processes**.

TIP experimentation involves controlled, Darwinian, and generative approaches, each offering different ways to test, refine, and scale innovations by embracing uncertainty and learning from outcomes.

Strategic learning in TIP integrates real-time feedback, monitoring, and multi-level governance, helping **align diverse actors and experiments with broader goals, ensuring interventions remain adaptive and context-specific**.

Effective TIP requires a culture of **continuous discovery, collective sensemaking, and strategic directionality**, where stakeholders not only improve practices but also challenge assumptions and adapt to emergent opportunities.

Source: UNECE.

4.1 Introduction to experimentation and learning

Victoria Shaw, Programme Director, Transformative Innovation Policy Consortium (TIPC) and University of Sussex Business School

With thanks to Bipashyee Ghosh, University College London, and Ed Steinmueller, University of Sussex Science Policy Research Unit for contributions, via narratives adapted from the TIP Resource Lab (www.tipresourcelab.net)

Transformative innovation policy (TIP) recognizes that current social practices and technologies are inadequate for fostering a sustainable and socially just future. To redirect socio-technical systems toward these goals requires a different approach, one that embraces experimentation and sees TIP not as simply a matter of planning, design and implementation – but as a process of continuous discovery, experimentation, strategic learning, dialogue, and gradual improvement.

The term "experimentation" is often used to refer to a method of investigation in a controlled environment that offers proven, reproducible results. Yet, experiments in social and policy settings often require a more iterative approach that adapts to the complex nature of change.

Therefore, in TIP, the term may be used to capture a broader ethos of exploration,[29] one that demands a shift in culture and mindset: to approach challenges with curiosity, to embrace uncertainty and to see failure as a chance to surface new learning.

Experimentation and learning within TIP is context-specific and evolves. It requires a step-by-step approach to trying out alternatives and navigating the changes that result from them. Although TIP experiments may in principle target an entire socio-technical system, they often take place at the policy, project or programme level.[30] A formative approach to evaluation is useful,[31] making it possible to take stock of any shifts in a system that result from an intervention and then plan the next move accordingly. The approach is akin to exploring a forest of options, where each step uncovers viable paths and unforeseen obstacles.

TIP experimentation incorporates methods for learning and reflexivity that help define pathways to transformative change and surface the rules driving an unsustainable way of doing things – not only regulation, but also values, norms and habits that direct users of a system towards choices and action. Crucially, TIP experimentation and learning empowers participants to be agents of change, not merely subjects, ensuring that they actively contribute to and shape transformative outcomes.[32]

The contributions in this chapter (1) expand further on the nature of experimentation for policy interventions and (2) introduce the concept of strategic learning for transformative innovation, developed by the ETIN Task Force on Strategic Learning, which describes different types of learning that need to be incorporated into strategy processes to ensure that experiments are oriented to agreed directionality and can be effectively coordinated.

4.2 Experimentation and strategic learning in transformative innovation policy

Kjell-Håkan Närfelt, Chair of UNECE Team of Specialists on Innovation and Competitiveness Policies (ToS-ICP), Chief Strategy Officer, Vinnova

Why do we need experimentation?

TIP tries to address our most pressing societal and environmental challenges by intentionally incentivizing and supporting innovation development that contributes to solving these challenges.

One of the most difficult aspects of implementing TIP is mobilizing and coordinating time, money and other resources from different actors in society in solving societal and environmental challenges. This difficulty arises from several uncertainties and risks associated with transformative innovation that create barriers to transformative innovation efforts:

- Will the technologies that the solution relies on work?

[29] Schot, J., Kivimaa, P. and Torrens, J. (2019), "Transforming experimentation: Experimental policy engagements and their transformative outcomes", Transformative Innovation Policy Resource Lab, available at https://tipresourcelab.net/resource/transforming-experimentation-experimental-policy-engagements-and-their-transformative-outcomes/

[30] Bernal Hernandez, P. et al. (2022), "Tool: Articulating an initiative as a TIP experiment", Transformative Innovation Policy Resource Lab, available at https://tipresourcelab.net/resource/tool-articulating-an-initiative-as-a-tip-experiment/

[31] Molas-Gallart, J. et al. (2021), "A formative approach to the evaluation of Transformative Innovation Policies", Research Evaluation, 30(4), 431–442

[32] Ghosh, B. et al. (2021), "Transformative outcomes: assessing and reorienting experimentation with transformative innovation policy", Science and Public Policy, 48(5), 739–756

- Is the solution technically feasible?
- Will investors and funding organizations supply necessary resources for the development and scaling of the solution?
- Will the market or customers appreciate and adopt the solution?
- Is the solution scalable?
- Are the ecosystem and framework conditions sufficiently supportive of the implementation and scaling of the solution?

These and related questions cannot be answered by traditional predictive, rational, measurable and controllable approaches. An illustration and analysis of the barriers in the case of funding solutions for addressing climate challenges points out that probabilities of different outcomes are impossible to calculate because of the radical uncertainty about how policy interventions will affect different developments.[33] The cause of this uncertainty is the complex adaptive nature of markets and societies, where individual and organizational interactions create non-linear system behaviour and emergent system properties that makes reductionistic and predictive approaches inappropriate.

Hence, there is a need for different approaches to design, implementation and evaluation of policy interventions. Experimentation is one approach that seems promising to manage the uncertainties and complexity associated with transformative innovation.

What is experimentation and what does it imply in terms of policy interventions?

Experimentation is usually associated with scientific procedures to discover or understand what happens to something under certain controlled conditions. In this context it denotes a broader way of acting to understand or learn what a given action leads to. Table 2 defines three type of experiments, based on three experimentation logics.[34]

Table 2 | Types of experimentation

Type/Logic	Description [a]	Examples
Controlled	An experimental strategy in which the experimenter tries to control the environment and isolate relevant factors believed to cause a given effect or needed to validate a given hypothesis. The concept of "control" and "treatment" groups – i.e. counterfactual approaches – is part of this type of experimentation. Randomization is often used to prevent bias, both from the experimenter and from unknown factors. This strategy is closely associated with scientific discovery.	Randomized controlled trials [b]
Darwinian	An experimental strategy in which the experimenter uses a set of experiments to, for example, find factors or solutions that are successful. The experiments are supposed to test different ways to succeed, and the strategy is used when controlled circumstances are difficult to set and it is easier to create a variety of experiments that will pave the way for success. This strategy is closely associated with portfolio management, which deals with high risks and genuine uncertainty regarding outcomes.	Venture capital investment portfolio strategies [c]
Generative	An experimental strategy in which the experimenter iteratively generates solution concepts that are tested on customers or users and, based on feedback, fine-tunes the solution or redefines it. This strategy is closely associated with entrepreneurial discovery.	Effectuation [d] Customer development process [e]

Source: [a] Ansell, C. and Bartenberger, M. (2016), "Varieties of experimentation", Ecological Economics 130, 64–73.

[b] Edovald, T. and Firpo, T. (2016), "Running randomised controlled trials in innovation, entrepreneurship and growth: An introductory guide", Nesta/Innovation Growth Lab.

[33] Chenet, H., Ryan-Collins, J. and van Lerven, F. (2021), "Financing, climate-change and radical uncertainty: Towards a precautionary approach to financial policy", Ecological Economics, 183, 106957

[34] Ansell, C. and Bartenberger, M. (2016), "Varieties of experimentation", Ecological Economics, 130, 64–73

[c] Nanda, R. and Rhodes-Kropf, M. (2015), "Financing entrepreneurial experimentation", NBER Working Paper 21278.

[d] Sarasvathy, S (2008), "Effectuation: Elements of entrepreneurial expertise", Edward Elgar Publishing.

[e] Blank, S. (2020), "The four steps to the Epiphany: Successful strategies for products that win", Wiley.

Transformative innovation policy should promote, support, incentivize and use all three logics depending on the circumstances associated with a certain hypothesis to be validated or a desired outcome to be achieved. Experimentation also implies new ways of designing, implementing and evaluating interventions.

Learning what works and does not work, based on experimentation, becomes a key aspect of the design and implementation of interventions. Hence, monitoring and evaluation must be performed in real time to guide design decisions and coordinate actors and resources towards the desired future.

4.3 Strategic learning for transformative innovation

Leonard Kelleher, Research Associate, Institute for Manufacturing, University of Cambridge

Why is learning important for transformative innovation?

Learning is recognized as being important for transformative innovation. However, there is now growing concern that the potential of TIP is not being fully realized because public sector organizations (PSOs) have not adopted the types of learning necessary for their implementation. [35] To address this issue, the ETIN Task Force on Strategic Learning introduce "strategic learning", describing key learning processes that enable interventions in the experimentation, coordination and governance, and directionality orientation stages of the strategy process that are critical for realizing TIP potential.

Learning processes for experimentation (policy implementation)

Section 4.2 described two types of experiments useful for encouraging innovation in complex systems: Darwinian and generative. [36] Darwinian experimentation focuses on increasing the frequency of experiments within a portfolio or system of experimentation. The assumption is that by "letting a thousand flowers bloom" through many experiments (i.e. increasing variation) and evaluating which are most promising through trial-and-error learning, successful adaptions to changing environments are more likely to emerge. This approach underpins agent-based modelling, part of the European Union's approach to TIP design. [37] Generative experimentation focuses on generating a solution to address a particular problem within a single experiment and refining the solution through learning by doing.

Learning processes for policy coordination and governance

Darwinian experimentation aims to discover successful experiments from a portfolio of trials conducted in parallel to achieve broad framework goals. These are monitored using real-time learning by monitoring, [38] with information pooled and fed back to inform subsequent experiments through system- and policy-level collective learning. This type of approach

[35] Kattel, R. and Mazzucato, M. (2023), "Mission-oriented innovation policies in Europe: From normative to epistemic turn?", Working Paper 2023-09, UCL IIPP

[36] Ansell, C. and Bartenberger, M. (2016), "Varieties of experimentation", Ecological Economics 130, 64–73

[37] Palmer, E. and Cavicchi, B. (2023), "System-based methods for research & innovation policy – How can they contribute to designing R&I policy for transitions?", Publications Office of the European Union, Luxembourg

[38] Sabel, C. (1994), "Learning by monitoring: The institutions of economic development". In: Handbook of Economic Sociology, pp. 137–165, Princeton University Press/Russell Sage Foundation

underpins "experimentalist governance" [39] used in the mission-oriented innovation approach.[40]

Generative experimentation emphasizes social learning between stakeholders, to jointly iterate solutions in real time in the face of uncertainty.[41] This is consistent with the "adaptive governance" recommended in the European Union's approach to TIP experimentation.[42]

System thinking methods can be used in either governance approach to better understand system dynamics (see section 5.2).

Learning processes for directionality

The incorporation of directionality is necessary to make both Darwinian and generative experimentation transformative. Regarding the former, within the mission-oriented innovation approach, explicitly defining a direction is regarded as crucial to align multiple experimental activities and crowd in willing actors towards a collective goal.[43] Sensegiving and sensemaking mechanisms, including co-created visions, problem definitions, framings, narratives and socio-technical imaginaries (i.e. collectively embraced visions of preferable futures), can be used for this purpose.[44]

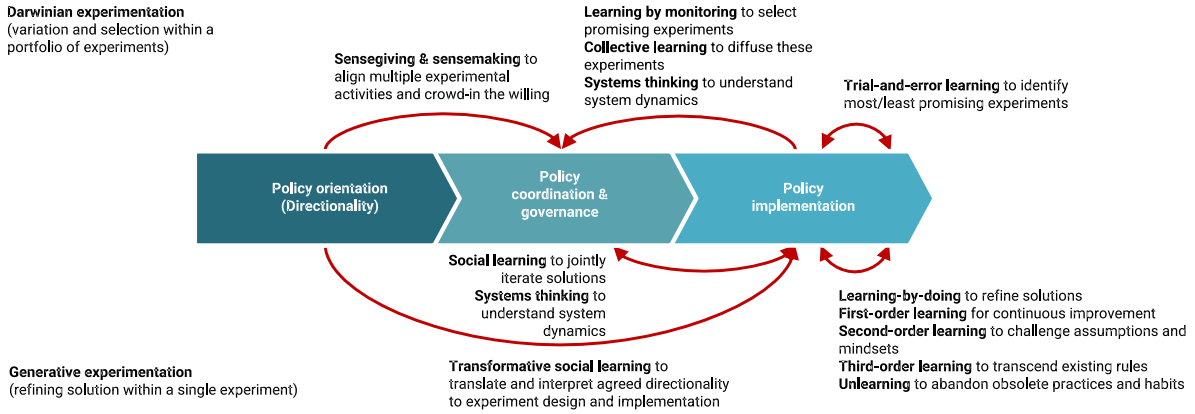
Transformative social learning is regarded as important for translating agreed directionality to the design and implementation of generative experiments.[45] Intended learning outputs include not only first-order learning to enable continuous improvement, but also second-order learning to encourage stakeholders to question assumptions, interpretative frames and mindsets, as well as unlearning to abandon obsolete practices and habits.[46] Third-order learning, enabling transcendence of rules, is also emphasized.[47]

Challenges and opportunities

These learning processes present an opportunity for transformative innovation in that they act as feedback and feedforward mechanisms throughout the strategy process (**Figure 2**). They can enable strategic interventions in public policy, where aspirations and capabilities are realigned to achieve goals in given contexts, and thereby help realize the potential of TIP.

[39] Sabel, C. and Zeitlin, J. (2012), "Experimentalism in the EU: Common ground and persistent differences", Regulation & Governance, 6(3), 410–426.
[40] Mazzucato, M. (2024), "Governing the economics of the common good: from correcting market failures to shaping collective goals", Journal of Economic Policy Reform, 27(1), 1–24
[41] Folke, C. et al. (2005), "Adaptive governance of social-ecological systems", Annual Review of Environment and Resources, 30(1), 441–473
[42] DG RTD (2023), "Experimenting with transformative innovation policy – Theoretical and practical perspectives", Publications Office of the European Union, Luxembourg
[43] Mazzucato, M. (2024), "Governing the economics of the common good: from correcting market failures to shaping collective goals", Journal of Economic Policy Reform, 27(1), 1–24
[44] Allen, C. and Malekpour, S. (2023), "Unlocking and accelerating transformations to the SDGs: A review of existing knowledge", Sustainability Science, 18, 1939–1960
[45] Boni, S., Velasco, D. and Tau, M. (2021), "The role of transformative innovation for SDGs localisation. Insights from the South-African 'Living Catchments Project'", Journal of Human Development and Capabilities, 22(4), 737–747
[46] Ghosh, B. et al. (2021), "Transformative outcomes: assessing and reorienting experimentation with transformative innovation policy", Science and Public Policy, 48, 739–756
[47] Fazey, I. et al. (2018), "Ten essentials for action-oriented and second order energy transitions, transformations and climate change research", Energy Research & Social Science, 40, 54–70

Figure 2 | Strategic learning for transformative innovation



Source: ETIN Task Force on Strategic Learning.

One challenge is that policy implementation and design cannot be considered in isolation, as can be the case in traditional 'set-and-forget' policy approaches. This is because the different outputs and outcomes realized from both design and implementation cannot all be anticipated beforehand, owing to the complex adaptive properties of systems. Rather, design and implementation must be integrated within a fluid strategy process enabled by these learning processes. This can include ex ante evaluation to inform design, formative evaluation to adjust and improve ongoing experiments, and ex post evaluation to appraise outcomes.[48]

[48] Wise, E. and Arnold, E. (2022), "Evaluating transformation – what can we learn from the literature?", No. 2022/01, CIRCLE-Centre for Innovation Research, Lund University

5 Capacitation will be essential to building the right skills, institutions and processes for innovation-led transformations

Leonard Kelleher, Research Associate, Institute for Manufacturing, University of Cambridge

Main Messages

Transformative capacity in Public Sector Organizations (PSOs) is built on **roles, resources, and skills that enable them to lead systemic changes by disrupting or reshaping existing institutions**.

Capacitation efforts are essential to address skills gaps within PSOs, equipping them with **dynamic capabilities for agility and capacities for long-term stability**, which are vital for innovation-based transformations.

The **EU approach emphasizes system-based methods and experimental approaches** to build PSO capacities, focusing on skills like foresight, system thinking, and multi-actor governance.

Innovation-enhancing procurement (IEP) highlights how PSOs can leverage procurement to co-develop solutions, but effective capacitation requires overcoming institutional resistance and integrating new learning processes into daily practices.

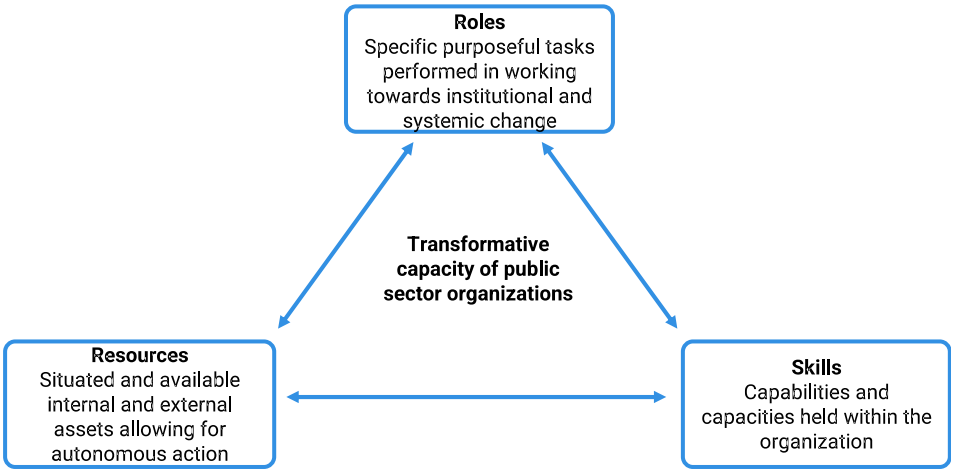
Source: UNECE.

5.1 Introduction to capacitation for sustainable transformations

The transformative capacity of a PSO refers to its potential to lead and trigger institutional, system-wide transformation, moving away from the status quo.[49] It consists of three core elements: the roles played by the PSO in maintaining, creating or disrupting system institutions; the internal and external resources available to the PSO; and the skills (analytical, operational, coordination, learning and reflection) that the PSO can apply (**Figure 3**).

[49] Borrás, S. et al. (2023), "The transformative capacity of public sector organizations in sustainability transitions: A conceptualization", No. 2023/2, CIRCLE-Centre for Innovation Research, Lund University

Figure 3 | PSO transformative capacity



Source: Adapted from Borrás, S. et al. (2023), "The transformative capacity of public sector organizations in sustainability transitions: A conceptualization", No. 2023/2, CIRCLE-Centre for Innovation Research, Lund University.

Without effective capacitation efforts, PSOs cannot be expected to drive transformative innovation. The types of skills necessary to enhance transformative capacity and how to build them are currently the focus of significant attention.

In this chapter, we highlight insights into capacitation for innovation-based transformation, with a focus on (1) the EU approach and (2) practical experiences with capacitation in the case of innovation-enhancing public procurement, developed by the ETIN Task Force on Innovation-Enhancing Procurement.

5.2 The EU approach to capacitation for innovation-based transformation

Leonard Kelleher, Research Associate, Institute for Manufacturing, University of Cambridge, Bianca Cavicchi, Policy Officer, DG RTD, European Commission and Igor Oliveira, Independent Consultant

Why do we need capacitation?

Recent evidence highlights that significant skills gaps exist in PSOs, constraining many mission-oriented policies to business-as-usual or incremental changes in practices.[50] This highlights the need for capacitation to build both capacities and capabilities that can enhance the overall transformative capacity of a PSO .

Capacities typically refer to abilities to design and implement effective policy offering long-term stability, including political, analytical and operational competencies at individual, organizational and system levels.[51] A number of capacities for transformative system innovation have recently been defined (Table 3).[52]

[50] Kattel, R. and Mazzucato, M. (2023), "Mission-oriented innovation policies in Europe: From normative to epistemic turn?", Working Paper 2023-09, UCL IIPP
[51] Wu, X., Howlett, M. and Ramesh, M. (2018), "Policy capacity and governance. Assessing governmental competences and capabilities in theory and practice", Springer
[52] Laranja, M. and Pinto, H. (2024), "Capacities for transformative social systems innovation: A tentative framework for public policies", Atlantic Social Lab and Centro de Estudos Sociais: Coimbra

Table 3 | Capacities and dynamic capabilities

Capacities	**Landscape reading capacity** to interpret long-term trends, spot emerging gaps and jointly develop change visions using foresight, road-mapping and scenario planning
	System awareness and thinking capacity to perceive and understand system dynamics, boundaries, power networks and rules; test scenarios using system dynamics, systems mapping, causal loops or agent-based modelling; and respond to unforeseen effects of change
	Unlocking capacity to destabilize or phase out regimes that create lock-in, through mediating, undermining vested interests, reducing political and financial support, or penalizing unsustainable regimes, and to mobilize critical mass for change through forming partnerships, clustering niches or brokering information
	Discovery and experimentation capacity to search for, discover, experiment with and diffuse alternative ways of thinking, organizing, producing and consuming. This includes defining new pathways for transformative change, providing spaces and resources for experimentation, prototyping and testing, and knowledge brokerage
	Recombination and structuring capacity to diffuse and replicate promising experiments and halt those showing little promise, e.g. by aggregating small initiatives into larger coalitions and institutionalizing new regimes
	Relational governance capacity to coordinate or steer multi-actor governance processes, promote synergies and trade-offs, and minimize conflict through communication, facilitation, mediation, negotiation, expectations management and tentative governance arrangements
	Individual capacity to engage in system-level change processes, including open-mindedness, empathy, system awareness, imagination, storytelling and reflection
Dynamic capabilities	**Sense-making routines** for gathering, analysing and assessing information to facilitate new learning and evaluation
	Connecting routines for enabling new networks and coalitions of internal/external stakeholders to be built
	Shaping routines for designing and implementing new directionality for an organization or policy area, or embedding and mainstreaming new solutions into existing capacities

Source: Adapted from Kattel, R. (2022), "Dynamic capabilities of the public sector: Towards a new synthesis", Working Paper 2022-07, UCL IIPP and Laranja, M. and Pinto, H. (2024), "Capacities for transformative social systems innovation: A tentative framework for public policies", Atlantic Social Lab and Centro de Estudos Sociais: Coimbra.

Capabilities are patterns of learning, adaptation and experimentation necessary for agility, be it to enable PSOs to act as innovator or change agent itself,[53] or to empower localized change agency to enable people to be or do what they value.[54]

Both concepts are seen as necessary within the mission-oriented innovation approach, in which State capacities for long-term stability and dynamic capabilities for short-term agility are currently being explored.[55]

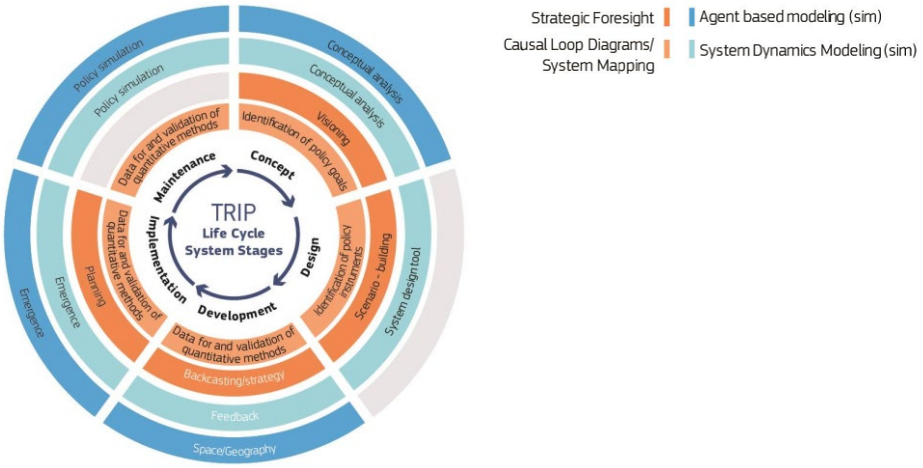
The EU approach to capacitation

In 2023, DG RTD published the results of a study that articulates how to support capacitation efforts in the TIP life cycle. It emphasizes in particular a range of system-based and

[53] Breznitz, D., Ornston, D. and Samford, S. (2018), "Mission critical: the ends, means, and design of innovation agencies", Industrial and Corporate Change, 27(5), 883–896
[54] Boni, S., Velasco, D. and Tau, M. (2021), "The role of transformative innovation for SDGs localisation. Insights from the South-African 'Living Catchments Project'", Journal of Human Development and Capabilities, 22(4), 737–747
[55] Kattel, R. (2022), "Dynamic capabilities of the public sector: Towards a new synthesis", Working Paper 2022-07, UCL IIPP

experimental approaches through which many of the above-mentioned capacities can be exercised (Figure 4).[56,57]

Figure 4 | System methods addressing complexity in the transformative innovation policy life cycle



Source: Palmer, E. and Cavicchi, B. (2023), "System-based methods for research & innovation policy – How can they contribute to designing R&I policy for transitions?", Publications Office of the European Union, Luxembourg and DG RTD (2023), "Experimenting with transformative innovation policy – Theoretical and practical perspectives", Publications Office of the European Union, Luxembourg.

Challenges and opportunities

The identification of key capacities and capabilities represents an opportunity to enhance overall PSO transformative capacity. However, a key challenge concerns how these can be developed. Learning-by-doing within networks and communities of practice may be useful to build capacities.[58] But dynamic capabilities may be more difficult to imitate or substitute because they consist of complex combinations of simpler routines.[59]

5.3 Capacitation in practice – Innovation-enhancing procurement

Lina Svensberg, Innovation Manager, Compare Foundation/DigitalWell Arena, Jakob Lindvall, Founder and CEO, ALDAB Innovation/DigitalWell Arena, Leonard Kelleher, Research Associate, Institute for Manufacturing, University of Cambridge

Why is public procurement important for transformations?

TIP emphasizes the role of PSOs in creating public value by developing and co-shaping markets in line with public purpose.[60] Public procurement, accounting for 14 per cent of the

[56] Palmer, E. and Cavicchi, B. (2023), "System-based methods for research & innovation policy – How can they contribute to designing R&I policy for transitions?", Publications Office of the European Union, Luxembourg
[57] DG RTD (2023), "Experimenting with transformative innovation policy – Theoretical and practical perspectives", Publications Office of the European Union, Luxembourg
[58] Laranja, M., and Reimeris, R. (2024) "Discovery-oriented innovation and industrial policies: insights from five regions about open discovery processes", EUR 31983 EN, Publications Office of the European Union, Luxembourg, JRC138135
[59] Pavlou, P., and El Sawy, O. (2011) "Understanding the elusive black box of dynamic capabilities", Decision Sciences, 42(1), 239-273
[60] Mazzucato, M. and Ryan-Collins, J. (2022), "Putting value creation back into 'public value': from market-fixing to market-shaping", Journal of Economic Policy Reform, 25(4), 345–360

gross domestic product (GDP) of the European Union,[61] holds massive potential to give directionality to innovation in response to public missions.

One approach to realize this potential is through innovation-enhancing procurement (IEP).[62] Public procurers can play multiple roles in the deployment of IEP – i.e. R&D purchaser, lead-user, catalyst, broker – to support private providers in co-developing new or upgraded solutions to meet public needs and to shape markets to facilitate the scaling of these solutions to maximize public value.

Capacitation for IEP

Capacity-building in IEP is essential to tap into the power of public procurement because innovation and procurement operate on fundamentally different principles.[63] Innovation navigates uncertainty, whereas procurement assesses purchases against predefined criteria. Experiences in IEP capacitation suggest that PSOs typically respond to this tension by adapting innovation frameworks to fit procurement processes. This can inadvertently constrain the capacity to respond to public missions for which no solutions exist in the market and therefore can undermine the potential of public procurement and the public value it can bring to society.

To facilitate capacitation efforts, a range of PSO capabilities have been identified along a four-phase IEP cycle. The cycle begins with (1) clarification of unmet needs and missing solutions and moves through (2) development of a procurement strategy, (3) execution of the procurement process and (4) use of learnings for future procurement.[64] These capabilities were categorized as ordinary ("doing things right"), dynamic ("doing the right things") and functional ("doing the right things right" to address the functional challenges of IEP). Once the capabilities are identified, the next step is to understand how they can be effectively built within PSOs.

Challenges and opportunities

Here, experiences of the ETIN IEP Task Force indicate that capacitation efforts face a number of challenges. First, public sector workers can be reluctant to engage in transformative innovation efforts or can face significant impediments when they attempt to do so.[65,66] Evidence suggests that the development of dynamic capabilities in PSOs, in particular, may require prerequisites such as the availability of a critical mass of motivated and talented people wanting to work for the PSO, high-level political support and legitimization, and internal dissatisfaction with existing ways of working.[67] These prerequisites suggest the need for a broader approach to capacitation, one that incorporates capabilities necessary to manage institutional resistance to change and to continually renew ways of working.

Second, recent evidence suggests that "mission washing" is prevalent as PSOs implement mission-oriented innovation policies through existing institutions and policy schemes,

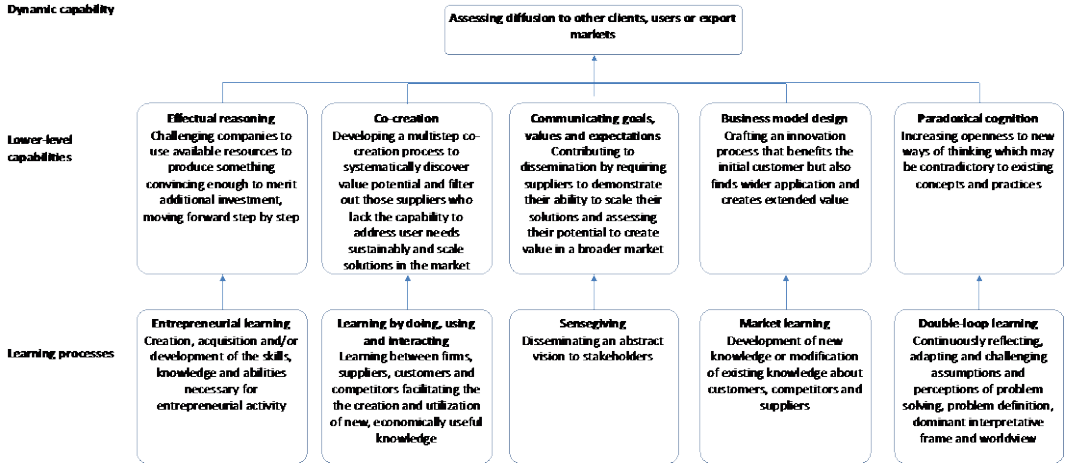
[61] European Commission (2024), "Public procurement", available at https://single-market-economy.ec.europa.eu/single-market/public-procurement_en
[62] UNECE (2021), "Building back better: using platforms to enable sharing and progress towards the circular economy", 14th Session of the Committee on Innovation, Competitiveness and Public-Private Partnerships, ECE/CECI/2021/4
[63] Edquist, C. et al. (2018), "Mutual Learning Exercise: MLE on innovation-related procurement", Report for DG RTD, Publications Office of the European Union, Luxembourg
[64] Grimbert, S., Zabala-Iturriagagoitia, J and Valovirta, V. (2024),"Transformative public procurement for innovation: Ordinary, dynamic and functional capabilities", Public Management Review, 1–24
[65] Braams, R. et al. (2022), "Understanding why civil servants are reluctant to carry out transition tasks", Science & Public Policy, 49, 905–914
[66] Braams, R. et al. (2024), "Civil servant tactics for realizing transition tasks: understanding the microdynamics of transformative government", Public Administration, 102(2), 500–518
[67] Kattel, R. and Takala, V. (2024), "Dynamic capabilities in the public sector: The case of the UK's Government Digital Service", UCL IIPP Working Paper 2021/01

expecting transformative outcomes without incorporating new ways of working and knowing.[68] This highlights the importance of different learning processes to support IEP and the need to develop capabilities that deliberately facilitate these learning processes.

Third, dynamic capabilities are known to be difficult to imitate or substitute because they are made up of complex combinations of resources and lower-order capabilities.[69] The building and (re)configuring of these lower-order capabilities is an important strategic consideration for PSOs that may determine the success of IEP efforts.

The ETIN IEP Task Force is currently exploring an approach that may address these challenges. Based on capacitation experiences outlined in our handbook for policymakers,[70] we have distilled the lower-order capabilities and learning processes that underpin one specific dynamic capability – assessing innovation diffusion to other clients, users or export markets – the lack of which inhibits scalability (Figure 5).

Figure 5 | IEP dynamic and lower-order capabilities



Source: ETIN IEP Task Force.

By focusing capacitation efforts on a broad set of lower-level capabilities and associated learning processes, the ambition is that this approach may eventually lead to the institutionalization of IEP so that it becomes the "business as usual" of PSOs, rather than the exception.

[68] Kattel, R. and Mazzucato, M. (2023), "Mission-oriented innovation policies in Europe: From normative to epistemic turn?", UCL IIPP Working Paper 2023-09
[69] Teece, D. (2007), "Explicating dynamic capabilities: the nature and microfoundations of (sustainable) enterprise performance", Strategic Management Journal, 28, 1319–1350
[70] Svensberg, L. et al. (2023), "The demand acceleration handbook: Policymakers edition", Compare Foundation

6 Emerging and future trends for innovation-led sustainable transformations

Main Messages

Successful policies for accelerating transformative change in sustainability must consider the specific contextual factors and emerging trends, such as digitalization, evolving energy needs, and shifting political priorities.

Digitalization plays a crucial role in facilitating sustainability and social equality by integrating advanced technologies; however, it presents **challenges such as the digital divide and ethical concerns that need to be addressed** through inclusive and responsible innovation.

Effective R&I policy frameworks should incorporate methods for managing complexity and systemic change, ensuring that innovations can respond quickly to emerging needs and enhance overall resilience and sustainability.

Transforming energy systems requires a holistic approach that considers interconnections, existing structures, and the broader context of technological integration to achieve sustainable outcomes. **Powershoring presents a strategic opportunity for the EU to leverage green energy resources in emerging economies**, facilitating sustainable production and enhancing competitiveness while addressing decarbonization goals.

Source: UNECE.

6.1 Future outlook for sustainable transformations

Mikael Román, formerly Economic Affairs Officer, ECE Transformative Innovation Network (ETIN), Economic Cooperation and Trade, UNECE

Any policies and measures to accelerate innovation for transformative change are highly dependent on the context in which they are carried out. In fact, a defining aspect of larger sustainability transformations is precisely the need for individual initiatives to feed into ongoing parallel processes. This emphasizes the role of innovation as a vehicle to leverage the links and synergies necessary for transformative change.

The contextual factors may differ, as may the ways in which they influence sustainability transformations. To illustrate the point, this section provides examples of emerging and future trends particularly relevant to innovation. These are not the only relevant trends. Instead, they illustrate the more general phenomenon, in which broader developments in areas such as (1) the emergence of new technologies (digitalization) (2) altered and emerging needs (energy), and (3) fluctuating political priorities (competitiveness versus sustainability) influence the conditions for innovation-driven sustainability transformations.

6.2 The digitalization, sustainability and equality nexus

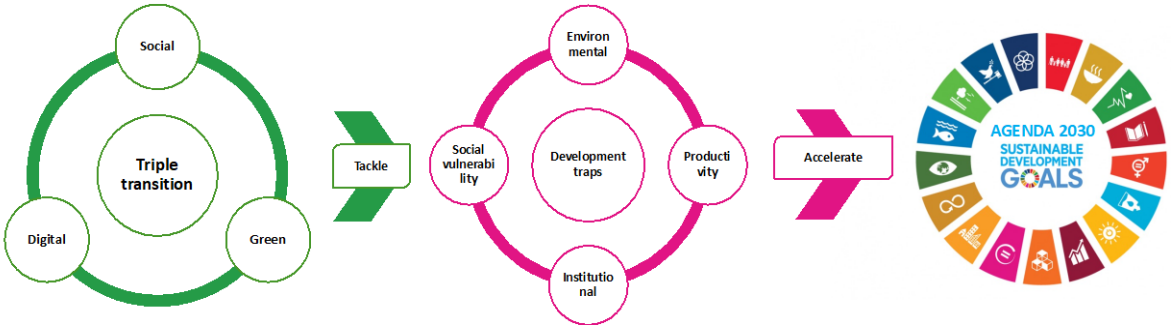
Zoi Roupakia, Policy and AI Research Lead, UCI, Institute for Manufacturing, University of Cambridge

Why is digitalization important for transformations?

Digitalization transforms industries and societies by integrating advanced technologies like AI, the Internet of Things and blockchain into everyday processes, offering solutions to global challenges such as sustainability and social equality.

The interconnected nexus between digital, green and social transitions is emphasized in the Triple Transition framework (Figure 6).[71] This framework advocates for integrating digital, environmental and social strategies to drive transformative innovations by tackling development traps, highlighting the need for simultaneous management of widespread technology adoption, the shift towards sustainability and the promotion of inclusivity and equality.

Figure 6 | Triple transition and the SDGs



Source: Adapted from OECD (2023), "Towards a triple transition: Strategies for transformational European development action", OECD Publishing, Paris.

Challenges and opportunities

Digitalization enhances sustainability across sectors by improving efficiency and reducing environmental impact, and can also promote equality by providing access to essential services and opportunities for marginalized communities (Table 4). But integration of digital technologies also introduces several risks (Table 5).

Future directions could prioritize inclusivity, sustainability and adaptive governance. Digital solutions must ensure accessibility for all, including marginalized communities,[72] and incorporate responsible innovation principles to address ethics and data privacy and minimize negative impacts.[73] Efforts should also focus on the "twin transition", combining digital transformation with sustainability goals,[74] and adopt agile and adaptive governance

[71] OECD (2023), "Towards a triple transition: Strategies for transformational European development action", OECD Publishing, Paris
[72] GRSI (2022), "Meeting report annual session of the gender-responsive standards initiative (GRSI)", available at https://unece.org/sites/default/files/2022-07/GRSI 08th June 2022 Report %28Final%29.pdf
[73] OECD (2024), "Agenda for transformative science, technology, and innovation policies" OECD Publishing, Paris
[74] JRC, Muench, S. et al. (2022), "Towards a green & digital future – Key requirements for successful twin transitions in the European Union", Publications Office of the European Union, Luxembourg

frameworks to develop flexible regulations that protect public interests while fostering innovation.[75]

Table 4 | Digital innovations and their impact on sustainability, equality and inclusion

Digital Innovation	Sustainability Impact	Equality & Inclusion Impact	Case Studies
AI-driven smart grids[a]	Optimize energy use, integrate renewables	Improve energy access in rural areas	California's Grid Modernization Initiative
Satellite-based precision agriculture[b]	Reduce water usage, optimize inputs	Empower small-scale farmers	European Space Agency's Copernicus Program
Blockchain for circular economy[c]	Enhance supply chain transparency, reduce waste	Promote fair trade practices	IBM's Food Trust platform
AI-powered adaptive learning platforms[d]	Personalized education, reduced resource use	Democratize access to quality education	Khan Academy's AI-driven learning platform
Mobile financial services[e]	Reduce transaction costs, improve financial inclusion	Empower marginalized communities	M-PESA in Kenya

Sources: [a] IEA (2017), "Digitization and energy", available at https://www.iea.org/reports/digitalisation-and-energy.

[b] JRC, Muench, S. et al. (2022), "Towards a green & digital future – Key requirements for successful twin transitions in the European Union", Publications Office of the European Union, Luxembourg.

[c] JRC, Baldini, G. et al. (2019), "Digital transformation in transport, construction, energy, government and public administration", Publications Office of the European Union, Luxembourg.

[d] UNESCO (2021), "Non-state actors in education. Who chooses? Who loses?", Global education monitoring report, Paris.

[e] Pazarbasioglu, C. et al. (2020), "Digital financial services", World Bank.

Table 5 | Emerging risks and challenges of digitalization

Risk	Risk
Digital divide and inclusion[a]	The digital divide can deepen social inequalities, limiting opportunities for those without access to digital technologies. Ensuring equitable access to digital technologies and skills remains a critical challenge for inclusive transformation
Ethics and data governance[b]	The collection and use of vast amounts of data raise concerns about privacy, sovereignty and potential misuse.
Environmental sustainability[c]	Managing the energy demands and material use of digital infrastructure is essential; AI can improve efficiency but may also increase e-waste and energy use.
AI biases and fairness[d]	AI systems can perpetuate or amplify societal biases if not carefully designed.
Misinformation and information pollution[e]	The growth of online social networks, the impact of recommender systems, the rise of automation and the emergence of generative AI tools are swiftly altering both the pace and spread of misinformation on climate change and sustainability.
Cybersecurity[f]	Increased digitalization exposes critical systems to cyberattacks and potential cascading failures.

Sources: [a] Van Dijk, S. (2020), "The digital divide", Journal of the Association for Information Science and Technology, 72(1), 136–138.

[b] UNCTAD (2024), "Data for development", E/CN.16/2024/2, 27th Session, Commission on Science and Technology for Development, available at https://unctad.org/system/files/official-document/ecn162024d2_en.pdf.

[c] European Commission (2022), "Twinning the green and digital transitions in the new geopolitical context", 2022 Strategic foresight report, COM(2022) 289, Brussels.

[75] OECD (2024), "Framework for anticipatory governance of emerging technologies", OECD Science, Technology and Industry Policy Papers no. 165, OECD Publishing, Paris, https://doi.org/10.1787/0248ead5-en

[d] Schwartz, R. et al. (2022), "Towards a standard for identifying and managing bias in artificial intelligence", NIST Special Publication 1270

[e] Galaz, V. et al. (2023), "AI could create a perfect storm of climate misinformation", Research brief, Stockholm Resilience Centre and the Beijer Institute of Ecological Economics

[f] ENISA, Lella, I. et al. (2023), "ENISA threat landscape 2023"

6.3 Research and innovation for competitiveness and transformative change

Bianca Cavicchi, Policy Officer, DG RTD, European Commission and Igor Oliveira, Independent Consultant

Why is R&I important for sustainability and competitiveness?

In these past two decades of geopolitical turmoil, climate change disasters, worsening social inequalities and aging populations, research and innovation (R&I) has proven to be essential to increasing the European Union's economic competitiveness and sustainability, improving living standards and providing solutions to address climate change. R&I drives technological development, the creation of new markets and the enhancement of existing ones. It contributes to increasing employment, to re-skilling, and to improving health care systems. In addition, R&I provides groundbreaking solutions to improve resource efficiency while boosting productivity growth. For instance, innovative approaches such as waste recycling and reuse and energy efficiency can help to accomplish more with fewer resources.

The contribution of R&I to competitiveness and sustainability

R&I can provide a more systemic approach to competitiveness, in which social, environmental and economic dimensions are integrated to achieve the transformation of our socioeconomic system. [76] Competitiveness refers to a country's overall economic performance relative to other global players.

The European Union's vision of how R&I can contribute to competitiveness has changed over the years as new challenges emerged. Initially, it was focused solely on productivity growth via R&D investments to strengthen the knowledge base, build up capacities and create new markets. Following the Lisbon goals, which emphasized competitiveness and knowledge-intensive sectors, the Europe 2020 strategy and the European Green Deal introduced a stronger focus on societal goals and emission reductions. Nowadays, competitiveness is again very central though emissions reduction, socioeconomic resilience, resource efficiency and strategy autonomy may continue playing a central role.

Challenges and opportunities

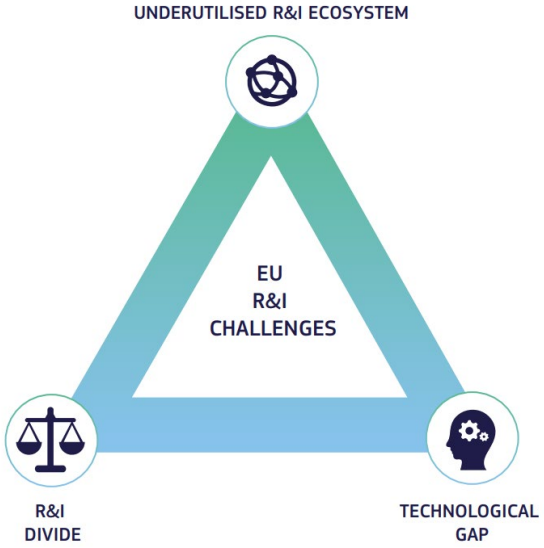
Despite the importance of R&I, the European Union faces obstacles in its R&I landscape. While being a global leader in green technologies, the Union lags behind in critical areas such as digital technologies and AI, which are essential complements to many other fields, such as health and the green transition. The fragmentation of the R&I ecosystem and the continuation of spatial divides in R&I performance affect the European Union's competitive advantage and transformative capacity (Figure 7). [77] Furthermore, the Union is overly dependent on critical raw materials from non-members and politically unstable countries, which makes it vulnerable to supply chain disruptions and market oscillations.

[76] DG RTD, Richardson, K. et al. (2024), "Why Europe needs a systemic R&I policy – Redefining competitiveness for long-term sustainability", Publications Office of the European Union, Brussels

[77] DG RTD (2024a), "Science, research and innovation performance of the EU – A competitive Europe for a sustainable future", Publications Office of the European Union, Brussels

R&I in the European Union plays a crucial role in addressing these gaps. The socioeconomic resilience of the European Union increasingly depends on the agile deployment of technologies that can help increase the competitiveness of Europe. Key technologies include AI, military or dual-use technologies, quantum computing, biotechnology, renewable energy and cybersecurity solutions. [78] Europe can leverage its unique capability to facilitate exchange of knowledge, pooling intellectual and financial resources, and the coordination of policy interventions across member States. These collective efforts can help accelerate market uptake and diffusion of innovations and ensure gains are distributed more equally.

Figure 7 | Triangle of current R&I challenges



Source: DG RTD (2024a), "Science, research and innovation performance of the EU – A competitive Europe for a sustainable future", Publications Office of the European Union, Brussels.

These strengths are demonstrated by the European Framework Programme for R&I. As an example of the Programme's multiplier impact, Horizon 2020, the predecessor to Horizon Europe, is estimated to contribute between €421 billion and €798 billion over the period 2014–2040, considering its total budget of about €80 billion. This indicates that for each €1 of cost to society associated with Horizon 2020, the programme is estimated to bring from €5 to €11 of benefits for citizens of the European Union. The Framework Programme has also substantially contributed to medical breakthroughs in infectious diseases and renewable energy. [79]

Implications for policy

However, R&I does not happen in a vacuum. R&I's full potential to contribute to competitiveness and transformative change can be achieved through well-designed and agile policy frameworks. To this purpose, R&I policy should make use of methods that deal with complexity. For instance, policy experimentation, scenarios simulation, strategic foresight and regulatory experimentation can support R&I policy be better prepared to respond to unforeseen circumstances and adapt more quickly to emerging needs. Furthermore, traditional monitoring and evaluation methods are not suitable for assessing systemic change. Metrics also need to be rethought to complement patents, publications, GDP and productivity growth, and with other metrics for resilience, complexity, well-being

[78] DG RTD (2024b), "Science, research and innovation performance of the EU – EU facts and figures from the #SRIP report 2024", Publications Office of the European Union, Brussels
[79] DG RTD, Steeman, J.-T. et al. (2024), "Why investing in research and innovation matters for a competitive, green, and fair Europe – A rationale for public and private action", Publications Office of the European Union, Brussels

and environmental sustainability, and more. This approach can help support R&I policy to be more efficient, adaptive and quicker to respond to changing circumstances.[80]

6.4 A holistic approach to transforming energy systems

Stefan Büttner, Director Global Strategy and Impact, Institute for Energy Efficiency in Production, University of Stuttgart, Chair of UNECE Group of Experts on Energy Efficiency

System transformation is rarely a linear process but rather the result of a multidimensional approach involving both visible and hidden elements. Understanding and incorporating interconnections and dependencies into transformation processes can help ensure impactful and sustainable outcomes. This requires a deep, systemic approach.

Transforming energy systems

While the availability of innovative, market-ready technologies is crucial for evolving systems, their full potential can only be realized when the necessary conditions for market uptake are met. These include the widespread availability of equipment at scale; the presence of skilled personnel to install, operate and optimize the technology; and the development of strategies that facilitate a broad market roll-out. Equally important is awareness of the technology's existence and its suitability within specific contexts. This awareness often determines the success or failure of its adoption. In many cases, even when technologies are available, their integration into existing systems is hindered by a lack of readiness on multiple fronts, such as infrastructure, regulatory frameworks and market incentives.

Transforming energy systems requires more than just introducing new technologies; it necessitates a carefully balanced approach that combines leveraging existing structures with the strategic introduction of new elements. To determine which existing components can serve as a foundation for the future and which new elements are essential, it is imperative to thoroughly explore all available options. Traditional methods of assessing technologies, focusing solely on individual performance metrics, may be insufficient. Instead, we must evaluate the effectiveness of technologies within the broader system context. A technology that performs well in one geographic region may prove inefficient or counterproductive in another due to differences in environmental, economic and social factors.

The complexity of system transformation lies in understanding that it is not merely about choosing the best available technologies. Rather, it involves optimizing a multidimensional process that considers a range of factors, including input resources, transmission pathways and end-use processes. These are interconnected, and their combined effect determines the overall efficiency and viability of the system. Here, the importance of non-technological innovations becomes evident. While technological solutions are often emphasized, it is the non-technical innovations — e.g. policy frameworks, business models, stakeholder engagement strategies — that often enable, trigger and encourage impactful action.

One key perspective for these innovations is understanding the needs, input factors, context and goals of the transformation. The share of renewables in the energy system and the growth rate of energy efficiency are critical indicators of progress, as outlined in SDG7. However, these indicators alone are insufficient for the actual transformation of the energy system. They do not reflect the realities on the demand side. For instance, while the share of green electricity is increasing in many countries, it often falls short of meeting industrial needs. This creates a scenario where, even if all available green electricity were allocated to

[80] Idem

industry, the rest of the grid would still be heavily reliant on fossil fuels. Consequently, the overall emission factor for electricity may not improve as expected.

To fully implement decarbonization plans, energy generation must be viewed in the context of demand, including when and how much energy will be needed. Companies must assess their decarbonization potential in light of uncertain external factors while communicating their needs to energy system operators. Successful transformation approaches must reduce unknown variables and provide clarity on these critical issues. For example, understanding that a large portion of industrial energy demand is non-electric emphasizes that green electricity alone isn't sufficient. We must identify what types of energy are needed, in what amounts and when they will be required. As of now, most countries are lagging behind in providing the necessary non-electric green energy supply for their industries.

Systemic efficiency and the interconnectedness of success factors

As we strive for electrification — leading to increased electricity demand — many industrial processes cannot easily switch energy carriers without significant changes, which may not be systemically efficient. The concept of systemic efficiency goes beyond the efficiency of individual processes or equipment; it considers the combined efficiency and viability of interdependent measures. Understanding both the process and the subsector it operates within, as well as its economic impact, is crucial for making informed decisions. This broader perspective is essential for ensuring that the transformation process is not only technologically sound but also economically and socially viable.

System transformations inevitably affect the structure of the economy and its subsectors. Given limited resources and the need for impactful solutions, it's essential to understand the diversity within industry sectors. This understanding goes beyond subsector classifications, energy intensities and company sizes; it involves assessing relevance in context. How do we determine the relevance of a sector? Is it based on economic weight, employment numbers, energy consumption or emission intensity? Awareness of these factors, along with an understanding of innovative technologies that can make the most significant impact, is vital for successful transformation. Equally important is understanding the necessary infrastructure and the potential barriers to adoption.

Applying a systemic efficiency framework requires a comprehensive understanding of green energy generation and industrial demand per energy carrier to identify deficits or surpluses. Transformations extend beyond the present situation; therefore, approaches must aim to understand intended goals, progress in implementing actions and what support is needed to achieve impactful change. Demand-side engagement is essential for assessing progress and obstacles. The usefulness of innovative technologies largely depends on the processes they support and the contexts in which they are applied. Prioritizing innovations with the potential for significant impact and multisector applicability is often a sensible approach, especially in times of resource scarcity.

Digital tools and methodologies play a critical role in navigating these complex interactions. By enabling the assessment of cross-cutting interactions, economic performance and systemic efficiency, digital approaches can provide a more nuanced understanding of the underlying drivers and conversion factors that influence transformation processes. These tools can help stakeholders visualize and analyse the interconnectedness of various factors, enabling identification of the most effective strategies for achieving desired outcomes.

Mastering transformation with innovations is possible if we understand the overall energy generation and supply structure and, in times of limited resources, identify the most relevant subsectors to address. To achieve tangible impacts, we need a sectoral understanding of goals, company actions and obstacles. This understanding enables informed decisions on effective decarbonization measures and helps identify the most appropriate technologies.

While this highlights the interconnectedness of success factors in industry and energy system contexts, the approach is equally applicable to other areas, such as buildings or infrastructure.

The path to transformative innovation is complex and multifaceted, requiring a deep understanding of both technological and non-technological factors. By focusing on systemic efficiency and considering the broader context in which innovations are applied, we can develop strategies that not only meet immediate needs but also lay the foundation for long-term sustainability. Through this holistic approach, we can ensure that transformations are both impactful and resilient, capable of meeting the challenges of today and tomorrow.

6.5 Why does powershoring matter for the European Union?

Jorge Arbache, Professor of Economics, University of Brasilia, Mikael Román, formerly Economic Affairs Officer, ECE Transformative Innovation Network (ETIN), Economic Cooperation and Trade, UNECE

Access to energy will condition many of the innovation-driven pathways of future sustainability transitions. This is largely due to the ways in which energy issues cut across critical policy areas in these processes, i.e. European global competitiveness, the region's commitment to mitigate climate change, and fundamental security concerns.

Powershoring: the concept

One recent development that illustrates this dynamic is powershoring.[81] This differs from established public policy strategies such as reshoring, nearshoring and friendshoring. It is fundamentally a corporate strategy to meet companies' interests in (1) decarbonizing production; (2) complying with international environmental standards; (3) gaining market access; and (4) gaining competitiveness. Powershoring means that companies place production in locations that provide access to green, secure, cheap and abundant energy, along with the vast amounts of water necessary for energy-intensive production processes.

The dynamic

From a corporate perspective, the selection of production sites is becoming increasingly challenging in the present European context, where geopolitical tensions and regulatory demands are affecting both current access to energy and future energy investments. Many corporate actors are gradually "shoring" their activities to locations overseas.

Regions with active ports, abundant access to green energy and water, and industrial areas constitute ideal locations for powershoring, particularly in hard-to-abate sectors. Other considerations include maintaining distance from complex geopolitical issues and access to production and supply networks that reduce risks related to extreme climatic events. All these reinforce the importance of resilience and shape the package of interest in powershoring.

The trend towards powershoring is already underway, particularly in some Latin American countries where the energy matrix is largely renewable. Brazil, Costa Rica, Paraguay and Uruguay all get more than 90 per cent of their energy from green energy. Correspondingly,

[81] Arbache, J. (2022), "Powershoring", Development Bank of Latin America and the Caribbean, available at https://www.caf.com/en/knowledge/views/2022/11/powershoring/

these countries are already receiving significant investment, including in green fertilizers, e-methanol, green steel, sustainable aviation fuel, biodiesel, and green paper and pulp.

Critically, powershoring is becoming an asset class that is already attracting growing international attention outside government, despite the immense subsidies, protectionism and even discriminatory industrial policies of advanced countries. Major consulting firms, investment funds and banks are already involved in this agenda. Data from UN Trade and Investment for 2023 and preliminary data for the first half of 2024 show that a significant portion of Brazilian foreign direct investment is concentrated in energy-intensive activities.[82, 83]

The current development is important as it (1) indicates an untapped opportunity; (2) allows for emerging economies to play a constructive and prominent role in extended partnerships with industrialized countries; and (3) can promote sustainable transformation in the environments of both host and guest countries. Surprisingly, this broader issue has not yet reached the corresponding level of attention in governmental circles.

The opportunity: powershoring as a lever for innovation-driven sustainable transformation

Powershoring has enormous potential as a lever connecting markets, actors and sectors in a way that creates unprecedented synergies and spillovers. This does not necessarily emerge automatically, but requires alternative modes of collaboration between government, the private sector and civil society.

To illustrate, it would seem as if Latin America and the European Union have a fundamental opportunity for economic cooperation that also aligns with the principles of a just and green energy transition. The logic also applies to other emerging and transition economies.

In the short term, Latin America could attract investment by leveraging its green energy and water resources to produce and export energy- and water-intensive industrial goods. This would make it possible to establish green European production lines more quickly and at lower cost—consider, for example, the role of green steel, green aluminium and green plastics in the production of the European automotive industry. This alliance can help secure jobs, increase competitiveness and reduce costs, and expand the supply of green consumer industrial products at competitive prices, benefiting the average European citizen. The alliance can help create jobs and income in Latin American with significant implications for poverty and inequality. Powershoring can therefore be an important factor in just and green transition and in accelerating the decarbonization of Europe.

Latin American countries also offer other advantages, such as a vast potential carbon market, many critical minerals for the transition, immense biodiversity and important biomes. These create a unique framework for tackling decarbonization on a global scale.

Europe is the region with by far the highest investment stock in many Latin American countries and has a strong presence in several countries in the region. Moreover, European companies and banks consider Latin America one of their main markets worldwide. The relationship between Europe and Latin America is long-standing, broad, solid and well established, which helps to build an important bridge, positioning the region as a natural ally to help accelerate Europe's decarbonization.

[82] UNCTAD (2024), "World Investment Report 2024", New York
[83] Arbache, J. and Esteves, L. (2023), "Resilience with efficiency: How powershoring can contribute to the decarbonization and economic development of Latin America and the Caribbean", Development Bank of Latin America and the Caribbean

Collaboration between Latin America and the European Union will require a great deal of creativity, flexibility and, above all, room to test business models and technologies in frontier areas such as climate change. This calls for continuous experimentation and learning, supported by innovation policies and measures in both the public and the private spheres. The latter will necessarily include agendas for scientific and technological development partnerships, technology sharing, market access, bold trade and investment policies, regulatory frameworks, human capital, financing, innovative capital structures, environmental preservation, protection of social rights and political partnerships.

Final reflection

Powershoring highlights at least two important observations: (1) the importance for Europe of strategic alliances in addressing decarbonization; and (2) the opportunity for emerging and transition economies to play a constructive role in mutually beneficial partnerships.

7 Conclusion and Way Forward

It is clear that there is a growing urgency to accelerating progress towards the SDGs, given the slow, and in some places reversing, progress to date. Concerted and structured dialogues on innovation for transformative change can play a role in identifying and diffusing the types of policy interventions that can enable such innovation. Specifically, there is a significant need for increased and inclusive peer-learning and exchanges, to share and reflect on practical experiences, as well as facilitate learning about different approaches to policies for innovation-led transformations. This can help stakeholders assess, evaluate, and apply approaches that fit their context. Through networks such as ETIN, members can establish a foundation for mutual learning and support among those pursuing transformative innovation policy efforts.

The UN-ECE Transformative Innovation Network (ETIN) fills an important niche in the field of innovation-led sustainable transformations	
	**Focus on practical implementation of transformative innovation** ETIN emphasizes real-world application by sharing case studies and learnings from member projects, creating a knowledge base focused on the practical aspects of transformative innovation.
	**Open and honest dialogue and exchanges** The nature of the ETIN activities foster a safe space for members to share both successes and setbacks, offering realistic insights and understandings of the challenges in sustainable transformations.
	**Space for experimentation and mutual learning** ETIN provides a collaborative environment for experimentation, encouraging members to test ideas, refine approaches with feedback, and adapt strategies for effective, sustainable results.
	**Translation of concepts into practical guidelines** ETIN supports the translation of theory into actionable guidelines, bridging the gap between policy concepts and practical innovation-led transformation strategies.

	**Ensuring synergies as a "network of networks"** Acting as a "network of networks," ETIN ensures coordination across national and international initiatives, enhancing support for sustainable projects alongside OECD, EU, TIPC and others.
	**Complementarities and integration with other UN initiatives** Working alongside other UN projects, ETIN strengthens cooperation across fields like economic cooperation, trade, transport, energy, and, more broadly, international cooperation, advancing shared goals aligned with the *Pact for the Future*.

Source: UNECE.