Shared challenges, transformative actions

OECD Science and Technology Policy Ministerial

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Issues Notes

BETTER POLICIES FOR BETTER LIVES

Plenary 3: A Transformative Science, Technology and Innovation (STI) Agenda for Green and Just Transitions

24 April 2024, 10:15 -11:45 Paris time, OECD Conference Centre, Room CC15

Chaired by: Ms. Leonore Gewessler, Federal Minister for Climate Action, Environment, Energy, Mobility, Innovation and Technology, Austria

Key issues

- Without a major acceleration in low-carbon innovation, reaching net-zero emissions by 2050 will be unachievable. Reaching this target requires rapid large-scale deployment of available technologies, such as wind and solar, as well as the development and widespread use of technologies that are far from mature today, such as green hydrogen. It also requires behavioural change. Concerns are mounting that progress to date is not proportionate to the urgency or magnitude of evolving global challenges. The climate emergency requires nothing short of a profound transformation of sectors like energy, heavy industry, agrifood and transportation. To make this transition possible there is also need for a broad range of complementary measures, such as reducing demand for some forms of transportation by, for instance, redesigning cities, increasing telework, improving public transport and logistics, and so forth.
- Governments must be more ambitious and act with greater urgency in their policies for science, technology, and innovation (STI) to help meet these challenges. This calls for renewed thinking in how STI policy is situated, developed, and implemented (OECD, 2023c). Governments will need to revisit STI policy models, visions, targets, and instruments with a view to adapting them or displacing them in favour of others better suited to achieving sustainability transitions.
- While STI is critical to economic growth, advances in technology have occurred in parallel with, and in some cases played a role in driving, growing social divides. However, a green and justice-based transition could also bring social benefits. Promoting inclusive socioeconomic renewal involves resetting economic models to significantly advance inclusion and diversity. Measures are also needed to increase the resilience of socio-economic systems (e.g., in supply chains, energy production systems) to better absorb, recover from and adapt to change, a need underscored by the COVID-19 pandemic.

Agenda

Intervention	Duration
Opening remarks by Chair	5'
1st round / Question 1 on whole-of-government approaches: Scheduled interventions by HoDs –following the French alphabetical order – speaking priority given to Ministers	2' each
2st round / Question 2 on experimentations: Scheduled interventions by HoDs – following the French alphabetical order – speaking priority given to Ministers	2' per Delegation
Open floor for further non-scheduled interventions or responses by raising of flag	1' per Delegation
Closing remarks by Chair	5'

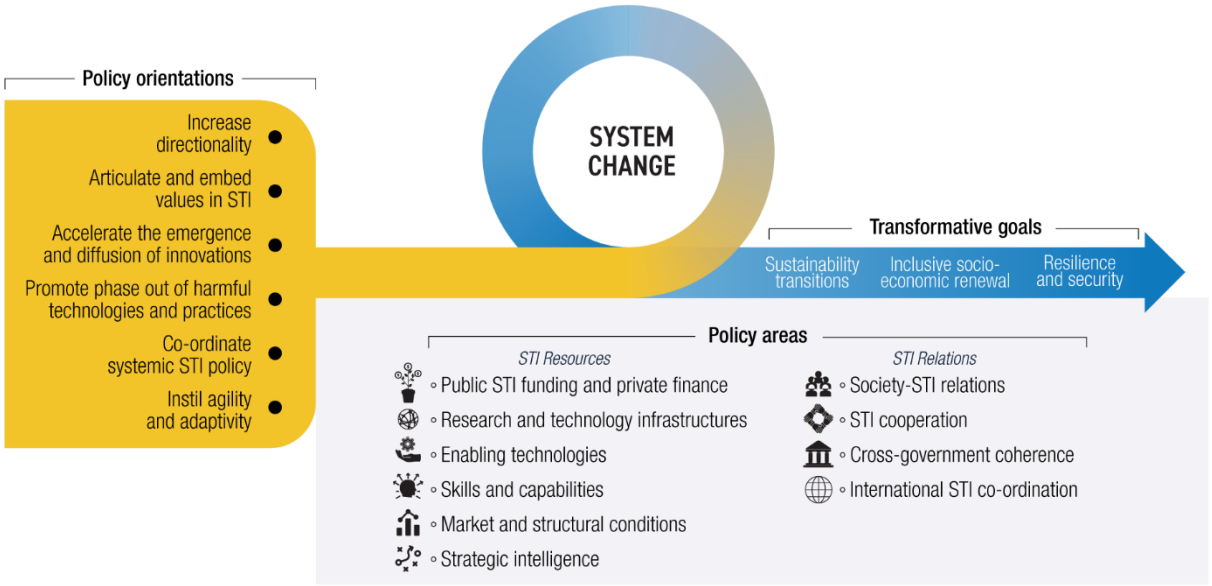
Key directions for policy

The OECD's Committee for Scientific and Technological Policy (CSTP) has developed the Agenda for Transformative Science, Technology, and Innovation Policies. The Agenda provides a framework for policymakers and other stakeholders to formulate and implement STI reforms that will accelerate progress on major transformative goals: advancing sustainability transitions, promoting inclusive socioeconomic renewal, and fostering resilience and security. The main elements of the Agenda are laid out in Figure 1.

To achieve these goals, STI policymakers need to orient policies to be more directional, co-ordinated and agile. While many countries have experimented with policy reforms along these lines for some time, these efforts must be scaled up and institutionalised. This will require systematic efforts to:

- **Direct STI policy to accelerate transformative change:** STI policy portfolios are required that target transformative goals while maintaining the diversity required to advance scientific knowledge and contend with the uncertainty of unfolding events.
- **Embrace values in STI policies that align with the transformative goals:** Values have implications for what and how STI is carried out and diffused. STI policy should intentionally emphasise a broad set of values, including respecting human rights, promoting democracy, and expanding equity and inclusivity.
- **Accelerate both the emergence and diffusion of innovations for transformative change:** To achieve an appropriate mix of existing and novel STI, policymakers must support researchers, industry and entrepreneurs in accelerating the innovation cycle and bridging multiple 'valleys of death'.[i]
- **Promote the phase-out of harmful technologies and practices:** Policies targeting the phase out, discontinuation and divestment from targeted technologies and practices should be an important part of transformative change agendas, especially as a necessary driver of science and innovation in this area. The relevant policies can fall within the mandate of STI policy but often require co-ordination with other policy domains.
- **Implement systemic and co-ordinated STI policy responses to global challenges:** Vertical and horizontal co-ordination is required to design and implement systems of policies that reflect feedback dynamics, politics and power dynamics, and path dependence.
- **Instil greater agility and experimentation in STI policy**: Experimentation can enable STI policymakers to iterate and learn from a range of options before scaling up preferred interventions.

Figure 1. The Agenda's transformative goals, policy orientations and STI policy areas



Key questions for discussion

- The OECD Agenda for Transformative Science, Technology and Innovation Policies underscores the importance of integrating STI into whole-of-government approaches for accelerating transitions. What has been your country's experience in co-ordinating with different ministries to set and implement ambitious measures for sustainability transitions? Please outline specific lessons or successes related to targeted policy examples.
- To the extent you work with experimentation in policymaking, can you provide some lessons or good practice from efforts to integrate or scale up experimentation and/or specific policy innovations into mainstream policy? This could relate to specific policy examples like regulatory sandboxes, living labs, or agile funding instruments, among others.

Background

There is a transformation imperative for current socio-economic systems

Multiple crises, including the climate emergency, growing geopolitical tensions, large-scale involuntary migration, rising living costs, and the erosion of social cohesion are affecting many OECD countries. These crises are triggering instability and insecurity, with impacts on economies, the environment, politics, and global affairs. Difficulties like these create pressures for the transformation of economies and societies towards configurations that embody desirable traits. These desirable traits represent the Agenda's **three interdependent transformative goals:** (i) advancing sustainability transitions, (ii) promoting inclusive socioeconomic renewal, and (iii) fostering resilience and security. This background paper focuses specifically on the sustainability imperative and, in part, how this relates to inclusion, resilience and security.

Sustainability transitions require that socio-economic systems to evolve to ensure that current human needs are not satisfied at the expense of future generations and to mitigate and adapt to a legacy of unsustainable development. For example, the climate emergency requires nothing short of a profound transformation of sectors like energy, heavy industry, agrifood and transportation, to transition to more sustainable, inclusive and resilient operating models. Yet, financial support to fossil fuels exceeds financing for climate adaptation and mitigation (UN, 2023[1]).[1] The recent surges in support for fossil fuel consumption and production have been attributed, in part, to rising energy prices and deficits in global energy supply chains triggered by Russia's invasion of Ukraine. Such increases indicate that in many countries, economic growth and national security remain coupled to fossil fuel-based sectors. However, there is also evidence to suggest that recent volatility in global energy markets has triggered a significant boost in clean energy investments in several regions (i.e., China, EU, USA, Japan, and India) (IEA, 2023[2]).

In the context of sustainable development, a green and justice-based transition should bring social as well as environmental and economic co-benefits (Altenburg and Assmann, 2017[3]) (OECD, 2023[4]) but will also need to address unequal starting points and the differential impacts that can occur as a result (OECD, 2018[5]). Most OECD countries are experiencing growing levels of inequality[2] and recent global pressures have enabled the largest growth of between-country income inequality in thirty years.[3] These trends have significant implications for advancing green and just transitions, which often entail sizeable disruption and distributional consequences. Many economically underrepresented communities are more likely to be negatively affected by both the triple planetary crisis of climate change, pollution and biodiversity loss,[4] and the green transition policies adopted in response (Thomas et al., 2018[6]) (OECD, 2021[7]) (OECD, 2023[8]). **There is therefore a need to promote inclusive socioeconomic renewal, which will involve resetting economic models to significantly advance representation, diversity and equity.**

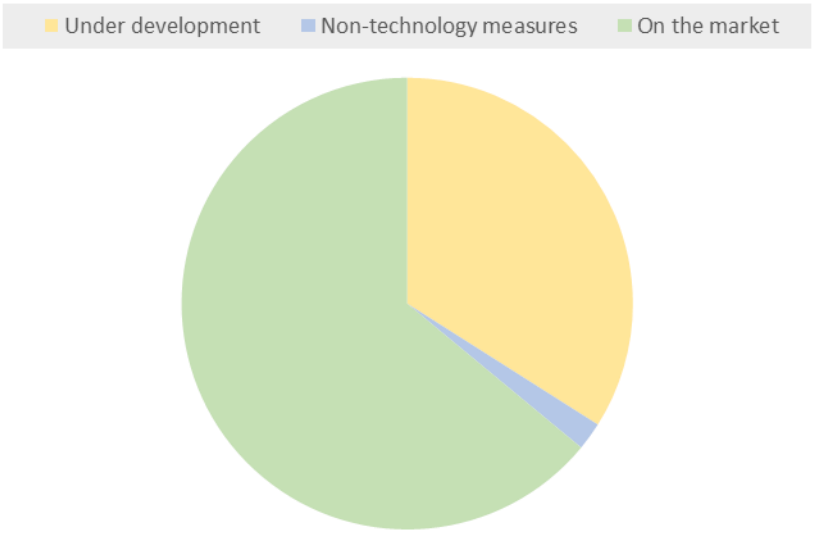
Fostering resilience and security is necessary to improve the ability of modern global socio-economic systems (e.g., energy and food production systems) to anticipate, absorb, recover from and adapt to adversity (OECD, 2020, p. 11[9]) (Linkov and Palma-Oliveira, 2017[10]).[5] The COVID-19 pandemic demonstrated the necessity of greater preparedness and resilience in dealing with future shocks. Learning this lesson is, perhaps, increasingly important as the crises associated with the changing climate (e.g., extreme weather events, wildfires, drought, etc.) grow more prevalent and volatile.

STI is uniquely positioned to help economies and societies transform

STI activities and outcomes can contribute to sustainability, inclusion, security and resilience in several ways. These include but are not limited to:

- **Monitoring and anticipating the evolution of natural and social systems:** For example, the availability and timeliness of data and scientific research is necessary to take stock of and forecast the evolution of global challenges. Research from the natural as well as the social and behavioural sciences also provides important insights into factors that lead to exclusion and the divergence of outcomes for different groups (e.g., social determinants of health).
- **Accelerating the development and equitable deployment of innovation and technology:** Anticipated pathways to achieve net zero will require a more rapid pace of technology development than has typically been achieved, placing new demands on STI systems and policy (See Figure 2).[6] There is also a need to shorten deployment timelines for many clean energy solutions across regions.[7]
- **Steering the responsible and anticipatory governance of innovative-driven development:** Rapid uptake and phase out of technologies can bring a range of consequences, such as threats to privacy and human rights, increased inequality, and environmental degradation (OECD, 2023[11]) (OECD, 2024[12]). Advances in scientific methodologies and digital technologies can help anticipate such challenges.

Figure 2. Contribution to global CO2 emissions reductions in 2050 by technology maturity



Note: Non-technology measures include changes in behaviour and account for roughly 2% of projected emissions reductions needed by 2050 to achieve the IEA 2023 Net Zero Emissions Scenario. On the market includes technologies that are mature or where adoption is being scaled up. These account for over 60% of required emissions reductions. Under development technologies are those currently at prototype of demonstration phases of development. These account for over 30% of required emissions reductions.
Source: (IEA, 2023[13])

- **Expanding and strengthening international connections:** Transnational STI activities offer opportunities for diplomacy and the reinforcement of shared norms and values through co-operation, collaboration and knowledge sharing. International linkages in STI can be led by states, but are also often built from the bottom-up, via individual researchers, institutions and platforms.

There is a simultaneous need to transform STI and STI policy systems

Advancing green and just transitions will require governments to be more ambitious and act with greater urgency in their STI policies. The ability of countries to generate and utilise relevant knowledge, technologies, and various types of innovation at pace and at scale will also depend on the existence and mobilisation of well-functioning STI systems. To date, there has been insufficient progress in achieving some important collective goals, like the Sustainable Development Goals, which have featured in national and international research agendas for some time.[8] This suggests **there may also be a need to transform certain aspects of STI and STI policy systems.**

Many of the necessary reforms are familiar to the STI policy community (See Figure 3). However, barriers remain, for example, in bridging aspirational strategies with the development and implementation of policy interventions, and in scaling-up and institutionalising corresponding policy innovations. Governments will need to revisit STI policy models, visions, targets and instruments with a view to adapting them or displacing them in favour of others better suited to achieving transformative goals (Schwaag Serger and Palmberg, 2022[14]). All aspects of STI policy and governance are involved, including research and innovation funding, human resources for science and technology, research and technology infrastructures, STI system co-ordination mechanisms, and evaluation and measurement (OECD, 2023[11]).

This background paper explores why transformative STI policy needs to be more **directional, co-ordinated and agile** and what this means for particular STI policy areas. Target policy areas align with the three planned breakout sessions of Plenary 3: funding and finance, cross-government coherence, and society-STI engagement.

Figure 3. From traditional to transformative STI policy orientations

STI activities and policy must be directed towards global challenges

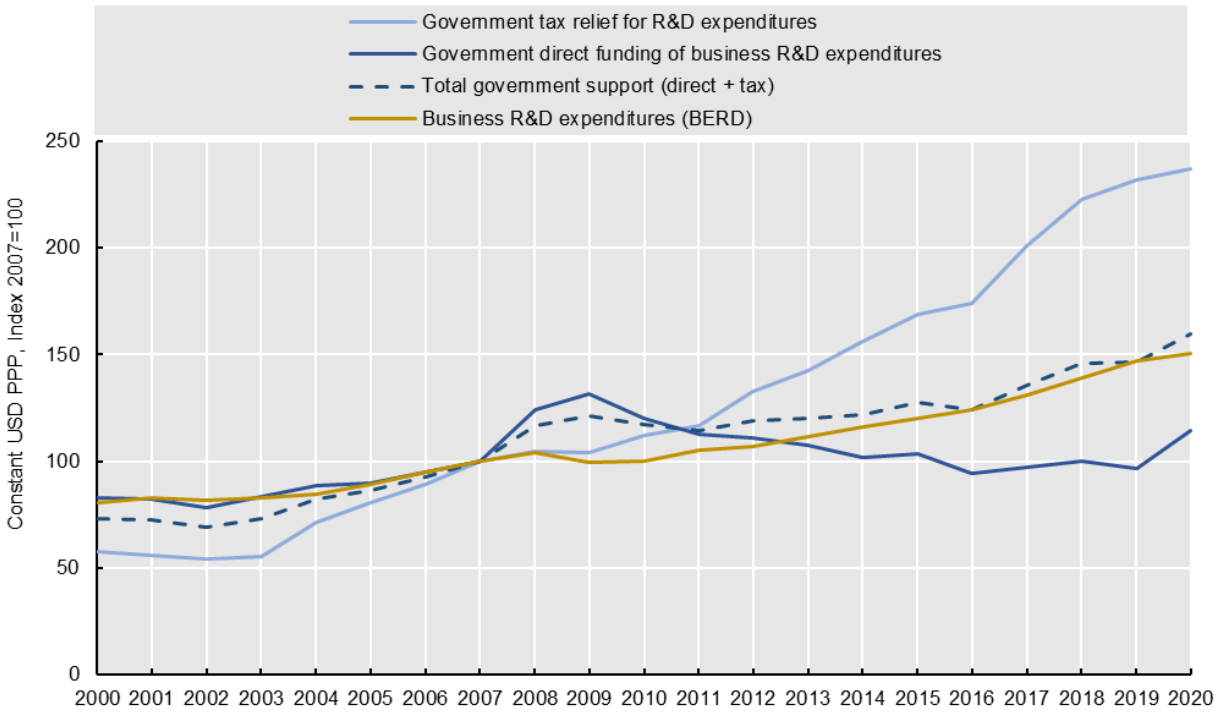
Societal and environmental objectives, such as sustainable development, have featured within national STI agendas for many years, However, over the past two decades STI policy mixes in many countries have become more 'horizontal' and 'agnostic' in terms of the research and innovation areas supported.

For instance, over this period, there has been considerable change in the policy portfolios targeting business R&D, with a near-universal shift from direct funding support, e.g., through grants, to a greater reliance on R&D tax incentives (Figure 4).

While R&D tax incentives can be a useful tool in increasing general R&D activities, they can be biased towards established technologies or industries. By themselves, technology neutral R&D tax credits are not sufficient to direct innovation towards societal challenges and to bridge basic research and product development (OECD, 2021[15]). Recent research suggests that R&D tax credits can undermine the directional effects of other policy instruments, such as carbon pricing, if the former are technology neutral or technology agnostic (Pless and Srivastav, 2023[16]).

There is need for greater directionality in STI systems to scale up and accelerate sustainability transitions across economies and societies (Weber and Rohracher, 2012[17]). Direct measures, including R&D grants, loans and credits, and innovation-oriented public procurement, are superior for supporting breakthrough technologies and should be more prominent in STI policy portfolios. Given that science and technological innovation are inherently uncertain, these direct measures should support a diverse range of priorities to avoid technological lock-ins and develop capacities to absorb a wider span of knowledge and technologies developed elsewhere. **This points to the need for a balanced policy portfolio approach** that targets global challenges like climate change while maintaining support for a variety of STI areas.

Figure 4. Continuing shift in government policy support mix for business R&D

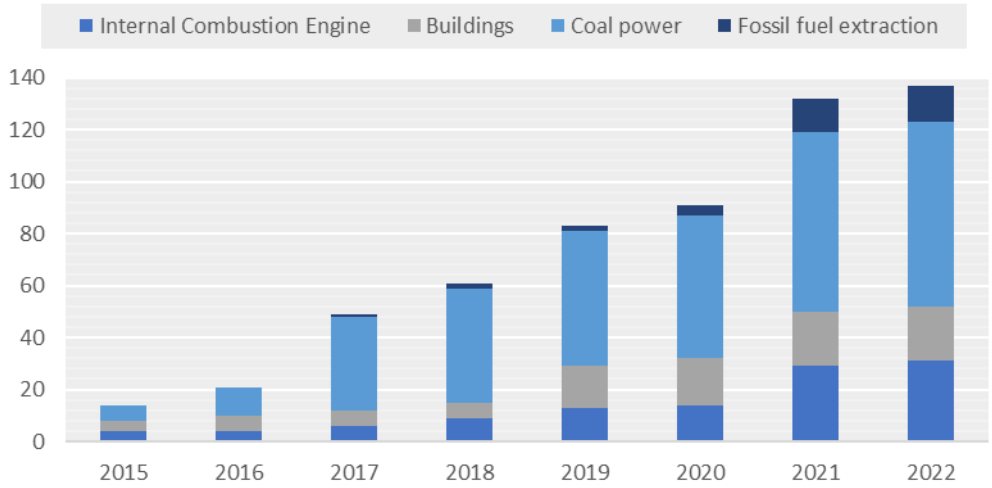


Note: Estimates of total OECD direct funding of BERD cover OECD countries, except Costa Rica. Estimates of total OECD R&D tax support (central government level) cover all OECD countries. Direct support estimates include government R&D grants and public procurement of R&D services, but exclude loans and other financial instruments that are expected to be repaid in full. For general and country-specific notes on the estimates of government tax relief for R&D expenditures (GTARD), see http://www.oecd.org/sti/rd-tax-stats-gtard-ts-notes.pdf.
Source: OECD R&D Tax Incentives Database, http://oe.cd/rdtax, October 2023, and OECD R&D statistics, September 2023. See OECD MSTI Database, http://oe.cd/msti, for most up-to-date OECD indicators.

A further important policy question is how much to invest in diffusion of existing technologies and innovation compared to basic and applied research, and technology development and demonstration. While all are needed, the relative importance of deployment support (market pull) vis-à-vis R&D and demonstration support (technology push) should increase with the movement from immature technologies towards technologies closer to market competitiveness (OECD, 2023[18]) (Cervantes et al., 2023[19]). At the same time, curiosity-driven basic science is associated with various breakthroughs and academic freedom is a fundamental tenet of many national research systems. A portfolio approach should therefore also balance funding support across the innovation chain[9] and promote interactions and complementarities between stages of innovation to help bridge 'valleys of death'. There is no one-size-fits-all and composition of these portfolios and the scientific disciplines, industries, technologies, activities, and innovation that are prioritised will depend significantly on the current context of individual countries and their desired futures.

Governments need to cultivate institutional and governance capacities to be able to set directions and change course as needed. Policymakers can also help to articulate shared visions that mobilise firms (who account for most R&D and innovation activities in OECD countries) and public sector scientists (many of whom work within frameworks of academic autonomy).[10] Many governments are experimenting with novel policy instruments, such as challenge-based funding and mission-oriented innovation policies (MOIPs) that bring together multiple actors, including from different policy domains, as well as firms and public-sector research organisations, to co-create and collaborate across innovation chains on transformative pathways (OECD, 2023[11]; Larrue, 2021[20]). Cross-government co-ordination with other policy domains is especially important, since market and structural conditions, such as regulations and standards, can play a substantial role in facilitating technology diffusion and phase out. For example, Figure 5 shows that regulations targeting the phase out of technologies have become a more common option among OECD and OECD partner countries. At the same time, continued experimentation with novel approaches will be key to directing and scaling private R&D and innovation investments, alongside public funding, to better meet global challenges in both developed and developing countries.

Figure 5. The use of regulation to phase out fossil fuel assets has become increasingly popular Error! No text of specified style in document.



Note: Figure 5 shows the number of policies (vertical axis) that have been adopted by OECD and OECD partner countries to either phase out or ban certain types of technology from 2015 to 2022. This is measured via the OECD Climate Actions and Policies Measurement Framework.
Source: Original source (Nachtigall et al., 2022[21]) and adapted from (OECD, 2023[8])

STI activities and policy must be systemic and co-ordinated

System-wide change often requires sequenced interventions that involve the development, deployment and phase-out of technologies, business practices, regulatory frameworks, and common practice and behaviour of consumers. In addition, the substantial scope of investment needed necessitates the mobilisation of a wide mix of stakeholders from firms, government, public research and civil society. It is evident that transformation towards greater sustainability, inclusivity, resilience and security cannot be achieved or even chiefly driven by STI policies, although they are certainly essential.

A range of sectors contribute to challenges like unsustainable levels of emissions and pollution, which often disproportionately impact marginalised communities and, in part, perpetuate cycles of poverty (Ganzleben and Kazmierczak, 2020[22]). Targeted sector-specific policies (e.g., subsidies, regulation, innovation procurement, etc.) are also expected to do much of the heavy lifting to advance decarbonisation and address structural social and economic inequities. In addition, sectors like energy (IEA, 2023[23]), agrifood (OECD, 2022[24]), and transport (ITF, 2023[25]) are often at different phases in their decarbonisation journeys, face different barriers and enablers, and will require different configurations of actors and technologies to reach net zero.

STI policy also needs to take a strong place-based approach that tailors interventions to specific local conditions (OECD, 2019[26]; OECD, 2020[27]). For example, subnational data and policy are needed to understand and address the distributional impacts of green transitions. Risks and opportunities for workers are often concentrated regionally due to differences in economic and industrial structure and the composition of the labour force (OECD, 2023[28]). Areas where high-emission sectors dominate may see greater job loss or transition stresses, necessitating upskilling or reskilling efforts. Currently, highly skilled and educated workers also hold most green jobs, which are often associated with a substantial wage premium, while most polluting jobs are held by medium- or low-skilled workers. As a result, it is imperative that policymakers foresee and actively address impacts of sustainability transitions on socio-economic disparities between (in-country) regions and across local labour markets.

Given this variety between sectors, demographics, and geographies, STI policymakers should co-operate with sector-specific and horizontal policy domains to co-invest in and co-manage coherent portfolios of programmes tailored to specific sectors and places (See Table 1). Active co-operation across levels of government - local, regional, national, and supranational - is also needed to clarify roles and responsibilities and to ensure that policies at all levels of government are well aligned. Some progress has been made in terms of aligning objectives and activities across policy domains; however, this has largely been limited to high-level strategy development (OECD, 2023[29]). New governance arrangements will require a clear mapping of interdependencies to understand what types of co-operation channels and joint actions are needed to deal with specific challenges. In this respect, governments can deploy a range of measures, including shared national visions, roadmaps and missions; joint programming; and strategic oversight by cross-departmental committees. Nuanced and strategic co-ordination in the public sector will also demand new skills, organisational capabilities and incentives.

Table 1. Examples of horizontal and sectoral public policy areas closely related to STI policies
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Example policy domains	Policy instruments and relevance to the Agenda
Tax & finance	**Taxation**, including general corporate taxes, carbon taxes, R&D tax incentives, etc. can influence the propensity of firms to conduct low carbon R&D. **Financial services regulation**, which circumscribe the investment profiles and roles of institutional and other investors, can promote responsible investment practices, e.g., environmental, social and governance investment approaches.
Economy & industry	**Market rules and regulations** that promote competition and consumer or environmental protection can impact the rates of general versus green innovation. **New industrial policies**, including subsidies, can promote low carbon sectors or technologies. **Investment promotion**, both inward and outward, shapes the profile of domestic business, the business environment, and international linkages, which can influence the types and levels of R&D and innovation performed. **Trade policies**, including export promotion, international agreements that remove trade barriers, and export controls can shape the production and consumption of low carbon products and services.
Education & employment	**Investments in education and other education policies**, from early learning to tertiary education, including adult learning and retraining, can provide the skills necessary for green R&D and innovation and help ensure that underrepresented groups are able to contribute to sustainability transitions.
Environmental protection	**Environmental regulations** that promote biodiversity, pollution control, waste management, natural resource management, etc., shape incentives for R&D and innovation in the public and private sectors, both to develop new products and services and to ensure regulatory compliance.
Foreign affairs & international development	**Science and technology diplomacy** promotes international STI linkages, particularly with low- and middle-income countries, and can advance global sustainability transitions. **Overseas development assistance**, which increasingly incorporates elements of STI, including technology transfer and the development of STI skills and capabilities, can bolster efforts that tackle global challenges like climate change.
Examples of sectoral policies	
Health & social care Energy Transport Agriculture & food Construction Defence	Sectoral policies in many OECD countries often have their own **R&D and innovation support activities and capabilities**, which can be considerable and complement funding initiatives under the direct purview of STI ministries and agencies. Policies in these sectors include **standards and regulation** that shape related STI activities. These are especially important in later phases of transformation, since they shape the environment for new technologies to emerge and diffuse and for established ones to be phased-out. Sectoral policies here play leading roles in creating markets for new technologies and innovation, for example, through **innovation-oriented public procurement**.

STI activities and policy must be agile and evidence-based

Pursuing the transformation of socio-economic and STI policy systems will involve novelty, uncertainty and complexity. There is growing recognition that governments and researchers cannot be expected to anticipate how all potential systemic threats (economic, environmental, geopolitical, societal and technological) and corresponding challenges might evolve (UNISDR, 2015[30]). Similarly, traditional policy mechanisms can be too slow and/or conservative to support certain types of activity, such as industry partnerships or the responsible governance of rapid technological change. So while green transitions call for bold and urgent policy interventions, these need to be sufficiently flexible to consider emerging developments, seize new opportunities and tackle unexpected challenges as they arise.

Agile policymaking processes are needed to prepare for and respond quickly and effectively to changing circumstances, emerging trends, and evolving challenges, and to target action where it is most needed. Agile policymaking is also needed to halt policy initiatives that are unsustainable or do not deliver expected outcomes. Policy support has conventionally been developed as 'fully baked' individual instruments, which can limit their ability to leverage opportunities, avoid bottlenecks and act on evolving evidence (Kuhlmann and Rip, 2014[31]).

Emerging tools and methodologies that embody experimentation, engagement, and iteration represent promising advancements. Policy experimentation, which involves the systematic evaluation of new ideas or interventions, can enable STI policymakers to balance flexibility and stability by testing and iterating a range of options before choosing the programmes to scale up (Kuhlmann and Rip, 2014[31]). Many governments are already exploring ways to create spaces for experimentation inside the public sector, using, for example, policy innovation labs (Monteiro and Kumpf, 2023[32]), living labs (Bouwma et al., 2022[33]), and regulatory sandboxes (Attrey, Lesher and Lomax, 2020[34]). However, their adoption remains relatively nascent in most jurisdictions and sectors. These efforts now need scaling to become more routine and institutionalised.

Diverse types of strategic intelligence will also be essential. Governments have deployed horizon scanning, early-warning systems, and nowcasting to anticipate change and associated threats and opportunities (Arnold et al., 2023[35]). Some policymakers and researchers have also turned to crowdsourcing platforms to gather insights directly from affected citizens, which is arguably one of the most expedient and effective paths to address the needs and concerns of different social groups, including underrepresented groups, in the development of STI-based solutions (Paunov and Planes-Satorra, 2023[36]). In addition, public engagement can cultivate trust in scientific and governing institutions, which is a critical enabler of agile decision-making and the agile deployment of STI-based solutions (See Box 1). This was made evident during the COVID-19 pandemic, where widespread social acceptance was necessary to accelerate the adoption of STI-based solutions and to facilitate the development of transition policies with strong public support (Caulfield et al., 2021[37]) (Tan et al., 2022[38]) (OECD, 2023[39]). Similarly, social acceptance and engagement will be necessary to mitigate environmental threats, to advance sustainability transitions and to respond swiftly and effectively to unintended consequences of green policies.

Box 1. Tools and platforms to support participatory policymaking: examples from Portugal

There are several examples of infrastructure, platforms, and other tools to support public participation in Portuguese policymaking. For example, the LabX – Centre for Innovation in the Public Sector was launched in 2017 under the government's Administrative Modernization Agency. It has since been institutionalised by the government to provide autonomy and broad connectivity to public entities at national, regional, and local levels. The Lab aims to provide a safe space to support policymakers in experimenting, while prioritising citizen needs and expectations and technological and economic feasibility. As such, operations promote a culture of ideas exchange and co-creation to involve the public in identifying needs, and the (re)design of public services.

LabX originally faced difficulties stemming from the reluctance of policymakers to collaborate with citizens to transform public governance. Accumulated experience through the collaboration of more than 10,000 citizens and 2,000 civil servants has enabled participants to move past these initial biases. The Portuguese government has also attempted to enable the active participation of citizens in the definition of the national science and technology agenda through the Public Participation Laboratories, and in government budgeting processes through the Portugal Participatory Budget initiative (PPB). Specifically, PPB has been deemed the world's first national public participatory budget. It allows citizens to propose and vote on public investment priorities and uses a combination of face-to-face interactions and digital platforms to maximise engagement and ensure inclusion. The first PPB took place in 2017, gathering over 1,000 ideas and almost 80,000 votes from Portuguese citizens, and resulting in roughly 40 projects for implementation. The initiative has continued to evolve, resulting in improvements to the website, increases in the available budget, and the inclusion of all policy domains.

Towards a Transformative Agenda for STI Policy

To support the reappraisal and reform of STI policy, the OECD's Committee for Scientific and Technological Policy (CSTP) has developed the *Agenda for Transformative Science, Technology and Innovation Policies*.[11] The Agenda is comprised of 3 main components (Figure 1), as follows:

1) Transformative goals for STI to pursue

Instability posed by current socioeconomic, environmental, and political challenges create pressures for the transformation of contemporary economies and societies towards configurations with desirable traits. These traits are reflected in the Agenda's three transformative goals: **advancing sustainability transitions, promoting inclusive socioeconomic renewal, and fostering resilience and security.**

2) Policy orientations to steer STI policy towards transformative change

The Agenda identifies six key policy orientations that should help point STI policies towards positive transformative change. These policy orientations are crosscutting and apply to all areas of STI policy. While they are hardly novel and have been in evidence for some time, their broader adoption would represent a shift in orientation of much STI policy seen over the last 25 years. The policy orientation in most countries remains traditional, however, with some signs of movement towards a more transformative orientation. As for future prospects, the transformative STI policy orientation may become a dynamic additional layer in the policy mix rather than wholly displacing the traditional orientation.

3) Areas of STI policy where change is most urgently needed

This reappraisal of STI policy is best done at the level of specific policy areas. Because transformations depend on well-functioning STI systems to generate and utilise STI-based solutions at pace and at scale, all aspects of STI policy and governance are implicated. This may require the phase out of established ways of doing things, while the evolution or maintenance of current practices may also be key.

Endnotes

[1] Since 2020, there has been a resurgence in the subsidisation of fossil fuels. The cost of production and consumption supports grew to over USD 1.4 trillion in 2022, up from 2021 levels of roughly USD 770 billion and 2020 levels of over USD 400 billion (OECD, 2023[40]).

[2] Longitudinal data from the mid-1980s to 2012 indicate that income inequality has increased in 17 of the 22 OECD countries for which data is available (Cingano, 2014[41]). Analysis indicates a widening gap between high- and low-income households in countries that are already pre-disposed to higher levels of inequality. However, income inequality has also risen in some countries that have traditionally had lower levels of income disparity, such as Germany and the Nordic countries.

[3] Analysis suggests that the COVID-19 pandemic contributed to the largest growth of between-country income inequality in thirty years (UN, 2023[1]). From 2019-2020 this was projected to rise 4.4%, up from the pre-pandemic forecast of a 0.8% decline.

[4] See other related OECD works, such as publications developed through the Resource Efficiency and Circular Economy (RE-CIRCLE) project, the Horizontal Project on Climate and Economic Resilience (NET Zero+), and the OECD Roundtable on Financing Water, among others. In addition, the organisation manages several databases, such as the International Programme for Action on Climate (IPAC).

[5] OECD government budget allocations research and development (GBARD) statistics indicate that, while there has been limited real growth in defence R&D funding since 1991, spending in this area has recently seen a sustained recovery (OECD, 2023[42]). In the near term, total defence expenditures are projected to continue to grow in a number of OECD countries.

[6] In the 2023 update to the IEA's Net Zero Roadmap, roughly 35% of the emissions reductions required by 2050 to reach net zero are projected to come from pre-commercial technologies (IEA, 2023[23]).

[7] While manufacturing capacity and adoption rates have accelerated for many clean energy solutions (e.g., solar photovoltaics, electric cars, residential heat pumps, battery storage) in the last 2 years, a considerable lag persists between when a technology becomes dominant in new deployments versus when dominance is achieved in terms of overall operating stock (IEA, 2023[23]). The deployment of many larger scale technologies (e.g., carbon capture, utilisation and storage; liquid biofuel, hydrogen) has also accelerated. However, the majority of projects remain in the concept and feasibility stage, with 95% of announced projects not yet at the point of a final investment decision. Deployment rates are also relatively uneven across regions. For example, from 2015-2022, roughly 85% of the wind and solar capacity that came online was located in advanced economies and China.

[8] The most recent IPCC report suggests that without urgent effort to strengthen policies, projected global GHG emissions to 2030 are likely to contribute to a rise in global temperatures greater than 1.5C above the pre-industrial level and may result in an average increase of 3.2C by 2100 (IPCC, 2023[43]).

[9] The innovation chain refers to the complete pipeline or range of activities that occur within STI systems (Miremadi, Saboohi and Jacobsson, 2018[44]). Taken as a complete sequence from basic research to the diffusion of a resulting innovation, it represents the sequence of steps required to move from initial conception to adoption. However, knowledge often does not move through this 'chain' of steps: research, development, demonstration, deployment and diffusion, in a linear way. Instead, this is an iterative process with numerous feedbacks between the various steps. It is also often the case that knowledge does not consistently advance from one step to the next. For example, much of the research activity that occurs is fundamental, curiosity-driven research that is undertaken to advance scientific understanding.

[10] A narrow conception of scientific excellence continues to drive public research in many countries. Academic research and assessment processes that prioritise traditional outcomes (e.g., journal publications) can disincentivise certain types of STI activities, such as inter- and transdisciplinary research (OECD, 2020[45]). Yet such activities are needed to advance on issues of sustainability, inclusion, resilience, and security, which are inherently multidimensional and multi-scalar, and require insights from different disciplines and sectors of society.

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[11] The Agenda for Transformative STI Policies provides a starting point policymakers and other relevant stakeholders to formulate and implement STI reforms that will accelerate positive change. It will be supplemented by two additional layers of support: modular guidance for specific STI policy areas where change is most urgently needed and policy toolkits, or step-by-step, interactive online tools to support users in translating policy actions into feasible and context-specific actions. A 2023-2024 pilot project with Thailand is being used to test and experiment with module guidance and toolkits for several STI policy areas. It is also envisioned that future projects will use mutual learning methodologies to partner with OECD member countries with a focus on co-creation and sense-making to codify insights into improved policy guidance.

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