Shared challenges, transformative actions

OECD Science and Technology Policy Ministerial

23-24 April 2024, OECD, Paris

Issues Notes

BETTER POLICIES FOR BETTER LIVES

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Breakout B – How to direct research and innovation funding and finance to address the climate challenge?

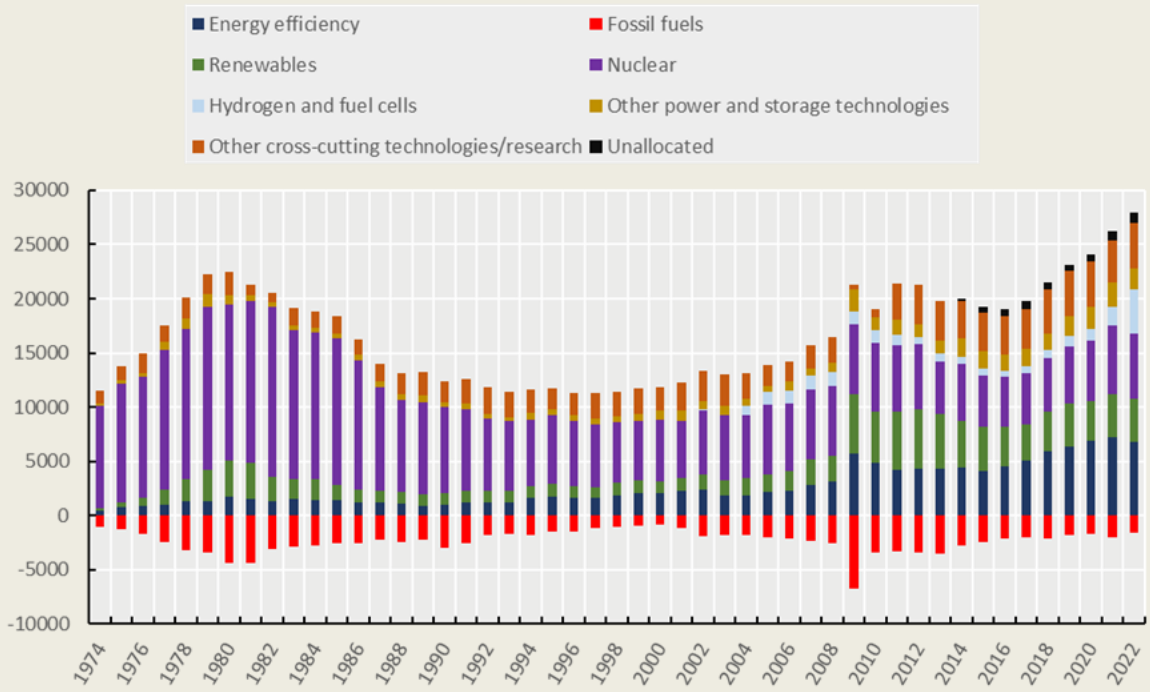
24 April 2024, 11:45-13:00 Paris time, OECD Conference Centre, Room CC18

Chaired by: Lee Chang-Yune, 1st Vice-Minister of Science and ICT of Korea

Key issues

- The green transition will require sustaining high levels of investment across the entire research and innovation chain, from generating cutting-edge scientific knowledge to devising and implementing new solutions that accelerate the **transition to net zero** and make it a winning proposition for all. Since the industrial revolution, increasing levels of wellbeing and material prosperity have been achieved through scientific and technological advances, which have ultimately contributed to the challenge of global warming faced today. Continuing this path risks endangering humankind's future if there is no collective action to undergo a deep and increasingly urgent transition.
- Advances in science, technology and innovation (STI) are necessary for such a large scale and complex change. Without the contribution of STI, the transition to net zero may prove too difficult for all countries and parts of society to embark upon and sustain. Indeed, modelling of the energy sector shows that 35% of the required reduction in CO2 emissions through to 2050 will have to come from technologies that are not yet on the market (IEA, 2023[1]). Moreover, the technologies needed to decarbonise other key industries vital for feeding the planet's population whilst protecting ecosystems, providing shelter, and enabling transportation need substantial breakthroughs.
- Government financial support for STI in the public and private sectors is a key part of the broader set of policy measures to combat climate change, both for mitigation and adaptation. Without this support, including for fundamental research, progress on low-carbon innovation, such as recent advances in the affordability of renewable energies, would not have been possible.
- However, current levels of government support and private sector investments are not sufficient to meet the challenge. As OECD data shows, growth in government budgets for research and development (R&D) on energy and the environment has stalled in comparison other government priorities. Public expenditures on low-carbon energy research, development and demonstration expenditures have only recently risen back to 1980s levels. Data from the International Energy Agency (IEA) on government budgetary support for R&D and demonstration show that support for low carbon technologies has only recently caught up with the levels of the early 1980s, notwithstanding a recent upsurge in investment in R&D for renewables and energy efficiency (Figure 1).

Figure 1. Public R&D and demonstration expenditures on low-carbon and fossil-fuel technologies, IEA member countries, 1974-2022



Note: Figures in USD million in 2022 purchasing-power equivalent prices. Fossil fuel R&D&D expenditures depicted in red in bottom scale (negative), so that the sum of other categories approximates support for low-carbon technology (categories like Hydrogen may not be entirely low-carbon).
Source: OECD analysis of IEA Energy Technology RD&D Budgets database, accessed from https://www.iea.org/data-and-statistics/data-product/energy-technology-rd-and-d-budget-database-2

- Market-driven policy instruments designed to promote climate change mitigation and to raise overall levels of R&D and innovation are necessary but not sufficient for an effective mobilisation of STI funding. Breakthrough innovation in areas like energy, agricultural and industrial process emissions, is affected by shortcomings in markets and institutions that limit innovation in general. However, such innovation involves additional uncertainties and problems in aligning efforts, risks and rewards. There are deep-seated incentives for private and public actors to continue directing their scientific, inventive and innovative efforts to technologies and solutions that draw upon and entrench polluting technologies and habits, making it ultimately more difficult to transition to a net zero economy.
- In this context, public funding to support scientific and technological breakthroughs as well as their diffusion must come from several parts of government, including sectoral ministries and agencies in areas like energy, transport, agriculture, and health. Ministries and authorities with formal STI policy responsibilities need to help orchestrate this effort and steer public and private investments to where they are most needed. In addition to increasing levels of R&D expenditure, governments need to consider what their investments ultimately support and how, deploying portfolios of funding instruments that support high-risk high-reward research, development and demonstration of breakthrough technology, especially with direct or indirect links to green transformation objectives.

Key directions for policy

Previous and ongoing OECD work (Cervantes et al., 2023[1]; Larrue, 2021[2]) highlights several actions that governments can take to enhance the impact of their financial support for science and innovation to achieve net zero objectives:

- Adopt an appropriate, complementary and comprehensive set of measures that optimise the contribution of each component of the STI system to the green transition. Whilst the urgency to act on climate requires a focus on implementing already available state-of-the-art technologies, new solutions based on recent and future scientific breakthroughs are still needed and must be effectively supported.
- Sustain and increase investment in scientific research and transdisciplinary linkages, across domains and actors, to help build the knowledge foundations required for low-carbon innovation and for climate policies more broadly. This requires paying specific attention to the role of scientific and technical infrastructures and their unique business and financing models.
- Pivot towards a more appropriate balance of financial support (as well as an enabling regulatory framework) for business R&D and demonstration between outcome-targeted and technology neutral, demand-driven funding instruments. While neutrality and reduced policy discretion have several desirable features when funding R&D, they tend to favour work on technologies that are closest to the market and with the shortest payback time, which may direct some R&D away from key societal goals.
- Acknowledge that the green transformation requires active private and public investment in demonstrating and scaling up technologies to a point where they can be considered economically viable and ready for widespread adoption. This requires adopting measures that improve the alignment between private and public risk-bearing and rewards.
- Manage public STI funding and financing portfolios designed with a greater orientation to climate challenge requires consideration of governance arrangements. These must reconcile the need for agile policy responses with the need to provide a reliable sense of direction and incentives to invest over the long-run, build on domestic and international coordination and broaden stakeholder engagement in designing and implementing STI funding, while managing the risks of “greenwashing” support for STI.

Key questions for discussion

As discussed during Ministerial Plenary 3, the OECD Agenda for Transformative Science, Technology and Innovation Policy provides high-level guidance to support national STI policymakers in formulating and implementing reforms to accelerate and scale-up positive economic and societal transitions in the face of mounting global challenges. To help advance this Agenda, participants in this session are invited to consider the following questions:

- What are the key challenges and opportunities faced by science and innovation ministries in OECD and partner countries when prioritising and directing financial support for STI to contribute to the transition to net zero?
- How can the OECD, through the projects and initiatives of its Committee for Scientific and Technological Policy and in partnership with others, help governments to articulate, implement and monitor effective policies to accelerate the contribution of science and innovation to the green transition?

Background

Transformative change at the scale and depth required by the climate challenge calls for ambitious levels of STI investment over a long period, covering all parts of the innovation chain, from exploratory fundamental research to the deployment and diffusion of tested technologies. Some of the low-carbon technologies necessary to reach net zero emissions already exist, but their economic costs need to be reduced so that they can become fully competitive with more polluting alternatives and can be deployed rapidly and at scale (IPCC, 2022[4]). Other technologies are still in their infancy need to be further developed. Examples include hydrogen, bioenergy, and carbon capture, utilisation and storage. Meeting the climate targets will require sustained and elevated levels of investment in research, development, and deployment (RD&D). The IEA estimates that at least USD 90 Billion of funding needs to be raised by the public and private sectors by 2026 to complete a portfolio of demonstration projects for low-carbon energy technologies that could be commercially ready by 2030 to help achieve net zero emissions by 2050 (IEA, 2023[1]).

Government financial support for STI in the public and private sectors plays a key part in the broader set of policy measures to combat climate change, both in terms of mitigation and adaptation capabilities. The rationale for public support is particularly strong on account of the unique features of investments in STI aiming to help combat climate change:

- There are **large knowledge spillovers** from government support for early-stage R&D (Rubin et al., 2015[5]). These can be significantly larger for low-carbon technologies (Dechezleprêtre, Martin and Mohnen, 2014[6]).
- Firms developing clean innovations may face acute **financial constraints**, in part because many clean technologies are immature and because it is difficult to anticipate who will reap the returns along complex supply chains.
- Greenhouse gas emissions (and the damage they generate) transcend national **boundaries over long time periods and are not priced by the market**. As a result, the market for low-carbon technologies is severely underdeveloped (OECD, 2023b[9])
- **Climate policy uncertainty** is associated with significant risk and disincentives to investment, particularly in pollution-intensive sectors that are most exposed to climate policies and among capital-intensive companies (Berestycki et al., 2022[8]).

Several additional factors can impede low-carbon innovation at large such, including institutional and technology lock-in and path dependence (Aghion et al., 2019[10]). When making the case for and designing policies for transformative change, policymakers should draw on lessons from experiences in addressing structural system failures (i.e. infrastructure, institutional, interaction/network, and capabilities failures) and pursuing transformations (i.e. relating to directionality, demand articulation, and policy coordination). Directionality failures can reflect the lack of a shared vision, clear ownership, inability to coordinate across key institutions, inadequate regulation or standards, and a “lack of targeted funding for R&D and demonstration projects and infrastructures to establish corridors of acceptable development paths” (Weber and Rohracher, 2012[11]).

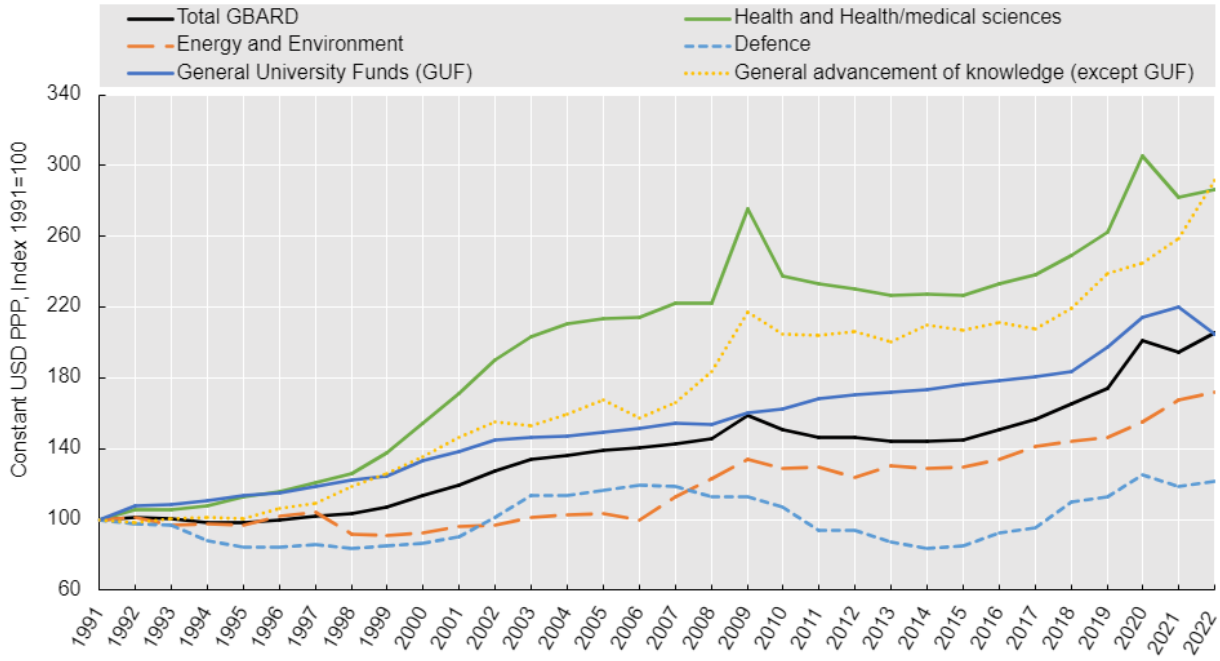
Low-carbon technologies will also be a source of future competitiveness for many countries. In view of the active nature of intervention by states to seize on the opportunities, international rules-based systems that shape how governments can intervene in markets are being tested. Global supply chains are being reshaped, and countries that rely heavily on fossil fuels are at particular risk. Russia’s war of aggression against Ukraine has exacerbated these pressures and highlights the importance of establishing reliable supply chains – particularly as many key minerals and metals currently come from high-risk areas (OECD, 2023b[9]).The geopolitical context provides an additional motivation for better aligning low carbon, competitiveness and energy security objectives when it comes to STI investments.

How are governments directing STI funding to address the climate challenge?

The broad picture on the directionality of public R&D

In view of these unique challenges, securing additional public funds for STI is not sufficient. Resources must be channelled to projects and institutions where they can make the biggest difference. Current levels of government support and private investment are not sufficient to meet the climate challenge. As OECD data shows, government budgets for R&D on energy and the environment have not grown as much as those focused on other government priorities (Figure 2).

Figure 2. Government budgets for R&D on energy and environment have been lagging support for other areas



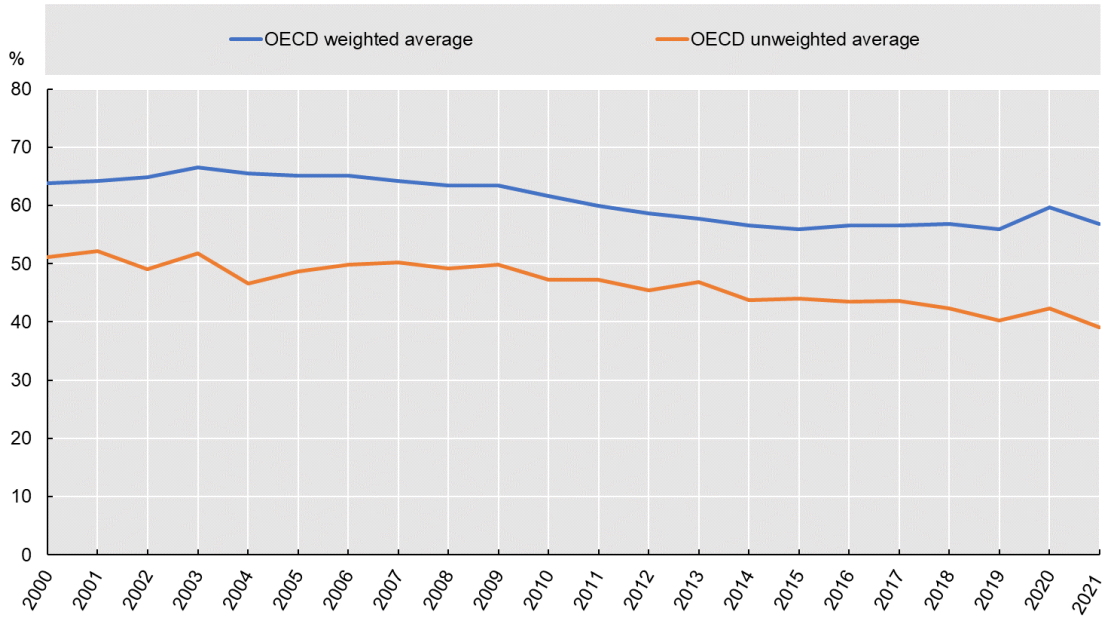
OECD calculations based on OECD, Main Science and Technology Indicators (MSTI) Database, March 2024, www.oecd.org/sti/msti.htm

Across OECD countries, a growing proportion of government support for public and private R&D is being channelled through instruments and funding oversight arrangements that transfer responsibility for where to invest to R&D performers. The share of R&D budgets for defined policy objectives has declined as support for mission-related objectives has been outpaced by non-directed R&D support programmes and instruments, such as tax incentives and support for the general advancement of knowledge (Figure 3).

By reducing directionality, a supposedly neutral demand-led approach to public R&D funding and financing, if not counterbalanced by means of a portfolio with more outcome-oriented instruments, can eventually undermine the ultimate objective of supporting scientific and technological efforts characterised by high risk but also high potential rewards for society. IEA data on government budgetary support for R&D and demonstration show that support for low carbon technologies has only caught up recently with the peak levels of the early 1980s, despite a recent upsurge in investment in R&D on renewables and energy efficiency. The role of low carbon technology within R&D budgets is also very heterogeneous across OECD countries and minimal among several (Figure 4).

Figure 3. The directionality of government support for R&D has declined across the OECD area

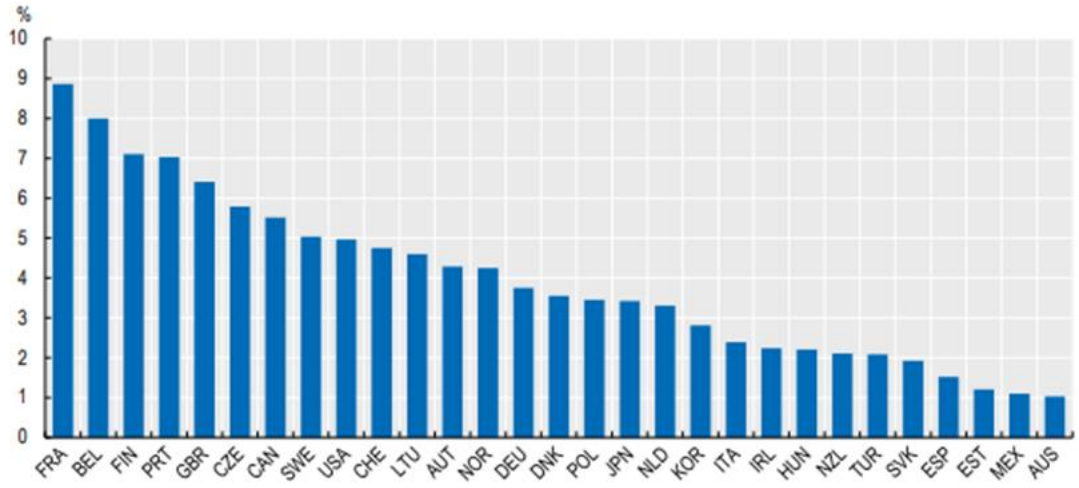
Share of total public support for R&D oriented towards specific socioeconomic objectives, OECD, 2000-2020



Note: The indicator displays the weighted and unweighted share of total government budgets for R&D (GBARD) and tax incentives for R&D that are not targeted towards specific Socioeconomic Objectives (SEOs) other than the general advancement of knowledge (SEOs 12 and 13) and R&D tax incentives. The directed component comprises GBARD) allocated to Socio Economic Objectives from 1 to 11 and 14. One key reason why the weighted OECD average share is higher than the unweighted equivalent is that the United Sates, the largest OECD country in terms of public support for R&D, has a higher shared of directed funding than the median country.
Source: OECD calculations based on OECD, Main Science and Technology Indicators (MSTI) Database, March 2024, www.oecd.org/sti/msti.htm, and OECD R&D Tax Incentives Database, https://oe.cd/rdtax, April 2024

Figure 4. OECD governments give different degrees of priority to low-carbon technology in their R&D budgets

Implied share of total government budgets for R&D devoted to low-carbon technologies, 2021



Source: Cervantes et al. (2023), based on IEA Energy Technology RD&D Statistics 2022 for low-carbon R&D budgets and OECD MSTI for total government R&D budget (GBARD).

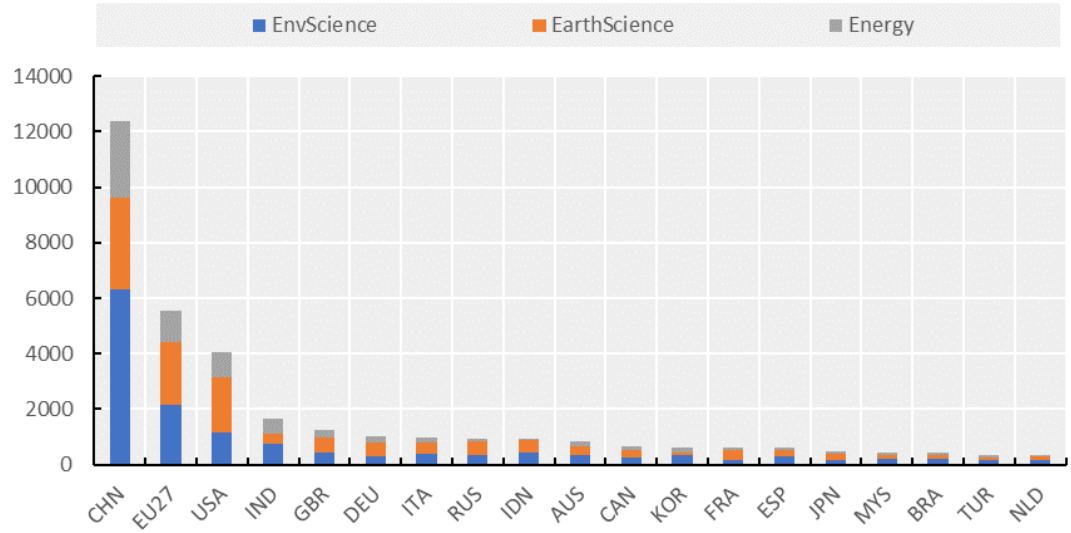
The response to the COVID-19 pandemic appears to have generated some momentum in terms of STI investments for the low carbon transition. According to recent OECD analysis, 51 OECD, EU and G20 countries allocated USD 1.29 trillion in spending for the development and deployment of low-carbon technologies as part of recovery and resilience fiscal packages since 2020. These new investments, including packages such as those supported by the EU's Recovery and Resilience Facility (RRF) and the US Inflation Reduction Act, are projected to reduce the greenhouse gas emissions of OECD countries by 9% in 2030 and 11% in 2050 (Aulie et al., 2023[12]). While investment supporting technology adoption today can have significant positive impacts, such as costs reductions through learning-by-doing, investing in R&D can have a very sizeable if not larger impact on emissions reduction over the long-term. However, the subset of measures funding technology development appears to be principally concentrated in later stages of technology development, while innovative technologies still need to be created and scaled-up.

Funding for science and scientific research

The response to a complex crisis like climate change depends on the mobilisation of knowledge and resources across a broad range of scientific disciplines. Scientific research plays a major part in the action to address climate change. As documented for example in the reports of the Intergovernmental Panel on Climate Change (IPCC) and the United Nations Framework Convention on Climate Change (UNFCC), science provides the necessary evidence to inform governments and citizens about the potential impacts from climate change, helping dispel mis- and dis-information that can erode public understanding of the challenges and trust in the institutions and policies designed to combat them. Investment for scientific research in several domains helps build consensus on the actual state of the planet's climate, its key drivers and the scenarios for future development and human intervention. Without a good understanding of the complex underlying interactions between natural and social phenomena, policy action would be significantly impaired and misguided. Governments need to support this continued effort, encouraging interdisciplinarity and citizen engagement. A welcome development is that major new actors such as China, India and Indonesia are contributing to science relevant to the green transition (Figure 5).

Figure 5. Major new actors are contributing to science relevant to the green transition

Main contributors to top-cited scientific publications in energy, environmental and earth science, 2022



Note: Total number of 10% most cited publications within the fields of Environmental Science, Earth and Planetary Science and Energy. Publications fractionally attributed to territories and scientific domains based on the authors' institutional affiliations and journal ASJC.
Source: OECD Science Bibliometric Indicators, based on Scopus Custom Data, Elsevier, March 2023. Accessed from https://stip.oecd.org/stats/SB-StatTrends.html?i=TOP10FPUBS_19_NBFRAC,TOP10FPUBS_23_NBFRAC,TOP10FPUBS_21_NBFRAC&v=8&t=2021&r=4

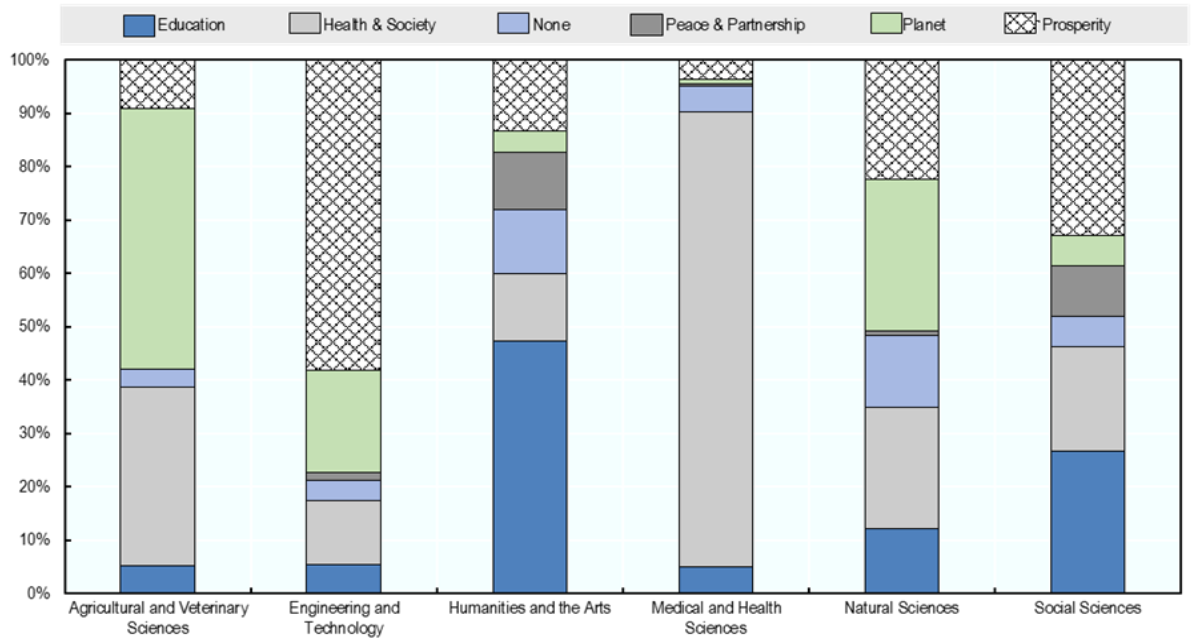
Scientific research also plays a critical role in pushing the boundaries of knowledge that applied researchers, engineers and designers can draw upon to come up with new viable technological solutions. By helping understand fundamental principles and charting unexplored pathways, basic science provides the means to develop new approaches for tackling otherwise intractable technical and socio-economic problems using current technology. Without such advances, social and political willingness to embrace climate change objectives and act on them would be severely diminished.

There is a natural tension between promoting scientific research that is explicitly oriented towards solving the practical challenges of climate change and encouraging a broad-based development of scientific capabilities that might ultimately contribute to such goals. While scientists in some fields are more likely to indicate that their research is relevant to the green transition (Figure 6), policy makers should avoid crude classification of scientific domains as relevant for net zero. This is because research for nominally different purposes can help to achieve climate goals in unexpected ways. Analysis of low-carbon and other environmental management patents indicates that core scientific disciplines like chemistry and physics, together with material sciences and biology, are among the most heavily cited sources of scientific knowledge relevant for new inventions by inventors and examiners.

Another example of the role of funding for scientific research in relation to low-carbon technology stems from the contribution of independent scientific research to enabling effective public understanding, trust and acceptance of low-carbon technologies, providing a key mechanism of defence for consumers, regulators, investors, and several others against “greenwashing” claims on products, activities and organisations. Support for scientific enquiry can also help anticipate and manage unintended effects of new technologies, ultimately contributing to societal trust and accelerated adoption of effective solutions.

Figure 6. Scientists in several fields report that their work primarily contributes to green Sustainable Development Goals (SDGs)

Distribution of SDGs reported as most relevant, clustered by group and broad field of R&D



Note: Planet = Goal 6: Clean water and sanitation, Goal 12: Responsible consumption and production, Goal 13: Climate action, Goal 14: Life below water, Goal 15: Life on land. The Prosperity SDG cluster includes Goal 7: Affordable and clean energy. Results based on 2908 responses.
Source: OECD International Survey of Science, 2021 http://oe.cd/issa.

Mobilising science to combat climate change also requires long-term commitment and sustainable support for research infrastructures and basic research across the breadth of science (OECD, 2023a[34]). From a public funding perspective, these infrastructures require special attention and considerable international co-ordination because they constitute strategic assets for monitoring and discovery as well as unique resources for capacity-building and applied research. Scientific research in several areas that are critical for the green transition relies on progress in highly specialised and advanced scientific technical equipment, the development of which requires that the public sector collaborate closely with business. Approaches to scientific research contributing to the green transition should also heed OECD recommendations on the pursuit of high-risk, high-reward research (OECD, 2021a[35]).[1]

Financial support for business R&D and innovation

As businesses account for close to 70% of total R&D in the OECD area, it is apparent that advances towards the green transition require the commitment of this sector. Public support can help mitigate, in part, the disincentives for private investment in R&D and other innovation activities that are particularly marked in the case of green technologies. While patent filings are not necessarily comparable indicators of inventive activity across different technology domains (a patent in one field may cover a narrower set of claims than in another), comparative trends on patent filings for climate related technologies are a cause of concern. Following a period of robust growth between 2004 and 2011, patenting of climate-related technologies declined as a share of global patenting, from 12.6% in 2011 to 9.0% in 2020 (Cervantes et al., 2023[2]). Inventions in several low-carbon technologies make intensive use of science as implied by patent references to non-patent literature. This is an indication of high potential spillovers from science to private R&D efforts.[2]

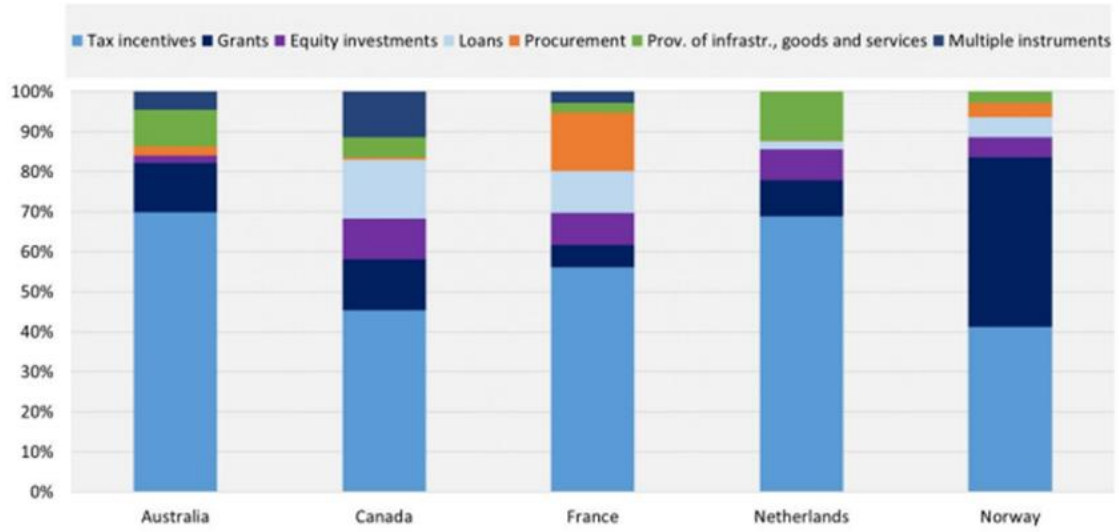
Several conditions shape the directionality of government support for R&D and innovation within businesses. This area still lacks systematic measurement and documentation, particularly for support instruments of an indirect nature and focusing on innovation activities beyond R&D. Since internationally compiled statistics on R&D budgets do not distinguish how these are allocated by objectives and beneficiaries, the OECD started a pilot project to map government financial support for innovation and develop a measurement framework (OECD, 2023c[15]). This exercise has revealed the need to factor in financial support mechanisms that may facilitate a return on investment, procurement of innovative solutions and the provision of infrastructure, goods and services, often mediated through R&D specialist organisations with a mandate to serve business needs. Among the countries participating in the pilot study assessing this methodology, R&D tax incentives tend to play the leading role (Figure 7), raising further questions about effective scope for directionality.

[1] This has been defined as research that 1) strives to understand or support solutions to ambitious challenges; 2) strives to cross scientific, technological, or societal paradigms in a revolutionary way; 3) involves a high degree of novelty; and 4) while having the potential for transformational impact, also carries a high risk of not realising its full ambition within the scope and timescale that many other scientific projects are assessed against.

[2] In contrast, growth in trademarks for climate-related goods and services has accelerated over the last two decades. (OECD, 2023b[9]). This may signal that industry is concentrating on diffusion and commercialisation as consumers begin to appreciate "green attributes" in goods and services, so that it pays off for firms *to be* and *appear to be* green.

Figure 7. An OECD pilot study shows the diverse range of business support instruments and their directionality by design and socioeconomic objective

Share of government support for business innovation by type of instrument in five pilot countries, 2021



Source: (OECD, 2023a[34]). OECD MABIS-SUPRINNO pilot mapping studies of business innovation support, June 2023.

There has been considerable change in the business R&D support mix over the last two decades, with a near-universal shift from direct support instruments, such as grants, to a greater reliance on R&D tax incentives. These incentives are best suited for helping firms systematise their innovation activities, encouraging near-market R&D. They are less costly to administer and, when neutrally designed and available on demand, are more easily compliant with state aid rules (OECD, 2018[16]). Only a few countries have also used tax measures to provide directionality for R&D in specific priority areas, such as green or energy related R&D. This includes the cases of Italy, which has a higher tax credit rate for certain types of technological innovation support for the environment, and Korea, which has an enhanced tax credit rate for R&D aimed at so-called "New Growth and Basic technologies" (235 technologies in 12 areas, including future cars, next generation electronic information devices, energy and environment) and "National Strategy Technologies" (Appelt and Galindo-Rueda, 2023[17]).

There is growing consensus that direct forms of support with demanding criteria are more suitable for supporting longer-term, high-risk research, as well as for targeting activities that generate public goods or positive spillovers. Direct and indirect measures are useful in combination, but the growing urgency of the climate crisis points to the need for an approach using more direct and targeted measures (OECD, 2021b[18]), connected to public-interest criteria. For instance, when assessing proposals, Canada's Strategic Innovation Fund Net Zero Accelerator considers diverse potential economic benefits (e.g., growth of Canadian firms, clusters, and supply chains), public benefits (e.g., gender balance in hiring), and innovation benefits (e.g., the creation of intellectual property). Directed programmes allow for more and possibly more efficient choice in determining the composition of project portfolios. The Strategic Innovation Partnership programmes in Sweden is one example. In this case, Vinnova ranks proposals and the Partnerships themselves can then pick the projects that rank above a certain threshold, and which best align with their broader objectives. While such direct funding programmes can help to direct R&D, many governments need to increase the capabilities necessary to operate these schemes (OECD, 2023d[19]). The strategic use of public procurement as an instrument to drive low-carbon innovation is still in its infancy despite considerable rhetoric about its potential, whilst policy makers remain reluctant to combine multiple types of policy instruments in view of the difficulties of implementation.

Leveraging financing from private sources

As noted above, the required investments for the transition to net zero must include private financing for STI. Sources can include R&D and innovation-performing firms, banks, venture capital investors and other sources of innovative finance. These can be spurred by policy, not only through public funding. The ultimate logic of government support for low-carbon innovation is not to replace what the private sector can do or socialise its costs while returns remain private. Rather, the aim is to provide a catalytic effect on for-profit investment sufficient to shift innovation dynamics towards a greener pathway. Governments can use risk-mitigation tools, such as first-loss mechanisms and equity guarantee schemes, to help firms cross 'valleys of death' at various stages in the innovation chain.

A new OECD database of "clean-tech" start-ups shows that there has been a substantial increase in global venture capital investment in climate-related start-ups in the last decade, growing from USD 3.1 billion in 2010 to USD 18.6 billion in 2020. However, only 3.5% of total venture capital investment in green start-ups from the period 2010-2020 was directed towards seed funding, compared to 7.8% for non-green start-ups. Governments are also incentivising venture capital and private equity investment for the green transition using a variety of models that vary in terms of the level of public ownership and direction over investment decisions (Berger, Criscuolo and Dechezleprêtre, Forthcoming[20]). For example, the Business Development Bank of Canada has a CAD 400 million Climate Tech Fund to invest directly in Canadian startups. The Government of Canada more recently launched the CAD 15 billion Canada Growth Fund, which will be managed by its Public Sector Pension Investment Board, to help Canada speed up the deployment of technologies to reduce emissions.

Several non-profit organisations share similar goals and are also active in this space, working alongside governments and the private sector. By combining public funds with private investment, governments can create a more favourable risk-reward balance for private investors. An example is the Dutch entrepreneurial development bank's SDG Loan Fund, which has successfully mobilised USD1.1 billion to advance the SDGs. The Fund's first investment was loss making. However, coupled with a MacArthur Foundation guarantee of USD 25 million for credit enhancement, the Fund is now mobilising capital from institutional investors who would not customarily be able to finance loans in emerging and frontier markets. Another example is the Green Growth Equity Fund (GGEF), supported by India's National Investment and Infrastructure Fund, and the U.K. Foreign, Commonwealth, and Development Office. The GGEF is a fund of funds aimed at sectoral platforms in firms working on renewable energy, e-mobility, energy services, and resource efficiency (Loukoianova et al., 2022[21]). Approaches like 'blended finance', which emerged as an innovative tool in the development community to mobilise private financing for sustainability projects in developing countries (Samans, 2016[22]), are gaining traction in the STI policy field as a way to combine public and private finance across the innovation chain (OECD, 2022[23]) (Miedzinski et al., 2020[24]). Governments should continue to experiment with these approaches, which have the potential to direct STI finance and help scale up private investments in R&D and innovation to better meet global challenges in both developed and developing countries.

Governance, coordination and monitoring

Governance and coordination

Public funding for STI to contribute towards the green transition must come from research and innovation ministries and agencies, as well as sectoral ministries and agencies in areas like energy, transportation, agriculture, health, and ministries dedicated to the environment, who invest in these areas on behalf of current and future generations.

The OECD Agenda for Transformative Science, Technology and Innovation Policy provides high-level guidance to support national STI policymakers in formulating and implementing reforms needed to accelerate and scale-up positive economic and societal transitions in the face of mounting global

challenges. Several messages apply to the aims of directing funding and finance for the green transition, including:

- **Actively co-ordinate and align priorities and interventions across government**: The fragmentation of governmental structures, often divided between government agencies with sometimes ambiguous mandates and sectoral ministries with different interests and priorities, which can be more complex in the case of federal states, can hinder the ability of governments to deliver the sorts of cross-cutting priorities and interventions called for by the transformative goals. Governments can deploy a range of cross-government and territorial co-ordination measures to alleviate fragmentation and better orchestrate their interventions, including shared national visions, roadmaps and missions; joint programming between research and innovation funding agencies; and strategic oversight by high-level cross-departmental committees. Some countries have also implemented structural and organisational changes, for example, by merging funding agencies or ministries and territorial authorities for STI that cover different parts of the innovation chain (Halme et al., 2019[25]). Some countries are experimenting with novel approaches, such as complementary pairings of supply-push and demand-pull interventions, as well as mission-oriented innovation policies (OECD, 2023e[26]). (see Box 1).

Box 1. Mission orientations for directing STI funding and financing

While setting objectives under a broad strategy is important for adding directionality to public policy, so is coordination among these policies. This includes ensuring coherence and integration of STI policies among themselves as well as integrating them with broader policy frameworks (e.g. with respect to regulations, skills, and infrastructure). **Mission-oriented innovation policies** (MOIPs) involve coordinated packages of policy and regulatory measures tailored to mobilising STI to address well-defined objectives related to a societal challenge, in a defined period. Many of the existing MOIPs are targeted directly to the 2030 and 2050 aims of The Paris Agreement treaty on climate change. MOIPs can span various stages of the innovation cycle from research to demonstration and market deployment. They can also mix supply-push and demand-pull instruments, and cut across various policy fields, sectors, and disciplines. While they confront many of the traditional challenges of national innovation systems, MOIPs tend to provide longer-term and more consistent funding compared to traditional research and innovation schemes, reflecting their alignment with the long-term character of broader, transformative goals. Integrating the lessons learned from MOIPs into the broader policy landscape can lead to more targeted, effective, and sustainable climate action.

Before the pandemic, mission-oriented policies were gaining popularity. Many governments integrated this approach into their COVID-19 recovery packages, launching new mission-oriented policies and missions under existing policies. The OECD has identified 101 "net-zero missions" under 35 MOIP initiatives – packages comprising multiple missions – in 21 member countries. Missions are adding directionality to innovation funding through a variety of models. For instance, Australia's national science organisation CSIRO is using a mission-oriented approach to guide one third of its funding. Its missions are large-scale, collaborative projects aimed at tackling national challenges. Denmark's Innomission programme has awarded funding for four green mission-driven partnerships, which bring together the country's top researchers, companies, and research organisations. The Innomission model allows these consortia to make funding decisions based on a roadmap that the consortia developed. In addition, five EU Missions are being used to focus a portion of Horizon Europe funding and encourage member states to act towards ambitious goals, with the goal of delivering results by 2030.

Source: (Larrue, 2024[3])

- **Align national transformative STI priorities and co-ordinate funding for research and innovation activities to address global challenges**: Cross-country information sharing, greater harmonisation of research priorities and joint funding calls among national funding agencies, private foundations and others can help address transformative goals in a more cohesive and international global manner. Such measures can help reduce duplication, enhance synergies and resilience, and maximise the impact of funding and scientific advancements. In this respect, inclusive international goals and conventions can aid in securing ambitious commitments, help to destabilise the status quo (Kanger, Sovacool and Noorkõiv, 2020[27]) and align context-specific efforts to address global challenges (Meadowcroft et al., 2021[28]). Long-term funding commitments will also provide researchers and institutions with the necessary financial security to engage in meaningful and impactful international collaboration.

Understanding public support and its contribution to the green transition

Understanding the intended and actual directionality of public support can help in policy reform. Investing in internationally comparable and comprehensive data on support for research and innovation can also provide the international community with the evidence required to help foster a level playing field, where countries compete and cooperate under a shared rules-based system.

Governments should develop and deploy the capabilities necessary to assess their policies to fund and promote STI investments for the green transition. Such assessment should occur both before policies are implemented and on a rolling and ex-post basis. This will help to drive policy learning and reform in a transparent and predictable fashion. It will also help to instil confidence among different actors, including taxpayers and the public at large.

Despite conceptual and practical difficulties, there is room for greater international coordination in developing common measurement approaches and making better use of available data resources, whilst also making progress towards higher quality and more interoperable administrative data that policy makers can draw upon for monitoring and analysis. These are among the goals for future OECD work in this area.

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