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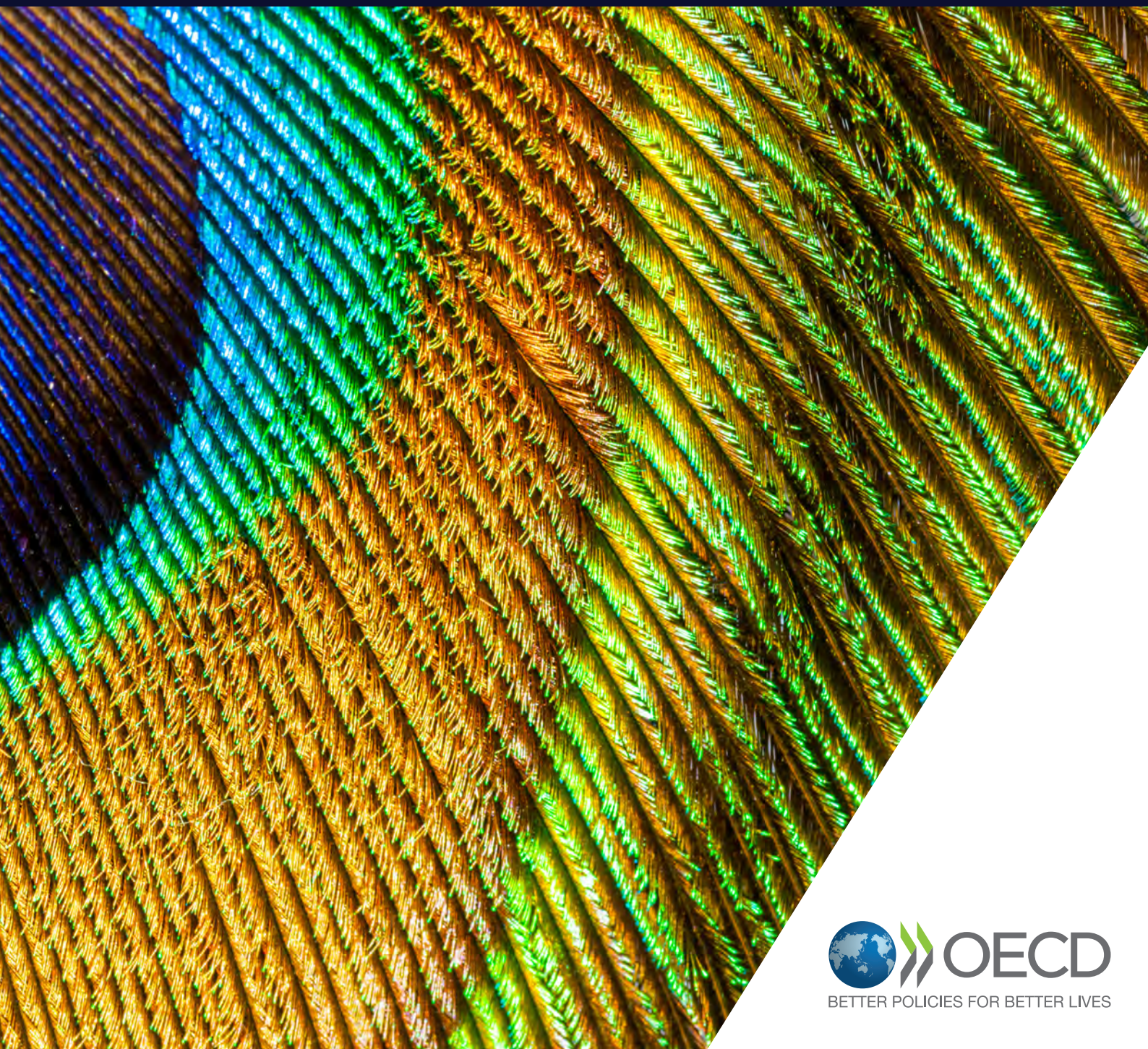
SCIENCE, TECHNOLOGY AND INDUSTRY POLICY PAPERS
APRIL 2024 No. 165

FRAMEWORK FOR ANTICIPATORY GOVERNANCE OF EMERGING TECHNOLOGIES



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Note to Delegations:

This document is also available on O.N.E under the reference code:

DSTI/STP(2023)33/FINAL

Please cite this publication as:

OECD (2024), Framework for Anticipatory Governance of Emerging Technologies, OECD Science, Technology and Industry Policy Papers, OECD Publishing, Paris,

https://doi.org/10.1787/0248ead5-en.

Framework for Anticipatory Governance of Emerging Technologies

Emerging technologies can contribute to unprecedented gains in health, energy, climate, food systems and biodiversity. However, these technologies and their convergence sometimes carry risks to privacy, security, equity and human rights. This dual-edged nature of emerging technology requires policies that better anticipate disruptions and enable technology development for economic prosperity, resilience, security and address societal challenges. Drawing on prior OECD work and legal instruments, this framework equips governments, other innovation actors and societies to anticipate and get ahead of governance challenges and build longer-term capacities to shape innovation more effectively. Its "anticipatory technology governance" approach consists of five interdependent elements and associated governance tools: (1) guiding values, (2) strategic intelligence, (3) stakeholder engagement, (4) agile regulation and (5) international co-operation. The emerging technology context determines how each of these elements is applied.

Keywords: Governance, Emerging Technologies, anticipation, foresight, citizen engagement.

JEL codes: H8, O3, H1, H0

Acknowledgements

The Framework for Anticipatory Governance of Emerging Technologies was a joint effort under the Technology Governance Pillar of the OECD's 2023-24 horizontal project on Going Digital, Phase IV (GDIV). The Committee for Scientific and Technology Policy (CSTP) led this pillar in collaboration with the Digital Policy Committee (DPC), the Regulatory Policy Committee (RPC), the Investment Committee's Working Party on Responsible Business Conduct (WPRBC), and the OECD the Strategic Foresight Unit. The framework was prepared with inputs from the Working Party on Bio-, Nano-, and Converging Technologies (BNCT) and also benefitted from contributions by all GDIV partners.

The framework text was drafted by David Winickoff, Laura Kreiling and Douglas K.R. Robinson (Directorate for Science, Technology and Innovation) with important inputs from Miguel Amaral and Guillermo Hernandez (Public Governance Directorate) and the other GDIV partners. The framework was produced under the guidance of Alessandra Colecchia, Head of STP Division (DSTI).

The team extends thanks to all those who have contributed throughout its development. This includes Hanna-Mari Kilpelainen, Jens Lundsgaard and Jerry Sheehan of DSTI for providing valuable comments and guidance and Eric Meslin, former President and CEO of the Council of Canadian Academies. Sylvain Fraccola designed infographics and oversaw all aspects of the publication process.

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Foreword

Today's technological landscape presents not only unprecedented opportunities, but formidable challenges and deep uncertainties. Even as we invest heavily in emerging technologies to drive ecological, social, and economic transformations, we are confronted by governance challenges: threats to research integrity, intensifying competition over supply chains, autocratic misuse, and disruptions to our social systems. These developments underscore the urgent need for innovation not only in technology but also in our institutions.

To enable responsible innovation, the OECD has developed an important set of activities in technology governance. This new Framework for Anticipatory Governance of Emerging Technologies helps synthesise and advance this line of work. It complements the recently inaugurated Global Forum on Technology (GFTech), a venue for regular in-depth dialogue to foresee and get ahead of long-term opportunities and risks presented by particular technologies. The Framework provides a general set of considerations that are intended to be a useful guide in these and related discussions.

This new Framework for Anticipatory Governance of Emerging Technologies actively promotes responsible innovation across policy fields, emphasizing shared values, anticipation, societal engagement, agile governance, and international cooperation. Both the GFTech and the Framework are built on the premise that, even as technology seems more and more autonomous, value-driven policy choices can and should shape better outcomes.

In what is a central pillar of its argument, the new Framework for Anticipatory Governance of Emerging Technologies suggests that better technological outcomes can be achieved through forward-looking, “agile”, and participatory strategies. These include developing norms, standards, regulations and early-stage innovation processes like building technology roadmaps. This anticipatory approach encourages broader policymaking communities to collaborate closely to ensure the effectiveness of these governance processes and mechanisms.

Finally, the Framework emphasizes that international co-operation centred on shared values, a fundamental tenet of the OECD, has never been more important. Realizing the transformative potential of these technologies amidst shared global challenges calls for enhanced co-operation and a collective understanding of risks and opportunities. This points to an important role for the OECD on technology governance in the years ahead.

1 Introduction

The political, economic and ecological stakes of realising good policies for emerging technologies have never been higher. Emerging technologies like synthetic biology, artificial intelligence (AI), advanced materials, neurotechnologies and quantum technologies can contribute to unprecedented gains in health, energy, climate, food systems and biodiversity. The promise of these technologies underscores the importance of the basic research that helps give rise to them. These technologies, as well as their convergence, will be key to future innovations in medicines, clean energy, and advanced manufacturing. A central challenge for innovation and regulatory policies will therefore be to support basic research and enable the development and diffusion of these technologies for economic prosperity, resilience, security and sustainable development.

Another goal for good emerging technology policy, however, will be to better anticipate disruptions, manage downside risks and bridge global technology divides. The release of generative AI and its sweeping functionality took many by surprise, underscoring the challenges of governing powerful new technology and highlighting the need for anticipation. The same emerging technologies that offer so much promise can also contribute to social disruption, environmental harm, the loss of privacy and trust in governing institutions, inequality, and threats to security and human rights. For example, facial recognition and spyware are tools in mass surveillance (Ryan-Mosley, 2022[1]), social media is a known vector for misinformation (Matasick, Alfonsi and Bellantoni, 2020[2]) and mandatory involvement in genomics research threatens human rights (Wee, 2021[3]). The importance of promoting responsible innovation that is inclusive and shaped by anticipatory technology governance has therefore never been greater and is now widely recognised.

Aims and audience

- **leverage emerging technologies** for societal benefit
- **anticipate, prepare for and act** on governance challenges in future emerging technology contexts
- **build longer-term governance capacities** to deal with emerging cases more effectively and efficiently

The framework might also inform national emerging technology strategies in addition to shaping emerging technology governance activities on the national and international level. The framework might also be a source of guidance for technology governance discussions within the OECD Global Forum on Technology (see Box 6.1), as well as future OECD work, including on future OECD legal instruments.

As the implementation of anticipatory governance requires a whole-of-government approach and collaboration across agencies, the framework has been designed with and for actors from a variety of sectors and agencies, e.g. governmental science and technology policy communities, regulatory communities, foresight and strategic units, and sector specific agencies in health, environment and economy.

Box 1.1. Key concepts

Emerging technologies. Technologies characterised by rapid development, evolution, novelty and uncertainty in trajectory and impact. Key examples include new gene editing tools and synthetic biology, neurotechnology, the latest advanced AI technologies, immersive technologies and quantum technologies.

Technology governance. The process of exercising political, economic and administrative authority in the development, diffusion and operation of technology in societies (OECD, 2012[4]; Kaufmann and Kraay, 2007[5]; OECD, 2018[6]). It can consist of norms (e.g. regulations, technical standards, and customs) and institutions, but also physical and virtual architectures that manage risks and benefits. Technology governance is effected through governmental activities, but also the activities of firms, civil society organisations and communities of practice, each of which have different modalities (Green, 2014[7]). **Anticipatory governance**, e.g. Guston, seeks to apply innovative forms of governance in earlier stages of technology development through the elements in this framework (Guston, 2013[8]).

Responsible innovation. Trustworthy technology development (from agenda-setting, to applied research and development and commercialisation phases, See Figure 2.2) that is guided by democratic values, responsive to social needs and accountable to society. Responsible innovation depends on effective anticipatory governance (see, e.g. *OECD Recommendation on Responsible Innovation in Neurotechnology* (OECD, 2019[9]).

Source: OECD

Rationale for a general framework: common governance questions

This framework brings together existing OECD standards, policy tools, and good practices to propose a general approach to the governance of emerging technologies. Working with and building upon governance work on specific technological areas, the framework aims to address recurrent issues and policy questions.

This approach is consistent with recent efforts to develop holistic technology ethics frameworks at the national level (National Academies of Sciences, Engineering and Medicine, 2023[10]; Nesta, 2019[11]). It is true that emerging technologies have unique governance needs that will differ across sectors and stages of innovation. Not every technology is ripe for additional governance approaches, nor will governance be effective in every case. Still, emerging technologies pose many of the same policy questions and challenges, for example:

- **How to balance risks and benefits of emerging technologies under conditions of political, technological and economic uncertainty?** Pace and uncertainty in the direction, impact and risk creates challenges for governance to anticipate change and cope with unknowns. The private sector will generally continue to move at a pace that challenges governments and society to reflect on and develop effective policies. AI provides a case in point for the unexpected directions and impacts technology might take. Gene editing and the unexpected announcement of twins whose genomes were selectively modified at the embryonic stage also illustrate how disruptive advances and their implications can be hard to predict (Marx, 2021[12]).
- **How to adapt governance to converging technologies that cut across multiple regulatory categories?** Convergence of technologies results in the blurring of categories in prior frameworks, making it more complex and harder to govern emerging technologies. Here, synthetic biology provides a case in point as it combines biotechnology with AI and other digital technologies to

speed up the manufacture of novel and useful organisms; as a further example, brain-computer interfaces are bringing together neuroscience, digital tools, and new materials to restore or even enhance cognitive and motor function.

- **How to rally multilateral actors to engage in cooperative governance approaches given accelerating global competition?** Countries are calling for greater technological independence for reasons of economic competitiveness and resilience as well as national security. New pressures on trade in critical materials, intermediates and existing approaches to cross border data flows reflect shifts in multilateral co-operation on emerging technologies. Deepening competition, while an engine of innovation, carries the danger of putting downward pressure on the controls that might be necessary to promote accountable and responsible innovation.
- **How to address the mismatch between the transboundary nature of technology and the jurisdictional boundaries of governance and regulation?** While governance and regulation cleave to political jurisdictions, technologies tend to diffuse across borders, raising problems for the effective governance of technology, especially where international approaches are infeasible or unenforceable.
- **How to engage a broader range of actors in the design of technology and governance to make emerging technology more inclusive, democratic and effective?** Fake news, disinformation, conspiracy theories, political polarisation and risks related to the increase in special interest lobbying in the tech sector have all helped to erode trust in the authority of regulatory institutions (OECD, 2022[13]). This has contributed to undermining public understanding of potential risks and benefits of emerging technologies. Broader stakeholder engagement in the innovation is an avenue for building trust in the governance and innovation systems.

Summary of the framework

Importance of anticipation

To help address these challenges and answer these questions, this framework places anticipation at the centre of emerging technology governance. The common drivers noted above – and experiences with, for example, AI, neurotechnology and genetic engineering – point to the need to take on new kinds of forward-looking approaches to emerging technology governance. What might be called, “Anticipatory technology governance” encourages a shift in how we imagine the challenge of governance from the management of technological risks to “getting ahead” of technology developments (Guston, 2013[8]).

This approach seeks to address technology as it emerges and evolves to increase the power of governance both to stimulate innovation and manage risks. The framework aims to guide the development of national and international norms and standards, but also elements at earlier stages in the innovation process such as setting technology strategies, agendas and roadmaps, codes of scientific and engineering practice, and the organisation of research and development.

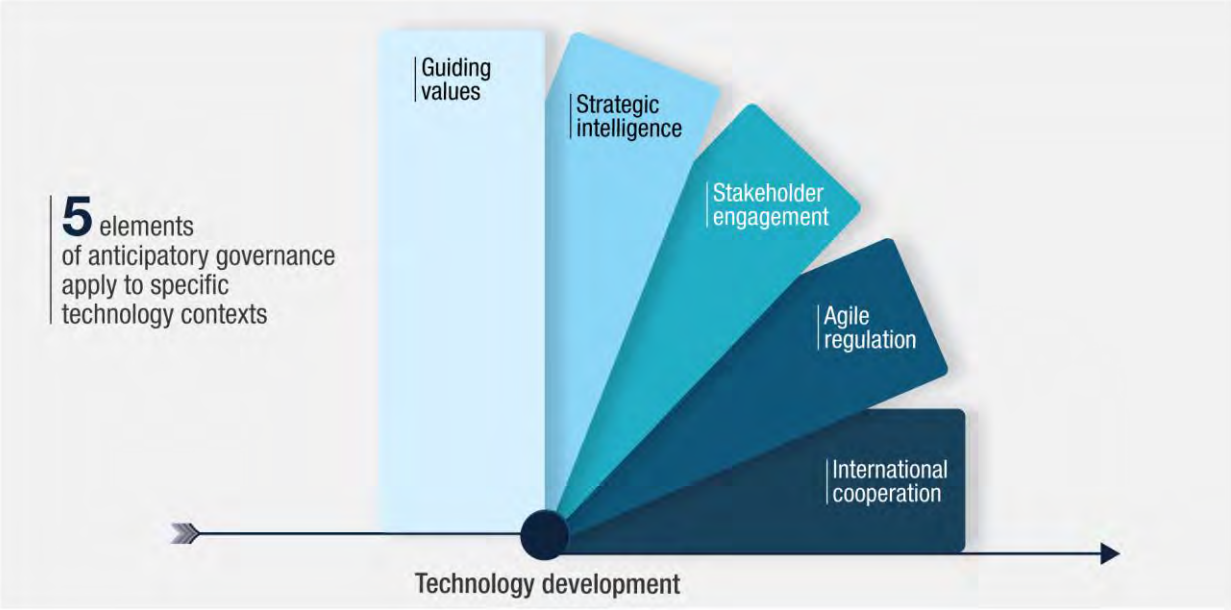
The notion of anticipation here promotes consideration of potential concerns through open and inclusive processes to better align innovation and regulation trajectories with societal goals (OECD, 2018[6]). Different policymaking communities will need to work hand in hand to achieve this vision.

Recent OECD publications have stressed the potential utility of upstream engagement, technical standards, and codes of practice (OECD, 2023[14]; OECD, 2023[15]) within the communities of science policy. In a complementary fashion, *the OECD Recommendation for Agile Regulatory Governance to Harness Innovation* stresses the need for a more forward-looking and agile approach within regulatory communities (OECD, 2021[16]).

Five elements of emerging technology governance

This framework features five interconnected elements (Figure 1.1). The elements and their associated actions should be interdependent and interactional.

Figure 1.1. Five elements of emerging technology governance



Source: OECD authors

Guiding values: technological development should be anchored in guiding values, both foundational (encompassing shared ethical, political, economic, and cultural ideals) and technology-specific (tailored to technology policy decisions). These values must be debated in particular technology contexts to ensure that technology governance aligns with human rights, democratic principles, sustainability, equity, inclusion, safety and public good. Ethical, social, and political dialogue can nurture and develop this values-based innovation culture. Integrating these values – and reflection upon them – throughout the entire process, from agenda-setting to deployment by innovators will help enable responsible and inclusive technological advancement.

Strategic intelligence: recognizing the unpredictable nature of emerging technologies, policies should foster shared forms of strategic intelligence, involving the comprehensive analysis of technology's potential directions, economic stakes, and societal implications. Robust tools such as horizon scanning, advanced data analytics, forecasting and technology assessment should be employed to anticipate future challenges and inform governance strategies. This anticipatory approach aids in the informed development of strategic visions, plans, and roadmaps for emerging technologies.

Stakeholder engagement: policies should prioritize the proactive engagement of stakeholders and the broader society in the policy-making cycle. Similarly, engaging diverse actors early in the technology development cycle enriches the understanding of issues, fosters trust, and aligns technological innovation with societal needs. Care is needed to balance the range of perspectives and ensure that vocal vested interests do not dominate the process. Tools for societal engagement, including capacity-building, communication, consultation and co-creation should be leveraged to ensure broad-based participation and alignment of science and co-design of technology strategies and governance.

Agile regulation: given the fast pace and evolving nature of emerging technologies, governance systems must strive for agility and anticipation through adapting regulatory tools, fostering inter-agency co-operation, developing forward-looking governance frameworks, and ensuring responsiveness to stakeholder concerns. Experimentation and testing under regulatory supervision should be encouraged to foster innovation, reduce uncertainty, and ensure that governance systems remain relevant and effective. Policy makers should also explore the potential of non-binding governance approaches such as high-level principles, technical standards and codes of conduct.

International co-operation: acknowledging the transboundary nature of technology, policies should promote international co-operation in the face of a shifting geopolitical landscape. Forward-looking dialogue in inclusive fora should be facilitated to coordinate approaches to emerging technology governance, share experiences, deepen understandings, and lay the groundwork for collective standard-setting. Promoting a multi-stakeholder, consensus-driven development of technical standards and principles ensures the interoperability of emerging technologies and the creation of markets for responsible technology products and services.

As Figure 1.1 (above) depicts, these elements and their associated actions should be interdependent and interactional. This interaction is especially prominent in the cross-cutting nature of stakeholder engagement. Dialogue and deliberation over guiding values will depend on the creation of fora for the engagement of policymakers, stakeholders and citizens, as will participatory forms of strategic intelligence and technology assessment. But other intersections are important, e.g. international co-operation and agile regulation will be greatly aided by forms of collective evidence-making like technology assessment and foresight.

Each of these framework elements apply to specific emerging technology contexts. The stage of technological development and the nature of the concerns raised in a technology case will determine how exactly the elements are applied. For example, the application of the elements to a technology like quantum computing, where risks and benefits are more speculative and removed from the present moment, will necessarily look different to their application in more developed technologies like synthetic biology where industrialisation has begun. There already exist regulatory systems in health or biosafety, or of AI, with sets of governance principles and where regulation is in development so that governance may be more a question of filling gaps or coordination.

Box 1.2. Key sources

This framework draws from high-level guidance as well as analysis from the most relevant OECD legal instruments in this domain, prior OECD analytical work, and scholarly and expert commentaries. The OECD has been at the leading edge of setting standards on technology governance through the adoption of OECD Recommendations. These are non-binding legal instruments adopted by the OECD Council and present a political commitment to the principles they contain. Three of these Recommendations are foundational to the topics covered in this framework:

- The Recommendation on Artificial Intelligence (OECD, 2019[17]) sets out five principles and five recommendations for policy makers to enable governments and other actors to shape a human-centric approach to trustworthy AI.
- The Recommendation on Responsible Innovation Neurotechnology (OECD, 2019[9]) guides governments and innovators to anticipate and address the ethical, legal and social challenges raised by novel neurotechnologies while promoting innovation in the field.

- The Recommendation for Agile Regulatory Governance to Harness Innovation (OECD, 2021[16]) provides guidance for using and adapting regulatory policy and governance in the face of the regulatory challenges and opportunities arising from innovation.

The framework also builds upon other OECD legal instruments and work of high relevance: the *Going Digital Integrated Policy Framework* (OECD, 2020[18]), the *Recommendation on the Governance of Critical Risk Regulation* (OECD, 1995[19]), *Recommendation on Regulatory Policy and Governance* (OECD, 2012[20]), *Declaration on Public Sector Innovation* (OECD, 2019[21]); the *OECD Innovation Strategy* (OECD, 2015[22]), the *Going Digital Guide to Data Governance Policy Making* (OECD, 2022[23]), the *OECD framework for the classification of AI systems* (OECD, 2022[24]), the *Recommendation on the OECD Due Diligence Guidance for Responsible Business Conduct* (OECD, 2018[25]), the *OECD Guidelines for Multinational Enterprises on Responsible Business* Conduct (OECD, 2023[26]) and the *OECD Recommendation Governing the Protection of Privacy and Transborder Flows of Personal Data* (OECD, 2013[27]).

Source: OECD

2 Guiding Values

Table 2.1. Key actions

Place the consideration of values at the centre of innovation policy to harness the positive potential of emerging technologies
Use foundational values shared by liberal democracies as a starting point to anchor responsible innovation and identify values specific to technology contexts
Enable deliberative, accountable and trustworthy processes, to prioritise and specify values in a given technology context. To do so, create fora within and across diverse communities, build capacity for meaningful engagement and ensure information integrity
Embed values throughout the innovation cycle, including in agenda-setting, design of R&D, design of technology and regulation. This requires innovation actors to seek to align technological development with values in particular institutional contexts at particular loci in that process

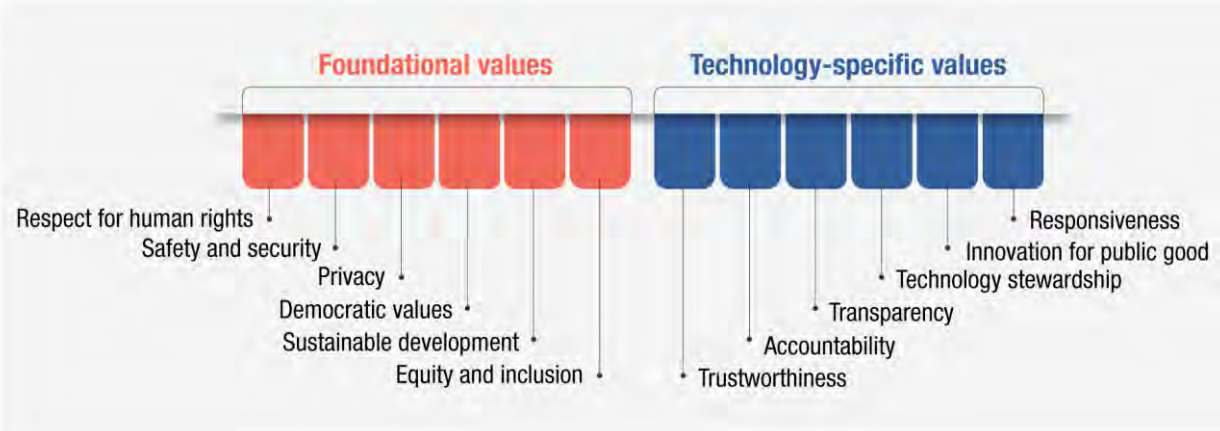
Technology is necessarily shaped by the logics of physics and the properties of matter, but the history and sociology of technology shows that human values, institutions, choices and economic structures also shape technological trajectories (Bijker, Hughes and Pinch, 1987[28]). Element 1 emphasises the importance of placing the consideration of values and human rights at the core of the innovation process to enable the realization of the great promise of emerging technology for addressing the challenges we face. These values can be embedded in our innovation processes and even within technologies, as illustrated by "ethics by-design" approaches to technology development and the rise of "privacy enhancing technology" (D'Acquisto et al., 2015[29]) both within the public and private sector (see Box 5.3).

Embedding values in the innovation process requires a number of steps: first, identifying as a starting point a set of foundational values and technology-specific values shared by liberal democracies to root responsible innovation; second, building robust processes and engaging fora in which to deliberate on these values and how they should be applied in particular contexts; third, integrating values through diverse means in different phases of the innovation cycle. These three points are covered in what follows.

Identify shared values

Two sets of values are located here as relevant starting point for emerging technology governance: foundational values and values specific to the technology governance context (Figure 2.1).

Figure 2.1. Foundational values and values specific to the technology governance context



Source: OECD Authors

Foundational values

Foundational values express shared commitments to certain ideals of ethical, political, economic or cultural importance -- whether they be individual or social, professional or institutional, community or nation. It is important to note that values are subject to evolution, and technological change can reshape them. An example here is privacy, where the adoption of new technologies may drive or reflect new attitudes with respect to the protection of personal data.

Foundational values anchoring this framework can be found in collective public declarations of the OECD such as those at the yearly Council meeting at Ministerial level, which publicly express the "shared values" of the OECD community that should be considered for any standard it issues. These encompass several key concepts (OECD, 2021[30]; OECD, 2023[31]; OECD, 2022[32]):

- **Respect for human rights**, including protections of human dignity and basic liberties such as freedom of thought, freedom of expression and freedom from harms.
- **Safety and security** involve the adoption of measures to minimise risk of harm to economy, environment and human well-being.
- **Privacy**, including the basic interest in being free from interference with other basic rights and liberties, including the protection of personal data.
- **Democratic values**, including the rule of law, equality under law, representation and participation in public life and debate, procedural justice and the advancing the public interest.
- **Sustainable development**, including the responsibility to protect and enhance biodiversity and ecosystems, promote nature-based solutions, and address climate change while promoting human well-being.
- **Equity and inclusion**, recognising diversity and accessibility in its many forms, ensuring fair treatment and full participation of individuals or groups that are vulnerable and/or have been historically excluded or marginalised, and providing fair access to the benefits of innovation. It should be understood both in terms of outcome, i.e. striving to ensure the availability of technology, as well as process, i.e. expanding who participates in technological development. Importantly, in the technology context, it also aims to redress technological disparities across geographical regions.

Technology-specific values

Whereas foundational values convey broadly held, shared commitments and beliefs, a set of technology-specific values can be more targeted guides for policy decisions at specific points in time. Values specific to the technology governance context provide a moral and political basis for the priorities and trade-offs that are a feature of all technology governance decisions. These values have been promoted in other OECD work in specific technology contexts. Importantly, these values must work together.

- **Trustworthiness** includes ensuring that technologies, actors and their decisions can be counted on for accuracy, reliability and regulatory compliance[1]
- **Responsibility** involves the attribution of the consequences, positive or negative, of actions and decisions related to technologies, as well as accountability to those affected or to society in general.
- **Transparency** involves giving an open and honest description of information conveyed, its justification, and limitations, in language that is understandable and accessible.
- **Technology stewardship** places a duty on those with sufficient expertise and knowledge to create and use technology in ways that are aligned with foundational values (e.g. those above) and promote public goods.
- **Innovation for public good** emphasises the important benefits to society from technology innovation, and the need to lower unnecessary barriers to achieve that goal.
- **Responsiveness** requires meeting the expectation that promised technological outcomes are delivered in a timely way.

Enable deliberative processes

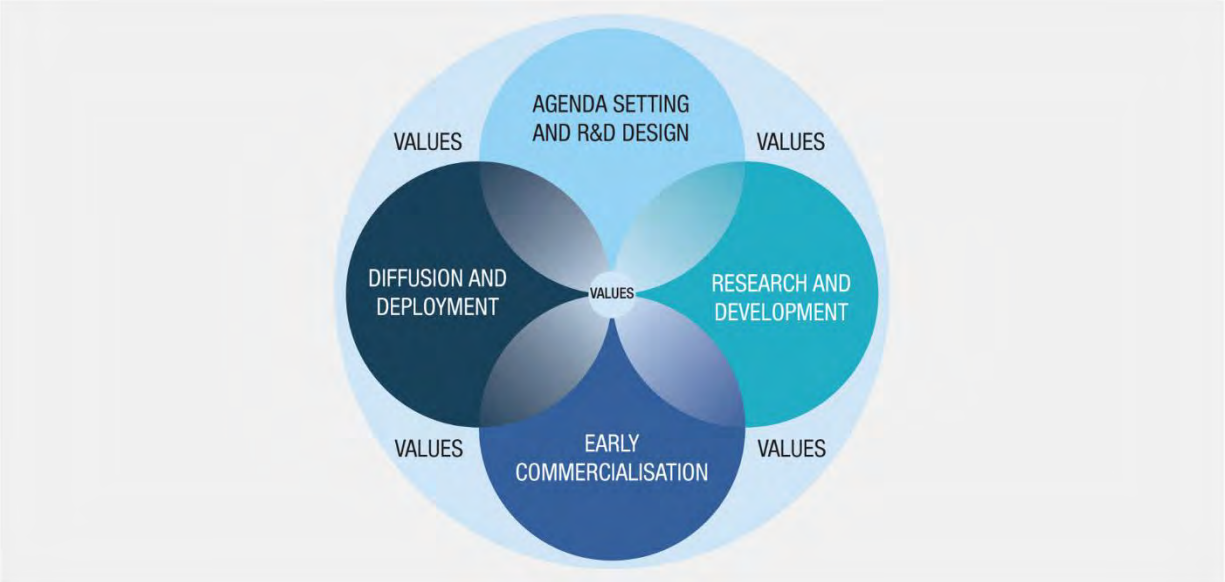
Embedding values in innovation requires their prioritisation and their specification in particular technology contexts. This work necessarily entails political, social and technical elements and requires accountable and trustworthy processes. Therefore, it requires (i) the active creation of fora at different levels of governance and within and across diverse communities of stakeholders to gather views that might be taken into account for political and technological decision-making – an example would be the support of technology "observatories" that collect available data and commentary such as the OECD AI Policy Observatory or the Global Observatory for Genome Editing based in the academic sector; (ii) building the capacity of policymakers, technologists, citizens and stakeholders for meaningful engagement in these discussions (see Element 3) through education, training, and better communication; and (iii) ensuring the integrity of information that is shared and forms the background of these discussions. These then can feed into processes of agenda setting, structuring research and development, early commercialisation and regulation. The creation of such communication spaces are themes in the rest of this framework, especially in Element 3 on engagement and Element 5 on international co-operation.

Communities and individuals make judgments about the acceptability of technology which may differ from person to person, group to group, and country to country. Actors must discuss and even debate what the values mean in specific contexts, and on how best to apply them in practice. In this way, a commitment to values-based innovation encourages dynamic and forward-looking consideration of what makes responsible technological development. And this underlines the high importance of creating suitable fora for these discussions.

Embed values throughout the innovation process

Innovation actors should strive to integrate values throughout the innovation process, not merely as an aspirational initial statement. This process includes, but is not limited to, four phases: (1) agenda-setting and research and development (R&D) design, (2) R&D, (3) early commercialisation, and (4) diffusion and deployment (Figure 2.2). This requires innovation actors to seek to align technological development with values in particular institutional contexts at particular loci in that process.

Figure 2.2. Integrating values at innovation phases



Source: OECD Authors

For instance, integration will require a considerable role for R&D funders in the public and private sectors, a commitment to engaging stakeholders and society (see Element 3), agility in the development of normative institutions, i.e. guidelines, codes of practice, and regulation (see Element 4) and forms of international co-operation (see Element 5). This consideration also puts responsibilities on private and public sector actors to uphold shared values in the development of technology.

3 Strategic Intelligence

Table 3.1. Key actions

Gather strategic intelligence in situations of technological uncertainty. Strategic Intelligence is useable knowledge that supports policy makers in understanding the relevant aspects and scope of the impacts of science, technology and innovation, and their potential future developments. It is particularly important for emerging and rapidly evolving technologies
Identify, diagnose, assess. (1) horizon scan to pick up weak signals for potential technologies of high interest; (2) diagnose the technology for levels of policy concern and ripeness for governance interventions using six dimensions; (3) appraise using broader array of tools and a wider involvement of experts and society -- assessing risks, uncertainties, and potential technology futures
Build capacity through international co-operation and best practice exchange. Advance the development of national and international foresight and technology assessment initiatives on emerging technologies by supporting national scientific agencies or institutes, offer targeted funding opportunities, and/or support collaborations between academia, government and industry
Nurture ecosystems of intelligence. Build an ecosystem of technology appraisal that is broadly inclusive of stakeholders and publics and coordinated across agencies

Many countries are actively creating and enacting national strategies or forward-looking policy agendas for the development of emerging technologies. These strategies as well as other policies require the capacity to anticipate in situations of high uncertainty. What kinds of capacities, evidence and evidence-making can enable anticipation and the development of strategic visions, plans and roadmaps? How can societies conduct appraisals of emerging technology that help inform both investment portfolios and forward-looking technology governance?

“Strategic intelligence” is a critical resource for useful anticipation. It refers to analysis and knowledge of the potential developments and implications of an emerging technology: the possible directions and economic stakes of its development, levels of social support, possible ethical and societal aspects that may need to be considered and potential impacts, benefits and risks. Such forward-looking analysis will be especially important where technology is predicted to have high societal impacts but with uncertain timelines and pathways. Here quantum technologies are a useful example (see Box 3.1).

Box 3.1. In focus: Quantum technology

Strategic will have a key role to play in building policies for technologies whose importance is clear but precise implications and pathways are still uncertain. For example, emerging quantum technologies (such as quantum computers, sensors and communications), promise to transform multiple industries, bolster advances in traditional computation and help tackle complex societal challenges through the harnessing of quantum mechanics. However,

quantum technologies are at an early stage many issues remain unclear including the effects of quantum on economic growth, national and international security and equity in both access and impacts of quantum.

Strategic Intelligence tools can help, such as Horizon Scanning to further articulate the expected developments in the field (UBA, 2023[33]). Technology Foresight can be conducted to identify potential transformative changes quantum could deliver; and participatory Technology Assessment, including public dialogues, can unpack the hopes, concerns and open questions regarding the impacts of quantum on various sectors, actors and communities (EPSRC, 2018[34]). For example, Quantum Delta NL has developed an Exploratory Quantum Technology Assessment approach to operationalise responsible innovation through structured and collective forward-looking processes combined with multi-stakeholder dialogue and assessment (Quantum Delta NL, 2023[35]). Another example is the Council of Canadian Academies' Quantum Potential which mobilises an expert-based horizon scanning technique to anticipate on a responsible approach to quantum technology adoption (CCA, 2023[36]).

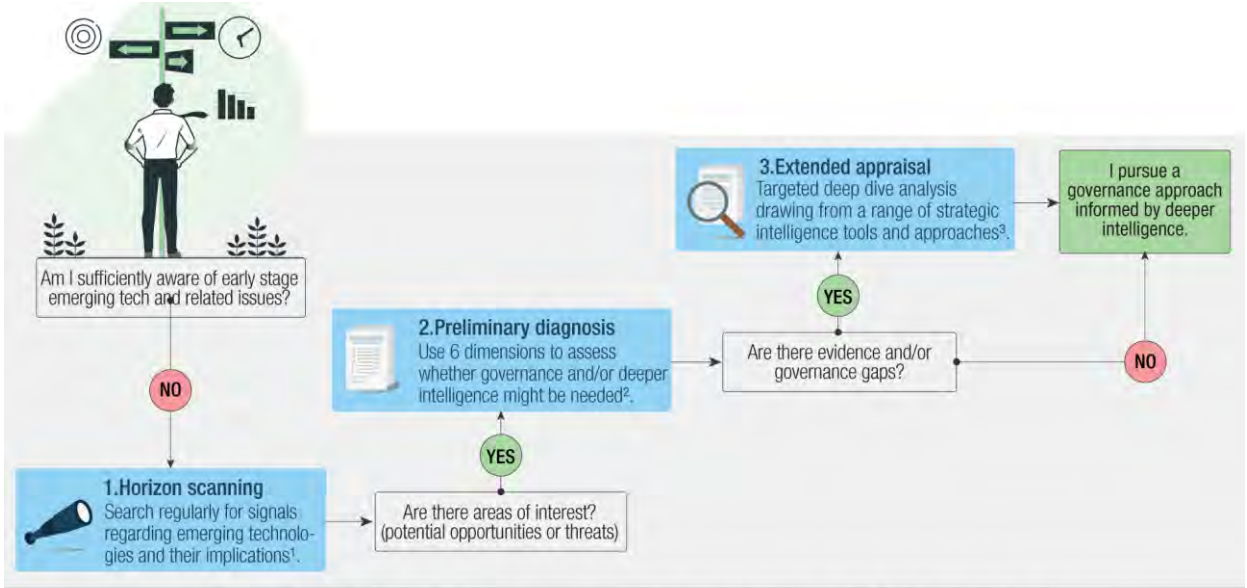
Anticipatory governance by like-minded nations with share values is key for building a prosperous and equitable post-quantum world. For instance, in a world where there remain digital divides, forward-looking strategic intelligence on quantum can inform policies to anticipate and better bridge these divides upstream.

Source: OECD

Tools for strategic intelligence and technology assessment

For agile and adaptive governance of new technologies, the production and use of strategic intelligence is important, but it is also important to target resources appropriately. To be both lean and adaptive, a three-step approach is needed (Figure 3.1): (1) exploring weak signals of potential opportunities and threats (horizon scanning); (2) a structured assessment of the situation along six dimensions, requiring low resource investment, to assess whether further investment in strategic intelligence gathering is necessary (preliminary diagnosis); (3) deeper dive analysis of technology to provide a richer evidence base selecting appropriate tools from the range of strategic intelligence tools (extended appraisal).

Figure 3.1. The three-step approach from horizon scanning to extended appraisal



[1]Scan for New technologies, Techno-environmental issues, New societal issues and Risks and opportunities.
[2]The 6 dimensions are: Uncertainty, Risk and Scale, Level of Public Concern, Pace of Maturation, Strategic Importance and Governance Gaps.
[3]Strat inteleligence toolbox: Tech Forecasting, Technology Foresight, Technology Assessment, Emerging Risk, Assessment

Step 1. Horizon scanning

Anticipatory governance requires policy makers to attend to newly emerging technologies that pose a particular threat or offer socio-economic and sustainability benefits. Horizon scanning is a regular exploration of new technology developments and signals that indicate which technologies (for example quantum), or socio-technical issues (such as the digital or quantum divide) are becoming areas of interest (seen as an opportunity or a potential concern).

By finding and exploring weak signals, horizon scanning can locate areas of technological interest, find key drivers of technological change and suggest how they may create new opportunities or threats. In this first (and ongoing) stage assessment, horizon scanning encompasses a 360-degree exploration of all early-stage technology domains. Governmental bodies, national and international agencies produce horizon scans on technology and global trends. For example, the US Office of the Director of National Intelligence regularly produces its Global Trends Report (National Intelligence Council, 2021[37]) to identify drivers, opportunities and threats, and the World Health Organisation (WHO, 2022[38]) scans for new health technologies and trends that may shape human health and health care systems around the globe.

Step 2. Preliminary diagnosis: six dimensions

Once an area of interest has been identified through horizon scanning, the next step is to see whether deeper analysis is needed to take policy action and what forms of strategic intelligence are required. Not all emerging technologies will require new or additional forms of governance or new strategic intelligence, so a preliminary diagnosis will be useful to position and evaluate the technology as one of greater or lesser concern. A preliminary diagnosis should use a set of six factors designed to assess and diagnose whether a more detailed appraisal is necessary (Box 3.2), and if so, to focus the appraisal and to assess the presence of any evidence gaps.

Box 3.2. Six dimensions for assessing governance needs of emerging technologies

- **Uncertainty**. Are the trajectories of development clear? If there is uncertainty, how could it be reduced? A higher degree of uncertainty militates for a greater amount of intelligence gathering, societal engagement and/or upstream governance.
- **Risk and scale of impact**. Despite uncertainties, how would we estimate/evaluate the potential impact of this technology on the foundational and technology-specific values discussed above -- from human rights and liberties to the environment, to human and or animal health and safety? How likely are the potential harms? How severe? How reversible?
- **Level of public concern or value conflict**. Is there an increase in public attention in this technology domain? Are there hopes or concerns about the emerging technology field? Are there high political stakes, or political disagreements and controversies? If high public attention warrants a more thorough technology assessment, as well as citizen and stakeholder engagement in governance approaches.
- **Pace of technology emergence**. Is there a rapid expansion in activity? Have developments in this area been accelerating in recent years? Is rapid development desirable? For example, an emerging technology may be perceived as especially promising a societal goal or mission, rendering high-pace development an imperative.

- **Strategic importance**. Is the emerging technology featured in national strategic goals such as global competition, response to crises, achieving green transitions?
- **Governance gaps**. Are present governance instruments fit-for-purpose? Are there recognisable (or suspected) regulatory or governance gaps?

Source: OECD Authors

Step 3. Extended appraisal

Extended appraisal of emerging technologies is a process that aides the understanding of the status of an emerging technology domain, the potential directions of development, possible ethical and societal aspects and potential impacts and risks of the technology area. It helps inform policy decisions, but does not involve decision making; rather, it provides strategic intelligence to understand deeply an emerging field and inform decision-making. Table 1 outlines four tools for technology appraisal, each of which addresses the reduction and management of uncertainty in specific ways. These tools are complementary and can be assembled into a whole.

Table 3.2. Strategic intelligence tools to provide data for extended appraisal

Approach	Description	Insights provided
Technology Forecasting	Uses trends and weak signals in the present to extrapolate into potential tech pathways	Gauges the pace of technology as well as identify key stakeholders and makes explicit their expectations on how the field is likely to unfold over time, thereby reducing uncertainty.
Foresight	Draws on multiple data sources to elaborate potential alternative tech future scenarios	Broadens the perspective of policy makers by increasing the understanding of new technologies in the envisioned future context and informs current day policy making. Can be made more robust by involving more stakeholders.
Technology Assessment (TA)	Analyses through mixed methods potential impacts of a new and emerging technology. Interrogates hopes and concerns of various stakeholders through the lens of norms and values of particular communities.	Provides deep insights into the actual and potential impacts of new and emerging technologies on the economy, on society and on the governance system. Participatory TA, complementary to expert-driven TA, mobilises a diverse range of stakeholders and can reveal various perspectives. Overall, TA can reveal governance gaps from both the technology development perspective and the application perspective (See Box 5.1).
Emerging Risk Assessment	Assesses of the ability of existing governance arrangements to manage or control emerging risks.	Provides a means of assessing existing risk governance approaches in a situation of paucity of data. Emerging risks include new risks (stemming from novel materials or technologies) or familiar risks that are becoming apparent in new or unfamiliar conditions. Such risks are highly uncertain and often have limited evidence on which to base assessments.

Source: OECD authors

While horizon scanning (see step 1) focuses on identifying new technologies of interest and policy options, governance actors are also interested in how new technologies may emerge and shape the world. Technology forecasting and foresight approaches handle this in two different ways. **Technology forecasting** uses trends and weak signals in the present to extrapolate potential pathways of emergence into the future (Sylak-Glassman, Williams and Gupta, 2016[39]). **Technology foresight** draws on multiple

data sources, including structured imagining, to elaborate potential alternative future worlds (scenarios) that can then be used to (a) broaden the perspective of policy makers by increasing the understanding of new technologies in this future context and (b) inform current day policy making. In combination, these tools allow to explore the future based on present day assumptions (forecasting) and to open perspectives to alternative futures that question our current assumptions, to inform and stress test policy (foresight).

One concrete example is the recent exploration by the European Food Safety Authority (EFSA) on whether risk and safety assessment methods for recombinant DNA in food and feed is suitable for synthetic biology. EFSA's approach mobilised hypothetical case studies (scenarios) to evaluate existing guidelines to explore the adequacy of the food and feed risk assessment of genetically modified plants obtained or enhanced through synthetic biology. In this example, EFSA conducted domain-specific technology forecasting to see whether they were able to understand what kind of product would be on the market in 10 years. EFSA then developed four kinds of hypothetical scenarios to study whether the current risk assessment method can be applied to the new hypothetical case. This approach allowed the testing of the robustness of current risk assessment approaches in a situation where there is limited and heterogenous data (EFSA Scientific Committee, 2022[40]).

Technology Assessment (TA) is an evidence-based, interactive process designed to bring to light the societal, economic, environmental, and legal aspects and consequences of new and emerging science and technologies. TA can inform public opinion, help direct R&D, and unpack the hopes and concerns of various stakeholders at a given point in time to guide governance. Examples include the Exploratory Quantum Technology Assessment approach (Box 3.1) and the DNA-Dialogue participatory Technology Assessment (Box 4.1).

Emerging risk assessment can be especially useful for new and early-stage technologies because there is insufficient evidence to undertake a full risk analysis. It involves not only the anticipation of potential risks and benefits, but also the exploration how risks are perceived and framed by different stakeholders. Such framing is dependent on the values of those perceiving risks and thus unpacking what are underlying norms and values around an emerging technology and its possible impact is key. One example is the International Risk Governance Council (IRGC) guidelines for emerging risk governance: a set of flexible guidelines that support public and private organisations to design internal processes to proactively deal with emerging and evolving risks (Mazri and Florin, 2015[41]).

Build an inclusive ecosystem of technology appraisal

Within governments, appraising technology often happens and should happen across multiple institutional sites that use different methodologies, including dedicated agencies and units of technology foresight and assessment, national academies of science and technology, ad hoc national commissions, regulatory bodies and standard-setting processes. Diversity of expertise and perspectives is a strength, and these institutions and methods can help create a mutually supportive ecosystem of appraisal for policy. But there may also be a role for synthesis of perspectives to coordinate across agencies for the purpose of informing governance.

Stakeholders and, ideally, affected communities, need to play a role within these assessing institutions. One of the key functions of strategic intelligence is to identify (and involve) stakeholders who should participate in the appraisal process. This could include funders, technologists, private sector actors, and the larger society. It also opens the question of the need for international technology assessment for international policy making (Element 5).

4 Stakeholder Engagement

Table 4.1. Key actions

Determine an appropriate breadth and depth of engagement activities by diagnosing the technology case in terms of the six assessment factors (Box 4.1)
Invest in building a long-term foundation for societal engagement. Select engagement tools and techniques based on their purposes: capacity building, communication and consultation, and/or co-creation
Use deliberative processes to co-design technology strategies and agendas with policy makers, science advisers, other experts and citizens to better align science funding and societal priorities
Encourage interdisciplinary research and engineering to infuse technological development with diverse perspectives and ethical, legal and social considerations
Develop **"collaborative platforms"** with partners in industry, start-ups, and civil society, to nurture emerging technologies

Engaging stakeholders and society in the different stages of the science policy-making process is now a pillar of received good practice (OECD, 2024[42]). The engagement of stakeholders – whether they are scientists and engineers, affected communities, investors, companies, institutions, and citizens – can enrich the understanding of issues by contributing missing knowledge, opening problem framings, and illuminating key values at stake. Moreover, engagement can help policymakers anticipate problems of public acceptance, and promote good communication about science (Paunov and Planes-Satorra, 2023[43]). Such deliberation and consultation can breed trust and enrich the relationship between science and society (OECD, 2020[44]), although pre-ordained consultation with pre-cooked outcomes can undermine these goals (Society Inside and ECNL, 2023[45]).

What does engaging stakeholders mean in the context of emerging technology policy? Here gaining forward-looking input into technology development is of critical importance, a process that might be called "**anticipatory engagement**". Anticipatory engagement in the development of technologies is the focus in this framework element, while its role in the development of regulatory approaches is featured in Element 4 on building agile regulation. The element is cross-cutting, as it is just as important in implementing guiding values (Element 1) technology assessment (Element 2) and international co-operation (Element 5).

Beyond practical advantages, anticipatory engagement promises to help action democratic principles in technology governance, as well as values of equity and inclusion. Key decisions pertaining to technology governance, particularly those with far-reaching societal implications, should be subject to public dialogue and scrutiny. A greater emphasis on including stakeholders and citizens upstream – from agenda-setting to technology design, from technology assessment to designing governance – can help align science and technology with societal goals and needs (Stilgoe, Owen and Macnaghten, 2013[46]) (see Box 4.1 for an example).

Box 4.1. The DNA dialogue in the Netherlands

In 2019-2020, the Rathenau Instituut -- an independent research and dialogue organisation relating to the societal aspects of STI that advises the government in the Netherlands -- coordinated technical inputs and moderated 27 public dialogues on the controversial topic of Human Germline Genome Editing (HGGE), the so-called "DNA-dialogue". HGGE is where embryos are genetically altered to enhance or inhibit certain traits, then inserted into the uterus of the mother-to-be to develop and be born.

This approach aimed (i) to inform a diverse range of stakeholders about the opportunities and uncertainties surrounding HGGE, as well as the societal and ethical issues it raises, (ii) to bring people together to articulate and discuss their hopes, questions, wishes and concerns, and (iii) to gather and synthesise the rich diversity of perspectives and considerations around this controversial technology with the aim of informing political decision-making about HGGE and stimulating further societal reflection. The DNA-dialogues were part of a broader political re-evaluation of the Dutch Embryo Law that also pertains to the creation of human embryos for research purposes and expanding the indications for embryo selection. The results of the societal dialogue on HGGE were a source of synthesised policy-relevant strategic intelligence on societal hopes and concerns surrounding the future use (or not) of HGGE.

Source: (Robinson, Winickoff and Kreiling, 2023[47])

Where engagement is most important

Engaging stakeholders and deepening societal dialogue requires time and resources. The same level of consultation will not be required across all emerging technologies and situations. The six assessment factors (Box 3.2) can be useful for diagnosing the level of real or potential public concern and therefore help prescribe an appropriate breadth and depth of engagement activities, i.e. uncertainty, risk and scale of impact, level of public concern or value conflict, pace of technological change, strategic importance and governance gaps. Deeper engagement might be indicated in cases where expected social impacts are high – e.g. on equity -- but where there are unresolved uncertainties and where there might be anticipated or actual value conflicts.

Tools for upstream societal engagement

There are a range of anticipatory engagement tools and techniques, ranging from short-lived or ongoing activities, content-specific or general expressions of support or concern or involvement in technology development or other co-creation processes. These can be distinguished based on their respective purposes (see Figure 4.1):

- **Capacity-building** aims to lay a stronger and long-term foundation for societal engagement in a way that anticipates the arrival of new technologies of public concern or potentially so. Elements might include science communication and media training, online resources, interdisciplinary education programmes that combine sciences, engineering and social sciences, and collective foresight exercises with an educational component.
- **Communication and consultation** gather the views of citizens and stakeholders and/or encourage their exchange on emerging technologies, which may have an influence on governance decisions that anticipate innovation trajectories.

- **Co-creation** engages societal stakeholders more directly in the construction of science and technology, policy-relevant knowledge-making and governance, thereby working in a more upstream or anticipatory mode of governance (OECD, 2023[14]; Kreiling and Paunov, 2021[48]).

Figure 4.1. Tools for upstream societal engagement

Source: Adapted from OECD (2023)

Co-creation in focus: technology strategies, interdisciplinarity, collaborative platforms

Of the anticipatory engagement tools and techniques described above, co-creation contemplates the deepest engagement of stakeholders. Here funders of R&D are promoting forms of collaborative innovation that integrate technology developers and other stakeholders in the co-design or "co-creation" of technology and technology governance. Co-creation encompasses a variety of modalities for direct contributions by stakeholders, publics and diverse groups of experts to the creation of new knowledge and technology (see Figure 4.1). It also entails the need to actively bring together agencies from across government to join up activities and bring together different bodies and groups such as the human rights and technology communities. In the arena of technology policy, co-creation might involve the following activities:

Co-designing technology strategies and agendas. Today, in some jurisdictions, policymakers have moved away from purely top-down agenda-setting which relies only on elected officials, to include science advisers and other experts, using deliberative processes, to better align science funding and societal priorities. In a now canonical example, the European Commission's Citizen and Multi-Actor Consultation on Horizon 2020 (CIMULACT) distilled input from European Union citizens in 30 countries into a list of 23 distinct research topics for Europe, partly reflected in the European Union's new Horizon 2020 (H2020) research agenda (OECD, 2017[49]; CIMULACT, 2017[50]). Government experience with participatory agenda-setting could easily be adapted to processes of developing critical technology strategies that would involve a richer array of expertise and stakeholders than usual.

Interdisciplinary and transdisciplinary approaches. Interdisciplinary R&D can be an important tool of upstream technology governance thanks to which new design principles and goals might emerge. They consist of a range of inclusive processes that integrate communities of scientists and engineers who interact closely with the social sciences and humanities communities as well as with user and other relevant groups. Governments and universities should encourage interdisciplinary research and engineering that focuses both on technical issues as well as social, legal and ethical implications and policy issues. This can be driven by the creation of integrated centres of excellent and incentivised through grant-making and interdisciplinary academic hiring.

"Trans-disciplinarity" as a mode of STI goes a step further, seeking a deeper integration of different academic disciplines and of broader stakeholders and relevant communities into the making of science and technology. These diverse perspectives and sources of expertise can produce robust understandings of complex sociotechnical problems (OECD, 2020[51]). Normally associated with applied social science settings, these techniques could be adapted to engineering problems in emerging technology contexts.

Collaborative platforms. Many governments, along with partners in industry, start-ups, and civil society are developing experimental forms of "collaborative platforms" to nurture emerging technologies and to provide better linkages between innovation processes and society (Winickoff et al., 2021[52]). For example, "Living labs" are a widespread experimentation tool to co-create, prototype, test and upscale innovative solutions to (local) needs in real-life settings. Citizen involvement is a distinguishing feature of these experiments (European Commission, 2023[53]).

Success factors for societal engagement

Working through processes of stakeholder and societal engagement requires time and resources, so policymakers will have to triage technology situations to determine when to deploy thicker engagement processes. Regardless of the case, the dynamic among academic experts, experiential experts, and lay publics will have to be managed to achieve more legitimate and deliberative outcomes. Decades of learning on what makes for successful citizen engagement techniques on emerging technology policy point to a set of success factors:

- **Start early and iterate**: build ownership, develop trust, and ensure relevant and timely inputs; allow time for the process to unfold: iterate engagements or have different stages to enable more holistic involvement.
- **Effective communication**: present balanced and accurate information (preventing as much as possible manipulation, mis- and dis-information), allow for diverse opinions, and willingness to exchange perspectives among all participants.
- **Define expertise broadly**: involve different forms of expertise in the process, including experts from diverse disciplines, technical backgrounds and lived experiences.
- **Diverse inputs**: include diverse stakeholders and publics by education level, experience, race, gender and socio-economic status.
- **Transparent process**: analyse the results together with all actors that were involved, keeping them informed about how insights are used. Ideas for procedural integrity and transparency might be drawn from the *OECD Recommendation on Principles for Transparency and Integrity in Lobbying* (OECD, 2010[54]). Policy discussions should always be subject to transparency and integrity standards including regarding who provides input, to whom, and on what issues.
- **Demonstrating real impact**: translate and integrate stakeholder insights into decision-making. Come back to participants with the result on how their inputs have been considered and ensure relevant public disclosures through transparency tools, such as transparency registers or dedicated public decision-making process footprints.

5 Agile Regulation

Table 5.1. Key actions

Implement adaptive and iterative regulatory assessment cycles, respond to stakeholder and public concerns, and coordinate across regulatory silos
Use experimentation tools like testbeds and regulatory sandboxes for adaptive policy learning
Use outcome-based approaches that can prove more effective in new policy areas where limited evidence is available, such as emerging technologies
Consider non-binding governance approaches (high-level norms, principles and guidelines, technical and normative standards, codes of conduct and by-design approaches) as complementary approaches to public governance
Engage and incentivise the private sector for responsible innovation early on. This requires a new set of policy perspectives and tools, like the “ethics-by-design” paradigm and the Responsible Business Conduct approaches

Governance systems for emerging technologies feature a range of formal and informal kinds of governance mechanisms, spanning guidelines, codes of practice and regulation, working across the public and private sector. The fast pace and evolving nature of emerging technologies necessitates an agile and anticipatory governance system that balances the robust protection of values while encouraging innovation, accommodating new evidence, and adapting to new situations. These approaches might sit in the public or private sector, or some hybrid arrangement, though governments are ultimately responsible for the outcomes of governance and must live up to its challenges if they are to remain legitimate and trustworthy.

Like in other elements in this framework, the choice of governance mechanisms should track the stage of technology development. Later stages of innovation, e.g. the phase of early commercialization where a technology is about to be released to the consumer market, will tend to focus on safety, quality, efficacy, and overcoming impediments to uptake. These might be handled better within formal regulatory frameworks. The early, upstream environment is demonstrably different from the later stages of innovation: there will be different actors in each, different forms of evidence and knowledge used, different audiences, and different gating procedures. Here, guidelines and codes of practice might be more applicable. In any case it is essential to carefully assess available options, from prescriptive regulation to experimental or self-regulation approaches, and consider the best combination of options in each specific context.

A large array of prevailing norms and institutions condition innovation. A systemic approach to the governance of emerging technology takes account of the policy cycle in its entirety as well as of the complexity of innovation ecosystems and associated value chains. Such an approach involves understanding how features of the governance landscape such as property right regimes, ethical standards, pre-market trials and industrial standards will affect innovation trajectories and incentive structures, from early-stage technological development to innovation diffusion.

Make regulation more agile

There are several enabling factors to strengthen and modernise governance approaches for emerging technologies and to ensure better governance outcomes. Toward this end, the *OECD Recommendation for Agile Regulatory Governance to Harness Innovation* (OECD, 2021[16]) is organised around four pillars: (i) Adjust regulatory management tools to ensure regulations are fit for purpose; (ii) Lay institutional foundations to enable co-operation and joined up approaches within and across jurisdictions; (iii) Develop or adapt governance frameworks to enable the development of agile regulation; (iv) Adapt regulatory enforcement strategies to evolving needs. Pillar three on agile regulation can help advance the above-mentioned objectives by several factors, including:

- **Develop robust strategic intelligence** as a key building block for assessing the needs for governance, risks, benefits, etc. (see also Element 2)
- **Deploy adaptive, iterative, and flexible regulatory assessment cycles**, while capitalising on technological solutions to improve the quality of evidence
- **Respond to stakeholder and public concerns** through stakeholder and citizen engagement and feed results back into decision-making (see also Element 3)
- **Cooperate within and across jurisdictions** to ensure the effectiveness, coherence and continued relevance of policies and frameworks. International Regulatory Co-operation is also critical to avoid regulatory fragmentation and arbitrage (see also Element 5)
- **Build capacity, skills and resources** to support the development and application of forward-looking and anticipatory governance

Non-binding approaches

Commitments and obligations that are not directly enforceable by government – i.e. non-binding -- are increasingly common tools of emerging technology governance. Types include high-level norms, principles and guidelines, technical standards, codes of conduct and by-design approaches (Box 5.1). These normative mechanisms can offer flexible interim solutions to govern emerging technologies as uncertainties of technological pathways are reduced over time.

Non-binding interventions are well suited to shape the norms surrounding the development and deployment of emerging technologies due to their collaborative nature: they can provide a venue for back-and-forth dialogue between technologists, regulators, and society. This collaborative approach can help air divergent perspectives, pinpoint disagreements, and build shared understandings. Challenges include the potential difficulty to enforce such norms.

Box 5.1. Examples of non-binding governance approaches

High-level principles and guidelines. Principles and guidelines can be an attractive modality for innovation actors to make moral and political commitments with some flexibility and accommodation for differences and changing circumstances.

Technical standards. Technology-based standards determine the specific characteristics (size, shape, design, or functionality) of a product, process, or production methods. These standards are an important form of governance that can emanate from both the private sector (e.g. *de facto* standards in the form of dominant designs) and the public sector (e.g. government-regulated vehicle safety standards or mobile phone frequency bands). Partnerships, for example between non-governmental organisations

(NGOs) and industry, can help generate standards or certification schemes that may command premiums in the market. Co-developed product standards have potential utility for "upstream governance" because retailers can leverage their market power to influence how technology developers consider consequences throughout the supply chain, from design and sourcing to disposal.

"By-design" governance approaches. Ethics-by-design, privacy-by-design and like approaches seek to embed societal values – such as privacy, diversity, and inclusion – into technologies and their protocols (e.g. search protocols in AI). Standard-setting bodies like the Institute of Electrical and Electronics Engineers (IEEE) are increasingly targeting the engineering phase of product development to address social values and standardise certain features from the beginning, including in the fields of neurotechnology and AI.

Codes of conduct. Also referred to as "codes of ethics" or "codes of practice", codes of conduct seek to shape professional norms by communicating clear expectations for ethical professional conduct. Codes of practice are a form of self-governance as organizations are autonomously responsible for their adoption, implementation, and enforcement.

Source: OECD Authors

For constructive and effective non-legally binding instruments, public agencies could:

- **Monitor and assess** their performance and effects, whose success hinges on the capacity of governments to access the necessary data to monitor and assess their effects.
- **Seek to understand the incentive structure** underpinning participation in voluntary regimes.
- **Seek to prevent undue influence** of interested actors, through, e.g. the use of integrity and transparency standards.
- **Use the potential of technical standard development** processes to facilitate responsible innovation by fostering co-operation among across the public and private sector.
- **Monitor practices** and engage in regular reviews of technical standards and codes of practice in an open and inclusive way to avoid inappropriate market distortions.
- **Define credible sanction mechanisms** to prevent and address potential misconduct.

Legally binding approaches

While non-binding instruments may be easier to adopt and offer more flexibility in implementation and adaptation, legally binding approaches may be deemed necessary to sufficiently manage an emerging technology. These include, for example, mandatory administrative provisions enforceable by a regulatory body or technical regulations setting out product characteristics or mandating the use of specific processes and production methods. Legally binding instruments may also consist of outcome-based regulation, which focuses on achieving specific and measurable results (e.g. binding environmental performance or safety targets).

Outcome-based approaches to regulation can be systematically used as part of the policy mix (OECD, 2021[16]). These approaches, which tend to mandate the achievement of a result rather than require specific measures, can prove more effective in new policy areas on which limited evidence is available, such as emerging technologies.

When selecting a suitable approach, it is vital to examine the pros and cons of available options based on the risk/benefit profile of a technology as well as devising mechanisms to ensure their continuous alignment with policy goals. Rather than mutually exclusive, they may be combined into a hybrid approach that provides both enough flexibility, monitoring and enforcement (OECD, 2018[25]; OECD, 2021[55]).

Experiment and learn

In the context of emerging technology governance, reliable information on potential impacts or effectiveness of policy options is often difficult to obtain through traditional approaches such as information gathering and consultations. Here, regulatory experimentation, testing, and trialling (under regulatory supervision) can sometimes enable better and more timely policy learning and adaptation grounded in an improved understanding of risks and opportunities brought by innovation. If used in combination with more established regulatory management tools -- e.g. regulatory impact assessment, stakeholder engagement and ex-post evaluation, institutional co-operation, and technological monitoring solutions -- experimentation can help bring about more effective and efficient public policy action through adaptive learning, increased coherence, and an enhanced evidence base.

Experimentation comes in various forms, each suited to specific contexts, objectives and depending on available time and resources. These different forms can be largely distinguished by focusing either on regulation itself, or on the implications of innovations that may be brought to the market (Box 5.2). While potentially useful in many situations where adaptive learning is critical for regulatory relevance and effectiveness, experimentation's benefits are neither automatic nor uncontested. There are potential constraints regarding legality, feasibility, and equity.

The choice of experimentation tools in innovation also depends on technology readiness levels (TRLs) (European Commission, 2023[53]). In all cases, experimentation approaches should be well-coordinated within as well as beyond domestic boundaries to provide clear and coherent incentives. In addition, it is important to assess related trade-offs and privilege instances in which experimentation can yield the highest net benefits.

Box 5.2. Experimentation in innovation – innovation testbeds and regulatory sandboxes

Innovation testbeds are programs that provide access to physical or virtual environments in which companies or public sector stakeholders can test, develop, and introduce new products, services, regulatory processes, organizational solutions, and business models, typically in collaboration with multiple stakeholders (Inter-American Development Bank, 2020[56]). They focus primarily on the technical dimension of developing, testing and upscaling a product or service and are thus suitable for earlier maturity stages. Like living labs (see Element 3 above), test beds are sites of collaborative invention, testing and demonstration for future technologies and sociotechnical arrangements in a model environment, under real-world conditions. Test beds can serve as an instrument to co-develop the very rules and regulations needed to cope with new technologies, and to gauge which existing regulations might be detrimental to adoption (OECD, 2018[57]).

Regulatory sandboxes have been described as "schemes that enable the testing of innovations in a controlled real-world environment, under a specific plan developed and monitored by a competent authority" (European Commission, 2023[58]). Important in AI and other emerging technologies such as biomedicine, they create space where authorities engage firms to test innovative products or services that challenge existing legal frameworks (OECD, 2023[59]). They tend to involve a temporary loosening or modification of applicable norms and feature new kinds of guardrails to preserve overarching regulatory objectives, such as safety and consumer protection (European Commission, 2023[53]) or privacy (Business at OECD, 2020[60]).

Source: OECD Authors

Incentivise the private sector for responsible innovation

Formal decision-making authority for emerging technology governance rests with government. Nevertheless, firms are key players in the system of emerging technology governance. In addition to being the key factor in commercialisation of technology, firms are responsible for a large portion of total R&D. The share of R&D expenditure by the business enterprise sector has been steadily increasing in OECD countries since 2010, reaching 73% in 2021 (OECD, 2023[61]). In practice, innovators are often on the front lines of technology development and firms – investors, start-ups, SME, larger companies – are deeply involved in governance development and implementation, including leading on the development of technical standards.

There are, however, obvious challenges for companies to participate in effective governance. Profit-orientation and speed-to-market are key decision-making factors in the private sector, and responsible innovation approaches may not be readily identifiable to relevant private sector actors; furthermore, because of the strength of corporate interests, firms are not well placed to govern technology without broader public accountability.

The private sector should be engaged and incentivized for responsible innovation early on — before trajectories are locked in and scaling takes off – but these requires a new set of policy perspectives and tools to do so (Pfotenhauer et al., 2021[62]). Hence, the framework outlines a few kinds of actions that might be taken in company settings. Already in use in particular sectors, these tools must complement existing ethics efforts in public sector research and product regulation.

- **Empower diverse perspectives** as part of the R&D process. Bring together engineers, ethicists, social scientists, and people with relevant experience to actively shape development of the technology.
- **Promote implementation of responsibility principles** and standards (see example in Box 5.3) as part of a company mission already at the start-up stage.
- **Embrace collectively legitimated 'ethics-by-design' approaches**. International standard-setting fora that are multi-stakeholder are good opportunities to co-create by-design standards with industry.
- **Incentivise investors to select for responsible technology**. Deploy a new sub-set of investment instruments or venture capital niches dedicated to responsible innovation practices, like the recent surge in sustainable investment and "green bonds" that target environmental or climate-related projects.
- **Apply Responsible Business Conduct approaches** to the oversight and governance of innovation and emerging technology. Corporate Social Responsibility or Responsible Business Conduct regimes address the protection of workers, local communities, and the environment through self-governance tools. Technology development and deployment are becoming a feature of these frameworks, e.g. that of the *OECD Guidelines for Multinational Enterprises* (OECD, 2023[26]) (see Box 5.3).

Box 5.3. Example: *OECD Guidelines for Multinational Enterprises on Responsible Business Conduct*

The *OECD Guidelines for Multinational Enterprises on Responsible Business Conduct* aims to encourage positive contributions enterprises can make to economic, environmental and social progress, and to minimise adverse impacts by an enterprise's operations, products and services. The 2023 edition of the Guidelines provides updated recommendations for responsible business conduct

across key areas, including technology. Concretely, it now includes specific recommendations to enterprises involved in the development of new technology or new applications of existing tools to:

- **manage potential adverse impacts associated with science, technology and innovation**: "[i]n the context of development, financing, sale, licensing, trade and use of technology, including gathering and using data, as well as scientific research and innovation, enterprises should observe the Guidelines and comply with applicable national laws and requirements, including privacy and data protection requirements and export control regulations" (IX, introduction).
- **"carry out risk-based due diligence** with respect to actual and potential adverse impacts related to science, technology and innovation" (IX, 1).
- **"anticipate** to the extent feasible and, as appropriate, **address ethical, legal, labour, social and environmental challenges** raised by novel technology while **promoting responsible innovation** and engaging in dialogue and information sharing with local regulatory authorities and worker representatives" (commentary on IX, 113).

Source: (OECD, 2023[26])

6 International Co-operation

Table 6.1. Key actions

Engage in forward-looking dialogue within inclusive and multilateral fora
Help develop common analysis and agreed forms of evidence and evidence-making to inform emerging technology governance approaches at the international level
Reinforce international co-operation in science and technology development to bolster shared approaches to the ethics of science and technology
Develop international norms – e.g. principles, guidelines and technical standards -- based on shared values

The development, use and effects of emerging technologies span national borders, highlighting the need for multilateral approaches to governance. The cross-jurisdictional character of emerging technologies carries implications for the design of both national and international technology governance systems. International co-operation for the effective anticipatory governance of emerging technologies can take many forms; this framework presents four mutually reinforcing pathways to the development of greater international co-operation on anticipatory technology governance. This element on international co-operation crosscuts the other elements in the framework, i.e. international co-operation should be guided by values, feature forward-looking evidence gathering, engage stakeholders and seek to be agile in governing norms and institutions.

Forward-looking dialogue in inclusive fora

Inclusive and multilateral fora for dialogue and collective policy making can lay the groundwork for coordinated approaches to emerging technology governance. Such fora should seek to engage broader stakeholder communities that include the private sector and civil society. Such engagement would enrich the exchange with different viewpoints and expertise, and make sure key perspectives are represented in the exploration of possible technology futures. The OECD Global Forum on Technology is an example of a forward-looking multistakeholder forum (Box 6.1).

Inclusive fora have several important purposes. First, they can enable the discussion of the core values and priorities relevant to emerging technology governance – including the airing of commonalities and differences – which is essential for putting common values-based approaches into practice in particular contexts. Second, practical experiences can be shared to help identify good practices. Third, understandings can be deepened through interaction with experts. Fourth, they can lay the groundwork for collective standard setting among like-minded partners.

Box 6.1. Example: The OECD Global Forum on Technology

Inaugurated in 2023, the OECD Global Forum on Technology provides a venue for regular in-depth dialogue "to foresee and get ahead of long-term opportunities and risks presented by technology".[2] It seeks to facilitate inclusive, in-depth, multi-stakeholder and values-based discussions on specific technology policy topics among OECD Members and partners. Its goals are to:

- **Foster strategic evidence-based dialogue and international co-operation**, informed by external expertise and initiatives, on topics at the forefront of global digital and technology policy debate, including with a view to informing principles and approaches based on shared values.
- **Identify and analyse specific technological developments** where there are gaps in existing fora, their potential societal, economic, security, and sustainability impacts and the potential implications for policy and regulatory frameworks.
- **Explore nascent approaches to policy challenges and opportunities** posed by emerging technologies and business models and share good practices for the governance of technologies to build trust among participants and foster common and coherent approaches based on mutual interests and democratic values.

Source: OECD

Use common analysis and evidence

To be effective, approaches to emerging technology governance at the international level should be just as forward-looking as approaches at national or more local levels. While most countries have their own forms of strategic intelligence and technology assessment, shared understandings about potential risks and benefits will be important, making agreed forms of evidence and evidence-making about potential futures essential.

Common models and agreed forms of evidence and evidence-making are important for international co-operation on STI, as is witnessed by the Intergovernmental Panel on Climate Change's influence in climate policy for instance. By analogy, there might be advantages to building shared models of technology assessment and common accounts of potential technology futures as a basis for advancing international dialogue or policy on particular technologies. An international capacity for sharing, correlating, and synthesising the forward-looking assessment being produced in a distributed way across, e.g., technology assessment and foresight communities in different countries, could help support the dialogues and policy process on emerging technology governance at the international level.

Reinforce co-operation in science and technology development

Co-operation on the production of new science and technology work hand in hand with dialogue on technology governance. International co-operation in science and technology can and should co-emerge with the development of common ethical practices, norms and understanding of good technology governance. International scientific and technological co-operation has been embraced at the OECD, see for example the *Recommendation on International Co-operation in Science and Technology* (OECD, 2021[63]). The organisation promotes the collaborative development of technology where possible.

Further important work on principles and values for international co-operation in STI is being carried out at national and international levels, including by the OECD, UNESCO, the European Union, the International

Science Council, the G7, the G20, as well as in other international fora devoted to AI, data privacy, and other emerging technology governance. These efforts lay the groundwork for co-operation on the creation of norms in emerging technology governance.

Develop international principles, technical standards and guidelines based on shared values

Evidence-based principles on technology governance as well as technical standards can grow out of dialogue. Principles and guidelines can be an attractive modality for international, transnational and/or global actors to make moral and political commitments with some flexibility and accommodation for differences and changing circumstances. This is particularly useful in situations where new legally binding instruments are rarely developed. Principles on emerging technology governance can operate at the international level through several organisations, e.g. the United Nations, G7, G20, Council of Europe and the OECD.

International technical standards are essential for the diffusion and interoperability of emerging technologies and the creation of markets for technology products and services. Prominent examples are Bluetooth or Wi-fi technologies which enabled innovation, resulting in product improvements, cost reduction and widespread adoption.

Governments and stakeholders should promote a multi-stakeholder and consensus-driven development of technical standards. For instance, in the realm of research data, the *OECD Recommendation on Access to Research Data from Public Funding* calls for Adherents to "support the development, maintenance, adoption, dissemination, and implementation of technical standards that are open, freely accessible, and internationally agreed to the greatest possible extent" (OECD, 2021[64]).

International approaches to setting technical standards need to be coordinated as far in advance as possible, to help ensure that they are consistent with shared values of co-operation partners. They should also take into account relevant instruments developed by other bodies in relevant contexts. In terms of government activities, both the latest United States national standards strategy for critical and emerging technologies (The White House, 2023[65]) and the European Union strategy on standardisation (The European Commission, 2022[66]) revolve around a rules-based and private sector-led approach with opportunities for political involvement or interventions.

Endnotes

[1] In the OECD AI Recommendation, trustworthiness includes transparency, accountability, security and safety, privacy and human-centred values (OECD, 2019[17]).

[2] Quotation from the mission statement of the OECD Global Forum on Technology, see online at: https://www.oecd.org/digital/global-forum-on-technology/ (last accessed 14/01/2024)

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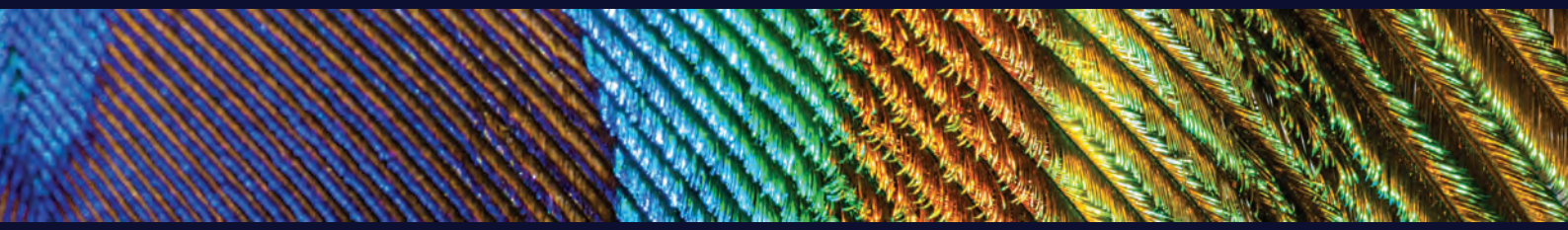

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