


Innovation, precaution, and sustainable development in EU environmental law—a false trichotomy?

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ABSTRACT

In European (environmental) law, the precautionary principle sets, *inter alia*, norms for the regulation of technology. Some argue that the precautionary principle causes excessive risk aversion and that it hinders innovation. The ‘innovation principle’ has been suggested as a necessary countermeasure. Since then, the innovation principle has been mentioned in several policy and one (non-binding) legislative document(s), including the Research and Innovation Tool that forms part of the Commission’s Better Regulation framework. The interpretation of the set principle has evolved in the process. We review the use and function of the innovation principle within EU policymaking and investigate the relationship between the precautionary principle, the innovation principle, and the principle of sustainable development. The conclusion that we draw from this is that, since the principles of sustainable development and precaution already apply to innovation, the innovation principle is superfluous.

KEYWORDS: EU environmental law; precautionary principle; innovation principle; sustainable development.

1. INTRODUCTION

Does EU law need an innovation principle? Several recent developments in Union policy appear to call for legal reform along those lines. The recent crises, including the COVID-19 pandemic, the climate crisis, and geopolitical developments such as the Russian invasion of Ukraine and competition over technological leadership between the USA and China,¹ have

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¹ Cinczia Alcidi and others, ‘What ways and means for a real strategic autonomy of the EU in the economic field?’ (Publications Office of the European Union 2023) 4–6; Luuk Schmitz and Timo Seidl, ‘Protecting, transforming, and projecting the single market: Open strategic autonomy and digital sovereignty in the EU’s trade and digital policies’ (2022) OSF Preprint 1.

illuminated structural weaknesses within the Union, including insufficient progress in critical technological domains.² In response, the EU has prioritized strategic autonomy, technological sovereignty, and industrial resilience.³ It has focused its efforts on supporting innovation in key sectors, including digital technologies, clean energy, and biotechnologies.⁴ These initiatives are intended to bolster the global competitiveness of the EU, to drive the green and the digital transition, and to reduce reliance on external actors.⁵

Further, the Better Regulation scheme is an European Commission (‘Commission’) initiative that is intended to ensure the effective implementation of EU law, thereby maximizing benefits while minimizing costs for both individuals and businesses.⁶ The scheme has three fundamental objectives: first, to simplify existing legislation; second, to eliminate unnecessary administrative burdens, or ‘red tape’ and, third, to ensure that policies are both evidence based and fit for purpose.⁷ The scheme is comprehensive, spanning the entire policy cycle—from inception to evaluation and revision—and it calls for the employment of a range of tools and procedures, including impact assessments, stakeholder consultations, and quality control, in the development of efficient legislation.⁸

The Better Regulation Toolbox provides detailed and practical guidance on the implementation of the Regulatory Guidelines, which contain the principles that the Commission should follow to facilitate evidence-based decision-making in all its actions. The innovation principle finds some support in Tool #22 on Research and Innovation in the Better Regulation Toolbox. The principles that have been included in the Better Regulation scheme before the innovation principle are based on specific provisions of the EU Treaties and the Charter of Fundamental Rights;⁹ the innovation principle is not. On a general level, the Toolbox reflects the importance of principles of proportionality and subsidiarity, in line with the Treaties.¹⁰ Nevertheless, at present, the innovation principle serves as a conceptual device for the identification of impacts in evaluations, fitness checks, and impact assessments of legislation. Thus, the Commission has used the principle to invoke questions about (technological) innovation when it drafts laws and when it implements them. However, the EU Commission, as a legislator, is not expected to employ each tool in every case—the Toolbox is meant to be used selectively and judiciously.¹¹

This contribution has two objectives. First, it examines the intricate interplay between the principles of sustainable development, precaution, and innovation. Second, it explains the position of the innovation principle in that triad. The discourse on the interplay between precaution and innovation is rooted in a long-standing tradition, which also includes concepts such as ‘technology-enablement law’, ‘economization of precaution’, and ‘innovation-openness and

2 Alcidi and others, *ibid*; Mario Draghi, ‘The future of European competitiveness: Part B | In-depth analysis and recommendations’ (Publications Office of the European Union 2025) 44–47 and 68.

3 Jakob Edler and others, ‘Technology sovereignty as an emerging frame for innovation policy. Defining rationales, ends and means’ (2023) 52 *Research Policy* 104765, 104765 and 104770–1.

4 Regulation (EU) 2024/795 of the European Parliament and of the Council of 29 February 2024 establishing the Strategic Technologies for Europe Platform (STEP) [2024] OJ L795, Preamble 4 and Article 2.

5 Commission, ‘A Green Deal Industrial Plan for the Net-Zero Age’ COM (2023) 62 final, 1–3, 8, and 13.

6 Commission, ‘REFIT—making EU law simpler, less costly and future proof’ SWD (2021) 305 final (‘Better Regulation Guidelines’) 5; Notably, Mario Monti, ‘Report on the Future of the Single Market: A New Strategy for the Single Market at the Service of Europe’s Economy and Society’ (Publications Office of the European Union 2010) made the same point.

7 Better Regulation Guidelines, *ibid* 8–12.

8 *ibid* 8.

9 *ibid* 5.

10 *ibid*.

11 European Commission, ‘“Better regulation” toolbox—July 2023 edition’ (European Commission 2023) (‘Better Regulation Toolbox’) <https://commission.europa.eu/document/download/9c8d2189-8abd-4f29-84e9-abc843cc68e0_en?filename=BR%20toolbox%20-%20jul%202023%20-%20FINAL.pdf> accessed 29 August 2025.

responsibility of the law'.¹² All of these concepts are intended to relax some of the limitations that are associated with the precautionary approach to the economy, technology, research, and innovation.¹³ What is new is that they are attracting the attention of politicians and influencing legislative processes, chiefly in virtue of the Better Regulation scheme.¹⁴

We examine the way the various principles are considered when the Commission formulates new policies, when it enacts new legislation, and when it amends existing laws in the context of the Better Regulation scheme. In addition, to understand the rationale behind the incorporation of the innovation principle in EU policy, we examine the Commission's policy guidelines. Furthermore, the novel innovation principle is not a legal principle as it is not included in EU primary legislation. However, it may influence the formulation of new policies and the (secondary law) legislative agenda of the Commission.

We answer the following questions: what is the purpose of the innovation principle? What functions does it discharge in the regulatory toolbox of the Commission? Is the dichotomy between innovation and precaution false? We develop our answers to these questions by using doctrinal legal methods and political discourse analysis. The exposition is structured as follows: Section 2 introduces the principles of sustainable development, precaution, and innovation. We scrutinize the position of sustainable development and precaution in the Treaties of the EU and that of the innovation principle in the Better Regulation scheme and in various domain-specific documents. Section 3 examines references to the innovation principle in Union policy documents and legislative measures, with a view to unearthing its intended purpose. Section 4 analyses the interplay between the principles of sustainable development, precaution, and innovation in EU policies. In Section 5, we conclude that the innovation principle is devoid of purpose because innovation is already addressed by the principles of sustainable development and precaution.

2. SUSTAINABLE DEVELOPMENT, PRECAUTION, AND INNOVATION

We focus on three closely intertwined principles here: sustainable development, precaution, and innovation. When innovations are first introduced to market and when they are being tested, the precautionary principle provides guidance on the acceptable level of environmental and health risk. The principle of sustainable development is intended to render EU policies more sustainable in social, environmental, and economic terms. In general, the EU Treaties' provisions establishing the fundamental principles of environmental law have been formulated in such a manner as to obligate the relevant institutions to implement them when conducting activities within the environmental sphere.¹⁵

In turn, the innovation principle is not mentioned in the Treaties, and thus, a preliminary question concerns what it means, in EU law, for a norm to be characterized as a legal 'principle'. Formal recognition in the Treaties is not strictly necessary, as the case law of the European Court of Justice (CJEU) demonstrates: several principles have been recognized as general principles of EU law¹⁶ on the basis of their normative weight, their recurrence

12 See Ivo Appel, 'Vorsorgeprinzip und Innovation' in Moritz Reese, Wolfgang Köck, and Till Marcus (eds), *Zukunftsfähiges Umweltrecht I* (Nomos Verlagsgesellschaft 2023) 147.

13 *ibid.*

14 *ibid.*

15 Nicolas de Sadeleer, *Environmental Principles: From Political Slogans to Legal Rules* (2nd edn, OUP 2020) 473.

16 In summary, the general principles of law are defined by the convergence of national legal traditions, with shared values serving as robust reference points, conducive to the cultivation of a shared constitutional conscience, see Takis Tridimas, 'The General Principles of EU Law and the Europeanisation of National Laws' (2020) 13 *Review of European Administrative Law* 5, 8.

across the legal order, and their coherence with Treaty objectives.¹⁷ For instance, the principle of proportionality was applied by the Court as a general principle prior to its formal codification as part of the 1992 Treaty of Maastricht.¹⁸ Likewise, fundamental rights were developed as general principles of EU law well before their eventual codification in the Charter.¹⁹ Furthermore, although the CJEU did not employ the term ‘precautionary principle’ prior to its codification in the Treaty of Maastricht, its substance was already evident in pre-Maastricht jurisprudence, particularly in free-movement and public-health cases.²⁰

By contrast, simple reference to a principle in political or policy documents, without anchoring in primary law or judicial recognition, does not suffice to establish its legal status. In such instances the identified principle may serve a discursive or programmatic role, but it remains at the level of policy guidance rather than a binding principle, which could be interpreted in the courts. In this light, the so-called innovation principle cannot, at present, be regarded as a legal principle in the strict sense, as we further explain in the following. The argument of our contribution, in brief, is that contents of the legally binding principles overlap to such an extent with the innovation principle that it is redundant.

2.1. Sustainable development as an umbrella principle

We begin by outlining the substance of the principles which we will examine. The concept of sustainable development was first articulated in the 1987 Brundtland Report, which was produced by the World Commission on Environment and Development.²¹ At the UN 1992 Conference on Environment and Development (UNCED), many nations committed to a global partnership for sustainable development.²² This commitment was reaffirmed in 2012 at the World Conference on Sustainable Development in Rio de Janeiro, at which those nations agreed to pursue an economically, socially, and environmentally sustainable future, and once more in 2015, when the same countries adopted 17 Sustainable Development Goals and 169 targets for the next 15 years.²³

The EU upholds the principle of sustainable development. This principle, which is entrenched in, among others, Article 3(3) TEU,²⁴ Article 11 TFEU,²⁵ and Article 37 of the

¹⁷ *ibid* 13.

¹⁸ *ibid*. In the preliminary cases, the proportionality principle was introduced through the requirement that measures (which are prohibiting an economic activity) must be suitable for the stated aim; necessary, in the sense that no equally effective, less onerous alternative exists; and not excessively burdensome overall. See e.g. Case 114/76 *Bela-Mühle Josef Bergmann KG v Grows-Farm GmbH & Co KG* [1977] ECR 1211, paras 5, 7; Case 261/81 *Walter Rau Lebensmittelwerke v De Smedt PVBA* [1982] ECR 3961, para 12; Case C-331/88 *The Queen v Minister of Agriculture, Fisheries and Food, ex p Fedesa and Others* [1990] ECR I-4023, para 13.

¹⁹ Tridimas (n 16) 13.

²⁰ Alberto Alemanno, ‘The Shaping of the Precautionary Principle by European Courts: From Scientific Uncertainty to Legal Certainty’ in L Cuocolo and L Luparia (eds), *Valori costituzionali e nuove politiche del diritto* (Cahiers Européens, Halley 2007) 11–13; See, e.g., Case 174/82 *Sandoz BV* [1983] ECR 2445, paras 15–18; Case 227/82 *Leendert van Bennekom* [1983] ECR 3883, paras 28–29. In these cases, acknowledging scientific uncertainty and pending harmonisation, the Court permitted protective measures so long as they were proportionate, necessary and non-discriminatory.

²¹ World Commission on Environment and Development, *Our Common Future: Report of the World Commission on Environment and Development* (OUP 1987).

²² ‘Report of the UN Conference on Environment & Development’ (Rio de Janeiro, 3–14 June 1992) UN Doc A/CONF.151/26/Rev. 1 (Vol. I) (‘Agenda 21’), Principle 1.

²³ ‘Outcome Document of the UN Conference on Sustainable Development’ (Rio de Janeiro, 20–22 June 2012) UN Doc A/CONF.216/L.1*; UNGA Res A/70/L.1 (25 September 2015); John C Dernbach & Federico Cheever, ‘Sustainable development and its discontents’ (2015) 4(2) *Transnational Environmental Law* 247, 250.

²⁴ ‘The Union shall establish an internal market. It shall work for the sustainable development of Europe based on balanced economic growth and price stability, a highly competitive social market economy, aiming at full employment and social progress, and a high level of protection and improvement of the quality of the environment. It shall promote scientific and technological advance’.

²⁵ ‘Environmental protection requirements must be integrated into the definition and implementation of the Union’s policies and activities, in particular with a view to promoting sustainable development’.

Charter of Fundamental Rights of the European Union, are designed to calibrate the relationship between the social, the economic, and the environmental. Sustainable development therefore functions not only as a principle but also, arguably, as a goal and a means of integrating environmental requirements across all domains of EU policy. This integration should accord with the (non-binding) SDGs.²⁶

Sustainable development is also recognized as a principle in secondary legislation and in the case law of the European courts.²⁷ Article 3 TEU attests to the unwavering commitment of the Union to sustainable development. It refers to both environmental protection and the internal market. It also contains explicit mentions of the economic facets of sustainable development, such as economic growth and price stability, and it emphasizes the need for a highly competitive social market economy. Sustainability can boost Union competitiveness by accelerating the transition away from fossil fuels and by fostering the development and deployment of various net-zero technologies.²⁸ The social commitment to which Article 3 refers also has implications that extend beyond the boundaries of the EU, as is evident from Article 212(d) TFEU, which pertains to social development in developing countries.⁵

The Better Regulation initiative also touches on the concept of sustainable development; in this way, it integrates it into Union policymaking and the pursuit of the UN SDGs.²⁹ Notably, every impact assessment or evaluation of the legislative or non-legislative acts of the Commission involves a pragmatic identification of significant environmental, social, and economic impacts.³⁰ Tool #19 specifically addresses the SDGs, ensuring that all legislative proposals align with the 2030 Sustainable Development Agenda of the United Nations.³¹

Tool #19 on SDGs refers specifically to Tool #18, which is on the 'Identification of Impacts', as an integral component of every impact assessment, evaluation, and fitness check that is applied to legislation.³² The role of Tool #18 is to identify the most significant impacts across economic, environmental, and social dimensions.³³ The impact assessment process is systematic, and it consists of three steps. The first is to identify the potential impacts of the chosen policy options. The second is to discern which ones are significant. The last is to assess these significant impacts quantitatively or, if that is not possible, qualitatively.³⁴ The screening ensures that subsequent assessments prioritize the most crucial impacts in each specific case, in line with the principle of proportionality.³⁵

As far as the balance between the three dimensions of sustainable development is concerned, the European Environment Agency has emphasized that Europe cannot actualize its sustainable-development vision of 'living well, within the limits of our planet' solely by promoting economic growth and managing its harmful consequences through environmental and social policy. Instead, sustainable development ought to be a foundational principle that

26 Articles 3 and 21 TEU and Article 11 TFEU. See further, Better Regulation Toolbox 2023 (n 11) 'Tool #19. Sustainable Development Goals'.

27 See e.g. Case C-549/15 *E.ON Biofor Sverige* [2017] ECLI:EU:C:2017:490, para 48; Case C-128/17 *Poland v Parliament and Council* [2017] ECLI:EU:C:2019:194, paras 127–129; Case C-626/22 *C. Z. and others v Ilva SpA in Amministrazione Straordinaria and Others* [2024] ECLI:EU:C:2024:542, para 72.

28 COM(2023) 62 final (n 5) 1–3.

29 Better Regulation Guidelines (n 6) 10. Better Regulation Toolbox (n 11), 'Tool #1, Principles, procedures & exceptions': 'The balanced integration of economic, social and environmental considerations and impacts, pursued through 'better regulation' contributes to the objective of sustainable development laid down in the Treaties and the EU commitment to implement the sustainable development goals (SDGs)'.

30 Better Regulation Toolbox (n 11), 'Tool #19, Sustainable Development Goals'.

31 *ibid.*

32 *ibid.*

33 Better Regulation Toolbox (n 11), 'Tool #18, Identification of Impacts'.

34 *ibid.*

35 *ibid.*

guides ambitious and coherent actions and programmes.³⁶ The difficulty of balancing between different objectives is further compounded by the fragmented decision-making processes of the EU.³⁷ Maria Lee has observed that the problems which plague the process of integrating the concept of sustainable development into the legal framework of the EU are due largely to the intricate and multifaceted nature of its definition and the intricacy of its practical operation.³⁸ These problems mean that transformative change can only occur through comprehensive cooperation that cuts across several layers of government and which harnesses the ambition, creativity, and potential of citizens, businesses, and communities.³⁹ However, the Commission utilizes the Better Regulation scheme, which incorporates multiple considerations aligned with sustainable development, primarily as a governance mechanism at a high level, rather than across various domains and levels of government.

2.2. The precautionary principle as a constitutional basis

The precautionary principle was incorporated into EU law under the influences of the EU Member States, particularly Germany and Sweden, and international environmental law.⁴⁰ The best-known formulation of the principle is from the Rio UNCED of 1992,⁴¹ which has been characterized as the most significant new approach to international environmental cooperation.⁴² The precautionary principle contributes to sustainable development by guiding the management of risk in decision-making. It serves as the basis of a framework for proactive action in the face of uncertain or contested scientific evidence.⁴³ Although the status of the principle at the international level is disputed, it is fundamental to the EU regulatory framework: the precautionary principle sets norms for the assessment of the risk of severe environmental impacts in the absence of definitive scientific evidence.⁴⁴ Article 191 of the TFEU is its constitutional basis.⁴⁵ Article 191(2) TFEU, when read together with Article 114(3) TFEU, which concerns the internal market, indicates that EU environmental policy should provide a high level of protection, 'taking account, in particular, of any new development based on scientific facts'. Further, a non-binding Communication that the European Commission issued in 2000⁴⁶ explains the functioning of the precautionary principle, and it has been reinforced by the jurisprudence of the Court of Justice of the European Union.

The CJEU has established in some cases that environmental protection should be given precedence over economic considerations, even if said precedence would impose detriments on

36 European Environment Agency, 'The European Environment - State and Outlook 2020, Knowledge for transition to a sustainable Europe' (EEA Report No 10/2019, Publications Office of the European Union 2019) 17.

37 Eloise Scottford, *Environmental Principles and the Evolution of Environmental Law* (Hart 2017) 89.

38 Maria Lee, *EU Environmental Law, Governance and Decision-Making* (Bloomsbury 2014) 80.

39 European Environment Agency (n 36) 17.

40 de Sadeleer (n 15) 137–140; Peter H Sand, 'The precautionary principle: a European perspective' (2020) 6(3) *Human and Ecological Risk Assessment* 447.

41 Agenda 21 (n 23) Principle 15.

42 David Freestone, 'The Precautionary Principle' in Robin Rolf Churchill and David Freestone (eds), *International Law and Global Climate Change* (Graham & Trotman 1991) 21–39; Sand (n 41) 445.

43 *ibid*; see also EUR-LEX, 'Precautionary Principle' <<https://eur-lex.europa.eu/EN/legal-content/glossary/precautionary-principle.html>> accessed 29 August 2025.

44 The precautionary principle has substantial indirect repercussions for science and innovation, particularly in domains such as nanotechnology, the use of genetically modified organisms in agriculture, and the employment of endocrine-disrupting chemicals in products as varied as plastics, paints, toys, and clothes. On this matter see, Harald A Mieg, *The Responsibility of Science* (Springer Nature 2022) 7.

45 'Union policy on the environment shall aim at a high level of protection considering the diversity of situations in the various regions of the Union. It shall be based on the precautionary principle and on the principles that preventive action should be taken, that environmental damage should as a priority be rectified at source and that the polluter should pay. In this context, harmonisation measures answering environmental protection requirements shall include, where appropriate, a safeguard clause allowing Member States to take provisional measures, for non-economic environmental reasons, subject to a procedure of inspection by the Union'.

46 Commission, 'Communication from the Commission on the precautionary principle' COM (2000) 1 final.

particular economic operators.⁴⁷ However, environmental protection is subject to proportionality, the competent institutions must identify appropriate measures and levels of protection that reflect the circumstances of each case, meaning that the implementation of the precautionary principle should be predicated on the socioeconomic costs and benefits associated with the evaluated activity.⁴⁸ The principle is particularly germane when the scientific evidence is inconclusive or contested by experts and when an objective, preliminary, and scientific risk assessment raises justifiable concerns that a substance, a production process, or a product may cause harm to human health or the environment.⁴⁹ It has been argued that, in such contexts, the innovation principle could alleviate the economic burdens that are associated with the precautionary principle.⁵⁰ Those who embrace that view believe that the stringency of the precautionary principle causes regulation to become excessive and stifles human activity unduly.⁵¹

The precautionary principle also forms part of the Better Regulation initiative, particularly in instances in which prompt action is required to safeguard public health or the environment in the face of scientific uncertainty. It is embedded in the Better Regulation Toolbox, specifically in Tool #13 and Tool #14, which focus on impact assessments and risk management.⁵² Tool #13 (guidance on how to analyse problems) states that public policy interventions which are designed to prevent potential harm to public health or the environment can be justified even in the absence of definitive scientific evidence of harm.⁵³ When a phenomenon, product, or process is deemed to pose risks but the scientific evaluations are insufficiently certain, provisional measures such as market withdrawals may be implemented so as to maintain the highest standards of health protection while further risk assessments are pending.⁵⁴ Public health risks are among the most widely recognized subjects of risk assessments, which may address matters such as exposure to chemical substances (eg, pharmaceuticals, chemicals, certain foodstuffs, air pollutants, food contact materials, toys, cosmetics, and food contaminants) as well as biological hazards, including salmonella and campylobacter.⁵⁵ Designated authorities, such as the Commission or decentralized agencies, are responsible for implementing the requisite measures, including proportionate legal acts, the allocation of research funding, and the conduct of public information campaigns.⁵⁶

A more comprehensive overview of risk assessment as a foundation for impact assessments is provided by Tool #14, which identifies the essential steps in the process of evidence-based policymaking.⁵⁷ Risk assessments are conducted by the Commission and the decentralized agencies of the EU across a range of policy areas, including public health, climate change,

47 Case T-392/02 R *Solvay Pharmaceuticals BV v Council of the European Union* [2003] T:2003:277, para 125; Case T-177/02 *Malagutti-Vezinhet v Commission* [2004] T:2004:72, para 186; Case T-74/00 R *Artegodañ v Commission* [2002] ECLI:EU:T:2002:283 para 186; Case T-475/07 *Dow AgroSciences and others v Commission* [2011] T:2011:445, para 143; Case T-483/11 *Sepra Europe v Commission* [2013] T:2013:407, para 85; Case T-269/11 *Xeda International v Commission* [2014] T:2014:1069, para 138; Case T-584/13 *BASF Agro and others v Commission* [2010] T:2018:279, paras 55 and 168.

48 de Sadeleer (n 15) 209–210.

49 European Political Strategy Centre, 'Towards an Innovation Principle Endorsed by Better Regulation' (EPSC Strategic Notes Issue 14, Publications Office of the European Union, 30 June 2016).

50 Noah M Sachs, 'Rescuing the Strong Precautionary Principle from Its Critics' (2011) 2011 University of Illinois Law Review 1285, 1303 and 1304.

51 Sumudu A Atapattu, *Emerging Principles of International Environmental Law* (Brill 2007) 208. See further, EUR-LEX, 'Principle of Proportionality' <<https://eur-lex.europa.eu/EN/legal-content/glossary/principle-of-proportionality.html>> accessed 29 August 2025.

52 Better Regulation Toolbox (n 11) 'Tool #13, How to Analyse Problems', 'Tool #14, Impact Assessment', and 'Tool #4, Evidence-Informed Policymaking'.

53 *ibid* 'Tool 13, How to Analyse Problems'.

54 *ibid*.

55 *ibid* 'Tool #14, Impact Assessment'.

56 *ibid* 'Tool #13, How to Analyse Problems'.

57 *ibid* 'Tool #14, Impact Assessment'. See also 'Tool 4, Evidence-Informed Policymaking'.

the financial markets, food safety, and environmental protection.⁵⁸ Firstly, hazards are identified and characterized by assessing the inherent properties of the agents or phenomena that may cause harm, as well as by determining their potential negative effects.

Secondly, the likelihood of the hazard eventuating is assessed, with a focus on the probability of adverse effects on the human population, the environment, and other key constituencies. Finally, the risk is described quantitatively (eg, by estimating fatalities, economic losses, or increases in equality) or, when precise quantification is not feasible, qualitatively.⁵⁹ Non-market impacts, such as environmental or health effects, should also be monetized where possible. When the risks are deemed unacceptable, proportionate measures are implemented to mitigate or reduce them.⁶⁰ In cases in which uncertainty renders comprehensive evaluation impossible, precautionary measures are implemented pending the accumulation of further evidence.⁶¹ Post-implementation monitoring and evaluation (Tool #18) are intended to ensure the effectiveness of such measures and to support evidence-based policymaking.⁶² That policymaking is evidence based means that all of the evaluations that were described above ought to be based on evidence of the highest quality. That evidence should, furthermore, be elicited through diverse methods, in line with the methodological notion of triangulation. The weight that is allocated to different sources of evidence should, however, reflect their epistemic value, which may be determined through robustness analyses. More generally, it is in the spirit of the precautionary principle to evaluate and report uncertainty transparently, even when it cannot be modelled or quantified and especially in assessments of the risk of mutations and environmental damage.⁶³

2.3. The innovation principle—the odd one out?

It is evident from the foregoing that the precautionary principle regulates responsible innovation. The innovation principle also purports to achieve that end. It was formulated in 2013 by the European Risk Forum, an organization that included 12 CEOs who were investing more than €21 billion annually in innovation.⁶⁴ The new principle was intended to reshape precaution so as to enhance EU competitiveness.⁶⁵ The authors called for a balanced treatment of risk management and scientific rigour, as well as for a recalibration of the principles of precaution and proportionality.⁶⁶ A parallel development took place in France, where the principle of innovation was actively promoted by major industrial undertakings as a countermeasure to the constitutional principle of precaution enshrined in Article 5 of the French Environmental Charter.⁶⁷ This national debate illustrates that the innovation principle emerged not only from EU-level discourse but also as a reaction against the perceived regulatory burdens of precaution

58 *ibid* 'Tool #14, Impact Assessment'.

59 *ibid*.

60 *ibid*.

61 *ibid*; see also Better Regulation Toolbox (n 11) 'Tool #36, Environmental Impacts'.

62 *ibid*; see also 'Tool #18, Identification of Impacts'.

63 *ibid* 'Tool #14, Impact Assessment; Better Regulation Guidelines (n 6) 27.

64 European Risk Forum, 'The Innovation Principle, Stimulating Economic Recovery: Open Letter to Barroso, Van Rompuy and Schultz' (24 October 2013), <https://corporateeurope.org/sites/default/files/corporation_letter_on_innovation_principle.pdf> accessed 29 August 2025. The original definition of the innovation principle that the European Risk Forum suggested is as follows: '[w]henever policy or regulatory decisions are under consideration the impact on innovation as a driver for jobs and growth should be assessed and addressed'.

65 Kathleen Garnett, Geert Van Calster, and Leonie Reins, 'Towards an innovation principle: an industry trump or shortening the odds on environmental protection?' (2018) 10 *Law, Innovation and Technology* 1, 2.

66 European Risk Forum (n 64).

67 *Charte de l'environnement de 2004*, incorporated into the French Constitution by *Loi constitutionnelle n° 2005-205 du 1 mars 2005*, Article 5; see also Aurélie Barbaux, 'Un principe d'innovation dans la Constitution, est-ce bien raisonnable?' (*Usine Nouvelle*, 4 June 2014) <<https://www.usinenouvelle.com/article/un-principe-d-innovation-dans-la-constitution-est-ce-bien-raisonnable.N266735>> accessed 29 August 2025.

at the domestic level. Although the French attempt to constitutionalize it failed, it demonstrates the political strategy behind framing innovation as a ‘principle’: namely, to recalibrate the balance between environmental/health risk management and economic competitiveness due innovations. The European debate cannot be fully understood without acknowledging these national influences, which have shaped the Commission’s receptiveness to the innovation principle.

Despite the possibility of its origin being seen as an example of regulatory capture,⁶⁸ the Commission began referring to the innovation principle in policy documents, as well as in the Better Regulation Toolbox from 2021.⁶⁹ According to the Commission, the working definition of the principle suggests that EU policy and legislation should be designed, implemented, and evaluated in a way that encourages innovative solutions that contribute to the environmental, social, and economic goals of the Union while also anticipating and leveraging future technological advancements.⁷⁰ The innovation principle thus has the same dimensions as the principle of sustainable development but also covers the adoption and development of new technologies, in line with new competition policies of the EU.

One of the harshest critics of the innovation principle, the Corporate Europe Observatory, sees it as a tool that is designed to further business interests at an early stage of the decision-making process and to enable industry to counter evidence of risks, harms, and the existence of safer alternatives.⁷¹ More generally, Andrea Saltelli and his colleagues have identified corporate pressure as a vulnerability in the interface between science and law.⁷² According to them, that the subjectivity of the business perspective is oftentimes neglected, which is evidenced by the emergence of the ‘innovation principle’.⁷³ Conversely, Andrea Renda and Felice Simonelli have argued that the innovation principle, despite originating from industry, has been formulated incrementally and meticulously in the context of Better Regulation agenda.⁷⁴ In addition, these authors took the view that, industry concerns about excessive reliance on the precautionary principle in EU legislation notwithstanding, industrial incumbents have not argued that precaution should be sacrificed in the name of innovation. Instead, the innovation principle is intended to complete the precautionary principle ‘by increasing the salience of innovation during all phases of the policy cycle’.⁷⁵

Nevertheless, the innovation principle has several notable shortcomings beyond its origins. These include the absence of a clear legal foundation or an accepted definition, limited awareness of its content among EU officials and stakeholders, and lack of relevant skills among those are tasked with its implementation.⁷⁶ The integration of the innovation principle into

68 Jean-Jacques Laffont and Jean Tirole, ‘The Politics of Government Decision Making: A Theory of Regulatory Capture’ (1991) 106 *Quarterly Journal of Economics* 1089; See also Valeria Vinci and Sofia Ranchordás, ‘Regulatory sandboxes and innovation-friendly regulation: between collaboration and capture’ (2024) 16 *Italian Journal of Public Law* 107.

69 Better Regulation Toolbox (n 11).

70 European Commission, ‘The Innovation Principle’ (17 May 2022) <https://research-and-innovation.ec.europa.eu/system/files/2022-07/ec_rtd_factsheet-innovation-principle.pdf> accessed 29 August 2025.

71 Corporate Europe Observatory, ‘The “innovation principle” trap’ (5 December 2018) <<https://corporateeurope.org/en/environment/2018/12/innovation-principle-trap>> accessed 29 August 2025.

72 Andrea Saltelli and others, ‘Science, the Endless Frontier of Regulatory Capture’ (2022) 135 *Futures: The Journal of Policy, Planning and Futures Studies* 102860, 102871.

73 *ibid.* The principle has been ridiculed by reference to sociologist Ulrich Beck’s remark on science as a self-service shop for financially well-endowed customers in need of arguments: see Ulrich Beck, *Risk Society: Towards a New Modernity* (SAGE 1992).

74 Andrea Renda and Felice Simonelli, ‘Study supporting the interim evaluation of the innovation principle: final report’ (Publications Office of the European Union 2019).

75 *Ibid.*, 5 and 10: Furthermore, Ashford and Hall argue for more creative use of government intervention as a strategic approach to achieve sustainable industrial transformation which requires, systemic, multidimensional, and disruptive changes. However, in 2018, Ashford and Hall predicted that even radical disruptive innovation, as defined by Christensen, would not lead in towards ‘system’ transition. See Nicholas A Ashford and Ralph P Hall, *Technology, Globalization, and Sustainable Development: Transforming the Industrial State*, (London: Routledge, 2018) 494 and Nicholas A Ashford, ‘Technology-Focused Regulatory Approaches for Encouraging Sustainable Industrial Transformations: Beyond Green, Beyond the Dinosaurs, and Beyond Evolutionary Theory (3rd Blueprint Workshop on Instruments for Integrating Environmental and Innovation Policy, Brussels, September 2002) 10.

76 Renda and Simonelli (n 74) 4 and 45.

Union-level decision-making must be understood against the backdrop of the Commission's general treatment of innovation: an innovation-friendly regulatory framework should strike the delicate balance between safety and innovation. By focusing on this trade-off, the Better Regulation agenda can engender a regulatory landscape that is more robust and dynamic, as well as more conducive to innovation.⁷⁷

According to the text of Tool #22 of the Better Regulation Toolbox, the innovation principle is salient to three crucial stages of the policy cycle, namely the agenda-setting, impact assessment and implementation phases.⁷⁸ Consequently, it should guarantee that EU legislation is drafted in a manner that is sensitive to the emergence of policy-relevant technologies and the need to accelerate their development and adoption.⁷⁹ During the agenda-setting phase, the principle emphasizes the importance of access to information about innovation. Accordingly, the Directorate-General for Research and Innovation is currently establishing a Regulatory Advice Mechanism (RAM) to expand said access. The mechanism is designed to produce guidance and a deeper understanding of the relationship between innovation and regulation, with a focus on the early stages of the innovative process. It should highlight desirable innovations, regulatory designs that accelerate their diffusion, and means of ensuring that they are deployed safely and sustainably.⁸⁰

As a part of agenda-setting, Tool #22 refers to Horizon Europe and its objectives. EU legislation, cross-border cooperation, and the EU budget all determine the rate at which innovations are adopted.⁸¹ The analysis of technological and business-process innovation, which is based on the Horizon Scanning and Foresight method, is seen as particularly useful for the formulation of policy and for strategic decision-making in emerging or unregulated domains. Horizon Scanning also informs other stages of the policy cycle, such as evaluation, when it results in the identification of important developments that may impact existing legislation.⁸² The RAM that is being implemented as part of Horizon Scanning and Tool #22 is intended to expand the evidence base for evaluations and impact evaluations as well as to identify important stakeholders and to engage innovators in dialogue by increasing their visibility in networks.⁸³

Turning to the impact-assessment phase of the legislative process, Tool #22 is accompanied by guidelines which describe the various interactions between regulation and innovation. Those interactions may be considered during assessments of the impact of changes to EU legislation. The guidelines indicate that five matters must be considered. The first is 'flexibility and futureproofing': regulation should be technology neutral and sufficiently flexible in the light of the possibility of unexpected future developments.⁸⁴ The second is 'compliance costs', which should not dull incentives for innovation unduly.⁸⁵ The third is 'legal certainty', which also covers the need for periodic reviews.⁸⁶ The fourth is 'timing', that is, the need to ensure that unrealistic timelines and regulatory requirements do not prevent useful innovations from materializing.⁸⁷ The fifth and last factor is 'effect on the single market': legislation should be

77 European Political Strategy Centre (n 49) 7.

78 Better Regulation Toolbox (n 11) 'Tool #22, Innovation & Research'.

79 *ibid.*

80 *ibid.*

81 Commission, 'A renewed European Agenda for Research and Innovation Europe's chance to shape its future: the European Commission's contribution to the Informal EU Leaders' meeting on innovation in Sofia on 16 May 2018' COM (2018) 306 final, 3.

82 Better Regulation Toolbox (n 11) 'Tool #22, Innovation & Research'.

83 *ibid.*

84 Better Regulation Toolbox (n 11), 'Tool #22, Innovation & Research'.

85 *ibid.*

86 *ibid.*

87 *ibid.*

implemented harmoniously across the Member States, and regulations that target one sector should cohere with regulations that target others.⁸⁸

According to Tool #22, the implementation phase ought to be influenced by the innovation principle through measures that leverage the potential of innovation and reduce its negative impacts or, in other words, by adaptive legislation.⁸⁹ The Tool comprises a non-exhaustive list of methods that may enhance the design of legislation to promote innovation. Integrating adaptiveness into legislative design should facilitate the formulation of legislation that is genuinely sensitive to the imperative of sustainable innovation.⁹⁰ The available adaptive-legislation instruments, whose viability should be evaluated on a case-by-case basis, include experimentation clauses, outcome-oriented legislation, sunset clauses, tests of alternatives, and top-runner approaches.⁹¹ Among these five instruments, the top-runner approach stands out as a potential means of facilitating the adoption of more sustainable technologies. It entails updating requirements so that they reflect the higher performance levels that become possible in consequence of scientific or technological progress.⁹²

The positive impact of the top-runner approach is particularly evident when evaluated in parallel with the Industrial Emissions Directive⁹³ pertaining to the selection of technology due to known as Best Available Technology (BAT) conclusions, for industrial sites with polluting emissions.⁹⁴ In addition to the long-standing reliance on BAT conclusions and their cyclical revision,⁹⁵ the amended IED framework incorporates three mutually reinforcing mechanisms, which translate top-runner standards into regulatory practice. Firstly, competent authorities are now required, as a rule, to set permit BAT-associated emission limit values at the strictest end of the BAT-associated range.⁹⁶ This development is curbing of the permissive discretion that previously allowed comparatively lax in-site standards.

Secondly, the Directive explicitly integrates environmental performance levels—both emission and broader resource-efficiency metrics—into permitting.⁹⁷ These performance levels function as minimum benchmarks and as dynamic targets that steer continuous operational optimization. Thirdly, the European Innovation Centre for Industrial Transformation and Emissions (INCITE)⁹⁸ institutionalizes a feedback loop between real-world experimentation and regulation. It supports the development and testing of emerging techniques, assesses their environmental performance, and channels validated results into sector specific BAT reference document updates and, therefore, future BAT conclusions for that industrial sector.⁹⁹ The adoption of environmentally more efficient technology as BAT results in the update of emission limit values to stricter standards, reflecting the enhanced capabilities of the technology. Industrial operators within the sector are expected to adhere to these more stringent emission standards. These measures serve to enhance the probability of new technologies exerting an

88 *ibid.*

89 *ibid.*

90 *ibid.*

91 *ibid.*

92 *ibid.*

93 Directive 2010/75/EU of the European Parliament and of the Council of 24 November 2010 on industrial emissions (integrated pollution prevention and control) [2010] OJ L334 (IED 2010/75/EU); Amended by Directive 2024/1785 of the European Parliament and of the Council of 24 April 2024 amending Directive 2010/75/EU of the European Parliament and of the Council on industrial emissions (integrated pollution prevention and control) and Council Directive 1999/31/EC on the landfill of waste (IED 2024/1785).

94 See IED 2010/75/EU (n 93), article 3(10)-(12).

95 The Commission should aim to revise BAT conclusions within eight years of the publication of their previous versions. In this regard see IED (2010/75/EU) (n 102), preamble 13.

96 IED 2024/1785 (n 93) preamble (29), article 15(3).

97 *ibid.* recitals (27) and (40), articles 3(5a), 3(49), (13aa), 3(13b), article 15(4).

98 *ibid.* article 27a.

99 See *ibid.* preamble (40), articles 27a.

impact on the most stringent BAT-based requirements for industrial pollution across various industry sectors, with the potential to engender a favourable outcome regarding the enhancement of local environmental and health protection. In this regard, experimentation clauses and tests of alternatives can exert similar influences, primarily by affecting the amount of data that is available to an authority when it conducts risk assessments and thus contributing to the identification of optimal technological solutions. However, choosing ‘best innovations’ is not compatible with the technology-neutrality approach applied by the innovation principle.

The innovation principle, with its emphasis on a futureproof, flexible, and technology-neutral legal framework, may conflict with the precautionary principle, which sets a risk threshold. This risk is particularly acute when technology neutrality is at stake in environmental law.¹⁰⁰ The concept of technology neutrality appears straightforward: various technologies can be employed to achieve similar goals, and the choice of technology should not influence legal judgments, as long as the outcomes are identical.¹⁰¹ At the same time, outcome-oriented legislation, as an adaptive instrument, could conflict with the precautionary principle because it allows for flexible choices between means to specific ends. This flexibility may complicate the management of the risks that are associated with new technologies or techniques. In this regard, in addition to top-runner approach, the IED incorporates calibrated flexibility through derogations from the principal requirements.¹⁰² The aim of this combination is to accelerate the diffusion of superior techniques which cannot meet all the requirements before tested in the real-world circumstances. For example, time-limited derogations—with a duration of up to thirty months—may be authorized to facilitate the real-world evaluation of nascent techniques.¹⁰³ Therefore, the revised IED is spanning the interim between the top-runner approach and flexibility in promoting technological innovation, while the latter approach is characterized by an allowance of derogations, which in turn engenders increased risk-taking.

Likewise, sunset clauses, which provide for the suspension or repeal of provisions from legal texts after a specific date unless those provisions are explicitly extended, may prevent legislation from becoming an obstacle to risky innovations in rapidly changing environments. Sunset clauses also introduce uncertainty as to outcomes, for example, by potentially removing precautionary measures or forms of oversight before the full impact of a new technology has been understood. These approaches can generate biased decisions about technology, in that specific technologies may receive support before they are ready for use or sale. Resources may therefore be used less efficiently, and some projects may fail if they do not ultimately prove to be competitive or sustainable. The precautionary principle allows for the potential restriction of various freedoms, irrespective of their impact on innovation, when the legislator determines that the risks which it has identified and assessed are so serious as to require precautionary measures.¹⁰⁴

The fundamental question pertains to the potential of abovementioned procedure and the newly established EU body—RAM—to legitimize the innovation principle as an evidence-informed policy. As noted by Charlotte Ducuing, the innovation principle is

100 See Commission, Part 1/5, Commission Staff Working Document, Impact Assessment Report on reporting of environmental data from industrial installations and establishing an Industrial Emissions Portal SWD (2022) 111 final. See also Heinrich Parthey, ‘Institutionalization, interdisciplinarity, and ambivalence in research situations’ in Harald A Mieg (ed), *The Responsibility of Science* (Springer 2022).

101 Per Sandin, Christina Munthe, and Karin Edvardsson Björnberg, ‘Technology neutrality in European regulation of GMOs’ (2022) 25(1) *Ethics, Policy & Environment* 52, 56.

102 On derogations under normal operating conditions see IED 2010/75/EU (n 102), article 15(4); New conditions for derogations see IED 2024/1785 (n 102), especially article 15(5).

103 IED 2024/1785 (n 93), article 27b.

104 See Appel (n 12) 156–157.

predicated on the premise that science constitutes a stable and uncontroversial foundation upon which the law can be formulated. However, the ambitious nature of this principle is hindered by the inherent complexity of the subject matter.¹⁰⁵ The crux of the issue pertains to the methodology for conducting a concrete and scientific evaluation of the ‘innovation-friendliness’ of legislation, and the enhancement thereof. The question must be posed as to whether it is feasible for the lawmaker to evaluate the innovation-friendliness of a proposed legal regime, given that the innovation would arise much later than the adoption.¹⁰⁶

The innovation principle is thus a double-edged sword. As the European Environment Agency has shown, many innovations introduced without rigorous assessment caused significant harm, such as mercury-based medical treatments in the nineteenth century or the use of neonicotinoids in agriculture, which contributed to severe bee losses.¹⁰⁷ At the same time, innovations in pollution control, recycling, and wastewater treatment have delivered clear environmental benefits. These examples highlight that innovation is not inherently positive; its impacts are uncertain and context-dependent, which reinforces the need for precaution and sustainability as guiding principles.

3. THE INNOVATION PRINCIPLE IN EU POLICIES

The innovation principle appears in several EU policy documents, as well as in a non-binding Recommendation. This section examines the functions that the innovation principle discharges in them. The Commission’s embrace of the Innovation Principle reflects a broader policy orientation that seeks to align regulatory development with the imperatives of technological progress, industrial competitiveness, and economic growth. Across several key documents, including the Horizon Europe Regulation, the Council Conclusions on Regulatory Sandboxes, the European Agenda for Research and Innovation, and the Single Market Communication, the Innovation Principle is repeatedly invoked as a means of fostering innovation-friendly and future-proof regulation. This framing is firmly rooted in the belief that promoting innovation through flexible, evidence-based legislative frameworks will support not only economic expansion but also the achievement of sustainability goals.

3.1. Horizon Europe

In Horizon Europe, the EU’s principal research and innovation funding programme, the Innovation Principle is articulated as a tool for advancing Union policy objectives by transforming Europe’s scientific and knowledge assets into marketable, sustainable innovations. The term ‘Horizon Scanning’ is used to denote the detection of early indications of significant innovation. This detection involves the analysis of megatrends and the identification of fruitful applications of the €95.5 billion budget of the Horizon Europe programme.¹⁰⁸ The innovation principle is mentioned in Recital 6 to the Horizon Europe Regulation, which concerns the

¹⁰⁵ Charlotte, Ducing, ‘A legal principle of innovation? Need for an assessment against the principle of democracy’ (2022) 14(2) *Law, Innovation and Technology* 237, 261.

¹⁰⁶ *ibid* 253 and 261. See also Gaia Taffoni, ‘Regulating for Innovation? Insights from the Finnish Presidency of the Council of the European Union’ (2020) 11 *European Journal of Risk Regulation* 141.

¹⁰⁷ European Environment Agency, ‘Late Lessons from Early Warnings: Science, Precaution, Innovation’ (EEA Report No 1/2013, Publications Office of the European Union 2013).

¹⁰⁸ Renda and Simonelli (n 74) 9. Better Regulation Toolbox (n 11) ‘Tool #22, Innovation & Research’; See also COM (2018) 306 final (n 90) 9–10. On Horizon Europe, see European Commission, ‘Horizon Europe’ <https://research-and-innovation.ec.europa.eu/funding/funding-opportunities/funding-programmes-and-open-calls/horizon-europe_en> accessed 29 August 2025.

need to improve communication between the stakeholders of the innovation ecosystem. The text reads as follows:¹⁰⁹

To help achieve Union policy objectives, activities supported under this Programme should, where relevant, take advantage of and inspire innovation-friendly regulation, in line with the innovation principle, to support a faster and more intensive transformation of the Union's substantial knowledge assets into innovation.

The Annexes to the Horizon Europe Regulation also underscore the importance of innovation and innovative capacity.¹¹⁰ That importance should be reflected in improvements to existing collaborative and innovative environments and in attempts to stimulate the appearance of new ones,¹¹¹ as noted in Section (b) in Annex II.¹¹² In simpler language, the objective is to create spaces where EU researchers, innovators, industries, and governments can interact easily.¹¹³ However, there is no substantive reference to the precautionary principle within the Regulation's text, raising concerns about the adequacy of safeguards in the face of potentially disruptive or risky technologies.

However, the innovations that Horizon Europe promotes are intended to be sustainable. Sustainable development, climate objectives, and public well-being have been placed at the heart of Horizon Europe, alongside industrial competitiveness and economic growth. However, because of multidimensional objectives, when EU funding is allocated to research projects, there is a risk that the innovation principle could lead to economic benefits and competitiveness being prioritized at the expense of other objectives. This tendency is due to the unpredictable outcomes of innovation, as well as to the absence of robust evaluative frameworks and to the complexity of multi-actor transitions. These problems make it difficult to use the SDGs as a basis for the assessment of European research and development projects.¹¹⁴ Nevertheless, given that the innovation principle is intended to stimulate research and development in the context of Horizon Europe, the idea features much more prominently in the guidelines based on sustainable development. The latter are designed to direct investment towards sustainable innovations that appear to have the strongest prospects.¹¹⁵

3.2. The council conclusions on regulatory sandboxes

The emphasis on innovation-driven regulatory flexibility is more evident in the Council Conclusions on Regulatory Sandboxes. On 16 November 2020, the Council adopted a series of Conclusions about the role of regulatory sandboxes and experimentation provisions in an innovation-friendly, futureproof, sustainable, and resilient EU regulatory framework.¹¹⁶ In its findings, the Council emphasized that regulatory sandboxes may enable innovation and

109 Regulation (EU) 2021/695 of the European Parliament and of the Council of 28 April 2021 establishing Horizon Europe—the Framework Programme for Research and Innovation, laying down its rules for participation and dissemination, and repealing Regulations (EU) No 1290/2013 and (EU) No 1291/2013 [2021] OJ L170 ('Horizon Regulation'), Preamble 6.

110 Ibid.

111 Proposal for a Regulation of the European Parliament and of the Council establishing Horizon Europe—the Framework Programme for Research and Innovation, laying down its rules for participation and dissemination, COM (2018) 435 final, Recital 2, Annex II, b, Annex IV, and Annex VI.

112 Ibid.

113 Ibid, Recitals 17, 43, and 51; Annex II.

114 Nikos Kastrinos and K Mattias Weber, 'Sustainable development goals in the research and innovation policy of the European Union' (2020) 157 *Technological Forecasting and Social Change* 120056, 120059.

115 For an example, see Better Regulatory Toolbox (n 11), 'Tool #19, Sustainable Development Goals'.

116 'Council Conclusions on Regulatory sandboxes and experimentation clauses as tools for an innovation-friendly, future-proof and resilient regulatory framework that masters disruptive challenges in the digital age' (Brussels 16 November 2020) Document No 1306/20 ('Council Conclusions').

growth at numerous companies, particularly SMEs, micro-enterprises, and startups, in line with the experimentation clauses that were discussed in Section 2.3.¹¹⁷ The sandboxes aim to accelerate the development and market entry of innovations by streamlining authorization and certification processes through testing of the novel technology in a controlled real-world environment, thereby reducing bureaucratic delays and facilitating technological progress while maintaining regulatory oversight.¹¹⁸

Furthermore, the Conclusions on Regulatory Sandboxes acknowledge the increasing adoption of regulatory sandboxes across various sectors, including finance, healthcare, legal services, aviation, transportation, logistics, and energy.¹¹⁹ In the context of the Net-Zero Industry Regulation, 'legal sandboxes' are controlled regulatory environments that enable undertakings to experiment with and test innovative technologies under relaxed regulatory condition but only under a specific plan, developed and monitored by a competent authority.¹²⁰

The Conclusions contain two explicit references to the innovation principle, one of which has to do with a 2019 study that evaluates it. The third Preamble to the Conclusions refers to the innovation principle alongside precaution and proportionality and against the background of 'sustainable and inclusive growth'.¹²¹ Thus, the triangle of innovation, sustainable development, and precaution is stressed once more. The Conclusions encourage the Commission to continue considering the use of experimentation clauses when it drafts or revises legislation and to evaluate their use in *ex post* evaluations and fitness checks on the basis of information exchanges with the Member States.¹²²

3.3. The European agenda for research and innovation

The 2018 European Commission's Agenda for Research and Innovation¹²³ further consolidates pro-innovation orientation by asserting that all legislation should be assessed for its impact on innovation in order to ensure future-proof regulatory frameworks. This logic assumes that unimpeded innovation will lead to societal and ecological benefits, particularly in relation to climate change and energy transitions. The references on the innovation principle appear in the context of the transformative role of technological innovation and their benefits on energy, transport, and industry, among others, for progress towards a sustainable low-carbon economy.¹²⁴ It is also noted that a well-functioning internal market and robust competition rules are indispensable for the formation of innovation-friendly business environments.¹²⁵ Given that the communication was released in 2018, it can be interpreted as an invitation to incorporate the innovation principle into the Better Regulation scheme. Interestingly, the 2022 European Innovation Agenda does not include references to the innovation principle anymore.

117 *ibid.*

118 COM (2023) 62 final (n 5) 5.

119 Council Conclusions (n 116), Recital 5.

120 Regulation (EU) 2024/1735 of the European Parliament and of the Council of 13 June 2024 on establishing a framework of measures for strengthening Europe's net-zero technology manufacturing ecosystem and amending Regulation (EU) 2018/1724 [2024] OJ L2024/1735, Preamble 100 and Articles 1(2), 3(22), 33, and 34.

121 Council Conclusions (n 116), Recital 1.

122 Commission, Commission Staff Working Document Accompanying the Document Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of The Regions: A New European Innovation Agenda SWD (2022) 187 final, 30.

123 COM (2018) 306 final (n 81).

124 *ibid.* 2.

125 *ibid.* 4.

According to the communication, the regulatory framework should be simple and transparent, markets should be open and competitive, incentives to invest should be adequate, and capital should be easy to access.¹²⁶ Three key principles should be acknowledged for innovation capacity to improve, namely that substantial investment in scientific and technological research is necessary, that societal and industrial challenges such as climate change must be tackled, and that it is desirable to cultivate a business environment that is more conducive to innovation and less averse to risk.¹²⁷

It is evident that the Commission agenda for Research and Innovation is predicated on the fallacy that companies' innovative capabilities (unaffected by the 'precautionary principle' and its concomitant 'aversion to risk') will contribute—in conjunction with the competitiveness of EU businesses—to the overall sustainability, at least in terms of climate change. This supposition is fallacy, since the term 'innovation' is not defined in the context of Innovation agenda. Instead, the technology neutrality of its application engenders an uncertain situation regarding the social, environmental, and economic consequences of innovations. The Innovation agenda, with its emedding of the the innovation principle, reflects the fundamental assumptions of ecological modernization theory. This theory posits that sustainable development can be achieved through a technocratic approach to the environment. This approach suggests that there is a techno-institutional solution to the present environmental and social problems.¹²⁸ This is evidenced by the assumption that economic growth and ecological sustainability can be achieved through the facilitation of innovation-friendly regulation and competitive markets. This standpoint is predicated on the premise that environmental challenges, such as climate change, can be addressed without resorting to fundamental structural change. Instead, the argument is that there is a reliance on the transformative capacity of science, technology and the creative capacities of businesses.¹²⁹

3.4. The single market communication

Besides the Commission's Innovation Agenda, the 2018 Communication on the Single Market place strong emphases on the need for futureproof regulation in an age in which technological development is rapid and in which productivity growth is of the essence. Both documents refer to the innovation principle in these contexts. By aligning the innovation principle with regulatory approaches that support both innovation and industrial competitiveness, the Single Market Communication aims to guarantee the continued competitiveness of its industries in the global market. The Communication asserts that a forward-looking single market will conduce to progress and prosperity.¹³⁰ To fulfil this potential, the Commission is required to ensure that the legal framework is fair, clear, and effective; furthermore, it should assess the impacts of regulations, including their effect on innovation.¹³¹

It is evident that the innovation principle is articulated in a relatively ambiguous manner in the Single Market Communication. There is a risk that technological improvements will focus excessively on productivity, resulting in the other dimensions of sustainable development

¹²⁶ *ibid* 7–8.

¹²⁷ *ibid*.

¹²⁸ Sam Adelman, 'The sustainable development goals, anthropocentrism and neoliberalism' in Duncan French and Louis Kotzé, *Sustainable Development Goals* (Edward Elgar 2018) 27; See also Arthur PJ Mol, David A Sonnenfeld, and Gert Spaargaren (eds), *The Ecological Modernisation Reader: Environmental Reform in Theory and Practice* (Routledge 2020) 414.

¹²⁹ On the economic-modernisation theory and its limitations, see Hali Healy, Joan Martinez-Alier, and Giorgos Kallis, 'From ecological modernization to socially sustainable economic degrowth: lessons from ecological economics' in Raymond L Bryant (ed), *The International Handbook of Political Ecology* (Edward Elgar 2015) 586.

¹³⁰ Commission, 'The Single Market in a changing world: a unique asset in need of renewed political commitment' COM (2018) 772 final, 2.

¹³¹ *ibid* 1.

being neglected.¹³² Accordingly, the Single Market Communication states, ‘In order to move to a sustainably higher path of economic growth, the Union must urgently improve the conditions which foster productivity growth. As pointed out in the Commission’s Annual Growth Survey, together with innovation and diffusion of technology, markets which function efficiently are a key driver of productivity growth. The Single Market is also one of the foundations for the Economic and Monetary Union and Single Market integration is key to improving its resilience’.¹³³ Evidently, gains in productivity are seen as being at the core of sustainable growth, putting economic sustainability above other factors of sustainability.¹³⁴

3.5. Energy efficiency

The imperative of energy efficiency means that reliance on (imported) fossil fuels should be reduced, that the security of the energy supply should be guaranteed, and that the use of renewable energy should be expanded. The Commission has indicated that the potential of energy efficiency is often overlooked in existing planning and investment frameworks, both within and outside of the EU.¹³⁵ In the non-binding Commission Recommendation on the Implementation of the Energy Efficiency First principle,¹³⁶ the Commission recognized research and innovation as essential to the identification and exploitation of synergies in the energy system.

The Recommendation includes two direct references to the innovation principle. First, it states that the application of the energy-efficiency-first principle ought to cohere with and promote innovative solutions to social problems. (Energy) System integration stimulates investment, job creation, and growth. The stimulus in question can make the EU a global industrial leader, which would enable it to promote climate neutrality in emerging countries.¹³⁷ Second, in the text of the Recommendation, the innovation principle is treated as a tool that can ensure that legislative frameworks optimize innovation. The underlying assumption is that its invocation, in tandem with the invocation of ‘energy efficiency first’, would contribute to sustainable development.¹³⁸ In the wider policy context of the Recommendation, the innovation principle is called an ‘underlying policy principle’, together with ‘do no significant harm’. The Recommendation posits that the principles in question must be considered when policy-makers are ‘addressing emerging technologies and identifying future-proof approaches’, and ‘relevant markets and future trends’ are explicitly recognized as ‘critical elements’¹³⁹ in this context.

4. IS THE INNOVATION PRINCIPLE NECESSARY?

Our examination of the references to the innovation principle reveals several general tendencies. In this Section, we will argue that those tendencies are indicative of the principles

132 *ibid* 2; Commission, ‘The Commission Annual Growth Survey’ COM (2018) 770 final and Commission, ‘Commission Communication taking stock of the Investment Plan’ COM (2018) 771 make the same point.

133 COM (2018) 772 final (n 130) 11.

134 *ibid* 11.

135 Commission Recommendation (EU) 2021/1749 of 28 September 2021 on Energy Efficiency First: from principles to practice—guidelines and examples for its implementation in decision-making in the energy sector and beyond, C/2021/7014 s 9–59; See also European Commission, ‘Energy Efficiency First principle’ <https://energy.ec.europa.eu/topics/energy-efficiency/energy-efficiency-targets-directive-and-rules/energy-efficiency-first-principle_en> accessed 29 August 2025.

136 Commission Recommendation (n 135).

137 *ibid*, Preamble 14.

138 *ibid*. The exact reference is ‘The “innovation principle” is a tool to help achieve EU policy objectives by ensuring that legislation is designed in a way that creates the best possible conditions for innovation to flourish (10) and should be applied in conjunction with the EE1st principle, where relevant’.

139 *ibid* 17.

superfluity. First, the innovation principle often appears in passages that pertain to environmental, social, and economic matters, which are also the dimensions of sustainable development. Clearly, therefore, the innovation principle and sustainable development often go hand in hand. Arguably, this correspondence is symptomatic of the overlap between the two. As we noted in Section 2.1, sustainable development is a constitutional principle. It is not obvious what the innovation principle, which has a much more convoluted claim to legitimacy, adds to it.

Second, the innovation principle often features in the context of experimentation,¹⁴⁰ regulatory sandboxes, and innovation clauses. So much is evident from, among others, the Council Conclusions on Regulatory Sandboxes. Experimentation can result in various legal embroils. For example, those who are excluded from sandboxes may challenge the underlying legal regimes because they put them at a competitive disadvantage, particularly if they were always ineligible for these schemes or if they were never made aware of their existence.¹⁴¹ Furthermore, post-experimental regulatory actions may be challenged by companies that have formed legitimate expectations about future regulatory behaviour on the basis of the conduct and the outcomes of the experiment.¹⁴² There is a risk that ongoing interactions between regulators and market participants may enable the latter to exert undue influence, leading to regulatory decisions that serve private interests over the public good.¹⁴³ Experimental legislation can also disrupt regulatory norms by providing for derogations from existing environmental standards: Tool #22 of Better Regulation Toolbox indicates that the innovation principle could facilitate the drafting of legislation that focuses on sustainable innovation,¹⁴⁴ but the guidance on integrating the innovation principle into sustainable development, the SDGs, and the precautionary principle is lacking. This lack is problematic because if the innovation principle is applied differently in each regulatory experiment, the level of legal protection would vary across experimental conditions. Once more, it appears that abandoning the innovation principle and applying the more established principles of sustainable development and precaution more stringently instead would yield superior results in terms of environmental and social outcomes.

Third, even if the Better Regulation Toolbox mentions the precautionary principle, Tool #22 and most policy documents that refer to the innovation principle do not. According to the latter documents, the competitiveness of the EU depends on its capacity to embrace technological innovation. The focus of this argument is on regulatory density, and it is premised on the assumption that strict and profuse environmental regulations hamper the diffusion of innovation. However, if viewed from this perspective, the innovation principle as it appears in Tool #22 seems to be directed at the same objectives as sustainable development—both attempts to strike a trade-off between progress and risk. The latter principle, unlike the former, features in the Better Regulation framework and, more importantly, in the primary law of the Union.

The Net-Zero Industry Regulation provides for a simplified regulatory framework for production-capacity technologies that are key to achieving climate neutrality, such as batteries, wind turbines, heat pumps, solar panels, electrolysers, and carbon capture and storage

140 Better Regulation Toolbox (n 11) 'Tool #22, Innovation & Research'.

141 Stefan Philipsen, Evert F Stamhuis, and W Martin de Jong, 'Legal enclaves as a test environment for innovative products: toward legally resilient experimentation policies' (2021) 15(4) *Regulation & Governance* 1128, 1135–1136.

142 *ibid.*

143 Vinci and Ranchordás (n 68) 110.

144 Better Regulation Toolbox (n 11) 'Tool #22, Innovation & Research' and 'Tool #69, Emerging Methods and Policy Instruments'.

technologies.¹⁴⁵ On the other hand, the Critical Raw Materials Regulation establishes a streamlined regulatory framework for the supply and recycling of critical raw materials within the EU.¹⁴⁶ These materials are essential not only for climate technologies but also for numerous other technological applications, and their availability is considered to enhance the EU's industrial competitiveness.¹⁴⁷ These regulations constitute a pivotal illustration of the trade-offs that have been deliberately planned to be achieved between environmental regulations and processes that are designed to safeguard the local environment in accordance with the precautionary principle and the enhancement of technologies that have the potential to mitigate climate change. This trade-off is due to the streamlining of environmental permit procedures and the allowance of specific derogation in the Habitats Directive, the Birds Directive, and the Water Framework Directive to be applied in case of green investments.¹⁴⁸ In this context, it is important to acknowledge that even 'green' investments have the potential to pose significant risks to human health and the environment, particularly in circumstances characterized by substantial scientific uncertainty.¹⁴⁹ Consequently, the simplification of the regulatory framework may possibly result in the unintended and undesirable consequence of encouraging risk-taking in such circumstances, given that the evaluation of environmental impacts frequently necessitates a considerable investment of time, a factor that the objective of streamlining permit procedures appears to disregard. Moreover, the granting of a permit is also a matter of industrial operators' capacity to encompass the evaluation. The challenge is that environmental legislation should be designed to maximize the space available for novel innovations, while at the same time minimizing uncertain risks for human health and the environment. It is important to note that this pursuit may well prove elusive. This is because reductions in uncertainty often depend on the adoption of strict environmental standards and quality norms. However, it is possible that these standards and norms could hinder the adoption of new technologies and entrench existing ones.¹⁵⁰

Finally, the deregulation of markets and minimal state intervention serve to further reinforce the innovation paradigm. The prevailing notion is that environmental issues can be addressed through market-driven solutions and entrepreneurial creativity, often disregarding structural critiques or the necessity for systemic change. This standpoint is in alignment with the conceptualization of 'weak sustainability' as proposed by ecological economists.¹⁵¹ However, relying solely on market-driven solutions neglects the complex, non-linear dynamics of ecological systems and fails to address the root causes of environmental degradation. Within this paradigm, law is no longer treated as an autonomous domain grounded in normative commitments to justice, rights, or ecological stewardship. Instead, legal frameworks are increasingly repurposed as

145 Regulation (EU) 2024/1735 of the European Parliament and of the Council of 13 June 2024 on establishing a framework of measures for strengthening Europe's net-zero technology manufacturing ecosystem and amending Regulation (EU) 2018/1724 [2024] OJ L2024/1735, Section II (Streamlining administrative and permit-granting processes) and Annex ('NZI Regulation').

146 Regulation (EU) 2024/1252 of the European Parliament and of The Council of 11 April 2024 establishing a framework for ensuring a secure and sustainable supply of critical raw materials [2024] OJ L2024/1252 ('CRM Regulation'), Preambles 11, 14, and 26.

147 *ibid* Preamble 11.

148 NZI Regulation (n 145), Article 15(2); CRM Regulation (n 146), Article 10(2).

149 For example, lithium mining operations have the potential to cause substantial human health and social repercussions. The largest known lithium reserve is situated in a picturesque region of Bolivia, which has prompted the Bolivian government to seek means of minimizing environmental harm during extraction. In addition, lithium-based batteries have adverse effects on human toxicity, which stem from both the lithium-mining process itself and the utilization of copper, which carries its own environmental and sanitary consequences linked. See Marcelle C McManus, 'Environmental consequences of the use of batteries in low carbon systems: the impact of battery production' (2012) 93 *Applied Energy* 288, 291.

150 See Jonathan Verschuuren, 'Does Environmental Law Encourage or Obstruct Eco-Innovations: Evidence from Case Studies in the Netherlands' (2017) 26 *European Energy and Environmental Law Review* 51, 52.

151 See Louis J Kotzé, 'The sustainable development goals: an existential critique alongside three new-millennial analytical paradigms' in Duncan French and Louis Kotzé (eds), *Sustainable Development Goals* (Edward Elgar 2018) 58.

instruments for enabling market competitiveness and economic freedom.¹⁵² This orientation favours regulatory flexibility and economic optimization over precaution and long-term environmental safeguarding.

In contrast, the precautionary principle and the framework of sustainable development offer vital normative direction. These principles assert that uncertainty, irreversibility, and certain ecological limits must guide regulatory action, particularly in the context of complex socio-environmental systems. These principles, embedded into legal and policy design, aim to ensure that innovation is pursued not merely for economic gain but aligned with the imperative of ecological integrity and intergenerational responsibility. Responsible innovation, in this view, is not value-neutral but should be normatively anchored in sustainability, precaution, and justice.

5. CONCLUSIONS

We examined the rationale behind the innovation principle and the functions that it discharges in the regulatory toolbox of the Commission. We arrived at two conclusions. First, in the documents that we reviewed, the principle generally appears alongside economic, social, and environmental concerns, the three dimensions of sustainable development. Sustainable development is exceptionally well established in EU primary law. Therefore, the innovation principle appears to be unnecessary. If the legal framework is to be improved, strengthening existing principles seems to be more sagacious than introducing new ones. Such a solution would also skirt the legitimacy issues that the innovation principle raises. Furthermore, the dichotomy between innovation and precaution is false—the notion of precaution already encompasses innovation, as is evident, for example, from the no-data-no-market rule from Article 5 of the REACH Regulation. Instead of introducing an innovation principle, policymakers could use the existing precautionary-principle frameworks to foster responsible innovation. SDG 9 promotes resilient infrastructures, inclusive industrialization, and innovation. It accords with the objectives of the EGD and the Digital Single Market, which emphasize the long-term importance of research and innovation.¹⁵³ This sustainable-development approach could promote sustainable innovation while safeguarding public health, environmental protection, and social equity.

Second, the innovation principle is often invoked in the context of experimental legislation,¹⁵⁴ regulatory sandboxes, and innovation clauses. The effectiveness of experimental legislation largely depends on the capacity of the innovation that is being tested to ensure progress towards the SDGs. How the innovation principle can operate alongside extant principles such as sustainable development and precaution is unclear, and this lack of clarity can generate numerous legal issues. Once more, abandoning the new principle and focusing on the ones that are already established in law seems to be a more straightforward solution.

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¹⁵² Ducuing (n 105) 256–257.

¹⁵³ Eurostat, 'Sustainable development in the European Union—2022 edition: monitoring report on progress towards the SDGs in an EU context' (Publications Office of the European Union 2022) 163.

¹⁵⁴ Better Regulation Toolbox (n 11).