

ARTICLES

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It is a great pleasure to congratulate the Kazan University Law Review on its anniversary.

The Review has become a true international hub. Its pages bring together theorists and practitioners, established professors and early-career researchers, contributors from Russia and colleagues from universities across Europe, Asia, Africa and Latin America — a space where comparative dialogue actually takes place, and where a problem examined in one jurisdiction is seriously tested against how it is framed elsewhere.

Equally important is what the journal carries with it. A scholarly review is one of the most durable forms of cultural diplomacy: every issue places the name of Kazan in law libraries, databases and reading lists around the world, and introduces readers not only to a body of scholarship but to a city, a republic and a people. Through the Review, the international academic community encounters Kazan as a centre of legal learning, and Tatarstan and the Tatar

people as bearers of a long and distinguished intellectual tradition — a city that has for centuries been a meeting point of cultures and civilisations.

That standing is reinforced by the Kazan International Legal Forum, which in a handful of editions has grown into one of the region's principal legal gatherings, drawing some fifteen hundred participants from twenty-eight countries to debate arbitration, international law, digital regulation and legal education. Forum and journal work in tandem: the Forum brings the world's lawyers to Kazan, and the Review carries what is discussed there to those who could not attend, in a language they can read. Together they have made the city a standing venue for legal dialogue between Russia and its partners — not least across the BRICS countries, whose cooperation in investment, arbitration and dispute resolution depends on precisely this kind of accessible comparative scholarship.

My warmest congratulations go to the Editor-in-Chief, Professor Damir Kh. Valeev, whose vision and steady stewardship have given the journal its direction and standing, and to the entire editorial team, whose careful and largely unseen work is what readers recognise as the Review's quality.

May the years ahead be as productive and as internationally open as those behind.

TOWARDS GREEN AND ECO-EFFICIENT REGULATORY SANDBOXES: CHALLENGES AND PROSPECTS

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Abstract. *The gradual virtualization of society, driven by rapid digitalization, creates the misconception that digital processes reduce environmental pollution. In reality, the environmental impact of developing and deploying digital innovations often exceeds that of traditional industrial production. At the same time, states are increasingly promoting technological innovation through experimental legal regimes, such as regulatory sandboxes. A review of international experiences shows that “green” sandboxes are being established in several jurisdictions; however, little attention has been given to designing environmentally efficient sandbox frameworks. This article introduces the concept of environmental effectiveness in experimental legal regimes for digital innovation. It examines green sandbox initiatives in Austria, Vietnam, the USA, and Canada, and develops criteria for evaluating eco-efficiency in legal experimentation. The research applies case analysis, comparative legal methods, a systemic approach, and legal modeling to design a scalable framework for eco-efficient sandboxes. The proposed model embeds circular economy principles—such as resource efficiency, lifecycle thinking, and sustainability—into regulatory innovation. By integrating environmental and legal*

performance criteria, this approach offers policymakers and regulators a practical tool for fostering sustainable technological development.

Keywords: *regulatory sandbox, experimental legal regime, environmental effectiveness, circular economy, sustainable innovation, green technologies, legal framework.*

1. Introduction

It seems that with digitalization, we are gradually moving into the virtual world, and environmental issues tend to be overlooked. However, statistical data shows that the harm caused by creating and implementing digital innovations often outweighs the negative impacts of industrial production. Eco-activists have previously raised concerns about the damage caused by video cards used for cryptocurrency mining. Furthermore, the development and use of new technologies, especially generative artificial intelligence, demand significant electricity and water resources. Experts highlight that training a large neural architecture search language model (NAS) produced 626,155 pounds of CO₂, equivalent to 300 round-trip flights from the East Coast to the West Coast of the United States.¹ Another study suggests that image generation through neural networks produces a carbon footprint comparable to that of fully charging a smartphone.² Some experts have even introduced the term “electronic waste”, which refers to “electronic waste, including electrical and electronic equipment”.^{3, 4}

Today, issues related to environmental safety and the conservation of natural resources for future generations remain highly relevant. Moreover, their importance continues to grow both nationally and internationally. For example, the Declaration adopted at the BRICS Summit in October 2024 emphasizes the significance of cooperation between BRICS countries on developing the green agenda.⁵ Meanwhile, countries aim to develop and promote digital innovations and technologies, which

¹ Castro D. Rethinking concerns about AI's energy use. Washington (DC): Center for Data Innovation; January 2024. Available at: <https://www2.datainnovation.org/2024-ai-energy-use.pdf>. Accessed 15 Jul 2025.

² Korolev V., Mitrofanov A. The carbon footprint of predicting CO₂ storage capacity in metal-organic frameworks within neural networks. *iScience*. 2024;27(5):109644. <https://doi.org/10.1016/j.isci.2024.109644>

³ Firmansyah M. L., Rizki I. N., Ullah N. Recent advances in urban mining technology: A focus on electronic waste recycling potential in Indonesia. *Cleaner Waste Systems*. 2025;100239. <https://doi.org/10.1016/j.clwas.2025.100239>

⁴ Patil R. A., Ramakrishna S. A. Comprehensive analysis of e-waste legislation worldwide. *Environmental Science and Pollution Research*. 2020; 27:14412-14431. <https://doi.org/10.1007/s11356-020-07992-1>

⁵ BRICS. XVI Summit Kazan Declaration: Strengthening multilateralism for just global development and security. Kazan (Russian Federation); 23 Oct 2024. Available at: <http://static.kremlin.ru/media/events/files/en/RosOySvLzGaJtmx2wYFv0IN4NSPZploG.pdf>. Accessed 15 Jul 2025.

seems reasonable despite the previously noted negative environmental impacts of such technologies. The lack of competitive digital innovations and technologies domestically not only hinders countries from becoming leaders in the global political arena but also generally increases the risks to national security. Additionally, revisiting the earlier concern about the negative environmental impacts of technology, it is important to note that digital technologies can also serve as practical tools for combating pollution.

In this context, the desire of States to encourage technological advancement is essential. Regulatory sandboxes are also among the legal tools used to promote the development of competitive technologies. Therefore, the unique characteristics of technologies such as artificial intelligence or quantum technologies often prevent us from quickly identifying the most effective regulatory approach. As a result, the necessity to find suitable methods for legally regulating these technologies brings up the question of applying experimental regulation.

To date, many scientific papers have been published on experimental legal regimes. However, if we examine the impact of establishing such legal regimes on the environment, we find no published works on this topic. At first glance, this may be because a legal regime, as a form of regulatory structure, cannot by itself harm the environment. However, legal science and practice are aware of cases where the lack of proper regulation directly affects environmental conditions. That is why some foreign countries are focusing on the issue of “greening” mechanisms that promote technological development. For example, China introduced the concept of a model for sustainable special economic zones within the framework of the so-called “greening policy”.^{1,2} Later, the implementation of such models also became part of the goals of the Global Alliance of Special Economic Zones (GASEZ), created by UNCTAD to promote sustainable development (GASEZ UNCTAD). Additionally, the European Union also addresses stimulating green innovation among small and medium-sized enterprises.³

In this regard, this article aimed to develop a concept of the environmental effectiveness of experimental legal regimes in the field of digital innovation and technology. This study addresses the following central research question: How can regulatory sandboxes be designed to simultaneously foster digital innovation and meet circular economy and environmental protection goals? To achieve

¹ Kim E.J. China's green special economic zone policies — Development and implementation. Seoul (Korea): Global Green Growth Institute; 2017.

² Liang Z., Zhang M., Mao Q., Yu B., Ma B. Improvement of eco-efficiency in China: A comparison of mandatory and hybrid environmental policy instruments. *International Journal of Environmental Research and Public Health*. 2018;15(7):1473–1482.

³ Smith J. The impact of EU legislation in the area of digital and green transition, particularly on SMEs. Brussels: European Parliament; November 2024. Available at: <http://www.europarl.europa.eu/supporting-analyses>. Accessed 15 Jul 2025.

this goal, we applied a set of methods. This included a case analysis based on the assessment of four green sandbox initiatives from four different countries (UC1: Austria, UC2: Vietnam, UC3: USA, UC4: Canada). The application of the comparative legal method facilitated the identification of key features of green regulatory sandbox models as criteria for eco-efficient sandboxes. Applying a systemic approach enabled us to consider findings on green sandboxes from several countries and view them as a system for designing a national model of green sandboxes. Lastly, the legal modeling method was used to create a scalable model of the eco-efficient sandbox. To enhance methodological transparency, Table 1 presents a schematic overview of the analytical steps, illustrating how each method — case analysis, comparative legal method, systemic approach, and legal modeling — contributes to building the proposed eco-efficient sandbox model.

Table 1

Methodological framework

Stage	Method Applied	Purpose	Output
1	Case Analysis	Identify and examine international green sandbox initiatives.	Contextual understanding of regulatory sandbox practices in four jurisdictions.
2	Comparative Legal Method	Extract common elements, legal structures, and environmental considerations.	Comparative legal insights and key regulatory design principles.
3	Systemic Approach	Integrate findings into a coherent model applicable across national contexts.	Conceptual framework linking environmental objectives with regulatory experimentation.
4	Legal Modeling	Develop a normative model with eco-efficiency evaluation criteria.	Proposed eco-efficient regulatory sandbox model with measurable legal and environmental indicators.

Furthermore, to enhance the paper's readability and facilitate a deeper understanding of the topic among legal scholars, we have organized the article as follows. The introduction presents the problem statement and explains the need for creating green sandboxes and eco-efficient experimental legal systems. The second section discusses the idea of a regulatory sandbox, its history, and its benefits. The third section defines a green sandbox and highlights its main features. In the fourth section, we examine how international experiences with green sandboxes can inform the development of a national green sandbox model, with a focus on the Russian Federation, which currently lacks such sandboxes. The fifth section suggests a model for eco-efficient regulatory sandboxes and sets criteria for their environmental and

operational success. The sixth and final section provides recommendations for improving the eco-effectiveness of regulatory sandboxes.

2. Origin and benefits of regulatory sandboxes

Modern ideas of regulation and governance, such as smart regulation and good and agile governance, suggest that regulation must be flexible, adaptable to a rapidly changing world, and supportive of innovation¹. The regulatory sandbox is a tool for such regulation. The term “sandbox” comes from the technology sector, where a “sandbox” is a closed testing virtual environment designed for safely isolated testing of web products or software projects².

A regulatory sandbox is “a unified solution that coordinates and expedites regulatory relief under applicable laws and regulations to permit meaningful experimentation for innovative products, services, and processes”³. The experimentation enables the regulator to determine whether the innovation is viable and whether it is necessary to modify regulations to support it.⁴

Regulatory sandboxes were introduced in 2016 as part of a government initiative to support UK Fintech companies. The UK’s FCA (Financial Conduct Authority), the country’s financial regulator, was the first to introduce the FinTech sandbox in 2016. The British sandbox has fostered innovation in over 500 companies, with more than 40 being further regulated.⁵ The FCA reported that 90% of firms that completed testing in the sandbox are moving toward a broader market launch. Most firms also see an additional benefit: earning the “badge of honor” of being accepted into the sandbox and demonstrating their business model in a live, regulated environment, which boosts their credibility with customers and investors.⁶

The success of the UK Regulatory Sandbox led to its global expansion. Data show that implementing a regulatory sandbox in the fintech innovation sector has

¹ Gromova E., Ivanc T. Regulatory sandboxes (experimental legal regimes) for digital innovations in BRICS. *BRICS Law Journal*. 2020;7(2):10–36. <https://doi.org/10.21684/2412-2343-2020-7-2-10-36>

² Maass M. A systematic analysis of the science of sandboxing. *PeerJ Computer Science*. 2016;2: e43.

³ Mnuchin S. T., Phillips C. S. A financial system that creates economic opportunities: Nonbank financials, fintech, and innovation. Washington (DC): U.S. Department of the Treasury; 2018. Available at: <https://home.treasury.gov/sites/default/files/2018-08/A-Financial-System-that-Creates-Economic-Opportunities---Nonbank-Financials-Fintech-and-Innovation.pdf>. Accessed 15 Jul 2025.

⁴ Poncibo C., Zoboli L. Sandboxes and consumer protection: the European perspective. *International Journal on Consumer Law and Practice*. 2020;2(8):1–22.

⁵ Financial Conduct Authority. Regulatory sandbox. London: FCA; 2022. Available at: <https://www.fca.org.uk/firms/innovation/regulatory-sandbox>. Accessed 15 Jul 2025.

⁶ Vitória P. W., Pessoa RLPL, Simões-Borgiani D. S. Regulatory sandbox as an alternative to insert the disruptive innovations developed by startups in Brazil. *International Journal for Innovation Education and Research*. 2021;9(9):555–562. <https://doi.org/10.31686/ijer.vol9.iss9.3395>

increased investments from USD 1.8B to \$19B over the past five years.¹ Therefore, several reports on regulatory sandboxes highlight the following success indicators: most companies are progressing toward a more comprehensive market launch; most firms have moved on to secure full authorization.^{2, 3}

A regulatory sandbox promotes innovation by letting businesses test new technologies in a ‘safe’ environment since the regulator maintains control over the experimentation. It acts as an experimental framework that temporarily enables businesses to participate in tests with regulatory relaxations while exploring new digital services or business models. Consequently, it creates a legislation-free zone that permits crucial experimentation for new digital products.⁴

In this way, companies can benefit from the sandbox because it provides the opportunity to test whether a business model is appealing or how a specific technology performs in the market. It also helps identify consumer protection safeguards that can be integrated into new products and services.⁵ Regulators can assess the effectiveness of existing laws by evaluating the results of testing with regulatory relaxations. Consumers benefit from the rollout of new and potentially safer products, as regulatory sandboxes encourage innovation and consumer choice over the long term.⁶

The advantages of regulatory sandboxes, along with their unconventional nature, have attracted the interest of the global scientific legal community in such regimes. The current development of regulatory sandboxes indicates a trend toward their “specialization”. For example, there are efforts to establish so-called “thematic” sandboxes. These sandboxes are designed to develop specific technologies — such as artificial intelligence⁷ or blockchain technology.⁸

¹ Financial Conduct Authority. Regulatory sandbox. London: FCA; 2022. Available at: <https://www.fca.org.uk/firms/innovation/regulatory-sandbox>. Accessed 15 Jul 2025.

² Global Regulatory Sandbox Review. An overview on the impact, challenges, and benefits of regulatory FinTech sandboxes. 2017. Available at: <https://financedocbox.com/Insurance/73322297-Global-regulatory-sandbox-review.html>. Accessed 15 Jul 2025.

³ United Nations Secretary-General’s Task Force on Digital Financing of the Sustainable Development Goals. People’s money: Harnessing digitalization to finance a sustainable future. New York: United Nations; 2020. Available at: <https://unsdg.un.org/sites/default/files/2020-08/DF-Task-Force-Full-Report-Aug-2020-1.pdf>. Accessed 20 Oct 2025.

⁴ Alaassar A., Mention A., Aas T.H. Exploring a new incubation model for FinTechs: Regulatory sandboxes. *Technovation*. 2021;103: 102237.

⁵ Fenwick M., Van Uytsel S., Ying B. *Regulating FinTech in Asia: Global context, local perspectives*. Singapore: Springer; 2021.

⁶ Stern A. Innovation under regulatory uncertainty: Evidence from medical technology. *Journal of Public Economics*. 2017; 147:181.

⁷ OECD. Regulatory sandboxes in artificial intelligence. OECD Digital Economy Paper No. 356. Paris: OECD; July 2023. Available at: https://www.oecd.org/content/dam/oecd/en/publications/reports/2023/07/regulatory-sandboxes-in-artificial-intelligence_a44aae4f/8f80a0e6-en.pdf. Accessed 15 Jul 2025.

⁸ International Civil Aviation Organization. Blockchain sandbox. Montréal: ICAO; [cited 2025 Jul 15]. Available from: <https://www.icao.int/blockchain-sandbox>

3. The concept of Green Sandbox

An analysis of the practice of creating and applying regulatory sandboxes revealed that individual countries permit testing of green innovations within these frameworks, often called “green sandboxes” (Green Sandbox Builder), “environmental sandboxes”,¹ “sustainable regulatory sandboxes” (Austria’s sustainable sandbox), and even “Circular Economy Sandbox”.

To enhance clarity, we will refer to this concept as a “green regulatory sandbox”. Before outlining its definition and features, it is helpful to review the experiences of countries that have implemented such sandboxes (see Table 2).

Case 1: Austria’s Sustainable Sandbox

Austria is another country that utilizes regulatory sandboxes to promote sustainable development. The regulatory sandbox mechanism can be applied in the renewable construction sector, focusing on areas such as affordable and environmentally friendly building practices, including multi-story wooden structures, the use of renewable energy sources, and employing artificial intelligence to enhance the sustainability of construction processes (Austria Sustainable Sandbox).

Case 2. Vietnam’s circular economy sandbox

Vietnam has announced the launch of a regulatory sandbox dedicated to promoting a circular economy. The initiative will focus on testing regulatory legal acts related to industrial parks and economic zones, aiming to implement environmentally friendly practices in these areas (Vietnam Circular Economy Sandbox).

Case 3. The USA’s sunset legislation in the field of the environment

A unique form of regulatory innovation in the environmental sector is California’s “sunset legislation”, which suggests exempting environmental restoration projects from the state environmental review process (CEQA).

Case 4. Canada environmental sandbox

Canada’s testing within the so-called “environmental sandbox” aims to experiment with innovative technologies and methods used by farmers in the agricultural sector. In this context, the provisions of the Clean Water Act do not apply to the activities of these entities (Higgins & Huntley, 2024).

Thus, we can say that the green regulatory sandbox is a stimulating mechanism designed to test innovations and technologies aimed at environmental

¹ Higgins P., Male T. Sandboxing nature: How regulatory sandboxes could help restore species, enhance water quality and build better habitats faster. Washington (DC): Environmental Policy Innovation Center; 2019.

protection, based on applying regulatory exemptions from environmental or related legislation.

The features of green regulatory sandboxes are as follows: 1) They are experimental legal frameworks introduced in specific areas for limited subjects aimed at ensuring sustainable development or environmental protection; 2) They are applied to green innovations and technologies that are designed for environmental protection purposes; 3) As experimental legal regimes, green sandboxes rely on regulatory exemptions from environmental or related regulations legislation.

Table 2

Selected International Experiences with Green Regulatory Sandboxes

UC №	Country	Sandbox Type	Aim and Scope	Key Features
UC1	Austria	Sustainable regulatory sandbox in construction	Application of sandbox mechanisms in the renewable construction sector.	Focus on affordable and eco-friendly buildings, use of renewable energy, and AI to enhance construction sustainability.
UC2	Vietnam	Circular economy sandbox	Launch of a regulatory sandbox to test legal frameworks for circular economy practices in industrial parks and economic zones.	Focus on greening production areas and resource management.
UC3	USA	Sunset legislation in California	Exemption of environmental restoration projects from CEQA review to accelerate sustainable initiatives.	Regulatory derogations to facilitate environmental restoration.
UC4	Canada	Environmental sandbox	Experimentation with innovative agricultural technologies exempt from specific water protection rules under the Clean Water Act.	Promotion of eco-friendly farming practices while testing flexible regulatory approaches.

Note: This table summarizes key features of four regulatory sandbox models aimed at promoting environmental sustainability and circular economy practices.

4. Modeling Green Sandbox (Russia Case)

Ongoing developments in digital innovations and technologies are likely to give rise to new green technologies. Implementing these technologies may necessitate establishing an experimental legal framework in Russia. The Strategy

for Environmental Safety of the Russian Federation indicates that the country's overall environmental condition is currently unfavorable. Additionally, over 30 billion tons of waste from production and consumption have accumulated due to historical economic activities (Strategy of Environmental Safety of the Russian Federation). To address pollution, numerous technologies have been proposed and implemented. However, some of these innovative solutions are crucial for improving the ecological situation, but they also pose regulatory challenges. In this context, regulatory sandboxes could serve as an effective means to facilitate the development and deployment of these innovations.

Based on the basic act concerning such regimes, the Federal Law "On Experimental Legal Regimes in the Field of Digital and Technological Innovations in the Russian Federation" dated July 31, 2020, No. 258-FZ (referred to as the EPR Law), we conclude that this act does not prohibit the introduction of experimental regulation in the field of green technologies, since, during its development, the initiators aimed to make this act universal, focusing not just on specific application areas but also on technology. In this regard, for example, green unmanned vehicles can also be tested within the framework of such a direction.

At the same time, it is important to recognize that the field of environmental protection has unique and specific characteristics. In this context, the decision of whether to implement regulatory derogations requires careful assessment and informed judgment. The focus of the experiment is one of the most vital human resources — the environment. This calls for the development of specific provisions regarding the possibility of creating "green" sandboxes. The difference between such sandboxes, which stems from the nature of the protected good — the environment — is that, unlike typical experimental legal regimes that include measures to protect the interests of consumers — the direct participants in testing — the impact of using "green" sandboxes can extend beyond consumers to society, as the outcomes can influence public interests. Therefore, implementing such testing, even on private land, could disrupt the ecosystem. Consequently, rules on environmental protection guarantees and their enforcement mechanisms require special attention. It appears that when establishing "green" sandboxes, the following steps will need to be taken.

First, it is essential to update Part 2 of Article 1 of the EPR Law, specifically paragraph 8.2, by including an area of innovation and technology development, such as "digital and technological innovations in the field of environmental protection". Second, involve the relevant environmental protection authorities in assessing the possibility of implementing such a regime. The current version of the EPR Law notes the need to "involve an organization of the business community in evaluating an initiative proposal to establish a regulatory sandbox regime" (Article 8). It seems that if we are discussing establishing such a regime in environmental protection, the competence of the business community organization will likely be insufficient.

Therefore, for a more objective assessment of the initiative proposal, it is necessary to involve relevant government agencies.

Thirdly, additional mechanisms should be introduced to safeguard public interests. Thus, the EPR Law permits “the establishment of additional guarantees for the protection of the rights of persons entering into legal relations with subjects of the experimental regime” (Part 7 of Article 5). However, because testing within the “green” sandbox may impact not only the individuals mentioned above but also public interests in general, other measures should also be considered. Therefore, this section examines foreign experiences in creating “green” sandboxes, and by applying these models to Russian experimental legal regimes, we propose several amendments to adapt Russian legislation for the testing of green innovations and technologies. Additionally, it is crucial to assess whether the regulatory structures of such sandboxes align with the broader requirements of sustainable development and environmental protection. In this context, a doctrinal review of the effectiveness of these regimes, including their environmental impact, is necessary.

The following section builds upon this national modeling to establish broader criteria for transforming green sandboxes into fully eco-efficient experimental legal regimes, ensuring conceptual clarity and practical applicability.

5. From green sandboxes to eco-efficient experimental legal regimes in digital innovations and technologies: problem statement and its solution

One of the requirements for regulatory sandboxes, as well as other existing legal frameworks, is efficiency. That is why, for example, the final stage of applying each regulatory sandbox involves evaluating its efficiency.

Scholars note that effective legal norms underlie perfect legislation that has no contradictions and provides an adequate legal assessment of regulated public relations. At the same time, we should agree with the authors, who note that the issue of the effectiveness of legal norms is often raised in legal science, while remaining one of the least studied.¹

When evaluating the efficiency of legal regimes, we can identify only a few authors who have addressed this topic. Turning to the issue of the effectiveness of the experimental legal regimes considered in this article, we note that experts pay attention to the lack of clear criteria for evaluating their effectiveness.² Table 3 addresses the criteria for evaluation the eco-efficiency of regulatory sandboxes. These criteria provide

¹ Gromova E. Evaluating the effectiveness of models of incentive legal regimes of entrepreneurial activity in the sphere of digital innovations and technologies. *Pravoprimerenie*. 2023; 4: 69–73.

² Crampes C., Estache A. Efficiency vs. equity concerns in regulatory sandboxes. *TSE Working Paper*. 2023; 23:1466.

a structured framework for integrating legal, environmental, and circular economy dimensions into the design and evaluation of regulatory sandboxes.

Table 3

**Criteria for Evaluating the Eco-Efficiency
of Regulatory Sandboxes**

Dimension	Criterion	Description	Type
Legal-normative	Clarity and consistency of legal norms	Legal provisions defining the sandbox are unambiguous, coherent with superior norms, and transparent to all stakeholders.	Qualitative
	Involvement of environmental authorities	Presence of formal mechanisms ensuring participation of environmental agencies or scientific experts in the sandbox design and monitoring.	Qualitative
	Guarantees for environmental protection	Existence of legally binding provisions to prevent or mitigate environmental harm during experimentation.	Qualitative
	Stakeholder accountability	Existence of reporting, complaint, and appeal mechanisms to address environmental concerns and ensure public participation.	Qualitative
Environmental performance	Greenhouse gas emissions	Measurement and reporting of GHG emissions produced by technologies tested within the sandbox.	Quantitative
	Resource consumption (energy, water, etc.)	Evaluation of resource intensity of tested innovations compared to baseline scenarios.	Quantitative
	Waste generation and circularity	Assessment of waste output and its alignment with circular economy principles (reuse, recycling, recovery).	Quantitative
	Monitoring and feedback	Continuous monitoring of environmental impacts and mechanisms to adjust sandbox parameters accordingly.	Mixed

Note: The criteria integrate legal-normative and environmental performance dimensions for assessing sandbox regimes.

Indeed, if we turn to the Rules for Monitoring and Evaluating the Effectiveness of such Regimes in Russia, we will see that they lack clear criteria for such an assessment. The only clear indicators, the assessment of which is explicitly indicated in the Rules, are the economic indicators achieved during the implementation of the pilot legal regime.

At the same time, it is necessary to pay attention to the fact that such criteria relate to the effectiveness of a specific experimental regime program. Unfortunately, the assessment of the effectiveness of the legal regime itself, as well as its criteria, remains outside the scope of these and other legal acts.

The reader may object by pointing to performance assessment tools, such as regulatory and actual impact assessments. At the same time, the first of them applies to draft normative legal acts. In contrast, in the issue we are considering, we are discussing the model of the legal regime established in the current normative legal act. In addition, the assessment of regulatory and actual impact aims to verify whether regulatory legal acts contain excessive requirements that hinder business operations.

At the same time, we believe that the assessment of the effectiveness of the legal regime, including the experimental legal regime, should take into account not only the interests of the business community. It should be based on the principle of balancing the interests of the state, society and business. Therefore, the existing mechanisms for evaluating effectiveness need to be supplemented.

Before addressing the question of how these mechanisms should be complemented, including from the perspective of the environmental agenda, it is necessary to note that the lack of criteria for evaluating experimental legal models harms the regimes themselves. Scientists have repeatedly noted a decrease in public confidence in such regimes.¹

Due to the lack of such criteria in the legislation, it is necessary to refer to the few studies that aim to develop them. Turning to the issue of evaluating the effectiveness of legal regimes, scientists proposed to solve it from the perspective of the correlation of its goals and the outcome, offering such criteria as “awareness of the legal regime to its addressees; clarity and consistency of the legal norms that consolidate it; proportionality of social goals and legal means to achieve them; ensuring the functioning of legal regimes with effective work” law enforcement agencies.²

Positively assessing the criteria proposed by scientists for evaluating the effectiveness of legal regimes, as well as the possibility of their application to experimental legal regimes, the following should be noted. The approach

¹ Allen H. J. Regulatory sandboxes. *George Washington Law Review*. 2019; 87:34–41.

² Gromova E. Evaluating the effectiveness of models of incentive legal regimes of entrepreneurial activity in the sphere of digital innovations and technologies. *Pravoprimenenie*. 2023; 4:69–73.

proposed by the authors is again characterized by a certain “one-sidedness”, since it allows evaluating the effectiveness of these regimes from a legal (normative) perspective.

At the same time, an objective assessment of the effectiveness of such regimes requires a more comprehensive coverage of the types and criteria of effectiveness, including economic, social, moral, psychological, and environmental aspects. This approach resonates with core principles of the circular economy, which emphasize systemic thinking, resource efficiency, and sustainability throughout innovation processes.^{1,2,3} Embedding these principles in regulatory frameworks can ensure that legal experimentation actively supports environmental transition. It is worth noting that many reputable scientists emphasize the need to analyze the law in terms of its compliance with environmental principles. Among them, of course, it is worth mentioning the point of view of the founder of the theory of the ecologization of law, S. A. Bogolyubov, who notes that today it is imperative to ensure the “ecologization of legislation”. The followers of research in the field of ecology point out that the essence of the modern ecological approach lies in the perception of the economy not only as a development goal, but as a means of supporting the lives of both present and future generations.

Concerning legal regimes, we have proposed an “ecologization test”, for the successful passage of which the following provisions (qualitative criteria) must be contained in the regulations on the relevant legal regime:

1) the inclusion in the regulatory legal act under consideration of requirements on the compliance of activities carried out within their borders with the norms of environmental legislation;

2) the availability of a legally guaranteed opportunity to involve authorized bodies in the field of environmental protection, representatives of the ecological scientific community and/or environmental human rights organizations in the assessment of such a legal regime. This will ensure that a reasonable balance is maintained between the objectively necessary use of natural resources for profit and the constitutional requirements of environmental protection and the protection of fundamental environmental human rights.

3) It also seems necessary to supplement this group of criteria with such criteria as the presence or absence of received appeals and complaints related to violations

¹ Ellen MacArthur Foundation. How the circular economy tackles climate change. Cowes (UK): Ellen MacArthur Foundation; 2019.

² European Commission. A new circular economy action plan: For a cleaner and more competitive Europe. Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. COM (2020) 98 final. Brussels: European Commission; 2020.

³ Kirchherr J., Reike D., Hekkert M. Conceptualizing the circular economy: An analysis of 114 definitions. Resources, Conservation and Recycling. 2017; 127:221–232.

of the norms of environmental legislation and the rights of citizens to a favorable environment.

In addition to the qualitative criteria recommended above for assessing the environmental effectiveness of experimental legal regimes, it is necessary to supplement them with quantitative criteria directly related to the assessment of the negative environmental impact of technologies tested within their framework. Thus, it is proposed to evaluate data on greenhouse gas emissions, as well as the cost of other resources, concerning the technology being tested.

6. Recommendations for improving the eco-effectiveness of experimental legal regimes in the field of digital innovation and technology

Given the environmental damage caused by the IT industry, it is essential to prioritize greening the mechanisms that support digital innovation and technology. This includes ensuring the eco-efficiency of regulatory sandboxes and systematically evaluating their environmental performance.

Therefore, to develop an eco-efficient model of these regimes, it is recommended to consider four pillars of eco-efficient regulatory sandboxes.

First one — green stimulating. It means that the establishment and application of green sandbox regimes should be encouraged, as mentioned earlier. For such projects, shorter deadlines for considering initiative proposals or additional support measures, such as information or consulting related to preparing necessary documents, could be offered.

Second — preliminary eco-risk assessment. When selecting projects for initiative proposals, regulators should pay attention to the “eco-component” of these proposals and conduct a preliminary assessment of potential environmental risks.

Third — criteria and methodology to assess eco-efficiency. Therefore, it is necessary to develop criteria for eco-efficient experimental legal regimes and apply them in preparing reports to monitor the operation of the relevant legal regime. It is also important to develop a methodology for evaluating the effectiveness of experimental legal regimes, including criteria for assessing environmental impact.

Fourth — eco-efficient assessment regulation. It is important to supplement the subordinate regulatory legal acts in the field of monitoring and evaluating the effectiveness of experimental legal regimes with relevant provisions.

7. Conclusion

The challenges of implementing environmental policies and achieving the Sustainable Development Goals remain urgent and demand innovative legal and institutional solutions. Among these, “green” regulatory sandboxes (experimental

legal frameworks focused on environmentally oriented digital innovations) offer promising pathways for integrating sustainability into technological progress.

Drawing on international experiences, this study demonstrates that green sandboxes can serve as effective instruments for advancing eco-efficient governance models. Yet, greening legal regimes for digital and technological innovation must go beyond merely testing environmentally friendly technologies. It requires a comprehensive transformation of experimental legislation itself, ensuring that environmental and circular economy principles are embedded in the design, operation, and evaluation of such frameworks.

Lawmakers should therefore prioritize the development of effective, interdisciplinary models for regulatory sandboxes that measure success through both legal and environmental performance. The proposed criteria and recommendations in this paper provide a foundation for such assessment and can guide future policymaking, standard-setting, and enforcement practices.

By embedding circular economy principles into experimental legal regimes, regulatory sandboxes can become powerful mechanisms for promoting sustainable innovation and ecological transformation. Future research should focus on implementation strategies and empirical evaluations of these models in practice.

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