Volume XXI, Issue (1) (2025) 447-454

International May Conference on Strategic Management

DOI: 10.5937/IMCSM25447R *Original Research*

ASPECTS OF LEGAL REGULATION OF CO_2 EMISSIONS INTO THE ATMOSPHERE: A EUROPEAN UNION PERSPECTIVE

Evaldas Raistenskis*, Ligita Gasoarėnienė, Rita Remeikienė

Vilnius university, Faculty of Law, Lithuania

Abstract: This article examines the legal regulation of CO_2 emissions in the European Union through a structured analysis of key legislative instruments and climate policy frameworks. Focusing on the emissions trading system, carbon capture, utilization and storage mechanisms, and sector-specific regulatory measures, the paper explores the effectiveness, consistency, and legal implications of recent developments. Drawing on academic research, strategic planning documents, and binding legal acts, the study highlights both the progress made and the limitations that remain within the current legal landscape. While the emissions trading system has demonstrated the potential to incentivise decarbonisation, questions persist regarding allocation fairness, transparency, and cross-border enforcement. In the field of carbon capture and utilisation, the lack of clear definitions and regulatory scope continues to generate uncertainty. Similarly, new legal instruments addressing the transport sector represent a step forward but also reveal tensions between legal ambition and technological readiness. The article concludes that further legal refinement is necessary to address fragmentation, improve coordination between legal layers and governance levels, and ensure alignment between long-term strategic goals and concrete legal obligations. Strengthening legal precision and coherence is essential to support the credibility and functionality of climate law across the European Union.

Keywords: Carbon capture and storage, CO_2 regulation, Emissions Trading System, European Union climate law, Legal coherence.

1. INTRODUCTION

The growing urgency of mitigating climate change has brought the regulation of carbon dioxide (hereinafter – CO_2) emissions to the forefront of European Union (hereinafter – EU) legal and policy debates. As a key greenhouse gas, CO_2 is responsible for the majority of global warming effects, and its reduction is central to the EU's long-term strategic vision of achieving climate neutrality by 2050 (Bouckaert et al., 2021). The European Commission's 2050 long-

* *Corresponding author: evaldas.raistenskis@tf.vu.lt*

Evaldas Raistenskis, ORCID: 0000-0003-3049-2926
Ligita Gasparėnienė, ORCID: 0000-0002-5535-6552
Rita Remeikienė, ORCID: 0000-0002-3369-485X

term strategy outlines ambitious targets that require a coherent legal framework addressing energy systems, industrial emissions, and carbon removal mechanisms (European Commission, n.d.).

Over the past three decades, the EU has developed an extensive body of climate legislation, including the Emissions Trading System (hereinafter – EU ETS), renewable energy directives, carbon border mechanisms, and sector-specific regulations (Dupont et al., 2023). Yet, the legal complexity of these instruments, differences in national implementation, and the evolving nature of carbon capture and utilization (hereinafter – CCU) technologies present persistent challenges (Jones & Piebalgs, 2022).

This paper aims to examine the legal regulation of CO_2 emissions in the EU, focusing on the structure, evolution, and effectiveness of relevant legal acts. The study applies classical methods of legal research, including logical-systematic interpretation, document analysis, and comparative legal review. Particular attention is given to regulatory instruments adopted or amended in the past five years, reflecting the EU's accelerated efforts under the European Green Deal and the Fit for 55 packages.

2. LITERATURE REVIEW

The legal regulation of CO_2 emissions in the EU has evolved significantly over the past three decades, shaped by scientific consensus on climate change and the EU's commitment to international environmental standards. As noted by Dupont et al. (2023), EU climate policy has shifted from fragmented national initiatives to a comprehensive multi-level governance framework aimed at achieving climate neutrality.

A cornerstone of this framework is the EU ETS, introduced to internalize the cost of emissions and reduce industrial greenhouse gas outputs. Its legal structure, objectives, and effectiveness have been critically analysed in academic literature. Kotzampasakis and Woerdman (2024) provide a legal evaluation framework for assessing the normative foundations of the EU ETS, while Bayer and Aklin (2020) demonstrate its empirical success in reducing emissions, even during periods of low carbon prices. These insights are supported by Bianco et al. (2024), who use a decomposition and decoupling approach to trace CO_2 trends across EU member states.

Several studies have addressed the growing complexity of legal instruments related to renewable energy and emissions reduction. Frattini et al. (2024) provide a detailed overview of current regulatory frameworks for carbon capture, transport, and storage (hereinafter – CCS) across the European Economic Area. Their findings highlight the fragmented legal architecture and the need for clearer, harmonized provisions. Complementing this, Gabrielli et al. (2022) and Becattini et al. (2022) assess the infrastructure and supply chains necessary for CCS, emphasizing the role of legal predictability and system-level resilience.

More recently, attention has turned to CCU and carbon farming. Talus and Maddahi (2024) examine the legal status of CCU under EU law, with a particular focus on the permanence of CO_2 storage and the definitional boundaries between product-bound and atmospheric removal. Günther et al. (2024) critique the European Commission's Carbon Removal Certification Framework (CRCF), arguing that overestimated negative emissions and unverified claims may weaken the legal credibility of market-based land-use solutions.

The broader legal and policy direction is embedded in long-term strategic planning documents. Bouckaert et al. (2021) outline the EU's decarbonization pathway under the International Energy Agency, while the European Commission (2020) provides scenario-based projections of the EU energy system transformation. The 2050 long-term strategy reinforces

these trajectories, setting binding emission targets and emphasizing legal integration across sectors (European Commission, n.d.).

The role of sector-specific instruments is equally important. For instance, Regulation (EU) 2023/1805 and Regulation (EU) 2023/2405 set legal standards for low-carbon fuels in maritime and aviation transport, respectively. These are part of the broader Fit for 55 legislative package, aimed at aligning all sectors with the 2030 and 2050 climate goals. Furre et al. (2017) provide a case study of long-term monitoring of CO_2 injection at Sleipner, showcasing the practical implementation of CCS regulation.

To ensure legal consistency and adaptability, several updates have been introduced to existing frameworks. Directive (EU) 2023/959 revises the EU ETS, strengthening its governance structure and expanding its scope. Meanwhile, Directive (EU) 2023/2413 reinforces the promotion of renewable energy, supporting systemic integration with national policies. The Commission Implementing Decision (EU) 2025/792 introduces a new layer of transparency by publishing CO_2 data for heavy-duty vehicles (European Commission, 2025), and additional legal perspectives are offered by The National Law Review (2025) on the proposed flexibility mechanisms for emission targets in the transport sector.

Finally, the relationship between legal instruments and environmental outcomes has been explored through meta-analytical and comparative approaches. Thonemann et al. (2022) conduct a meta life cycle assessment on mineral carbonation, questioning the ecological gains of certain CCU applications. Jones and Piebalgs (2022) underline the strategic importance of carbon capture, utilization and storage (CCUS) in the EU's legal roadmap toward climate neutrality.

3. METHODOLOGY

In conducting this research and drawing conclusions, classical methods of legal analysis were applied, as typically used in the study of environmental and regulatory law. These included the logical-systematic method, legal document and normative content analysis, the comparative method, and selected methods of legal interpretation. The application of these methods enabled a thorough examination of European Union legislation and climate policy instruments concerning CO_2 emissions. The methodology also allowed for the identification of structural legal principles and cross-country regulatory differences within the EU framework.

4. RESULTS AND DISCUSSION

The legal regulation of CO_2 emissions in the EU reflects a multi-faceted system that combines market-based instruments, direct sectoral regulation, and long-term strategic commitments. While these elements appear coherent in principle, their interaction in practice reveals structural and interpretative inconsistencies. Many instruments operate in parallel, with overlapping scopes, divergent implementation mechanisms, and varying legal weight across Member States. As a result, the EU's legal climate governance is not only broad but also fragmented, requiring continuous coordination and review.

This section evaluates the effectiveness, coherence, and limitations of selected legal frameworks, with particular focus on recent legislative reforms and climate policy instruments. The aim is not only to assess their technical functioning but also to question their legal sufficiency in addressing systemic challenges posed by decarbonisation. In this regard, legal norms are analysed not merely as static texts but as instruments of policy that either enable or constrain climate action on the ground.

To ensure a structured and meaningful analysis, the discussion is divided into three thematic areas: the EU ETS, the regulation of CCUS, and sector-specific legal instruments in relation to the broader climate neutrality objective. These themes were selected due to their centrality in current EU legal and policy developments, as well as their representativeness of both horizontal and vertical regulatory challenges. Some of these instruments raise interpretative and implementation issues that merit critical reflection, especially as the EU strives to align legal design with ambitious environmental objectives. In particular, the tension between harmonised EU-level legislation and divergent national practices remains a persistent concern.

4.1. The Functioning and Reform of the European Union Emissions Trading System

The EU ETS has long been the cornerstone of the EU's climate policy. Introduced in 2005, it is designed as a market-based instrument to cap and reduce greenhouse gas emissions from energy-intensive sectors. Over time, it has evolved through several legislative phases to address both environmental objectives and economic feasibility.

From a legal perspective, the EU ETS represents a hybrid structure that combines supranational regulation with national implementation. According to Kotzampasakis and Woerdman (2024), the system's legal architecture reflects a balance between flexibility and enforceability, aiming to respect Member State autonomy while preserving the environmental integrity of the internal carbon market. However, such a structure also raises concerns about harmonisation, particularly in the interpretation and application of allocation rules, monitoring requirements, and sanctioning mechanisms.

Empirical evaluations show that the EU ETS has contributed to emissions reduction, even during phases marked by low carbon prices. Bayer and Aklin (2020) argue that the existence of a legally binding cap, regardless of fluctuating allowance values, creates a credible long-term signal for decarbonisation. This observation is echoed in the analysis by Bianco et al. (2024), who demonstrate a decoupling trend between CO_2 emissions and economic growth in several Member States.

Despite these achievements, important legal shortcomings remain. One issue is the uneven distribution of auction revenues and ongoing debates over the fairness of allocation methods. Directive (EU) 2023/959 addresses these gaps by amending the original 2003 Directive, reinforcing market stability mechanisms and expanding coverage to the maritime sector. While the reform enhances legal clarity, it also increases complexity and creates coordination challenges across sectors and Member States.

A critical reflection suggests that although the EU ETS has matured as a legal instrument, its capacity to drive structural transformation remains constrained. The principle of cost-effectiveness, while economically rational, may lead to suboptimal outcomes when the legal framework fails to integrate broader sustainability considerations. In this light, rethinking the EU ETS requires attention not only to emissions metrics but also to climate justice, sectoral equity, and intergenerational responsibility.

4.2. Legal Challenges in the Regulation of Carbon Capture, Utilization and Storage

The legal regulation of CCUS in the EU is fragmented, dynamic, and largely shaped by technological developments. While CCS is legally covered through Directive 2009/31/EC,

CCU remains significantly less defined. This asymmetry raises interpretative and implementation challenges across jurisdictions.

Directive 2009/31/EC provides the legal basis for geological storage of CO_2, including permitting procedures, monitoring obligations, liability rules, and site closure conditions. Frattini et al. (2024) highlight that administrative complexity, limited cross-border coordination, and public acceptance hinder the development of CCS infrastructure. Furre et al. (2017) confirm that long-term monitoring, such as at the Sleipner site, is legally feasible but burdensome, particularly regarding post-injection liability.

CCU technologies, by contrast, are not explicitly addressed in current climate law. Talus and Maddahi (2024) point out that the legal differentiation between permanent and impermanent storage is insufficiently defined, leading to ambiguity about whether such applications constitute valid emission reductions. This may compromise environmental integrity if accounting systems fail to distinguish between reversible and irreversible outcomes.

Criticism has also been directed at the CRCF. Günther et al. (2024) argue that it overestimates the permanence of certain removal techniques, including carbon farming and mineral carbonation. Thonemann et al. (2022) support this through lifecycle assessments showing marginal climate benefits from some CCU applications.

Infrastructure and investment uncertainty also limit the legal potential of CCUS. Gabrielli et al. (2022) and Becattini et al. (2022) note that stable, long-term legal frameworks are essential for scaling and integrating CCUS supply chains. Without predictable regulation, developers face a disconnect between technological readiness and legal security.

This area exemplifies the broader dilemma of legislating ahead of innovation. While stricter definitions could support environmental integrity, premature regulation may stifle emerging technologies. The EU must strike a careful balance between enabling climate solutions and preventing regulatory arbitrage or greenwashing.

4.3. Sector-Specific Measures and Long-Term Legal Coherence

Recent EU legislation has expanded climate-related obligations into sector-specific domains, notably maritime and aviation transport. These sectors, historically excluded from core emission reduction schemes, are now subject to tailored legal instruments designed to align with the EU's climate neutrality goals.

Regulation (EU) 2023/1805 introduces binding requirements for the use of low-carbon and renewable fuels in maritime transport. While the regulation represents a major step in integrating shipping into climate governance, its legal implementation relies heavily on fuel availability, port infrastructure, and monitoring capacity across Member States. The need for harmonised enforcement mechanisms is particularly pressing in a sector defined by cross-border operations and international legal overlaps. Similarly, Regulation (EU) 2023/2405 (ReFuelEU Aviation) mandates minimum shares of sustainable aviation fuels in airline fuel consumption. Although the regulation creates a clear legal obligation, its effectiveness will depend on market readiness and the avoidance of indirect emissions through land-use change. The regulation also illustrates a shift from market instruments to direct legal mandates, suggesting a broader change in legislative philosophy.

In the heavy-duty transport sector, the Commission Implementing Decision (EU) 2025/792 establishes transparency requirements for CO_2 emission data. This move is seen as a prelude to more targeted regulation. As noted in The National Law Review (2025), the Commission also proposed flexibility mechanisms for manufacturers to meet short-term climate targets, reflecting a pragmatic adaptation to industry capacity constraints.

These sectoral measures exist alongside the EU's broader climate roadmap. Bouckaert et al. (2021) outlines the strategic need for sectoral integration, while the Commission (2020, n.d.) emphasises systemic transformation across all economic areas. Yet, the legal coherence between long-term strategy and concrete instruments remains uneven. Jones and Piebalgs (2022) point out that carbon-intensive sectors still benefit from fragmented regulation, and Akerboom et al. (2021) note that implementation gaps undermine the consistency of national responses.

Taken together, the recent sector-specific instruments show legal progress but also raise questions about enforceability and strategic alignment. The coexistence of binding obligations, soft-law instruments, and national discretion generates a layered regulatory environment. Without improved vertical coordination and cross-sectoral legal integration, the full potential of EU climate legislation may remain unrealised.

5. CONCLUSION

The analysis of legal regulation related to CO_2 emissions in the EU reveals a complex, multilayered, and evolving system that combines market-based mechanisms, targeted sectoral mandates, and strategic planning instruments. While the EU has established a robust legislative framework to support its climate neutrality objectives, several normative and structural tensions continue to challenge its coherence and effectiveness.

The EU ETS remains the central legal instrument for reducing emissions in energy-intensive sectors. It has demonstrated measurable success in incentivising decarbonisation, particularly following recent reforms such as Directive (EU) 2023/959. However, legal concerns persist regarding the fairness of allocation methods, the balance between market efficiency and environmental ambition, and the consistency of implementation across Member States.

In the field of CCUS, regulatory developments are uneven. CCS is addressed by an established legal act, yet its practical application is limited by administrative burdens and liability concerns. Meanwhile, CCU operates without a clear legal framework, creating uncertainty around the recognition of impermanent carbon storage and its role in climate accounting. Although the introduction of certification tools like the CRCF reflects progress, more rigorous and transparent legal definitions are necessary to maintain regulatory integrity.

Sector-specific instruments – particularly in maritime, aviation, and heavy-duty transport – reflect the EU's effort to close legal gaps and extend climate obligations to all high-emission sectors. These initiatives mark a significant shift from market-based incentives to binding legal mandates. Yet, the implementation of such measures often encounters technological, infrastructural, and economic constraints. The alignment between long-term strategic planning and enforceable legal obligations therefore remains incomplete.

In summary, the EU has made substantial legal strides in regulating CO_2 emissions, but the system still lacks full integration. Addressing the disconnection between overlapping legal layers, improving vertical coordination, and enhancing the enforceability of obligations should be central to the next phase of EU climate law. The challenge lies not only in adopting new legal measures, but in refining the coherence, credibility, and legal precision of the existing regulatory framework.

REFERENCES

Akerboom, S., Waldmann, S., Mukherjee, A., Agaton, C., Sanders, M., & Kramer, G. J. (2021). Different this time? The prospects of CCS in the Netherlands in the 2020s. *Frontiers in Energy Research*, 9, 644796. https://doi.org/10.3389/fenrg.2021.644796.

Bayer, P., & Aklin, M. (2020). The European Union Emissions Trading System reduced CO_2 emissions despite low prices. *Proceedings of the National Academy of Sciences*, 117(16), 8804–8812. https://doi.org/10.1073/pnas.1918128117.

Becattini, V., Gabrielli, P., Antonini, C., Campos, J., Acquilino, A., Sansavini, G., & Mazzotti, M. (2022). Carbon dioxide capture, transport and storage supply chains: Optimal economic and environmental performance of infrastructure rollout. *International Journal of Greenhouse Gas Control*, 117, 103635. https://doi.org/10.1016/j.ijggc.2022.103635.

Bianco, V., Cascetta, F., & Nardini, S. (2024). Analysis of the carbon emissions trend in European Union: A decomposition and decoupling approach. *Science of the Total Environment*, 909, 168528. https://doi.org/10.1016/j.scitotenv.2023.168528.

Bouckaert, S., Fernandez Pales, A., McGlade, C., Remme, U., Wanner, B., Varro, L., D'Ambrosio, D., & Spencer, T. (2021). Net Zero by 2050: A roadmap for the global energy sector. *International Energy Agency*. https://trid.trb.org/view/1856381

Directive (EU) 2023/2413 of the European Parliament and of the Council of 18 October 2023 amending Directive (EU) 2018/2001, Regulation (EU) 2018/1999 and Directive 98/70/EC as regards the promotion of energy from renewable sources, and repealing Council Directive (EU) 2015/652. *Official Journal of the European Union*, L 2023/2413, 31 October 2023.

Directive (EU) 2023/959 of the European Parliament and of the Council of 10 May 2023 amending Directive 2003/87/EC establishing a system for greenhouse gas emission allowance trading within the Union and Decision (EU) 2015/1814 concerning the establishment and operation of a market stability reserve for the Union greenhouse gas emission trading system. *Official Journal of the European Union*, L 130, 16 May 2023, 134–202.

Directive 2009/31/EC of the European Parliament and of the Council of 23 April 2009 on the geological storage of carbon dioxide and amending Council Directive 85/337/EEC, European Parliament and Council Directives 2000/60/EC, 2001/80/EC, 2004/35/EC, 2006/12/EC, 2008/1/EC and Regulation (EC) No 1013/2006. *Official Journal of the European Union*, L 140, 5 June 2009, 114–135.

Dupont, C., Moore, B., Boasson, E. L., Gravey, V., Jordan, A., Kivimaa, P., Turnheim, B., & von Homeyer, I. (2023). Three decades of EU climate policy: Racing toward climate neutrality? *WIREs Climate Change*, 15(1), e863. https://doi.org/10.1002/wcc.863.

European Commission. (2020). Towards net-zero emissions in the EU energy system by 2050: Insights from scenarios in line with the 2030 and 2050 ambitions of the European Green Deal (Joint Research Centre Report). *Publications Office of the European Union*. https://data.europa.eu/doi/10.2760/081488.

European Commission. (2025). Commission Implementing Decision (EU) 2025/792 of 24 April 2025 on the publication of data reported by Member States on the CO_2 emissions of new heavy-duty vehicles. *Official Journal of the European Union*, L 2025/792. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=OJ%3AL_202500792.

European Commission. (n.d.). 2050 long-term strategy. https://climate.ec.europa.eu/eu-action/climate-strategies-targets/2050-long-term-strategy_en (accessed 4 March 2025)

Frattini, E., Lukacova, K., & Rivas, S. (2024). Main current legal and regulatory frameworks for carbon dioxide capture, transport, and storage in the European Economic Area. *International Journal of Greenhouse Gas Control*, 131, 103962. https://doi.org/10.1016/j.ijggc.2023.103962.

Furre, A. K., Eiken, O., Alnes, H., Vevatne, J. N., & Kiær, A. F. (2017). 20 years of monitoring CO_2-injection at Sleipner. *Energy Procedia*, 114, 3916–3926. https://doi.org/10.1016/j.egypro.2017.03.1523.

Gabrielli, P., Campos, J., Becattini, V., Mazzotti, M., & Sansavini, G. (2022). Optimization and assessment of carbon capture, transport and storage supply chains for industrial sectors: The cost of resilience. *International Journal of Greenhouse Gas Control*, 121, 103797. https://doi.org/10.1016/j.ijggc.2022.103797.

Günther, K., Häyhä, T., & Jänicke, C. (2024). Carbon farming, overestimated negative emissions and the limits to emissions trading in land-use governance: The EU carbon removal certification proposal. *Environmental Science & Policy*, 149, 70–78. https://doi.org/10.1016/j.envsci.2024.104354.

Jones, C., & Piebalgs, A. (2022). The role of CCUS on the EU road to climate neutrality (Policy Brief, European University Institute). https://cadmus.eui.eu/handle/1814/73595.

Kotzampasakis, M., & Woerdman, E. (2024). The legal objectives of the EU emissions trading system: An evaluation framework. *Transnational Environmental Law*, 13(2), 312–336. https://doi.org/10.1017/S2047102524000153.

Regulation (EU) 2023/1805 of the European Parliament and of the Council of 13 September 2023 on the use of renewable and low-carbon fuels in maritime transport and amending Directive 2009/16/EC. *Official Journal of the European Union*, L 234, 22 September 2023.

Regulation (EU) 2023/2405 of the European Parliament and of the Council of 18 October 2023 on ensuring a level playing field for sustainable air transport (ReFuelEU Aviation). *Official Journal of the European Union*, L 2023/2405, 31 October 2023.

Talus, K., & Maddahi, R. (2024). Carbon capture and utilization under EU law: Impermanent storage of CO_2 in products and pre-combustion carbon capture. *Journal of World Energy Law and Business*, 17(5), 295–308. https://doi.org/10.1093/jwelb/jwae009.

The National Law Review. (2025, April 16). Commission proposes to provide flexibility for manufacturers in meeting 2025 CO_2 emission targets. https://natlawreview.com/article/commission-proposes-provide-flexibility-manufacturers-meeting-2025-co2-emission (accessed 22 April 2025)

Thonemann, N., Zacharopoulos, L., Fromme, F., & Nühlen, J. (2022). Environmental impacts of carbon capture and utilization by mineral carbonation: A systematic literature review and meta life cycle assessment. *Journal of Cleaner Production*, 332, 130067. https://doi.org/10.1016/j.jclepro.2021.130067.