

ENVIRONMENTAL TAXATION AND REGIONAL READINESS FOR THE GREEN TRANSITION IN ROMANIA: A DESCRIPTIVE ANALYSIS OF OFFICIAL STATISTICS

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ABSTRACT: *This study examines national environmental-tax trends and the economic and innovation characteristics of Romania's eight NUTS 2 development regions. It uses a transparent descriptive comparison of official European Commission and Eurostat indicators, without econometric estimation or an unobserved regional eco-efficiency index. Regional GDP per capita, real growth, employment, industrial specialisation and research and development (R&D) expenditure are reported alongside national EU environmental-tax trends. In 2024, GDP per head ranged from 48% of the EU average in Nord-Est to 188% in București–Ilfov; R&D intensity in 2023 ranged from 0.12% in Sud-Est to 1.18% in Vest. EU environmental-tax revenue increased from EUR 350.4 billion in 2023 to EUR 371.9 billion in 2024, while its GDP share declined from 2.5% in 2014 to 2.1% in 2024. These indicators reveal unequal regional capacities to adapt to environmental policy, but do not measure regional emissions or establish causal policy effects. The study identifies policy priorities and a replicable data framework for subsequent environmental-performance research.*

Keywords: *Environmental Taxation; Green Transition; Regional Disparities; NUTS 2; Romania; Descriptive Statistics; Innovation Capacity.*

JEL Classification: *Q58, R11, O18, C82.*

1. INTRODUCTION

Romania's environmental transition combines common national and European rules with highly unequal regional economic structures. Environmental taxes change relative prices, but their effectiveness depends on technology, industrial composition, mobility, infrastructure and investment capacity. A regional comparison is useful even when causal estimation is neither feasible nor the aim of the study.

The study asks how environmental taxation has evolved at EU level, how economic and innovation capacities differ among Romania's eight NUTS 2 regions, and what these differences imply for the design of territorially sensitive environmental policy. It does not estimate the effect of taxation on emissions or eco-efficiency.

The contribution is a transparent cross-regional reading of economic resources, labour-market conditions, industrial specialisation and research capacity. The article distinguishes observable indicators from potential policy mechanisms: an economically advanced region is not automatically environmentally efficient, and national fiscal receipts cannot be assigned to

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individual regions. This separation is particularly relevant for an evidence-based discussion of the territorial green transition.

2. LITERATURE REVIEW AND CONCEPTUAL FRAMEWORK

Eco-efficiency refers to economic value generated relative to resource use and environmental pressures. Its direct quantification requires matched economic and emissions observations for the same territorial units and years. The present database does not contain such a harmonised series; consequently, the analysis addresses regional readiness and structural conditions for the green transition rather than claiming to rank measured eco-efficiency.

Porter and van der Linde (1995) argue that carefully designed environmental regulation can stimulate innovation; Ambec et al. (2013) emphasise that empirical effects are conditional. The present article does not test the Porter hypothesis. It documents the structural differences that may shape regional adjustment to common policy instruments.

Environmental taxation belongs to a wider policy mix that also includes emissions trading, standards, public procurement, subsidies and infrastructure investment. The economic purpose of an environmental tax is to make an environmentally harmful activity more costly relative to its alternatives. Yet revenue is not a direct measure of environmental stringency: receipts can rise because taxable activity increases, tax rates change, or inflation affects nominal collections. Conversely, successful reductions in fuel consumption can erode the tax base even when incentives are effective.

The four conventional environmental-tax categories are energy, transport, pollution and resources. Energy taxes usually account for a substantial part of environmental-tax receipts in European economies. Their incidence depends on energy prices, the fuel mix and exemptions, while transport taxes may be linked to vehicle ownership or use. Pollution and resource taxes target narrower bases. A comprehensive assessment therefore needs both the revenue-to-GDP ratio and the composition of receipts, rather than a single aggregate interpreted as an environmental outcome.

For Romania, national tax aggregates should not be interpreted as eight independent regional observations. A uniform national rate may have unequal local implications because households and firms differ in transport dependence, income, industrial processes and access to substitutes. This article treats that variation as a reason for differentiated policy design, not as a measured regional tax burden.

Environmental taxation is a price-based instrument, whereas standards and public investment act through different channels. The analytical interest here lies in adjustment capacity: the ability of enterprises, workers and local institutions to respond to changing energy and pollution costs. Regional income, labour-market participation and innovation intensity may be informative about that capacity, but they remain indirect indicators.

The Porter hypothesis provides a conceptual motivation, not an empirical result of this article. Testing it would require policy exposure, innovation and environmental outcomes observed consistently through time. Accordingly, the findings below concern structural heterogeneity and possible policy design, rather than measured effects of regulation.

3. DATA SOURCES AND DESCRIPTIVE METHODOLOGY

The territorial unit is the NUTS 2 development region. The regional comparison relies on the European Commission's 2026 Romania country report. Indicators refer to different reference years, which are disclosed in every heading; the table is a structural snapshot, not a balanced panel. National environmental-tax indicators are drawn from Eurostat and European Commission publications. Values reported to one decimal place retain the source's rounding.

The study uses a cross-sectional descriptive design with indicators from several reference years. The reported figures are not pooled into an artificial single-year database. Comparisons are made in the original units, while simple differences and ratios are explicitly identified as author calculations. No regression, frontier efficiency measure or causal identification strategy is used.

Table 1. Geographic coverage

NUTS 2	Development region
RO11	Nord-Vest
RO12	Centru
RO21	Nord-Est
RO22	Sud-Est
RO31	Sud-Muntenia
RO32	Bucureşti–Ilfov
RO41	Sud-Vest Oltenia
RO42	Vest

Source and notes: Eurostat NUTS 2 regional classification

The eight codes exhaust the Romanian NUTS 2 development-region coverage used in the study. This geographic consistency prevents the inappropriate combination of county-level figures with region-level outcomes. The table is a classification reference rather than evidence of economic or environmental performance.

Source handling: the economic and innovation indicators are transcribed from the European Commission (2026); environmental-tax benchmarks are EU aggregates from Eurostat (2026). For every table, reference periods and denominators are retained.

4. REGIONAL ECONOMIC DISPARITIES IN ROMANIA

Bucureşti–Ilfov reaches 188% of the EU average for GDP per head, compared with 48% in Nord-Est: a difference of 140 index points and a ratio of approximately 3.92. The capital region also records the highest employment rate (81.1%) and lowest unemployment (1.8%). Sud-Est has the highest unemployment (11.3%), while Sud-Vest Oltenia has the highest industry share in gross value added (29.1%). These observations reveal uneven starting conditions, not a ranking of environmental performance.

Table 2. Development, employment and industrial structure across all eight regions

Region	GDP/head EU=100 (2024)	Real GDP growth % p.a. (2014–24)	Employment % (2025)	Unemployment % (2025)	Industry GVA % (2024)
Nord-Vest	71	3.9	70.3	5.9	20.5
Centru	71	3.3	70.0	4.1	24.6
Nord-Est	48	3.7	69.1	5.7	14.8
Sud-Est	59	1.4	62.1	11.3	21.8
Sud-Muntenia	55	1.0	68.3	8.6	27.1
Bucureşti–Ilfov	188	4.5	81.1	1.8	10.2
Sud-Vest Oltenia	60	3.6	61.7	6.9	29.1
Vest	78	2.9	66.5	5.1	24.3

Source and notes: European Commission (2026), Romania country report

The average real GDP growth column covers 2014–2024, while the other columns refer to 2024 or 2025. They should therefore be read as a set of complementary structural indicators rather than as simultaneous outcomes.

Industrial specialisation is markedly different in Sud-Vest Oltenia (29.1% of GVA), Sud-Muntenia (27.1%), Centru (24.6%) and Vest (24.3%). Vest also reports the highest industrial-employment share (34.0% in 2023) and the largest R&D intensity (1.18% of GDP in 2023) among the eight regions. Higher industrial exposure may imply greater adjustment requirements under energy and carbon policies; research capacity may facilitate technological adaptation, but these mechanisms are interpretative rather than estimated results.

Sud-Est records an 11.3% unemployment rate and a 62.1% employment rate in 2025. Nord-Est has the lowest GDP-per-head index, while Sud-Muntenia has the slowest average real GDP growth (1.0% annually over 2014–2024). These differences argue against treating all regions as if they faced identical economic conditions.

The income gradient in Table 2 is striking. Bucureşti–Ilfov reaches 188% of the EU GDP-per-head benchmark in 2024, whereas Nord-Est reaches 48%. The 140-point difference is economically meaningful as a descriptive measure of territorial disparity. However, the index is expressed in purchasing power standards and should not be equated with disposable household income, nominal wages or fiscal capacity. Commuting and the concentration of high-value-added headquarters activities can affect metropolitan production measures.

Employment rates and unemployment rates provide a complementary picture. Bucureşti–Ilfov combines an employment rate of 81.1% with unemployment of 1.8% in 2025, while Sud-Est records employment of 62.1% and unemployment of 11.3%. The employment-rate gap between these two regions is 19.0 percentage points. These are distinct labour-market indicators, and they do not add to 100 because their populations and definitions differ.

Growth over 2014–2024 further complicates the cross-sectional ranking. Bucureşti–Ilfov has the highest reported average annual real GDP growth, 4.5%, while Sud-Muntenia records 1.0%. An average growth rate does not describe the path of every intervening year, nor does it indicate how growth was distributed among households. For transition policy, growth matters primarily because it can affect the resources available for investment and the pace of capital-stock renewal.

The employment–income contrast is policy-relevant. Lower income can constrain household investment in efficient buildings or cleaner mobility, while weaker labour-market outcomes can complicate workforce retraining. These are plausible channels, not directly measured barriers. Public programmes should be designed with locally verified household and firm evidence before resources are allocated.

5. ENVIRONMENTAL TAXATION AND EU COMPARISONS

Environmental taxes are reported in national accounts for Romania as a whole. The European Commission’s and Eurostat’s environmental-tax series must be distinguished from the share of environmental taxes in all taxes: these are different denominators and cannot be interchanged. Eurostat reports that EU environmental-tax receipts were EUR 371.9 billion in 2024, and that their share of EU GDP was 2.1% in 2024 versus 2.5% in 2014 (rounded in its July 2026 publication).

Table 3 reports two different kinds of information: a share of EU GDP and the monetary value of EU environmental-tax receipts. The share falls from 2.5% in 2014 to 2.1% in 2024, a decline of 0.4 percentage points. Receipts increase from EUR 350.4 billion in 2023 to EUR 371.9 billion in 2024, an increase of EUR 21.5 billion (difference calculated from rounded published totals), or approximately 6.1%. Both statements can hold simultaneously because the nominal tax base, price levels and GDP evolve.

Neither change identifies the impact of environmental taxation on emissions. In particular, a falling revenue share need not imply weaker tax incentives: the share may change with GDP, consumption patterns or tax design. Likewise, a nominal revenue increase does not

show that environmental damage increased. This is why the analysis avoids interpreting fiscal receipts as an environmental performance score.

EU aggregates are useful as context for Romania but cannot substitute for a Romania-specific series. The Eurostat environmental-tax dataset should be queried using explicit country, tax-category, unit and year filters before any national comparison is added. Until that extraction is documented, the article makes no claim about the full annual Romanian trajectory.

Table 3. Verified EU environmental-tax benchmarks

Indicator	2014	2023	2024
EU environmental taxes, % of GDP (Eurostat news, rounded)	2.5	—	2.1
EU environmental-tax receipts, EUR billion	—	350.4	371.9

Source and notes: Eurostat, “EU environmental tax revenue up 6.1% in 2024”, 22 July 2026. Dashes indicate values not reported in that specific news release, not zero

The reported EU environmental-tax revenue increased from EUR 350.4 billion in 2023 to EUR 371.9 billion in 2024, a rise of EUR 21.5 billion when subtracting the published rounded totals (approximately 6.1%). Separately, the share of environmental taxes in EU GDP fell from 2.5% in 2014 to 2.1% in 2024, a decline of 0.4 percentage points. These comparisons use different metrics and periods; a higher nominal total does not contradict a lower GDP share. Neither figure describes Romanian regional tax receipts.

Environmental tax receipts depend on the tax base, statutory rates, economic activity and behavioural changes. Revenue alone is therefore an imperfect proxy for policy stringency. A fall in tax receipts could arise from lower consumption of taxed fuels, a reduction in rates or shifts in economic structure; these mechanisms cannot be distinguished using aggregate receipts alone.

6. INDUSTRIAL STRUCTURE AND INNOVATION CAPACITY

Vest records the largest industrial employment share (34.0%) and the highest R&D intensity (1.18% of GDP). Centru also has a large industrial workforce (30.0%). By contrast, Sud-Est reports the lowest R&D intensity (0.12%). The ratio between Vest and Sud-Est is approximately 9.8, illustrating substantial dispersion in recorded research effort. Research spending is not itself proof of clean innovation or successful technology transfer.

Table 4. Industrial employment and research capacity

Region	Industrial employment % (2023)	R&D % of GDP (2023)
Nord-Vest	24.4	0.29
Centru	30.0	0.41
Nord-Est	11.2	0.25
Sud-Est	20.7	0.12
Sud-Muntenia	24.0	0.4
Bucureşti–Ilfov	10.1	0.82
Sud-Vest Oltenia	19.9	0.17
Vest	34.0	1.18

Source and notes: European Commission (2026), Romania country report.

Industrial structure is one channel through which common national and European environmental requirements may generate different adjustment needs. Industry accounts for 29.1% of gross value added in Sud-Vest Oltenia and 27.1% in Sud-Muntenia, compared with 10.2% in Bucureşti–Ilfov in 2024. This does not establish that either industrial region is more polluting: sectoral emissions depend on the mix of activities, fuel use, technology and output.

Industrial employment offers a related but non-identical measure. In 2023, Vest records 34.0% of employment in industry and Centru 30.0%, compared with 10.1% in Bucureşti–Ilfov and 11.2% in Nord-Est. A region can have a high industrial employment share without an equally high industrial value-added share, depending on productivity and sectoral composition. Because the two indicators refer to different years and denominators, they should not be subtracted to derive a productivity estimate.

Policy planning can nevertheless use these structural differences to identify where detailed energy audits, industrial electrification assessments and workforce-transition programmes may be most useful. Such prioritisation is preliminary and should be refined with plant-level or sector-level emissions and employment data.

R&D expenditure as a share of GDP is an indicator of recorded research effort, not a direct measure of green innovation. The regional range in Table 4 is wide: 1.18% in Vest versus 0.12% in Sud-Est in 2023, a difference of 1.06 percentage points. Bucureşti–Ilfov follows at 0.82%, while several regions remain below 0.5%. The regional variation is relevant because the ability to develop, adopt and maintain cleaner technologies depends partly on engineering skills, research organisations and firms capable of absorbing innovation.

Nevertheless, expenditure intensity alone cannot determine whether research is commercially successful or environmentally beneficial. A regional research project may concern health, digital services or other fields with no immediate effect on emissions. Imported equipment and technology transfer may also enable rapid environmental improvements in places with low domestic R&D spending. For these reasons, the study uses R&D as a structural capacity indicator, not as a proxy for measured decarbonisation.

Future descriptive work could combine regional R&D expenditure with patent data, enterprise innovation surveys, tertiary education and sector-specific energy investments. These additions would strengthen the account of technological readiness without requiring causal modelling.

Research capacity also requires interpretation beyond a single spending ratio. Public research institutes, private laboratories, supplier networks and university–industry partnerships can have different local effects. The data in this article do not identify the environmental purpose of R&D expenditure, and therefore do not permit a direct ranking of green innovation.

7. COMPARATIVE REGIONAL ANALYSIS

Rather than assigning a composite score with arbitrary weights, the study proposes a qualitative typology based on observed characteristics. Bucureşti–Ilfov is a high-income, service-oriented metropolitan region with high employment. Vest combines relatively strong income, the highest reported industrial-employment share and the highest R&D intensity. Centru and Nord-Vest display intermediate income levels and substantial manufacturing exposure, though their research intensities differ.

Nord-Est combines the lowest GDP-per-head index with relatively low industrial employment and modest R&D intensity. Sud-Est shows weak labour-market indicators and the lowest reported R&D intensity. Sud-Muntenia has a comparatively high industrial value-added share and the slowest average growth. Sud-Vest Oltenia has the highest industrial value-added share and relatively low R&D expenditure. These descriptions are not mutually exclusive categories and should not be treated as a ranking of environmental performance.

The practical advantage of a typology is transparency. Readers can trace each statement to the indicators in Tables 2 and 4. Its limitation is equally clear: structural proxies cannot replace information on emissions, energy poverty, public transport quality or the availability of clean electricity.

Table 5. Derived descriptive contrasts

Measure	Calculation	Result
GDP/head: Bucureşti–Ilfov minus Nord-Est	188 – 48	140 EU-index points
Employment: Bucureşti–Ilfov minus Sud-Est	81.1 – 62.1	19.0 percentage points
R&D: Vest minus Sud-Est	1.18 – 0.12	1.06 percentage points
EU environmental taxes, 2023–2024	371.9 – 350.4	EUR 21.5 billion

Source: author calculations and interpretations based on the verified descriptive indicators; no statistical model is estimated.

The derived comparisons express observable differences as gaps or ratios, without weighting them into a synthetic readiness score. Their principal value is interpretability: the reader can trace each contrast to a published regional indicator or EU tax benchmark. The contrasts should not be treated as causal estimates or as statistically tested differences.

The regional pattern is multidimensional. Bucureşti–Ilfov combines high income and employment with a comparatively small industrial share; Vest combines stronger industrial specialisation with relatively high R&D intensity; several southern and eastern regions face lower income, slower growth or weaker labour-market indicators. No single measure captures these different configurations.

A typology is more defensible here than a numerical ranking. It recognises that income, industrial exposure and research intensity can move in different directions. A region with a large manufacturing sector may have both greater decarbonisation requirements and a strong basis for technology upgrading. A metropolitan economy may have a smaller industrial share but substantial building and transport pressures. Because the database does not contain harmonised territorial emissions, these categories should be described as structural profiles. Terms such as “most eco-efficient” or “least polluting” would go beyond the evidence.

8. DISCUSSION AND POLICY IMPLICATIONS

The regional evidence points to different transition needs. Industrial regions may benefit from grid upgrades, energy efficiency and cleaner production technologies. Bucureşti–Ilfov faces a different set of potential priorities involving transport, buildings and urban infrastructure. Regions with weaker labour-market outcomes or lower R&D expenditure may require greater financing and institutional support to adopt low-emission technologies.

These are policy interpretations supported by observed structural differences, not causal estimates of the effects of taxes. A common national tax rate does not imply uniform regional incidence. Without a harmonised territorial emissions database, it is not possible to claim that a particular Romanian region is more eco-efficient than another.

In industrially specialised regions, a credible transition strategy may prioritise energy-efficiency retrofits, process heat electrification where technically feasible, grid reliability and worker reskilling. Public support should be assessed against measurable project outcomes such as verified energy savings or reduced emissions per unit of output. An industrial share by itself does not justify a subsidy; it identifies where more detailed diagnostics may be warranted.

In metropolitan areas, mobility and building stock are plausible priorities. Public transport integration, building renovation and urban planning can complement environmental price signals when households have limited short-run alternatives to private vehicles or inefficient heating. These recommendations reflect general policy mechanisms rather than evidence that a particular intervention has already succeeded in Bucureşti–Ilfov.

Regions with weaker employment outcomes and low recorded research expenditure may face greater constraints in co-financing and implementing clean investment. Technical

assistance, access to finance and project preparation capacity may therefore matter as much as nominal subsidy rates. A policy evaluation should separately monitor investment take-up, distributional impacts and environmental results.

Table 6. Descriptive regional policy considerations

Regional profile	Illustrative priorities	Evidence boundary
Metropolitan service concentration	Buildings, mobility, urban infrastructure	Not an emissions estimate
High industrial employment	Industrial energy efficiency, skills	Industry is not equivalent to emissions
Lower R&D intensity	Technology adoption and project support	R&D is not green innovation
Weaker labour-market outcomes	Affordable transition and inclusion	No causal effect estimated

Source: author calculations and interpretations based on the verified descriptive indicators; no statistical model is estimated.

The table translates structural indicators into differentiated policy considerations rather than evaluated interventions. Industrial profiles point to potential demand for cleaner process technology and energy infrastructure; weaker employment or research indicators point to possible needs for training and innovation support. These are policy hypotheses to be tested against local investment, emissions and social data before implementation.

A national fiscal instrument may have heterogeneous local consequences even when its legal rate is identical across the country. Sector composition, transport access, heating technology and investment finance influence adjustment options. Yet the present study cannot quantify those effects, because it does not observe regional tax liabilities or policy-induced behavioural responses.

Policy coordination should therefore combine national environmental objectives with territorially informed delivery. For industrial regions, public support could prioritise verifiable energy savings, grid readiness and workforce skills. For metropolitan regions, integrated mobility and building renovation may be relevant. In regions with weaker innovation capacity, access to technical assistance and co-financing deserves attention. These priorities are conditional recommendations rather than measured programme impacts.

A practical monitoring framework would publish, for each NUTS 2 region, consistent annual economic activity, greenhouse-gas emissions, energy consumption, environmental investment and social exposure. That information would make subsequent evaluation more informative than the structural snapshot presented here.

9. RESEARCH LIMITATIONS

The analysis is descriptive and cannot establish that taxes cause innovation, growth or emission reductions. The regional indicators are not a balanced time series and cannot support trend tests at NUTS 2 level. No regional greenhouse-gas data have been validated in the source manuscript. It would therefore be inappropriate to describe the regions as more or less eco-efficient on the basis of the current tables.

The use of EU-wide fiscal benchmarks creates a further boundary: these data show the broader policy context, not the tax payments of Romanian firms or households. R&D intensity measures total research expenditure rather than environmentally targeted research. Industry shares reflect economic structure rather than measured carbon intensity. These limitations do not invalidate the regional comparison, but they narrow the conclusions that can be drawn from it.

A logical next stage is to link annual NUTS 2 GDP data to consistent EDGAR greenhouse-gas estimates by region and year, calculate transparent emissions-intensity

indicators, and separately describe the Romanian environmental-tax mix. Such an extension would require a documented data extraction and should not be inferred from the present structural snapshot.

The principal source of regional figures is the European Commission 2026 Romania country report. The indicators are a multi-year structural snapshot: GDP per head and industrial gross value added refer to 2024; employment and unemployment to 2025; industrial employment and R&D to 2023; average real GDP growth covers 2014–2024. Mixing them into a fictitious single-year dataset would be methodologically misleading.

The GDP-per-head index is expressed relative to the EU average in purchasing power standards. It is not a nominal EUR measure. Percentages in the tables retain the source rounding, and simple differences calculated from them are approximate. This manuscript does not impute missing regional emissions or redistribute national tax receipts among the eight regions.

A reproducible update should archive the downloaded source table, retrieval date, indicator labels and metadata. Where Eurostat revisions alter earlier observations, authors should specify the data vintage. For EDGAR, documentation should cover greenhouse-gas species, territorial boundaries, sectoral coverage and the unit of emissions before a GDP-to-emissions ratio is constructed.

Table 7. Data dictionary for a future emissions-based extension

FIELD	Geography	Unit / rule	Source
YEAR	NUTS 2	calendar year	Eurostat / JRC
GEO	NUTS 2	RO11–RO42	Eurostat NUTS
GDP	NUTS 2	million EUR; consistent prices	nama_10r_2gdp
GHG	NUTS 2	kilotonnes CO ₂ -equivalent; consistent gases	EDGAR/JRC
EMISSIONS_INTENSITY	NUTS 2	kt CO ₂ e / million EUR	ghg divided by gdp
ENVIRONMENTAL_TAX	Romania	% GDP; national only	env_ac_taxind2

Source and notes: This is a variable dictionary, not a table of observed emissions. The two regional series must be downloaded and checked before computing intensities.

This table specifies the fields required for an emissions-intensity analysis but contains no observed emissions. A valid indicator would divide emissions and GDP only after confirming the same NUTS 2 boundary, calendar year, gas coverage and GDP price basis. The dictionary makes the missing empirical step explicit and prevents readers from mistaking a proposed database for completed results.

10. CONCLUSIONS

This study provides a descriptive assessment of the economic, industrial and innovation-related conditions shaping the readiness of Romania's eight NUTS 2 development regions for the green transition, while placing these regional differences within the broader context of European environmental taxation. By relying on official statistical indicators and explicitly acknowledging their methodological limitations, the analysis highlights the importance of territorial heterogeneity in the design and implementation of environmental and regional development policies. The findings demonstrate that the transition towards a more sustainable and resource-efficient economy cannot be approached as a uniform process, given the substantial differences in regional economic structures, labour-market conditions, industrial specialisation and technological capabilities.

The results reveal pronounced disparities in regional economic development. In 2024, GDP per capita in Bucureşti–Ilfov reached 188% of the European Union average, compared with only 48% in Nord-Est, indicating a difference of 140 index points and a ratio of

approximately 3.9 between the two regions. These disparities reflect unequal economic starting conditions that may influence the capacity of regional economies, businesses and households to finance investments associated with the green transition. Nevertheless, higher regional income should not automatically be interpreted as evidence of superior environmental performance, since economic prosperity does not necessarily imply lower emissions, greater resource efficiency or more sustainable production and consumption patterns.

Significant differences are also observed in industrial structures and innovation capacities. Regions such as Sud-Vest Oltenia and Sud-Muntenia exhibit relatively high industrial shares in gross value added, suggesting that industrial modernisation, energy efficiency and technological adaptation may represent important dimensions of their transition strategies. At the same time, Vest records the highest industrial employment share and the highest research and development intensity among the analysed regions, with R&D expenditure reaching 1.18% of regional GDP in 2023, compared with only 0.12% in Sud-Est. This substantial difference illustrates the uneven distribution of research resources and potential technological capabilities. However, R&D intensity remains an indirect indicator of innovation capacity and cannot independently establish the development or adoption of environmentally beneficial technologies.

Labour-market conditions further reinforce the differentiated character of regional transition challenges. The relatively high employment rate and low unemployment recorded in Bucureşti-Ilfov contrast with the weaker labour-market indicators observed in Sud-Est and other less economically developed regions. Such differences may influence the ability of regional economies to support workforce adaptation, occupational mobility and the acquisition of skills required by emerging low-carbon activities. Consequently, environmental transition strategies should be coordinated with employment, education and regional development policies, particularly in territories where structural economic vulnerabilities may constrain the adoption of cleaner technologies.

Regarding environmental taxation, the analysis confirms the importance of distinguishing fiscal indicators from environmental outcomes. At the European Union level, environmental-tax revenues increased from EUR 350.4 billion in 2023 to EUR 371.9 billion in 2024, while their share of GDP declined from 2.5% in 2014 to 2.1% in 2024. These developments illustrate that changes in environmental-tax revenues may reflect variations in economic activity, tax bases, prices and fiscal arrangements rather than changes in environmental effectiveness alone. Furthermore, national or European fiscal aggregates cannot be directly interpreted as measures of environmental-tax exposure at the Romanian regional level. The absence of harmonised regional tax and emissions data therefore prevents the identification of territorial differences in the environmental effectiveness of taxation.

From a policy perspective, the findings support the development of territorially differentiated approaches within a coherent national and European environmental policy framework. Industrially specialised regions may require targeted support for energy-efficient production processes, technological upgrading, industrial electrification and workforce retraining. Metropolitan areas may face different priorities, including sustainable urban mobility, building renovation and improvements in energy infrastructure. Regions characterised by lower income levels, weaker labour-market outcomes or limited research expenditure may benefit from improved access to financing, technical assistance, institutional capacity-building and technology-transfer mechanisms. These policy directions should be interpreted as potential priorities derived from observed structural characteristics rather than as interventions whose effectiveness has been empirically demonstrated by the present study.

An important implication is that environmental taxation should be considered part of a broader and coordinated policy mix. Fiscal instruments can provide economic incentives to reduce environmentally harmful activities, but their effectiveness may depend on the availability of technological alternatives, adequate infrastructure, access to finance and the

capacity of firms and households to adjust their behaviour. Consequently, the implementation of environmental taxation should be accompanied, where appropriate, by complementary measures supporting innovation, energy efficiency, sustainable transport and social inclusion. Such coordination may help address differences in regional adjustment capacity while maintaining consistency with national and European environmental objectives.

The scientific contribution of the study lies primarily in its transparent integration of official regional economic and innovation indicators with the broader fiscal context of environmental taxation. Rather than constructing a composite readiness index based on arbitrary weighting assumptions, the analysis identifies observable structural differences and interprets their potential relevance for the green transition. This approach provides a reproducible descriptive framework and avoids conflating economic development, innovation expenditure and industrial specialisation with directly measured environmental performance. The resulting regional profiles can serve as a preliminary analytical basis for identifying research priorities and informing more detailed territorial assessments.

Nevertheless, several limitations must be acknowledged. The analysis relies on indicators referring to different statistical years and does not constitute a harmonised regional panel dataset. Moreover, the absence of validated regional greenhouse-gas emissions, energy consumption and environmental-tax exposure data prevents the estimation of regional eco-efficiency or the assessment of causal relationships between taxation, innovation and environmental outcomes. The findings therefore describe structural conditions associated with potential transition capacity rather than measuring the actual environmental effects of public policies. These limitations are particularly important when interpreting regional disparities and formulating policy recommendations.

Future research should prioritise the construction of a consistent regional database integrating economic activity, greenhouse-gas emissions, energy consumption, environmental investment and innovation indicators at NUTS 2 level. Combining harmonised Eurostat regional statistics with appropriately validated emissions estimates from the European Commission's Joint Research Centre could enable the calculation of transparent emissions-intensity indicators and the examination of their evolution over time. A complementary analysis of Romania's environmental-tax structure, including the relative contributions of energy, transport, pollution and resource taxes, would further strengthen the national fiscal dimension of the research. Subject to data availability and methodological comparability, subsequent studies could investigate regional differences in adjustment patterns and evaluate the relationships between environmental policy instruments, technological change and environmental outcomes.

Overall, the study concludes that Romania's green transition takes place against a background of substantial territorial disparities that should be explicitly recognised in environmental and regional development strategies. Economic resources, industrial characteristics, labour-market conditions and innovation capacities differ considerably across the eight development regions, generating distinct potential opportunities and constraints. While these structural indicators do not establish regional environmental efficiency or the causal effects of environmental taxation, they provide a relevant empirical foundation for more territorially informed policy design. Strengthening regional environmental statistics, improving institutional coordination and aligning environmental objectives with regional economic and social conditions are therefore essential directions for supporting an inclusive and effective transition towards a more sustainable Romanian economy.

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