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Climate neutrality framework for rural settlements

Yuval Damari[1], Tristan Berchoux[1,2]

1. CIHEAM-IAMM (France)
2. TETIS lab, University of Montpellier (France)

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CLIMATE NEUTRALITY FRAMEWORK FOR RURAL SETTLEMENTS

Introduction: key policy framework, challenges and opportunities

- **European Green Deal (2019)**: Legally binding net-zero emissions by 2050, with rural areas critical for achieving 55% reduction by 2030
- **Long-term Vision for Rural Areas (2021)**: EU strategy for stronger, connected, resilient, and prosperous rural areas by 2040
- **Rural Pact & Action Plan**: 30 flagship initiatives mobilizing stakeholders for climate transition in rural territories

POLICY SHIFT FROM RURAL AREAS AS **PASSIVE RECIPIENTS TO ACTIVE PROTAGONISTS** IN THE GREEN TRANSITION

Challenges: Limited infrastructure, digital gaps (60% vs 87% broadband coverage), demographic decline, economic dependence on traditional sectors

Opportunities: Untapped potential for renewable energy, carbon sequestration, circular economy, and sustainable agriculture

OBJ1: Climate neutrality index tailored for rural communities by using diverse indicators across multiple domains

OBJ2: Actionable policy measures and indicators to empower decision makers and stakeholders in promoting climate neutrality within their communities.

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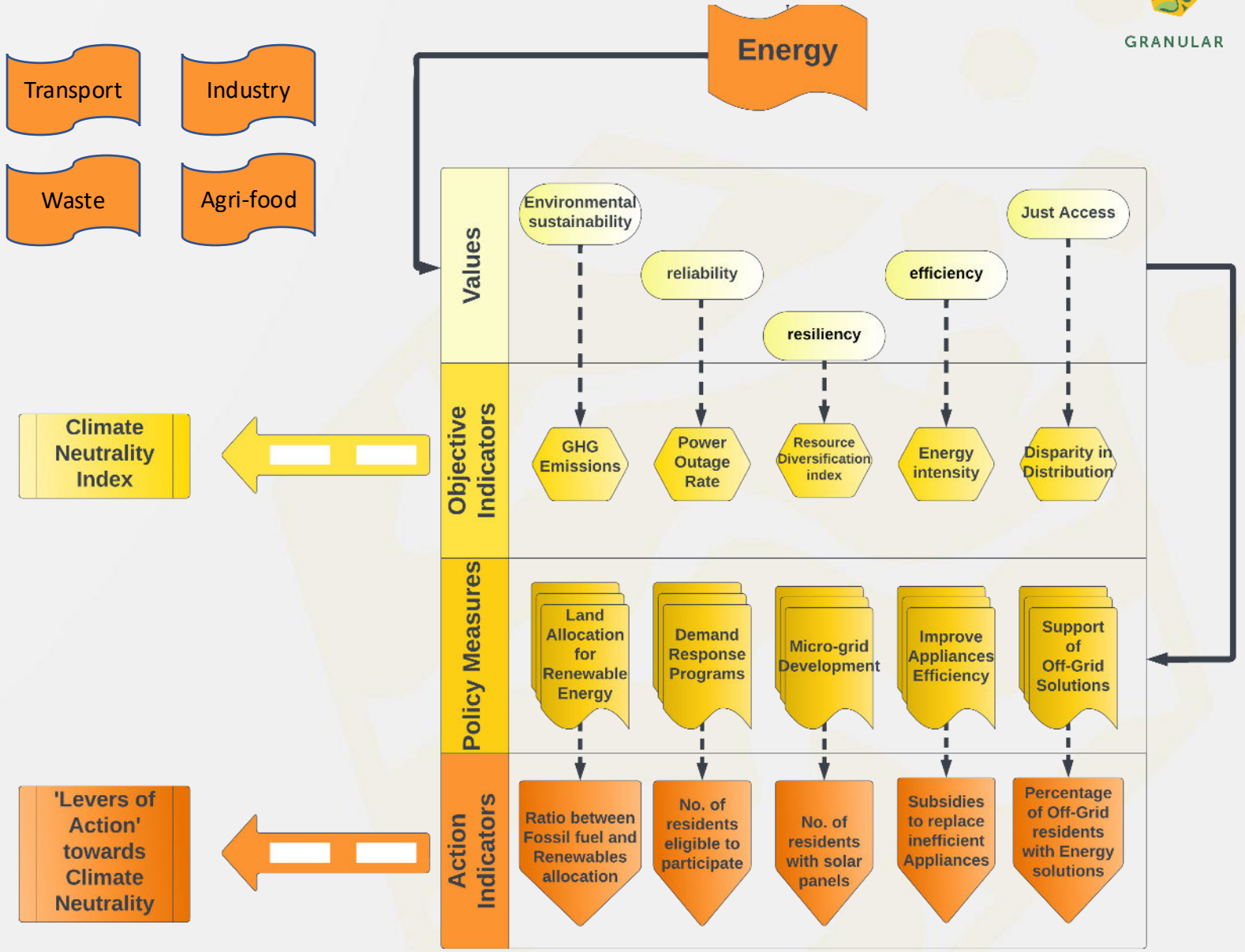
Conceptual framework

1. Benchmarks can be fine-tuned for local goals, such as adjusting public charging station density to match community needs

2. Flexible indicator weights to let communities prioritize relevant indicators, measure what matters most, and exclude irrelevant sections

3. Policy toolbox to help communities select solutions tailored to their context



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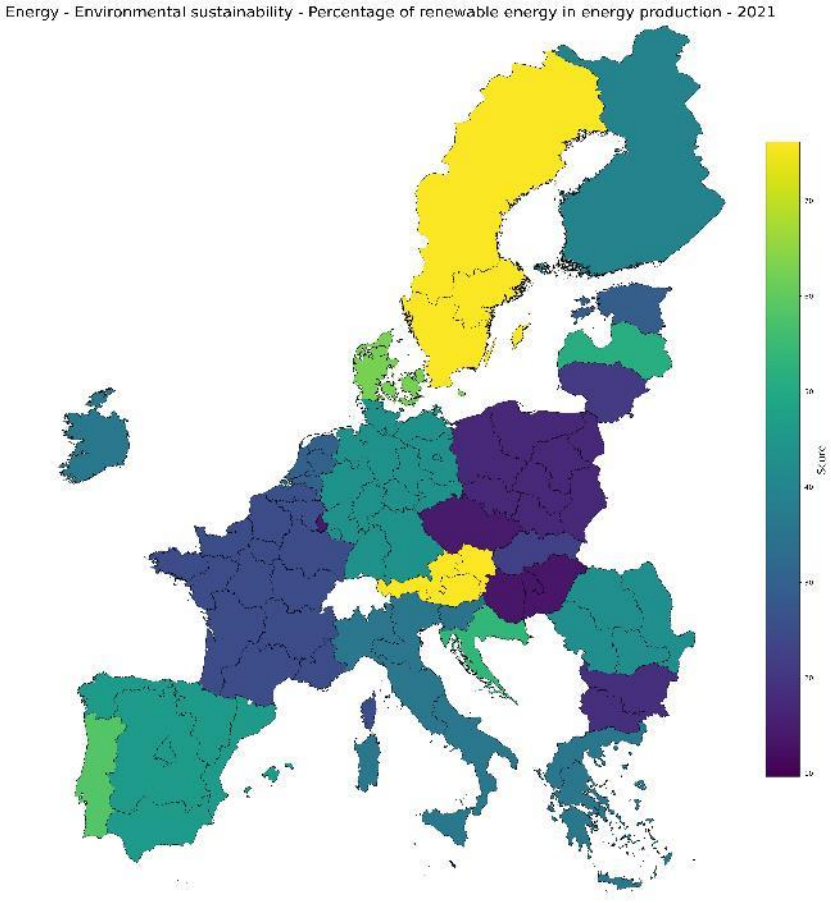
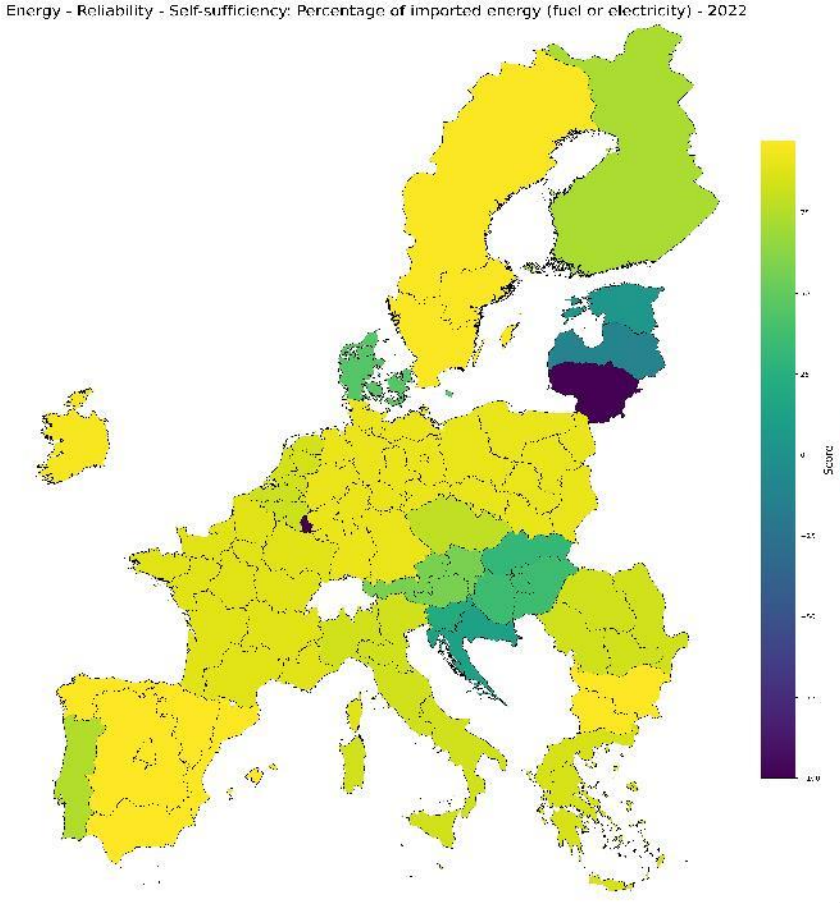
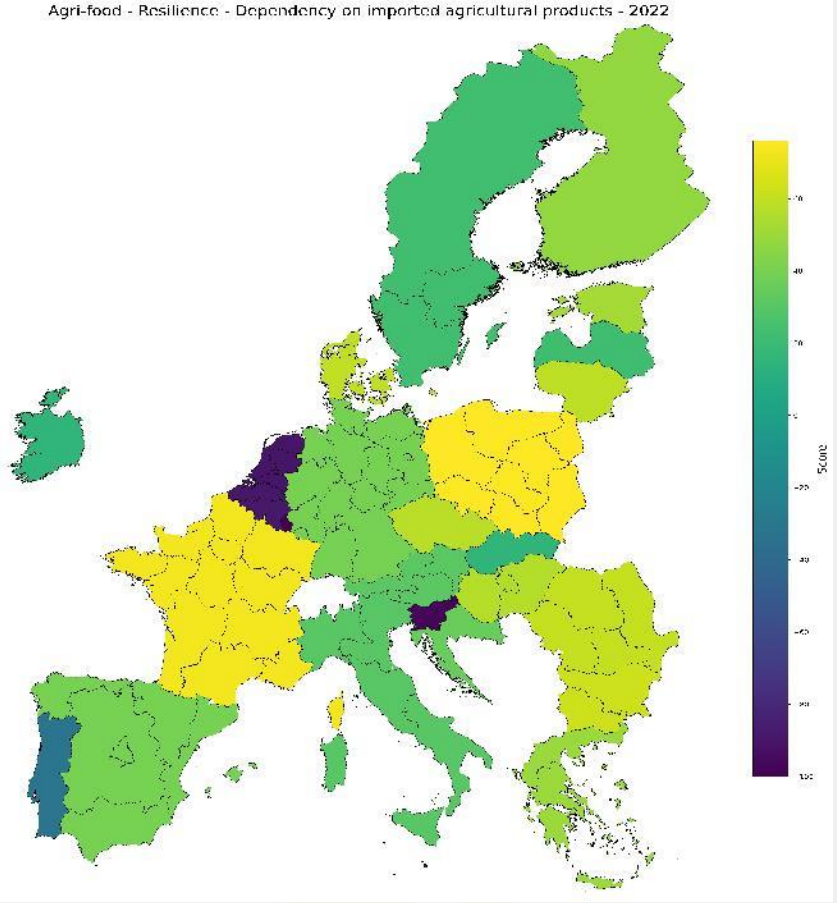
National level scores







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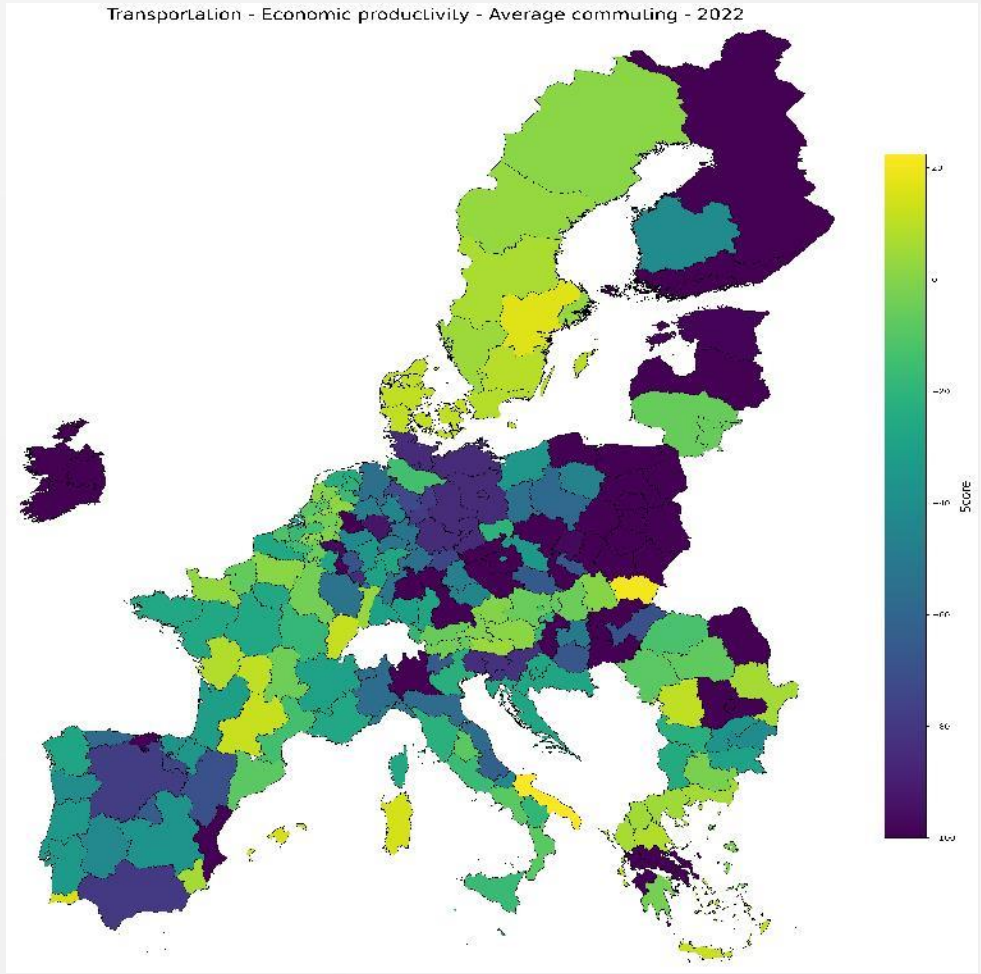
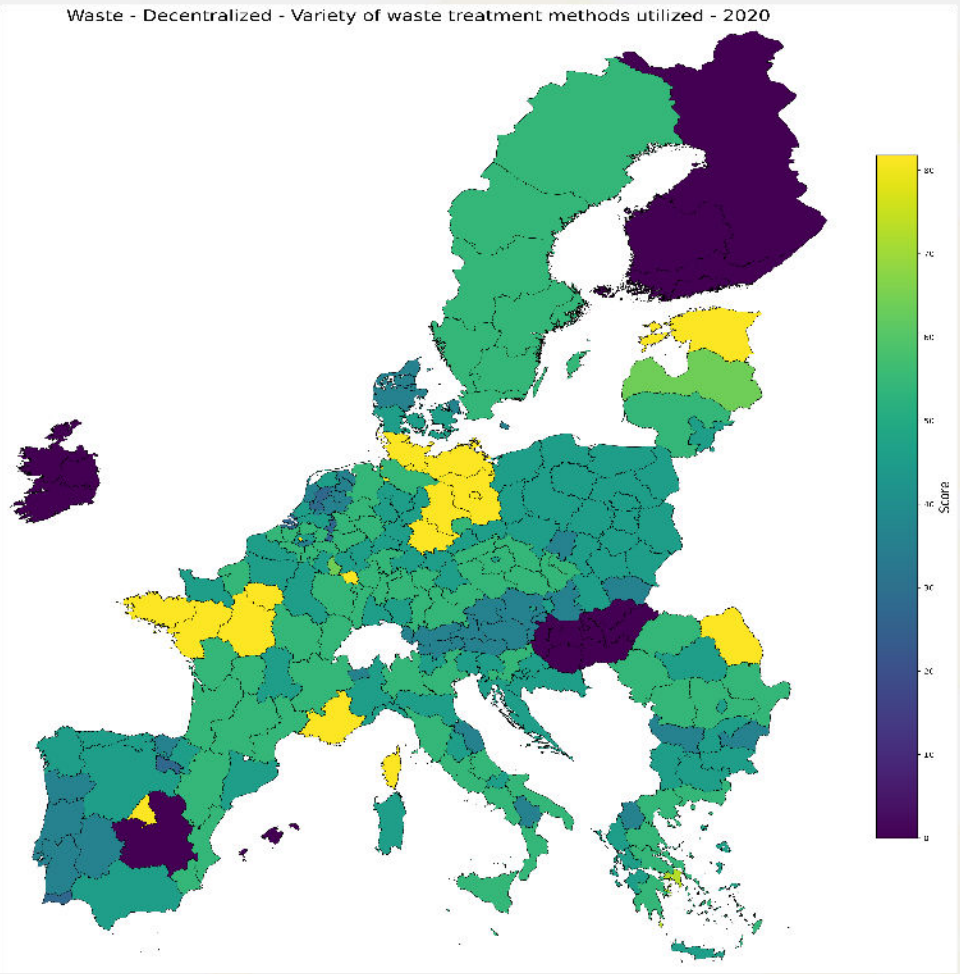
NUTS2 level scores





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LAU level scores

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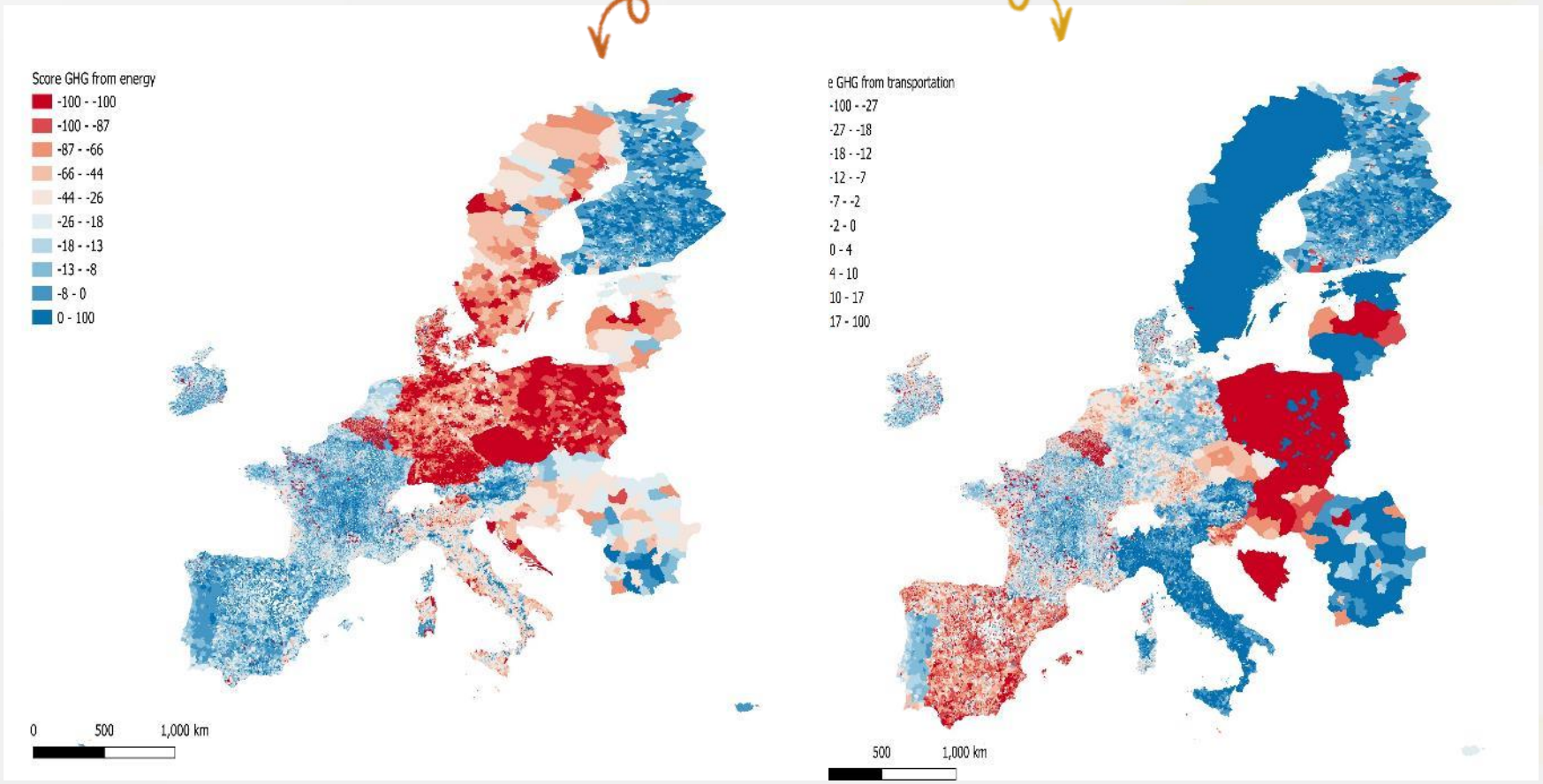
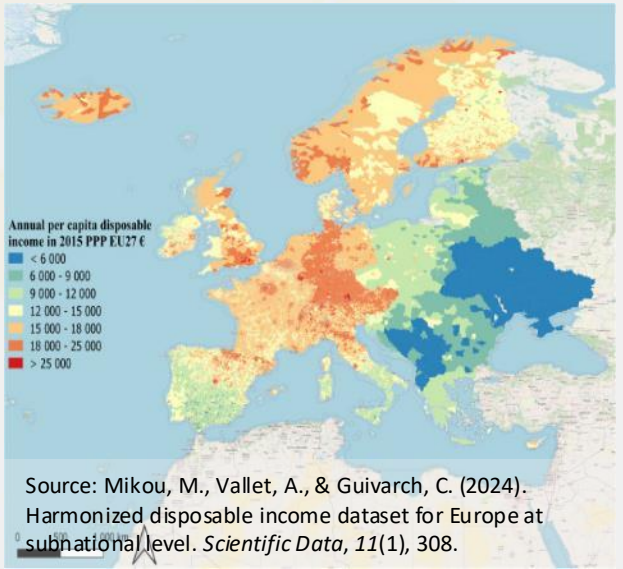
$$I_{mpact} = P_{opulation} * A_{ffluence} * T_{echnology}$$

GHG emissions at LAU level

energy transport





Source: Mikou, M., Vallet, A., & Guivarch, C. (2024). Harmonized disposable income dataset for Europe at subnational level. *Scientific Data*, *11*(1), 308.

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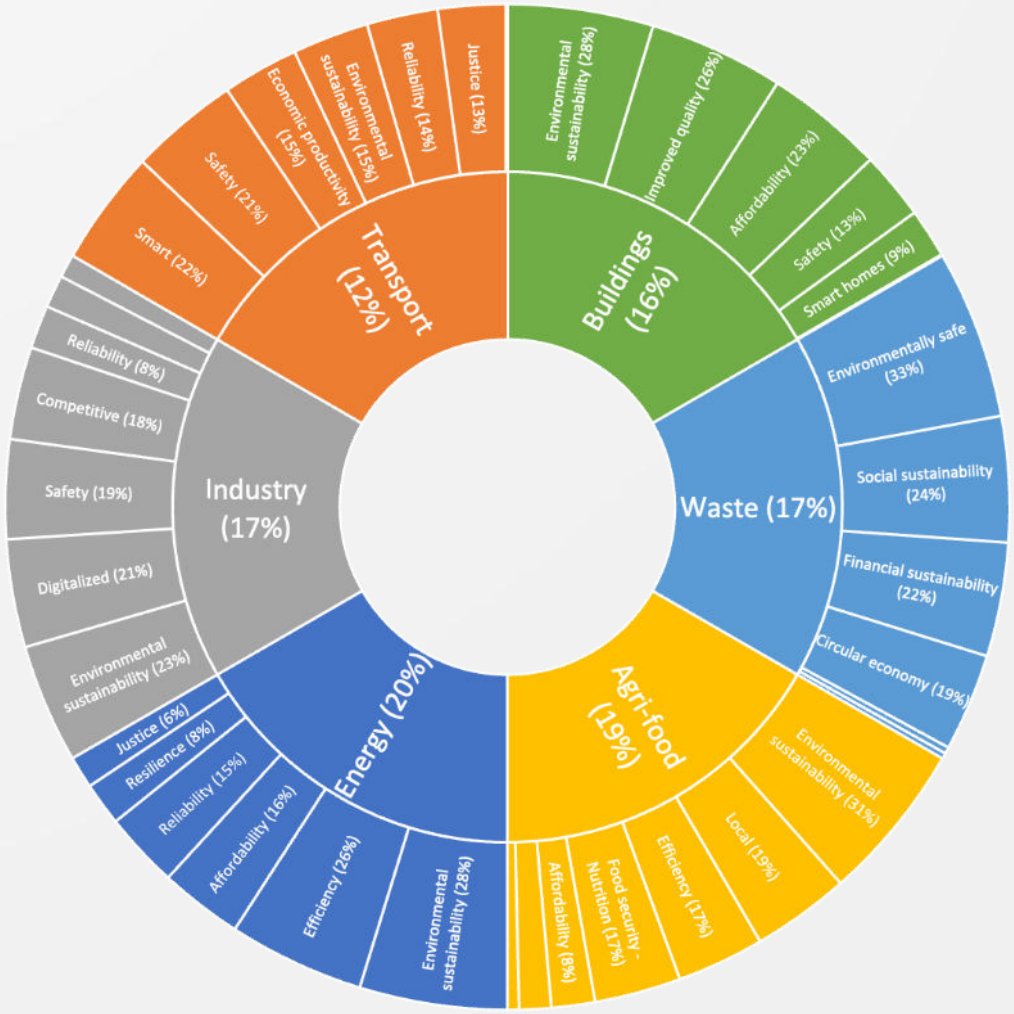
Composite Indicator Weights – Google Trends



Impact Category (j)	Impact category (1)	Impact category (2)	Impact category (3)
Search Terms (i) related to impact category (j)	(1,1) (2,1) (3,1)	(1,2) (2,2) (3,2)	(1,3) (2,3) (3,3)
Weekly relative search volume ($wRSV_{i,j,k}$)	$RSV_{1,1,k}$ $RSV_{2,1,k}$ $RSV_{3,1,k}$	$RSV_{1,2,k}$ $RSV_{2,2,k}$ $RSV_{3,2,k}$	$RSV_{1,3,k}$ $RSV_{2,3,k}$ $RSV_{3,3,k}$
Weekly total relative search volume ($wTRSV_{j,k}$)	$wTRSV_{1,k} = \sum_{i=1}^{3} wRSV_{i,1,k}$	$wTRSV_{2,k} = \sum_{i=1}^{3} wRSV_{i,2,k}$	$wTRSV_{3,k} = \sum_{i=1}^{3} RSV_{i,3,k}$
Total relative search volume ($TRSV_j$)	$TRSV_1 = \sum_k wTRSV_{1,k}$	$TRSV_2 = \sum_k wTRSV_{2,k}$	$TRSV_3 = \sum_k wTRSV_{3,k}$
Weighting factor (w_j)	$w_1 = \frac{TRSV_1}{\sum_{j=1}^{m} TRSV_j}$	$w_2 = \frac{TRSV_2}{\sum_{j=1}^{m} TRSV_j}$	$w_3 = \frac{TRSV_3}{\sum_{j=1}^{m} TRSV_j}$

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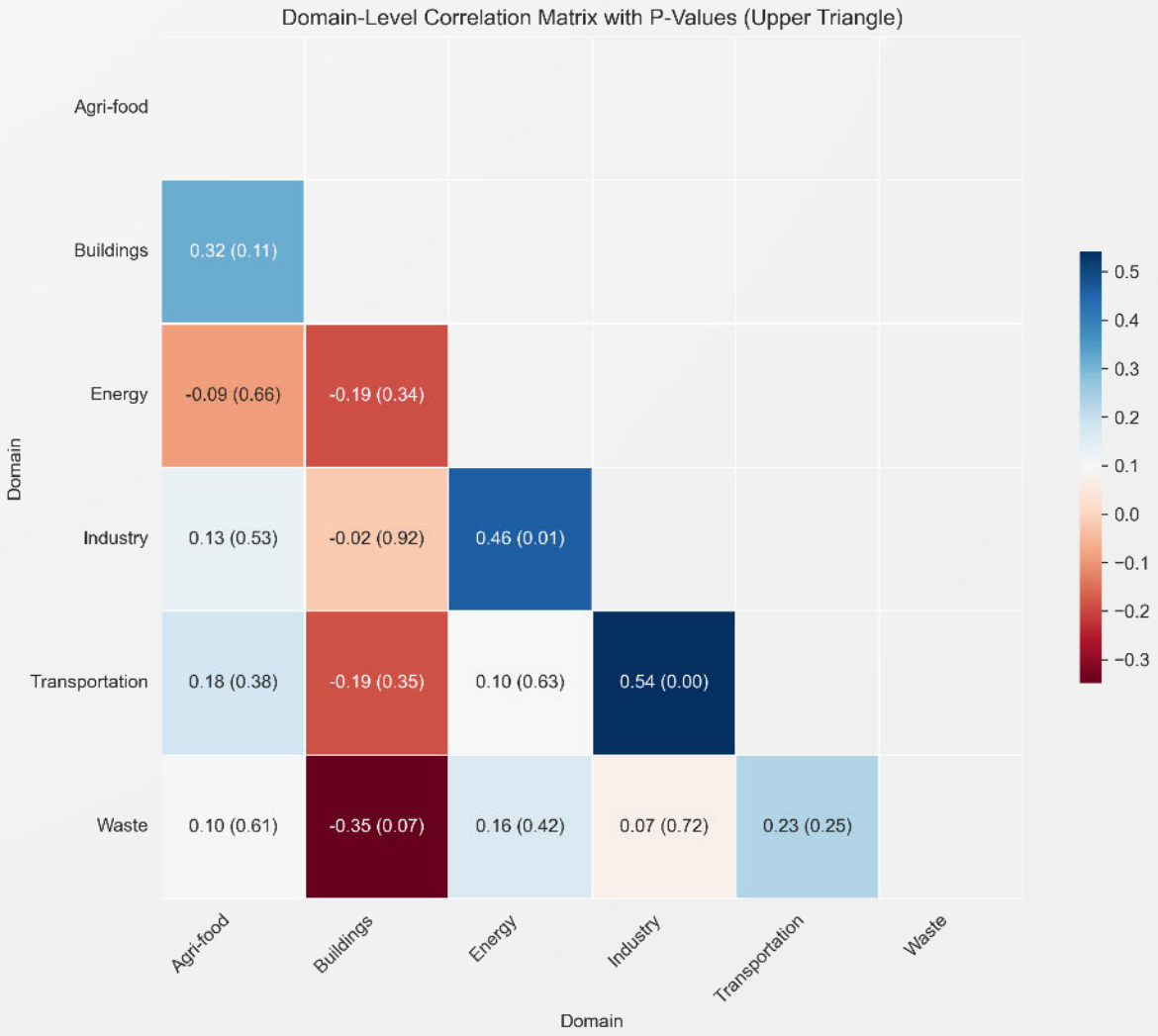
Trade-offs – Domains



Strong positive correlations

Energy: Reliability – Energy: Affordability **+0.76 (p=0.00)**
Energy: Reliability – Energy: Environmental sustainability **+0.63 (p=0.00)**
Industry: Resilience – Transportation: Smart **+0.6 (p=0.00)**

Strong negative correlations

Energy: Efficiency – Industry: Environmental sustainability **-0.65 (p=0.00)**
Energy: Efficiency – Transportation: Environmental sustainability **-0.5 (p=0.01)**
Energy: Efficiency – Agri-food: Efficiency **-0.52 (p=0.01)**

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Sensitivity analysis

DOMAINS

Improvements: Romania (16 → 5, +11) and Slovakia (21 → 12, +9) showed the most improvement in rankings.

Drops: Austria (10 → 17, -7) and France (13 → 19, -6) experienced the largest declines.

Domains that have significant variability in performance between countries, like **Transportation** and **Waste**, tend to drive the largest shifts in rankings. Domains with more uniform performance across countries, such as **Energy**, have less impact when removed.

VALUES

Improvements: Ireland (Buildings, Environmental Sustainability): 22 → 13 (+9); Slovakia (Transportation, Environmental Sustainability): 21 → 12 (+9); Czechia (Waste, Environmentally Safe): 14 → 5 (+9)

Biggest Drops: Greece (Buildings, Environmental Sustainability): 9 → 18 (-9); Italy (Transportation, Environmental Sustainability): 11 → 18 (-7); Austria (Waste, Environmentally Safe): 10 → 16 (-6)

Environmental sustainability (1.34) had the largest impact on rankings across domains while Efficiency had the lowest impact on ranking (0.64).

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Scenarios

Environmental Priority: Increased "Environmental sustainability" weights by +100%.

Affordability-Driven: Increased "Affordability" by +20% and decreased "Environmental sustainability" by -10%.

Energy Security: Increased Energy domain weight by +25%, reducing others by -5%.

Transportation Efficiency: Increased Efficiency value in Transportation by +15%, reducing Efficiency elsewhere by -10%.

Environmental Priority

The most significant improvements were observed for Greece (9 → 4), Portugal (12 → 7), and Sweden (19 → 15). Drops were seen for Denmark (7 → 11) and Germany (4 → 8).

Affordability Driven

Czechia (14 → 12) and Estonia (17 → 15) experienced improvements. Greece (9 → 11), Portugal (12 → 14), and Croatia (20 → 22) showed drops in ranking.

Energy Security

The largest improvements were for Ireland (22 → 20) and Germany (4 → 3). Cyprus (2 → 4) and Croatia (20 → 22) experienced drops.

Transportation Efficiency

Minimal changes were observed, with slight drops for Cyprus (2 → 3) and Romania (16 → 17). Rankings for most countries remained unchanged.

The **Environmental Priority** (1.85) scenario resulted in the most significant ranking changes. In contrast, scenarios like **Affordability Driven** (0.88) and **Energy Security** (0.37) caused relatively minor shifts, and **Transportation Efficiency** (0.14) had minimal overall impact.

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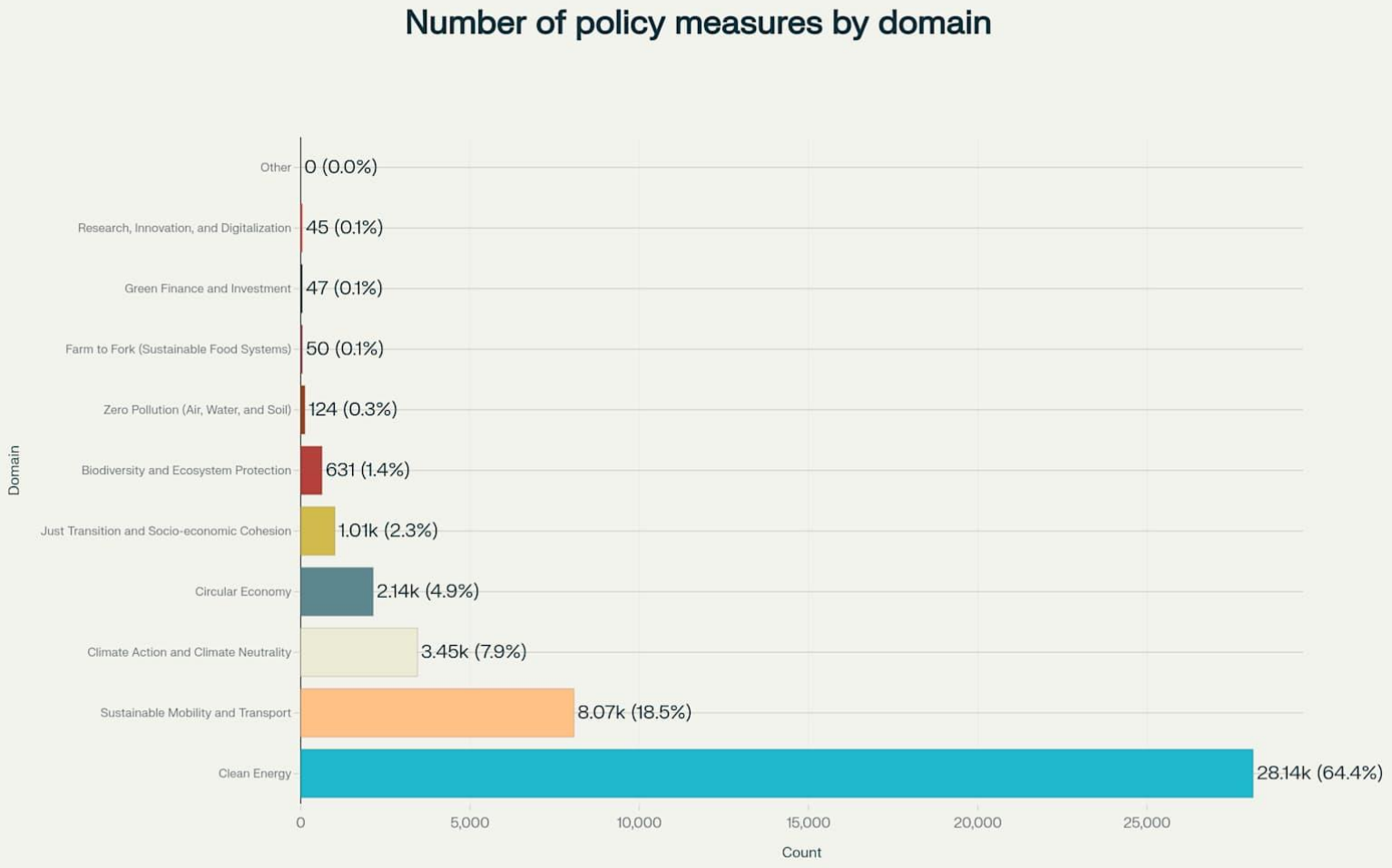
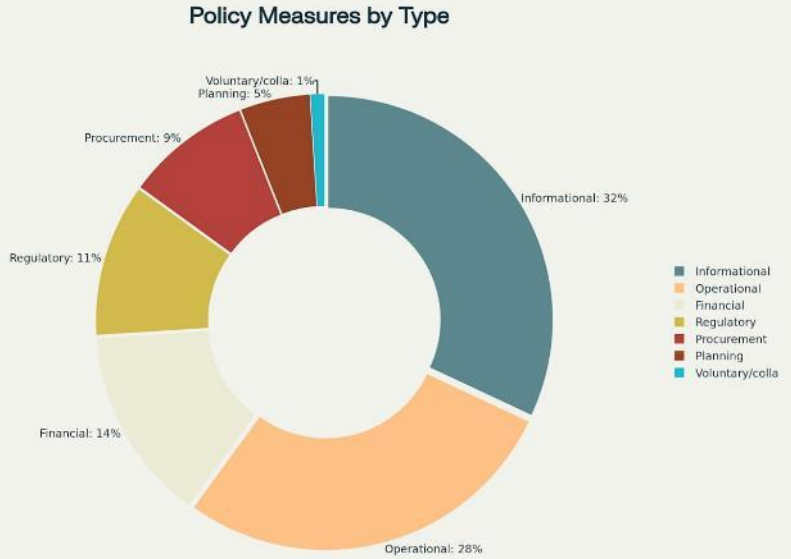
Evidence from local climate policy: towards a policy toolbox





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Conclusion

Lack of local data: a challenge for Climate Neutrality transition

Mismatch between domains that are highly relevant and feasible for rural municipalities and their actual degree of implementation.

Despite their direct relevance to rural resilience and livelihoods, domains like **Climate Adaptation, Water Quality, and Sustainable Agriculture are largely absent from local policy portfolios**.

Reliance on Informational and Operational instruments further limits the capacity of rural municipalities to effect systemic change, as more **transformative Financial, Regulatory, and Planning tools are underutilized**.

Thank you

berchoux@iamm.fr

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