Supplementary Materials

From Research to Regulation: Linking Scientific Evidence and European Climate Policy for Human Well-Being

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Supplementary Database S1: Literature Corpus

The Scopus_Corpus sheet lists all 1,499 documents with authors, year, title, source, DOI, citation counts, author keywords, document type and open access status. The Search_Protocol sheet documents the revised retrieval strategy summarized in Table S1, including the revision note relative to the original submission. The Core_Corpus sheet lists the 42 curated key publications (Table S5) classified into seven conceptual clusters, and the Summary_Clusters sheet computes their distribution automatically.

Table S1. Revised search protocol for the bibliometric corpus.

Field	Value
Database	Scopus
Search date	9 October 2026 (revised search, first revision)
Period covered	2020-2025
Search string	TITLE-ABS-KEY ("climate action" OR "climate policy" OR "climate governance" OR "climate mitigation" OR "climate change mitigation" OR "climate adaptation" OR "climate change adaptation" OR "climate legislation" OR "climate law") AND TITLE-ABS-KEY ("human well-being" OR "human wellbeing" OR "wellbeing" OR "well-being" OR "quality of life" OR "social welfare" OR "co-benefits" OR "just transition" OR "energy poverty") AND TITLE-ABS-KEY ("policy" OR "policies" OR "governance" OR "regulation" OR "legislation" OR "european union" OR "decision making") AND PUBYEAR > 2019 AND PUBYEAR < 2026
Records retrieved	1,949
Analytical screening	Post-retrieval limits applied in the Scopus interface: LIMIT-TO (DOCTYPE , "ar") OR LIMIT-TO (DOCTYPE , "re") and LIMIT-TO (LANGUAGE , "English"); duplicates checked on the Scopus identifier (EID). These limits were not part of the string reported in the first revision, which is why running the string alone returns the pre-screening population (1,949 records) rather than the corpus (1,499).
Records in final corpus	1,499 (1,255 articles; 244 reviews)
Analysis	Python (pandas, NetworkX): performance indicators; keyword harmonization; co-occurrence network of the 45 most frequent author keywords; Louvain community detection (resolution 1.1, fixed seed)
Revision note	Relative to the original submission (n = 339), the climate block was expanded with additional phrase variants, the well-being block with the hyphenated form well-being and with energy poverty, reviews were added to the document types and the subject-area limits were removed, following the reviewers' comments. Second revision: the string is reproduced here on a single line with straight quotation marks, the post-retrieval limits are stated separately, and a replication note is provided in Supplementary Database 1 (Replication_Note sheet). Scopus record counts drift over time as records are added or reclassified; the corpus analysed is defined by the EID list in the Scopus_Corpus sheet.

Supplementary Database S2: EU Climate Policy Corpus

Table S2. Well-being coding scheme applied to the policy corpus (presence coded 1 if the document contains substantive provisions or objectives on the dimension).

Code	Dimension	Operational definition
H	Health	Explicit references to human health protection, health co-benefits, air quality and health, or health systems
EP	Energy poverty / affordability	Provisions on energy poverty, vulnerable households, affordability of energy or transport
JT	Employment and just transition	Provisions on employment effects, reskilling, territorial just transition, workers in affected sectors
EQ	Equity and distributional fairness	Distributional impact considerations, fairness principles, burden sharing, vulnerable groups
PA	Participation and procedural	Public participation, stakeholder engagement, access to information, multilevel dialogue
QL	Quality of life / living environment	Living conditions, comfort, green space, nature access, urban environment, general well-being language

Table S3. The EU climate policy corpus (2019-2024) and document-level well-being codes (1 = present).

Document	Type	Reference	Year	Bind.	H	EP	JT	EQ	PA	QL
The European Green Deal	Communication	COM(2019) 640 final	2019	N	1	1	1	1	1	1
European Climate Pact	Communication	COM(2020) 788 final	2020	N	0	0	0	1	1	1
A Renovation Wave for Europe	Communication	COM(2020) 662 final	2020	N	1	1	1	1	0	1
Circular Economy Action Plan	Communication	COM(2020) 98 final	2020	N	0	0	1	0	0	1
Farm to Fork Strategy	Communication	COM(2020) 381 final	2020	N	1	0	1	1	0	1
European Climate Law	Regulation	Regulation (EU) 2021/1119	2021	Y	1	0	1	1	1	0
EU Strategy on Adaptation to Climate Change	Communication	COM(2021) 82 final	2021	N	1	0	0	1	1	1
Fit for 55 package (framing communication)	Communication	COM(2021) 550 final	2021	N	0	1	1	1	0	0
Just Transition Fund	Regulation	Regulation (EU) 2021/1056	2021	Y	0	1	1	1	1	0
New EU Forest Strategy for 2030	Communication	COM(2021) 572 final	2021	N	0	0	1	0	1	1
Zero Pollution Action Plan	Communication	COM(2021) 400 final	2021	N	1	0	0	1	0	1
8th Environment Action Programme	Decision	Decision (EU) 2022/591	2022	Y	1	0	1	1	1	1
Council Recommendation on ensuring a fair transition towards climate neutrality	Recommendation	2022/C 243/04	2022	N	1	1	1	1	1	1
REPowerEU Plan	Communication	COM(2022) 230 final	2022	N	0	1	0	1	0	0
Social Climate Fund	Regulation	Regulation (EU) 2023/955	2023	Y	0	1	1	1	1	1
Carbon Border Adjustment Mechanism	Regulation	Regulation (EU) 2023/956	2023	Y	0	0	1	1	0	0
Revised EU ETS Directive (including ETS2)	Directive	Directive (EU) 2023/959	2023	Y	0	1	1	1	0	0
Effort Sharing Regulation (amended)	Regulation	Regulation (EU) 2023/857	2023	Y	0	0	0	1	0	0
LULUCF Regulation (amended)	Regulation	Regulation (EU) 2023/839	2023	Y	0	0	0	0	0	1
Renewable Energy Directive (RED III amendment)	Directive	Directive (EU) 2023/2413	2023	Y	0	1	1	1	1	0
Energy Efficiency Directive (recast)	Directive	Directive (EU) 2023/1791	2023	Y	0	1	0	1	1	1
CO2 emission standards for cars and vans (amended)	Regulation	Regulation (EU) 2023/851	2023	Y	1	0	1	0	0	1
Energy Performance of Buildings Directive (recast)	Directive	Directive (EU) 2024/1275	2024	Y	1	1	0	1	0	1
Nature Restoration Regulation	Regulation	Regulation (EU) 2024/1991	2024	Y	1	0	0	0	1	1
Net-Zero Industry Act	Regulation	Regulation (EU) 2024/1735	2024	Y	0	0	1	0	0	0

Table S4. The 45 keywords of the co-occurrence network: frequency and cluster membership (K1, just transition, energy poverty and climate justice; K2, adaptation, nature-based solutions and well-being; K3, mitigation co-benefits and air quality; K4, sustainable development goals and cross-sectoral policy).

Keyword (harmonized)	Frequency	Cluster
climate adaptation	187	K2
climate mitigation	143	K3
just transition	142	K1
climate policy	128	K1
co-benefits	102	K3
sustainable development goals	94	K4
nature-based solutions	59	K2
Sustainability	57	K4
sustainable development	55	K4
well-being	55	K2
energy transition	52	K1
air pollution	49	K3
energy poverty	42	K1
ecosystem services	38	K2
urban planning	36	K2
Policy	35	K2
climate action	32	K1
public health	32	K2
Resilience	32	K2
Health	31	K2
climate justice	30	K1
energy policy	27	K1
renewable energy	26	K1
Governance	25	K3
Vulnerability	22	K2
Biodiversity	20	K2
food security	20	K2
mental health	20	K2
Agricultura	18	K4
China	18	K1
environmental justice	18	K1
ghg emissions	18	K4
green infrastructure	18	K2
energy efficiency	17	K3
Equity	17	K1
Climate	16	K4
Energy	15	K4
energy justice	15	K1
Gender	15	K1
Justice	15	K1
Decarbonization	14	K3
environmental policy	14	K4
human health	13	K3
Inequality	13	K1
trade-offs	13	K3

Table S5. Author-curated seed corpus (n = 42) used as interpretive anchor for the keyword clusters (conceptual clusters: C1, well-being, sufficiency and demand-side mitigation; C2, health co-benefits; C3, equity and just transition; C4, science-policy interface; C5, EU climate governance; C6, adaptation, resilience and quality of life; C7, methods of evidence synthesis).

ID	Authors	Year	Title	Source	Cluster
1	Lamb, W.F.; Steinberger, J.K.	2017	Human well-being and climate change mitigation	WIREs Climate Change	C1
2	O'Neill, D.W.; Fanning, A.L.; Lamb, W.F.; Steinberger, J.K.	2018	A good life for all within planetary boundaries	Nature Sustainability	C1
3	Creutzig, F. et al.	2022	Demand-side solutions to climate change mitigation consistent with high levels of well-being	Nature Climate Change	C1
4	Millward-Hopkins, J.; Steinberger, J.K.; Rao, N.D.; Oswald, Y.	2020	Providing decent living with minimum energy: A global scenario	Global Environmental Change	C1
5	Rao, N.D.; Min, J.	2018	Decent living standards: Material prerequisites for human wellbeing	Social Indicators Research	C1
6	Steinberger, J.K.; Roberts, J.T.	2010	From constraint to sufficiency: The decoupling of energy and carbon from human needs, 1975-2005	Ecological Economics	C1
7	Fanning, A.L.; O'Neill, D.W.	2019	The Wellbeing-Consumption paradox: Happiness, health, income, and carbon emissions in growing versus non-growing economies	Journal of Cleaner Production	C1
8	Buchs, M.; Koch, M.	2019	Challenges for the degrowth transition: The debate about wellbeing	Futures	C1
9	Costanza, R. et al.	2014	Development: Time to leave GDP behind	Nature	C1
10	Costanza, R. et al.	2016	Modelling and measuring sustainable wellbeing in connection with the UN Sustainable Development Goals	Ecological Economics	C1
11	Watts, N. et al.	2021	The 2020 report of The Lancet Countdown on health and climate change: Responding to converging crises	The Lancet	C2
12	Romanello, M. et al.	2023	The 2023 report of the Lancet Countdown on health and climate change	The Lancet	C2
13	Haines, A.; Ebi, K.	2019	The imperative for climate action to protect health	New England Journal of Medicine	C2
14	Whitmee, S. et al.	2015	Safeguarding human health in the Anthropocene epoch: Report of The Rockefeller Foundation-Lancet Commission on planetary health	The Lancet	C2
15	Ebi, K.L.; Hess, J.J.	2020	Health risks due to climate change: Inequity in causes and consequences	Health Affairs	C2
16	Karlsson, M.; Alfredsson, E.; Westling, N.	2020	Climate policy co-benefits: A review	Climate Policy	C2
17	Urge-Vorsatz, D.; Herrero, S.T.; Dubash, N.K.; Lecocq, F.	2014	Measuring the co-benefits of climate change mitigation	Annual Review of Environment and Resources	C2
18	Markkanen, S.; Anger-Kraavi, A.	2019	Social impacts of climate change mitigation policies and their implications for inequality	Climate Policy	C3
19	Klinsky, S. et al.	2017	Why equity is fundamental in climate change policy research	Global Environmental Change	C3
20	Hallegatte, S.; Rozenberg, J.	2017	Climate change through a poverty lens	Nature Climate Change	C3
21	Diffenbaugh, N.S.; Burke, M.	2019	Global warming has increased global economic inequality	PNAS	C3
22	Newell, P.; Mulvaney, D.	2013	The political economy of the just transition	The Geographical Journal	C3
23	McCauley, D.; Heffron, R.	2018	Just transition: Integrating climate, energy and environmental justice	Energy Policy	C3
24	Sovacool, B.K. et al.	2019	Decarbonization and its discontents: A critical energy justice perspective on four low-carbon transitions	Climatic Change	C3
25	Cash, D.W. et al.	2003	Knowledge systems for sustainable development	PNAS	C4
26	Oliver, K.; Innvar, S.; Lorenc, T.; Woodman, J.; Thomas, J.	2014	A systematic review of barriers to and facilitators of the use of evidence by policymakers	BMC Health Services Research	C4
27	Cvitanovic, C.; Hobday, A.J.	2018	Building optimism at the environmental science-policy-practice interface through the study of bright spots	Nature Communications	C4
28	Dupont, C.; Oberthur, S.; von Homeyer, I.	2020	The Covid-19 crisis: A critical juncture for EU climate policy development?	Journal of European Integration	C5
29	Skjaerseth, J.B.	2021	Towards a European Green Deal: The evolution of EU climate and energy policy mixes	International Environmental Agreements	C5
30	Oberthur, S.	2019	Hard or soft governance? The EU's climate and energy policy framework for 2030	Politics and Governance	C5
31	Reckien, D. et al.	2018	How are cities planning to respond to climate change? Assessment of local climate plans from 885 cities in the EU-28	Journal of Cleaner Production	C6
32	Salvia, M. et al.	2021	Will climate mitigation ambitions lead to carbon neutrality? An analysis of the local-level plans of 327 cities in the EU	Renewable and Sustainable Energy Reviews	C6
33	Berrang-Ford, L. et al.	2021	A systematic global stocktake of evidence on human adaptation to climate change	Nature Climate Change	C6
34	Adger, W.N.; Barnett, J.; Brown, K.; Marshall, N.; O'Brien, K.	2013	Cultural dimensions of climate change impacts and adaptation	Nature Climate Change	C6
35	IPCC	2022	Climate Change 2022: Impacts, Adaptation and Vulnerability. Working Group II Contribution to the Sixth Assessment Report	IPCC / Cambridge University Press	C6
36	IPCC	2022	Climate Change 2022: Mitigation of Climate Change. Working Group III Contribution to the Sixth Assessment Report	IPCC / Cambridge University Press	C1

ID	Authors	Year	Title	Source	Cluster
37	Aria, M.; Cuccurullo, C.	2017	bibliometrix: An R-tool for comprehensive science mapping analysis	Journal of Informetrics	C7
38	van Eck, N.J.; Waltman, L.	2010	Software survey: VOSviewer, a computer program for bibliometric mapping	Scientometrics	C7
39	Donthu, N.; Kumar, S.; Mukherjee, D.; Pandey, N.; Lim, W.M.	2021	How to conduct a bibliometric analysis: An overview and guidelines	Journal of Business Research	C7
40	Page, M.J. et al.	2021	The PRISMA 2020 statement: An updated guideline for reporting systematic reviews	BMJ	C7
41	Nita, A.	2019	Empowering impact assessments knowledge and international research collaboration - A bibliometric analysis of Environmental Impact Assessment Review journal	Environmental Impact Assessment Review	C7
42	Rozylowicz, L. et al.	2017	Recipe for success: A network perspective of partnership in nature conservation	Journal for Nature Conservation	C4

Table S6. Robustness of the keyword clustering (Figure 3): Louvain community detection repeated over 20 random seeds at each resolution, and comparison with the greedy modularity algorithm. The adjusted Rand index (ARI) measures agreement with the reported four-cluster partition (1 = identical). K1, K2 and K3 denote the just transition, adaptation and co-benefits clusters; K4 the sustainable development goals cluster. Modularity of the reported partition (weighted, resolution 1) is 0.22.

Resolution / algorithm	Clusters (most frequent)	ARI vs reported partition	Interpretation
0.8	2	0.39	Two clusters: K1 merges with K3; K2 merges with K4
0.9	3 (14 of 20 runs)	0.58	K1, K2 and K3 recovered; K4 members absorbed
1.0	4 (13 of 20 runs)	0.66	Four clusters; K1, K2, K3 stable
1.1 (reported)	4 to 5	0.65	K1, K2, K3 stable; K4 occasionally split
1.2	5 (16 of 20 runs)	0.64	K1, K2, K3 stable; K4 split
1.3	5 (19 of 20 runs)	0.70	K1, K2, K3 stable; K4 split
1.4	5 to 7	0.65	K1, K2, K3 stable; peripheral keywords form small communities
1.5	6 to 8	0.58	Fragmentation of peripheral keywords
Greedy modularity	3	0.67	K1, K2 and K3 recovered; K4 members distributed among them

Table S7. The 25 recent syntheses (2023-2025) used in Section 3.2 and in the evidence-policy correspondence network (Figure 6, Table 2), with their evidence stream and well-being coding (1 = the synthesis addresses the dimension in its stated scope or conclusions). S1 to S21 are reviews from the Scopus corpus (selected among the 158 reviews published in 2023-2025 by relevance to at least one well-being dimension, citation count and European scope); S22 to S25 are institutional assessments.

ID	Synthesis	Source	Evidence stream	H	EP	JT	EQ	PA	QL
S1	Schaeffer et al. 2025: Ten new insights in climate science 2024	One Earth	Cross-cutting	1	0	1	1	1	0
S2	Dupont et al. 2024: Three decades of EU climate policy: Racing toward climate neutrality?	WIREs Climate Change	EU governance	0	0	1	1	1	0
S3	Tonne et al. 2025: Promoting health through climate change mitigation in Europe	The Lancet Planetary Health	K3 co-benefits and health	1	0	0	1	0	1
S4	Moutet et al. 2025: The public health co-benefits of strategies consistent with net-zero emissions: a systematic review	The Lancet Planetary Health	K3 co-benefits and health	1	0	0	0	0	1
S5	Cuevas et al. 2024: Health co-benefits and trade-offs of carbon pricing: a narrative synthesis	Climate Policy	K3 co-benefits and health	1	1	0	1	0	0
S6	Finn and Brockway 2023: Much broader than health: Surveying the diverse co-benefits of energy demand reduction in Europe	Energy Research and Social Science	K3 co-benefits and health	1	1	1	0	0	1
S7	Dwarkasing 2023: Inequality determined social outcomes of low-carbon transition policies: A conceptual meta-review of justice impacts	Energy Research and Social Science	K1 just transition and justice	0	1	1	1	0	0
S8	van Bommel and Hoffken 2023: The urgency of climate action and the aim for justice in energy transitions: dynamics and complexity	Environmental Innovation and Societal Transitions	K1 just transition and justice	0	0	1	1	1	0
S9	Betts-Davies et al. 2024: Is all inequality reduction equal? Understanding motivations and mechanisms for socio-	Energy Research and Social Science	K1 just transition and justice	0	1	0	1	0	0

	economic inequality reduction in economic narratives of climate change mitigation								
S10	von Malmborg 2024: Strategies and Impacts of Policy Entrepreneurs: Ideology, Democracy, and the Quest for a Just Transition to Climate Neutrality	Sustainability	K1 just transition and justice	0	0	1	0	1	0
S11	Fujihara et al. 2025: Exploring Energy Poverty: Toward a Comprehensive Predictive Framework	Energies	K1 just transition and justice	0	1	0	1	0	0
S12	Mastrucci et al. 2023: Modeling Low Energy Demand Futures for Buildings: Current State and Research Needs	Annual Review of Environment and Resources	Sufficiency and demand side	0	1	0	0	0	1
S13	Blackburn et al. 2024: Could a minimalist lifestyle reduce carbon emissions and improve wellbeing? A review of minimalism and other low consumption lifestyles	WIREs Climate Change	Sufficiency and demand side	0	0	0	0	0	1
S14	Maduta et al. 2023: Towards climate neutrality within the European Union: Assessment of the Energy Performance of Buildings Directive implementation in Member States	Energy and Buildings	EU governance	0	1	0	0	0	1
S15	Herath and Bai 2024: Benefits and co-benefits of urban green infrastructure for sustainable cities: six current and emerging themes	Sustainability Science	K2 adaptation and well-being	1	0	0	1	0	1
S16	Aghaloo et al. 2024: How nature-based solutions can enhance urban resilience to flooding and climate change and provide other co-benefits: A systematic review and taxonomy	Urban Forestry and Urban Greening	K2 adaptation and well-being	1	0	0	0	0	1
S17	Sharifi 2023: Resilience of urban social-ecological-technological systems (SETS): A review	Sustainable Cities and Society	K2 adaptation and well-being	0	0	0	1	1	1
S18	Jurgilevich et al. 2023: Factors influencing vulnerability to climate change-related health impacts in cities: A conceptual framework	Environment International	K2 adaptation and well-being	1	0	0	1	0	0
S19	Rafa et al. 2025: Empirical research review on Solastalgia: Place, people and policy pathways for addressing environmental distress	People and Nature	K2 adaptation and well-being	1	0	0	0	0	1
S20	Stein et al. 2024: Advancing disability-inclusive climate research and action, climate justice, and climate-resilient development	The Lancet Planetary Health	K2 adaptation and well-being	1	0	0	1	1	0
S21	Zavala et al. 2024: Gender Inequities in the Impact of Climate Change on Health: A Scoping Review	International Journal of Environmental Research and Public Health	K2 adaptation and well-being	1	0	0	1	0	0
S22	IPCC 2023: Climate Change 2023: Synthesis Report	IPCC, Geneva	Cross-cutting	1	0	1	1	1	1
S23	Romanello et al. 2024: The 2024 report of the Lancet Countdown on health and climate change: facing record-breaking threats from delayed action	The Lancet	K3 co-benefits and health	1	0	0	1	0	0
S24	EEA 2024: European Climate Risk Assessment (EUCRA)	EEA Report 01/2024, Copenhagen	Cross-cutting	1	0	0	1	0	1
S25	ESABCC 2024: Towards EU climate neutrality: progress, policy gaps and opportunities	ESABCC, Copenhagen	EU governance	0	1	1	1	1	0