Regional convergence toward low-carbon and just development: insights from a systematic literature review

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Abstract Many regions and cities worldwide are striving to become climate-neutral, with numerous initiatives and projects underway to support this goal. However, each region is shaped by distinct structural conditions and governance capacities, leading to disparities in the progress of climate policy implementation, particularly in emissions reduction, energy efficiency, and the adoption of green technologies. While climate policies are often well-intentioned, they may reinforce regional inequalities or generate new ones, such as more developed regions benefiting from low-carbon subsidies or green technologies that less-developed areas cannot afford, undermining the goals of just development. These externalities highlight the need for continuous analysis of regional convergence and development trajectories. Such efforts are critical not only for aligning with international climate agreements but also for designing region-specific, equitable, and effective policy measures, consistent with the principle of common but differentiated responsibilities. This study presents a conceptual overview of regional convergence and its transformation under the green transition. It identifies emerging trends and innovations in this evolving field, based on a systematic literature review of 109 scientific articles retrieved from the Web of Science and Scopus databases, covering the period from 2011 to 2024. Findings show that convergence research has expanded beyond the national level, with growing application to regions, cities, and sectors. Most studies remain concentrated in Asian countries (49%), with 31% addressing global-scale issues. The convergence concept has shifted from a single-dimensional economic focus to a multidimensional framework, incorporating emissions intensity, energy efficiency, carbon productivity, governance and coordination. Despite this broadening, the economic dimension remains central, often connecting other components. Governance and coordination component is mostly associated with environmental one, reflecting a recognition that sustainable development requires not only technological progress but also policy-driven mitigation strategies. Recent research complements traditionally used economic indicators with environmental (e.g., CO⊠ per capita, CO⊠ per GDP) and energy indicators such as energy intensity and renewable energy share. For more accurate convergence analysis, researchers advocate the use of sophisticated approaches and methods, such as input–output models (including both desired and undesired outputs), factor decomposition techniques, the principle of "shared responsibility". Club convergence, stochastic convergence, and spatial convergence methods are increasingly applied, supported by advanced mathematical techniques. This research contributes to the theoretical development of convergence research.