Methodologies for Climate Neutrality Assessment. Review

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Introduction

Under the research project Decision-making Support System for Achieving Climate Neutrality Goals simulation modelling is used as a method for assessing climate neutrality across six sectors. To see if simulation modelling is still widely used and learn from latest trends in climate neutrality assessment across sectors and scales, ten suitable studies from 2022 to 2025 were selected. Key metrics range from life cycle assessment boundaries and greenhouse gas accounting to scenario modelling, carbon intensity, and indicators of strategy and mitigation.

Methods and Materials

To select the most appropriate academic papers for the review, certain criteria were set: (1) the study must describe, evaluate, or compare methodologies for climate neutrality assessment; (2) the study must include carbon accounting, offset verification, or net-zero measurement approaches as part of climate neutrality assessment; (3) the study must include assessment methodology components; (4) the study must consider comprehensive climate neutrality assessment; (5) the study must provide methodological innovation or evaluation.

Results

Based on the criteria defined in the materials and methods for a deeper analysis 10 the most appropriate academic papers were short-listed. From the assessment scope, 3 studies are sectoral, 2 studies are city-level, 4 studies are multi-sectoral at the national or global level, 1 study is building related. Key methodologies used for climate neutrality assessment are (1) modelling and scenarios: 5 studies; (2) strategy, action, mitigation, or offsetting indicators: 4 studies; (3) life cycle assessment and related boundaries/inventory/impact: 3 studies; (4) greenhouse gas accounting, emissions baselines, or carbon intensity: 3 studies; (5) definitions, assessment approaches, barriers, or disclosure quality: 2 studies.

Discussion

Several included studies report a lack of harmonized definitions and boundary-setting practices for climate neutrality (Huovila et al., 2022; Wang et al., 2025). Studies note that definitions of climate or carbon neutrality vary, with multiple authors highlighting ambiguous boundaries, challenges in accounting for offsetting and residual emissions, and inconsistent reporting practices. For example, Larrea et al. (2022) and Caiardi et al. (2024) reference the Intergovernmental Panel on Climate Change (IPCC) definition yet document significant variation in implementation, while sector-specific studies document further challenges in transparency and comparability (Cherepovitsyna et al., 2023; Rayegan et al., 2024). These findings document the diversity of approaches and the methodological challenges encountered in the assessment of climate neutrality.

Conclusion

Climate neutrality assessment methodologies vary widely across sectors and scales, with studies employing systematic reviews, quantitative modelling, and mixed methods while facing challenges in standardizing definitions, accounting boundaries, and reporting practices.

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References

Caiardi, F., Azzaro-Pantel, C., & Le-Boulch, D. (2024). Exploring Carbon Neutrality Scenarios Through the Life Cycle Assessment Lens: A Review of Literature and Methodological Challenges. *Environment, Development and Sustainability*, 1-24. https://doi.org/10.1007/s10668-024-05598-y

Cherepovitsyna, A., Shevelena, N., Riadinskaia, A., & Danilan, K. (2023). Decarbonization Measures: A Real Effect or Just a Declaration? An Assessment of Oil and Gas Companies' Progress towards Carbon Neutrality. *Energies, 16*(8), 3575. https://doi.org/10.3390/en16083575

Huovila, A., Siikavirta, H., Rozado, C.A., Rokman, J., Tuominen, P., Paiho, S., Hedman, A., & Ylen, P. (2022). Carbon-neutral cities: Critical review of theory and practice. *Journal of Cleaner Production, 341*(20), https://doi.org/10.1016/j.jclepro.2022.130912

Larrea, I., Correa, J.M., López, R., Giménez, L., & Solaun, K. (2022). A Multicriteria Methodology to Evaluate Climate Neutrality Claims—A Case Study with Spanish Firms. *Sustainability, 14*(7), 4310. https://doi.org/10.3390/su14074310

Rayegan, S., Wang, L., Zmeureanu, R., Katal, A., Mortezazadeh, M., Moore, T., Ge, H., Lacasse, M., & Shi, Y. (2024). Achieving carbon neutrality at single and multi-building complex levels – A review. *Energy and Buildings, 314*, 114263. https://doi.org/10.1016/j.enbuild.2024.114263

Wang, Z., Sun, Y., Kong, H., & Xia-Bauer, C. (2025). An in-depth review of key technologies and pathways to carbon neutrality: classification and assessment of decarbonization technologies. *Carbon Neutrality, 4*, 15. https://doi.org/10.1007/s43979-025-00129-8

Keywords

climate neutrality, assessment methodologies, review