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A Systematic Review of Electrochemical Conversion of Carbon Dioxide: Historical Reflection, Current State of Art and Future Vision for Sustainable Low Carbon Economy †

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Abstract: Carbon dioxide (CO_2) released from fossil fuels such as oil, coal, and natural gas contributes to the increase in Greenhouse Gas (GHG) levels in the atmosphere, due to which developed countries and scientific research communities endeavor to solve this issue by collaborating on CO_2 utilization techniques. In this direction, Electrochemical Carbon Dioxide Reduction (ECO_2R) has received much attention from scientific communities since a carbon-neutral energy cycle is achievable in combination with renewable energy sources, a crucial element for sustainable development, eventually leading to a low-carbon economy. The review article analyses ECO_2R research from its inception to its status in the past ten years (2011-2020) by using bibliometric methods and VOS viewer to visualize the data collected from the Web of Science (WoS). For the first time, the historical background of ECO_2R is discussed in detail concerning the timeline of the most influential published articles and the influence of countries, institutions, and authors. Also, an analysis of the research dynamics of the top one percent of highly cited articles from the top 15 countries is studied in terms of development trends, countries, research institutes, collaboration networks, citations received, bibliographic coupling, co-authorship, etc and co-occurrences of terms. The results show that ECO_2R research, in the past decade, has become highly collaborative, with the USA and China being the most productive countries attracting significant interest from startups and government agencies. Furthermore, researchers are now focusing on catalysts other than Copper (Cu), having multi-electron transport capabilities with selectivity towards a specific product that will lead to commercialization, with Opus 12 being a successful example. Therefore, researchers now need to direct their attention towards the role of active machine learning, nanotechnology, and operando techniques in ECO^2R research.

Keywords: Electrochemical Conversion; Sustainable Low Carbon Economy; multi-electron transport capabilities (List three to ten pertinent keywords specific to the article; yet reasonably common within the subject discipline.)

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Conflicts of Interest

The authors declare no conflict of interest.