

Unpacking the path toward a sustainable circular economy through industrial ecology

1 | BACKGROUND AND AIM OF THIS VIRTUAL ARTICLE COLLECTION

As the global environmental and climate crisis is accelerating and more and more planetary boundaries are crossed (Richardson et al., 2023), transformative approaches addressing “all aspects of society” (IPCC, 2022) are needed. The circular economy (CE) aims to be a systems-based transformative approach, which is shaping global debates, policy, business innovation, and research worldwide.

What we actually discuss as the circular economy has been central to industrial ecology since its inception and early pioneering contributions. Industrial ecology emphasizes that socio-economic systems rely on material, land, and energy use for production as well as consumption, which will always result in at least some waste and emissions. Societal activities, the required resource use and its impacts, have to be aligned with planetary boundaries. Finding pathways toward sustainable socio-economic systems therefore requires biophysical, systems-oriented assessments complementing socio-economic perspectives (cf., e.g., Fischer-Kowalski, 1998; Frosch & Gallopoulos, 1989). For example, Graedel and Allenby (1995) state that the

“concept [of Industrial Ecology] requires that an industrial ecosystem be viewed not in isolation from its surrounding systems, but in concert with them. It is a systems view in which one seeks to optimize the total materials cycle from virgin material, to finished material, to component, to product, to obsolete product, and to ultimate disposal. Factors to be optimized are resources, energy and capital.”

The *Journal of Industrial Ecology* (JIE) as the scientific journal of the International Society for Industrial Ecology has played a pivotal role in the emergence and development of the circular economy. By the end of the year 2023, 189 publications with a dedicated reference to the circular economy and circularity were published. Many of these are highly cited groundbreaking works with substantial societal and policy impact, for example, toward Japanese, Chinese, and European resource and climate policy (EC, 2018; Mayer et al., 2019; McDowall et al., 2017; Zhu et al., 2019), for widely cited circularity gap assessments (Circle Economy 2023; Haas et al., 2015), as well as for informing the global assessment reports by the Intergovernmental Panel on Climate Change (IPCC) (IPCC, 2022). Valuable contributions have come from across the International Society for Industrial Ecology, showing the breadth and complementarity of the approaches utilized across the field. These enable understanding the circular economy's potentials and limits across spatio-temporal scales, drawing on established methods such as life cycle assessment, environmentally extended input–output analysis, and social metabolism research utilizing material and energy stock-flow analysis. Further valuable contributions come from the complementary angles on industrial symbiosis, sustainable urban systems, and sustainable islands. In addition, in 2017, a JIE special issue on “Exploring the Circular Economy” was published (Bocken et al., 2017).¹

In 2023 the “Sustainable Circular Economy (SCE)” section of the International Society for Industrial Ecology was founded, to address increasing interest and demand from science, policy, and businesses to understand the potentials, limits, and pathways toward a more sustainable circular economy. Grounded in industrial ecology from its approach and with its methodological toolset, the section aims at contributing to the development of circular economy research that addresses all dimensions of sustainability—environmental, economic, and social—with a systemic approach. Thus, the section wants to foster developing conceptual, methodological, and empirical approaches aligned with the aim of being a transformative approach “addressing all aspects of society” (IPCC, 2022). As previous CE research was sometimes criticized for being solely focused on the physical side, a truly sustainable circular economy clearly requires addressing social, behavioral, economic, biophysical, and ecological considerations jointly in an inter- and transdisciplinary manner.

The aim of this virtual special issue (VSI) is therefore to take stock of what has so far been published in the JIE on the circular economy. We want to highlight excellent research from the field, provide an easy entry point for newcomers to the society and/or the topic, and identify research gaps and future priorities. To do so, the newly formed Sustainable Circular Economy section of the International Society for Industrial Ecology has compiled a list of exciting and prominent studies from the JIE. The temporal scope includes all works published in the JIE through the end of the year 2023. Clearly, highly relevant articles on the circular economy are also published in related journals, such as in *Resources, Conservation and Recycling*, *Journal of Cleaner Production*, *Ecological Economics*, *Sustainable Production and Consumption*, and others. For a broader review of these, we refer to Schögl

et al. (2020). Herein, we focus on what the *JIE* has published so far. The articles of this virtual special issue are available on the journal website at <https://bit.ly/JIE-circular-economy-VSI>.

2 | METHODOLOGICAL APPROACH

To compile this VSI, we used a triple-stacked literature search approach to achieve a comprehensive view integrating different perspectives.

First, we searched *JIE* for articles dealing with circular economy. In order to achieve the intended broad coverage, an initial SCOPUS search was conducted using the search string Title-Abstract-Keywords: "Circular" AND "Econom*" AND Journal title = "Journal of Industrial Ecology." This search returned 189 papers as of December 31, 2023.

Second, these papers were screened by at least two members of the SCE board (i.e., the authors of this editorial) based on the titles and abstracts of the articles to identify potentially relevant articles. A discussion among the SCE board members identified the most relevant. Criteria for inclusion were topical relevance, scientific contribution, and impact, considering also additional articles not found in the initial search.

Third, we selected the 44 articles collected in this VSI from the long list of exciting research. These are given in the [Supporting Information](#).

Inevitably, any collection will have to omit some excellent work due to space limitations. Therefore, the collection assembled in this VSI must be understood as at least partially subjective, biased, and incomplete. For example, as we focused on broader relevance, we had to exclude most fascinating case studies. Thus, we provide the initial Scopus query below and encourage interested readers to explore the contents of the journal further.²

3 | PERSPECTIVE

With this virtual collection of articles we want to achieve three things. First, we want to provide researchers and practitioners in the field of CE with a guided entry into this emerging and important research area. Second, by focusing on *JIE*, the home journal of the International Society for Industrial Ecology, we want to further contribute to the question of what industrial ecology can contribute to CE. Third, we want to initiate further discussions on the current state of CE research, research gaps, opportunities and limitations, and enablers and barriers.

In this sense, we see this as a starting point and the list may be revised as the field develops further. In addition, we encourage everyone to discuss the list and CE with us in order to further develop CE, fill research gaps, exploit opportunities, and overcome barriers so that CE and industrial ecology can fulfill their potential for the necessary sustainability transformation of industry and society.

CONFLICT OF INTEREST STATEMENT

The authors declare no conflict of interest.

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ENDNOTE

¹For the 2017 *JIE* special issue on "Exploring the Circular Economy" see <https://bit.ly/JIE-circular-economy>

²Scopus search: Title-Abstract-Keywords:"Circular" AND "Econom*" AND Journal title = "Journal of Industrial Ecology", https://www.scopus.com/results/results.uri?sort=plf-f&src=s&st1=Circular+AND+Economy&st2=Journal+of+Industrial+Ecology&sid=a5e00960dd9b6c944a902ef7426436c1&sot=b&sdt=b&sl=81&s=%28TITLE-ABS-KEY%28%22Circular%22+AND++Econom*<%29+AND+SRCTITLE%28%22Journal+of+Industrial+Ecology%22%29%29&origin=searchbasic&editSaveSearch=&yearFrom=Before+1960&yearTo=Present&sessionSearchId=a5e00960dd9b6c944a902ef7426436c1&limit=10

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.