

Social Science >> Economics

Entrepreneurial Education for a Circular Economy: Fostering Sustainable Innovation

Teresa Dieguez*

Polytechnic University of Cávado and Ave (IPCA), Portugal.

Abstract

This article discusses the central role of higher education institutions (HEIs) for the circular economy with a focus on entrepreneurial education, applied R&D, and multi-stakeholder cooperation. Based on a comparative study of seven international cases, it analyzes institutional approaches that facilitate universities to play an active role in sustainable innovation in business. By integrating circular economy concepts into their curricula, incubation activities, and relations with governmental and industrial organizations, HEIs generate future entrepreneurs who can contribute to reducing environmental and social impacts. The Triple Helix model also highlights that the interplay between academia, industry, and government promotes the co-creation of circular solutions. Results show that successful HEIs combine theoretical knowledge with practical implementation, establish interdisciplinary solutions, and promote an environment for fostering circular startups. The proposed conceptual framework places universities as key actors in promoting circular innovation by bridging knowledge generation and societal application. This study offers insights to academic management, policies, and practices by providing an overview of how educational systems can be designed to fit in sustainability ambitions and what the critical enablers are (including living labs, green incubators, and curriculum reforms) that support the circularization of business models over linear ones. Even if its qualitative nature and reliance on secondary data can be considered limitations, the present research can provide an impulse for further investigations of impact assessments and metrics development to evaluate circular maturity in academic institutions. Finally, it is proposed in this paper that HEIs have the transformative potential to educate the next generation of entrepreneurs with systemic sustainable practices.

Keywords: Sustainable innovation; entrepreneurial education; circular economy.

Introduction

Increasingly, the Earth's accelerating environmental degradation, scarce resources, and the rapidly worsening climate crisis are calling into question the logic of the linear economy that it operates with, which is currently based on taking out resources, manufacturing finished products, and then discarding them.

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*Corresponding author

Teresa Dieguez

Polytechnic University of Cávado and Ave (IPCA), Portugal.

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In response to this development, the circular economy (CE) has taken off as a transformative paradigm aiming to break the relation between growth and consumption of resources naturally produced by the environment, emphasizing reusing everything that can be reused as well as recycling and regenerating (Ghisellini et al. 2016).

At the heart of this transformation are the innovative and entrepreneurial activities of start-ups and SMEs (Odeyemi et al. 2024). They re-imagine value chains, design products that are environmentally sustainable, and disruptive systems that are not. Whereas there is increasing interest in CE, material guidance is still lacking for entrepreneurs on how to design and realize a circular business model that is feasible (Hina et al. 2022).

In this context, Higher Education Institutions (HEIs) play a crucial role in preparing future entrepreneurs as agents of sustainable transformation (Dieguez, 2023). Universities are not just places for knowledge generation but also centers of innovation and social change. By integrating CE principles into their entrepreneurial education programs, HEIs encourage holistic thinking, ethical maturity, and values that are supportive of sustainability. At the same time, they are interfaces between industry, business, and government for interdisciplinary programs, incubator formats, and public-private partnership collaborative architectures that enable green startups to thrive following undergraduate courses lead well into start-ups while still at university (Dieguez et al. 2021; Loureiro et al. 2022).

The environment is particularly important in regions where economic diversification and sustainable innovation is being prioritized in national strategies. In this context, the present article is an analysis of how entrepreneurial education can help young business leaders to design and scale up circular businesses. It reviews institutional best practices and suggests a conceptual framework: HEIs themselves become catalysts of sustainable innovation with reference to the Triple Helix model for collaboration between academia, industry, and government.

Literature Review

Circular Economy Principles and Sustainable Business Models

The Circular Economy (CE) is presented as an alternative to the traditional linear models. For that, it is supposed to be more sustainable. It seeks closure, delays, and narrowing of resource loops so that material remains at its highest and best use for as much time as possible (Geissdoerfer, et al., 2017; Rodríguez-Espíndola et al., 2022).

This means in practice designing out waste, extending product lifetimes, reusing components, and extracting value from by-products. These principles now shape business models across sectors (Alivojvodic, 2024; Yadav et al., 2025). Industry is taking welfare services serious-

ly. In many cases, firms have begun to stop taking back products that are left at the supermarket—returning dies and containers they provide, too. Hardware maintenance is being turned over to manufacturers or suppliers, and, for example, Global Mobile Telecommunications Co. can provide telephone system operations. It also repairs appliances, provides spare parts for TVs, and car repair (Bocken et al., 2016; Bocken et al., 2019; Lewandowski, 2016; Whalen & Whalen, 2020). This transition has been reinforced by public policy, most notably through the EU Circular Economy Action Plan. The Plan provides incentives for innovation and market reception of new products (Spani, 2020).

Beyond start-ups, established corporations are also shifting to circular practices. SMEs in particular are seeking benefits such as lower costs, better reputation, access to environmentally conscious consumers, and contribution to environmental regeneration by avoiding waste (Crecente et al., 2021; Geissdoerfer et al., 2020; Linder & Williander, 2017). However, they confront difficulties in reverse supply chains, finance, and competences, places where innovative business models can help close the gap (Rizos et al., 2016).

Circular Entrepreneurship as a Driver of Circular Practices in Key Sectors

Circular entrepreneurship targets opportunities created by the logic of CE, whether through start-ups that were born out of it or by modifying existing businesses (Geissdoerfer et al., 2020; Zucchella & Urban, 2019). It is a close relative to other forms of entrepreneurship that consider environmental and social aspects; here too we put weight on tangible improvements in environmental or social quality. Start-ups in the iii main productive sectors are a new force to be reckoned with. They jj provide credible challengers for established firms, create innovative next-generation products and services, and drive incumbents to respond (Sebestova et al., 2020; Veleva & Bodkin, 2018; York & Venkataraman, 2010). As with Golden Rachis, the academic research literature on entrepreneurship in CE is just getting off the ground (Filser & al., 2019; Hockerts & Wüstenhagen, 2010; Zhao et al., 2021).

Start-ups and smaller companies in different sectors are turning CE principles into reality (Heshmati, 2017), namely:

- Fashion & Textiles. Businesses are using new forms of manufacturing and materials like upcycling, resale, and bio-based products - industry solutions such as CircularID (Eon Group) make it easy for people to trace where these products came from so that they can be reused or recycled in future life; an example of this pattern can be found by looking at previous reviews on CE entrepreneurship (Suchek et al., 2022). The growing second-hand market shows that consumers accept this (Mobarak et al., 2025).

- Food & Agriculture. There's plenty of snacking while recycling and waste management on the side now, as one company shows off by turning surplus bread into beer (Toast Ale), and others like that find their work in reusing agricultural by-products for biodegradable wrapping (Ellen MacArthur Foundation, 2021; FAO, 2019).
- Construction & Materials. Digital platforms (e.g., Wastebox) superintend on-site collection and recycling; start-ups mess around with recycled plastic blocks and alternative casings like binders from it or silica, trends which follow the fortune of innovative monitors in construction (CEMEX Ventures, 2023).
- Clean Energy & Tech. Companies such as Redwood Materials establish circular supply chains for EV batteries by recovering critical metals and putting them back to work (Supply Chain Dive, 2023).

Universities as Catalysts for Sustainability and Entrepreneurship

In the world today, an entrepreneur institution that universities comprise has become anchors for all kinds of ecosystems, ecopreneurial, biocapitalist (a concept since the mid-1990s) just to list a few examples. Seishiro Yoshimura (2014) argues that apart from creating knowledge, they transform startup creation and promote social business entrepreneurship. They also foster innovation responsibly by combining incubation with technology transfer and building partnerships across business sectors (CEMEX Ventures, 2023; Supply Chain Dive, 2023). These activities link campus capabilities with societal needs and turn research into tangible results. We are assisting to a cultural change, an aspect especially true for students who are tomorrow's inheritors but are being trained merely as tomorrow's wage slaves. Schools have begun to make sustainability part of their curriculums, foster interdisciplinary academic studies, and advance green incubators (Dieguez, 2018; Dieguez, 2020;). Training in entrepreneurship directed towards sustainability enhances systems thinking, moral leadership, and innovation skills (Leal Filho et al., 2018; Rieckmann, 2018). Getting hands-on experience through living labs, accelerators, and projects helps students succeed in turning ideas into real-world solutions; it also increases graduates' employability, helping bridge between education and the green economy.

In the Gulf, including Bahrain, many higher education institutions begin to link their research to national development strategies. With a cautious approach, however, despite weak connections between higher education and industry, as well as centralized organizational structures that often hinder effective decision-making British-style, there remains hope for success in this task (Bacigalupo, 2019).

Triple Helix Collaboration for Circular Innovation

An aggressive step in the direction of re-launching the Marxist perspective was taken by Bródy: he concluded from situations in Western Europe that socialist development of the Eastern Bloc could only be brought about through technological revolution and large-scale industrialization (Bródy, 1926). In formal terms, CE simply means closing the loops in our material systems so that wisdom and resources cascade down to future generations instead of being mined fast and shipped out to pollute (C2CC, 2000); a fact indeed well appreciated by rocket scientists who set themselves off on a paving goal, that energy from solar cells can be used to fuel carbon dioxide emissions-free aircraft (Jin et al., 1999).

However, when public authorities frame policies and deliver incentives, universities deliver research, talent, and laboratories, and companies validate and scale solutions, circular innovation systems become more effective (Etzkowitz & Leydesdorff, 2000). European experiences are recounted where this integration has made a new, integrated industrial network. People have not only found dividends in terms of efficiency and costs, but they got more product variety as well (Ibrahim et al., 2024). Some scholars have also suggested moving to a Quadruple Helix by adding civil society to strengthen legitimacy and adoption (Brown et al., 2023).

Methodology

Qualitative and exploratory designs have the extreme flexibility of testing anything difficult to control for. They can therefore be chosen in new fields like circular entrepreneurship. It is the special advantage of qualitative approaches that conceptual insights and frameworks can be developed better in areas where one is not available in advance for testing based on predefined hypotheses. We employed a multiple case study strategy that allows for cross-case comparisons. The selection criteria for our cases were:

1. University involvement: the initiative must be linked to a university (leading or co-leading on circular economy activities).
2. Triple Helix collaboration: cases had to show active interaction among academia, industry, and government. Three criteria follow directly from the innovation dynamics discussed earlier (Etzkowitz and Leydesdorff, 2000).
3. Societal relevance: initiatives must make observable contributions to the environment, people (typically animals not currently occupying our economy), or economy.

Data for this analysis was gathered mainly from online sources (institutional reports, etc.) and documents during the period January to March 2025. This approach made it possible to collect accounts whose depth varies greatly ac-

cording to both publication year and type, and while some will therefore be richer than others, there is still much value in what they contain about each initiative. The sample comprises seven initiatives situated in Europe, Latin America, North America, and the Gulf region. These initiatives were chosen to represent geographical and sectoral diversity, thus offering a broader view of how universities can work as carriers for circular innovation in different governance and cultural settings.

Table 1 provides a summary of the cases chosen, showing their geographical location, key circular initiative, major partners, and key fields. The examples range from training students in circular design at the Technical University of Delft to an upcycling public campaign and industrial process involving university spinoff companies in the UK, and large-scale urban (Gulf region). It is through these different but interconnected paths that universities are embedding CE principles into the ecosystems of entrepreneurship and innovation.

University	Region	Circular Initiative	Partners	Key Focus
TU Delft (CIRCO)	Netherlands	Circular design training	Government, creative industries	Practical CE skills for SMEs and designers
University of Surrey / Toast Ale	United Kingdom	Brewing beer from surplus bread	Startup, university, local government	Academic validation of circular food innovation
Masdar Institute / Khalifa Univ.	United Arab Emirates	Development of Masdar City	Government, MNCs, university	Urban-scale CE implementation and clean energy R&D
Universidad de los Andes	Colombia	Circular Cities project	Ministries, companies, academia	Public policy experimentation with CE in urban environments
Chalmers University	Sweden	Re:waste project and startup incubation	Local government, Volvo	E-waste recovery and tech innovation
Arizona State University (ASU)	United States	Circular Living Lab	Local government, startups, incubators	Testing and incubating sustainable solutions
University of Coimbra	Portugal	BioShoes4All and green spin-offs	Footwear industry, academia, public support	Circularity in traditional manufacturing (footwear sector)

Table 1. University-Driven Circular Innovation Initiatives.

Findings and Conceptual Framework

Comparative Analysis of Seven Case Studies

Comparative analysis of these seven case studies confirms similarities in institutional settings, helping Higher Education Institutions (HEIs) play a more active part in advancing circular entrepreneurship. Despite differing geographic locations, scale, and specialization, all projects adopted strategic approaches making the university a platform for sustained innovation.

Strategic Approaches

To foster the circular economy within higher education, three strategic approaches can be highlighted, namely:

- **Integration of Training and Research:**
The first strategic approach is to integrate advanced academic training with original investigations, ensuring learners master the theoretical knowledge of the circular economy (CE) and gain hands-on experience. This combination enables students to acquire new entrepreneurial capabilities in realistic contexts, consistent with the view that sustainable entrepreneurship requires both 'systems thinking' and practice-based learning (Leal Filho et al., 2018, Rieckmann, 2018).

- **Incubation and Acceleration Support:**
The second approach provides comprehensive incubation and acceleration support for circular solutions throughout HEIs. Specialized infrastructures, such as living labs or green incubators, become the central platforms where students, faculty members, and external partners co-construct circular startups. They reinforce employability and empower innovation ecosystems, echoing earlier findings that universities serve as anchor institutions within regional development (Dieguez, 2020; Loureiro et al., 2022).
- **Cross-Sector Intervention:**
The third approach shows cross-sector intervention as crucial. According to the Triple Helix model (Etzkowit and Leydesdorff, 2000), HEI campuses bridge academia, industry, and government. This role extends beyond knowledge production to arranging collaborative processes where towns, businesses, and public institutions experiment and test circular practices. Examples can be seen on Joint efforts to develop urban agriculture and ecological building practices emerged in local areas with strong commercial potential. Partnerships were

evident in projects like the cooperation between TU Delft and the creative industry community for circular design training or Arizona State University and its neighboring cities testing sustainable solutions.

Outcomes and Impact

Universities were able to transform scientific knowledge into tangible social, environmental, and economic benefits, conforming to Sustainable Development Goals (SDGs) promoted by the United Nations while enhancing their sustainability missions' visibility and legitimacy.

Conceptual Framework

A conceptual framework may be designed, combining the strategic locations necessary for success in circular innovation at higher education institutions, ranging from government support through universities to industry outcomes. Figure 1 highlights the role of each axis, and the synergistic outcomes derived from their active collaboration. The government plays a foundational role by formulating public policies and establishing regulatory frameworks and incentive mechanisms that support the transition towards a circular economy.

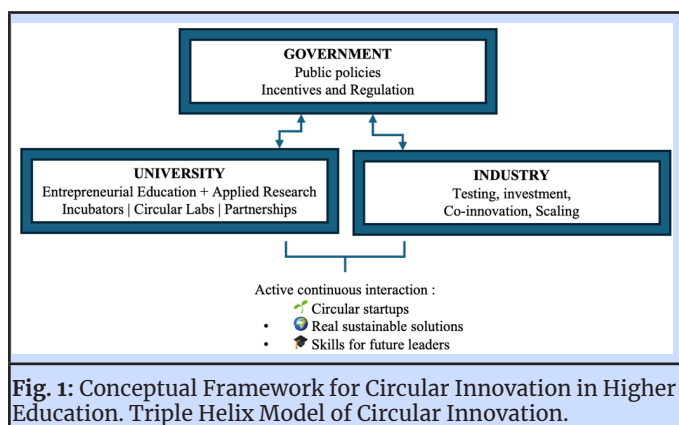


Fig. 1: Conceptual Framework for Circular Innovation in Higher Education. Triple Helix Model of Circular Innovation.

The framework emphasizes the roles of government, universities, and industry, as well as the synergies from their collaboration. In this sense,

- **Government:** Provides environment, regulation, and policies to build support conditions, consistent with Spani (2020) and Espuny et al. (2025) for a state-led strategy in circular transitions.
- **Universities:** Conduct enterprise education, applied research, knowledge production, and create infrastructures (e.g., CE labs, incubators) for widespread innovation, ensuring practical implementation in the market (Diegues, 2023).
- **Industry:** Conducts pilot projects, invests in, and scales circular solutions, ensuring practicality, market alignment, and widespread improvement (Whalen & Whalen, 2020).

The interaction among these three poles of interaction fosters circular enterprises and scalable sustainable

solutions. It instructs future entrepreneurial leaders in sustainability competencies, underlining HEIs' role as bridges between global innovation ecosystems and global challenges requiring unified entrepreneurial attention.

Contributions and Originality

This article makes an original contribution to the literature by bringing together the three main components that are never interrelated elaborately in any great detail. The three main components are that of the entrepreneurial study, the circular economy, and the triple helix model. The study's first part, from different dimension series, probes entrepreneurial education on Higher Education Institutions (HEIs) which strategically develop their forms of medium. The result of the research above points out that it is not just through theoretical content but rather by practical means such as incubators, accelerators (for when both classes are combined into one comprehensive group), even applied research initiatives and particular disciplines work easily in partnership with one another. At this point, the conclusions of Leal Filho et al. (2018) and Rieckmann (2018) call for such changes. Sustainably-oriented learning should go beyond learning from books and take on new practices.

Second, it applies the Triple Helix model (Etzkowitz & Leydesdorff, 2000) to university essence to circulate innovation. This approach displays that the interactive synergy between academia, industry, and government brings about conditions for systemic transformation. The papers illustrate that when universities provide research or talent, enterprises validate and scale the results of their research, and governments set up a suitable macro environment, transition to a circular economy is not only more possible but also more to the point of actually happening than has been realized before (Espuny et al., 2025; Ujwary-Gil, 2023).

Third, it develops a new framework in which HEIs are at the center of circular innovation ecosystems. The structure is founded on inputs from a number of regions and institutions, offering an organized model that academic heads, policymakers, and practitioners can follow for aligning educational systems with the goals of sustainability. The article also extends the geographical range of research into the circular economy by incorporating case studies from alternative places of research, such as the Gulf region and Latin America. Most previous research was conducted mainly in Europe or North America, but by covering a range of institutional backgrounds, this study provides a more inclusive and globally suitable standpoint (Rataj, Kemp, & Mordaszewska, 2024). Such cross-regional comparison permits us to distill good practice while acknowledging differences in context. In this way, the paper contributes to a more sophisticated and transferable knowledge of how HEIs can shape the next generation of circular entrepreneurs.

Conclusion

This study aimed at examining the strategic role which Higher Education Institutions play in promoting a circular economy through business education. It also looks at applied research and cross-sector collaboration in this area.

According to seven cases from abroad that were studied, the university may prove a lively force for environmental business innovation, although today's universities generally do not go in this direction. The most powerful HEIs are those that not only integrate CE into their teaching but also act as bridges between academia, industry, and government. This reflects the logic of triple helix models (Etzkowitz & Leydesdorff, 2000), which sees factories of invention emerging from dynamic collaboration among institutions. These cooperations allow the joint development of environmentally sound, economically viable, and socially beneficial solutions (Espuny et al., 2025).

Thereby, a case in point is UIBS's collaboration with business schools worldwide (Carlile and Christensen, 2006). At the same time, universities play a vital role in preparing future entrepreneurs to lead the transition toward sustainable business models. These abilities comprise systems thinking, ethical leadership, and the capacity to design and scale circular startups (Leal Filho et al., 2018; Rieckmann, 2018). By providing students with chances to experiment in incubators, experiential laboratories, and interdisciplinary projects, HEIs help change abstract theory into concrete results.

As the challenges of global sustainability continue to worsen, whether it is climate change, resource depletion, or something else, universities will have to transform themselves from mere knowledge producers to transforming agents of systems changes. This research offers a conceptual framework that positions HEIs at the heart of circular innovation ecosystems, boosting their role in linking theory with practice. In so doing, it also underscores the importance of entrepreneurial education not only for fostering environmentally friendly business innovation but also towards wider sustainable development objectives (Ghisellini et al., 2016).

Practical Implications and Future Research Directions

The conceptual framework being proposed here reinforces the idea that universities must develop far beyond their traditional role of teaching institutions into strategic transformation agents in sustainable innovation ecosystems. By introducing elements of entrepreneurial education, applied research, and circular economy (CE) principles, Higher Education Institutions (HEIs) can place themselves in the role of change drivers along the lines of the Triple Helix approach (Etzkowitz & Leydesdorff, 2000).

From the perspective of practical operation, there are several follow-up areas, namely:

- **Institutional Strategy.** In their entrepreneurship and incubation models, HEIs should incorporate sustainability and circularity as core performance criteria. This is to make sure that environmental and social dimensions are viewed not as appendices but as an essential part in the development of business (Rizos et al., 2016).
- **Cross-Sector Collaboration.** On an ongoing basis, relationships with government and industry must be organized formally as well as systematically assessed. Collaboration on this basis may create a favorable environment, bring resources into play, and match the activities of academic institutions with societal needs, echoing findings by Espuny et al. (2015) on government-led integration strategies.
- **Capacity Building.** Universities should reinforce supportive systems, say green incubators, accelerators, and living labs, to ensure that hands-on innovation is encouraged and students and researchers can also try out circular solutions for themselves (Dieguez, 2018; Leal Filho et al., 2018). **Policy Alignment.** National governments, especially in areas such as the Gulf where they are pushing diversification strategies, can stimulate the adoption of CE by setting up appropriate incentives and regulatory frameworks which reward circular entrepreneurship (Spani, 2020; Bacigalupo, 2019). From the research perspective, several lanes were still open:
- **Impact Assessment.** There is a need for quantitative assessments to arise not only the socio-economic impacts but also environmental consequences of circular startups by universities. Such research would also be well-placed to show how HEIs lead to job creation, efficiency in resource use, and mitigation of climate change (Zhao, Liu, & Shu, 2021).
- **Comparative Studies.** By comparing one region with another, it comes out how institutional contexts, governance models, and policy frameworks affect the effectiveness of university–industry–government efforts jointly (Hockerts & Wüstenhagen, 2010).
- **Longitudinal Analysis.** The future ought to call for studies about whether skills acquired during sustainability-focused entrepreneurial programs at university then shade into lifelong business practice. This can help us ascertain if the competences fostered in universities last our whole careers (Rieckmann, 2018).
- **Measurement Tools.** Finally, there is an urgent need for stable standards to evaluate how “circular-ready” universities are. Such tools could look straight at the level of CE that gets embedded and then mon-

tor progress over time (Geissdoerfer et al., 2020).

By addressing these follow-up areas and research opportunities, HEIs can have an ever-greater impact as key actors in global sustainability transitions, so much so that entrepreneurial education will no longer merely prepare future leaders but actively contribute to transforming the system. 483 Words

Limitations

To help encapsulate how Higher Education Institutions (HEIs) might promote circular entrepreneurship via the curriculum, study, and unhyprocritical collaboration of different sectors, several benefits are highlighted, while there are also several limitations to this study to recognize at all points along the way. The first is that the research is qualitative and exploratory. Such a design captures emerging dynamics and creates conceptually new frameworks for analysis capabilities testing, which other approaches do not possess. It does not, however, yield statistically generalizable findings. Relying on seven case studies, geographical distribution and industrial sector differences cannot, as a result, be considered representative of the worldwide university-led circular initiatives' landscape (Rizos et al., 2016). Second, this study is constrained by reliance mainly on secondary information: institutional reports, web pages, and previous academic publications. Depths of quality and date vary for all these data sources across. This may impact the robustness of findings. Future work should incorporate primary research—such as interviews with university leaders, entrepreneurs, and policymakers—to improve empirical validity. Thirdly, the case selections are mostly about best practices, which may give rise to some positive skew. However, in this analysis, neither failed initiatives nor difficulties faced by universities in setting circular economy (CE) principles into their environment are less visible. Nonetheless, these are absolutely essential to a proper comprehension of deep structural change complexities (Hockerts & Wüstenhagen, 2010).

Fourth, the transferability of results may be constrained by contextual differences between locations. For example, in the Gulf region, structural and governance features—such as centralized policy-making and resource dependence—differ dramatically from what is found in Europe or North America. Such differences might impact how easy it is to duplicate strategies for change over different regions (Bacigalupo, 2019). Finally, the conceptual frame developed here, though based on exploratory case studies, has not been tested in a systematic way within a wide range of HEIs. Its applicability and effectiveness in different institutional and cultural settings are yet to be verified through further research based on a longitudinal and comparative design if possible (Filser et al., 2019). Recognizing these limitations is importante to underline the necessity of more rounded and sensitive analyses, not just

based upon data, but also contextual awareness, on how universities can serve as loci for conversational innovation.

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