MANAGING THE CIRCULAR ECONOMY TRANSITION IN BULGARIA: A GENDER-RESPONSIVE SKILLS PERSPECTIVE

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УПРАВЛЕНИЕ НА ПРЕХОДА КЪМ КРЪГОВА ИКОНОМИКА В БЪЛГАРИЯ: ПОДХОД КЪМ УМЕНИЯТА, ОСНОВАН НА ПРИНЦИПИТЕ НА РАВНОПОСТАВЕНОСТТА МЕЖДУ ПОЛОВЕТЕ

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Abstract: *The transition to a circular economy (CE) requires not only technological innovation but a fundamental transformation of knowledge, skills, and institutional capacities. This article examines the role of higher education in fostering competencies for sustainable and circular economic transitions, drawing on empirical evidence from Bulgaria's National Skills Needs and Gaps Analysis (2024) [1]. Combining the survey, interview and case-study findings of this analysis with official statistics and with international and Bulgarian literature, the article argues that Bulgarian higher education institutions remain poorly aligned with green and digital skills demands of Industry 4.0 and circular business models, and, even though women outnumber men among university graduates, they remain underrepresented in the STEM fields most directly linked to these transitions. Specific competency gaps among women entrepreneurs are identified, structural barriers to education access are examined, and evidence-based policy recommendations are proposed for curriculum reform, institutional partnerships, and gender-responsive training design. Drawing on the GreenComp framework [2], UNESCO's greening skills agenda [3], and the EEA's circular economy country profile and the OECD's Sofia report [4,5] or circular economy country assessments [4,5], the article contributes to the discourse on education–economy alignment in post-socialist EU member states facing dual digital and green transitions.*

Keywords: *circular economy; higher education; sustainability competencies; Bulgaria; women entrepreneurship; green skills; digital transition*

1. Introduction

The global momentum toward sustainable development has positioned the circular economy (CE) as a central pillar of twenty-first-century economic policy. Defined as a systemic approach that eliminates waste and keeps materials in use through restorative and regenerative design (a concept that remains contested, with more than one hundred definitions identified in the literature [19]), the circular economy represents a shift from the linear 'take-make-dispose' model that has dominated industrial production since the Industrial Revolution. The European Union's Circular Economy Action Plan, first launched in 2015 and replaced by a new action plan in 2020, frames CE transition not merely as an environmental imperative but as a driver of economic competitiveness, job creation, and social equity [6]. However, the realization of this transition depends fundamentally on human capital: the availability of workers, managers, and entrepreneurs who possess the knowledge, attitudes, and practical skills to design circular business models, implement resource efficiency measures, and navigate the complex regulatory and financial landscapes associated with sustainable production.

Within this context, higher education institutions (HEIs) occupy a uniquely strategic position. Higher education institutions are not only responsible for the initial training of future professionals - they are also key actors in research and innovation, community engagement, and the broader cultural diffusion of sustainability values. Several major international frameworks - including the United Nations SDGs, particularly SDG 4 (Quality Education) and SDG 12 (Responsible Consumption and Production) - explicitly recognize the transformative role of education in enabling sustainable transitions [18]. The European Commission's GreenComp framework operationalizes this vision by identifying twelve sustainability competencies organized around four domains [2].

Yet despite growing policy consensus on the importance of education for sustainability, significant gaps persist between educational outputs and labour market demands in many European countries. These gaps are particularly pronounced in Central and Eastern European countries (CEECs), where post-socialist legacies, limited public investment, and structural economic vulnerabilities have slowed the development of both circular industry and the supporting educational infrastructure. Bulgaria presents a compelling case: an EU member state since 2007, it ranks consistently among the lowest performers on circular economy indicators and digital adoption rates, while women outperform men in non-formal training participation and among university graduates'. [1,4].

This article is structured as follows. Section 2 establishes the theoretical framework linking higher education, sustainability, and circular economy. Section 3 contextualises Bulgaria's socioeconomic and educational landscape. Section 4 examines the role of higher education in facilitating circular transition. Section 5 analyses the empirical evidence from Bulgaria's National Skills Needs and Gaps Analysis. Section 6 focuses on women entrepreneurs. Section 7 offers policy recommendations. Section 8 discusses implications, and Section 9 concludes.

Methodologically, the article is a policy-oriented analysis. It draws primarily on the National Skills Needs and Gaps Analysis for Bulgaria [1], which combined desk research, a survey of 53 women entrepreneurs, stakeholder interviews and case studies, and complements it with official statistics from the National Statistical Institute and Eurostat, with European policy documents, and with international and Bulgarian research on circular economy education, sustainability competencies and women's entrepreneurship.

2. Theoretical Framework: Education, Sustainability, and the Circular Economy

2.1. Education for Sustainable Development (ESD)

The concept of Education for Sustainable Development (ESD) has evolved significantly since the 1992 Rio Earth Summit and the adoption of Agenda 21. Initially framed as environmental education, ESD has expanded to encompass economic, social, and governance dimensions of sustainability, reflecting the integrated logic of the SDGs [18]. UNESCO's ESD for 2030 framework calls for a 'transformative' approach that develops learners' capacity for systems thinking, critical reflection, participatory decision-making, and transformative action [18]. At the higher education level, this translates into curriculum redesign, pedagogical innovation, and institutional greening - a triple agenda spanning campus operations, curricula and community engagement, as case studies of sustainability planning in higher education illustrate [7].

Academic work on sustainability competencies predates these policy frameworks: Wiek et al. proposed an influential reference framework of key competencies for academic programme development [26]. The GreenComp framework, developed by the European Commission's Joint Research Centre, represents the most comprehensive recent attempt to map sustainability competencies in a European context [2]. Its twelve competencies are grouped into four areas: embodying sustainability values (valuing sustainability, supporting fairness, promoting nature); embracing complexity in sustainability (systems thinking, critical thinking, problem framing); envisioning sustainable futures (futures literacy, adaptability, exploratory thinking); and acting for sustainability (political agency, collective action, individual initiative) [2]. Crucially, GreenComp envisions these as cross-cutting capacities to be developed throughout the educational lifespan, from primary school to continuing professional development [2].

2.2. Circular Economy as an Educational Imperative

The circular economy paradigm introduces specific competency demands that are both complementary to and distinguishable from broader sustainability competencies. Drawing together the concepts and analytical tools that recur across the circular economy literature, these demands can be summarized as a distinct set of ‘circular economy competencies’: life cycle thinking, cradle-to-cradle design principles, industrial ecology, reverse logistics, business model innovation, and material flow analysis. A recent competency map for CE education [8] organizes the required competences into four areas (resilience and soft skills, entrepreneurship, green transition, and digital skills), combined through a T-shaped learning approach, underscoring the interdisciplinary nature of CE education [8]. An analysis of 22 published descriptions of CE courses in higher education finds that a systems focus is central to CE education, and recommends extending courses to more industries and market contexts, to consumption and demand-side issues, to all levels of implementation, and to real workplace interaction [9]. Kirchherr and Piscicelli [20] further propose five teaching principles for CE education: constructive alignment, problem-based learning, interactivity, non-dogmatism, and reciprocity.

2.3. The Green–Digital Skills Nexus

A recurring theme in recent literature is the interdependence of green and digital skills - what the European Commission terms the 'twin transition'. Digital technologies including artificial intelligence (AI), the Internet of Things (IoT), big data analytics, and blockchain are increasingly recognized as critical enablers of circular economy implementation [3]. UNESCO's 2024 research brief on greening skills and TVET explicitly calls for the integration of green and digital

competency development, warning against treating these as separate educational domains [3]. Bulgaria's Innovation Strategy for Smart Specialization (ISIS) 2021–2027 identifies 'Cleantech, circular and low carbon economy' as one of five thematic areas for accelerated development, alongside a separate area for informatics and ICT, within a vision that explicitly links the green and digital transitions [1].

3. Bulgaria: Socioeconomic and Educational Context

3.1. Socioeconomic Profile

Since acceding to the EU in 2007, Bulgaria has relied heavily on European Structural Funds as a primary driver of economic modernization, with governance initiatives largely shaped by European Commission requirements [1]. The country's economy is dominated by small and medium-sized enterprises (SMEs): 'in 2021, 381,457 active enterprises were operating in Bulgaria, of which 92.8% employed fewer than ten people [1]. In 2024, 49.9% of Bulgarian SMEs had at least a basic level of digital intensity, compared to an EU average of 72.9% [21]. Resource productivity in Bulgaria was EUR 0.33 per kg of material consumed in 2021, against an EU average of EUR 2.09 per kg, and the circular material use rate stood at 4.9%, well below the EU average of 11.7% [4]. The national policy response is framed by the Strategy and Action Plan for the Transition to a Circular Economy 2022–2027, adopted by the Council of Ministers in October 2022 [22]. Survey evidence further shows that small, mostly family-run service and retail firms lag behind medium-sized manufacturing and logistics companies in the green transition and call for clearer state policy and better access to finance [25].

3.2. Education and Labour Market Dynamics

Bulgaria's educational system presents a complex picture of strengths and vulnerabilities. In the 2023/2024 academic year, 196,600 students were enrolled in higher education in Bulgaria [23], and women account for the majority of university graduates [1]. However, gender-segregated patterns of field of study persist, with women concentrated in education, health, and business administration, and men dominating engineering, manufacturing, and construction - the fields most directly associated with CE and digital transition [1]. Approximately 637,900 persons aged 25–64 (18.9%) participated in at least one non-formal training activity in the preceding twelve months, with women participating more often than men (19.9% compared to 17.8%); the main obstacles reported were lack of free time (36.1%), high costs (22.5%), and family responsibilities (10.4%) [24].

4. Higher Education as an Agent of Circular Transition

4.1. The Strategic Position of Universities

Universities occupy a multifaceted strategic position in relation to the circular economy transition. As producers of knowledge through research, they generate the evidence base needed to understand material flows, assess life-cycle impacts, and evaluate the effectiveness of circular business models. As educators, they shape the values, competencies, and career orientations of future entrepreneurs, managers, and policymakers. As institutional actors, they can model circular practices in their own operations. And as hubs of collaboration, they broker partnerships between industry, government, and civil society essential for systemic change [7]. The EUCEN position paper on integrating green skills into continuing education (2025) argues that universities have a

particular responsibility in lifelong learning provision [10] - especially relevant in the Bulgarian context, where skills gaps are most acute among the existing SME workforce [1].

4.2. Curriculum Gaps and Reform Imperatives

Despite the strategic importance of CE education, research reveals significant gaps in current higher education curricula across Europe. A review of published CE course descriptions finds that courses still cover a limited range of industries, rarely address consumption and demand-side issues, and offer too few opportunities for real workplace interaction [9]. This is a particular concern for business and management education — the most critical domain for disseminating CE principles among future entrepreneurs. In Bulgaria specifically, the OECD's 2025 report on the Circular Economy in Sofia identifies a gap between circular economy ambitions and implementation, pointing to a lack of measurable targets, an overemphasis on waste management, and limited financial incentives for businesses [5].

4.3. The GreenComp Framework as a Curriculum Design Tool

Applied to the CE domain, GreenComp competencies can be translated, as proposed here, into specific learning outcomes: systems thinking supports life cycle analysis and material flow understanding; futures literacy supports circular business model innovation; collective action supports multi-stakeholder circular value chain development; and individual initiative supports entrepreneurial adoption of circular practices. Universities that map their CE-related courses against the GreenComp competency framework can more effectively align with European sustainability education policy [2], which may also strengthen their applications to European programmes such as Erasmus+ and Horizon Europe.

5. Skills Gaps and Training Needs: Evidence from Bulgaria

5.1. Key Findings from the National Analysis

The National Skills Needs and Gaps Analysis for Bulgaria (2024), produced by RAPIV and Varna Free University under the Interreg Danube Region WE.Circular project, provides the most comprehensive recent empirical picture of skills gaps related to circular economy and digital transition among Bulgarian entrepreneurs [1]. The analysis combined desk research, a survey of 53 women entrepreneurs, stakeholder interviews, and case studies. Because the survey sample is small, its findings are indicative rather than statistically representative. The primary motivations for adopting circular business models are management mindset and personal commitment to the green transition, followed by the need to reduce raw material costs and meet customer expectations for green products [1]. Notably, role models were not identified as a significant driver - a finding with direct implications for higher education pedagogy, where case-based and role-model-centred learning is widely recommended.

5.2. Priority Training Areas

The analysis identifies a rich and practically specific set of training needs directly relevant for higher education curriculum design [1]. The most important topics for training programmes covering both digital and circular transitions include:

- Understanding the role of AI in business processes
- Integrating circular economy principles into business strategy

- Process digitization and data analysis
- Developing and adopting digital and circular business models
- Learning recycling methods and testing recycled products
- Application of CE in specific sectors (food and agriculture, textiles, manufacturing)
- Legal frameworks for circular and digital transitions
- Access to finance and funding procedures
- Cybersecurity and digital marketing tools

5.3. Ecosystem and Institutional Support

The Bulgarian ecosystem for supporting women entrepreneurs includes public institutions, NGOs, business networks, accelerators, and investors [1]. However, a critical weakness is that most support is sporadic, tied to project funding cycles, and difficult to sustain after project completion [1]. Unlike project-based support organizations, universities are permanent institutional actors with continuous mandates for education and research. They are therefore structurally better positioned to provide the sustained, long-term capacity building that the Bulgarian entrepreneurial ecosystem requires.

6. Women Entrepreneurs as a Key Constituency for CE Education

6.1. Gender, Entrepreneurship, and Circular Economy

The focus on women entrepreneurs in the Bulgarian National Skills Analysis reflects a growing body of literature linking gender equity in entrepreneurship to sustainable development outcomes. Research based on Global Entrepreneurship Monitor data from 48 countries shows that women entrepreneurs are more likely than men to emphasize social value creation goals over purely economic ones [11]. In Bulgaria, women constitute 41% of company managers and 39.45% of the self-employed as of Q1 2024 [1]. They are more active than men in non-formal training participation [24] and more likely to be motivated by intrinsic values - personal commitment, green mindset, customer responsiveness. Women entrepreneurs in sectors such as fashion, food, and personal services are positioned as potential pioneers of circular business model adoption [1].

6.2. Barriers Specific to Women

Women entrepreneurs face specific barriers that generic skills development programmes are rarely designed to address. These barriers operate at multiple and intersecting levels - structural, institutional, informational, and socio-cultural - and their interaction produces a compounding effect significantly more difficult to overcome than any single obstacle in isolation [12].

- **Financial Access as a Primary Structural Barrier**

Across all methodological strands of the Bulgarian analysis, access to finance emerges as the single most significant barrier to women's circular and digital transition [1]. A 2025 UNCTAD study of women digital entrepreneurs in Africa found that nearly 70% face challenges when seeking finance due to a lack of collateral and persistent gender biases in credit assessment [13]. Globally, female-only founding teams received just 2.3% of global venture capital in 2024 - a mere $6.7 billion out of $289 billion [13]. Critically, financial barriers and educational barriers are tightly

coupled: high programme costs are cited by 22.5% of Bulgarian adults aged 25–64 as a reason for not participating in training [24], a barrier likely to weigh heavily on micro-entrepreneurs. This creates a negative feedback loop where financial constraints prevent upskilling, while insufficient skills reduce productivity and the capacity to attract investment.

- **Time Lack and the Double Burden**

Among Bulgarian adults aged 25–64, lack of free time is the most frequently cited barrier to education and training participation (36.1%), with family responsibilities cited by 10.4% [24]. Because these data are not disaggregated by sex, the gendered dimension of time poverty in Bulgaria requires further research. This 'double burden' - documented extensively in the literature on unpaid care work - is structurally embedded in gender norms that assign primary caregiving responsibilities to women regardless of their professional status [12]. The Cherie Blair Foundation's (2025) survey of 2,870 women entrepreneurs in 96 low- and middle-income countries likewise documents persistent barriers to women's digital and entrepreneurial advancement [14]. For higher education institutions, this demands courses offered in modular, asynchronous, or hybrid formats, with time demands of assessment calibrated against the realistic constraints of working mothers.

- **Knowledge Gaps and Information Asymmetry**

While most surveyed women entrepreneurs report having some awareness of CE concepts, their familiarity drops sharply for complex and systemic concepts such as Product-as-a-Service, industrial symbiosis, and regenerative business model design — consistent with Bulgarian survey evidence that enterprises tend to underestimate opportunities for more efficient resource use [15]. Compounding this, 48 of the 53 women entrepreneurs surveyed in Bulgaria are not aware of the Smart Specialization Strategy (S3) in their region, effectively excluding the majority from a key financing and partnership mechanism [1]. Universities, with deep operational knowledge of S3 frameworks, are uniquely positioned to bridge this information gap.

- **Skills Mismatches in STEM-Adjacent Domains**

Women's underrepresentation in STEM disciplines creates a structural skills mismatch that compounds their disadvantage in accessing circular economy opportunities. In the EU, women accounted for 32.8% of STEM tertiary graduates in 2021 [16] and remain under-represented among ICT specialists. Notably, however, Bulgaria is among the Member States with the highest female share of ICT specialists, at around 27% [16] — a comparatively strong base of women with digital skills on which CE-related training can build. In Bulgaria, men dominate vocational and higher education in engineering, manufacturing, and construction, while women are concentrated in education, health, and business administration [1]. The UNDP-OECD regional study on gender and the green transition (2025) frames this as a 'life-course STEM pipeline' problem, with gender stereotypes and discouraging pedagogical environments pushing girls away from STEM pathways at multiple transition points [12].

- **Cultural Barriers and Institutional Invisibility**

Currently there is no specific law, strategic instrument, or policy measure in Bulgaria designed to support women's entrepreneurship in relation to circular or digital transitions [1]. Gender equality policy is treated as a horizontal priority — present nominally across operational programmes but rarely operationalized with dedicated instruments, budget lines, or monitoring

frameworks [1]. Academic stakeholders in Varna explicitly confirmed the 'lack of specific programmes and educational initiatives in the Varna region about circular economy-related skills of women entrepreneurs' and called for more topic-related training and networking opportunities [1].

- **The Role Model Deficit**

One counterintuitive finding warrants specific attention: role models are not indicated as a driver for the application of circular practices among women entrepreneurs in Bulgaria [1]. One interpretation is that the scarcity of visible female circular economy pioneers means that role model effects are simply absent. The 'Girls Go Circular' initiative, implemented by EIT RawMaterials with the European Commission, which has trained tens of thousands of girls aged 14–19 across Europe in digital, entrepreneurial and CE skills, suggests that structured, role-model-rich educational experiences can shift girls' and women's engagement with circular economy topics [17]. The successful case documented in the Bulgarian analysis — a woman-owned biotech company producing bio-fertilizers from algae — exemplifies the kind of story that needs to be integrated into educational narratives [1].

7. Policy Recommendations for Higher Education

The convergence of empirical evidence from Bulgaria's National Skills Analysis and international literature points to a clear and actionable set of recommendations organized around four strategic priorities.

- **Recommendation 1.** Integrate CE and digital competencies across all disciplines. HEIs should move beyond siloed sustainability courses and systematically integrate CE and digital competencies across business, social science, agriculture, textile, and health programmes, using GreenComp as a curriculum mapping tool [2].
- **Recommendation 2.** Design gender-responsive, flexible delivery models. Universities should develop micro-credential programmes in CE and digital skills that are modular, asynchronous, hybrid, and competitively priced — embedded in existing entrepreneurial communities to leverage trust relationships [14].
- **Recommendation 3.** Build a role model and mentoring infrastructure. Universities should develop mentoring programmes, practitioner lecture series, and case libraries that amplify the visibility of women circular economy entrepreneurs, in partnership with organizations such as the Academy for Women Entrepreneurs and the F.A.M.E. Foundation [1].
- **Recommendation 4.** Align university research and teaching with national S3 priorities. Universities must position themselves as active translators of S3 policy frameworks for SME audiences, creating accessible knowledge products — guides, toolkits, online courses — that demystify CE funding and support mechanisms for micro-enterprise owners [1,5].

8. Discussion

The evidence assembled in this article points to a structural paradox at the heart of Bulgaria's circular economy transition: the human capital most needed — women with circular economy competencies — is precisely the human capital most often underserved by the specialised educational and informational pathways through which those competencies are developed. This

paradox is not unique to Bulgaria; it reflects a broader European and global pattern in which the green transition risks reproducing existing gender inequalities if not accompanied by deliberate, gender-responsive investment in education and skills [12].

Higher education occupies a uniquely ambivalent position in this story. On one hand, universities are among the institutions best equipped to develop interdisciplinary, systems-level competencies that circular economy transitions demand, with the permanence and pedagogical infrastructure that project-oriented support actors lack [9,10]. On the other hand, in the author's reading of the Bulgarian evidence, universities appear to have been relatively passive participants in national sustainability strategies, plausibly constrained by institutional inertia and curriculum rigidity. This interpretation is not directly tested here: the present analysis includes no systematic review of Bulgarian university curricula, and it is offered as a hypothesis for further research. The GreenComp framework, as discussed in the EPRS briefing on women in STEM, the EIT's Girls Go Circular initiative all point toward educational institutions that are proactive, flexible, gender-aware, and deeply integrated into regional innovation ecosystems [2,16,17].

9. Conclusions

This article has examined the role of higher education in advancing sustainability and circular economy transitions in Bulgaria, with particular attention to the skills gaps experienced by women entrepreneurs. Drawing on Bulgaria's 2024 National Skills Needs and Gaps Analysis [1] and triangulating it with international research from the European Commission, UNESCO, OECD, and UNCTAD, as well as with Bulgarian research, the article demonstrates that the skills divide in Bulgaria is simultaneously a circular economy challenge, a digital challenge, a gender challenge, and an educational challenge.

Women in Bulgaria display a remarkable appetite for learning and genuine commitment to circular and sustainable business practices. They are more active than men in non-formal training and more likely to be motivated by intrinsic values — personal commitment, green mindset, and customer responsiveness [1]. Yet this appetite is constrained by financial barriers, time poverty, information asymmetries, STEM under-representation, the absence of gender-sensitive policy, and a dearth of visible role models [1,12,14]. As the empirical basis rests on a single national analysis with a small survey sample, these conclusions should be tested in larger and comparative studies.

Higher education institutions have the capacity to address many of these barriers — through curriculum reform, flexible delivery, mentoring infrastructure and S3 knowledge translation.. Policymakers must urgently move beyond treating gender equality as a nominal horizontal priority and develop dedicated, funded, and monitored instruments for women's circular and digital skills development that embed higher education institutions as permanent pillars of support. The transition to a circular economy cannot succeed if it leaves a substantial share of the entrepreneurial population behind.

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