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Integrating Circular Economy and the WEF Nexus: A Structured Review of Concepts, Synergies, and Gaps

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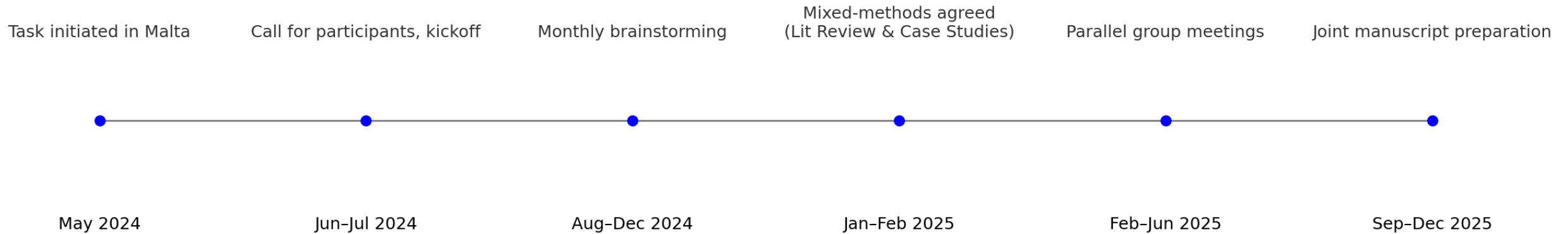
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THE WATER-ENERGY-FOOD NEXUS: BUILDING RESILIENCE TO GLOBAL CHALLENGES



Task Background & Timelines



- Task co-led by Janez and Hai-Ying
- Group 1 - Targeted literature review (Led by Janez and Hai-Ying, eight contributors).
- Group 2 - Structured case studies analysis (Led by Dimitris, 12 contributors).

Literature Review Group – Objectives

- Explore how Circular Economy (CE) and the WEF Nexus are integrated in the literature, and identify gaps, challenges, and future opportunities.

Presentation Objective

- To present the methodology, findings, and implications of the literature review on CE-WEF integration.

Methodology – Article Screening

- **Search Strategy:**

- **Databases:** Web of Science, Scopus, ScienceDirect
- **Keywords:** (“Circular Economy”) AND (“nexus”) AND (“water”) AND (“food”) AND (“energy”) AND (“integrat*” OR “synerg*” OR “intersect”*)
- **Period:** 2000–2025

- **Selection Process:**

- Articles screened: **164**
- Final sample: **57** (49 selected + 8 expert-suggested)
- **Inclusion:** CE-WEF integration, peer-reviewed, English
- **Exclusion:** Solely CE or WEF, grey literature, full books, pre-2000

Methodology – Assessment Framework

All **57 articles** were assessed based on **14 review criteria**, organized into **six thematic categories**

- **Conceptual Foundations**
 - Definitions and Conceptual Clarity
 - Rationale and Problem Framing
- **Relevance & Scope**
 - Inclusion/Exclusion Relevance
 - CE Elements Covered
 - WEF Elements Covered
- ➔ **Methodological Rigor**
 - Methodological Design and Transparency
 - Monitoring/Indicators
- **Integration Logic**
 - Conceptual Framing and Integration Logic
 - Trade-offs and Synergies
- **Impact and Innovation**
 - Sustainability Impact
 - Innovation or Contribution
 - Gaps and Challenges
- ➔ **Policy and Practical Relevance**
 - Policy and Practical Implications
 - Recommendations for Research

Key Findings from Literature Review

- Out of the 57 articles, 25 were excluded because they did not explain the relevance of CE-WEF integration or did not focus on the integration itself

Conceptual Foundation

CE is consistently defined (3R: reduce, reuse, recycle), but integration with the WEF nexus is often implicit or fragmented.

Theoretical alignment is emerging, but practical application lags behind.

Key Findings from Literature Review

Integration Rationale & Framing

Few studies clearly explain why CE-WEF integration matters.
Conceptual models and integration logic are limited.

Methods & Innovation

A range of tools is used (e.g., LCA, MFA), but methodological transparency and innovation are inconsistent.

Many studies replicate known approaches rather than proposing new ones.

Sectoral Scope

Water-energy interactions are well covered.

Food systems and cross-sector circularity are underrepresented.

Key Findings from Literature Review

Monitoring & Indicators

Most studies lack measurable indicators for CE-WEF performance.
Trade-offs and system-wide metrics are rarely assessed.

Policy & Implementation

Policy implications are often acknowledged, but guidance remains general rather than operational.

Real-world integration is hindered by fragmented governance and limited stakeholder coordination.

Conceptual grounding exists, but real progress requires integration framework, applied tools, measurable outcomes, and clearer policy roadmaps.

Visualizing CE-WEF Nexus Integration

Water-Energy-Food (WEF) nexus

1) Manages water, energy, and food as interconnected systems (**interlinkages**).

Circular Economy (CE)

1) Improves resource efficiency through the 4Rs: reduce, reuse, recycle, recover (**R strategies**)

Intersections and Synergies

- Both approaches aim for sustainability, efficiency, and waste reduction (**sustainability innovation**)
- CE enhances WEF outcomes by supporting recycling, recovery, and resilience (resilience)
- Together, they foster system thinking and enable low-impact, cross-sector solutions (system thinking)

2) Aims to use resources more efficiently and reduce conflicts across sectors (**trade-offs**)

3) Promotes integrated governance that considers ecological and social complexity (**governance**)

2) Keeps materials in use for longer to reduce waste (**resource use**)

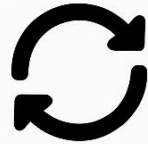
3) Focuses on regeneration and closed-loop systems (**regeneration**)

Diagram showing overlapping priorities and synergies between CE and the WEF Nexus

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Policy Documents on CE and the WEF Nexus

POLICY DOCUMENTS ADDRESSING CIRCULAR ECONOMY (CE) AND THE WATER-ENERGY-FOOD (WEF) NEXUS



CIRCULAR ECONOMY (CE)

- EU Circular Economy Action Plan (2020)
- China's Circular Economy Promotion Law (2009)
- UNEP's Global Circularity Gap Report
- OECD Policies for Circular Economy (2019)



WATER-ENERGY-FOOD (WEF) Nexus

- Bonn 2011 Nexus Conference Outcomes
- FAO's WEF Nexus Approach (since 2014)
- UN Water Reports (e.g. 2018 report)
- Nexus Regional Dialogues Programme
- SDG Framework (UN Agenda 2030)

Emerging Integration

- EU Green Deal
- National circular economy roadmaps
- National circular economy
- Urban strategies

Integrating CE strategies into the WEF Nexus: A Conceptual Framework

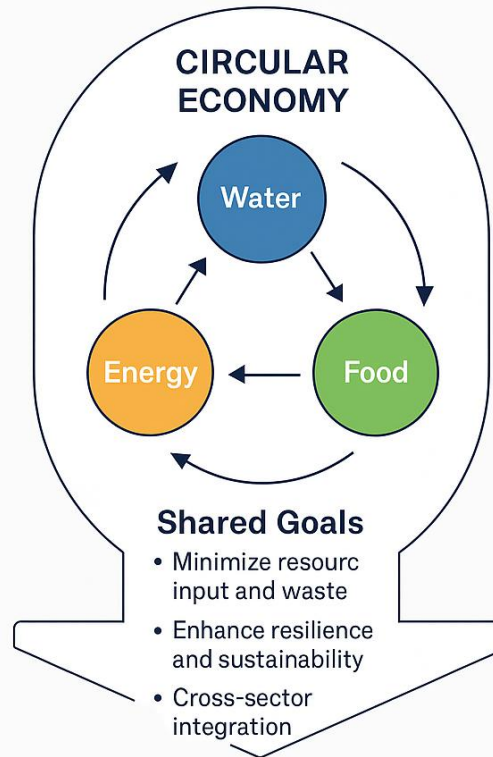
Conceptualizing the Linkages Between Circular Economy and the WEF Nexus

Core principles

- Resource efficiency via R-strategies
- Closing material loops and minimizing waste

R-strategies

(Reduce, Reuse, Recycle, Recover)



WEF Nexus

- Managing interdependencies and trade-offs among water, energy, and food systems
- Ensuring synergies and reducing conflicts among WEF sectors

Gaps and Leverage Points

- Siloed resource governance
- High food-energy-water footprint
- Lack of systemic performance indicators
- Low stakeholder alignment

Conclusions & Strategic Recommendations

- CE-WEF integration is still developing – both conceptually and practically.
- Future work should promote clear frameworks, harmonized assessment methods, and cross-sector governance models.
- **Combined insights from literature and case studies will underpin a peer-reviewed, open-access publication.**

Acknowledgements & Contributions

- This work is supported by COST Action NEXUSNET (CA20138)
- Eight contributors for literature review.
- 12 case study collaborators led by Dimitris.

Case study contribution
Dimitris Kofinas, Bahar Beigi
Sarah Milliken (food waste)
Elvis Ahmetović
Edyta Hewelke
Cevza Melek Kazezyilmaz-Alhan
Caro Mooren (helped with CS methodology), Stefania Munaretto & Josje Brouwers (We will contribute a case study from the Ultimate project - insights from practice, we could maybe do a couple of interviews with some of our case studies if interesting for the paper)
Luca Polidori
Michalis Chatzigeorgiou (treated wastewater reuse for irrigation)
Tamara Avellan (WW reuse in Central America)

Next Steps

- Finalize Introduction and Results sections.
- Integrate findings from case studies analysis.
- Prepare and submit manuscript:
“Strategic Directions for Integrating Circular Economy and the Water-Energy-Food Nexus: Conceptual Insights and Case Studies”

Thank you for your attention!