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#EU GREEN WEEK

EU Green Week Partner Event

Strengthening the WEFE Nexus through Sustainable Manufacturing: Evidence from Circular Economy Reengineering Integration

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

Introduction

Global environmental challenges
Climate change, biodiversity loss, resource depletion, and pollution
Waste projection: 2.24B tons (2020) → 3.88B tons (2050) (World Bank)

Industrial impact
Industry contributes ~23% of global GHG emissions
Linear production systems drive unsustainable waste

Business pressures
Need to reduce costs and stay competitive
Traditional growth models conflict with planetary boundaries

Aligning Lean, Green, and Sustainable practices

Lean practices (Toyota, 1950s)
Focus - Value creation by eliminating waste (muda)
Tools - Kaizen, resource efficiency, process optimization
Limitation - Operational focus; lacks environmental/social emphasis

Green practices
Focus - Reducing environmental impacts (pollution, energy use)
Tools - ISO 14001, eco-design, green supply chains
Aligns operations with environmental performance

Sustainable practices
Broader scope - Triple bottom line (economic, environmental, social)
Linked to SDGs, stakeholder engagement, long-term vision

Lean Business Practices

Core Lean principles
Value Specification – From the customer's perspective
Value Stream Mapping– Identify inefficiencies
Flow – Ensure smooth, uninterrupted processes
Pull – Produce based on actual demand
Perfection – Continuous improvement (Kaizen)

Lean Tools
VSM – Process visualization and redesign
Kaizen – Employee-driven incremental change
5S – Workplace organization
JIT – On-time resource delivery
Kanban – Visual workflow control
Poka-Yoke – Error prevention mechanisms

Green Practices in Industrial Context

Core Principles

Pollution Prevention (vs. end-of-pipe solutions)
Resource Conservation (energy, water, materials)
Life Cycle Thinking (durability, recyclability, repairability)

Tools & Standards

Environmental Management Systems (EMS)

ISO 14001: Global framework for environmental performance
Supports continuous improvement, legal compliance, stakeholder trust

Eco-Efficiency Metrics (WBCSD):

Energy Intensity – MJ/unit
Water Intensity – Liters/product
Carbon Footprint – kg CO_2-e/unit
Waste Intensity – kg/1,000 units

Analytical tools: Material Flow Analysis (MFA), LCA, EPDs

Integrated Lean–Green–Circular PDCA Model for Zero Waste

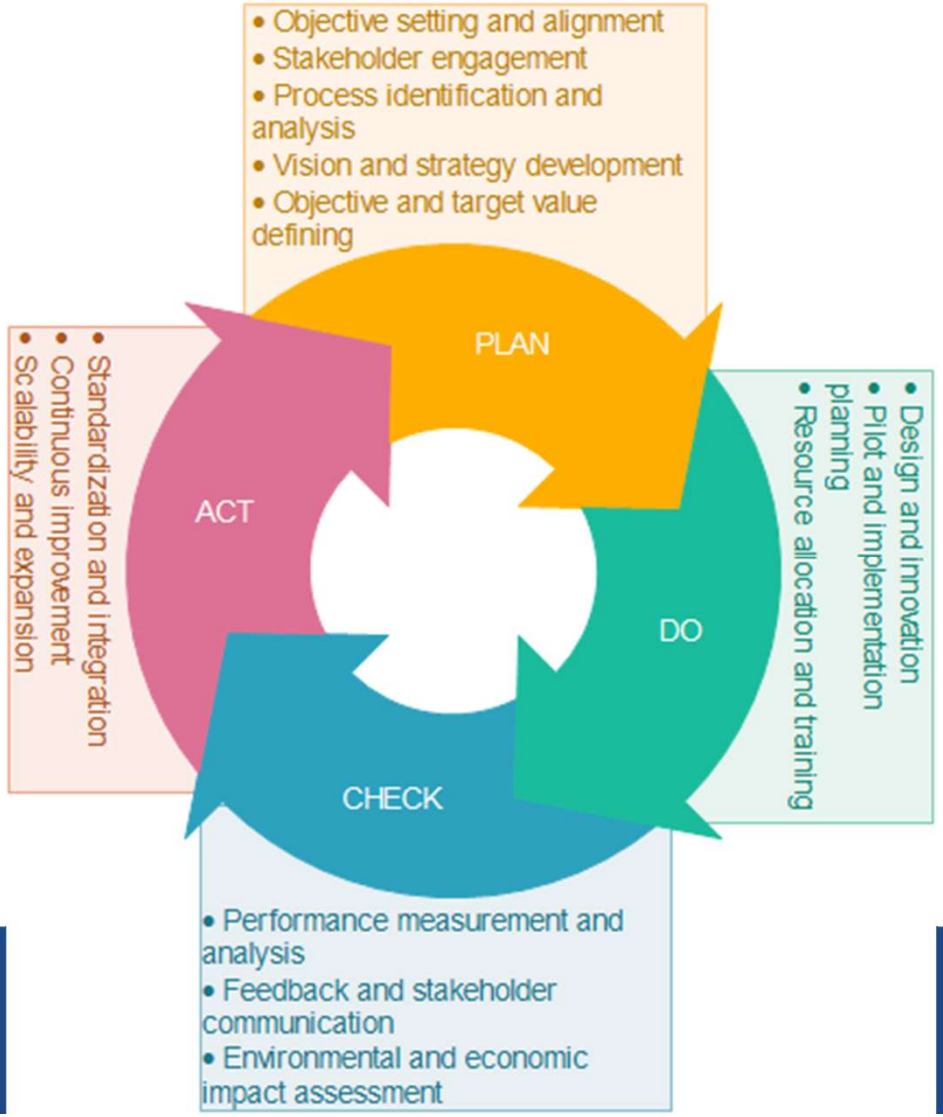
Lean layer:
Focuses on efficiency, flow, and elimination of non-value-added activities.
→ Tools: VSM, Kaizen, Kanban, 5S
→ Metrics: Lead time, inventory turnover, waste per unit produced

Green layer:
Focuses on environmental impact mitigation and resource conservation.
→ Tools: LCA, EMS (ISO 14001), carbon accounting
→ Metrics: Energy intensity, water use, emissions, hazardous waste

Circular economy layer: Focuses on lifecycle thinking and regenerative systems.
→ Strategies: Eco-design, product-service systems, secondary raw materials
→ Metrics: Material circularity index, recycling rate, reuse ratio

Sustainability outcomes layer: The synthesis of all layers to generate triple-bottom-line impacts.
→ Goals: Net-zero waste, decoupled resource use, SDG compliance
→ Instruments: Sustainability reporting (GRI), SDG impact indicators

Integrated Lean–Green–Circular PDCA Model for Zero Waste



Results

Territorial Distribution
South and East Serbia: 40%
Vojvodina: 22.2%
Sumadija and West Serbia: 22.96%
Belgrade: 14.81%

Sectors Covered
Food industry: 25.19%
Metal processing/mining: 23.70%
Wood industry: 19.26%
Other sectors: construction, rubber/chemicals, energy

Enterprise Size
Micro: 33.33%
Small: 30.37%
Medium: 19.26%
Large: 17.04%

Age of Equipment
10 years: 42.96%
5–10 years: 40%
<5 years: 17.04%

Results

ISO Certification
ISO 9001 (Quality Management): 59.26%
ISO 14001 (Environmental Management): 44.44%
None certified: 40%

Energy Sources Used:
1–2 types: 68.89%
3 types: 23.70%
4 types: 7.41%

Significant Energy Consumers:
≤5 processes: 69.63%

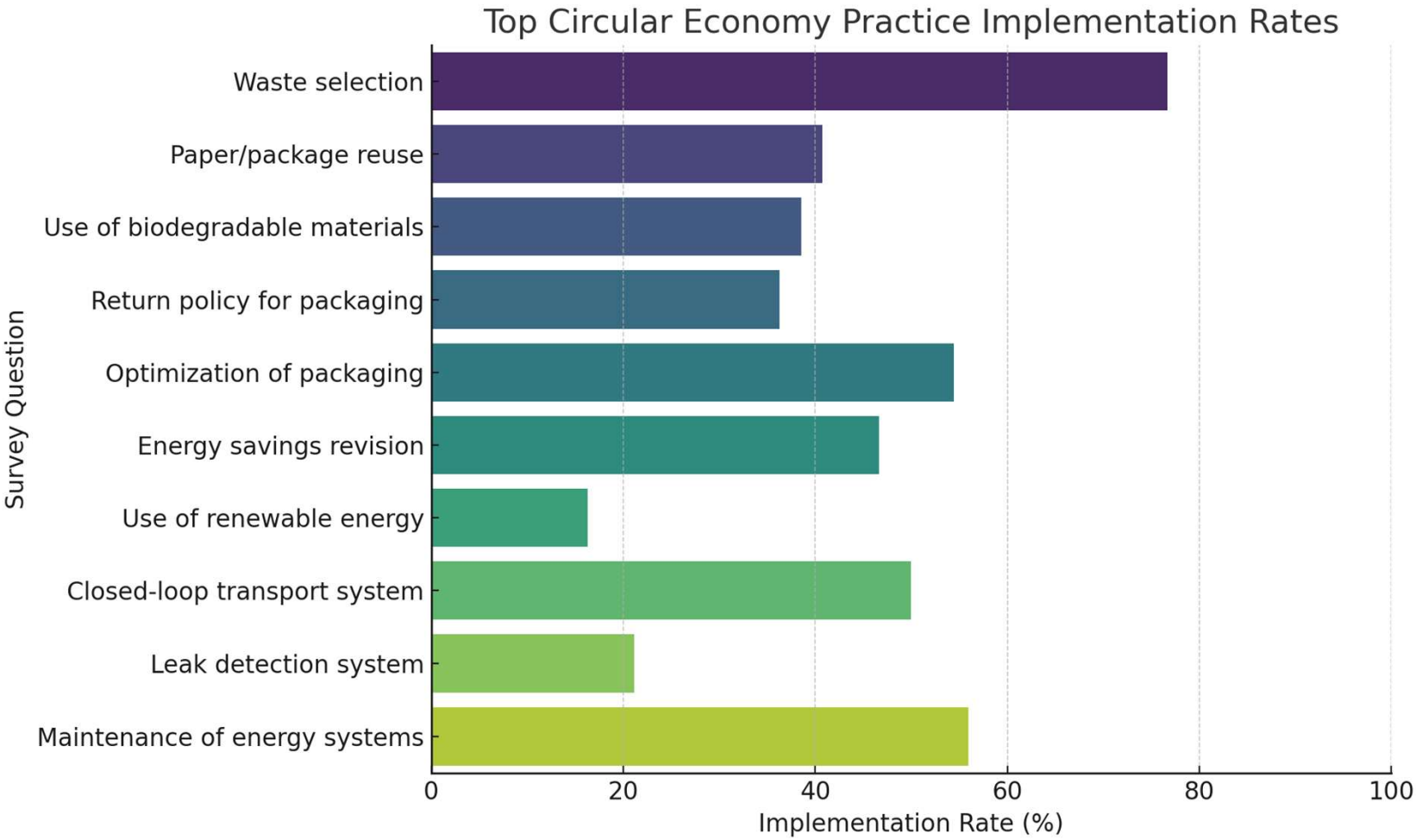
Average Annual Energy Consumption:
≤200 TJ: 27.41%
200–2,000 TJ: 34.81%
2,000–10,000 TJ: 31.11%
10,000 TJ: 6.67%

Categories with High Application Scores (Score = 2):
Waste classification and separation
Paper and packaging recycling
Water reuse and wastewater management
Energy metering and monitoring
Staff training for resource efficiency

Categories with Moderate or Low Scores (Score = 0 or 1):
Life Cycle Assessment (LCA)
Product eco-design
Use of biodegradable materials
Reverse logistics systems

Implication: While operational practices are partially implemented, strategic CE tools (LCA, eco-design, reverse flows) remain underutilized.

Results



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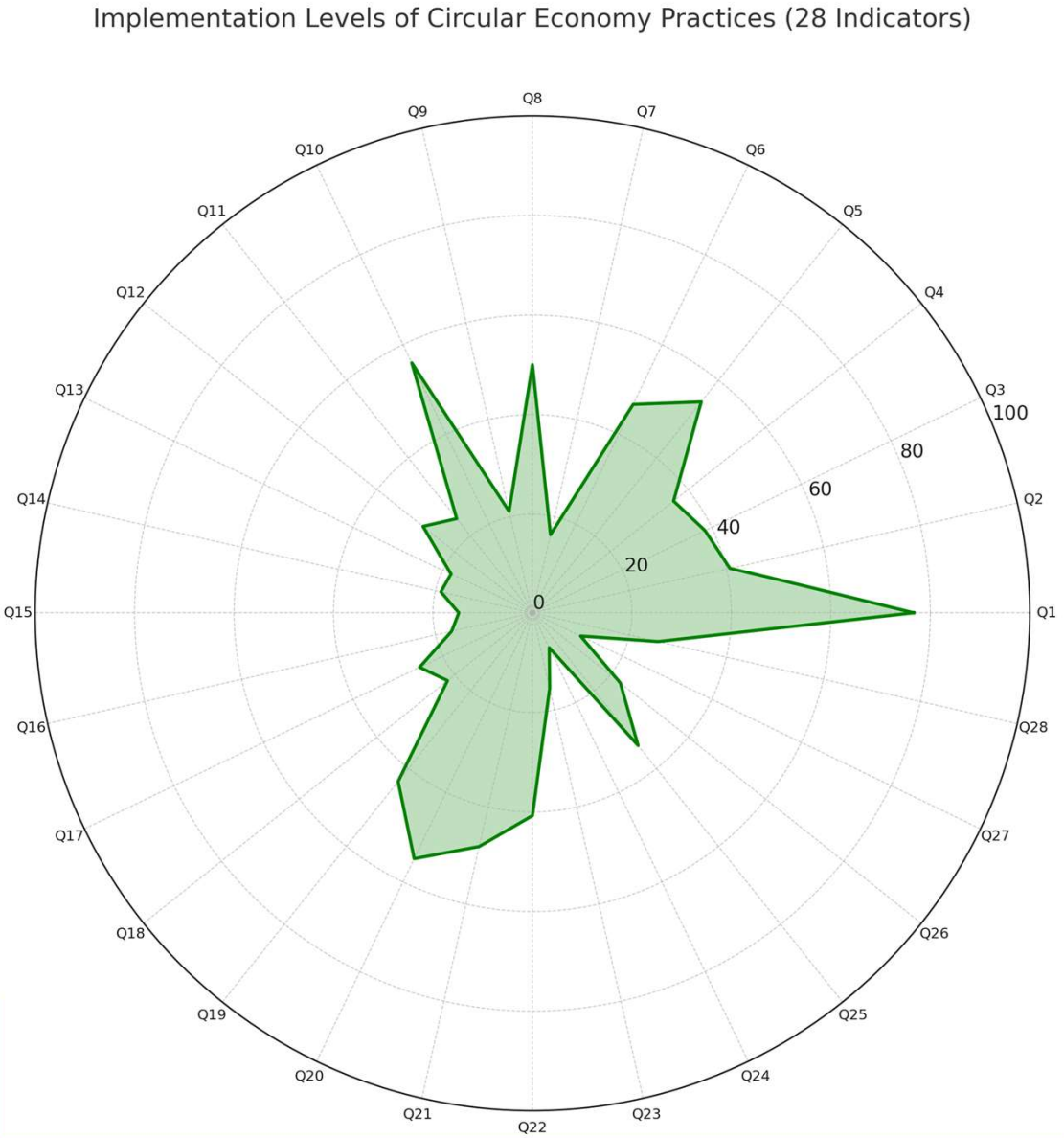
Results

Q1 (Waste Selection – 76.67%) and weak adoption in Q23–Q27 (Water reuse, LCA, renewable energy products – under 20%).

Figure: Radar chart of average implementation levels of 28 surveyed circular economy practices across Serbian manufacturing companies.



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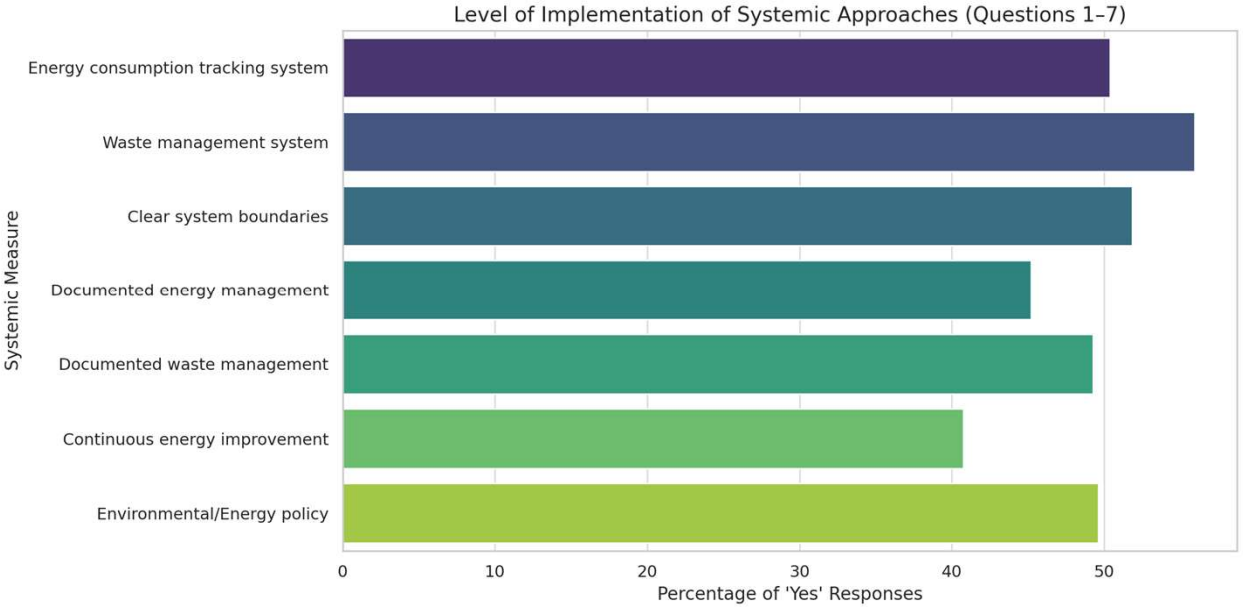
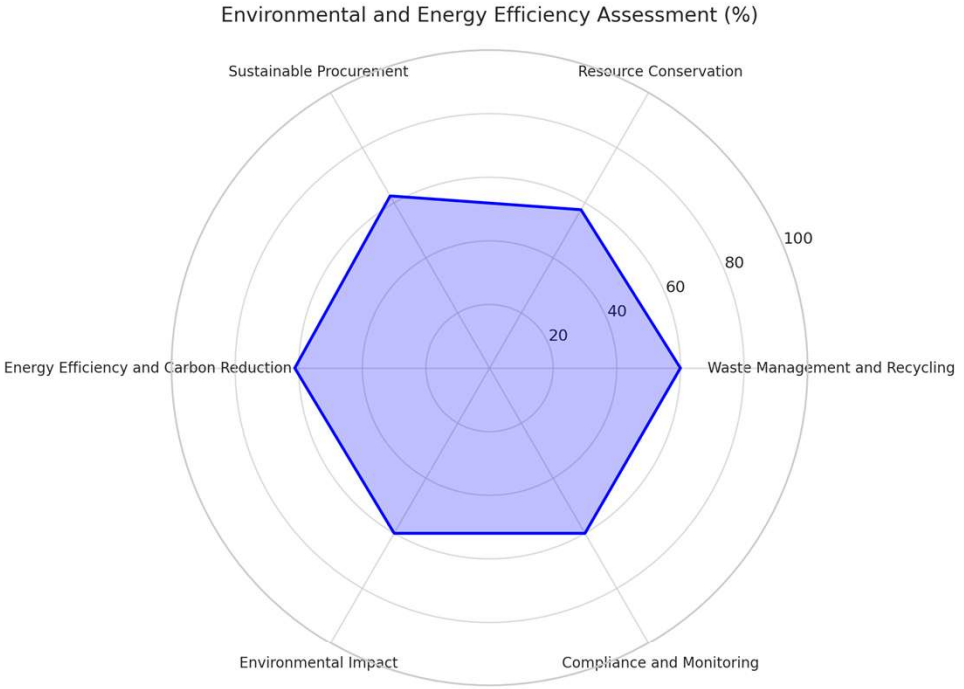
Results





CONCLUSION

The paper proposes an Integrated Lean–Green–Circular PDCA Model for Zero Waste, validated with real survey data.

The model provides companies:
Plan by setting zero waste goals and identifying hotspots via value stream mapping and eco-efficiency diagnostics.
Do by deploying cleaner technologies, lean methods (5S, Kaizen), and CE strategies (eco-design, reuse, modularity),
Check via rigorous KPIs, LCA, and ISO-aligned auditing systems,
Act by scaling successful interventions, standardizing practices, and updating metrics for continuous improvement.

Companies that will use lean-green-circular synergies are more likely to reduce risk, increase efficiency, and strengthen resilience in a decarbonizing global economy.

Thank you

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