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Circularity of Electrical Machines:
A Case Study from the UK Automotive Industry

June 2025

Matthew Lamb & Dr. Adriana Encinas-Oropesa

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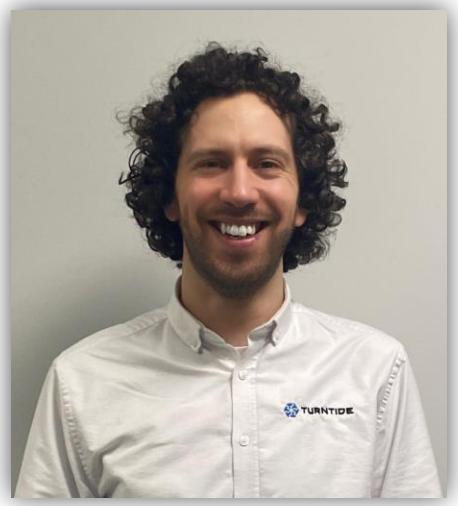
Presenters



Matthew Lamb

- Application Engineer at Turntide
- BEng Electrical and Electronic Engineering
- MSc Sustainability Business Specialist
- Research Focus: Circular Economy of Electrical Machines
- 13 Years Designing Power Electronics and Motors for the Automotive Industry

Dr. Adriana Encinas-Oropesa

- Senior Lecturer in Design and Material at Cranfield University
- MSc Industrial and Product Design
- PhD Advanced Materials
- 15 Years Evaluating Materials for Industry
- Published More Than 40 Technical Papers
- Contributed to the Development of New British Standards for Materials Testing

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Today's key topics

- Circular economy of electrical machines used in the U.K. Automotive Sector
- Review of the opportunities, drivers, barriers and potential mitigating strategies of implementing a more circular economy
- Propose a tangible circularity model for electrical machines used within the automotive industry
- Provide practical implementation strategies

Questions Arising

Why is the circular economy important now?

What are the current trends?

What solutions are there?

Circular economy models

Iterative Implementation

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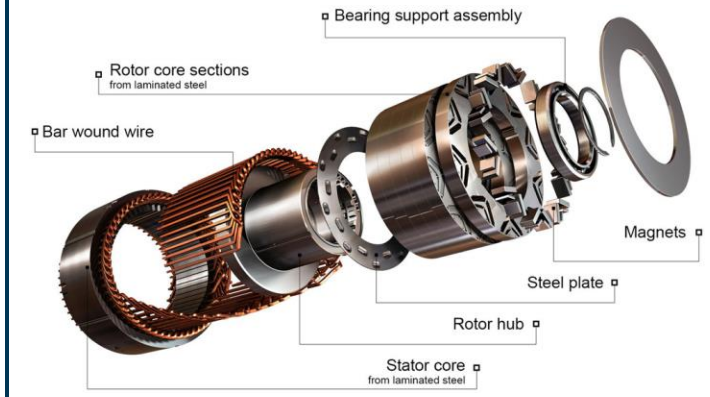
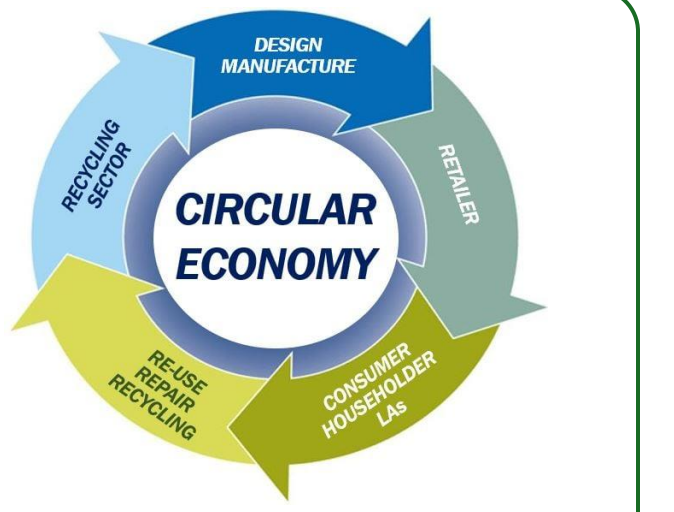
Background – Circular Economy of Electrical Machines Used in the UK Automotive Sector

Automative Industry



Electrical Machines



Circularity

- https://www.sw.siemens.com/en-US/automotive-battery-performance-engineering/
- https://www.vestbee.com/blog/articles/embracing-the-circular-economy-a-path-to-sustainable-business-transformation
- https://about-motors.com/motorcontrol/pmsm/

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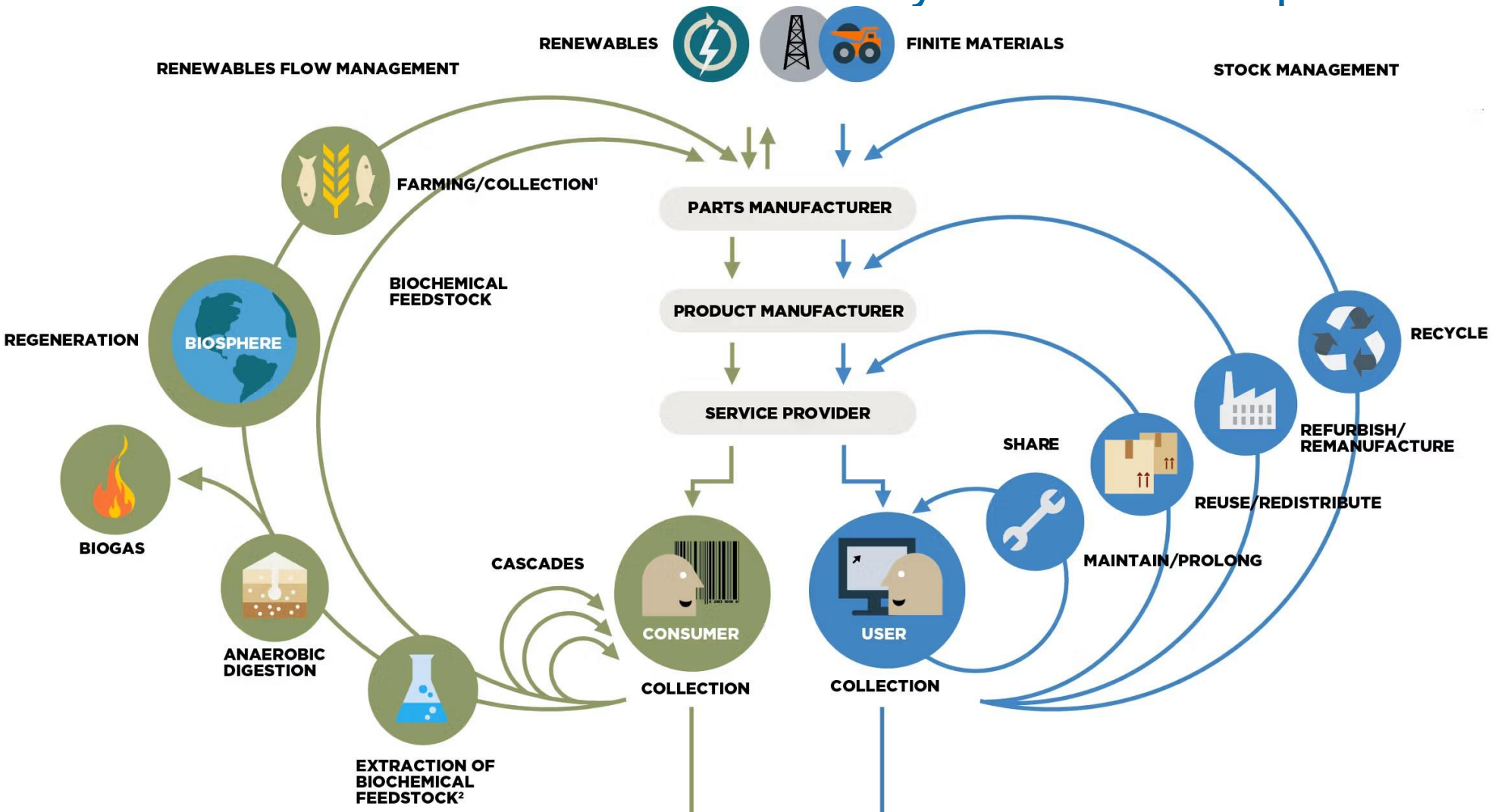
Definition of the Circular Economy – One Example



1 Hunting and fishing
2 Can take both post-harvest and post-consumer waste as an input

SOURCE
Ellen MacArthur Foundation
Circular economy systems diagram (February 2019)
www.ellenmacarthurfoundation.org
Drawing based on Braungart & McDonough, Cradle to Cradle (C2C)

ELLEN MACARTHUR FOUNDATION

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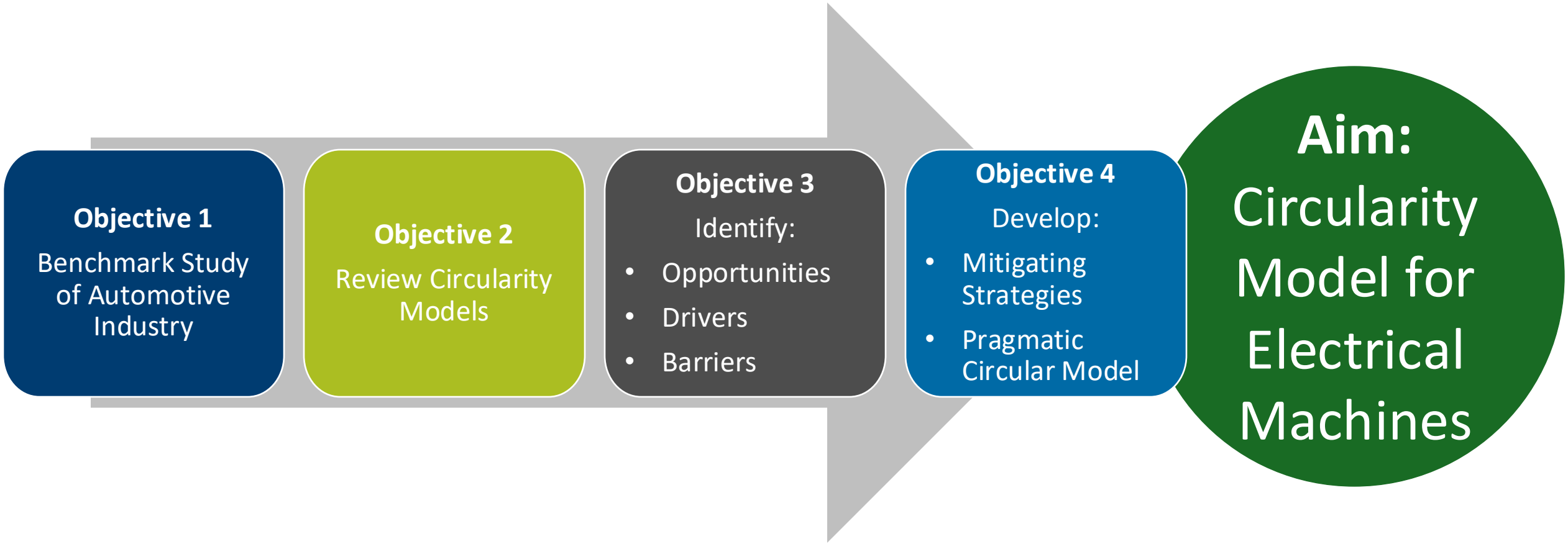
Why Now?

- Legislation (Current and Future)
- Reduce Costs / Resource Efficiency
- Supply Chain Resilience
- Increased Consumer Awareness – Marketing potential
- Reduce Environmental Impact
- Industry Transformation – Great time to implement change!
- Ownership – By industry

Research: Circularity Model for Electrical Machines Within the UK automotive sector



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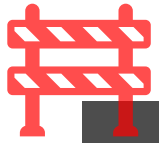
Research Findings – Questionnaire Results

Opportunities

1. **Environmental Impact**
2. **Resource Efficiency**
3. **Cost Savings**
4. Marketing
5. Regulation Compliance

Drivers

1. **Legislation**
2. **Economics**
3. Customer
4. Stakeholder Awareness
5. Design / Supply Chain / Environment



Barriers

1. **Legislation**
2. **High Costs**
3. Customer
4. Design Constraints
5. Limited Understanding

Mitigating Strategies

1. **Legislation**
2. **Education**
3. **Economics**
4. **Design for Sustainability**
5. **Collaboration**

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Research Findings – Interview Results

AUTOMOTIVE SECTOR STATUS	OPPORTUNITIES & DRIVERS	BARRIERS		ENABLING STRATEGIES & MODELS		FORESIGHT
		Culture	Ownership & Responsibility	Engineering & Manufacturing	Business	
Current Circular Strategies	Automotive Sector Transformation	Lack of Knowledge Transfer	No Incentives (Legislation)	Design for Sustainability	Education	Emerging Technologies & Processes
Current Circular Economy Status	Other Sustainability Initiatives	Lack of Collaboration	No Incentives (Financial)	Circular Models (Technical)	Collaboration	New Legislation
Current Business Model	Machine Design Simplicity	Unclear Definition of Circular Economy	Supply Chain	Manufacturing Best Practices	Business Best Practices	Increased Awareness
Complex Supply Chains	Marketing	No Incentives (customer)	No Ownership in Business Models	Engineering Best Practices	Lobby Groups	Open to Change
Lack of Enforced Policy	Resource Efficiency	Lowest-Cost Philosophy	Technical Barriers	Process Best Practices	Circular Models (Business)	Industry Searching for Knowledge & Understanding
Current U.K. Recycling Infrastructure	Potential to Reduce Costs	Throw-Away Philosophy	Lobby Groups	Waste Management Improvements	Change Management	
Current Manufacturing Processes	Reduced Environmental Impact		Decision Makers (Company HQs)		Giving Incentives (Legislative & Economical)	
	Increased Customer awareness					

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Research Findings – Key Themes and Findings

Automotive Sector Status

- Sector Transformation
- Limited Use of Circular Economy Principles

Circularity Models

- Clear, Simple Models Needed
- Capable of Explaining Details
- “Value Hill”

Barriers

- Legislation
- Economic
- Technological
- Ownership
- Cultural

Mitigating Strategies

- Design
- Education
- Collaboration
- ISO Standards

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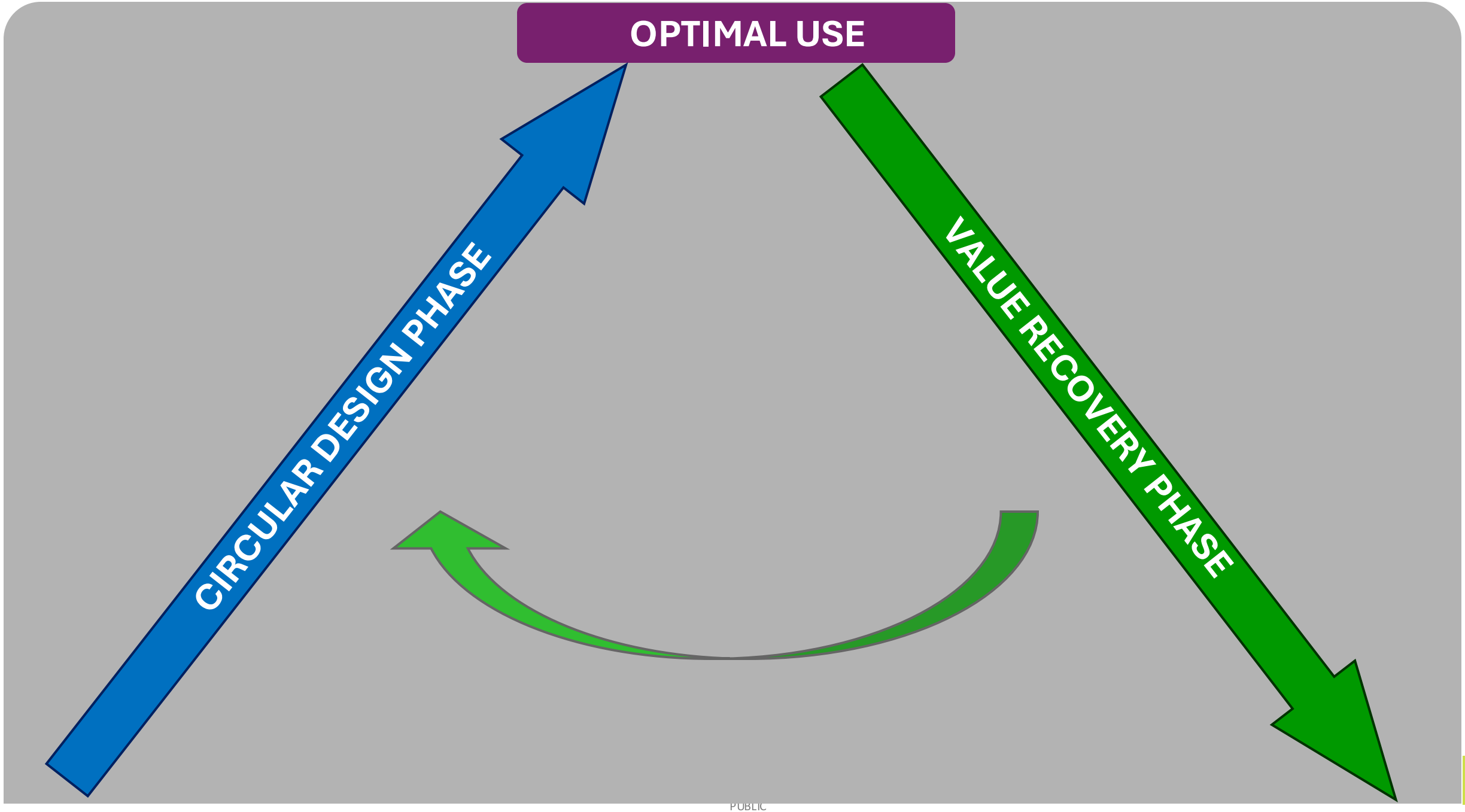
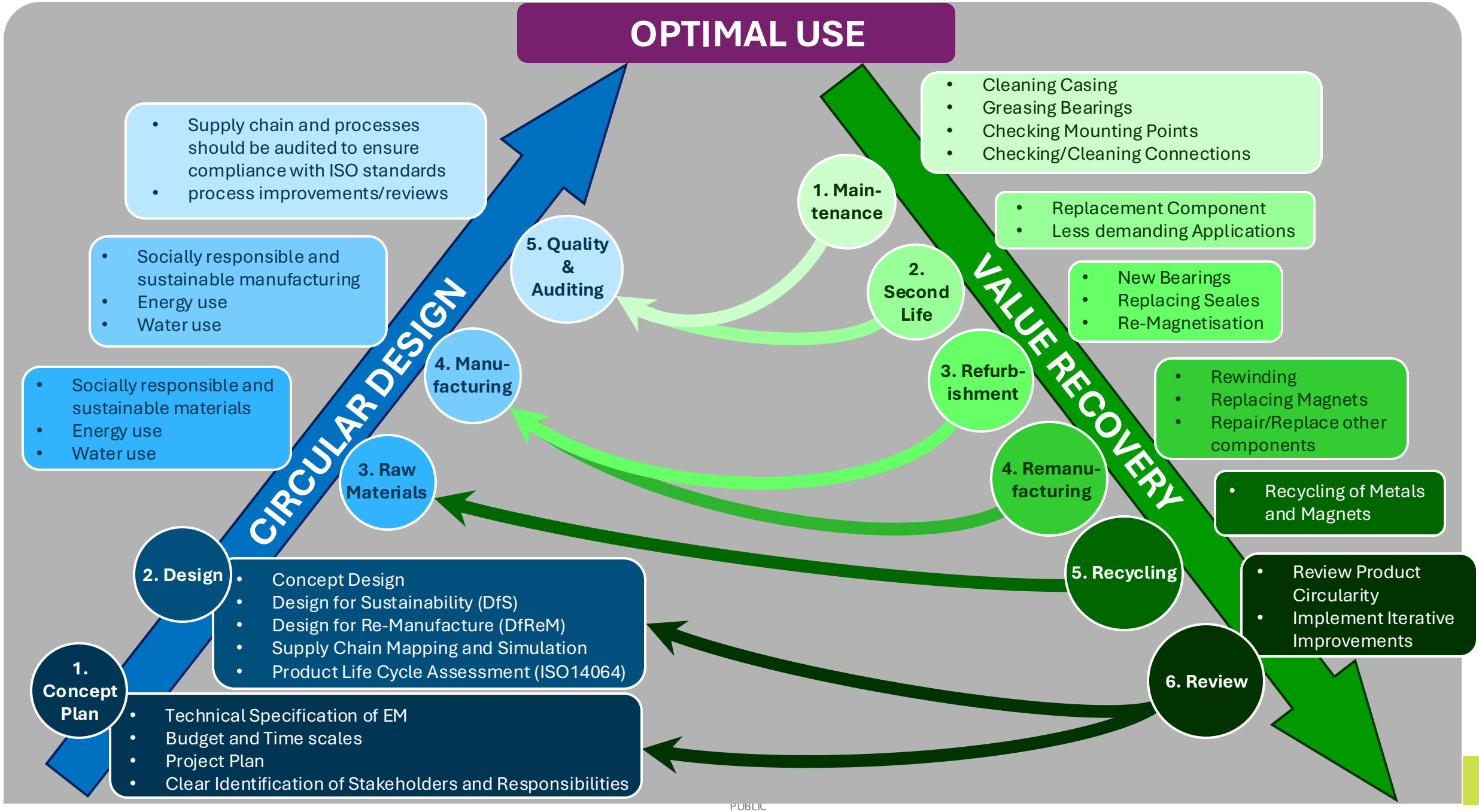

OPTIMAL USE
CIRCULAR DESIGN PHASE
VALUE RECOVERY PHASE


OPTIMAL USE
CIRCULAR DESIGN
VALUE RECOVERY
• Supply chain and processes should be audited to ensure compliance with ISO standards
• process improvements/reviews
• Socially responsible and sustainable manufacturing
• Energy use
• Water use
• Socially responsible and sustainable materials
• Energy use
• Water use
1. Concept Plan
• Technical Specification of EM
• Budget and Time scales
• Project Plan
• Clear Identification of Stakeholders and Responsibilities
2. Design
• Concept Design
• Design for Sustainability (DfS)
• Design for Re-Manufacture (DfReM)
• Supply Chain Mapping and Simulation
• Product Life Cycle Assessment (ISO14064)
3. Raw Materials
4. Manu-facturing
5. Quality & Auditing
1. Main-tenance
• Cleaning Casing
• Greasing Bearings
• Checking Mounting Points
• Checking/Cleaning Connections
2. Second Life
• Replacement Component
• Less demanding Applications
3. Refurb-ishment
• New Bearings
• Replacing Seales
• Re-Magnetisation
4. Remanu-facturing
• Rewinding
• Replacing Magnets
• Repair/Replace other components
5. Recycling
• Recycling of Metals and Magnets
6. Review
• Review Product Circularity
• Implement Iterative Improvements

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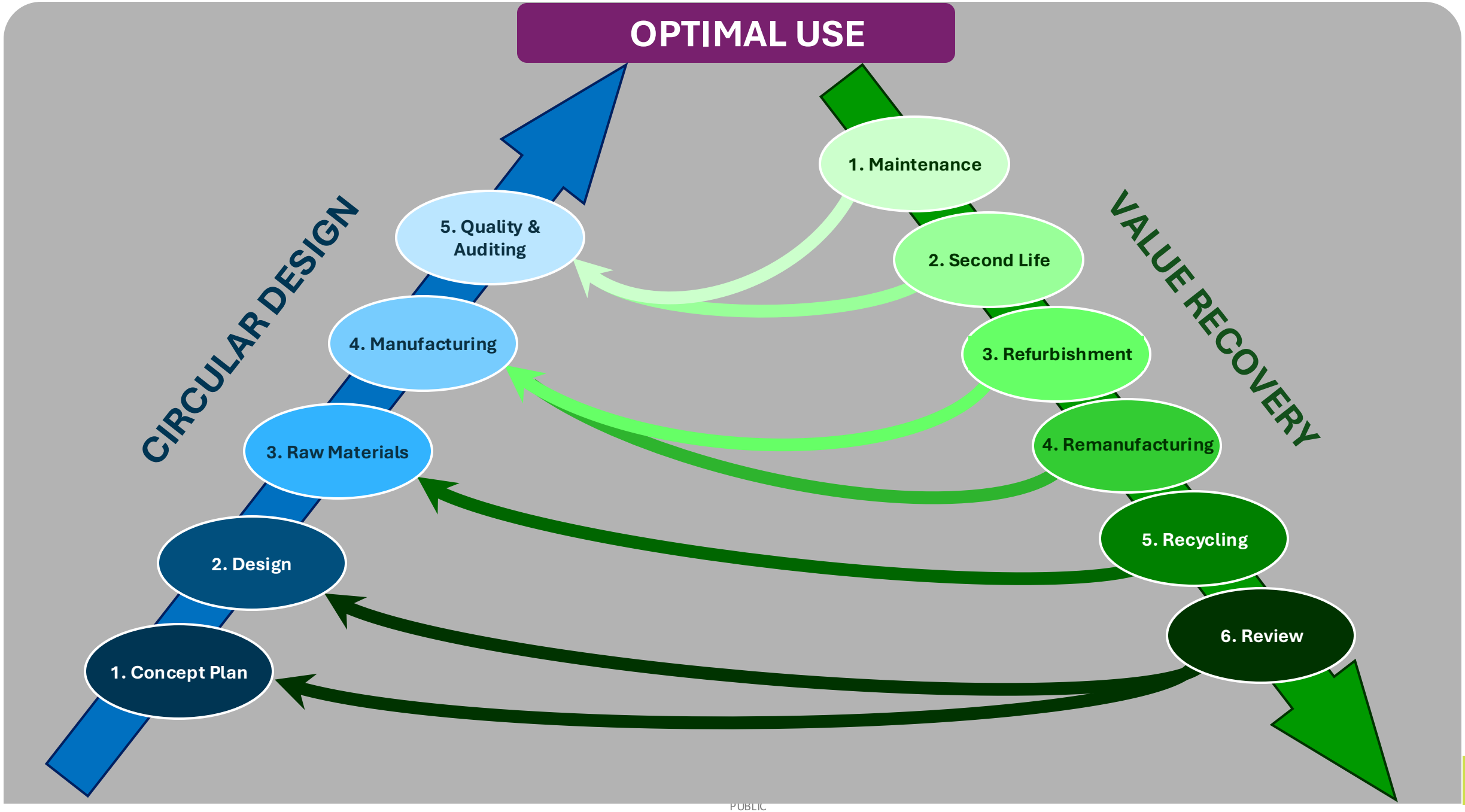
OPTIMAL USE
CIRCULAR DESIGN
VALUE RECOVERY
1. Concept Plan
2. Design
3. Raw Materials
4. Manufacturing
5. Quality & Auditing
1. Maintenance
2. Second Life
3. Refurbishment
4. Remanufacturing
5. Recycling
6. Review

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Key Points for Implementation

01 Take Ownership

- Owning the problem
- Drive/Influence change
- Create strategies
- Introduce standards
- Stakeholder motivation (operational and economical)

02 Design

- Begins with concept
- Design for circularity
- Design processes: sustainability design gates
- Manufacturing

03 Collaboration

- Work with supply chain up and down stream
- Engage with customers
- Research institutions: best practices

04 Iterative Improvement

- Don’t let perfection halt progress
- Fail fast
- Highlight successes

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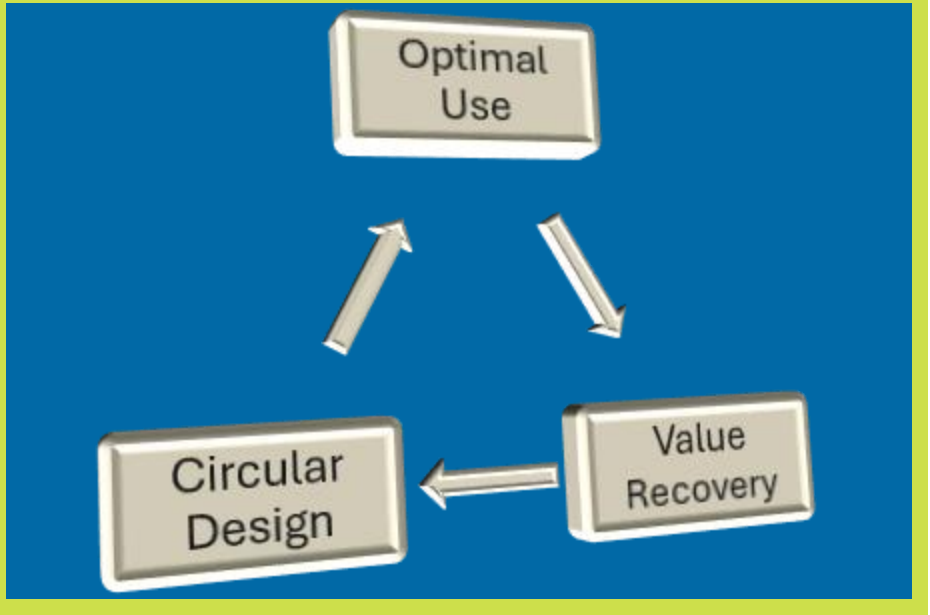
How Does the Model Help Promote Circularity?

- Circularity model tailored for electrical machines in the U.K. automotive industry
- Matches industry best practices
- Flexible and adaptable model for different motor topologies
- Simple to follow and understand
- Granularity can be condensed or expanded for different stakeholders
- Allows businesses to take ownership
- Has the potential to contribute to industry circular economy



- Three phase circularity triangle
- Starts with concept and design gates
- Focus on extending optimal use
- Adaptable to different supply chains
- Iterative implementation and improvements

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Research Summary

Automotive Industry

- Small scale use of the circular economy
- Complex supply chains
- Lack of enforced policy
- Linear manufacturing models

Circular Economy Model

- Three phase model based on “Value Hill”
- Adaptable to different motor topologies
- Simple to follow

Implementation

- Take ownership
- Start with design
- Collaborate with key stakeholders
- Make iterative improvements

Circular economy not widely used for electrical machines in the U.K. automotive industry

Dynamic industry shift towards EV is providing the opportune moment to implement industry wide change.

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Acknowledgements

- Turntide Technologies
- Cranfield University
- CWIEME

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Q&A

LinkedIn Profile:

Dame Ellen MacArthur

"If we could build an economy that would use things rather than use them up, we could build a future."

For additional questions, email: Matthew.Lamb@Turntide.com

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