UKRI Interdisciplinary Centre for Circular Metals

Brunel University London

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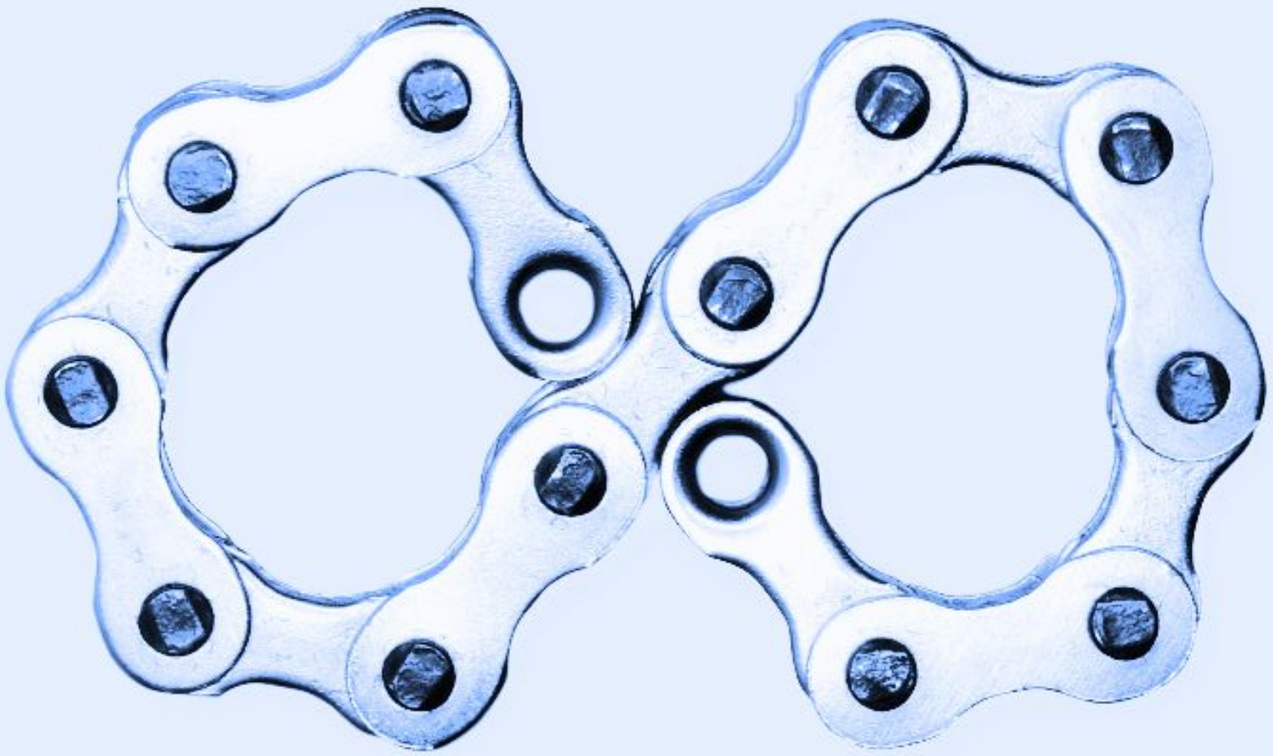
NICER PROGRAMME

UK Research and Innovation

Circular Business Model Toolkit for the Metal Sector



About this document

This document presents the Circular Business Model Toolkit, an analog tool that acts as a means of identifying and defining opportunities related to the circular metals economy. This toolkit is designed to aid our partners in visualising and planning their path towards a sustainable, circular future in metal usage. The toolkit forms part of the WP3 'Circular Business' of the UKRI Interdisciplinary Centre for the Circular Metals. The aim of the centre is to transform the metals industry and make the UK the first country in the world to have a fully circular metals system.

The work is the result of research activities that brought together leading experts from academia, industry, and government to explore how the UK could transition to a circular metal economy.

For environmental reasons, this document should not be printed because it contains numerous photographs and was originally meant to be a digital edition.

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This document was produced within the UKRI Interdisciplinary Centre for Circular Metals (Principal Investigator Prof Zhongyun Fan), as part of the activities of WP3 'Circular Business' (led by Prof Janet Godsell) and work stream WP3.1 'Circular business model innovation' (led by Dr Fabrizio Ceschin).

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PREVIOUS REPORTS

1st

2050 - Circular Metal Visions

Our initial report outlines 12 visions for a circular metal economy by 2050, supported by over 60 "snapshots from the future." These narratives and visuals illustrate potential paths forward, along with associated opportunities and challenges. This process helped stakeholders envision the desired future and develop strategies to achieve it. The report aims to identify shared goals for a circular metal economy in the UK by 2050, considering various stakeholder perspectives.

2nd

Navigating the Transition: Pathways to a Circular Metal Economy in the UK

Our second report presents roadmaps aligned with the visions from our first report. Each roadmap outlines at least three significant milestones towards achieving its vision, developed through stakeholder collaboration. These milestones, resulting from an in-person co-design session, include detailed activities and sub-objectives guiding the path to a circular metal economy by 2050. While not exhaustive, these milestones provide a comprehensive overview of actions across the metal supply chain and its ecosystem.

3rd

Circular Business Models for Metals

Our third report presents over 60 circular business models across the metal supply chain, categorized by the 12 visions from previous reports. We analyze each model's value creation and delivery, identifying key stakeholders and providing real-world examples. The report includes a framework classifying models by ecosystem levels, circular strategies, stakeholder engagement, and technological readiness. This serves as a practical guide for businesses aiming to embrace circularity in the metal supply chain.

EXECUTIVE SUMMARY

This toolkit report has been produced as part of Work Package 3 ‘Circular Business’ of the UKRI Interdisciplinary Centre for Circular Metals. Its main goal is to provide guidance on how to use the Circular Business Model toolkit developed as part of this work package. This toolkit incorporates conceptual and practical concepts that are used across 3 different stages within the workshop. The goal of the toolkit is to **generate ideas for how an organisation can contribute to a Circular Metal Economy (CME) in the future with their product-service and to focus these into a value proposition.**

A CME is one in which reuse, repair, refurbishing, and remanufacturing are prioritised over the recycling of metals. Metal recycling is essential for recovering the value of metals in a CME, but it should not be the primary focus. Instead, products and materials should be designed so that they can be reused with minimal value loss and without generating hazardous emissions. The 12 visions presented in this progress report are based on research involving a wide range of stakeholders, including businesses, governmental organisations, NGOs, policymakers, and scholars from several academic fields.

This document is for those looking to explore circular metal opportunities within their organisation. It provides a format for external consultancies or studios to use for client work, or for internal teams to explore ideas for their own companies.

CONTENTS

INTRODUCTION

The Opportunity
As discussed in the first report, *2050 - Circular Metal Visions*, the benefits of a circular metal economy can be summarised with 5 key highlights: reduced reliance on imported metals, reduced environmental impact, improved economic security and resilience, improved resource efficiency, and boosted innovation through cooperation. The research has been aligned with the UK's target of net zero greenhouse emissions by 2050.

Research Methodology and Co-Design Workshops - The foundation of this toolkit lies in the extensive research conducted throughout 2022/23, which involved collaborations with a broad spectrum of stakeholders in the metal supply chain. Together with stakeholders, 12 visions were conceptualised based upon the preferred future of a circular metal economy. Under these visions there examples of solutions to help achieve them.

List of Key Terms:

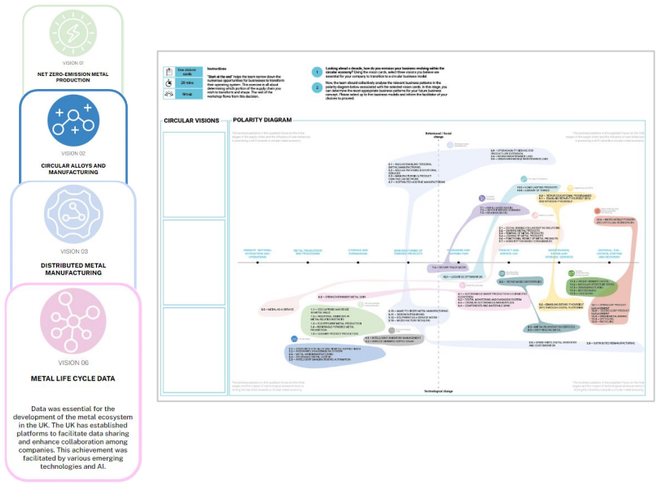
Circular Economy: (CE): Refers to an economic system where waste and pollution are designed out, and resources are kept in use for as long as possible.

Circular Design: (CD): Refers to a design approach that is sensitive to Circular Economy principles and is built upon strategies including designing things that use fewer resources, last longer, can be easily reused, and that regenerate nature.

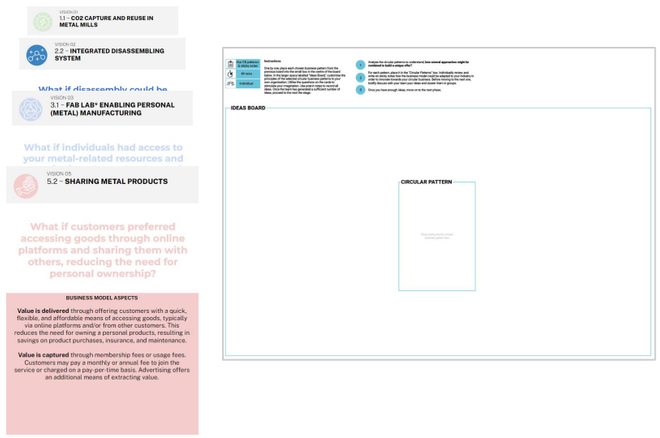
Circular Visions: A set of 12 concepts, each addressing a different part of the metal value chain, and together forming a picture of how full metal circulation can be achieved in the future.

Circular Business Opportunity: Generalised solutions that can address a problem in a given context which can be used to create circular business models .

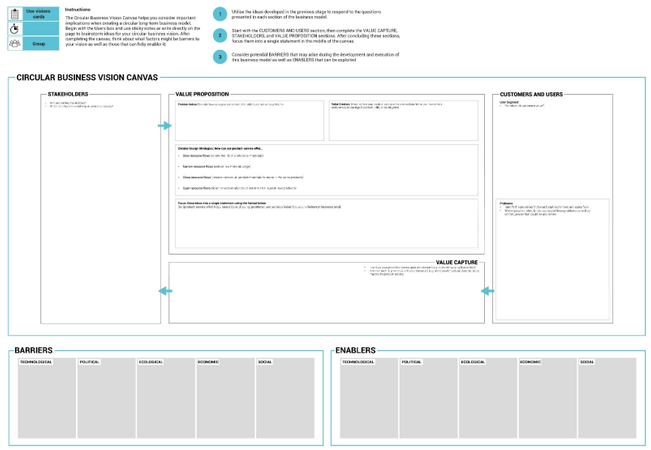
STAGE 1 | **STAGE 2** | **STAGE 3**



1. Narrow your focus through Vision Cards.
2. Select circular business opportunities through the polarity diagram.



1. Collaboratively brainstorm, select and prioritise ideas.



1. Define your circular business concept.
2. Identify implementation barriers.
3. Define your value proposition

Overview of the Circular Business Model Toolkit

The toolkit comprises a workshop framework set across 3 stages and supported by 5 resources.

The 3 workshop stages:

1. **Visions**
   Participants will select 3 Visions and 5 Business Patterns that they believe will have the most long-term impact on their business.
2. **Opportunities**
   Participants will discuss how each of their chosen Opportunities can contribute towards a Business Model.
3. **Business Model Canvas**
   Participants will explore various aspects of the business model and fill in sections including value proposition, value capture, and stakeholders.

The 5 printed resources

1A. Workshop Stage 1 Template
Key information about the workshop with a polarity diagram showing where visions and business patterns lie on the metals supply chain in relation to required technological and social changes

1B. Circular Vision Cards
12 cards, each highlighting a possible future vision of the Metal Circular Economy

2A. Workshop Stage 2 Template
Key information about the workshop

2B. Circular Business Opportunity Cards
61 cards, each highlighting a possible pattern within a vision

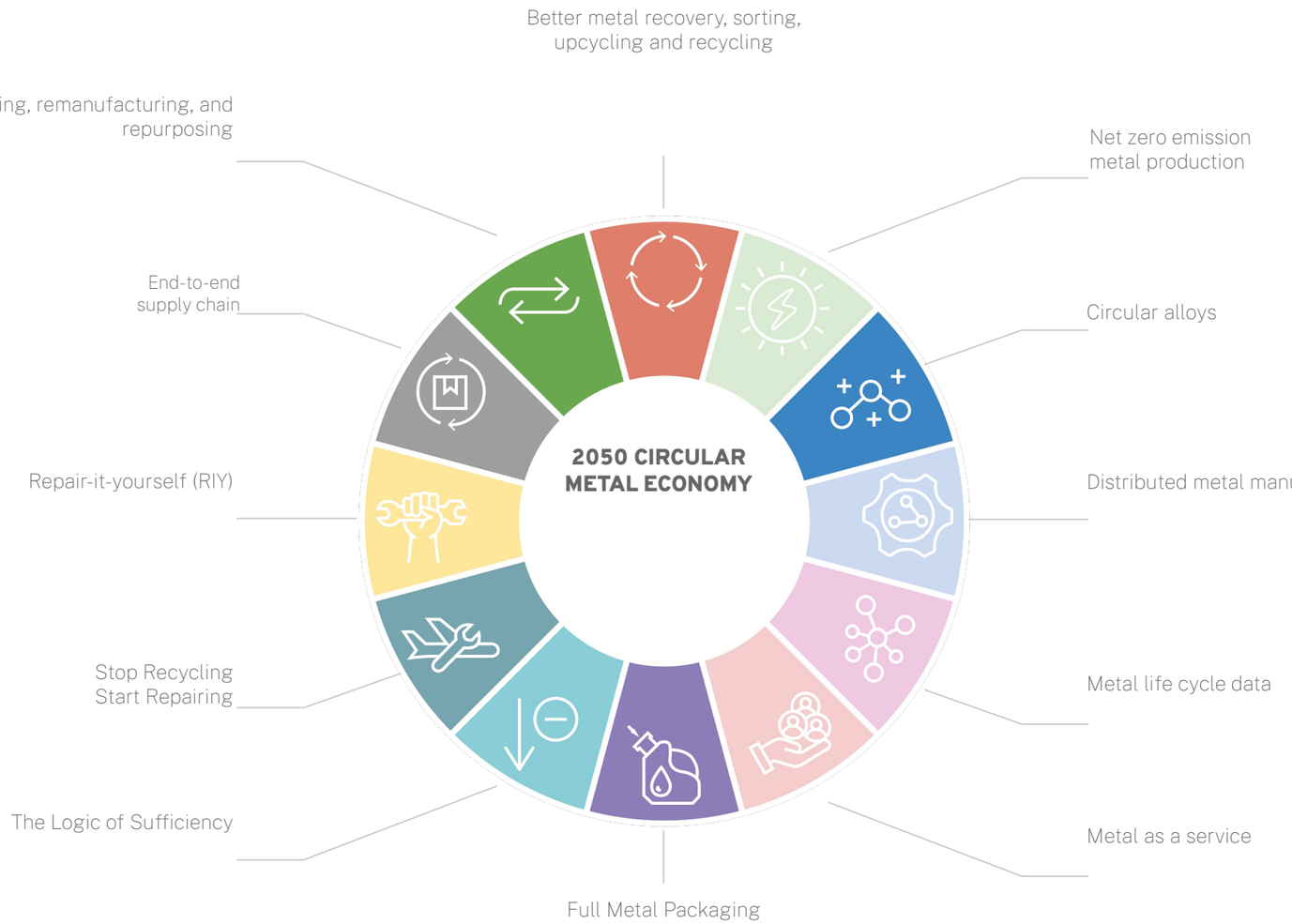
3A. Workshop Stage 3 Template
Key information about the workshop and the Circular Business Vision Canvas that guide participants towards a value proposition

FRAMEWORK FOR A CIRCULAR METAL ECONOMY

To help the participants get a handle on the material at hand, we've organised the previously specified visions into a framework.

The framework can be used to better understand the interrelations and the different pathways that can be used to achieve a circular metal economy.

Each vision is described in detail on the following page.



Net zero emission metal production

Today, all processes related to metal production release zero greenhouse emissions. This has been made possible by advances in renewable energy, energy storage, and process efficiency.

Circular alloys

Today, the UK has one of the most efficient metal closed loop systems worldwide. This has been made feasible by the implementation of rationalisation of usable alloys regulations, a new generation of more “circular” alloys, innovative fabrication processes, and improved metal application. Technology innovation has helped boost efficiency and production.

Distributed metal manufacturing

Numerous small and medium-sized businesses manufacture, repair, and distribute their goods in both urban and rural locations. These new local economies are supported by Fablabs and smart manufacturing systems, which provide innovative and tailored services for their customers.

Metal life cycle data

The UK created an open metal data system to increase the circularity of metals. This was made possible via MetalBlockchain's digital passports. The level of openness and data transparency is greater than ever before. All sensitive data relating to stakeholders is protected and only provided to secure parties.

Metal as a service

The UK is a world leader in metal as a service. A government "Department for Metal Services" licences metal molecules from metals and mining companies to UK materials firms. Companies sell metal components and goods as-a-service. Due to tracking technologies and product automation, B2C enterprises have adopted product sharing.

Full Metal Packaging

Metal packaging is recognized as an excellent material for preserving food quality and prolonging shelf life. Today, the majority of packaging is intended to be reused numerous times before being recycled. In this new paradigm, companies and/or customers keep ownership and responsibility over the packaging life cycle.

The Logic of Sufficiency

Today, individuals are more aware of the ethical implications of overconsumption and embrace a sufficiency economy. Sustainable consumption is being pushed by initiatives like MyMetal, which limits the amount of metal any individual can own, and open libraries of things, which let users borrow items instead of buying them.

Stop Recycling Start Repairing

Today's economy relies on repair. Metal Health Service provides new maintenance/repair services for metal products and components (MHS). This includes component and structure rejuvenation and metal day hospital. Metals are more robust and can self-heal cracks thanks to innovative alloys.

Repair-it-yourself (RIY)

Today's consumers own fewer, higher-quality items. Reuse and repair have replaced waste. Maintenance and repair are widespread knowledge thanks to educational courses. Repair community centres teach and share innovative repair methodologies. Users and small entrepreneurs can fix products using repair kits and new technology.

End-to-end supply chain

With the use of intelligent assets, the circular supply chain has radically altered the traditional constrained and silos system. The modern end-to-end suppl y chain encompasses all the aspects of a product lifetime. This is a fully integrated and automated system that allows for real-time monitoring and execution of all supply chain processes

Reusing, remanufacturing, and repurposing

In 2050, the UK is a world leader in reusing, remanufacturing, and repurposing products. The UK government has supported a radical shift in pace, encouraging the reuse of goods rather than the production of raw resources through a vast infrastructure adjustment. Consumers are educated on the benefits of buying products that are made to last or be repurposed.

Better metal recovery, sorting, upcycling and recycling

Successful firms reuse products, components, and materials. Most businesses employ open or closed distributed disassembly to reuse components. If the product and its components can't be reused, material recovery becomes vital. Material is recycled through industrial upcycling, efficient waste management, and landfill scavenging.

Planning
After deciding to run the workshop, key decision-makers should meet to agree on the scope (which parts of the business model and products are under review, and in which markets) and any key objectives that should be kept in mind. These could be pre-existing objectives or new ones could be developed for the purposes of the project. The scope should be phrased as a question, for example “How might we use metal packaging to provide circular solutions specifically tailored to the UK hotel industry” or “How can we ensure that our UK customers have the ability to repair and keep using our products.”

Scheduling
A standard length workshop will need a full day to run. Depending on business needs, it should be decided well in advance who should attend the workshop so as to ensure availability.
Outcomes should be reviewed following the workshops and actions such as further developing any concepts of interest should be planned.

Facilitation
Effectively facilitating a workshop requires practice and preparation. Internal staff can run the workshop if sufficient time is dedicated to it, but if there is nobody available, confident or comfortable to do this, it is recommended that a design professional with facilitation experience be brought in.
The facilitator needs to ensure there is clarity going into the workshop around goals and objectives and guide the participants through each stage, offering up key prompts to stimulate ideas. The participants are the experts of the business, however, and as such they should lead the direction of ideas and discussions. The facilitator also needs to ensure that outcomes are communicated following the workshop.

Background Knowledge
It is not necessary for participants to have specific knowledge of the Circular Economy or Circular Design prior to this work. However, in the run-up to the workshop the Workshop Preparation page should be circulated and understood. This content can also be reiterated at the beginning of the workshop day in the introductory presentation.

Participants
The intention of the workshop is to identify opportunities to integrate Circular Economy principles into the business by taking a holistic view of the areas of the business that relate to the metals value chain. As such, operations and supply chain staff should join with product teams and commercial staff. Representatives from account management and sales teams should also join to ensure the voice of the customer is present. Additionally, a customer or client representative can join if appropriate.
The participants should be divided up into groups of 3-4 ahead of time to ensure each group has different roles and skills represented.

Timing
The guide on the following pages is based on a workshop lasting 3 hours, preceded by a 20-30 minute presentation. In total, it is a good idea to allocate 4 hours in total.
Group numbers should be kept to 3-4 participants per group. If larger groups are used, additional time should be allocated, especially for Stage 2.

Location
The location should be a space large enough for the number of people. Each group should be able to sit around a table (or two tables pushed together) so that the posters for each stage can lie flat on them. There should be sufficient space between groups to lower distractions and allow facilitators to move around the room.
In the same room, or in a different room, there should be space as well as some sort of projector/ TV for the introductory presentation.
Ideally choose a room that has the option of plenty of natural light.

Materials
The facilitators should provide the following:
- Workshop assets
    - 3 x A1 Posters (1 set per group)
    - 12 x A6 Visions Cards (1 set per group)
    - 61 x A5 Business Opportunity Cards (1 set per group)
- Black markers (min 1 per participant)
- Back Ball-Point Pens (2 per group)
- Standard Yellow Sticky Notes, 76x76mm (min 30 per person)
- Name Labels (1 per person, so everyone including facilitators can wear their name badge)

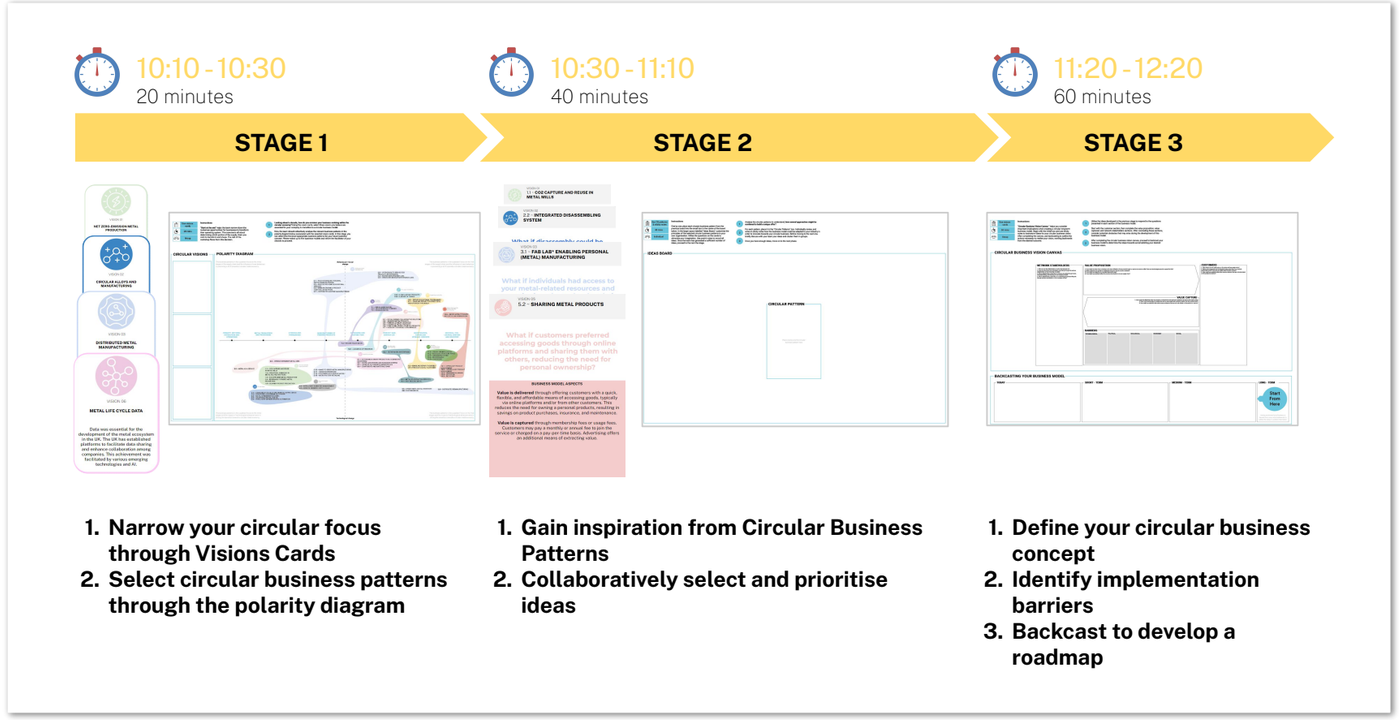
Introductory Presentation
A presentation that kicks off the workshop should be created. More information on this can be found on the next page.

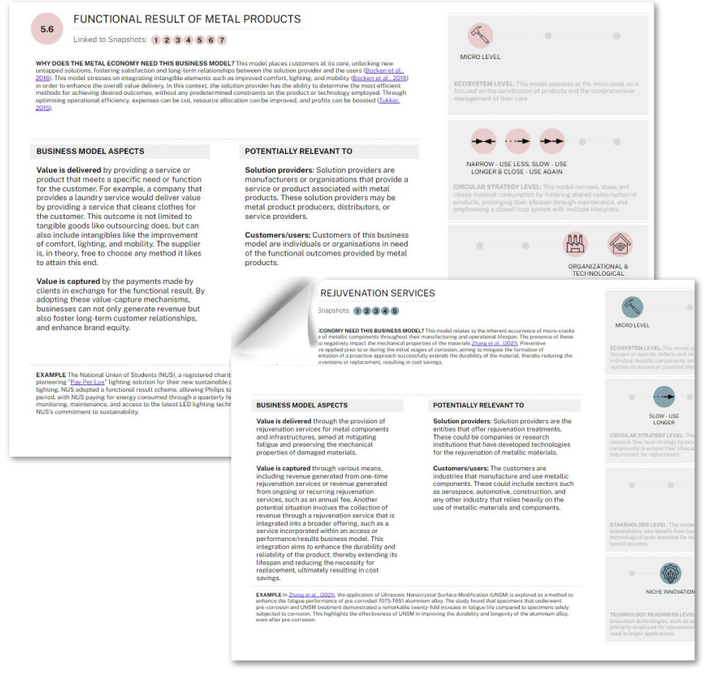
The introductory presentation is a chance to prepare the attendees for the workshops ahead. This should be tailored to the people present, and should include the following:

- Introduction to each of the facilitators
- Outline key objectives - these should have been communicated prior to the session and as such should not be a surprise to anyone
- A reminder of what the business area/ focus is for the workshop. This will have been decided beforehand
- An overview of the workshop format, highlighting each stage
- An introduction to the Visions
- An explanation of the Circular Business Opportunities and how they can inform a business model
- Divide the participants into preselected groups
- Run a 5 minute icebreaker/ energiser to help set the tone before the first stage of the workshop and introduce themselves and their roles

Example Energiser
Group Stretch

Go around the group and have each person introduce themselves with their name, their role, and a group stretch which they feel embodies their role (and explain why!).
Example: Health and Safety Manager touches toes to check suitable footwear is being worn, or the graphic designer does a wrist stretch because of so much keyboard and mouse time





Objectives

At the conclusion of this workshop stage, each group should have selected

1. 3 visions (from the **Vision Cards**) that they believe are essential for their company/organisation to transition to a circular business model.
2. 3-5 Circular Business Opportunities (from the **Business Opportunity Cards**)

Detail

- Begin by dividing attendees into the preselected groups of 3-4 and spend **15 minutes** reading through the vision cards and selecting **3** of them
- Once the 3 Vision Cards have been selected, take **15 minutes** to select a total of **5 Business Opportunity Cards**
- The **Business Opportunity Cards** should cover all 3 of the chosen **Visions**. For example, if the Visions chosen are 1, 3, and 6, then the group could choose Opportunity Cards 1.2, 3.1, 3.2, 6.1, and 6.2.

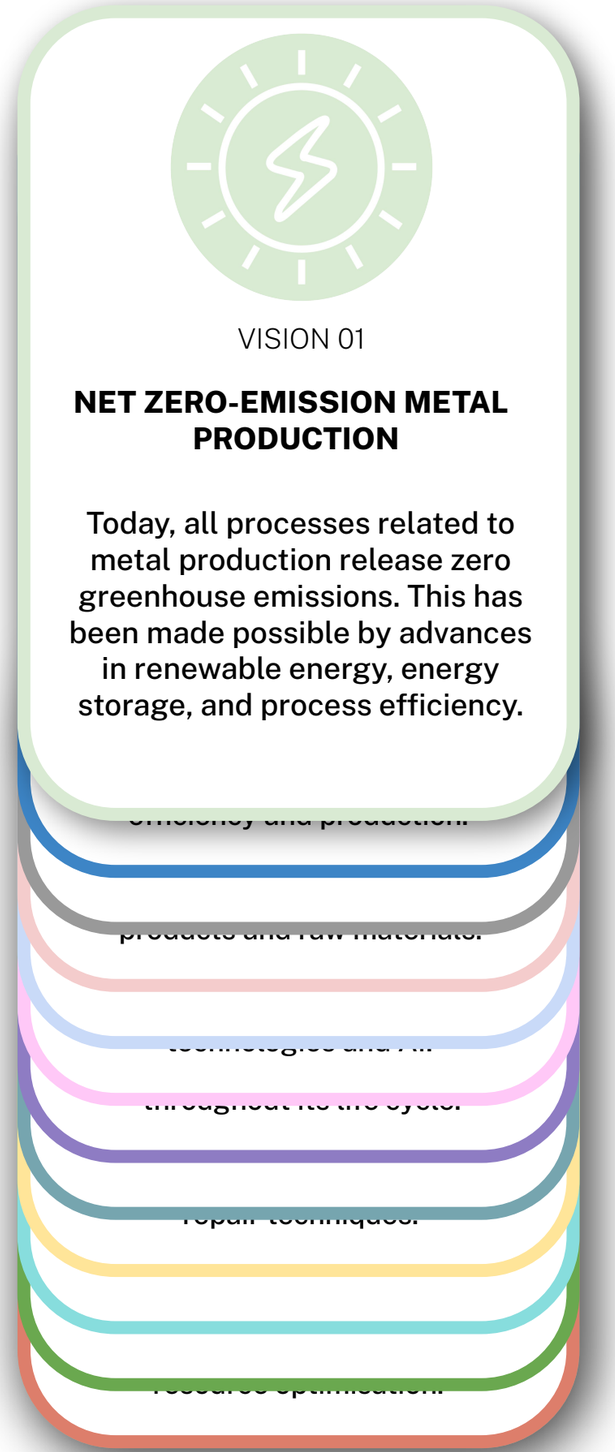
Key Questions

To help achieve each objective, there are helpful prompts to give

1. Looking ahead a decade, how do you envision your business evolving within the circular economy?
2. What might be the most appropriate **business opportunities**, and in turn **business models**, for your future business concept?

Notes

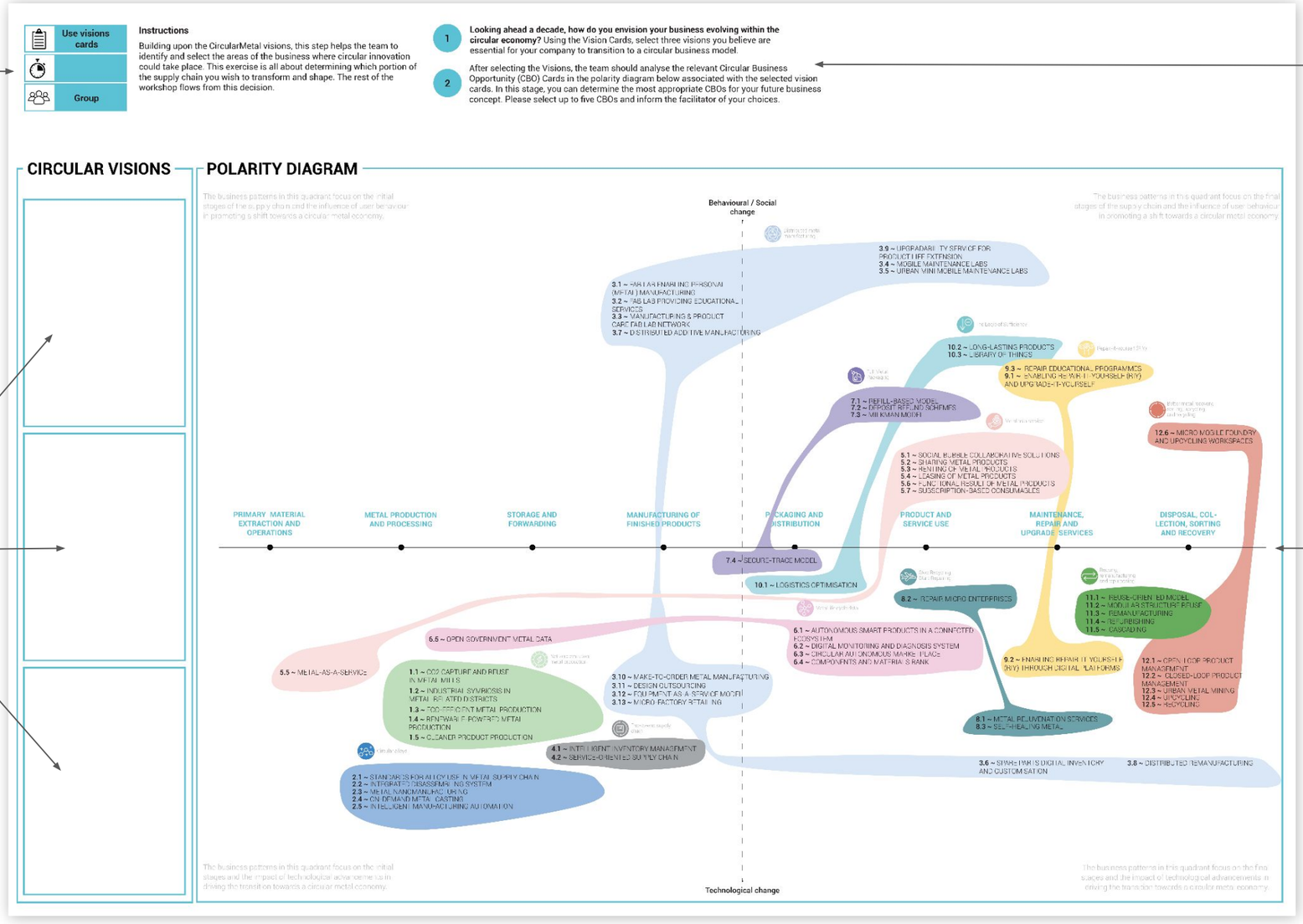
- As the selections are being made, look at the **Polarity Diagram** and see how the choices are spread or clustered across the metal value chain axis, as well as across the behavioural/ technological change axis. This will help with identifying Barriers and Enablers in Phase 3, the Business Model Canvas.
- The reverse of each card lists barriers to the vision, which will be important to note in Stage 3 of the workshop



Resource 1A: Workshop 1 Template with Polarity Diagram
The Workshop Template includes a key summary and prompts for the workshop, as well as the **Polarity Diagram** and spaces for the 3 selected **Vision Cards**

Recap of key workshop information

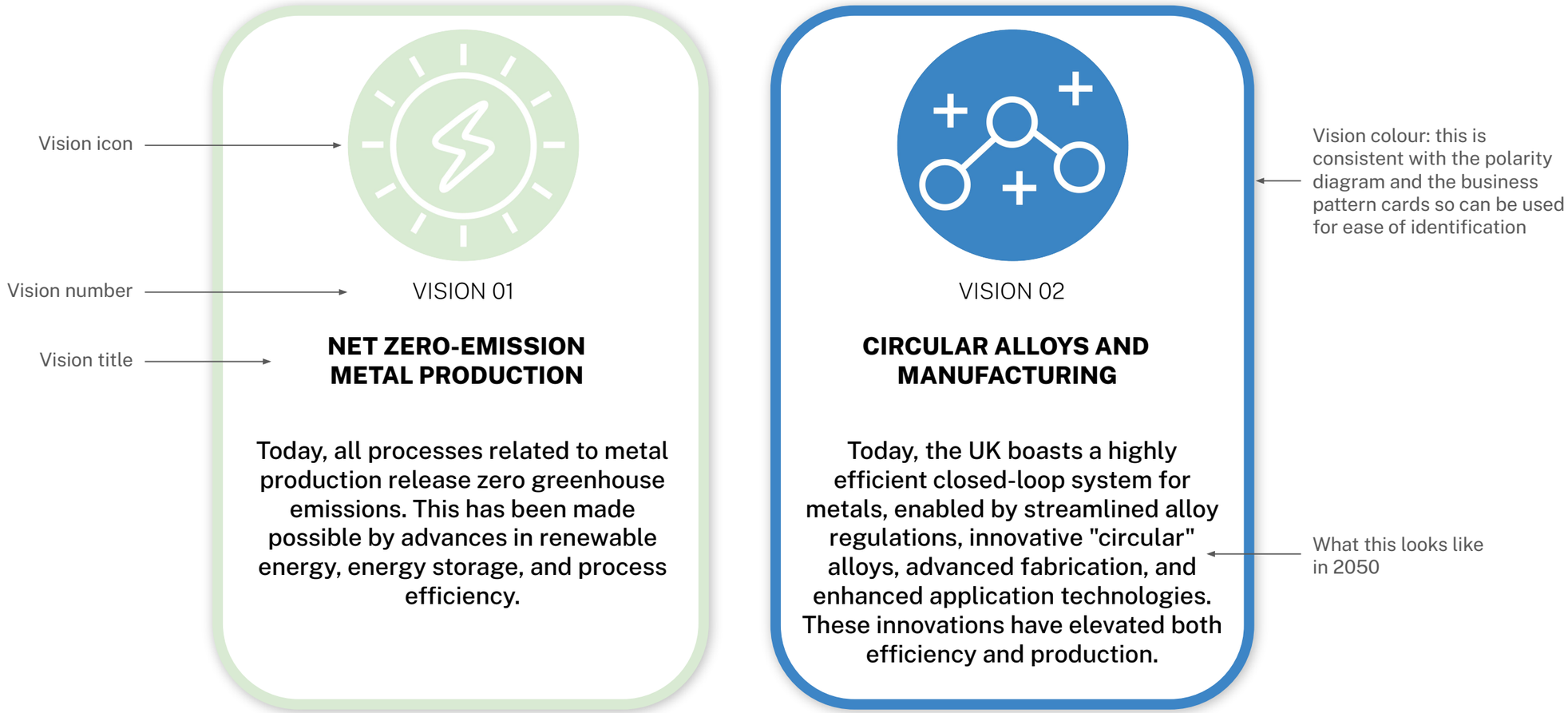
Key prompts and objectives



Participants can place their chosen vision cards here

The polarity diagram gives context to the participants on where each vision sits in the metal value chain, and whether the opportunities within each require behavioural/social changes and/or technological changes

Resource 1B: Vision Cards
A set of 12 cards. each outlining a 2050 vision of metal in the circular economy.



OVERVIEW

Objectives

At the conclusion of this workshop stage, each group should have generated

1. Several ideas on how each Opportunity could be approached
2. Ideas for each Opportunity on on how the business model could be adapted for their circular business
3. Key principles of their organisation, adapted from the principles on the Opportunity Cards

Key Questions

To help achieve each objective, there are helpful prompts on each of the Opportunity Cards as well as how value is delivered to the customers and captured by the company. For further clarity, there are practical examples on the backs of the cards

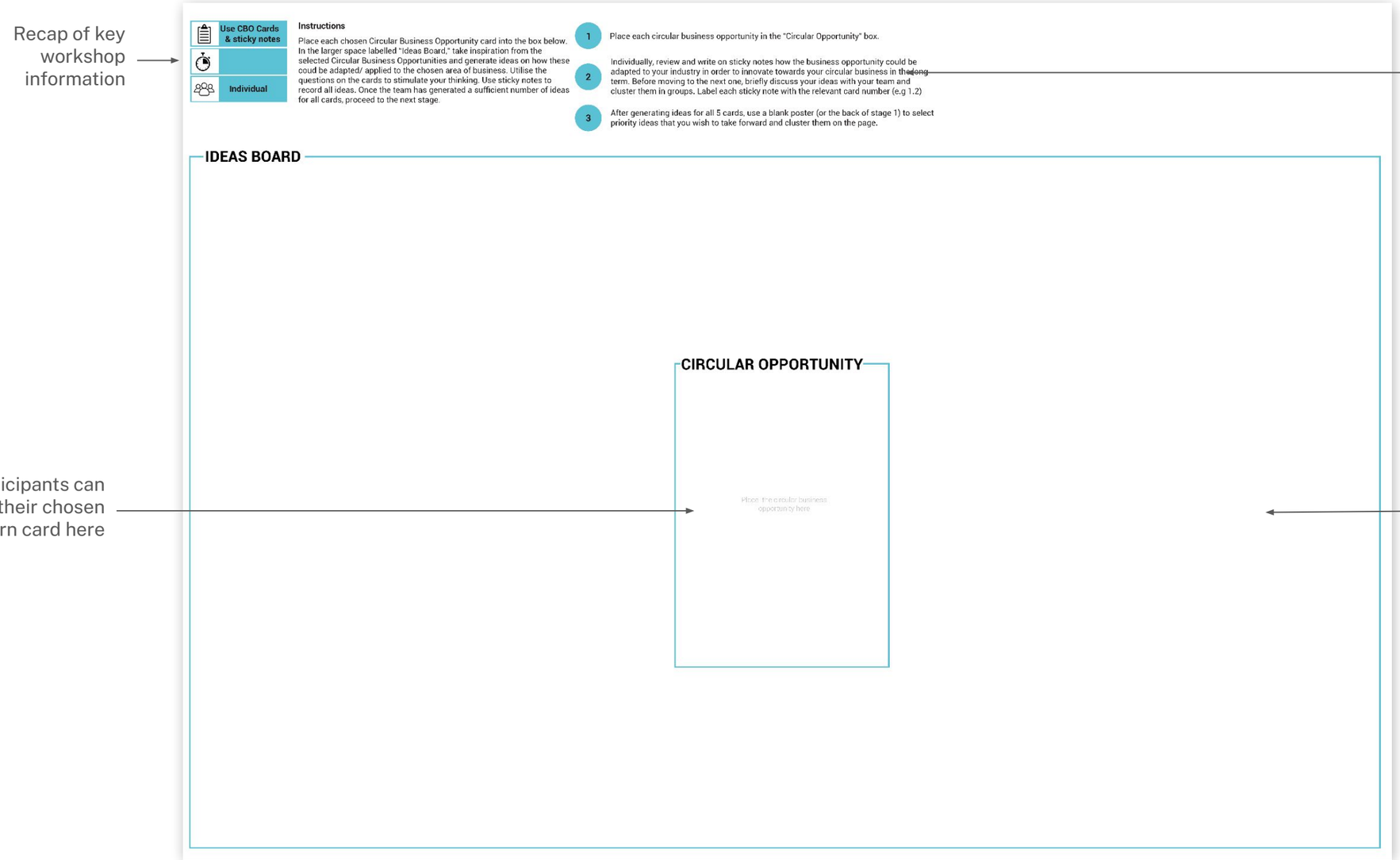
Detail

- Begin by handing out at least 30 sticky notes to each participant
- Place one of the 5 Opportunity Cards in the middle of the template
- Take 5 minutes for participants individually write ideas on sticky notes
- Take 5 minutes to go through them all as a group, placing them on the Stage 2 Template around the Opportunity Card
- Take another Stage 2 Template poster and repeat the previous steps for the remaining 4 Opportunity Cards, using a separate poster for each card
- On another poster, Take 10 minutes to prioritise and group the ideas by moving the chosen sticky notes onto the new poster

Notes

- The individual sticky note writing is important as each group will naturally have louder voices, but this time gives the quieter voices a chance to get their ideas down
- As each person goes through their sticky notes, if someone else has the same or very similar thing written down, they can add theirs at the same time
- The ideas can be grouped in any number of ways, for example by where they sit on the value chain or which company department they might fall under

Resource 2A: Workshop Stage 2 Template
The Workshop Template includes a key summary and prompts for the workshop, as well as a space for an **Opportunity Card** with sticky notes around it



Resource 2B: Opportunity Cards
A set of 61 cards, each highlighting a circular business opportunity that enables the corresponding vision

WORKSHOP STAGE 3: BUSINESS MODEL CANVAS

OVERVIEW

Objectives

At the conclusion of this workshop stage, each group should have

1. Defined their long-term circular business model
2. Identified barriers that might impact the business model as well as things that might enable it.
3. List out target customers as well as stakeholders that span the execution of the business model and the delivery and consumption of any products and services

Detail

- Starting with the User section, take 20 minutes to go through the Value Capture, Stakeholders, and Value Proposition Section, answering the prompts if helpful
- Use the ideas generated in the previous stage to help provide the answers
- Consider what Barriers there are to achieving the business model but also what things might Enable its execution
- Focus the work in a single statement in the middle to summarise the business proposition. Use the example format
-

Key Questions

There are helpful questions in each section of the canvas that can guide participants

Notes

- In the Users section, think about those who are Customers (i.e. those who pay for or commission the product or service) and those who use it at some point along its life cycle
- In the Users section, it is important to consider the problems that the product or service can solve. This answers the question “Why does the business exist?” Take time to identify problems that the user faces and their root causes or consequences that the product or service can address
- The backs of the Vision cards have possible Barriers that can be included.

Resource 3A: Workshop 3 Template with Circular Business Vision Canvas

Recap of key workshop information

Use visions cards

Group

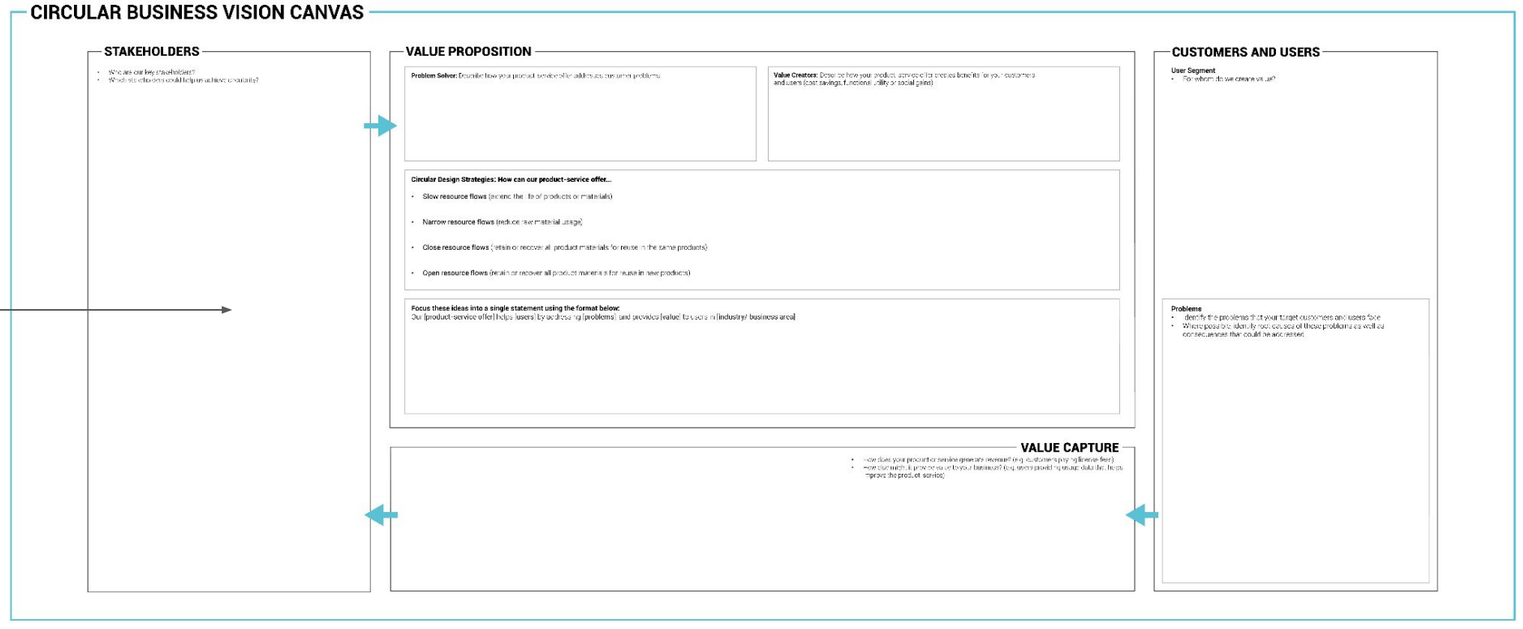
Instructions

The Circular Business Vision Canvas helps you consider important implications when creating a circular long-term business model. Begin with the Users box and use sticky notes or write directly on the page to brainstorm ideas for your circular business vision. After completing the canvas, think about what factors might be barriers to your vision as well as those that can help enabler it.

1. Utilise the ideas developed in the previous stage to respond to the questions presented in each section of the business model.
2. Start with the CUSTOMERS AND USERS section, then complete the VALUE CAPTURE, STAKEHOLDERS, and VALUE PROPOSITION sections. After concluding these sections, focus them into a single statement in the middle of the canvas.
3. Consider potential BARRIERS that may arise during the development and execution of this business model as well as ENABLERS that can be exploited

Key prompts and objectives

A blank Circular Business Vision Canvas with prompts to guide participants to map out stakeholders, value proposition, value capture, and customers as well as potential barriers and enablers



BARRIERS

TECHNOLOGICAL	POLITICAL	ECOLOGICAL	ECONOMIC	SOCIAL

ENABLERS

TECHNOLOGICAL	POLITICAL	ECOLOGICAL	ECONOMIC	SOCIAL

Space to allow participants to write down what factors might be barriers to their ideas and what factors might help enable them

How does the workshop end?
After each group has completed stage 3, allow 5 to 10 minutes for them to present their value proposition to the other group(s) and to take any questions that might come up. Then, as a larger group, discuss the similarities as well as differences between the different groups.

Feedback
Depending on your future use of the Toolkit, you may want to collect feedback using the available feedback forms. The answers may be of use to help hone future workshops.

What does success look like?
A rich collection of ideas from meaningful participant engagement. Everyone's voice should have been heard and new ideas should cover the full breadth of the Visions and Circular Business Opportunities selected. The groups should be able to sum up their value proposition in a short statement.

What happens next?
The participants can take the ideas developed in the workshop further. They can select one of the value propositions from Stage 3 or combine elements from them to create a new one. Work can then begin to develop the proposition into a product or product-service using circular design strategies.

Scaling up or down
The existing workshop could be scaled up or down in terms of scope and length. Instead of picking 3 Visions, for example, fewer or more could be picked. The same could be done with the Business Opportunities Cards.
Another variation would be to select 3 Visions and then *all* of the Business Opportunity Cards that are associated with that vision. Additional time should be allocated accordingly.

Context
A UK furniture company employing 60 people thought about ideas on how they could integrate more circularity into their business as they have identified sustainability is an increasingly critical focus of both their customers as well as their commercial prospects. Specifically, the area that they wanted to focus on was for metal brackets that are used to connect various parts of their furniture. They currently have 14 different types of brackets using 3 different material specifications across their range of 35 products.

Scoping Questions

How might we reduce the amount of metal in our products whilst maintaining the same performance?

Can we produce our products using fewer types of metals?

Can we reduce the number of unique components to streamline production and reduce waste?

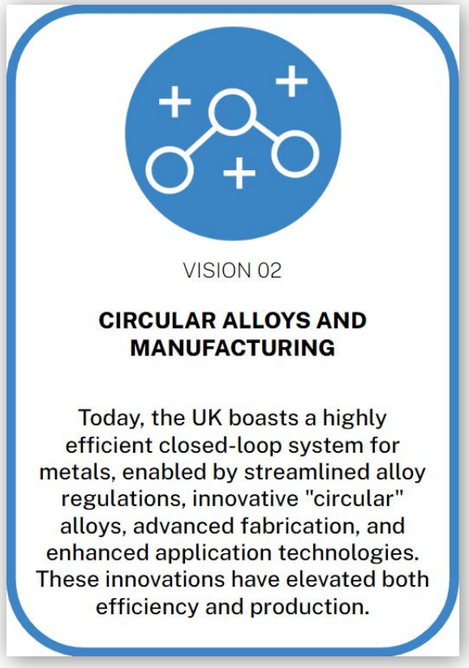
The goal was to take a holistic view at this area of the business, including key stakeholders, and come up with ideas to take forward over the next 5 years.

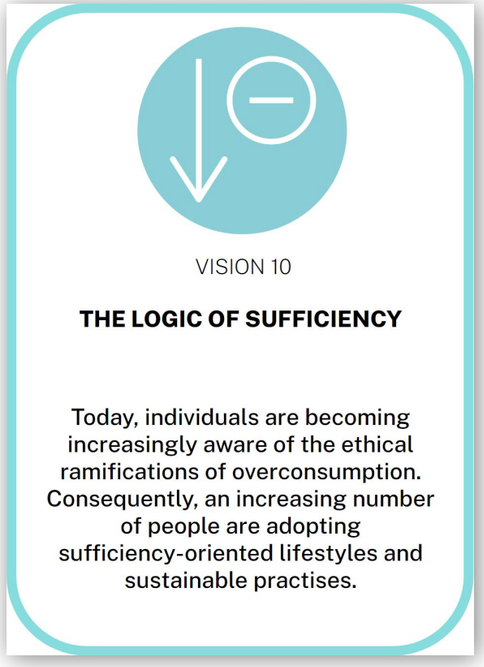
Stage 1 Results
The team settled on 3 visions to take forward:

- **Vision 2: Circular Alloys and Manufacturing**
  Currently 3 different metal specifications are used in the production of the product brackets and this can create difficulty in sourcing, production, wastage, and recycling. Can this be rationalised down to 1 specification that is highly recyclable?
- **Vision 8: Repairing**
  The company does not currently offer any repair services or advice for their products. Can repair guides and/or services be offered?
- **Vision 10: Sufficiency**
  The products are currently sold with a 1 year warranty - can this be extended to 5 years? Can products be rented as a service?

From the 3 visions, the team selected 5 business model patterns:

- **2.1: Standards for Alloy Use in Metal Supply Chain**
- **2.5: Intelligent Manufacturing Automation**
- **8.2: Repair Micro-Enterprises**
- **10.2: Long-Lasting Products**
- **10.3: Library of Things**





Stage 2 Results

For each of the business patterns selected, the team explored how they could be adapted to the furniture industry by using the Stage 2 template.

After exploring each of the patterns, ideas were prioritised and grouped by moving chosen sticky notes to a new page. This new page was then used for reference for Stage 3.

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Stage 3 Results

CIRCULAR BUSINESS VISION CANVAS

STAKEHOLDERS

- Who are our key stakeholders?
- Which stakeholders could help us achieve circularity?

Repair networks
Metal suppliers
Metal recyclers
Retailers
Interior designers
Architects
The environment
2nd hand sales channel

VALUE PROPOSITION

Problem Solver: Describe how your product service offer addresses customer problems

No need to throw away products if certain components break or wear down. Easier to keep products at top functionality and aesthetic

Value Creators: Describe how your product service offer creates benefits for your customers and users (cost savings, functional utility or social gains)

Maintaining and repairing the product will be cheaper than re-buying. Less product going to landfill, and stronger attachment to products - longer lasting

Circular Design Strategies: How can our product-service offer...

- Slow resource flows (extend the life of products or materials)
- Narrow resource flows (reduce raw material usage)
- Close resource flows (retain or recover all product materials for reuse in the same products)
- Open resource flows (retain or recover all product materials for reuse in new products)

-Durability, repair and maintenance services, buy-back schemes
-Reduction in types of metal used
-Take components for remanufacturing of the same furniture
-Standardising parts so products can be converted from one type to another (e.g. table to bench)

Focus these ideas into a single statement using the format below:
Our [product-service offer] helps [users] by addressing [problems] and provides [value] to users in [industry/ business area]

Our long-lasting furniture, enhanced by maintenance and repair services, helps residential and commercial customers with high quality, durable furniture backed by a 5 year warranty; providing them with a long use-life through maintenance and repair services whilst enhancing our brand reputation and providing additional revenue streams

VALUE CAPTURE

- How does your product or service generate revenues? (e.g. customers pay for license fees)
- How else might it provide value to your business? (e.g. users provide frequent data that helps improve the product service)

Online D2C Sales
Online/Brick and Mortar Retailers
Distributor Sales
Maintenance and Repair products/ services
Data collection and analysis to inform product performance and usage

CUSTOMERS AND USERS

User Segment

- For whom do we create value?

Customers (residential and commercial)
Retailers
Assemblers
Repairers
Logistics (delivery)
Reverse Logistics (pick-up)

Problems

- Identify the problems that your target customers and users face
- Where possible, identify root causes of these problems as well as consequences that could be addressed

Lack of repairability
Ease of (dis)assembly
Durability
Lack of clarity on how to maintain products

BARRIERS

TECHNOLOGICAL	POLITICAL	ECOLOGICAL	ECONOMIC	SOCIAL
3D printed metal strength			Costs of warranty	Repairing not the 'norm' yet changing tastes

ENABLERS

TECHNOLOGICAL	POLITICAL	ECOLOGICAL	ECONOMIC	SOCIAL
Improved metal on-demand manufacturing	Right to repair legislation	Restrictions on material impact	Lower CAPEX of new product lines	Leasing/Renting more acceptable