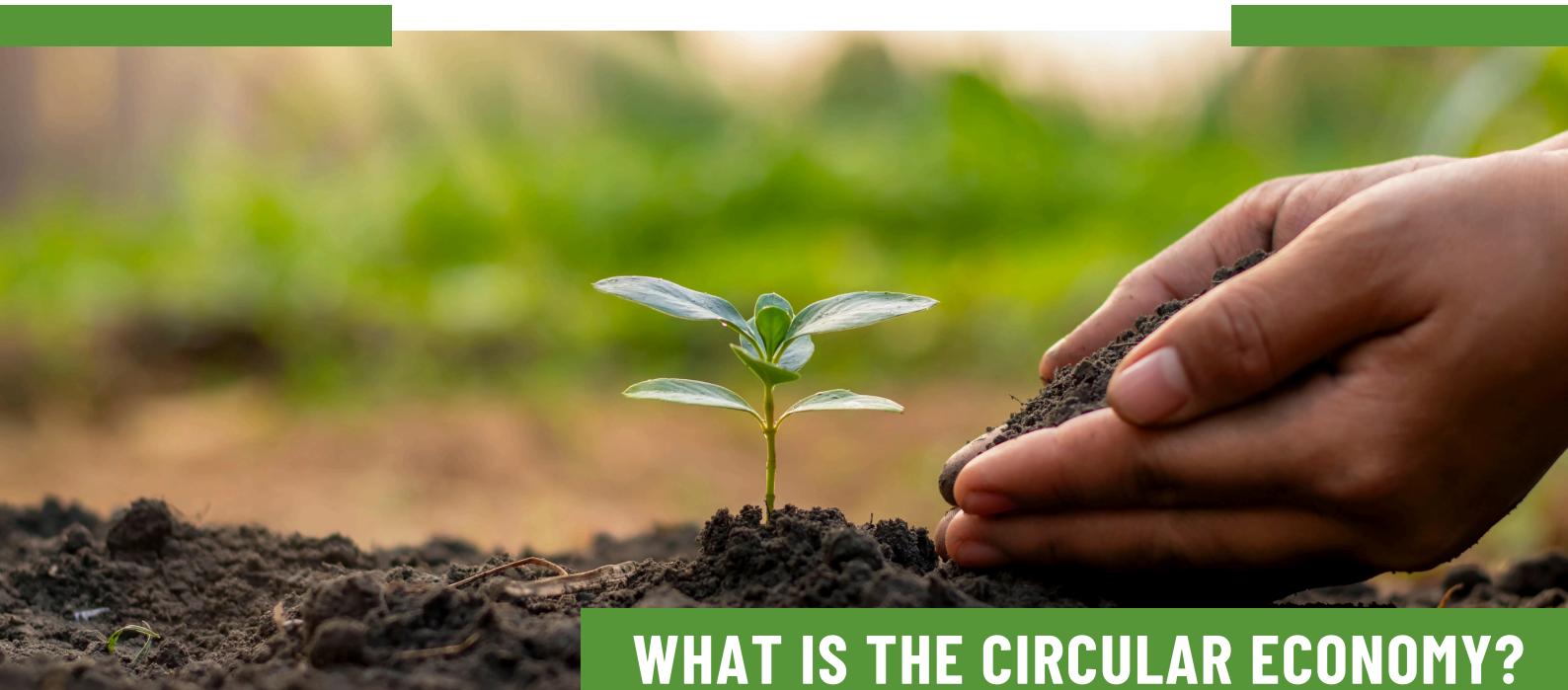


EDUCATION PROGRAMME FOR THE CIRCULAR ECONOMY

TARGET AUDIENCE: LOWER SECONDARY EDUCATION / MIDDLE SCHOOL



WHAT IS THE CIRCULAR ECONOMY?

The circular economy is an economic system based on business models that replace the concept of 'end-of-life' with the reduction, alternative reuse, recycling, and recovery of materials in production/distribution and consumption processes. It operates at the micro level (products, companies, consumers), meso level (eco-industrial parks), and macro level (cities, regions, nations, and beyond), with the aim of achieving sustainable development. This involves fostering environmental quality, economic prosperity, and social equity for the benefit of both present and future generations (Kirchherr et al., 2017, pp. 224–225).

The transition to a circular economy (CE) requires the broad engagement of multiple stakeholders, including not only consumers and producers but also policymakers and academics (Kirchherr et al., 2023). Educational institutions play a prominent role in this context, as education is essential in preparing future professionals for this new economic paradigm. In particular, it contributes to the development of a skill base necessary to foster circular innovation and systems thinking, which should be encouraged across primary, secondary, and higher education programmes (Ellen MacArthur Foundation, 2022).

The construction of a sustainable future is intrinsically linked to education, which plays a fundamental role in equipping individuals to become future decision-makers capable of addressing the complex challenges of the 21st century (Décamps et al., 2017). In this regard, organisations such as the United Nations have prompted the education sector to advocate for the sustainability agenda (Hermes and Rimanoczy, 2018), and to develop structures, materials, processes, and learning environments that enable effective educational experiences for responsible leadership (Warwik and Conway, 2017). Furthermore, the Sustainable Development Goals (SDGs) set the target that, by 2030, all learners should acquire the necessary competencies to promote sustainable development (Montiel et al., 2020).

INTRODUCTION

Throughout world history, human societies have prioritised economic development, capital accumulation, and increased consumption (De Melo et al., 2020). However, the validity of this model has increasingly been called into question in light of its dysfunctional consequences. A brief overview of global conditions in recent decades reveals pressing sustainability issues, indicating that the level of sustainability in human activities is inadequate (Faham et al., 2017). Social and environmental problems—such as climate change, biodiversity loss, and rising inequality—have intensified to such an extent that they are now regarded as urgent global challenges (Montiel et al., 2020).

Consequently, the world is in need of new economic models, such as the circular economy (CE), which emerges as a production system that enhances the resilience of the Earth and biodiversity, while decoupling economic growth from environmental impact (Messerli et al., 2019).

LEVELING

SESSION 1

Required materials: Computer with internet access, projector, speakers, and, if necessary, a printed case study.

1 PRE-TEST

Before the start of the activities, students should complete a pre-test (Appendix A), which may be administered either virtually (via Google Forms) or in printed format.

>>> APPENDIX A

The test is designed to assess students' knowledge, skills, and attitudes (Sulitest, 2023; Wersun et al., 2019) both before and after the implementation of the didactic sequence. It draws inspiration from internationally recognised tools such as the Sulitest®: TASK™, Awareness Tools, and its additional module "SDG 12", which includes questions related to circularity. The test is also informed by academic literature, including the works of Bugallo-Rodriguez and Vega-Marcote (2020), Chappin et al. (2017), Keramitsoglou et al. (2023), Korsunova et al. (2021), Nikolic et al. (2022), Tolppanen et al. (2019) and Zizka e Varga (2021).

2 VIDEO

Initially, the instructor should divide the class into small groups and explain that an activity related to a video will be conducted, which the students are expected to watch attentively.



Play the following video (approximate duration: 17 minutes):

Talk by Ellen MacArthur

Available at:

<https://www.youtube.com/watch?v=oolxHVXgLbc>



UNDERSTANDING THE CHALLENGE OF FINITE RESOURCES ELLEN MAC ARTHUR FOUNDATION

Level-setting in Circular Economy education represents an initial phase in the teaching process, aimed at ensuring that all students possess a common foundational knowledge of the subject before progressing to more complex concepts. This stage serves to identify varying degrees of familiarity with the circular economy and to tailor instruction inclusively, thereby establishing a shared starting point and enabling all learners to grasp essential fundamentals prior to advancing their studies.

One of the pioneering institutions in circular economy education is the Ellen MacArthur Foundation (EMF), which works to popularise the circular economy (Kopnina, 2019). The Foundation provides lesson plans for the age group 12 to 19 years, which can be utilised for this purpose. We recommend Lesson Three, entitled "Understanding the Challenge of Finite Resources," which includes reflection on a YouTube video (Talk by Ellen MacArthur), accompanied by suggested questions for discussion.



If schools encounter difficulties in streaming the video, the lecture has been transcribed and translated in Lesson 3 and can be adapted into a case study.

LEVELING

SESSION 1

After viewing the video, it is recommended to facilitate a discussion on the central questions proposed in Lesson 3 of the Ellen MacArthur Foundation. Specifically, questions 6, 7, 12, 13, 16, 18, and 19 are suggested for debate.

It is advisable to distribute these questions among small groups for initial discussion, followed by a plenary session to share insights with the entire class. To enhance engagement during the plenary, questions may be randomly assigned to students or groups. The questions can be printed on cards with instructions such as: "Answer the following question," "Select a group member to respond," or "Choose another group to answer this question." Active participation may also be encouraged through the appointment of a rapporteur in each group or by creating a synthesis panel or collective mural. The instructor should foster dialogue, critical thinking, and systemic reasoning throughout the activity.

Optional: Playposit®

The EMF lesson plan proposes 19 questions for video discussion using the Playposit® platform. Playposit® enables the integration of interactive content within videos, allowing students' responses to appear dynamically on the shared screen. If the instructor wishes to use this tool, it is recommended to view its tutorial in advance. If not, the discussion of the questions will not be affected.

3

QUESTIONS



6. Ellen MacArthur compares her journey through these dangerous parts of the world to driving a car at high speed, without windshield wipers or headlights. What is she trying to convey with this comparison? Why is this analogy effective? What other comparison could you make?

7. If Ellen now asked you to go out and find everything you would need to survive for the next three months, what would you take? Why?

12. Materials such as copper and zinc are finite. However, we are using them at an increasingly rapid rate. What does this mean for our economy? What does this mean for your own life?

13. The more Ellen MacArthur learned about the resources and materials on which our economy is based, the more concerned she became. As the speed at which we consume our resources is part of the problem, she – like many others – began to use less, travel less, and consume less. What would you have to give up in your daily life for our resources to last longer? Would this approach work forever? Why or why not?

16. What is the difference between a circular economy and a linear model?

18. What would you do to change the economic system? Who would you talk to? Where would you start? Explain your choices.

19. Reflecting on the life of her grandfather, Ellen MacArthur highlights how many things have changed and developed during his lifetime: car usage has increased, airplanes were invented, the first computers arrived, mobile phones, and the internet are now widely accessible. A transition to a circular economy is possible – why is it so important? What opportunities does it bring, in your opinion?

>>> HOMEWORK: WASTE DIARY



Inspired by the PEA – Campo Limpo Environmental Education Programme, it is recommended that, throughout the lessons on Circular Economy, students maintain a Waste Diary. This activity encourages students to record the waste they generate each day, whether at school or within the family environment.

The diary may be kept in handwritten form; however, if students have access to mobile phones and computers with internet connectivity, it is advisable that they document their waste through photographs taken on their phones or by using online platforms, such as:

<https://inpevcampolimpo.org.br/jogos/meu-diario-de-residuos>
and <https://jogo.3.inpevcampolimpo.org.br>



The website allows students to add emojis, post-its, and GIFs to reflect on their waste; however, it does not support continuous tracking, as the diary must be downloaded as a ".png" file each time it is used. If students are able to monitor their waste through photographs, the instructor may schedule a specific session near the end of the module for students to upload their records or use the online diary to review their peers' entries.

For the purpose of initial awareness, it is also proposed that students maintain a waste diary throughout the didactic sequence. Reflective diaries have been identified as one of the primary methods for learning about the Sustainable Development Goals (UNESCO, 2017).

Alternatively, the instructor may create a Padlet® (<https://padlet.com>) where students can post their photos online, enabling viewing, interaction, and commentary on their peers' submissions. The aim of this activity is to encourage students to reflect on the quantity of packaging and waste generated over the course of a day or week by an individual or family, and to stimulate thinking about how to design products with circularity or more sustainable packaging (the theme of Stage 4). The instructor should also encourage students to retain recyclable packaging from products used during the week for activities related to Stage 7.

RESOLVE FRAMEWORK

SESSION 2

Required materials: a computer laboratory with internet access, headphones, and speakers. Students should also preferably have a Gmail account to access the applications.

REgenerate 

Share 

Optimise 

Loop 

Virtualise 

Exchange 

Knowledge of circular business models (CBMs) is valuable as it demonstrates that the circular economy is a viable option, with some companies already exploring these models, which have the potential to strengthen the economy not only at the local level but also globally (Borschiver and Tavares, 2022). According to Lewandowski (2016), although various CBMs exist in the literature, most can be encompassed within the ReSOLVE framework developed by the Ellen MacArthur Foundation. This framework is derived from an acronym representing six actions for the transition to the circular economy, namely: Regenerate, Share, Optimise, Cycle, Virtualise, and Exchange. In the teaching of the circular economy, employing this model assists students in understanding how the principles of circularity can be practically applied across different sectors, transforming production chains and business models. Therefore, it is proposed that this topic be introduced through the creation of songs for each of these actions, supported by artificial intelligence tools (ChatGPT® and SUNO®).

1) Instructors should provide a brief explanation of the ReSOLVE framework.

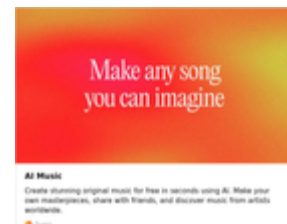
2) The class should be divided into 6 groups, and each group will be randomly assigned one action from the framework: Regenerate, Share, Optimise, Loop, Virtualise, and Exchange.

3) The groups should proceed to the computer laboratory to conduct a brief research on their assigned topic. Following this, they will be encouraged to create songs related to their topic using artificial intelligence tools. Instructions on how to proceed are as follows:

- Students may create the song independently and/or enhance it using ChatGPT® (<https://openai.com/chatgpt/overview>). Suggested prompt: “We are students from the lower secondary level / middle school and we are learning about Circular Economy. We would like to create a song that helps us learn dynamically and creatively about the action '[insert assigned action]' from the framework proposed by the Ellen MacArthur Foundation, providing practical examples of how to implement this action. Please suggest a song lyric that is engaging and facilitates learning the listed content”.
- Students should review the content they have created, assess its relevance, and make any necessary adjustments.
- The song lyrics should be pasted into the website:

>>> [HTTPS://SUNO.COM](https://suno.com) <<<

- To use the site, students must create an account (by selecting the “sign in” option at the top right).
- In Suno®, students should navigate to the menu on the left-hand side and click on “Create.” They should then paste the lyrics of the song they have composed. Below the text box, they may enter instructions regarding how they would like the song to be generated, specifying the desired rhythm or style — for example, samba, rap, pop, pagode, rock, or country music — and subsequently click on “Create.” It is recommended that they be instructed to limit the song duration to a maximum of three minutes. After processing, students should export the generated song and send it to the instructor or class group via WhatsApp (if available). Alternatively, if the song was created using a mobile phone, it may be synchronised with the classroom’s speaker system via Bluetooth, if such an option is available.
- Additional time should be allocated for students to review and rehearse their musical performances. The songs are then to be presented to the class. A friendly competition and democratic voting process may be encouraged to select the best song, based on the quality of the lyrics, rhythm, and performance. The winning song may be performed by the entire class for the wider school community.
- This activity may also be integrated with Art classes, where students can create musical instruments from recyclable materials, such as drums.
- After each presentation, time should be reserved for constructive feedback and reflection on what was learned through each of the ReSOLVE actions, as well as how the songs contributed to this learning process. Students may also be invited to create a summary table outlining the ReSOLVE actions and their practical examples, as a means of consolidating knowledge and concluding the activity.
- It should be noted that, in the absence of technological resources, the activity may be adapted for free-form song creation, with the instructor providing printed news articles or practical cases related to each action.



CIRCULAR BUSINESS MODELS

SESSION 3

Required materials: computer laboratory with internet access; projector; speakers.

Knowledge of circular business models is valuable as it demonstrates that the circular economy is a viable option, with some companies already exploring these models, which in turn enable the strengthening of the economy not only at the local level but also globally (Borschiver and Tavares, 2022). Research on circular business models in practice across various sectors such as fashion, footwear, technology, architecture, packaging, and food can help students to recognise that circularity is already part of the reality of many organisations. Accordingly, the students are encouraged to exercise autonomy in researching and presenting circular companies and products, thereby employing a flipped classroom approach.

The objective of this lesson is to familiarize students with companies that adopt circular economy frameworks, enabling them to propose the design of a product or service based on the circular economy in the subsequent lesson. This lesson is inspired by Lesson 4 of the Ellen MacArthur Foundation (Designing for the Circular Economy). However, it has been supplemented with additional business models beyond those mentioned on the EMF website, so that students also gain insight into the local context. Accordingly, the following is proposed:

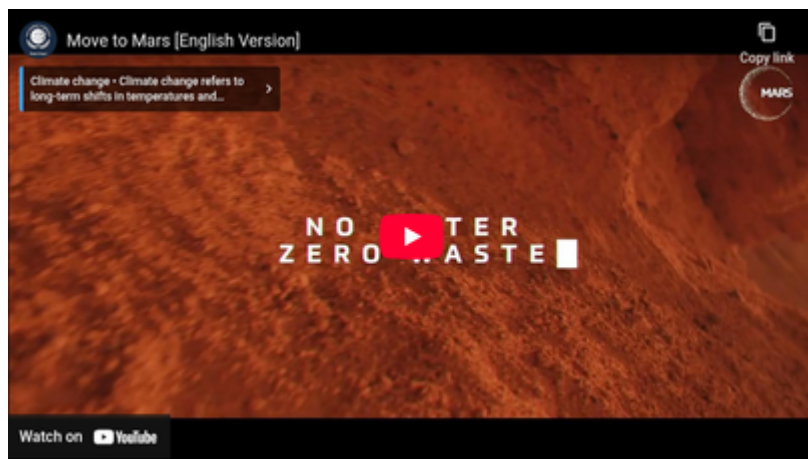
1) Introduce the topic by presenting the YouTube video from the UN Global Compact (duration: 1 minute and 35 seconds)



MOVE TO MARS

[HTTPS://WWW.YOUTUBE.COM/WATCH?V=XTOZ6MWFU4](https://www.youtube.com/watch?v=XTOZ6MWFU4) (ENGLISH)

[HTTPS://WWW.YOUTUBE.COM/WATCH?V=7RCFW53DQ9Y](https://www.youtube.com/watch?v=7RCFW53DQ9Y) (PORTUGUESE)



2) Flipped classroom model: Each group will be assigned a specific sector along with a list of potential websites featuring successful circular economy case studies. Students are expected to proceed to the computer laboratory to explore the provided cases, as well as to research additional circular economy business models within the assigned sector. They should prepare a slide presentation incorporating photographs and interesting facts for subsequent sharing with the class. The presentation should focus on innovative products and companies rather than theoretical concepts.

Observation: The suggested case studies may be adapted to the students' geographical and cultural context.



DIVISION OF THEMES AND CASE SUGGESTIONS



A) CIRCULAR ECONOMY IN FOOTWEAR

- Shoes made from plastic collected from the oceans: <https://ecossis.com/noticias/dica-ambiental/tenis-feito-com-plastico-retirado-dos-oceanos-rende-milhoes/> and <https://www.denovo.shoes/pages/ocean>
- Sneakers with chewing gum (look on websites [ReciclaSampa](#) ou [Pequenas Empresas Grandes Negócios](#));
- Sneakers that Grow - Aretto (look on websites [ConexãoPlaneta](#) ou [CicloVivo](#));
- Case ALME - <https://www.somosalme.com.br/sustentabilidade/>;
- Bottero - <https://blog.bottero.net/sustentabilidade/bottero-sustentavel/>;
- Adidas (FutureCraft.loop) - <https://ideiacircular.com/tenis-100-reciclavel/>
- Other topics and companies for research:
 - Havaianas reverse logistics;
 - Insecta Shoes; Yuool; Linus; Ahimsa; Urban Flowers; Misci (look on [Revista Forbes](#));



B) CIRCULAR ECONOMY IN FASHION

- Explore: <https://ellenmacarthurfoundation.org/pt/temas/moda/exemplos>
- Also search for topics such as:
 - Sustainable fabrics;
 - Desserto – cactus leather;
 - C&A's Ciclos Collection and Revoada. ([Vide IdeiaCircular*](#));
 - Tecido com sobras de abacaxi (see [Ecycle](#) ou [CicloVivo](#));
 - Impact of Jeans;
 - Second-hand clothing stores (Brechós);
 - Greenpeace Podcast: "As Árvores Somos Nozes Episode 66" – Fast Fashion and Socio-environmental Impacts;
 - Refazenda: <https://www.vivarefazenda.com.br/p/sobre> and https://www.oneplanetnetwork.org/sites/default/files/09-caso_ref_pt.pdf;
 - Áurea Lúcia Circular Company;

Adaptation: Depending on the level of technological access and the time available, instead of a presentation, students may produce a podcast detailing the innovations they have discovered. It is recommended that, prior to the activity, students be introduced to the Greenpeace podcasts available at: <https://www.greenpeace.org/brasil/podcast/>, such as:

- As Árvores Somos Nozes Episode 83 – Oceans Flooded with Plastics
- As Árvores Somos Nozes Episode 53 – Bioeconomy: Solution or Greenwashing?
- As Árvores Somos Nozes Episode 14 – Do You Have a Minute for the Environment?
- As Árvores Somos Nozes Episode 12 – We Need to Talk About Meat Consumption
- As Árvores Somos Nozes Episode 06 – The Climate Is Heating Up

CIRCULAR BUSINESS MODELS

SESSION 3



C) CIRCULAR ECONOMY IN ARCHITECTURE, CIVIL ENGINEERING AND SUSTAINABLE CITIES

- See examples at:
 - <https://ellenmacarthurfoundation.org/pt/temas/cidades/exemplos>;
 - <https://ideiacircular.com/cidades-na-economia-circular/>
- Also research initiatives such as:
 - Green Energy;
 - "Tijopór";
 - Vertical Farms;;
 - Cambará Eco Hotel;
 - Circular House (See [IdeiaCircular*](#));



D) CIRCULAR ECONOMY IN TECHNOLOGY AND ARTIFICIAL INTELLIGENCE

- <https://ellenmacarthurfoundation.org/pt/exemplos-circulares/inteligenciaartificial-para-reciclagem-amp-robotics>

Please also conduct research on the following topics:

- Planned obsolescence;
- Fairphone and modular smartphones (see [IdeiaCircular](#));
- Remote-guided surgeries;
- 3D organ printing;
- Food Ink: a restaurant offering 3D-printed meals;
- Applications that connect waste producers with solution providers (e.g., TerraCycle);
- Applications for supply chain traceability.



E) CIRCULAR ECONOMY IN PACKAGING

research about:

- Edible water bubbles (Ooho);
- <https://jafuimandioca.com.br/>
- Edible plates: <https://www.okabioembalagens.com.br/>
- Bamboo plates;
- Waste generated by delivery services;
- The company Irani Celulose;
- The companies Algramo, Cellugy, EcovativeDesign, Evoware e RePote (See [IdeiaCircular*](#));
- Packaging-free markets (@Menos 1 Lixo):

<https://www.menos1lixo.com.br/posts/mercados-sem-embalagem-pelo-mundo> and <https://www.youtube.com/watch?v=HYFr4sDRpmM>



F) CIRCULAR ECONOMY OF PLASTICS

- Please explore the following resource:
<https://ellenmacarthurfoundation.org/pt/temas/plastico/exemplos>
- Research the edible straw as a solution to replace plastic;
- Additionally, investigate the following companies:
 - Sintronics and Zeroplast (See [IdeiaCircular*](#));
 - Imaplast Plastic Recovery;
 - Alcaplas;



G) CIRCULAR ECONOMY IN FOOD AND AGRICULTURE

- <https://ellenmacarthurfoundation.org/pt/temas/alimentos/exemplos>
- <https://www.ellenmacarthurfoundation.org/pt/artigos/o-papel-dos-restaurantes-em-um-sistema-circular-dos-alimentos>;
- Terraform Kitchen (an appliance that transforms food waste into fertiliser);
- Circular Economy in Cafeterias: biodegradable coffee cups made from PLA and bamboo fibre, reuse of coffee grounds, capsule recycling, among other initiatives — for example, the Tundum café;
- Company: "Bosta em Lata";
- INPEV – agrochemical packaging.



H) ECODESIGN

- <https://www.ellenmacarthurfoundation.org/pt/temas/design-circular/exemplos>
- Lego has launched a range of sustainable products made from sugarcane (see [ReciclaSampa](#));
- Bamboo toothbrushes;
- Herman Miller chairs (See [IdeiaCircular*](#));

OTHERS

Depending on the number of groups, additional topics may be proposed, such as the circular economy in tyres, furniture, public policies, and carbon credits.

Additional supplementary materials can be found at:

- www.eco4planet.com;
- www.wwf.org.br;
- www.ecycle.com.br;
- <https://movimentocircular.io>;
- The Action to Communicate and Engage Platform (PACE) – Agenda 2030: <https://www.pactoglobal.org.br/cases-pace/> and <https://www.aberje.com.br/blog/agenda-2030-comunicacao-e-engajamento/>;
- CNI. Strategies to Support a Low-Carbon Economy. https://static.portaldaindustria.com.br/media/filer_public/52/06/5206f144-2646-456c-a234-b2173fa87219/fact_sheet_estrategia_baixo_carbono_interativo.pdf;
- IDEIA CIRCULAR. 28 Case Studies: Design and Innovation for the Circular Economy in Brazil and Worldwide. São Paulo, 2021. Available at: <https://www.ideiacircular.com/estudos-de-caso-economia-circular/>
- Ellen MacArthur Foundation website: <https://www.ellenmacarthurfoundation.org/resources/business/examples>
<https://www.ellenmacarthurfoundation.org/resources/business/circular-startup-index>
Empresas B Brasil website: <https://sistemabbrasil.org/empresas-b/>;

CIRCULAR DESIGN

SESSION 4

Required materials: cell phones or computers with internet access.

Printout of the Transform Game, available at: www.Reference hidden for blind review purposes

The topic of circular design plays a significant role in the teaching of circularity and is emphasised in the European Union's Circular Economy Action Plan (European Commission, 2020). Future professionals must be able to envision and anticipate the extended use of products by considering aspects such as circular impact assessment, design for multiple use, design for recovery, and the implications for reverse logistics channels (Kopnina, 2019). In this context, problem-based learning is proposed, whereby students are encouraged to redesign everyday products, developing solutions to prevent them from becoming waste. This approach fosters an understanding of the closed-loop concept inherent to the circular economy.



ENVIRONMENTAL IMPACT CALCULATOR

[HTTPS://CLIMATEHERO.ME/PT/](https://climatehero.me/pt/)

According to Hermes and Rimanoczy (2018), education for sustainability can extend beyond a purely technical perspective, encompassing emotional and existential dimensions that may be fundamental in fostering a new mindset. In this regard, with the aim of encouraging self-reflection on everyday behaviours, it is proposed that students engage in an activity involving the calculation of their environmental impact or ecological footprint, using online tools. The Climate Hero calculator is recommended for this purpose.

This tool aims to help individuals understand their climate impact based on their current lifestyle and to take informed actions to reduce it (Climate Hero, 2024). The ecological footprint calculation refers specifically to emissions of carbon dioxide and other greenhouse gases (Climate Hero, 2024). The calculator presents questions in three categories: housing, travel, and consumption, and the estimated completion time is five minutes (Climate Hero, 2024). However, it is advisable to allocate at least 20 minutes for the activity, allowing students sufficient time to reflect on their behaviours, engage in peer discussion, and carefully review the recommended actions provided upon completion of the questionnaire.

This tool was selected due to its availability for various countries, its relative ease of use, the brief explanatory notes accompanying each question, and the personalised feedback provided upon completion of the questionnaire.

After completing the questionnaire, participants receive messages highlighting positive aspects of their current practices—for instance, living in a country that has ratified the Paris Agreement or taking the initiative to calculate their environmental footprint. Additionally, they are presented with suggestions for improving their results, such as reducing meat consumption or prioritising locally sourced products. For each recommended improvement, participants have the option to adjust their final score by making "climate pledges," indicating whether they agree with the proposed action and are willing to commit to it, or whether the step would be too challenging. The test also categorises respondents into one of four groups—Climate Villain, Climate Consumer, Climate Friend, or Climate Hero—which may prompt comparisons and discussions among peers.

Other environmental impact calculators are also available at various platforms:

- <https://especiais.g1.globo.com/meio-ambiente/calculadora-emissoes-carbono/>
- <https://pslifestyle-app.net/test>
- <https://www.nestleoncologia.com.br/sustentabilidade/calculadora-sustentabilidade>
- <http://www.pegadaecologica.org.br>

Adaptations: As a suggestion, if the activity is to be implemented at other educational levels—such as in entrepreneurship schools—there is a specific calculator focused on circularity applied to products and businesses, available at: circularitycalculator.nl.

If educators are interested, this activity may also be supplemented with a task proposed by the Movimento Circular (Gina Rizpah Besen), entitled "How can we leave a positive environmental footprint on the planet?", available at: https://docs.google.com/document/d/1KbH3e2p_wiFbBFBdkQ3tf3FMBU4QTx4TQACUVgtVwtc/edit. This activity explains the concept and main components of the ecological footprint, and encourages students to propose a Circular Manifesto.



Calculadora de impacto ambiental - ClimateHero

Qual é o seu impacto ambiental? Com a calculadora de pegada ClimateHero, pode testar o seu impacto ambiental em apenas 5 minutos.

climatehero.org

OPTIONAL ACTIVITY: DISASSEMBLING PACKAGING

The objective of this activity is for students to learn about circular design by developing a critical perspective on consumption and the environmental impact of packaging. In Lesson 1, students were encouraged to save various types of packaging, which will now be utilised in this task. Where possible, the support of a chemistry teacher would be beneficial to explain the composition of the materials involved. The activity consists of the following stages:

a) Analysis of collected materials: Students are to identify the different types of materials used in the packaging (e.g., plastic, aluminium, ink, adhesive).

b) Identification of the function of each component: Students should examine the purpose of each material (e.g., sealing, preservation, visual appeal). At this stage, they should also be encouraged to consider how these elements contribute to increased complexity in the recycling process.

c) Discussion on disposal: After identifying the components, students should engage in a discussion on how the packaging could be recycled, reused, or even avoided altogether. What alternative materials or design solutions could be more sustainable?

An effective suggestion is to analyse a crisp packet, as it is an accessible example featuring multiple layers and components for students to examine—such as metallised plastic, the label, sealing adhesive, and in some cases, an additional pouch for smaller portions. Cartons used for milk, juice, or other beverages (e.g., Tetra Pak) also serve as valuable examples. These packages help illustrate the complexity involved in separating their composite layers and understanding the function of each. They are typically made from a combination of cardboard, plastic, and a thin layer of aluminium—materials that, when fused, pose significant challenges for recycling. Similarly, packaging for filled biscuits often consists of thick plastic, a metallised layer, and occasionally even internal support trays. Yoghurt containers usually comprise plastic pots, aluminium lids, and paper or plastic labels. Personal hygiene products frequently involve thick plastic bottles, pump valves, and labels made from additional materials, all of which can complicate the recycling process.



CIRCULAR DESIGN

SESSION 4



CREATING SOLUTIONS FOR CIRCULAR DESIGN

Lesson 3 from the Ellen MacArthur Foundation (introduced in Stage 1) posed the following question: **“Ellen MacArthur provides a series of examples of products that could be redesigned so that they never become waste: cars; packaging; lightbulbs; and motors. Take a look around the room you are in, or in your home, and choose a product that needs to be redesigned. What could be done to ensure it never becomes waste?”** Building on the reflections from previous activities, students—working in small groups—should select a product from their daily lives that they believe requires redesigning and propose a potential solution to ensure it does not become waste. Depending on the group’s level of maturity and academic background, these proposals may be enriched by sketches of their solutions or even by the development of prototypes.

It is also recommended to explore the concept of “Product as a Service”, through the Ellen MacArthur Foundation’s video What If We Don’t Buy Products and We Buy Service? Circular Economy Explained | Animated Video Essay (Available at: https://www.youtube.com/watch?v=Cd_isKtGaf8) – (Duration: 3 minutes and 11 seconds).



The publication “Design and the Circular Economy – Deep Dive” by the Ellen MacArthur Foundation can also be explored by students as a complementary resource. It is available at: <https://www.ellenmacarthurfoundation.org/design-and-the-circular-economy-deep-dive>.

The proposals should be shared with peers in the form of a pitch* and may be evaluated by a panel consisting of teachers, staff members, or student representatives, who will select the best solution—similar to television programmes such as Shark Tank**.

*A pitch is a concise and focused presentation technique used by entrepreneurs to sell a product or service idea. The Ellen MacArthur Foundation also encourages this format—see: <https://www.ellenmacarthurfoundation.org/make-a-circular-economy-pitch-in-your-organisation-deep-dive>.

**Shark Tank is a television programme where entrepreneurs present their ideas to potential investors. See examples at <https://www.youtube.com/@SharkTankGlobal>

If possible, instructors may enhance the activity by offering some form of incentive for the best solution.

To conclude the activity, it is recommended to hold a discussion on the challenges of circular design and the implementation of proposed solutions, such as costs, changes in consumer behaviour, and technological limitations. This discussion will serve as a transition to the next topic, which focuses on stakeholder engagement.

Another adaptation of the activity is through the “Transform Game” created by the authors:



TRANSFORM GAME

APPENDIX D

The game “Transform” aims to stimulate creativity and circular thinking by encouraging players to propose new functions that transform disposable objects into useful, entertaining, or sustainable solutions. This process extends the life cycles of products and prevents premature disposal. The game is grounded in key concepts of the Circular Economy, including product life cycle extension, circular design, and upcycling. Players must draw one white card, which presents an object, and one green card, which contains a challenge. They must then devise a new function for the object according to the rule stated on the challenge card. The proposals are presented, and the most creative and coherent idea of the round receives the cards as a “trophy.” At the end of the game, the player with the greatest number of cards is declared the winner.



If time permits (approximately 10 minutes), students may access the website <https://www.atividadeseducativas.com.br/index.php?id=10758> to play the game “Detective” (Clubinho Faber Castell), in which they must find clues to form a secret sentence: “One-third of everything you buy goes straight to the bin. Plan your purchases. Be a conscious consumer. Learn more at Akatu.com.br.”

This activity can also be adapted to a physical format, with the teacher hiding words around the classroom for groups to find and assemble the sentence—thus fostering friendly competition and interaction among students.





STAKEHOLDER ENGAGEMENT

SESSION 5

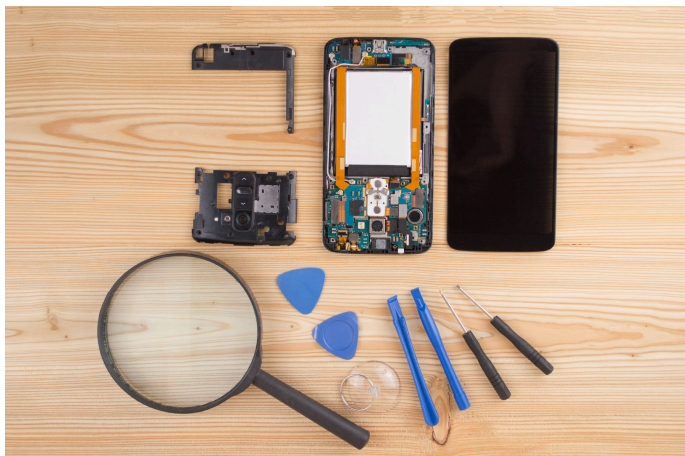
The United Nations identifies stakeholder and actor analysis as one of the principal methods for learning about the Sustainable Development Goals (UNESCO, 2017). This topic should be addressed in the teaching of the circular economy, as sustainability challenges are generally complex and require engagement with stakeholders (Freudenreich et al., 2020). The transition to the circular economy depends on the broad involvement of diverse actors, including consumers, producers, policymakers, and academics (Kirchherr et al., 2023). Stakeholders play a prominent role in the shift from a linear to a circular economy (Marjamaa et al., 2021), and their pressure can assist companies in recognising the added value of circular initiatives, as well as facilitate the adoption of the circular economy by positively influencing drivers and mitigating barriers (Jabbour et al., 2020). Therefore, the aim of this session is for students to understand the importance of engaging multiple stakeholders in the circular economy.

Initially, students (in the Brazilian context) should be invited to engage in a joint reading of Decree 12.082/2024 (https://www.planalto.gov.br/ccivil_03/ato2023-2026/2024/decreto/D12082.htm).

Note: This activity should be adapted in accordance with the legislation of the students' respective country.

Optionally, students may also access the interactive resource available at <https://www.atividadeseducativas.com.br/index.php?id=7280> to explore how a mobile phone is produced, the origins of its raw materials, and the potential health risks posed by improper disposal of its waste.

If access to the interactive resource is not possible, the instructor may use screenshots of the sections illustrating each component and provide explanations through a dialogic lecture.



Required materials: Copies or projection of Decree 12.082 (Brazilian context); mobile phones or computers with internet access (optional); copies outlining the expectations for each stakeholder group.

Subsequently, a simulated public hearing is proposed, as education for the Circular Economy should involve the practical application of concepts in everyday life (Ab Hamid et al., 2024).

The topic of the simulated public hearing will be **“Electronic Waste and Information Technology Platforms for Sharing and Dematerialisation”**.

In this simulation, each student group will represent a social actor, including:

- (i) large-scale industries;
- (ii) technology startups;
- (iii) the third sector (NGOs);
- (iv) schools, universities, and research institutes;
- (v) citizens;
- (vi) public authorities.

The instructor should guide the hearing with the following central issue:

“In recent years, the increased consumption of electronic devices (such as mobile phones, computers, tablets, and household appliances) has generated a significant volume of electronic waste. Only a small proportion of this waste is recycled, with the majority being disposed of improperly, leading to environmental problems and the loss of valuable materials. In addition to the large volume of electronic waste produced, there is a growing need to reconsider the consumption of electronic devices and to discourage planned obsolescence. Frequently, products that could be reused or shared are discarded prematurely. This occurs not only due to device wear and tear but also as a result of consumer desire for newer models.”

Adaptation: In classes with younger students, the task may be too complex. In such cases, the number of stakeholders may be reduced, or each group may instead be asked to create a poster presenting solutions for electronic waste, rather than engaging in the debate simulation.

STAKEHOLDER ENGAGEMENT

SESSION 5

This topic enables each group to engage in dialogue on how the circular economy can improve the situation, taking into account environmental impact, resource recovery, and new economic opportunities. It is anticipated that the discussion will explore how sharing platforms and product dematerialisation can be applied to, for example, extend product lifecycles or reduce the volume of discarded electronics.

Each group will initially be allocated 20 minutes to prepare their position for the public hearing, addressing issues and potential solutions related to their assigned social actor.

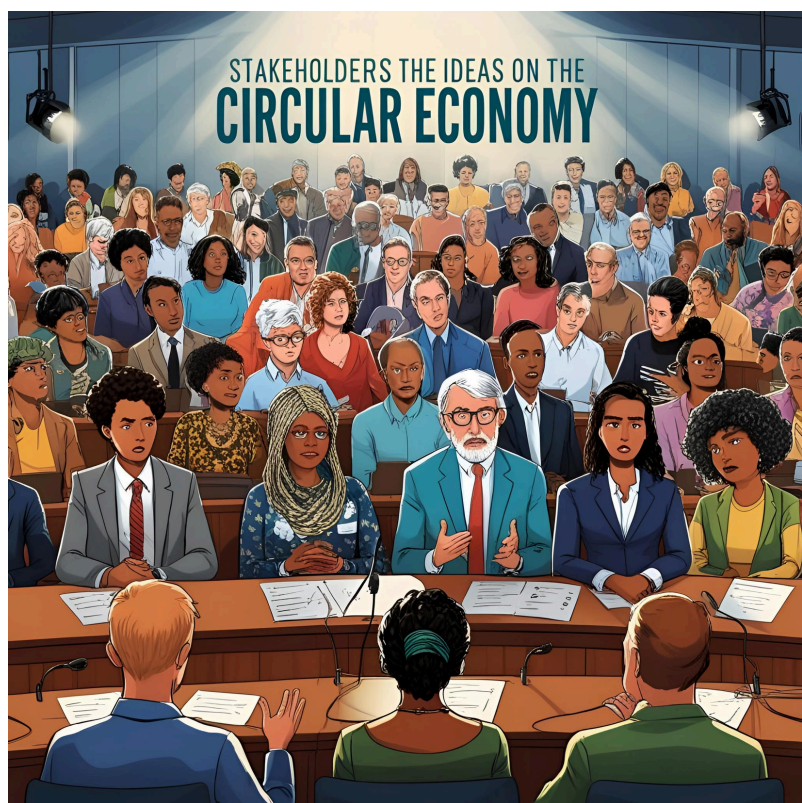
During the hearing, each group will have 10 minutes for their presentation, followed by an additional 5 minutes allocated for critiques, compliments, or suggestions from the other social actors. The instructor may facilitate the discussion by encouraging collaboration among the different groups to combine efforts. It is expected that the “actors” will discuss aspects such as:

1. Large Industries: The costs associated with adapting to recycling systems and optimising production processes; Challenges in sustainable product design, including research and development difficulties, the necessity of economies of scale, and the balance between voluntary initiatives and regulatory requirements; The impact of industrial symbiosis platforms, which facilitate waste exchange between companies, and the need for digital applications that connect businesses.; Exploration of new business models, such as “product-as-a-service”—for instance, leasing electronic devices instead of selling them—which could reduce the number of newly manufactured products.

2. Technology Startups: Development of innovative solutions for the collection and recycling of electronic waste; Implementation of tracking and product return platforms to enhance circularity; Creation of consumer monitoring applications, industrial symbiosis apps, and digital platforms for product sharing, rental, or repair services to extend product lifecycles and minimise waste.

3. Schools, Universities, and Research Institutes: These stakeholders could highlight existing research and technological advancements in electronic component reuse and circular design. They may propose collaborations between the public and private sectors to facilitate the testing and implementation of innovative solutions. Schools and universities could discuss curriculum integration, emphasising the need for teacher training and student awareness regarding circular economy principles.

4. Third Sector (NGOs): NGOs would play a key role in advocating for circular economy education and raising public awareness about proper electronic waste disposal, circular design, and product sharing. They could promote the development of public policies to support circular economy initiatives. Additionally, NGOs might propose awareness campaigns to encourage product sharing and extended product use. They could also suggest the creation of support hubs that connect consumers with industries to facilitate reverse logistics and ensure the proper disposal of electronic materials.



5. Citizens: Citizens would present their perspectives on conscious disposal, the challenges of properly discarding electronic waste, and their expectations regarding solutions provided by businesses and governments. They may express concerns and opinions on sharing platforms, debating their preferences between ownership and access. Discussions could address issues such as trust in the quality of shared products, the perceived value of dematerialisation, and even the cost or social stigma associated with circular products, including remanufactured, second-hand, or recycled items.

6. Public Authorities: Public authorities could propose public policies and regulations aimed at encouraging or enforcing electronic recycling practices, including subsidies, collection infrastructure, and partnerships for environmental education. They might explore incentive policies for sharing platforms and regulations to ensure the safety and appropriate use of electronic devices. Additionally, they could propose fiscal policies that benefit companies promoting dematerialisation and the sharing of electronic products.

The ideas outlined above may be distributed to the groups in advance. This approach allows for multiple possibilities of argumentation and negotiation, which should be facilitated by the instructor, encouraging students to reflect on the collaboration between different sectors to address environmental and social challenges.

To conclude the activity and reinforce learning, the groups may be encouraged to prepare a report summarising the main conclusions related to each social actor.

GAMIFICATION

SESSION 6

Required materials: Printed physical games; computer laboratory and/or mobile phones with internet access.



In this session, students will engage with both physical and digital games focused on the circular economy. Author-designed games are also proposed, given the difficulty in finding freely available online games in Portuguese that are easy for teachers to implement, do not require complex computer operating systems, and are still appealing to the target age group. Similarly, many of the games identified addressed the broader theme of sustainability rather than circular economy specifically; therefore, analogue games were developed that can be printed and used in class.

It is suggested to begin with the “Circular Economy Bingo” (an original game design available for free download).



CIRCULAR ECONOMY BINGO

APPENDIX E

The game was developed based on concepts extracted from ISO 59004 (Circular Economy – Vocabulary, Principles, and Implementation Guidelines) and the guide Circular Economy in Practice: Implementation Guide According to the ABNT NBR ISO 59000 Series (CNI, 2024). The objective of the bingo is to facilitate students’ learning of circular economy concepts in an interactive and engaging manner.

To play, the instructor distributes different bingo cards to the students. A card with descriptions is then drawn, and the instructor reads aloud the definition or example on the card without mentioning the corresponding term. It is recommended that the term be revealed only after 30 seconds, allowing students to attempt to identify it independently.

Students must identify the term corresponding to the definition and mark it on their cards (using beans, popcorn, or other small objects) if present. The game continues until a student completes their entire card by marking all the relevant terms. Upon completion, the student calls out “Bingo.” The instructor then verifies whether the marked terms are correct and, if so, declares the winner.

Following the bingo activity, it is suggested to set up various stations in the classroom or computer lab, allowing students to play additional physical and digital games, including:

Teaching circular economy also requires an approach that leverages technology and aligns with students’ needs (Ab Hamid et al., 2024). Accordingly, Stage 6 involves gamification, defined as the use of game elements and dynamics in non-game contexts such as education, business, and professional training. Educational games provide students with experiential learning opportunities, fostering active engagement, developing management competencies, and enhancing learning outcomes (De La Torre, 2021). Through player engagement and competitive, entertainment-related elements, these games elicit emotional involvement that stimulates critical thinking—a key learning objective in circular economy education, yet challenging to implement from a theoretical perspective (De La Torre, 2021). Gamification transforms learning into an interactive and immersive experience, making the teaching of circular economy more dynamic and effective.

As it is necessary to provide flexible models and methodologies adaptable to specific circumstances and constraints (De La Torre, 2021), various online games, applications, and even physical games—such as printable board games and original tools—are recommended. These resources can be tailored to the particular needs of each school, instructor, or class.

An Open Access Platform has also been created, compiling both existing and newly developed tools, allowing educators to select those most appropriate for their context. Access it at:

[WWW.\[REFERENCE HIDDEN FOR BLIND REVIEW PURPOSES\]](#)



CIRCULAR ECONOMY DOMINOES

APPENDIX C

Original proposal – available for free download and printing. The developed domino game consists of 30 cards, in which students must match circular economy concepts with their corresponding terms. It is recommended that the game be printed on durable material and played with a minimum of four players.



CIRCULAR ECONOMY BOARD

APPENDIX B

Original proposal – available for free download and printing. In this game, students use dice and pawns to draw cards representing behaviours, which they must correctly classify as either circular or linear economy in order to advance on the board. The game also includes cards with true-or-false questions and open-ended prompts. Additionally, green-backed cards illustrating the consequences of the linear economy may move pawns or even return all players to the start of the board, thereby enhancing the element of fun during gameplay.



10 RS” PUZZLE

APPENDIX F

A puzzle has been developed in which each piece represents one of the “10 Rs of the Circular Economy” (Refuse, Rethink, Reduce, Reuse, Repair, Restore, Remanufacture, Repurpose, Recycle, and Recover). Each piece includes definitions and examples of the corresponding term and must be placed in the correct hierarchical order. The central idea is to prioritise preventive actions (such as avoiding waste generation) over corrective measures (such as treating generated waste).

GAMIFICATION

SESSION 6

ONLINE GAMES



GUARDIANS OF THE PLANET AND THE SUSTAINABLE DEVELOPMENT GOALS

[HTTPS://JOGO.1.INPEVCAMPOLIMPO.ORG.BR](https://jogo.1.inpevcampolimpo.org.br)

The Environmental Education Programme Verde Campo offers the online game Guardians of the Planet and the SDGs. This game was selected due to its intuitive interface, availability in Portuguese, and its integration of the 5Rs for Sustainability and the Circular Economy with the Sustainable Development Goals (SDGs).



HUM-1976: ECO-SOCIUS

[HTTPS://VIRTUAL.FEBRACE.ORG.BR/2023/HUM/1976](https://virtual.febrace.org.br/2023/hum/1976)

It is a mobile educational game app on circular economy, developed by Victória Leal Altmayer Silva from IFRS – Osório Campus. The game is intuitive and easy to understand, recommended for young people aged between 14 and 19, and is available for download exclusively on the Play Store (for Android devices). The board game, based on a question-and-answer format, challenges players to reduce carbon emissions by transitioning from a linear to a circular economy. Available in Portuguese.



BEECARBONIZE

[HTTPS://STORE.STEAMPOWERED.COM/APP/2486750/BEECARBONIZE/?L=BRAZILIAN](https://store.steampowered.com/app/2486750/BEECARBONIZE/?l=brazilian)

The game Beecarbonize was selected because it is freely available on both Steam and Google Play, is offered in Portuguese, does not require advanced operating systems, includes a guided tutorial, and has received positive user reviews. In the game, the enemy is carbon emissions, and players must take action through cards, such as researching advanced technologies, enacting policies, protecting ecosystems, and modernising industry in order to prevent climate catastrophe. The game also includes cards specifically related to the circular economy. According to the Steam website, the simulation is accessible yet complex, making it particularly suitable for lower secondary education (Ensino Fundamental II), as it presents a greater challenge than the other games previously listed. Available in: English, Czech, French, Spanish and Portuguese (Brazil).



OTHER GENERALIST GAMES

Other, more general games focused on sustainability and sustainable development may also be proposed.



SUSTAINABLE DEVELOPMENT GOALS

[HTTPS://GO-GOALS.ORG/DOWNLOADABLE-MATERIAL](https://go-goals.org/downloadable-material)

Board game available for free printing. According to the developers (Go-Goals.org), the objective is to teach the Sustainable Development Goals (SDGs) in a simple manner and to encourage reflection on everyday actions that could contribute to achieving these goals. Although it is highly intuitive and available in Portuguese, it was designed primarily for children aged 8 to 10 years.



PLANET TRAIL

[HTTPS://WAGNERPASSOSBLOG.BLOGSPOT.COM/P/MATERIAIS-DIDATICOS.HTML](https://wagnerpassosblog.blogspot.com/p/materiais-didaticos.html)

Board game available for free printing. According to the author's blog, the game begins with a polluted city, and as players advance along the board, they encounter both positive and negative behaviours towards people and nature. By the end of the game, a vibrant and colourful world is revealed.



ON THE SUSTAINABLE PATH

[HTTPS://WWW.ATIVIDADESEDUCATIVAS.COM.BR/ATIVIDADES/7788-SUSTENTABILIDADEETABULEIRO/INDEX.HTML](https://www.atividadeseducativas.com.br/atividades/7788-sustentabilidade-etabuleiro/index.html)

Online board game (COPASA). The player advances the number of spaces indicated by the virtual spinner and is rewarded for sustainable actions while being penalised (moving backwards on the board) for incorrect behaviours. It can also be used with students in Early Primary Education.



MEMORY GAME ABOUT THE 5RS

[HTTPS://WWW.ATIVIDADESEDUCATIVAS.COM.BR/INDEX.PHP?ID=15988](https://www.atividadeseducativas.com.br/index.php?id=15988)

Through a simple virtual memory game, students are assisted in memorising the 5Rs of sustainability: Rethink, Refuse, Reduce, Reuse, and Recycle. This game is also suitable for younger students in primary education (Elementary School I).

Note: Priority was given to games in Portuguese; however, other games can also be found at:

<https://www.atividadeseducativas.com.br/index.php?id=15751> and <https://games4sustainability.org>

The instructor may allow students the freedom to explore these websites independently, as well as to discover new games.

It is important to emphasise the instructor's role as a facilitator during the competition, fostering a collaborative and respectful environment.

If the school has sufficient budget, robust information technology systems, and extended available instructional time, games requiring paid expansions, such as The Sims – Sustainable Life, are recommended.



ART EXHIBITION

SESSION 7

ABOUT

As a closing activity, it is proposed to conduct an Artistic Exhibition, which aligns with the growing body of evidence from learning science highlighting the educational effectiveness of active and playful learning approaches (Blikoff et al., 2023). The Artistic Exhibition is a pedagogical strategy grounded in active and playful learning, wherein students express their knowledge and perceptions through photographs, comic strips, songs, and other artistic forms.

Within the context of teaching Circular Economy (CE), this approach enables students to connect theoretical concepts with personal and creative experiences, positioning them as protagonists of their own learning process. Students achieve better learning outcomes when they are active and engaged in meaningful, socially interactive, iterative, and joyful learning environments (Blikoff et al., 2023).

Playfulness fosters an affective climate conducive to learning, introducing lightness, enjoyment, and pleasure into the classroom—benefits that extend beyond children to learners of all ages (Scheuer and Cremin, 2024). Playful activities serve as effective tools for teaching and learning sustainability concepts, stimulating reflection on the importance of socio-environmental awareness in everyday life (Moraes et al., 2024). This approach strengthens critical, creative, and socio-emotional skills while broadening awareness and fostering dialogue regarding the necessity of sustainable practices in society.

The exhibition may include comic strips and cartoons about the circular economy, student-produced photographs, songs previously created with the assistance of artificial intelligence, and other relevant materials sourced from the internet, as detailed below.

For classes with younger students or activities with limited time, certain works have been adapted into colouring versions with the assistance of artificial intelligence and are available at [www.\[Reference hidden for blind review purposes\]](http://www.referencehiddenforblindreviewpurposes.com). Students are encouraged to complete the colouring and compose a short reflective text alongside their work.

Required materials: computer with multimedia projector, cell phones with cameras, speakers, room for displaying materials, recyclable materials, drawings for printed paintings.

ACTIVITY 1: PHOTOGRAPHY AT SCHOOL

On this day, students are expected to bring their waste diaries for discussion, along with the recyclable materials they have collected, as proposed in Step 1. Initially, the instructor should project images by the American photographer Gregg Segal from the project *Seven Days of Garbage*: <https://greggsegal.com/P-Projects/7-Days-of-Garbage/4/thumbs>) to the students. This will serve as a stimulus for discussion, encouraging students to present and reflect on their own waste diaries.

Subsequently, students will have approximately one hour to recreate Segal's photographs using their own waste or to take a brief guided walk around their school or local area (accompanied by the instructor) to photograph examples illustrating either the application or absence of circular economy principles.

Following the activity, students will return to the classroom to display their images via projector and engage in a group discussion about their findings. From the photographs taken, at least one image per group will be selected for inclusion in the Artistic Exhibition.

The works of Vik Muniz may also be explored (<https://vikmuniz.net/pt/gallery/garbage>). Vik Muniz is a Brazilian visual artist who uses waste materials to create his artworks, including photographs that address social and environmental issues.

ACTIVITY 2: CIRCULAR GALLERY

It is proposed to organise an Art Exhibition encompassing humour, photography, cartoons, comic strips, and music focused on the circular economy. Schools should create a “Circular Gallery”, for example in a corridor or classroom, where students' artworks and photographs can be displayed for other classes, either in printed format or via projectors.

An additional incentive may be provided in the form of an award for the best photograph or artwork, based on criteria such as creativity, relevance to the theme, originality, and visual impact. For the award, an open vote (either virtual or in-person) could be conducted to select the most impactful artwork or photograph, giving voice to students and the wider school community. If feasible, this activity should be guided by a formal notice or brief, fostering a healthy and transparent competitive environment. Voting boxes may be transparent, and votes could be cast using bottle caps, promoting both the collection of recyclable materials and student engagement, as suggested by Inella et al. (2023).

It is also recommended that the award-winning images be shared in the 1st International Humour Exhibition on Environmental Education at the V CEPEA Sul, available at <https://cpeasul.blogspot.com/search/label/Mostra%20de%20Humor%20sobre%20Educa%C3%A7%C3%A3o%20Ambiental>. Comic strips on the circular economy may also be displayed to promote reflection on the topic, such as the Família Folhas series (Prefeitura de Curitiba: <https://familiafolhas.curitiba.pr.gov.br/>). Students may also be encouraged to create their own cartoons and comic strips.

It is recommended that students participate in setting up the gallery as well as welcoming other classes. On this day, the music created in Stage 2 may also be presented to visiting classes. Alternatively, the “Circular Gallery” can be implemented virtually via Padlet (<https://padlet.com/>), with the link shared with students, families, and the wider community.



CLOSURE

SESSION 8

Following the completion of the didactic sequence, it is important to administer the questionnaire used at the beginning of the activities again (post-test) to assess any improvements in students' knowledge, skills, and attitudes. The post-test aims to measure the impacts of the intervention and to collect both qualitative and quantitative feedback regarding its effectiveness. Additional questions are also included to evaluate students' motivation in relation to the activities undertaken.

This individual-level assessment seeks to obtain information on and record students' progress concerning the intended learning outcomes, as well as to provide feedback on the success of teaching and learning processes, thereby supporting the planning, implementation, and improvement of these processes (UNESCO, 2017). In the context of circular economy education, the post-test plays a crucial role in validating learning, identifying areas for improvement, and facilitating the continuous adjustment of the Educational Programme, ensuring that the pedagogical approach is effective, engaging, and replicable. It should be noted that the pre- and post-tests contain the same questions, except for the final section of the post-test, which includes additional items addressing students' perceptions and motivations regarding the methodology and the games employed.

➤➤➤ POST-TEST (APPENDIX A)

Following the post-test, a period of reflection and discussion should be encouraged, allowing students to share their perceptions of the activities undertaken, highlighting strengths and weaknesses, and offering suggestions for future improvements to the Programme. It is also recommended to include a brief symbolic closing ceremony for the Circular Economy module, recognising students' participation through digital certificates or public acknowledgement, thereby reinforcing a sense of achievement and belonging. Schools may share the experience and outcomes through their communication channels (websites, noticeboards, or social media), enhancing the visibility of the project and inspiring other institutions.

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APPENDIX A

PRE AND POST TEST

This test aims to assess your prior knowledge and perceptions of the circular economy. It will be administered both before and after participation in the Educational Programme for the Circular Economy to determine whether the activities have produced positive outcomes and to help improve them for future students. Thank you very much for your participation!

>>> PRELIMINARY QUESTIONS

1. Age (please indicate only the number): _____

2. Gender:

☐ Female

☐ Male

☐ Other. Please specify: _____

☐ Prefer not to answer

3. City and neighborhood where you live: _____

4. Have you heard of the circular economy?

☐ Yes

☐ No

5. What do you think is a circular economy?

6. On a scale from 1 to 5, where 1 represents no knowledge and 5 represents extensive knowledge, how would you rate your understanding of the circular economy?

7. On a scale from 1 to 5, where 1 represents no interest and 5 represents a high level of interest, how would you rate your interest in learning about the circular economy?

8. On a scale from 1 to 5, where 1 represents no interest and 5 represents a high level of interest, how would you rate your interest in implementing circular economy ideas and actions in your home or school?



PRE AND POST TEST

>>> KNOWLEDGE QUESTIONS (UNDERSTANDING)

9. The Circular Economy is a model based on:

- a) Extracting resources, producing products, using them, and disposing of them.
- b) Eliminating waste and pollution, while keeping products, components, and materials at their highest utility and value at all times.
- c) Promoting recycling as the primary means to ensure sustainable growth.
- d) Increasing production to drive economic growth.

10. Which approaches can facilitate the adoption of the circular economy?

- a) Finding ways for companies to collect and recover their products from consumers (reverse logistics)
- b) Implementing new business models, such as sharing platforms
- c) Applying strategies like circular design in product development
- d) All of the above

11. Which action helps to regenerate nature within the circular economy?

- a) Using high-carbon energy sources, such as coal, oil, and natural gas
- b) Implementing practices that return more to nature than is taken, such as regenerative agriculture
- c) Avoiding practices like composting
- d) Extracting virgin raw materials and practising monoculture

12. How can companies adopt the circular economy?

- a) By developing single-use products that can be quickly replaced
- b) By using cheap and abundant raw materials
- c) By increasing the production of disposable plastics
- d) By designing products that are easy to disassemble, with replaceable parts, and providing repair guides for users

13. Regarding sustainable production and consumption, select the correct option:

- a) The concept of sustainable consumption involves acquiring products in large quantities at low cost, taking advantage of promotions
- b) Sustainable production is solely the responsibility of companies, while sustainable consumption depends only on the government
- c) Sustainable production and consumption involve practices such as “product-as-a-service” business models, where consumers can rent or share products instead of purchasing them
- d) Sustainable consumption is only possible in developed countries, where there is greater access to clean technologies and eco-friendly products

14. What is industrial symbiosis?

- a) A company using another company’s waste as raw material
- b) Producing more disposable products
- c) A greenwashing strategy
- d) A type of certification ensuring that industrial products are produced without environmental impact

15. How can the transition to a circular economy be achieved in a fair, inclusive, and equitable manner?

- a) By reducing taxes for companies that increase production
- b) By increasing the profits of large corporations
- c) By contributing to poverty reduction through job creation, lowering the cost of living, circular entrepreneurship, and social innovation, such as recycling cooperatives
- d) The circular economy is based solely on economic pillars and therefore does not need to address social issues



PRE AND POST TEST

>>> QUESTIONS ON SKILLS (KNOW-HOW)

Please indicate the extent to which you agree with the following statement:

- a) I strongly dislike wasting resources, such as food, water, or energy.
- b) I consider it a good idea for supermarkets to stop providing plastic bags to customers, as I am aware of the environmental impacts of plastic.
- c) I believe it is important to purchase durable products, such as mobile phones, and take good care of them to extend their lifespan.
- d) I consider it important for countries and companies to invest in clean energy sources, such as solar and wind power.
- e) I believe it is important to adopt sustainable practices in the use of materials, such as using both sides of paper, avoiding unnecessary printing, and prioritising digital files whenever possible.
- f) I consider it a good idea to minimise the number of personal possessions, such as bicycles, electronics, and clothing.
- g) I am able to think of ways to reuse materials that would otherwise be discarded, such as bottles or clothing.
- h) Awareness campaigns on sustainability, circular economy, and social causes are important.

Response options:

- a) Strongly disagree
- b) Disagree
- c) Neither agree nor disagree
- d) Agree
- e) Strongly agree

>>> QUESTIONS ON ATTITUDES (DOING)

Please indicate the extent to which you agree with the following statements:

- a) I seek to avoid unnecessary use of electricity—turning off lights when leaving a room and preferring natural lighting whenever possible.
- b) I separate waste to facilitate recycling.
- c) I use the same water bottle multiple times.
- d) I participate in activities such as caring for gardens or vegetable plots at school or in the community, composting, planting trees, or joining clean-up initiatives.
- e) I shop at second-hand stores to reduce the consumption of new raw materials.
- f) I try to reuse materials or transform waste into something useful.
- g) I share items such as bicycles and clothing with family and friends.
- h) I repair broken products whenever possible.
- i) I purchase products unnecessarily, for instance when a new model is released or because it is fashionable.
- j) I am interested in social and environmental causes and try to positively influence others, for example by sharing experiences about eco-friendly products or social causes on social media or discussing these topics with friends and family.
- k) Whenever possible, I choose to consume products that are less polluting, have eco-friendly designs, or support organisations that protect the environment or promote social causes.

Response options:

- a) Never
- b) Rarely
- c) Occasionally
- d) Frequently
- e) Very frequently



POST TEST

>>> ADDITIONAL QUESTIONS

Please indicate the extent to which you agree with the following statements:

- a) I enjoyed the circular economy lessons/activities.
- b) I had fun participating in the circular economy activities.
- c) I learned new things about the circular economy by participating in the activities.
- d) The activities increased my interest in the circular economy.
- e) After the activities, I feel more motivated to adopt sustainable behaviours in my daily life and to help care for the planet.
- f) After participating in the activities, I feel enthusiastic about discussing the circular economy with my classmates and friends.
- g) I believe that games and digital resources about the circular economy helped me to better understand the topic.

Response options:

- a) Strongly disagree
- b) Disagree
- c) Neither agree nor disagree
- d) Agree
- e) Strongly agree

Regarding the games used, would you play them again?

☐ Yes ☐ No ☐ Maybe

Would you recommend the Programme to your friends and family?

☐ Yes ☐ No ☐ Maybe

Which activity (game, video, project) did you enjoy the most? Why?

After participating in the activities, have you started doing anything differently to care for the environment? Please describe any changes. / Have you applied any ideas learned from the Programme in your daily life? If so, which ones?

How did you feel while learning about the circular economy? (e.g., bored, curious, excited, concerned, inspired).

Please rate the Circular Economy Programme on a scale from 1 (lowest) to 10 (highest): _____

Would you like to leave any additional comments, compliments, criticisms, or suggestions?

[illegible]

Circular Economy BOARD



A CHAIR DESIGN PROJECT
UTILISING RECYCLED MATERIALS.
SPECIFICALLY ENGINEERED FOR
EASY DISASSEMBLY AND
SUBSEQUENT RECYCLING



() LINEAR ECONOMY OR
(X) CIRCULAR ECONOMY?

A FASHION COMPANY HAS
LAUNCHED A CLOTHING
LINE MADE ENTIRELY FROM
RECYCLED AND
BIODEGRADABLE
MATERIALS



() LINEAR ECONOMY OR
(X) CIRCULAR ECONOMY?

IMPLEMENTATION OF
A RETURN AND REUSE
SYSTEM FOR GLASS
PACKAGING.



() LINEAR ECONOMY OR
(X) CIRCULAR ECONOMY?

MASS PRODUCTION OF
PLASTIC TOYS THAT ARE
DISCARDED AFTER ONLY A
FEW USES



(X) LINEAR ECONOMY OR
() CIRCULAR ECONOMY?

DISPOSAL OF
ELECTRONIC WASTE
IN LANDFILLS



(X) LINEAR ECONOMY OR
() CIRCULAR ECONOMY?

YOU HOSTED A
BIRTHDAY PARTY USING
PLASTIC CUPS THAT
WERE USED ONLY ONCE
AND THEN THROWN
AWAY



(X) LINEAR ECONOMY OR
() CIRCULAR ECONOMY?

YOUR REGION HAS ADOPTED
REGENERATIVE
AGRICULTURAL PRACTICES.
IMPROVING SOIL HEALTH
AND PRODUCTIVITY.



ROLL THE DICE AND CHOOSE
A PLAYER TO MOVE
FORWARD WITH YOU.

THE GROUP BEHIND YOU
ON THE BOARD
CHANGES PHONES WITH
EACH NEW TURN.

ASK THEM TO MOVE
BACK 3 SPACES.



A FLOOD HAS OCCURRED.
AND ALL RESIDENTS HAD TO
FLEE THEIR HOMES. LEAVING
EVERYTHING BEHIND.

ALL PLAYERS MUST RETURN
TO THE START OF THE BOARD.





YOU ARE A CUSTOMER OF
A FURNITURE FACTORY
THAT USES RECYCLED
WOOD AND OFFERS
PRODUCT REPAIR
SERVICES.

() LINEAR ECONOMY OR
(X) CIRCULAR ECONOMY?



DEVELOPMENT OF A MODULAR SMARTPHONE
WHERE PARTS CAN BE REPLACED OR UPGRADED
INSTEAD OF BUYING A NEW DEVICE.

() LINEAR ECONOMY OR
(X) CIRCULAR ECONOMY?



A SHOE FACTORY ACCEPTS
OLD SHOES FOR
RECYCLING AND USES
THEM TO PRODUCE NEW
MODELS.

() LINEAR ECONOMY OR
(X) CIRCULAR ECONOMY?

BETA INDUSTRIES
IGNORED PREVENTIVE
MAINTENANCE AND HAD
TO DISCARD AN
EXPENSIVE PIECE OF
EQUIPMENT.



(X) LINEAR ECONOMY OR
() CIRCULAR ECONOMY?



EXCESSIVE
CONSUMPTION OF
FAST FASHION
CLOTHING THAT IS
WORN ONLY A FEW
TIMES.

(X) LINEAR ECONOMY OR
() CIRCULAR ECONOMY?



EVERY WEEK, YOU
ORDER DELIVERY
WITH EXCESSIVE
PACKAGING.

(X) LINEAR ECONOMY OR
() CIRCULAR ECONOMY?



YOUR CITY IS FACING
AN ENERGY CRISIS
WITH FREQUENT
BLACKOUTS.

DON'T PLAY FOR A
ROUND.

THE AMOUNT OF SINGLE-
USE PLASTIC IN YOUR
COMMUNITY IS OUT OF
CONTROL.

SWAP YOUR TOKEN WITH
THE PLAYER IN THE LAST
POSITION.



HEAVY RAINS CAUSED A
LANDSLIDE THAT
BLOCKED THE PATH.

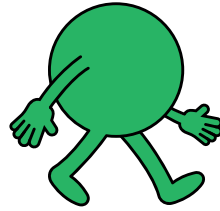
SKIP ONE TURN WHILE THE
AREA IS STABILISED.





YOU PREFER USING
MUSIC, BOOK, AND
MOVIE STREAMING
SERVICES INSTEAD OF
BUYING PHYSICAL
PRODUCTS.

() LINEAR ECONOMY OR
(X) CIRCULAR ECONOMY?



YOUR GROUP TOOK PART IN
CREATING A COOPERATIVE
FOR COMPOSTING ORGANIC
WASTE IN THE
NEIGHBOURHOOD.

() LINEAR ECONOMY OR
(X) CIRCULAR ECONOMY?

DEVELOPMENT OF AN APPLIANCE RENTAL
SYSTEM WHERE CUSTOMERS PAY PER USE
AND RETURN ITEMS FOR RECONDITIONING.



() LINEAR ECONOMY OR
(X) CIRCULAR ECONOMY?

OIL EXTRACTION TO
MANUFACTURE
SINGLE-USE
PLASTIC
PRODUCTS.

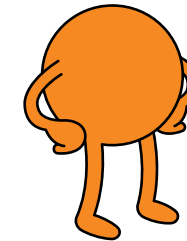


(X) LINEAR ECONOMY OR
() CIRCULAR ECONOMY?

AN AREA NEAR YOUR
HOME IS SUFFERING
FROM ILLEGAL
DEFORESTATION.



(X) LINEAR ECONOMY OR
() CIRCULAR ECONOMY?



AIR QUALITY IN YOUR
CITY HAS WORSENERD
DUE TO INCREASED
CARBON EMISSIONS.

(X) LINEAR ECONOMY OR
() CIRCULAR ECONOMY?

TORNADO ALERT! THE
STRONG WINDS HAVE
MOVED THE PIECES
AROUND — EVERYONE
MUST SWITCH THEIR GAME
PIECES WITH THE GROUP
TO THEIR RIGHT.



A MAJOR REFORESTATION
PROJECT WAS
SUCCESSFULLY
COMPLETED.



SWAP YOUR PIECE WITH THE
GROUP CURRENTLY IN FIRST
PLACE.

A GLOBAL CLEANUP INITIATIVE REMOVED TONS OF
PLASTIC FROM THE OCEAN. SAVING MANY MARINE
SPECIES.



() LINEAR ECONOMY OR
(X) CIRCULAR ECONOMY?

ONLINE PLATFORM FOR BUYING
AND SWAPPING SECOND-HAND
CLOTHES BETWEEN CONSUMERS.



() LINEAR ECONOMY OR
(X) CIRCULAR ECONOMY?



YOUR CITY HAS
IMPLEMENTED A
BICYCLE-SHARING
SYSTEM.

() LINEAR ECONOMY OR
(X) CIRCULAR ECONOMY?



DESIGN OF AN
INDUSTRIAL PARK WHERE
THE WASTE FROM ONE
FACTORY IS USED AS RAW
MATERIAL BY ANOTHER.

() LINEAR ECONOMY OR
(X) CIRCULAR ECONOMY?

PRODUCTION OF
ELECTRONICS WITH
PLANNED
OBSOLESCENCE.
DESIGNED TO LAST ONLY
A SHORT TIME.



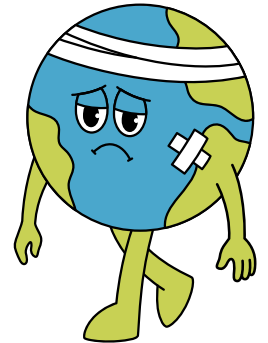
(X) LINEAR ECONOMY OR
() CIRCULAR ECONOMY?

DEVELOPMENT OF
BIODEGRADABLE
CLOTHING THAT
NATURALLY
DECOMPOSES AT THE
END OF ITS LIFE CYCLE.



() LINEAR ECONOMY OR
(X) CIRCULAR ECONOMY?

LARGE AMOUNTS OF
FOOD ARE BEING
WASTED AT YOUR
SCHOOL.



(X) LINEAR ECONOMY OR
() CIRCULAR ECONOMY?

MELTING OF THE POLAR ICE
CAPS:
SEA LEVELS HAVE RISEN.
FLOODING PART OF THE
COASTLINE.



ALL PLAYERS MUST MOVE
BACK FIVE SPACES TO AVOID
THE FLOODED AREAS.

THE USE OF PLASTIC
STRAWS HAS LED TO
THE DEATH OF SEVERAL
DOLPHINS.



SWAP PLACES WITH THE PLAYER IN LAST
POSITION TO REFLECT ON
ENVIRONMENTAL IMPACT.

A LACK OF RAINFALL
HAS SEVERELY
AFFECTED
AGRICULTURAL
PRODUCTION.



LOSE ONE TURN TO REORGANISE AND
SEEK NEW WATER SOURCES.

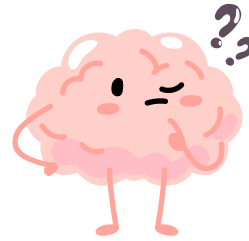
YOUR SCHOOL INSTALLED
LIGHTING SENSORS TO
AVOID LEAVING LIGHTS
ON UNNECESSARILY.



() LINEAR ECONOMY OR
(X) CIRCULAR ECONOMY?

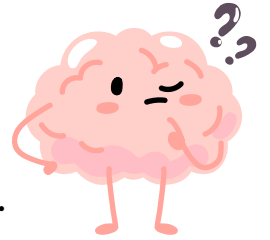
A CLOTHING BRAND OFFERS
DISCOUNTS TO CUSTOMERS
WHO RETURN THEIR USED
CLOTHES FOR RECYCLING.

BUT MOST ITEMS ARE NOT
REUSED.



(X) LINEAR ECONOMY OR
() CIRCULAR ECONOMY?

YOUR FAMILY
CONSUMES
EXCESSIVE
AMOUNTS OF MEAT.



(X) LINEAR ECONOMY OR
() CIRCULAR ECONOMY?

A COMPANY RECYCLES PET
BOTTLES TO PRODUCE NEW
BOTTLES.

BUT SELECTIVE COLLECTION
IS STILL LOW IN MOST
PLACES.



YOUR OPPONENTS MOVE FORWARD ONE
SPACE AND YOU MOVE BACK ONE SPACE.

A COMPANY
MANUFACTURES CUSTOM
FURNITURE USING MDF.
BUT DOES NOT CONSIDER
THE PRODUCT'S END-OF-
LIFE DISPOSAL.



(X) LINEAR ECONOMY OR
() CIRCULAR ECONOMY?

YOU MANAGED TO BUY AN
ELECTRIC VEHICLE. BUT IT HAS
LITHIUM BATTERIES WITH A
LIMITED LIFESPAN AND
DIFFICULT RECYCLING.



YOUR OPPONENTS MOVE FORWARD ONE
SPACE AND YOU MOVE BACK ONE SPACE.

INSTEAD OF
TRAVELLING 800 KM
TO ATTEND A
MEETING. YOU
PARTICIPATED
ONLINE.



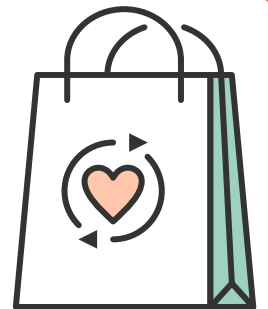
() LINEAR ECONOMY OR
(X) CIRCULAR ECONOMY?

YOU HELPED CREATE
A COMMUNITY
GARDEN THAT
PROVIDES FRESH
FOOD FOR THE
NEIGHBOURHOOD.



() LINEAR ECONOMY OR
(X) CIRCULAR ECONOMY?

YOU BUY CLOTHES AT
THRIFT STORES AND ALSO
ASSIST IN ORGANISING
CHARITY THRIFT SALES.



() LINEAR ECONOMY OR
(X) CIRCULAR ECONOMY?

**YOU STARTED A
CARPOOLING
PROGRAMME AT
YOUR SCHOOL.**



() LINEAR ECONOMY OR
(X) CIRCULAR ECONOMY?

**YOU IMPLEMENTED
A RAINWATER
COLLECTION
SYSTEM AT YOUR
HOME.**



() LINEAR ECONOMY OR
(X) CIRCULAR ECONOMY?

**YOUR COMPANY
DEVELOPED AN
EFFICIENT REVERSE
LOGISTICS SYSTEM
FOR ITS PRODUCTS.**



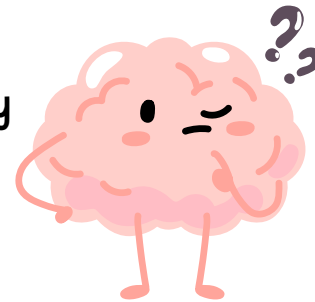
() LINEAR ECONOMY OR
(X) CIRCULAR ECONOMY?

**YOU LED A PROJECT TO
CREATE PRODUCTS
DESIGNED FOR
DURABILITY AND EASY
DISASSEMBLY.**



() LINEAR ECONOMY OR
(X) CIRCULAR ECONOMY?

**YOU FREQUENTLY
TRAVEL BY
PLANE.**



(X) LINEAR ECONOMY OR
() CIRCULAR ECONOMY?

**YOU BOUGHT A
BICYCLE BUT DO
NOT USE IT.**



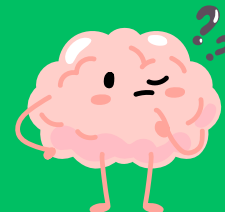
(X) LINEAR ECONOMY OR
() CIRCULAR ECONOMY?

**IMPLEMENTATION OF LARGE-
SCALE SOLAR PANELS, BUT
THERE IS NO PLAN FOR
DISPOSAL OR RECYCLING AT
THE END OF THE PANELS'
LIFESPAN.**



THE PLAYER IN FIRST PLACE LOSES THE NEXT TURN. AND THE
PLAYER IN LAST PLACE MAY ADVANCE TWO SPACES.

**A FAST-FOOD COMPANY
USES RECYCLED
PACKAGING, BUT FOOD
WASTE IS DISCARDED
WITHOUT COMPOSTING.**



INSTEAD OF MOVING FORWARD THE NUMBER OF SPACES
ROLLED, MOVE BACKWARD BY THAT AMOUNT.

**A CITY IMPLEMENTED AN ADVANCED
WASTEWATER TREATMENT SYSTEM, WHERE
WATER IS PURIFIED AND REUSED FOR
IRRIGATION AND INDUSTRIAL PROCESSES,
CLOSING THE WATER CYCLE.**



() LINEAR ECONOMY OR
(X) CIRCULAR ECONOMY?

A TOOL RENTAL SERVICE. WHERE CUSTOMERS SHARE EQUIPMENT INSTEAD OF BUYING NEW ONES.



() LINEAR ECONOMY OR
(X) CIRCULAR ECONOMY?

USE OF JUICE MANUFACTURING WASTE TO PRODUCE SECONDARY PRODUCTS. SUCH AS ANIMAL FEED OR COSMETICS.



() LINEAR ECONOMY OR
(X) CIRCULAR ECONOMY?

YOU HAVE ADOPTED A MINIMALIST LIFESTYLE AND REDUCED WASTE IN YOUR HOUSEHOLD.



() LINEAR ECONOMY OR
(X) CIRCULAR ECONOMY?



THE MARKET ON YOUR STREET DISCARDS LARGE QUANTITIES OF EXPIRED FOOD.

(X) LINEAR ECONOMY OR
() CIRCULAR ECONOMY?

YOU DO NOT BUY PRODUCT REFILLS; YOU ALWAYS USE COSMETICS AND SHAMPOOS IN PLASTIC PACKAGING THAT IS DISCARDED AFTER USE.



(X) LINEAR ECONOMY OR
() CIRCULAR ECONOMY?



YOU PARTICIPATED IN A WASTE COLLECTION PROGRAMME IN YOUR COMMUNITY.

() LINEAR ECONOMY OR
(X) CIRCULAR ECONOMY?

ELECTRONICS WERE DISCARDED WITHOUT SEEKING RECYCLING CENTRES.



SWAP YOUR
TOKEN WITH
THE PLAYER
IN LAST
PLACE.

YOU DONATED CLOTHES AND UNUSED ITEMS.



() LINEAR ECONOMY OR
(X) CIRCULAR ECONOMY?

ONLY SINGLE-USE PLASTIC PACKAGING IS USED IN YOUR HOUSEHOLD.



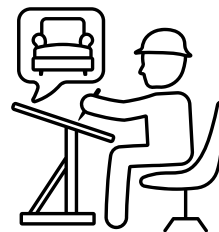
(X) LINEAR ECONOMY OR
() CIRCULAR ECONOMY?



THE MOST
DESIRED ACTION
IN THE CIRCULAR
ECONOMY IS
RECYCLING.

() TRUE OR
(X) FALSE?

ONE OF THE PRINCIPLES OF
THE CIRCULAR ECONOMY IS
SUSTAINABLE DESIGN,
WHICH PROMOTES MORE
DURABLE AND EASILY
REPAIRABLE PRODUCTS.



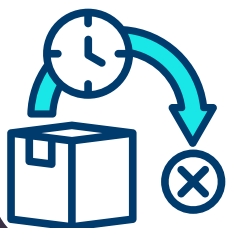
(X) TRUE OR
() FALSE?

THE CONCEPT OF THE CIRCULAR
ECONOMY IS BASED ON THE IDEA OF
IMITATING NATURAL CYCLES, WHERE
THERE IS NO WASTE.



(X) TRUE OR
() FALSE?

THE CIRCULAR ECONOMY
ENCOURAGES PLANNED OBSOLESCENCE
TO INCREASE PRODUCT RECYCLING.



() TRUE OR
(X) FALSE?

THE "CRADLE TO CRADLE" CONCEPT IS RELATED
TO THE CIRCULAR ECONOMY, AS IT
ADVOCATES THAT PRODUCTS SHOULD BE
DESIGNED TO RETURN TO THE ENVIRONMENT
WITHOUT CAUSING HARM.



(X) TRUE OR
() FALSE?



THE CIRCULAR ECONOMY
CAN ONLY BE APPLIED IN
THE INDUSTRIAL SECTOR
AND IS NOT VIABLE FOR
SMALL BUSINESSES OR
INDIVIDUAL CONSUMERS.

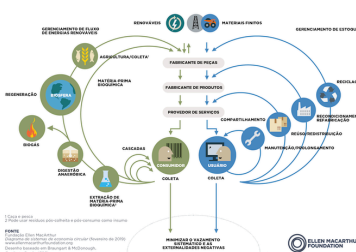
() TRUE OR
(X) FALSE?

IN BRAZIL, ABOUT 80% OF
PLASTIC PACKAGING IS
DISCARDED AFTER THE FIRST
USE.



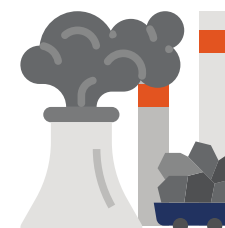
(X) TRUE OR
() FALSE?

THE CIRCULAR ECONOMY IS BASED ON
THE BUTTERFLY DIAGRAM.



(X) TRUE OR
() FALSE?

ONLY 30% OF THE GLOBAL ENERGY MIX
COMES FROM HIGH-CARBON SOURCES
SUCH AS COAL, OIL, AND NATURAL GAS.



() TRUE OR
(X) FALSE?

**WHAT IS THE ELLEN
MACARTHUR
FOUNDATION?**

POSSIBLE ANSWER:
A NON-PROFIT ORGANISATION THAT PROMOTES THE CIRCULAR
ECONOMY.

**WHAT IS INDUSTRIAL
SYMBIOSIS?**

POSSIBLE ANSWER:
A BUSINESS MODEL WHERE THE WASTE OF ONE COMPANY BECOMES
THE RAW MATERIAL FOR ANOTHER.

**WHAT IS PRODUCT AS A
SERVICE?**

POSSIBLE ANSWER:
A BUSINESS MODEL IN WHICH THE CONSUMER PAYS FOR THE USE OF A
PRODUCT INSTEAD OF BUYING IT. ENCOURAGING DURABILITY, REUSE, AND THE
CIRCULAR ECONOMY.

**GIVE AN EXAMPLE OF
PRODUCT
DEMATERIALISATION.**

POSSIBLE ANSWER:
NETFLIX, SPOTIFY, KINDLE...

**WHAT ARE THE 6 ACTIONS
OF THE RESOLVE
DIAGRAM?**

ANSWER:
REGENERATE, SHARE, OPTIMISE, CYCLE,
VIRTUALISE, AND EXCHANGE

**WHAT IS PLANNED
OBSOLESCENCE?**

POSSIBLE ANSWER:
IT IS A STRATEGY WHEREBY A PRODUCT IS DELIBERATELY MADE
UNUSABLE WITHIN A SHORT PERIOD OF TIME TO INCREASE
CONSUMPTION.



**UP TO 80% OF A
PRODUCT'S
ENVIRONMENTAL
IMPACT IS DETERMINED
DURING THE DESIGN
PHASE.**

(X) TRUE OR
() FALSE?

**WHAT IS REVERSE
LOGISTICS?**

POSSIBLE ANSWER:
ACTIONS AIMED AT THE COLLECTION AND RETURN OF SOLID
WASTE TO THE BUSINESS SECTOR.



**AT A GLOBAL LEVEL,
THE CONSUMPTION OF
RAW MATERIALS HAS
BEEN DECREASING IN
RECENT YEARS.**

() TRUE OR
(X) FALSE?

WHAT IS ECOLOGICAL FOOTPRINT?

POSSIBLE ANSWER:
CALCULATION OF THE AMOUNT OF NATURE NEEDED TO SUPPORT
PEOPLE OR AN ECONOMY.

THERE ARE "ISO"
STANDARDS RELATED
TO THE CIRCULAR
ECONOMY.



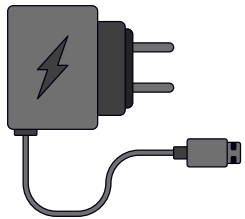
(X) TRUE OR
() FALSE?

BRAZIL ESTABLISHED
THE DECREE THAT
INSTITUTES THE
NATIONAL CIRCULAR
ECONOMY STRATEGY IN
1998.



() TRUE OR
(X) FALSE?

A SMARTPHONE INDUSTRY
ADOPTS DIFFERENT TYPES
OF CHARGERS WITH EACH
MODEL LAUNCHED.



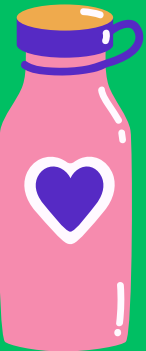
(X) LINEAR ECONOMY OR
() CIRCULAR ECONOMY?

REPAIRED APPLIANCE:
INSTEAD OF DISCARDING
YOUR BROKEN WASHING
MACHINE, YOU REPAIRED IT
AND EXTENDED ITS USEFUL
LIFE.



() LINEAR ECONOMY OR
(X) CIRCULAR ECONOMY?

LESS PLASTIC:
YOU STARTED USING REUSABLE BAGS.
A WATER BOTTLE. AND A REUSABLE
CUP. ELIMINATING THE USE OF
DISPOSABLE PLASTICS IN YOUR DAILY
LIFE.



MOVE FORWARD: MULTIPLY THE
NUMBER ROLLED ON THE DICE BY TWO.

CLOSED LOOP IN CONSTRUCTION: A
CONSORTIUM OF CONSTRUCTION
COMPANIES HAS DEVELOPED A SYSTEM
WHERE ALL DEMOLITION WASTE IS
REUSED IN NEW PROJECTS. REDUCING
THE NEED FOR NEW MATERIALS.



() LINEAR ECONOMY OR
(X) CIRCULAR ECONOMY?

HOME GARDEN: YOU HAVE CREATED A
GARDEN AT HOME AND NOW CONSUME FRESH
VEGETABLES. REDUCING THE NEED TO BUY
PACKAGED FOOD TRANSPORTED FROM AFAR.



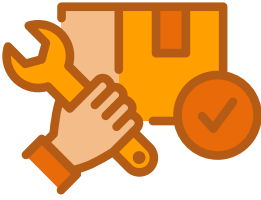
() LINEAR ECONOMY OR
(X) CIRCULAR ECONOMY?

HOME COMPOSTING: YOU STARTED
COMPOSTING ORGANIC WASTE
FROM YOUR HOUSEHOLD.
REDUCING THE GARBAGE SENT TO
LANDFILLS AND PRODUCING
FERTILISER FOR YOUR PLANTS.



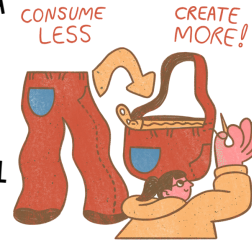
CALL THE PLAYER IN LAST PLACE TO
COLLABORATE AND MOVE TO THE
SAME POSITION AS YOU.

REMANUFACTURING IS THE INDUSTRIAL PROCESS BY WHICH AN ITEM IS RESTORED TO A CONDITION SIMILAR TO THAT OF A NEW ITEM. IN TERMS OF QUALITY AND PERFORMANCE.



(X) TRUE OR
() FALSE?

REUSE IS THE PROCESS BY WHICH A PRODUCT OR ITS PARTS ARE ADAPTED FOR USE IN A DIFFERENT FUNCTION THAN ORIGINALLY DESIGNED. WITHOUT MAKING MAJOR CHANGES TO ITS PHYSICAL OR CHEMICAL STRUCTURE.



(X) TRUE OR
() FALSE?



"SUSTAINABLE CLOTHING" ONLY IN NAME: YOU BOUGHT CLOTHES FROM A BRAND THAT CLAIMED TO BE SUSTAINABLE. BUT LATER DISCOVERED IT WAS PURE GREENWASHING.

MOVE BACK FIVE SPACES AND LEARN HOW TO CHECK ENVIRONMENTAL CERTIFICATIONS!

"GREEN MOBILITY": IF SOMEONE IN THE GROUP CAME TO SCHOOL TODAY BY WALKING, BIKING, PUBLIC TRANSPORT, OR CARPOOLING — YOU CAN MOVE FORWARD 3 SPACES.



OTHERWISE, MOVE BACK 2 SPACES.

FOOD WASTE: YOU THREW AWAY A LARGE AMOUNT OF FOOD BECAUSE IT EXPIRED IN THE FRIDGE AND KITCHEN CUPBOARD.



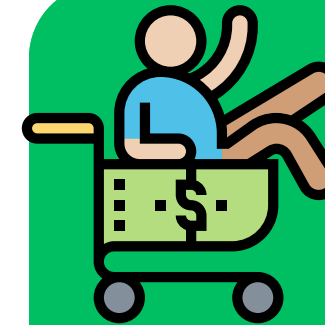
THE LAST-PLACE PLAYER ROLLS THE DICE FOR YOU AND DECIDES WHETHER YOU MOVE FORWARD OR BACKWARD.

LACK OF DIGITIZATION: YOUR COMPANY STILL USES PAPER FOR PROCESSES THAT COULD BE DIGITAL. INCREASING UNNECESSARY RESOURCE CONSUMPTION.



THE LAST-PLACE PLAYER CAN CHOOSE AN EVEN-NUMBERED PLAYER.

WHO HAS EVER BOUGHT FROM A THRIFT STORE? ALL GROUPS WITH MEMBERS WHO HAVE DONE THIS CAN ADVANCE 2 SPACES.



IMPULSIVE BUYING: IF SOMEONE IN THE GROUP HAS BOUGHT UNNECESSARY CLOTHES JUST BECAUSE THEY WERE ON SALE. AND THEY HAVEN'T USED THEM FOR MORE THAN TWO MONTHS:

SKIP ONE TURN AND PRACTICE CONSCIOUS CONSUMPTION

WHAT IS GREENWASHING?

POSSIBLE ANSWER:
IT IS A MARKETING STRATEGY AIMED AT DECEIVING THE CONSUMER INTO BELIEVING THAT A COMPANY IS MORE SUSTAINABLE THAN IT ACTUALLY IS.

CIRCULAR ECONOMY BOARD



How to play:

To play, you need a dice and pawns, as well as the cards and the board. The cards should be stacked into two groups: cards with a white background and cards with a green background.

The game can be played by two or more people, who can be divided into groups. It is recommended to have a maximum of 4 pairs.

One team should start the game by drawing a card with a white background and directing the question to the group on their right. According to the card, this group must:

- a) Answer the question verbally;
- b) Answer true or false;
- c) Answer whether the action described on the card fits the linear or circular economy model.

If the group answers correctly, they should roll the dice and move forward the number of spaces shown. Otherwise, they must stay in the same position.

If a pawn lands on a space with an image on the board, the group must draw a green-background card in the next round (instead of a question-and-answer card). In this case, often there will be no need to roll the die; the group should simply follow the instructions described on the card.



APPENDIX C:

CIRCULAR ECONOMY CONCEPTS DOMINO GAME

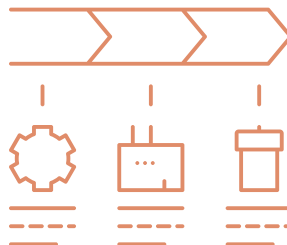


Target audience:
Lower Secondary Education / Middle School



TO ADAPT A PRODUCT OR ITS COMPONENT PARTS FOR USE IN A DIFFERENT FUNCTION THAN THE ONE FOR WHICH IT WAS ORIGINALLY DESIGNED, WITHOUT MAKING MAJOR MODIFICATIONS TO ITS PHYSICAL, CHEMICAL, OR MECHANICAL STRUCTURE.

LINEAR ECONOMY

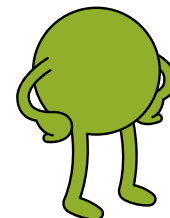


CIRCULAR ECONOMY



CARBON CREDIT

A REPRESENTATION OF ONE TON OF CARBON THAT WAS PREVENTED FROM BEING EMITTED INTO THE ATMOSPHERE, WHICH HELPS REDUCE THE GREENHOUSE EFFECT.



ENVIRONMENTAL RACISM

DISCRIMINATION AND SOCIAL INJUSTICES THAT AFFECT THE MOST VULNERABLE POPULATIONS, RESULTING FROM THE DETERIORATION OF ENVIRONMENTAL CONDITIONS.



IT IS AN ACRONYM IN ENGLISH THAT STANDS FOR ENVIRONMENTAL, SOCIAL, AND GOVERNANCE (ESG), AND IT REPRESENTS CRITERIA FOR MEASURING A COMPANY'S IMPACT.



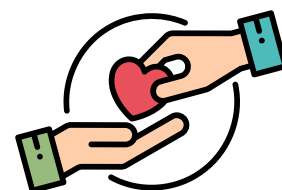
TECHNICAL CYCLE

TO KEEP PRODUCTS AND MATERIALS IN CIRCULATION THROUGH PROCESSES SUCH AS REUSE, REPAIR, REMANUFACTURING, AND RECYCLING.



BIOLOGICAL CYCLE

PROCESSES SUCH AS COMPOSTING AND ANAEROBIC DIGESTION, WHICH TOGETHER HELP REGENERATE NATURAL CAPITAL.



INDUSTRIAL SYMBIOSIS

A COMPANY'S WASTE CAN BE USED AS RAW MATERIAL BY ANOTHER.



PRODUCT AS A SERVICE

A BUSINESS MODEL IN WHICH THE CUSTOMER DOES NOT HAVE PERMANENT OWNERSHIP OF THE PRODUCT BUT PAYS A SUBSCRIPTION TO USE IT.



SDGS

**17 SUSTAINABLE
DEVELOPMENT GOALS —
A GLOBAL CALL FOR THE
CREATION AND
IMPLEMENTATION OF
PUBLIC POLICIES AIMED AT
GUIDING HUMANITY
THROUGH 2030.**



COMPOST

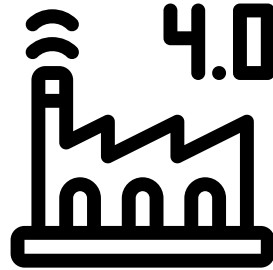
**A BIOLOGICAL PROCESS
THAT TRANSFORMS
ORGANIC MATTER INTO
NATURAL FERTILIZER.**



MODULAR DESIGN

FONTE IMAGEM: WWW.FAIRPHONE.COM

**A DESIGN PRINCIPLE THAT
BREAKS DOWN A SYSTEM
INTO SMALLER PARTS
(MODULES) THAT CAN BE
CREATED, MODIFIED,
REPLACED, OR
EXCHANGED
INDEPENDENTLY.**



INDUSTRY 4.0

**THE INTEGRATION OF SMART
DIGITAL TECHNOLOGIES INTO
INDUSTRIAL AND
PRODUCTION PROCESSES,
SUCH AS CLOUD
COMPUTING, ROBOTICS,
AND AUTOMATION.**



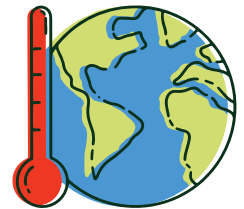
**REVERSE
LOGISTICS**

**A SET OF ACTIONS TO
ENABLE THE COLLECTION
AND RETURN OF SOLID
WASTE TO THE BUSINESS
SECTOR FOR REUSE OR
ENVIRONMENTALLY
APPROPRIATE FINAL
DISPOSAL.**



SHARING

**SHARING OF GOODS AMONG
USERS. EXAMPLES:
SHARING OF MACHINES,
BICYCLES, SECONDHAND
CLOTHING, AIRBNB, AND
UBER.**



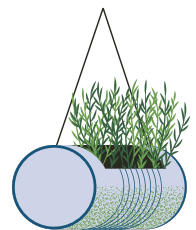
**GLOBAL
WARMING**

**AN ABNORMAL INCREASE
IN THE PLANET'S AVERAGE
TEMPERATURE, CAUSED
BY THE ACCUMULATION OF
POLLUTING GASES IN THE
ATMOSPHERE.**



DEMATERIALIZATION

**DELIVERY OF
PRODUCTS AND
SERVICES IN A VIRTUAL
FORMAT.**



UPCYCLING

**CREATIVE REUSE — GIVING
A NEW PURPOSE TO A
PRODUCT, WITHOUT
BREAKING IT DOWN, IN A
FUNCTION DIFFERENT FROM
THE ONE IT WAS
ORIGINALLY DESIGNED FOR.**



RECYCLING

**IT IS A LAST-RESORT ACTION,
AS THE ENERGY AND
EMBEDDED VALUE HAVE
ALREADY BEEN LOST IN THE
PROCESS. IT CONSISTS OF
TRANSFORMING PRODUCTS
OR COMPONENTS AND
REPROCESSING THEM INTO
NEW MATERIALS.**



REPAIR

TO RETURN A DEFECTIVE OR BROKEN PRODUCT OR COMPONENT TO A USABLE STATE, SO IT CAN FULFILL ITS INTENDED USE.



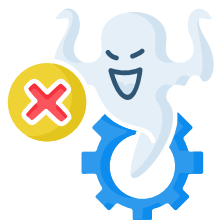
GREENWASHING

A DECEPTIVE PRACTICE IN WHICH A COMPANY OR ORGANIZATION TRIES TO CONVEY AN IMAGE OF SUSTAINABILITY THAT DOES NOT ACTUALLY EXIST.



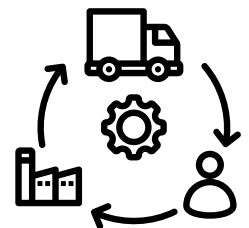
CONSCIOUS CONSUMPTION

TO RETHINK CONSUMPTION HABITS IN ORDER TO PROMOTE A MORE SUSTAINABLE AND BALANCED LIFESTYLE.



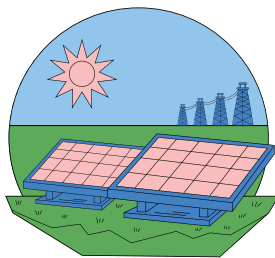
PLANNED OBSOLESCENCE

A PRODUCTION STRATEGY IN WHICH GOODS ARE DESIGNED WITH A SHORT LIFESPAN, AIMING TO FORCE CONSUMERS TO BUY NEW PRODUCTS OR UPGRADES.



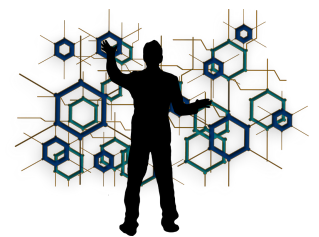
SUPPLY CHAIN

A SET OF OPERATIONS THAT ENCOMPASS ALL STAGES OF PRODUCTION, STORAGE, AND TRANSPORTATION OF PRODUCTS.



CLEAN ENERGY

ENERGY PRODUCED FROM RENEWABLE SOURCES, WITH LOWER IMPACT ON NATURE.



SYSTEMIC VISION

THE ABILITY TO UNDERSTAND A SITUATION COMPREHENSIVELY, RECOGNIZING HOW EACH PART INFLUENCES AND INTERACTS WITH THE WHOLE.



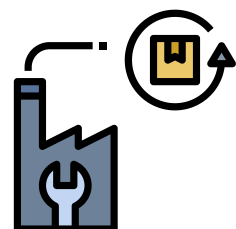
ECO-FRIENDLY

PEOPLE, PRODUCTS, OR COMPANIES THAT ARE "ENVIRONMENTALLY FRIENDLY" AND ADOPT SUSTAINABLE PRACTICES IN THEIR DAILY LIVES.



FINITE RESOURCE

NON-RENEWABLE RESOURCE — A RESOURCE THAT CANNOT BE REGENERATED IN A SHORT PERIOD OF TIME AND/OR AT THE SAME RATE AS ITS CONSUMPTION.



REMANUFACTURE

TO RETURN AN ITEM TO A CONDITION SIMILAR TO THAT OF A NEW ITEM, IN TERMS OF QUALITY AND PERFORMANCE, USING AN INDUSTRIAL PROCESS.



REUSE

APPENDIX D: TRANSFORM GAME

Theme: Product Life Cycle Extension; Upcycling; Circular Economy;

Target Age Group: Lower Secondary Education;



Objective

The primary objective of the Transforme game is to stimulate creativity and circular thinking by encouraging players to propose new functions for discarded objects. These proposals should aim to transform such items into useful, enjoyable, or sustainable solutions, thereby extending their life cycles and preventing premature disposal.

The game is grounded in two key concepts of the circular economy:

- Product Life Cycle Extension – the prolongation of a product's use in its original form or with minor modifications;
- Upcycling – the process of using existing products or materials to create something new, with added value.

Required Materials

- Cards featuring names and images of disposable objects (white background);
- Challenge cards presenting restrictions or thematic prompts for transformation (green background).

Games Rules

Number of Players: 3 to 6 players or groups.

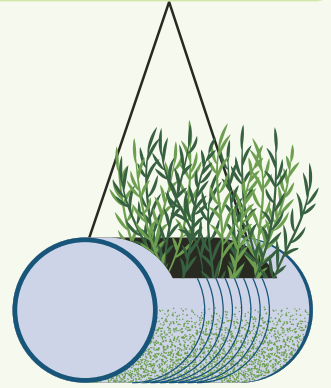
How to play:

1. In each round, one object card (white background) and one challenge card (green background) are drawn. Both cards apply to all players.
2. Ideation Time: Players are given 2 to 3 minutes to individually reflect and generate a new function for the selected object, in accordance with the constraint or theme presented by the challenge card. Ideas may also include suggestions for how the object could avoid becoming waste, through strategies such as circular design or the "product-as-a-service" model.
3. Following the ideation phase, each player presents their proposal for transforming the object in line with the challenge. Alternatively, a collective brainstorming session may be held, allowing for an unlimited number of ideas per participant.
4. All players (or a facilitator, if present) vote for the idea they consider the most creative and aligned with the challenge. When evaluating, participants should take into account creativity, feasibility, environmental impact, and consistency with the proposed challenge.
5. In the event of a tie, the winner may be determined through either: A round of arguments, during which each participant defends their idea; or a deciding vote cast by the facilitator or teacher.
6. The best idea of each round is awarded the object card as a "trophy". At the end of the game, the player with the greatest number of object cards is declared the winner.

TRANSFORM GAME

Examples of Transformation

- Holey sock → sachet of aromatic herbs for drawers or a puppet for storytelling
- Old CD → decorative mosaic or coaster holder
- Used tyre → swing, garden planter, or dog bed
- Aluminium can → perforated design lamp
- Old T-shirt → reusable shopping bag (eco-bag)
- Toothbrush → cleaning tool for small corners
- Toilet paper roll → children's binoculars
- Cardboard box → doll's castle
- Torn jeans → handbag or mobile phone holder
- Egg carton → storage box or jewellery organiser
- Ice cream tubs → cupboard organisers
- Torn bedsheet → decorative bunting
- Wedding dress → rental service; alteration service
- Toothpaste box → avoid packaging / use tube only



Advantages of the Game

- Encourages circular design, creativity, and collaboration.
- Can be adapted for use in schools, workshops, or events.
- Stimulates critical thinking regarding consumption and waste disposal

Discussion Questions

At the end of the challenge, the teacher may use some object cards to prompt reflection:

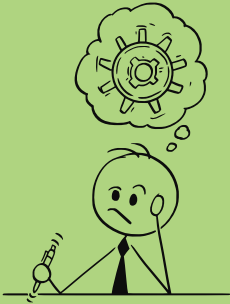
- Could this object have been designed to last longer?
- Could it have been made to be easily disassembled and reused?
- Could this object be modular, with interchangeable parts?
- How might the design enable it to be repaired rather than discarded?
- Could it be manufactured from biodegradable materials?
- Could this product be transformed into a service (such as a rental model)?
- How could this object be redesigned to be reused by multiple generations, or to avoid generating waste at the end of its life cycle?
- How could it be made easier to recycle at the end of its useful life?
- How could this object be produced locally with a lower environmental impact?



**TURN THIS OBJECT INTO
SOMETHING A CHILD
CAN USE**



**TRANSFORM THIS OBJECT
INTO SOMETHING WITH AN
EDUCATIONAL PURPOSE**



**TRANSFORM THE OBJECT
INTO SOMETHING THAT CAN
BE USED OUTSIDE THE HOME**



**TRANSFORM THE OBJECT
INTO SOMETHING THAT CAN
BE USED IN A COMPANY**



**TRANSFORM IT INTO A
SUSTAINABLE FASHION
ITEM**



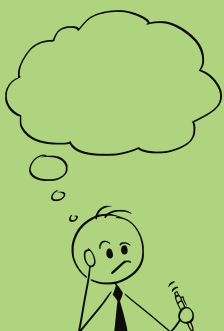
**CREATE A TOY USING
THIS OBJECT**



**TRANSFORM THIS OBJECT
INTO SOMETHING THAT CAN
BE USED BY ELDERLY PEOPLE**



**CREATE SOMETHING THAT
CAN BE SOLD AT A
SUSTAINABLE MARKET.**



**TRANSFORM IT INTO A
PIECE OF ART WITH A
NAME AND TITLE**

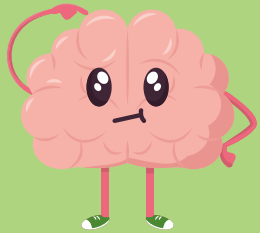


**USE THE OBJECT TO
CREATE A DECORATIVE
ITEM**



**TRANSFORM IT INTO AN
IMPROVISED MUSICAL
INSTRUMENT**

**CREATE AN ITEM THAT
WOULD BE POPULAR
WITH A DIGITAL
INFLUENCER**



**TRANSFORM IT INTO A
HANDMADE BIRTHDAY GIFT
FOR YOUR BEST FRIEND**



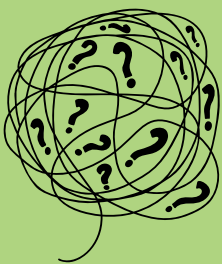
**TRANSFORM IT INTO A GIFT
FOR MOTHER'S DAY OR
FATHER'S DAY**



**TRANSFORM IT INTO
SOMETHING THAT CAN BE
DONATED TO SOMEONE**



**TRANSFORM IT INTO AN
INSTAGRAMMABLE ITEM (PERFECT FOR
SOCIAL MEDIA PHOTOS)**



**TRANSFORM THE OBJECT
INTO SOMETHING THAT
REPRESENTS YOUR
PERSONALITY OR A
THEME IMPORTANT TO
YOU**

**TRANSFORM IT USING ONLY
SCISSORS AND GLUE.**



**TRANSFORM IT INTO
SOMETHING RELATED TO
SPORTS**



**🎮 CREATE AN OBJECT
INSPIRED BY A FAMOUS
GAME OR GEEK
UNIVERSE**





PET BOTTLE



TOOTHBRUSH



SODA CAN



MILK CARTON



SHOE BOX



HOLEY SOCK



OLD T-SHIRT



OLD CD OR DVD



FLAT TIRE



WOODEN PALLETS



FALLEN UMBRELLA



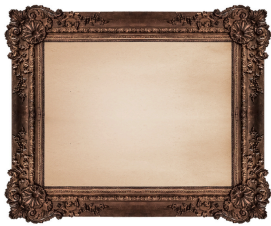
TORN TOWEL



TOILET PAPER ROLL



OLD WINDOW



OLD PICTURE FRAME



OLD MAGAZINES



BROKEN SUITCASE



CRACKED BUCKET



USED BOOKS



CLOTHES THAT NO LONGER FIT



BROKEN STAIRS



BURNED OUT LIGHT BULB



EGG CARTON



LOST BUTTONS



RIPPED JEANS



HOLEY SHEET



ICE CREAM POT



POT OF YOGURT



PRESERVING GLASS



USED WEDDING DRESS



BOTTLE OF WINE



CRACKED MIRROR



COFFEE CAPSULES



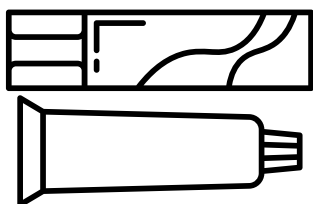
**USED NOTEBOOK
(WITH BLANK PAGES REMAINING)**



WINE CORKS



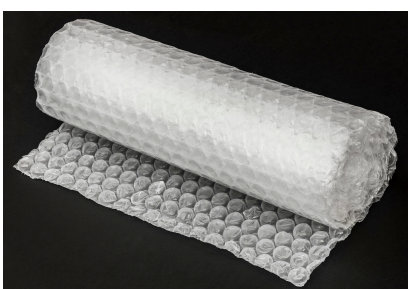
FLOPPY DISKS



TOOTHPASTE BOX



EARRINGS WITHOUT SCREW BACK



BUBBLE WRAP



OLD CELL PHONE



OLD BICYCLE



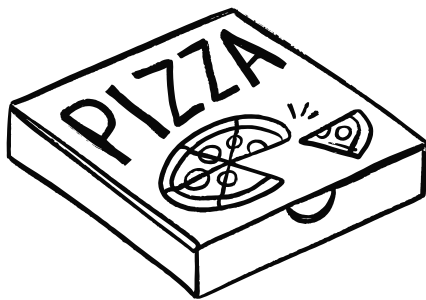
CARDBOARD BOX



BROKEN BLENDER



FABRIC SOFTENER BOTTLE



PIZZA PACKAGING



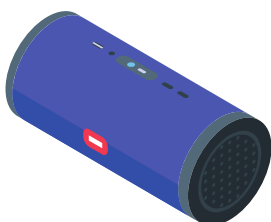
OLD PROFESSIONAL TENNIS RACKET



OLD CELL PHONE CASE



BROKEN EARPHONE



BROKEN SPEAKER



UNUSED USB CABLE



APPENDIX E:

Circular Economy Bingo

Suggested Application:
Lower Secondary Education

INSTRUCTIONS

1. Objective of the Game: The objective of the bingo game is to assist students in learning the concepts of the circular economy in an interactive and enjoyable manner.

2. Required Materials:

- Bingo Cards: The game includes 40 bingo cards. If the class comprises more than 40 students, duplicate cards may be printed or students can be paired to play in teams of two.
- Instruction Manual and Definition Cards: Cards containing definitions of relevant terms.
- Markers: Small items such as beans, coins, or any other small objects to mark the cards. It is recommended that the cards are not marked permanently to allow for reuse with other groups or at different times.
- Prizes (optional).

3. How to Play

- Step 1: The teacher distributes different bingo cards to the students.
- Step 2: The teacher draws a card containing a description.
- Step 3: The teacher reads aloud the definition or example without mentioning the term to which it refers. It is recommended that the term is only revealed after 30 seconds, allowing students to attempt to identify it independently.
- Step 4: Students must identify the term corresponding to the definition and mark it on their cards, if present.
- Step 5: The game continues until a student completes the entire card by marking all the corresponding terms. Upon doing so, the student shouts "Bingo!".
- Step 6: The teacher verifies whether the marked terms are correct and, if so, declares the student as the winner.

4. Variations: If there is insufficient time for students to complete the entire card, the game can be adapted so that the winner is the first player to complete a row, a column, or a diagonal by correctly marking the terms. When this occurs, the student calls out "Bingo!".

5. Recommendations for Teachers:

- At the conclusion of the game, allocate time to discuss with the students the concepts that were learned. Ask which terms were most challenging to identify and encourage a discussion on how the principles of the circular economy can be applied in everyday life.
- Depending on the students' age group, prior to the game's implementation, the teacher may request that students undertake a preliminary reading of the referenced materials (such as ABNT standards and the CNI Guide).

Cards created based on concepts extracted/adapted from:

Associação Brasileira de Normas Técnicas (2024). *Projeto ABNT ISO/FDIS 59004 - Economia circular — Vocabulário, princípios e orientações para implementação*.

Confederação Nacional da Indústria (2024). *Economia circular na prática: guia de implementação segundo a série ABNT NBR ISO 59000*. Confederação Nacional da Indústria, Federação das Indústrias do Estado do Rio de Janeiro, Federação das Indústrias do Estado de São Paulo. Brasília : CNI.





AN ECONOMIC SYSTEM THAT EMPLOYS A SYSTEMIC APPROACH TO MAINTAIN A CIRCULAR FLOW OF RESOURCES, RECOVERING, RETAINING, OR ADDING VALUE TO THEM WHILE SIMULTANEOUSLY CONTRIBUTING TO SUSTAINABLE DEVELOPMENT:

CIRCULAR ECONOMY



DEVELOPMENT THAT MEETS THE ENVIRONMENTAL, SOCIAL, AND ECONOMIC NEEDS OF THE PRESENT WITHOUT COMPROMISING THE ABILITY OF FUTURE GENERATIONS TO MEET THEIR OWN NEEDS:

SUSTAINABLE DEVELOPMENT



PROCESS TO RECOVER THE VALUE OF AN OBJECT:

VALUE RECOVERY



A RESOURCE THAT CAN BE RECOVERED AND REUSED AFTER HAVING ALREADY BEEN PROCESSED OR USED:

RECOVERABLE RESOURCE



PROCESS TO MAINTAIN THE VALUE OF AN OBJECT:

VALUE RETENTION



DEGREE OF ALIGNMENT WITH THE PRINCIPLES OF A CIRCULAR ECONOMY:

CIRCULARITY



PROCESS TO INCREASE THE VALUE OF AN OBJECT:

VALUE ENHANCEMENT



CYCLE WITHIN THE SOCIAL SYSTEM THROUGH WHICH RESOURCES ARE USED, RECOVERED, RESTORED, AND EMPLOYED WITHIN EXISTING OR NEW SOLUTIONS:

TECHNICAL CYCLE



CYCLE THROUGH WHICH BIOLOGICAL NUTRIENTS ARE USED BY LIVING ORGANISMS AND SUBSEQUENTLY RESTORED TO OR WITHIN THE BIOSPHERE, SO AS TO REBUILD ECOSYSTEM RESILIENCE AND NATURAL CAPITAL AND ENABLE THE RENEWED GROWTH OF RENEWABLE RESOURCES:

BIOLOGICAL CYCLE



SET OF ORGANISATIONS THAT PROVIDE A SOLUTION RESULTING IN VALUE FOR THEM:

VALUE CHAIN



AEROBIC BIOLOGICAL PROCESS, GENERALLY CARRIED OUT UNDER CONTROLLED CONDITIONS, THAT CONVERTS ORGANIC MATERIAL INTO A NUTRIENT-RICH MATERIAL SIMILAR TO HUMUS:

COMPOSTING



ECONOMIC SYSTEM WHERE RESOURCES TYPICALLY FOLLOW THE PATTERN OF EXTRACTION, PRODUCTION, USE, AND DISPOSAL:

LINEAR ECONOMY



ENVIRONMENTALLY CONSCIOUS DESIGN:

ECODESIGN



PROCESS OF MANAGING, COLLECTING, AND MOVING PRODUCTS FROM THEIR CURRENT LOCATION AFTER END OF USE WITH THE PURPOSE OF RECOVERING OR RETAINING VALUE THROUGH APPROPRIATE HANDLING:

REVERSE LOGISTICS



MOMENT IN TIME WHEN A RESOURCE IS TAKEN OUT OF USE AND DISCARDED:

END OF LIFE



INCREASE EFFICIENCY IN THE MANUFACTURE OR USE OF PRODUCTS BY CONSUMING FEWER NATURAL RESOURCES AND MATERIALS:

REDUCE



WHEN SEPARATE INDUSTRIES OR VALUE CHAINS ENGAGE IN EXCHANGING (OR SHARING) RESOURCES SUCH AS ENERGY, WATER, OR BY-PRODUCTS, DUE TO THE SYNERGISTIC POSSIBILITIES OFFERED BY GEOGRAPHICAL PROXIMITY:

INDUSTRIAL SYMBIOSIS



A SYSTEM WHEREBY PRODUCTS OR RESOURCES ARE USED AND THEN RECOVERED AND TRANSFORMED INTO NEW PRODUCTS OR RECOVERED RESOURCES, WITHOUT LOSING THEIR INHERENT PROPERTIES:

CLOSED-LOOP SYSTEM



SERVES TO INCREASE THE UTILISATION OF A GOOD OR PRODUCT OVER TIME AND REDUCE THE NUMBER OF PRODUCTS THAT NEED TO BE PRODUCED. AVOIDING THE NEED FOR EACH POTENTIAL USER TO PURCHASE AND OWN A PRODUCT:

SHARING



CONSIDERING THE ENTIRE LIFE CYCLE OF PRODUCTS AND SERVICES WITH A LONG-TERM PERSPECTIVE THAT TAKES INTO ACCOUNT THE INTERACTIONS BETWEEN ENVIRONMENTAL, SOCIAL, AND ECONOMIC SYSTEMS:

SYSTEMS THINKING



PROPOSES DELIVERING A "FUNCTION" TO THE CUSTOMER INSTEAD OF A PRODUCT. CONVERTING THE CONSUMER INTO A USER, THE CUSTOMER GAINS ACCESS TO THE PRODUCT THROUGH LEASING, PAY-PER-USE, SUBSCRIPTION, OR ANOTHER STRATEGY WHEREBY OWNERSHIP REMAINS WITH THE MANUFACTURER OR SUPPLIER, WHO IS RESPONSIBLE FOR ITS UPKEEP, MAINTENANCE, AND END-OF-LIFE MANAGEMENT:

PRODUCT AS A SERVICE



IMPROVING THE CAPACITY TO ANTICIPATE, RESPOND TO, AND ADAPT TO CHANGES BY USING CIRCULARITY:

RESILIENCE



SOMETHING THAT HOLDS INSUFFICIENT VALUE TO ITS CURRENT HOLDER BUT WHICH ANOTHER PERSON MAY ATTRIBUTE VALUE TO, THEREBY RESTORING IT AS A RESOURCE:

WASTE



BRAZILIAN DECREE THAT ESTABLISHES THE NATIONAL CIRCULAR ECONOMY STRATEGY:

DECREE 12.082/2024



THE USE OF A PRODUCT OR ITS COMPONENT PARTS AFTER ITS INITIAL USE. FOR THE SAME PURPOSE FOR WHICH THEY WERE ORIGINALLY DESIGNED:

REUSE



TO RESTORE A DEFECTIVE OR DAMAGED PRODUCT SO THAT IT CAN BE USED FOR ITS ORIGINAL FUNCTION:

REPAIR



TO RESTORE AN ITEM, DURING ITS EXPECTED USEFUL LIFE, TO A USEFUL CONDITION FOR THE SAME PURPOSE. AT LEAST WITH SIMILAR QUALITY AND PERFORMANCE CHARACTERISTICS. THIS MAY INCLUDE ACTIVITIES SUCH AS REPAIR, REWORK, REPLACEMENT OF WORN PARTS, AND SOFTWARE OR HARDWARE UPDATES. BUT DOES NOT INCLUDE ACTIVITIES RESULTING IN SIGNIFICANT CHANGES TO PRODUCT PERFORMANCE:

REFURBISH



TO RETURN AN ITEM TO A CONDITION SIMILAR TO THAT OF A NEW ITEM, FROM THE PERSPECTIVE OF QUALITY AND PERFORMANCE, BY MEANS OF AN INDUSTRIAL PROCESS:

REMANUFACTURE



TO ADAPT A PRODUCT OR ITS COMPONENT PARTS FOR USE IN A DIFFERENT FUNCTION THAN THAT FOR WHICH IT WAS ORIGINALLY DESIGNED, WITHOUT MAKING MAJOR MODIFICATIONS TO ITS PHYSICAL, CHEMICAL, OR MECHANICAL STRUCTURE:

REPURPOSE



TO IMPROVE OR RESTORE A DEGRADED ECOSYSTEM:

REGENERATE



TO RECOVER AND PROCESS MATERIAL TO OBTAIN THE SAME QUALITY (HIGH GRADE) OR LOWER QUALITY (LOW GRADE) THROUGH ACTIVITIES SUCH AS RECOVERY, COLLECTION, TRANSPORTATION, SORTING, CLEANING, AND REPROCESSING:

RECYCLING



TO RECONSIDER DESIGN AND MANUFACTURING DECISIONS, TO MAKE SERVICE UTILISATION MORE INTENSIVE (FOR EXAMPLE, THROUGH SHARING OR MARKETING MULTIFUNCTIONAL PRODUCTS):

RETHINK



Circular Economy BINGO

Recover Value	Ecodesign	Composting	Refurbish
Biological Cycle	Circular Economy	Value Chain	Technical Cycle
Recoverable Resource	Sustainable Development	Retain Value	Reuse
Add value	Repair	Reverse Logistics	Circularity





Circular Economy BINGO

Recover Value	Reuse	Greenwashing	Reverse Logistics
Residue	Biological Cycle	Systems Thinking	End of Life
Circularity	DECREE N ^o 12.082/2024	Composting	Recoverable Resource
Reuse	Closed-loop system	Remanufacture	Reduce





Circular Economy BINGO

Recover Value	Ecodesign	Composting	Remanufacture
Biological Cycle	Circular Economy	Value Chain	Technical Cycle
Recoverable Resource	Recycling	Retain Value	Reuse
Add Value	Repair	Reverse Logistics	Circularity





Circular Economy BINGO

Regenerate	Ecodesign	Composting	Remanufacture
Biological Cycle	Closed Loop System	Value Chain	Technical Cycle
Recoverable Resource	Recycling	Retain Value	Reuse
Add Value	Repair	Reverse Logistics	Circularity





Circular Economy BINGO

Recondition	Biological Cycle	Sustainable development	Ecodesing
Ellen MacArthur Foundation	DECREE Nº 12.082/2024	Virtualization	ISO 59004
Reduce	Residue	Closed Loop System	Rethink
Remanufacture	Reverse Logistics	Resilience	Sharing





Circular Economy BINGO

Regenerate	Ecodesign	Composting	Remanufacture
Biological Cycle	Industrial Symbiosis	Value Chain	Technical Cycle
Recoverable Resource	End of Life	Retain Value	Reuse
Add Value	Repair	Reverse Logistics	Circularity





Circular Economy BINGO

Regenerate	Ecodesign	Composting	Remanufacture
Biological Cycle	Industrial Symbiosis	Value Chain	Technical Cycle
Recoverable Resource	End of Life	Retain Value	Reuse
Add Value	Repair	Reverse Logistics	Circularity





Circular Economy BINGO

Regenerate	Ecodesign	Composting	Remanufacture
Biological Cycle	Industrial Symbiosis	Value Chain	Technical Cycle
Sharing	End of Life	Retain Value	Reuse
Add Value	Repair	Reverse Logistics	Circularity





Circular Economy BINGO

Circular Economy	Composting	Technical Cycle	Reuse
Ecodesign	Recover Value	Value Chain	Recoverable Resource
Retain Value	Linear Economy	Sustainable development	Reverse Logistics
Biological Cycle	Add Value	Remanufacture	Circularity





Circular Economy BINGO

Retain Value	Repair	Add Value	Reuse
Circular Economy	Rethink	Retrieve Value	Biological Cycle
Recondition	Ecodesign	Sustainable development	Reduce
Value Chain	Remanufacture	Reverse Logistics	Composting





Circular Economy BINGO

Retain Value	Repair	Add Value	Reuse
Recycling	Rethink	Recover Value	Biological Cycle
Recondition	Industrial Symbiosis	Sustainable development	Regenerate
Value Chain	Remanufacture	Reverse Logistics	Composting





Circular Economy BINGO

Retain Value	Repair	Add Value	Reuse
Recycling	Rethink	Recover Value	Biological Cycle
Recondition	Industrial Symbiosis	Sustainable development	Reduce
Value Chain	Remanufacture	Reverse Logistics	Composting





Circular Economy BINGO

Rethink	End of Life	Technical Cycle	Reuse
Biological Cycle	Reuse	Recycling	Resilience
Recondition	Repair	Sharing	Regenerate
Reduce	Remanufacture	Product as a Service	Circularity





Circular Economy BINGO

Residue	End of Life	Technical Cycle	Circular Economy
Biological Cycle	Reuse	Recycling	Resilience
Recondition	Repair	Systems Thinking	Regenerate
Reduce	Remanufacture	Product as a service	Circularity





Circular Economy BINGO

Product as a service	Repair	Systems Thinking	Stakeholders
Industrial Symbiosis	Reuse	Recycling	End of Life
Recondition	Resilience	Sharing	Regenerate
Reduce	Remanufacture	Closed Loop System	Rethink





Circular Economy BINGO

Rethink	Residue	Retain Value	Reuse
Linear Economy	ESG	Recycling	Industrial Symbiosis
Recondition	Repair	Circular Economy	Add Value
Reduce	End of Life	Remanufacture	Regenerate





Circular Economy BINGO

Rethink	Residue	Cradle to cradle	Reuse
Linear Economy	Greenwashing	Recycling	Industrial Symbiosis
Planned Obsolescence	Repair	Conscious Consumption	Add Value
Reduce	End of Life	Remanufacture	Regenerate





Circular Economy BINGO

Circular Economy	Reuse	Technical cycle	Recycling
Refurbish	Recover Value	Repair	Recoverable Resource
Retain Value	Remanufacture	Sustainable Development	Regenerate
Biological Cycle	Add Value	Conscious Consumption	Circularity





Circular Economy BINGO

Circular Economy	Reuse	Technical Cycle	Recycling
Refurbish	Recover Value	Repair	Digitization
Retain Value	Remanufacture	Durability	Regenerate
Selective Collection	Add Value	Conscious Consumption	Circularity





Circular Economy BINGO

Circular Economy	Reuse	Technical Cycle	Recycling
Refurbish	Recover Value	Repair	Reduce
Rethink	Remanufacture	Sustainable Development	Regenerate
Biological Cycle	Add Value	Conscious Consumption	Circularity





Circular Economy BINGO

Circular Economy	Reuse	Technical Cycle	Recycling
Refurbish	Recover Value	Thrift store	Reduce
Ellen MacArthur Foundation	Remanufacture	Sustainable Development	ISO 59004
Biological Cycle	Add Value	Conscious Consumption	Circularity





Circular Economy BINGO

Agenda 2030	Reuse	Technical Cycle	Recycling
Refurbish	Recover Value	Thrift store	United Nations
Ellen MacArthur Foundation	Remanufacture	Sustainable Development	ISO 59004
Biological Cycle	Add Value	Conscious Consumption	Circularity





Circular Economy BINGO

Resilience	Reuse	Sustainable Development	Reduce
Recover Value	Industrial Symbiosis	Circular Economy	Sharing
End of Life	Recycling	Regenerate	Retain Value
Rethink	Closed-loop system	Add Value	Residue





Circular Economy BINGO

Thrift store	Reuse	Ecodesing	Sustainable Development
Recover Value	Industrial Symbiosis	ReSOLVE framework	Sharing
ISO 59010	Recycling	Regenerate	Stakeholders
Rethink	Closed-loop system	Add Value	Residue





Circular Economy BINGO

Value Chain	Resilience	Systems Thinking	Refurbish
Biological Cycle	Product as a Service	Residue	Circularity
Composting	Ecodesign	Linear Economy	Recoverable Resource
Reuse	Reverse Logistics	Technical Cycle	Repair





Circular Economy BINGO

Value Chain	Resilience	Systems Thinking	Agenda 2030
Biological Cycle	Product as a Service	Sharing Platforms	Circularity
Virtualization	Ecodesign	Linear Economy	Renewable energies
Reuse	Reverse Logistics	Technical Cycle	Repair





Circular Economy BINGO

Value Chain	Reuse	Systems Thinking	Resilience
Circularity	Remanufacture	Residue	Repair
Composting	Biological Cycle	Linear Economy	Recoverable Resource
Product as a Service	Reverse Logistics	Technical Cycle	Ecodesign





Circular Economy BINGO

Value Chain	Industrial Symbiosis	Add Value	Rethink
Circularity	Retain value	Sustainable Development	Ecodesign
Composting	Reduce	Retrieve Value	Refurbish
Biological Cycle	Systems Thinking	Reverse Logistics	Residue





Circular Economy BINGO

Certifications	Industrial Symbiosis	Ellen MacArthur Foundation	Rethink
Circularity	Retain value	Sustainable Development	Ecodesign
Composting	Solar Energy	Retrieve Value	Recondition
Biological Cycle	Systems Thinking	Carbon Credit	Residue





Circular Economy BINGO

Value Chain	Industrial Symbiosis	Virtualization	Rethink
Circularity	Retain value	Sustainable Development	Ellen MacArthur Foundation
Composting	DECREE № 12.082/2024	Retrieve Value	Refurbish
Biological Cycle	Systems Thinking	Reverse Logistics	Residue





Circular Economy BINGO

Value Chain	Carbon Credit	Virtualization	Rethink
Circularity	Retain value	Sustainable Development	Collaboration
Composting	Traceability	Retrieve Value	Refurbish
B Corps	Systems Thinking	Reverse Logistics	Residue





Circular Economy BINGO

Value Chain	Carbon Credit	Virtualization	Rethink
Circularity	Energy Efficiency	Sustainable Development	Ellen MacArthur Foundation
Composting	DECREE № 12.082/2024	Retrieve Value	Planned Obsolescence
B Corps	Systems Thinking	Reverse Logistics	Residue





Circular Economy BINGO

Industry 4.0	Carbon Credit	Virtualization	Value Chain
Circularity	Energy Efficiency	Sustainable Development	Ellen MacArthur Foundation
Composting	DECREE № 12.082/2024	Retrieve Value	Planned Obsolescence
B Corps	Systems Thinking	Reverse Logistics	Residue





Circular Economy BINGO

Industry 4.0	Carbon Credit	Virtualization	Environmental Certification
Carbon Footprint	Energy Efficiency	Optimize	Ellen MacArthur Foundation
Composting	Stakeholders	Retrieve Value	Planned Obsolescence
B Corps	Recycling	Reverse Logistics	Residue





Circular Economy BINGO

Industry 4.0	Carbon Credit	Virtualization	Environmental Certification
Carbon Footprint	Energy Efficiency	Optimize	Ecodesign
Composting	Zero Waste	Retrieve Value	Planned Obsolescence
B Corps	Social	Reverse Logistics	Residue





Circular Economy BINGO

Zero Waste	Carbon Credit	Optimize	Environmental Certification
Cycle	Cradle to Cralde	Industry 4.0	Ecodesign
Governance	Green Seal	Retrieve Value	Waste as a resource
Ellen MacArthur	Recycling	Reverse Logistics	Regenerate





Circular Economy BINGO

Zero Waste	Carbon Credit	Optimize	Efficiency
Cycle	Digitise	Industry 4.0	Anaerobic Digestion
Modularity	Green Seal	Retrieve Value	Waste as a resource
Ellen MacArthur	Recycling	Reverse Logistics	Regenerate





Circular Economy BINGO

Zero Waste	Carbon Credit	Optimize	Efficiency
Cycle	Digitise	Industry 4.0	Ecodesign
Dematerialization	Green Seal	Retrieve Value	Waste as a resource
Product as a service	Recycling	Reverse Logistics	Regenerate





Circular Economy BINGO

Zero Waste	Carbon Credit	Optimize	Efficiency
Cycle	Digitise	Life Cycle	Ecodesign
Returnable Packaging	Green Seal	Retrieve Value	Waste as a resource
Product as a Service	Closed Cycle	Reverse Logistics	Recycling





Circular Economy BINGO

Butterfly Diagram	Carbon Credit	Governance	Optimize
Cycle	Digitise	Life Cycle	Ecodesign
Returnable Packaging	Green Seal	ReSOLVE framework	Waste as a resource
Product as a service	Recycling	Reverse Logistics	Regenerate



APPENDIX F: 10 RS" PUZZLE

