



Bio-based strategies and roadmaps for enhanced rural and regional development in the EU



Educational materials on sustainability, circular economy and bioeconomy for schools, colleges and universities

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www.be-rural.eu



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EXECUTIVE SUMMARY

A key aim of BE-Rural is to increase awareness and understanding of bioeconomy, sustainability and circular economy through education. This report includes a variety of educational resources that can be used by teachers. It is possible to envisage that geography, biology, environmental studies, technology and/or business classes could integrate some of these resources as part of their teaching, but it is up to the teachers to decide how they are best used.

The bioeconomy is the production of goods, services or energy using biological material as the main resource, instead of the use of fossil resources. As the bioeconomy uses renewable and biodegradable resources, it can avoid the depletion of resources and waste is often completely designed out of the system. The European Union is taking steps towards a sustainable bioeconomy and has a strategy to promote the bioeconomy and to avoid reaching ecological limits. The sustainability implications of the bioeconomy, and of specific bio-based products, permeates all the learning materials and explicit reference is often made to the UN's 2030 Agenda for Sustainable Development and its Sustainable Development Goals (SDGs).

The material covered in this report is mostly aimed at teachers of high school pupils (in the 12-18 age range) in Bulgaria, Latvia, North Macedonia, Poland and Romania to help them teach their pupils on bioeconomy, circular economy and sustainability. To facilitate this, the material in this report is translated into Bulgarian, Latvian, Macedonian, Polish and Romanian. The educational materials in this report also aim to promote the participation in the development of regional bioeconomy strategies, which is the overall aspiration of BE-Rural.

The educational resources build upon a “strong sustainability” approach, with avoidance of trade-offs between social, economic and environmental issues. This fits with the ecological limits advocated by the European bioeconomy strategy.

This report presents the four main outputs in terms of high school education for bioeconomy, circular economy and sustainability developed for the BE-Rural project as follows:

- Output 1 - Review of 100 free online educational resources
- Output 2 - New power point slides for presentations with notes for teachers
- Output 3 - New workshops, quizzes and games
- Output 4 - New extracurricular activities (such as school clubs or societies)

It was important to review what resources already exist. The 100 free online educational resources show the richness of resources already available and provides teachers with a list of resources that they may want to use in their teaching.

Another key output is power point slides for use by teachers. They include material on “Introduction to the bioeconomy”, “Bioeconomy and key principles of sustainability”, “Bioeconomy and SDGs (and respective targets)”, “Bioeconomy and the Circular Economy”, “Bioeconomy in the agriculture sector”, “Bioeconomy in the forestry sector”, “Bioeconomy in the fisheries sector”, and “Bioeconomy in the sector of essential oils and herbs for cosmetics/pharmaceuticals”.

Games can make students become more involved in their learning, so in addition to the lecture sides, these educational materials include games, quizzes and workshops related to bioeconomy, sustainability, the UN Sustainable Development Goals (SDGs), and circular economy. Finally, extracurricular activities (such as school clubs or societies) provide a unique opportunity to bring new or additional content in terms of bioeconomy, circular economy, and/or SDGs and Sustainability, and so suggestions for those are also included.

The report concludes with final thoughts and how best to deliver learning materials online. As a response to the Coronavirus (Covid-19) pandemic, the report discusses online delivery of materials. The EU aims to build the world's leading bioeconomy and raising awareness of the value of bioeconomy and how it relates to sustainability is fundamental. The BE-Rural educational resources included in this report intend to contribute to this essential aspect.

Table of contents

Acknowledgments and Disclaimer

Executive summary

1	Introduction	7
2	Geographical & sectoral context of educational resources	8
3	How educational resources were developed and tested	8
3.1	Input from BE-Rural consortium and teachers on what educational resources should contain	10
3.2	Contribution to the development of educational resources from MSc students at the University Strathclyde	11
3.2.1	Developing Output 1	12
3.2.2	Developing Outputs 2, 3 and 4	12
3.3	Workshop to test the educational materials on bioeconomy and sustainability on 9 th March 2020 at the University Strathclyde	13
4	Output 1 - Review of 100 free online educational resources	13
5	Output 2 - New power point slides for presentations with notes for teachers	15
6	Output 3 - New workshops, quizzes and games	15
7	Output 4 – New extracurricular activities (such as school clubs or societies)	16
8	How educational resources can be delivered online	17
9	Conclusions and next steps	18

References

Annex I	Questions to participants during the BE-Rural kick-off meeting (9-10 th April 2019)
Annex II	Questions to consortium and people who showed interest in attending a teachers summer school on the bioeconomy (April 2020)
Annex III	Programme of the workshop to test the educational resources
Annex IV	Key questions used 9 th March workshop surveys for feedback & ideas
Annex V	Review of 100 free online educational resources (listed by theme: bioeconomy, circular economy & SDGs)
Annex VI	Power Point slides and notes on "Introduction to the bioeconomy"
Annex VII	Power Point slides and notes on "Bioeconomy and key principles of sustainability"
Annex VIII	Power Point slides and notes on "Bioeconomy and SDGs (and respective targets)"
Annex IX	Power Point slides and notes on "Bioeconomy and the Circular Economy"
Annex X	Power Point slides and notes on "Bioeconomy in the agriculture sector "
Annex XI	Power Point slides and notes on "Bioeconomy in the forestry sector"
Annex XII	Power Point slides and notes on "Bioeconomy in the fisheries sector"
Annex XIII	Power Point slides and notes on "Bioeconomy in the sector of essential oils and herbs for cosmetics/pharmaceuticals "
Annex XIV	Mentimeter Ideas
Annex XV	Workshop and Card Game "Business Match"
Annex XVI	Game "Sustainability and SDGs Heatwave"
Annex XVII	One set of cards and two games: "BE-Match" and "SDG-Link"
Annex XVIII	Bioeconomy Word Search Puzzles

Figures

- Figure 1: The regions involved in the BE-Rural project: a) the geographical location, b) the sectoral focus (modified from BE-Rural, 2020a) 8
- Figure 2: Results to the question “The educational materials on the theme of sustainability and the bioeconomy should primarily target which groups?” 10
- Figure 3: The workshop to test the educational materials conducted on 9th March 202013
- Figure 4: Ideas for extracurricular activities related to bioeconomy, circular economy & SDGs. 17

Tables

- Table 1: The nine partners of BE-Rural that provided input on the educational resources 8
- Table 2: Views from the surveys on how the educational materials should look and how such views are addressed by BE-Rural (numbers in brackets are number of suggestions)11

Boxes

- Box 1: The wide range of degrees for students attending the postgraduate class “Circular Economy and Transformations Towards Sustainability” 12

Abbreviations

CEPS	Centre for European Policy Studies
DECC	Department of Energy and Climate Change (UK)
EFFAT	European Federation of Food, Agriculture and Tourism Trade Unions
EMF	Ellen MacArthur Foundation
ESD	Education for Sustainable Development
EU	European Union
FAO	Food and Agriculture Organization
GDP	Gross Domestic Product
IBioIC	Industrial Biotechnology Innovation Centre
MOOC	Massive Open Online Course
NGO	Non-Governmental Organization
OIP	Open Innovation Platform
SDG	Sustainable Development Goal
SME	Small and Medium Enterprise
STEM	Science, Technology, Engineering and Mathematics
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNICEF	United Nations Children's Fund
UNRIC	United Nations Regional Information Centre
WHO	World Health Organisation

1 Introduction

The bioeconomy uses renewable biological resources from land and sea – such as crops, forests, fish, animals and micro-organisms – to produce food, materials, services and energy. The bioeconomy is a huge growth area around the world (check world map of Bioeconomy Strategies in here: BE-Rural, 2020b). According to the European Commission (2018) the bioeconomy has the potential to generate 1 million new green jobs by the year 2030.

Importantly, the aim of the bioeconomy is to substitute the use of fossil resources by renewable resources (Heimann, 2019) and therefore it can contribute to a reduction of carbon emissions. The bioeconomy is strongly linked to sustainability as biodegradable resources are often used and waste is often completely designed out of the system to avoid the depletion of resources for future generations. According to Bell *et al.* (2018, p. 25) the “bioeconomy offers great opportunities to realising a competitive, circular and sustainable economy with a sound industrial base that is less dependent on fossil carbon. A sustainable bioeconomy also contributes to climate change mitigation, with oceans, forests and soils being major carbon sinks and fostering negative CO₂ emissions.”

BE-Rural has many ambitions in the development of regional bioeconomy strategies and roadmaps. One of these ambitions is to increase awareness and understanding of sustainability and the bioeconomy through education (BE-Rural, 2020a). The material covered in this report is mostly aimed at high school teachers (i.e. those teaching pupils in the age range 12-18) in several countries of Eastern Europe (see Section 2) to help them teach their pupils on bioeconomy, circular economy and sustainability. While some of these students will speak English, many will not so the educational materials in this report are also translated into Bulgarian, Latvian, Macedonian, Polish and Romanian. These countries were selected because of their underutilised potential to harness the bioeconomy (Colmorgen and Khawaja, 2019). The educational materials in this report are a key contributor to facilitating the participatory development of regional bioeconomy strategies (the overall ambition of BE-Rural).

These educational resources can be used more widely: at a higher education level (e.g. colleges and universities), other countries, and as help for businesses. The sustainability implications of the bioeconomy, and of specific bio-based products, permeates all the educational materials and explicit reference is often made to the Sustainable Development Goals (SDGs) (UN General Assembly, 2015).

This report, and educational resources, uses a “strong sustainability” approach advocating avoidance of trade-offs between social, economic and environmental issues (Gibson, 2013). There should be thresholds beyond which no trade-off should take place and therefore “the demarcation of acceptable from unacceptable impacts becomes a key aspect of managing trade-offs” (Morrison-Saunders and Pope, 2013, p. 54). This fits with the ecological limits advocated by the EU Bioeconomy strategy (European Commission, 2018) and equates with what Heimann (2019) calls the “sustainable bioeconomy”. Without a strong sustainability approach, the bioeconomy could cause negative impacts. For example, “increased demand for land can lead to land grabbing, displacements, unequal distribution of land considering soil quality, and loss of communal land” (Heimann, 2019, p. 52).

The report starts by explaining the geographical and sectoral context in the development of these educational resources and explains how these resources were developed and tested. The report (and detailed associated appendices) then presents four main outputs in terms of high school education for bioeconomy, circular economy and sustainability developed for the BE-Rural project:

- Output 1 - Review of 100 free online educational resources
- Output 2 - New power point slides for presentations with notes for teachers
- Output 3 - New workshops, quizzes and games
- Output 4 - New extracurricular activities (such as school clubs or societies)

As a response to the Coronavirus (Covid-19) pandemic, it was important to discuss online delivery of materials. Online and blended learning can diversify the learning experience, increase the accessibility of educational resources and has become even more pressing given the global Coronavirus pandemic. The report ends therefore with suggestions on how resources can be delivered online, before presenting conclusions and next steps.

2 Geographical & sectoral context of educational resources

BE-Rural has five regional Open Innovation Platforms (OIPs) for the development of bioeconomy strategies and roadmaps. The five OIP regions that can be seen in Figure 1 are: Vidzeme and Kurzeme in Latvia; Szczecin and Vistula Lagoons in Poland; Covasna in Romania; Stara Zagora in Bulgaria; and Strumica in North Macedonia (BE-Rural, 2020a). This regional context influenced the educational resources in terms of content and case studies (and translated languages of this report). In addition, each region has a different sectoral focus (e.g., fisheries, forestry, agriculture and green industry) and this has also determined the development of the educational resources.

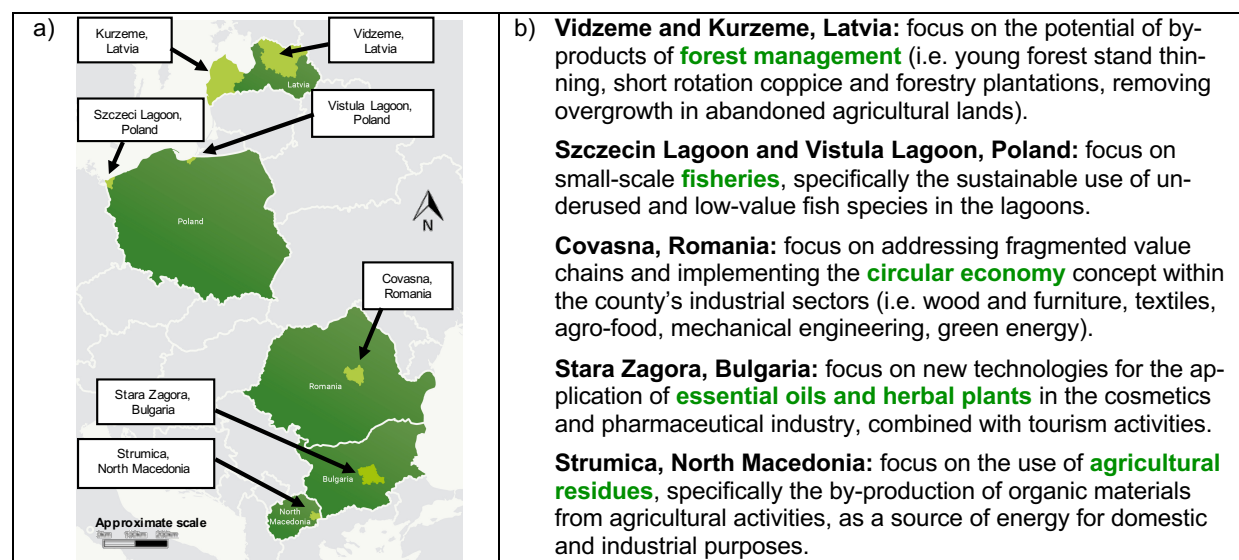


Figure 1: The regions involved in the BE-Rural project: a) the geographical location, b) the sectoral focus (modified from BE-Rural, 2020a)

3 How educational resources were developed and tested

Following the BE-Rural principles of co-creation and transparency (Abhold *et al.* 2019), the nine partners that form the BE-Rural consortium (see Table 1) were all contacted to provide input on what the educational resources on sustainability, circular economy and bioeconomy should contain. Section 3.1 describes how that consultation was done together with the outcomes.

The educational resources were developed at the University of Strathclyde in Scotland, and had the contribution of MSc students in their development. How that was done is described in section 3.2. Finally, a workshop took place on 9th March 2020 at the University Strathclyde, to test and obtain feedback on the educational materials, as described in section 3.3.

Table 3: The nine partners of BE-Rural that provided input on the educational resources

Logo	Name and web link	Mini description	Country
	Ecologic Institute https://www.ecologic.eu	A private, independent institute devoted to the task of addressing the relevant socio-political questions of sustainability research and to bring new insights into environmental policy.	Germany
	The Bulgarian Industrial Association – Union of the Bulgarian Business (BIA) https://en.bia-bg.com	A voluntary, non-governmental organisation, representing over 100 sector-oriented organisations, over 100 regional and local bodies, scientific organisations, universities, and other companies.	Bulgaria

Logo	Name and web link	Mini description	Country
	BIOCOM https://biocom.de/	A leading specialized communication and information company focused on life sciences.	Germany
	Institute for Economic Forecasting (IPE) http://www.ipe.ro/	Part of the National Institute for Economic Research belonging to the Romanian Academy. It carries out research projects on a range of fields – economic modeling and forecasting, policy evaluation, empirical studies and long-term and short-term forecasts.	Romania
	National Marine Fisheries Research Institute (NMFRI) https://mir.gdynia.pl/	Provides knowledge based on scientific activity as well as research and development works, which supports economically sustainable and environmentally sound development of marine fisheries.	Poland
	International Centre for Sustainable Development of Energy, Water and Environment Systems – Macedonian Section (SDEWES-Skopje) https://www.sdewes.org	Gathers professionals and scientists from a broad range of disciplines of sustainable development of energy, water and environment systems in order to provide scientific support for policy-making in the following topics: sustainable development, green economy and better governance, climate change, low emission development strategies, and energy.	North Macedonia
	The Latvian State Forest Research Institute (SILAVA) http://www.silava.lv/	National research organization with the main goal of to get new knowledge, based on scientific methods, and developing the innovative technologies to promote the sustainable development and competitiveness of forest sector.	Latvia
	University of Strathclyde, Glasgow https://www.strath.ac.uk	Leading technological university in the UK, which was founded as a 'place of useful learning' and undertakes internationally excellent research, education, & knowledge exchange with business & society.	Scotland, UK
	WIP Renewable Energies https://www.wip-munich.de	Private multi-disciplinary company active in the fields of renewable energy technologies, providing a range of technical expert and non-technical services to both industrial and public sector clients at the international level.	Germany

Source: BE-Rural (2019)

3.1 Input from BE-Rural consortium and teachers on what educational resources should contain

Ideas on potential educational resources were first gathered in April 2019, during the BE-Rural project kick-off meeting. Eighteen people working in groups of two provided feedback using the survey in Annex I. Then, in April 2020, both the BE-Rural consortium and ten teachers that had shown interest in attending a teachers' summer school on the bioeconomy were consulted. Finally, in May 2020 a draft of this report (which includes the educational resources developed) was provided for feedback. In total, 27 people (from all the countries involved in BE-Rural project) provided ideas on the April 2019 and April 2020 survey.

It can be seen in Figure 2 that overall the preference is for the educational materials to focus on high school teaching and to be mainly aimed at teachers rather than students (as one participant said “we target pupils through the teachers”). One participant also suggested that educational materials could be used with Small and Medium Enterprises (SMEs). The educational materials in this report are mostly aimed at high school level, although it is possible that the educational materials can also be used with college and university students, and even SMEs.

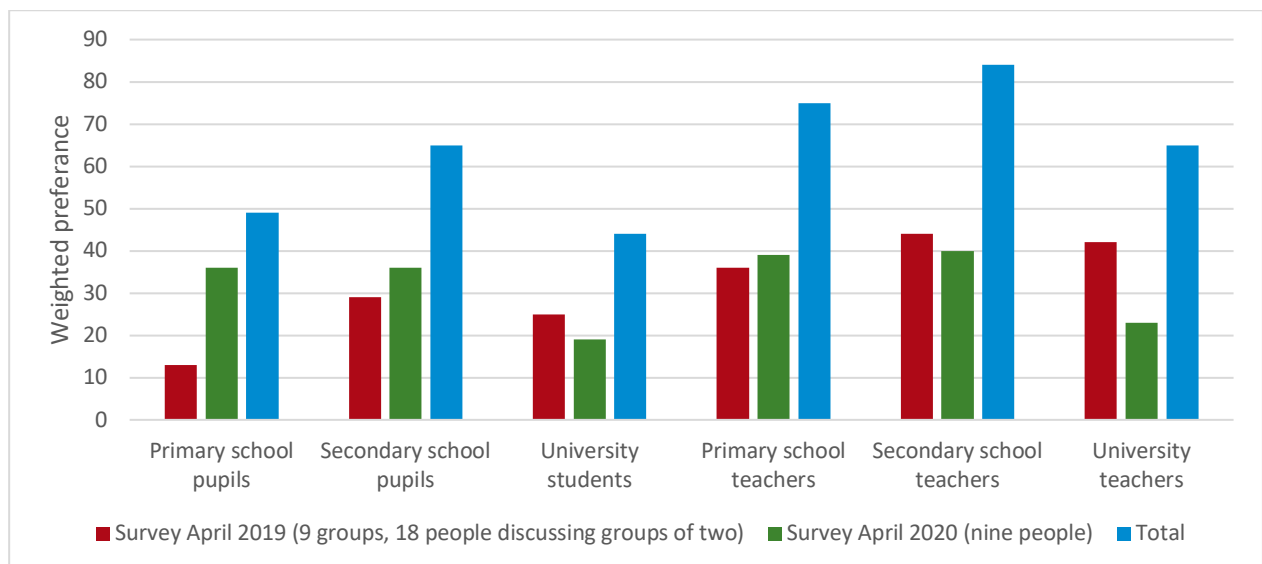


Figure 2: Results to the question “The educational materials on the theme of sustainability and the bioeconomy should primarily target which groups?”

Key: Rank from 6 (most important) to 1 (least important). Weighted preference – the higher the number, the most preferred. In this graph, secondary school = high school.

Both in April 2019 and April 2020, the participants were asked what the educational materials should look like. Table 2 shows the views from the 27 participants and how the BE-Rural project is addressing each of these views. It can be seen that educational materials presented in this report address every single one of the views but are also complemented with other outputs from the BE-Rural project, such as the BE-Rural Handbook already published (Colmorgen *et al.*, 2020) and the BE-Rural pop-up stores brochures (e.g. Griestop *et al.* 2020).

Table 4: Views from the surveys on how the educational materials should look and how such views are addressed by BE-Rural (numbers in brackets are number of suggestions)

Type of educational materials	Answer to question “What do you think educational materials should look like?”, from surveys April 2019 & 2020	How BE-Rural is addressing each of these
Presentations	Presentations (5)	Addressed Output 2 - New power point slides for presentations with notes for teachers, described in this report.
Games	Games (3); action puzzles (1)	Addressed Output 3 - New workshops, quizzes & games, described in this report.
Quizzes	Quiz (2)	Addressed Output 3 - New workshops, quizzes & games, described in this report
Workshops	Worksheets for children (1); material to discuss in discussion groups (1); interactive study materials (1)	Addressed Output 3 - New workshops, quizzes & games, described in this report
Online tools	Online tools (4)	Addressed Output 1 - Review of 100 free online educational resources, described in this report.
Videos	Videos (5)	Addressed Output 1 - Review of 100 free online educational resources, described in this report.
Portfolio of bioproducts	catalogue with pictures (1); simple information with examples (1)	Addressed Output 3 - New workshops, quizzes & games, described in this report. Plus the BE-Rural pop-up stores brochures (e.g. Griestop <i>et al.</i> 2020).
Handbook	Booklet or handbook (9)	This is addressed by the BE-Rural Handbook already published (Colmorgen <i>et al.</i> , 2020)
Other	Examples of real products (1); use of concrete products (1); tangible products & experiences (1); excursions (1)	This is addressed in Output 4 - New extracurricular activities (such as school clubs or societies), described in this report.

Finally, in April 2020, survey participants were asked how they thought schools could best use these educational materials. For example, should the educational resources be integrated with an existing class or course (e.g. science, art, biology) or should a new class or course be created instead? Of the eight people who answered this question, five thought that it was better to be integrated into an existing class. Type of classes mentioned were: science, biology (2), earth and environmental science, art, technical subjects and even needlework. The materials presented in this report have been developed in a modular basis and can therefore be integrated to existing classes or be used to create a new syllabus.

3.2 Contribution to the development of educational resources from MSc students at the University Strathclyde

Dr Elsa João (senior lecturer, Department of Civil and Environmental Engineering at the University of Strathclyde in Glasgow, Scotland) was the lead researcher developing these educational resources. The class “Circular Economy and Transformations Towards Sustainability”, run by Dr João, was used to create and test some of the materials. MSc students studying at the University also contributed collaboratively in the development of the teaching resource as explained in sections 3.2.1 and 3.2.2.

3.2.1 Developing Output 1

The search for a rich and relevant set of resources on the Circular Economy, Bioeconomy and/or Sustainable Development Goals/Sustainability/Sustainable Development began with an appraisal of the many sources available online. For the class “Circular Economy and Transformations Towards Sustainability”, 95 students were asked to find existing online educational resources on bioeconomy, circular economy or sustainability that they would find particularly useful and interesting. The students were studying for a wide range of degrees (see Box 1) and came from a wide range of countries, which contributed to the richness of this data.

Box 2: The wide range of degrees for students attending the postgraduate class “Circular Economy and Transformations Towards Sustainability”

MEng Aero-Mechanical Engineering
 MEng Civil and Environmental Engineering
 MEng Mechanical Engineering
 MEng Mechanical Engineering with Aeronautics
 MEng Mechanical Engineering with International Study
 MSc Civil Engineering
 MSc Civil Engineering with Industry
 MSc Global Sustainable Cities
 MSc Entrepreneurship, Innovation and Technology
 MSc Environmental Engineering
 MSc Environmental Entrepreneurship
 MSc Industrial Biotechnology
 MSc Public Policy
 MSc Sustainability and Environmental Studies
 MSc Sustainable Engineering: Renewable Energy Systems and the Environment
 Undergraduate exchange programme in Civil Engineering

The data for each teaching resource was entered in a database and each student was asked to champion at least one unique resource that was not already in the database. As MSc students were used to find these resources, a Scottish high school student was then given the task to check the interest and clarity of these resources for his peers. The result of this work is Output 1 “Review of 100 free online educational resources (listed by theme: bioeconomy, circular economy & SDGs)” which is discussed in more detail in Section 4.

In addition to English and the five key OIP Partners’ languages, the OIP Partners suggested that educational resources in other languages could also be useful and therefore resources in all these languages have been highlighted in Output 1: Bosnian, Bulgarian, Croatian, English, French, German, Hungarian, Latvian, Macedonian, Polish, Romanian, Russian, Serbian and Spanish. To increase further the resources in local languages, in the translated version of these educational resources, project partners will add more links in Bulgarian, Latvian, Macedonian, Polish and Romanian.

3.2.2 Developing Outputs 2, 3 and 4

Eight MSc students taking the classes “Independent Study in Collaboration with Industry” and “Client-Based Environmental Entrepreneurship in Practice” were selected to contribute to the development of the educational resources and in particular innovative games. It is thanks to these students’ creativity, that the educational resources presented in this report include these new games. The result of this work is: Output 2 “New power point slides for presentations with notes for teachers” (see Section 5), Output 3 “New workshops, quizzes and games” (see Section 6) and Output 4 “New clubs or societies” (see Section 7).

From the outset, one of the main aims of the project was to create new games. With this in mind, the team met with an expert on sustainable communities from the University of Strathclyde Dr Robert Rogerson (e.g. Rogerson *et al.* 2011), to discuss an innovative sustainability board game that he developed and uses in teaching. The team also attended the Industrial Biotechnology Innovation Centre (IBioIC) annual conference in February 2020 in Glasgow. The IBioIC connects industry, academia and

government with the aim to accelerate new biotechnology processes and products (see Barrie et al., 2019; IBiolC, 2020a). The IBiolC annual conference focussed on biotechnology with some of the talks establishing a clear connection between biotechnology, sustainability, circular economy and the bioeconomy (see IBiolC, 2020b). In addition, some sessions also had links to the teaching of these concepts, which was particularly relevant for the research required in the development of the educational resources for the BE-Rural project.

3.3 Workshop to test the educational materials on bioeconomy and sustainability on 9th March 2020 at the University Strathclyde

A whole day event was organised to test the presentations, quizzes and games with an audience (see Annex III for the programme of the workshop). The event had 20 different attendees (all with University education and ages 23-58) who listened to the presentations, and were invited to participate in the quizzes and games (see Figure 3). After each 1.5-hour session, while the material was still fresh in peoples' minds, the participants were asked to provide detailed feedback on the materials (see Annex IV for the key questions asked to get feedback and ideas). According to the BE-Rural ethical procedure, all participants filled a consent form and were assured anonymity. Feedback received from the attendees of this workshop were used to improve the educational materials presented in this report.



Figure 3: The workshop to test the educational materials conducted on 9th March 2020

4 Output 1 - Review of 100 free online educational resources

One hundred free online educational resources were selected for inclusion in this report (see Annex V). The selection process considered the relevance of the resource and how useful, clear and fun it was (helped by the fact that students were used to help find and select these resources - see section 3.2.1). This shows the richness of resources already available and provides teachers with a list that they may want to use in their teaching.

Please note that the list is not meant to be exhaustive. There are many other free resources online. In addition, the searches were done in English so many other resources might be available in other languages. The list in annex V shows the language of the resource, and it can be seen that some of the resources are also available in other languages (e.g. EU resources that are available in all 24 EU languages) and in the cases of videos spoken in English that have as many as 17 different languages available in subtitles. As explained in section 3.2.1, resources in all these languages have been highlighted in Output 1: Bosnian, Bulgarian, Croatian, English, French, German, Hungarian, Latvian, Macedonian, Polish, Romanian, Russian, Serbian and Spanish. In addition, the translated version of these educational resources will include new links in the local languages (Bulgarian, Latvian, Macedonian, Polish and Romanian).

The resources in Annex V are organised into three main themes: Bioeconomy, Circular Economy and Sustainable Development Goals/Sustainability/Sustainable Development. Although many of the concepts presented are effectively timeless, a date has been included for each resource. They are all from the last 10 years – 77 produced or updated between 2015 and 2020, and 23 between 2010 and 2014. For each resource it is specified the type of online resource (e.g. video, quiz, downloadable pdf document, game, app) and, if possible the time it takes to read or use a resource. To help teachers decide if any of these resources would be of interest to use in their teaching a summary and review is included for each resource specifying content, interest, clarity and fun.

Importantly, for each resource ideas are included on how they may be used in the classroom, sometimes with a lesson plan. The level of difficulty or complexity is suggested and colour-coded: **Beginner**, **Intermediate**, **Advanced**. In some cases, more than one level of difficulty is proposed as some resources have different components of different complexity, plus it is possible to use the same resource in either a simpler or in a more complex way.

A key target audience is suggested. Although the educational resources included in Annex V are mainly for high school students, they are not exclusively for them. In the interest of flexibility and wider applicability, some of the resources are also recommended for primary school students and University students. Plus, some resources are recommended for teachers, lecturers, business & industry, government and NGOs, who may even be interested in getting a certificate for one of the training courses listed - e.g. the course “Circular Economy - Sustainable Materials Management”, 21 hours over 5 weeks (see Annex V).

Of the 100 listed resources, 53% are either videos or include videos. Videos can be an effective teaching resource because they allow students to visualize concepts. Often a video is more interesting, engaging and easier to understand than if the discussion was delivered as a report. They can also help generate discussion and debate that enhance student learning. Although, video tutorials may miss the depth needed and therefore need to be used together with other resources with more in-depth description and analysis. Mitra *et al.* (2010, p. 405) suggest that “videos can provide useful material for students to engage with, but it needs to be used as part of an overall blended learning approach”.

Some educational resources should be highlighted as being particularly important. The BLOOM School Box (BLOOM, 2020) is a collection of bioeconomy related educational resources which educators can use to introduce the concept of bioeconomy in their classrooms. These educational resources have eleven innovative learning scenarios which have already been tested in a classroom setting (e.g. “Bloom your school with your biofuel and soap lab” and “Examining the thermal properties of bio-based building materials”).

In terms of teaching circular economy, the Ellen MacArthur Foundation has a wide range of high quality educational materials. Ellen MacArthur Foundation (2020) provides an organised collection of all knowledge and educational materials, starting from the introduction to Circular Economy to Business Case Studies and CE Reports. Among many other resources, there are ready-made lessons for school & college students ages 12-19 to learn about circular economy (Ellen MacArthur Foundation, 2017) and a whole 1-year course for target ages of 11-14, 14-16 and 16-19 on “System Reset: Design and Technology for a Circular Economy”, available via the STEM Learning web site (STEM Learning 2019).

In terms of teaching sustainability, there are many resources available (e.g. Manitoba Council for International Cooperation, 2018), but the UNESCO resources on “Sustainable Development Goals - Resources for educators” (UNESCO, 2019) should be highlighted. Education for Sustainable Development (ESD) is a key element of the 2030 Agenda for Sustainable Development and the UNESCO (2019) resources provide resources for educators of early childhood care and education, primary education, and secondary education. Another key resource is the “World’s Largest Lesson” on the Sustainable Development Goals (or Global Goals) for primary and secondary school children (Project Everyone, 2015). These resources are free, open source, translated into over 10 languages and can be adapted for any age group.

Finally, the set of 100 free online resources in Annex V should complement the wide range of books, papers and other publications that are not listed. For example, Lacy and Rutqvist’s (2015) educational book “Waste to Wealth: The Circular Economy Advantage” discusses how ‘green’ and ‘growth’ need not be binary alternatives. The book examines five new business models that provide circular growth

from deploying sustainable resources to the sharing economy before setting out what business leaders need to do to implement the models successfully.

5 Output 2 - New power point slides for presentations with notes for teachers

The aim of these educational resources is to produce educational resources that can be used by teachers. It is possible to envisage that geography, biology, environmental studies, technology or business could integrate some of these resources as part of their teaching, but teachers have to comply with approved curriculums so they may not always have time to do alternative classes. Therefore, educational resources are presented in a modular basis and is up to the teachers to decide how to adapt them.

One key output is power point slides that are ready for use by teachers. In some cases, a summary of key background information and key links for further information have also been added. The following sets of power point slides are included with these educational resources:

- Introduction to the bioeconomy (Annex VI)
- Bioeconomy and key principles of sustainability (Annex VII)
- Bioeconomy and SDGs (and respective targets) (Annex VIII)
- Bioeconomy and the Circular Economy (Annex IX)
- Bioeconomy in the agriculture sector (Annex X)
- Bioeconomy in the forestry sector (Annex XI)
- Bioeconomy in the fisheries sector (Annex XII)
- Bioeconomy in the sector of essential oils and herbs for cosmetics/pharmaceuticals (Annex XIII)

There are two topics dedicated to sustainability and SDGs because the links between bioeconomy and Sustainability/SDGs are so key (see for example, European Commission, 2018; Gomez San Juan *et al.*, 2019; Heimann, 2019). The teacher can choose as many or as few slides from the sets as needed. The slides have been made with rich imagery and include links to videos (some listed in Output 1) and in some cases use the Mentimeter tool. Mentimeter is an interactive presentation software platform that allows a presenter to get real-time input from participants with live polls, quizzes and word clouds (check <https://www.mentimeter.com/features>). The audience needs their mobile phones to participate, and WiFi or mobile data to be able to get online and submit their answers. Mentimeter can be used in presentations or workshops to engage and interact with the participants, but it can also be used to gather data or opinions from the audience (see Annex XIV for more information and ideas).

6 Output 3 - New workshops, quizzes and games

According to Goss *et al.* (2017), students become more involved in their learning when playing games; the retention of content is strengthened and group positivity is increased. So in addition to the lecture slides, these learning materials include games related to bioeconomy, sustainability, the UN Sustainable Development Goals (SDGs), and the circular economy. These join other games already available related to sustainability and circular economy (see for example, Games4Sustainability, 2020 and The Agency of Design, 2020). The games are flexible and should be able to be played by anyone aged 12 and above (including adults) with no prior knowledge on bioeconomy. More complex learning can be achieved by adding discussion time after each game. They can also be played as part of extracurricular activities (see Output 4). Simplifying some of the games (e.g. the Bioeconomy Word Search Puzzles) would make them suitable for younger children.

These are the games, quizzes and puzzles specifically created for these educational resources (with links to bioeconomy, sustainability, SDGs and circular economy highlighted):

1. **Workshop and Card Game “Business Match”** – The workshop was developed to inspire participants about the innovativeness of emerging circular business models and the possibilities created by **circular economy** concepts (see Annex XV for the game materials and instructions). It aims to familiarise the participants with five circular business models and enables them

to recognise these in daily life by using 25 company case studies. The aim of the game is to match each company to one of the five circular business models. Each company case study card includes an image, a description and key **SDGs** links. The game can be played in three different ways, and can be played individually or in groups. It takes 15-30 minutes depending on how the game is played and the amount of discussion. Before starting the game, the workshop leader could briefly introduce and explain the circular business models.

2. **Game “Sustainability and SDGs Heatwave”** – This is a game where players answer **sustainability** and **SDGs** quiz questions and gain and lose points in the process (see Annex XVI for all the game materials and instructions). Four or five players compete against each other using one playing board. The game takes around 20-25 minutes.
3. **“BE-Match” and “SDG-Link” Games - One set of cards for two games** – Two games were developed using the same cards to inspire participants about innovative products made of biological resources (see Annex XVII for all the game materials and instructions). These workshops or classroom activities were created to introduce 35 bioproducts, which can substitute traditional products in our daily life, and to inspire the potential of the **bioeconomy** industry. The activities also encourage discussion on the links of these 35 bioproducts to the **SDGs**. Participants could play the “BE-Match” Game first, followed by the “SDG-Link” Game, either in the same day or in different days. Both games take between 15 to 30 minutes.
4. **Bioeconomy Word Search Puzzles** – Word search puzzles are a simple, fun and innovative idea to help remember technical terms explained in class. They can be played by people of all ages, can be done in any language and can be done with different levels of complexity to suit the audience. See Annex XVIII for two examples on **bioeconomy** word search puzzles of different complexity which can be done individually or in groups.

7 Output 4 – New extracurricular activities (such as school clubs or societies)

Extracurricular activities (such as school clubs or societies) can provide a unique opportunity to bring new or additional content in terms of bioeconomy, circular economy, and/or SDGs and Sustainability. In a situation where teachers are constrained by the curriculum that they need to deliver, and may not have space to add extra content within class time, extracurricular activities could provide the possibility of students being involved in these themes. Further, students can take leadership of these. Extracurricular activities are both about fun and learning, and hold great potential for embedded learning and can also be critical for students with disabilities (see Pence and Dymond, 2015).

Decisions on extracurricular activities should really come from students and teachers, who should decide what interests them and which activities are applicable to their school's resources and infrastructure. However, Figure 4 shows ideas for extracurricular activities related to bioeconomy, circular economy and SDGs, which could take place at lunch time or after school and last about 45-60 minutes. Some of these ideas came from the discussion on school clubs at the 9th March workshop (see section 3.3 and Annex III).

Each activity in Figure 4 could be a weekly, bi-weekly or monthly theme, that changes each time, depending on staffing and resources at the school. Alternatively, each of the activities in Figure 4 could be used to form a stand-alone club. For example, the club could purely be a Sustainable Cooking Club, which highlights ways to reduce food waste and use seasonal, local produce. This teaches valuable life skills and highlights messages about reducing energy consumption through the importation of food. However, it is recognised that not every school will have cooking facilities, and this is why these activities are provided as a framework to be moulded and adapted by individual schools according to their resources and needs.

These practical activities can work together with the lecture material presented in Section 5 to consolidate learning and transform abstract concepts into tangible actions. Ultimately, it is hoped that incorporating at least a few of these activities into school clubs will encourage a greater engagement with

issues relating to the bioeconomy and inspire students to bring knowledge and sustainable practices back to their homes. These activities also show that social innovations and sufficiency are no less important than technological innovations, in the transformation towards a more sustainable bioeconomy.

Welcome to the “Trash is Gold” Club First meeting - students could see three short videos: one on bioeconomy, one on CE and one on SDGs. Students could decide club name and agree activities to be done over the year.	Games and Quizzes Play with the wide range of games and quizzes on bioeconomy, CE and SDGs. Could compete in groups. Could vote for best quiz and game. Could create new games and quizzes.	Champion a Champion Many organisations are winning sustainability, bioeconomy or circular economy awards. Students pick award winning organisations and tell the club what that company is about and why they won a prize.	Get creative Students to do arts and crafts using bioproducts and other recyclable materials. Companies could be asked to donate left-over products. An art exhibition could be organised & prize given.
Circular me Each club member to think how they can become more circular and sustainable at home and in the things they do. Then they share ideas and successes with the club.	Ethical Fashion Think of the environmental and social impacts of the fashion industry, and what can be done about it. Can you do some clothes from recycled materials? Can you restyle some old shirts?	Sustainable Cooking Learn about no-waste cooking techniques and batch cooking, so no food is wasted. Think about using seasonal and local produce. Any entrepreneurial ideas related to food waste?	Swap Fair A Community Swap Meet is a great way to give away something you do not need and get something you want in return. Swap books, cloths, etc. Swapping clothes is as an alternative to ‘fast fashion’!
Grow food from scraps Some fruits and vegetables that you can replant and grow yourself, from scraps! Lettuce, celery, ginger, pineapple, garlic, onions, basil, apples, spring onions. Give it a try!	Visit in or visit out Invite an industry speaker to come and talk to the club or go on a site visit. Could you also present what the club is doing? Could industry guest help with some of your work?	News and Views Write about what the club and the school is doing about bioeconomy, circular economy and SDGs. Can you engage with the local community so they learn about your ideas?	SDG Achievements What can your school do to achieve some or all of the SDGs? Which SDG would the club champion? Can you do posters showing what the school is doing?
What job and career? What skills/qualifications would be needed to pursue a career in the bioeconomy? Explore the bioenergy career map: https://www.energy.gov/eere/bioenergy/bioenergy-career-map	Repair Fair Organise event where people bring broken items that need repairing and they learn to repair them from people who volunteer to help – repair bikes, clothing. Reduce waste and increase repair skills.	Life on land This is SDG15 – what can we do to achieve it? What bioproducts we can get from forestry and agriculture? What about essential oils from plants to be used in cosmetics and medication?	Life below water This is SDG14 – what can we do to achieve it? What bioproducts we can get from fisheries? What art work we can do with this theme? How can we reduce plastic in the sea?

Figure 4: Ideas for extracurricular activities related to bioeconomy, circular economy & SDGs

8 How educational resources can be delivered online

Online and blended learning has been embraced around the world as they can diversify the learning experience and increase the accessibility of educational resources (e.g. Barbour *et al.*, 2011; Mio *et al.*, 2019). E-learning has become even more pressing given the global Coronavirus pandemic in 2020 (e.g. Lau *et al.*, 2020; Nordmann *et al.*, 2020). Many of the learning resources included in this BE-Rural report can be delivered online. The 100 resources listed as part of Output I are all online and that is a key reason why they were selected.

The lecture material could all be made available online. Teachers can provide video or audio recordings of themselves presenting the lecture. While an interactive element, which allows students to ask real-

time questions, can be enabled by using platforms such as Blackboard, GoToMeeting, Microsoft Teams, Skype or Zoom. Mentimeter, which is already an online tool, could be used during these online conference platforms. These provide secure multi-person conferences as participants can use a password to join the conference. Alternatively, students could email teachers with questions and receive clarification via this method, if instant discussion is not required or possible. Video content and additional links to further information can be provided in slide notes and so students can use these in the same way to gain extra information on areas they are interested in to supplement their taught learning.

Regarding the games and quizzes for the workshops, the playing cards (for the games “Business Match”, “BE-Match” and “SDG-Link”) could be created in a digital game format, based on the same concept as the physical card games. Quizzes could be converted into a questionnaire and sent to the participants to fill in during or after the lecture. While the online tool used to create the word search puzzles provides a web link to the word puzzle once it has been created. This link could also be shared with participants who could be asked to complete them online or print out before solving. Exactly as the lectures, the workshops can be combined with the same online conference packages such as Blackboard, GoToMeeting, Microsoft Teams, Skype or Zoom.

In terms of extra-curricular activities, the current Coronavirus pandemic and the need for social distancing may mean that some of the school clubs may not be able to be conducted physically. However, teachers could set tasks that students do at home, such as art work. Additionally, parents or guardians may be able to oversee cooking, if recipes are made available online for students to follow whilst studying from home. Therefore, some activities may still be able to go ahead in a single household setting with online instructions from teachers. This method may also provide additional benefits of dissemination of awareness of the bioeconomy beyond the school building and into individual homes. It allows parents and guardians to become involved in the activities alongside their children. For example, by identifying unsustainable practices, such as single use plastic in their own homes. This gives households an opportunity to look at ways to reduce their own consumption habits and, as a result, could help spread the message of the bioeconomy principles more widely through society.

9 Conclusions and next steps

The EU aims to build the world’s leading bioeconomy (Bell *et al.*, 2018). One key aspect is related to raising awareness of the value of bioeconomy and how it relates to sustainability. The BE-Rural educational resources included in this report intends to contribute to this important aspect. The report reviewed existing educational resources, presented power points slides to be used by educators and suggested possible extracurricular activities. This project created new games and quizzes related to the bioeconomy, sustainability, the UN Sustainable Development Goals (SDGs), and the circular economy. It is hoped that these games will both educate and inspire the next generation.

The material in this report will be translated into Bulgarian, Latvian, Macedonian, Polish and Romanian. As part of the BE-Rural activities, these educational resources will be used in a series of educational events on sustainability and the bioeconomy. Facilitators from the five OIP (see Figure 1), will deliver at least three educational events in each region on the broad theme of ‘Sustainability and the Bioeconomy’, focused on school/college/university pupils/students and/or teachers. The specific focus of these events will be tailored to the interests and needs of each region, both in terms of sub-themes, and in terms of target group, e.g. which age group and educational level, and whether students/ pupils and/or teachers.

These educational resources will also be used in a teachers’ summer school on sustainability and the bioeconomy school for teachers interested in developing curricula and educational material on sustainability and the bioeconomy. The summer school will primarily be targeted at teachers in the five OIP regions, but participation could also be widened to some teachers from other moderate or modest innovator regions.

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Annex I - Questions to participants during the BE-Rural kick-off meeting (9-10th April 2019)

What are your thoughts on the following?

(within the theme of education, awareness and engagement in sustainability and bioeconomy)

**** Work in groups of two to discuss ideas ****

If you are focusing on a specific **region** write it here:

If you are focusing on a specific **sector** write it here:

Why are you picking this region and sector?:

- The educational materials on the theme of sustainability and the bioeconomy should primarily target these groups - rank from 6 (most important) to 1 (least important)::**

a) () Primary school pupils	d) () Primary school teachers
b) () Secondary Schools pupils	e) () Secondary Schools teachers
c) () University students	f) () University teachers
- Given the main target group you picked above (the one you ranked with number 6), what do you think the educational material should look like (e.g. should it be a booklet with information)?**

- What are the key sub-themes that we should cover within the theme of sustainability and the bioeconomy, both overall sub-themes relevant to all and specific sub-themes of interest to a region?**

Overall sub-themes relevant to all:	Specific sub-themes for region _ _ _:
.....
.....
- The bioeconomy can potentially contribute to some of the sustainable development goals (SDGs). Which of the SDGs do you think the educational materials should focus on (tick the most relevant ones)**

SDG 1: No Poverty	SDG 9: Industry, Innovation and Infrastructure
SDG 2: Zero Hunger	SDG 10: Reduced Inequality
SDG 3: Good Health and Well-being	SDG 11: Sustainable Cities and Communities
SDG 4: Quality Education	SDG 12: Responsible Consumption & Production
SDG 5: Gender Equality	SDG 13: Climate Action
SDG 6: Clean Water and Sanitation	SDG 14: Life Below Water
SDG 7: Affordable and Clean Energy	SDG 15: Life on Land
SDG 8: Decent Work and Economic Growth	SDG 16: Peace and Justice Strong Institutions
	SDG 17: Partnerships to achieve the Goal
- Any other thoughts?**

Annex II - Questions to consortium and people who showed interest in attending a teachers summer school on the bioeconomy (April 2020)



Your thoughts on educational materials on sustainability and the bioeconomy

1. The educational materials on the theme of sustainability and the bioeconomy should primarily target these groups - rank from 6 (most important) to 1 (least important):
 - a) () Primary school pupils
 - b) () Secondary Schools pupils
 - c) () University students
 - d) () Primary school teachers
 - e) () Secondary Schools teachers
 - f) () University teacher

2. Given the main target group you picked above (the one you ranked with number 6), what do you think the educational material should look like (e.g. should it be a booklet with information)?

3. How do you think the schools can best use these materials? (For example, integrated with an existing class/course (e.g. science, art, biology) or creating a new class/course? How many hours of materials would be ideal? etc)

4. What is your experience with teaching and teaching support?
.....

5. Any other thoughts?

- What is your region?

- What is your country?

- What is the name of the organisation that you work for?

Many thanks for your thoughts!

Annex III – Programme of the workshop to test the educational resources

Workshop on educational materials on bioeconomy and sustainability

Monday, 9th March 2020, 9am - 5pm

University of Strathclyde, Level 5, James Weir Building, Room JW509a (KE hub), 75 Montrose Street, Glasgow



Aim: As part of the BE-Rural Project (<https://be-rural.eu/>) we are developing educational materials on bioeconomy and sustainability. This workshop aims to get feedback on what we have been doing and get new ideas from attendees. If you have any further thoughts after the event please email Dr Elsa João, University of Strathclyde.

Programme:

9.00-10.30

- Introduction to event (Elsa João)
- Introduction to bioeconomy (Lauren Hirsch)
- Bioeconomy and the Circular Economy (Khaing Thet Htar Aung)
- Workshop on Bioeconomy and Circular Economy (Lauren Hirsch and Khaing Thet Htar Aung)
- *Participants to fill survey about the above lectures and workshop*

10.30-11.00 – tea/coffee break

11.00-12.30

- Bioeconomy and key principles of sustainability (Hannah Lane)
- Bioeconomy and SDGs (and respective targets) (Nada Alwakdany)
- Workshop on Bioeconomy and sustainability and SDGs (Nada Alwakdany and Hannah Lane)
- *Participants to fill survey about the above lectures and workshop*

12.30-13.30 – Lunch

13.30-15.00

- Bioeconomy in the agriculture sector (Conaill Carolan)
- Bioeconomy in the fisheries sector (Rebeca Casado Rodriguez)
- Workshop on Bioeconomy in the agriculture and fisheries sector (Conaill Carolan and Rebeca Casado Rodriguez)
- *Participants to fill survey about the above lectures and workshop*

15.00-15.30 – tea/coffee break

15.30-17.00

- Bioeconomy in the forestry sector (Beatrice Morel)
- Bioeconomy in the sector of essential oils and herbs for cosmetics and pharmaceuticals (Eilidh Shaw)
- Workshop on Bioeconomy school clubs (Eilidh Shaw, Beatrice Morel and Elsa João)
- *Participants to fill survey about the above lectures and workshop*
- Closure and thanks (Elsa João)

Annex IV – Key questions used 9th March workshop surveys for feedback & ideas

Evaluation of the educational materials on bioeconomy and sustainability		Individual code, to match the answers to different surveys by participants:
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The completion of this feedback survey is completely voluntary. All responses will be treated anonymously.

Power Point Presentations – filled-in after each 1.5 hour session (see Annex III):

- A. Any comments about any of the sides (fun/boring, clear/unclear, complete/incomplete, good/bad)?**
B. Any comments overall so we can improve this presentation?

1. On a scale from 1 to 5 (where 1 is 'poor' and 5 is 'excellent') – how would you evaluate these slides?

1	2	3	4	5

2. Please explain rating above
 3. What did you find most fun and interesting?
 4. Were any issues missing or not clear?
 5. What are your suggestions for improvement?
 6. Any other comments?

Games - filled-in after each 1.5 hour session (see Annex III):**Any comments so we can improve this game?**

1. On a scale from 1 to 5 (where 1 is 'poor' and 5 is 'excellent') – how would you evaluate this game?

1	2	3	4	5

Why?

2. On a scale from 1 to 5 (where 1 is 'my knowledge has not increased' and 5 is 'my knowledge has definitively increased') – has this game helped you to gain a better understanding of what the bioeconomy is?

1	2	3	4	5

What was your key learning or take-home message?

3. What did you find most fun and interesting?
 4. What do you think about the format, content and visuals of this game?
 5. Were any issues missing or not clear or unhelpful?
 6. What are your suggestions for improvement?
 7. Any other comments?

Any other ideas? – participants asked to fill this at the end of the day:

1. Any other ideas about Bioeconomy school clubs?
 2. Any other ideas about Bioeconomy careers?
 3. Any other ideas about Bioeconomy teaching materials?

Annex V – Output 1: Review of 100 free online teaching resources (listed by theme: bioeconomy, circular economy & SDGs)

No	Title online teaching resource	Web link (and reference if applicable)	Main theme	Type online resource (e.g. video, quiz, game)	Author and year	Summary and review in terms of interest, clarity, fun, content	Key target audience	Time to read or do	Level of difficulty or complexity	Language	Ideas for use in classroom
1	A Sustainable Bioeconomy for Europe	https://ec.europa.eu/research/bioeconomy/pdf/ec_bioeconomy_strategy_2018.pdf	Bioeconomy	PDF report available online	European Commission 2018	This updated Bioeconomy Strategy builds on the 2012 Strategy. It proposes actions to scale-up the bioeconomy to create growth and job opportunities at local level, reinforce the bio-based sector and contribute to the modernisation of EU industry, protect the environment and enhance ecosystems' functions and biodiversity. Important report as it provides the EU views on sustainable bioeconomy and includes action plan.	secondary school teachers, university lecturers, university students, business & industry, government, NGOs	2 hours	Intermediate Advanced	English	Discussion of key issues in class.
2	Bio...what? The Bioeconomy game	https://www.fvaweb.eu/biowhat/	Bioeconomy	Interactive educational online game.	BIOWAYS & BioStep 2019	Educational online game that reveals information on various bio-products in relation to the Bioeconomy. Students can move a small character to a resource and then pair it to a bio-product that can be made from the resource. Information on the bio-product and how it is made is then shown. Very engaging and well designed. The educational element is easy to understand and informative. The game can be shared on Facebook where students can upload their scores and get competitive with each other. The resource stimulates curiosity and delivers information on bio-products. The quiz throughout the game makes it a good learning resource.	primary school pupils, secondary school pupils	5 - 10 minutes	Beginner	English Estonian Greek Portuguese Slovakian Spanish	Students could play on their own or in groups, or teacher could display game to the whole class, for students to try and pair resources to their bio-products.
3	Biobased Products for a Sustainable Bioeconomy	https://www.edx.org/course/biobased-products-for-a-sustainable-bioeconomy	Bioeconomy	Online teaching course with videos, interactive assignments and quizzes to help evaluate the progress of the user	edX, DELFT University of Technology 2020	An introduction to the world of biobased products and processes using biobased resources, including biobased feedstock, sustainability aspects, links to climate change, and how to design a biobased product ready to be brought into the market. Great interactive online teaching resource with real life examples on how these products are created and commercialised into the global market. Quizzes are a good way to keep people engaged to the course.	primary school teachers, secondary school teachers, university students, university lecturers, business & industry, NGOs	5–6 hours per week, over 10 weeks	Intermediate Advanced	English	A full online course, 5–6 hours per week, over 10 weeks. <i>Free course but course completion certificate costs around €46.</i>

No	Title online teaching resource	Web link (and reference if applicable)	Main theme	Type online resource (e.g. video, quiz, game)	Author and year	Summary and review in terms of interest, clarity, fun, content	Key target audience	Time to read or do	Level of difficulty or complexity	Language	Ideas for use in classroom
4	Bioeconomy in everyday life	https://www.bio-vale.org/wp-content/uploads/2015/11/Bioeconomy-in-everyday-life-2015.pdf	Bioeconomy	PDF report - formatted like a shopping catalogue, giving a mini case study on the material and its relevance to bioeconomy on each page.	European Commission 2015	Report explains and creates awareness how bioeconomy can impact upon our daily lives, using different examples of everyday products (e.g. from conditioner to trainers) and explains how these items can be made using renewable biodegradable materials. Informative, interesting, and compact resource about the bioeconomy. Helpful that legend at the bottom of each page scores each product based upon their performance (e.g. cost-efficiency, innovation, and fossil fuel reduction).	secondary school pupils, university students, business & industry, NGOs	1.5 hours	Beginner	English	Different pages detailing different bio-based products could be passed around to show students the potential applications.
5	Bioenergy Basics 101 Game	https://www1.eere.energy.gov/bioenergy/basics101/game.html	Bioeconomy	Online game	Department of Energy's Bioenergy Technology Office (USA) 2012	Game with questions regarding bioeconomy and biofuel production, uses and benefits. It can be played alone or in teams. The game is amusing and intellectually stimulating. A competition against each other, like jeopardy, would make it more fun. Game good for making you think about what you know. The levels differ from beginner to intermediate so works well for a range of knowledge.	secondary school pupils, university students	20-30 minutes	Beginner Intermediate	English	Would work great in a class, keeping people engaged and having fun while they learn.
6	BioStep - Products	http://products.biostep.eu/	Bioeconomy	Online quiz and a short database with some bioproducts in homes.	BioStep 2018	Website which includes a short slideshow with examples of possible bioproducts we can find at home, and an interactive short quiz which evaluates knowledge of bioproducts, their resources and their potential. Explanations and examples are provided in the answers to the quiz.	primary school pupils, secondary school pupils	20 minutes	Beginner Intermediate	English	Slideshow;. Ask students to provide examples of bioproducts they know; Do quiz.
7	BLOOM Bioeconomy	https://bloom-bioeconomy.eu Cossu, C. (2019): An innovative vision of the Bioeconomy problems in the class: The BLOOM Project. <i>Geophysical Research Abstracts</i> , 21: 1-11	Bioeconomy	Web page with a variety of resources: webinars, videos, MOOC, and online quiz https://bloom-bioeconomy.eu/repository/bloom-bioeconomy-quiz/	BLOOM (project funded by the EU Horizon 2020, running since 2017) 2018	BLOOM aims to spread awareness of strategies for creating bioeconomies in Europe with a large focus on education within schools with online resources and physical workshops. Trialled new teaching resources in classrooms in different curricular subjects, e.g. maths, engineering and science. Twitter feed regularly updated with links to articles and information about bioeconomies. YouTube page with teaching videos describing bioproducts. MOOC on "Boosting bioeconomy knowledge in schools".	secondary school pupils, university students, secondary school teachers, university lecturers	Varies with each resource.	Intermediate	English (video captions in many languages including Bulgarian, Latvian, Macedonian Polish and Romanian)	Presentation on the bioeconomy and different bioproducts. Showing videos. Quiz to test students' knowledge and ensure key concepts were understood.

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						Multiple-choice online quiz to be answered within a time limit, user gaining a score at the end.					
8	Educational Resources: Bioenergy in the Classroom	https://www.energy.gov/eere/bio-energy/educational-resources-bioenergy-classroom	Bioeconomy	Web page with a variety of resources (videos, exercises, etc)	Office of Energy Efficiency & Renewable Energy, US Department of Energy, 2020	Wide range of educational resources related to bioenergy. A wide of resources well organised. It is possible to search by student level and by topic (e.g. Bioenergy, Renewables, Energy Efficiency, Biofuels, Science Education, Alternative Fuel Vehicles, Fuel Economy, Hydrogen, Solar, Wind, Clean Cities, Consumption, Energy Economy, Energy Usage, Geothermal)	primary school pupils, secondary school pupils, primary school teachers, secondary school teachers	Depends of activity	Beginner Intermediate	English	Resources ready to be used in classroom.
9	EFFAT Bioeconomy Workshop	https://bioeconomy.effat.org EFFAT (2017): The bioeconomy and a future biobased food industry and agriculture sector. Brussels: EFFAT	Bioeconomy	Video and report	European Federation of Food, Agriculture and Tourism Trade Unions (EFFAT) 2018	Short video summarising EFFAT report on the EU bioeconomy and how to shape its future. Video describes importance of biorefineries and biomass production to the EU economy & pinpoints areas for future opportunity. The video is snappy, engaging & interesting, and report gives a in-depth explanation. In the report, a few 'National Focus' countries are selected, and case studies show how some bioenergy/biomass-based companies operate within these countries.	secondary school pupils, university students	2 minutes (video); 2 hours (report)	Intermediate Advanced	English	Can be used at start of a lesson to initiate a discussion on what students think the bioeconomy is.
10	Energy from floating algae pods	https://www.ted.com/talks/jonathan_trent_energy_from_floating_algae_pods/ Trent, J. (2012): Grow Your Own Energy, New Scientist, September 3.	Bioeconomy	Video from TEDtalk (TEDGlobal)	Jonathan Trent, TEDtalk 2012	Video on the use of micro-algae to produce biofuels. Author invented Offshore Membrane Enclosures for Growing Algae (OMEGA) project. OMEGA created to grow micro-algae in floating offshore pods, feed by wastewater from cities. Presentation covers how floating structure works, its impact on environments and further developments (e.g. link with wind energy). Video relevant to anyone interested in biofuels, nanotechnology and wastewater treatment. Video is excellent and easy to understand with interesting animations.	secondary school pupils, secondary school teachers, university students, university lecturers, business & industry	14 minutes and 21 seconds	Intermediate Advanced	English but 17 languages available in subtitles (Including Bulgarian, French Polish, Romanian, Russian)	Students to discuss what they learned from this video. Assign tasks in groups. Ask questions, e.g. how can microalgae be used for wastewater treatment?

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11	Forest based Bioeconomy in Finland	https://www.bioeconomy.fi/video-forest-based-bioeconomy-in-finland/	Bioeconomy	Video	Bioeconomy.fi (Finland) 2014	About the bioeconomy in Finland and with interesting examples of how Finland has used their vast amounts of forest land to develop sustainable alternatives to commonly used products. Good that shows a wide range of uses and innovations that can be made using a bioeconomy system. Video concise, informative and visually interesting.	secondary school pupils, university students, business & industry	1 minute and 43 seconds	Beginner Intermediate	English	Develop Ideas from video, e.g. how viscose replaces cotton & cellulose fibre replaces plastics.
12	Quiz #1 - Are you ready for the bioeconomy?	http://www.all-things.bio/quiz/are-you-ready-for-the-bioeconomy/	Bioeconomy	Quiz	AllThings.Bio 2018	Interactive quiz with six questions about the bioeconomy. User can see if answer is right or wrong right away and explanation is provided, plus explore every question's concept by clicking on "Learn more about this" link, redirecting users to other sites with in-depth information. Quiz is entertaining and informative. Questions ranges from simple ones to those which require a bit more background, so relevant to different target audiences.	primary school pupils, secondary school pupils, university students, primary school teachers, secondary school teachers	6 minutes or more - depending if reading extra information	Beginner Intermediate	English	QR Code could be projected for students to scan and be redirected to online quiz. % right or wrong questions could appear on screen.
13	The Bioeconomy starts here!	https://www.youtube.com/watch?v=2xvXkOMRTs4	Bioeconomy	Video accessible via youtube	European Commission 2014	Video explains briefly the most important basics of a bioeconomy by means of an animated film. It presents the differences between fossil and biological resources as basis for products. It introduces the bioeconomy as a circular economy and illustrates its positive aspects and advantages in the future. Video is well made and informative. As it is only 2 min long and can have captions in 24 EU languages, it a useful teaching resource.	primary school pupils, secondary school pupils, university students	2 minutes	Beginner	English but captions in all 24 EU languages	Video could be a nice start to a presentation on key principles of bioeconomy and circular economy.
14	The Blue Bioeconomy	https://www.youtube.com/watch?v=WEp3fFleZc4	Bioeconomy	Video accessible via youtube	Matís Iceland 2016	Focus on the bioeconomy linked to the sea and related industries - the blue bioeconomy. Interesting that shows route that bioproducts can make from source to production. Video gives insight on how byproducts that are commonly considered as waste can be utilised for other purposes, e.g. use of Atlantic cod's bones used for food supplements (fatty acids and proteins). Video explained in simple and easy to under-	secondary school pupils, university students, primary school teachers, secondary school teachers, university lecturers, business & industry, NGOs	3 minutes and 40 seconds	Beginner	English (sub-titles include: Bulgarian, Latvian, Macedonian, Polish and Romanian)	Video can be used as an introductory video to bioeconomy due to its simple and concise definitions and easy to understand examples.

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						stand language, and has enjoyable animations, and so is suitable for a wide audience with varying abilities.					
15	Towards Sustainable Bioeconomy - Lessons Learned from Case Studies	http://www.fao.org/3/ca4352en/ca4352en.pdf	Bioeconomy	PDF report	Marta Gomez San Juan, Anne Bogdanski and Olivier Dubois 2019	Amazing resource with 26 case studies on sustainable bioeconomy with links to SDGs. Interesting detail about uses of bioeconomy around the world. Well formatted report that can easily be used as a teaching resource. Report highlights value and success of each case study.	secondary school pupils, university lecturers, business & industry, government, NGOs	2 hours or more	Intermediate Advanced	English	In groups, discuss how case studies can be implemented on a local, national or global scale.
16	3 creative ways to fix fashion's waste problem	https://www.ted.com/talks/amit_kalra_3_creative_ways_to_fix_fashion_s_waste_problem	Circular Economy (CE)	Video - Ted talk	Amit Kalra, TED@Tommy 2017	interesting video on fashion and waste. Discusses ways to reuse and recycle unwanted clothes and how industry could make clothes more modular in their composition and use biodegradable materials. Interesting that video also talks about the use of harsh chemicals as garment dyes and how these dyes are affecting possible water supplies. It also addresses how use of these chemicals can make it harder for a product to be reused/recycled as it is not possible to remove the colour, adding another factor to consider when establishing a CE.	secondary school pupils, university students, secondary school teachers, university lecturers, business & industry	9 minutes and 37 seconds	Beginner Intermediate	English but transcript available in 19 different languages (Including, French, Hungarian, Polish, Russian, Spanish)	Show video to students to get them thinking about the fashion industry and the waste associated with fast fashion.
17	A circular economy for salt that keeps rivers clean	https://www.ted.com/talks/tina_arrowood_a_circular_economy_for_salt_that_keeps_rivers_clean/	Circular Economy (CE)	Video	Tina Arrowood, TEDTalk 2019	Video informs and educates on the possibility and necessity of protecting the rivers from excessive salt that comes from human activity; this can be achieved through circular economy. A three-step river defence mechanism is introduced, explaining how to recover salt from salty industrial wastewaters and reuse it..	university students, university lecturers, business & industry	13 minutes	Intermediate Advanced	English but subtitles in 11 languages (including French, Hungarian, Spanish)	Use diagrams explaining three-step river defence mechanism and salt generation in linear and CE.
18	A healthy economy should be designed to thrive, not grow	https://youtu.be/Rhcrbcg8HBw Raworth, K. (2017): <i>Doughnut Economics: Seven Ways to Think Like a 21st-Century</i>	Circular Economy (CE)	TED Talk (Youtube video)	Kate Raworth, TEDTalk 2018	An important and interesting talk highlighting the issues with our current mass consumerist culture and critiques an economy built on endless growth. Unpicks the issues of GDP growth. This video contrast these issues with a new model of Doughnut Economics - a visual framework for sustainable development	secondary school pupils, university students, secondary school teachers, university lecturers, business	16 Minutes	Intermediate	English (but subtitles in 23 languages including Bulgarian, French, Hun	Students could try and plot their own lives on the Doughnut model.

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		Economist. 1st ed. Vermont: Chelsea Green Publishing.				combining the concept of planetary boundaries with the complementary concept of social boundaries.	& industry, NGOs			garian, Russian and Spanish)	
19	A short guide to the Circular Economy: The CEPS framework	http://www.ceps-ech.eu/sites/default/files/PPT%20CEPS%20Special%20Report%20on%20the%20CE_0.pdf	Circular Economy (CE)	PowerPoint	Igor Taranic (CEPS - Centre for European Policy Studies) 2016	Presentation based on a report about the framework 'Circular Economy Progress for Stakeholders' (which confusingly has the same acronym as the Centre for European Policy Studies), with an overview of the key principles of the CE model and recommendations to European policy-makers on how best to support the transition towards a CE in the EU. Links CE to political change and policy creation and it is useful to see some real-life examples.	secondary school pupils, secondary school teachers, university students, university lecturers, business & industry	20 Minutes	Intermediate	English	Could use diagrams & different building blocks of the CE Model as an intro to the concept.
20	A World without waste	https://www.ted.com/talks/kate_e_brandt_a_world_without_waste	Circular Economy (CE)	Online Video of a TED-Women Talk	Kate Brandt (Google Sustainability Officer), TED-Women Talk 2018	Video explains the CE concept and the speaker's plan to green up Google by creating a CE which reuses, recycles and eliminates waste altogether. Using her own experience, she discusses the idea of a Circular Datacentre. An engaging speaker and a useful video in terms of content and explanation of the CE concept.	secondary school pupils, university students, business & industry	12 minutes and 18 seconds	Intermediate	English	Show video in class, followed by discussion on the various ways of applying CE.
21	Circular Canvas	https://circulab.com/toolbox-circular-economy/circular-canvas-regenerative-business-models/ NuÃholz, J.L.K., (2018): A circular business model mapping tool for creating value from prolonged product lifetime & closed material loops. <i>Journal of Cleaner Production</i> , 197: 185- 194.	Circular Economy (CE)	Materials to support a workshop discussion.	Circulab 2014	Circulab provides this Circular Canvas for companies and other organisations to download, print and then use in group exercises for structured conversations about designing for circularity. This simple tool is targeted at organisations that had not previously considered circularity. It comes with instructions on how to run a group exercise using it. It could be used for considering ways in which to increase the circularity of existing products, or to support the design process for a new product. It could be used by multi-functional teams in industry that are not yet familiar with circular economy concepts. The suggested "investigation cards" provide useful stimulus for discussion. It can also be used by high	secondary school pupils, secondary school teachers, university students, university lecturers, business & industry	2 hours	Intermediate	Chinese Dutch English French German Italian Spanish	Workshop in groups of 4 to 8

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						school and University students, maybe in a business class.					
22	Circular economy	http://www.europa.eu/thinktank/infographics/circular-economy/public/index.html	Circular Economy (CE)	Interactive Graphics	European Parliamentary Research Service 2018	Great attractive interactive informational graphics to use in class that explain linear economy, circular economy, materials, waste, smarter use of resources, materials usage, reduce, recycle, reuse, and EU actions (rules, regulations, statistics, initiatives).	secondary school teachers, university, university lecturers,	30 minutes	Beginner Intermediate	English	Class activity to discuss and explore facts & figures of the interactive infographics.
23	Circular Economy - hacking a broken system while building a new future	https://www.youtube.com/watch?v=_PKbUFJ3lu4	Circular Economy (CE)	Video - TEDx-Tirana talk	Harald Friedl (CEO of Circle Economy) 2018	Video provides an engaging, informative, and valuable intro to the concept of a CE. Three real companies and their services/ products are discussed that aim to operate in a more circular fashion. Explains feasibility and need for a transition towards more sustainable ways of living. Highlighting how detrimental the linear economy (take, make & dispose) is.	secondary school pupils, university students, business & industry, NGOs	22 minutes and 44 seconds	Beginner Intermediate	English	Show video to class. Possibly show in smaller excerpts.
24	Circular Economy - Sustainable Materials Management	https://www.coursera.org/learn/circular-economy	Circular Economy (CE)	Course taught online through videos, readings & quiz. Quiz done at the end of each module to ensure that the learner has fully understood content.	Lund University and seven others partners 2020	Free online course that looks at sustainability and the circular economy. This is a fantastic learning tool that is not only delivered by the top university of Lund but also involves industry experts such as EIT RawMaterials through Coursera. Additionally, there is opportunities to get involved in peer reviewed activity to allow learners to engage in discussion with fellow users. Course modules encourage learner to consider circular economy at all levels from the materials chosen for production of a product, to policies and networks.	university students, secondary school teachers, university lecturers, business & industry, NGOs	21 hours over 5 weeks	Beginner	English	A full online course, 21 hours, over 5 weeks. <i>Free course but course completion certificate costs around €41 (financial aid is available if required).</i>
25	Circular Economy Business Worksheet	https://ceaccelerator.zerowastescotland.org.uk/circular-guide/how-can-i-get-started/ The additional resource 'Circular Economy Strategy	Circular Economy (CE)	Worksheets	Zero Waste Scotland 2019	Worksheets to help companies review their current practices and identify how they could incorporate the CE into their business. There are four worksheets which take you through step by step: 1. starts with analysing current practices, finding all inputs and outputs. 2. look at these and find if any of the inputs could be sourced more sustainably or if any of	secondary school pupils, secondary school teachers, university students, university lecturers, business &	1 hour and 20 minutes	Intermediate	English	Split into groups of 4 or 5 and work through the worksheets for their own business (or case study business if students)

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		Cards' is also required. This is available for download at https://ceaccelerator.zerowastescotland.org.uk/ under the heading 'Circular Strategies'.				their outputs could be used by someone else. 3. then use this to see how their business fits into CE strategies (by using another resource, the 'Circular Economy Strategy Cards'). 4. Finally, make a commitment to allocating time and money to researching these further and implementing them. Really good resource that works with students working in groups analysing a case study (maybe as part of a business class).	industry, government, NGOs				and discuss findings in their groups.
26	Circular Economy Club	http://www.circular-economy-club.com/listings/	Circular Economy (CE)	Website	Circular Economy Club (CEC) 2012	CEC is the largest international network of CE professionals with 260 CEC local chapters in 110 countries. The website allows members from all over the world to share overviews and links to resources (articles, books, news, podcasts) about CE. Good source of links to interesting case studies and examples of circular products and systems. As there are members from all around the world, there are also sources with different languages.	secondary school teachers, university students, university lecturers, business & industry, NGOs	Variable, depending of activity and reading.	Beginner Intermediate Advanced	Chinese Dutch English French Italian Japanese Portuguese Spanish	Provide examples of developments and utilization of circular models in businesses.
27	Circular Economy General Resources Map (Ellen MacArthur Foundation)	https://kumu.io/ellenmacarthurfoundation/educational-resources#circular-economy-general-resources-map/key-for-general-resources-map .	Circular Economy (CE)	Web page that contains lots of video, articles, business case studies and reports in one single place.	Ellen MacArthur Foundation (EMF) Since 2010 & constantly updated	This is an amazing resource, completely interactive and incorporating a large spider diagram (or mind map) to show the connections of all the aspects of the CE. The interactive resource mind map is a collection of almost all educational resources that have been published, including videos, graphics, reports, case studies, articles, etc., providing an organised collection of all knowledge and educational materials published by EMF, starting from the introduction to Circular Economy to Business Case Studies and CE Reports. This is the best place to go to learn more about CE and what progress is being made worldwide. This page provides all types of educational materials from very interesting few-minutes-long videos to inspiring long research report publications for different industries.	primary school teachers, secondary school teachers, university lecturers, secondary school pupils, university students, business & industry, government, NGOs	Varies due to the wide range of materials - it could take minutes, hours, days or weeks to go through some or all of these materials.	Beginner Intermediate Advanced	English	Since this webpage contains lot of materials in one place, the teachers or users of this resource should go through this resources to find out what kind of information is there and what can be incorporated into their teaching curriculum.

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28	Circular Economy in Cities	http://www3.weforum.org/docs/White_paper_Circular_Economy_in_Cities_report_2018.pdf	Circular Economy (CE)	White Paper	World Economic Forum - PwC 2018	In-depth analysis of the need for cities to transition towards a circular economy. Highlights innovative solutions applying circular principles to up-cycle waste from existing buildings, infrastructure and construction, harvest rainwater for reuse, generate clean and resource-efficient energy, treat medicinal waste, as well as procurement of goods and services. Also identifies barriers to implementation and the role of individual stakeholders in overcoming these barriers. Interesting use of case studies (e.g. up-cycling brick walls by cutting out modules to use in buildings).	secondary school pupils, secondary school teachers, university students, university lecturers, business & industry	1 hour or more	Intermediate Advanced	English	This white paper includes a number of case studies on different topics and cities which could be discussed in class.
29	Circular economy: Marcel Wubbolts at TEDxMaas-tricht	https://www.youtube.com/watch?v=Es0zREJUxjw	Circular Economy (CE)	TEDx talk video	Marcel Wubbolts, TEDx 2014	Talk about how the linear economy is affecting our global ecological footprint and how CE can help manage and protect our resources by transforming 'waste' into something valuable. Plus how this change applies to everyone: scientists, industries, the government, and consumers. Talk discusses how biotechnology can transform the way we handle waste and use it to generate energy or fuels.	secondary school pupils, university students, business & industry, NGOs	13 minutes 19 seconds	Intermediate	English	Discussion on how waste can become a resource.
30	Circular Economy: An Introduction	https://www.edx.org/course/circular-economy-an-introduction	Circular Economy (CE)	Online teaching course with videos, interactive assignments and quizzes to help evaluate the progress of the user.	edX, Delft University of Technology 2019	This course teaches how to contribute to a sustainable economic system by implementing novel business and design approaches, based on the circular economy. It is at an introductory level course under business & management subjects. It is very well organised with nicely designed videos and staff that could be contacted for further information.	secondary school teachers, university students, university lecturers, business & industry, NGOs	3-6 hours per week, over 7 weeks course	Beginner Intermediate	English	Full online course, 35 hours, over 7 weeks. <i>Free course but course completion certificate costs around €46.</i>
31	Circular Economy: case studies	https://www.worldsteel.org/steel-by-topic/circular-economy/case-studies.html	Circular Economy (CE)	Webpage	World Steel Association 2020	This is a very good learning resource to help understand the benefits of CE. A very practical teaching resource that provides a lot of concrete examples of CE. A resource that links CE ideas to actual case studies, for example, 'reduce' topic links to production technologies that reduce waste.	secondary school pupils, secondary school teachers, university students	1 hour	Beginner Intermediate	Chinese English	Discuss in small groups one or more of the case studies.

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32	Dame Ellen MacArthur: food, health and the circular economy	https://www.youtube.com/watch?v=M6MLFJDddM4	Circular Economy (CE)	Youtube Video	Ellen MacArthur at the 2015 EAT Food Forum 2015	An opportunity to listed to Ellen MacArthur, an inspirational speaker. She explains what is the CE and how CE can improve the entire economic system, re-using raw materials and flow them back into the economy, changing the whole system, not only the item itself. This teaching resource is very useful because it is easy to understand. Talk is rich in examples, and has many diagrams and pictures, to show how CE is important and relevant.	secondary school pupils, university students, , secondary school teachers, university lecturers, business & industry, NGOs	10 minutes	Beginner	English but subtitles translated in many languages (including Bosnian, Latvian, Macedonian, Bulgarian, Polish, Romanian)	It could be used during early lessons because it is an introduction of the Circular Economy concept.
33	Developing Scotland's circular economy: consultation on proposals for legislation	https://www.gov.scot/publications/delivering-scotlands-circular-economy-proposals-legislation/pages/3/	Circular Economy (CE)	Website	Scottish Government 2019	Informative website with detailed description of what the CE and waste hierarchy are. Information on the Scottish Government waste targets. This is a useful resource to learn about CE and sustainability. This resource also has information about the Zero Waste Scotland plan and certain systems which are in place to help reach waste targets, such as a "deposit return scheme" used for single use plastics and containers. Diagrams are very good as they are clear & informative.	secondary school teachers, university lecturers, business & industry, government, NGOs	30 minutes	Intermediate	English	Suggested reading for students, or reference the figures and diagrams in lecture slides.
34	DK Osseo-Asare: What a scrapyard in Ghana can teach us about innovation	https://www.ted.com/talks/dk_osseo_asare_what_a_scrapyard_in_ghana_can_teach_us_about_innovation	Circular Economy (CE)	TEDTalk	DK Osseo-Asare, TEDTalk 2017	An informative talk about a bottom-up approach to CE. In Agbogbloshie, a community in Accra, Ghana, people descend on a scrapyard to mine electronic waste for recyclable materials. Without formal training, these urban miners often teach themselves the workings of electronics by taking them apart and putting them together again. Designer and TED Fellow DK Osseo-Asare questions: What would happen if we connected these self-taught community members from Agbogbloshie with students and young professionals in STEAM fields (science, technology, engineering, art and mathematics)? This video is informative in many ways. Firstly, the speaker uses lots of visuals such as photographs to address the	secondary school pupils, university students, business & industry, NGOs	14 minutes and 9 seconds	Intermediate Advanced	English but 18 languages available in transcript, including French, Hungarian, Russian, Serbian, Spanish)	Lesson Plan 1: in groups list 10 items that could be re-generated into a new device (a race as fastest team wins). 2: ask examples & put on board. 3: Ask what is world's largest digital dump? 4: intro to video and ask to try and answer the following questions: a) What

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						theme of CE. By using a grassroots approach as an example of CE, students and young professionals in STEAM fields may be encouraged to apply similar models in their own area of work. Additionally, the scope of social capital in this community in Accra, Ghana is a positive incentive to other communities around the world faced with similar problems. Important real world example of the possibilities of the CE, given in an easy to understand and engaging format. The move away from more traditional ways of learning and instead to more heuristic learning could help create more sustainable communities and do away with consumerist societies.					harm can burning electronic devices have on human health and the planet? b) What might industries learn from this community in terms of CE?. 5): Go over answers & discuss video.
35	Eliminating waste in a circular economy	https://finland.fi/business-innovation/eliminating-waste-in-a-circular-economy/	Circular Economy (CE)	Online magazine	Fran Weaver 2016	This article discusses innovative technologies in maximizing materials and reducing waste. It explains how industries & businesses are being changed in Finland to fit into the CE model. It is an interesting article, recommended because it can help students better understand how to achieve CE and how to sort and recycle materials, helpful for sustainable development.	secondary school teachers, university lecturers, business & industry, NGOs	30 minutes	Beginner	Chinese English French German Portuguese Spanish	Discussion of key issues in class.
36	Executive Summary on Waste to Wealth book by Peter Lacy & Jakob Rutqvist	https://thecirculars.org/content/resources/Accenture-Waste-Wealth-Exec-Sum-FINAL.pdf	Circular Economy (CE)	7-page online PFD document	Lacy & Rutqvist's Book published by Palgrave Macmillan; Executive Summary by Accenture 2015	This is published as an executive summary of the 2015 book "Waste to Wealth" by Peter Lacy & Jakob Rutqvist, introducing the circular economy, explaining the need for circular economy, five circular economy business models, ten disruptive technologies and how the businesses can achieve the circular advantages. Very practical and inspiring knowledge on circular business models.	secondary school teachers, university lecturers, business & industry	20 minutes	Intermediate	English	Could ask students to read this 7 page summary as reading materials and discuss the ideas or do quiz in class.
37	Fashion industry & Circular Economy	https://www.youtube.com/watch?v=65zR2nU0sBU	Circular Economy (CE)	Youtube video	WorldDynamics 2017	Video gives an explanation of linear economy and CE in the fashion industry and how companies are trying to transition to CE and how customers can play a part. Good educational video focusing on fashion industry in CE.	secondary school pupils, university students,	5 minutes and 45 seconds	Beginner	English	Show video in class, followed by discussion.

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38	Lecture 39 : Plastics and Circular Economy - Case Studies	https://www.youtube.com/watch?v=rxmTvPxRNIk	Circular Economy (CE)	Video from open course ware under the name "National Programme on Technology Enhanced Learning (NPTEL)", funded by the Government of India.	Dr. Brajesh Kumar Dubey (Indian Institute of Technology Kharagpur, India) 2019	Talk on CE with primary focus on re-thinking the design of products, the concept of which is explained by considering the company "Unilever" as a case study and the paradigm shift that is happening in terms of redesigning the products at the fundamental level so that they could be easily reused, recycled or composted. Talk focused on explaining the method by which we adjust productions of things to make them more useful for CE. With an analysis of an example along with the explanation, this resource is both useful and interesting.	secondary school pupils, university students, business & industry, NGOs	31 minutes and 46 seconds	Beginner Intermediate	English	Show video in class, followed by discussion. Ask students to think of other organizations and other countries.
39	Lesson 1: Challenging common conceptions	https://www.elenmacarthurfoundation.org/assets/downloads/schools-colleges/Schools-Colleges-WLL-Lesson-Plan-1-F.pdf	Circular Economy (CE)	Webpage and YouTube videos Lesson plan has detailed instructions on how teachers can make use of material.	Ellen MacArthur Foundation 2012	1 st lesson of the lesson plan created to introduce students different ways of thinking how the economy could work: a CE. The series builds up exactly how a CE is different from the status quo, and looks at the economic, environmental and social advantages of a new approach. These lesson plans provide a good introduction to the CE, and can be taught in sequence or as stand-alone lessons. Very good to introduce the challenges of modern world in terms of productions and consumptions and the possible consequences in very short videos.	Age range: 12-19 (Economics, Geography, Environmental Systems, Sociology, Business, Citizenship)	60 minutes	Intermediate	English	Teachers should pre-watch nine 1-min videos & read notes for each video. Each video ends with a question. Show videos in class & ask students solutions & thoughts to each question.
40	Lesson 2: Exploring the circular economy	https://www.elenmacarthurfoundation.org/assets/downloads/schools-colleges/Schools-Colleges-WLL-Lesson-Plan-2-V2.pdf	Circular Economy (CE)	Webpage	Ellen MacArthur Foundation 2012	2 nd lesson of the series about the CE (see row 38 above). These lesson plans provide a good introduction to the circular economy, and can be taught in sequence or as stand-alone lessons. Good practical interactive activity in class.	Age range: 12-19 (Economics, Geography, Environmental Systems, Sociology, Business, Citizenship)	60 minutes	Beginner	English	Lesson plan has detailed instructions on how teachers can make use of material.
41	Lesson 3: Understanding the challenge of 'finite' resources	https://www.elenmacarthurfoundation.org/assets/downloads/schools-colleges/Schools-Colleges-WLL-Lesson-Plan-3-F.pdf	Circular Economy (CE)	Webpage	Ellen MacArthur Foundation 2012	3 rd lesson of the series about the CE (see row 38 above). These lesson plans provide a good introduction to the circular economy, and can be taught in sequence or as stand-alone lessons. Good practical interactive activity in class.	Age range: 12-19 (Economics, Geography, Environmental Systems, Sociology, Business, Citizenship)	45 - 70 minutes	Intermediate	English	Lesson plan has detailed instructions on how teachers can make use of material.

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42	Lesson 4: Designing for a circular economy	https://www.ellenmacarthurfoundation.org/assets/downloads/schools-colleges/Schools-Colleges-WLL-Lesson-Plan-4-F.pdf	Circular Economy (CE)	Webpage	Ellen MacArthur Foundation 2012	4 th lesson of the series about the CE (see row 38 above). These lesson plans provide a good introduction to the circular economy, and can be taught in sequence or as stand-alone lessons. Good practical interactive activity in class.	Age range: 12-19 (Economics, Geography, Environmental Systems, Sociology, Business, Citizenship)	120 minutes	Intermediate	English	Lesson plan has detailed instructions on how teachers can make use of material.
43	Lesson 5: The circular economy and modern agriculture	https://www.ellenmacarthurfoundation.org/assets/downloads/schools-colleges/Schools-Colleges-WLL-Lesson-Plan-5-F.pdf	Circular Economy (CE)	Webpage	Ellen MacArthur Foundation 2012	5 th lesson of the series about the CE (see row 38 above). These lesson plans provide a good introduction to the circular economy, and can be taught in sequence or as stand-alone lessons. Good practical interactive activity in class.	Age range: 12-19 (Economics, Geography, Environmental Systems, Sociology, Business, Citizenship)	45 - 70 minutes	Intermediate	English	Lesson plan has detailed instructions on how teachers can make use of material.
44	Lesson 6: Re-designing Plastics	https://www.ellenmacarthurfoundation.org/assets/downloads/schools-colleges/Redesigning-plastics-Final-v4.pdf	Circular Economy (CE)	Webpage	Ellen MacArthur Foundation 2012	6 th lesson of the series about the CE (see row 38 above). This lesson plan intends to deepen awareness of the systemic challenges around plastic packaging and how these might be overcome through redesign.	Age range: 12+ (Design and Technology, Biology, Chemistry, Environmental Sciences, Business)	90 minutes	Intermediate	English	Lesson plan has detailed instructions on how teachers can make use of material.
45	Re-thinking Progress	https://www.youtube.com/watch?v=zCRKvDyyHml	Circular Economy (CE)	YouTube video	Ellen MacArthur Foundation 2011	Short animated video which explains the circular structure of the natural world and the linear, disposable structure of human society. Explains the steps that are needed to progress into a CE and the need for the whole system to work together to implement lasting change. The animation is really colourful and fun and this adds to how clear and accessible the video is.	secondary school pupils, university students, business & industry, NGOs	3 minutes and 48 seconds	Beginner Intermediate	English	After watching the video, students could propose ideas for a circular business.
46	Rethinking Plastic & Waste to drive the Circular Economy in Asia	https://www.youtube.com/watch?v=gPCTIDO2Z5U	Circular Economy (CE)	YouTube Video	Wastepickers 2016	Video about the state of plastic waste in Asia, more specifically India. Mentions how plastic can be reused back into the economy, and how Wastepickers (an organisation in Bangalore) is aiding in this process. Describes how companies in India are being made more responsible. Video is useful to show benefits and viability of CE.	secondary school pupils	4 minutes and 50 seconds	Beginner	English	Show video in class, followed by discussion.

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47	Sustainable Packaging in a Circular Economy	https://www.edx.org/course/sustainable-packaging-in-a-circular-economy	Circular Economy (CE)	Online course that uses a mix of PowerPoint slides, videos, quiz and readings as deliverables.	TU Delft 2020	Free course available as MOOC. It's divided into six 'episodes', one per topic regarding different aspects of packaging. The episodes are presented by various instructors and each episode is followed by a case study and assessment sections. The content is engaging from the beginning. The lectures are delivered via video, with extra features such as transcript, subtitles and speed control. Below the videos are reading suggestions and the lecture main takeaways. At times, a slide is presented in between videos and this acts as recap for the previous video or introduction to the new video. The course is good, concise enough but still informative.	university students, secondary school teachers, university lecturers, business & industry, NGOs	3-4 hours per week over 6 weeks	Intermediate	English	A full online course, 3-4 hours per week over 6 weeks. Free course but official certificate of course completion costs around €46.
48	System Reset: Design and Technology for a Circular Economy	https://www.stem.org.uk/re-sources/collection/3927/system-reset-design-and-technology-circular-economy	Circular Economy (CE)	Collection of lessons, presentations, videos, games, and flash cards.	Ellen MacArthur Foundation; STEM Learning Ltd. 2010 - 2019	Material was specifically designed for high school teachers to teach key principles of CE. It is divided up into six separate activities with additional material such as videos and virtual index cards. Each activity contains lesson plans, lessons and presentations. The multiple lessons, videos, games, and other tools allow for teachers to individualize their lessons.	secondary school pupils, secondary school teachers (Target ages: 11-14, 14-16, 16-19)	1 school year (contains entire lesson plans)	Intermediate	English	Material is ready to be used with high school students.
49	Taking trash talk to a whole new level	https://www.ted.com/talks/peter_harris_taking_trash_talk_to_a_whole_new_level/details#t-2154	Circular Economy (CE)	Online Video of a TED Talk	Peter Harris (UPS Sustainability Director), TED 2015	Very good talk on an interesting topic, given by UPS' Sustainability Director, Peter Harris. Talk describes dealing with the waste of a consumer society as one of the greatest challenges at the moment. He proposes a plan where methane from the trash we produce fuels trucks that transport our critical goods as part of a closed-loop. This is an excellent resource for educating on the benefits of using renewable gas as part of a CE, and how companies can make changes to be part of a CE.	secondary school pupils, university students, secondary school teachers, university lecturers, business & industry, NGOs	9 minutes and 55 seconds	Beginner	English	Incorporate video into CE lesson or a class on logistics (UPS are a logistics company). Could also be used to spark discussion on renewable gas benefits.
50	The circular classroom	https://circular-classroom.com/ Web article by the creator: "The Circular Classroom: a	Circular Economy (CE)	Three modules with workbooks that include information and ac-	Dr. Leyla Acaroglu (in consultation with upper secondary	The circular Classroom is a free high quality toolkit designed for high school students and teachers to incorporate the principles of CE into their lives. It was co-created with the help of both teach-	secondary school pupils, secondary school teachers	3-6 hours	Intermediate	English Finnish Swedish	Material is ready to be used with high school students.

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		Free Toolkit for Activating the Circular Economy through Experiential Learning", https://medium.com/disruptive-design/the-circular-classroom-a-free-toolkit-for-activating-the-circular-economy-through-experiential-64ffe1274b9c		activities with accompanying videos.	Finnish Educators & students), The Circular Classroom, Finland 2018	ers and students. It includes three modules each with a workbook and complementary videos. There are also lots of extra resources on the website (e.g. on sustainability, zero waste initiatives, SDGs, life cycle of different products, ecology, human footprint, issues of fast fashion, the story of microplastics). It is excellent as it has many interactive activities that help to fully engage the student. These activities can also be completed in groups, allowing individuals to share ideas and see different viewpoints. Not only does it provide the resources for learning, it also gives directions on how to deliver and teach the content to a class. Website also provides a platform for teachers and students to share their own experiences.					Material was specifically designed as a learning resource for secondary school students.
51	The Circular Economy	https://www.youtube.com/watch?v=N-cWaRRLh3k	Circular Economy (CE)	YouTube video	Ellen MacArthur Foundation 2010	Ellen MacArthur takes us on a journey to investigate how insights from living systems might offer some of the answers to how we can re-design our future, in a world of increasing finite materials and energy. Very good informational short video	secondary school pupils, university students, business & industry, NGOs	7 minutes and 4 seconds	Beginner	English	Show video in class, followed by discussion
52	The Circular Design Guide	https://www.circulardesignguide.com/ Reigado, C., Fernandes, S., Saavedra, Y., Ometto, A. & Da Costa, J. (2017): A Circular Economy Toolkit as an Alternative to Improve the Application of Product Service Systems Methodologies. Procedia CIRP, 64: 37–42.	Circular Economy (CE)	Website with lot of resources. The workshop section provides downloadable sheets.	Collaboration between the Ellen MacArthur Foundation & IDEOS 2018	The Circular Design Guide is an online tool to help innovators rethink and redesign their design process in order to help create a more efficient CE. There are free, downloadable workshops, worksheets, and videos available, which all help to illustrate how transformative circular principles are for businesses. This is a useful and unique resource, as it encourages debate and discussion with fellow participants highlighting that the CE is a fundamentally collaborative process, where inputs and outputs are reconfigured to maximise the resilience and sustainability of the system as a whole. This is particularly relevant for business owners who are perhaps looking to change their business model or production process. It could also be eye-opening to students,	secondary school pupils, university students, business & industry, NGOs	1-2 hours	Intermediate Advanced	English	Instructions for workshops are very well laid out and should not require much facilitation. All is needed is to give the instructions to participants and let them get to work.

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						as it can help internalize this thought-process for the next generation of entrepreneurs.					
53	The Circular Economy Podcast	http://www.circulareconomy-podcast.com/	Circular Economy (CE)	Podcast and script	Catherine Weetman, Rethink 2019	A podcast informing about CE (episode 1) and how different people use the circular approach, rethinking how we design, make and use everything. A different media of resource compared to the rest, and therefore an interesting change. People & businesses presented on the podcast are very diverse in terms of their businesses (e.g. baby clothing renting, food-to-go containers, reusable school uniforms). Plus, people talk about challenges they had to overcome with their own businesses which is useful for people who are thinking about opening their own business. The podcast can inspire but also inform people about wider possibilities	university students, primary school teachers, secondary school teachers, university lecturers, business & industry, NGOs	Podcast Episode 1 is 21 minutes and 47 seconds long. Other episodes are up to around 40 minutes long	Intermediate	English	To use a podcast in a classroom might be difficult. However, it could be recommended for students to use it as a reference to gain additional information on a specific topic.
54	The Circular Economy: A Simple Explanation	https://www.youtube.com/watch?v=cbm1MCTobVc	Circular Economy (CE)	Video - TEDx talk	TEDx Talks, Cillian Lohan 2018	What is a "Circular Economy"? Why should we care? What does it mean for us? In this talk, Cillian Lohan, CEO of an Irish NGO, the Green Economy Foundation, explains the basic principles behind the economic concept of a circular economy and how it can really change the world for the better. A very well made TED talk about the circular economy, explained clearly with easy to understand language and applicable examples. The video is great at giving people the knowledge of what a circular economy is, touching on the basic principles and why it is important. I would recommend the video to younger people and highly recommend that they spread the message of the importance of the circular economy concept.	primary school pupils, secondary school pupils, university students, primary school teachers, secondary school teachers, business & industry, NGOs	13 Minutes	Beginner	English	Show the video in the classroom, discuss the basic principles. Then move on to a more in depth discussion on goals that could be achieved.

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55	The circular economy: from consumer to user	https://www.youtube.com/watch?v=Cd_isKtGaf8	Circular Economy (CE)	YouTube video	Ellen MacArthur Foundation 2013	What if we didn't buy the goods we use, but instead favoured access and performance over ownership? This very good short animation provides a brief introduction of circular business models and in particular the performance model, as a solution to transition to a regenerative circular economy.	secondary school pupils, university students, secondary school teachers, business & industry, NGOs	3 minutes and 11 seconds	Beginner	English	Show video in class, followed by discussion.
56	The Circularity Gap Reporting Initiative interactive tool	https://www.circularity-gap.world/2020#interactive	Circular Economy (CE)	interactive web tool to explore how countries can close the global circularity gap	Circle Economy 2020	Very useful, well made and interesting interactive tool to actually see how different countries around the world compare to each other and why they are different and what can be done to improve it. Very easy to use. It gives a good visualisation of the world needs to do to live sustainably, and provides information on how we can work towards a CE. Annual report on progress made to fill the 'gap found here': https://www.circularity-gap.world/about	secondary school pupils, university students, secondary school teachers, university lecturers, business & industry, NGOs	5-10 minutes	Beginner Intermediate	English	Use tool in class, followed by discussion
57	The Circularity Gap	https://www.youtube.com/watch?v=Wiax9ISCfYY	Circular Economy (CE)	YouTube video linked to Circularity Gap website (www.circularity-gap.world)	Mark de Wit (Circularity Gap), TEDx 2018	Video addresses the issue of our world only being 9% circular - a 'gap' that must be fixed. Video presents 4 practical strategies to fill the 'gap': 1. Recycle more, 2. Optimise more, 3. Stop wasting, 4. Stop extracting. The video is clear and concise.	secondary school pupils, university students, business & industry, NGOs	11 minutes and 44 seconds	Intermediate	English	Show video before using the circularity gap tool (line 56 above)
58	The Circulars Yearbooks	https://thecirculars.org/insights	Circular Economy (CE)	Circulars Yearbooks - have statistics and data of the yearly circular economy movement, and short summaries of the Circulars' Winners, Runners Up, Finalists and Highly Commended.	World Economic Forum and the Forum of Young Global Leaders / Accenture Strategy Yearly since 2015	The Circulars is the world's premier CE award program. The award offers recognition to individuals and organizations across the globe that are making notable contributions to the CE in the private sector, public sector and society. Reports showcase pioneering CE efforts, ranging from innovative, new and digitally disruptive enterprises and pioneering multinationals, to cities pushing established sustainability boundaries, to dedicated CE investors developing infrastructure to finance this growing movement. Definitely offers a unique perspective and engaging ideas on the CE. Plus, works as a great source of inspiration for continued innovation in the CE. Offering great insights into the key	university students, secondary school teachers, university lecturers, business & industry, government, NGOs	Depends of what information is checked and how many of the yearbooks – could range from minutes, to hours or days..	Intermediate	English	The Circulars award winners over the years is a great resource for case studies. Leaders could give guest lectures. Business model and tech adoption across 5 years of circular entries can be used to learn about the evolution of the

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						players and industries that are disrupting their business practises to be eco-friendlier and sustainable. With the Young Global Leaders Award for Circular SME you learn what each SME is doing and what's their impact. The bitesize information with links to each award recipients profile (website & social media) is very useful too.					CE and how the industry are adapting to changes.
59	The Future of Cities	https://www.ellenmacarthurfoundation.org/resources/learn/schools-colleges-resources	Circular Economy (CE)	Website with lesson plan and other teaching resources	Ellen MacArthur foundation 2017	Impressive high quality resource that actually provides ready-made lessons for students to learn about CE. An adaptable teaching resource for children around the age of 15. To be used in school or college settings. To be led by a teacher with a focus on group or class discussion. Tablets and computers will make it more engaging. This lesson plan outlines the need for a CE in future cities. It argues that doing so will create better ways of effectively managing cities through technological advance and innovation. The resource provides the same narrative that is found throughout the Ellen MacArthur website, that is a framework that is restorative and regenerative by design is the way forward.	secondary school pupils, secondary school teachers	Six one hour classes	Beginner Intermediate	English	Resource has quick and easy lesson plans ready to be used by teachers.
60	Towards the circular economy: Economic and business rationale for an accelerated transition	https://www.ellenmacarthurfoundation.org/assets/downloads/publications/Ellen-MacArthur-Foundation-Towards-the-Circular-Economy-vol.1.pdf	Circular Economy (CE)	PDF report	Ellen MacArthur Foundation 2013	Ellen MacArthur Foundation's in-depth report on the Economics of a Circular Economy. The report has detailed information on the CE, including limits of linear consumption and economic opportunity of CE. The in-depth report takes the concept of a "circular economy" one step further, to analyse its promise for businesses and economies, and to prepare the ground for its adoption.	secondary school teachers, university lecturers, business & industry, government, NGOs	2 days	Intermediate Advanced	English	Students could give a presentation or write a one page summary the report.
61	Waste generation and management	https://www.activesustainability.com/environment/waste-generation-management/	Circular Economy (CE)	Video, along with text description in the webpage.	Acciona, Sustainability for all 2019	Video explains how increasing waste generation is directly related with the current model of production and consumption, and need to change to a circular model where producers use waste as raw materials and consumers make a responsible use of products applying the 3Rs rule: reduce, reuse and recycle.	secondary school pupils, university students, secondary school teachers, university lecturers, business & industry	Video 4 minutes and 22 seconds (15 minutes text web page)	Beginner	English	Show video in class, followed by discussion

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						Video has an interesting approach relating the CE model with product consumption and waste generation. The animations are dynamic keeping attention of audience. Information straightforward and simple to follow.					
62	What is circular economy?	https://www.youtube.com/watch?v=HKpH89xAAWs	Circular Economy (CE)	Video	Acciona 2018	An informative and engaging introduction to the CE. Video reviews the issues with the linear economy and the advantages of a CE. Environment impact evaluation and waste-to-energy production are both covered. A very simple video explaining the CE, this is a very well made video and it is clear and concise. The video benefits from engaging animations throughout. The use of text is limited which helps keep the video dynamic while allowing it to be accessible to a wide range of audiences including those who do not speak English.	primary school pupils, secondary school pupils, university students, primary school teachers, secondary school teachers, business & industry, NGOs	2 minutes and 18 seconds	Beginner	English	Show video as part of an introduction to the circular economy
63	What is the circular economy? CNBC Explains	https://www.youtube.com/watch?v=___0Spwj8DkM	Circular Economy (CE)	YouTube video	CNBC International 2018	Brief explanation of how circular business model works using lighting as a leasing service, policy developments in Europe, environmental and economic benefits, the cost involved in redesigning the products and supply chain. Very good short video.	Anyone interested	3 minutes and 42 seconds	Beginner	English	Use case study example on lighting as a service model.
64	Why we need to rethink how we build homes	https://www.youtube.com/watch?v=5RrEJMMil9w	Circular Economy (CE)	YouTube Video	Ged Finch; TEDxWellington 2019	Video is about how a CE model can fundamentally disrupt the way we build houses and the use of Modern Digital Fabrication. If construction can be done in an eco-friendly way, then we can ensure that the impact on environment by harmful infrastructure can be reduced.	secondary school pupils, university students,	14 Minutes	Intermediate	English	This video can be used for explaining students about the new techniques in construction sector.
65	52 steps towards a greener city	https://op.europa.eu/en/publication-detail/-/publication/080dffa8-49c5-11e8-be1d-01aa75ed71a1/	Sustainability/Sustainable Development Goals (SDGs)	Downloadable PDF booklet	Directorate-General for Environment, European Commission 2018	This beautifully illustrated booklet contains 52 suggestions on how to support urban biodiversity throughout the year. Cities contain a lot of biodiversity, it is important that we protect it because we need it for our quality of life, our clean air, our food and water and our mental health. It links to Natura 2000 – a network of protects precious and threatened species and the natural environments that shelter them. There are 100	primary school pupils, secondary school pupils (ages 12 to 15, and 15 and over)	20 minutes	Beginner	Available in all 24 EU languages	Discuss in class which of the 52 ideas could be implemented at the school.

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						Natura 2000 sites in 32 major cities, sheltering 40% of threatened habitat types, half EU bird species, and 25% of rare butterflies protected by EU.					
66	#Teach SDGs	http://www.teachsdgs.org/	Sustainability/Sustainable Development Goals (SDGs)	Webpage with educational videos, facilitates teacher connection, connects people through social media. Goals project facilitates collaboration of classrooms working towards SDGs	TEACH SDGs 2020	Resource used to support the UN SDGs within primary and secondary classrooms and aims to connect to global educators dedicated with responding to a call to action and meet the SDGs. This teaching resource could be very helpful for teachers in schools. This content is valid for all ages. The resource allows and facilitates for collaboration with schools and classrooms across the world and this would give children a great appreciation for the world outside the classroom as well as forming the basis for a lesson that most of them would enjoy. It is relevant to inform educators, students, parents, and community members.	primary school pupils, secondary school pupils, primary school teachers, secondary school teachers	Varies for different resources. To get through the whole website takes a few hours.	Beginner Intermediate	English	Good to set up some projects in classroom and use video resources to give all the projects context. It is the kind of activity that school children would enjoy.
67	A Guide for Teaching the Sustainable Development Goals.	http://mcic.ca/pdf/SDG_Primer_FINAL.pdf	Sustainability/Sustainable Development Goals (SDGs)	Guide (pdf)	Manitoba Council for International Cooperation (Canada) 2018	Excellent guide on teaching SDGs written with educators in mind, including case studies and links for further information. Guide has clear information, educational resources and other support to help educate and engage young people so that they support SDGs and are inspired to turn their support into action. Guide also explores how you can incorporate the different topics covered by each goal into lessons across multiple subjects. Each chapter in this guide summarizes main targets of each goal, indicates learning objectives, gives context to 'the big questions' we need to ask to understand the issues, and what needs to be done by different stakeholders to achieve each goal.	primary school teachers, secondary school teachers, university lecturers,	Depends number of SDGs considered and in what detail.	Beginner Intermediate Advanced	English	Guide designed for educators or anyone who would like to teach young people about the UN SDGs.

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68	Ambitious, but not rocket science: SDG #6	https://www.youtube.com/watch?v=Cm7Ra5fbDic	Sustainability/Sustainable Development Goals (SDGs)	YouTube video	United Nations 2018	Short informative video with effective animations on the SDG 6 - "Clean Water and Sanitation". Video highlights scale of the problem (1/3 world's population don't have a safe water supply) but goes on to detail SDGs role in tackling this important issue. This is an excellent resource. It does a great job of highlighting the disparity between human advancement (robots, AI, driverless cars) and the very large portion of the global population without access to clean water & safe sanitation facilities.	secondary school pupils, university students, secondary school teachers, university lecturers, business & industry, NGOs	3 minutes 16 seconds	Beginner	English	Show video in class, followed by discussion on SDG6.
69	Bulbs Carbon Quiz	https://calculator.bulb.co.uk/questions/transport	Sustainability/Sustainable Development Goals (SDGs)	Quiz	Bulb Energy Limited 2020	Quiz asks questions about user's every day life. The questions range from what transports are used, what food eaten, and how renewable house is. The quiz then assesses answers and calculates a carbon footprint. It also tells biggest contributor to carbon footprint. An engaging and easy to use quiz which is personal and gives individual recommendations on how to reduce carbon footprint.	secondary school pupils' secondary school teachers, university students, university lecturers	10 minutes	Beginner Intermediate	English	Students to take the quiz in a computer class. In small groups discuss the factors most important to become more sustainable.
70	Concepts in Sustainable Development: An Introduction to the Key Issues	https://www.future-learn.com/courses/sustainability	Sustainability/Sustainable Development Goals (SDGs)	Online course with videos, articles and online quizzes as well as group discussion.	Future Learn: Derek Raine (University of Leicester, UK) 2020	Online course in sustainable development, economic growth and human activity on the environment. There are options for discussion and also the opportunity to ask questions to other students and gain feedback from the teachers. Students also have the ability to follow other students if they find their views and comments interesting, furthering the chances for learning and networking for the future.	university students, secondary school teachers, university lecturers, business & industry, NGOs	3 hours per week, over 6 weeks	Beginner Intermediate	English	Full online course, 18 hours, over 6 weeks <i>Free course but course completion certificate costs around €46.</i>
71	DECC 2050 Energy Calculator	http://2050-calculator.decc.gov.uk/#/home	Sustainability/Sustainable Development Goals (SDGs)	Interactive Carbon Calculator	Department of Energy and Climate Change (UK) 2011	Allows to create energy pathway to reduce greenhouse gas emissions by at least 80% by 2050. It allows to make choices and trade-offs across forty-two different sectors using real, open-source scientific data. Is an excellent tool for mapping a low carbon future in both a personal and professional capacity. It is user-friendly, intuitive, fun and engaging energy calculator and takes an all-en-	secondary school pupils, university students, secondary school teachers, university lecturers, business & industry, NGOs	Depends of amount of pathways created and, as new data is always becoming available, it could be	Beginner Intermediate	English	Students could do exercise to achieve 80% CO2 reduction target using multiple pathways.

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						compassing approach by looking at demand, supply and storage. Calculator already been used by local communities, businesses, political leaders and the general public. Is a good platform for these groups to collaborate to see their collective impact and how they can work together towards a more sustainable future.		done several times.			
72	Education for Sustainable Development Goals: learning objectives	https://unesdoc.unesco.org/ark:/48223/pf0000247444	Sustainability/Sustainable Development Goals (SDGs)	Online and PDF document	UNESCO United Nations Educational, Scientific and Cultural Organization 2017	International guide for educators and professionals on education for SDGs. Recommends several topics and learning activities for each SDG. Document is well organised and arranged with attractive colours making the contents easy to grasp. Educators can use the suggested topics and projects in their classroom. The document outlines indicative topics and pedagogical approaches for each SDG. It clearly outlines what is required to implement learning for the SDGs.	primary school teachers, secondary school teachers, university lecturers	Can vary depending of what parts are read.	Beginner Intermediate	Arabic Chinese English Portuguese Russian Spanish	Document can be used as guide to enable educators to provide appropriate contents to teach SDGs.
73	Free carbon calculators for individuals and small businesses	https://www.carbonfootprint.com/calculator1.html	Sustainability/Sustainable Development Goals (SDGs)	Calculator	Carbon Footprint Ltd, UK 2020	Free resource to calculate carbon footprint of an individual or a small business based on annual gas and energy use, travel and consumerism. Also includes secondary carbon footprint factors such as food, pharmaceuticals and consumables. Gives tips on how to reduce carbon footprint and links to carbon offsetting projects.. Mulrow et al. (2019) says is one of the top three carbon calculators.	secondary school pupils, secondary school teachers, university students, business & industry, NGOs	10 minutes	Beginner Intermediate	English	Ask students to guess if their footprint is above or below average then calculate to see how accurately they have guessed.
74	Frieda Makes a Difference: The Sustainable Development Goals and How You Too Can Change the World	https://is-suu.com/unpublications/docs/frieda_2018	Sustainability/Sustainable Development Goals (SDGs)	Children's book that you can either read online or download to print.	United Nations 2019	Children's book about the 17 SDGs. Book focuses on primary school students by outlining a better understanding of the SDGs. It is a fun, colourful and illustrative book that aims to engage younger people to participate and make a difference on their lives and on their surrounding lives.	primary school pupils, primary school teachers (children aged from 6 to 8)	15 minutes	Beginner	English French Spanish	Groups of 2-3 choose one SDG, learn about it & find ways to make a change. Then present to class.

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75	Future Learn: Organising for the Sustainable Development Goals (SDGs)	https://www.future-learn.com/courses/organising-for-sustainable-development-goals	Sustainability/Sustainable Development Goals (SDGs)	Online course that includes a series of lectures, videos and online quizzes to consolidate students' knowledge on subject matter.	Future Learn - Hanken School of Economics 2020	Course comprises an overview of the 17 SDGs and how to approach them. The course provides a fun and engaging approach to learning about the UN's SDGs. Users can interact and engage with other course-members via the online discussion forum. Innovatively, the course modules encourage users to work towards SDGs on a personal level through the suggestion of personal sustainable goals.	university students, secondary school teachers, university lecturers, business & industry, NGOs	3 hours per week over 7 weeks	Beginner Intermediate	English	Full online course, 3 hours per week over 7 weeks. <i>Free course but course completion certificate costs around €52.</i>
76	Go Goals!	https://go-goals.org/	Sustainability/Sustainable Development Goals (SDGs)	Board Game that can be downloaded for free, in 20 different languages. (4 to 6 players) (8 – 10 years)	United Nations Regional Information Centre (UNRIC), with artist Yacine Ait Kaci 2017	An interesting and fun game, of high quality. Set up as a game similar to the classic "snakes and ladders" board game it has a fun and competitive aspect combined effectively with learning about the SDGs. With easy instructions in 20 languages, and all components (e.g. board, token, dice and cards) printable on a standard printer, the game is accessible to a large range of audiences from various backgrounds.	primary school pupils, primary school teachers (Parents could also play game with their.)	30-60 minutes	Beginner	English and 19 other languages (Including French Romanian Spanish)	Play board game in class.
77	Great Lakes Bioenergy Research Center Fields of Fuel Computer Game	https://www.glbrc.org/outreach/educational-materials/fields-fuel-computer-game	Sustainability/Sustainable Development Goals (SDGs)	Computer game	Great Lakes Bioenergy Research Center- United States of America 2013	This computer game allows students to become farmers and learn skills about farming crops for biofuels. Demonstrates the economics and sustainability of farming biofuels, which is a major aspect of learning about bioenergy. It's a free resource for teaching the players the complex balance of economics, sustainability and energy use. Playing the game itself was fun and interesting to see the differences on a season to season basis based on which crops you play. The game has a multiplayer option and playing against classmates would be more fun.	secondary school pupils, secondary school teachers	30-40 minutes	Intermediate	English	Play in class. The teaching guide for teachers gives instructions on what the students should do based on their age.
78	Growing bricks, not another brick in the wall	https://www.youtube.com/watch?v=OcZl2rRocCU	Sustainability/Sustainable Development Goals (SDGs)	YouTube Video	Ginger Kreig Dossier (Bio-Mason); TEDxWWF 2013	Talk on how bricks can be grown using bacteria and advantages of this process over the traditional clay firing process. An interesting introduction to the potentials of bio-based materials in construction. It creates excitement around the possibility of using bacteria to grow ma-	secondary school pupils, univ students, secondary school teachers, univ lecturers, business & industry, NGOs	12 minutes and 25 seconds	Beginner Intermediate	English	Show video in class, followed by discussion.

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						terials and could create interesting discussion between engineers and scientists.					
79	Healthy and sustainable diets for the 21st century	https://www.nutrition.org.uk/nutritionscience/sustainability/sustainability.html	Sustainability/Sustainable Development Goals (SDGs)	Web Article	British Nutrition Foundation 2019	Interesting article discussing what it means to have a healthy, sustainable diet and provides a guide of how to eat with these considerations in mind. It acknowledges that sustainable diets have to incorporate numerous criteria: protective and respectful of biodiversity and ecosystems, culturally acceptable, accessible, economically fair and affordable; nutritionally adequate, safe and healthy; while optimizing natural and human resources.	secondary school pupils, university students, secondary school teachers, university lecturers	20 minutes	Intermediate	English	Read and discuss in class about the complexity of sustainable choices and role of consumers.
80	Learning Design for Sustainability	https://www.lynda.com/Graphic-Design-tutorials/Learning-Design-Sustainability/616671-2.html	Sustainability/Sustainable Development Goals (SDGs)	Videos accompanied with commentary from author and instructor, and exercise files	Scott Boylston, via Lynda.Com 2017	Multi-module online learning course which covers the built environment, design, and the social, economic, and ecological aspects of sustainability. The materials are structured and presented in an easily-digestible way.	secondary school pupils, univ students, secondary school teachers, univ lecturers, business & industry, NGOs	1.5 Hours (structured into four modules ranging in times from 15-30 minutes)	Intermediate	English	Short online course that students can do at home.
81	Life Cycle Analysis: Tap Water vs. Bottled Water	https://sustainability.asu.edu/sustainabilitysolutions/programs/teacher-sacademy/teacher-resources/	Sustainability/Sustainable Development Goals (SDGs)	Lesson plan, pictures and worksheets	The Sustainability Teachers' Academy team - USA 2015	This teaching resource engages the students in thinking about the life cycle of everyday items with a focus on bottled water in comparison with tap water. Includes the concept of "cradle to grave". Students work in groups using workshops (using a computer or printed hardcopies) to detail and evaluate the lifespan of a product and encourage them to start applying this evaluation to their own lives.	secondary school pupils, secondary school teachers	30-40 minutes	Beginner	English	In groups, students use hardcopies of worksheets and pictures or they can be used online by copy & paste pictures in PDF file.
82	Operation Sustainability - a story on the world's important customer	https://www.youtube.com/watch?v=R Mx3bcTlxqY	Sustainability/Sustainable Development Goals (SDGs)	YouTube Video	Animaskin on behalf of UN Association of Norway and UNICEF Norway 2017	This is a short animation that highlights misconceptions of sustainable development through one girl's journey. She follows the supply chain of recycled electronics including transportation, sorting and processing and sees much that is wrong but does not act on it when she finds out she is a consumer. This is a fantastic animation both visually and in	primary school pupils, primary school teachers, secondary school pupils, secondary school teachers	5 minutes and 25 seconds	Beginner Intermediate	English	After video ask: What was most recent purchase? How long did it take to be delivered? Where was it made?

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						terms of storyline. A fun video, entertaining and teaching important lessons about sustainability, and with good examples. Students could be asked to think if one of their recent purchases was sustainable.					More complex: draw supply chain for product, with estimate for CO ₂ emissions
83	SDG Dashboards	https://dashboards.sdgindex.org/#/	Sustainability/Sustainable Development Goals (SDGs)	Interactive online map	Sustainable Development Solutions Network / Bertelsmann Stiftung 2019	A fantastic interactive map showing the current status of each country's progress towards the individual SDGs, with data on the targets for each SDG, as well as an overall country index, all based on the Sustainable Development Report 2019. Map grades countries on a colour-coded key depending on their progress. SDGs are displayed as images at the side of the map to allow ease of moving between goals, with each country easily labelled on the map. When a goal and country pairing is selected, further graphically-represented data on this pairing appears. It is such an accessible, well-built tool that increases understanding of SDGs and their progress, engaging people who may otherwise have felt the subject too daunting to approach.	primary school pupils, secondary school pupils, university students, primary school teachers, secondary school teachers, university lecturers, business & industry, government, NGOs	Information on one goal/one country quickly accessed in minutes. Could be used just for 5 or 10 minutes in class, but opportunity for in-depth research over hours/days.	Beginner	English	The map could be used on individual student devices for free exploring, or taught from a central screen with students giving input in a classroom setting.
84	SDG Resources for Educators - Industry, Innovation and Infrastructure	https://en.unesco.org/themes/education/sdgs/material/09	Sustainability/Sustainable Development Goals (SDGs)	Videos, Presentations, Worksheets and Case Studies (that can all be downloaded as one single PDF)	UNESCO 2019	Teaching resource designed for educators that provides up-to-date info on SDG9: Industry, Innovation and Infrastructure. It has a number of classroom activities (clearly marked for what age range they are for) and multimedia educational resources to access and download. Videos show up-to-date case studies with real life examples. For example, there is the "Monsoon Proof Roof" activity aimed for kids aged 9-11. In addition, there are also materials and case studies for children ages 14-17. There are also project ideas for older people. Resources are easy to navigate and understand,	primary school pupils, secondary school pupils, university students, primary school teachers, secondary school teachers, university lecturers, business & industry, NGOs	1-3 hours approx	Beginner Intermediate	English French Spanish	Interactive games and case studies can be printed off and worked through in groups.

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85	SDGs in Action app	https://www.un.org/sustainabledevelopment/blog/2016/09/new-mobile-app-launches-to-drive-action-on-sustainable-development-goals/	Sustainability/Sustainable Development Goals (SDGs)	It is an app - available for iOS or Android devices.	United Nations, in collaboration with GSMA 2017	An app that provides information and case studies on all 17 SDGs, including targets, explanatory videos, key facts and figures, alongside a picture gallery. This dynamic, collaborative tool includes the latest sustainable development news from around the world. The app includes features such as sharing, likes, scoring designed to drive engagement with the app. Users can tailor their experience based on the SDGs that interest them most. The app is up-to-date and easy to use, and self-explanatory once you have logged in. The app also tells you what you personally can do to create impact and how to take action to help others accelerate progress. You can choose what goals are important to you, create your own events and actions and invite others to join you in sustainable actions and events.	secondary school pupils, university students, secondary school teachers, university lecturers, business & industry, NGOs	Could spend as long as you want. Videos average at 1.5 minutes.	Beginner Intermediate	English, Arabic, French, Russian, Simplified Chinese, Spanish.	Group work - the app allows you to create an 'action' - this could be done as a group task in the classroom, with previous examples being given on the app. Presentations could be done on what the action is and why groups chose to do such actions.
86	Sustainability explained	https://www.youtube.com/watch?v=_5r4loXPx8	Sustainability/Sustainable Development Goals (SDGs)	video	explainity® explainer video 2012	Video explains sustainability and why it is so important. Uses the three pillar model of sustainability: environmental, economic and social considerations. It is visually interesting using cartoon-like characters and animations.	primary school pupils, secondary school pupils	4 minutes	Beginner Intermediate	English + subtitles: Bulgarian, Latvian, Macedonian, Polish, Romanian	Show video in class, followed by discussion.
87	Sustainable Development Goals Quiz	https://www.research.net/r/WHO_SDG_Quiz	Sustainability/Sustainable Development Goals (SDGs)	Multiple Choice Quiz - 17 questions	World Health Organisation (WHO) - European region. 2019	Quiz has 17 questions testing understanding of the 17 SDGs. Quiz is specifically targeted at the WHO European region. Quiz is interesting in that it provides justification for the need for the SDGs through various statistics (for each corresponding SDG) in the European region. Also provides links to relevant fact sheets which explain in further detail the statistics and needs for each SDG.	secondary school pupils, university students, secondary school teachers, university lecturers	30 minutes	Intermediate	English	A teacher or lecturer could collaboratively complete the quiz with their pupils, which would be engaging and interesting for the class.
88	Take the quiz: How much do you know about the SDGs?	http://17goals.org/quiz-level-1/	Sustainability/Sustainable Development Goals (SDGs)	An interactive quiz with feedback.	17Goals 2015	A 10-question quiz which focuses on the SDGs and their targets. Useful for testing knowledge and interesting information is conveyed in it. Although the quiz itself is short, doing it could lead to people clicking on the other resources to find out more.	primary school pupils, secondary school pupils, university students,	10-15 minutes	Beginner Intermediate	English	Go through questions on an interactive whiteboard.

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89	The Story of Stuff Project	https://storyofstuff.org/	Sustainability/Sustainable Development Goals (SDGs)	There are videos, blog posts, case studies as well as podcasts.	Annie Leonard (Founder) 2020	Online organisation and resource dedicated to sustainability. The website currently features 16 videos on various topics like bottled water, electronics, cosmetics, microfibers, case studies and more. Plus links are available so people can take action on topics that they feel strongly about. The Story of Stuff Project started due to the online viral sensation of The Story of Stuff video in 2007.	primary school pupils, secondary school pupils, primary school teachers, secondary school teachers	20-30 minutes	Beginner	English	Play videos in the class, followed by discussion.
90	The Sustainable Development Goals - Action Towards 2030	https://www.youtube.com/watch?v=9-xdy1Jr2eg	Sustainability/Sustainable Development Goals (SDGs)	YouTube video	CAFOD Catholic Agency for Overseas Development 2016	Video explains the 17 SDGs and the four underlining principles. 1. they are universal and apply to every country. 2. integrate all dimensions of sustainability: economic development, social progress, and environmental protection. 3. leave no one behind. 4. require the participation of all. Video contains information about the Millennium Development Goals (MDGs).	secondary school pupils, university students, primary school teachers, secondary school teachers	5 minutes and 52 seconds	Beginner	English	Show video in class, followed by discussion.
91	The Sustainable Development Goals: A guide for teachers	https://oxfamlibrary.openrepository.com/bitstream/handle/10546/620842/edu-sustainable-development-guide-15072019-en.pdf?sequence=4	Sustainability/Sustainable Development Goals (SDGs)	PDF report available online	Oxfam 2019	Clearly written guide designed to support educators who work with young people to learn about SDGs. Gives practical ideas for implementing the SDGs into a school curriculum in many different ways (and for different subjects - e.g. maths, geography). Contains further reading, support, data and websites. Good use of case studies from projects and school initiatives.	primary school teachers, secondary school teachers	Depends of activity.	Beginner Intermediate	English	Follow activities given. Also contains a section on how to link to curriculum in various countries.
92	The Unbearable Whiteness of Green Workshop Resources	https://onca.org.uk/2019/05/26/the-unbearable-whiteness-of-green-workshop-learning-resources/	Sustainability/Sustainable Development Goals (SDGs)	Selection of articles, books, websites and videos related to the topics of environmentalism and racism.	ONCA Gallery. Brighton, UK 2020	Social Justice is a fundamental part of the Climate Emergency that sometimes is left behind when scientists and engineers address Sustainability. This reading list gives a different insight of sustainability. Web page has links to papers about sustainability and social justice. Tackles and important issue from a different perspective. It is a great resource to question preconceived ideas and hear different perspectives targeted to other audiences. Good link to human geography.	university students, university lecturers, NGOs	5 hours	Advanced	English	Reading list could be used to prepare a workshop, e.g. discussion on how our own backgrounds affect how we approach Climate Change.


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93	The Worlds Largest Lesson Animated Films	http://worldslargestlesson.globalgoals.org/animated-films/	Sustainability/Sustainable Development Goals (SDGs)	They are 3 mini animated films (videos)	WHO, UNICEF, UNESCO 2015	The Worlds Largest Lesson provides learning plans and creative tools for teachers for primary and secondary school children in terms of SDGs. One of these resources is the Animated Films, which describe SDGs in a short period of time. These three animated films are really interesting, they provide a lot of information on the SDGs for younger people and could help them understand why the SDGs are so important. The animated films are easy to follow and could be presented to the class as part of a lesson. There are also videos presented by famous people, such as Emma Watson and Serena Williams, which may make children listen more as they are more widely known.	primary school pupils, secondary school pupils, primary school teachers, secondary school teachers,	about 5 min for each film	Beginner Intermediate	Arabic Bangla Chinese English English (India) French German Greek Gujarati Hindi Indonesian Portuguese Russian Spanish Tamil Telugu	Films could be presented in the classroom, or given as an extra resource for children to look at outside of class.
94	UN Sustainability Goals	https://www.un.org/sustainabledevelopment/sustainable-development-goals/	Sustainability/Sustainable Development Goals (SDGs)	Web page	United Nations 2020	Web page with a user friendly and attractive interface describing in detail the 17 SDGs. Each goal has a brief description and its importance. There are then three tabs: Facts & Figures, Targets and relevant links. On a tile for each goal it displays a quick snapshot of how the UN is achieving that goal and a fact to emphasise its importance. This informs the user of the actions being taken by the UN.	secondary school pupils, university students, secondary school teachers, university lecturers, business & industry, NGOs	2 hours	Intermediate	English	Good infographics which effectively explain SDGs. A lot of readily available facts & figures for presentations too.
95	Understanding Sustainable Living	http://cdn.worldslargestlesson.globalgoals.org/2016/06/Understanding-Sustainable-Living.pdf	Sustainability/Sustainable Development Goals (SDGs)	Lesson plan explaining the concept of sustainability.	Trayle Venus Kulshan, Raffles World Academy, Dubai 2015	Document aimed at explaining sustainability and more specifically SDG11: Make cities and human settlements inclusive, safe, resilient and sustainable. Contains several activities such as calculating ecological footprint, questions for students and discussion topics for the class. Includes resources for the different class activities and specifies time each activity should take. Resource is ready to give to students with tasks already defined.	primary school pupils, secondary school pupils, primary school teachers, secondary school teachers	Depends of activity.	Beginner Intermediate	English	In groups, work in activities provided.

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96	Understanding the Dimensions of Sustainable Development	https://www.youtube.com/watch?v=pgNLonYOc9s	Sustainability/Sustainable Development Goals (SDGs)	YouTube video	Simpleshow 2017	Video explains the 2030 Agenda and its 17 SDGs, and the commitment of the world community to ensure sustained and economic growth, social inclusion and environmental protection. It is a good video that is encouraging, entertaining and educational.	primary school pupils, secondary school pupils, university students	4 minutes	Beginner Intermediate	English	Show video in class, followed by discussion
97	What is Sustainable Development?	https://www.youtube.com/watch?v=3WODX8fyRHA	Sustainability/Sustainable Development Goals (SDGs)	YouTube video	United Nations 2015	Interesting video is about sustainable development, SDGs, and strategies, methods and advances related to the same. Video is really well made and fulfils its purpose to educate people and inform them about sustainable development, why sustainable development is necessary, and reasons and advantages of setting SDGs.	secondary school pupils, secondary school teachers	2 minutes and 8 seconds	Beginner	English (captions in many languages including Bulgarian, Latvian, Macedonian Polish and Romanian)	Show video in class, followed by discussion
98	World Economic Forum Platform: Shaping the Future of Global Public Goods	https://www.weforum.org/platforms/shaping-the-future-of-global-public-goods	Sustainability/Sustainable Development Goals (SDGs)	Reports, Case studies, and Videos.	World Economic Forum 2020	This platform offers a wide variety of case studies and examples of projects carried out by organisations, as well as key reports and videos. The aim is to encourage the public and private sectors, as well as civil society to engage in sustainability issues and the CE to accelerate actions on climate change. Resource full of interesting videos and reports that offer great insight into opportunities for change. If small businesses also engage in this platform could motivate them to seek out sustainable opportunities or partnerships in their communities or cities to help bring sustainability to the forefront.	secondary school pupils, university students, secondary school teachers, university lecturers, business & industry, government, NGOs	Reports: 30 minutes. Videos: 2 minutes.	Intermediate Advanced	English French Japanese Spanish	Videos, projects and case-studies are a great supplementary information to teaching materials.
99	WWF Footprint Calculator	https://footprint.wwf.org.uk/#/	Sustainability/Sustainable Development Goals (SDGs)	Quiz	WWF 2020	Calculates your carbon footprint based on four life aspects - food, travel, home and "stuff". It then compares your results to the national average and shows the aspects you could improve on the most. It also gives tips for each of the areas to help you lower your footprint. The resource is good for getting an idea of how much carbon you produce. However, some of the questions are potentially too complex for younger children as they required knowledge of types of housing and insulation etc. The comparison of your carbon footprint to the world	secondary school pupils, university students, secondary school teachers, university lecturers	15 minutes	Intermediate	English	Allow the students to take the quiz and then discuss what their largest carbon outputs are and how they could reduce these.

No	Title online teaching resource	Web link (and reference if applicable)	Main theme	Type online resource (e.g. video, quiz, game)	Author and year	Summary and review in terms of interest, clarity, fun, content	Key target audience	Time to read or do	Level of difficulty or complexity	Language	Ideas for use in classroom
						average is interesting. The tips for decreasing the footprint were relatively basic, e.g. 'Cycle More' and are perhaps unrealistic for a lot of people.					
100	What is sustainable development?	https://www.youtube.com/watch?v=7V8oFI4GYMY	Sustainability/Sustainable Development Goals (SDGs)	YouTube video	Animaskin on behalf of UN Association of Norway & UNICEF Norway, 2017	A simple introduction to sustainable development and the SDGs. The film is produced by Animaskin on behalf of UN Association of Norway and UNICEF Norway, as part of an interdisciplinary learning program for students on primary and secondary level. A very beautiful film that will appeal to the students.	primary school pupils, secondary school pupils	3 minutes and 40 seconds	Beginner	English Norwegian	Show video in class, followed by discussion

Annex VI - Power Point slides and notes on "Introduction to the bioeconomy"

Slide	Notes for teacher, comments and links
 <p>What is the Bioeconomy? Opportunities, challenges and solutions</p> <p>Name of presenter</p>	<p>Notes to the teacher:</p> <p>Teacher's name to go in the space at the bottom left of the slide. Explain that this presentation introduces the key principles of bioeconomy and the links to sustainability. Excluding the two videos and quiz, the outline slide and this first slide, there are 9 slides – so these slides should take between 9 and 18 minutes to present, depending of amount of explanation.</p> <p>The two videos are around 2 minutes long each.</p> <p>Quiz with 6 questions - will take 6 minutes or more (depending if reading extra information).</p>
 <p>Outline</p> <ul style="list-style-type: none"> - What is the bioeconomy and what is biomass? (including video) - Bioeconomy around the world - Bioeconomy jobs by sector and socio-economic impacts - Bioeconomy – links to SDGs - Bioeconomy & climate change - Ecological limits - Bioeconomy resources and video "Bioeconomy starts here" - The transition to a bioeconomy is complex - Bioeconomy challenges: Resource Provision and Biodiversity loss - Biodiversity assessment - Direct, indirect and cumulative impacts - What are 'impacts and need for EIA and/or SEA. - Net positive outcomes, enhancement and the mitigation hierarchy - Example: the impacts of biofuels - Bioeconomy Quiz 	<p>Notes to the teacher: Briefly run through the topics that will be spoken about in this presentation as shown on the slide.</p>
 <p>What is the bioeconomy?</p> <p>The Bioeconomy...</p> <ul style="list-style-type: none"> • Is the production of goods, services, or energy from biological material as the main resource. • Is strongly linked to sustainability as biodegradable resources are often used and waste is often completely designed out of the system. • Can avoid the depletion of resources for future generations and protect the stability of the planet. <p>European Bioeconomy Strategy</p> <p>The European Commission is taking steps towards a sustainable bioeconomy and has a bioeconomy strategy to promote the bioeconomy and to avoid reaching ecological limits.</p> 	<p>Notes to teacher: Explain to class that in order to take steps towards sustainability and the avoidance of reaching ecological limits the bioeconomy is very important. The bioeconomy is the production of goods, services, or energy from biological material as the main resource. This is strongly linked to sustainability as biodegradable resources are often used and waste is often completely designed out of the system. This can avoid the depletion of resources for future generations and protect the stability of the planet. The European Commission is taking steps towards a sustainable bioeconomy. Turning waste into valuable resources and creating incentives to help retailers and consumers cut food waste. The European Commission has a bioeconomy strategy to promote the bioeconomy and avoid reaching ecological limits.</p> <p>European Commission (2018), <i>A sustainable Bioeconomy for Europe: strengthening the connection between economy, society and the environment. Updated Bioeconomy Strategy</i>. Directorate-General for Research and Innovation, available at: https://ec.europa.eu/research/bioeconomy/pdf/ec_bioeconomy_strategy_2018.pdf accessed: 22 May 2020].</p>
 <p>What is the bioeconomy?</p> <p>What is Bioeconomy?</p> <p>A SUSTAINABLE BIOECONOMY FOR EUROPE: STRENGTHENING THE CONNECTION BETWEEN ECONOMY, SOCIETY AND THE ENVIRONMENT</p> <p>Video (2 minutes and 9 seconds): https://www.youtube.com/watch?v=RfRN_hHeIKk Languages for sub-titles for video include: Bulgarian, Latvian, Macedonian, Polish and Romanian</p>	<p>The bioeconomy uses renewable biological resources from land and sea – such as crops, forests, fish, animals and micro-organisms – to produce food, materials and energy. This video gives an overview.</p> <p>Video (2 minutes and 9 seconds): https://www.youtube.com/watch?v=RfRN_hHeIKk</p> <p>Languages for sub-titles for video include: Bulgarian, Latvian, Macedonian, Polish and Romanian</p>




What is biomass?


Biomass is the physical basis of the bioeconomy.

Biomass is "the biodegradable fraction of products, waste and residues from biological origin from agriculture (including vegetal and animal substances), forestry and related industries including fisheries and aquaculture, as well as the biodegradable fraction of industrial and municipal waste" (EC 2019)

Measuring biomass availability is important because it is limited, which can potentially lead to competition for biomass between different biomass-using sectors.


Knowledge on biomass production, availability and use is key.






Bioeconomy around the world

Bioeconomy Policies around the World




As of March 2018



Bioeconomy jobs by sector

EU Bioeconomy Jobs by Sector



Data for 2015

Sector	Employment (thousands)	Value added (billion EUR)	Export (billion EUR)
AGRICULTURE	9.2	180	174
FORESTRY	0.5	50	24
FISHING AND AQUACULTURE	0.2	12	7
FOOD, BEVERAGES AND OTHER ALCOHOLIC DRINKS	6.9	1,155	235
BIO-BASED TEXTILES	1.0	105	28
WOOD PRODUCTS AND FURNITURE	1.4	174	47
PAPER	0.6	187	46
BIO-BASED CHEMICALS AND PHARMACEUTICALS, PLASTICS AND RUBBER	0.4	177	56
LIQUID BIOFUELS	0.05	12	5
BIOELECTRICITY	0.01	11	5

Notes for teacher, comments and links

EC (2019), Biomass - Knowledge for policy, https://ec.europa.eu/knowledge4policy/bioeconomy/topic/biomass_en

Image source: Camia A., Robert N., Jonsson R., Pilli R., García-Condado S., López-Lozano R., van der Velde M., Ronzon T., Gurria P., M'Barek R., Tamosiunas S., Fiore G., Araujo R., Hoepffner N., Marelli L., Giuntoli J., *Biomass production, supply, uses and flows in the European Union. First results from an integrated assessment*, EUR 28993 EN, Publications Office of the European Union, Luxembourg, 2018, ISBN 978-92-79-77237-5, doi:10.2760/539520, JRC109869

This map shows bioeconomy policies around the world. The countries colored in green are the countries that either have a dedicated bioeconomy strategy or a bioeconomy-related strategy in place. The grey scaled countries do not currently have a dedicated or related strategy in place for a transition to a bioeconomy. Poland, Romania, Bulgaria, and North Macedonia are all shaded grey, but BE-Rural is looking to change this.

According to the EC (2018), the bioeconomy has the potential to generate 1 million new green jobs by the year 2030. The expected job growth will help countries, like Poland, Romania, Bulgaria, and North Macedonia, build their economy by building industries that will help rural communities who have seen a decline in job opportunities.

An example provided by the EC (2018) states "local deployment of one biorefinery can create up to 4000 jobs in 4 years and better recycling of high value organic waste in cities could create 1200 new jobs in the long run".

EC (2018), Bioeconomy: A new strategy for a sustainable Europe Restoring healthy ecosystems and enhancing biodiversity. European Commission https://ec.europa.eu/research/bioeconomy/pdf/ec_bioeconomy_actions_2018.pdf




Image: BE-Rural (2019). *Background - BE-Rural*. <https://be-rural.eu/background/>






There are 10 sectors that are contributing the bioeconomy job growth in the EU. Agriculture, forestry, fishing and aquaculture, food/beverages, bio-based textiles, wood products and furniture, paper, bio-based chemicals and pharmaceuticals, plastics and rubber, liquid biofuels, and bioelectricity are all industries that will see a continue rise in employment numbers if the pursuit towards a bioeconomy continues.

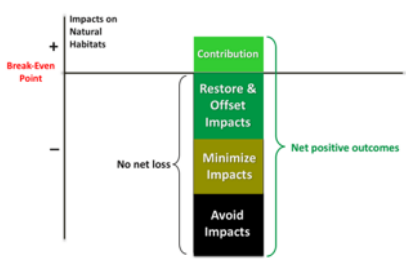


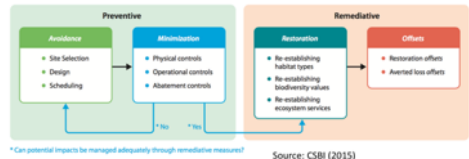

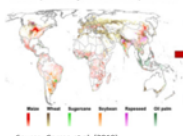

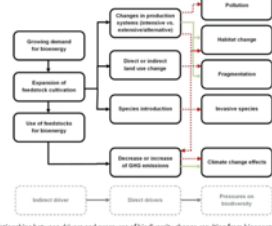
The numbers represented in the chart are the 2015 employment numbers in the European Union for the bioeconomy sectors. These industries reached close to 18 million jobs and added value back to the economy that reached approximately €621 billion.

EC (2018), Bioeconomy: A new strategy for a sustainable Europe Restoring healthy ecosystems and enhancing biodiversity. European Commission https://ec.europa.eu/research/bioeconomy/pdf/ec_bioeconomy_actions_2018.pdf

Slide	Notes for teacher, comments and links
 <p>Socio-economic impacts of bioeconomy</p> <p>The bioeconomy can have a positive impact in local jobs.</p> <p>However, negative impacts can also occur. The quality of work and livelihoods of rural communities depend on direct access to land and water for food production, community and cultural life. So if the production of bioproducts affects the livelihoods of rural communities, then that would be an unacceptable negative impact.</p> <p>It is critical that investments in the bioeconomy (such as biofuels) do not increase inequalities in income, power and access to resources such as land and water.</p>	<p>Source:</p> <p>Work, Water and Food on the Energy Frontiers: Challenges and Futures for 21st Century Technologies in Scotland and Brazil. Stewart, P., Garvey, B., João, E., Tuohy, P., Silva Plata, C., Mendonca, M., Oliveira, A. R., Santos, C., Alves, L. C., Gonçalves, R. J. A. F., Souza, E. A., Mazzu, A., Sheridan, P., Shearer, A., Breen, L. & de Bartolo, C., 2 Feb 2016, 20 p. Glasgow : University of Strathclyde. https://strathprints.strath.ac.uk/57280/</p>
 <p>Bioeconomy – links to SDGs</p> <p>SDGs and the Job Sectors</p>  <p>Agriculture – 1, 2, 3, 6, 8, 11, 12, 13, 15 Forestry – 12, 13, 15 Fishing and Aquaculture – 12, 13, 14 Food and Beverages – 1, 2, 3, 6, 12, 13, 14, 15 Bio-based Textiles – 8, 9, 12 Wood products and Furniture – 8, 9, 12 Paper – 8, 9, 12 Bio-based Chemicals and Pharmaceuticals – 3, 8, 9, 12 Plastics and Rubber – 8, 9, 12 Liquid Biofuels and Bioelectricity – 7, 8, 9, 11, 12</p>	<p>There are 17 Sustainable Development Goals set out by the United Nations to create a sustainable global economy and environment. The 10 job sectors for the EU all play multiple roles in helping obtain the goals set forth by the UN. The common goal under each industry is number 12: responsible consumption and protection. SDG 12 aims to “drastically reduce food waste, begin making more environmentally sound decisions, and help encourage companies to adopt increasingly sustainable practices in all forms of their business” (The Founder Institute, 2019). SDG 12 embodies the purpose surrounding the transition to a bioeconomy as it aims to encompass all aspects surrounding the production of goods, services, and energy to lead to a more sustainable environment for the people and for our planet.</p> <p>The Founder Institute (2019). <i>Founder Institute</i>. https://fi.co/insight/17-companies-helping-meet-the-17-un-sustainable-development-goals</p>
 <p>Links between SDGs and Bioeconomy</p> <p>Sustainable Development Goals are affected by bioeconomy activities</p> <p>Some of the aims of the bioeconomy are complementary or even identical to SDG targets. A sustainable bioeconomy has the potential to advance several SDGs.</p> <p>However, there can also potential negative effects that should be eliminated or reduced. For example, “increased demand for land can lead to land grabbing, displacements, unequal distribution of land considering soil quality, and loss of communal land” (Heimann, 2019, p. 52)</p>  <p>Source: Heimann, T., 2019. Bioeconomy and SDGs: does the bioeconomy support the achievement of the SDGs? <i>Earth's Future</i>, 7(1), pp.43-57. ¹⁰</p>	<p>This slide shows links between the bioeconomy and the SDGs.</p> <p>Heimann, T., 2019. Bioeconomy and SDGs: does the bioeconomy support the achievement of the SDGs?. <i>Earth's Future</i>, 7(1), pp.43-57.</p>
 <p>Interactions among Sustainable Development Goals (SDGs)</p> <p>The importance of the interactions between SDGs was emphasised in the UN's Global Sustainable Report for 2019.</p> <p>This figure is based on 65 global assessments comprising UN reports and international scientific assessments, as well as 112 scientific articles published since 2015 with explicit reference to the SDGs.</p> <p>This assessment reveals relative importance of the potential trade-offs by mapping the summed scores of influencing (horizontal) and influenced (vertical) interactions among SDGs. Figure also shows important gaps in knowledge where certain cells in the matrix are left blank.</p> <p>Source: Independent Group of Scientists appointed by the Secretary-General (2019), <i>Global Sustainable Development Report 2019: The Future is Now – Science for Achieving Sustainable Development</i>, (United Nations, New York). https://sustainabledevelopment.un.org/content/documents/24797GSDR_report_2019.pdf</p> 	<p>Source: Independent Group of Scientists appointed by the Secretary-General (2019), <i>Global Sustainable Development Report 2019: The Future is Now – Science for Achieving Sustainable Development</i>, (United Nations, New York). https://sustainabledevelopment.un.org/content/documents/24797GSDR_report_2019.pdf</p>
 <p>Bioeconomy & climate change</p> <p>Bioeconomy and climate change mitigation</p> <p>“Bioeconomy offers great opportunities to realising a competitive, circular and sustainable economy with a sound industrial base that is less dependent on fossil carbon. A sustainable bioeconomy also contributes to climate change mitigation, with oceans, forests and soils being major carbon sinks and fostering negative CO₂ emissions.” Bell et al. (2018, p. 25)</p>  <p>Scottish Highlands</p> <p>Bell, J., Paula, L., Dodd, T., Németh, S., Nanou, C., Mega, V. & Campos, P. (2018) EU ambition to build the world's leading bioeconomy: Uncertain times demand innovative and sustainable solutions. <i>New Biotechnology</i> 40: 25–30.</p>	<p>It is important to point out not only links to sustainability but also climate change mitigation.</p>

Slide	Notes for teacher, comments and links
<div></div> <div>Ecological limits</div> <p>In addition to links to sustainability and climate change mitigation, it is critical that the bioeconomy operates within safe ecological limits.</p> <p>With the new bioeconomy strategy, the European Commission supports initiatives at national and regional level to develop an efficient and sustainable bioeconomy and this includes:</p> <ul style="list-style-type: none"> • implementing an EU-wide monitoring system to track progress towards a sustainable and circular bioeconomy. • providing guidance on how best to operate the bioeconomy within safe ecological limits. <div></div>	<p>Notes to teacher: Explain that to try and tackle the issues surrounding ecological limits: National and international bodies have specific guidelines. An example of this is the European Commission's 2018 publication; 'A new bioeconomy strategy for a sustainable Europe.' Further information available at: https://ec.europa.eu/commission/news/new-bioeconomy-strategy-sustainable-europe-2018-oct-11-0_en</p> <p>Key reading: EC (2018), Bioeconomy: A new strategy for a sustainable Europe Restoring healthy ecosystems and enhancing biodiversity. European Commission https://ec.europa.eu/research/bioeconomy/pdf/ec_bioeconomy_actions_2018.pdf Could also check for more advanced reading: Giampietro, M. (2019). On the circular bioeconomy and decoupling: implications for sustainable growth. <i>Ecological economics</i>, 162, 143-156. https://www.sciencedirect.com/science/article/pii/S0921800918317178 Vivien, F. D., Nieddu, M., Befort, N., Debref, R., & Giampietro, M. (2019). The hijacking of the bioeconomy. <i>Ecological economics</i>, 159, 189-197. https://www.sciencedirect.com/science/article/abs/pii/S0921800918308115</p>
<div></div> <div>Bioeconomy resources</div> <p>So what can the bioeconomy use as resources?</p> <ul style="list-style-type: none"> • Discarded Shells and Fish Skin from Fisheries • Aquafaba (the water leftover from cooking chickpeas) • Algae and Seaweed • Milk Protein • Mushroom Roots • Coffee Grounds • Wheat Bran • Plants • Insects • Wood • Elephant Poo <div></div>	<p>Reminder: the bioeconomy uses renewable biological resources from land and sea – such as crops, forests, fish, animals and micro-organisms – to produce food, materials and energy.</p> <p>Companies are finding innovative ways to use materials that would otherwise end up in a landfill and transforming them into products that can be made in a more sustainable way.</p>
<div></div> <div>Video: Bioeconomy starts here</div> <div></div> <p>Video (1 minute and 57 seconds): https://www.youtube.com/watch?v=2xvXGOMRTs4 Languages for sub-titles for video include: Bulgarian, Latvian, Macedonian, Polish and Romanian</p>	<p>Video explains briefly the most important basics of a bioeconomy by means of an animated film. It presents the differences between fossil and biological resources as basis for products. It introduces the bioeconomy as a circular economy and illustrates its positive aspects and advantages in the future.</p>
<div></div> <div>The transition to a bioeconomy is complex</div> <p>Factors influencing the bioeconomy: government policy, regulatory conditions, intellectual property rights, human resources, social acceptance, market structure (McCormick and Kautto, 2013), resource availability, sustainability and environmental impacts.</p> <p>"The transition to an energy and materials production regime based on renewable resources can [...] be expected to be fraught with many setbacks and obstacles, technically and politically. [This is further complicated by] the grand challenges faced today: energy security, food security and water security and climate crisis." (Philp, 2018, p.11)</p> <p>"What further complicates the bioeconomy is that the drivers and constraints involve complex interactions and feedbacks, making it highly challenging to isolate and analyse factors." (McCormick and Kautto, 2013, p. 2599).</p> <p>McCormick, K. and Kautto, N. (2013). The Bioeconomy in Europe: An Overview. <i>Sustainability</i>, 5: 2589-2608. Philp, J. (2018). The bioeconomy, the challenge of the century for policy makers. <i>New Biotechnology</i>. 40 (Part A): 11-19.</p>	<p>These two papers discuss issues associated with the complexity of the transition to bioeconomy.</p> <p>Key reading: McCormick, K. and Kautto, N. (2013). The Bioeconomy in Europe: An Overview. <i>Sustainability</i>, 5: 2589-2608. Philp, J. (2018). The bioeconomy, the challenge of the century for policy makers. <i>New Biotechnology</i>. 40 (Part A): 11-19.</p>









Slide	Notes for teacher, comments and links
 <p>Bioeconomy challenges: Resource Provision and Biodiversity loss</p> <p>Bioproducts are derived from renewable biological resources. The bioeconomy makes use of many different biomass resources, from crops to forests to microorganisms. Without these feedstocks, there would be no bioeconomy.</p> <p>It is critical that the bioeconomy does not compete with food production and does not affect biodiversity. For example, marginal lands may not be used for food production but may be important for biodiversity</p> <p>It is therefore fundamental to carry a biodiversity assessment.</p>	<p>Key reading: The Bioeconomy Consultants (2018), BIG BIOECONOMY CHALLENGES - PART 2. https://www.nnfcc.co.uk/news-big-bioeconomy-challenges-2 Brownlie, S. (2013), IAIA fast tips No. 5 - Biodiversity Assessment. International Association for Impact Assessment (IAIA). https://www.iaia.org/fasttips.php</p>
 <p>Biodiversity assessment</p> <p>Five important things to do when carrying out a biodiversity assessment:</p> <ol style="list-style-type: none"> 1. Identify major constraints, high risk areas, and significant impacts on biodiversity and ecosystem services at the outset, seeking alternatives to avoid them. Only when impacts are unavoidable should measures to minimize, restore, offset biodiversity loss, and compensate for lost ecosystem goods and services be addressed. 2. Use appropriate local specialists with explicit Terms of Reference and integrate social, economic and biodiversity considerations. Assess indirect, induced and cumulative impacts on biodiversity as well as direct impacts; these impacts are often more harmful than direct or "footprint" impacts. 3. Engage with interested and affected parties—including indigenous peoples—to identify and evaluate impacts and to determine how traditional knowledge and local cultural practices can contribute to any biodiversity initiative. 4. Take a precautionary approach when baseline information is poor, or there is uncertainty about impacts or the effectiveness of mitigation. Good monitoring, research and adaptive responses are crucial for managing impacts on biodiversity. 5. Seek to make a lasting net positive contribution to biodiversity conservation in the affected area through interventions beyond "no net loss." 	<p>Key reading: Brownlie, S. (2013), IAIA fast tips No. 5 - Biodiversity Assessment. International Association for Impact Assessment (IAIA). https://www.iaia.org/fasttips.php</p>
 <p>Direct, indirect and cumulative impacts</p> <p>In addition to direct impacts, it is critical to assess indirect, induced and cumulative impacts on biodiversity as these impacts are often more harmful than direct impacts.</p> <p>Direct - caused by the project and occur in the same time and place as the project itself. <i>Example:</i> Damage to wetland due to construction of a bridge.</p> <p>Indirect impacts - triggered by project but affect the environment as a knock-on effect, which can be later in time or farther removed in distance from project. <i>Example:</i> A road could include potential changes in land use, which in turn can trigger erosion, which in turn can trigger silting of a river, which in turn can affect water supply.</p> <p>Cumulative impacts - caused by the sum of the project's impacts on the environmental component and/or the project's impacts when added to those of other past, present, or future projects. Three types of cumulative impacts:</p> <ol style="list-style-type: none"> a. <i>additive or aggregate</i> - the simple sum of all the impacts b. <i>antagonistic or neutralising</i> - where impacts counteract each other, reducing the overall impact. c. <i>synergistic</i> - where impacts interact to produce an impact greater than the sum of the individual impacts 	<p>In addition to direct impacts, it is critical to assess indirect, induced and cumulative impacts on biodiversity as these impacts are often more harmful than direct impacts. Students could think of both direct and indirect impacts of different activities</p>
 <p>What are 'impacts'?</p> <p>Impacts are changes that are judged to have environmental, political, economic or social significance to society. Impacts may be positive or negative and may affect the environment, communities, human health and well-being, desired sustainability objectives, or a combination of these.</p> <p><small>Source: Partidário, M. (2012), IAIA fast tips No. 1 - What is Impact Assessment. International Association for Impact Assessment (IAIA). https://www.iaia.org/fasttips.php</small></p>	<p>Key reading: IAIA (1999), <i>Principles of EIA best practice</i>. International Association for Impact Assessment. [http://www.iaia.org/best-practice.php] Partidário, M. (2012), IAIA fast tips No. 1 - What is Impact Assessment. International Association for Impact Assessment (IAIA). https://www.iaia.org/fasttips.php</p>
 <p>An EIA and/or SEA may also be needed or useful</p> <p>What is Environmental Impact Assessment (EIA)?</p> <p>EIA is a <i>process</i> that examines (in a transparent way) the environmental consequences of a proposed project, e.g. a new biofuel factory, in advance, to inform decision-making.</p> <p><small>EIA has been in force in the EU since 1985</small></p> <p>What is SEA (Strategic Environmental Assessment)?</p> <p>SEA is the process of evaluating the impacts of proposed <i>policies, plans</i> and <i>programmes</i>, to inform decision-making.</p> <p>For example, an <i>energy policy</i>, a <i>local plan</i>, and a <i>coordinated series of dams</i>.</p> <p><small>SEA has been in force in the EU since 2001</small></p>	<p>Key reading: IAIA (1999), <i>Principles of EIA best practice</i>. International Association for Impact Assessment. [http://www.iaia.org/best-practice.php] Partidário, M. (2012), IAIA fast tips No. 1 - What is Impact Assessment. International Association for Impact Assessment (IAIA). https://www.iaia.org/fasttips.php Environmental assessment in Europe: https://ec.europa.eu/environment/eia/index_en.htm Member States' summaries of Strategic Environmental Assessment - Each national summary provides basic information on the legal, administrative and policy context regarding the SEA system in a Member State. It describes the legal and administrative framework supporting the implementation of the SEA Directive, including the organisational arrangements as well as procedural obligations in place. https://ec.europa.eu/environment/eia/member_states_summaries.htm</p>






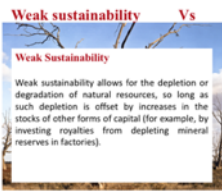


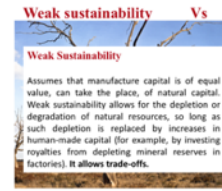
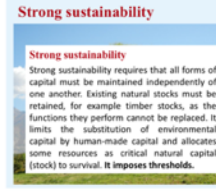

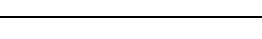

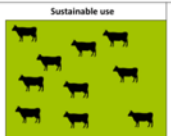

Slide	Notes for teacher, comments and links
 <p>Projects need to think about net positive outcomes</p>	<p>"Net Positive Impact (NPI) on biodiversity is a target for project outcomes in which the impacts on biodiversity (i.e. the variety of ecosystems and living things) caused by the project are outweighed by the actions taken to avoid and reduce such impacts, rehabilitate affected species/landscapes and offset any residual impacts." (NPI Alliance, 2015).</p> <p>Key reading: Brownlie, S. (2013), IAIA fast tips No. 5 - Biodiversity Assessment. International Association for Impact Assessment (IAIA). https://www.iaia.org/fasttips.php NPI Alliance (2015). Net Positive Impact for biodiversity: The conservation case. Gland, Switzerland: IUCN. https://www.iucn.org/sites/dev/files/import/downloads/npi_conservation_01_2016_1.pdf</p>
 <p>Importance of enhancement</p> <p>In addition to consider the mitigation of negative environmental impacts (i.e. making changes to the project or potential location to avoid adverse effects) it is important to also consider the enhancement of positive impacts (ensuring the success of a wider range of direct and indirect benefits that could possibly flow from the project or strategic action).</p> <p>'Benefits' means positive outcomes to communities and/or the biophysical environment in the form of (João et al., 2011):</p> <ul style="list-style-type: none"> • opportunities for social and community development • improved health and wellbeing • improved biodiversity • restored ecosystems • increased green spaces and improved urban design • improved landscape character • protected and respected cultural heritage 	<p>Key reading: João, E, Vanclay, F and den Broeder, L. (2011), Emphasising enhancement in all forms of impact assessment: introduction to a special issue. <i>Impact Assessment and Project Appraisal</i>, 29(3): 170-180.</p>
 <p>Mitigation hierarchy</p> <p>When considering negative impacts, the mitigation hierarchy must be always considered</p>  <p>Source: CSBI (2015)</p> <p>The mitigation hierarchy is a tool to prevent the negative impacts of development projects. And, if prevention is not possible, then to remediate any impacts. It has a sequence of four key actions—avoid, minimize, restore and offset. Avoid is the most preferred action and offset is the least preferred one.</p>	<p>Key reading: CSBI (2015). <i>A cross-sector guide for implementing the mitigation hierarchy</i>. Prepared by the Biodiversity Consultancy on behalf of IPIECA, ICMM and the Equator Principles Association: Cambridge UK.</p> <p>This publication is aimed at environmental professionals working in, or with, extractive industries and financial institutions, who are responsible for overseeing the application of the mitigation hierarchy to biodiversity conservation, while balancing conservation needs with development priorities. The guide is currently available in English, and may be translated into additional languages in the future subject to demand. It is a companion document to CSBI's Timeline Tool and the joint CSBI-MFI Biodiversity Working Group's Good Practices for the Collection of Biodiversity Baseline Data.</p> <p>There is a summary (which includes the diagram in the slide) available in English, Italian, French, Russian and Spanish.</p>
 <p>Need to maximize socioeconomic and environmental benefits</p> <p>Correa et al. (2019, p. 250) argue that:</p> <p>"A sustainable biofuel production should maximize socioeconomic and environmental benefits."</p> <p>"The identification and implementation of sustainable biofuel production alternatives should be based on rigorous assessments that integrate socioeconomic and environmental objectives at local, regional, and global scales."</p>  <p>Source: Correa et al. (2019)</p> <p>Which are their relative environmental impacts? How to identify and implement more sustainable biofuel systems? How to overcome economic challenges for their implementation?</p>	<p>Key reading: Correa, D., Hawthorne, B., Fargione, J., Hill, J., Possingham, H., Thomas-Hall, S. and Schenk, P. (2019). Towards the implementation of sustainable biofuel production systems. <i>Renewable and Sustainable Energy Reviews</i>, 107: 250-263.</p>
 <p>Example: The impacts of biofuels</p> <p>Immerzeel et al. (2014), provide a detailed review on biodiversity impacts of bioenergy crop production. The authors point out:</p> <ul style="list-style-type: none"> • importance of the initial land use - majority of negative impacts refer to the conversion of natural vegetation to first generation biofuel crops. • crops have different impacts – depends if 1st, 2nd and 3rd generation biofuels • biodiversity impacts include habitat change, fragmentation, pollution, invasive species and climate change effects (see Figure)  <p>Relationships between drivers and pressures of biodiversity change resulting from bioenergy crop production. Negative influence: → Positive influence: → (Immerzeel et al., 2014)</p>	<p>Very important to consider the impacts of biofuels that vary according to 1st, 2nd and 3rd generation biofuels.</p> <p>Key reading: Immerzeel, D.J., Verweij, P., Hilst, F. and Faaij, A.P. (2014), Biodiversity impacts of bioenergy crop production: a state-of-the-art review. <i>GCB Bioenergy</i>, 6:183-209</p>







Slide	Notes for teacher, comments and links
 <p>Three types of biofuels (Oregon State University, n.d.):</p> <ol style="list-style-type: none"> 1st generation biofuels (e.g. rape oil, sunflower oil, beet sugarcane, corn, potatoes) - main drawback: come from biomass that is also a food source. 2nd generation biofuels (e.g. agricultural and forest residues) come from non-food biomass, but still compete with food production for land use. 3rd generation biofuels (e.g. engineered crops such as algae) present the best possibility for alternative fuel because they don't compete with food. Algae can grow in areas unsuitable for 1st and 2nd generation crops, which would relieve stress on water and arable land used. Plus it can be grown using sewage, wastewater, and saltwater.  <p>Algae Energy Farm in Australia (Algae Biotechnology Laboratory, University of Queensland, Australia).</p> <p>Cultivation on open ponds (a) following initial growth in sealed bags (b).</p> <p>Source: Correa, et al. (2019)</p>	<p>Key reading:</p> <p>Correa, D., Hawthorne, B., Fargione, J., Hill, J., Possingham, H., Thomas-Hall, S. and Schenk, P. (2019). Towards the implementation of sustainable biofuel production systems. <i>Renewable and Sustainable Energy Reviews</i>, 107: 250-263.</p> <p>Oregon State University (n.d.), Bioenergy Education Initiative. https://agsci.oregonstate.edu/sites/agsci.oregonstate.edu/files/bioenergy/generations-of-biofuels-v1.3.pdf</p>
 <p>The world of bioeconomy still remains a mystery to many. Try out our quiz to see how you fair in knowing a thing or two on bio-based products.</p> <p>http://www.allthings.bio/quiz/are-you-ready-for-the-bioeconomy/</p>	<p>Interactive quiz with 6 questions about the bioeconomy. User can see if answer is right or wrong right away and explanation is provided, plus explore every question's concept by clicking on "Learn more about this" link, redirecting users to other sites with in-depth information. Quiz is entertaining and informative. Questions ranges from simple ones to those which require a bit more background, so relevant to different target audiences.</p> <p>This is a good way to both acquire new knowledge and test existing knowledge.</p> <p>Time that will take: 6 minutes or more - depending if reading extra information.</p>
 <p>Questions and Discussion</p> <p>Name of provider</p>	<p>Notes to the teacher: Speaker's name to go in the space at the bottom left of the slide. This is the final slide of the presentation. Allow time for students/participants to ask any questions.</p>
 <p>These educational resources were developed as part of the BE-Rural project Bio-based strategies and roadmaps for enhanced rural and regional development in the EU (April 2019 – March 2022)</p> <p>BE-Rural supports</p> <p>... regional stakeholders in five countries:</p> <ul style="list-style-type: none"> Latvia: Vidzeme and Kurzeme Poland: Szczecin and Vistula Lagoons Romania: Covasna Bulgaria: Stara Zagora North Macedonia: Strumica  <p>The goal of BE-Rural is to realise the potential of regional bio-based economies by supporting relevant actors in the participatory development of bioeconomy strategies and roadmaps</p> <p>https://be-rural.eu/innovation-regions/</p>	<p>BE-Rural will create five regional Open Innovation Platforms (OIPs) for the participatory development of bioeconomy strategies and roadmaps.</p> <p>Stara Zagora, Bulgaria: will focus on seeking new technologies for the application of essential oils and herbal plants in the cosmetics and pharmaceutical industry.</p> <p>Vidzeme and Kurzeme, Latvia: will focus on the potential of by-products of forest management (i.e. from young forest stand thinning, short rotation coppice and forestry plantations, removing of overgrowth in abandoned agricultural lands and perennial grasses) as a source of bioenergy or biorefinery.</p> <p>Strumica, North Macedonia: will focus on the utilization of agricultural residues, specifically the by-production of organic materials from agricultural activities, as a source of energy for domestic and industrial purposes.</p> <p>Szczecin Lagoon and Vistula Lagoon, Poland: will focus on small-scale fisheries, specifically on the sustainable use of currently underused and low-value fish species located in two lagoons.</p> <p>Covasna, Romania: will focus on addressing fragmented value chains and implementing the circular economy concept within the county's industrial sectors (i.e. wood and furniture, textiles, agro-food, mechanical engineering, green energy).</p> <p>Source: BE-Rural (2020), <i>Innovation regions</i>, available at: https://be-rural.eu/innovation-regions/</p>





Annex VII - Power Point slides and notes on "Bioeconomy and key principles of sustainability"









Slide	Notes for teacher, comments and links
  <p>Key principles of sustainability and links to bioeconomy</p> <p>Name of presenter</p>	<p>Notes to the teacher: Teacher's name to go in the space at the bottom left of the slide. Explain that this presentation aims to educate on the key principles of sustainability (and how the bioeconomy can be a strategy for sustainability), using definitions, examples and interactive questions.</p> <p>Excluding the two Mentimeter exercises, this first slide and the outline slides, there are 20 slides – so these slides should take between 20 and 40 minutes to present, depending of amount of explanation.</p> <p>The two Mentimeter exercises will take around 2 minutes each.</p>
  <p>Outline</p> <ul style="list-style-type: none"> - What is Sustainability? - The Sustainability problem - Weak vs Strong Sustainability - Tragedy of the commons - Quick Quiz - How The Bioeconomy contributes to sustainability - Ecological limits and the Bioeconomy - The importance of innovation 	<p>Notes to the teacher: Briefly run through the topics that will be spoken about in this presentation as shown on the slide.</p>
 <p>Mentimeter code - - - - -</p> <p>What is Sustainability?</p> <p>Go to - https://www.menti.com/</p> <p>Type any words that you associate with Sustainability into the Mentimeter</p>	<p>** This slide only works after obtaining a Mentimeter code before the presentation.**</p> <p>Notes to the teacher:</p> <p>Explain that sustainability can be hard to define, and it can mean different things to different people. Use the mentimeter app word-cloud function and get participants to type in the words that they associate with "Sustainability". Put Mentimeter code in top right of slide.</p> <p>When participants/students have finished this; read out some of the most popular words and make any comments that you feel are relevant. This task will get the students/participants thinking about how they already view the concept of sustainability. Use link - https://www.menti.com/</p>
 <p>What is sustainability?</p> <p>"Development that meets the needs of the present without compromising the ability of future generations to meet their own needs"</p> <p>(World Commission on Environment and Development, 1987)</p> 	<p>Notes to the teacher: This is the most famous definition. Our Common Future is also called the "Brundtland Report" (because the former Norwegian Prime Minister Gro Harlem Brundtland's role was the Chair of the World Commission on Environment and Development).</p> <p>Read out this definition and try to link back to the words that the participants/students came up with on the Mentimeter activity on the previous slide.</p> <p>World Commission on Environment and Development. (1987). Our common future. Oxford: Oxford University Press. (Available at: http://www.princeton.edu/~ota/disk1/1993/9340/934004.PDF)</p> <p>The publication of Our Common Future and the work of the World Commission on Environment and Development laid the groundwork for the convening of the 1992 Earth Summit and the adoption of Agenda 21, the Rio Declaration and to the establishment of the Commission on Sustainable Development.</p>






Slide	Notes for teacher, comments and links
 <p>What is sustainability?</p> <p>“The property of being environmentally sustainable; the degree to which a process or enterprise is able to be maintained or continued while avoiding the long-term depletion of natural resources”</p> <p>(Oxford English Dictionary, 2020)</p>	<p>Notes to the teacher: This is a newer definition. Read out this definition and try to link back to the words that the participants/students came up with on the Mentimeter activity on the previous slide.</p> <p>Oxford College of Procurement and Supply, (2020), <i>How sustainable is sustainability?</i>, available at: https://www.oxfordcollegeofprocurementandsupply.com/how-sustainable-is-sustainability/</p>
 <p>What is sustainability?</p> <p>The key point within both definitions can be identified as avoiding the depletion of resources so that future generations can have their needs met.</p> <p>What do we mean by resources?</p> <p>By resources we mean both infinite and finite materials that can be found on the earth.</p>  <p><small>This image is licensed under CC BY-SA</small></p>	<p>Notes to the teacher: The key point within both of the previous definitions can be identified as avoiding the depletion of resources so that future generations can have their needs met. – Try to link words back to the Mentimeter word cloud if possible. The first animation on the slide will highlight the words “avoiding the depletion of resources”. The second animation on the slide will make the “What do we mean by resources?” text appear. Say that by resources we mean both infinite and finite materials that can be found on the earth.</p>
 <p>What is sustainability?</p> <p>Social equity...</p> <p>The global challenge can be simply stated: To reach sustainability, humanity must increase the consumption levels of the world's poor, while at the same time reducing humanity's ecological footprint</p>  <p><small>This image is licensed under CC BY-SA</small></p> <p><small>Meadows et al. (2005), p. xv</small></p>	<p>Notes to the teacher: Explain that: It should be noted that sustainability is not just to do with resources though. It should also be about social equity. It should be about increasing consumption levels of the world's poor, while also reducing humanity's overall ecological footprint. Social, economic and ecological issues must therefore be considered when thinking about sustainability. This is often represented in diagrams. – Show diagram on next slide.</p> <p>Meadows, Dennis; Meadows, Donella; Randers, J.; (2005). <i>Limits To Growth: The 30-Year Update</i> (Hardcover ed.). Chelsea Green Publishing. ISBN 1931498512.</p>
 <p>Sustainability diagram</p>  <p><small>https://commons.wikimedia.org/wiki/File:Sustainability_diagram_v2.pdf</small></p> <p><small>The links between these factors is critical. “Many approaches to sustainability... have begun by addressing the social, economic and ecological considerations separately. The combined effect is not merely an absence of integrative expertise, data and authority but an entrenched tendency to neglect the interdependence of these factors.” (Gibson 2006, p. 259)</small></p>	<p>Notes to teacher: Some students/participants may benefit from seeing diagrams of the concepts being talked about. Explain that to truly achieve sustainability; Ecological, Economic and Social issues need to be considered. An integral approach to tackling social, economic and ecological issues together is important. Tackling the issues separately or neglecting one can lead to poor or mixed results. Use laser pointer to point at “bearable” “equitable” and “viable” when talking about the mixed results.</p> <p>Gibson, R.B., 2006. Beyond the pillars: Sustainability assessment as a framework for effective integration of social, economic and ecological considerations in significant decision making. <i>Journal of Environmental Assessment Policy and Management</i>, 8(3), pp.259–280.</p>
 <p>The Sustainability problem</p> <p>Complexity and Wickedness</p> <p>The examination of the process of sustainability transition and the hurdles that make it difficult.</p> <p>These have been called wicked problems (Rittel and Webber 1973), the ‘problematique’ (Reid et al. 2006) or the sustainability problem (Common 1995).</p>	<p>Explain that - The complexity of approaching sustainability and trying to give equal attention to the three main issues is known as The Sustainability Problem. The main concern is around the problem's constantly changing nature and the uncertainty of our knowledge on it.</p> <p>Common, M. (1995), <i>Sustainability and Policy: Limits to Economics</i>. Cambridge UK: Cambridge University Press.</p> <p>Pryshlakivsky J., Searcy C. (2013) Sustainable Development as a Wicked Problem. In: Kovacic S., Sousa-Poza A. (eds) Managing and Engineering in Complex Situations. Topics in Safety, Risk, Reliability and Quality, vol 21. Springer, Dordrecht</p> <p>Reid, W.V., Berkes, F., Wilbanks, T. and Capistrano, D. (eds.) 2006. Bridging Scales and Knowledge Systems: Concepts and Applications in Ecosystem Assessment. Washington DC: Millennium Ecosystem Assessment and Island Press.</p> <p>Rittel, H.W.J. and Webber, M.M. 1973. Dilemmas in a general theory of planning. <i>Policy Sciences</i>, Vol. 4, No. 2, pp. 155-169.</p>

Slide	Notes for teacher, comments and links
 <p>The Sustainability problem</p> <p>“Knowledge of the system we deal with is always incomplete. Surprise is inevitable. Not only is the science incomplete, the system itself is a moving target”.</p> <p>(Hollings 1973, p. 2)</p>	<p>More about the complexity of approaching sustainability and any other complex systems.</p> <p>Hollings, C.S. 1973. Resilience and Stability of Ecological Systems. <i>Annual Review of Ecology and Systematics</i> , Vol. 4 , pp. 1-23.</p>
 <p>Weak vs Strong sustainability</p> <div style="display: flex; justify-content: space-around;"> <div style="text-align: center;"> <p>Weak sustainability</p>  </div> <div style="text-align: center;"> <p>Strong sustainability</p>  </div> </div>	<p>Notes to teacher: Explain thta another issue surrounding sustainability is the important distinction that needs to be made between weak sustainability and strong sustainability. Animate the first picture when the word WEAK is said, and the second picture when the word STRONG is said.</p> <p>Neumayer, E. 2010. <i>Weak versus Strong Sustainability</i>. 3rd Ed. UK: Elgar.</p>
 <p>Weak vs Strong sustainability</p> <div style="display: flex; justify-content: space-around;"> <div style="text-align: center;"> <p>Weak sustainability</p>  </div> <div style="text-align: center;"> <p>Strong sustainability</p>  </div> </div>	<p>Notes to teacher: Explain that weak Sustainability allows for the depletion or degradation of natural resources, so long as such depletion is offset by increases in the stocks of other forms of capital. For example, by investing royalties from depleting mineral reserves in factories.</p>
 <p>Weak vs Strong sustainability</p> <div style="display: flex; justify-content: space-around;"> <div style="text-align: center;"> <p>Weak sustainability</p>  </div> <div style="text-align: center;"> <p>Strong sustainability</p>  </div> </div>	<p>Notes to teacher: Explain that strong sustainability requires that all forms of capital must be maintained independently of one another. Existing stock must be retained, for example timber stocks, as the functions the timber can perform cannot be replaced or offset by anything else, such as investing in royalties.</p>
 <p>Weak vs Strong sustainability</p> <p>A weak sustainability approach considers that human-made and natural capital are substitutable in the long term, whilst supporters of strong sustainability believe they are not.</p>	<p>Notes to teacher: This is a summary of weak and strong sustainability - supporters of weak sustainability suggest that human-made and natural capital are substitutable in the long term, whilst supporters of strong sustainability believe they are not.</p>
 <p>Tragedy of the Commons</p> <div style="display: flex; justify-content: space-around;"> <div style="text-align: center;"> <p>The commons</p>  <p>20 acres of shared grazing land</p> </div> <div style="text-align: center;"> <p>Sustainable use</p>  <p>10 Cows (Carrying capacity)</p> </div> <div style="text-align: center;"> <p>Unsustainable use – Depleted resource</p>  <p>20+ Cows (Over the tipping point)</p> </div> </div>	<p>Notes to teacher: Explain that; the tragedy of the commons is a concept that is linked to sustainability. It comes about when there is a shared resource that individuals have incentive to use. If individuals neglect the well-being of society and favour personal gain then it can result in overconsumption, under investment, and depletion of the resource. Ultimately the resource is lost for everyone.</p> <p>Show the 3 pictures and explain. Picture 1 – The commons: A shared pasture that multiple farmers have access to and freedom to graze their cattle on. Picture 2 – Sustainable use of this shared resource would be all the farmers sticking to the carrying capacity amount of cattle. Picture 3 – However, if</p>

Slide	Notes for teacher, comments and links
 <p>Tragedy of the Commons</p> <p>Historic examples:</p> <p>Grand Banks fisheries</p> <p>The Grand Banks are fishing grounds off the coast of Newfoundland.</p> <p>In the 1960s and 1970s, advances in fishing technology meant that more and more cod could be caught.</p>  <p>Slide 16</p>	<p>individuals decide to keep adding a few more cows thinking that their additional input will not make a difference then the tipping point will be reached and the resource will be depleted and no farmer will be able to use the resource.</p> <p>Carrying capacity in ecology refers to the number of people, animals, or crops which a region can support without environmental degradation.</p> <p>Notes to teacher: This is a real-life example to help students/participants understand the concept. Explain that the Grand Banks are fishing grounds off the coast of Newfoundland. In the 1960s and 1970s, advances in fishing technology meant that more and more cod could be caught. Because of this, By the 1990s, cod populations were so low that the Grand Banks fishing industry collapsed. It was too late for regulation and management; the cod stocks had been irreparably damaged. Since then, the cod populations have remained low, and some scientists doubt the Grand Banks ecosystem will ever recover.</p>
 <p>Mentimeter code – – – –</p> <p>Quick Quiz!</p> <p>Go to - https://www.menti.com/</p> <p>On Mentimeter match the situations to what they are examples of:</p> <ul style="list-style-type: none"> - The Sustainability problem - Weak Sustainability - Strong Sustainability - Tragedy of the commons 	<p>** This slide only works after obtaining a Mentimeter code before the presentation.**</p> <p>Notes to teacher: Use the Mentimeter quiz function and input the questions below. Put Mentimeter code in top right corner of slide. There are 3 situations being described, and each one is an example of either weak sustainability, strong sustainability or tragedy of the commons. Allow students some time to select their answers and then read the correct answer/title combinations.</p> <p>Question 1: "Planting two trees for every one tree cut down is an example of..."</p> <p>Options: Weak sustainability, Tragedy of the commons, Strong sustainability, or the Sustainability problem?"</p> <p>The correct answer is Strong sustainability.</p> <p>Question 2: "Depleting timber stocks, then buying royalties to compensate is an example of..."</p> <p>Options: Weak sustainability, Tragedy of the commons, Strong sustainability, or the Sustainability problem?"</p> <p>The correct answer was Weak sustainability.</p> <p>Question 3: "All of us driving to the shops thinking: "One more car won't make a difference," Then the excessive cars causing us all to suffer from air pollution is an example of..."</p> <p>Options: Weak sustainability, Tragedy of the commons, Strong sustainability, or the Sustainability problem?"</p> <p>The correct answer is Tragedy of the commons.</p>
 <p>Outline</p> <ul style="list-style-type: none"> ✓ What is Sustainability? ✓ ✓ The Sustainability problem ✓ ✓ Weak vs Strong Sustainability ✓ ✓ Tragedy of the commons ✓ ✓ Quick Quiz ✓ - How The Bioeconomy contributes to sustainability - Ecological limits and the Bioeconomy - The importance of innovation 	<p>Notes to teacher: Go over what has already been covered, and what is still to be covered. What has been covered in black, what is still to cover in white.</p>
 <p>What is the bioeconomy?</p> <p>The Bioeconomy...</p> <ul style="list-style-type: none"> • Is the production of goods, services, or energy from biological material as the main resource. • Is strongly linked to sustainability as biodegradable resources are often used and waste is often completely designed out of the system. • Can avoid the depletion of resources for future generations and protect the stability of the planet. <p>European Bioeconomy Strategy</p> <p>The European Commission is taking steps towards a sustainable bioeconomy and has a bioeconomy strategy to promote the bioeconomy and to avoid reaching ecological limits.</p> 	<p>Notes to teacher: Explain to class that in order to take steps towards sustainability and the avoidance of reaching ecological limits the bioeconomy is very important. The bioeconomy is the production of goods, services, or energy from biological material as the main resource. This is strongly linked to sustainability as biodegradable resources are often used and waste is often completely designed out of the system. This can avoid the depletion of resources for future generations and protect the stability of the planet. The European Commission is taking steps towards a sustainable bioeconomy. Turning waste into valuable resources and creating incentives to help retailers and consumers cut food</p>


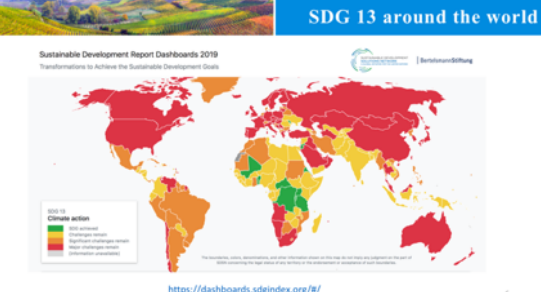



Slide	Notes for teacher, comments and links
	<p>waste. The European Commission has a bioeconomy strategy to promote the bioeconomy and avoid reaching ecological limits.</p> <p>European Commission (2018), <i>A sustainable Bioeconomy for Europe: strengthening the connection between economy, society and the environment. Updated Bioeconomy Strategy</i>. Directorate-General for Research and Innovation, available at: https://ec.europa.eu/research/bioeconomy/pdf/ec_bioeconomy_strategy_2018.pdf accessed: 22 May 2020].</p>
 <p style="text-align: center;">Ecological limits</p> <p style="text-align: center;">In addition to links to sustainability and climate change mitigation, it is critical that the bioeconomy operates within safe ecological limits.</p> <p>With the new bioeconomy strategy, the European Commission supports initiatives at national and regional level to develop an efficient and sustainable bioeconomy and this includes:</p> <ul style="list-style-type: none"> • implementing an EU-wide monitoring system to track progress towards a sustainable and circular bioeconomy. • providing guidance on how best to operate the bioeconomy within safe ecological limits. 	<p>Notes to teacher: Explain that to try and tackle the issues surrounding ecological limits: National and international bodies have specific guidelines. An example of this is the European Commission's 2018 publication; 'A new bioeconomy strategy for a sustainable Europe.' Further information available at: https://ec.europa.eu/commission/news/new-bioeconomy-strategy-sustainable-europe-2018-oct-11-0_en</p> <p>Key reading:</p> <p>EC (2018), Bioeconomy: A new strategy for a sustainable Europe Restoring healthy ecosystems and enhancing biodiversity. European Commission https://ec.europa.eu/research/bioeconomy/pdf/ec_bioeconomy_actions_2018.pdf</p> <p>Could also check for more advanced reading:</p> <p>Giampietro, M. (2019). On the circular bioeconomy and decoupling: implications for sustainable growth. <i>Ecological economics</i>, 162, 143-156. https://www.sciencedirect.com/science/article/pii/S0921800918317178</p> <p>Vivien, F. D., Nieddu, M., Befort, N., Debref, R., & Giampietro, M. (2019). The hijacking of the bioeconomy. <i>Ecological economics</i>, 159, 189-197. https://www.sciencedirect.com/science/article/abs/pii/S0921800918308115</p> <p>See slides "What is the Bioeconomy? Opportunities, challenges and solutions" for information on:</p> <ul style="list-style-type: none"> - Bioeconomy – links to SDGs and climate change, and bioeconomy resources - The transition to a bioeconomy is complex - Biodiversity assessment - Direct, indirect and cumulative impacts - What are 'impacts and need for Environmental Impact Assessment (EIA) and/or Strategic Environmental Assessment (SEA). - Net positive outcomes, enhancement and the mitigation hierarchy - Example: the impacts of biofuels
	<p>Notes to teacher: Explain that to try and tackle the issues surrounding ecological limits: National and international bodies have specific guidelines. An example of this is the European Commission's 2018 publication; 'A new bioeconomy strategy for a sustainable Europe.' Further information available at: https://ec.europa.eu/commission/news/new-bioeconomy-strategy-sustainable-europe-2018-oct-11-0_en</p>
 <p style="text-align: center;">Ecological limits and the bioeconomy</p> <p>Ecological limits</p> <p>Ecological limits centre around three main areas:</p> <ul style="list-style-type: none"> - Food resources - The capacity of ecosystems - The populations within ecosystems <p>With a linear economy, and such a large population, we will exceed the ecological limits!</p> <p style="text-align: center;">It is projected that the world's human population will reach about 10 billion by 2050</p> 	<p>Notes to teacher: Explain that another key issue surrounding sustainability relates to ecological limits. Ecological limits are the planet's limits on being able to support life as it currently is. Ecological limits centre around three main areas: (1) Food resources (2) The maximum capacity of ecosystems (3) The territoriality of populations within ecosystems.</p> <p>Explain that with the human population predicated to hit 10 billion by 2050 it does not seem farfetched to imagine a world where the ecological limit will be reached.</p> <p>Background information: "Carrying capacity" is the number of people who can live, in the way they happen to be living, without damaging the environment or diminishing its ability to</p>

Slide	Notes for teacher, comments and links
 <p>Ecological limits and the bioeconomy</p> <p>Measures being taken by the European Commission</p> <ul style="list-style-type: none"> • Implement an EU-wide monitoring system to track progress towards a sustainable and circular bioeconomy; • Enhance our knowledge base and understanding of specific bioeconomy areas by gathering data and ensuring better access to it through the Knowledge Centre for the Bioeconomy; • Provide guidance and promote good practices on how to operate in the bioeconomy within safe ecological limits. <p>European Commission (2018)</p>	<p>support people in the future. Steps need to be taken to protect food resources and ecosystems.</p> <p>Notes to teacher: Some measures that the European Commission outline are as follows: (1) Implement an EU-wide monitoring system to track progress towards a sustainable and circular bioeconomy; (2) Enhance our knowledge base and understanding of specific bioeconomy areas by gathering data and ensuring better access to it through the Knowledge Centre for the Bioeconomy; (3) Provide guidance and promote good practices on how to operate in the bioeconomy within safe ecological limits.</p> <p>Explain that these measures would help prevent ecological limits being reached as they help to educate people and promoted effective practices. Further information available at: https://ec.europa.eu/commission/news/new-bioeconomy-strategy-sustainable-europe-2018-oct-11-0_en</p>
 <p>The importance of innovation</p> 	<p>Notes to teacher: Explain that Innovation is incredibly important when considering how the human population can remain within ecological limits. Products that can be used again and again, often from waste are highly sustainable and avoid a depletion of resources. These can be known as bio-products.</p>
 <p>The importance of innovation</p>  <p>What are these two items made from?</p>	<p>Notes to teacher: Ask the participants if they have any idea what these two items are made from.</p>
 <p>The importance of innovation</p>  <p>What are these two items made from?</p>	<p>The answer is coffee ground waste for both. An animation will remove the blue rectangle in the middle and reveal the answer.</p>
 <p>Outline</p> <ul style="list-style-type: none"> ✓ What is Sustainability? ✓ ✓ The Sustainability problem ✓ ✓ Weak vs Strong Sustainability ✓ ✓ Tragedy of the commons ✓ ✓ Quick Quiz ✓ ✓ How The Bioeconomy contributes to sustainability ✓ ✓ Ecological limits and the Bioeconomy ✓ ✓ The importance of innovation ✓ 	<p>Notes to the teacher: Mention that that is everything to be spoken about today.</p>











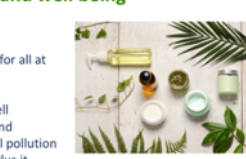



Slide	Notes for teacher, comments and links
 <p>Key Points Covered – Sustainability</p> <ol style="list-style-type: none"> 1. Preserving resources for future generations and social equity! 2. Many problems surrounding the issue! 3. The risk of reaching ecological limits! 4. Innovation into the future! 	<p>Notes to the teacher: This is a slide to summarise the Power point's main points. Explain that (1) Sustainability should be about preserving resources for future generations and social equity. (2) There are many issues and concepts surrounding sustainability such as weak sustainability/strong sustainability/the tragedy of the commons/the sustainability problem. (3) As the human population continues to rise, there is a risk that we will hit our ecological limits (4) Innovation, such as bio-products is one way in which we could try and combat this problem.</p>
 <p>Questions and Discussion</p> 	<p>Notes to the teacher: Speaker's name to go in the space at the bottom left of the slide. This is the final slide of the presentation. Allow time for students/participants to ask any questions.</p>
 <p>These educational resources were developed as part of the BE-Rural project Bio-based strategies and roadmaps for enhanced rural and regional development in the EU (April 2019 – March 2022)</p> <p>BE-Rural supports</p> <ul style="list-style-type: none"> ... regional stakeholders in five countries: • Latvia: Vidzeme and Kurzeme • Poland: Szczecin and Vistula Lagoons • Romania: Covasna • Bulgaria: Stara Zagora • North Macedonia: Strumica <p>https://be-rural.eu/innovation-regions/</p>  <p>The goal of BE-Rural is to realise the potential of regional bio-based economies by supporting relevant actors in the participatory development of bioeconomy strategies and roadmaps</p>	<p>BE-Rural will create five regional Open Innovation Platforms (OIPs) for the participatory development of bioeconomy strategies and roadmaps.</p> <p>Stara Zagora, Bulgaria: will focus on seeking new technologies for the application of essential oils and herbal plants in the cosmetics and pharmaceutical industry.</p> <p>Vidzeme and Kurzeme, Latvia: will focus on the potential of by-products of forest management (i.e. from young forest stand thinning, short rotation coppice and forestry plantations, removing of overgrowth in abandoned agricultural lands and perennial grasses) as a source of bioenergy or biorefinery.</p> <p>Strumica, North Macedonia: will focus on the utilization of agricultural residues, specifically the by-production of organic materials from agricultural activities, as a source of energy for domestic and industrial purposes.</p> <p>Szczecin Lagoon and Vistula Lagoon, Poland: will focus on small-scale fisheries, specifically on the sustainable use of currently underused and low-value fish species located in two lagoons.</p> <p>Covasna, Romania: will focus on addressing fragmented value chains and implementing the circular economy concept within the county's industrial sectors (i.e. wood and furniture, textiles, agro-food, mechanical engineering, green energy).</p> <p>Source: BE-Rural (2020), <i>Innovation regions</i>, available at: https://be-rural.eu/innovation-regions/</p>

Annex VIII - Power Point slides and notes on "Bioeconomy and SDGs (and respective targets)"

Slide	Notes for teacher, comments and links
 <p>Introduction to the Sustainable Development Goals (SDGs) and their links to the bioeconomy</p> 	<p>Notes to the teacher: Teacher's name to go in the space at the bottom left of the slide. Explain that this presentation introduces the 17 Sustainable Development Goals (SDGs) and shows links between the bioeconomy and some of the SDGs.</p> <p>Excluding the first slide, the video and the outline slide, there are 18 slides – so these slides should take between 18 and 36 minutes to present, depending of amount of explanation. The video is 2 minutes and 8 seconds long.</p> <p>Time to do the exercise on SDGs achievement around the world can vary. Information on one goal and one country can be quickly accessed in minutes. So could be used just for 5 or 10 minutes in class, but there is opportunity for in-depth research over hours or even days (which could be used as part of homework).</p>
 <p>Overview</p> <p>Overview</p> <ul style="list-style-type: none"> What are the Sustainable Development Goals (SDGs)? What are the targets in each SDG? Exercise on SDGs achievement around the world. The links between the bioeconomy and some of the SDGs. 	<p>Source image: Biobased Industries Consortium, 2018. Bioeconomy and the UN Sustainable Development Goals. Biobased Industries Consortium: Brussels, Belgium.</p>
 <p>The Sustainable Development Goals (SDGs)</p> <ul style="list-style-type: none"> In September 2015 the United Nations adopted the 17 Sustainable Development Goals (SDGs). The 17 SDGs contain 169 specific targets. Governments from 193 countries agreed to implement these goals to achieve the 2030 Agenda for Sustainable Development.   <p>Source: https://sustainabledevelopment.un.org/?menu=1300</p>	<p>This slide presents an overview of the SDGs – when they started, number of SDGs, number of targets and number of countries that agreed to implement these goals.</p> <p>Source image: United Nations. (2015): <i>Sustainable Development Goals</i>. https://sustainabledevelopment.un.org/?menu=1300</p>
 <p>SDG 'Wedding Cake'</p> <p>A new way of viewing the economic, social and ecological aspects of the SDGs. <small>(proposed by Johan Rockström and Pavan Sukhdev, Stockholm Resilience Centre)</small></p>  <ul style="list-style-type: none"> This model implies that the economy and society are seen as embedded parts of the biosphere. All SDGs are directly or indirectly connected to each other. Goal 17 is the global partnership required for sustainable development. <p>Source: Azote Images On Resilience, Stockholm Resilience Centre, Stockholm University</p>	<p>This is a very important slide and could be discussed in class. It suggests that all SDGs are directly or indirectly connected to each other and that the SDG17 is fundamental as it is the global partnership required for sustainable development. Very importantly, this way at looking at the SDGs implies that the economy and society are seen as integral part of the biosphere (which relates to the concept of "strong sustainability"). This model is sometimes called the SDG 'Wedding Cake'.</p> <p>Stockholm Resilience Centre. (2016) <i>Stockholm University: Azote Images</i>. https://www.stockholmresilience.org/research/research-news/2017-02-28-contributions-to-agenda-2030.html</p> <p>This excellent guide shows the connections between all SDGs and is a very useful education resource: Manitoba Council for International Cooperation (2018) <i>Sustainable Foundations: A Guide for Teaching the Sustainable Development Goals</i>, http://mcic.ca/pdf/SDG_Primer_FINAL.pdf</p>

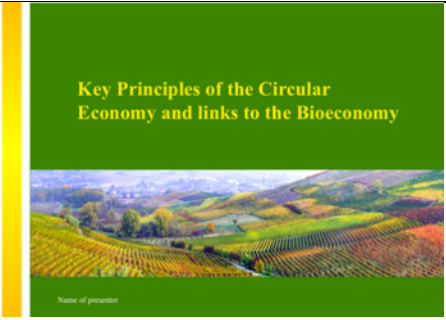

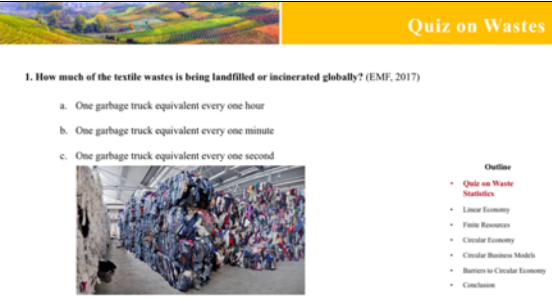
Slide	Notes for teacher, comments and links
<p>SDGs around the world</p> <p>Exercise on SDGs achievement around the world</p>  <p>Access this web https://dashboards.sdindex.org/#/ and pick the country that you have visited last to check their SDGs achievement (including the 169 targets).</p>	<p>This amazing interactive map provides a visual representation of countries' performance by SDGs to identify priorities for action. Students can access this resource on their phones or computers, or results for different countries can be shown on the screen. This is the best resource to explain how each SDG is associated with different targets and to see how the different countries are performing in relation to each of the 17 SDGs and each of the 169 targets.</p> <p>A Global Initiative for United Nations. (2019): <i>Sustainable Development Report Dashboards</i>. https://dashboards.sdindex.org/#/</p> <p>SDGs logo image source: C-CHANGE (2017) <i>Sustainable Development Goals</i> (SDGs). https://www.c-change.io/blogs/2017/8/3/time-for-a-new-normal-in-global-capital-markets-advancing-investment-in-the-sustainable-development-goals-sdgs</p>
<p>SDG 13 around the world</p>  <p>https://dashboards.sdindex.org/#/</p>	<p>This is an example for SDG 13 (Climate Action). The same can be done for all 17 SDGs.</p>
<p>SDGs in Poland</p> <p>Poland OECD members</p> <p>Achievement of SDGs in Poland in 2019</p>  <p>https://dashboards.sdindex.org/#/</p>	<p>Then the performance for each country for each SDG can be assessed. This is an example for Poland but can be done for any country.</p>
<p>SDG 13 and SDG 15 in Poland</p> <p>Poland OECD members</p>  <p>https://dashboards.sdindex.org/#/</p>	<p>Then the detailed performance for each SDG for each country can be assessed with regards to the achievement for all the targets for that SDG.</p> <p>This is an example for Poland for SDG 13 and SDG 15 but this can be done for the combination of any country and any SDG.</p>
<p>What is the bioeconomy?</p> <p>The Bioeconomy...</p> <ul style="list-style-type: none"> Is the production of goods, services, or energy from biological material as the main resource. Is strongly linked to sustainability as biodegradable resources are often used and waste is often completely designed out of the system. Can avoid the depletion of resources for future generations and protect the stability of the planet. <p>European Bioeconomy Strategy</p> <p>The European Commission is taking steps towards a sustainable bioeconomy and has a bioeconomy strategy to promote the bioeconomy and to avoid reaching ecological limits.</p> 	<p>Notes to teacher: Explain to class that in order to take steps towards sustainability and the avoidance of reaching ecological limits the bioeconomy is very important. The bioeconomy is the production of goods, services, or energy from biological material as the main resource. This is strongly linked to sustainability as biodegradable resources are often used and waste is often completely designed out of the system. This can avoid the depletion of resources for future generations and protect the stability of the planet. The European Commission is taking steps towards a sustainable bioeconomy. Turning waste into valuable resources and creating incentives to help retailers and consumers cut food waste. The European Commission has a bioeconomy strategy</p>

Slide	Notes for teacher, comments and links
<div><div>Ecological limits</div><p>In addition to links to sustainability and climate change mitigation, it is critical that the bioeconomy operates within safe ecological limits.</p><p>With the new bioeconomy strategy, the European Commission supports initiatives at national and regional level to develop an efficient and sustainable bioeconomy and this includes:</p><ul style="list-style-type: none">• implementing an EU-wide monitoring system to track progress towards a sustainable and circular bioeconomy.• providing guidance on how best to operate the bioeconomy within safe ecological limits.</div>	<p>to promote the bioeconomy and avoid reaching ecological limits.</p> <p>European Commission (2018), <i>A sustainable Bioeconomy for Europe: strengthening the connection between economy, society and the environment. Updated Bioeconomy Strategy</i>. Directorate-General for Research and Innovation, available at: https://ec.europa.eu/research/bioeconomy/pdf/ec_bioeconomy_strategy_2018.pdf accessed: 22 May 2020].</p> <p>Notes to teacher: Explain that to try and tackle the issues surrounding ecological limits: National and international bodies have specific guidelines. An example of this is the European Commission's 2018 publication; 'A new bioeconomy strategy for a sustainable Europe.' Further information available at: https://ec.europa.eu/commission/news/new-bioeconomy-strategy-sustainable-europe-2018-oct-11-0_en</p> <p>Key reading: EC (2018), Bioeconomy: A new strategy for a sustainable Europe Restoring healthy ecosystems and enhancing biodiversity. European Commission https://ec.europa.eu/research/bioeconomy/pdf/ec_bioeconomy_actions_2018.pdf</p> <p>Could also check for more advanced reading: Giampietro, M. (2019). On the circular bioeconomy and decoupling: implications for sustainable growth. <i>Ecological economics</i>, 162, 143-156. https://www.sciencedirect.com/science/article/pii/S0921800918317178 Vivien, F. D., Nieddu, M., Befort, N., Debref, R., & Giampietro, M. (2019). The hijacking of the bioeconomy. <i>Ecological economics</i>, 159, 189-197. https://www.sciencedirect.com/science/article/abs/pii/S0921800918308115</p> <p>See slides "What is the Bioeconomy? Opportunities, challenges and solutions" for information on:</p> <ul style="list-style-type: none">- Bioeconomy – links to SDGs and climate change, and bioeconomy resources- The transition to a bioeconomy is complex- Biodiversity assessment- Direct, indirect and cumulative impacts- What are 'impacts and need for Environmental Impact Assessment (EIA) and/or Strategic Environmental Assessment (SEA).- Net positive outcomes, enhancement and the mitigation hierarchy- Example: the impacts of biofuels
<div><div>Links SDGs - Bioeconomy</div><p>Sustainable Development Goals are affected by bioeconomy activities</p><p>Some of the aims of the bioeconomy are complementary or even identical to SDG targets. A sustainable bioeconomy has the potential to advance several SDGs.</p><p>However, there can also be potential negative effects that should be eliminated or reduced. For example, "increased demand for land can lead to land grabbing, displacements, unequal distribution of land considering soil quality, and loss of communal land" (Heimann, 2019, p. 52)</p></div>	<p>This slide shows links between the bioeconomy and the SDGs.</p> <p>Heimann, T., 2019. Bioeconomy and SDGs: does the bioeconomy support the achievement of the SDGs?. <i>Earth's Future</i>, 7(1), pp.43-57.</p>


Slide	Notes for teacher, comments and links
 <p>The importance of the interactions between SDGs was emphasised in the UN's Global Sustainable Report for 2019.</p> <p>This figure is based on 65 global assessments comprising UN reports and international scientific assessments, as well as 112 scientific articles published since 2015 with explicit reference to the SDGs.</p> <p>This assessment reveals relative importance of the potential trade-offs by mapping the summed scores of influencing (horizontal) and influenced (vertical) interactions among SDGs. Figure also shows important gaps in knowledge where certain cells in the matrix are left blank.</p> <p>Source: Independent Group of Scientists appointed by the Secretary-General (2019), <i>Global Sustainable Development Report 2019: The Future is Now – Science for Achieving Sustainable Development</i>, (United Nations, New York). https://sustainabledevelopment.un.org/content/documents/24797GSDR_report_2019.pdf</p>  <p>Interactions among Sustainable Development Goals (SDGs)</p>	<p>Source: Independent Group of Scientists appointed by the Secretary-General (2019), <i>Global Sustainable Development Report 2019: The Future is Now – Science for Achieving Sustainable Development</i>, (United Nations, New York). https://sustainabledevelopment.un.org/content/documents/24797GSDR_report_2019.pdf</p>
 <p>SDG 1</p> <p>Goal 1: No Poverty</p>  <p>Aim: End poverty in all forms everywhere.</p> <p>Bioeconomy can contribute to the eradication of poverty while respecting local natural resources. Bioeconomy can be important to the poorest people by, for example, contributing to local economic development and livelihoods by creating new local jobs in cities and rural areas.</p>  <p>Source of image: https://www.un.org/sustainabledevelopment/sustainable-development-goals/</p>	<p>Manitoba Council for International Cooperation. (2018) <i>Sustainable Foundations: A Guide for Teaching the Sustainable Development Goals</i>. http://mcic.ca/pdf/SDG_Primer_FINAL.pdf</p> <p>Heimann, T., 2019. Bioeconomy and SDGs: does the bioeconomy support the achievement of the SDGs?. <i>Earth's Future</i>, 7(1), pp.43-57.</p> <p>Source of image: https://www.un.org/sustainabledevelopment/sustainable-development-goals/</p>
 <p>SDG 2</p> <p>Goal 2: Zero Hunger</p>  <p>Aim: End hunger, achieve food security and improved nutrition and promote sustainable agriculture.</p> <p>Bioeconomy can contribute to sustainable investments in agriculture, crops increase, utilization of undervalued resources for nutrition and improvement of food quality, indirectly contributing also to reducing food waste. For example, a spray produced using organic waste residues can make food stay fresh for longer.</p>  <p>https://apeelsciences.com/</p>	<p>Manitoba Council for International Cooperation. (2018) <i>Sustainable Foundations: A Guide for Teaching the Sustainable Development Goals</i>. http://mcic.ca/pdf/SDG_Primer_FINAL.pdf</p> <p>Heimann, T., 2019. Bioeconomy and SDGs: does the bioeconomy support the achievement of the SDGs?. <i>Earth's Future</i>, 7(1), pp.43-57.</p> <p>Source of image: https://apeelsciences.com/</p>
 <p>SDG 3</p> <p>Goal 3: Good health and well being</p>  <p>Aim: Ensure healthy lives and promote well-being for all at all ages.</p> <p>Bioeconomy can contribute to good health and well being by providing modern sources of probiotics and essential nutrients, and reducing air, water and soil pollution associated with hazardous fossil-based products. Plus it can integrate bioactive compounds, in food and health & cosmetic products, that may promote good health.</p>  <p>Source: Quimidroga S.A.</p>	<p>Manitoba Council for International Cooperation. (2018) <i>Sustainable Foundations: A Guide for Teaching the Sustainable Development Goals</i>. http://mcic.ca/pdf/SDG_Primer_FINAL.pdf</p> <p>Heimann, T., 2019. Bioeconomy and SDGs: does the bioeconomy support the achievement of the SDGs?. <i>Earth's Future</i>, 7(1), pp.43-57.</p> <p>Quimidroga (2019) Qd: Natural Cosmetics. https://www.quimidroga.com/en/2019/09/26/natural-cosmetics/</p> <p>Manitoba Council for International Cooperation. (2018) <i>Sustainable Foundations: A Guide for Teaching the Sustainable Development Goals</i>. http://mcic.ca/pdf/SDG_Primer_FINAL.pdf</p>
 <p>SDG 9</p> <p>Goal 9: Industries, Innovation and Infrastructure</p>  <p>Aim: Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation.</p> <p>Bioeconomy is important for this SDG as stimulates the growth of bio-based industry and innovation. For example, low-value solid wood waste can be converted into high purity intermediate building blocks of cellulosic sugars. These wood-based materials can be used to replace fossil-based materials in everyday applications, e.g., biofuels, coatings and bio-based foams.</p>  <p>Source: Researcher's report</p> <p>Source: photograph by wood-foam.com</p> <p>Source: wood-foam.com</p>	<p>European Coatings. (2020): EC Survey: Bio-based coatings. https://www.european-coatings.com/Raw-materials-technologies/Raw-materials/EC-Survey-Bio-based-coatings</p> <p>Novasep: services and technologies for life science and chemical industries. (2018): Purification processes for cellulosic sugars https://www.novasep.com/home/products-services/fermentation-products-and-chemicals-intermediates/industrial-processes/purification-processes-for-cellulosic-sugars.html</p> <p>Wood-based panels international. (2018) wbp: Wood foam – a product on the rise? http://www.wbpionline.com/features/wood-foam-a-product-on-the-rise-6097690/</p> <p>Bio-based Industries Consortium (2018), Bioeconomy and the UN Sustainable Development Goals. A view from the Bio-based Industries Consortium – July 2018.</p>

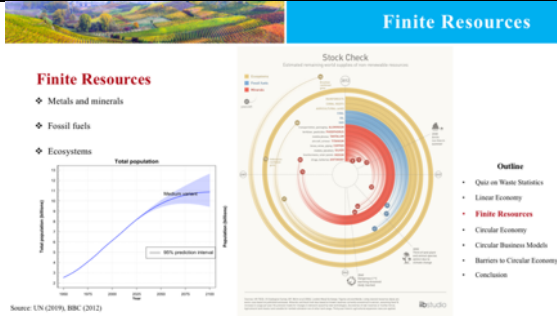
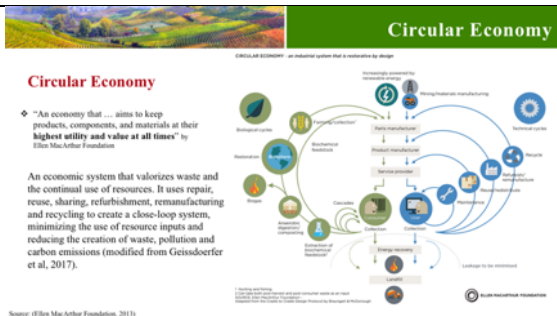

Slide	Notes for teacher, comments and links
 <p>SDG 11</p> <p>Goal 11: Sustainable cities and communities</p> <p>Aim: Making cities and human settlements inclusive, safe, resilient and sustainable.</p> <p>Bioeconomy can link rural and urban areas through bio-based products and bioenergy. It can contribute to sustainable cities and communities by using bio-based materials in new sustainable buildings. For example, the use of new filtration systems such as moss plantation. The surfaces of moss can remove dust, carbon dioxide and ozone from the air.</p>  <p><small>Source: Chris Giles, CNN [http://www.cnn.com/2017/04/26/tech/urban-plantations/index.html]</small></p>	<p>Manitoba Council for International Cooperation. (2018) Sustainable Foundations: <i>A Guide for Teaching the Sustainable Development Goals</i>. [http://mcic.ca/pdf/SDG_Primer_FINAL.pdf]</p> <p>Heimann, T., 2019. Bioeconomy and SDGs: does the bioeconomy support the achievement of the SDGs?. <i>Earth's Future</i>, 7(1), pp.43-57.</p> <p>Chris Giles (2017) Edition.CNN: This 'tree' has the environmental benefits of a forest. [Online] Available from: https://edition.cnn.com/style/article/citytree-urban-pollution/index.html</p>
 <p>SDG 12</p> <p>Goal 12: Responsible consumption and production</p> <p>Aim: Ensure sustainable consumption and production patterns.</p> <p>Bioeconomy can contribute to responsible consumption and production by decoupling production and consumption from use of fossil-based products. And instead using renewable resources and residues from everyday products to produce new products for a variety of sectors such as clothing, fashion and furniture. For example, leather made of mushrooms or a fabric made from waste milk.</p>  <p><small>Source: The World Economic Forum by WEF/SDGDavid Gray</small></p>	<p>Manitoba Council for International Cooperation. (2018) Sustainable Foundations: <i>A Guide for Teaching the Sustainable Development Goals</i>. [http://mcic.ca/pdf/SDG_Primer_FINAL.pdf]</p> <p>Heimann, T., 2019. Bioeconomy and SDGs: does the bioeconomy support the achievement of the SDGs?. <i>Earth's Future</i>, 7(1), pp.43-57.</p> <p>Anke Domaske. (2011)LS: N global: MILK MADE: DAIRY DRESS IS A NATURAL WINNER.[Online] Available from: https://www.lsnglobal.com/news/article/4921/milk-made-dairy-dress-is-a-natural-winner</p> <p>Tucker Bowe. (2018)Gear patrol: In the Future, Leather Will Be Made From Mushrooms Not Cows.[Online] Available from: https://gearpatrol.com/2018/04/16/bolt-threads-mylo-leather/</p>
 <p>SDG 13</p> <p>Goal 13: Climate action</p> <p>Aim: Take urgent action to combat climate change and its impact.</p> <p>Bioeconomy can replace fossil resources with renewable resources and using CO₂ as a feedstock and low-carbon production. For examples, the use of CO₂ as a feedstock to make key products such as building materials, chemicals and fuels. Billions of tons of CO₂ can be removed from the atmosphere every year and turned into commercially successful products.</p>  <p><small>Source: The World Economic Forum by WEF/SDGDavid Gray</small></p>	<p>Manitoba Council for International Cooperation. (2018) Sustainable Foundations: <i>A Guide for Teaching the Sustainable Development Goals</i>. [http://mcic.ca/pdf/SDG_Primer_FINAL.pdf]</p> <p>Heimann, T., 2019. Bioeconomy and SDGs: does the bioeconomy support the achievement of the SDGs?. <i>Earth's Future</i>, 7(1), pp.43-57.</p> <p>A Global Initiative for United Nations. (2019): Sustainable Development Report Dashboards 2019.[Online] Available from: https://dashboards.sdindex.org/#/</p> <p>The World Economic Forum. (2019): CO2 can be a valuable raw material, not just a climate killer. Here's how.: https://www.weforum.org/agenda/2019/01/turning-co2-from-climate-destroyer-into-useful-raw-material</p>
 <p>SDG 14</p> <p>Goal 14: Life below water</p> <p>Aim: Conserve and sustainably use the oceans, seas and marine resources for sustainable development.</p> <p>Bioeconomy (or Blue bioeconomy) can make better use of the marine fauna (fish) and flora (algae) for high value bio-products such as food/feed, cosmetics and bio-pharma. For example, can use fish, shellfish and seaweed residues to develop alternatives to fossil-based plastics. This way it can convert a waste stream into new plastic-like products, that are strong, organic, biodegradable and do not harm the environment.</p>  <p><small>Source: Reuters (Reuters)</small></p>	<p>Heimann, T., 2019. Bioeconomy and SDGs: does the bioeconomy support the achievement of the SDGs?. <i>Earth's Future</i>, 7(1), pp.43-57.</p> <p>Stuart McDill. (2019) Reuters: Tipping the scales? Briton develops fish waste 'plastic'. https://www.reuters.com/article/us-britain-dyson-award/tipping-the-scales-briton-develops-fish-waste-plastic-idUSKBN1X0007</p> <p>The James Dyson Award. (2019) MarinaTex: INTERNATIONAL WINNER. [Online] Available from: https://www.jamesdysonaward.org/2019/project/marinatex/</p> <p>Bio-based Industries Consortium (2018), Bioeconomy and the UN Sustainable Development Goals. A view from the Bio-based Industries Consortium – July 2018.</p>
 <p>SDG 15</p> <p>Goal 15: Life on land</p> <p>Aim: Sustainably management forests, combat desertification, halt and reverse land degradation, halt biodiversity loss.</p> <p>Bioeconomy promotes the value of biodiversity as a bioeconomy asset. It sees plants as a highly valuable resource for biomass, including biofuels. Sustainability, biodiversity and soil conservation are enabled by using natural resources sustainably according to the specific local conditions, preventing overexploitation and land degradation, and avoiding scarce resources. For example, olive leaves can be natural and environmentally friendly alternative tanning agents.</p> 	<p>Manitoba Council for International Cooperation. (2018) Sustainable Foundations: <i>A Guide for Teaching the Sustainable Development Goals</i>. [http://mcic.ca/pdf/SDG_Primer_FINAL.pdf]</p> <p>Biobased Industries Consortium, 2018. Bioeconomy and the UN Sustainable Development Goals. <i>Biobased Industries Consortium: Brussels, Belgium</i>.</p> <p>United Nations. (2015): <i>Sustainable Development Goals</i>. [Online] Available from: https://sustainabledevelopment.un.org/?menu=1300</p> <p>Source of image: https://www.herbal-supplement-resource.com/wp-content/uploads/2019/07/OliveLeaves2.jpeg</p>

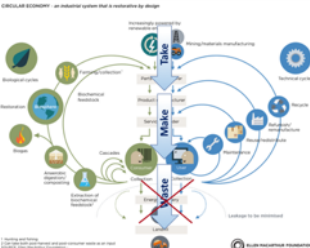

Annex IX - Power Point slides and notes on "Bioeconomy and Circular Economy"





Slide	Notes for teacher, comments and links
 <p>BE-Rural</p> <p>Key Principles of the Circular Economy and links to the Bioeconomy</p> <p>Name of presenter</p>	<p>Notes to the teacher: Teacher's name to go in the space at the bottom left of the slide. You can edit this slide to introduce the topic. This presentation is designed to introduce the circular economy concept. You can see the outline of the presentation in the next slide with the justifications on why the slides are structured the way they are.</p> <p>Most of the earlier slides up to slide number 12 should be quite basic and easy to understand. Starting from slide 13, the contents might be a little bit more challenging to grasp the concept and fully appreciate. Target audience can be secondary, high school students, colleges and university students.</p> <p>Excluding the video, this first slide and the outline slide, there are 26 slides – so these slides should take between 26 and 52 minutes to present, depending of amount of explanation. The video is 3 minutes and 48 seconds long.</p>
 <p>Outline</p> <ul style="list-style-type: none"> ◆ Quiz on Waste Statistics ◆ Linear Economy ◆ Finite Resources ◆ Circular Economy ◆ Circular Business Models ◆ Barriers to Circular Economy ◆ Conclusion 	<p>This slide shows the outline of the contents for this presentation on circular economy.</p> <ol style="list-style-type: none"> 1. It will start with a small quiz on waste statistics. There are four questions regarding food wastes, textile wastes, electronic wastes and plastic waste. 2. Then, linear economy would be introduced as one of the underlying problems causing these wastes. 3. Brief overview on finite resources would be provided to illustrate that the current linear system cannot be sustained. 4. Then, circular economy would be introduced as a system change to solve some of the pressing problems created by linear economy. 5. Five circular business models would be introduced as ways to incorporate circular economy in the way business operates. 6. Finally, barriers to circular economy would be introduced as to why the circular business models have yet to become mainstream business models. <p>The circular economy is considered as a system solution to tackle some of the most pressing global challenges created by a linear economy. Hence, it would be great if the learners know and understand first what the linear economy is, its associated problems, the underlying causes and future challenges before introducing the solution which is a circular economy. This way, the audience would fully appreciate the explanation of circular economy, its purpose, how it can be implemented and what is hindering its progress. The structure of the slides was designed based on this thought.</p> <p>Image used: https://uxplanet.org/the-rise-of-the-circular-economy-8fdcf0a18ca5</p>
 <p>Quiz on Wastes</p> <p>1. How much of the textile wastes is being landfilled or incinerated globally? (EMF, 2017)</p> <ol style="list-style-type: none"> a. One garbage truck equivalent every one hour b. One garbage truck equivalent every one minute c. One garbage truck equivalent every one second <p>Outline</p> <ul style="list-style-type: none"> ◆ Quiz on Waste Statistics ◆ Linear Economy ◆ Finite Resources ◆ Circular Economy ◆ Circular Business Models ◆ Barriers to Circular Economy ◆ Conclusion 	<p>This slide asks the first question of the quiz. Instead of giving away a few statistics, you can make the students think a little bit. This way, they would remember the figure better compared to just giving away the statistic. Hence, a quiz was chosen to highlight the statistics of four very common wastes (Fashion & textiles, electronic, food and plastic wastes) in our daily life, before introducing a linear economy. Correct answer is C. One garbage truck load of textile wastes every one second. Maybe you can make use of mentimeter to conduct the quiz in the class to make it more fun, interactive and engaging. If this is not an option, you can try to get all students to engage by asking for a show of hand for each option A, B or C, instead of waiting for just one student to voice out the answer.</p> <p>Key links for further information:</p> <p>This quiz is based on the information from the report called "A new textile economy: Redesigning fashion's future" by Ellen MacArthur Foundation, found in</p>





Slide	Notes for teacher, comments and links
 <p>Quiz on Wastes</p> <p>2. What is the approximate annual volume of global electronic wastes in 2016? (WEF, 2017)</p> <ol style="list-style-type: none"> 4.7 million tonnes (equivalent in weight of 450 Eiffel Towers) 44.7 million tonnes (equivalent in weight of 4,500 Eiffel Towers) 444.7 million tonnes (equivalent in weight of 45,000 Eiffel Towers)  <p>Outline</p> <ul style="list-style-type: none"> Quiz on Waste Statistics Linear Economy Finite Resources Circular Economy Circular Business Models Barriers to Circular Economy Conclusion 	<p>https://www.ellenmacarthurfoundation.org/publications/a-new-textiles-economy-redesigning-fashions-future</p> <p>Image Link: https://ichef.bbci.co.uk/news/976/cpsprodpb/49F7/production/_102753981_hm_soex0372.jpg</p> <p>This slide provides a second question of the quiz. This is based on electronic waste, which is also a very common waste in our daily lives. This quiz is based on the information from the report called “A New Circular Vision for Electronics: Time for a Global Reboot” by World Economic Forum, found in http://www3.weforum.org/docs/WEF_A_New_Circular_Vision_for_Electronics.pdf</p> <p>The answer is B – 44.7 million tonnes (4,500 Eiffel towers equivalent in weight)</p> <p>Image Link: https://upload.wikimedia.org/wikipedia/commons/thumb/2/2f/Skyscrapercompare-with-eiffel.svg/1200px-Skyscrapercompare-with-eiffel.svg.png https://content.internetretailing.net/AcuCustom/Sitenam/DAM/043/White_goods_scrap_AdobeStock_257612304.jpeg</p>
 <p>Quiz on Wastes</p> <p>3. What is the estimated annual volume of food waste globally? (FAO, 2011)</p> <ol style="list-style-type: none"> 1.3 billion tonnes (one-third of the food produced) 2 billion tonnes (half of the food produced) 2.6 billion tonnes (two-third of the food produced)  <p>Outline</p> <ul style="list-style-type: none"> Quiz on Waste Statistics Linear Economy Finite Resources Circular Economy Circular Business Models Barriers to Circular Economy Conclusion 	<p>This quiz is based on the information from the report called “Global Food Loss and Food Waste” by Food and Agriculture Organisations of the United Nations, found in http://www.fao.org/3/a-i2697e.pdf</p> <p>The answer is A – 1.3 billion tonnes (one-third of the food produced)</p> <p>Image Link: https://greenblueorg.s3.amazonaws.com/smm/wp-content/uploads/2017/05/Food-Scraps-1024x792.png https://www.adamsmith.org/blog/proof-perfect-that-supermarket-food-waste-is-not-a-problem</p>
 <p>Quiz on Wastes</p> <p>4. How much plastic waste is produced globally every year? Hint – It is close to the weight of entire human population. (UN Environment, 2015)</p> <ol style="list-style-type: none"> 200 million tonnes 300 million tonnes 500 million tonnes  <p>Outline</p> <ul style="list-style-type: none"> Quiz on Waste Statistics Linear Economy Finite Resources Circular Economy Circular Business Models Barriers to Circular Economy Conclusion 	<p>This slide is the final question of the quiz, based on plastic waste statistic. The answer is B. 300 million tonnes of plastic waste. These are four very common wastes in our daily lives – food waste, clothing and textile wastes, plastic wastes and electronic wastes. You can try to link it to the next slide on linear economy. Linear economy (the unsustainable production and consumption) is the cause of these wastes of precious resources.</p> <p>Key links for further information: Statistics was obtained from this interactive infographic on plastic waste statistics from UN Environment - https://www.unenvironment.org/interactive/beat-plastic-pollution/ Image link: https://www.packaging-gateway.com/wp-content/uploads/sites/2/2019/05/Plastic-waste-mountain.jpg Floating plastic bag - https://static1.squarespace.com/static/5a3798f32aeba55a92e8d1ee/5b6069a48a922d3f43c62e2c/5b714b0521c67c133d171761/1548083313212/_98802366_bigblue.00_44_51_12.still008.jpg?format=1500w</p>
 <p>Linear Economy</p> <ul style="list-style-type: none"> Take – Make – Waste In 2015, about 93 billion tons of virgin raw materials extracted annually (91% of resources used) Almost 70% resource use are from finite resources Only 9.3 billion tonnes (9%) are in the loop About 68% of input raw materials becomes unrecoverable waste and either landfilled or incinerated <p>Source: ©Circular Economy, cited in National Geographic, 2020</p> <p>© Circular Economy</p>	<p>This slide was included to link up to the challenging waste problems introduced earlier and to the circular economy solution which consider waste reduction as one of its principles in later slides. X-ray of the global economy was included to illustrate a linear economy concept and how waste is a big part of this system by providing statistics. You may spend longer time to explain the diagram as the text and figures are relatively small to properly see from the back of the class. Hence, you can point at the key figures and text on the diagram to make your points.</p> <p>You can explain the underlying cause of those wastes is due to the fact that we are operating in a linear system where we take the materials just out of the ground as if there is no limit, to make the products, just to throw them away when we no longer want.</p>

Slide	Notes for teacher, comments and links
	<p>This unsustainable production and consumption practices is fuelling the waste economy. You can explain the key figures circled in red.</p> <p>The image has small lettering but it can be displayed or printed in a larger format and can be the basis for a class discussion. It can also be deleted for a younger audience.</p> <p>Key links for further information: You may read a very good article where this diagram and information are extracted from in here: https://www.nationalgeographic.com/magazine/2020/03/how-a-circular-economy-could-save-the-world-feature/</p> <p>Image used: https://www.nationalgeographic.com/magazine/2020/03/how-a-circular-economy-could-save-the-world-feature/</p>
 <p>Linear Economy</p> <p>Problems of Linear Economy</p> <ul style="list-style-type: none"> ◆ Depletion of natural resources ◆ Environmental pollutions & climate change ◆ Damages caused to ecosystem & biodiversity ◆ Economic disadvantages 	<p>In this slide, you can talk about how the linear economy (take-make-waste system and mindset) is putting a strain on the finite natural resources because it assumes a constant supply of natural resources. The linear economy could be linked to a lot of environmental problems as well. All stages of “take-make-dispose” mindset affect ecosystem. Extraction and processing of raw materials and manufacturing of the products lead to high energy and water consumption, and disruption of the natural systems of forests and lakes. Emission of toxic substances, discharge of wastewater, and greenhouse gases during manufacturing harms the land, water bodies, the atmosphere. Eventually, when these products are discarded, the land space is taken up and the toxic substances are also leaked into the soil and some leaked into the waterways and the seas and oceans.</p> <p>All these negative environmental impacts have effect on both humans and animals – uncontrollable forest fires, frequent flooding, plastic soup in the oceans, plastic pollution impacts on animals, etc. Not just social or environmental impacts, it also have economic disadvantages - raw material price fluctuation, problems for those businesses with reliance on critical raw materials such as indium and chromium, interdependence of raw materials and global trade in such a way that scarcity of one material could have wide spread impacts on the prices and availability of other materials.</p> <p>Key links for further information: https://kenniskaarten.hetgroenebrein.nl/en/knowledge-map-circular-economy/ce-disadvantages-linear-economy/</p> <p>Links for Images used: CO2 emission: https://www.psychologicalscience.org/news/releases/polluted-air-may-pollute-our-morality.html Flood in Pakistan - https://cache.boston.com/resize/bonzai-fba/Globe_Photo/2010/07/30/1280548279_2291/539w.jpg Forest fire in Australia - https://cdn.cnn.com/cnnnext/dam/assets/191220111759-01-australia-bushfire-1219-super-169.jpg Plastic waste - https://sustyvibes.com/psp-operators-disdain-visionscapes-attempts-waste-management/ Plastic soup - https://www.dailymail.co.uk/news/article-5114157/Idyllic-Caribbean-island-ruined-rubbish.html Dead albatross full of plastics - https://www.nwf.org/Home/Magazines/National-Wildlife/2019/June-July/Conservation/Ocean-Plastic Tangled tortoise in fishing net - https://www.worldwildlife.org/initiatives/plastics Bird tangled in plastic bag - https://www.wwf.org.au/news/blogs/how-many-birds-die-from-plastic-pollution#gs.l2kr3d Dead kangaroo due to Australia fire - https://i.redd.it/a6f0ias9kg841.jpg</p>

Slide	Notes for teacher, comments and links
<div> <h3>Finite Resources</h3> <ul style="list-style-type: none"> Metals and minerals Fossil fuels Ecosystems  <p>Source: UN (2019), BBC (2012)</p>  <p>Stock Check</p> <p>Outline</p> <ul style="list-style-type: none"> State of World Resources Linear Economy Finite Resources Circular Economy Circular Business Models Barriers to Circular Economy Conclusion </div>	<p>Here, you can briefly explain about the finite resources such as metals, minerals, fossil fuels and ecosystems. At the same time, the population is growing and it is expected to grow by another 2 billions by 2050 (graph on the left). There is also a growing middle class population which is the major contributor to the throwaway culture. More population means more demands for products, hence more extraction of raw materials and more production. However, the resources are depleting. You can take a few examples from the stock check graph and their respective remaining years to explain to the students. Try to spend some time to explain the stock check graph as the texts are small for the students to see properly. Even though the figures could not be exact, the main point you want to highlight is that the stock is decreasing and unlikely to be able to sustain the demand of a growing population. The “Stock Check” image has small lettering but it can be displayed or printed in a larger format and can be the basis for a class discussion.</p> <p>Links for images used: Stock check - https://www.bbc.com/future/article/20120618-global-resources-stock-check Population growth - https://population.un.org/wpp/Graphs/DemographicProfiles/Line/900 https://population.un.org/wpp/Graphs/1_Demographic%20Profiles/World.pdf</p>
<div> <h3>Circular Economy</h3> <p>“An economy that ... aims to keep products, components, and materials at their highest utility and value at all times” by Ellen MacArthur Foundation</p> <p>An economic system that valorizes waste and the continual use of resources. It uses repair, reuse, sharing, refurbishment, remanufacturing and recycling to create a close-loop system, minimizing the use of resource inputs and reducing the creation of waste, pollution and carbon emissions (modified from Geissdoerfer et al, 2017).</p>  <p>Source: (Ellen MacArthur Foundation, 2015)</p> </div>	<p>This slide introduces the circular economy. Circular economy concept has become more popular during the past decade, as the system solution to some of the most pressing problems of the linear economy. You can read up the report provided in the link below to understand more about the circular economy and the butterfly diagram mentioned here. The butterfly diagram is extremely important. It does have small lettering but it can be displayed or printed in a larger format and can be the basis for a class discussion. The picture on the right is the butterfly diagram to illustrate how technological and biological nutrient-based products and materials cycle through the system in the circular economy. The products, components and materials are kept in the economy through repair, reuse, remanufacturing and recycling, where recycling is the least preferable.</p> <ul style="list-style-type: none"> Power of inner circle - On the technical side, the tighter the circles are, the larger the savings should be in the embedded costs in terms of material, labour, energy, capital and of the associated externalities such as GHG emissions, water or toxic substances. Power of circling longer - A second core value creation potential stems from keeping products, components, and materials in use longer within the circular economy, through consecutive cycles or by spending more time within a cycle. Power of cascaded uses (on biological side) - In the cascades, the arbitrage value creation potential is rooted in the lower marginal costs of reusing the cascading materials as a substitute for virgin material inflows and their embedded costs (labour, energy, material) as well as externalities against the marginal costs of bringing the material back into a repurposed use. <p>Key links for further information: https://www.ellenmacarthurfoundation.org/assets/downloads/publications/Ellen-MacArthur-Foundation-Towards-the-Circular-Economy-vol.1.pdf Geissdoerfer, M., Savaget, P., Bocken, N., Hultink, E. (2017). The Circular Economy – A new sustainability paradigm?. <i>Journal of Cleaner Production</i>, 143 (1), 757-768.</p> <p>Images used: Ellen MacArthur Foundation</p>


Slide	Notes for teacher, comments and links
<div>  <p>Circular Economy</p> <p>Principles of Circular Economy</p> <ol style="list-style-type: none"> 1. Design out waste and pollution 2. Keep products and materials in use 3. Regenerate natural systems <p>Source: Ellen MacArthur Foundation</p> </div>	<p>Notes to teacher on how to present slide</p> <p>This slide introduces three CE Principles and their relevant explanations below are extracted from EMF to give further information and assist understanding.</p> <ol style="list-style-type: none"> 1. Design out waste – A circular economy reveals and designs out the negative impacts of economic activity that cause damage to human health and natural systems. This includes the release of greenhouse gases and hazardous substances, the pollution of air, land, and water, as well as structural waste such as traffic congestion. The biological and technical components (or nutrients) to make the products, and the products are designed by intention to fit within a biological or technical materials cycle, designed for disassembly and refurbishment. Technical nutrients—polymers, alloys, and other man-made materials are designed to be used again with minimal energy and highest quality retention. (whereas recycling as commonly understood results in a reduction in quality and feeds back into the process as a crude feedstock). The biological nutrients are non-toxic and can be simply composted. 2. Keep products and materials in use – A circular economy favours activities that preserve value in the form of energy, labour, and materials. This means designing for durability, reuse, remanufacturing, and recycling to keep products, components, and materials circulating in the economy. Circular systems make effective use of bio-based materials by encouraging many different uses for them as they cycle between the economy and natural systems. 3. Regenerate natural system – A circular economy avoids the use of non-renewable resources and preserves or enhances renewable ones, for instance by returning valuable nutrients to the soil to support regeneration, or using renewable energy as opposed to relying on fossil fuels. <p>Key links for further information:</p> <p>Link for more information - https://www.ellenmacarthurfoundation.org/explore/the-circular-economy-in-detail https://www.ellenmacarthurfoundation.org/assets/downloads/publications/Ellen-MacArthur-Foundation-Towards-the-Circular-Economy-vol.1.pdf Mayumi, K., Giampietro, M. (2019). Reconsidering “Circular Economy” in terms of irreversible evolution of economic activity. <i>Romanian Journal of Economic Forecasting</i>, 22(2): 197-207.</p> <p>Images used: Ellen MacArthur Foundation</p>
<div>  <p>Rethinking Progress: The Circular Economy</p> <p>♦ Short video (3:48 minutes) by Ellen MacArthur Foundation</p> <p>Video Link: https://www.youtube.com/watch?v=zCRKvDyyHml</p> <p>Outline</p> <ul style="list-style-type: none"> • Quiz on Waste Statistics • Linear Economy • Finite Resources • Circular Economy • Circular Business Models • Barriers to Circular Economy • Conclusion </div>	<p>This video was published by Ellen MacArthur Foundation. This is a very good video that explains a linear economy, the problems of a linear economy, a circular economy, what inspires the circular economy concept, what the circular business models are like and how they could be implemented in real world. This would be a very inspiring video for your students. After watching the video together with the students, you can ask a few questions to discuss with the students. For example, what problems of a linear economy can you identify in their daily life or at home? What other negative impacts does the linear economy have apart from a waste of resources? The video introduces about licensing a washing machine for use at home instead of buying, other other products can you imagine using in this model?</p> <p>Key links for further information:</p> <p>Video Link: https://www.youtube.com/watch?v=zCRKvDyyHml</p>

Slide	Notes for teacher, comments and links
<div>  Circular Business Models </div> <div> Five Circular Business Models </div> <div> 1. Circular Supplies </div> <div> <ul style="list-style-type: none"> ❖ Replace conventional virgin raw materials inputs with bio-based, renewable, recyclable OR biodegradable materials ❖ Reduce pressures on limited virgin raw materials ❖ E.g. Vollebak produces T-shirt made from pulped eucalyptus, beech and algae which biodegrade in 12 weeks </div> <div>  </div> <div> Outline <ul style="list-style-type: none"> • Quiz on Waste Statistics • Linear Economy • Finite Resources • Circular Economy • Circular Business Models • Barriers to Circular Economy • Conclusion </div> <div> <small>Source: Accenture (2014), OECD (2018)</small> </div>	<p>This slide introduces the first circular business model which is circular supplies. Circular Supplies: this business models basically tries to replace traditional single-lifecycle inputs / virgin raw materials inputs with bio-based materials which are fully renewable, recyclable or biodegradable. Hence, it aims to reduce demand for virgin resource extraction in the long run. Only one example is provided here as there are more company examples adopting this business cycle in the workshop materials.</p> <p>Company example – this company Vollebak makes biodegradable t-shirt made from pulped eucalyptus, beech from sustainably managed forests and algae grown in bioreactors. The t-shirt is fully biodegradable in just 12 weeks. It solves the waste problem, the reliance on fossil fuels for petrochemicals to make synthetic fibres.</p> <p>Key links for further information: https://www.accenture.com/t20150523t053139_w_us-en/_acnmedia/accenture/conversion-assets/dotcom/documents/global/pdf/strategy_6/accenture-circular-advantage-innovative-business-models-technologies-value-growth.pdf https://thecirculars.org/content/resources/Accenture-Waste-Wealth-Exec-Sum-FINAL.pdf https://www.oecd.org/environment/waste/policy-highlights-business-models-for-the-circular-economy.pdf</p> <p>For case study company example: https://www.vollebak.com/product/plant-and-algae-t-shirt/ Image used: https://dyk8bhziatzfed.cloudfront.net/wp-content/uploads/2019/08/plant-and-algae-t-300-1376-1376x776.jpg</p>
<div>  Circular Business Models </div> <div> Five Circular Business Models </div> <div> 2. Resource Recovery and Recycling </div> <div> <ul style="list-style-type: none"> ❖ Recover and reuse of resources or energy from discarded wastes or by-products ❖ Valorise wastes and by-products by giving a second life and by reusing them to make a new product ❖ E.g. Toast Ale - Bread waste to Beer </div> <div>  </div> <div> Outline <ul style="list-style-type: none"> • Quiz on Waste Statistics • Linear Economy • Finite Resources • Circular Economy • Circular Business Models • Barriers to Circular Economy • Conclusion </div> <div> <small>Interesting, in Latvia (and also Poland) traditionally bread was processed into "kvass" (a drink similar to beer, still quite popular in Latvia, Poland and some other Eastern European countries). Which shows that looking for innovation is often worth returning to tradition.</small> </div>	<p>This slide introduce a second business model. Resource recovery and recycling models basically reuse the resources and energy from waste materials or by-products of other industry. Industrial symbiosis is a good example for this model. Hence, this material diverts wastes from landfills, where they have been normally disposed off. It also displace the extraction and processing of virgin natural resources. It valorise the waste and by-products by giving a second life. Normally, these inputs are being repurposed or transformed to a totally different type of products.</p> <p>Case example: Toast Ale - In UK alone, about 44% of all bread produced was thrown away into bin. In order to tackle food waste problem, this UK company collects the bread waste from bakeries, delis and so on to divert them from landfills and give a second life as a beer. These surplus breads can be incorporated into the normal brewing processes together with the usual ingredients of malted barley, hops, yeast and water without the need for any new technology, by simply replacing up to one third of the required malted barley amount.</p> <p>Key links for further information: https://www.accenture.com/t20150523t053139_w_us-en/_acnmedia/accenture/conversion-assets/dotcom/documents/global/pdf/strategy_6/accenture-circular-advantage-innovative-business-models-technologies-value-growth.pdf https://thecirculars.org/content/resources/Accenture-Waste-Wealth-Exec-Sum-FINAL.pdf https://www.oecd.org/environment/waste/policy-highlights-business-models-for-the-circular-economy.pdf</p> <p>For case study company example: https://www.ellenmacarthur-foundation.org/case-studies/brewing-beer-from-surplus-bread https://www.toastale.com</p> <p>Image used: https://www.iamrenew.com/wp-content/uploads/2019/07/Toast-Ale-Banner.jpg</p>

Slide	Notes for teacher, comments and links
<div>  <div>Circular Business Models</div> </div> <div> Five Circular Business Models </div> <div> 3. Product Life Extension </div> <div> <ul style="list-style-type: none"> Extend working lifecycle of the existing products by repairing, upgrading, remanufacturing and reselling Slows the resource extraction, flow of materials through economy and waste generation For example, Kaiyo repairs and resell the unwanted furniture to new buyers and share profit with previous owners </div> <div>  </div> <div> Outline <ul style="list-style-type: none"> Quiz on Waste Statistics Linear Economy Finite Resources Circular Economy Circular Business Models Barriers to Circular Economy Conclusion </div> <div> <small>Source: Accenture (2014), OECD (2018)</small> </div>	<p>This third model extends the productive lifetime of the products and components by repairing, remanufacturing, upgrading and reselling. Hence, it slows the flow of constituent materials through the economy, and reduce the rate of resource extraction and waste generation.</p> <p>Company example: Kaiyo is an online marketplace that aims to save the unwanted high-quality durable furniture from landfills and keep them in productive use for as long as possible. This platform allows the owners, workers or students on the move who no longer want some pieces of their furniture to recoup some values, instead of simply disposing which could also be costly. The furniture owners could contact Kaiyo who will review the furniture, collect it from the owner, clean and repair if necessary, list it on the website, store it in their warehouses for free of charge until it sells and deliver them to the buyers. Kaiyo will be responsible for all the necessary work to get the most value out of the unwanted furniture and it pays the donors a commission of up to 40% once items are sold.</p> <p>Key links for further information: More information on the description and explanation of this business model could be found in: https://www.accenture.com/t20150523t053139__w_/us-en/_acnmedia/accenture/conversion-assets/dotcom/documents/global/pdf/strategy_6/accenture-circular-advantage-innovative-business-models-technologies-value-growth.pdf https://thecirculars.org/content/resources/Accenture-Waste-Wealth-Exec-Sum-FINAL.pdf https://www.oecd.org/environment/waste/policy-highlights-business-models-for-the-circular-economy.pdf</p> <p>For case study company example: https://www.ellenmacarthurfoundation.org/case-studies/the-final-stop-for-quality-furniture https://kaiyo.com/how-it-works#do-you-allow-local-pickups</p> <p>Image used: https://moneydotcomvip.files.wordpress.com/2019/09/aklnwpu_a.jpeg?quality=85</p>
<div>  <div>Circular Business Models</div> </div> <div> Five Circular Business Models </div> <div> 4. Sharing Economy </div> <div> <ul style="list-style-type: none"> Enable sharing of under-utilised products and assets Reduce demand for new products and raw materials input For example, Spinlister - a peer-to-peer sharing platform that allows bike owners to list their bikes available for renting and renters to search for a bike to rent in whatever area they are in. </div> <div>  </div> <div> Outline <ul style="list-style-type: none"> Quiz on Waste Statistics Linear Economy Finite Resources Circular Economy Circular Business Models Barriers to Circular Economy Conclusion </div> <div> <small>Source: Accenture (2014), OECD (2018)</small> </div>	<p>Sharing Platforms helps increased utilization rate of less-frequently-used products by making possible shared use/access/ownership. Hence, it eliminates the need to buy more products and therefore reduce demand for new products and their embedded raw materials.</p> <p>Case example: Spinlister is a peer-to-peer sharing platform that allows bike owners to list their bikes available for renting and renters to search for a bike to rent in whatever area they are in by city, zip code, available date and ride types. Its primary market is bikes with listing in 63 countries. However, they are also expanding into other markets, enabling sharing of surfboards, Stand up Paddle boards (SUPs), ski equipment and snowboards etc. The company also offers coverages for damages and theft protection in selected areas for a fee.</p> <p>Key links for further information: More information on the description and explanation of this business model could be found in: https://www.accenture.com/t20150523t053139__w_/us-en/_acnmedia/accenture/conversion-assets/dotcom/documents/global/pdf/strategy_6/accenture-circular-advantage-innovative-business-models-technologies-value-growth.pdf https://thecirculars.org/content/resources/Accenture-Waste-Wealth-Exec-Sum-FINAL.pdf https://www.oecd.org/environment/waste/policy-highlights-business-models-for-the-circular-economy.pdf</p> <p>Image used: https://www.netted.net/wp-content/uploads/sites/14/2015/02/Spinlister_1000x563_2.6.15.png</p>

Slide

Notes for teacher, comments and links




Circular Business Models

Five Circular Business Models

5. Product as a Service

- Offer product access services and retain ownership of the products
- Customers don't need to buy but use it through lease or pay-per-use arrangements
- Promotes sparing use of natural resources
- For example, Philips provides 'pay-per-lux' lighting services to the business customers who wants to purchase light, but not the associated lighting infrastructure.



Outline

- Q1 on Waste Statistics
- Linear Economy
- Finite Resources
- Circular Economy
- Circular Business Models**
- Barriers to Circular Economy
- Conclusion


Source: Accenture (2014), OECD (2015)

This is product service system models, where services rather than products are marketed, improve incentives for green product design and more efficient product use, thereby promoting a more sparing use of natural resources. Customers do not need to spend upfront cost to purchase the products they might use very rarely, instead they can lease them through subscription or one-off rental arrangement.

Case example: Philips provides 'pay-per-lux' lighting services to the business customers who wants to purchase light, but not the associated lighting infrastructure. Philips retains the ownership and is responsible for designs, installation, operation, monitoring, maintenance, upgrades and recovery throughout the lifecycle. It incorporates the use of the natural light resources in a more effective way, motion sensor and LED lighting technology with better performance, longer life and energy efficiency. Customers do not need to invest upfront and own the lighting infrastructure which eventually needs to be discarded for replacement. Instead, they just need to pay for the optimal amount of light they require and use. This arrangement could also result in receiving better services, as the light provider has incentives to provide long-lasting lighting infrastructure.

Key links for further information:
More information on the description and explanation of this business model could be found in:
https://www.accenture.com/t20150523t053139_w_/us-en/_acnmedia/accenture/conversion-assets/dotcom/documents/global/pdf/strategy_6/accenture-circular-advantage-innovative-business-models-technologies-value-growth.pdf
<https://thecirculars.org/content/resources/Accenture-Waste-Wealth-Exec-Sum-FINAL.pdf>
<https://www.oecd.org/environment/waste/policy-highlights-business-models-for-the-circular-economy.pdf>


Images used:
[https://johnlewis.scene7.com/is/image/JohnLewis/237006205?\\$rsp-plp-port-320\\$](https://johnlewis.scene7.com/is/image/JohnLewis/237006205?$rsp-plp-port-320$)



Circular Business Models

Five Circular Business Models

- Circular Supplies (renewable bio-based inputs)
- Resource Recovery and Recycling (wastes, by-products, industrial symbiosis)
- Product Life Extension (reuse, repair, remanufacturing, etc)
- Sharing Platforms
- Product as a service



Outline



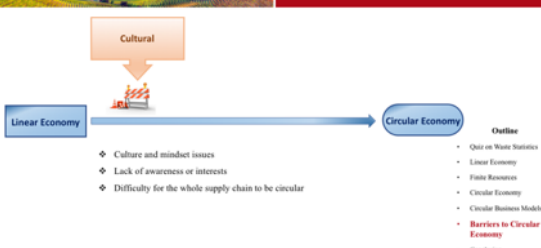

- Q1 on Waste Statistics
- Linear Economy
- Finite Resources
- Circular Economy
- Circular Business Models**
- Barriers to Circular Economy
- Conclusion


Source: Adapted from Accenture (2015) and OECD (2015)

You can provide the summary of what you have talked about so far on 5 circular business models. You can explain that first and second models are linked to bioeconomy as well, since circular supplies primarily use bio-based renewable inputs and the waste/ by products for recovery and recycling models could be from forestry, agriculture or fishery. All these models try to reduce the pressures on the limited virgin resources, hence less need for extraction of new finite resources and also try to eliminate the waste generation.

So distinction between circular various circular business models could be clear in theory. However, it is not very clear cut in reality. Some companies adopt a combinations of business models. For example, in product as a service system, the company retains the ownership of the products, which they could repair and remanufacture at some points in the future. You should also explain that circular business models operate in different parts of value chain. You can explain about where each of those business models could occur along the value chain as per the diagram. Circular business models, by closing resource loops and by slowing and narrowing resource flows, can reduce the environmental footprint of economic production and consumption.




Key links for further information:
<https://www.oecd.org/environment/waste/policy-highlights-business-models-for-the-circular-economy.pdf>
Image used: <https://www.oecd.org/environment/waste/policy-highlights-business-models-for-the-circular-economy.pdf>

Slide	Notes for teacher, comments and links
<p>What is the bioeconomy?</p> <p>The Bioeconomy...</p> <ul style="list-style-type: none"> Is the production of goods, services, or energy from biological material as the main resource. Is strongly linked to sustainability as biodegradable resources are often used and waste is often completely designed out of the system. Can avoid the depletion of resources for future generations and protect the stability of the planet. <p>European Bioeconomy Strategy</p> <p>The European Commission is taking steps towards a sustainable bioeconomy and has a bioeconomy strategy to promote the bioeconomy and to avoid reaching ecological limits.</p> 	<p>Notes to teacher: Explain to class that in order to take steps towards sustainability and the avoidance of reaching ecological limits the bioeconomy is very important. The bioeconomy is the production of goods, services, or energy from biological material as the main resource. This is strongly linked to sustainability as biodegradable resources are often used and waste is often completely designed out of the system. This can avoid the depletion of resources for future generations and protect the stability of the planet. The European Commission is taking steps towards a sustainable bioeconomy. Turning waste into valuable resources and creating incentives to help retailers and consumers cut food waste. The European Commission has a bioeconomy strategy to promote the bioeconomy and avoid reaching ecological limits. European Commission (2018), <i>A sustainable Bioeconomy for Europe: strengthening the connection between economy, society and the environment. Updated Bioeconomy Strategy</i>. Directorate-General for Research and Innovation, available at: https://ec.europa.eu/research/bioeconomy/pdf/ec_bioeconomy_strategy_2018.pdf accessed: 22 May 2020].</p>
<p>Barriers to Circular Economy</p>  <p>Source: Kirchherr, et al (2017)</p>	<p>Here in this slide, you can explain that although there are a lot of benefits of the circular economy, this system has not been widely adopted yet. You can introduce 4 types of barriers. The following four slides will provide a few examples for each category of barriers to explain further.</p> <p>Key links for further information: Breaking the Barriers to the Circular Economy Research conducted by Deloitte and Utrecht University https://www2.deloitte.com/nl/nl/pages/risk/articles/breaking-the-barriers-to-the-circular-economy.html Kirchherr, J., Piscicelli, L., Bour, R., Kostense-Smit, E., Muller, J., Huibrechtse-Truijens, A., Hekkert, M.P. (2018): Barriers to the Circular Economy: Evidence From the European Union (EU). <i>Ecological Economics</i>, 150: 264-272.</p>
<p>Barriers to Circular Economy</p> <p>Cultural</p>  <p>Source: Kirchherr, et al (2017)</p>	<p>This slide provide examples of cultural barriers towards circular economy. You may read the two reports mentioned below to gain more understanding to explain to your students.</p> <p>Key links for further information: Same as slide above</p>
<p>Barriers to Circular Economy</p> <p>Technological</p>  <p>Source: Kirchherr, et al (2017)</p>	<p>This slide provide examples of technological barriers towards circular economy. You may read the two reports mentioned below to gain more understanding to explain to your students.</p> <p>Key links for further information: Same as slides above</p>

Slide	Notes for teacher, comments and links
 <p>Barriers to Circular Economy</p> <ul style="list-style-type: none"> ❖ Lack of economic viability ❖ Low price of virgin materials ❖ High upfront investment costs ❖ Steep learning curves ❖ Limited funding <p>Linear Economy → Circular Economy</p> <p>Market</p> <p>Source: Kirchherr, et al (2017)</p>	<p>This slide provides examples of market barriers towards circular economy. You may read the two reports mentioned below to gain more understanding to explain to your students.</p> <p>Key links for further information: Same as slides above</p>
 <p>Barriers to Circular Economy</p> <ul style="list-style-type: none"> ❖ Lack of policies to support circular economy transition ❖ Obstructing laws and regulations ❖ Limited circular procurement ❖ Lack of global consensus <p>Linear Economy → Circular Economy</p> <p>Regulatory</p> <p>Source: Kirchherr, et al (2017)</p>	<p>This slide provides examples of regulatory barriers towards circular economy. You may read the two reports mentioned below to gain more understanding to explain to your students.</p> <p>Key links for further information: Same as slides above</p>
 <p>Conclusion</p> <ul style="list-style-type: none"> ❖ What is the Circular Economy ❖ Three Principles of Circular Economy ❖ Five Circular Business Models ❖ Four Barriers to Transition to Circular Economy <p>LINEAR ECONOMY</p> <p>CIRCULAR ECONOMY</p> <p>Outline:</p> <ul style="list-style-type: none"> • Quiz on Waste Statistics • Linear Economy • Finite Resources • Circular Economy • Circular Business Models • Barriers to Circular Economy • Conclusion 	<p>You can give a summary of the key points you have covered to conclude the presentation.</p> <p>Image used: https://community.materialtrader.com/cms/wp-content/uploads/2019/02/linear-vs-recycling-vs-circular-economy-doodle.jpg</p>
 <p>Questions and Discussion</p>	<p>Notes to the teacher: Speaker's name to go in the space at the bottom left of the slide. This is the final slide of the presentation. Allow time for students/participants to ask any questions.</p>
 <p>BE-Rural</p> <p>These educational resources were developed as part of the BE-Rural project</p> <p>Bio-based strategies and roadmaps for enhanced rural and regional development in the EU (April 2019 – March 2022)</p> <p>BE-Rural supports</p> <p>... regional stakeholders in five countries:</p> <ul style="list-style-type: none"> • Latvia: Vidzeme and Kurzeme • Poland: Szczecin and Vistula Lagoons • Romania: Covasna • Bulgaria: Stara Zagora • North Macedonia: Strumica <p>https://be-rural.eu/innovation-regions/</p> <p>The goal of BE-Rural is to realise the potential of regional bio-based economies by supporting relevant actors in the participatory development of bioeconomy strategies and roadmaps</p>	<p>BE-Rural will create five regional Open Innovation Platforms (OIPs) for the participatory development of bioeconomy strategies and roadmaps.</p> <p>Stara Zagora, Bulgaria: focus on seeking new technologies for the application of essential oils and herbal plants in the cosmetics and pharmaceutical industry.</p> <p>Vidzeme and Kurzeme, Latvia: will focus on the potential of by-products of forest management (i.e. from young forest stand thinning, short rotation coppice and forestry plantations, removing of overgrowth in abandoned agricultural lands and perennial grasses) as a source of bioenergy or biorefinery.</p> <p>Strumica, North Macedonia: focus on the utilization of agricultural residues, specifically the by-production of organic materials from agricultural activities, as a source of energy for domestic and industrial purposes.</p> <p>Szczecin Lagoon and Vistula Lagoon, Poland: focus on small-scale fisheries, specifically on the sustainable use of currently underused & low-value fish species located in 2 lagoons.</p> <p>Covasna, Romania: focus on addressing fragmented value chains and implementing the circular economy concept within the county's industrial sectors (i.e. wood and furniture, textiles, agro-food, mechanical engineering, green energy).</p> <p>Source: BE-Rural (2020), <i>Innovation regions</i>, available at: https://be-rural.eu/innovation-regions/</p>





Annex X- Power Point slides and notes on "Bioeconomy in agriculture sector "

Slide	Notes for teacher, comments and links
 <div style="background-color: #008000; color: white; padding: 10px; text-align: center;"> <h3>Agriculture and the Bioeconomy</h3>  <p>Name of presenter</p> </div>	<p>Notes to the teacher: Teacher's name to go in the space at the bottom left of the slide. Explain that this presentation will look at the relationship between the bioeconomy and agriculture, and specifically how agricultural residues can be utilised to aid both environmental and societal goals. Excluding the this first slide, outline slide and the video, there are 11 slides – so these slides should take between 11 and 22 minutes to present, depending of amount of explanation. The video is 2 minutes and 52 seconds long.</p>
 <div style="background-color: #008000; color: white; padding: 10px;"> <h3>Outline</h3> <ul style="list-style-type: none"> - Bioeconomy overview – what it is, ecological limits and challenges - Agriculture feedstock - Agriculture = A plethora of biological resources - Why is the bioeconomy important for agriculture? - Agriculture and SDGs - Agri-derived Bio based products - Biofuels from waste straw - T-Shirts made with waste milk - Paper from cocoa beans shells - Grass Fed Mobile Biorefinery - Impacts of biofuels - Video: bioeconomy in a rural setting </div>	<p>Notes to the teacher: Briefly run through the topics that will be spoken about in this presentation as shown on the slide.</p>
 <div style="background-color: #FFA500; color: white; padding: 5px; text-align: center;"> <h3>Bioeconomy overview</h3> </div> <div style="display: flex; justify-content: space-between; padding: 10px;"> <div style="width: 45%;"> <h4>The Bioeconomy...</h4> <ul style="list-style-type: none"> Is the production of goods, services, or energy from biological material as the main resource. Is strongly linked to sustainability as biodegradable resources are often used and waste is often completely designed out of the system. Can avoid the depletion of resources for future generations and protect the stability of the planet. </div> <div style="width: 45%;"> <h4>European Bioeconomy Strategy</h4> <p>The European Commission is taking steps towards a sustainable bioeconomy and has a bioeconomy strategy to promote the bioeconomy and to avoid reaching ecological limits.</p>  </div> </div>	<p>Notes to teacher: Explain to class that in order to take steps towards sustainability and the avoidance of reaching ecological limits the bioeconomy is very important. The bioeconomy is the production of goods, services, or energy from biological material as the main resource. This is strongly linked to sustainability as biodegradable resources are often used and waste is often completely designed out of the system. This can avoid the depletion of resources for future generations and protect the stability of the planet. The European Commission is taking steps towards a sustainable bioeconomy. Turning waste into valuable resources and creating incentives to help retailers and consumers cut food waste. The European Commission has a bioeconomy strategy to promote the bioeconomy and avoid reaching ecological limits. European Commission (2018), <i>A sustainable Bioeconomy for Europe: strengthening the connection between economy, society and the environment. Updated Bioeconomy Strategy</i>. Directorate-General for Research and Innovation, available at: https://ec.europa.eu/research/bioeconomy/pdf/ec_bioeconomy_strategy_2018.pdf accessed: 22 May 2020].</p>
 <div style="background-color: #0000FF; color: white; padding: 5px; text-align: center;"> <h3>Bioeconomy overview</h3> </div> <div style="background-color: #FFA500; color: white; padding: 10px; text-align: center;"> <h4>Bioeconomy and Circular Economy – waste is a valuable resource</h4> <div style="display: flex; justify-content: space-around; align-items: center;"> <div style="text-align: center;">  <p><small>Video (2 minutes and 9 seconds): https://www.youtube.com/watch?v=RfRN_hHelKk Languages for sub-titles for video include: Bulgarian, Latvian, Macedonian, Polish and Romanian</small></p> </div> <div style="text-align: center;">  <p>Moving towards a circular economy</p> </div> </div> </div>	<p>1. Explain bioeconomy to introduce topic and contextualise bioproducts portfolio.</p> <p>Bioeconomy is defined as the production, utilization and conservation of biological resources to provide information, products, processes and services across all economic sectors aiming towards a sustainable economy (Bell et al., 2018). Bell, J., Paula, L., Dodd, T., Németh, S., Nanou, C., Mega, V. and Campos, P. (2018). EU ambition to build the world's leading bioeconomy—Uncertain times demand innovative and sustainable solutions. <i>New Biotechnology</i>, 40: 25–30.</p> <p>Video (2 minutes and 9 seconds): https://www.youtube.com/watch?v=RfRN_hHelKk Languages for sub-titles for video include: Bulgarian, Latvian, Macedonian, Polish and Romanian</p> <p>2. Explain circular economy to give context to bioproducts.</p> <p>Circular Economy is a framework for the development and management of sustainable, waste-as-resource economic system. It aims to keep products, components and materials at the highest utility and value at all times (EC, 2018).</p>

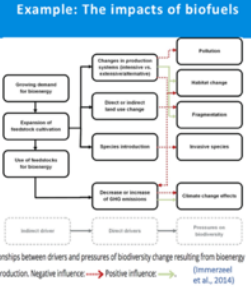
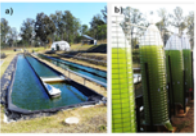



Slide	Notes for teacher, comments and links
 <p>Ecological limits</p> <p>In addition to links to sustainability and climate change mitigation, it is critical that the bioeconomy operates within safe ecological limits.</p> <p>With the new bioeconomy strategy, the European Commission supports initiatives at national and regional level to develop an efficient and sustainable bioeconomy and this includes:</p> <ul style="list-style-type: none"> • implementing an EU-wide monitoring system to track progress towards a sustainable and circular bioeconomy. • providing guidance on how best to operate the bioeconomy within safe ecological limits. 	<p>European Commission (2018), <i>A sustainable Bioeconomy for Europe: strengthening the connection between economy, society and the environment. Updated Bioeconomy Strategy</i>. Directorate-General for Research and Innovation, available at: https://ec.europa.eu/research/bioeconomy/pdf/ec_bioeconomy_strategy_2018.pdf</p> <p>Notes to teacher: Explain that to try and tackle the issues surrounding ecological limits: National and international bodies have specific guidelines. An example of this is the European Commission's 2018 publication; 'A new bioeconomy strategy for a sustainable Europe.' Further information available at: https://ec.europa.eu/commission/news/new-bioeconomy-strategy-sustainable-europe-2018-oct-11-0_en</p> <p>Key reading: EC (2018), Bioeconomy: A new strategy for a sustainable Europe Restoring healthy ecosystems and enhancing biodiversity. European Commission https://ec.europa.eu/research/bioeconomy/pdf/ec_bioeconomy_actions_2018.pdf</p> <p>Could also check for more advanced reading: Giampietro, M. (2019). On the circular bioeconomy and decoupling: implications for sustainable growth. <i>Ecological economics</i>, 162, 143-156. https://www.sciencedirect.com/science/article/pii/S0921800918317178</p> <p>Vivien, F. D., Nieddu, M., Befort, N., Debref, R., & Giampietro, M. (2019). The hijacking of the bioeconomy. <i>Ecological economics</i>, 159, 189-197. https://www.sciencedirect.com/science/article/abs/pii/S0921800918308115</p> <p>See slides "What is the Bioeconomy? Opportunities, challenges and solutions" for information on:</p> <ul style="list-style-type: none"> - Bioeconomy – links to SDGs and climate change, and bioeconomy resources - The transition to a bioeconomy is complex - Biodiversity assessment - Direct, indirect and cumulative impacts - What are 'impacts and need for Environmental Impact Assessment (EIA) and/or Strategic Environmental Assessment (SEA). - Net positive outcomes, enhancement and the mitigation hierarchy - Example: the impacts of biofuels
 <p>Bioeconomy challenges: Resource Provision and Biodiversity loss</p> <p>Bioproducts are derived from renewable biological resources. The bioeconomy makes use of many different biomass resources, from crops to forests to microorganisms. Without these feedstocks, there would be no bioeconomy.</p> <p>It is critical that the bioeconomy does not compete with food production and does not affect biodiversity. For example, marginal lands may not be used for food production but may be important for biodiversity</p> <p>It is therefore fundamental to carry a biodiversity assessment.</p>	<p>Key reading: <i>The Bioeconomy Consultants</i> (2018), <i>BIG BIOECONOMY CHALLENGES - PART 2</i>. https://www.nnfcc.co.uk/news-big-bioeconomy-challenges-2</p> <p>Brownlie, S. (2013), <i>IAIA fast tips No. 5 - Biodiversity Assessment</i>. International Association for Impact Assessment (IAIA). https://www.iaia.org/fasttips.php</p> <p>See slides "What is the Bioeconomy? Opportunities, challenges and solutions" for information on:</p> <ul style="list-style-type: none"> - Bioeconomy – links to SDGs and climate change, and bioeconomy resources - The transition to a bioeconomy is complex - Biodiversity assessment - Direct, indirect and cumulative impacts - What are 'impacts and need for Environmental Impact Assessment (EIA) and/or Strategic Environmental Assessment (SEA). - Net positive outcomes, enhancement and the mitigation hierarchy

<div>Slide</div> <div><div>Agriculture feedstock</div><div>What are examples of bioeconomy feedstocks (or raw materials) in the agri-food sector?</div><div>In groups of two write a list of all the bioeconomy feedstocks (or raw materials) from the agri-food sector that you can think of.</div><div>You have 2 minutes</div></div>	<div>Notes for teacher, comments and links</div> <div>Ask students to write a list of all the bioeconomy feedstocks (or raw materials) from the agri-food sector. The next slide has a list of these materials.</div>
<div><div>Agriculture feedstock</div><div>Examples of bioeconomy feedstocks (or raw materials) in the agri-food sector</div><div><div><div>•Animal produce</div><div>•Animal manure</div><div>•Apples</div><div>•Bean varieties</div><div>•Berries</div><div>•Barley</div><div>•Beeswax</div><div>•Beet</div><div>•Canola</div><div>•Cotton</div><div>•Coffee beans</div></div><div><div>•Corn/maize</div><div>•Citrus fruits</div><div>•Dairy produce</div><div>•Flax</div><div>•Grapes (wine, etc.)</div><div>•Grass</div><div>•Nuts</div><div>•Miscanthus</div><div>•Mushrooms</div><div>•Olives</div><div>•Onions</div></div><div><div>•Potatoes</div><div>•Rapeseed</div><div>•Rice</div><div>•Rye</div><div>•Sunflower</div><div>•Tomatoes</div><div>•Tobacco</div><div>•Wheat</div><div>•Whey</div></div></div><div>Source: Bio-based Industries Consortium (2019), Examples of bioeconomy feedstocks. https://ec.europa.eu/knowledge4policy/glossary/feedstock_en</div></div>	<div>Examples of bioeconomy feedstocks in the agri-food sector.</div> <div>Source: Bio-based Industries Consortium (2019), Examples of bioeconomy feedstocks. https://ec.europa.eu/knowledge4policy/glossary/feedstock_en</div>
<div><div>Agriculture = A plethora of biological resources</div><div><div>Diagram showing circular flow of bio materials (Biovale, 2020)</div><div><div>► The farming industry is inextricably linked with the organic process and the circular flow of life on earth</div><div>► Agricultural practices involve harnessing natural processes to produce food.</div><div>► These processes create both intentional produce (fruit/vegetable) and indirect waste (orange peels/ wheat straw)</div><div>► Bioeconomy = waste as an opportunity/resource.</div></div></div></div>	<div>Biological resources are the base of the agriculture industry. This makes it especially important to the development of the bioeconomy. The farming industry is inextricably linked with the organic process and the circular flow of life on earth. This means that farming has a crucial role to play in harnessing the biological resources at their disposal. In order to create food, farming practices create both intentional produce (e.g. fruit and vegetables) and indirect waste (e.g. orange peels and wheat straw). The central theme of the Bioeconomy requires us to look at the way we process certain products and how we can maximise the potential of the resources contained therein. Agricultural residues is one way for adding value to resources already extracted.</div> <div>References: Biovale. 2020. <i>The Bioeconomy</i>. https://www.biovale.org/the-bioeconomy/</div>
<div><div>Why is the bioeconomy important for agriculture?</div><div><div><div>► Increasing challenges to farmers:</div><div>► Need for diversification</div><div>► Growing competition</div><div>► Climate change</div><div>► Changing dietary habits</div><div>► The bioeconomy as an opportunity to meet these challenges</div></div><div><div>Macedonian farmer (Vittuari, 2011)</div></div></div></div>	<div>Farmers are a group of people who will feel the more immediate consequences of the rapidly changing world. Agriculture depends on the weather and seasonal cycles, so the effects of climate change can have extremely negative impacts for farmers through not being able to harvest their crops as a result of too much rain or too little rain, or not being able to let their cattle outside as a result of bad weather. Growing competition from an increasingly global world means farmers must adapt and diversify their output if they are to compete. Taking advantage of opportunities that come along with embracing the bioeconomy could be key the farmers thriving in the future. The rise of veganism and resulting dietary changes in the coming generations will mean that farmers who have traditionally bred animals for human consumption may have to alter methods.</div> <div>References: Vittuari, M., 2011. <i>Macedonia discovering a green economy</i>. Osservatorio Balcani Caucaso Transeuropa [online]. https://www.balcanicaucaso.org/eng/Areas/North-Macedonia/Macedonia-discovering-a-green-economy-104620</div>


Slide	Notes for teacher, comments and links
<div>  <h3>Agriculture and SDGs</h3> <ul style="list-style-type: none"> ▶ SDG 1: No poverty ▶ SDG 2: Zero hunger ▶ SDG 6: Clean water and Sanitation ▶ SDG 7: Affordable and clean energy ▶ SDG 12: Responsible consumption and production ▶ SDH 13: Climate action ▶ SDG 15: Life on land  <p>Source: The Founder Institute (2019)</p> </div>	<p>Given that agriculture aims to create food for humans and it has a large impact on the environment, creating more sustainable farming practices is crucial if we are to forge a more sustainable future. Goals 1, 2, 6, 7, 12, 13, and 15 are particularly related to agriculture for the following reasons: SDG1: End poverty - Growth in the agriculture sector, particularly in low-income and agrarian economies is at least twice effective in reducing hunger and poverty than from any other sector. (Nhemachena et al, 2018)</p> <p>By supporting a more sustainable approach to agriculture and encouraging innovative solutions to problems by employing methods like those promoted through the bioeconomy, we can go a long way to helping achieve the targets set out in the SDG's.</p> <p>References:</p> <p>Nhemachena, C., Matchaya, G., Nhemachena, C.R., Karuaihe, S., Muchara, B. and Nhlengethwa, S., 2018. Measuring baseline agriculture-related sustainable development goals index for southern Africa. <i>Sustainability</i>, 10 (3), p.849</p> <p>Source of image: The Founder Institute. 2019. UN Sustainable Development Goals. https://fi.co/insight/17-companies-helping-meet-the-17-un-sustainable-development-goals</p>
<div>  <h3>Agri-derived Bio based products</h3> <h4>FPC™ (Fiber Particulate Composite) – a bio-composite from agricultural waste that can reduce the use of plastic</h4> <ul style="list-style-type: none"> ▶ Every year, about 8 million tons of plastic waste escapes into the oceans from coastal nations (Parker, 2019). ▶ FPC™ is made of 100% natural ingredients from agricultural by-products and can be used like a "plastic" with current plastic molding methods (eTic, 2020). ▶ FPC™ is biodegradable and its production does not compete with food production (eTic, 2020).  <p>FPC™ Pellets from coffee residues, flax, bamboo and rice husk (eTic, 2020)</p> </div>	<p>A slide with an example of a product that illustrate the potential for new bioproducts derived from agricultural residues.</p> <p>Plastic pollution is a huge problem for our oceans. Every year, about 8 million tons of plastic waste escapes into the oceans for coastal nations. What makes this an especially troublesome issue is the fact that these oil based plastics can persist for hundreds of years before breaking down (Parker, 2019). Bio-based plastics such the one from the Taiwanese company eTouchic Innovation Company Limited (eTic) aims to embrace agricultural by-products in order to move away from conventional oil based plastics (European Commission, 2015). eTic combines the rice husks with a sort of biobased resin. This mixture can then be processed into a fibre composite building material (FPC™ - Fiber Particulate Composite) that has similar properties as conventional oil based plastics but is biodegradable (eTic, 2020). FPC™ comes in pellets it can be used with current plastic moulding methods (eTic, 2020). Such biohybrid materials are lightweight, sturdy, fire resistant and have excellent insulation characteristics, making them an attractive green building material (eTic, 2020). FPC™ can be decomposed naturally and does not emit any greenhouse gases. Bio-plastics such as PLA (Polylactic Acid is a polymer made from renewable resources), compete for land and water with biofuels and food crops (as the primary feedstock is currently corn). To produce 200,000 tones of bio-plastics such as PLA, requires 250,000-350,000 tonnes of crops. On the other hand, FPC™ utilizes agricultural waste and therefore its production does not compete with food production (eTic, 2020). In the picture we can see the different materials from which the company have created FPC™. What makes this innovation particularly exciting is the array of biological materials from which it can be created.</p> <p>References:</p> <p>European Commission (2015). Bioeconomy in everyday life. [online] Brussels: European Commission, pp.1–44. https://www.biovale.org/wp-content/uploads/2015/11/Bioeconomy-in-everyday-life-2015.pdf</p> <p>eTic (2020) What is FPC™? eTouchic Innovation Company Limited (eTic). http://www.etic.com/en/waste-management</p> <p>Parker, L. (2019) The World's Plastic Pollution Crisis Explained. National Geographic, 7 June 2019. https://www.nationalgeographic.com/environment/habitats/plastic-pollution/</p>





Slide	Notes for teacher, comments and links
<div><div></div><div><h3>Biofuels from waste straw</h3></div><div><ul style="list-style-type: none">▶ Biofuels are derived from renewable resources.▶ Until now, mostly sugar from arable crops has been used.▶ To avoid competition with food production, residual materials such as straw have come to the attention of several biofuel manufacturers.▶ 240 million tons of cereal straw are produced each year as an agricultural by-product in the EU alone (Clariant, 2020).</div><div><div><p>SUNLIQUID® - COMPETITIVE AND SUSTAINABLE CELLULOSIC ETHANOL</p></div><div><p>Diagram showing the process followed in order to create Sunliquid Biofuel (Clariant, 2020)</p></div></div></div>	<p>The continued use of carbon based fossil fuels are one of the main drivers of human-made climate change. Alternative, less environmental harmful fuels must be invested in if we are to reach climate targets like those set out in the SDG's. Biofuels derived from arable crops are not a new innovation but Sunliquid Biofuel differs in that it is derived exclusively from the residues of wheat straw. The Swiss chemical company Clariant has established a biorefinery demonstration plant, in which wheat straw bioethanol is produced. With the help of enzymes, the lignocellulose is decomposed and recovered from the plant fibre into its individual components. The resulting sugar molecules serve as food for yeast and the fungi ferment them into alcohol. This can then be added to premium petrol for petrol engines (Clariant, 2020). For some time now, many companies have shown a growing interest in the production of ethanol from renewable lignocellulosic resources, such as agricultural residues. These resources do not compete with food and feed crops, but are created in sufficient quantities worldwide as a by-product of current agricultural practices, as in the case of straw left over from cereal production (Clariant, 2020). About 240 million tons of cereal straw are produced each year as an agricultural by-product in the EU alone. Only a small part of this is currently utilized. Long term studies have shown that up to 60% could be taken of the field and are thus available for further uses. By processing this amount of straw, about 25% of the predicted EU demand for petrol could be replaced by cellulosic ethanol in 2020, solely out of surplus material. This means that cellulosic ethanol can play a key role along Europe's path towards sustainable and climate-friendly road transport (Clariant, 2020).</p> <p>References: Clariant. 2020. Sunliquid. https://www.clariant.com/en/Business-Units/New-Businesses/Biotech-and-Biobased-Chemicals/Sunliquid</p>
<div><div></div><div><h3>T-Shirts made with waste milk</h3></div><div><ul style="list-style-type: none">▶ 16% of dairy products are thrown away every year (Gross, 2018).▶ The fashion industry is responsible for 10% of the world's carbon emissions (McFall-Johnsen, 2019).▶ It takes about 700 gallons of water to produce one cotton shirt (McFall-Johnsen, 2019).▶ Using excess milk to make clothes reduces water, reduces carbon emissions and reduces water consumption.</div><div><div></div><div><p>Milk fiber and Mi Terro t-shirt (Mi Terro, 2020)</p></div></div></div>	<p>1.3 billion tons of food end up in landfills, where it releases 3.3 billion tons of greenhouse gases. Amongst that, 128 million tons of milk are dumped every year globally (Mi Terro, 2020). Scientists are working on technology that allows them to create fibres from waste milk. The process starts by obtaining waste milk that gets fermented and then skimmed, removing its fat content. It is subsequently dewatered, resulting in a powdered milk that gets purified to remove all substances other than a naturally-occurring protein known as casein. The powdered casein is next immersed in alkali, producing a solution that is passed through a spinneret to create fibers. Sulfuric acid is then used to remove the alkali from those fibers, which are finally stretched and spun into yarn (Mi Terro, 2020). Given the enormous amount of milk wasted every year globally, along with the huge impact of the fashion industry on our environment, utilising waste products in such a manner is an exciting and innovative way to create value whilst at the same time helping to curb detrimental impact on the environment.</p> <p>References: Gross, A. S., 2018. One in six pints of milk thrown away each year, study shows. <i>The Guardian</i>, 28 Nov 2018. https://www.theguardian.com/environment/2018/nov/28/one-in-six-pints-of-milk-thrown-away-each-year-study-shows McFall-Johnsen, M., 2019. The fashion industry emits more carbon than international flights and maritime shipping combined. Here are the biggest ways it impacts the planet. <i>Business Insider</i>, 21 October 2019. https://www.businessinsider.com/fast-fashion-environmental-impact-pollution-emissions-waste-water-2019-10 Mi Terro. 2020. Mission. https://www.miterro.com/pages/mission</p>






Slide	Notes for teacher, comments and links
<div>  </div> <div>Paper from cocoa beans shells</div> <div> <ul style="list-style-type: none"> ▶ Global warming potential (GWP) of chocolate ranges from 2.9-4.2 kg CO₂ eq./kg (Konstantas et al., 2018). ▶ According to the International Cocoa Organisation, 4.25 million tonnes of cocoa beans were produced in 2016 (The Economic Times, 2018). ▶ For every pound of cocoa beans, farmers produce 12 times as much biomass (Wright, 2019). ▶ Turning cocoa bean shells into paper can make use of this waste product. </div> <div>  </div> <div> <p>James Cropper paper (Nirvana Creative Production House, 2015)</p> </div>	<p>Chocolate is a delicacy consumed with world over. According to the International Cocoa Organisation, 4.25 million tonnes of cocoa beans were produced in 2016 (The Economic Times, 2018). For every pound of cocoa beans, farmers produce 12 times as much biomass. (Wright 2019). British manufacturer James Cropper has been pioneering a technology that turns the shells of cocoa beans into paper. "A bio-recycling solution that, unlike other cocoa recycling processes, doesn't necessitate burning or gradual degrading of the fibres of the cocoa shell, the finished light brown paper utilises the cocoa as a natural colourant, avoiding the need for artificial dyes." (James Cropper plc, 2014). "The cocoa shell represents around 12% of the fruit itself, making the production of a versatile paper from the remnants of the chocolate production process a potentially significant breakthrough for the food and packaging industries" (James Cropper pls, 2014)</p> <p>References: The Economic Times 2018. Chocolate production may be harming environment: Study. <i>The Economic Times</i>, 2 April 2018. https://economictimes.indiatimes.com/news/science/chocolate-production-may-be-harming-environment-study/articleshow/63577769.cms?from=mdr James Cropper plc. 2014. Sweet innovation as cocoa waste is transformed. https://www.jamescropper.com/news/2014-01-17-sweet-innovation-as-cocoa-waste-is-transformed. Von Dacre, J. S., 2019. How your chocolate addiction traps cocoa farmers in poverty. Inside Over, 7 November 2019. https://www.insideover.com/society/how-your-chocolate-addiction-traps-cocoa-farmers-in-poverty.html. Nirvana Creative Production House (2015) Material of the month, June 2015: Cacao Paper. Nirvana Creative Production House, 29 May 2015. https://nirvanacph.com/2015/05/cacao-paper/ Wright, A., 2019. Scientists around the world are turning agricultural waste into food, packaging and skincare products. GreenBiz. https://www.greenbiz.com/article/scientists-around-world-are-turning-agricultural-waste-food-packaging-and-skincare-products Konstantas, A., Jeswani, H., Stamford, L., & Azapagic, A. (2018). Environmental impacts of chocolate production and consumption in the UK. <i>Food Research International</i>, 106: 1012-1025.</p>
<div>  </div> <div>Grass Fed Mobile Biorefinery</div> <div> <ul style="list-style-type: none"> ▶ The grass fed mobile biorefinery separates the grass into juice and fibre. ▶ The juice can be turned into a dry protein-rich cake that can be absorbed more easily by cows. ▶ The leftover fibre can be processed into a sustainable alternative to synthetic fertiliser or used as a more efficient supply of fuel for anaerobic digesters. <p>(Phys.org, 2019).</p> </div> <div>  </div> <div> <p>A grass fed mobile biorefinery (Phys.org, 2019).</p> </div>	<p>Researchers at University of Tralee developed Ireland's first grass fed biorefinery, which aims to look at grass-based bioeconomy options. This mobile biorefinery separates the grass into a juice and a fibre. "The juice is turned into a dry protein-rich cake that can be absorbed easier by cows so it generates less emissions from their digestion process or from feeding them other feed, like soy beans" (Phys.org, 2019). "The leftover fibre can be processed into a sustainable alternative to synthetic fertiliser or used as a more efficient supply of fuel for anaerobic digesters, which breaks down the biological material and turns it into natural gas" (Phys.org, 2019). This technology hopes to decrease emissions and make Ireland less dependent on imported protein.</p> <p>References: Finn, C. (2013) Ireland really is the garden of Europe, survey finds. <i>TheJournal.ie</i>, 26 October 2013. https://www.thejournal.ie/eurostat-ireland-covered-by-the-most-grasslands-in-europe-1148673-Oct2013/ Phys.org (2019) Ireland's first grass-fed biorefinery. <i>Phys.org</i>, 15 May 2019. https://phys.org/news/2019-05-ireland-grass-fed-biorefinery-road-farmers.html</p>

Slide	Notes for teacher, comments and links
<p>Example: The impacts of biofuels</p>  <p>Immerzeel et al. (2014), provide a detailed review on biodiversity impacts of bioenergy crop production. The authors point out:</p> <ul style="list-style-type: none"> importance of the initial land use - majority of negative impacts refer to the conversion of natural vegetation to first generation biofuel crops. crops have different impacts – depends if 1st, 2nd and 3rd generation biofuels biodiversity impacts include habitat change, fragmentation, pollution, invasive species and climate change effects (see Figure) <p>Relationships between drivers and pressures of biodiversity change resulting from bioenergy crop production. Negative influence → Positive influence → (Immerzeel et al., 2014)</p>	<p>Very important to consider the impacts of biofuels that vary according to 1st, 2nd and 3rd generation biofuels.</p> <p>Key reading: Immerzeel, D.J., Verweij, P., Hilst, F. and Faaij, A.P. (2014), Biodiversity impacts of bioenergy crop production: a state-of-the-art review. <i>GCB Bioenergy</i>, 6:183-209</p>
<p>1st, 2nd and 3rd generation biofuels</p> <p>Three types of biofuels (Oregon State University, n.d.):</p> <ol style="list-style-type: none"> 1st generation biofuels (e.g. rape oil, sunflower oil, beet sugarcane, corn, potatoes) - main drawback: come from biomass that is also a food source. 2nd generation biofuels (e.g. agricultural and forest residues) come from non-food biomass, but still compete with food production for land use. 3rd generation biofuels (e.g. engineered crops such as algae) present the best possibility for alternative fuel because they don't compete with food. Algae can grow in areas unsuitable for 1st and 2nd generation crops, which would relieve stress on water and arable land used. Plus it can be grown using sewage, wastewater, and saltwater.  <p>Algae Energy Farm in Australia (Algae Biotechnology Laboratory, University of Queensland, Australia).</p> <p>Cultivation on open ponds (a) following initial growth in sealed bags (b).</p> <p>Source: Correa, et al. (2019)</p>	<p>Key reading: Correa, D., Hawthorne, B., Fargione, J., Hill, J., Possingham, H., Thomas-Hall, S. and Schenk, P. (2019). Towards the implementation of sustainable biofuel production systems. <i>Renewable and Sustainable Energy Reviews</i>, 107: 250-263.</p> <p>Oregon State University (n.d.), Bioenergy Education Initiative. https://agsci.oregonstate.edu/sites/agsci.oregonstate.edu/files/bioenergy/generations-of-biofuels-v1.3.pdf</p>
<p>Video: bioeconomy in a rural setting</p>  <p>Video (2 minutes and 52 seconds): https://youtu.be/JfLNRR2IFcg?list=UUY-frt3uTqgVZW-DLjoo5bA</p> <p>Languages for sub-titles for video include: Bulgarian, Latvian, Macedonian, Polish and Romanian</p>	<p>This video is a great explanation of the bioeconomy in a rural setting. Explains how focusing on bio-resources, like those found in agricultural settings, can enhance communities and lives of people who live in the areas the resources are found, but also addresses environmental issues. Video is a good way to summarise presentation and also start a discussion.</p> <p>Matis Iceland (2017), The Bioeconomy – A rural area approach. https://youtu.be/JfLNRR2IFcg?list=UUY-frt3uTqgVZW-DLjoo5bA</p> <p>Languages for sub-titles for video include: Bulgarian, Latvian, Macedonian, Polish and Romanian</p>
<p>Questions and Discussion</p> 	<p>Notes to the teacher: Speaker's name to go in the space at the bottom left of the slide. This is the final slide of the presentation. Allow time for students/participants to ask any questions.</p>
<p>BE-Rural</p> <p>These educational resources were developed as part of the BE-Rural project Bio-based strategies and roadmaps for enhanced rural and regional development in the EU (April 2019 – March 2022)</p> <p>BE-Rural supports</p> <ul style="list-style-type: none"> regional stakeholders in five countries: Latvia: Vidzeme and Kurzeme Poland: Szczecin and Vistula Lagoons Romania: Covasna Bulgaria: Stara Zagora North Macedonia: Strumica <p>https://be-rural.eu/innovation-regions/</p>  <p>The goal of BE-Rural is to realise the potential of regional bio-based economies by supporting relevant actors in the participatory development of bioeconomy strategies and roadmaps</p>	<p>BE-Rural will create five regional Open Innovation Platforms (OIPs) for the participatory development of bioeconomy strategies and roadmaps.</p> <p>Stara Zagora, Bulgaria: will focus on seeking new technologies for the application of essential oils and herbal plants in the cosmetics and pharmaceutical industry.</p> <p>Vidzeme and Kurzeme, Latvia: will focus on the potential of by-products of forest management (i.e. from young forest stand thinning, short rotation coppice and forestry plantations, removing of overgrowth in abandoned agricultural lands and perennial grasses) as a source of bioenergy or biorefinery.</p> <p>Strumica, North Macedonia: will focus on the utilization of agricultural residues, specifically the by-production of organic materials from agricultural activities, as a source of energy for domestic and industrial purposes.</p> <p>Szczecin Lagoon and Vistula Lagoon, Poland: will focus on small-scale fisheries, specifically sustainable use of currently underused and low-value fish species located in two lagoons.</p> <p>Covasna, Romania: will focus on addressing fragmented value chains and implementing the circular economy concept within the county's industrial sectors (i.e. wood and furniture, textiles, agro-food, mechanical engineering, green energy).</p> <p>Source: BE-Rural (2020), <i>Innovation regions</i>, available at: https://be-rural.eu/innovation-regions/</p>

Annex XI - Power Point slides and notes on "Bioeconomy in the forestry sector"





Slide	Notes for teacher, comments and links
	<p>Notes to the teacher:</p> <p>Teacher's name to go in the space at the bottom left of the slide. Explain that this presentation introduces forest bioeconomy.</p> <p>Excluding the two videos, the outline slide and this first slide, there are 17 slides – so these slides should take between 17 and 34 minutes to present, depending of amount of explanation.</p> <p>The two videos are around 2 minutes long each.</p>
 <ul style="list-style-type: none"> • Bioeconomy overview • Forestry feedstock • Video: Forest Bioeconomy • SDGs linked to forest bioeconomy • Forestry technology: Sustainable fibres from wood • Forestry technology: Small-scale pelletising units • Forestry technology: The containerised pyrolysis unit • Forestry technology: Biomaterials from agro-forestry residues & mycelium • Forestry technology: Mobile wood chipping units • Examples of bioproducts • Conclusion 	<p>Notes to the teacher: Briefly run through the topics that will be spoken about in this presentation as shown on the slide.</p>
 <p>The Bioeconomy...</p> <ul style="list-style-type: none"> • Is the production of goods, services, or energy from biological material as the main resource. • Is strongly linked to sustainability as biodegradable resources are often used and waste is often completely designed out of the system. • Can avoid the depletion of resources for future generations and protect the stability of the planet. <p>European Bioeconomy Strategy</p> <p>The European Commission is taking steps towards a sustainable bioeconomy and has a bioeconomy strategy to promote the bioeconomy and to avoid reaching ecological limits.</p>	<p>Notes to teacher: Explain to class that in order to take steps towards sustainability and the avoidance of reaching ecological limits the bioeconomy is very important. The bioeconomy is the production of goods, services, or energy from biological material as the main resource. This is strongly linked to sustainability as biodegradable resources are often used and waste is often completely designed out of the system. This can avoid the depletion of resources for future generations and protect the stability of the planet. The European Commission is taking steps towards a sustainable bioeconomy. Turning waste into valuable resources and creating incentives to help retailers and consumers cut food waste. The European Commission has a bioeconomy strategy to promote the bioeconomy and avoid reaching ecological limits.</p> <p>European Commission (2018), <i>A sustainable Bioeconomy for Europe: strengthening the connection between economy, society and the environment. Updated Bioeconomy Strategy</i>. Directorate-General for Research and Innovation, available at: https://ec.europa.eu/research/bioeconomy/pdf/ec_bioeconomy_strategy_2018.pdf accessed: 22 May 2020].</p>
 <p>Bioeconomy and Circular Economy – waste is a valuable resource</p> <p>A SUSTAINABLE BIOECONOMY FOR EUROPE INTEGRATING ECONOMIC, SOCIAL AND ENVIRONMENTAL DIMENSIONS</p> <p>Moving towards a circular economy</p> <p>Video (2 minutes and 9 seconds): https://www.youtube.com/watch?v=RfRN_hHeIKk Languages for sub-titles for video include: Bulgarian, Latvian, Macedonian, Polish and Romanian</p>	<p>1. <i>Explain bioeconomy to introduce topic and contextualise bioproducts portfolio.</i></p> <p>Bioeconomy is defined as the production, utilization and conservation of biological resources to provide information, products, processes and services across all economic sectors aiming towards a sustainable economy (Bell et al., 2018). Bell, J., Paula, L., Dodd, T., Németh, S., Nanou, C., Mega, V. and Campos, P. (2018). EU ambition to build the world's leading bioeconomy—Uncertain times demand innovative and sustainable solutions. <i>New Biotechnology</i>, 40: 25–30.</p> <p>Video (2 minutes and 9 seconds): https://www.youtube.com/watch?v=RfRN_hHeIKk Languages for sub-titles for video include: Bulgarian, Latvian, Macedonian, Polish and Romanian</p> <p>2. <i>Explain circular economy to give context to bioproducts.</i></p>

Slide	Notes for teacher, comments and links
	<p>Circular Economy is a framework for the development and management of sustainable, waste-as-resource economic system. It aims to keep products, components and materials at the highest utility and value at all times (EC, 2018).</p> <p>European Commission (2018), <i>A sustainable Bioeconomy for Europe: strengthening the connection between economy, society and the environment. Updated Bioeconomy Strategy</i>. Directorate-General for Research and Innovation, available at: https://ec.europa.eu/research/bioeconomy/pdf/ec_bioeconomy_strategy_2018.pdf</p>
 <p>Ecological limits</p> <p>In addition to links to sustainability and climate change mitigation, it is critical that the bioeconomy operates within safe ecological limits.</p> <p>With the new bioeconomy strategy, the European Commission supports initiatives at national and regional level to develop an efficient and sustainable bioeconomy and this includes:</p> <ul style="list-style-type: none"> • implementing an EU-wide monitoring system to track progress towards a sustainable and circular bioeconomy. • providing guidance on how best to operate the bioeconomy within safe ecological limits. 	<p>Notes to teacher: Explain that to try and tackle the issues surrounding ecological limits: National and international bodies have specific guidelines. An example of this is the European Commission's 2018 publication; 'A new bioeconomy strategy for a sustainable Europe.' Further information available at: https://ec.europa.eu/commission/news/new-bioeconomy-strategy-sustainable-europe-2018-oct-11-0_en</p> <p>Key reading: EC (2018), Bioeconomy: A new strategy for a sustainable Europe Restoring healthy ecosystems and enhancing biodiversity. European Commission https://ec.europa.eu/research/bioeconomy/pdf/ec_bioeconomy_actions_2018.pdf Could also check for more advanced reading: Giampietro, M. (2019). On the circular bioeconomy and decoupling: implications for sustainable growth. <i>Ecological economics</i>, 162, 143-156. https://www.sciencedirect.com/science/article/pii/S0921800918317178 Vivien, F. D., Nieddu, M., Befort, N., Debref, R., & Giampietro, M. (2019). The hijacking of the bioeconomy. <i>Ecological economics</i>, 159, 189-197. https://www.sciencedirect.com/science/article/abs/pii/S0921800918308115</p>
 <p>Bioeconomy challenges: Resource Provision and Biodiversity loss</p> <p>Bioproducts are derived from renewable biological resources. The bioeconomy makes use of many different biomass resources, from crops to forests to microorganisms. Without these feedstocks, there would be no bioeconomy.</p> <p>It is critical that the bioeconomy does not compete with food production and does not affect biodiversity. For example, marginal lands may not be used for food production but may be important for biodiversity</p> <p>It is therefore fundamental to carry a biodiversity assessment.</p>	<p>Key reading: The Bioeconomy Consultants (2018), BIG BIOECONOMY CHALLENGES - PART 2. https://www.nnfcc.co.uk/news-big-bioeconomy-challenges-2 Brownlie, S. (2013), IAIA fast tips No. 5 - Biodiversity Assessment. International Association for Impact Assessment (IAIA). https://www.iaia.org/fasttips.php See slides "What is the Bioeconomy? Opportunities, challenges and solutions" for information on:</p> <ul style="list-style-type: none"> - Bioeconomy – links to SDGs and climate change, and bioeconomy resources - The transition to a bioeconomy is complex - Biodiversity assessment - Direct, indirect and cumulative impacts - What are 'impacts and need for Environmental Impact Assessment (EIA) and/or Strategic Environmental Assessment (SEA). - Net positive outcomes, enhancement and the mitigation hierarchy - Example: the impacts of biofuels
 <p>Forestry Feedstock</p> <p>What are examples of bioeconomy feedstocks (or raw materials) in the forestry sector?</p> <p>In groups of two write a list of all the bioeconomy feedstocks (or raw materials) from the forestry sector that you can think of.</p> <p>You have 2 minutes</p>	<p>Ask students to write a list of all the bioeconomy feedstocks (or raw materials) from the forestry sector. The next slide has a list of these materials.</p> <p>What is feedstock? Feedstock is the raw/bio material from the forests that is input into process to make biobased products. This can be classified into waste products from forest management as well as wood, leaves etc produced by forest.</p>


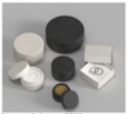











Slide	Notes for teacher, comments and links
<div>  <div>Forestry Feedstock</div> </div> <div> <p>Examples of bioeconomy feedstocks (or raw materials) in the forestry sector</p> </div> <div> <ul style="list-style-type: none"> Bamboo Bark Branches Black liquor Cellulose Hardwood Lignin Leaves Post-consumer wood Softwood Sawdust Stumps Wood pellets </div> <div> <p>Source: Bio-based Industries Consortium (2019), Examples of bioeconomy feedstocks. https://ec.europa.eu/knowledge4policy/glossary/feedstock_en</p> </div>	<p>Examples of bioeconomy feedstocks in the forestry sector. Source: Bio-based Industries Consortium (2019), Examples of bioeconomy feedstocks. https://ec.europa.eu/knowledge4policy/glossary/feedstock_en</p> <p>Feedstock List (Bark to Wood Pellets): Bio-based Industries Consortium (2020) <i>Examples of Bioeconomy feedstocks</i>, available at: [https://biconsortium.eu/bioeconomy-feedstocks]</p> <p>The forestry sector has been found to have potential for the bioeconomy. This would be bio-based products from wood and by products of forest management.</p> <p>“The forest-based sector includes all stakeholders with a major interest in forestry, forest-based materials and products. Wood is the key component of the pulp and paper industry, it can be used for energy production, it is an important construction material and for the furniture industry. Forest-based biomass is also used for many different bio-based products, such as insulation material, barrier materials for damp protection, biopolymers, bio-based plastics and composites, carbon fibre, chemicals and cellulose-based textiles, smart packaging materials (Swedish Forest Industries Federation 2013 in European Commission, 2017 [https://ec.europa.eu/research/bioeconomy/pdf/publications/bioeconomy_development_in_eu_regions.pdf])</p> <p>“Many companies are making efforts to replacing fossil feedstock with renewable biological resources in other products and processes, using innovative technologies” (BLOOM Factsheet What is the bioeconomy (2019) available at: [https://bloom-bioeconomy.eu/wp-content/uploads/2019/01/BLOOM-Factsheet-What-is-the-Bioeconomy.pdf])</p> <p>“Renewable feedstocks are already playing a central role within the bioeconomy: 150 million tonnes of forestry products are used to generate 770 TWh of primary energy each year in Europe, with a further 210 TWh from waste and 12 TWh from agricultural residues.” (National Non-Food Crops Centre (NNFCC) available at: [https://www.nnfcc.co.uk/feedstocks])</p>
<div>  <div>Forestry Feedstock</div> </div> <div> <p>What are forest bioeconomy feedstocks?</p> </div> <div>  <p>Sawdust (Colmorgen and Khawaja, 2019)</p> </div> <div>  <p>Forestry residue (EERE, 2020)</p> </div> <div> <p>Source: Forest Pedagogics (2016)</p> </div> <div>  <pre> graph TD P[Polymers] --> L[Lignin] P --> C[Cellulose] L --> LP[Leather, Plastics, Polyurethanes, Adhesives, Ink, Biochemicals, etc.] L --> LC[Cellulose, Sugar, Food Bioproducts, Paper, Plastics, Ethanol, Chemicals, etc.] C --> CP[Paper, Packaging, Textiles, Biochemicals, etc.] C --> CC[Wood-based products, Wood, Wood-based products, etc.] </pre> </div>	<p>Point out how Lignin and cellulose have the potential to provide for a wide range of products – see flowchart Feedstock List (Lignin and Cellulose) and flowchart: Forest Pedagogics (2016) 11th European Forest Pedagogics Congress 2016 Bioeconomy Teaching material [http://forestpedagogics.eu/mediadata/en/biri-2016/Bioeconomy_Teaching-material.pdf]</p> <p>Image Forest residue: Energy Efficiency and Renewable Energy (EERE) (2020), <i>Biomass Feedstock</i>, available at: [https://www.energy.gov/eere/bioenergy/biomass-feedstocks]</p> <p>Image Sawdust: Colmorgen, F., Khawaja, C. (2019): <i>Small-scale technology options for regional bioeconomies</i>. [https://be-rural.eu/wp-content/uploads/2019/10/BE-Rural_D2.1_Small-scale_technology_options.pdf]</p> <p>Other examples of feedstock - InnProBio ‘Factsheet No. 1 What are bio-based products?’ available at: [https://innprobio.innovation-procurement.org/fileadmin/user_upload/Factsheets/Factsheet_n_1.pdf]</p> <p>“Approximately 490 million tonnes of forestry biomass (dry mass) are currently exploited annually in Europe (including for pulp, paper and other traditional uses). An estimated 245 million tonnes of wood are used in the woodworking and pulp and paper industry annually and 240 million tonnes of wood are used for heat and power production. Forest based raw materials have high shares in the production of biobased products and bioenergy, mainly via the lignin platform. At industrial scale, forest residues and waste wood can be converted to advanced biofuels or intermediates. However,</p>


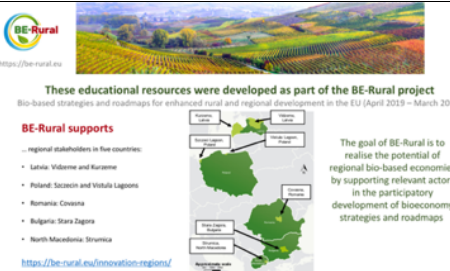
Slide	Notes for teacher, comments and links
	<p>sustainability considerations are very important as increasing the extraction of forest residues and biomass beyond a certain point will inevitably lead to trade-offs between productivity and environmental and economic sustainability. Beyond sustainability considerations, there are technical and economic limitations of forestry biomass used as feedstock” –Tsagaraki, E., Karachaliou E., Delioglani, I. and Kouzi E. (2017) Bio-based products and applications potential, available at: [http://www.bioways.eu/download.php?f=150&l=en&key=441a4e6a27f83a8e828b802c37adc6e1] p.5</p>
<p>Video: Forest Bioeconomy</p> <p>What is the forest bioeconomy?</p>  <p>Video [1 minutes and 43 seconds]: https://www.youtube.com/watch?v=w8JaCLECuM4&t=8s</p>	<p>Finland is an example of a forest-based bioeconomy. <i>*play video*</i> 'Forest based bioeconomy in Finland' https://www.youtube.com/watch?v=w8JaCLECuM4&t=8s “Even though many people are not aware of it, the bioeconomy is already part of our everyday lives. Biological resources and innovative technologies are already being used to replace unsustainable products and processes that are currently produced from fossil resources. Some biobased goods may even have novel properties which make them superior to the products we currently depend on. “ (BioSTEP (2016) Exhibition brochure Glasgow: Bioeconomy in everyday life [http://www.bio-step.eu/fileadmin/BioSTEP/Bio_documents/BioSTEP_Bioeconomy-in-everyday-life_Glasgow_Exhibition-Guide.pdf]) Factsheet from BLOOM on the bioeconomy can also be used to introduce bioeconomy (BLOOM Factsheet What is the bioeconomy (2019) available at: [https://bloom-bioeconomy.eu/wp-content/uploads/2019/01/BLOOM-Factsheet-What-is-the-Bioeconomy.pdf])</p> <p>Alternatives to video in slide: Video: 'The bioeconomy starts here!' https://www.youtube.com/watch?v=2xvXkOMRTs4 Video: 'Bioeconomy – University of Hohenheim' https://www.youtube.com/watch?v=OvpD52n1oiM Video: 'ERIFORE – European Research Infrastructure for Circular Forest Bioeconomy' https://www.youtube.com/watch?v=eMnTI0XV_F4 Video: 'Bioeconomy in Norway' https://www.youtube.com/watch?v=fJJckwyHaKA Video: 'Bioeconomy Knowledge centre' https://www.youtube.com/watch?v=oPadmhFDajk https://www.youtube.com/watch?v=D5KNcdsT2lY&t=68s</p>
<p>SDGs link to forest bioeconomy</p> <p>How does the forest bioeconomy lead to sustainable development?</p> 	<p>The Sustainable Development Goals was introduced by the UN in 2015 and is part of the 2030 Agenda for Sustainable Development (UN Sustainable Development Goals Website [https://sustainabledevelopment.un.org/?menu=1300]) Question: Which goals do you think are relevant to a forest-based bioeconomy? Once answers given – allow images to show up on slides SDG Explanations (UN Sustainable Development Goals Website [https://sustainabledevelopment.un.org/?menu=1300]): (Can explain all or focus on a few such as SDG 15, 13, 12) (Text in italics can be used to link SDGs presented with rest of the presentation) SDG 2. End hunger, achieve food security and improved nutrition and promote sustainable agriculture <i>*as will be seen later on one of the products from the forest bioeconomy is a health drink, showing potential for the forest bioeconomy to provide nutrition*</i> SDG 7. Ensure access to affordable, reliable, sustainable and modern energy for all <i>*forests are a source of renewable energy especially in the form of wood chips and pellets which are burnt to produce renewable energy, switching to energy from the forest bioeconomy can help meet this target*</i></p>

Slide	Notes for teacher, comments and links
	<p>SDG 8. Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all <i>*growing the bioeconomy will create new jobs for example in regions such as Vidzeme and Kurzeme*</i></p> <p>SDG 9. Build resilient infrastructure, promote inclusive and sustainable industrialisation and foster innovation <i>*The bioeconomy encourages innovation as new technologies are needed to convert feedstock into biobased products*</i></p> <p>SDG 12. Ensure sustainable consumption and production patterns <i>*resource efficiency, reducing waste and mainstreaming sustainability practices across all sectors of the economy is part of this goal and the bioeconomy has sustainability and circularity as an important aspect of it helping to reduce waste and avoid the depletion of resources*</i></p> <p>SDG 13. Take urgent action to combat climate change and its impacts <i>*The bioeconomy looks to alternatives to fossil fuels to produce products which tend to have lower carbon footprints and also result in less emissions when produced*</i></p> <p>SDG 14. Conserve and sustainable use the oceans, seas and marine resources for sustainable development <i>*using biobased products means less plastics entering and polluting the oceans and affecting marine life. Moreover, technology used to make fibres from forest-based feedstocks does not pollute waters*</i></p> <p>SDG 15. Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss <i>*This is probably the most significant SDG to a forest bioeconomy as a forest-based bioeconomy will encourage the sustainable use and management of forest and can help halt and reverse land degradation and halt biodiversity loss*</i></p> <p>SDG 17. Strengthen the means of implementation and revitalize the global partnership for sustainable development <i>*Some SDGs will be more relevant to a forest-based bioeconomy than others. For example, SDG 15.</i></p>
<p>Forestry technology: Sustainable fibres from wood</p> <p>Spinnova Ltd</p> <ul style="list-style-type: none"> Technology that can turn wood fibres into yarn without using harmful chemicals The produced yarns are fire retardant, antimicrobial, as warm as wool, & naturally biodegradable The only by-product is evaporated water, which is re-used in the processing Scalable technology that can use FSC-certified wood instead of less ecological fibres e.g. cotton, viscose or polyester Creation of new & extended value chains  <p>Source: Spinnova, 2020</p>	<p>This process is built upon a mechanical treatment of the pulp, fiber suspension flows and rheology. Spinnova produces fiber out of micro fibrillated cellulose which can be described as a pasty mass of tiny wood fibers. This finely ground pulp mass then flows through a nozzle, where the fibers rotate and align with the flow, creating a strong, elastic fiber network. Using the patented spinning technology, the fiber is spun and dried. The outcome of this process is a fluffy but solid wool-like material, suitable for spinning into yarn and to use for textile production. The only by-product of the process is evaporated water, which is lead back into the process. (Colmorgen and Khawaja, 2019).</p> <p>Colmorgen, F., Khawaja, C. (2019): Small-scale technology options for regional bioeconomies. BE-Rural Project, https://be-rural.eu/. WIP Renewable Energies, Munich, Germany.</p> <p>Video on Spinnova: https://spinnova.com/wp-content/uploads/2018/06/Spinnova-vimeo-20180507.mp4?_1 [3 minutes] – This video explains more about the company and what they do.</p>

Slide	Notes for teacher, comments and links
<div>  Forestry technology: Small-scale pelletising units </div> <div> GEMCO, abc Machinery, AMISY </div> <ul style="list-style-type: none"> Technology for pelletising solid biofuels – which improves their mechanical & physical properties (eg increased density & homogenisation) & so facilitates transport & handling Various feedstocks can be used (eg wood waste, sawdust, crop residues) to produce eg animal feed, organic fertiliser, biofuel Processing of raw materials in small local plants can create new local income streams <div>  <p>Pelletizing - the process of compressing or molding a material into the shape of a pellet.</p> <p>Source: Colmorgen and Khawaja (2019)</p> <p>Small pellet plant with a capacity of 50-120kg/h from GEMCO Energy. Source: Colmorgen and Khawaja (2019)</p> </div>	<p>Pelletizing is a pressure agglomeration process that can be used to improve the mechanical and physical properties of solid biofuels. The compacting process leads to the formation of larger fuel particles with reduced surface area. The technology is often used to homogenize the mechanical properties, increase the density and improve the transportation and handling properties. Depending on the feedstock, a water content of 10-15 % is needed to achieve the required physical fuel properties (Colmorgen and Khawaja, 2019)</p> <p>Colmorgen, F., Khawaja, C. (2019): Small-scale technology options for regional bioeconomies. BE-Rural Project, https://be-rural.eu/. WIP Renewable Energies, Munich.</p> <p>Company: GEMCO http://www.biofuelmachines.com/</p> <p>The process of pelletising includes the following steps: (Colmorgen, Khawaja and Rutz (2020))</p> <ol style="list-style-type: none"> 1. Initial size reduction (chipping) if it is not already in a small size (e.g. sawdust) 2. Drying until a moisture content of 8-12% 3. Fine grinding using a hammer mill which will grind the raw materials into smaller pieces with a diameter under 5 mm 4. Pelletising where pellets are extruded using special dies. High pressure and temperatures are needed in this process, which softens lignin in the wood and binds the material in the pellet together 5. Cooling which allows the pellets to become rigid 6. Bagging and truck loading <p>Colmorgen, F., Khawaja, C. and Rutz, D., (2020): <i>Handbook on regional and local bio-based economies</i>, available at: [https://be-rural.eu/wp-content/uploads/2020/03/BE-Rural_D2.5_Handbook.pdf]</p>
<div>  Forestry technology: The containerised pyrolysis unit </div> <div> ETIA Biogreen </div> <ul style="list-style-type: none"> Fossil-free pyrolysis process (thermal decomposition of materials at high temperatures in an inert environment) Highly versatile system for converting biomass (wood, crops & forest residues) & waste into high-value products & energy (pyrolysis oil, syngas, biochar, heat, wood vinegar) Ready-to-use technology that is suitable for fast, temporary applications, & can easily be shipped or stored Suitable for decentralised use on a small-scale, thus creating new income streams <div>  <p>Biogreen containerised pyrolysis unit. Source: Colmorgen and Khawaja (2019)</p> <p>Biogreen's patented technology. Source: Colmorgen and Khawaja (2019)</p> </div>	<p>"Pyrolysis is the thermal decomposition of materials at high temperatures in an inert environment. The treatment leads to the formation of new molecules and is irreversible. The exclusion of oxygen during the treatment provokes high energy contents in the products received, that often have a more superior character than the original residue. Biogreen® offers a fossil-free pyrolysis process that allows to convert various feedstocks into bio-based products and renewable energy. By not emitting carbon, replacing petroleum-based products and thus sequestering carbon, Biogreen® contributes to the decarbonization of industries. Biogreen® offers a continuous process based on the Spirajoule® technology, an exclusive process for thermal treatment. The centerpiece of the process is a hollow shaft screw conveyor that is heated by a low voltage current." (Colmorgen and Khawaja, 2019)</p> <p>Colmorgen, F., Khawaja, C. (2019): Small-scale technology options for regional bioeconomies. BE-Rural Project, https://be-rural.eu/. WIP Renewable Energies, Munich.</p> <p>Biogreen© is a simple and flexible pyrolysis solution to produce biochar, oil, solid fuels and syngas from your biomass residues. Company website → (http://www.biogreen-energy.com/)</p>





Slide	Notes for teacher, comments and links
<p>Forestry technology: Biomaterials from agro-forestry residues & mycelium</p> <p>Spawnfoam</p> <ul style="list-style-type: none"> A 100% biodegradable, biocomposite material made of fungi, organic additives & biomass from local agroindustry & forestry Mycelium acts as a bonding agent to cohere the biomass particles The biocomposite material can be pressed & moulded into different shapes (eg pots, packaging material, construction material) The biocomposites are as effective & efficient as their fossil-based counterparts but are harmless or beneficial to the natural environment  <p>Source: Colmorgen and Khawaja (2019)</p>	<p>“Spawnfoam developed a process, which enables them to produce an innovative biocomposite material made of fungi, organic additives and biomass from the surrounding agroindustry and forestry. The chopped and blended biomass used is the raw material base for the process. The key of Spawnfoam is the application of mycelium, which works as a bonding agent to cohere the biomass particles. Finally, the composite material can be pressed and molded in different shapes, depending on the desired product” (Colmorgen and Khawaja, 2019).</p> <p>Colmorgen, F., Khawaja, C. (2019): Small-scale technology options for regional bioeconomies. BE-Rural Project, https://be-rural.eu/. WIP Renewable Energies, Munich.</p>
<p>Forestry technology: Mobile wood chipping units</p> <p>Erpék Ind SRL</p> <ul style="list-style-type: none"> The mobile wood chipping unit is highly flexible as it is mounted on a trailer chassis & can operate without an external power source The wood chipper requires only a small investment (c. €17,000) & payback can be reached after running for 900 hours Simple technology & high replication potential means good scope for new income streams Wood chips have various potential uses (e.g. solid fuel, wood pulp production, mulch)  <p>Mobile wood chipping unit (Erpék Ind 2019) Source: Colmorgen and Khawaja (2019)</p>	<p>“Erpék Ind offers a mobile wood chipping unit which can be fed with wood based raw material from forest industry, agriculture and municipalities. The woodchipper is mounted on a trailer chassis why it is highly flexible and suitable for different surfaces. Since the woodchipper is driven by an integrated 60 HP diesel engine, it can work autonomously without any external power. The feeding of the chipper is done manually. In one hour, up to 15 m3 of chipped biomass can be produced. The volume of the raw materials can be reduced to 25% whereby the transport and logistic process of wood materials becomes simpler and cheaper”. (Colmorgen and Khawaja, 2019)</p> <p>Colmorgen, F., Khawaja, C. (2019): Small-scale technology options for regional bioeconomies. BE-Rural Project, https://be-rural.eu/. WIP Renewable Energies, Munich.</p> <p>Wood chips can be divided into the following groups: Forest chips (produced from logs, whole trees, logging residues, or stumps) Wood residue chips (produced from untreated wood residues, recycled wood, offcuts) Sawing residue chips (produced from sawmill residues) Short rotation coppice chips (produced from energy crops)” (European Technology and Innovation Platform (2020) Wood chips, available at: http://www.etipbioenergy.eu/value-chains/feedstocks/forestry/wood-chips)</p>
<p>Example of bioproduct</p> <p>Health Drink Ho-Fi</p>  <p>Source: Biolat, 2019</p> <p>Company Name: Biolat Country: Latvia Feedstock: conifer needle foliage Description: Coniferous sodium chlorophyllin is a concentrate of chlorophyll derivatives obtained from coniferous (mainly SPRUCE) extracts. It contains water-soluble chlorophyll derivatives (chlorines, feopitins, feoforbides), coniferous paraffinic acids and fatty acids sodium salts and other compounds. Sodium chlorophyll stimulates the body's overall immunity.</p>	<p>The Latvia Bioeconomy Strategy includes producing more sustainable and environmentally-friendly products, and also completely new products (Country Profile: Latvia [https://bioekonomierat.de/fileadmin/profiles_for_map/Country_profile_Latvia_1.pdf])</p> <p>Image and product information: Biolat ‘Healthy drink Ho-Fi 0.05 %’ (2020a) available at: [https://www.biolat.lv/en/products/hofi-en/]</p>
<p>Example of bioproduct</p> <p>Eco Hairbrush</p>  <p>Source: Wild Good, 2020</p> <p>Company Name: Wild Good Country: Latvia Feedstock: boar hair and sustainably sourced wood Description: Hairbrush with wild boar skin, these bristle brushes are made of wild boar bristle and 100 percent chemical free wood. Boar bristles have been used for centuries and according to the producers they give hair strength, suppleness and get rid of static electricity. Boars are numerous in Latvian forests and hunted for their meat, to control the population and to allow agriculture. The fur is a by-product and would otherwise be thrown away. Conventional Product: Plastic Hairbrush</p>	<p>Questions: How do they link with the SDGs? – less plastic use What other plastic products can be made of wood instead? – link to products in their everyday life https://www.wild-good.com/</p>

Slide	Notes for teacher, comments and links
<div>  Example of bioproduct </div> <div>Cosmetics Containers</div> <div>  </div> <div>Source: Sulapac, 2020</div> <div>  </div> <div> <p>Company Name: Sulapac Country: Finland Feedstock: wood and biodegradable, plant-based binders Description: biodegradable and microplastic-free material made entirely from renewable sources and certified wood. It can be used as packaging for everything from cosmetics to foodstuff to gift boxes and more. It has all the benefits of plastic, yet it biodegrades completely and leaves no trace once it's gone CO₂ and Water: Carbon neutral Conventional Product: Plastic packaging</p> </div>	<p>These products are also made from forest biomass and with further investment and development in the Latvian regions these too could be produced there.</p> <p>Guess what the products are made from before explaining. Discuss benefits and who would be willing to buy this instead https://www.sulapac.com/.</p>
<div>  Example of bioproduct </div> <div>Bathroom Sink</div> <div>  </div> <div>Source: Woodio, 2020</div> <div>  </div> <div> <p>Company Name: Woodio Ltd Country: Finland Feedstock: small woodchips bound together with resin Description: Approximately 80% of the material is solid wood. All Woodio products are disposable as energy waste at the end of their lifecycle. CO₂ and Water: Woodio products have a significantly lower carbon footprint, throughout the whole product lifecycle, than similar traditional ceramic bathroom fixtures. In fact, 55kg lower per unit. Conventional Product: Ceramic sinks and bathtubs</p> </div>	<p>Guess percentage of material that is wood before showing information.</p> <p>Discuss benefits and drawbacks of using woodbased sink. https://woodio.fi/</p>
<div>  Example of bioproduct </div> <div>Plant Pots</div> <div>  </div> <div>Source: Spawnfoam, 2020</div> <div>  </div> <div> <p>Company Name: Spawnfoam Country: Portugal Feedstock: By-products and residues from agriculture and forestry; mycelium Description: 100% biodegradable, contributing to: + Environmental sustainability; + Decarbonization; + Ecological footprint reduction. CO₂ and Water: the biocomposites have the potential to replace petroleum-based products, they reduce the dependence on fossil fuels and GHG emissions. Thus, Spawnfoam helps reducing the ecological footprint and contributes actively to decarbonization Conventional Product: Plastic or ceramic pots</p> </div>	<p>Presenter can ask which SDGs linked to the product before they appear.</p> <p>Spawnfoam (2020) 'Products' available at: http://www.spawnfoam.pt/en/#products</p>
<div>  Example of bioproduct </div> <div>Biofuel</div> <div>  </div> <div>Drax Power Station, Source: Drax, 2020</div> <div>  </div> <div> <p>Company Name: Drax (Drax Power Station together with Drax Biomass) Country: United Kingdom Feedstock: wood chips and pellets, largely made up of low-grade wood and low value residues produced as a bi-product of the production and processing of higher value solid wood products (e.g. saw-timber for construction and furniture). Description: produced from burning wood chips. Europe's largest biomass-fuelled power station. Wood pellets to produce 17% of the UK's renewable energy. Drax Biomass manufactures compressed wood pellets produced from sustainably managed working forests CO₂ and Water: Wood pellets at Drax: Lead to 80% less CO₂ than coal, including supply chain emissions Conventional Product: fossil fuel</p> </div>	<p>Discuss renewable energy – why do we still use fossil fuels? https://www.drax.com/</p>
<div>  Conclusion </div> <div> <ul style="list-style-type: none"> • Forestry is one key sector of the bioeconomy • Several feedstocks have the potential to create a wide range of products • The Bioeconomy can help meet SDG targets – for forest-based bioeconomies: SDG 15 is the most relevant • Biobased products may also result in less use of water and less CO₂ emissions </div>	<p>Final summary points.</p>

Slide	Notes for teacher, comments and links
	<p>Notes to the teacher: Speaker's name to go in the space at the bottom left of the slide. This is the final slide of the presentation. Allow time for students/participants to ask any questions.</p>
 <p>These educational resources were developed as part of the BE-Rural project Bio-based strategies and roadmaps for enhanced rural and regional development in the EU (April 2019 – March 2022)</p> <p>BE-Rural supports</p> <p>... regional stakeholders in five countries:</p> <ul style="list-style-type: none"> Latvia: Vidzeme and Kurzeme Poland: Szczecin and Vistula Lagoons Romania: Covasna Bulgaria: Stara Zagora North Macedonia: Strumica <p>https://be-rural.eu/innovation-regions/</p> <p>The goal of BE-Rural is to realise the potential of regional bio-based economies by supporting relevant actors in the participatory development of bioeconomy strategies and roadmaps</p>	<p>BE-Rural will create five regional Open Innovation Platforms (OIPs) for the participatory development of bioeconomy strategies and roadmaps.</p> <p>Stara Zagora, Bulgaria: will focus on seeking new technologies for the application of essential oils and herbal plants in the cosmetics and pharmaceutical industry.</p> <p>Vidzeme and Kurzeme, Latvia: will focus on the potential of by-products of forest management (i.e. from young forest stand thinning, short rotation coppice and forestry plantations, removing of overgrowth in abandoned agricultural lands and perennial grasses) as a source of bioenergy or biorefinery.</p> <p>Strumica, North Macedonia: will focus on the utilization of agricultural residues, specifically the by-production of organic materials from agricultural activities, as a source of energy for domestic and industrial purposes.</p> <p>Szczecin Lagoon and Vistula Lagoon, Poland: will focus on small-scale fisheries, specifically on the sustainable use of currently underused and low-value fish species located in two lagoons.</p> <p>Covasna, Romania: will focus on addressing fragmented value chains and implementing the circular economy concept within the county's industrial sectors (i.e. wood and furniture, textiles, agro-food, mechanical engineering, green energy).</p> <p>Source: BE-Rural (2020), <i>Innovation regions</i>, available at: https://be-rural.eu/innovation-regions/</p>







Annex XII - Power Point slides and notes on "Bioeconomy in the fisheries sector"

Slide	Notes for teacher, comments and links
	<p>Notes to the teacher: Teacher's name to go in the space at the bottom left of the slide. Explain that this presentation will explore the potential of the bioeconomy in the fishery sector, by learning about its potentials and challenges. Two small case studies will be presented: Poland and the Faroe Islands. Finally, we will learn about some interesting bioproducts resulting from the implementation of a bio-based economic framework.</p> <p>Excluding this first slide, outline slide and the video, there are 10 slides – so these slides should take between 10 and 20 minutes to present, depending of amount of explanation. The video is 2 minutes and 9 seconds long.</p>
	<p>Notes to the teacher: Briefly run through the topics that will be spoken about in this presentation as shown on the slide.</p>
	<p>Notes to teacher: Explain to class that in order to take steps towards sustainability and the avoidance of reaching ecological limits the bioeconomy is very important. The bioeconomy is the production of goods, services, or energy from biological material as the main resource. This is strongly linked to sustainability as biodegradable resources are often used and waste is often completely designed out of the system. This can avoid the depletion of resources for future generations and protect the stability of the planet. The European Commission is taking steps towards a sustainable bioeconomy. Turning waste into valuable resources and creating incentives to help retailers and consumers cut food waste. The European Commission has a bioeconomy strategy to promote the bioeconomy and avoid reaching ecological limits.</p> <p>European Commission (2018), <i>A sustainable Bioeconomy for Europe: strengthening the connection between economy, society and the environment. Updated Bioeconomy Strategy</i>. Directorate-General for Research and Innovation, available at: https://ec.europa.eu/research/bioeconomy/pdf/ec_bioeconomy_strategy_2018.pdf accessed: 22 May 2020].</p>
	<p>1. <i>Explain bioeconomy to introduce topic and contextualise bioproducts portfolio.</i></p> <p>Bioeconomy is defined as the production, utilization and conservation of biological resources to provide information, products, processes and services across all economic sectors aiming towards a sustainable economy (Bell et al., 2018). Bell, J., Paula, L., Dodd, T., Németh, S., Nanou, C., Mega, V. and Campos, P. (2018). EU ambition to build the world's leading bioeconomy—Uncertain times demand innovative and sustainable solutions. <i>New Biotechnology</i>, 40: 25–30.</p> <p>Video (2 minutes and 9 seconds): https://www.youtube.com/watch?v=RfRN_hHelKk Languages for sub-titles for video include: Bulgarian, Latvian, Macedonian, Polish and Romanian</p> <p>2. <i>Explain circular economy to give context to bioproducts.</i></p>


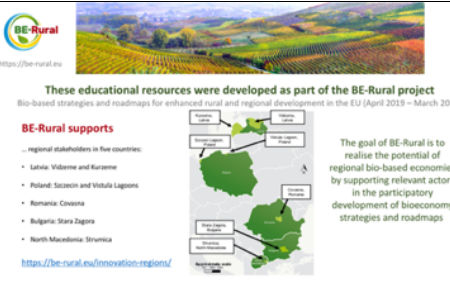
Slide	Notes for teacher, comments and links
 <p>Ecological limits</p> <p>In addition to links to sustainability and climate change mitigation, it is critical that the bioeconomy operates within safe ecological limits.</p> <p>With the new bioeconomy strategy, the European Commission supports initiatives at national and regional level to develop an efficient and sustainable bioeconomy and this includes:</p> <ul style="list-style-type: none"> • implementing an EU-wide monitoring system to track progress towards a sustainable and circular bioeconomy. • providing guidance on how best to operate the bioeconomy within safe ecological limits. 	<p>Circular Economy is a framework for the development and management of sustainable, waste-as-resource economic system. It aims to keep products, components and materials at the highest utility and value at all times (EC, 2018).</p> <p>European Commission (2018), <i>A sustainable Bioeconomy for Europe: strengthening the connection between economy, society and the environment. Updated Bioeconomy Strategy</i>. Directorate-General for Research and Innovation, available at: https://ec.europa.eu/research/bioeconomy/pdf/ec_bioeconomy_strategy_2018.pdf</p> <p>Notes to teacher: Explain that to try and tackle the issues surrounding ecological limits: National and international bodies have specific guidelines. An example of this is the European Commission's 2018 publication; 'A new bioeconomy strategy for a sustainable Europe.' Further information available at: https://ec.europa.eu/commission/news/new-bioeconomy-strategy-sustainable-europe-2018-oct-11-0_en</p> <p>Key reading: EC (2018), Bioeconomy: A new strategy for a sustainable Europe Restoring healthy ecosystems and enhancing biodiversity. European Commission https://ec.europa.eu/research/bioeconomy/pdf/ec_bioeconomy_actions_2018.pdf</p> <p>Could also check for more advanced reading: Giampietro, M. (2019). On the circular bioeconomy and decoupling: implications for sustainable growth. <i>Ecological economics</i>, 162, 143-156. https://www.sciencedirect.com/science/article/pii/S0921800918317178</p> <p>Vivien, F. D., Nieddu, M., Befort, N., Debref, R., & Giampietro, M. (2019). The hijacking of the bioeconomy. <i>Ecological economics</i>, 159, 189-197. https://www.sciencedirect.com/science/article/abs/pii/S0921800918308115</p>
 <p>Bioeconomy challenges: Resource Provision and Biodiversity loss</p> <p>Bioproducts are derived from renewable biological resources. The bioeconomy makes use of many different biomass resources, from crops to forests to microorganisms. Without these feedstocks, there would be no bioeconomy.</p> <p>It is critical that the bioeconomy does not compete with food production and does not affect biodiversity. For example, marginal lands may not be used for food production but may be important for biodiversity</p> <p>It is therefore fundamental to carry a biodiversity assessment.</p>	<p>Key reading: The Bioeconomy Consultants (2018), BIG BIOECONOMY CHALLENGES - PART 2. https://www.nnfcc.co.uk/news-big-bioeconomy-challenges-2</p> <p>Brownlie, S. (2013), IAIA fast tips No. 5 - Biodiversity Assessment. International Association for Impact Assessment (IAIA). https://www.iaia.org/fasttips.php</p> <p>See slides "What is the Bioeconomy? Opportunities, challenges and solutions" for information on:</p> <ul style="list-style-type: none"> - Bioeconomy – links to SDGs and climate change, and bioeconomy resources - The transition to a bioeconomy is complex - Biodiversity assessment - Direct, indirect and cumulative impacts - What are 'impacts and need for Environmental Impact Assessment (EIA) and/or Strategic Environmental Assessment (SEA). - Net positive outcomes, enhancement and the mitigation hierarchy - Example: the impacts of biofuels
 <p>Fisheries feedstock</p> <p>What are examples of bioeconomy feedstocks (or raw materials) in the fisheries & aquaculture sector?</p> <p>In groups of two discuss and write a list of all the bioeconomy feedstocks (or raw materials) from the fishery and aquaculture sector that you can think of.</p> <p>You have 2 minutes</p>	<p>Ask students to write a list of all the bioeconomy feedstocks (or raw materials) from the fisheries and aquaculture sector. The next slide has a list of these materials.</p> <p>Fisheries could be inland or marine; aquaculture could be inland or marine (mariculture).</p>

Slide	Notes for teacher, comments and links
<div></div> <div>Fisheries feedstock</div> <p>Examples of bioeconomy feedstocks in the fisheries & aquaculture sector</p> <ul style="list-style-type: none"> • micro and macro algae (also potentially beach-cast algae) • water plants (also from aquaponics) • fish (including low-grade fish and fish by-products: bones, skin, oils, heads, viscera, tails, fins, scales, mince, blood, fish excrements*) • crustaceans (including by-products: shrimp tails, crab shells), • shellfish (including by-products: scallops shells, mussel shells), • other invertebrates (including jellyfish), provided they are sustainably produced. <p>* fish excrements (recovered on filters and settling tanks) from aquaculture is valuable biomass for the production of agricultural fertilizers.</p>	<p>Examples of bioeconomy feedstocks in the aquaculture & marine sector. Source: Bio-based Industries Consortium (2019), Examples of bioeconomy feedstocks. https://ec.europa.eu/knowledge4policy/glossary/feedstock_en</p> <p>The European bioeconomy in the fishery sector is estimated to have a turnover of £10bn (EC, 2018a). It also involves 200,000 jobs across all Member States of the EU. Although the processing and trading of fish products is of high importance for the European economy, it generates high amounts of waste during the cycle (EC, 2018b). Processing of fish gives rise to by-products in the form of heads, viscera, shells, frames, skins and others such as tails, fins, scales, mince, blood, etc. These leftovers generated while processing fish are extremely valuable as raw material. The most traded feedstock, and therefore the highest generators of fish waste, are: salmon, tuna, shrimps, and other crustaceans (FAO, 2013). One of the major issues in the fish sector is finding a place for the amounts of fish mort. Its main disposal system is burning the waste in order to produce energy. However, techniques to generate energy from fish waste are still limited. Roughly 66% of fishmeal made from by-products originates from wild capture fish and 34% from aquaculture (EC, 2018c). There are currently many technologies under development to enhance and optimise our use of all fishery resources, from raw material to what we consider as “waste-as-resource” (Europarl, 2020). Most common feedstock after processing fish is: fish processing residues, fish waste, and low value fish. From these it is common to obtain products such as animal feed, Omega-3 fish oil, and protein hydrolysates (*).</p> <p>(*) Protein hydrolysates: any product of hydrolysis. Protein hydrolysate has special application in sports medicine because its consumption allows amino acids to be absorbed by the body more rapidly than intact proteins, thus maximizing nutrient delivery to muscle tissues.</p> <p>References</p> <p>Europarl.europa.eu. 2020. The Fish Meal And Fish Oil Industry - Its Role In The Common Fisheries Policy - Think Tank. https://www.europarl.europa.eu/thinktank/en/document.html?reference=IPOL-PECH_ET(2003)341942</p> <p>EC, 2018a. A Sustainable Bioeconomy For Europe: Strengthening The Connection Between Economy, Society And The Environment. Bioeconomy Strategy. https://ec.europa.eu/research/bioeconomy/pdf/ec_bioeconomy_strategy_2018.pdf</p> <p>EC, 2018b. Facts And Figures On The Common Fisheries Policy. https://ec.europa.eu/fisheries/sites/fisheries/files/docs/body/pcp_en.pdf</p> <p>EC, 2018c. Targeting fish parasites for a healthier aquaculture industry. https://ec.europa.eu/research/infocentre/article_en.cfm?&artid=49518&caller=other</p> <p>FAO, 2013. Fish to 2030. Prospects For Fisheries and Aquaculture. Agriculture and Environmental Services. http://www.fao.org/3/i3640e/i3640e.pdf</p>

Slide	Notes for teacher, comments and links
<div>  Examples of bioproducts </div> <p>Bioproducts are materials, chemicals or energy derived from renewable biological resources</p> <div>  </div> <p>In the next slides you will see some bioproducts based on "waste" from the fisheries sector.</p>	<p>Bioproducts are materials, chemicals or energy derived from renewable biological resources. It links to Circular Economy as big percentage of these products focus on reusing most of what we consider waste as their base material (European Commission, 2019). This way, discarded products are used in various ways, helping reduce the amount of waste that goes to landfill which takes decades to degrade and contaminates the environment while doing this. A big benefit of bioproducts is that generally the raw material can be grown, harvested and processed close to the point of consumption.</p> <p>The skin of fish is highly rich in nutrients and proteins. However, it is not a product we are willing to eat. Therefore, fish processing plants remove this part of the fish before it reaches the market (FAO, 2020). These businesses are left, not only with the skin, but with guts, bones and other waste generated through the process. What to do with these "waste", is a very common question.</p> <p>Well, many European countries have decided these are not waste but by-products which means skin, guts and bones from fish can still be processed and used to either create new products or implement them in old ones (European Commission, 2018). In the next slides you will see some Bioproducts based on "waste" from the fishery sector.</p> <p>References European Commission, 2018. Facts And Figures On The Common Fisheries Policy. Basic Statistical Data. [online] Luxembourg: Imprimerie Centrale. Available at: https://ec.europa.eu/fisheries/sites/fisheries/files/docs/body/pc_p_en.pdf European Commission, 2019. <i>European Bioeconomy Strategy Graphic</i>. [online] Available at: https://ec.europa.eu/knowledge4policy/publication/updated-bioeconomy-strategy-2018_en Fao.org. 2020. Fish Silage. [online] Available at: http://www.fao.org/3/x5937e/x5937e01.htm</p>
<div>  Examples of bioproducts </div> <p>Cosmetics</p> <ul style="list-style-type: none"> • Natural collagen - made of top-quality ecological materials, essentially skin of freshwater and saltwater fish • Nail Polisher - natural and water-based nail-polisher made from algae <div>  </div> <div>  <p>Baltic collagen, 2020</p> </div>	<p><i>1st slide introducing bioproducts related to the waste in the fishery sector. These bioproducts are related to the cosmetics field.</i></p> <p>One of the most famous applications for fish-waste products is recovering the nutrients and proteins within the skin to produce high-quality natural collagen. This collagen is then used to create cosmetics and some pharmaceutical products. Baltic cosmetics are one of the first companies in the Nordic countries to manufacture and launch bioproducts obtained from fish-waste (Baltic cosmetics, 2020).</p> <p>An interesting product that was released last year by a german company is a water-based nail polisher made from recovered sea algae (Bioökonomie, 2020).</p> <p><i>*Explain how these products are linked to the SDGs – check out page sdgcompass.org for more information on the goals.*</i></p> <p>SDG2 SDG3 SDG12 SDG14 SDG15</p> <p>Image references: Baltic collagen, 2020 SDGcompass, 2020</p> <p>References: Baltic Collagen. 2020 [online] balticcollagen.pl. Available at: http://balticcollagen.pl/baltic-collagen-en/ Bioökonomie.de. 2020. Nail Polish Bioökonomie.De. [online] Available at: https://biooekonomie.de/en/produkt/nail-polish Sdgcompass.org. 2020. Learn More About The Sdgs – SDG Compass. [online] Available at: https://sdgcompass.org/sdgs/</p>





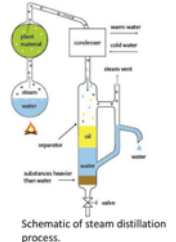
Slide	Notes for teacher, comments and links
<div>  </div> <div> Examples of bioproducts </div> <div> Food </div> <div> <ul style="list-style-type: none"> • Recovery of Omega-3 • Production of fish-based flours and powders • Extraction of fish oil </div> <div> <p>Example - Sea Chips - handcrafted salmon skin crisps, using the often wasted nutrient-packed skin.</p> </div> <div>  </div> <div>  </div>	<p>Slide includes food bioproducts made from fish waste and other products generated in the fishery sector. The main nutrient recovered from fish waste is Omega-3 as it is used for many applications in medicine and nutrition. In addition, there is a current increase in the production of fish-based flour, powders, and oils for cooking and as food supplements (European Commission, 2018b). This product that you see in the photo are salmon skin crisps developed by the company UK Seachips. These crisps are handcrafted and made from recovered skin of salmons in aquaculture farms (Seachips, 2020). A German company has created an algae chocolate called Algen shokolade (Algenheld, 2020). A scientist in the University of Puebla Mexico is developing a toothpaste highly rich in nutrients recovered from the bones of fish (Buap, 2020).</p> <p><i>*Explain how these products are linked to the SDGs – check out page sdgcompass.org for more information on the goals.*</i></p> <p>SDG2 SDG3 SDG12 SDG14 SDG15</p> <p>Image references: SDGcompass, 2020; Seachips, 2020</p> <p>References: Algenheld.de. 2020. Algenheld. https://algenheld.de/ Buap.mx. 2020. Investigador De La BUAP Desarrolla Pasta Dental Reciclando Hueso De Pescado, Benemérita Universidad Autónoma De Puebla. https://www.buap.mx/content/investigador-de-la-buap-desarrolla-pasta-dental-reciclando-hueso-de-pescado European Commission, 2018b. Facts And Figures On The Common Fisheries Policy. Basic Statistical Data. https://ec.europa.eu/fisheries/sites/fisheries/files/docs/body/pc_p_en.pdf Sdgcompass.org. 2020. Learn More About The Sdgs – SDG Compass. https://sdgcompass.org/sdgs/ seachips. 2020. Seachips. https://www.sea-chips.com/</p>
<div>  </div> <div> Examples of bioproducts </div> <div> Packaging </div> <div> <p>Ooho! - Sustainable packaging made from a combination of brown seaweed and plants</p> <ul style="list-style-type: none"> • Edible and tasteless packaging </div> <div> <p>MarinaTex - A home compostable alternative to plastic.</p> <ul style="list-style-type: none"> • Made from fish waste and compostable materials • Degrades in the soil environment within 6 weeks </div> <div>  </div> <div> <p>In 2019, London marathon runners were given edible seaweed pouches filled with a sports drink instead of plastic bottles.</p> </div> <div>  </div>	<p><i>This slide relates to produces made from fish waste for packaging food and objects, such as bio-plastic.</i></p> <p>Ooho! - sustainable version of conventinal packaging (Notpla, 2020). Made of brown seaweed and additional plants, it resembles plastic in almost all its properties. It was mainly created to replace most, if not all, single-use plastics in packaging. The final product is edible and tasteless and can be stored for long periods without affecting its characteristics.</p> <p>MarinaTex - is also a sustainable alternative to plastic made from fish waste and compostable materials. However, in most aspects, this bioproduct exceeds the characteristics from conventional plastics. For instance, it degrades in the environment within 6 weeks and does not release any toxins or harm the surroundings during the degradation process. Additionally, several tests have proven that at the same thickness, this material is stronger than LDPE (low-density polyethylene).</p> <p><i>*Explain how these products are linked to the SDGs – check out page sdgcompass.org for more information on the goals.*</i></p> <p>SDG2 SDG8 SDG9 SDG12 SDG13 SDG14 SDG15</p> <p>Image references: SDGcompass, 2020; Notpla, 2020</p> <p>References: MARINATEX. 2020. https://www.marinatex.co.uk/ Nace, T. (2019), London Marathon Runners Were Handed Seaweed Pouches Instead Of Plastic Bottles. Forbes, 29 April. https://www.forbes.com/sites/trevornace/2019/04/29/london-marathon-runners-were-handed-seaweed-pouches-instead-of-plastic-bottles/#2311b052ba20 Notpla. 2020. https://www.notpla.com/ Sdgcompass.org. 2020. https://sdgcompass.org/sdgs/ Video: London Marathon swaps plastic bottles for edible Ooho. https://www.youtube.com/watch?v=Z2Qz_2UtsPM</p>

Slide	Notes for teacher, comments and links
<div>  </div> <div> Examples of bioproducts </div> <div> Clothing </div> <div> <p>Bloom - Foam with different applications made from algae waste in polluted water. Material is biodegradable and helps mitigate negative effect from excessive algae growth.</p> </div> <div>  </div> <div>  </div>	<p><i>In this slide, algae as a waste from the fishery sector is explained.</i></p> <p>Another less commonly known waste produced during fishing is algae. The amount of algae extracted from the sea during commercial and industrial fishing is so high it is very difficult to give an accurate amount. These algae are then put back to the sea or disposed of with the rest of the waste. Initially this should not be a problem. However, an excess of algae in the sea can lead to the depletion of oxygen in these waters, a release of harmful toxins and to a variation in taste and odour in marine ecosystems.</p> <p>Algae are rich in potassium, calcium, iron and magnesium and provide many vitamins essential to human health. Moreover, scientist have proven that through the adequate processes, algae can be transformed into a super-material, as strong as steel but only half its weight.</p> <p>Bloom, a shoe manufacturer, is advocating to reduce the amount of toxic chemicals from human activity which are present in fresh-water. After years of researching in algae technology, they discovered that algae suffer a plasticization process after being subject to heat and pressure. They created the very first sustainable flexi-foam from algae (Bloom, 2020).</p> <p><i>*Explain how these products are linked to the SDGs – check out page sdgcompass.org for more information on the goals.*</i></p> <p>SDG2 SDG3 SDG8 SDG11 SDG12 SDG13 SDG14 SDG15</p> <p>Image references: BLOOM, 2020. https://www.bloomtreadwell.com EcoWatch. 2020. Researchers Turn Algae Into A Material As Hard As Steel. https://www.ecowatch.com/algae-science-material-hard-as-steel-2640980632.html Sdgcompass.org. 2020. Learn More About The Sdgs – SDG Compass. [online] Available at: https://sdgcompass.org/sdgs/</p>
<div>  </div> <div> Examples of Bioproducts </div> <div> Accessories </div> <div> <ul style="list-style-type: none"> Leather-type material from salmon skin </div> <div>  </div> <div>  </div> <div> <small>NANAI, 2020</small> </div>	<p>NANAI is a company which has developed a leather-type material made entirely from salmon skin.</p> <p><i>*Explain how these products are linked to the SDGs – check out page sdgcompass.org for more information on the goals.*</i></p> <p>SDG2 SDG8 SDG12 SDG14 SDG15</p> <p>Images references: NANAI, 2020. Nanai Leather – Salmo Leather – Lachsleder Product. https://www.salmo-leather.de/en/produkt/ Sdgcompass.org. 2020. Learn More About The Sdgs – SDG Compass. [online] Available at: https://sdgcompass.org/sdgs/</p>
<div>  </div> <div> Example of bioproducts </div> <div> <p>The company Cuantec produces anti-microbial, compostable food packaging that can make food last longer</p> </div> <div> <p>Process to extract chitin from the shells of langoustines and other sea creatures and process the chitin (*) to obtain chitosan (**).</p> </div> <div>  <p>(*) Chitin a fibrous substance consisting of polysaccharides, which is the major constituent in the exoskeleton of arthropods and the cell walls of fungi.</p> <p>(**) Chitosan is a sugar that is obtained from the hard outer skeleton of shellfish.</p> <p>Video from Cuantec (2 minutes and 52 seconds) https://www.youtube.com/watch?v=d9qw5pLiTjQ</p> </div>	<p>Cuantec is a Scottish blue biotech company with a circular economy model which tackles two of the world's worst problems – food waste and plastic pollution. They produce an anti-microbial, compostable food packaging which can extend the shelf-life of fresh seafood. They extract chitin from the shells of langoustines and other sea creatures and process the chitin to obtain chitosan.</p> <p><i>*Play video here (2 minutes and 52 seconds)</i> https://www.youtube.com/watch?v=d9qw5pLiTjQ</p> <p>The bioplastic produced by Cuantec can make food last longer. Cuantec have successfully moved away from the conventional and widely used chemical processes to produce chitosan. This process generally implements harmful chemicals and consumes a lot of energy. Instead their biological fermentation process uses 5 times less sodium hydroxide and eliminates the need for hydrochloric acid, making it more sustainable.</p> <p>Image references: Cuantec. 2020. Cuantec - Opening Up The Potential Of The Sea. [online] Available at: https://www.cuantec.com/</p>

Slide	Notes for teacher, comments and links
	<p>Notes to the teacher: Speaker's name to go in the space at the bottom left of the slide. This is the final slide of the presentation. Allow time for students/participants to ask any questions.</p>
 <p>These educational resources were developed as part of the BE-Rural project Bio-based strategies and roadmaps for enhanced rural and regional development in the EU (April 2019 – March 2022)</p> <p>BE-Rural supports</p> <ul style="list-style-type: none"> ... regional stakeholders in five countries: • Latvia: Vidzeme and Kurzeme • Poland: Szczecin and Vistula Lagoons • Romania: Covasna • Bulgaria: Stara Zagora • North Macedonia: Strumica <p>https://be-rural.eu/innovation-regions/</p> <p>The goal of BE-Rural is to realise the potential of regional bio-based economies by supporting relevant actors in the participatory development of bioeconomy strategies and roadmaps</p>	<p>BE-Rural will create five regional Open Innovation Platforms (OIPs) for the participatory development of bioeconomy strategies and roadmaps.</p> <p>Stara Zagora, Bulgaria: will focus on seeking new technologies for the application of essential oils and herbal plants in the cosmetics and pharmaceutical industry.</p> <p>Vidzeme and Kurzeme, Latvia: will focus on the potential of by-products of forest management (i.e. from young forest stand thinning, short rotation coppice and forestry plantations, removing of overgrowth in abandoned agricultural lands and perennial grasses) as a source of bioenergy or biorefinery.</p> <p>Strumica, North Macedonia: will focus on the utilization of agricultural residues, specifically the by-production of organic materials from agricultural activities, as a source of energy for domestic and industrial purposes.</p> <p>Szczecin Lagoon and Vistula Lagoon, Poland: will focus on small-scale fisheries, specifically on the sustainable use of currently underused and low-value fish species located in two lagoons.</p> <p>Covasna, Romania: will focus on addressing fragmented value chains and implementing the circular economy concept within the county's industrial sectors (i.e. wood and furniture, textiles, agro-food, mechanical engineering, green energy).</p> <p>Source: BE-Rural (2020), <i>Innovation regions</i>, available at: https://be-rural.eu/innovation-regions/</p>




Annex XIII - Power Point slides and notes on "Bioeconomy in the sector of essential oils and herbs for cosmetics/pharmaceuticals"


Slide	Notes for teacher, comments and links
 <p>New technologies for processing herbs and producing essential oils for the cosmetics and pharmaceutical industries</p>  <p>Name of presenter</p>	<p>Notes to the teacher:</p> <p>Teacher's name to go in the space at the bottom left of the slide. Explain that this presentation introduces the new technologies for processing herbs and producing essential oils for the cosmetics and pharmaceutical industries.</p> <p>Excluding the video, the outline slide and this first slide, there are 11 slides – so these slides should take between 11 and 22 minutes to present, depending of amount of explanation.</p>
 <p>Presentation Content</p> <ol style="list-style-type: none"> 1. Bioeconomy overview 2. What are essential oils and herbs and how are they made? 3. Case study bioproducts <ol style="list-style-type: none"> a) Herbs in cosmetics b) Herbs in pharmaceuticals c) Essential oils in cosmetics d) Essential oils in pharmaceuticals 3. Extracting oils from coffee waste 4. SDGs applicable to producing bioproducts in the cosmetics and pharmaceutical industries 5. Examples of the use of Bulgarian rose and snail oil 	<p>Notes to teachers:</p> <p>Explain the structure of the lecture to students to set the scene on what will be covered.</p> <p>The lecture provides information on the processing of essential oils and herbs for use in the cosmetics industry and gives some examples of how these are currently being used. Links to the Sustainable Development Goals (hereafter SDGs) are also made to highlight the additional socioeconomic benefits which creating bioeconomies in these industries bring.</p>
 <p>Bioeconomy overview</p> <p>The Bioeconomy...</p> <ul style="list-style-type: none"> • Is the production of goods, services, or energy from biological material as the main resource. • Is strongly linked to sustainability as biodegradable resources are often used and waste is often completely designed out of the system. • Can avoid the depletion of resources for future generations and protect the stability of the planet. <p>European Bioeconomy Strategy</p> <p>The European Commission is taking steps towards a sustainable bioeconomy and has a bioeconomy strategy to promote the bioeconomy and to avoid reaching ecological limits.</p> 	<p>Notes to teacher: Explain to class that in order to take steps towards sustainability and the avoidance of reaching ecological limits the bioeconomy is very important. The bioeconomy is the production of goods, services, or energy from biological material as the main resource. This is strongly linked to sustainability as biodegradable resources are often used and waste is often completely designed out of the system. This can avoid the depletion of resources for future generations and protect the stability of the planet. The European Commission is taking steps towards a sustainable bioeconomy. Turning waste into valuable resources and creating incentives to help retailers and consumers cut food waste. The European Commission has a bioeconomy strategy to promote the bioeconomy and avoid reaching ecological limits.</p> <p>European Commission (2018), <i>A sustainable Bioeconomy for Europe: strengthening the connection between economy, society and the environment. Updated Bioeconomy Strategy</i>. Directorate-General for Research and Innovation, available at: https://ec.europa.eu/research/bioeconomy/pdf/ec_bioeconomy_strategy_2018.pdf accessed: 22 May 2020].</p>
 <p>Bioeconomy overview</p> <p>Bioeconomy and Circular Economy – waste is a valuable resource</p>   <p>Video (2 minutes and 9 seconds): https://www.youtube.com/watch?v=RfRN_hHeIKk Languages for sub-titles for video include: Bulgarian, Latvian, Macedonian, Polish and Romanian</p>	<p>1. <i>Explain bioeconomy to introduce topic and contextualise bioproducts portfolio.</i></p> <p>Bioeconomy is defined as the production, utilization and conservation of biological resources to provide information, products, processes and services across all economic sectors aiming towards a sustainable economy (Bell et al., 2018). Bell, J., Paula, L., Dodd, T., Németh, S., Nanou, C., Mega, V. and Campos, P. (2018). EU ambition to build the world's leading bioeconomy—Uncertain times demand innovative and sustainable solutions. <i>New Biotechnology</i>, 40: 25–30.</p> <p>Video (2 minutes and 9 seconds): https://www.youtube.com/watch?v=RfRN_hHeIKk Languages for sub-titles for video include: Bulgarian, Latvian, Macedonian, Polish and Romanian</p> <p>2. <i>Explain circular economy to give context to bioproducts.</i></p>






Slide	Notes for teacher, comments and links
	<p>Circular Economy is a framework for the development and management of sustainable, waste-as-resource economic system. It aims to keep products, components and materials at the highest utility and value at all times (EC, 2018). European Commission (2018), <i>A sustainable Bioeconomy for Europe: strengthening the connection between economy, society and the environment. Updated Bioeconomy Strategy</i>. Directorate-General for Research and Innovation, available at: https://ec.europa.eu/research/bioeconomy/pdf/ec_bioeconomy_strategy_2018.pdf</p>
 <p>Ecological limits</p> <p>In addition to links to sustainability and climate change mitigation, it is critical that the bioeconomy operates within safe ecological limits.</p> <p>With the new bioeconomy strategy, the European Commission supports initiatives at national and regional level to develop an efficient and sustainable bioeconomy and this includes:</p> <ul style="list-style-type: none"> • implementing an EU-wide monitoring system to track progress towards a sustainable and circular bioeconomy. • providing guidance on how best to operate the bioeconomy within safe ecological limits. 	<p>Notes to teacher: Explain that to try and tackle the issues surrounding ecological limits: National and international bodies have specific guidelines. An example of this is the European Commission's 2018 publication; 'A new bioeconomy strategy for a sustainable Europe.' Further information available at: https://ec.europa.eu/commission/news/new-bioeconomy-strategy-sustainable-europe-2018-oct-11-0_en</p> <p>Key reading: EC (2018), Bioeconomy: A new strategy for a sustainable Europe Restoring healthy ecosystems and enhancing biodiversity. European Commission https://ec.europa.eu/research/bioeconomy/pdf/ec_bioeconomy_actions_2018.pdf Could also check for more advanced reading: Giampietro, M. (2019). On the circular bioeconomy and decoupling: implications for sustainable growth. <i>Ecological economics</i>, 162, 143-156. https://www.sciencedirect.com/science/article/pii/S0921800918317178 Vivien, F. D., Nieddu, M., Befort, N., Debref, R., & Giampietro, M. (2019). The hijacking of the bioeconomy. <i>Ecological economics</i>, 159, 189-197. https://www.sciencedirect.com/science/article/abs/pii/S0921800918308115</p>
 <p>Bioeconomy challenges: Resource Provision and Biodiversity loss</p> <p>Bioproducts are derived from renewable biological resources. The bioeconomy makes use of many different biomass resources, from crops to forests to microorganisms. Without these feedstocks, there would be no bioeconomy.</p> <p>It is critical that the bioeconomy does not compete with food production and does not affect biodiversity. For example, marginal lands may not be used for food production but may be important for biodiversity</p> <p>It is therefore fundamental to carry a biodiversity assessment.</p>	<p>Key reading: The Bioeconomy Consultants (2018), BIG BIOECONOMY CHALLENGES - PART 2. https://www.nnfcc.co.uk/news-big-bioeconomy-challenges-2 Brownlie, S. (2013), IAIA fast tips No. 5 - Biodiversity Assessment. International Association for Impact Assessment (IAIA). https://www.iaia.org/fasttips.php See slides "What is the Bioeconomy? Opportunities, challenges and solutions" for information on:</p> <ul style="list-style-type: none"> - Bioeconomy – links to SDGs and climate change, and bioeconomy resources - The transition to a bioeconomy is complex - Biodiversity assessment - Direct, indirect and cumulative impacts - What are 'impacts and need for Environmental Impact Assessment (EIA) and/or Strategic Environmental Assessment (SEA). - Net positive outcomes, enhancement and the mitigation hierarchy - Example: the impacts of biofuels
 <p>Technologies for processing essential oils</p> <ul style="list-style-type: none"> • Aromatic plants account for only ~10% of counted plant species globally (rare) e.g. lavender/peppermint • These synthesise a unique essence compound which often have health benefits due to their properties (antibacterial/antimicrobial) • Essential oils are extracted via steam distillation or mechanically through cold pressing • Can be combined to produce natural products such as face creams, medicines and aromatherapy/herbal remedies  <p>Schematic of steam distillation process.</p>	<p>Notes to teachers: Explain to students firstly what essential oils are and then how they are extracted from their plant material to be used in cosmetics and pharmaceutical products. Draw students attention to the schematic which illustrates the steam distillation process by providing an annotated diagram of the equipment used. Particularly highlight the rarity of essential oils and thus their potential to produce cosmetics and pharmaceuticals which can be marketed as luxury products and therefore can be a lucrative business opportunity for local manufacturers.</p> <p>Key Information Summary:</p>

Slide	Notes for teacher, comments and links
	<p>Plants and herbs which have properties valuable to the cosmetics/pharmaceutical industries (moisturizing, skin strengthening, antimicrobial etc). These can be distilled to access their essential oils which are unique to the plant and are often used in flavouring and perfumes. However, it is now being recognized that these could be used to build cosmetics and pharmaceutical economies in place where these types of plants grow well (for example in Stara Zagora). This is due to the recognition of the health benefits of essential oils and herbs such as reducing inflammation, dermatological benefits and wellbeing aromatherapy applications.</p> <p>Essential oils are present in small quantities (only about 10% of counted plant species globally) making them valuable commodities which can bring lucrative business opportunities and be used to create luxury cosmetics and pharmaceuticals products. Common examples of aromatic plants include lavender and peppermint and these are particularly pertinent to the cosmetics and pharmaceuticals industry. These are seen as luxury products, often more expensive but of higher quality and a more natural alternative to synthetic chemicals used in such products. Therefore, utilizing essential oils from plants can reduce the adverse environmental effects associated with producing synthetic chemicals (energy use etc) and disposal of these chemicals (effluent water pollution and ecosystem disruption).</p> <p>Essential oils are mainly extracted through steam distillation as seen in the schematic on the slide. Plant material is heated by steam and the vapours are passed through a condenser to separate the essential oil from the floral waters by virtue of their different boiling points, allowing the essential oil to be collected and then used to make cosmetics products and pharmaceuticals which are then enhanced with the properties of the natural essential oil. This reduces the need for the manufacturing of essential oils which has environmental benefits in terms of reducing pollution of water systems (not as many potential harmful synthetic chemicals are entering back into the water systems) and reducing resource use (not as much energy, carbon and water is needed for steam distillation of natural materials than producing synthetic chemicals in factories and using local produce reduces the need to transport resources between manufacturing plants).</p> <p>Key Links to Further Information: https://techni-pharma.fr/en/essential-oils/ https://www.pharmatutor.org/articles/essential-oil Rios, J. (2016). 'Chapter 1 - Essential Oils: What They Are and How the Terms Are Used and Defined.' In: Preedy, V.R. (Ed). <i>Essential Oils in Food Preservation, Flavour and Safety</i>, Academic Press, London, pp3-10. Figure source: https://www.pinterest.com/pin/228135537350517432/</p>
 <p>New technologies for processing herbs</p> <p>Drying of Herb → Grinding of herb to powder → Evaporation → Further processing</p> <p>Rotary Evaporator</p> <p>Condenser, Inlet Valve, Flange, Receiving Flask, Digital Control, Motor, Evaporating Flask, Heating Bath</p>	<p>Notes to teachers: Explain to students the way herbs are dried, ground and evaporated to be used in cosmetics and pharmaceuticals, highlighting emerging technology of Supercritical Fluid Extraction (SFE) which could become a more sustainable method, further increasing the benefits of using these biomaterials as opposed to synthetic alternatives. Emphasise the potential market for herbal medicines etc and that this could therefore provide a growth industry for areas where these plants grow well. The slide shows a process of the steps which occur to get to the final pure herb extract (eg peppermint oil etc) and it is important to go through each step so the way in which these products come to be used in cosmetics and pharmaceuticals is understood.</p> <p>Key Information Summary:</p>

Slide	Notes for teacher, comments and links
	<ul style="list-style-type: none"> Both researchers and consumers are becoming more aware of the potential of using herbs in medicines due to their health benefitting properties. For example, for 80% of the world's population, herbal medicines are their first line of health care (correct as of 2003 – may have altered in the years since but no further data can be accessed). Additionally, the botanical dietary supplement market in the U.S. has expanded rapidly from US\$ 2.9 billion in 1995 to US\$ 4.8 billion in 2008. Therefore, this is a growing global market, as consumers demand less synthetic chemicals which have negative effects in terms of marine pollution and product safety. This shows that there is appetite for natural biomaterials such as herbs in pharmaceutical products. Herbs can be processed in several ways to access the health benefitting properties they contain. However, before processing can begin, the herbs must be dried so that bacteria and fungi don't form if any moisture is present. The dried plants are then ground to increase their surface area, meaning chemical reactions with the added solvents are sped up and extraction yields are increased. The solvents added to the dried herb powders are then subject to heat, pressure or microwave power in order to allow the phytochemicals within the herb cells to diffuse out into the solvent. This either forms a mixed liquid or two layers if an essential oil is produced as this will not mix with the solvent. Evaporation by virtue of their different boiling points allows the separation of the herb extract/essential oil and water. This process is facilitated usually through a rotary evaporator. The herb extract is then processed further to create pure, natural products. Now, Supercritical Fluid Extraction (SFE) (which uses CO₂ as the solvent) is becoming more popular due to the recognition of the ability to gain a high yield of extraction from herbs at lower temperatures and with less harmful environmental and health impacts than organic solvents since it is non-toxic. The herb extracts and essential oils produced can then be used in several cosmetic and pharmaceutical products. <p>Key Links to Further Information: Quotation source: WHO (2003) Traditional Medicine, WHO. 1995 data: Aarts T. (1998) Industry Overview. Nutrition Business Journal 3(9):1-5. 2008 data: Nahin R., Statistics N. (2009) Costs complementary and alternative medicine (CAM) and frequency of visits to CAM practitioners. US Department of Health and Human Services. Azmin, S.N.H.M., Manan, Z.A., Alwi, S, R, W., Chua, L.S., Mustafa, A., Yunus, N. (2016) 'Herbal Processing & Extraction Technologies.' <i>Separation and Purification Reviews</i>, 45: 1-57. Fornari, T., Vicente, G., Vázquez, E., García-Risco, M.R., Reglero, G. (2012). Isolation of essential oil from different plants and herbs by supercritical fluid extraction. <i>Journal of Chromatography</i>, 1250: 34-48.</p>
 <p style="text-align: center;">Herbal Cosmetics Bioproducts</p> <p style="text-align: center;">Soothing and Healing Benefits</p> <div style="display: flex; justify-content: space-around; align-items: flex-start;"> <div style="text-align: left;"> <ul style="list-style-type: none"> 100% brown algae extract (Alginate) Algal blooms removals as possible source material  <p style="text-align: center;">Algae Face Mask</p> </div> <div style="text-align: left;"> <ul style="list-style-type: none"> Peppermint essential oil and volcanic rock granules Smooth hard skin while providing cooling effect  <p style="text-align: center;">Peppermint Foot Scrub</p> </div> </div>	<p>Notes for teachers: Explain the use of herbs in cosmetics products using the two examples on the slides. Firstly explain how using algal plants can add in soothing and healing properties to skin products such as the face mask shown on the slide. Then, draw students attention to a more familiar herb (peppermint) which also has soothing benefits when used in pampering products such as foot scrubs as shown. Stress that both these products are available to purchase online or in store today and so highlight that these bioproducts which are advocated to be created are not abstract ideas but are available for people to use now. If possible and have physical examples could pass these around the class and let students see the tangible products which can be created from naturally growing herbs.</p> <p>Key Information Summary:</p>





Slide	Notes for teacher, comments and links
	<p>ALGAE FACE MASK: Made from Polish based company Bielenda. Active ingredients: Diatomaceous clay, Alginate (100% brown algae extract). It calms and soothes the skin after treatments / eliminates redness / intensifies the process of microdamage regeneration and improves skin firmness and elasticity. Algae grow readily and work as the trees of the oceans (ie undertake photosynthesis), taking in carbon dioxide and producing oxygen. Therefore, utilising these important, abundant herbs can act to reduce the amount of synthetic chemicals which need to be produced. Algae come in many different species and often build ups called algae blooms are removed from lakes to increase their aesthetic value, particularly in managed parks. This removal of algae could serve as a source for the biomaterial's use within the cosmetics industry to create natural products free from harmful chemicals for the user and the environment once these make their way back into the water system through drains.</p> <p>PEPPERMINT FOOT SCRUB: Uses essential oil from the peppermint herb. Mixed with volcanic rock granules to produce a scrub which will smooth hard skin and provide a cooling and soothing effect during and after application. The herb has many benefits (other than its flavor and fragrance) which can be used in cosmetics products such as its moisturizing effect particularly for lip balms and ability to reduce inflammation of the skin makes it useful in products such as moisturisers and face creams.</p> <p>Key Links for Futher Information: https://www.sciencedirect.com/science/article/pii/S0960852414017350 https://bielendaprofessional.pl/en/products/ultra-soothing-algae-face-mask-with-diatomaceous-clay https://www.thebodyshop.com/en-gb/body/foot-care/peppermint-reviving-pumice-foot-scrub/p/p000737 McKay, D.L., Blumberg, J.B. (2006). A review of the bioactivity and potential health benefits of peppermint tea (<i>Mentha piperita</i> L. <i>Phytotherapy Research</i>, 20: 619-633.</p>
 <p>Herbal Pharmaceuticals Bioproducts</p> <p>Naturally high in vitamins and minerals</p> <ul style="list-style-type: none"> Blue-green algae 66% protein High in vitamin A (immune system support) Good calcium source (contributes to healthy bones)  <p>Spirulina Nutritional Supplement</p>  <p>Peppermint Oil Capsules</p> <ul style="list-style-type: none"> Can reduce bloating and help irritable bowel syndrome When combined with eucalyptus/ clove oil can combat allergies 	<p>Notes for Teachers: Draw students attention to the Spirulina nutritional supplement which can be used to ensure users are intaking the required amounts of vitamins and minerals to maintain a healthy diet and lifestyle. Then draw attention to peppermint oil capsules, highlighting how one herb can be used in different ways depending on its differing beneficial properties. For example, not only for use in cosmetics but also to reduce bloating etc in herbal medicine remedies. Highlight how herbal medicines are popular on the market currently, but that their increased advertising and use could help reduce use of artificial medicines which may be more harmful both to consumers and the environment if toxic chemicals are released into water and ecosystems.</p> <p>Key Information Summary: SPIRULINA NUTRITIONAL SUPPLEMENT: Nutritious blue-green algae cyanobacteria (66% protein (!) – as well as fibre, B vitamins, manganese, iron and calcium). Spirulina powder is rich in vitamin B1 (thiamine) which contributes to the normal function of the heart, psychological function and immune system. Spirulina powder is super high in plant-based protein, with 15g providing just under 10g of protein. Protein helps us to maintain muscle mass. Spirulina powder is bursting with vitamin A, which contributes to a healthy functioning immune system. Spirulina powder contains lots of iron, which helps the body feel less tired and fatigued as well as transporting oxygen around the body. Spirulina is a good source of calcium, which contributes to the maintenance of healthy bones. Again, algae is an abundant natural resource which can be utilised for its particular health benefits.</p>


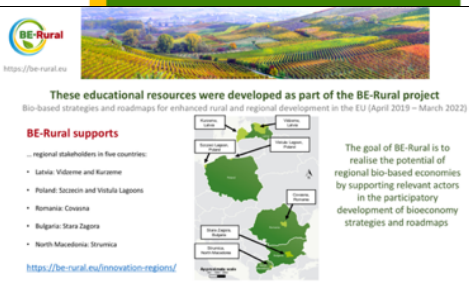
Slide	Notes for teacher, comments and links
	<p>PEPPERMINT OIL CAPSULES: Peppermint oil has been proven to have health benefits such as reducing bloating and irritable bowel syndrome. The oil can also be combined with other oils to have additional effects (e.g. when combined with eucalyptus and clove oil it can reduce symptoms of allergies and so can be used as a natural remedy for conditions like hay fever instead of having to use artificial antihistamines. Additionally, if used with coconut oil, it is said to reduce fever symptoms.</p> <p>Reducing the need for artificial medicines not only reduces the energy needed to produce these and transport them to labs where the medicines are made. It also means when these medicines are disposed of/dissolved back into the water system, they do not contaminate marine ecosystems as the herb extracts are non-toxic and, thus, not harmful to humans or marine life.</p> <p>Key Links to Further Information: https://naturya.com/single-ingredients/spirulina-powder https://thracianoils.com/peppermint-oil/ McKay, D.L., Blumberg, J.B. (2006). A review of the bioactivity and potential health benefits of peppermint tea (<i>Mentha piperita</i> L. <i>Phytotherapy Research</i>, 20: 619-633.</p>
 <p>Essential Oils in Cosmetics Products</p> <p>Increased moisturisation and use of industrial waste</p> <ul style="list-style-type: none"> Natural collagen from fish skins Collagen comprises many essential oils eg rosehip and lemon etc Using waste from fishery industry <p>Baltic Collagen "Exclusive Cream"</p> <p>Juicy Beauty "Phyto-Pigments Sheer Lipgloss"</p> <p>Blend of pomegranate and rose essential oils</p> <p>Grown organically (increases antioxidant levels)</p> <p><small>New Technologies for processing herbs and producing essential oils for the cosmetics and pharmaceutical industries</small></p>	<p>Notes for Teachers: Draw students attention to each product which utilises essential oils mostly for added moisturization, giving the cosmetics products an additional dermatological benefit. Highlight that Baltic Collagen cream comprises many different essential oils and uses waste material from the fishery industry so is seen to be circular in the sense that no artificial products need to be manufactured (reducing the energy and resources involved in this) and what was previously viewed as waste material is now formed into high value products. Highlight the opportunities of growing aromatic plants organically to ensure no artificial fertilisers contaminate land and products are naturally safe for human use, especially on sensitive and allergy-prone skin.</p> <p>Key Information Summary: BALTIC COLLAGEN EXCLUSIVE CREAM: Polish based company (Gdynia). Uses freshwater and saltwater fish skins to retrieve natural collagen. In contrast to artificial collagen creams, a small amount of gel is enough to moisturize and enrich the skin with valuable substances. Importantly, the products from the Baltic Collagen line do not contain any chemical additives: fragrances or dyes. It is a completely natural hydrate of connective tissue protein obtained from freshwater and marine fish, thus reducing fishery waste whilst creating a dermatologically advantageous product. JUICY BEAUTY PHYTO-PIGMENTS SHEER LIPGLOSS: Contains the Juice Beauty exclusive Moisture Plant Blend (glycerin, betaine and phospholipids) to increase skin hydration and the Juice Beauty Phyto-Pigments exclusive blend of pomegranate and rose essential oils. US based company which grows their own ingredients organically on their own farm in California. On their company website www.juicybeauty.com, they herald the benefits of growing and using natural and organic products such as rose and pomegranate, as in the lipgloss range. For example, they say "According to a study conducted by The Organic Center, organically farmed fruits and vegetables can increase antioxidant levels by nearly 30 percent compared with produce grown on conventional farms." Therefore, using these naturally occurring essential oils can have dermatological benefits as well as reducing environmental pollution from harmful synthetic chemicals. They argue essential oils such as rose etc increase the moisturisation of the products too, meaning their</p>

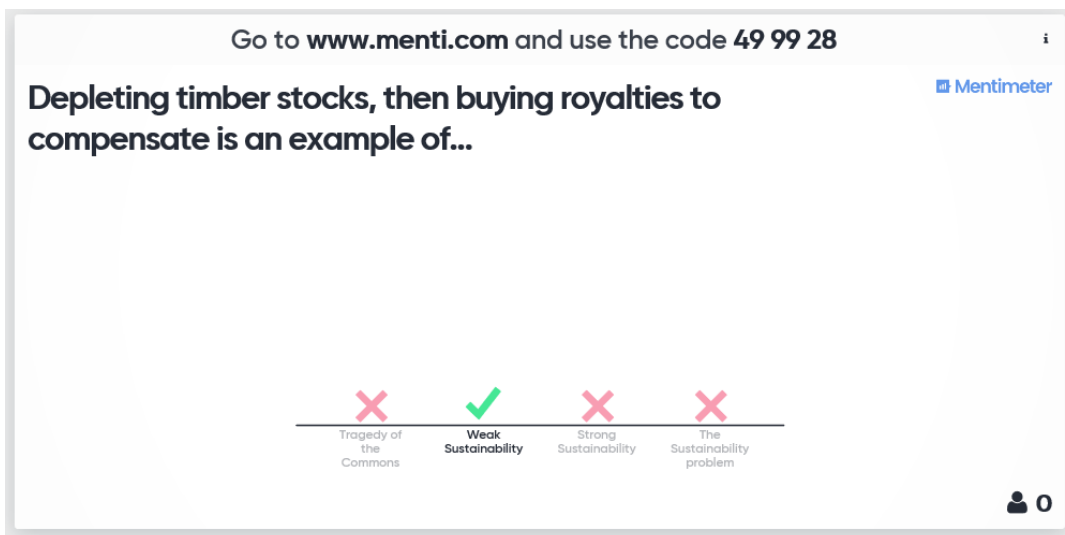
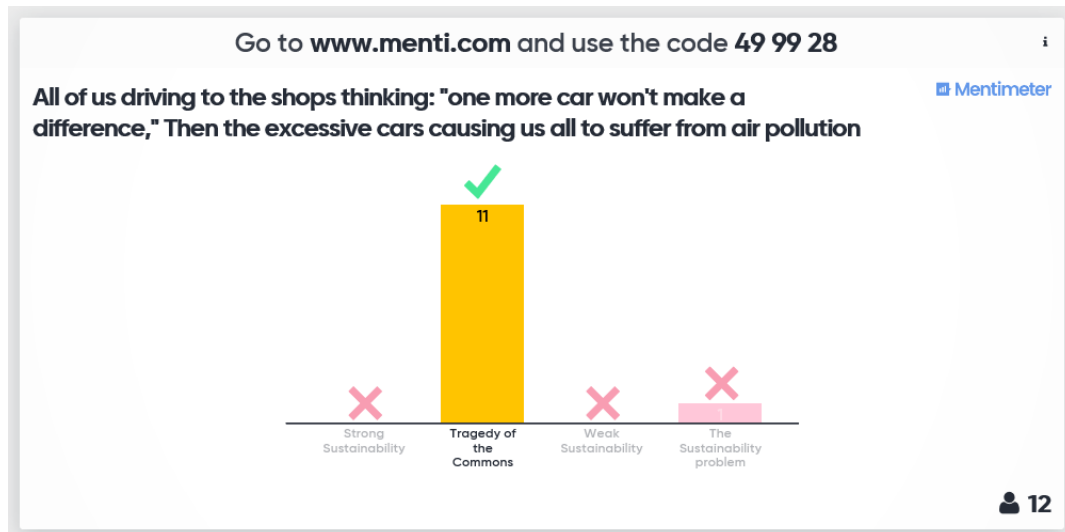
Slide	Notes for teacher, comments and links
<div>  <h3>Essential Oils in Pharmaceuticals Products</h3> <p>Soothing / calming properties</p> <ul style="list-style-type: none"> Essential oils from conifer trees eg pine, spruce Cream for allergy-prone / inflamed skin due to cooling and healing properties  <p>Biolat 'Silbiola' Cream</p>  <p>Tisserand Lavender Essential Oil</p> <ul style="list-style-type: none"> £12.95 for just 20ml Organic, pure lavender oil calms anxiety, helps promote a good night's sleep Sooth minor cuts and grazes </div>	<p>cosmetics, such as the lipgloss shown, have additional benefits to conventional cosmetics products.</p> <p>Key Links to Further Information: http://balticcollagen.pl/baltic-collagen-en/ https://juicebeauty.com/pages/why-juice https://juicebeauty.com/collections/makeup-shop-by-category-lips/products/phyto-pigments-sheer-lip-gloss</p> <p>Notes for Teachers: Highlight how Biolat cream can be used to treat inflamed skin due to the healing properties found in conifer tree essential oils. Draw students attention to the mental health benefits of lavender oil (helps reduce anxiety etc) as well as the conventional physical health benefits (treating cuts and grazes) of the pharmaceutical product.</p> <p>Key Information Summary: BIOLAT 'SILBIOLA CREAM': Made from essential oils - Silbiols is an extract of spruce with bio-active compounds containing epimanol, phytosterols etc. The essential oils are extracted from conifer trees such as spruce and pine trees. These are used in aromatherapy, body butter and creams as seen here for inflamed or allergic skin as the essential oils have cooling and healing properties. Also used in health drink Ho-Fi to supplement the diet, especially during winter. So, Biolat process the raw plant materials in the way previously described (mainly conifer needle foliage) to extract the bio-active substances and turn them into high-quality products that are good for strengthening health, supplementing diet, cosmetic use and plant protection.</p> <p>LAVENDER ESSENTIAL AROMATHERAPY OIL: Lavender is one of the most popular essential oils for use in pharmaceuticals, especially aromatherapy applications due to its soothing properties. It is extracted using steam distillation as explained previously. Costs £12.95 for just 20ml of the organic pure oil (quite expensive as marketed as a luxury product). The soothing properties of Lavender essential oil will help calm anxiety, improve relaxation and help to promote a good night's sleep. Used on the skin, Lavender is effective for soothing minor cuts and grazes and can also provide nourishment to dry or sun-chapped skin.</p> <p>Key Links for Further Information: https://www.biolat.lv/en/products/needle-processing-products/ https://www.tisserand.com/aromatherapy/lavender-ethically-harvested-pure-essential-oil-20ml/</p>
<div>  <h3>Extracting oils from waste coffee</h3> <p>Extracting oils from waste coffee</p> <ul style="list-style-type: none"> Oils extracted from waste coffee are a sustainable alternative to palm oil. Palm oil derivatives occur in approximately 70% of cosmetics produced globally (Zuckerman, 2017). By using waste coffee instead of palm oil, this could reduce the negative environmental impacts from deforestation whilst reducing coffee waste going to landfill.  <p>https://revive-eco.com/about/</p> </div>	<p>Notes to Teachers: Play youtube video describing Revive Eco by clicking on image or using the following web link: https://www.youtube.com/watch?v=lc7dYah5CtM&feature=youtu.be (Video duration 1 minute 20 seconds). Use this to highlight the key aspects of Revive Eco, what their company ethos is and how they collect waste coffee grounds to be used to make high value products such as for the cosmetics and pharmaceuticals industries by extracting essential oils from the coffee. Highlight the importance of finding alternatives to palm oil by explaining the vast environmental damage mass production of this oil is having globally, most widely reported in the Amazon. Finally, draw students attention to the benefits which could be felt by using waste biomaterial as an alternative in cosmetics and pharmaceuticals which rely quite heavily on palm oil for production of many products.</p> <p>Key Information Summary: "In the UK, we drink 55 million cups of coffee each day, leading to over half a million tonnes of coffee grounds being generated and wasted" (Revive Eco website). Revive Eco uses these</p>

Slide	Notes for teacher, comments and links
	<p>waste coffee grounds, collecting them from local cafes and businesses. Revive Eco extract oils from the coffee grounds in a German lab, which provides them with many different essential oils which can be used in the pharmaceuticals, cosmetics & food industries. One of these such essential oils can be an environmentally conscious alternative to palm oil which has the potential to make a big impact on the negative effects of deforestation for the production of palm oil.</p> <p>Palm oil is extracted from the fruit of the oil palm tree. "Now, Indonesia and Malaysia make up over 85% of global supply but there are 42 other countries that also produce palm oil" according to the WWF website (WWF, 2020). However, there is mass media attention on the effects deforestation from palm oil production is having in the Amazon rainforest. It is a growing industry in parts of the Amazon both for its use in the manufacturing of many different products, but also as a form of biofuel for the region. "From 2010 to 2012, the palm oil sector presented an impressive increase, from 1090 km² to almost 1400 km² in Pará state, the largest producer, due to bioenergy demands." (Carvalho et al, 2015: 868). This is having negative environmental effects as species, such as Orangutans, are becoming extinct and reducing tree numbers has implications for climate change. "Palm oil is in nearly everything – it's in close to 50% of the packaged products we find in supermarkets, everything from pizza, doughnuts and chocolate, to deodorant, shampoo, toothpaste and lipstick." (WWF, 2020). This is especially true of cosmetics as palm oil derivatives occur in approximately 70% of cosmetics produced globally (Zuckerman, 2017). Therefore, if Revive Eco are able to provide a widely used alternative to palm oil, this could greatly reduce the negative environmental impacts from deforestation whilst reducing coffee waste going to landfill.</p> <p>Key Links To Further Information: https://revive-eco.com/about/ WWF (2020). 8 Things to Know About Palm Oil. https://www.wwf.org.uk/updates/8-things-know-about-palm-oil. Carvalho, C.M, Silveira, S., Rovere, E.L., Iwama, A.Y. (2015). Deforested and degraded land available for the expansion of palm oil for biodiesel in the state of Pará in Brazilian Amazon. <i>Renewable & Sustainable Energy Reviews</i>, 44: 867-876. Zuckerman (2017). Palm Oil Controversy. https://www.vogue.com/projects/13535833/palm-oil-controversy-beauty-products-ingredient-sourcing-deforestation-climate-change/.</p>
 <p>17 Sustainable Development Goals as adopted in 2015 by UN member countries</p> <p>8 DECENT WORK AND ECONOMIC GROWTH</p> <p>9 INDUSTRY, INNOVATION AND INFRASTRUCTURE</p> <p>11 SUSTAINABLE CITIES AND COMMUNITIES</p> <p>12 RESPONSIBLE CONSUMPTION AND PRODUCTION</p> <p>SUSTAINABLE DEVELOPMENT GOALS KNOWLEDGE PLATFORM</p>	<p>Notes to Teachers: Explain how the Sustainable Development Goals (SDGs) aim to encourage sustainable development and highlight how these can be related to using essential oils and herbs for cosmetics and pharmaceuticals as explained in the information summary below. Encourage students to look at the SDGs website (https://sustainabledevelopment.un.org/?menu=1300) either in class or in their own time to understand all 17 goals and their targets that were not explained in depth here as other may be applicable and this can encourage critical thinking and wider understanding of how bioeconomies can help to solve global issues such as unemployment and climate change.</p> <p>Key Information Summary: The SDGs overall aim is to encourage sustainable development globally in a fair manner. Encouraging the implementation of bioeconomies is key to many of these goals and their targets. For example...</p> <p>SGD 8 (Decent work and economic growth) – Creating bioeconomies provides jobs in new industries. According to Trading Economics, the unemployment rate in Bulgaria at the</p>

Slide	Notes for teacher, comments and links
	<p>end of 2019 was approx. 5.9%, compared to the UK unemployment rate of 3.8%. Therefore, there is scope to reduce the unemployment rate through creating new job opportunities, particularly in the rural region of Stara Zagora, not just in major cities. This works towards Target 8.3 which advocates the need to “Promote development-oriented policies that support productive activities [and] decent job creation...” as well as Target 8.2 which seeks to “achieve full and productive employment and decent work for all women and men, including for young people and persons with disabilities...” by 2030. Creating these value-added products can be seen to stimulate new industry and work towards decreasing the unemployment rate in the area, whilst bringing in new economic prosperity. Target 8.9 also seeks to “devise and implement policies to promote sustainable tourism that creates jobs and promotes local culture and products...” and thus the possibility of advertising a new ‘healing tourism’ in Bulgaria and elsewhere. For example, encouraging people to come on wellness holidays and view the farms where they grow the aromatic plants may add another layer of development to the drive to increase employment and economic prosperity (this is possible with Bulgaria’s reputation as a world leader in rose and lavender growth).</p> <p>SDG 9 – (Industry, innovation and infrastructure) – The target particularly of concern here is Target 9.4 which states “By 2030, upgrade infrastructure and retrofit industries to make them sustainable, with increased resource-use efficiency and greater adoption of clean and environmentally sound technologies and industrial processes...” Therefore, there is an explicit call for industry to think of new practices in terms of production to minimise their environmental effects, and reducing and reusing waste is a way to do this. Although not explicitly, this target encourages circular economy models which use waste resources and therefore create industries which are sustainable in terms of greenhouse gas emissions and waste disposal. Using essential oils and herbs to create bioproducts for the cosmetics and pharmaceuticals industry can thus be seen to increase economic growth, whilst keeping in line with the environmental values at the heart of the SDG’s.</p> <p>SDG 11 (Sustainable cities and communities) – Target 11.A aims to “Support positive economic, social and environmental links between urban, peri-urban and rural areas by strengthening national and regional development planning.” Therefore, the BE-Rural project, encouraging the development of sustainable business particularly in rural areas can be seen to increase local culture, and strengthen links between regions within a country by reducing socioeconomic inequalities such as job opportunities and economic prosperity. Through creating bioeconomies in Stara Zagora this aims to create links between this area and industries across not only Bulgaria, but more widely if companies are to export their products and compete in global cosmetics and pharmaceuticals industries.</p> <p>SDG 12 – (Responsible consumption and production) – Target 12.2 is perhaps the most important to consider here. It states “By 2030, achieve the sustainable management and efficient use of natural resources.” This is an ambitious target and is broken down into material footprint and domestic material consumption indicators. Therefore, by using waste biomaterial, this both reduces material footprints (as less new plastic etc is required to make the same products) and reduces consumption as these biomaterials are reducing waste from other industries.</p>

Slide	Notes for teacher, comments and links
	<p>Other goals are also important but these are, in my opinion, the most relevant for creating bioproducts from essential oils and herbs in the cosmetics and pharmaceuticals industries.</p> <p>Key Links to Further Information: https://www.un.org/sustainabledevelopment/sustainable-development-goals/ Unemployment statistics available at: Bulgaria (https://tradingeconomics.com/bulgaria/unemployment-rate) UK (https://tradingeconomics.com/united-kingdom/unemployment-rate)</p>
 <p style="text-align: right;">Phytocode</p> <p>Bulgarian Rose Oil</p> <ul style="list-style-type: none"> • Beauty Brand based in Bulgaria • Utilises locally grown rose oil • Reduces energy/carbon emissions involved in importing chemicals for production • Increases dermatological benefits for consumer • Uses waste plant material  <p style="text-align: center; font-size: small;">Phytocode Rose Kiss Protective Day Cream</p>	<p>Notes to Teachers: Explain how Phytocode are utilising Bulgarian rose oil in cosmetic products currently and the potential for this to be used widely. This helps to illustrate that these are not just abstract ideas but are possible and available, albeit not on industrial scales, right now.</p> <p>Key Information Summary: Some examples of Bulgarian use of native oils and herbs for the cosmetics and pharmaceuticals industries already exist, proving the opportunity is viable. Phytocode is a Bulgarian based beauty company utilising naturally grown local oils such as rose oil to create natural beauty products such as the day cream from the Rose Kiss range. The rose oil has good hydrating properties and can eliminate acne inducing bacteria. Thus, as well as meaning local cosmetics industries don't need the additional cost of importing artificial oils for their products, using local rose oil reduces the carbon footprint of the manufacturing process and increases the dermatological effects of the product, compared to other moisturisers without this essential oil.</p> <p>Key Links to Further Information: http://phytocode.net/products/rose-kiss/protective-day-cream/ Danube Transnational Programme (DanuBioValNet), (2019). 'Top Bio-based products in the Danube Region, page 12. Available at: http://www.interreg-danube.eu/uploads/media/approved_project_output/0001/30/a319626f134bfa2747eab95550024252de5b37c0.pdf</p>
 <p style="text-align: right;">Rosa Damascena</p> <p>Bulgarian Rose and Snail Oil</p> <ul style="list-style-type: none"> • Using foreign exchange rates, costs approx. £11.75 for 50ml • Rose oil, Rose absolute, snail extract • Moisturising and rejuvenating qualities • Grown locally • Tourism potential 	<p>Notes For Teachers: Explain the Rosa Damascena product putting emphasis on the healing tourism aspect they incorporate through holding tours of their gardens in which they grow the roses to be used to provide dermatological benefits to their products. Highlight how this relates to the BioStep Report (2018) and helps to contribute to achieving the SDGs by creating additional jobs and prosperity within the tourism sector.</p> <p>Key Information Summary: Again, this product utilises rose oil grown locally in Bulgaria. Damascena combines this with Rose absolute and 100% snail extract to formulate their intensive day cream. This rejuvenates the skin and strengthens tissue and can be used on sensitive skin as the components are hypoallergenic. Damascena have their own "complex" in which they grow over 150 different types of roses to make their different cosmetic products. Additionally, this encourages a tourism industry as the company lead tours through their gardens and sell their essential oils (e.g. rose oil) as well as sample of their oils in food stuffs like jams/drinks. This could provide additional jobs and income for the region if utilised as a national point of interest and could encourage tourists to Bulgaria more widely. This, therefore, contributes to the Biostep (2018) report calling for more promotion of healing tourism to increase bioeconomies in the region.</p> <p>Key Links to Further Information:</p>

Slide	Notes for teacher, comments and links
	<p>https://www.damascena.net/en/produkt/day-face-cream-with-bulgarian-rose-oil-and-snail-extract-50ml/</p> <p>Zelljadt, E., Stoyanov, M., Bianchini, C., Mazzariol, F., Davies, S., Millar, K. (2018). 'Strategies for Strengthened Regional Bioeconomies in Stara Zagora and Veneto.' Biostep Report.</p>
	<p>Notes to the teacher: Speaker's name to go in the space at the bottom left of the slide. This is the final slide of the presentation. Allow time for students/participants to ask any questions.</p>
 <p>These educational resources were developed as part of the BE-Rural project Bio-based strategies and roadmaps for enhanced rural and regional development in the EU (April 2019 – March 2022)</p> <p>BE-Rural supports</p> <p>... regional stakeholders in five countries:</p> <ul style="list-style-type: none"> Latvia: Vidzeme and Kurzeme Poland: Szczecin and Vistula Lagoons Romania: Covasna Bulgaria: Stara Zagora North Macedonia: Strumica <p>https://be-rural.eu/innovation-regions/</p> <p>The goal of BE-Rural is to realise the potential of regional bio-based economies by supporting relevant actors in the participatory development of bioeconomy strategies and roadmaps</p>	<p>BE-Rural will create five regional Open Innovation Platforms (OIPs) for the participatory development of bioeconomy strategies and roadmaps.</p> <p>Stara Zagora, Bulgaria: will focus on seeking new technologies for the application of essential oils and herbal plants in the cosmetics and pharmaceutical industry.</p> <p>Vidzeme and Kurzeme, Latvia: will focus on the potential of by-products of forest management (i.e. from young forest stand thinning, short rotation coppice and forestry plantations, removing of overgrowth in abandoned agricultural lands and perennial grasses) as a source of bioenergy or biorefinery.</p> <p>Strumica, North Macedonia: will focus on the utilization of agricultural residues, specifically the by-production of organic materials from agricultural activities, as a source of energy for domestic and industrial purposes.</p> <p>Szczecin Lagoon and Vistula Lagoon, Poland: will focus on small-scale fisheries, specifically on the sustainable use of currently underused and low-value fish species located in two lagoons.</p> <p>Covasna, Romania: will focus on addressing fragmented value chains and implementing the circular economy concept within the county's industrial sectors (i.e. wood and furniture, textiles, agro-food, mechanical engineering, green energy). Source: BE-Rural (2020), <i>Innovation regions</i>, available at: https://be-rural.eu/innovation-regions/</p>



The above questions were done for free. The questions below were input using a premium Menti plan which allows for a larger amount of questions to be available. The following quiz slides were designed to be visually appealing and to be as interactive as possible. To create the slides, choose the type of question in the Mentimeter content tab and the type of answer layout appropriate to the question. Then, write the question and the answers and make sure the option 'Give correct answer' is selected – this should be active for all questions except the ones about personal opinion and the word-cloud questions. Finally, add a background picture to each slide according to the topic of each question. This will make the quiz more dynamic as the white background for a larger number of slides can become monotonous.

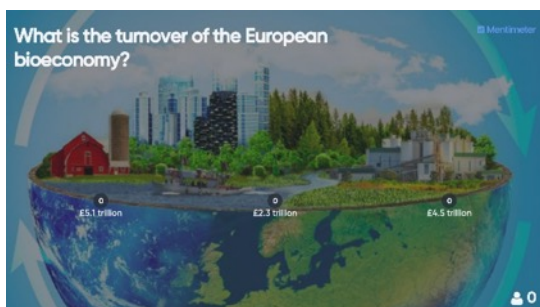
The Mentimeter quiz is an extremely interesting and engaging format that introduces an element of fun and competitiveness when users are able to see how many people get each answer correct. Check the "Data Processing Agreement Statement" on how Mentimeter handles personal data (Mentimeter, 2020).



How many people are employed in the agriculture sector in the EU?

Answer: **9.8million**

European Commission, 2018. *A Sustainable Bioeconomy For Europe: Strengthening The Connection Between Economy, Society And The Environment*. Bioeconomy Strategy. https://ec.europa.eu/research/bioeconomy/pdf/ec_bioeconomy_strategy_2018.pdf



What is the turnover of the European bioeconomy?

Answer: **£2.3 trillion**

European Commission, 2018. *A Sustainable Bioeconomy For Europe: Strengthening The Connection Between Economy, Society And The Environment*. Bioeconomy Strategy. https://ec.europa.eu/research/bioeconomy/pdf/ec_bioeconomy_strategy_2018.pdf



How much profit does the bioeconomy in the agriculture sector generate annually?

Answer: **£380 billion**

European Commission, 2018. *A Sustainable Bioeconomy For Europe: Strengthening The Connection Between Economy, Society And The Environment*. Bioeconomy Strategy. https://ec.europa.eu/research/bioeconomy/pdf/ec_bioeconomy_strategy_2018.pdf



How much profit does the bioeconomy in the fishery sector generate annually?

Answer: **£10 billion**

European Commission, 2018. *Facts And Figures On The Common Fisheries Policy. Basic Statistical Data*. https://ec.europa.eu/fisheries/sites/fisheries/files/docs/body/pcp_en.pdf
Image source: European Commission, 2018. Targeting Fish Parasites For A Healthier Aquaculture Industry. [https://ec.europa.eu/research/infocentre/article_en.cfm?&artid=49518&caller=other]



What words come to mind when you hear the word biofuel?

Answers: **wheat, biodiesel, crops, biogas, fossil-fuels, ethanol, cars, planes, refinery, salmon, fish skin, fish bones, fish oil...**

Image source: Genetic Literacy Project., 2018. CRISPR-Edited Yeast Could Make Biofuel Production More Efficient. <https://geneticliteracyproject.org/2018/08/15/crispr-edited-yeast-could-make-biofuel-production-more-efficient/>



How many bioproducts mentioned before made from fish waste can you remember?

Answers: **face cream, leather, fish oil, crisps, biofuels, Omega-3, fish powder, fish flour, edible packaging, (bio)plastic, shoes, bags, carpets, chocolate, toothpaste, nail polisher...**

OBIC, 2015. What Are Bioproducts? OBIC, Ohio State Univ
<https://www.youtube.com/watch?v=eCwPj0RGBRs>



Which words come to your mind when you hear "fish waste"?

Answers: **location, fish skin, dead fish, guts, fish bones, odour, algae, nets, nylon...**

Aquaculture Directory, 2015. Nearly Half Of U.S. Seafood Supply Is Wasted, <http://aquaculturedirectory.co.uk/nearly-half-of-u-s-seafood-supply-is-wasted/>



What country will ban all single use, non-biodegradable plastics by 2022?

Answer: **China**

In addition, Costa Rica will ban all single-use plastic by 2021.



What is the quantity of milk wasted every year in the UK?

Answer: **330,000 tonnes**

Image source: Association for Dietetics in South Africa (ADSA) 2015. NutritionConfidence Blog. World Milk Day. <https://nutritionconfidence.wordpress.com/2015/06/01/world-milk-day/>

[Data for another country can be used instead.]



Which of the following is a bioproduct made from fish waste?

Answer: **Toothpaste**



Which of these bioproducts made from fish waste would you be willing to try?

Answer depends on participants' likes.

Image source: Notpla. 2020. We Make Packaging Disappear - Notpla. [online] Available at: <https://www.notpla.com/>



What chemical element is not present in anaerobic digestion?

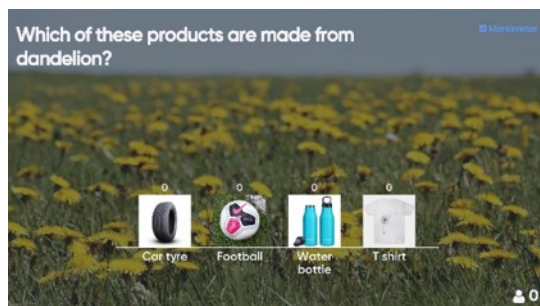
Answer: Oxygen

Anaerobic digestion is a chemical process which can be used convert organic material into bio-gas. (3 guesses allowed)



Which of these bioproducts made from fish waste would you be willing to try?

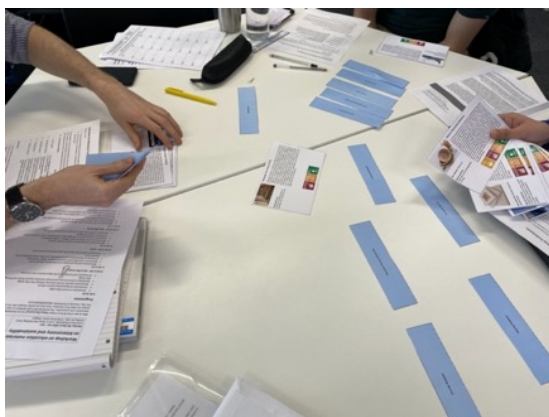
Answer depends on participants' likes.



Which of these products are made from dandelion?

Answer: Car tyre

Annex XV Workshop and Card Game “Business Match”



In this workshop participants play the game “Business Match”. The workshop was developed to inspire participants about the innovativeness of emerging circular business models and the possibilities created by circular economy concepts. It aims to familiarise the participants with various types of circular business models and enable them to recognise these in daily life by using 25 company case studies. Plus, shows links to the UN Sustainable Development Goals (SDGs).

The game “Business Match” has 25 cards with brief descriptions on companies which offer their products and services using one of these five circular business models (identified by Accenture 2015):

- | | |
|------------------------------------|-------------------------|
| 1. Circular Supplies | 4. Sharing Platforms |
| 2. Resource Recovery and Recycling | 5. Product as a Service |
| 3. Product Life Extension | |

Game can be played individually or in groups. Game takes 15-30 minutes depending how game is played and amount of discussion. Before starting the game, workshop leader could briefly introduce and explain the circular business models in a presentation.

Two different ways to play game:

- A. Walk to answer.** The titles of the five circular business models can be written in large font and be distributed in a room. Each participant is given one of the cards and must walk to the designated areas for the correct circular business model that they think their cards belong to. They can see other students' cards there and discuss with them about the cards they have. Or they can also explain to the class why they think their cards belong to a particular circular business model.
- B. Compete individually or in groups.** An equal number of cards is distributed to each person/team and each person/team must match the cards with correct circular business models. Person/team with higher number of correctly categorised cards wins the game. Activity takes 10-30 minutes depending number of cards per person/team and amount of discussion among team members.

Advanced discussion - What other business models may be suitable for each company?

Using the “information for further study on the 25 companies”, discuss what other business models may be suitable for each company. Although the majority of the 25 companies were selected because they clearly use or highlight the use of one of the circular business models, the reality is that business models are not clear cut and some businesses adopt multiple circular business models. For example, product-as-a-service system retains the ownership of the products which they could repair or recycle when the products are no longer suitable for leasing. Some companies use a combination of new biological resources and waste materials from other industries to make products. Also some business models themselves could overlapped. For example, both the sharing platforms and product-as-a-service system involve the concept of sharing the same products with multiple users.

Accenture (2015) Accenture Strategy. Executive Summary of “Waste to Wealth” book by P. Lacy and J. Rutqvist, <https://thecirculars.org/content/resources/Accenture-Waste-Wealth-Exec-Sum-FINAL.pdf>



Instructions for the “Business Match” Game

1. Three people or three teams should compete to get the highest number of points. If working in teams, start by grouping yourself into three small teams.
2. Each team takes five blue title cards with different circular business model titles. The descriptions below have highlighted key words to clearly differentiate these models:

Circular Business Models	Description
Circular Supplies	The use of biological raw materials which are fully renewable, recyclable OR biodegradable
Recovery and Recycling	Valorising the waste materials or by-products to repurpose and produce new products
Product Life Extension	Extending the working lifecycle of the existing products by repairing, upgrading, remanufacturing and reselling
Sharing Economy	The platform which helps the consumers share under-utilized products and assets or eliminate the need to buy more assets
Product as a Service	The access over ownership model which rents the products through lease or pay-per-use arrangements rather than selling them

3. Mix and shuffle all the 25 company cards with pictures.
4. Randomly distribute 8 cards with company descriptions to the three person/team, with image face down. So 24 cards will be distributed, and the 25th final bonus card is placed in the centre of the table.
5. Once each person/team have 8 cards each and are ready to play, game can start. All groups should **start at the same time**.
6. Read the cards and place them into one of the five circular business models.
7. The bonus point card should be taken by the first team which completes the grouping of the first 8 cards. (Grabbing the last card in advance before you are done with the grouping of the first 8 cards will result in a deduction of 2 points.)
8. Check correct answer. Each card each person/team has categorised correctly, will earn one point.
9. The person/team which earns the higher points wins the game.

Instructions can be given to participants or can be explained verbally by workshop leader.

Tip: The brief company descriptions on the case study cards were written by making use of the key words highlighted above in the description of the circular business models, and by drawing attention to more prominent features if the company uses multiple business models.

Circular Business Models Title Cards – Print and cut along dotted line to create five title cards. One set of the five title cards is needed for each person/team.



Circular Supplies



Resources Recovery & Recycling



Product Life Extension



Sharing Platforms



Product as a Service



Company Description Cards - print & cut along dotted line to create 25 individual cards



Spinnova (Textile fibres)

This company manufactures 100% biodegradable textile fibres using renewable biological resources, the wood pulp from sustainably managed forests. Spinnova's mechanical processes enable wood pulp to be grounded into a gel-like material called micro-fibrillated cellulose which flow through the patented machinery to be spun into fibres. This natural fibre is an ecofriendly alternative to cotton or synthetic fibres, as its production process consumes 99% less water than cotton value chain. No toxic chemical is used at any stage of manufacturing of these fibres compared to other textile fibres manufactured using conventional technology which uses a range of toxic chemicals during fibre production, bleaching, dyeing, printing and finishing of cloth or fabric. Most human-made synthetic fibres are considered a source of various negative environmental consequences, as they use limited fossil fuels and release microfibres, polluting the water bodies and ecosystems. These natural fibres do not contribute to microplastic pollution.

Raw materials: Wood pulp

Special attributes:

100% biodegradability,
0% harmful chemicals,
0% microplastic pollution,
99% less water usage compared to cotton value chain



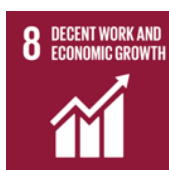
Vollebak (T-shirt)

This company makes fully biodegradable t-shirts made from pulped eucalyptus and beech from sustainably managed forests and algae grown in bioreactors. Its fabric comprises 70% lyocell from trees and 30% linen from plants, and the print on t-shirts is also made with algae ink. Algae could be grown successfully at high speed as it only needs light, carbon dioxide and water. In order to make a printable ink from algae, the water from bioreactor is passed through a filter to separate the algae paste, which is then dried to create a fine powder. This powder is then be mixed with a water-based binder to turn it into algae ink which is used to print the front of this t-shirt instead of dye. Unlike other t-shirts, this t-shirt is completely biodegradable in just 12 weeks, turning into worm food, if it is buried in the soil at the end of its life.

Raw materials: Eucalyptus, beech and algae

Special attributes:

100% biodegradability in 12 weeks





Biotrem (Disposable tableware)

The Zambrow-based company manufactures biodegradable disposable tableware. These products are environmentally-friendly alternatives to single-use plastic tableware which takes centuries to degrade and pollutes the ecosystems in the process. Wheat bran and a small amount of water is used to make edible and compostable plates, bowls and cutlery under high pressure and high temperature using patented technology. Biotrem mentioned that its production process does not require significant amount of water, minerals resources or chemical compounds. 10,000 units of dishes could be produced using 1 ton of wheat bran. The robust and stable wheat bran tableware could hold both hot and cold meals, and can be used in ovens or microwave ovens. These products are edible after use or fully compostable within 30 days, compared to 6 months for paper disposable products and hundreds of years for plastic disposable tableware.

Raw materials: Wheat bran

Special attributes:
Edible after use and biodegradability in 30 days



Ecovative (Packaging)

This company produces sustainable and environmentally-friendly alternatives to styrofoam packaging, skincare accessories, textiles, apparel and meat, using mushroom, renewable biological raw materials. These products are made of mycelium which is the roots of mushroom, together with hemp. All the products are completely biobased, and the packaging and skincare accessories such as make-up sponge, eye mask, make-up removers are 100% biodegradable. In order to make the packaging, the reusable or recyclable growth trays of any shape are filled with a mixture of hemp, flour and mycelium, sealed to grow for 4 days. After that, the parts are pop out of the moulds to grow for another 2 days to attain velvety layer of overgrowth. Those parts are then dried to prevent future growth to get final fully compostable packaging.

Raw materials: Mushroom and hemp

Special attributes:
100% biodegradable packaging alternatives to styrofoam





Huski Home (Straws)

This company produces completely edible and biodegradable straws, made from renewable biological resources of bull rush grass. These straws do not go mushy or soggy mid-drink like paper straws. They are fully food-safe, gluten-free, non-toxic, preservatives-free, colourings-free, odourless and flavourless. They are environmentally-friendly alternatives to plastic straws, which takes few hundred years to decompose and often end up in the seas and oceans, harming the marine animals.

Raw materials: Bull rush grass

Special attributes:

Edible after use and biodegradability



Toast Ale (Beer)

Globally, over one third of food produced is wasted. One of the most common wasted food is bread due to its relatively cheap price with a short shelf life. In UK alone, about 44% of all bread produced was thrown away into bin. In order to tackle food waste problem, this UK company collects the bread waste from bakeries and sandwich makers to divert them from landfills and give a second life as a beer. These surplus breads can be incorporated into the normal brewing processes together with the usual ingredients of malted barley, hops, yeast and water without the need for any new technology, by simply replacing up to one third of the required malted barley amount.

Raw materials: Bread waste with conventional inputs

Special attributes:

Diverting huge amount of bread waste from landfills





Raw materials: Elephant dung and recycled paper

Special attributes:

Valorising dung, saving trees, creation of local jobs, protection of elephants, reduction in humans-elephants conflicts



Ellie Pooh (Paper)

This Sri Lanka based company turns the elephant dung into a paper, mixing 30% dung with 70% recycled paper. The elephants can produce up to 180 – 200 kg of manure, which is normally regarded as wastes without any value. Elephant dung consists 50% to 60% undigested plant fibres. The dung is collected, washed to get the fibres, boiled to disinfect, blended with recycled paper before it is moulded into submerge screens to be compressed and sun dried to make paper. By valorising this waste, this paper production not only brings positive environmental impacts, by saving trees, reducing carbon footprint and using less water, energy and chemicals, but also protects elephants and creates jobs for local community. Elephants, generally seen as nuisance and threat by farmers as they disturb the crops, are sometimes shot and killed. Provision of sustainable papermaking jobs helps change the perceptions of elephants as economic assets, rather than threats.



Raw materials: Citrus juice by-products

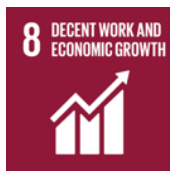
Special attributes:

Valorising of citrus waste, flexibility of fabric features



Orange Fibre (Fabrics)

This Italian company valorised and repurposed the citrus juice by-products, which are normally thrown away, by turning them into sustainable fabrics for scarfs or clothes. Up to 700,000 tonnes of wastes are produced from citrus production in Italy alone annually. With the patented technology and process, the citrus cellulose is extracted from recovered citrus wastes. The extracted silk-like cellulose yarns are spun into fabrics by blending with other materials. The fabric is also enriched with citrus fruit essential oil by using nanotechnology techniques. The resulting citrus textile is soft and silky to the touch, light weight and could be made opaque or shiny based on production needs.





Raw materials: Fish skins

Special attributes:

Use of by-products of fishing industry and comparable good features of fish skin leather



Nanai (Leather)

This company valorised the fish skins, by-products of smoked salmon industry, by turning it into high-quality leather. The natural structure of the skin is preserved in the production processes. The resulting leather is tanned in a 100% chrome-free eco-friendly process using vegetables such as chestnut and mimosa. The fish skin leather is strong, durable, lightweight, tear-resistant and water repellent. The finish can be glossy or natural, with the soft and comfortable touch. The fish skin is sourced from certified organic salmon farms, which are subject to stringent regulations regarding care and breeding. This leather is an alternative solution to conventional leather and other exotic species like crocodile, stingray, ostrich or snake. It has been used to make a lot of products such as fashion clothing, shoes, accessories, etc.



Raw materials: Waste coffee grounds and other plant-based materials

Special attributes:

Valorising of waste coffee grounds which are normally thrown away



Koffeeform (Coffee Cups)

This berlin-based company Koffeeform gives a second life to the used/ waste coffee grounds by transforming them into reusable, durable coffee cups with marbled surface appearance. The products are made of used coffee grounds and other renewable plant-based materials, hardened with biopolymers. This company partners with bicycle courier collective to recover the used coffee grounds from partnered cafes and roasteries in Berlin. The collected coffee grounds are dried and preserved in a local social workshop, before being sent to small plants in Germany, where the mixture of raw materials are transformed into coffee cups. These cups receive the final polish when they are back in the social workshop, before being packaged for deliveries to cafes, shops and customers.





Special attributes:

Repairing and reselling unwanted furniture to keep them in use for longer



Kaiyo (Furniture)

Kaiyo aims to save the unwanted high-quality durable furniture from landfills and keep them in productive use for longer. This platform allows the owners, workers or students on the move to recoup some values out of their unwanted furniture, instead of simply disposing which could also be costly. The furniture owners could contact Kaiyo who reviews the furniture, collects it from the owner, cleans and repairs if necessary, lists it on the website, stores it in Kaiyo warehouses for free of charge until it is sold and delivered to the buyers. Kaiyo is responsible for all the necessary work to get the most value out of the unwanted furniture and it pays the donors a commission of up to 40% once those items are sold. The buyers also benefit from discounts on high-quality pre-loved furniture. Kaiyo takes care of delivery and setting up the furniture.



Special attributes:

Offering refurbished or remanufactured furniture option, and remaking of existing products to as-if-new conditions



Rype Office (Office Furniture)

Rype office offers office furniture – new, refurbished or refreshed, and remanufactured furniture to suit different customer types and their preferences. If the customers prefer new furniture, they sell it with options of buy-back scheme or rent it, so that they could recover all used furniture at the end of its first life for refurbishing and remanufacturing to extend the working lives. For those customers who want a fresh look of their current office furniture, Rype office offers customised refurbishment and resizing options to remake existing furniture to as-if-new products to suit customers' specifications and their office at about 30% of the cost of buying new.





Special attributes:

Cheaper options of used or remanufactured vehicles, extension of vehicle lifespan



Refuse Vehicle Solutions (Refuse Vehicles)

This company offers a cost-effective alternative for new, quality used or remanufactured refuse vehicles. It aims to extend the operational life of refuse vehicles to longer than 15 years, about three times longer than typical operational lifespan through mid-life overhaul and remanufacturing processes. It sources the vehicles using its long experience in the industry and robust inspection processes. It undertakes major modifications through stringent quality controls to resell these high-quality refuse vehicles, providing the same operation lifetime of a new vehicle and a savings of up to 50% to the customers. It offers after-sales sales support of product and equipment training, field service repairs or preventative maintenance. It also leases these vehicles for short or long term hire.



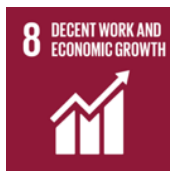
Special attributes:

Repairing and redistribution of defective electronic appliances



CoreCentrics Solutions (Appliances)

Rapid technological advancements and product designs with shorter lifecycles make repair services increasingly scarce for customers. Hence, they mostly end up disposing defective electrical and electronic consumer appliances and get replacements. CoreCentrics Solutions has developed a business model and repair/redistribution infrastructure to recoup values from returned or defective appliances, collected through both its own system and collaborations with largest retailers and manufacturers. It provides product returns management, repairs and remanufacturing services that re-make the damaged or returned parts/products to as-if new conditions for original equipment manufacturers and parts wholesalers. Its services and infrastructure extend the effective lives of those products, enabling higher utility and value and saving them from landfills.




Special attributes:

Durability, offer of repair services, product warranty, repair and care guides for customers, recommerce


Patagonia (Outdoor Clothing)

Patagonia makes high-quality outdoor clothing that lasts for many years and could be repaired so that the customers do not need to buy more. It also provides Ironclad guarantee that allows customers to return the products to Patagonia for a repair, replacement or refunds if they are not satisfied with the performance of the products. The customers can also send the damaged products due to wear and tear for repair services at reasonable fee. They could also trade in used Patagonia clothing in good functional conditions for credits toward new purchases. Patagonia then partners with Yerdle to recommence those pre-loved quality products. Besides, it has also created partnership with iFixit to provide repair and care guides for various damages or general maintenance on its website to enable the customers to repair Patagonia products by themselves. Patagonia has put in huge effort to keep its products in use for longer and out of landfill.


Special attributes:

Sharing of spare or underutilised room, apartment or house


Airbnb (Lodging)

Airbnb is an online platform that matches the apartment or house owners who want to rent a spare room or the whole place to visitors or travellers who are looking for short term lodging, allowing home sharing in many cities worldwide. The company does not own any of those properties and its earns the commission on each booking completed. It is beneficial to both the house owners and the guests, as it provides the property owners additional income stream by renting a space which has been less utilised. The travellers and guests could also live like locals during their visits to those cities, having access to bigger spaces, kitchen, home appliances and amenities, and at a cheaper cost compared to hotels.





Special attributes:

Sharing of bikes and other sport equipment among consumers



Spinlister (Bikes)

Spinlister is a peer-to-peer sharing platform that allows bike owners to list their bikes available for renting and renters to search for a bike to rent in whatever area they are in by city, zip code, available date and ride types. Its primary market is bikes with listing in 63 countries. However, they are also expanding into other markets, enabling sharing of surfboards, Stand up Paddle boards (SUPs), ski equipment and snowboards etc. The company also offers coverages for damages and theft protection in selected areas for a fee. Bike owners could make some money by sharing their underutilised bikes, and travellers and active people could get the flexibility of having access to nearby bikes located throughout different cities when they need.



Special attributes:

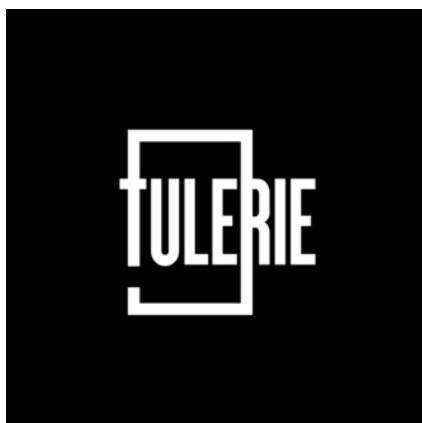
Peer-to-peer rental platform to share underutilised private cars



Getaround (Cars)

Getaround is peer-to-peer car renting platform where the private car owners can rent their cars when they are not in use. People who want to rent a car can find, book on demand, rent and unlock different types of cars all from the mobile phones instantly near their locations or cities they are at. The borrowers have to pick the cars up at their home locations and need to pay by hour (but only for the time they actually use the cars) and by additional mileages if it exceeds the daily limits. Borrowers are responsible for refuelling before they return the cars to original locations. The 24/7 roadside assistance and insurance for drivers and vehicles are covered by Getaround's insurance policy during an active trip. This service is available in 300 cities worldwide. It allows private car owners earn some money for their car when they are not using it and the borrowers to have access to cars without the need to buy.



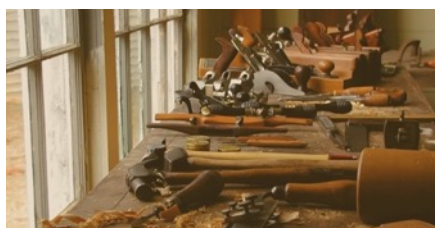


Tulerie (Clothing, Shoes, Accessories)

Tulerie is peer-to-peer platform that allows lending and borrowing high-end women clothing, shoes and accessories to each other. In order to join this platform, the users go through the face-time interviews to ensure the trust within this community that rented clothing would be treated and cared as if they were their own. Borrowers can browse and request the clothing of their choices, by choosing delivery date and rental period. Once the request is approved, the items are delivered via postal service to their preferred locations by the lenders and those could be returned in original packaging with pre-paid return labels. The lenders should have it cleaned to get it ready for the next rental. Tulerie enables the women to have access to designers clothing without the commitments and the investments while reducing their environmental footprints. It also allows the owners to earn the money out of underutilised expensive clothing.

Special attributes:

Peer-to-peer renting platform to share underutilised clothing

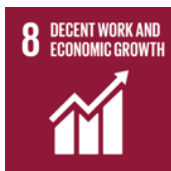


Edinburgh Tool Library (Tools)

Edinburgh tool library is the first tool library in the UK, to lend tools for its members for do-it-yourself projects, gardening, decorating, machine repairs etc. This organisation promotes sharing of tools to reduce the environmental impacts, recognising the underutilisation patterns for most tools. The average utilisation rate of a power drill is estimated as 13 minutes in total during its entire life time. This tool library accepts donations of good quality tools which have been built to last a lifetime. The members of the tool library pay a small fee per year to have access to over 1,000 tools without the need to store, maintain or buy them. It also runs guided workshops on woodworking, tool maintenance and bike repairs for its members.

Special attributes:

Sharing of underutilised tools and elimination of the need to buy tools





Philips (Light)

Philips provides 'pay-per-lux' lighting services to the business customers who want to purchase light, but not the associated lighting infrastructure. Philips retains the ownership and is responsible for designs, installation, operation, monitoring, maintenance, upgrades and recovery throughout the lifecycle. It incorporates the use of the natural light resources in a more effective way, motion sensor and LED lighting technology with better performance, longer life and energy efficiency. Customers do not need to invest upfront and own the lighting infrastructure which eventually needs to be discarded for replacement. Instead, they just need to pay for the optimal amount of light they require and use. This arrangement could also result in receiving better services, as the light provider has incentives to provide long-lasting lighting infrastructure.

Special attributes:

Pay-per-lux arrangement instead of buying the whole lighting infrastructure

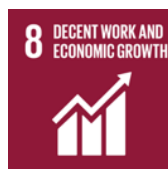


Run the Runway (Clothing)

The company offers the fixed monthly subscription rental plans which allow the customers to lease a fixed number of designers clothing from various brands at a time. The selected items would be delivered to the customers in two days with prepaid shipping labels and reusable garment bags to return the clothing when they are ready to swap for new items. The monthly rental fee includes insurance for general wear and tear and minor spills, and covers shipping and dry cleaning of the garments. This model increases the utilisation rate of the clothes by renting to multiple users, and ensures the collections of old clothing for recycling or upcycling at the end of the useful life by retaining the ownership. Customers have the benefits of being able to experiment different styles and brands without the need to invest in the purchases, having always-rotating selection of designer clothing without taking up the space, and not having to deal with the disposal.

Special attributes:

Fixed monthly subscription payment plan to lease without the need to purchase





Bundles (White Goods)

Bundles provides high-end and energy efficient washing machines, tumble dryers, coffee machines or dishwashing machines from Miele on monthly subscription plans. The customers do not need to purchase these products. They are only required to pay a one-time small refundable deposit, fixed monthly fees and few cents per cycle of use for each product they have chosen to rent. Bundles provides free delivery, installations, removal of old appliances, insights about the usage and personalised tips, maintenance and repairs. The customers would receive monthly invoice with cost of usage and they can cancel the contract at any time. The smart tools measure the energy use, recognise opportunities to decrease consumption and improve design, monitor the appliance performances and prevent the functional problems. Customers also benefit by not having to invest large upfront cost in these high quality appliances, saving money through smarter use tips provided and pay per use.

Special attributes:

Monthly fixed rental fee and pay-per-use fee structure, instead of large upfront cost

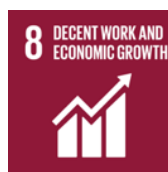


Xerox (Printers)

Xerox allows business customers lease the printers, copiers, multi-function devices and product equipment over a specified contract period from a few days to years. The rental comes with supplies, reliable support, delivery, installation and removal. The customers do not need to bear the burden of a large capital outlay and can distribute the cost over longer period. The rental model is also suitable for temporary offices, sales offices, short-term needs, special events requiring large amount of printed materials and peak periods of increased workload.

Special attributes:

Leasing over a specified period with regular interval rental fees





IKEA (Furniture)

IKEA has announced in 2019 about its plan to test subscription-based furniture leasing offers in 30 markets throughout 2020 in response to its consumer research. This would enable its products to be more affordable, accessible and sustainable, while helping the consumers move away from the wasteful and unsustainable consumption behaviours. Its research has identified the key consumer groups such as university students, expatriate workers and small enterprises. These customer segments want to have access to the home furnishing products with little emotional connection and less importance on ownership due to the temporary nature of needs, the need to move frequently and the desire to distribute the investment in furniture over a longer period of time. This model would also allow the company to retain the ownership of the furniture which can be fed back into the loop through reuse and repairs before finally recycling the materials and parts at the end of useful life.

Special attributes:
Subscription-based furniture leasing



Answer Sheet for Workshop Participants (to show participants at the end of the game)

Circular Supplies	Resources Recovery & Recycling	Product Life-Extension
Spinnova (Textile fibres)	Toast Ale (Beer)	Kaiyo (Furnitures)
Vollebak (T-shirt)	Mr Ellie Pooh (Paper)	Rype Office (Office Furnitures)
BioTrem (Tableware)	Orange Fibre (Fabrics)	Refuse Vehicle Solutions (Refuse Vehicles)
Ecovative (Packaging)	Nanai (Fish skin leather)	CoreCentrics Solutions (Appliances)
Huski Home (Straws)	Kaffee foam (Coffee Cups)	Patagonia (Clothing)

Sharing Platforms	Product-as-a-Service
AirBnB (Lodging)	Philips (Light)
Spinlister (Bikes)	Rent the Runway (Fashion Clothing)
GetAround or Turo (Cars)	Bundles (White Goods)
Tulerie (Clothing)	Xerox (Printers)
Edinburgh Tool Library (Tools) – <i>could also be Product as a Service</i>	IKEA (Furniture)



Workshop leader can read out the correct answers. Or correct answers could be projected on the screen/board. Or answer sheet could be provided in an envelope which would only be opened after individuals/teams have completed grouping all cards.

Information for further study on the 25 companies, used in “Business Match”

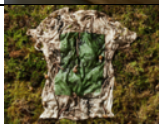


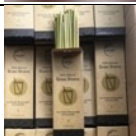



















Circular Business Models Examples	Corresponding References, Sources or Links for Further Information
Circular Supplies	
Spinnova (Textile fibres)	<ul style="list-style-type: none"> • https://spinnova.com/our-method/fibre/ • https://www.fastcompany.com/90208791/this-startup-wants-to-your-next-t-shirt-to-be-made-from-wood • https://materialdistrict.com/article/wood-based-textile-fibre/ • https://www.worldofchemicals.com/448/chemistry-articles/chemistry-of-textile-manufacturing.html
Vollebak (T-shirt)	https://www.vollebak.com/product/plant-and-algae-t-shirt/
Biotrem (Disposable tableware)	https://biotrem.pl/en/
Ecovative (Packaging)	<ul style="list-style-type: none"> • https://ecovatedesign.com • https://www.businessinsider.com/ecovative-turns-mushrooms-into-packaging-ikea-dell-2016-8?r=US&IR=T#this-is-styrofoam-it-doesnt-break-down-in-the-environment--at-least-not-for-more-than-a-million-years-literally-yet-we-use-it-in-tons-of-different-types-of-packaging-from-cups-to-building-materials-1
Huski Home (Straws)	https://www.huskihome.co.uk/home/products/huski-home-100-natural-grass-straws
Resources Recovery & Recycling	
Toast Ale (Beer)	<ul style="list-style-type: none"> • https://www.ellenmacarthurfoundation.org/case-studies/brewing-beer-from-surplus-bread • https://www.toastale.com
Mr Ellie Pooh (Paper)	<ul style="list-style-type: none"> • https://mrelliepooh.com • Farah, N. <i>et al.</i> (2014) 'Processing of Elephant Dung and its Utilization as a Raw Material for Making Exotic Paper', <i>Research Journal of Chemical Sciences Res. J. Chem. Sci</i>, 4(8), pp. 2231–606. Available at: http://www.isca.in/rjcs/Archives/v4/i8/15.ISCA-RJCS-2014-134.pdf. • https://thekidshouldseethis.com/post/84437356027 • https://www.bbc.co.uk/news/business-36162953
Orange Fibre (Fabrics)	<ul style="list-style-type: none"> • http://orangefiber.it/en/ • http://orangefiber.it/en/how-to-turn-citrus-waste-into-a-sustainable-fabric/
Nanai (Fish skin leather)	https://www.salmo-leather.de
Kaffeeform (Coffee cups)	https://www.kaffeeform.com/en/
Product Life-Extension	
Kaiyo (Furniture)	<ul style="list-style-type: none"> • https://www.ellenmacarthurfoundation.org/case-studies/the-final-stop-for-quality-furniture • https://kaiyo.com/how-it-works#do-you-allow-local-pickups
Rype Office (Office Furniture)	<ul style="list-style-type: none"> • https://www.rypeoffice.com • https://www.ellenmacarthurfoundation.org/case-studies/circular-economy-options-in-office-furnishing
Refuse Vehicle Solutions (Refuse Vehicles)	<ul style="list-style-type: none"> • https://www.ellenmacarthurfoundation.org/case-studies/remanufacturing-of-refuse-vehicles • https://www.refusevehiclesolutions.co.uk
CoreCentrics Solutions (Appliances)	<ul style="list-style-type: none"> • https://www.ellenmacarthurfoundation.org/case-studies/a-second-life-returns-management-parts-recovery-and-product-repairs • https://www.corecentricsolutions.com

Circular Business Models Examples	Corresponding References, Sources or Links for Further Information
Patagonia (Outdoor Clothing)	https://eu.patagonia.com/gb/en/worn-wear-repairs/
Sharing Platforms	
Airbnb (Lodging)	<ul style="list-style-type: none"> • https://www.airbnb.co.uk • https://www.mccooltravel.com/8-great-airbnb-advantages/ • https://en.wikipedia.org/wiki/Airbnb
Spinlister (Bikes)	<ul style="list-style-type: none"> • https://www.spinlister.com/about • https://www.forbes.com/sites/carltonreid/2019/01/03/airbnb-style-bicycle-rental-platform-spinlister-relaunches-via-oprahs-favorite-bike-firm/#3d10742f538f • https://en.wikipedia.org/wiki/Spinlister
GetAround (Cars)	https://www.getaround.com
Tulerie (Clothing, Shoes, Accessories)	https://tulerie.com
Edinburgh Tool Library (Tools)	https://edinburghtoollibrary.org.uk
Product-as-a-Service	
Philips (Light)	<ul style="list-style-type: none"> • https://www.ellenmacarthurfoundation.org/case-studies/selling-light-as-a-service • https://www.greenbiz.com/article/how-philips-became-pioneer-circularity-service • https://www.lighting.philips.co.uk/cases/cases/office/edge
Rent the Runway (Clothing)	https://www.renttherunway.com
Bundles (White Goods)	https://bundles.nl/en/
Xerox (Printers and Copiers)	https://www.xerox.co.uk/en-gb/office/prINTER-copier-rental
IKEA (Furniture)	<ul style="list-style-type: none"> • https://www.ikea.com/us/en/this-is-ikea/newsroom/ikea-will-test-furniture-leasing-in-30-markets-during-2020-pub1ae9e5e1 • https://uk.reuters.com/article/uk-ikea-sustainability-cities/ikea-to-test-furniture-rental-in-30-countries-idUKKCN1RF1ST

Web links for Images used in the “Business Match” game



Circular Business Models Examples	Sources or Links for Images used in ‘Group the Circular Business Models’ Game
Circular Supplies	
	Spinnova (Textile fibres) https://spinnova.com/wp-content/uploads/2018/11/Spinnova-Fibres-1024x684.jpg
	Vollebak (T-shirt) https://dyk8bhziatzfed.cloudfront.net/wp-content/uploads/2019/08/plant-and-algaet-300-1376-1376x776.jpg
	Bioterm(Disposable tableware) https://industry europe.com/downloads/4481/download/biotrem1.jpg?cb=493b12efb431dff28baf3fa3af9563a0&w=640
	Ecovative (Packaging) https://pbs.twimg.com/media/B8TCwCSCUAAA1vQ.jpg
	Huski Home (Straws) https://www.huskihome.co.uk/application/files/8515/5741/7446/Huski-Home-Grass-Straws.jpg
Resources Recovery & Recycling	
	Toast Ale (Beer) https://www.iamrenew.com/wp-content/uploads/2019/07/Toast-Ale-Banner.jpg
	Mr Ellie Pooh (Paper) https://www.paperhigh.com/media/catalog/product/cache/1/thumbnail/600x600/9df78eab33525d08d6e5fb8d27136e95/e/ele-dung-group-note-books-_9.jpg
	Orange Fibre (Fabrics) http://orangefiber.it/wp-content/uploads/2017/04/8_noframe-900x900.jpg
	Nanai (Fish skin leather) https://i.pinimg.com/originals/b8/00/71/b80071aeae24b0b47ad73260628fe47f.jpg
	Kaffeeform (Coffee cups) https://www.packaging-gateway.com/wp-content/uploads/sites/2/2019/10/Kaffeeform-Tassen-aus-Kaffeersatz-1.jpg
Product Life-Extension	
	Kaiyo (Furniture) https://moneydotcomvip.files.wordpress.com/2019/09/aklnwpua.jpeg?quality=85

Circular Business Models Examples	Sources or Links for Images used in 'Group the Circular Business Models' Game
	Rype Office (Office Furniture) https://lh3.googleusercontent.com/proxy/NL9naTWzDW16kcEQcNBn-BMwIH2dVjT1ikGeNMiidE2Cd_15cpXw2xyLioRjbC6hm8yK8w8p-gmtrD-EdveUsNQ59puln3872dSWNgj88BTdutzhqiM9BphF5BMJNhxPXzTum0Q
	Refuse Vehicle Solutions (Refuse Vehicles) https://www.epicmediagroup.co.uk/wp-content/uploads/2017/01/DSC_0546.jpg
	CoreCentrics Solutions (Appliances) https://www.cdn.corecentricsolutions.com/wp-content/uploads/2018/09/p2.jpg
	Patagonia (Outdoor Clothing) https://www.patagonia.com/static/on/demandware.static/-/Sites/default/dwbeb60e6f/images/seo/1920x1080_patagonia_fitroy_P6.jpg
Sharing Platforms	
	Airbnb (Lodging) https://hackernoon.com/hn-images/1*yZ1LPicXnnW6Ubmp2M-0rQ.png
	Spinlister (Bikes) https://www.netted.net/wp-content/uploads/sites/14/2015/02/Spinlister_1000x563_2.6.15.png
	Getaround (Cars) https://la.streetsblog.org/wp-content/uploads/sites/2/2019/02/Getaroundlogo.jpg
	Tulerie (Clothing, Shoes, Accessories) https://is2-ssl.mzstatic.com/image/thumb/Purple123/v4/c8/b4/ef/c8b4efc9-af99-f6c3-e801-4f8e87c3b08d/source/512x512bb.jpg
	Edinburgh Tool Library (Tools) https://edinburghtoolibrary.org.uk/wp-content/uploads/2013/04/edinburgh-tool-library-banner.jpg
Product-as-a-Service	
	Philips (Light) https://johnlewis.scene7.com/is/image/JohnLewis/237006205?\$rsp-plp-port-320\$
	Rent the runway (Clothing) https://media.glamour.com/photos/582f27050700a182135fdead/16:9/w_1280,c_limit/rent-the-runway-store.jpeg
	Bundles (White Goods) https://lh3.googleusercontent.com/proxy/b1tGHoOx0B9IIvWGFLonGRQilo-FPc1GKBK_TtdIFUdz6w2798-LHFUtSmtl3Xbndq-efYzjYkb5xV4xQzxzmFLPIT1YWRG8
	Xerox (Printers and Copiers) https://3.imimg.com/data3/TD/CU/MY-3885680/xerox-work-center-500x500.jpg
	IKEA (Furniture) https://www.ikea.com/images/66/2d/662d5bb982c13e4b0336f75c08f9f263.jpg?f=s

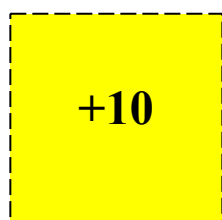
Annex XVI Game “Sustainability and SDGs Heatwave”

A game on sustainability and SDGs with an element of luck. Four or five players compete against each other using one playing board. The game takes around 20-25 minutes.



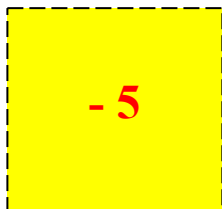
Required materials:

1. A4 Printed playing board (see next page). Each board can have 4 or 5 players, so need to print out the necessary amount of boards depending of the class size.
2. 16 point cards - print and cut to stick facedown with Blu Tack to each playing board as follows:

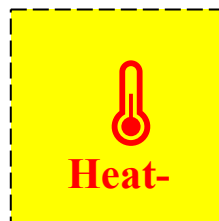


Amount needed for each playing board:

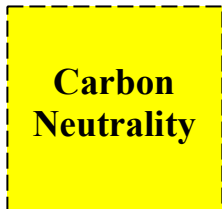
→ Print and cut out 7



→ Print and cut out 4



→ Print and cut out 2



→ Print and cut out 2



→ Print and cut out 1




3. Blu Tack or similar adhesive to attach above point cards to each playing board.
4. Printed and cut out pack of 16 question cards. Each player's board needs its own pack of questions so students can quiz each other
5. Small pieces of paper to cover quiz question answers as follows, that can be easily peeled off during the game:

<p>1) Goal 1 is about poverty. What is the main target of this Goal?</p> <p>A. Cut poverty in half by 2030. B. End poverty in all forms everywhere C. Reduce poverty by 75% by 2030.</p> <div style="background-color: yellow; width: 50px; height: 20px; margin-left: auto;"></div>
--

<p>1) Goal 1 is about poverty. What is the main target of this Goal?</p> <p>A. Cut poverty in half by 2030. B. End poverty in all forms everywhere C. Reduce poverty by 75% by 2030.</p> <p style="text-align: right; color: red;">Answer: B</p>

Note: This game could be made more sustainable by laminating the materials so they can be reused.

Playing Board to use by each set of 5 players

	1	2	3	4
A				
B				
C				
D				
	Name	Points		
Player 1				
Player 2				
Player 3				
Player 4				
Player 5				

Game “Sustainability & SDGs Heatwave” – The Rules

1. Make sure you have all the materials: 1 playing board with 16 point cards stuck randomly facedown, 1 pack of 16 question cards with the answers covered and at least 1 pen.

Sustainability and SDGs heatwave

Point cards are placed in this way, where the points or action in the card are hidden from the players.

Here, write the names of the students participating in this group, and the players write the points earned in the box besides the name. At the end of the game, the number of points is calculated to know the winner.

	Name	Points
Player 1		
Player 2		
Player 3		
Player 4		
Player 5		

2. Write your names into the points table at the bottom of the playing board.
3. To start the game, one person will pick up a question card and read out the question and the three possible answers to the person on their right.
4. Only one player is asked a question at a time.
5. If the person gets the question wrong, then **DO NOT READ OUT THE CORRECT ANSWER!** The next person to the right is then asked the same question and so on, until the question has been answered correctly.
6. The player who answers the question correctly can select a points card, e.g.: B:3 (like in the figure above). The player peels off this card and is awarded the points on it.
7. The meaning of the points cards are as follows:

	= Plus Sustainability points (Player receives points)		= Minus Sustainability points (Player loses points)
	= Carbon Neutrality (Player's current points double)		= Heatwave (Player's current points halve)
	= Sea levels rise (Player can steal all the points from a player of their choice)		

8. The person asking the question changes clockwise after each question.
9. The game ends when all the points cards have been peeled off.

Sustainability quiz questions

(Pass cut out questions around. Person asking a question changes every time.)

What is the most accurate definition of sustainability?

- a. "Development that meets the needs of the present without compromising the ability of future generations to meet their own needs."
- b. "Development that meets the needs of the present by using resources to ensure maximum economic development."
- c. "The shutting down of fossil fuel plants to reduce CO₂ emissions."

Answer: A



Which three main issues can be considered together when tackling sustainability?

- a. Ecological, Economic and Entrepreneurial
- b. Social, Ecological and Economic
- c. Social, Environmental and Sustainable

Answer: B



Complete the sentence: "Weak sustainability..."

- a. ... plants more trees.
- b. ... is good for preserving resources.
- c. ... allows for the depletion of natural resources.

Answer: C



Complete the sentence: "Strong sustainability..."

- a. ... requires that all forms of capital must be maintained independently of one another.
- b. ... demonstrates the sustainability problem.
- c. ... allows for the depletion of natural resources.

Answer: A



Tragedy of the Commons is a situation that:

- a. comes about when resources are almost depleted in a natural ecosystem.
- b. comes about when an individual has ownership over one resource.
- c. comes about when there is a shared resource that individuals have incentive to use.

Answer: C



By 2050 what number is the world's human population predicted to reach?

- a. 9 Billion
- b. 10 Billion
- c. 11 Billion

Answer: B



Products that are made from biological resources from land and sea (such as crops, forests, fish, animals and micro-organisms) are known as:

- a. Genetically Modified Organisms
- b. Bioproducts
- c. Green products

Answer: B



In Poland, in the regions of Szczecin and Vistula Lagoons, what is there is an available resource of?

- a. Low value fish-stocks.
- b. Wood chips
- c. Coal

Answer: A



How many Sustainable Development Goals (SDGs) are part of the UN 2030 Agenda for Sustainable Development?

- a. 17
- b. 8
- c. 10

Answer: A



Each SDG is supported by a set of targets with specific objectives that are associated with that Goal. How many targets are there in total?

- a. 99
- b. 1,016
- c. 169

Answer: C



SDG 1 is about poverty. What is the aim of this goal?

- a. Cut poverty in half by 2030.
- b. End poverty in all its forms everywhere.
- c. Reduce poverty by 75% by 2030.

Answer: B



To which countries are the sustainable development goals designed to apply?

- a. Low-and middle-income countries.
- b. All countries.
- c. Only high-income countries.

Answer: B



Sustainably managed forests, combat desertification, halt and reverse land degradation, halt biodiversity loss, enhanced value of biodiversity as a bio-economy asset. This is mainly related to:

- a. Goal 2 (Zero Hunger)
- b. Goal 9 (Industries, Innovation and Infrastructure)
- c. Goal 15 (Life on land)

Answer: C



A bioeconomy can contribute to sustainable yield increase, investments in agriculture, improved food and nutrition security. This is mainly related to:

- a. Goal 2 (Zero Hunger)
- b. Goal 13 (Climate action)
- c. Goal 15 (Life on land)

Answer: C



Bioeconomy can develop alternatives to fossil-based plastics and convert a waste stream into a major component of a new product. This is related to:

- a. Goal 12 (Industries, Innovation and Infrastructure)
- b. Goal 14 (Life below water)
- c. Goal 1 (No Poverty)

Answer: B



The UN agenda “Transforming Our World: The 2030 Agenda for Sustainable Development” was agreed by how many countries?

- a. 173
- b. 183
- c. 193

Answer: C



Annex XVII One set of cards and two games: “BE-Match” and “SDG-Link”

Two games were developed using the same cards to inspire participants about innovative products, already in the market, made of biological resources:

- “BE-Match” Game
- “SDG-Link” Game

These workshops or classroom activities were created to introduce various bioproducts, which can substitute traditional products in our daily life, and to inspire the limitless possibilities enabled by the bioeconomy industry. The activities also encourage discussion on the links of bioproducts to the UN Sustainable Development Goals (SDGs). Participants could play the “BE-Match” Game first, followed by the “SDG-Link” Game, either in the same day or in different days. Both games take about 15 minutes to 30 minutes and no prior knowledge on bioeconomy is required to play them.

In both games, cards have pictures and corresponding detailed text. The pictures show either biological raw materials used or final product or both. While the detailed text provides more information such as their benefits and properties.

The detailed text can also be a continuation of the text above the images – for example:

Russian dandelions can be considered a cost-effective and environmentally friendly substitute for natural rubber because



the conventional subtropical rubber tree plantations in South East Asia which supplies 95% of global demand are under increased threat of devastating fungus, resulting in price volatility of rubber. Since Russian dandelions can grow in abundance in Central Europe, and even on soil not suitable for crop farming, it cuts down the reliance on natural rubber. Hence reducing the transport distance of raw materials and the corresponding carbon dioxide emissions.



Bend here for SDG-Link; Cut here too for BE-Match

In the case of the “BE-Match” Game, images and text should be cut separately to create 76 individual cards. While for the “SDG-Link Game”, 35 individual cards need to be cut (image and text need to be together and the last three fake products should not be used).

The aim of the BE-Match” Game is to match the image with the text. There are also three sets of cards with fake bioproducts - **Polystyrene, Synthetic fibres and Lipsticks** - which students need to identify. Ideally, there should be a workshop facilitator to help determine if the pairings done by participants are correct and confirm which are the fake bioproducts. If there is only a small number of participants, individuals can compete against each other. If there is a larger number of participants, then groups of 2 to 4 people can compete against other teams. Each game can be followed by more advanced discussion using the “Information for further study on the 35 resources and/or bioproducts”.

Instructions for the “BE-Match” Game



You have:

- **38 cards with pictures** – these describe or show the biological raw materials and/or bioproducts.
- **38 cards with the corresponding text** – these discuss the benefits, properties or special attributes of those biological raw materials and/or bioproducts shown in the cards with the pictures.
- **38 paper clips** to attach the cards with the pictures with the cards with the text.

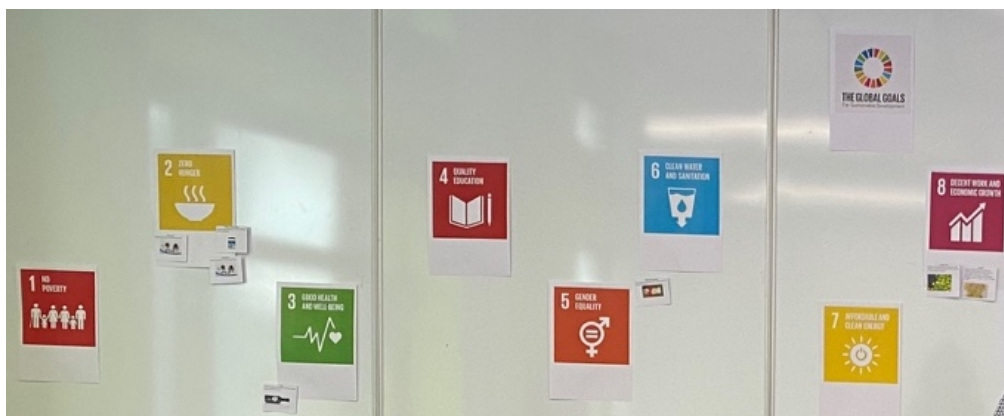
Aim of the game is to pair the two types of cards correctly, in the shortest time.

Instructions:

10. Three people or three teams should compete to get the highest number of points.
If working in teams, start by grouping yourself into three small teams.
11. Each person/team should get 11 pairs of cards of real bioproducts.
12. Each person/team should get 1 pair of fake bioproducts.
13. Make sure to shuffle the 12 pairs of cards before you start.
14. Two extra pairs of cards should be placed in the middle of the table.
15. Each person/team should start matching the 12 pairs of cards **at the same time**.
16. After finishing pairing the initial 12 sets of cards, each person/team can attempt to do the matching of the extra two sets of cards in the middle of the table for extra points. (Grabbing the extra cards in advance before you are done with the matching of the first 12 set of cards will result in a deduction of 2 points).
17. Each correct pair will earn one point.
18. But remember there are **fake bioproducts**. These must be identified. If you identify them correctly, you get two points. If you do not identify them correctly, you lose two points.
19. The quickest person/team earns a bonus of two points.
20. The person/team with the higher number of points overall wins.

Instructions can be given to participants or can be explained verbally by workshop leader. However, note that each set of 12 pairs of cards for each person/team should ideally be prepared in advance by the workshop leader, to make sure each set (12 pairs of cards, including 1 fake bioproduct) includes the correct pairs of cards.

Instructions for the “SDG-Link” Game



You have:

- **35 cards with pictures and extra text in the back.** The front with the image describes the biological raw materials and/or bioproducts and the reverse of the card discusses the benefits, properties or special attributes of those biological raw materials and/or bioproducts.
- **Large print outs of all 17 SDGs** (with respective targets written the back)
- **Blu Tack or tape**

The aim of the game is to link each card to a key SDG.

Instructions:

1. Place print outs of all 17 SDGs on a wall, on the floor or in separate tables.
2. Five people or five teams should each get seven cards of the real bioproducts.
3. Discuss in your groups which bio-product might contribute to each SDG. Note that each bioproduct may contribute to more than one SDG and each SDG may have a valid link to more than one bioproduct.
4. Place your bioproduct next to the key SDG that your product contributes but, for the game, **there is a maximum space of two bioproducts for each SDG**, and therefore one bioproduct will be “homeless” and one team has at least one card left in the hand.
5. Now the reasoning behind placing the bioproduct with each SDG needs to be explained by each team. If participants agree that the link is not valid, then that team needs to removed card.
6. The team with least amount of cards in the hand wins the game.

Instructions can be given to participants or can be explained verbally by workshop leader.

Playing Cards - print and cut along dotted lines to create either:

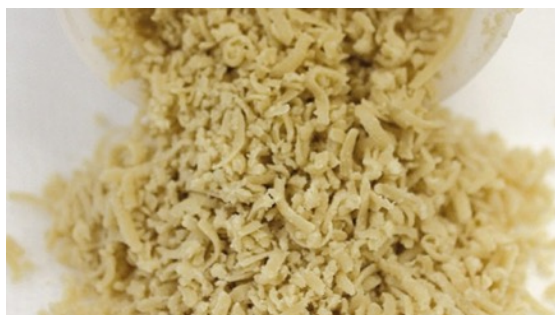
BE-Match - 76 individual cards – images and text should be cut separately

SDG-Link – 35 individual cards (image and text needed together; do not include last 3 fake products)

Bend here for SDG-Link; Cut here too for BE-Match



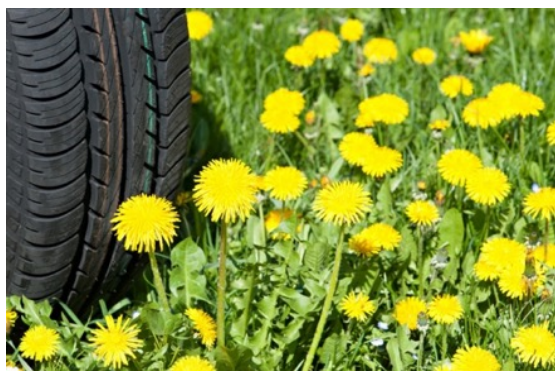
Curran, a material extracted using root vegetable waste streams such as carrot or sugar beets, can be used in different applications such as paper and cardboard packaging, paints, coatings, or even cosmetics because



its strong and light nanocellulose fibres make the packaging stronger and more lightweight. It also enhances the consistency, anti-cracking and drying behaviour of the paints and coating and makes them last longer and easier to clean. The use of root vegetable wastes prevents the problem of direct competition for farm land with food crops. Less water and chemicals are needed to manufacture it, and there is no release of harmful gases during production. These properties and benefits make it a greener substitute for non-organic performance additives.



Russian dandelions can be considered a cost-effective and environmentally friendly substitute for natural rubber because



the conventional subtropical rubber tree plantations in South East Asia which supplies 95% of global demand are under increased threat of devastating fungus, resulting in price volatility of rubber. Since Russian dandelions can grow in abundance in Central Europe, even on soil not suitable for crop farming, it cuts down the reliance on natural rubber. Hence reducing the transport distance of raw materials and the corresponding carbon dioxide emissions.



Insects, such as buffalo worms, can be used as a healthy and sustainable alternative to traditional beef patties because



they have high protein content and unsaturated fats and they also consume significantly lower resources. They consume 10 times less feed than cows, and growing them produces 100 times less greenhouse gas emission than beef production.



Chlorella algae can be used to produce healthy vegan soft drink because it contains vitamins such as B12, minerals and vegetable protein. One of the notable things about this chlorella algae is that it can grow 10 times faster than ordinary plants on land.



Cocoa shell wastes can be used to make sustainable and eco-friendly alternatives for ice cream spoons because



it uses renewable resources by valorising the wastes and can replace conventional single-use plastic spoons which are thrown away after single use. Its fibres ensure the stability of the spoon and give a pleasant chocolate taste.



Blue sweet lupines can be used to make ice cream suitable for people with lactose intolerance because



they make a dairy-free product, which does not contain lactose or gluten. Their protein-rich seeds are peeled and processed into paper-thin flakes which are then de-oiled and undesired odour are removed to make this ice cream.



Bread waste, instead of being thrown into the bins, can be given a second life as



beer, by replacing one-third of the malt required for brewing. Each bottle of beer contains an equivalent of one slice of this waste diverted from landfill where they are normally left to rot and emit methane. This also help free up part of the land used to grow barley, save energy and water, and avoid CO₂ from one-third of barley never grown.



Bacteria can be used to grow environmentally friendly bricks because



they eliminate the firing process, hence eliminating CO₂ emissions. The bacteria *Sporosarcina pasteurii* is used to grow a durable cement. Sand is packed into rectangular moulds and bacteria are added, which wrap themselves around the grains of sand. Calcium carbonate crystals begin to form around the grains while an irrigation system feeds nutrient-rich water. The crystals grow larger and after 3-5 days these products are ready for use. Process was inspired by corals, which grow in all kind of formations and can withstand water and erosion.



Enzymes have been used in cleaning products such as detergents because



the biocatalysts accelerate biological processes and are active even at low temperatures. Some classes of enzymes remove dirt particles, while others work by preventing the fabrics from pilling. Less detergent and energy are required with the use of enzymes.



The advantages of using plant-derived Isosorbide, chemically produced from sugar, to make smartphone display are



high transparency, excellent durability and higher resistance to impact, heat and weather than conventional plastics. This new bioplastic can be used in a variety of industrial applications such as automobile sunroofs, headlights, transparent highway noise barriers, and exteriors of electronics.

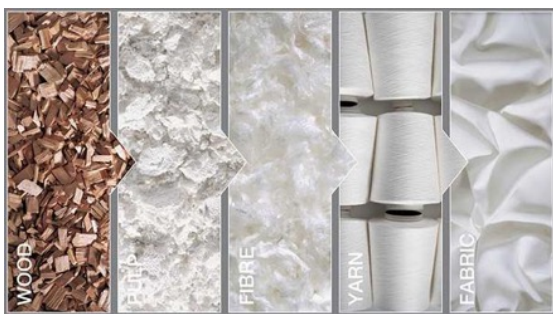


Orange and citrus waste can be given a second life as



sustainable fabrics to make scarfs and shirts. Up to 700,000 tonnes of waste materials are produced from citrus production in Italy alone annually. These wastes could be valorised by extracting cellulose from the fibres, enriched with citrus fruit essential oil by using nanotechnology techniques.





Textile fibres can be extracted from wood and they are called Tencel or lyocell fibres. Some of the benefits of using these fibres to make clothes are the use of renewable raw materials from sustainable forestry and plantations, the water absorption capacity of 50% higher than that of cotton, no harmful chemicals used during fibre manufacturing, its recyclability and biodegradability.



Casein protein in milk waste can be used to produce textile fibres to make clothing such as dresses or underwear, which are silky to the touch, naturally antibacterial and can be easily dyed. This milk waste to fibres process requires significantly fewer resources, and organic fibres have been produced in accordance with the Global Organic Textile standard.



Some of the advantages of using pineapple leaves waste as raw materials to make shoes are the valorisation of waste and left-overs from pineapple production process and the waterproof, anti-allergic, warm and breathable fibres.





The use of algae biomass to make products such as bathing shoes can help solve the problem of a threat to sea ecosystems as the abundance of algae removes oxygen and blocks the sunlight to pass through for aquatic animals.



Olive leaves can be natural and environmentally friendly alternative tanning agents because



they make the leather extremely skin-friendly. This process valorises these traditionally burned green leaves waste during harvest time in the Mediterranean. It also eliminates the use of toxic acids and heavy metal salts such as Chromium(III) sulphate during the procedures.



Natural fibres produced using the mixture of Icelandic seaweed, beechwood and medical zinc are more environmentally friendly than cotton products because



its production uses 97% less water and emits 90% less CO₂ compared to cotton productions. These seaweed, only harvested every two years in crystal-clear waters of Iceland, is dried and finely ground with a special jet mil. The fine powder is then mixed with zinc powder and cellulose from beech, and weaved into the fibres using a patented procedure to retain all vitamins and minerals of high-quality Icelandic seaweed in the final fabric.





The t-shirt made from pulped eucalyptus, beech and algae can biodegrade in just 12 weeks and turn into food for all animals living in the soil. Hence, these old t-shirts can be disposed of just by either burying in the garden or putting out together with the compost.



Tinder fungus can be used to produce a soft leather-like vegan product such as



wallet, caps, watch straps, etc. These fungus are harvested naturally, dried for up to a year, peeled and then processed. The resulting leather is absorbent, antibacterial and antiseptic properties.



Wheat bran can be alternative raw materials to produce environmentally friendly and disposal tableware products because



its production process does not require significant amount of water or mineral resources or chemical compounds. These products can biodegrade in 30 days.



How can apple residues be valorised to make a vegan backpack?



Apple skin can be dried, milled to fine powder and mixed with 50 percent polyurethane. The mixture is placed on a tear resistant roll of cotton fabric and then heated to produce a weather resistant and durable fabric.



How can the fish skins by-product of the fishing and food industry be valorised?



By turning these by-products into the leather to make purses, handbags, backpacks, belts, shoes, clothing etc.



Juice of the sapodilla tree can be used to produce environmentally friendly chewing gums because



the conventional products contain plastic-filled rubber base, which hardly rot on the streets, whereas these chewing gums are completely vegan and biodegradable alternatives.



How can used coffee grounds be transformed into new products such as coffee cups and saucers?



By mixing these waste coffee grounds with plant fibres, cellulose and a resin made of biopolymers and by using an injection moulding procedures during manufacturing to make stable, washable and reusable coffee cups and saucers.



Elephant dung can be turned into a paper because



up to 50% to 60% of the dung is undigested fibres of grass, fruits and plants fibre cellulose. Hence, elephant manure can be washed and boiled to be sterilised. It could then be blended with other paper wastes into a pulp which is thereafter dried and treated in the same way as conventional paper.



Shells from shellfish, the waste materials from the fisheries industry, can be valorised by upcycling it into the plastic packaging. This packaging material is compostable, anti-microbial and extends the shelf-life of fresh seafood.





At least 4,000 tonnes/year of standard lacquer can be replaced with lacquer derived from tomato, by-products of industrial tomato processing (mainly skins). This would enable a reduction of CO₂-eq emissions of 2 tonnes/year. In Italy alone, 650,000 tonnes of metal packaging are used every year. The emissions reduction by replacement with tomato-peel based bio-lacquer for metal cans could be impressive i.e. some 1 million kg of CO₂/year.



A spray produced using organic waste residues to make the food stay fresh for longer.



This is an edible protective spray for sensitive fruits and vegetables. It is tasteless, low in calories and is obtained from the remains of food products such as pear stalks, fruit peels, seeds and much more. The main constituent of the edible coating are glycerol and phosphatides, which are involved in the formation of biomembranes in higher plants. Due to the molecular structure, the odourless and tasteless lipids are water-insoluble and offer permanent protection against moisture and gases.



Cold pressed oil is a type of fresh juice squeezed from the seeds of particular plants, containing their natural nutrients. It is unrefined and rich in essential fatty acids, vitamins soluble in oil, lecithin, phytosterols and minerals valuable for people's health. The seeds are processed by using a technology for cold seed pressing which means that the oil is mechanically pressed on a low temperature. As a result of the essential fatty acids present in flax seed oil, the flax seed soap provides better skin care, regenerate and soothe.





Insect protein feed could be produced using black soldier fly and this is a hypoallergenic alternative to conventional food for aquaculture or pets. These insects can convert 60% of organic waste into proteins, lipids and other useful substances by eating voraciously and becoming protein and lipid-rich body mass. These insect biomass are turned into animal feeds using an efficient and sustainable production system based on circular economy.



Nutrients for biogas optimisation to a biological and non-polluting alternative to chemical de-rust processes.



Rust is simply atoms of iron which have reacted with oxygen. There are some microorganisms, such as bacteria, that eat iron. In order to obtain this important element, the bacteria produce siderophores, protein molecules that can trap iron atoms and incorporate them into their structure. This is the reason why siderophores are used as biodegradable rust removers. In order to use siderophores to remove rust, ASA Spezialenzyme has developed a procedure that uses the bacteria of the species *Streptomyces olivaceus*.



Agricultural wastes locally sourced in India to produce sanitary napkins.



This product is fully compostable and aimed at solving rural and urban disposal issues while ensuring environmental sustainability. Disposal of this Anandi pad should be done by burying it in a pit for the compounds to de-compost. Composting is recommended due to its environmentally sustainable nature, compared to other methods of disposal.



Producing high-end products using sugar, corn starch, and cooking oil.



These are fully biobased and biodegradable materials that can be competing standard polymers and other oil-based plastics in terms of properties and processability. It can be adjusted to the needs of each product and application. The material can withstand the temperatures of over 100 degrees Celsius and has an estimated lifespan of 1 - 50 years depending on blend composition, with stable properties while stored.



These are edible straws made of sugar, water, maize starch, gelatine, flour and water. EcoStraws do not dissolve in the drinks and stay in their original form for up to 50 minutes. These straw act like a sponge and absorb the taste of the drink. So, the users can eat the tasty straw after they finish the drinks.



Aquafaba could be used as a substitute for eggs to make smooth and creamy mayo that can be enjoyed by vegans. Aquafaba is the protein-rich water left over from cooking chickpeas which would normally be thrown away. Creating condiments using this is considered to be sustainable as it makes use of surplus ingredients.





Polystyrene is widely used as packaging materials due to its several benefits. It is lightweight, water resistant and also resistant to bacterial growth. It has excellent insulation property and shock absorption quality. It can be moulded into customised shape and size. These advantages combined with economical production cost make it an ideal product for packaging to transport goods.



The benefits of synthetic fibres have enabled it to be one of popular materials to make clothes. It is stain resistant and does not wrinkle easily. These make it ideal for regular wash and daily wear. Its waterproof and durable properties also makes it popular to be used in outdoor and rain gears. It is also elastic and strong to handle heavy loads without breaking. On top of all these great benefits, it is a lot cheaper compared to alternatives raw materials to make clothes.



Cosmetics including lipsticks can be traced back to ancient civilisations. Many improvements have been made to make lipsticks as time passes. Basic ingredients are wax, oil, alcohol, pigment, antioxidant and emollients. Wax provides the structure to solid lipstick. Many modern-days lipsticks use paraffin wax, derived from petroleum. The pigment that is used for colours also comes from a variety of organic or inorganic materials.




Information for further study on the 35 resources and/or bioproducts, used in the two games

Biological resources (and/or new bioproducts)	Sources/ Links for Images used in 'Match the Cards' game	Sources/ Links for further information
Curran in coatings, packaging, cosmetics	http://products.bio-step.eu/fileadmin/Other_FP7/Paint_procedure.jpg	<ul style="list-style-type: none"> • http://products.bio-step.eu • https://www.cellucomp.com/blog/article/curran-a-microfibrillated-cellulose-mfc-wonder-product-1 • https://be-rural.eu/wp-content/uploads/2020/05/BE_Rural_Latvia_Brochure_ENGL.pdf
Russian dandelion to substitute natural rubber	https://www.uni-muenster.de/news/data/img/2015/04/7635-9g7sOM50-previewL.jpg	<ul style="list-style-type: none"> • http://products.bio-step.eu • https://phys.org/news/2015-06-natural-rubber-dandelions.html • https://be-rural.eu/wp-content/uploads/2020/05/BE_Rural_Latvia_Brochure_ENGL.pdf
Insects as alternatives to traditional beef patties	https://icdn5.digitaltrends.com/image/digitaltrends/bug-burger-space10-ikea-test-kitchen.jpg	<ul style="list-style-type: none"> • https://bugfoundation.com/our-burger.html • https://be-rural.eu/wp-content/uploads/2020/05/BE_Rural_Latvia_Brochure_ENGL.pdf
Chlorella Algae vegan soft drink	https://lifestyle-drinks.online/media/image/85/d3/d9/helga-algen-drink-chlorella-algen-0-29l-24-pet-flaschen-10922459d51b148dd88.jpg	<ul style="list-style-type: none"> • https://lifestyle-drinks.online/en/products-on-request/helga-pure-alga-drink/ • https://be-rural.eu/wp-content/uploads/2020/05/BE_Rural_Latvia_Brochure_ENGL.pdf
Cocoa shell waste ice cream spoon	https://en.reset.org/files/imagecache/sc_832x468/2019/04/01/spoonable-loeffel-aus-kakao2.jpg	<ul style="list-style-type: none"> • https://en.reset.org/blog/spoonable-making-summer-more-sustainable-edible-cocoa-ice-cream-spoons-04062019 • http://engnews24h.com/breakthrough-2020-award-spoonable/ • https://be-rural.eu/wp-content/uploads/2020/05/BE_Rural_Latvia_Brochure_ENGL.pdf
Blue sweet lupines ice cream	https://c8.alamy.com/comp/W1X936/waffle-cone-with-purple-lilac-ice-cream-on-the-dark-gray-background-decorating-lupines-W1X936.jpg	<ul style="list-style-type: none"> • http://www.bio-step.eu/fileadmin/BioSTEP/Bio_documents/Bio-STEP_Bioeconomy-in-everyday-life_Glasgow_Exhibition-Guide.pdf • https://bioekonomie.de/en/lupin-ice-cream-sustainable-dessert • https://be-rural.eu/wp-content/uploads/2020/05/BE_Rural_Latvia_Brochure_ENGL.pdf
Leftover bread to beer	https://www.iamrenew.com/wp-content/uploads/2019/07/Toast-Ale-Banner.jpg	<ul style="list-style-type: none"> • https://www.toastale.com/impact/ • https://edition.cnn.com/2017/11/14/world/toast-ale/index.html • https://be-rural.eu/wp-content/uploads/2020/05/BE_Rural_Latvia_Brochure_ENGL.pdf
Bricks grown from bacteria	https://i0.wp.com/biomason.com/wp-content/uploads/2014/04/6bricks-4-960x525_c.jpg	<ul style="list-style-type: none"> • http://products.bio-step.eu • https://www.inc.com/kevin-j-ryan/best-industries-2016-sustainable-building-materials.html • https://goexplorer.org/growing-bricks-with-bacteria/ • https://be-rural.eu/wp-content/uploads/2020/05/BE_Rural_Latvia_Brochure_ENGL.pdf
Enzymes detergent	https://5.imimg.com/data5/VD/LH/MY-13547509/detergent-enzymes-500x500.jpg	https://ec.europa.eu/research/bioeconomy/pdf/eu_bioeconomy_apartment_katalog.pdf
Plant-based isosorbide/ bio-based polycarbonate resin	http://web.tradecore.com/upload_file2/product/758/P00295758/cbe9caa5_214d3947_c68b_429e_b8d7_7e12988512f9.jpg	<ul style="list-style-type: none"> • https://bioplasticsnews.com/2019/10/29/south-korea-japan-bio-polycarbonate/ • https://www.m-chemical.co.jp/en/products/departments/mcc/sustainable/product/1201026_7964.html • https://be-rural.eu/wp-content/uploads/2020/05/BE_Rural_Latvia_Brochure_ENGL.pdf
Orange and citrus waste to sustainable fabric	https://y6auj24xr4y3qq95tz7io6uwpengine.netdna-ssl.com/wp-content/uploads/2017/09/Orange-Peels-Banners_Zatevakhin-900x600.jpg	<ul style="list-style-type: none"> • http://orangefiber.it/en/how-to-turn-citrus-waste-into-a-sustainable-fabric/ • https://be-rural.eu/wp-content/uploads/2020/05/BE_Rural_Latvia_Brochure_ENGL.pdf
Tencel or lyocell fibres from wood	https://ecotouch.com.au/wp-content/uploads/2018/08/tencel-eucalyptus_grande.jpg	<ul style="list-style-type: none"> • Hutten, I. M. (2016) Handbook of Nonwoven Filter Media. (https://www.sciencedirect.com/topics/engineering/lyocell) • https://www.lenzing.com/sustainability/production • https://spinnova.com/our-method/fibre/ • https://be-rural.eu/wp-content/uploads/2020/05/BE_Rural_Latvia_Brochure_ENGL.pdf
Milk waste to fabric	https://www.china-daily.com.cn/photo/images/attachment/jpg/site1/20110616/002170196e1c0f63adc404.jpg	<ul style="list-style-type: none"> • https://ec.europa.eu/research/bioeconomy/pdf/eu_bioeconomy_apartment_katalog.pdf • https://cordis.europa.eu/article/id/135536-making-clothes-from-milk • https://sewport.com/fabrics-directory/milk-fabric • https://be-rural.eu/wp-content/uploads/2020/05/BE_Rural_Latvia_Brochure_ENGL.pdf

Biological resources (and/or new bioproducts)	Sources/ Links for Images used in 'Match the Cards' game	Sources/ Links for further information
Pineapple leaves waste fibre shoes	https://danandmez.com/content/uploads/2019/05/ananas-anam-pinatex-ona691-1.jpg	<ul style="list-style-type: none"> https://skizoshoes.com/material-v2/ https://be-rural.eu/wp-content/uploads/2020/05/BE_Rural_Latvia_Brochure_ENGL.pdf
Algae biomass bathing shoes	https://media.treehugger.com/assets/images/2017/05/4464986156_ec0c4e9784_b.jpg.860x0_q70_crop-scale.jpg	<ul style="list-style-type: none"> https://mashable.com/article/kanye-west-yeezy-algae-shoes-sustainable/?europa=true https://www.vivobarefoot.com/uk/blog/may-2017/vivobare-footxbloom https://be-rural.eu/wp-content/uploads/2020/05/BE_Rural_Latvia_Brochure_ENGL.pdf
Olive leaves tanning agent	https://www.herbal-supplement-resource.com/wp-content/uploads/2019/07/OliveLeaves2.jpeg	<ul style="list-style-type: none"> https://ec.europa.eu/research/bioeconomy/pdf/eu_bioecnomoy_apartment_katalog.pdf https://internationalleathermaker.com/news/full-story.php/aid/3841/Olive_leaf_tanning_specialist_to_speak_at_Automotive_Conference.html https://www.ackermann-leather.com/en/online-shop/collec-tions/eco/ https://be-rural.eu/wp-content/uploads/2020/05/BE_Rural_Latvia_Brochure_ENGL.pdf
Icelandic algae, beechwood, medical zinc fibre	https://cdn2.f-cdn.com/contesten-tries/1229468/3242038/5a5fd2d8e4e7b_thumb900.jpg	<ul style="list-style-type: none"> https://www.vitadylan.com https://be-rural.eu/wp-content/uploads/2020/05/BE_Rural_Latvia_Brochure_ENGL.pdf
T-shirt made from pulped eucalyptus, beech and algae	https://dyk8bhziatfed.cloudfront.net/wp-content/uploads/2019/08/plant-and-algaet-300-1376-1376x776.jpg	<ul style="list-style-type: none"> https://www.vollebak.com/product/plant-and-algae-t-shirt/ https://be-rural.eu/wp-content/uploads/2020/05/BE_Rural_Latvia_Brochure_ENGL.pdf
Tinder fungus leather	https://c8.alamy.com/comp/BXBETH/tinder-bracket-fungus-hoof-fungus-tinder-polypore-horses-hoof-fomes-BXBETH.jpg	<ul style="list-style-type: none"> https://fashionunited.uk/news/business/sustainable-textile-innovations-mushroom-leather/2018051429598 https://be-rural.eu/wp-content/uploads/2020/05/BE_Rural_Latvia_Brochure_ENGL.pdf
Wheat bran dish-ware	https://industry europe.com/download/4481/download/biotrem1.jpg?cb=493b12efb431dff28baf3fa3af9563a0&w=640	<ul style="list-style-type: none"> https://biotrem.pl/en/ https://be-rural.eu/wp-content/uploads/2020/05/BE_Rural_Latvia_Brochure_ENGL.pdf
Apple residues backpack	https://i0.wp.com/stylewithasmile.co/wp-content/uploads/2019/04/IMG_8336.jpg?w=3420&ssl=1	<ul style="list-style-type: none"> https://www.nuuwai.com/pages/materials https://be-rural.eu/wp-content/uploads/2020/05/BE_Rural_Latvia_Brochure_ENGL.pdf
Salmon fish skin leather	https://img4.mashed.com/img/gallery/8-mistakes-everyone-makes-when-cooking-salmon/removing-the-skin.jpg	<ul style="list-style-type: none"> https://www.salmo-leather.de/en/ https://be-rural.eu/wp-content/uploads/2020/05/BE_Rural_Latvia_Brochure_ENGL.pdf
Sapodilla tree chewing gum	https://cdn.shopify.com/s/files/1/0076/0522/3537/products/True-Gum-3-flavours-biodegradable-gum-no-plastic-angle-Marvels.jpg?v=1550970461	<ul style="list-style-type: none"> https://www.truegum.com/ingredients/ https://be-rural.eu/wp-content/uploads/2020/05/BE_Rural_Latvia_Brochure_ENGL.pdf
Coffee cups and saucers using coffee ground	https://www.designboom.com/wp-content/uploads/2018/07/kaffeeform-reusable-coffee-cups-made-old-recyclable-coffee-grounds-designboom-1200.jpg	<ul style="list-style-type: none"> http://www.bio-step.eu/fileadmin/BioSTEP/Bio_documents/Bio-STEP_Bioeconomy-in-everyday-life_Glasgow_Exhibition-Guide.pdf https://www.kaffeeform.com/en/story/ https://be-rural.eu/wp-content/uploads/2020/05/BE_Rural_Latvia_Brochure_ENGL.pdf
Elephant poo paper	https://www.paperhigh.com/media/catalog/product/cache/1/thumb-nail/600x600/9df78eab33525d08d6e5fb8d27136e95e/ele-dung-group-note-books-9.jpg	<ul style="list-style-type: none"> https://www.bbc.co.uk/news/business-36162953 https://thekidshouldseethis.com/post/84437356027 http://www.ecomaximus.com https://mrelliepooh.com
Shells from shellfish into plastic packaging.	https://www.cuantec.com/	https://www.cuantec.com/
Tomato-peel based bio-lacquer for metal cans	https://www.tomapaint.com/	https://www.tomapaint.com/
Organic waste residues spray	https://apeelsciences.com/	https://apeelsciences.com/
Soaps from cold pressed flaxseed/ pumpkin/ sesame/ black cumin/ chia seeds oil	http://e-shop.filla.com.mk/product-category/%d1%81%d0%b0%d0%bf%d1%83%d0%bd%d0%b8/	http://e-shop.filla.com.mk/product-category/%d1%81%d0%b0%d0%bf%d1%83%d0%bd%d0%b8/

Biological resources (and/or new bioproducts)	Sources/ Links for Images used in 'Match the Cards' game	Sources/ Links for further information
Organic food waste to make protein feed	https://nasekomo.life/	https://nasekomo.life/
Alternative to chemical de-rust processes	http://asa-enzyme.com/	http://asa-enzyme.com/
Agri wastes to sanitary napkins	https://aakarinnovations.com/	https://aakarinnovations.com/
Producing high-end products using sugar, corn starch and cooking oil	https://www.craftingplastics.com/nuatan	https://www.craftingplastics.com/nuatan
Edible straws using sugar, water, maize starch and gelatin; flour and water, and pasta.	https://ecostraws.ie/	https://ecostraws.ie/
Using surplus ingredients to create condiments that are sustainable	https://rubiesintherubble.com/	https://rubiesintherubble.com/
Polystyrene	https://sc01.alicdn.com/kf/H3576e43f177b468d8d6240aac5f0b52fx/223439956/H3576e43f177b468d8d6240aac5f0b52fx.jpg	NA – This is a fake bioproduct
Synthetic Fibres	https://www.songwon.com/assets/files/content/textile_content.png	NA – This is a fake bioproduct
Lipsticks	https://www.kcet.org/sites/kl/files/thumbnails/image/earth-focus_petroleum-products_lipstick.jpg	NA – This is a fake bioproduct

Annex XVIII Bioeconomy Word Search Puzzles

Word search puzzles are a simple, fun and innovative idea to help remember technical terms explained in class. They can be played by people of all ages, can be done in any language and can be done with different levels of complexity to suit the audience. Difficulty depends on number and type of hidden words, size of the word search puzzles in terms of columns and rows, and if list of words to be found is provided or not. Below are two examples created using the free online tool “word search”, part of “Discovery Education’s Puzzlemaker” (<http://puzzlemaker.discoveryeducation.com/WordSearchSetupForm.asp>) but teachers will be able to do their own word search puzzles that suits their classes using this link. The word search puzzles can be done individually or in groups, and can be printed or done online. The online tool provides a web link to the word puzzle once it has been created. This link could be shared with participants and asked to complete online.

Easier word search– 10 hidden words

R	E	N	E	W	A	B	L	E	M	A
N	A	S	O	T	I	H	C	T	Q	L
N	O	I	T	A	V	O	N	N	I	G
E	R	U	T	L	U	C	A	U	Q	A
S	U	S	T	A	I	N	A	B	L	E
G	R	A	S	S	L	A	N	D	T	G
N	E	G	A	L	L	O	C	U	V	O
F	E	R	T	I	L	I	S	E	R	G
A	I	N	O	D	E	C	A	M	X	M

Find these words: renewable, culture, collagen, chitosan, fertiliser, sustainable, grassland, Macedonia, algae, innovation. **Tip:** Words can be vertical, horizontal, diagonal or written backwards.

More difficult word search – 15 hidden words

A	J	A	R	C	D	H	P	E	M	U	K	S	E	N
L	J	Q	M	E	O	L	L	O	R	L	U	K	L	L
G	S	U	I	T	S	L	T	R	L	S	C	H	B	W
A	S	A	N	E	O	I	L	W	T	A	G	Z	A	C
E	A	C	G	O	B	B	L	A	A	L	N	T	W	H
S	M	U	B	I	I	V	I	I	G	Q	Y	D	E	I
U	O	L	Z	O	W	N	N	S	T	E	M	L	N	T
F	I	T	F	J	A	O	K	C	C	R	N	K	E	O
P	B	U	B	B	D	Y	B	V	Z	C	E	E	R	S
R	E	R	L	E	G	N	I	M	R	A	F	F	H	A
L	V	E	C	N	O	I	T	A	V	O	N	N	I	N
G	R	A	S	S	L	A	N	D	C	A	R	B	O	N
B	M	C	D	E	P	U	H	G	X	P	A	Y	N	Y
X	A	P	H	F	C	J	C	M	J	S	W	C	C	A
K	K	T	L	K	C	A	D	I	M	I	Z	O	M	P

Find these words: algae, biomass, aquaculture, grassland, carbon, oil, collagen, renewable, chitosan, Macedonia, sustainable, fertiliser, innovation, Poland, farming.
Tip: Words can be vertical, horizontal, diagonal or written backwards.