What is the Bioeconomy?

KS4 Pack 1: Laying the foundations

THYME Project
Teesside, Hull and York - Mobilising Bioeconomy Knowledge Exchange

UNIVERSITY OF HULL

KS4

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Introduction

Human overconsumption of Earth's natural resources is putting the planet under rapidly increasing stress. Our reliance on fossil fuels for energy, heating, the powering of vehicles and factories, and the production of many household materials such as plastic, is significantly contributing towards the depletion of the planet's resources, as well as exacerbating climate change. By 2050, nearly 10 billion humans will live on Earth. They will consume 40% more energy, 50% more food and demand more consumer goods than ever before. If we are to prevent such things from running out, and if we are to put a halt to climate change, it is imperative we reduce both consumption and waste, and find alternatives to these resources.

Fortunately, there are many things that scientists, businesses, schools, communities, children and the general public as a whole can do to prevent the bleak predictions often seen in news headlines. Many of these solutions are a part of the Bioeconomy. This pack is the first of a series of three that will introduce you and your students to the concept of the Bioeconomy.

What is the Bioeconomy?

To break it down, the term **bio** refers to any living thing; while **economy** means the making and usage of goods and services by those within a country or region. So, the **Bioeconomy** is an economy based on renewable biological resources. By using living things instead of those that are non-renewable, humans can grow more to replace diminishing reserves.

This might be as simple as replacing single-use plastic coffee cups with the increasingly popular reusable bamboo ones, that can be reused over and over before composting back into the environment. It could be repurposing food waste to heat homes, or growing algae to create shoes! By making these switches, we not only lessen our reliance on fossil fuels and other finite resources, but we can reduce overall waste and CO2 emissions. However, the answer doesn't lie in just one of these options; instead it takes a concerted and collective effort, with sustainability at the forefront.

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What is in the packs?

Pack 1 will introduce these concepts, making direct links to the National Curriculum and UN Sustainable Development Goals (SDGs). It will draw upon previously learned concepts from the lower Key Stages and will frequently encourage classroom debate to enhance student's learning. These debates will have accompanying prompts to help highlight the multiple layers, perspectives and dimensions to the Bioeconomy and sustainability.

This will provide the foregrounding for Pack 2, where students will be encouraged to critically assess the sustainability of them school/home/youth group/etc. Drawing upon many geographical skills, children will identify both barriers and opportunities to employing the principles of the Bioeconomy in such a location.

After this, students will democratically decide from a toolkit of ideas, how they might best increase the bio-economic value of their school/home/youth group/etc. These activities utilise outdoor learning and experiential learning and is not exhaustive. It is hoped that students will identify their own opportunities and find innovative ways to implement them.

Objectives: What will students learn?

By the end of the two packs, students will have a critical and informed knowledge base from which they can make sustainable consumer choices: considering economic, environmental and societal impacts to various decisions. They will have developed their skills in formulating coherent and balanced arguments and will have applied their knowledge to improve their own surroundings. They will have gained an understanding of the types of jobs that exist within the Bioeconomy, and how it maps to their futures. By engaging in outdoor activities that require teamwork and engagement with nature, their social and emotional development will be enhanced, and hopefully, their care and love for the environment increased!

National Curriculum and SDG Links

Geography

Understand:

- Economic activity in the primary, secondary, tertiary and quaternary sectors
- How human and physical processes interact to influence change in environments
- How human activity relies on effective functioning of natural systems
- Geological timescales linked to natural resource usage
- The use of natural resources in economic activity
- How human activity relies on effective functioning of natural systems
- How geographical processes interact to create distinctive human and physical landscapes that change over time
- Increasingly complex geographical systems in the world around them.

Be Able to

- Use geographical models to enrich environmental understanding

Science

- Ask questions and develop a line of enquiry based on observations of the real world, alongside prior knowledge and experience
- Make predictions using scientific knowledge and understanding
- Select, plan and carry out the most appropriate types of scientific enquiries to test predictions, including identifying independent, dependent and control variables
- Use appropriate techniques, apparatus, and materials during fieldwork and laboratory work, paying attention to health and safety
- Make and record observations and measurements using a range of methods for different investigations; and evaluate the reliability of methods and suggest possible improvements
- Apply sampling techniques
- Understand:
  - Living organisms and the means of transferring energy
  - How organisms affect, and are affected by, their environment
  - Earth as a source of limited resources and the efficacy of recycling
  - The production of carbon dioxide by human activity and the impact on climate.

English

- Use discussion in order to learn; able to elaborate and explain clearly their understanding and ideas
- Understand the difference between fact and opinion
- Competent in the arts of speaking and listening, making formal presentations, demonstrating to others and participating in debate
- Use Standard English confidently in a range of formal and informal contexts, including classroom discussion
- Summarise and organise material, and supporting ideas and arguments with any necessary factual detail
- Give short speeches and presentations, expressing their own ideas and keeping to the point
- Participate in formal debates and structured discussions, summarising and/or building on what has been said.

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D&T

- Understand developments in D&T, and its impact on individuals, society, and the environment, and the responsibility of designers, engineers and technologists
- Understand and use properties of materials and the performance of structural elements to achieve functional solutions.

Citizenship/PSHCEE

- Understand ways in which citizens work together to improve their communities, including opportunities to participate in school-based activities
- Recognise responsibilities in the community
- Build and support the ethos and value system of the school
- Skills and knowledge to explore political and social issues critically, to weigh evidence, debate and make reasoned arguments
- Prepared to take their place in society as responsible citizens
- Equipped with the skills to think critically.

How do I use them?

These packs are all flexible, and have purposely been created on editable templates for teachers/ educators to adapt to local contexts and the needs/abilities of students. We recommend conducting the packs in numerical order.

Where possible we have provided a time estimate for activities, however we suggest teachers use their own initiative to chop, change, shorten or lengthen activities based on their students. We know students and educators alike are interested in how their education links to careers in the future. For that reason, you'll find bubbles stating what kind of job the activity links in with. We encourage educators to highlight these and explore further with students.

The pack is multimedia, and uses PowerPoints, print-outs, activity guides and video to encourage meaningful learning. Some activities require outdoor space or access to ICT equipment.

Recommended Reading/Resources

The Bioeconomy is a multifaceted topic that enables the exploration of multiple points of view, and many societal, environmental and economic issues. In order for students to get the maximum benefit from these packs, we offer teacher guidance throughout. However there exists many external and brilliant resources we recommend teachers explore, to increase their own knowledge and understanding before conducting the activities.
We personally recommend the below:

https://sdgs.un.org/goals
http://www.fao.org/3/ca4352en/ca4352en.pdf

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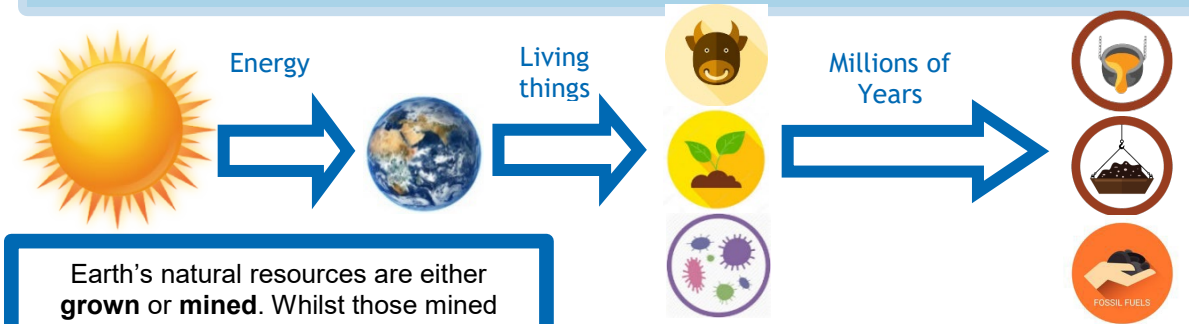
Progression	Focus	Curriculum links	Activities
Lesson 1 Page	Will we ever run out?	Geography Science English	Students will consider which of the Earth's spheres are responsible for the production of bioresources. Describe how these bioresources are used by businesses to produce everyday products. This will provide the foregrounding for students to consider the role of the Bioeconomy in moving towards a sustainable future. A PowerPoint with guidance notes, as well as video, will support teaching.
Lesson 2 Page	What is the Bioeconomy?	Geography Science English	Students investigate how the economy can be sustainable whilst trying to continue to develop. How are sustainable Development Goals aimng to support a sustainable society, economy and envioronment. Research how a variety of biobased products are supporting economic development, society and the environment.
Lesson 3 Page	Applying the Bioeconomy to our own environment	Geography Science English	Initially, this session will re-address waste and personal choices in relation to sustainability. Students will then suggest how the Bioeconomy reduces waste through the concept of the circular economy. Students will then think innovatively to design or redesign a familiar product that supports the bioeconomy which students will then pitch to the classroom 'Dragons'!

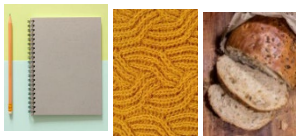
The Bioeconomy Knowledge Organiser

The Bioeconomy can help achieve many of the above **SDGs**. Equally, for the Bioeconomy to work, it must be **sustainable**. Sustainability means **'to meet the needs of the present without compromising the ability of future generations to meet their own needs'**. Sustainability **requires society,** the **environment** and the **economy** to work together.

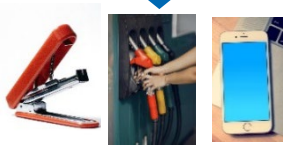
Concept Digram: How are Earth's resources made?



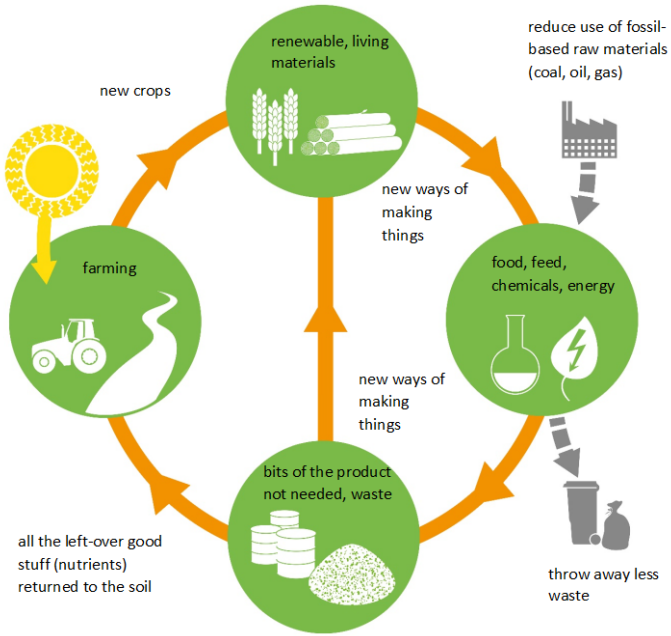
Earth's natural resources are either **grown** or **mined**. Whilst those mined (such as fossil fuels), originally come from dead plants and animals from millions of years ago, these are considered **inorganic**, or **non-bio**. Those that are grown, are known as **organic,** or **bio-based** resources, like plants, animals and microbes, and are created much faster than non-bio resources. This means that if grown **sustainably**, they can be **renewable resources.** We need to reduce our useage of mined resources (especially fossil fuels) as they are running out, and contribute to climate change!



Grown bio-based resources



Mined non bio-based resources



What is the Bioeconomy?

The term **bio** refers to any living thing, while **economy** means the making and usage of goods and services by those within a country or region. So, the Bioeconomy is an **economy based on renewable biological resources**. These resources may be converted into food, feed (the food we give animals), bio-based products (like biodegradable bags, coffee cups, chairs, clothes) or bioenergy.

Examples of the Bioeconomy

Electricity from bio-waste (like poop and food!)

Everyday products from bamboo, seaweed and coffee beans!

Exposure Vocabulary Grid

Word	The word in context	My understanding/Class Definition
Bioeconomy (n)	The main reason the Bioeconomy is gaining attention, is because existing production practices contribute to serious environmental and climate problems.	
Renewable	There are an increasing number of renewable options nowadays, for both energy and products.	
Fossil Fuel	Governments are now realising that we can't keep relying on fossil fuels to keep our economy going.	
Sustainable	Humans' current transport practices are not sustainable.	
Biomass	An anaerobic digester uses biomass to create energy.	
Biogas	We can make biogas from all kinds of things, like animal manure, food, and sewage!	
Biodegrade	Whilst plastic does break down over time, it does not biodegrade or decay.	
Organic/bio-based	You can improve soil quality by adding organic/bio-based matter.	
Products	Seagrown have launched a new range of products made from seaweed.	
Services	Some of the biggest energy providers have reduced their reliance on coal to provide heating and electricity services.	
Greenwashing	Many high-profile fashion brands have been criticised for greenwashing.	
Carbon Footprint	Many people are now considering the carbon footprint and air-miles that come with their food as they make their consumer choices.	

Lesson 1:

Will we ever run out?

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Lesson 1:
Will we ever run out?

Resources Required:
PowerPoint Slides for "Will we ever run out",
Activity Sheets A (page 14), and B (page 15)

Lesson Objectives

- Identify which of the Earth's resources are renewable and non-renewable.
- Classify resources by their renewal times.
- Understand that living (bio-based) resources can offer a more sustainable economic model: The Bioeconomy
- Define the term Bioeconomy.

Lesson Outcomes

- Explore where the Earth's resources are created and suggest why.
- Define the term Bioeconomy and suggest how it supports the sustainable use of resources.
- Demonstrate how businesses can continue to use the Earth's resources.

Curriculum Links

Geography

AQA Geography

Ecosystems: Interaction between biotic and abiotic components.

Edexcel Geography

The principles of material cycling

A natural resource is any feature or part of the environment that can be used to meet human needs.

- Natural resources can be defined and classified in different ways (biotic, abiotic, renewable and non-renewable).
- Ways in which people exploit environments in order to obtain water, food and energy (extraction of fossil fuels, fishing, farming and deforestation.

Science - Chemistry

Describe the physical states of products. Carbon compounds both fuels and feedstock:

- Recall that crude oil is the main source of hydrocarbons and is feedstock for the petrochemical industry.
- Explain how modern life is crucially dependent upon hydrocarbons and recognise that crude oil is finite resource.

Design & Technology AQA

- Selecting materials: Functionality and Availability.
- Selecting materials: Environmental Factors, Social Factors and Ethical Factors.

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Preparation

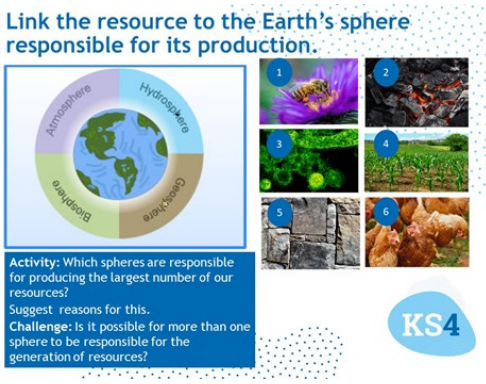
This introductory session will rely on group discussion to bring about deep and meaningful learning. Through the corresponding PowerPoint, this lesson includes question prompts and scaffolding recommendations at relevant points. We recommend the teacher/educator considers ahead of time, what prompts they could use that are of local relevance.

Previous Learning

Students will have considered material properties, natural resources and economic activity, renewal of living and non-living resources, sustainability, and limited resources in Key Stage 3 Science and Geography. A grounded understanding of these areas is necessary for the understanding of this lesson. Please see resources for Key Stage 3 if these areas need re-addressing.

The Lesson

This lesson follows PowerPoint Presentation KS4 Pack 1 Lesson 1 “Will we ever run out”. More detailed guidance is provided in the notes section within it.



Starter activity: Slide 4 asks students to match the resources to one or more of the Earth’s spheres, it is important for students to recognise that the Earth is responsible for the production of many resources used in the economy. The challenge question asks students to suggest how more than one sphere can be responsible for the generation of resources.

Slide 5: Students can check their answers, students may have made the link that more than one sphere is responsible for the production of resources.

Slide 6: Students read the quote and then are asked to define the meaning of the phrase ‘limited resources 'within this context.

Challenge: Suggest how businesses can use limited resources and still be economically productive, students may suggest recycling of resources or the use of resources that can be renewed quickly, i.e. bio-based resources.

Slide 7: Introduce the term Bioeconomy, students use literacy strategies to suggest the meaning of the term, by splitting the term into familiar parts, bio and economy. Students suggest what they think the Bioeconomy is.

Slide 8: The video explains what the Bioeconomy in simple to understand terms, students use the printed graphic organiser on **Slide 9** to make notes during the playing of the clip. Students may find it useful to do this in pairs.
Review the video clip and define the term Bioeconomy.

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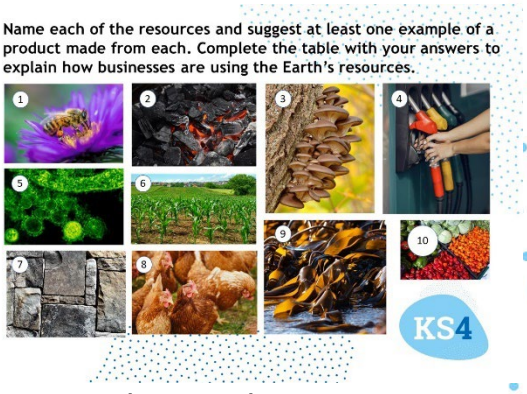
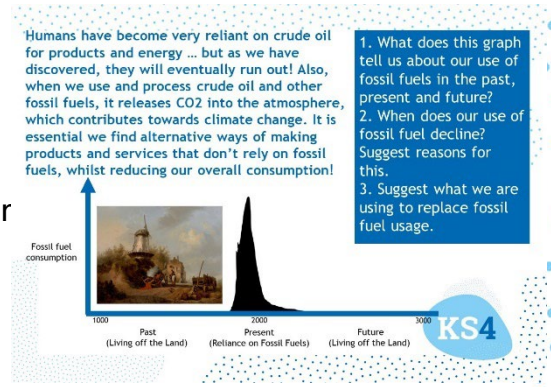


Slide 10 and 11: Using the images of bio-based resources students are asked to complete the table on slide 11, name the resource, economic use(s) then rank the renewal time (1 – fastest renewal time, 10-longest renewal time).

Slide 12: The question asks students to think about the economic issues with renewal rates of bio-based resources (feeding the population, for transport, for energy production) Can we sustain our current use of these products and continue to be economically productive and develop economically?

Slide 13: Students can answer the question using one of the sentence starters to begin their paragraph. Encourage students to follow the success criteria to produce a detailed answer to the question, in addition to exposure vocabulary grid may encourage students to extend their answers.

Slide 14: Is a video that explains the journey of plastic, from fossil fuel to plastic and marine litter. Plastic originates from a bio-based product but is currently not used in a sustainable economic or environmental way. Use notes to guide the discussion about the future use of plastic.



Slide 15: Introduces a graph showing society's fossil fuel usage over time and asks the students to consider what this graph indicates. Encourage students to discuss alternatives to fossil fuels

Plenary:

Slide 16: Return to the quote from the starter activity, use the PowerPoint notes to guide student reflections. Will we ever run out?

Activity Sheet A

Lesson 1: Print out A
Defining the Bioeconomy

Facts	Examples
Why is the Bioeconomy important?	What do you think? Is it achievable? A good solution?

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Activity Sheet B

Lesson 1: Print out B
How do businesses use the Earth's resources?

	Name of resource	Economic uses	Renewal ranking (1- 10)
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

Are there any bio-based resources missing from this list?

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Lesson 2:

What is the Bioeconomy?

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Lesson 2:
What is the Bioeconomy?

Resources Required:
PowerPoint Slides for "What is the Bioeconomy",
Case Study Pack,
Hexagon template C

Lesson Objectives

- Recognise how sustainable development can be supported by elements of the Bioeconomy.
- Examine how the Sustainable development Goals (SDGs) are interrelated and how they underpin one another
- Analyse personal consumption practices and behaviours in relation to the SDGs.

Lesson Outcomes

- Discuss the term sustainability, in relations to society, environment and economy.
- Categorise the SDGs and identify the links between them.
- Rank the SDGs in order of priority and provide justification for choices.
- Suggest how the bioeconomy can help achieve the SDGs explored.

Curriculum Links

AQA Geography

Features of sustainable urban living:

- Water and energy conservation
- Waste recycling.

Climate Change:

- Climate change is the result of natural and human factors.
- Managing climate change involves both mitigation (reducing causes) and adaptation (responding to change). Managing climate change:
- mitigation – alternative energy production, carbon capture, planting trees, international agreements
- adaptation – change in agricultural systems, managing water supply, reducing risk from rising sea levels.

Global economic development issues:

- Moving towards a post-industrial economy: development of information technology, service industries, finance, research, science and business parks
- Impacts of industry on the physical environment. An example of how modern industrial development can be more environmentally sustainable.

EdExcel Geography

3.2 The biosphere is a vital system. How the biosphere provides resources for people (food, medicine, building materials and fuel resources) but is also increasingly exploited commercially for energy, water and mineral resources he chosen UK city.

4.5 Globalisation and economic change create challenges for the chosen UK city that require long-term solutions. The range of possible strategies aimed at making urban living more sustainable and improving quality of life (recycling, employment, education, health, transport, affordable and energy-efficient housing) for the UK city.

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Background

The UN Sustainable Development Goals (SDGs) are an urgent call for action from all United Nations member states. They were adopted in 2015, and set out the path for peace, prosperity, people and the planet in the following 15 years, up to 2030. There are 17 goals in total, and UN countries are working in partnership to achieve them all. Primarily, the goals recognise that ending poverty and social inequalities is key to economic growth, and must go hand in hand with tackling climate change and protecting our land and seas. These goals are a key motivator for the Bioeconomy, and help us make rational choices that consider multiple impacts of certain actions. By addressing these goals in this lesson, students will increase their critical skills in relation to the Bioeconomy and sustainability.

Previous Learning

Students may have already learned about the SDGs in relation to LICs, they will have also covered recycling in previous Key Stages.

Preparation

If not already familiar with the SDGs we recommend spending some time exploring these. There are some amazing resources online *

Print out Hexagon Activity Sheet C (page 20) and the Case Studies (page 21-31)

The Lesson

Following a similar format to lesson 1, this lesson will also utilise a PowerPoint, classroom discussion and collaborative investigation to enhance and support students learning.

Slide 4 Ask students to define sustainability based on their existing knowledge. Students should be encouraged to use the key terms Economy, Environment and society. Further discussion guidance in the notes section of slide 4.

Slide 5: Students brainstorm what is sustainable in our economy and what is not? The images at the bottom of the slide can be used as prompts (transport, clothing, packaging, energy production) students, what impact does this have on people and the environment?

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* Online resources re United Nations SDGS
https://sdgs.un.org/goals

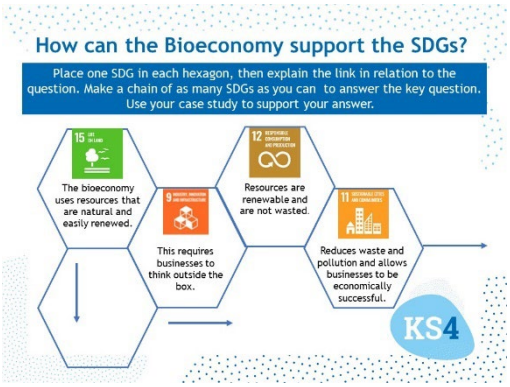
Slide 6: Introduce the SDGs, guidance is provided on the slide notes. Ask by asking students to match the SDGs with the pillars of sustainability - Society, Environment and Economy, which one does each SDG support?

Guide discussion to conclude that the SDGs overlap and do not fit into neatly contained categories. They work together for a common purpose.

Examples are provided on the PowerPoint.
You could also use a Venn diagram to support this exercise.

Slide 7: The case study allows students to investigate how a widely produced product is supporting economic development, people and the environment.

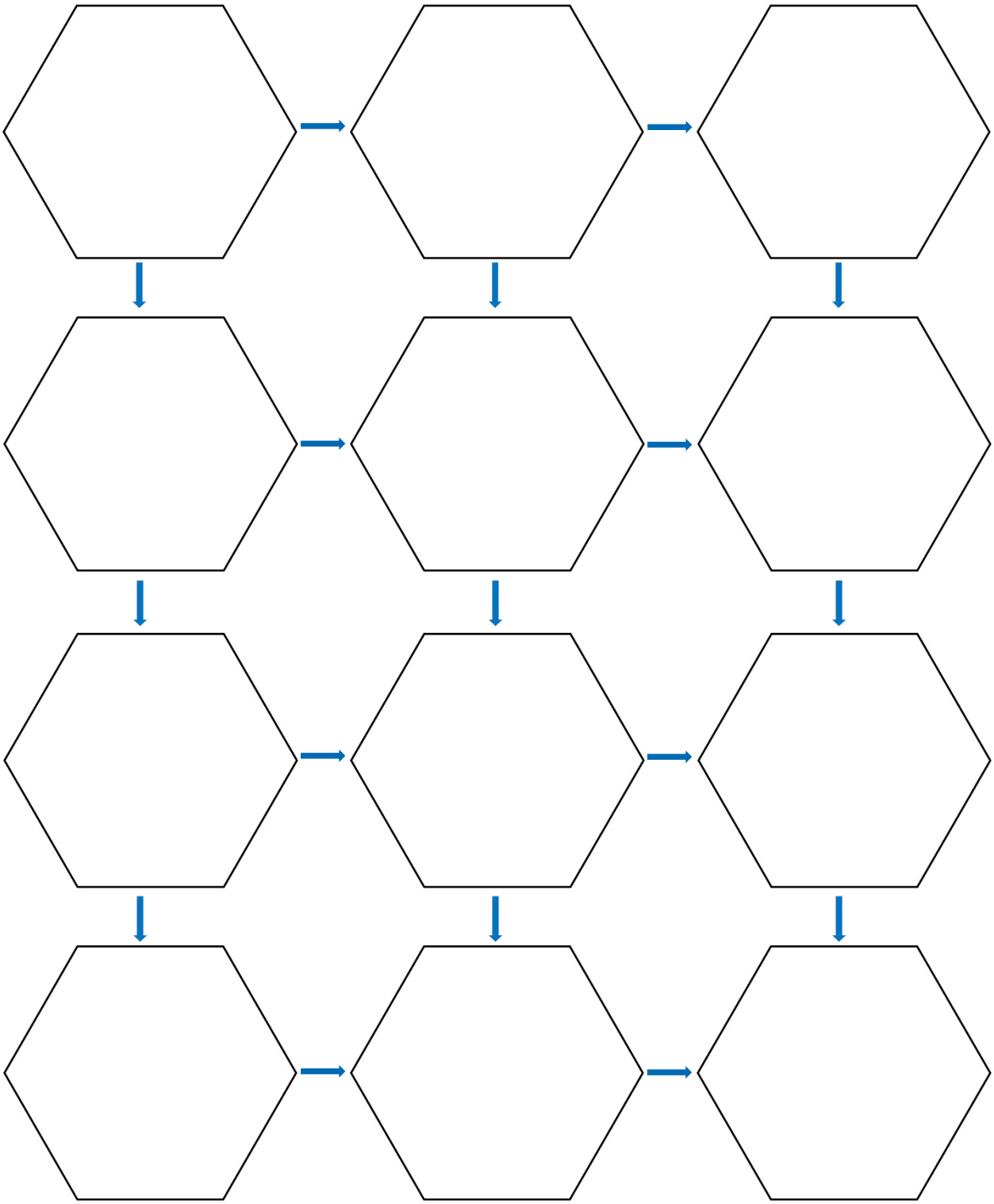
Slide 8: Plenary – students use their case study knowledge and knowledge of the SDGs to complete a thinking diagram and form an explanation to the question posed; How can the Bioeconomy support the Sustainable Development Goals?



Encourage students to use specific facts from their case study to support their answer.

Activity Sheet C

Lesson 2: Print out C Hexagon chain
How can the bioeconomy support the SDGs?



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Case Study 1

VEJA: Moving towards a Bioeconomy

The VEJA is a sneaker company, who have found a way to sustainably and ethically produce their footwear. Click here for their YouTube video, and to listen to their journey towards being a sustainable footwear brand.
Watch: https://www.youtube.com/watch?v=Jv3ZShuPatw

Or use the following article which has been compiled from the YouTube video.

In 2003 we discovered that the Chinese factory workers that manufactured our sneakers were living in cramped conditions with inadequate sanitary conditions. It was then that we decided that we needed to address the balance between producers and consumers. We decided to reinvent the product to be more sustainable, we chose sneakers because we loved them, but also as 30% of the cost of a sneaker goes to raw materials and production, so if we invested more money in the raw materials, we could create a more sustainable product. That's what VEJA is all about.

We thought if we gave up advertising, we could make sneakers that were 5 times more expensive to produce, yet still offer them at the same retail price as the big brands. We could reallocate advertising resources to production, raw materials, and the people who make the sneakers. Producing sneakers that do respect the environment, sneakers with greater economic justice, simply by removing advertising from the equation. Sounds great, right?

So we fly to Brazil, because it's a country that has all the raw materials we need and factories that protect the workers. And it's a country where everything seems possible, a country that welcomes with open arms those who are willing to try. We explain that we want to create an incredible product, and make it differently, and they trust us. Day after day, we learn to work together. And this wild rubber they harvest from the rubber trees becomes the cornerstone of our sneaker. It represents 40% of all sneaker soles we've made since.

Then, we leave for the Brazilian Nordeste, by the Atlantic coast: very arid and poor part of Brazil. It's hard for anything to grow there. But this is exactly where we met organic cotton producers. A very small cooperative of 35 producers, supported by a local NGO.

In fact, they grow organic cotton without fertilizers or pesticides, but it's more than just organic: its agro-ecological cotton, it makes the soil richer after the harvest instead of harming it. The organic cotton became the upper of our sneakers.

We then discovered a sneaker factory in the south of Brazil with strong social rights. The workers do reasonable hours and 82% of them are unionised. And that's where we decide to manufacture our sneakers.

We keep going, and a few years later, we decide to launch leather sneakers. Not with regular leather, but a leather tanned with a vegetal process. At the same time, with a factory next to Sao Paulo, we develop a new kind of fabric that's entirely made from recycled plastic bottles. It's called B-mesh and it's more expensive than the regular materials used in the shoe industry. The plastic bottles are picked up from the streets of Rio and Sao Paolo, before being crushed into flakes. Then they're shipped to a Brazilian factory where they turn the flakes into fibre.
In 2005 we decide that we need to do more to support the environment and the people linked to the company.

So, we start changing our suppliers. For instance, we choose banks that have no branches in tax heavens, and we change our power supplier to Enercoop, who provides green electricity collected from small independent producers. In 2009, we start posting our limits on the VEJA website. Everything we do wrong, we post it, we publish everything. And we love it. And that's precisely what we're going to continue doing in our future projects; keep improving, step by step, and stay faithful to what we are and to what we'd like to see happen in the world.

We love this transparency that drives us to do a little better each time. Because "changing the world" has become a buzz word. Even Google or Amazon use it every day. So instead of trying to change the world and the people in it, we stick to what we believe in: being even more transparent, improving the consistency of our project and make solutions happen. And instead of trying to convince everybody, **we start with ourselves."**

Think:

1. How did VEJA manage to pay their suppliers and workers a higher wage?
2. What bio-based resources do VEJA use in their trainers?
3. Which of the SDGs do VEJA tackle?
4. Why do you think they source all their materials in one country?
5. What does transparency mean?
6. Veja trainers cost around £100. Is this an issue?

Case Study 2: Energy

Key facts:

- In 2019, 78.8% of global total energy supply, came from non-renewable sources: Coal, Oil and Gas.
- We need to find and increase our use of alternative, renewable energy sources.
- Biofuels are fuels that come from bio-based things.
- Biogas can be made from waste food, manure and even sewage, and is used to heat homes and create electricity.
- Biofuels made from waste bio-materials are more sustainable as they repurpose waste and do not require more land.
- Biofuels still release greenhouse gases –

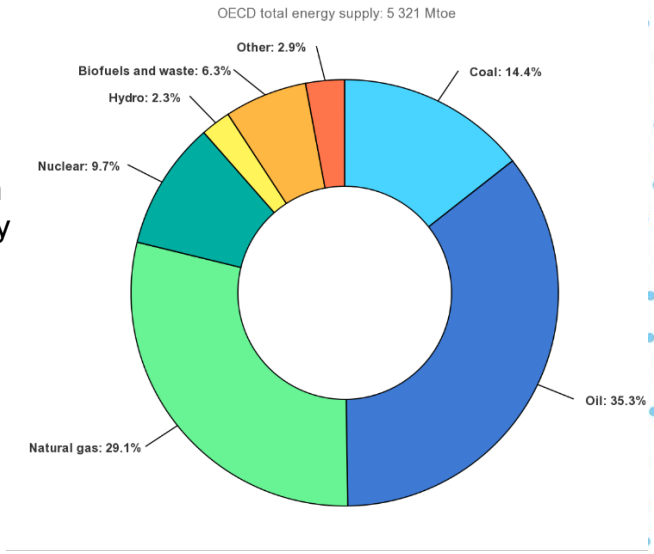
Right now, people are working hard to make biofuels more efficient.

- There are other innovative ways of using Bio-based resources for energy (look at the example *Carvey Maigue: Moving toward a Bioeconomy*).

Facts taken from IEA, OECD share of total energy supply by source, 2019, IEA, Paris https://www.iea.org/data-and-statistics/charts/oecd-share-of-total-energy-supply-by-source-2019 and http://biofuel.org.uk/biofuel-facts.html

The History and Use of Bio-based Resources for Energy

Using bio-based resources to create energy is not a new concept. Rudolph Diesel, inventor of the diesel engine, ran one of his first demonstrations on peanut oil … and **humans have been burning wood to keep warm for millennia!** Yep, turning wood into energy to make heat counts as a bio-energy process. We know that burning wood releases CO_2, much like the burning of fossil fuels. This never used to be a problem, because there wasn't so many of us on Earth, and so the use of wood as fuel for energy *(heat) was sustainable. However, a lot more people live on Earth now, meaning the demand for energy has increased rapidly. We also have cars, planes, factories, electricity, heating, air conditioning and so on … all things that require a lot more energy that what we used to rely on. Our energy consumption has sky rocketed, and we rely on fossil fuels to run a lot of this stuff meaning the releasing of greenhouse gasses (such as CO_2 and Methane) has also increased. This is making the Earth warmer, and means we need to find alternative, renewable and more sustainable ways of creating energy.



We know why we need to move away from fossil fuels (we're running out of them, and they contribute to climate change), but the alternatives we currently have aren't being used enough, and don't quite fix the problem on their own. Only around 6% of global energy comes from biofuels, and even these aren't perfect. Biofuels still release greenhouse gases, and they take up a lot of land. It requires a lot of CO_2 to power the machines needed for growing, harvesting and processing plants for biofuel too. However, that doesn't mean people are giving up on plants for power, and instead, many engineers and scientists are looking for new and innovative solutions. One of these people, is student, Carvey Maigue.

In your teams, find out:

- What is the problem with current energy consumption practices?
- How can the Bioeconomy help tackle these problems?
- There are three different classifications of biofuel: 1st, 2nd and 3rd generation. What is the difference and which is the best for the environment?
- Is Biofuel the only Bioeconomy based solution?
- What challenges exist?
- What can ***you/we*** do?

Gathered your information? Create a presentation to share your findings with the rest of the group!

KS4

Case Study 3: Medicine and Health

Key facts:

- Hospitals and labs emit 4.4% of the world's greenhouse gases.
- Globally, hospitals generate more than 5 million tonnes of waste a year - that's around the weight of 25,000 blue whales.
- The invention of plastic in the early 20th century has made the healthcare sector much safer as it has reduced the need to sterilise devices; instead, items such as gloves and syringes can be used once before being discarded. This helps prevent the spread of dangerous diseases.
- In order to reduce the spread of COVID-19, the use of single use plastic in hospitals and amongst the general public has increased.
- Plastic is an amazing invention that has saved many people's lives throughout the world, but plastic also poses a threat to human's health.

KS4

Hospitals and Single Use Plastic: Friend or Foe?

Single use straws can be replaced with reusable or bio-degradable ones. Plastic bottles can be traded out for ones we can refill time and time again. Plastic bags – no problem, just remember to bring your canvas one to the store. But medical supplies … that's another story. Hospitals need to be hygienic, and the tools used need to be sterile to prevent cross contamination and infection.

Single use plastic is the perfect material to meet these needs. We see doctors and nurses cover themselves in plastic aprons, plastic gloves, plastic hairnets and masks, replacing them between every patient; before unwrapping plastic needles in plastic packaging. From the IV drip to the blue wrap that covers operating theatres all over the world, it's everywhere; and once it has been used, it ends up in the bin.

Swapping out single-use plastics in hospitals isn't as easy as in other places. Plastic is cheap, durable, and can be easily thrown out to ensure hygiene standards. It can also be modified to make it more resistant to infections and creates a barrier between the medical profession and patient, reducing cross contamination. Any replacement material needs to stand up to the test, and currently, there's no all-encompassing functional or feasible alternative. Whilst more sustainable practices need to be found and developed, this really does show just how instrumental plastic is to our health as humans. It isn't always the foe we paint it out to be.

Nevertheless, where trades can be made, they should. Plastic has been proven to impact human health. When plastic enters water streams, animals such as fish eat it, mistaking it for food. Humans then eat the fish, and with it, the plastic. The production of plastic also releases a lot of toxic air pollutants that impact humans and climate change. This happens again when medical supplies are processed as waste, often being burned and releasing nasty pollutants again.

Fortunately, there's a wealth of people out there trying to find those solutions – one of them being medical professional, Dr Edmar Maciel.

In your teams, find out:

- What is the problem with current Medicine and Healthcare practices?
- What is the lifecycle of plastic in healthcare?
- How can the Bioeconomy help tackle these problems?
- What challenges exist?
- What can ***you/we*** do?

Gathered your information? Create a presentation to share your findings with the rest of the group!

KS4

Something fishy is going on … Literally!

The skin of Talapia fish has naturally occurring antimicrobial properties, is high in collagen and has a similar structure to human skin. That's why Dr Edmar Maciel decided to trial it as a replacement for the typical combination of cream, dressings and bandages.

The creams contain silver, and the dressings and bandages often include some kind of non-renewable manmade material. These require replacing every few days until the burn has healed – much to the discomfort of the patient - and the products are always discarded after use. In the trials of Talapia however, the fish skin healed burn wounds faster, caused less pain and discomfort, and needed replacing much less frequently (meaning even less waste!).

In the Western world, pig skin is often used to help the wound healing process, so using animal skin isn't an entirely new idea. But in Brazil, pig skin isn't widely available. That's why Dr Maciel thought of using Talapia skin. Talapia accounts for over 50 percent of farmed fish in Brazil, and the skin is usually discarded as a waste product. That means there is a lot of the stuff going to waste, that could be repurposed and made valuable. Nevertheless, the fish skin still needs to be sterilised before it can be used, and plastic packaging is still relied upon to keep it hygienic. It's not a perfect solution just yet, but by using a locally sourced waste product, Dr Maciel is one step closer to achieving a fully circular Bioeconomy.

Read this webpage and watch the video to see the product in action
(The video includes footage of burns – so be cautious watching if you're squeamish)
https://www.statnews.com/2017/03/02/brazil-tilapia-skin-burns/

Think:
Why do the properties of fish skin (antimicrobial, high in collagen and similar structure to human skin) make it a good product?
How could this product be improved?
Would Talapia skin be a good solution for healing burn wounds in the UK? Why?

KS4

Lesson 3:

Applying the Bioeconomy to your own environment

THYME Project

Teesside, Hull and York - Mobilising Bioeconomy Knowledge Exchange

UNIVERSITY OF HULL

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Lesson 3:

Applying the Bioeconomy to your own environment

Resources Required:
PowerPoint Slides for "Apply the Bioeconomy to your own environment",
Innovation Cue Card D
Dragons Den
Worksheet E

Lesson Objectives

- Describe attitudes to waste in modern society.
- Apply growing knowledge of sustainability to own practices.
- Compare the linear and circular economy.
- Think innovatively to create a product that supports the circular economy.

Lesson Outcomes

- Analyse own habits in relation to sustainability.
- Design or redesign a product that supports the Bioeconomy and the Circular Economy.
- Apply knowledge of sustainability and Bioeconomy to pitch a product to an audience.

Curriculum Links

AQA Geography

Managing climate change involves both mitigation (reducing causes) and adaptation (responding to change):

- mitigation – alternative energy production, carbon capture, planting trees, international agreements
- adaptation – change in agricultural systems, managing water supply, reducing risk from rising sea levels.

EdExcel Geography

- Global climate is now changing as a result of human activity
- The biosphere is a vital system
- The range of possible strategies aimed at making urban living more sustainable and improving quality of life (recycling, employment, education, health, transport, affordable and energy-efficient housing) for the chosen UK city
- A natural resource is any feature or part of the environment that can be used to meet human needs
- The patterns of the distribution and consumption of natural resources varies on a global and a national scale.

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Previous Learning

The previous two lessons have looked at resource sustainability and the role of the Bioeconomy in supporting economic development and the environment. This lesson aims to bring those idea together by exploring how the circular economy links these two areas together.

Preparation

This activity is suited equally to a classroom-based activity or a drop-down day. Preparation involves setting groups and creating space for groups to work. Groups may need access to the internet to research product origins. The educator should think about how groups will Pitch their product and how best to vote on the winning product. As suggested in the PowerPoint the most successful product will think about the whole journey of the product.

The Lesson

The previous two lessons have looked at resource sustainability and the role of the Bioeconomy in supporting economic development and the environment. This lesson aims to bring those idea together by exploring how the circular economy links these two areas together.

Slide 4 Starter activity: Use a series of questions to investigate students' attitudes to waste. Educators may wish to allocate a question to individual or pairs of students based on ability or ask students to annotate their answers to the question on a printout of the slide. Use the PowerPoint notes to encourage students to think a scale of different contexts. Is everyone's attitude the same?

Slide 5: Introduce the linear economy and the circular economy to the students (PowerPoint notes give further detail). Debate the Bioeconomy as an example of a circular economy. Ask students to give examples of a small scale or large-scale circular economy.

Slide 6: Students are going to think innovatively in pairs or groups to design or redesign a product that supports the circular economy model and uses bio-based products. Use **Slide 7** to begin the thinking process – how has the bag changed over the years to adapt to support society? (Carry more, be reused, withstand weather, be disposable, be recyclable?)

Slide 8: The Pitch guidance asks students to think about the whole journey of the product. The most successful pitches will include all elements of the journey and use key terminology in context.

Slide 9: Students use their knowledge of the bioeconomy to start or finish the statement. Students will hopefully think about this from a positive point of view, linking the circular economy and biobased resources in their answer.

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Activity Sheet D

DRAGONS DEN - CUE CARD

Can you come up with a new approach, a new solution to an everyday item?

Think about the materials you're going to use, where they are sourced and how they can be recycled or reused.

In general, we can separate waste into two categories, organic and inorganic waste; or bio and non-bio. Bio waste originates from living things; like leaves, fruit, vegetables, eggs, wool … and so on. We call these materials biodegradable, because they decompose naturally in nature. When they decompose, they release nutrients, and transfer stored energy, back into the environment. This enables new life to grow, and is part of the circle of life.

The other type, non-bio or inorganic waste, cannot decompose in nature. This includes plastic, metals, glass, and anything else that does not come from living things. When these things end up in the environment, they will spend thousands of years intact, and although they may break down into smaller pieces, they will not benefit the environment like those of organic origin. Since the rise of plastic, we have gone from using and reusing items made from organic materials, to replacing many items with those made from single use plastic. This leads to a lot of waste.

Stage 1: Innovation

What is the product made from? Name the biobased products
Where are they from?
What is the renewal time of the biobased products?
How many times can the product be used?
What do consumers do with the product at the end of its product life?

Stage 2: Persuade the consumer to buy your product

Explain to the Dragons and the consumer what a biobased product is.
Describe the biobased products in your design.
Why is it important to use biobased resources rather than finite resources?

Stage 3: Impact Assessment

How will your product support the SDGs?
Explain the benefits of a biobased economy (supply and longevity of your product)

Discuss in your groups and complete the Worksheet before presenting your idea to our own Dragons Den.

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Activity Sheet E

DRAGONS DEN -THE PITCH

Locate the raw materials on the UK map. How far do your raw materials travel to the factory where they are turned into the finished product? Why is this important to your business?

Raw material	Where was the raw material produced?

Stage 1: Innovation

What is the product made from? Name the biobased products.
Where are the raw materials produced?
What is the renewal time of the biobased products?
How many times can the product be used?
What do consumers do with the product at the end of its product life?

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Stage 2: Persuade the consumer to buy your product

How will you explain to the Dragons and the consumer what a biobased product is?
Describe the biobased products in your design.
Why is it important to use biobased resources rather than finite resources?

Stage 3: Impact Assessment

How will your product support the SDGs?
Explain the benefits of a biobased economy (supply and longevity of your product)

KS4

Activity Sheet F

Dragons Den Peer Review

Name of Reviewer: _____ Bag Design Team: _____

Property	Comments	Score out of 10 (10 being amazing)
Strength/Durability		
Permeability		
Sustainability		
Recyclability		
Practicality		
Weight		
Style		
Affordability		
	Total out of _____	

Additional Comments:

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Next steps

That concludes *Pack 1: What is the Bioeconomy? Laying the foundations*.

Over the past few weeks your students have grappled with global issues surrounding sustainability and consumption, and have learned how the Bioeconomy, when executed in a sustainable way, can provide some of the solutions to the issues we are facing.

In pack 2, 'Is our school a Bioeconomy?' students will get the chance to apply this to their own worlds both at home and at school, drawing upon geographical mapping, personal judgement and critical analysis. Download pack 2* now to get started, and thank you for planting the seed, and taking your students on such an important and necessary journey!

* https://www.hull.ac.uk/work-with-us/research/institutes/energy-and-environment-institute/our-work/thyme-education-resources

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For more information on the THYME Project, including downloadable education resources please visit:

https://www.hull.ac.uk/work-with-us/research/institutes/energy-and-environment-institute/our-work/thyme-education-resources

https://thyme.biovale.org/resources/schools-resources/

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