

What is the Bioeconomy?

Pack 1: Laying the Foundations

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


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KS3

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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 two-part series 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.

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 students' 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 their school/home/youth group/etc. Drawing upon many geographical and scientific 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
- And able to use geographical models to enrich environmental understanding
- 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.

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.

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 resources:

<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 11	Will we ever run out?	Geography Science English	Using classroom discussion, students will consider the origin of Earth's resources. By investigating how long it takes for the Earth to create and renew various resources, students will be (re)introduced to the concepts of renewable and non-renewable, and organic and inorganic. 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 16	What <i>is</i> the Bioeconomy?	Geography English Citizenship	Using a combination of PowerPoint slides and group work, students will explore the UN Sustainable Development Goals. They will explore how the Bioeconomy can work towards meeting those goals, before the option of conducting case studies on various real-world solutions.
Lesson 3 Page 32	Is it time to bin the plastic bag?	Science Design & Technology Citizenship English Maths History	Initially, this session will re-address waste and personal choices in relation to sustainability. It will then focus on the history of the plastic bag; specifically enquiring into human's past, present and future practices. Students will also conduct a decomposition experiment, to explore how alternative materials are (or are not) better for the environment. Students will then have the opportunity to design their own experiments that will uncover other desirable properties of bags. They will conduct, analyse and present their findings to the group. We suggest this is conducted over several weeks.

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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Resources Required:
PowerPoint Slides for “Will we ever run out”,
Activity Sheet A (page 14),
FOST (page 15)

Lesson 1:

Will we ever run out?

Lesson Objectives

- Understand that some resources are limited
- Understand that resources can be classified as living and non-living and have different renewal times
- Understand that living (bio-based) resources offer a more sustainable economic model: The Bioeconomy
- Define the term Bioeconomy.

Lesson Outcomes

- Summarise a statement about sustainable development
- Describe how Earth’s resources are created
- Challenge: Which resources are limited and why?
- Sort elements into living and non-living resources
- Match resources to a timeline to classify their renewal times
- Apply knowledge to respond to the question: Will the earth run out of natural resources?

Curriculum Links

Geography

- 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.

English

- Use discussion in order to learn
- Elaborate and explain clearly their understanding and ideas
- Understand the difference between fact and opinion.

Science

- 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.

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.

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Previous Learning

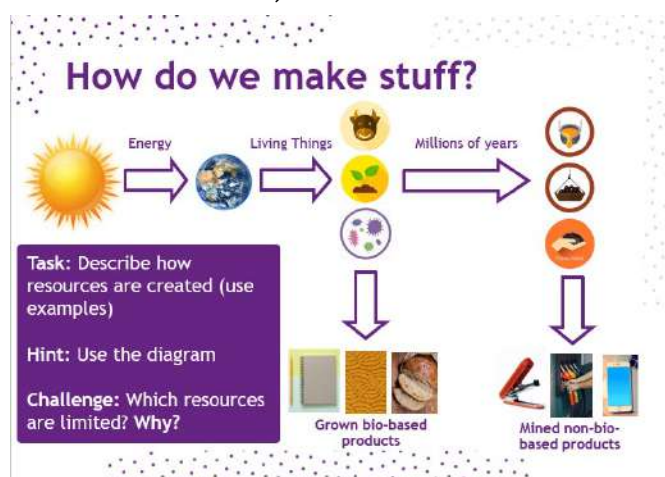
Students will have covered Material Properties, Humans and Nature, Living Things/Plants and Animals, and Recycling in Primary and Lower KS3 Science and Geography. A grounded understanding of these areas is necessary for the understanding of this lesson.

The Lesson

This lesson follows PowerPoint Presentation 1. More detailed guidance is provided in the notes section within it.

Starter activity: Start by showing the students the quote on **Slide 4**, asking them to summarise what they think it means in one sentence. After a few minutes, encourage students to share their answers with one another - either in pairs, groups, or as a whole class. Students will revisit this at the end of the session, to see if their opinions have changed.

Slides 5-6 provides a visual that can be used to help explain how Earth's resources are created. Students will use this image to describe how resources are created. A WAGOLL is on slide 6, to support students where necessary. This can be adapted, and the teacher may choose to remove some words for students to fill in. Adapt the task to suit the abilities of students, providing more or less guidance where necessary.



Slide 7 is a [video](#) that explains the journey of plastic, from fossil fuel to marine litter. An understanding of this is essential to future activities.

Main Activity: Slides 8-11 have a corresponding print-out sorting activity (page 14), to facilitate tactile learning and group conversations. Ask students to first sort the images into two obvious piles. By allowing students to sort with minimal guidance, teachers/educators can see where students' current level of knowledge is, and build on it appropriately. Students will then develop this, to place the images on a timeline. This will aid students in visually identifying how long it takes certain resources to regenerate. This will lead them to identify which ones are more, or less, renewable. Finally, students will be encouraged to contribute to classroom discussions, exploring how humans make money from the Earth's resources.



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Slide 12 requires students to apply their growing knowledge, and consider if the Earth's resources will ever run out. Challenge words are provided.

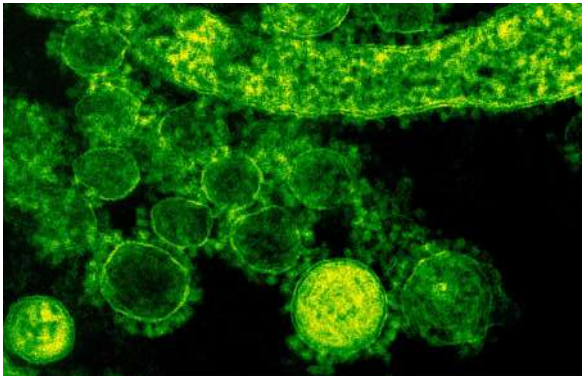
Slide 13 will provide some final context of resource usage and its contribution to CO₂ emissions, climate change and the diminishing reserves of fossil fuels.

Slides 14-15 contain another video that explains the Bioeconomy in easy to understand terms. We highly recommend watching this with students, and if students understand, there is a second film that addresses at a more advanced level, the elements of the Bioeconomy. There is a FOST worksheet (page 15) to encourage engagement.

Plenary: Slide 16 Returns to the initial quote on slide 1, asking students to consider any changes in their opinion as a result of the lesson. Ask students to also consider the question of the whole PowerPoint, *will we ever run out?* This could be done as summative writing or as further classroom discussion.

Lesson 1: Print out A (Sorting activity)

Activity Sheet A



FOST

Facts... what 5 facts did you learn?

Opinions... what are your opinions on the video?

Surprises... what 5 things surprised you?

Take Further... what do you want to know more about?

F	
O	
S	
T	

FOST

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Opinions... what are your opinions on the video?

Surprises... what 5 things surprised you?

Take Further... what do you want to know more about?

F	
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Lesson 2:

What *is* the Bioeconomy?

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Resources Required:

- Tech for showing Video and PowerPoint,
- PowerPoint 2,
- Resource Sheet 1 (printed)

Lesson 2:

What *is* the Bioeconomy?

Lesson Objectives

- Recognise how sustainable development can be supported by elements of the Bioeconomy
- Examine how the Sustainable Development Goal (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 relation 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

Geography

- Understand how geographical processes interact to create distinctive human and physical landscapes that change over time
- Aware of increasingly complex geographical systems in the world around them
- Aware of geographical models that enrich environmental understanding
- Understand economic activity in the primary, secondary, tertiary and quaternary sectors
- Understand how human and physical processes interact to influence change in environments
- Understand how human activity relies on effective functioning of natural systems

English

- Use discussion in order to learn; able to elaborate and explain clearly their understanding and ideas
- 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

Citizenship

- 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
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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 will have covered recycling in the lower key stages. Some students may have already been introduced to SDGs. Students may recognise the SDGs from the previous lesson.

Preparation

If not already familiar with the SDGs we recommend spending some time exploring these. There are some amazing resources [online](#)

Print out Bioeconomy Bingo 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, videos, classroom discussion and collaborative investigation to enhance and support students learning.

Starter Activity: To begin the lesson, give each student a Bioeconomy BINGO print out. They must then go around the room, and complete the sheet as they speak to people and ask questions, seeing who they can tick off on their Bingo sheet. The first student to get a “full house” is the winner. Direct the follow up discussion to explore which ones are the odd ones out on the sheet (more guidance provided on the PowerPoint).

Slide 5 asks students to define sustainability based on their existing knowledge. The words Economy, Environment and Society are on the slide as prompts, however these can be removed if sustainability has been covered in depth in previous lessons.

Slide 6 provides a popular definition of sustainability. Ask students to compare this with their definition, and discuss anything they missed, or that they think this definition doesn't capture. Extend discussion by talking about needs. What constitutes a *need* and what is a *want*?

Online SDG resources: <https://sdgs.un.org/goals>

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Slide 7 introduces the SDGs. Guidance is provided on the slide to support the teacher/educator. Start 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 constrained categories. They work together for a common purpose. Examples are provided on the PowerPoint guidance. You could use a Venn diagram to support this exercise.



Follow up by asking students to rank the SDGs in order of importance. This will develop upon previous discussions.

Finally, explore human practices that are currently preventing us from meeting these goals. This gives students the space to be critical thinkers, and work upon their debating skills.

Slide 8-11 readdress the Bioeconomy, and give space for students to make links between this and the SDGs, finding solutions within each. Slide 10 in particular, encourages students to use their knowledge and imagination to suggest innovative solutions to the SDGs that come from bio-based resources.

Case Study 1

Fashion and Textiles



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Part 2:

Slide 12 onwards can be done as a separate lesson, homework, or if time, as an addition to the same lesson. This draws upon the Case Studies on pages 21 to 31 in this document. These can be explored as the teacher/educator sees fit, but we suggest breaking the class up into small groups, assigning each a case study. Students are then given an allocated amount of time to investigate the case study, and use online sources to inform a presentation that they will give to the rest of the class.

End the session by returning to the original question "*What is the Bioeconomy?*" Can students summarise in one paragraph?

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Bioeconomy BINGO

Find someone who ... (write their names in the box)

Has walked to school	Has grown something from a seed	Has recycled something
Has used leftovers to make another meal	Has ever taken antibiotics	Has a pair of leather shoes
Is wearing something made of wool	Has put something in a compost bin	Uses a refillable water bottle everyday

Bonus points: Which one(s) are the odd one out?

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Bioeconomy BINGO

Find someone who ... (write their names in the box)

Has walked to school	Has grown something from a seed	Has recycled something
Has used leftovers to make another meal	Has ever taken antibiotics	Has a pair of leather shoes
Is wearing something made of wool	Has put something in a compost bin	Uses a refillable water bottle everyday

Bonus points: Which one(s) are the odd one out?

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Case Study 1:

Fashion and Textiles



Key facts:

- The fashion industry is the second largest polluter in the world.
- It contributes to around 10% of global CO2 emissions because of the greenhouse gasses used in production, manufacturing and transportation.
- Synthetic fibres (polyester, acrylic, nylon, etc.) are used in the majority of our clothes. They are made from fossil fuels.
- Clothing that uses wood-based fabrics, is leading to deforestation. This is threatening ecosystems and indigenous communities, and is not sustainable.
- On average, people in the West wear a piece of clothing 7 times before getting rid of it.
- Garment workers in manufacturing countries typically work 14-16 hours a day, 7 days a week.

Greenwashing

*“Greenwashing happens when a brand puts more effort into **appearing sustainable and eco-friendly** to consumers than actually working on the issues.” (Mustafa, T, 2021)*

The fashion industry, as it currently stands, is unsustainable and damaging for the environment. Fashion brands know this. Because they realise that their consumers (us!) are wanting more sustainable and eco-friendly products, they use terms like ‘eco range’ or ‘environmentally conscious clothing’, to convince us that they are producing, manufacturing and transporting their products in an environmentally friendly way. Unfortunately, a deeper look into their practices often reveals that this is not the case. People have started to call this ‘greenwashing’, and it is common not just in the fashion industry, but in almost all sectors of the economy. Many companies have been called out on this, including H&M and Primark. Which companies come up when you search “greenwashing” in your search engine?

Fast Fashion

One of the main reasons that the industry is so unsustainable, is because of ‘fast fashion’. About 20 years ago, people would buy clothes every now and again, when the seasons changed or when clothes no longer fit. However, since then, clothing has become cheaper, trends change more frequently, and shopping has become a ‘hobby’. This shift, and our ability to now buy cheap and trendy clothes that replicate celebrity styles with the click of a button, is being termed fast fashion. This might not seem a bad thing, but as demand has increased and as prices have dropped, the quality of garments and the conditions that those who make the clothes must work within, have also reduced significantly. Because these clothes are made with cheaper materials, they often don’t last as long either, and are thrown away, adding to the Earth’s increasing waste problem.

In your teams, find out:

- What are the current problems in fashion and textiles?
- How is/can the Bioeconomy help reduce these problems?
- What challenges exist?
- What can **you/we** do personally, to help?

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

VEJA: Moving towards a Bioeconomy

The following is a transcript by the CEOs of VEJA, 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>



“In 2003, we’re 25 years old, and we’re visiting a Chinese factory, following a social audit for a French fashion brand. We spent three days among the workers: they looked pale and tired, but the factory was clean, and the working conditions seemed pretty good. Everything went well with the audit, until we asked to see the living quarters. At first, the director refused, but after insisting and arguing, they opened the doors. We found ourselves in a 25 square meter room where 32 Chinese workers were sleeping together, stacked in 5-level bunk beds. And in the middle of the room, only a hole that served both as a shower and a toilet. On that day, we realised globalisation had gone wrong. These workers were making the clothes we were wearing every day; clothes that people we knew, our families, our friends were wearing every day. Something had really gone wrong.

In 2003, big companies were already throwing around concepts like sustainable development... but it was all talk, with no real action to back it up. Meanwhile, we’d been working with Tristan Lecomte who had just started AlterEco, the first French brand for fair trade. He was making orange juice, tea, rice, coffee and chocolate working directly with producers and farmers around the world. We audited the cooperatives he was working with, and for us, it was a revelation.

We saw first-hand how fair-trade changes the economy, making it a little different, more balanced, how it pushed for fairer exchanges between producers and consumers. So, after working for international corporations and for Tristan, we went back to Paris. But instead of diving into the Internet like the rest of our generation, we thought we should try and reinvent a product. But not just any product, but the most symbolic object of our generation. We wanted to deconstruct it, and rebuild it differently. And it was obvious to us that this object was going to be a new brand of sneakers.

So why sneakers? Because we loved them, we were wearing sneakers every day. And as a consumer product, it stood as a symbol for our generation: we were the ones wearing sneakers in the 90s, when they became massively popular and went from sport fields to the streets.

But this is also one of the most interesting products on an economic level because it concentrates the most advertising spend ... When you buy a pair of sneakers from a big brand, 70% of its costs goes to advertising and communication. And only 30% goes to raw materials and production.

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 here we are, in 2004, we're 25 years old, we have no money, but we want to try. We're lucky enough to have loving families, lucky enough to have a good educational background, so if we don't give it a try, who will? Worst case: we fail, but we would still have a place to live, and a chance to start over. 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.

The purpose of this trip is to break down the sneaker and start over from the raw material, all the way to the finished product, and try to change each production stage to have a positive impact on the environment and society. So, we end up in the Amazon rainforest, with the *seringueiros*: those are communities that live in and from the forest, without destroying it, without cutting trees down, but trying instead to live in harmony with it.

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 fertilisers or pesticides, but it's more than just organic: its agro-ecological cotton. Conventional agriculture uses chemicals and tends to damage the soil over the long term. In Brazilian Nordeste, we discover the principles behind agroecology: it makes the soil richer after the harvest instead of harming it.

In the first contract, we paid twice the market price. They didn't understand, they thought it was strange. They called us *Os Franceses Locos*, *the crazy French*. But they finally agreed and we bought three tons of organic cotton, and that became the upper of our first sneakers. Three tons of organic cotton, bought according to fair trade principles: we pay for crops in advance, at a price set in a three-year contract. In other words, when they plant a cotton seed, they already know how much they're going to get when they sell one kilo.

We keep following the production path and find ourselves in the south of Brazil, in a Porto Alegre sneaker factory. It's a developed region, similar to Europe, 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.

After that, the fourth step of VEJA is Bonneuil-sur-Marne, in the suburbs of Paris, where we meet with a social reintegration organisation that eventually becomes our logistics provider. Meaning they receive the containers, store the sneakers, take care of our online store and dispatch the shoes all over the world.

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 Paulo, before being crushed into flakes. Then they're shipped to a Brazilian factory where they turn the flakes into fibre.

This is the heart of VEJA: connecting great projects to one another. In 2005, we sell our first sneakers, and it's a success. The Parisian department stores buy them right away, and stores start calling from all over the world. The adventure becomes a business, VEJA grows, and 10 years later, we're a team of 60 people, with an office in Brazil, another in France, and we're happy.

We sell in fifty countries around the world, we've sold more than two million pairs of sneakers since we began, and we didn't start from much. But we have a foot in several worlds: fashion, fair trade, organic farming, design, social inclusion, factories, travel, cotton fields, the Amazon... But there's a common thread in everything we do: transparency. This is the meaning of VEJA: in Portuguese, VEJA means "look". In our minds, it means look through your sneakers, look what's behind. Eventually, we realised that even though we make a very transparent product, with a positive impact, the company itself was not transparent enough. We felt we needed to change VEJA from the inside out.

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?

KS3

Case Study 2: Energy



Key facts:

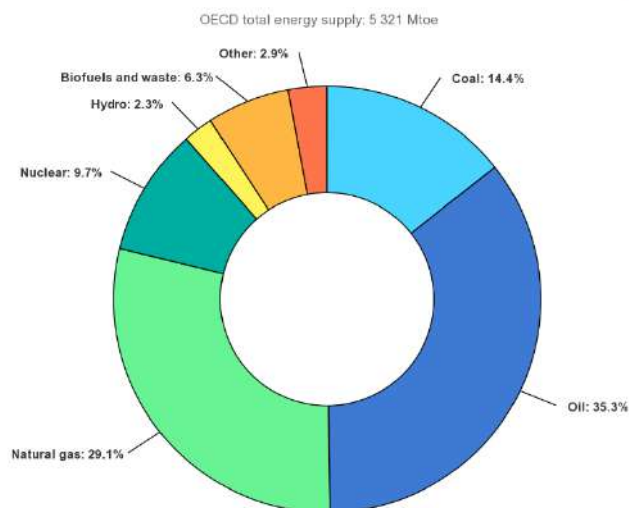
- In 2019, 78.8% of global total energy supply, came from non-renewable sources: Coal, Oil and Gas.
- We need to find and increase our use of alternative, renewable energy sources.
- Biofuels are fuels that come from bio-based things.
- Biogas can be made from waste food, manure and even sewage, and 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 Maigne: Moving toward a Bioeconomy*).

KS3

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 CO₂, 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 than 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 CO₂ 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 CO₂ 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!

KS3

Carvey Maigue: Turning waste crops into renewable energy



Picture 1: Carvey Maigue invented a new material from waste crop, which converts UV light into renewable energy. Photograph: Dyson

Rotting fruit and vegetables. No good to anyone, you'd assume, right? Not to Carvey Maigue, a student from the Philippines, who uses waste crops to create a novel material that converts UV light from the sun into a renewable energy source! We've all heard of Solar Power, the conversion of sunlight into electricity. However typical solar panels don't utilise UV rays, are usually made from silicon (it takes a lot of energy and money to create silicon) and they aren't transparent, meaning they wouldn't make very good windows. Carvey's invention however, can absorb UV rays through clouds and as they bounce off walls, pavements and other buildings, meaning direct sunlight isn't necessary. This makes them much more efficient. Their transparency means they can be attached to windows, and in his vision, Carvey anticipates his product, Aureus, will one day turn the everyday into high energy producing tools. From embedding it onto the exterior of cars, to weaving it through the clothes we wear, Carvey believes this is true plant power, and the way to a sustainable future.

Watch this YouTube video to find out more:

<https://www.youtube.com/watch?v=grDN3y5qNYQ>

And read more here:

<https://www.dyson.com/newsroom/overview/features/november-2020/interview-aureus-system-technology-jda-2020>

Think:

Usually, people think bio-energy means biogas. Carvey's invention produces energy in a very different way. Is one better than the other? What other ways could we use plants to create energy? How do you use plants and bio-based resources to create energy in your day-to-day life?

KS3

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.

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!

KS3

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?

KS3

Lesson 3:

Is it time to bin the plastic bag?

Lesson 3:

Is it time to bin the plastic bag?

Resources Required

- Collection of bio and non bio-based resources (plastic bag, biodegradable bag, tin foil, banana skin, onion skin, mushroom, paper/card etc.)
- Garden trowels
- Watering cans (and water)
- Equipment for recording notes
- Lollypop sticks or similar to mark areas

Lesson Objectives

- Understand that organic/bio waste streams can decompose back into the environment, and non-bio ones cannot
- Understand that bio-based waste can contribute to a circular economy
- Develop scientific inquiry skills and use these to make decisions

Lesson Outcomes

- Differentiate between two different types of waste: bio and non-bio
- Make predictions and propose hypotheses
- Work as a group to design and implement their own scientific inquiry
- Use their inquiry to make informed decisions
- Work as a group to present their inquiry and its findings to the wider class

Bags are, and have for a long time in human history, been a useful tool to help us both protect and carry stuff. Since the rise of plastic however, we have gone from using and reusing bags made from organic materials, to single use plastic. This leads to a lot of waste.

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 biodegradables, 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.

In this activity, students will explore decomposition in a hands-on way, and use the information they gather to inform further decision-making/activities/debates surrounding plastic bags.

There is an option for students to further design and implement their own experiment that will assess additional properties that are important to bags, and to design an idealist bio-bag.

KS3

Curriculum Links

Geography

- Understand economic activity in the primary, secondary, tertiary and quaternary sectors
- Understand how human and physical processes interact to influence change in environments
- Understand how human activity relies on effective functioning of natural systems
- Awareness of geographical models to enrich environmental understanding

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

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

Citizenship

- Understand ways in which citizens work together to improve their communities, including opportunities to participate in school-based activities

PSHCE

- Recognise responsibilities in the community
- Build and support the ethos and value system of the school.



Previous Learning

If you have been following the packs, students will have already covered bio and non-bio waste, however they will have done so from the perspective of origin and the overconsumption of fossil fuels. This activity will allow them to make connections to waste, recycling, and the life cycle of living things, all of which should have been covered in Primary education.

KS3

Preparation

This activity requires time, and should be split across several lessons. We suggest introducing it at the end of a previous lesson, to allow students to bring in their own materials in order to test their biodegradability. Alternatively, you as the educator can decide and obtain appropriate materials ahead of the lesson (see 'Resources Required' bubble on page 33 for ideas). Ensure you have a suitable outdoor area for digging and burying the waste, preferably away from the usual footfall of school. Decide on group numbers, and ensure everyone/each group has the appropriate resources to take notes and record their findings.

Starter activity

Begin with the corresponding PowerPoint '*Is it time to bin the plastic bag?*', working up to and including slide 9. These slides will encourage students to consider sustainability in terms of waste, applying this to their own consumption habits. It will allow them to look at changes in materials since the industrial revolution, where plastic quickly replaced many bio-based materials.

Explain to students that everyone in the class is going to have the opportunity to design their own bag. To decide what material the bag will be made of, a sequence of experiments will be conducted. The first experiment will be to test how biodegradable different materials are, and therefore how much of an impact it will have on the environment once disposed of. Allow students to suggest experiment ideas. It may be that some students come up with a very similar approach, or an even better way. Feel free to allow students to apply their own testing methods, if you agree it is a suitable and feasible approach.

Main Outdoor Activity

1. Divide the class into group sizes of your choosing. Take the whole class, along with the waste, to the selected area in your school grounds where you will conduct the experiment. Ideally, if area size permits, each group will have their own assigned patch of soil. If weather or other obstacles do not permit, this can be conducted in trays filled with soil inside.
2. Ask students to a) record the existing properties of the waste materials and b) record their predictions of what will happen to each waste product when it is left in the ground for several weeks. This can be followed up with a group discussion.
3. Dig some holes several centimetres deep (to correspond to the number of waste products you have). In each hole, insert a single waste material. Cover the waste material with the previously removed soil. Ensure it is fully covered.
4. Water the area till the soil is moist, but not soaking. A sprinkler head watering can or spray bottle will do the job well!
5. Mark the area with a labelled lollipop stick or similar, to note what is buried where.

Main Outdoor Activity Cont...

Return to the area regularly to ensure the soil remains moist. After 2-3 weeks, return and dig up the waste materials (make sure you do not leave any in the environment).

7. Record the changes to the materials, and compare this to their first observations and initial predictions. Were the students correct? Did anything unanticipated happen? Explore why the changes noted occurred.
8. Discuss the pros and cons of those that did not show signs of decomposition, and the pros and cons of those that do.
9. Based on biodegradability, which ones do students consider to be the best material from which to make an eco-friendly bag?

The previous debate may have led some students to conclude that the one with the quickest decomposition is the best. However, this would likely mean it would degrade soon after one use. This can open up a debate as to whether single use but biodegradable bags, or multiple use - less or non-biodegradable bags, are best.

Hints for discussion:

Single use biodegradable bags would mean a rapid increase in demand for land to grow the resources required to meet existing world consumption needs. This would severely effect biodiversity, ecosystems and likely lead to mass deforestation. However, non-biodegradable plastic bags are made using fossil fuels, can damage the health, and even cause the death, of animals once in the environment, and will exist for thousands of years, never contributing positively to the environment.

Back in the Classroom

This can either be done in between the first and last outdoor sessions above, or as a follow on at the end. Return to slide 11 of the PowerPoint. Remind students that biodegradability is not the only property that might be desirable in a bag:

- Strength/durability
- Permeability (is it waterproof?)
- Sustainability
- Recyclability
- Practicality
- Style
- Affordability
- Anything else?

Ask students, in groups, to design a research project that can test at least one of these factors. Encourage students to:

- Come up with a research question
- Make predictions, or a hypothesis
- Consider and decide what research methods best apply to collect the data they need to order to answer their question
- Consider how they will analyse and present their findings
- Ensure the experiment is safe.

Part 2

Using the slide number 11 onwards, **extend** learning either within the same lesson, or in a follow up lesson (this will likely be determined by time and whether all the resources needed for the experiments are readily available). Support students in conducting these experiments. Allocate the necessary resources, and allow students to use Activity Sheet E to support their scientific thinking. Adjust adult support as appropriate to each group, encouraging their creative approaches and inquires.

Remaining in their groups, students will analyse their findings, before making them understandable for the rest of the group. Ask students to present their findings to the rest of the class. This can be adapted to suit the group of students, with more or less support given as required. Encourage students to record the findings of other groups, to better inform their decision making in terms of the best material.

Evaluation

To evaluate students learning, ask them to design a bio-based bag that takes account of the classroom experiments and their new knowledge. This could be a homework activity, follow on lesson, or if time, could be a part of the previous activity. It can be as detailed or as simple as the educator sees fit, and could be simply an annotated sketch, or a full prototype. Once completed, students can share their designs with the rest of the class, and peer review each one, marking them against the standards outlined. See print out sheet number F to support peer review.

End the lesson asking the students two fundamental questions:

- A) Is it time to bin the plastic bag? Students should make an argument for or against.
- B) After learning everything they have over the past few weeks, what do they think the most important thing they/we can do? This will get them thinking in preparation for the next session, where they will analyse the sustainability and bio-economic value of their school/youth club/home.

Conducting your own scientific investigation

Question: What are you trying to find out?

Hypothesis: What do you think will happen?

Materials: What will you need to conduct the experiment?

Procedure: What steps will you take to conduct the experiment?

Results: What happened during the experiment?

Analysis and Conclusion: What do these findings mean and what did you discover?

Next Steps: What do the findings mean, and what further questions have been raised as a result of this research?

Design-a-Bag Peer Review

Name of Reviewer: _____ Name of Bag Designer: _____

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

Additional Comments:**KS3**

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. It has drawn upon scientific investigation, hands-on activities, case studies and debate to do this. In Pack 2, 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!



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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/>