

The BLOOM School Box

Future Classroom Scenario

Bloom your school with your biofuel and soap lab

This scenario is part of the BLOOM School Box, which consists of a set of five Future Classroom Scenarios combining bioeconomy into science, technology, engineering and mathematics (STEM) subjects. These resources were developed and tested in classrooms by 20 BLOOM expert teachers from 10 different countries.

This Future Classroom Scenario has been developed as part of the BLOOM project, using the methodology of the Future Classroom Toolkit (<http://fcl.eun.org/toolkit>).



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Area / Subject

In which subject(s) or area of expertise can the scenario be used?

Subjects: Science, Biology, Chemistry, Physics, Technology and Arts

Curriculum: National, International Baccalaureate, As and A –Level

Age of students: 13 - 16 years old

Relevant Trends

Relevant trend(s) the Scenario is intended to respond to. E.g. at <http://www.allourideas.org/trendiez/results>

STE(A)M Learning: An increased focus will be given to how Science, Technology, Chemistry, Physics, Biology and Arts will be incorporated into the educational process.

Collaborative Learning: A strong focus on group work.

Lifelong Learning: The learning process does not stop when leaving school.

Cloud Based Learning: data, tools, software is all online and can be reached and modified from different devices.

Edutainment: Students learn while having fun.

Visual Search and Learning: Images and multimedia are more powerful than verbal stimuli as the main part of the communication process happens non-verbal.

Assessment: the focus of assessments is shifting from “what you know” to “what you can do”.

Peer Learning: Students learn from peers and give each other feedback.

Learning Objectives and Assessment

What are the main objectives? What skills will the learner develop and demonstrate within the scenario? (e.g. 21st Century Skills). How will the progress in achievement be assessed, ensuring the learner has access to information on their progress so they can improve?

Learning Objectives:

Content Knowledge:

After the lesson, learners will be able to:

- Define and explain what bioeconomy is
- Discover different ways of applying bioeconomy
- Compare bio-based and non-bio-based products
- Compare biofuels and other fuels
- Design/suggest bio-based solutions instead of non-bio-based products

Learning, Innovative and ICT Skills:

Learners will enhance their:

- Experimental skills through laboratory work
- Critical thinking on bioeconomy topics
- Collaborative work, communication and responsibility by working in teams
- Information, media and technology skills as well as creativity by creating their own advertisement

Assessment:

Learners will be assessed based on the delivery of the following products:

- Poster: Learners create a poster on bio-based products they found in the market. Learners get feedback from the teacher.
- Experimental Laboratory: Learners conduct three experiments, collect data and make conclusions according to the instructions given in the three worksheets. The teacher provides feedback to enhance students' understanding.

- Creative advertisement: Learners are peer assessed on the advertisement they have produced

Learner's Role

What sort of activities will the learner be involved in?

The learner will be involved in activities that focus on the following areas:

- Content knowledge
- Critical thinking
- Scientific inquiry
- Laboratory skills
- Data collection
- Creativity
- Reflection
- Collaboration

Activities:

1. Learners create a poster on bio-based products they found in the market.
2. Learners are involved in experimental laboratory work. Students conduct three experiments, collect data and make conclusions according to the instructions given in the three worksheets:
 - *1st Experiment: Making your Biodiesel*
 - *2nd Experiment: Testing your Biodiesel*
 - *3rd Experiment: Making your Soap*
3. Learners produce a 1-minute-long creative advertisement.

Tools and Resources

What resources, particularly technologies, will be required?

Videos:

Bioeconomy starts here: <https://www.youtube.com/watch?v=2xvXkOMRTs4> [in English]

Bioeconomy in our everyday lives: <https://www.youtube.com/watch?v=ir3MgOSmvLg> [in English]

The girl who silenced the world /20th Anniversary - Best Quality:
<https://www.youtube.com/watch?v=FlQn1KwW4Es&t=1s> [in English]

Articles:

A Bio-Economy in Everyday Life: <http://www.bio-step.eu> [in English]

Biodiesel Lesson Plans, Institute of Environmental Sustainability, LOYOLA University Chicago:
<http://www.luc.edu/sustainability/initiatives/biodiesel/high-schools/lesson-plan/> [in English]

PowerPoint presentation: Bloom presentation (Annex 1)

Worksheets (Annex 2)

Laboratory Equipment:

1st Experiment:

- 100 mL graduated cylinder
- 10 ml pipette
- Large separatory funnel with ring stand
- Waste (vegetable) cooking oil

What resources, particularly technologies, will be required?

- Alcohol (methanol)
- Potassium hydroxide solution (KOH) 0.6M in ethanol
- Beakers
- Alcohol thermometer

2nd Experiment:

- Glass rod
- Clay triangle
- Tripod stand
- Forceps
- Ring stand with ring attached
- 1 crucible
- beakers
- 250 ml graduated cylinder
- 10 ml graduated cylinder
- 3 pieces of foil
- 3 pieces of wick
- 5- 10 ml biofuel (e.g. biodiesel)
- 5-10 ml fuel A (e.g. ethanol)
- 5-10 ml fuel B (e.g. petrol)
- Lighter
- Alcohol thermometer
- Scale accurate to 0.1g (Weight capacity: ~500 g)
- Ruler
- Stopwatch

3rd Experiment:

- Glycerine (Methanol Removed)
- Essential Oil (optional)
- Coconut Oil
- Citric Acid
- 250 ml graduated cylinder
- Potassium Hydroxide solution (KOH) 9M
- 1,000 ml beaker
- 250 ml beaker x 2
- Pot
- Burner
- Lighter
- Thermometer
- Silicone moulds

ICT: Mobile phones or Cameras

Learning Space

Where will the learning take place e.g. school classroom, local library, museum, outdoors, in an online space?

- School classroom
- Science laboratory
- Local market
- Online space

Future Classroom Scenario Narrative

The detailed description of the activity

Number of Students: 20

Instructor: 1

Time: 5 lessons (40 min each)

Teams: 5

Age of students: 13-16

1st Activity: Introduce the idea of bioeconomy

Duration: 1 lesson (40 min)

Learning space: School class

Aim: Provoking learners to think critically on bioeconomy topics

Educational material: BLOOM presentation (Annex 1)

1. Organise students in groups of four.

2. Discuss about environmental issues nowadays.

Use a video as a trigger to introduce environmental issues. For example: “The girl who silenced the world/20th Anniversary - Best Quality”

<https://www.youtube.com/watch?v=FlQn1KwW4Es&t=1s>

Reflect on the video and use the presentation to discuss with students the following questions (“think-pair-share”):

- What would you like to change in the world?
- Which are the main environmental issues nowadays?
- Is there anything we can do?

3. Introducing the idea of bioeconomy

Use pictures of bio-based products as a trigger to introduce bio-based products from the presentation (Annex 1).

Discuss with students the role of plants in our ecosystem. Plants are great engines of creating energy for us.

Define what biomass and biofuels are.

Discuss with students the importance of bioeconomy and circular economy.

Key ideas for discussion:

- What do we use plants for?
- What do we do with the parts of plants we do not eat?
- Can we use plants as fuel?
- What is used to create biomass fuels?
- Why do biofuels have an advantage?
- Besides fuel, what can biomass be used to create?
- How can biofuels reduce the amount of petroleum we use without entirely replacing it?
- How are biofuels created?
- Why are biofuels favourable?

Extra videos:

Bioeconomy starts here: <https://www.youtube.com/watch?v=2xvXkOMRTs4>

Bioeconomy in our everyday lives: <https://www.youtube.com/watch?v=ir3MgOSmvLg>

4. Homework Project (optional): Bio-based products of our market

The detailed description of the activity

Encourage students to go to the supermarket and find as many bio-based materials as possible, then take a picture of them.

Ask students to find biofuels and bio-based material that is already used in different countries.

Ask students to work with in their teams and collect all the information.

Finally, students should create a poster to present their results.

2nd Activity: Making your biodiesel

Duration: 1 lesson (40 min)

Learning Space: Experimental Laboratory

1st Experiment (Annex 2 (a))

3rd Activity: Testing your biodiesel

Duration: 1 lesson (40 min)

Learning Space: Experimental Laboratory

2nd Experiment (Annex 2 (b))

4th Activity: Producing soaps from glycerine

Duration: 1 lesson (40 min)

Learning Space: Experimental Laboratory

3rd Experiment (Annex 2 (c))

Homework Project: Ask students to create a 1 min advertisement of a bio-based material in their groups, which their fictional company is looking to introduce in the market.

5th Activity: Presenting your advertisement

Duration: 1 lesson (30 min)

The advertisements of the students will be presented in class and uploaded in YouTube (optional).

The rest of the class will have to find arguments whether this is a good product to use or not.

Key ideas for arguments:

- Recycling PLA endlessly
- Eco-friendly
- Differently Quality
- Economy

Learning Activities

Link to the Learning Activities created with Learning Designer (<http://learningdesigner.org>)

<https://v.gd/eOVIGy> (Full text available in Annex 3)

Annexes

Annex 1: BLOOM presentation



Boosting
European Citizens'
Knowledge and Awareness
of Bio-Economy
Research and Innovation



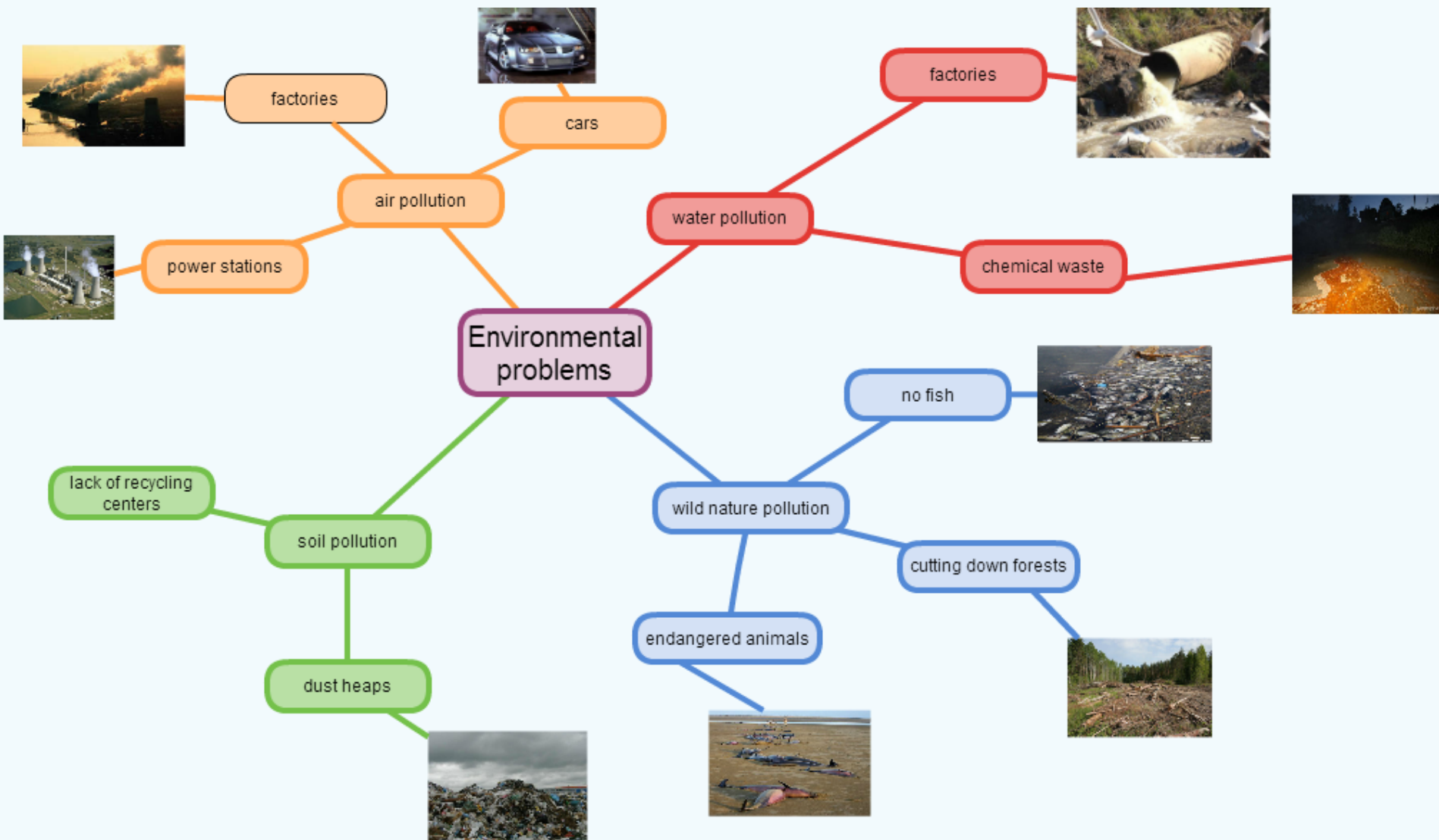
What would you like to change in the world?

Video: <https://www.youtube.com/watch?v=FIQn1KwW4Es&t=1s>



Environmental Problems





Is there anything we can do?



What are they made of?





Edible spoons



Edible spoons made from sorghum flour, a crop commonly grown in South Asia, Africa and Central America. The spoons are durable, easy to eat, and come in three flavours: plain, sweet and savoury.

(Founded in 2010 by Bakeys, an Indian company)



**These Edible Plates
are The Ultimate
Eco-Friendly Solution**

What is this?



World's first human urine brick



South African university researchers have created bricks using human urine.

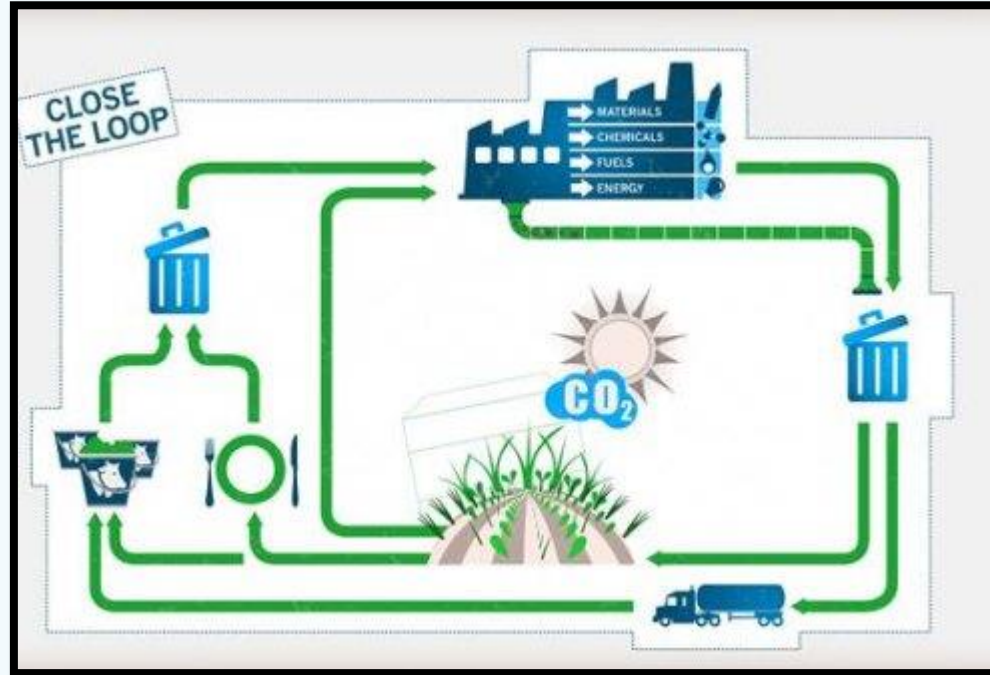




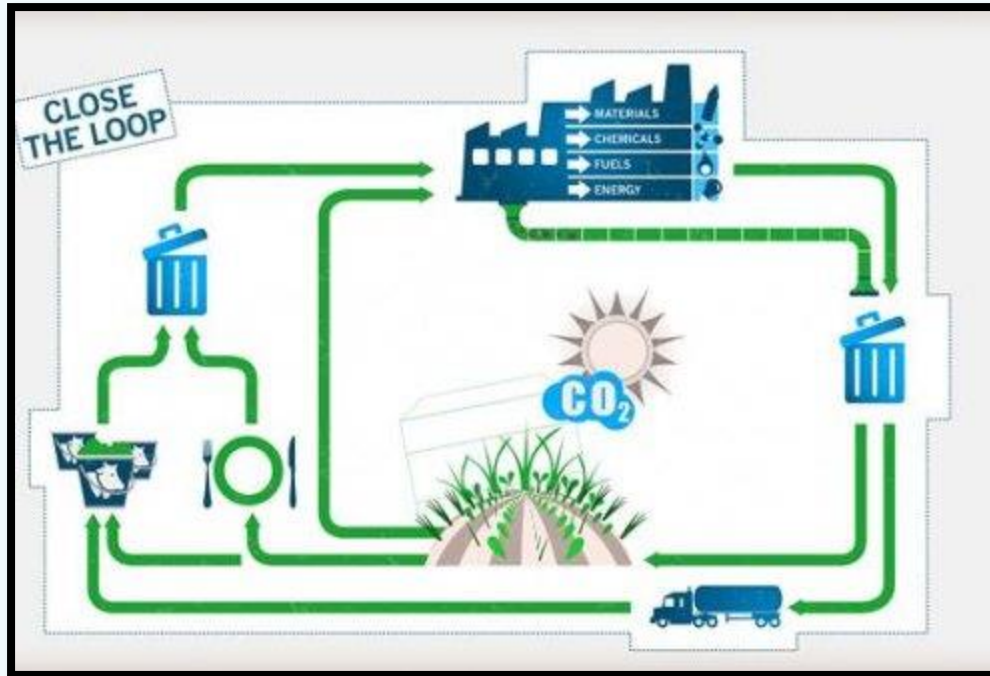


World's first circular car, Noah, mainly made by flax.

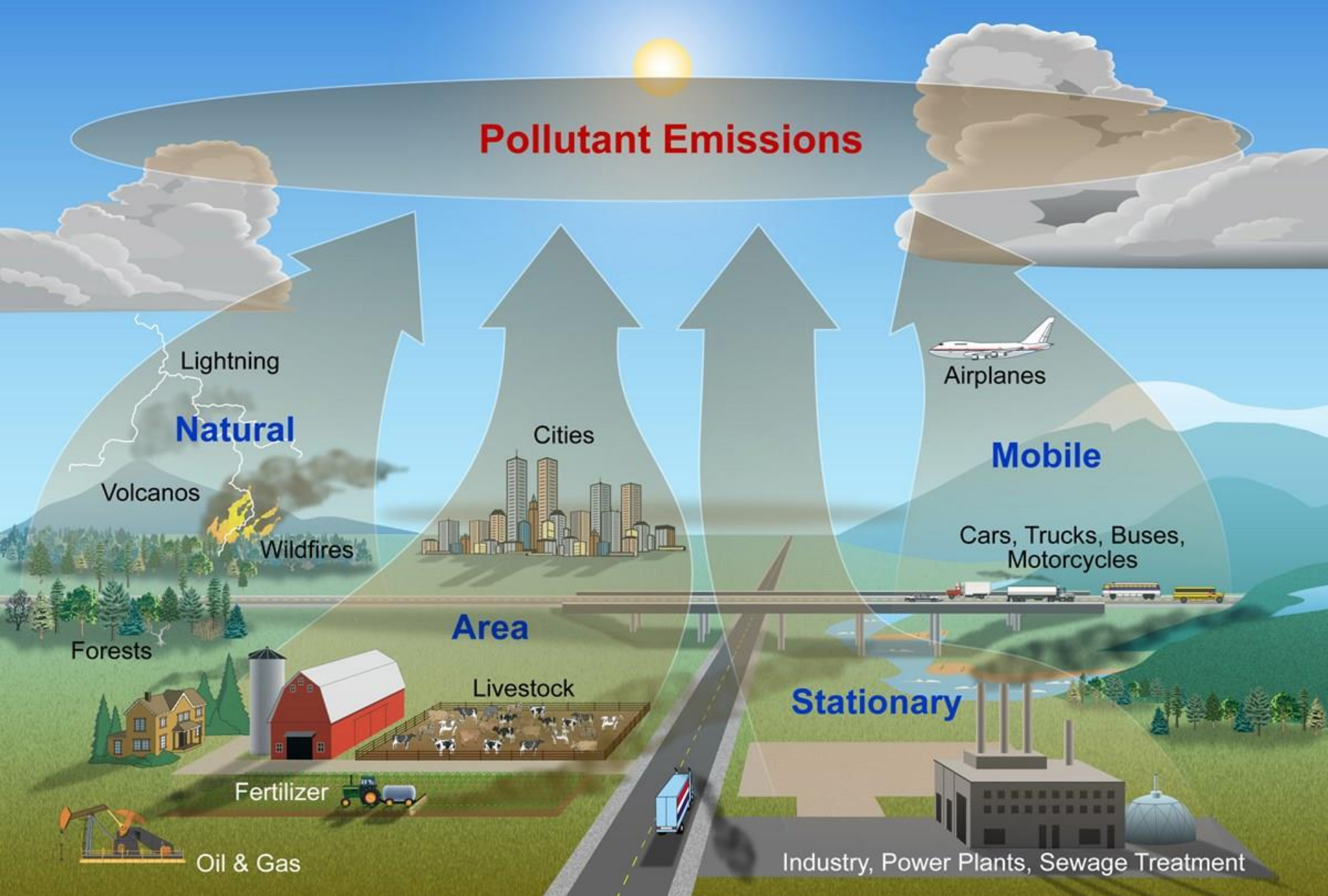
Bio-based products



Bio-based products



- ✓ The term **bio-based product** refers to products wholly or partly derived from **biomass**, such as plants, trees or animals.
- ✓ (The biomass may have undergone physical, chemical or biological treatment).
- ✓ Some of the reasons of the increasing interest in bio-based products lay in their benefits in relation to depletion of resources and climate change.

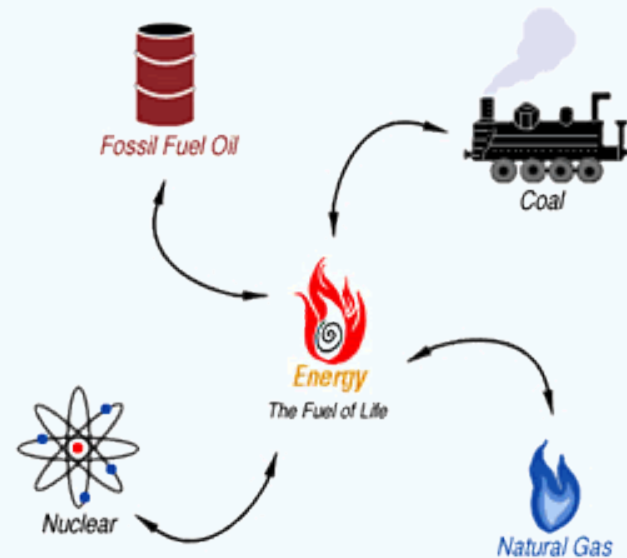


Energy Resources

Renewable Energy



Non-Renewable Energy



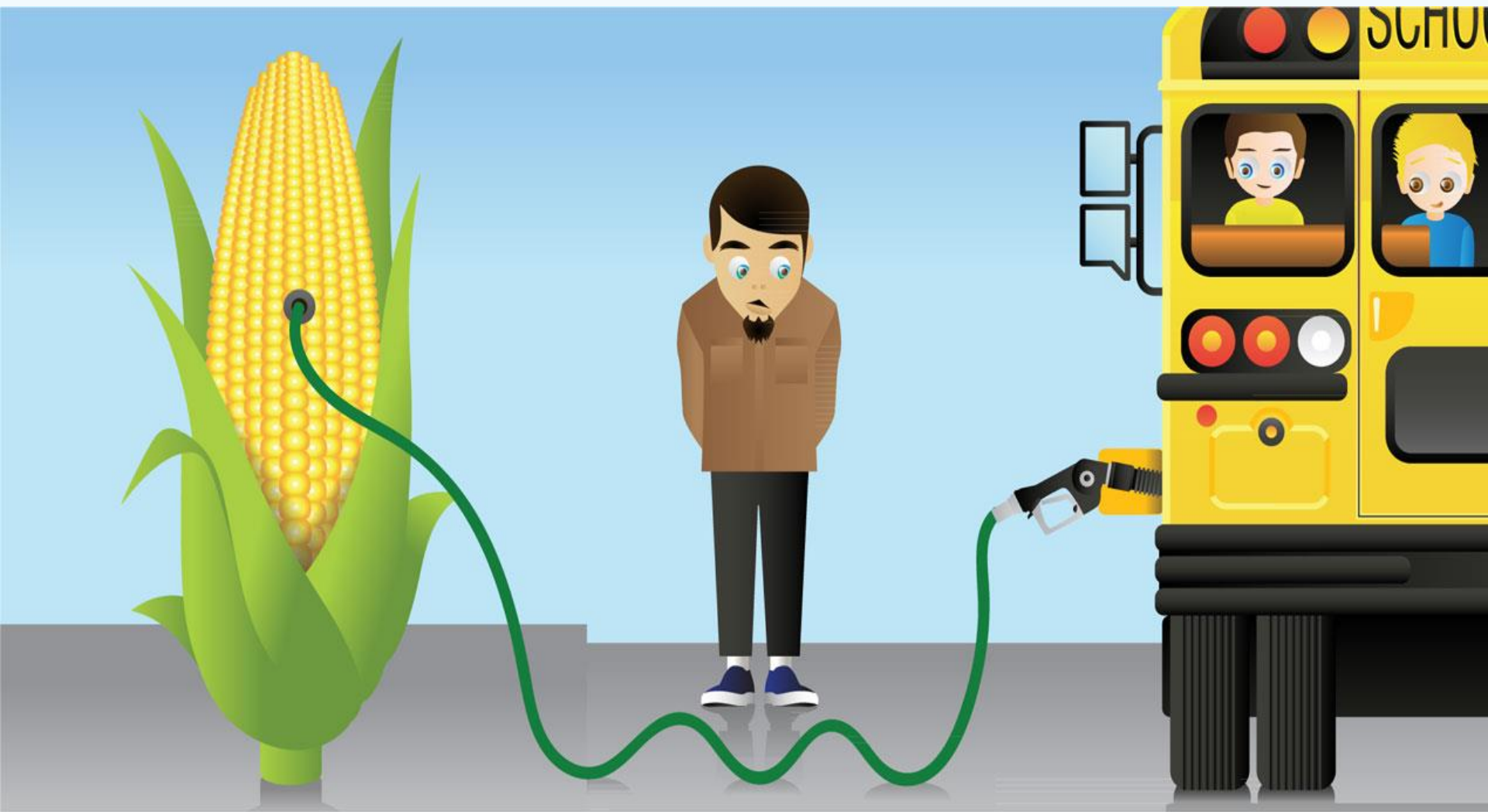
Plants...



Great engines of energy production!



Biofuels



Biofuels



- ✓ Biofuel is one type of fuel that shows a lot of promise for our energy future, because it is both **renewable** and **environmentally friendly**.
- ✓ Biofuels are usually produced from **plant materials that cannot be eaten by humans**, such as corn stalks, grasses, and wood chips.
- ✓ Biomass is another name for the plant materials that are used to make biofuels. When biomass processed, scientists can break down and convert the plant cells into renewable fuels or chemicals. So, instead of waiting a million years for nature to change plants into fossil fuels, scientists are trying to speed up this process by using clever chemistry to make biofuel from plants that are alive today.



Now, wait a second!

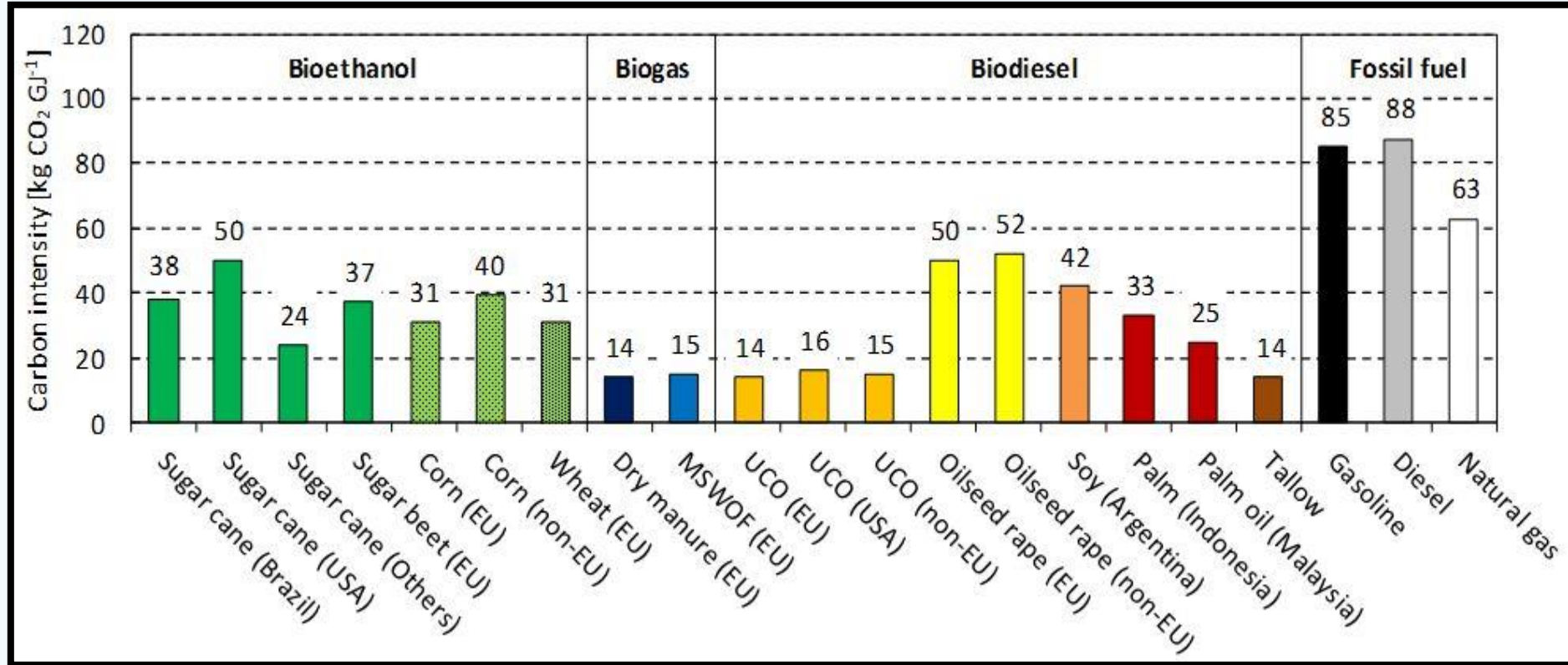
- ✓ If burning fossil fuels, which are made from ancient organic matter, pumps CO₂ into the atmosphere ... does not burning biofuels create the same problem?



- ✓ Fortunately, the answer is no!
- ✓ Burning biofuel does indeed release CO_2 , but remember that the plants used in biofuel are not ancient – they were living on the earth at the same time as you and me. And while we, as humans, breathe oxygen to stay alive, plants instead breathe CO_2 . This means that because the plants used for biofuel consume CO_2 as they grow, there is no total increase in the amount of CO_2 in the atmosphere when they are burned. They are only replacing what they have taken. In addition, unlike petroleum, we can always grow new plants for biofuel when we need them.



Pollutants



Carbon intensity of **biofuels** compared to traditional **fossil fuels**.
<http://dx.doi.org/10.4136/ambi-agua.1492>

Bioeconomy

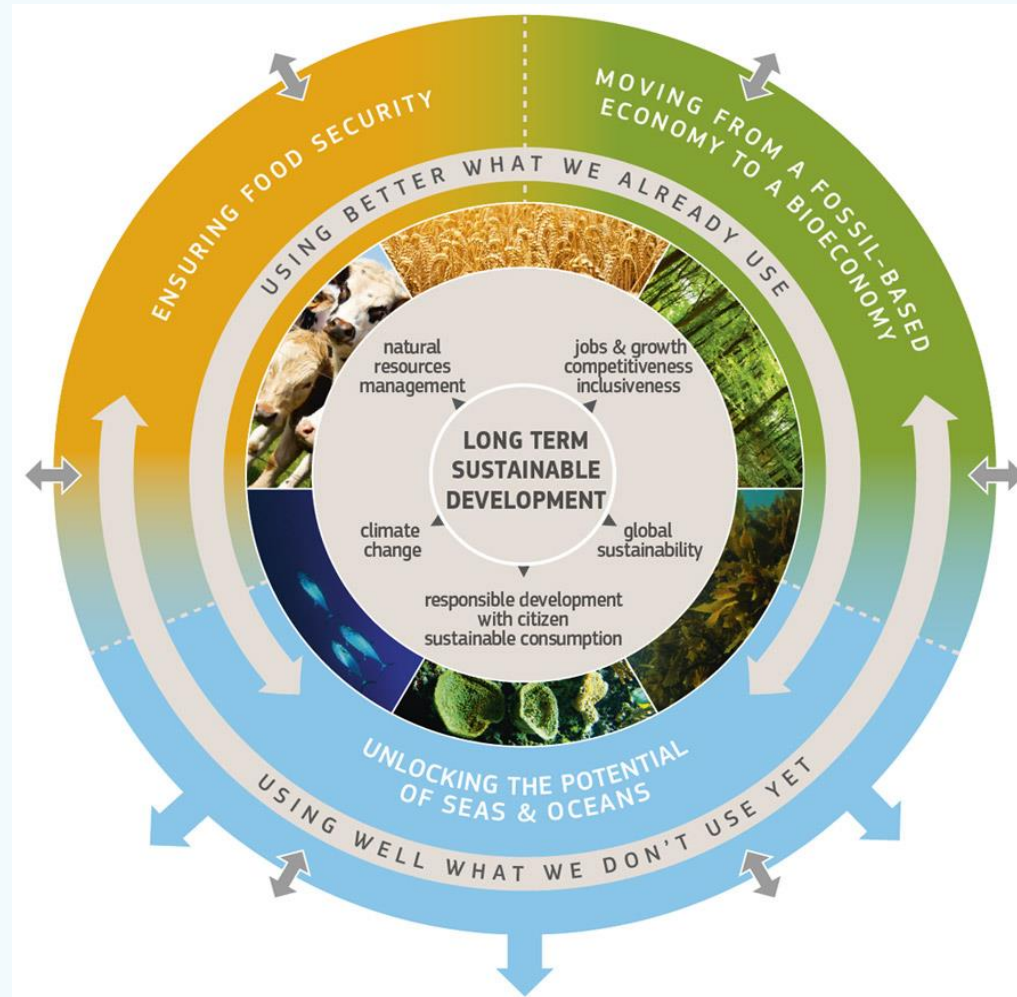
Bio + Economy:

Economy based on biological products

The bioeconomy is a circular economy that uses renewable biological resources from land and sea – such as crops, forests, fish, animals and microorganisms – to produce food, materials and energy.

Video:

<https://www.youtube.com/watch?v=2xvXkOMRTs4>



Annex 2 (a): 1st Experiment

NAME: _____

DATE: _____

GROUP: _____

SCHOOL: _____

Introductory Vocabulary

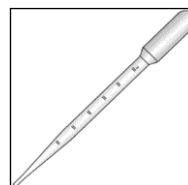
Match each picture with the correct scientific terminology.

Equipment

- Pipette



- Graduated cylinder



- Beaker



- Large separatory funnel with ring stand



1st Experiment: Making your Biodiesel

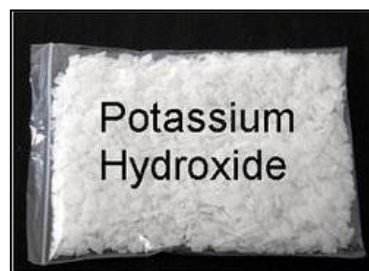
Question: **Can biodiesel be produced by vegetable cooking oil?**

Background:

Biodiesel is a mixture of methyl esters of fatty acids. It can be made very easily from vegetable cooking oil. The synthesis is a simple chemical reaction that produces biodiesel and glycerol. Cooking oil is mixed with methanol and potassium hydroxide. The products separate into two layers, with the biodiesel on the top. The biodiesel is separated and washed and is then ready for further experimentation.

Materials:

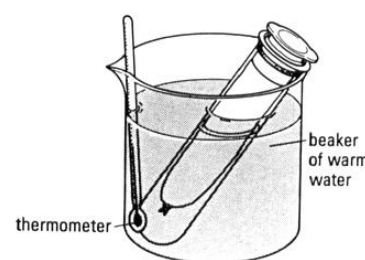
- 100 mL graduated cylinder
- 10 ml pipette
- Large separatory funnel with ring stand
- Waste (vegetable) cooking oil
- Alcohol (methanol)
- Potassium hydroxide solution (KOH) 0.6M in ethanol
- Beakers
- Alcohol thermometer

***Safety Rules:***

- ✓ You must wear goggles, gloves and an apron.
- ✓ Alcohol is flammable.
- ✓ Potassium hydroxide is corrosive.

Procedure:

1. Measure 18 ml of methanol, using a graduated cylinder, and pour it into the separating funnel.
2. Using a pipette, carefully add 3ml of the KOH solution into the funnel as well.
3. Swirl gently.
4. Measure 72 ml of waste cooking oil using the cylinder.
5. Warm the cooking oil up to 40°C, using a water bath and an alcohol thermometer. A water bath is made from a container, such as a big beaker, filled with heated water. (approx. 100ml of heated water)
6. Add the 72ml of cooking oil into your separating funnel.
7. Swirl and shake the mixture for 10 minutes. Occasionally release any pressure.
8. Transfer the mixture into a beaker.
9. Let the mixture stand.
10. Record your observations (e.g. color, viscosity, odor of the mixture).
Data collection should include observations before, during and after the reaction.
11. Allow the mixture to sit and separate for one day.
12. Next day record your observations again.
13. Remove the top layer (biodiesel) by using a pipette and store it for next lab day.



14. Carefully remove the bottom layer (glycerin) by using a beaker and store the glycerin for next lab day, as well.

Data collection:

Mixture	Starting Observations	Interim observations (optional)	Final Observations
Color			
Viscosity			
Other			

Questions:

1. Which were the reagents and which were the products in this experiment?

2. What did you use as a catalyst?

3. What did you observe as you mixed the oil with the alcohol?

4. Why do the biodiesel and the glycerin separate?

Annex 2 (b): 2nd Experiment: Testing your Biodiesel

NAME: _____

DATE: _____

GROUP: _____

SCHOOL: _____

Question: How does biodiesel compare with other fuels?

Background:

Combustion involves a series of chemical reactions between a fuel (i.e. a hydrocarbon, or an organic compound containing only carbon and hydrogen) and oxygen. The result is a major reorganization of both matter and energy.

Materials:

- Glass rod
- Clay triangle
- Tripod stand
- Forceps
- Ring stand with ring attached
- 1 crucible
- 2 beakers
- 250 ml graduated cylinder
- 10 ml graduated cylinder
- 3 pieces of foil
- 3 pieces of wick
- 5- 10 ml biofuel (e.g. biodiesel)
- 5-10 ml fuel A (e.g. ethanol)
- 5-10 ml fuel B (e.g. petrol)
- Lighter
- Alcohol thermometer
- Scale accurate to 0.1g (Weight capacity: ~500 g)
- Ruler
- Stopwatch



Safety Rules:

- ✓ You must wear goggles, gloves and an apron.
- ✓ Alcohol is flammable.
- ✓ You should not use fuels such as petrol on your own, they are really flammable!!!

Procedure:**Making a fuel burner:**

In this part you will make the fuel burner you will use for the combustion.

1. Measure 10ml of the biodiesel, you created during the 1st experiment, using a graduated cylinder.
2. Soak entire the wick into the fuel.
3. Use the glass rod to submerge the wick.
4. Position the wick in a crucible in a way that part of it ($\frac{1}{4}$) is outside the crucible.
5. Cover the top of the crucible with foil so as only the wick is exposed.
The foil must completely cover the opening.
6. Light the wick and wait for the flame to die down.

**Combustion**

7. Record the mass of the fuel burner, using the scale, on the data table.
8. Measure 200 ml of water using a graduated cylinder.
9. Pour the water into a beaker.
10. Record the mass of water in the beaker on the data table.
Note: 1 ml H₂O = 1 g H₂O at room temperature
11. Place the beaker on the ring stand carefully.
12. To measure the initial temperature of the water, hold an alcohol thermometer in the water so that it does not touch the sides of the beaker. Record the temperature in the data table.
13. Place your fuel burner on a tripod stand under the beaker.
14. Adjust the ring height so that the top of the wick is a measured 3 cm below bottom of the beaker. Center the fuel burner under the beaker.
15. Light the wick using a lighter.
16. Use a thermometer to measure the temperature of the water.
17. Use the thermometer to stir the water periodically.
18. As you burn your fuel make observations on your data table about associated smells, and the nature of the flame and smoke.
19. Continue heating and stirring the water until the temperature has increased by ~25°C. At that point, record the maximum temperature the water reaches.
20. Remove the beaker from the ring and quickly extinguish the flame by placing another beaker over the wick.
21. Calculate the heat transferred in water by using the formula: $Q = mc\Delta T$,
Specific heat capacity of water: $c = 4.186 \text{ J/g } ^\circ\text{C}$
Mass of water: $m \text{ (g)}$
 $\Delta T = \text{Change in Temperature } (^\circ\text{C})$

$$Q = mc\theta$$

Heat Energy

Specific Heat Capacity

Mass

Temperature change

22. Record the final mass of the fuel burner (with the cap, wick and the remaining fuel) using the balance.
23. Calculate the used mass of the fuel burner.
24. Repeat steps 1- 23 with another fuel (e.g. petrol or ethanol).
25. Answer questions 1-5.



Data collection:

	Biodiesel	Fuel A -----	Fuel B -----
Initial water temperature			
Final water temperature			
Change in water temperature (ΔT)			
Heat ($Q = m c \Delta T$) (J) $c = 4.186 \text{ joule/gram } ^\circ\text{C}$			
Initial mass of fuel burner			
Final mass of fuel burner			
Mass of fuel burner			
Observations			

Questions:

1. Where did the energy you measured as heat come from?

2. Did you witness complete or incomplete combustion of diesel and biodiesel? How do you know?

3. What did you observe as you mixed the fuel with the alcohol?

4. Can you explain the differences in the combustion results described above?
(Hint: Look at the molecular formulas of diesel and biodiesel!)

5. What are the comparative advantages of using biodiesel instead of regular diesel?

Annex 2 (c): 3rd Experiment: Making your Soap

Question: **Can glycerin from biodiesel be turned into a liquid soap?**

Background:

By-products retain both financial and environmental value that we can capture through other chemical processes. Biodiesel glycerin is actually a mixture of free fatty acids (FFA) that were neutralized during transesterification, soaps, water, catalyst (NaOH or KOH depending on what was used to make the biodiesel), methanol, and glycerin.

Once the methanol is removed, the glycerin is safe to handle and is suitable for making soap. The remaining contaminants are all ingredients in soap making soap production the easiest way to capture the value of the glycerin. The following lab is designed to show how glycerin, from biodiesel made with KOH, can be turned into a liquid soap with a multitude of uses from hand soap to stainless steel cleaner.

Materials:

- Glycerin (Methanol Removed)
- Essential Oil (optional)
- Coconut Oil
- Citric Acid
- 250 mL graduated cylinder
- Potassium Hydroxide solution (KOH) 9M
- 1,000 mL beaker
- 250 mL beaker x 2
- Pot
- Burner
- Lighter
- Thermometer
- Silicon molds



Procedure:

1. Heat glycerin and coconut oil in a pot.
2. Stir your mixture.
3. Pour 40ml of hot glycerin into a beaker.
4. Add 40ml of KOH solution into the beaker as well.
5. While stirring you can put essential oil and color to your mixture. (Optional)
6. Pour the mixture into the silicon molds.

Safety Rules:

- ✓ You must wear goggles, gloves and an apron.
- ✓ Alcohol is flammable.
- ✓ Potassium hydroxide is corrosive.

Questions:

1. What is the purpose of adding glycerin to the soap? What is the purpose of adding an essential oil?

2. What would happen if we dissolved the soap paste in water?

3. What could this soap be used for?

4. How does making soap fit in with making biodiesel?

Annex 3: Learning Design

Description	
Context	Topic: Bioeconomy Total learning time: 400 h Number of students: 20 students Description: Science, Chemistry, Physics, Mathematics, Technology and Arts Curriculum: National, International Baccalaureate, As and A -Level Age of learners: 13 – 16
Aims	The scenario aims on enhancing learners': 1) Content knowledge on bioeconomy topics. 2) Experimental skills by conducting experiments. 3) Critical thinking on bioeconomy topics 4) Creativity by producing their own soaps 5) Collaborative work, communication and responsibility by working in teams. 6) Information, media and technology skills by producing a 1 min advertisement.
Outcomes	Knowledge (Define): Define what bioeconomy is Comprehension (Explain): Explain what bioeconomy is. Knowledge (Recognise): Recognise different ways of applying bioeconomy. Comprehension (Contrast): Contrast biobased to non-biobased products. Synthesis (Design): Design a biobased solution. Evaluation (Reflect): Learners reflect on the bioeconomy products they designed.
Teaching-Learning activities	
1st Activity: Introduce the idea of Bioeconomy Duration: 1 lesson (40 min) Learning space: School Class	Read Watch Listen 5 minutes 20 students Tutor is available 1. Create groups of 4 with which you will work during the Bioeconomy project.
	Read Watch Listen 10 minutes 20 students Tutor is available 2. Start the lesson by watching a video: <ul style="list-style-type: none"> Older learners: The girl who silenced the world for 6 minutes: https://www.youtube.com/watch?v=d7ep_8SLQho Younger learners: There's a Rang- Tan in my bedroom: https://youtu.be/3Ha6xUVqezQ
	Ask the students to discuss in their group (Think Pair-Share) <ul style="list-style-type: none"> What is the problem in the video? Is it real? What can we do to solve this? Can humans use something else and stop cutting trees Which plant grows fastest?
	Discuss 15 minutes 20 students Tutor is available 3. Introducing the idea of Bioeconomy

	<p>The Bioeconomy starts here: https://www.youtube.com/watch?v=2xvXkOMRTs4</p> <p>The Bioeconomy in our everyday lives: https://www.youtube.com/watch?v=ir3MgOSmvLg</p> <ul style="list-style-type: none"> - Start showing examples of biobased products. - Discussing with students the importance of bioeconomy and circular economy. <p>Key idea: Plants are great engines of creating energy for us.</p> <ul style="list-style-type: none"> - What do we do with the plants? - What do we do with the parts of the plants we do not eat? - Can we use plants as a fuel? - What is used to create biomass fuels? - Why do biofuels have an advantage? - Besides fuel, what can biomass be used to create? - How can biofuels reduce the amount of petroleum we use without entirely replacing it? - How are biofuels created? - How does biochemical refining work? - How does thermochemical refining work? - What happens if you add oxygen to the process - thermochemical gasification? - Why are biofuels favourable? <p>Energy 101/Biofuels: https://www.youtube.com/watch?v=-ck3FYVNI6s&feature=youtu.be</p> <p>Algae Power: https://www.youtube.com/watch?v=waPgGQNppHY&feature=youtu.be</p>
	<p>Collaborate 10 minutes 20 students Tutor is available</p> <p>3. Mind Map: Create a mind map of bioeconomy</p> <p>Investigate 100 minutes 20 students Tutor is not available</p> <p>4. Homework Project:</p> <ul style="list-style-type: none"> - Go to the supermarket and find as many bio-based materials as possible. Take pictures of them. - Find biofuels and biobased material that is already used in different countries. <p>Work with your team and collect all the information. Create a poster to present your results.</p>
<p>2nd Activity: Making your Biodiesel</p> <p>Duration: 1 lesson (40 min)</p> <p>Learning Space: Experimental Laboratory</p>	<p>Produce 40 minutes 20 students Tutor is available</p> <p>Experimental work: Students make their own Biodiesel from used cooking oil of their school</p> <p>Worksheet of the 1st experiment (Annex 2 (a))</p>

3rd Activity: Testing your Biodiesel Duration: 1 lesson (40 min) Learning Space: Experimental Laboratory	<i>Investigate 40 minutes 20 students Tutor is available</i> Experimental work: Students test the biodiesel by comparing it with other fuels. Worksheet of 2nd experiment (Annex 2 (b))
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