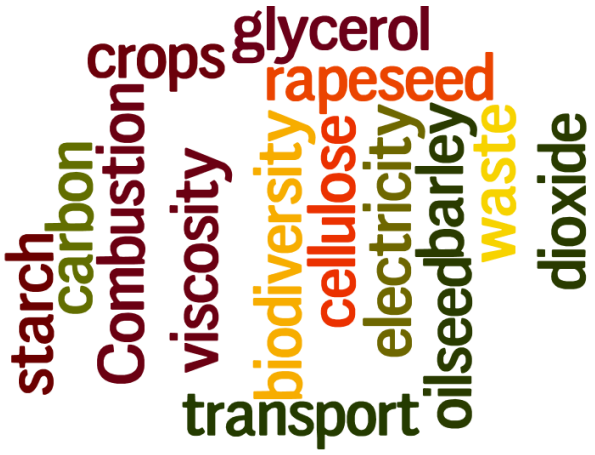
Fat to Fuel

Teacher's notes:

1. Guessing the lesson

Outline	Learners guess the content of the lesson from word cues.
Thinking skills	Guessing, hypothesising
Language focus	Nouns and questions related to topic
Language skills	Speaking
Time	15minutes
Level	A2 or above
Preparation	Make a copies of the word cloud worksheet 1 between 2 students



Procedure

- Distribute the worksheet 1between 2 students.
- In pairs students answer the questions on their worksheet, filling out the table (5mins)
- You may want to give them copies of the science glossary (attached at the end of this document) and/or a dictionary on line oxforddictionaries.com
- Two pairs come together to form a group of 4 students. They check their answers and exchange on missing information. (5mins)
- Check the students' responses as a whole class and be sure to give the students the key words from the answer box.(5mins)

Answers:

1. What do you think the lesson will be about?	***Bio fuel, renewable energy, climate change,***
2. Which words can you add to these?	***Bioenergy, fuel, biofuel, sustainability, biodegradable, biodiesel***
3. Which words do you know?	
4. How can you guess the meaning of the words you don't know?	*Repeated suffix '**bio**' / '**ity**' indicates a noun / French cognates (same in French)*

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2. Vital visuals – biofuel sources

Outline	Learners discover the name of the biofuel plants by matching the description to the image.
Thinking skills	Visual recognition and deduction
Language focus	Description, adjectives
Language skills	Reading and speaking
Time	15mins
Level	A2 or above
Preparation	Make copies of the vital visuals worksheet 1 between 3 students. Cut up and mix the image and description cards.

Procedure

- Distribute the picture and description cards, one set between three students.
- Ask the students to match the picture to the description.
- Check this as a whole class and ask the students to name the plant (embedded in the text).
- Check the correct pronunciation of maize /maize/ http://translate.google.com/?hl=en#en/de/maize

Answers

	Naturally reddish in colour, **palm oil**, is one of the few highly saturated vegetable fats.
	Known as rape, **oilseed rape** or **rapeseed**. It is a bright yellow flowering member of the cabbage family.
	The leafy stalk produces ears which contain seeds called kernels. **Maize** */maize/* kernels are eaten as a vegetable.
	The pods are covered with fine brown or grey hairs. The coat of the mature **soya bean** is hard.
	It has a rough, hairy stem and broad leaves. The **sun flower** has a big circular head of orange flowers.
	This comes from animal fat. **Tallow** is solid at room temperature.

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3. Guiding understanding

Outline	Learners read different parts of the text in a group to answer questions about Oil and biodiesel.
Thinking skills	Comparing and contrasting, reasoning
Language focus	Asking and answering questions / 'Wh' question forms
Language skills	Reading and speaking
Time	40mins
Level	A2 and above
Preparation	Make copies of the different parts of the text 'Oil and biodiesel' worksheet 3A (A,B,C,D) enough for one text between 4 students. Make copies of the question table worksheet 3B, one for each student.

Procedure

- Divide the class into groups of four; A, B, C,D. If you have a large class, make two groups of each letter.
- Assign each member of each group a number; 1,2,3,4
- Distribute the parts of the text to their respective groups e.g. **Text A – Background**, group A
- Distribute the question table worksheet, one for each student.
- Ask the students to work in their groups collaboratively and explain that they need to read the text, find out and note the answers to the questions on their worksheet, as effectively as they can, in order to share the answers to a new group which they will be assigned to afterwards.
- Explain that they will only be able to find the answers to three of the questions in their first group.
- Monitor the groups as they work together, point out the glossary and encourage them to the recall the language they have seen in the previous vocabulary exercises. Check they understand the questions. **(20mins)**
- Divide the class into their new groups of four, this time by numbers e.g. group (1- 4) so that each group is made up of one learner from each of the four original groups (A-D).
- Ask the learners to share their information in order to complete their question tables. Set them a time of **10mins.**
- This can be a noisy moment in the lesson, don't worry! Observe, help and monitor.
- Check the answers as a whole class.

Answers:

(Following page)

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Answers: Guiding understanding, question table

1. Where can oil be extracted from?	**2. Which are the most important crops in the UK?**	**3. Where does palm oil come from?**	**4. Where might the future sources of oil be produced?**
Answer: A variety of plants e.g. soya, oilseed rape, maize and palm oil	Answer: Wheat and Barley	Answer: Malaysia and Indonesia	Answer: From crops which are drought tolerant
5. How is oil extracted from plants?	**6. Which countries produce the most plants for biodiesel production in Europe?**	**7. What are the effects of palm oil plantations on the indigenous people?**	**8. What is the oil content of future possible biofuel crops?**
Answer: the raw material is pressed and then solvents and steam distillation improves the quality.	Answer: Germany and the UK	Answer: Poor working conditions	Answer: 40%
9. Can any vehicle operate on biofuels?	**10. How can we ensure the availability of food crops?**	**11. What is the impact of oil palm production on the environment?**	**12. How might fossil fuels be replaced in the future?**
Answer: no, only with 5% of biofuel without modification to the engine.	Answer: manage food security	Answer: deforestation, production of biofuels become counter productive (no point) to carbon release.	Answer: with algal feedstocks

4. 'Titration' experiment

Outline	Learners understand the reason for the experiment and sequence instructions once they have seen it, getting meaning through context
Thinking skills	Ordering, understanding
Language focus	Amounts, laboratory equipment
Language skills	Listening
Time	30mins
Level	A2 or above
Preparation	Makes copies of the 'Titration' worksheet one for each student

Procedure:

- Ex: 1+2 can be done before the science workshop. Invite students to use the diagram and dictionaries to support understanding.
- Ex: 3 Should be done during the experiment while the language is being activated.

Answers:

Ex: 1 Antonyms

Viscous	diluted
Transform	maintain
Conventional	alternative
Thinner	thickener
Expensive	cheap

Ex: 2 Gap fill

Pure vegetable oil is too viscous to be used in a modern diesel engine. We have to chemically transform the oil to make it thinner. This process is called trans-esterification. After this process the fuel can be used in modern conventional engines.

Ex: 3 Jumbled instructions

No:	Instruction
2	*Add a few drops of indicator and stir*
4	*Continue to add the KOH, 0.5mls at a time, until the red colour persists after stirring. The isopropyl alcohol is now pH neutral*
6	*Continue adding KOH, 0.5ml's at a time, until the red colour persists. Record how much KOH you put into the solution.*
3	*Add 0.5ml of KOH solution to the solution*
5	*Add 1ml of the waste oil to the solution and stir. The red colour will disappear as the oil has made the solution acidic.*
1	*Add 10ml of isopropyl alcohol to a beaker*
7	*The amount of KOH (ml's) it takes to neutralise 1ml of oil equates to the number of grams of KOH it takes to neutralise a litre*

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5. Eyewitness account – The majestic plastic bag

Outline	Learners role play a television interview with a plastic bag who has returned from its amazing journey to the pacific ocean
Thinking skills	Creative thinking
Language focus	Describing events and feelings. Past tense verbs, prepositions, urban landscape
Language skills	Speaking
Time	40mins
Level	A2 and above
Preparation	Show the class the clip of the *mockumentary*, 'The majestic plastic bag' which the scientist showed during the workshop. This is a satirical clip about the dammage and pollution plastic bags cause and their accumulation in the Pacific ocean. Youtube link: https://docs.google.com/folder/d/0BxB4aOZuYQgDTTA0QjU4MXZ0eUE/edit?docId=0BxB4aOZuYQgDR0NDWENoT05tdDA Make copies of Worksheet A Eyewitness account 1 between 2 and Worksheet B Peer speaking assessment rubric, 1 between 2

Procedure

- Show the students the 'mockumentary', 'The majestic plastic bag' from the science workshop.
- Ask the learners what sort of film it is: Documentary / feature film / mockumentary (satirical documentary)
- Tell the students they are going to role play an interview with the plastic bag from the clip.
- Brainstorm interview type questions, re-cast in English if necessary, writing them up on the board. E.g. ***What happened when you arrived in the park? How did you feel? What happened next?***
- Learners work in pairs, one taking the role as the plastic bag, the other as the interviewer.
- Students complete the eyewitness worksheet A which will help them structure their role play.
- Distribute the peer assessment rubric (success criteria). Students practice their interview ready to present to the rest of the class. Set a time of 2mins for the interview.
- Observe, monitor and help. Encourage learners to use the speaking frames on the worksheet as support. **(Prep 20mins)**
- Each pair presents their interview while the rest of the class complete the assessment rubric, explain that they are helping each other understand where they need to develop and not to give each other a score.

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Glossary

Adapted from Royal Society *Sustainable biofuels* **publication, Nuffield bioethics publication and using** www.biology-online.org **dictionary**

This glossary is designed to provide some simple definitions that will enable students to understand and explain the terminology used by BBSRC to explain bioenergy research. Some terms have been simplified and others will be too advanced for younger students. A student word list for Key Stage 2 and 3 students is also provided.

Advanced plant breeding strategy - a type of plant breeding strategy in which the genetic basis of a trait is screened for in the progeny of a cross using a lab-based test. This saves time and labour compared with conventional plant breeding. There are two types of advanced plant breeding strategy: *marker-assisted breeding* and *genomics-assisted breeding*.

Aerobic - With oxygen.

Alcohol - An organic chemical containing one or more hydroxyl groups.

Algae - Phototrophic eukaryotic microorganisms.

Anaerobic - Without oxygen.

Arable land - land that is suitable for crop production.

Asexual reproduction - Reproduction involving only one parent, producing offspring that are genetically identical to each other and to the parent.

Atmosphere - A layer of gases that surrounds the Earth.

Bacteria - Microscopic, single-celled organisms belonging to Kingdom Monera that possess a prokaryotic type of cell structure.

Barley - A valuable grain, of the family of grasses, genus Hordeum, used for food, and for making malt, from which are prepared beer, ale, and whisky.

BBSRC - Biotechnology and Biological Sciences Research Council.

Biobutanol - Butanol produced by some strains of bacteria, such as *Clostridium acetobutylicum*.

Bioenergy - Energy including, heat, electricity and liquid fuels, derived from non-food feedstocks or from inedible elements and waste from food crops.

Biodiesel - An organic compound derived by processing and transesterification of plant oil or animal fats that can be used as a transport fuel in replacement of diesel derived from fossil fuel.

Biodiversity - Shorthand for biological diversity. This is the variability among living organisms from all ecosystems and the ecological complexes of which they are part. It includes diversity within species, between species and of ecosystems.

Bioethanol - Biofuel consisting of ethanol produced by the fermentation of plant material rich in sugar or lignocellulose.

Biofuel - A renewable fuel produced from biological material such as recently dead plants, animals or their waste.

Biogas - Renewable gaseous fuel comprised of methane (approximately 60%) and carbon dioxide, produced by anaerobic digestion of organic material by microorganisms. Can be used as a transport fuel or, as a replacement for natural gas.

Biomass - Any biological material that can be used either directly as a fuel, converted to a fuel or used in industrial or fibre production.

Biomass - The term for the dry weight of a living thing.

Bio-oil - A carbon-rich liquid produced by pyrolysis of plant material, which can be used to produce chemicals and fuels.

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Bioprospecting - The search for useful organic compounds or organisms in the environment.

Carbohydrate - An essential food group found in our diet (includes sugar, starch and fibre).
Carbon cycle - How carbon is cycled between living organisms and the air.
Carbon dioxide (CO_2) - A gas produced by cell respiration and the burning of fuels. Used by plants for photosynthesis.
Carbon neutral - applies to a process which occurs without any change in the total amount of carbon dioxide present in the atmosphere.
Catalyst - A substance, including enzymes, that increases the rate of a chemical reaction but is not consumed during the process.
Cell - The basic unit that living things are made of.
Cellulose - Major material from which the plant cell walls are made.
Centrifuge - A piece of equipment used to separate substances according to their density by rotation.
Chemical energy - Energy that is stored in chemical form, such as in coal, oil or food.
Chemical reaction - A chemical change in which new substances are formed but there is no change in the number of atoms of each element.
Chlorophyll - The green chemical in plants that absorbs light energy and converts it into chemical energy through photosynthesis.
Chloroplasts - The compartments inside plant cells that contain chlorophyll, where photosynthesis occurs.
Chromatography - A method of separating substances. The substances are separated as they move, in a solvent, through a material, e.g. paper. The substances often move at different speeds.
Combustion - An oxidation reaction in which energy is released.
Complete combustion - An oxidation reaction that takes place when oxygen gas is in excess.
Compound - A substance containing two or more elements chemically joined together.
Crops - A plant grown to be harvested for agricultural use.
Crystalline - A material that has some regular arrangement of particles.

Decomposers - Organisms that break down dead organisms (e.g. bacteria and fungi).
Digester - A large vessel used to carry out biological decomposition.
Directed evolution - A method used to alter the proteins or RNA produced by organisms through mutation and selection or screening of variants with desirable properties.
Distillation - A process in which a liquid is converted into vapour by heating and then condensed back into a liquid. It is used to purify and to separate a liquid mixture.

Element - A substance that cannot be broken down into anything simpler by chemical reactions. An element consists of one type of atom.
Energy - The ability to do work or produce change.
Enzyme - A protein that speeds up reactions in living things.

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Extremophile - Microorganisms that live optimally at relatively extreme conditions e.g. of acidity, salinity, temperature or pressures. Enzymes isolated from these organisms are used in some industrial manufacturing processes.

Fatty acid - A group of long chain hydrocarbons derived from the breakdown of fats with a single carboxylic group and aliphatic tail.

Fermentation - An anaerobic (without oxygen) cellular process in which organic foods are converted into simpler compounds such as alcohol, and chemical energy (ATP) is produced.

Fertilisers - Substances added to soil to replace lost nutrients and help plant growth

First generation biofuels - refers commonly to biofuels that are made from the food parts of food crops, such as sugar cane and oil palm, including bioethanol fermented from sugars and broken-down starch, and biodiesel derived from plant oils. Biogas is also known as a first generation biofuel.

Fossil fuels - Non-renewable fuels, such as coal, oil and gas, formed over millions of years from the decomposition, in anaerobic conditions, of plant and animal remains.

Fuel - A substance that can undergo a chemical change to release energy, usually as heat, in a controlled way.

Gasification - A process that converts materials, such as coal, petroleum or biomass, into synthesis gas (or 'syngas'), which comprises mainly carbon monoxide and hydrogen.

Genetic modification (GM) - The technology entailing all processes of altering the genetic material of a cell to make it capable of performing the desired functions, such as producing novel substances

Gene - Part of a chromosome. One gene contains the 'instructions' for a particular characteristic such as flower colour. The fundamental, physical, and functional unit of heredity

Global warming - The steady increase in the temperature of the Earth's atmosphere.

Glucose - The specific sugar made by photosynthesis.

Glycerol - A compound with the molecular formula $C_3H_5(OH)_3$ which is a by-product of the production of biodiesel via transesterification. Can be used in other industries, e.g. pharmaceuticals, cosmetics etc

Glycosidic bonds - A type of covalent bond that joins carbohydrate (sugar) molecules together in di- or polysaccharides

Greenhouse gas - Gas such as carbon dioxide that traps heat in the atmosphere

Gribbles - Marine wood borers

Hazard - A property of something that could cause harm to health or the environment.

Hexose - Monosaccharide containing six carbon atoms

Hydrocarbon - Chemicals that are made only from hydrogen and carbon. Fuels contain large amounts of this chemical group.

Hydrolysis - A chemical reaction where a compound, such as starch or cellulose, is broken down by reaction with water into smaller components. In the case of biofuels, this can use enzymes or acid

Incomplete combustion - An oxidation reaction that takes place when oxygen gas is in a limited supply.

Iodine solution - This solution is used to indicate the presence of starch in a leaf - it turns blue-black in contact with starch.

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Life Cycle - The sequence of events that happen to a material from obtaining the raw materials for its manufacture to its disposal as waste

Life Cycle Assessment - An examination of every stage in the manufacture and use of a material for a particular purpose, comparing its economic and environmental costs with other potential materials.

Lignin - Organic substance which act as a binder for the cellulose fibres in wood and certain plants and adds strength and stiffness to the cell walls.

Lignocellulose - Plant cell walls are composed of lignin and cellulose, which provide mechanical strength. Can be broken down to lignin and cellulose or used directly as a feedstock.

Maize - A cereal crop commonly known as corn that is grown predominantly in the USA, Canada and Australia.

Methane - A gas that is found with crude oil and produced in decomposition. At home we use cookers and boilers to react it with oxygen to provide heat.

Methanogens - Methane producing microorganisms.

Microbe - A very small living thing that can only be seen with a microscope. Some are harmful and some are useful.

Miscanthus - A fast-growing tall grass species that is grown as an energy crop.

Molecule - A particle made up of two or more atoms joined together.

Natural Gas - Found in association with hydrocarbon fuels, primarily coal, and consisting mainly of methane.

Non-renewable resource - A resource that cannot be renewed at the same rate as it is being used and will eventually run out.

Organic compound - A compound that contains carbon-carbon bonds.

Pascal - The unit for measuring pressure. It equals one Newton per m^2.

Pentose - Any monosaccharide sugar containing five atoms of carbon per molecule.

Perennial - Lasting through the year or for several years.

Phloem - A tissue in a vascular plant that functions primarily in transporting organic food materials (e.g. sucrose) from the photosynthetic organ (leaf) to all the parts of the plant.

pH - A measure of the acidity of a solution; the lower the pH number the stronger the acid.

Photosynthesis - A process carried out in green plants that uses light energy captured by chlorophyll to convert carbon dioxide and water to carbohydrates and oxygen.

Pollutant - A substance present in the environment as a result of human activity that can harm the environment or health.

Polysaccharide - A complex carbohydrate composed of a chain of monosaccharides joined together by glycosidic bonds.

Product - The substances formed during a chemical reaction.

Reactant - The substance present at the start of a reaction A chemical that undergoes a chemical change in a chemical reaction.

Renewable resource - A resource that can be renewed more quickly or at the same rate as it is being used or is unlikely to run out due to inexhaustible supplies.

Risk - An estimate of how dangerous a hazard is in a particular situation.

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Saccharification - The process of converting complex carbohydrate (e.g. starch) into simple monosaccharide components (e.g. glucose) through hydrolysis.

Saturated compound - A compound with only single bonds between its atoms.

Second generation – Bioenergy solutions that either make use of waste or rely on non-food crops that can be grown on marginal land.

Selective breeding - The process of allowing certain animals or plants to breed so as desirable characteristics are found in the next generation.

Species - (In evolution) a group of organisms with the same characteristics, (living) a group of organisms with the same characteristics that can breed with each other.

Starch - An insoluble carbohydrate found in plants and plant products. The storage molecule for the surplus glucose made by photosynthesis.

Straw - The stalks of harvested cereal crops such as wheat and barley.

Substrate - The substance acted upon by an enzyme.

Sugar - A carbohydrate that is a source of energy in respiring cells. Glucose belongs to this food group.

Sustainable development – A programme of developing new energy technology that does not harm the environment or use up non-renewable resources.

Sustainability - The use of resources to meet the need of present generations without compromising the need of future generations by balancing environmental, social and economic factors.

Synthetic biofuels - Fuels produced via thermochemical conversion of biological material, such as biodiesel, which have exactly the same properties as fuels derived from fossil fuels. These are defined differently to synthetic fuels, because synthetic fuels can also be made from coal, gas and oil.

Synthetic biology - A new and growing science that focuses on re-designing and re-building natural biological systems synthetically from the ground up.

Transesterification - A reaction that is catalysed by an acid or a base, where the alkoxy group of an ester compound is replaced by another alcohol. This process can be used to produce biodiesel.

Unsaturated compound - A hydrocarbon that contains double or triple bonds.

van der Waals - Electrodynamic forces arising between atoms or molecules.

Variety - A subgroup of a species which has a slightly different set of characteristics.

Viscosity - A measurement of the 'thickness' of a fluid.

Water - Combined with CO_2 in photosynthesis to produce glucose.

Willow - Any tree or shrub of the genus *Salix*, including many species.

Xylem - A type of vascular tissue in terrestrial plants primarily involved in transporting water and nutrient (from the roots to the shoot and leaves) and providing structural support.

Yeast - Colloquial name for the fungus that is characteristically single-celled most of its life, eukaryotic, reproduce asexually by budding or binary fission, capable of fermenting carbohydrates. used in the production of ethanol.

Yield - A measure of the amount of crop produced.