

Renewables Don't Run Out

A science investigation pack for teachers of
9 – 12 year olds



This package has been developed by the Chemical Industry Education Centre at the

Department of Chemistry
University of York
Heslington
York YO10 5DD

Telephone: 01904 432523
Facsimile: 01904 434460
E-mail: ciec@york.ac.uk
Website: www.ciec.org.uk

© Chemical Industry Education Centre

First published: 2009
ISBN: 978 1 85342 5943

The contents of this book have limited copyright clearance. They may be photocopied or duplicated for use in connection with teaching within the establishment for which they were purchased. They may not be duplicated for lending, hire or sale.

Acknowledgements

Many people were involved in developing the activities in this resource, and we would like to offer our thanks to them.

The National Non-Food Crops Centre have provided funding for the development of these materials and the associated website. Their staff have provided advice, information and enthusiasm throughout the development period, and we would like to thank in particular Alison Hamer, Louise Dommett and Adrian Higson.

We have drawn upon the expertise of Odette Murtland and Ray Marriott, of the Green Chemistry group in the University of York's Department of Chemistry, and also our own primary science and technical team, Mike Dunn, Cliff Porter, Joanne Rout, Tanya Shields, and Nicky Waller.

Thanks also go to two dedicated primary science practitioners, Janet Chetwood of Sedbergh Primary School, Cumbria and Bryony Turford of Garforth Green Lane Primary School, near Leeds, who trialled the original ideas with their class.

Thanks go to, Kim Carmichael, Croda Enterprises Ltd, Widnes, Lucy Cowton of Innovia Films, Wigton, and John Pinkney of Ensus, Yarm who gave us the industrial background on which we based the story line.

We would like to thank the four schools who have provided us with the images for this publication. The children on the front cover appear courtesy of Tickton Primary School, East Riding. Other images of classroom activities were provided by Sedbergh, Hale, Woodmansey and Tickton Primary Schools. The photograph of the science shirts has been provided by Linda James, Whitehouse Primary School, Stockton-on-Tees, who introduced this well used idea to primary science. Permission to use the photograph of sunflowers in Appendix 1 was given by Petr Kovar Czech Republic.

Michele Smale
Project Officer

Joy Parvin, Gayle Pook
Editors

Contents

Introduction	1
Activity summary	4
Curriculum links	5
Resource requirements	10
Activity notes	12
Activity sheets	31
Appendix 1: Sourcing dried sunflowers	35
Appendix 2: Post-it note planning sheets	36
Appendix 3: The effect of temperature change on oils and fats	39
Appendix 4: Loop game	40
Appendix 5: Spinner	47

Introduction

Age range	<p>The activities in this book provide practical opportunities for children in years 5 and 6 to consider the use of plant material (biomass) as a solution to some of our requirements for renewable energy, to address the problems that use of these materials can pose and to begin thinking about other applications for plant derivatives.</p> <p>The concept of 'How Science Works' and the inclusion of a more detailed explanation of energy will provide an excellent opportunity to use the resource as a Year 6-7 transition unit.</p> <p>The suggested activities can be adapted to suit the needs of the children, staff and the planning requirements of the school.</p>
Approximate duration	<p>The timings for each activity given are a guide, and will vary from class to class. They range in length from 1 to 2 hours.</p>
Context	<p>The activities are set in the context of a company that is considering its future needs for power. The children investigate the suitability of a number of different sources of biomass to fuel the boiler and also the implications of transporting bulky materials to the site. The same company also wishes to explore the use of biomass to replace some of the non-renewable ingredients in its products. This provides a further avenue for exploration by the children.</p>
Background information	<p>This resource introduces the concept of renewable resources from non-food crops. Renewable materials are made from crops, plants and animal sources rather than from fossil fuels or other diminishing non-renewable natural resources.</p> <p>The activities can lead to discussions in other areas such as sustainability, fossil fuels, greenhouse gases, global warming, etc. which can be introduced during the activities or covered at a different time. Further information on renewables and other related topics can be found at the sister website to this resource www.plants4products.org.uk and also www.nnfcc.co.uk</p> <p>The websites provide teachers with ideas for managing discussion and questions to stimulate children's ideas.</p> <p>Forging links with the local secondary school may be beneficial when carrying out some of the activities in this pack, e.g. Activity 2: Fuel from plants. The secondary school may be happy for the class to use their equipment and fume cupboards. The class could write to the science</p>

department requesting their help and advice and use the staff's expert knowledge of the equipment required. This would model the cooperative approach often used by scientists and industry.

Activities

Activity 1 should be carried out prior to any of the other investigations as it sets the scene for the use of plant materials to solve a number of predicted shortages in coming years. It focuses on one solution to the ultimate scarcity of fossil fuels. The five investigative activities following Activity 1 provide a sequence that helps the children to explore the potential for using plants for non-food purposes. They introduce the children to a number of different problems each requiring enquiry skills, discussion and problem solving consistent with National Curriculum requirements.

In some activities detailed instructions have been provided to model a specific investigation process. Teachers may choose to provide children with these instructions following a preliminary discussion and to focus on practicing skills such as measuring, controlling factors, using simple equipment, observing, predicting, and data handling. As an alternative, or in later activities, the children may draw on these experiences to plan their own investigations.

The crop suggested as the source of biomass is the sunflower, which gives the children the opportunity to revise their knowledge of green plants and to consider the most appropriate uses for different parts of the plant. Other plants which bear oil rich seeds, such as maize, or oilseed rape can be used if they are more easily available.

The extraction of oil from the sunflower seeds is investigated, and the use of the oil as a fuel, lubricant or ingredient for a number of different products is explored.

The **literacy activity** is intended for use at any stage during the investigations. Ideally, the suggestions provided will be used alongside all of the activities to develop gradually the children's understanding of the scientific vocabulary they encounter.

The activity sheets provided in this pack are there to help children to organise their ideas but teachers should not feel constrained by them. They may be adapted or other methods, with which the children are already familiar, can be used. The activity sheets are available on the web site www.plants4products.org.uk and can be adapted to individual teacher's needs.

**Advance preparation
of resources**

Ideally, this unit will be carried out in the autumn term, using sunflowers grown in the summer term, which have been dried and stored. However, the activities can be carried out at other times of the year, using stored or purchased dried sunflower heads, and adapting the sequence of activities as appropriate.

We recommend that any plants to be used are planted in early May to be ready for the autumn term. Although dried sunflowers can be purchased, the cost may be prohibitive and alternatives may be required.

Activity Summary

Title	Description	Page	Timing
1. Crops for all purposes	The children are introduced to the idea that some crops are grown for non-food purposes. They review the parts of a plant and their function.	12	1½ hrs
2. Fuel from plants	Children observe how well different materials burn and if they can be compressed for transporting.	14	2 hrs
3. Oil from seeds	Different techniques are used to extract oil from a variety of seeds and nuts.	18	2 hrs
4. Separating oil and water	Methods of separating a mixture of oil and water are investigated.	21	1 hr
5. Oil as a fuel	Children use a variety of oils as fuels and compare results to find the best fuel.	23	1½ hrs
6. Oil as a lubricant	The children are challenged to find out which oil would be the best lubricant.	25	1 hr
7. Focus on vocabulary	Intended for use throughout Activities 1-6; suggestions are made for motivating the children to develop their use of relevant scientific vocabulary.	28	N/A

Curriculum Links

The following **National Curriculum** Key Stage 2 areas are supported by this work:
Pupils should be taught:

Scientific Enquiry: Sc1	
1a	That science is about thinking creatively to try to explain how living and non-living things work, and to establish links between causes and effects.
1b	That it is important to test ideas using evidence from observation and measurement.
2a	Ask questions that can be investigated scientifically and decide how to find answers.
2d	Make a fair test or comparison by changing one factor and observing or measuring the effect while keeping other factors the same.
2e	Use simple equipment and materials appropriately and take action to control risks.
2f	Make systematic observations and measurements.
2g	Check observations and measurements by repeating them where appropriate.
2h	Use a wide range of methods to communicate data in an appropriate and systematic manner.
2i	Make comparisons and identify simple patterns or associations in their own observations and measurements or other data.
2j	Use observations, measurements or other data to draw conclusions.
2k	Decide whether conclusions agree with any prediction made and /or whether they enable further predictions to be made.
2l	Use their scientific knowledge and understanding to explain observations, measurements or other data.
Sc2 Life Processes and living things	
3c	That the root anchors the plant, and that the minerals are taken in through the roots and transported through the stem to other parts of the plant.
3d	About the parts of the flower and their role in the life cycle of flowering plants, including pollination, seed formation, seed dispersal and germination.
Sc3 Materials and their properties	
2g	That burning materials (for example, wood, wax, natural gas) results in the formation of new material and that change is not usually reversible.
3e	To use knowledge of solids, liquids and gases to decide how mixtures might be separated.
Sc4 Physical processes	
2c	Friction, including air resistance, as a force that slows moving objects and may prevent objects from starting to move.
2e	How to measure forces and identify the direction in which they act.
Breadth of Study	
1a	A range of domestic and environmental contexts that are familiar and of interest to them.
1b	Looking at the part science has played in the development of many useful things.
2a	Use appropriate scientific language and term, including SI units of measurement, to communicate ideas and explain the behaviour of living things, materials, phenomena and processes.
2b	Recognise that there are hazards in living things, materials, physical processes and assess risks and take action to reduce risks to themselves and others.

The following **National Curriculum** Key Stage 3 areas are supported by this work:

Key Concepts	
1.1	Scientific thinking
1.1a	Using scientific ideas and models to explain phenomena and developing them creatively to generate and test theories.
1.1b	Critically analysing and evaluating evidence from observations and experiments.
1.2	Applications and implications of science
1.2a	Exploring how the creative application of scientific ideas can bring about technological developments and consequent changes in the way people think and behave.
1.2b	Examining the ethical and moral implications of using and applying science.

Key Processes	
2.1	Practical and enquiry skills
2.1a	Pupils should be able to use a range of scientific methods and techniques to develop and test ideas and explanations.
2.1b	Pupils should be able to assess risk and work safely in the laboratory, field and workplace.
2.1c	Pupils should be able to plan and carry out practical and investigative activities, both individually and in groups.
2.2	Critical understanding of evidence
2.2a	Pupils should be able to obtain, record and analyse data from a wide range of primary and secondary sources, including ICT sources, and use their findings to provide evidence for scientific explanations.
2.2b	Pupils should be able to evaluate scientific evidence and working methods.
2.3	Communication
2.3a	Pupils should be able to use appropriate methods, including ICT, to communicate scientific information and contribute to presentations and discussions about scientific issues.

Range and Content	
3.1	Energy, electricity and forces
3.1a	energy can be transferred usefully, stored, or dissipated, but cannot be created or destroyed.
3.2	Chemical and material behaviour
3.2a	the particle model provides explanations for the different physical properties and behaviour of matter.
3.2b	elements consist of atoms that combine together in chemical reactions to form compounds.
3.2c	elements and compounds show characteristic chemical properties and patterns in their behaviour.
3.4	The environment, Earth and universe
3.4c	human activity and natural processes can lead to changes in the environment.

Curriculum opportunities - The curriculum should provide opportunities for pupils to:	
4a	research, experiment, discuss and develop arguments.
4c	use real-life examples as a basis for finding out about science.
4e	experience science outside the school environment, including in the workplace where possible
4f	use creativity and innovation in science, and appreciate their importance in enterprise.
4g	recognise the importance of sustainability in scientific and technological developments.

Curriculum Links

National Curriculum Links

Scientific and Technological Understanding

The activities in this pack will enable teachers to provide learning experiences consistent with this new area of learning in the reformed Primary Curriculum.

The following statements can be addressed using the materials. This is more clearly demonstrated in the Curriculum Progression table.

Essential Knowledge a, b, c, d

Key Skills a, b, c, d

Breadth of Learning a, b, c, d

Curriculum Progression

The overall breadth of learning should be used when planning curriculum progression. Children should be taught:

Across the area of learning			
Middle		Later	
M1	to explore and investigate in order to collect data, analyse it and identify patterns	L1	to ask questions that can be answered by different types of investigative activity and decide the best approach to use
M3	to capture, record and analyse data using a range of instruments, including sensors	L2	to choose equipment and tools, including ICT: to make their work more effective and efficient, and explain the reasons for their choices
M4	to offer simple explanations for their findings	L3	to make and record accurate measurements and detailed observations, presenting them appropriately, and analyse and interpret them.
M5	to evaluate their skills, findings and outcomes using given criteria.		

Science		Science material behaviour	
M11	to investigate the effects of different forces and to use these to move mechanical parts or objects in specific ways	L12	to explore, explain and use reversible and non-reversible changes that occur in the world around them
M12	to identify, group and select materials using properties and behaviours that can be tested, and identify and group living things using observable features and other characteristics	L13	to investigate how non-reversible changes can be used to create new and useful materials.
M13	to investigate what happens when materials are mixed, and whether and how they can be separated again.		
		Science- life and living things	
		L15	to investigate the structure, function, life cycle and growth of flowering plants and explain how these are linked
		Science- the environment, Earth and solar system	
		L18	to investigate and explain how scientific and technological developments affect the physical and living worlds
		L19	to explore and explain practical ways in which science can contribute to a more sustainable future.

Cross-curricular Studies

Children should have opportunities to negotiate and offer each other feedback in order to ensure a high-quality outcome which enhances their scientific and technological understanding. Links can be made to other areas of learning and to wider issues of interest and importance, in particular developing understanding of sustainability by assessing the impact on the environment of choices in their design.

Children should have opportunities to develop and apply the skills of literacy, numeracy, and ICT, in particular by developing and using specialist vocabulary and meaningful contexts.

Children should have opportunities to extend their personal, emotional and social development, particularly by working collaboratively towards a common goal such as planning and carrying out investigations or developing products. Within the area of learning they share ideas, and make compromises.

Scottish Curriculum for Excellence

The science and technologies frameworks from the *Curriculum for Excellence* provide contexts for learning that draw upon important aspects of everyday life and work. The following table shows the key statements covered during the activities within this resource.

Activity	Curriculum for Excellence					
	Society		Science		Technology	
	Second	Third	Second	Third	Second	Third
1	SOC2-22a	SOC3-20a	SCN2-14a SCN2-20a SCN2-20b	SCN3 -04b SCN3-17b	TCH2-02b TCH2-02a TCH2-02b TCH2- 08a	TCH3-01a
2	SOC2-22a	SOC3-20a	SCN2-15a SCN2-19a SCN2-20a SCN2-20b		TCH2-02a TCH2-02b TCH2- 08a	TCH3-01a
3	SOC2-22a	SOC3-20a	SCN2-20a SCN2-20b	SCN3-17b	TCH2-02a TCH2-02b TCH2- 08a	TCH3-01a
4	SOC2-22a	SOC3-20a	SCN2 -16a SCN2-20a SCN2-20b		TCH2-02a TCH2-02b TCH2- 08a	TCH3-01a
5	SOC2-22a	SOC3-20a	SCN2-15a SCN2-19a SCN2-20a SCN2-20b		TCH2-02a TCH2-02b TCH2- 08a	TCH3-01a
6	SOC2-22a	SOC3-20a	SCN2 -07a SCN2-20a SCN2-20b		TCH2-02a TCH2-02b TCH2- 08a	TCH3-01a

Resource requirements

Activity 1

Per group of 4

1 dried sunflower plant, or other plants that produce seed oils can be used e.g. maize, rape
3-4 clear food bags
Sugar paper
Adhesive labels
A selection of photographs/images linking crops to their end products. A suitable selection can be downloaded and printed from the teachers section of www.plants4products.org.uk

Activity 2

Per class

Bowl of each: straw, hay, wood shavings/chips, sunflower stalk
1 pair safety glasses or goggles
Bag of sand/ bucket of water (emergency use)
3-4 metal baking trays/ roasting tins or similar
Timer
Safety lighter

Per group of 4

Activity sheet 1
Post-it note planning boards (optional, see Appendix 2)
Cup of each: straw, hay, wood shavings/chips and sunflower stalk
4 plastic drinking cups/food cans
500g and 1kg weights
Weighing scales
String
Plastic food bags
Shallow trays

Activity 3

Per class

Bottles of oil from a range of sources to include corn oil, groundnut (peanut) oil, almond oil, rapeseed oil, sunflower oil, sesame oil, olive oil, vegetable oil.
A range of seeds, nuts and crops to include maize, peanuts, almonds, walnuts, sunflower seeds with and without outer casing, sesame seeds, pumpkin seeds.

Per group of 4

Activity sheet 2
Samples of the different seeds and nuts from the list above.
1 rolling pin
1 sealable clear bag per seed/nut sample
1 filter paper or sugar paper square (10cm x 10cm approx) per sample
1-2 teaspoons
Bluetac or adhesive tape
Camera (optional)

Activity 4

Per group of 4

Small transparent plastic bottle (approx. 200-400 ml) containing equal amounts of water and a coloured oil, e.g. corn oil

A range of separating equipment such as:

Clean, empty, plastic sauce bottle with one way valve, e.g. shower gel, tomato sauce

Clean, empty, transparent, plastic detergent bottle

Funnel

Tubing

Flexible plastic drinking straw

Small transparent pump action dispenser bottle

Plastic cups

2-3 plastic pipettes

Syringes

Digiblue movie creator or similar software

Activity 5

Per class

Safety lighter

Per group of 4

Activity sheets 2-3

Tidy tray containing sand

Heating stand (available from TTS)

2 small metal containers, e.g. individual foil cake cases, empty tea light candle cases, metal screw cap lids (bottle lid)

1 sample per group of a selection of cooking oils, e.g. corn oil, groundnut (peanut) oil, almond oil, rapeseed oil, sunflower oil, sesame oil, olive oil, vegetable oil.

Candle wick (available from craft stores) or cotton string and plasticine

Thermometer

Timer

Tweezers

Data logger (optional)

Activity 6

Per group

Activity sheets 2 and 4

A range of oils and fats, e.g. maize, oil, groundnut (peanut) oil, almond oil, rapeseed oil, sunflower oil, sesame oil, olive oil, vegetable oil.

Depending on the investigative methods chosen, some of:

Ramp

Foil

Margarine tub filled with dried peas or marbles

Timer

Detergent and paper towels

3 elastic bands and force meter (1-10N scale)

Metre stick/long ruler

Activity 1 Crops for all purposes

Objectives To understand that plants are grown as crops for a number of different uses.

To be able to identify the parts of a plant and their functions.

Duration 1½ hours

Resources **Per group of 4**
1 dried sunflower plant, or other plants that produce seed oils can be used e.g. maize, rape
3-4 clear food bags
Sugar paper
Adhesive labels
A selection of photographs/ images linking crops to their end products. A suitable selection can be downloaded and printed from the teachers section of **www.plants4products.org.uk**

Advance Preparation We recommend that sunflowers are planted during the summer term (planting seeds in early May will produce mature plants by September) ready for this activity.

Note: Sunflower seeds will be found only in the matured plants. The use of dried flower heads therefore provides the best introduction to subsequent activities. See Appendix 1 for information on how to dry the heads and where to purchase pre-dried ones. The comparison of fresh and dried sunflowers using photographs or dried heads can overcome the problem of using pre-dried ones.

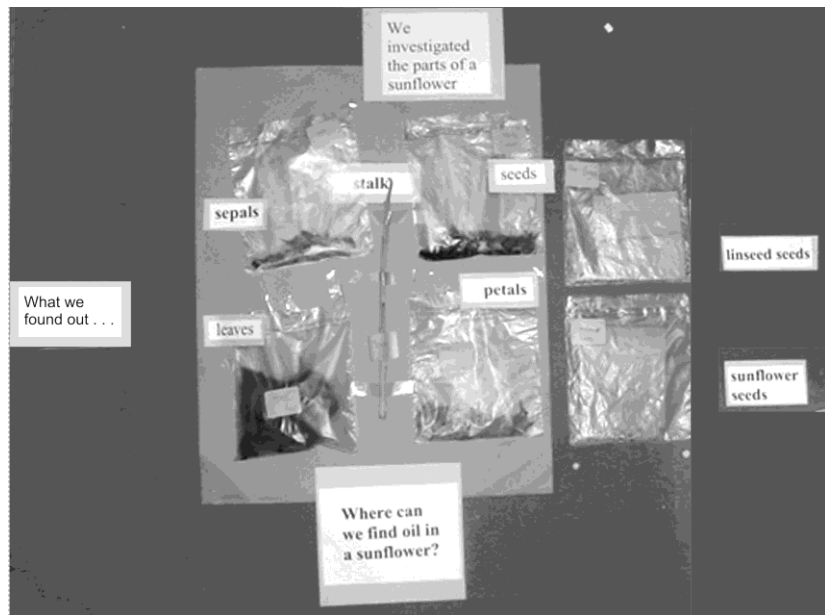
Introducing the activity Each group of four children is provided with a set of images from the website. The groups are invited to sort the pictures using criteria of their choice. Once familiar with the pictures they are asked to record links between the photographs, matching the products to the plants that produced them.

Discuss the children's sorting criteria and consider other aspects of the pictures including:

- Do the pictures show living/non-living things?
- How many of the plants can be used for food?
- How many of the plants can be used for non-food purposes?
- Do any plants produce both food and non-food products?
- How many of the products does their family use; have they seen them in the shops?

Main Activity

Each group is given a sunflower plant to observe, separate into the different parts, label and display. They can include explanations about the function of the parts, e.g. 'leaves use sunlight and water to make food for the plant to grow'. A plastic bag may be useful to collect the seeds from the dried flower, as well as other small parts of the plant. Work can be mounted by the children and displayed.



Wall display of parts of a sunflower.

Extension: Weigh the whole plant before separating. Each separate part can be weighed and the percentage of the whole can be calculated. The weight distribution of the plant can then be displayed in a bar chart or pie chart. Charts representing different specimens can be compared to see if distribution is always the same.

Plenary

Each group presents their displayed findings and explains what each part of the plant does and what the different parts of the plant could be used for.

The discussion can extend to include all the plants in the photographs, focusing on how they are used to make different products and which parts of the plants are used, e.g. the branches of the willow are used for wicker baskets, the fibres from the seed of the cotton plant are used to produce cotton thread and the sunflower produces seeds and oil.

Homework

Children can be asked to research one or more of the plants in the photographs and their non-food uses.

Activity 2 Fuel from plants

Objectives To know that dried plant material burns.
To know that burning the same mass of different plants produces different amounts of heat.
To understand that mass stays the same when materials are compressed.

Duration 2 hours

Resources **Per class**
Bowl of each: straw, hay, wood shavings/chips, sunflower stalk
1 pair safety glasses or goggles
Bag of sand/bucket of water (emergency use)
3-4 metal baking trays/roasting tins or similar
Timer
Safety lighter

Per group of 4
Activity sheet 1
Post-it note planning boards (optional, see Appendix 2)
Cup of each: straw, hay, wood shavings/chips and sunflower stalk
4 plastic drinking cups/food cans
500g and 1kg weights
Weighing scales
String
Plastic food bags
Shallow trays

Advance Preparation The plant material needs to be completely dried.

If using the post-it planning method, activity sheets in Appendix 2 can be copied and laminated – one set per group is adequate for use at each relevant stage of this activity.

You may wish to carry out the burning investigation the day after planning, to allow time for equipment suggested by the children to be collected.

As this teacher-led practical activity involves burning a range of materials, the following safety precautions must be taken:



1. Carry out the activity in the open-air (middle schools may have a fume cupboard), or liaise with the local secondary school.
2. Have a bag of sand/bucket of water close by for use as an extinguisher, if necessary.
3. The teacher should wear safety goggles and have long hair tied back.
4. Children who have asthma should have ready access to their inhalers.

Introducing the activity

Activity sheet 1 is a letter which introduces the children to a fictitious company. This letter forms the introduction to several activities in this resource.

Tell the children that today they are going to plan a test to find out which plants are best for the company to burn in their boiler. Each group discusses what being 'best' means, e.g. burns for the longest, brightest flame. Post-it planning can be used at this stage, before collating ideas on the white board. Through class discussion, the best aspects of each group's plans are combined to provide the teacher demonstration.



Example of hay burning in a controlled manner.

The children can be involved in several aspects of the practical activity, such as:

- Measuring equal amounts of plant material.
- Emptying one bag of material at a time into a metal tray ready for testing.
- Measuring and recording the duration of burning.
- Photographing and/or filming the process.
- Recording a commentary.
- Making and recording close observations, including flame types, smoke produced.

Be aware of the weather conditions so that the children are not downwind of the activity and are out of any smoke produced or any material which may get blown about.

The ash and unburned material can be collected and once cool could be put into a clear plastic bag and used for display purposes.

Extension: The amount of ash and burnt material can be weighed and compared to the weight of the plant material at the start. Discuss why there may be a difference and what has happened to the plant material during the burning, i.e. an irreversible change.

Sample burning results

Material	Observations
Hay	takes time to ignite, smoulders rather than burns, produces a lot of smoke, and does not burn out completely.
Straw	burns readily, produces little smoke, quickly burns itself out, and leaves very little ash.
Wood shavings	ignite readily, produce little smoke, burn slowly but steadily and leaves ash.
Sunflower stalk	very slow to ignite and produces smoke.

Discussion

After observing this demonstration, the children need to consider what the findings tell them. They should discuss the advantages and disadvantages of using renewable fuels and compare them to non-renewable fuels. Questions such as the following may be considered:

- What properties should the fuel heating the boiler have? (e.g. burn cleanly with no smoke, produce small amounts of ash and burn slowly.)
- Which properties would be a disadvantage?
- How do these materials compare to the most common fuels; gas, electricity, coal and oil?
- Can the waste products be used for other purposes? (e.g. ash can be used to manufacture concrete and be used as fertilizer.)

Background Information for the teacher

The most appropriate measure of energy produced in this activity would be to measure the heat produced by each plant source. To produce energy from sustainable sources the materials used as fuel need to be easily available in very large amounts. Oil, coal and gas are fossil fuels that have been created from plants over millions of years. They will be used up much more quickly than they can be replaced. Plant materials capture energy from the sun and carbon dioxide. They use up carbon dioxide and produce oxygen as they grow. This is why they are called renewable resources. Electricity can be produced using both fossil fuels and plants.

Main Activity

Each group is now given samples of the plant materials already used for the burning investigation to observe and handle. They discuss how each material would be stored and transported to the company; consider:

- Would they be easy to move?
- Are they heavy?
- What difficulties could there be in moving enough dried plant material to keep the furnace going?

The material takes up a lot of space, so would be inefficient to transport in its current state. Groups of children discuss how this could be changed, e.g. bundled up, packed in bags.

The children explore the effect of compressing the dried plant material, e.g. does it change the weight? Does it make it easier to transport? Would compressing the material make any difference to the burning and/or heat produced? Could the compressed material be used for anything else?

The following process provides one possible way to investigate the changes taking place and suggested method of collecting data:

1. Carry out the activity in shallow trays (to contain plant material).
2. Fill a plastic drinking cup with plant material.
3. Mark the level of the material and weigh the filled cup.
4. Compress the material using weights or by pushing down and mark the new level.
5. Re-weigh the cup (after removing the weights).
6. This process could be carried out once, compressing as much as possible, **or**, the level can be decreased by steps of 2cm, and weighed each time.

Extension: An explanation of density could be offered to extend the understanding of some children, as appropriate:

Density is how much mass is packed into the space taken up by an object. Something that is very heavy yet is small has a high density. When material is squashed to make it smaller, it weighs the same but becomes more dense. You may wish to link to literacy and create a class description of density.

Plenary

From observations made during the introductory activity, the children can make recommendations as to which plant material makes the best fuel for the company (based on the amount of smoke produced, burning time, etc.). Each group can also report their findings on the compression of the dried plant materials, explaining what they have found out with respect to mass and volume, and possibly density.

Focusing again on the letter, discuss the idea that reducing the volume of the biomass (plant material) will reduce the number of vehicles required to transport it. By producing briquettes, small compressed packs of material, it is easier to handle and transport and will be in a form that can be used easily when adding to the furnace.

Materials also take up less space if air can be removed from between the pieces. Get the children to compare the space taken up by wood shavings or saw dust and the same weight of twigs or small wooden blocks.

Industry also grind up solid fuel so that it can be blown into the furnace. Ask the children why this might be a good idea, (the material will ignite more quickly).

Ask the children to discuss why it may be more convenient to convert fuel to electricity and supply it through a cable rather than burn the fuels on site.

Recommendations can be reported in the form of a letter or PowerPoint presentation.

Activity 3 Oil from seeds

Objectives To identify seeds and nuts which contain oils.
To know that oils from seeds and nuts have a variety of uses.
To be able to compare the oil content of seeds and nuts.

Duration 2 hours

Resources



Be careful not to include nut oils if involving children with nut related intolerance or allergies.

Per class

Bottles of oil from a range of sources to include corn oil, groundnut (peanut) oil, almond oil, rapeseed oil, sunflower oil, sesame oil, olive oil, vegetable oil.

A range of seeds, nuts and crops to include maize, peanuts, almonds, walnuts, sunflower seeds with and without outer casing, sesame seeds, pumpkin seeds.

Per group of 4

Activity sheet 2

Samples of the different seeds and nuts from the list above.

1 rolling pin

1 sealable clear bag per seed/nut sample

1 filter paper or sugar paper square (10cm x 10cm approx) per sample

1-2 teaspoons

Bluetac or adhesive tape

Camera (optional)

Introducing the activity

Begin with a recap of previous activities with particular reference to non-renewable and renewable forms of energy.

Ask the children what is used to power most vehicles and where it comes from, i.e. products made from crude oil. Explain to the class that crude oil is found deep underground and was formed over millions of years. To access the oil, companies drill down under the earth or sea, pump it to the surface and send it by pipeline to oil refineries where it is separated into different parts and used for many different things.

The children are asked to discuss what other things oil is used for, e.g. to make plastic products, for lubrication, to burn for heat and to make electricity.

Explain to the class that all of this type of oil will be used up at some time in the future; i.e. it is not renewable.

Introduce the email from the company (Activity sheet 2). The email thanks the children for their help, as requested in the initial letter. The email goes on to ask for help with some further investigations.

The focus of this activity is on the extraction of the oils, i.e. the company wants you to find out if oil can be separated or 'extracted' from a selection of seeds and nuts and then explore and compare the oil content obtained.

Show the class the bottles of oils and ask the children to look carefully at the appearance of the oils and the labels, paying close attention to the names, photographs, pictures, ingredients and other information provided on the label. Can they now suggest which seeds the oils have been extracted from? Explain that oils that are extracted from seeds and nuts are from renewable sources.

Next, show children some examples of different seed and nut crops, and ask them to match the oils to their seeds and explain their choices.

Note: Children may suggest that vegetable oils come from a vegetable source e.g. carrot or cabbage. Explain that vegetable oil is made from a blend of seed oils including rapeseed and sunflower oils.

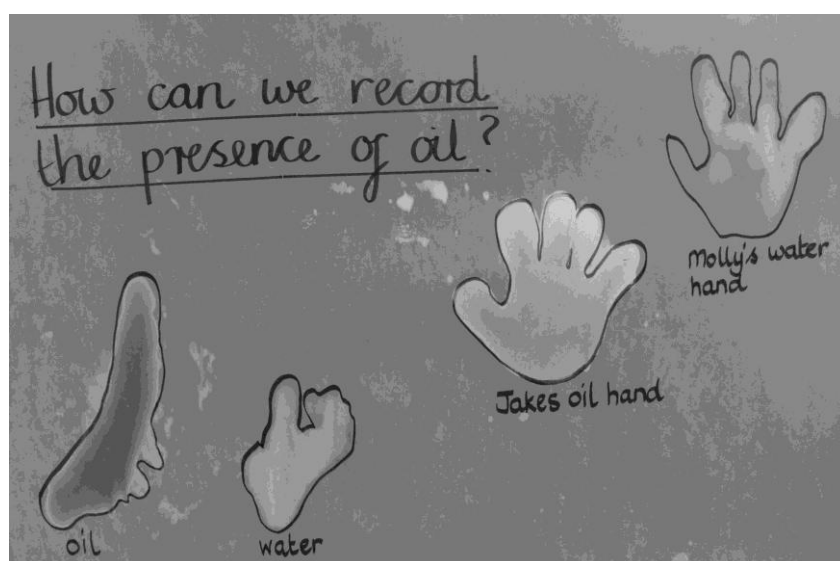
Main Activity

The children explore methods for separating or 'extracting' oil from the seeds and nuts and compare the oils obtained.

Begin by demonstrating how to show the presence of oil by smearing a small amount of vegetable oil across a piece of filter or sugar paper. The children should note that the paper is translucent when held up to the light. Smear a similar amount of water next to the oil and then display the sample on a window pane.

Ask the children what they think will happen when the paper dries. They may think that both samples will evaporate if left to dry. However, they will find that the oil can still be seen after the water evaporates.

Allow time for children to explore the translucency of other oils in comparison with water and make further window displays. Children can display and photograph oil and water hand prints on paper towels in the window.



Window display comparing oil based prints to water prints.

Ask the children how they think they can extract the oil from a seed, e.g. sesame or sunflower seed. Establish that the oil can be obtained by crushing the seed to leave an oily residue.

The children can use a wide range of resources, and request additional items. They can explore their own extraction ideas, or use those provided below if needed:

- Place a measured quantity of seeds/nuts on filter/sugar paper and crush with a rolling pin. This needs some force as larger nuts are more difficult to break down. A small plastic bag reduces the amount of mess created and collects the crushed material for display or to record results.
- Place the seeds/nuts into a mortar and crush with a pestle. Smear the crushed material onto a piece of filter/sugar paper. However, the results are not as clear as when crushed directly onto paper. Try using the mortar to crush the seed directly onto the paper.
- The seeds/nuts can be crushed in a mortar and then a small amount of water added and the mixture crushed again. The resulting mixture can then be filtered through filter paper and left to dry. Leave the paper overnight to allow remaining water to evaporate. This is a lengthy procedure.

Evidence can be displayed as oil marks beside relevant crushed and whole seeds/nuts. They could also be displayed in order of the amount of oil extracted. This makes a very effective window display.

Plenary

Children share their findings with each other and discuss the merits and the weaknesses of the various methods they have used to extract oil. Encourage the children to talk about the quantity of oil extracted in each case, as well as the difficulty or ease with which each method was carried out. Children can begin to discuss how they think industry might extract oils from seeds.

Extension: Design a machine to carry out the extraction of seed/nut oils on a large scale. How would the machine be powered? How will the oil be collected?

Background Information:

A number of fruits yield oil from their flesh and these are exploited commercially for oil production, e.g. olives and avocados. Demonstration of the oil content of fruits is much more challenging. Olives are stored in brine, and therefore can be messy and it is difficult to get clear results.

Oils are extracted commercially by using a variety of techniques including drying the seed then crushing before extracting or boiling the seeds in water and then separating the oil from the water. Some of these techniques are not suitable for the classroom.

Oilseed rape is now the third most important crop in the UK after barley and wheat. It is very useful to us because the seed contains a lot of oil which is commonly used in many food products, e.g. cooking oil and margarine. Some parts of the oil can also be used in a range of cosmetic and cleaning products too. More recently, rapeseed oil has been used in the making of biodiesel for powering motor vehicles. The seeds from the plant contain the oil. The rest of the plant can be used as biofuel.

Activity 4 Separating oil and water

Objectives To know that oil and water do not mix.
To choose appropriate equipment to carry out an activity.

Duration 1 hour

Resources



Be careful not to include nut oils if involving children with nut related intolerance or allergies.

Per group of 4

Small transparent plastic bottle (approx. 200-400 ml) containing equal amounts of water and a coloured oil, e.g. corn oil

A range of separating equipment such as:

Clean, empty, plastic sauce bottle with one way valve, e.g. shower gel, tomato sauce

Clean, empty, transparent, plastic detergent bottle

Funnel

Tubing

Flexible plastic drinking straw

Small transparent pump action dispenser bottle

Plastic cups

2-3 plastic pipettes

Syringes

Digiblu movie creator or similar software

Introducing the activity

Explain that, in industry, oil is often extracted from plants and seeds by boiling them in water after they have been crushed. Show the class a transparent plastic bottle with equal volumes of oil and water, explaining that it is similar to that produced from an industrial extraction. Ask them what will happen when you shake the container? Following the discussion, give each group their own bottle of oil and water to observe, shake, keep stationary, shake again, etc.

Main Activity

Once the children's observations have been discussed, and possibly drawn or photographed, the groups are challenged to create a 'separator' to collect both the oil and water separately.

Demonstrate that the oil can be poured off the top of the water but as the amount of oil reduces, it gets very difficult to complete the separation.

The focus of this activity is exploration, rather than planning, measuring, recording, etc. Each group is given the full selection of equipment, and given plenty of exploration time to try different methods. Possible methods include:

- Removing oil from the surface of the water with a pipette.
- Pouring the mixture into a funnel where the flow of liquid is controlled by either a finger or a blu-tac/plasticine stopper.
- Putting the mixture in a sauce bottle with a one-way valve.
- Putting the mixture into a syringe and gently emptying.
- Adding to a pump dispenser.
- Creating a unique piece of equipment.

Note: To prevent spillage of the oil and water working in shallow trays will help contain the liquids.

Plenary

Each group demonstrates their preferred method to the rest of the class, and explain what makes it superior to the other methods they have tried. Each group could video-record their demonstration to play to the rest of the class.

Activity 5 Oil as a fuel

Objectives To understand that cooking oils can also be used as fuels.
To be able to use a thermometer to take accurate readings.
To be able to carry out an investigation and be aware of controlling risks.

Duration 1½ hour

Resources *Per class*
Safety lighter

Per group of 4
Activity sheets 2-3
Tidy tray containing sand
Heating stand (available from TTS)
2 small metal containers e.g. individual foil cake cases, empty tea light candle cases, metal screw cap lids (bottle lid)
1 sample per group of a selection of cooking oils e.g. corn oil, groundnut (peanut) oil, almond oil, rapeseed oil, sunflower oil, sesame oil, olive oil, vegetable oil.
Candle wick (available from craft stores) or cotton string and plasticine
Thermometer
Timer
Tweezers
Data logger (optional)

Introducing the activity Read the email from the company (Activity sheet 2). With ideas from the class, create a list of examples of oils being used as fuels, e.g. heating our homes, schools and offices, fuel for transport etc, energy for industrial sites and steel making.

Main Activity



Be aware of naked flames and hot oil. An adult must move any samples of heated oil at the end of the test.

The planning and design of this investigation has been provided, due to the health and safety aspects that need to be considered. The children can discuss the elements of fair testing, controlling variables, what to change, and what to measure. The development of children's measurement skills provides the investigative focus. Activity sheet 3 provides a table for them to record their results if required.

Each group collects their equipment to test one of the oil samples, and carries out the test, setting up the equipment as shown in the photograph:



Photograph showing an oil burner heating water on a heating stand. The sand tray provides a safe area for this kind of activity.

Note: To establish whether the oil is needed to keep the flame alight, a small piece of wick can be lit in the foil tray before adding the oil. The wick could also be placed in a non-flammable liquid (water) to show that the flame does not then stay alight.

The following is an example of how to carry out the activity.

1. Place a wick in the metal container and secure it with plasticine. Add a measured amount of oil to the container. Make sure the plasticine is below the oil's surface.
2. Fill a second metal container with a measured amount of water and place it on top of the heating stand. Measure the temperature of the water and record it.
Light the wick in the lower container and start the timer.
Note: If the wick has fallen into the oil, use tweezers to hold up a section prior to lighting.
3. After a set period of time (typically 5 minutes), record the temperature of the water and compare it to the start temperature to find the difference.
4. Extinguish the oil burner and leave it to cool before clearing away.

Extension: The temperature can be taken at regular intervals over a specific time period. The data can then be used to produce a graph illustrating the rise in temperature for each oil. Alternatively a data logger with a heat sensor probe can be used to produce a graph illustrating the increase in temperature.

Plenary

All the groups' data are collated and compared. The children suggest which oil would be the best to use as a fuel and why (the maximum temperature change per unit mass of water). Some discussion of where the crop is grown, the necessary energy investment and how much the crop costs to produce can be introduced here. An email can be created, with attachments showing the experimental design and resulting tables/graphs. A willing governor or other adult may be prepared to receive the data and respond.

Background Information

The best application for each type of oil depends on its properties. For example an ideal lubricant would not burn and would be involatile whereas a fuel oil would burn easily and be volatile.

Oils also have different freezing/melting points which can make them difficult to use in certain circumstances. Palm oil, grown in tropical climates, can be solid at room temperature in Britain which means it could be difficult to use during our winter. Oils from other crops may have similar properties but have a lower freezing point. A table of softening (melting) and boiling points can be found in Appendix 3.

Diesel oil used in vehicles was once susceptible to freezing in winter months. In some cold climates fuel tanks have an independent heating system to warm fuel. Improved refining methods have been able to remove more impurities from the oil lowering the freezing temperature. The impurities were fractions of oil that became solid at temperatures just below 0°C.

Activity 6

Oil as a lubricant

Objectives

To be able to plan and carry out an investigation to compare lubricants.
To be able to draw conclusions from data collected.

Duration

1 hour

Resources

Per group

Activity sheets 2 and 4

A range of oils and fats, e.g. corn oil, groundnut (peanut) oil, almond oil, rapeseed oil, sunflower oil, sesame oil, olive oil, vegetable oil.

Depending on the investigative methods chosen, some of:

Ramp

Foil

Margarine tub filled with dried peas or marbles

Timer

Detergent and paper towels

3 Elastic bands and force meter (1-10N scale)

Metre stick/long ruler



Be careful not to include nut oils if involving children with nut related intolerance or allergies.

Introducing the activity

Reread the e-mail from the company (Activity sheet 2).

Ask the class “What is a lubricant?”. Discuss occasions when they have used oil as lubricants, or seen others using them, e.g. oiling a squeaky hinge, oiling a bicycle chain, etc. What does the oil do in each of these examples? Children’s understanding of lubricants may be expressed in terms of reducing noise, rubbing, grinding, and friction. You may wish to link to literacy and create a class description of lubricant, e.g. “A type of liquid that is spread over two touching surfaces to help them move freely over each other and therefore reduce the friction.”

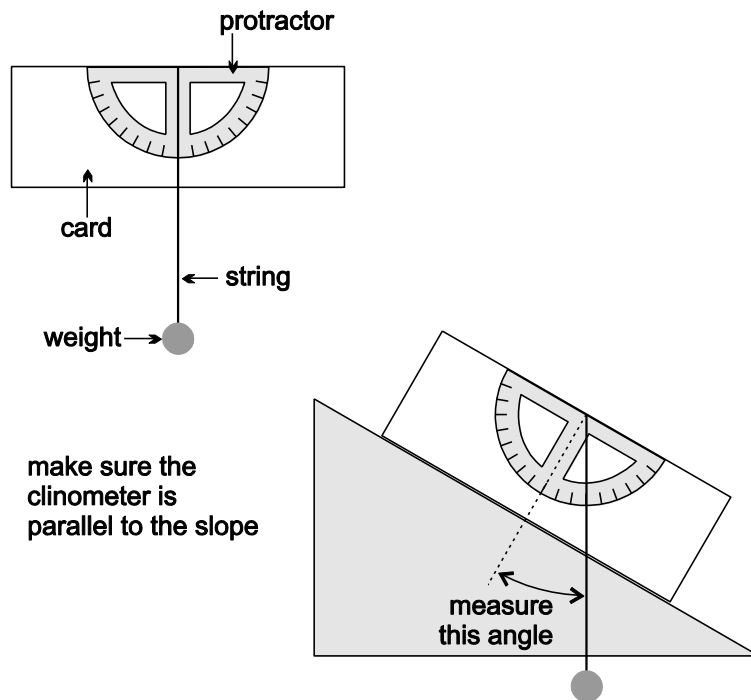
Main Activity

The children can design an investigation to find the best lubricant, or use one of the methods below, depending on the investigative focus of the lesson.

Method One

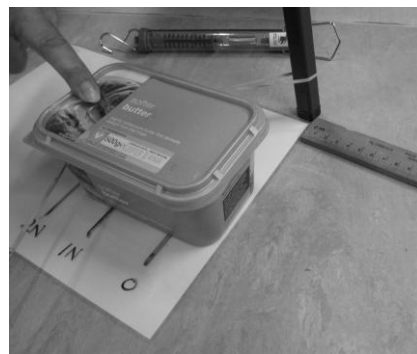
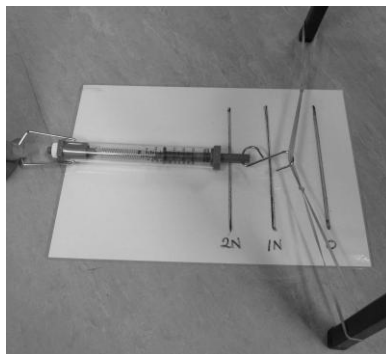
1. Cover a board with foil or use a non-stick baking tray and smear with oil.
2. Fill a margarine tub with the marbles or dried peas to add weight.
3. Smear the base of the margarine tub with the same oil.
4. Place the margarine tub on the end of the board and slowly lift until the tub starts to slide.
5. Either measure the height of the end of the board or the angle that the board makes with the floor when the tub starts to slide. Take repeat readings and calculate an average for each oil under test.
6. Clean and dry the base of the tub and the foil thoroughly before testing the next oil.
7. Tabulate results (Activity sheet 4) and represent them graphically to report back to the company.

Extension: Children make a clinometer to measure the angle.



Method Two

Using an elastic band launcher along the board or across a table. The force can be controlled by making a scale for the launcher using a force meter, and marking lines for each 1 or 2N. The tub is then pulled back a designated force each time.



Method Three

Use a ramp at a set angle and measure the time taken for the tub to travel a fixed distance down the ramp.

Plenary

The class share the results and conclusions they have drawn from the investigation. Discuss which of the oils would be the best lubricant for the machinery and why. What are the advantages and disadvantages of using vegetable oils or petrochemical oils, e.g. vegetable oils come from a sustainable source and decompose more easily but may smell strongly. Petrochemical oils are a finite resource which are being used faster than they can be made, they have to be processed and refined before they can be used, and they decompose more slowly.

This is also an opportunity to evaluate the success of the different investigative methods.

Extension: Children can investigate the effect of heat on a lubricant (the viscosity of the oil will change). Does this make a difference to the efficiency of the lubricant?

Activity 7 Focus on vocabulary

Objectives To understand vocabulary to support scientific learning.

Introduction The following activities can be used as stand alone activities, as lesson starters or be used as part of any of the activities in this resource. It is important to identify vocabulary to be used during the activities and to make sure that children are familiar with the words and can use them in the correct context.

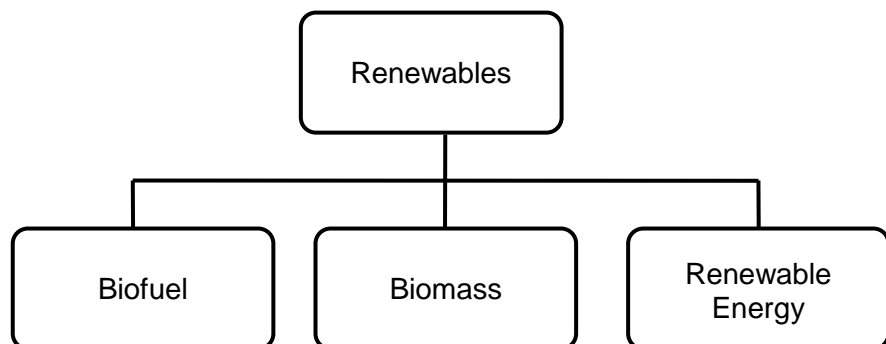
The children need to be aware that some scientific words have everyday meanings as well as scientific meanings. Reinforcement of these terms is important to ensure correct usage.

There are many different ways to develop literacy in science: the ideas below are suggestions and are not the only strategies that can be used. You may be able to think of many more providing the children with a varied and stimulating experience.

Word banks displays, and mobiles

Creating word banks and displays around the classroom will increase the correct use of vocabulary. By reminding the children to use the targeted words during investigations, the vocabulary will be reinforced.

Word mobiles can be produced in ways which will create links with their meanings and associated words. The words cascade from the topic down through related areas to possible vocabulary.



Illustrated words Ask the children to find ways of illustrating words that demonstrates their meaning, e.g.



Word shirts



The children bring a plain white shirt to school at the start of the year. They choose an area of the shirt, e.g. right front or a sleeve, to group words relating to a specific topic and they are written on the shirt in permanent ink. The shirts are worn for science practical work. The children are allowed to add a word to their shirts when they can demonstrate to the teacher that they understand what the word means. By the end of the year, each shirt should be a colourful array of scientific vocabulary!

Splat

This is a game to identify word meanings. Each group has a number of words each written on post-it notes. Around the classroom are posters containing the definitions. At a signal one member of each group takes a word and 'splats' it on the definition poster. The group can agree on the definition before the group member leaves. Each child takes it in turn to 'splat' the word. The winning team will have posted all their words the quickest.

'Taboo'

A group of children are given a set of cards which are placed face down in the middle of the group. Each child takes it in turn to take the top card. On each card there is a word which the child has to describe to the rest of the group. There are also 'taboo' words indicated on the card which cannot be used in the description. The rest of the group have to guess the word from the description.

Definition dominoes

A set of cards, which are similar to a set of dominoes, are used in this game. On one end of the card there is a description of a word whilst on the other end is a word. The children have to match up the words and meanings by placing them down on the table, matching the cards until all the cards have been put down.

Loop card game

This is a similar idea to definition dominoes. In this game, all the descriptions and words follow on from each other so they form a loop. Although the cards follow a specific order, the loop can be started anywhere. The first child reads out the definition, the child who has the word described on their card calls it out and then reads out the definition for the next word. When the game is first introduced the children can link the words to their meanings at their own pace. Once the group is accustomed to playing the game, it could be timed. The group could be given a specific time to complete or could try to beat their previous time. See Appendix 4 for a set of cards to be used for this game.

Spinner game	A spinner is used to choose a strategy to describe a word chosen from the word bank. This strategy is then used by one child while the other children try to identify the word. See Appendix 5 for an example of a spinner. Alternatively a die can be made using the different strategies on the different faces.
Connect 4	This is a game for two players or two groups. The children start by drawing a grid on a white board; this can be either a 4x4 or a 5x5 grid. The children suggest a word from the scientific vocabulary they have been using in their work and if they can correctly explain the meaning they can write it into one of the grid squares. Two colours are used so the two sides can identify their own words. The aim of the game is to connect 4 words together in a row, column or diagonal. Grids and word cards could be made up ready for the children to use if there is certain vocabulary the teacher wants to cover. The words and meanings contained in Appendix 4 could be used for this activity.
Word completion exercises	This includes activities such as crosswords and word searches. There are many software packages available to produce these.
Science dictionary	Once the children can confidently use a set of vocabulary, they can include it in their own science dictionary. A blank exercise book is divided into letters of the alphabet, e.g. 2-3 pages for 'A' and 1 page for 'XYZ'. When a child is confident of a word's meaning, he/she adds the word along with its definition, examples of use, and illustrations. This dictionary can then be used to identify areas which have been learned and understood.



Persind Products
Holme Lane
Greenton

Dear Science Consultants

Our company makes ingredients used in many different products, ranging from soap and body wash to kitchen cleaners. We want to ensure our products do as little damage to the environment as possible and would like your help with this matter.

We were wondering if we could burn dried plants instead of petroleum oil in our boiler to produce steam for heating and making electricity for use on our site.

Things we think we could burn, available from local companies, include straw, hay, wood shavings and sunflower stalks, but we are not sure which one would be best to use.

The oil we currently use is delivered to us by pipeline with little or no disruption. We are worried that we would need very large quantities of plant material and we don't have enough room to store it on site.

Also we would need many lorries every day to bring the plant materials on to our site. This will be very expensive and result in a lot of extra traffic on the roads.

We would like you to carry out some tests and provide us with evidence to help us make some difficult decisions. Any additional research you can do would also be gratefully received.

Yours faithfully

Susan Carlton
Environmental Manager

From: Susan Carlton [scarlton@persind.com]
Sent: 28 April 13:34
To: Science Consultants
Subject: Renewables

Dear Science Consultants,

Thank you for the information you have sent us so far. We have already started to make some important changes on site.

We are now thinking of other ways to make our company more environmentally friendly and we thought we might be able to use seed or nut oil as one of the ingredients in our products, rather than oils made from crude oil.

As we have no experience in extracting oil from seeds and nuts, we hoped you could investigate this process on our behalf and tell us how much oil different seeds and nuts produce.

We have also been told that we may be able to use any excess seed or nut oil in other ways that you may be able to investigate; could we

- burn any excess oil we make but don't use in our products?
- lubricate machines with seed or nut oil instead of using refined crude oil?

We look forward to hearing from you with your recommendations.

Kind Regards,

Susan Carlton
Environmental Manager

Oil as a Fuel

Oil type	Temperature at the start (°C)	Temperature after minutes (°C)	Comments

Oil as a Lubricant

Oil type	Height at which box starts to move (cm)	Time taken to move down the ramp (mins)																		
No oil																				

Sourcing dried sunflowers

Dried sunflower head bird feeders can be purchased from some garden centres or via the internet from sites such as www.franceshilarly.com

Drying Sunflowers

Outlined below are two different ways to dry sunflowers. Harvest the sunflowers when their heads become brown and dry and most of the leaves have fallen off the stem (the plant will look wilted).

Method 1 – In the garden



The first method is to dry the head and the stem naturally. When the back of the flower's head turns yellow and the petals have fallen off, cover it with a brown paper bag. This prevents the seeds falling to the ground and it will also protect it from birds, squirrels and other animals. The bag allows the plant to 'breathe' and prevents moisture from building up which could cause the seeds to become mouldy. If it rains and the bag becomes soggy, it may need replacing. If just the flower head is needed it can be removed from the

plant once the head has turned brown about 30cm down the stem, making sure the bag does not fall off in the process. If the whole plant is required, the plant can be removed from the garden at this stage and stored somewhere dry.

Method 2 – Drying indoors



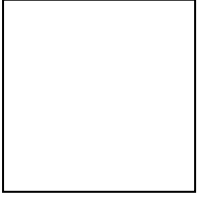
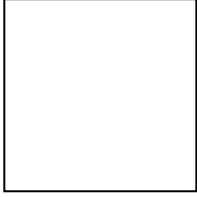
The sunflower head can be dried away from the plant if there is a strong risk of losing the seeds to wildlife. When the flower head starts to yellow and the petals have died away, harvest the head approximately 30cm down the stem. The head can be dried in any location which is warm, dry and has good ventilation to prevent the seed head becoming mouldy. As with the natural method, a brown bag can be placed over the seed head to prevent losing any seeds, and will protect against wildlife attack.

Further information regarding sunflowers can be obtained from www.sunflowerguide.com

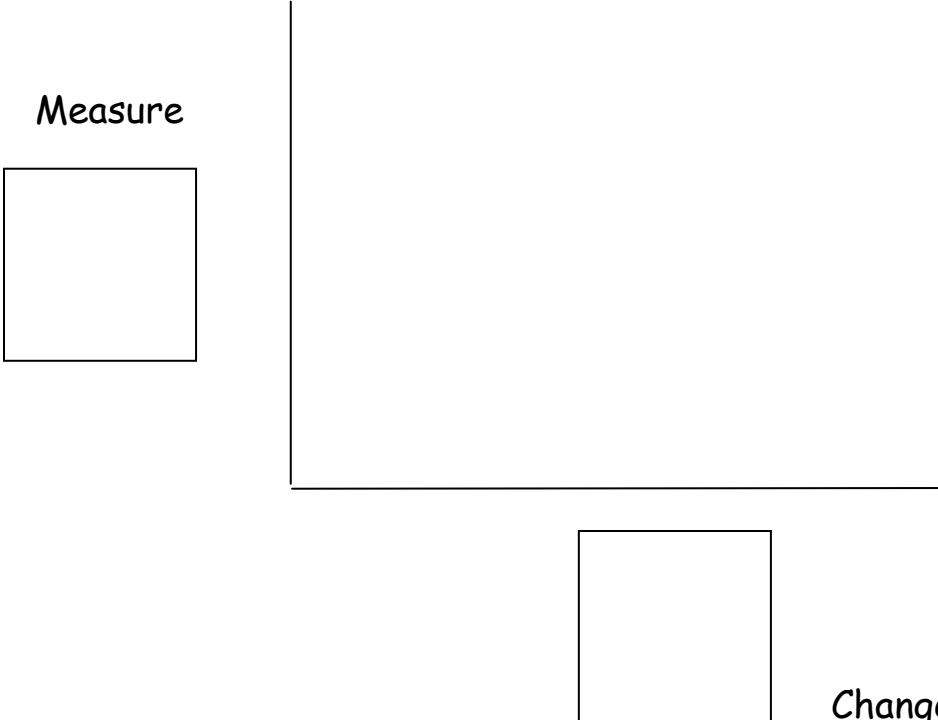
Planning

We are investigating.....	
<p style="text-align: center;">We could change</p> <div style="display: flex; justify-content: space-around;"> <div style="border: 1px solid black; width: 40px; height: 60px; margin: 5px;"></div> <div style="border: 1px solid black; width: 40px; height: 60px; margin: 5px;"></div> <div style="border: 1px solid black; width: 40px; height: 60px; margin: 5px;"></div> </div> <div style="display: flex; justify-content: space-around; margin-top: 10px;"> <div style="border: 1px solid black; width: 40px; height: 60px; margin: 5px;"></div> <div style="border: 1px solid black; width: 40px; height: 60px; margin: 5px;"></div> <div style="border: 1px solid black; width: 40px; height: 60px; margin: 5px;"></div> </div>	<p style="text-align: center;">We could measure/observe</p> <div style="display: flex; justify-content: space-around;"> <div style="border: 1px solid black; width: 40px; height: 60px; margin: 5px;"></div> <div style="border: 1px solid black; width: 40px; height: 60px; margin: 5px;"></div> <div style="border: 1px solid black; width: 40px; height: 60px; margin: 5px;"></div> </div> <div style="display: flex; justify-content: space-around; margin-top: 10px;"> <div style="border: 1px solid black; width: 40px; height: 60px; margin: 5px;"></div> <div style="border: 1px solid black; width: 40px; height: 60px; margin: 5px;"></div> <div style="border: 1px solid black; width: 40px; height: 60px; margin: 5px;"></div> </div>
<p style="text-align: center;">We will change</p> <div style="text-align: center; margin-top: 10px;"> <div style="border: 1px solid black; width: 60px; height: 60px;"></div> </div>	<p style="text-align: center;">We will measure/observe</p> <div style="text-align: center; margin-top: 10px;"> <div style="border: 1px solid black; width: 60px; height: 60px;"></div> </div>
Our investigation question is.....	
<p style="text-align: center;">We will keep these the same...</p> <div style="display: flex; justify-content: space-around; margin-top: 10px;"> <div style="border: 1px solid black; width: 40px; height: 60px; margin: 5px;"></div> <div style="border: 1px solid black; width: 40px; height: 60px; margin: 5px;"></div> <div style="border: 1px solid black; width: 40px; height: 60px; margin: 5px;"></div> <div style="border: 1px solid black; width: 40px; height: 60px; margin: 5px;"></div> <div style="border: 1px solid black; width: 40px; height: 60px; margin: 5px;"></div> <div style="border: 1px solid black; width: 40px; height: 60px; margin: 5px;"></div> </div>	
<p style="text-align: center;">When we change</p> <div style="text-align: center; margin-top: 10px;"> <div style="border: 1px solid black; width: 60px; height: 60px;"></div> </div>	<p style="text-align: center;">What will happen to . . . ?</p> <div style="text-align: center; margin-top: 10px;"> <div style="border: 1px solid black; width: 60px; height: 60px;"></div> </div>
Why?	

Obtaining evidence

<i>Change</i> 	<i>Measure/observe</i> 

Considering evidence and evaluating

<p>Measure</p>  <p>Change</p>	
<p>When we changed . . .</p>	<p>What happened to . . .</p>
<p>Was our prediction correct?</p> <p>How could we improve what we did?</p>	

The effect of temperature change on oils and fats

The following table lists the softening (melting) and boiling points for commonly used oils and fats. It is not a definitive list and there may be slight variances depending on the purity of the oil. Because of the impurities, the change to a liquid takes place over a temperature range when the solid will soften.

Oil	Softening (melting) point °C	Boiling point °C
Linseed (Flax seed)	-24	316
Olive	-6	191
Peanut	3	227
Rapeseed	-10	200
Sunflower	-17	230
Palm Kernel	24	350
Palm	35	n/a
Grapeseed	10	230
Coconut	25	177
Hempseed	-8	166
Corn	-20	246
Sesame	-6	216
Lard	33	n/a
Butter	35	n/a

Palm oil, lard and butter do not have a specific boiling point. These fats are likely to break down before they change to a gas state. Oils and fats are the same chemical composition but they are described as fats when solid at room temperature.

Game cards for dominoes and loop game

Organic material
which can be used
to produce energy.

Liquid

A state of matter.
It can be poured and
take on the shape of
the container.

Evaporation

The process of
change from a
liquid into a gas.

Melting

The process of changing a solid to a liquid.

Biofuels

A source of fuels which comes from plants or animals.

Fuel

A source of energy, e.g. wood, gas, coal.

Volume

The space
taken up by a
substance.

Burning

To be in flames, a
change that is
irreversible which
involves fuel,
oxygen and a flame.

Heating

The process of
increasing the
temperature of
an object.

**Reversible
change**

A change that can be easily reversed e.g. freezing water to make ice.

Irreversible change

A change that cannot easily be reversed e.g. burning.

Renewable energy

A source of energy that does not involve the burning of fossil fuels and won't run out.

Weight

The downward force on an object caused by gravity.

Friction

A force affecting movement between two materials.

Lubrication

The method to reduce the friction between two surfaces.

Filtration

The process of separating a solid from a liquid.

Biomass

Game card solutions and glossary

Organic material which can be used to produce energy.	Biomass
A state of matter. It can be poured and take on the shape of the container.	Liquid
The process of change from a liquid into a gas.	Evaporation
The process of changing a solid to a liquid.	Melting
A source of fuels which comes from plants or animals.	Biofuels
A source of energy, e.g. wood, gas, coal.	Fuel
The space taken up by a substance.	Volume
To be in flames, a change that is irreversible which involves fuel, oxygen and a flame.	Burning
The process of increasing the temperature of an object.	Heating
A change that can be easily reversed e.g. freezing water to make ice.	Reversible change
A change that cannot easily be reversed e.g. burning.	Irreversible changes
A source of energy that does not involve the burning of fossil fuels and won't run out.	Renewable energy
The downward force on an object caused by gravity.	Weight
A force affecting movement between two materials.	Friction
The method to reduce the friction between two surfaces.	Lubrication
The process of separating a solid from a liquid.	Filtration

Spinner

Cut out the spinner and paste on to a piece of card.

Place a paper clip to the centre of spinner.

Put the point of a pencil in the middle of the spinner through the paper clip.

Spin the paper clip round.

Where the paper clip stops indicates how the word should be represented.

