2. Fuel from plants

2 hours

Children observe how well different materials burn and if they can be compressed for transporting.

OBJECTIVES

- Explain that some changes result in the formation of new materials, and that this kind of change is not usually reversible, including changes associated with burning and the action of acid on bicarbonate of soda (Y5 Properties and changes of materials)
- Reporting and presenting findings from enquiries, including conclusions, causal relationships and explanations of and a degree of trust in results, in oral and written forms such as displays and other presentations

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.

Safety note

Ensure all bags have ventilation holes.

Children must not hold the bag during the test, to prevent a full bag falling on their feet.

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.

Appendix 2: Planning

We are investigating.....

We could change

We could measure/observe

We will change

We will measure/observe

Our investigation question is.....

We will keep these the same...

When we change

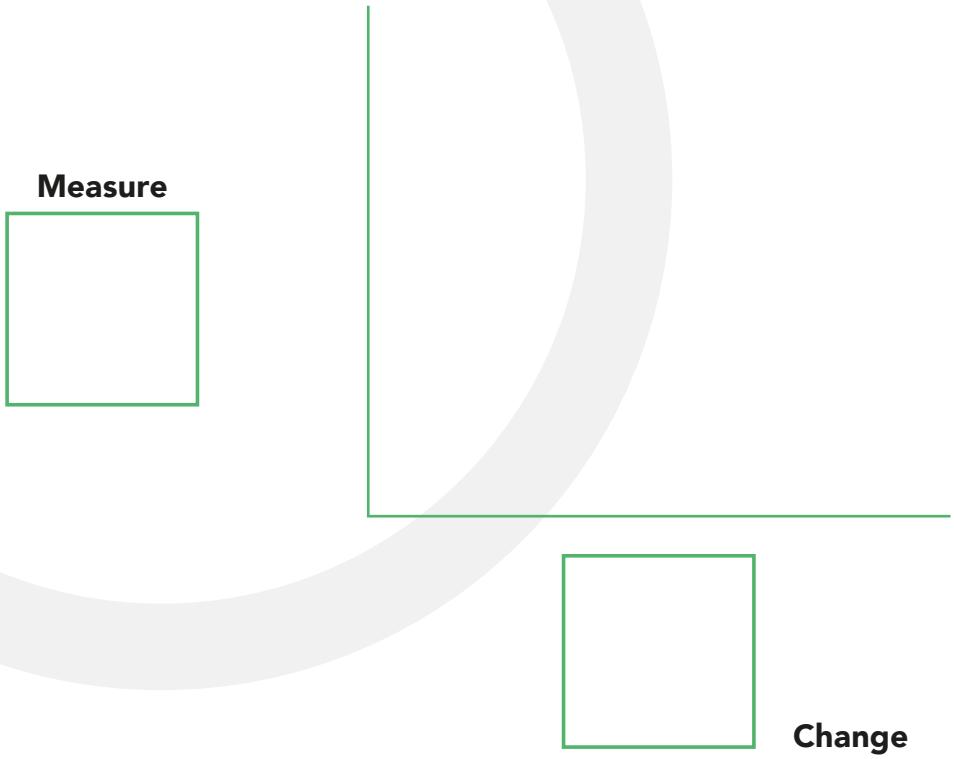
What will happen to...?

Why?

APPENDIX 2: OBTAINING EVIDENCE

Change	Measure/observe
	

APPENDIX 2: CONSIDERING EVIDENCE AND EVALUATING



When we changed . . .	What happened to . . .

Was our prediction correct?

How could we improve what we did?