Power House Maths Follow up Activity Teacher notes

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Power House

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Introduction

This is an extension activity to the Power House workshop. It allows pupils to explore different ways of generating energy for private homes. This activity has a strong focus on maths and numeracy, encouraging pupils to calculate the costs of different energy projects and work with budgets.
You can download the related PowerPoint presentation to assist you in delivering these sessions.

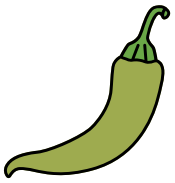
Contents

Chilli challenge model

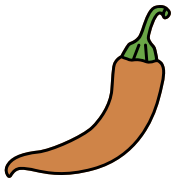
The activities use the 'chilli challenge' model, which includes scales of mild, hot, and flaming hot. This gives pupils a choice over their learning and in how much they want to challenge themselves.

All the activities are progressive with each problem building on the previous with almost all having a 'mild' and 'hot' variation meaning that pupils working at a higher level can tackle more challenging problems (although it usually requires them to complete the mild problem first and then build on this). The problems also get progressively harder so teachers can choose to end the activity wherever feels most appropriate for their class. The final challenge is more suitable for pupils working at the upper end of Second Level. PowerPoint slides are provided for each activity.

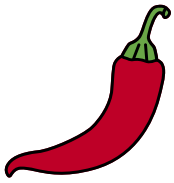
Note about figures
Please note, all figures used throughout this booklet are to demonstrate the premise of energy generation and useage, rather than being factually accurate. For more information about up to date energy statistics from across Scotland, visit the Scottish Government website and search for 'Energy'.



Mild



Hot



Flaming hot

1. Powering your house

In the workshop, your pupils calculated the best way to power their *LEGO®* house using wind turbines and solar panels. We provided this information:

- A house needs 60kW of energy per day.
- A solar panel provides 5kW of energy per day.
- A small wind turbine provides 15kW of energy per day.

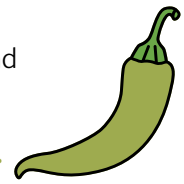
Teacher tips:
kW stands for kilowatts (1000 watts). This is the unit used to measure how much power can be used or generated by an appliance.
Note, for this challenge, they are calculating per day energy generation. Later challenges are per year.

Teacher tips:
If you would like to make a model *LEGO®* back in class, we usually ask pupils to build 20cm x 15cm and 8 layers high. Note, this may change on a workshop where we have less time.

In this resource, you will instead be using the following figures:

- A house uses between 50-70kW of energy per day.
- A solar panel provides 6kW of energy per day.
- A small wind turbine provides 14kW of energy per day.

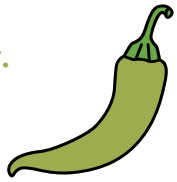
MILD ACTIVITY:
This activity is the basis for all other activities in this booklet. We recommend all pupils do this activity and keep the results to use in other activities.



Houses need different amounts of energy throughout the year. Can you plan a project that uses between 50-70kW per day?

Discussion points
Why would there be this range in what is needed?
Can pupils find out what times of year/day energy use peaks in their own houses/school?

MILD ACTIVITY:
On average throughout the year, a house needs 60kW per day. Is your project making at least 60kW? If so, how many extra kWs a day is your energy project making?



Discussion points
Some projects may be making less than 60kW per day. What could they do on days when they need more energy?
What times of year might you need more energy?

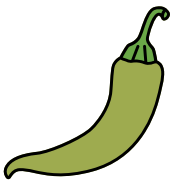
Teacher tips:
For more information, visit **www.renewableenergyhub.co.uk/**

2. How much does it cost?

When deciding how to power your house, the amount of power is not the only consideration. Wind turbines are a lot more expensive than solar panels. The figures we'll use for our activities are:

- Solar panel = £6,000.
- Wind turbine = £20,000.

MILD ACTIVITY:
Can you calculate the cost of your energy project?



Discussion points

Who made the cheapest energy project?

Did any groups calculate the same amount of energy at different prices?

If not, do you think this is possible?

HOT ACTIVITY:
What is the cheapest way to generate at least 60kW of energy?

Solution

10 solar panels = 60kW = £60,000.

Discussion points

Is this the best way to power your house?
Example answer: Using only solar panels means you are relying on one source of power. In the summer in Scotland we have long days but in the winter, you might not generate enough energy. It will also result in all your energy being generated during the day whereas most is used at night for heat and light. You would therefore need to store energy in batteries.

Is there another cost-effective way if your house was somewhere reliably windy (e.g. on top of a hill)?

Teacher tips:
If you want to show this variation based on real weather data the Met Office has graphs showing sunshine or windspeeds for your area. **www.metoffice.gov.uk**

3. The National Grid

If you generate more electricity than you need it can be sold back to the National Grid (the network of cables that connect homes to power stations all over the country) so that other houses can use it.

If you generate the equivalent of at least 1kW extra per day over a year, you can earn £500 a year by selling it back to the National Grid.

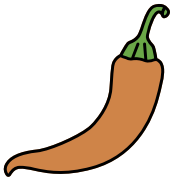
MILD ACTIVITY:
Calculate how much money you could make per year from your first project in Section 1. Powering your house activity at the start of this resource.

Pupils can calculate this by taking the number of extra kW they generated per day, using 60kW as the average, multiplying it by £500.

If pupils generated less than 60kW per day, ask them to add an additional solar panels or wind turbine to allow them to generate more energy.

Teacher tips:
The feed in tariffs change all the time and are different for how you generate your energy so this number is an estimate. For more information **www.ofgem.gov.uk**

HOT ACTIVITY:
How many years would it take you to earn back the full cost of your energy project?



Pupils should have calculated the full cost in the mild activity of Section 2. How much does it cost?

You calculate this by dividing the full cost of the system by the yearly earnings calculated above.

Reminder: Solar panel = £6,000

Wind turbine = £20,000

Discussion points
Is this the total cost of the system? Example answer: Over time you will also pay for electricity and any cleaning/maintenance costs.

4. Insulation and energy efficiency

There is one more way to save money and that is by saving energy in the first place. You can do this through insulating your house (preventing the heat escaping) or by getting appliances (like fridges and kettles) which are energy efficient (use the least amount of energy possible).

Insulation cost: £3000 saves 9kW per day.

Energy efficient appliances cost: £1000 saves 5kW per day.

MILD ACTIVITY:
If you added insulation and energy saving appliances to your energy project how many kWs of power would you still need to produce?

Solution

On average, a house needs 60kW of power a day. Insulation saves 9kW per day and energy efficient appliances save 5kW each day. So, 60kW – 9kW – 5kW = 46kW. This house would need 46kW of power per day.

What combination of wind turbines and solar panels would you use to generate this amount of energy?

Solution

To generate exactly 46kW of energy per day:

- *2 x wind turbines at 14kW each = 28kW.*
- *3 x solar panels at 6kW each = 18kW.*
- *28 + 18 = 46kW.*

Pupils may have many different options which calculate slightly more energy than required.

Discussion points

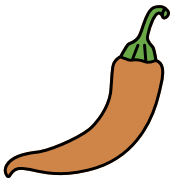
What other ways can we reduce the amount of energy we use?

Think about both in school and at home?

When would your house use the most energy?

Could this be a problem for your energy project?
(eg. Only using solar panels but need energy at night).

HOT ACTIVITY:
How much would it cost to build your energy project including insulation and energy efficient appliances?



Wind turbines cost £20,000 and solar panels cost £6,000.
Insulation costs £3,000, energy efficient appliances cost, £1,000.

For the above example:

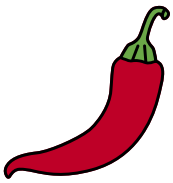
- *2 x wind turbines: £40,000*
- *3 x solar panels; £18,000*
- *£3000 + £1000 (for insulation and energy efficient appliances) = £62,000.*

Discussion points

Did anyone find a cheaper method?

Did anyone's cost more than their original project before energy saving?

FLAMING HOT ACTIVITY:
You have £86,000 to spend. You have space in your house for a maximum of 8 solar panels and a maximum of 4 wind turbines. How much money could you make per year? (you can sell energy at £500 per year per kW).



Pupils can add to their above project or start completely from scratch. You can decide how complex you make the activity by adding in as many or as few of the elements we've included throughout this booklet.

Reminder of figures

- *1 wind turbine = 14kW per day = £20,000*
- *1 solar panel = 6kW per day = £6,000*
- *Insulation costs: £3,000 saves 9kW per day.*
- *Energy efficient appliances cost: £1,000 saves 5kW per day.*

Solutions

Starting with the energy project we used in this booklet:

- *2 x wind turbines: £40,000.*
- *3 x solar panels; £18,000.*
- *£3000 + £1000 (for insulation and energy efficient appliances = £62,000*

With the remaining £24,000, we could purchase two options:

A)
- *1 wind turbine = £20,000, which would give us 14kW a day over and above what we need.*
- *14kW x £500 = £7,000.*
- *This could therefore make us £7,000 per year.*

B)
- *4 x solar panels = £24,000. Then 4 x 6kW = 24kW per day over and above what we need.*
- *24 x £500 = £12,000.*
- *This could therefore make us £12,000 per year.*

Discussion points

Which group made the most money?

Were there any advantages or disadvantages of their energy project?

Who do you think would need to do calculations like this for their job? (architect, town planner, building manager, hotel owners, electricity companies, etc).

What would you need to think about when positioning your solar panels and wind turbines?

Teacher tips:
To find out more about National Museums Scotland's collections and activities related to renewable energy visit **nms.ac.uk**

Notes

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