

**Power House**

**Maths Follow up Activity**

**Teacher notes**

**Introduction**

This is an extension activity to follow up the Power House workshop. It allows pupils to explore different ways of generating electricity for private homes and the advantages and disadvantages of solar and wind power. This activity has a strong focus on maths and numeracy encouraging pupils to calculate the costs of different energy projects and work with budgets.

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**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. We have created different activities for Primary 4-5 and 6-7 pupils.

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 feel most appropriate for their class. The final challenge is more suitable for pupils working at the upper end of Second Level.

**Primary 4-5 Version**

Powering your house

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

A house needs 50 kW of electricity each day.

A solar panel will give around 5 kW of electricity per day.

A small wind turbine gives us 15 kW of electricity.

*If you didn’t record, or can’t remember, pupil energy projects then you can get pupils to recalculate this.*

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.

Powering your house (the exact amount)

Teacher Tips:

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

There is a way to generate exactly 50kW

Can you work it out?

**ACTIVITY:** pupils try and work it out.

*1 wind turbine at 15kW = 15*

*7 solar panels at 5kW= 35*

*Total= 50kW*

***There are many other ways to get 50kW of energy***

How much does it cost?

The amount of power is not the only consideration. Wind turbines are a lot more expensive than solar panels

Solar panel = £5,000

Wind turbine= £20,000

So, the above 50kW energy project above would cost £55,000.

Teacher tips:

For more information, visit <https://www.renewableenergyhub.co.uk/>

**MILD ACTIVITY:** Get each group to calculate the cost of their own 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?*

*Did anyone generate more electricity than they needed?*

**HOT Activity:** What is the cheapest way to generate at least 50kW of energy?

*10 solar panels = 50kW = £50,000*

***Discussion points***

*Why would this not be the best way to power your house? (using only solar panels means you are relying only on one source of power in the summer in Scotland this would probably be fine because we have long days but in the winter, you might not generate enough electricity. It will also result in all your electricity being generated during the day whereas most is used at night for heat and light. So, you would need to store energy in batteries.)*

Teacher Tips

If you want to show this variation based on real weather data, the Met Office has great graphs showing sunshine or windspeeds for your area. <https://www.metoffice.gov.uk/public/weather/climate/gcvw5vmsn>

How much does it cost? (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 1kW extra per day over a year, you can earn £500 by selling it back to the national grid.

**MILD ACTIVITY:** Get pupils to calculate how much money they could make per year from their original energy project.

You calculate this by taking the number of extra kW they generated and multiplying it by £500. So, if you generated 55kW of electricity (with 11 solar panels) which is 5kW more than needed 5x500=2,500 so this system would make £2,500 per year.

Teacher Tips:

The feed in tariffs change all the time and are different for how you generate your electricity- so this number is an estimate. For more information <https://www.ofgem.gov.uk/environmental-programmes/fit/fit-tariff-rates>

**HOT ACTIVITY:** How many years would it take pupils to earn back the full cost of their energy project?

*You calculate this by dividing the full cost of the system by the yearly earnings calculated above. Therefore, for the 11 solar panel example the whole system cost £55,000 and you earn £2,500 per year. 55,000÷2,500=22. It would take 22 years to earn back the cost of the system.*

***Discussion points***

*Why is this not the true value of the system? (because in that time you are also not paying for electricity)*

How much does it cost? (insulation)

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 electricity possible).

Insulation costs: £3000 saves 10kW per day

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

***Discussion points***

*What other ways can we reduce the amount of energy we use? Think about both in school and at home?*

*What would the ‘peak times’ be when your house is using the more electricity? Could this be a problem for your energy project? (eg. Only using solar panels but need energy at night)*

The Final challenge

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

*A house needs 50kW of power, insulation saves 10kW and energy efficient appliances save 5kW. So 50-10-5= 35. Your new house needs 35kW of power per day.*

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

*There are 3 solutions to generate exactly 35kW of energy:*

*7 solar panels: 7x5kW = 35kW*

*1 wind turbine and 4 solar panels: 15kW, 4x5kW=20, 15+20=30kW*

*2 wind turbines and 1 solar panels: 2x15kW= 30kW and 5kW, 30+5= 35kW*

*Pupils may have many different options which calculate slightly more electricity than required which is also fine.*

**HOT ACTIVITY:** How much would it cost to build the energy project you designed above?

Wind turbines cost £20,000 and solar panels cost £5,000. Insulation costs £3000, energy efficient appliances cost, £1000

*For the above examples:*

*7 solar panels: 6x£5,000= £35,000 +£4,000 (for insulation and appliances) = £39,000*

*1 wind turbine and 4 solar panels: 1x20,000= £20,000 and 4x5,000= £20,000.*

*20,000+20,000+4,000= £44,000*

*2 wind turbines and 1 solar panels: 2x20,000= £40,000 and 1x5,000= £5,000.*

*40,000 + 5,000 + 4,000= £49,000*

***Discussion points***

*Did anyone find a cheaper method?*

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

**Extra Hot activity:** You have £70,000 to spend. If you add additional wind turbines or solar panels to your project. 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 kW)

*Pupils can add to their above project or start completely from scratch if they think they have a better project. They can use any combination of wind turbines or solar panels and can use insulation, energy efficient appliances or none.*

*The highest earning energy projects (I could find but I’m sure there are others) was:*

*13 Solar Panels (£65,000) + All energy saving (£4,000) = £15,000 (£69,000 initial)*

*3 wind turbines (£60,000) + 1 Solar panel (£5,000) + All energy saving (£4,000) = £7,500 (£69,000 initial)*

*2 Wind turbines (£40,00) + 8 solar panels (£40,000)= £10,000 (£70,000 initial)*

***Discussion points***

*Which group made the most money?*

*Where there any advantages of disadvantages of their energy project? (the first project above has a low initial cost which is an advantage but only uses solar which makes it less reliable)*

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

Teacher tips

You can also try our Build a Windfarm game which encourages pupils to consider some of the same issues <https://www.nms.ac.uk/explore-our-collections/games/build-a-wind-farm/>

**Primary 6-7 Version**

Powering your house

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

A house needs 50 kW of electricity each day.

A solar panel will give around 6 kW of electricity per day.

A small wind turbine gives us 14 kW of electricity.[[1]](#footnote-1)

*If you didn’t record, or can’t remember, pupil energy projects then you can get pupils to recalculate this.*

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.

Powering your house (the exact amount)

Teacher Tips:

If you would like to make a model house 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.

There is a way to generate exactly 50kW

Can you work it out?

**ACTIVITY:** pupils try and work it out.

*1 wind turbine at 14kW = 14*

*6 solar panels 6kW= 36*

*Total= 50kW*

How much does it cost?

The amount of power is not the only consideration. Wind turbines are a lot more expensive than solar panels

Solar panel = £6,000

Wind turbine= £20,000

So, the above 50kW energy project would cost £56,000.

Teacher tips:

For more information, visit <https://www.renewableenergyhub.co.uk/>

**MILD ACTIVITY:** Get each group to calculate the cost of their own 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?*

*Did anyone generate more electricity than they needed?*

**HOT Activity:** What is the cheapest way to generate at least 50kW of energy?

*9 solar panels = 54kW = £54,000*

***Discussion points***

*Why would this not be the best way to power your house? (using only solar panels means you are relying only on one source of power in the summer in Scotland this would probably be fine because we have long days but in the winter, you might not generate enough electricity. It will also result in all your electricity being generated during the day whereas most is used at night for heat and light. So, you would need to store energy in batteries.)*

Teacher Tips

If you want to show this variation based on real weather data the met office has great graphs showing sunshine or windspeeds for your area. <https://www.metoffice.gov.uk/public/weather/climate/gcvw5vmsn>

How much does it cost? (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 1kW extra per day over a year, you can earn £500 by selling it back to the national grid.

**MILD ACTIVITY:** Get pupils to calculate how much money they could make per year from their original energy project.

You calculate this by taking the number of extra kW they generated and multiplying it by £500. For the example above the solar panels generated 54kW of electricity which is 4kW more than needed 4x500=2,000 so this system would make £2000 per year.

Teacher Tips:

The feed in tariffs change all the time and are different for how you generate your electricity so this number is an estimate. For more information <https://www.ofgem.gov.uk/environmental-programmes/fit/fit-tariff-rates>

**HOT ACTIVITY:** How many years would it take pupils to earn back the full cost of their energy project?

*You calculate this by dividing the full cost of the system by the yearly earnings calculated above. Therefore, for the above example the whole system cost £56,000 and you earn £2,000 per year. 56,000÷2,000=28. It would take 28 years to earn back the cost of the system.*

***Discussion points***

*Why is this not the true value of the system? (because in that time you are also not paying for electricity)*

How much does it cost? (insulation)

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 electricity possible).

Insulation costs: £3000 saves 9kW per day

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

***Discussion points***

*What other ways can we reduce the amount of energy we use? Think about both in school and at home?*

*What would the ‘peak times’ be when your house is using the more electricity? Could this be a problem for your energy project? (eg. Only using solar panels but need energy at night)*

The Final challenge

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

*A house needs 50kW of power, insulation saves 9kW and energy efficient appliances save 5kW. So 50-9-5= 36. Your new house needs 36kW of power.*

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

*There are two solutions to generate exactly 36kW of energy:*

*6 solar panels: 6x6kW = 36kW*

*2 wind turbines and 2 solar panels: 2x14kW= 28kW and 2x6kW=12kW, 12+28= 36kW*

*But pupils may have many different options which calculate slightly more electricity than required which is also fine.*

**HOT ACTIVITY:** How much would it cost to build the energy project you designed above?

Wind turbines cost £20,000 and solar panels cost £6,000. Insulation costs £3000, energy efficient appliances cost, £1000

*For the above examples:*

*6 solar panels: 6x£6,000= £36,000 +£4,000 (for insulation and appliances) = £40,000*

*2 wind turbines and 2 solar panels: 2x20,000= £40,000 and 2x6,000= £12,000.*

*40,000 + 12,000 + 4,000= £56,000*

***Discussion points***

*Did anyone find a cheaper method?*

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

**Extra Hot activity:** You have £70,000 to spend. If you add addition wind turbines or solar panels to your project. 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 kW)

*Pupils can add to their above project or start completely from scratch if they think they have a better project. They can use any combination of wind turbines or solar panels and can use insulation, energy efficient appliances or none.*

*The highest earning energy projects (I could find but I’m sure there are others) was:*

*All energy saving (£4,000), 8 solar panels (£48,000) = £6000 per year (£52,000 initial)*

*8 solar panels (£48,000), 1 wind turbine (£20,000) = £6000 per year (£68,000 initial)*

*All energy saving (£4,000), 3 wind turbines (£60,000), 1 solar panel (£6000) = £6,000 (£70,000 initial)*

***Discussion points***

*Which group made the most money?*

*Where there any advantages of disadvantages of their energy project? (the first project above has the lowest initial cost which is an advantage but only uses solar which makes it less reliable)*

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

Teacher tips

You can also try our Build a Windfarm game which encourages pupils to consider some of the same issues <https://www.nms.ac.uk/explore-our-collections/games/build-a-wind-farm/>

1. For P5 classes, during the workshop we use 5kW and 15kW respectively. For the activities in this resource, we suggest you use 6kW and 14kW. [↑](#footnote-ref-1)