ADVANCED CONNECTIONS | CYSYLLTIADAU PELLACH

SESSION PLAN

Physics Tutorial 7: We're All Physicists!

Aim

To use the skills developed throughout these tutorials to design a wind farm in Wales

Learning Objectives

By the end of this session, the mentees will be able to...

- Present a cohesive design for a wind farm in Wales
- Explain the reasoning behind their choices
- Evaluate other mentees' designs in an objective, constructive way

Prepare in Advance

- There shouldn't be anything to prepare in advance, just have a read through the task details. Most of the session will be presentations.
- Timings in this session are variable, because they depend on how many mentees you have.

Scaffolding

- No mentees should be finishing early as it's a presentation! If anyone seems a little bored or disinterested, encourage them to think of ways they could improve their own design, or think of feedback to give to presenters.

If a mentee is struggling:

- If they **really** don't want to present, get them to share their screen, and you/the others could ask them some questions about their design
  - Use this as a last resort; presentation skills are important to practice, and this session is a good safe space to do that!

Session Flow

Time	Activity
5 min	**Introduction** • Run through the aim and LOs • Recap the ground rules if needed
5 min	**Self-Study Recap** • Run through the answers to Task 1
25-45 min	**Wind Farm Presentations** • Mentees present their wind farms to the group • Ask observing mentees to take notes to feed back afterwards • After each presentation, give your feedback then prompt other mentees to provide their own as well (remind mentees to be kind and respectful!)
5-10 min	**Wind Farm Discussion** • Lead a discussion about the different wind farm ideas • Link the discussion to the importance of working in a team and utilising everyone's skill sets and expertise
5+ min	**Plenary** • If you have time and mentees have done it, you can run through the exam question in the optional extras. • If you don't have time, just allow a few minutes for any questions, and we will send them the exam answers after the session.

ADVANCED CONNECTIONS | CYSYLLTIADAU PELLACH

MENTOR GUIDANCE

SESSION 7: WE'RE ALL PHYSICISTS

SELF-STUDY RECAP

There were a few self-study tasks for mentees to complete ahead of this session.

TASK 1: WIND TURBINE ENERGY YIELD

5 MINS

It's important to note that only the proposed number of turbines is real data from the projects. The blade diameter is estimated from the wind turbines being considered for each project, and the wind speeds are estimated using the Global Wind Atlas for that area.

Mentees just need to use the methods in the worked examples to get the energy yield and homes powered equivalents:

Twyn Hywel: $E = 919.8$ MW

Aberedw: $E = 1605.0$ MW

Len Fawr: $E = 3628.0$ MW

HOMES POWERED EQUIVALENT

Twyn Hywel = 1,114,460 homes

Aberedw = 1,944,671 homes

Len Fawr = 4,395,805 homes

COMPARISONS

On the websites for each wind farm (each button has the link), the MW produced and homes powered equivalent is **much lower** than the values we've just calculated. Why?

This is because of two things:

- Not all the power generated will reach the generator, due to losses when converting from mechanical to electrical power.
- These calculations are in a perfect world - in reality, there will be inefficiencies in the designs of the turbines, loss of power due to friction in the blade motors, etc. which causes the actual power generated to be lower.

ADVANCED CONNECTIONS | CYSYLLTIADAU PELLACH

MENTOR GUIDANCE

SESSION 7: WE'RE ALL PHYSICISTS

WIND FARM DESIGNS

This majority of this tutorial is for mentees to present their wind farm designs and receive constructive feedback from each other.

TASK 2: PRESENTATIONS

25-45 MINS

For their pre-tutorial task, mentees will have been asked to **design a wind farm in Wales.** They will have been given some data (real-life, provided by Bute Energy). They will be expected to use the skills and knowledge they've gained over the last year to create the design.

Before mentees start presentations, explain to all mentees that they should take some notes when watching others, as they will be expected to provide feedback after each presentation.

You could suggest the **"2 stars 1 wish" method:** they note down 2 things that the presenter did **well,** and 1 thing they think they could **improve**

- Allow each mentee **up to 5 minutes** to present their wind farm idea.
  - It might be worth keeping a **timer** and giving them a signal when they have 1 minute left.
  - If you only have a few mentees the timing doesn't matter so much, but if you have more than 5/6 mentees, you will need to keep an eye on the time.
- After each presentation, start by providing some **feedback** of your own. Then encourage the **other mentees** to feed back to the presenter. Everyone doesn't have to contribute each time, but try to get at least 2 mentees to speak.

DISCUSSION

10-15 MINS

Lead a discussion with the mentees about their **designs,** and the importance of **teamwork.** Hopefully you will have some diversity in the mentees' designs, so you can point out that everyone approaches problems differently and has different ideas. **Working in a team** means you can **utilise everyone's strengths and expertise,** and the product is likely to be much better than if you worked alone.

You could use the following prompt questions:

- Having seen the others' ideas, is there anything you would **change** about your design?
- Do you think your design would have come out **differently** if you worked in a group? **Why/why not?**
- Can you think of a **strength** another mentee has? How could they **use** that as part of a team when making a design like this? (e.g. Elen is really good at maths, so they could do the calculations of wind speed. Huw is great at seeing the big picture, so they could make sure the project stays in budget.

ADVANCED CONNECTIONS | CYSYLLTIADAU PELLACH

MENTOR GUIDANCE

SESSION 7: WE'RE ALL PHYSICISTS

OPTIONAL EXTRAS (IF TIME)

If you have time, you can run through the exam practice answers from the optional extras.

OPTIONAL EXTRAS

1 mark

EXAM PRACTICE

(a)(i) Substitute the equation for mass / density / volume into the given equation:

$$\left.\begin{array}{l} V = Au \\ \text{and} \\ M = \rho V \end{array}\right\} \text{ so } M = \rho Au$$

1 mark

$v = u$
$m = M = \rho Au$

(in their exam booklets)

Then substitute into the equation for energy: $E = \frac{1}{2}mv^2$ so $E = \frac{1}{2}\rho Au \times u^2 = \frac{1}{2}A\rho u^3$ **1 mark**

(a)(ii) (I) The power arriving is proportional to the *square of the radius*. So doubling the length of the turbine blades will increase the power arriving by a factor of

4 1 mark

(allow written in words)

(II) Doubling the wind speed will increase the power arriving by a factor of

8 1 mark

(a)(iii) $P_{lost} = P_{before} - P_{after} = \frac{1}{2}\rho Au^3 - \frac{1}{2}\rho Av^3 = \frac{1}{2}\rho A(u^3 - v^3)$

1 mark

(a)(iv) Turbines in front will have removed energy from the wind. **1 mark**

(allow any equivalent explanation)

(a)(v) First calculate the area: $A = \pi r^2 = \pi \times 2^2 = 12.57$ (-1 mark if A is incorrect)

Then substitute into the equation from (iii): **1 mark** *(knowing to substitute and getting the right answer are the 2 marks here)*

$$P_{lost} = \frac{1}{2}\rho A(u^3 - v^3) = \frac{1}{2} \times 1.2 \times 12.57 \times (7^3 - 5^3) = 1644 \text{ W}$$ **1 mark**

(b) (i) Energy passing through blades insufficient to overcome friction of moving parts. **1 mark**

(b) (ii) Using the graph, efficiency at 7 m/s is ~54% (+/- 1) **1 mark**

(allow ecf from (a) (v))

54% of the answer from (a) (v) = 888 W **1 mark**

(c) Density of water is much greater than density of air. **1 mark**