**Transmission current**

A wind turbine has a power of 2 MW (2 000 000 W).

The voltage across it is 1000 V.



Power lines connect the wind turbine to the national grid.

A **step-up transformer** makes the transmission voltage 275 000 V

What happens to current when transmission voltage is increased?

*Put a tick (✓) in the box next to the best answer.*

|  |  |  |
| --- | --- | --- |
| **A** | Current decreases. |  |
|  |  |  |
| **B** | Current stays the same. |  |
|  |  |  |
| **C** | Current increases. |  |

*Physics > Big idea PEM: Electricity and magnetism > Topic PEM8: Mains electricity > Key concept PEM8.3: Transmitting electricity*

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| --- |
| **Diagnostic question** |
| **Transmission current** |

**Overview**

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| --- | --- |
| Learning focus: | Transmission lines dissipate less power when they transfer power with a higher transmission voltage and lower current. When current is lower there is a smaller drop in voltage along their length. |
| Observable learning outcome: | Predict changes to current through transmission lines using P = I x V. |
| Question type: | Simple multiple choice |
| Key words: | Transmission voltage, power, current, wind turbine, national grid |

**What does the research say?**

Students often readily accept that power dissipation from electricity transmission lines is reduced when transmission voltage is high and transmission current is low. There may however be confusion because transmission voltage is inversely proportional to current, which seems to violate Ohm’s law.

It is easy to think that a higher transmission voltage gives current a bigger push through a transmission line, but when the transmission voltage is higher a smaller current is pushed through the wire, by a transformer, and the *voltage drop along its length* is smaller. To overcome these misunderstandings, the difference between transmission voltage and the voltage drop along transmission wires needs to be clearly understood (Bissell, 2021).

**Ways to use this question**

Students should complete the question individually. This could be a pencil and paper exercise, or you could use an electronic ‘voting system’ or mini white boards and the PowerPoint presentation.

The answers to the question will show you whether students understood the concept sufficiently well to apply it correctly.

If there is a range of answers, you may choose to respond through structured class discussion. Ask one student to explain why they gave the answer they did; ask another student to explain why they agree with them; ask another to explain why they disagree, and so on. This sort of discussion gives students the opportunity to explore their thinking and for you to really understand their learning needs.

*Differentiation*

You may choose to read the question to the class, so that everyone can focus on the science. In some situations, it may be more appropriate for a teaching assistant to read for one or two students.

**Expected answer**

A

**How to respond - what next?**

By assuming there are no power losses, all the power the wind turbine has is transferred by the transmission lines. The equation for the power of an electrical device is P = I x V. With no power loss, if the voltage is increased, the current must decrease to compensate because power remains constant.

B A few students may think that the current stays the same, perhaps because they think it depends on the resistance of the wires.

C Students who think that current increases are likely to be applying Ohm’s law inappropriately. It is common for students (and also many experienced practitioners) to have the misunderstanding that the transmission voltage is pushing current through the transmission lines – but it isn’t.

The current through a transmission line is largely determined by the output of the step-up transformer, and results in a relatively small voltage drop across the length of the transmission line. At the far end of a transmission line, the transmission voltage is still very high.

If students have misunderstandings about predicting changes to current through transmission lines using P = I x V, it can help to show them what happens using a transmission line demonstration, set up to show the current before and after the step-up transformer, perhaps using a multi-meter set to read alternating current.

The following BEST ‘response activity’ could be used in follow-up to this diagnostic question:

* Response activity: Transmission lines

**Acknowledgments**

Developed by Peter Fairhurst (UYSEG).

Image by PublicDomainPictures from Pixabay.

**References**

Bissell, J. (2021). Clarifying misconceptions about Ohm’s law and power dissipation in grid electricity transmission. *Physics Education,* 56(3)**,** 033009.