2025Q5 ENERGY AND POWER

Hello, students! In our recent Wind Studies, we've explored how matter and air move and behave—and how we measure them. A quick reminder: **mass** is the amount of matter in an object, and **volume** is the space that an object takes up. Today, we'll see how these concepts come together to help us better understand energy, with a focus on wind turbines. We'll be looking at a special type of energy called Kinetic Energy (KE), which is the energy an object has when it is moving!

Educator: Related Science Shorts: Potential vs Kinetic Energy and Energy vs Power

First Law of Thermodynamics

Energy is fascinating because it can change forms, but it never just disappears. This idea comes from a basic rule in science called the First Law of Thermodynamics, which says that energy can't be created or destroyed, only transformed. For example, a wind turbine takes moving energy from the wind (kinetic energy) and changes it into energy we can use in our homes (electrical energy, or electricity). Think of it like this: the amount of energy you start with is the same as what you end up with—it just changes form along the way.

Power

The speed at which the energy is transferred is called '**power**.' It's like running—the faster you go, the more power you're using. For wind turbines, power measures how quickly they can convert the wind's kinetic energy into electrical energy, called electricity. The faster the wind blows, the more power a turbine can generate. Here is the equation we use:

$$P_{wind} = \frac{1}{2}\dot{m}({v_{in}}^2 - {v_{out}}^2)$$

Where:

- P_{wind} is generated by the wind turbine (W)
- v_{in} is the incoming wind speed (m/s)
- $\dot{m}$ is the mass flow rate (kg/s)
- v_{out} is the outgoing wind speed (m/s)

Useful Power and Efficiency

Not all the kinetic energy from the wind can be converted to electricity, some is lost to things like friction and heat. The energy that does get transformed into electricity is called '**useful power**.' The efficiency of a turbine measures how well it can convert the wind's energy into useful power. Higher efficiency means less energy is wasted. The amount of useful power a turbine can produce depends on its efficiency:

$$P_{useful} = \eta P_{wind}$$

Where:

- P_{useful} is useful power output (W)
- η is the turbine's efficiency, as a decimal (80% = 0.8)
- P_{wind} is power extracted from wind (W)

WIND STUDY

Wind Study is intended for grades 5-8 and 8-11
Questions posted on: Monday Answers posted on: Friday
Find downloadable one pagers at www.onepower.com/one-power-feed

LEVEL 1 QUESTION (GRADES 5 – 8)

Imagine a wind turbine at a science fair that generates electricity from wind. The turbine generates 500 watts of power before accounting for any losses. After all calculations, it was found that the turbine actually supplies 475 watts to light up bulbs at the fair. What is the efficiency (%) of the turbine?

Hint: Use division to get efficiency in decimals and convert the decimal to a percent.

LEVEL 2 QUESTION (GRADES 8 –11)

A wind turbine receives air with a mass flow rate of 53 kg/s, at an incoming speed of 14 m/s, and after passing through the blades, the wind slows down to 9 m/s. The turbine system loses 18% of its extracted power due to energy inefficiencies.

Calculate the final useful power output (in kW) that the wind turbine generates before it is converted into electricity using the power formula:

Hint: Find the wind power output and then find the useful power output.