

Energy vs power

Français

Energy and **power** are closely related but are not the same physical quantity. Energy is the ability to cause change; power is the rate energy is moved, or used.

Energy

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Energy is the ability to create a change, for example, creating motion. Tasks (like lifting a box) require an amount of energy to complete. A **battery** will hold a particular amount of energy; so will a given amount of **fuel**, like food.

The base unit of energy is the **joule**. This means that a task, like lifting a box in figure 1, takes a certain number of joules regardless of how quickly the box is picked up.



Figure 1: Lifting a box requires a specific amount of **energy**, no matter how quickly the box is picked up. Lifting faster will change the amount of **power** but not the amount of **energy**.^[1]

Power

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Power is how fast energy is used or transmitted - power is the amount of energy divided by the time it took to use the energy. Its unit is the **watt**, which is one **joule** per **second** of energy used. A circular saw will draw a certain amount of power to run, and how quickly power is drawn from a battery determines how long its stored energy will last.

$$P = \frac{\Delta E_{sys}}{\Delta t}$$

- P is the average power output, measured in watts (W)
- ΔE_{sys} is the net change in **energy** of the system in joules (J) - also known as **work**.
- Δt is the duration - how long the energy use takes - measured in seconds (s)

Multiplying a value of power and the period of time over which it is used gives an amount of **energy**. This is why a kilowatt is a unit of power but a **kilowatt-hour** (1 kilowatt times 1 hour) is a unit of energy.

Tasks (like lifting a box) take a certain amount of energy (a certain number of joules), but the faster the task is done (the smaller Δt), the more power it takes (more watts).

Engines vs. gas tanks

A car's engine determines how much power it can exert (this is a **mechanical power** often rated in **horsepower**, as opposed to the **thermal power** which is how fast it burns gasoline), while the amount of **gasoline** in the gas tank determines how much energy the engine has at its disposal. The greater the amount of gasoline, the longer the engine can run without running out of energy. The more power the engine is using (like when driving fast or revving the engine to accelerate quickly), the shorter the amount of time the **chemical energy** available in the gasoline will last. Here's a page on tricks for [improving fuel economy](#).

Capacitors vs. batteries

Capacitors often have a little bit of energy that can be discharged quite quickly. This short time means that they can have a fairly high power, even with a low amount of stored energy (this is useful with camera flashes, for example). **Batteries**, on the other hand, contain much more energy than a capacitor but discharge that energy far more slowly, meaning that they have a lower power output.

An analogy with containers of water

Figure 2 shows a mug with a small amount of water being poured quickly and a jug holding a greater amount of water being poured more slowly. The mug is delivering more water in a given amount of time, but the total amount of water delivered will be less than the jug. The analogy is that the mug has higher power, but lower energy. The jug releases smaller amounts of liquid for a longer period of time. The analogy continues with the jug having a smaller power output but more energy. The mug releases all its water (energy) very quickly. Conversely, the jug holds much more water (energy), even if it is not losing it quickly.



Figure 2. The mug labelled 'Power' has a greater rate. The jug labelled 'Energy' has more water. This image represents how energy and power are different. Both have water and a flow rate.^[2]

References

- ↑ This image is of a proper lifting technique from WebMd: <http://www.webmd.com/back-pain/proper-lifting-technique> Accessed, August 16th, 2017.
- ↑ (2014, June 30). *What is the difference between power and energy?* [Online]. Available: <http://www.tecategroup.com/ultracapacitors-supercapacitors/ultracapacitor-FAQ.php>]

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