POWER VS ENERGY

ENERGY AND POWER ARE CLOSELY RELATED, BUT NOT SYNONYMS. KNOWING THE DIFFERENCE BETWEEN THEM IS IMPORTANT WHEN WE MAKE DECISIONS ABOUT THE TRANSITION TO A LOW-CARBON ECONOMY

Energy just means the ability to do work, to push or pull something a distance. Its unit is called the joule.

Power is how much energy is transmitted over time. It is a rate. Its unit is called the watt, which means one joule per second.

Think of energy as the amount of wine in a bottle.

And think of power as how fast the wine is flowing out.

Confusingly, the energy industry generally uses the term watt-hour to describe amounts of energy instead of joule. But one watt-hour is just a joule per second (one watt) but transmitted over an hour. There are 3600 seconds in an hour, so one watt-hour equals 3600 joules. Alternately, one watt-second equals one joule.

WATTS

(INSTANTANEOUS RATE OF ENERGY)

A 100 watt light-bulb needs 100 joules per second.

Electric motors need several kilowatts (1 KW = 1000 joules per second).

Use varies so much from region to region that it is hard to produce a meaningful average, but a very rough rule of thumb says that 1 megawatt is enough to service the instantaneous demand of about 1000 homes (1 MW = a million joules per second).

The world's biggest data centres require 80-150 MW,[1] the Large Hadron Collider 120 MW,[2] and aircraft carriers about 200 MW.[3]

Using the same rough rule of thumb as before, 1 gigawatt is enough to power a million Canadian homes (1 GW = a billion joules per second).

According to Doc Brown, a DeLorean time machine needs 1.21 gigawatts.

British Columbia's proposed Site C hydroelectric dam could provide 1.1 GW at any one moment.[4]

The installation of a sixth turbine at the existing dam at Revelstoke offers 500 MW of capacity, or just under half the power of Site C.

China's Three Gorges Dam can provide 22.5 GW.

The average lightning bolt delivers 1 terawatt (TW), or a rate of a trillion joules per second, in 30 millionths of a second. Yup. That much.

The total average power consumption of all humans clocked in at 12.5 TW in 2016.[5]

WATT-HOURS

(TOTAL AMOUNT OF ENERGY)

A 100 watt light-bulb consumes 100 watt-hours per hour (or 360,000 joules).

A 12-volt lead car battery stores 1200 watt-hours of energy.

Tesla's Model S electric car comes in two flavours: one with a 60 kilowatt-hour (kWh) batttery and another with an 85 kWh battery. Both cars have the same power needs. One battery just lasts longer.

A fridge will consume 500-700 kWh per year.

The average British Columbia household consumes about 11 gigawatt-hours (GWh) per year.[4]

The Large Hadron Collider's total annual energy demand clocks in at 700 GWh.[2]

The Site C dam could provide 5,100 GWh over the course of a year.

The installation of a sixth turbine at the existing dam at Revelstoke offers 26 GWh of generation,[4] or about 0.5% of the energy of Site C.

The Three Gorges Dam provides 87 terawatt-hours (TWh) a year.

One terawatt-hour is equivalent to 114 megawatts over the course of a year.

The total energy consumption of all humans clocked in at 109,593 TWh in 2016,[5] or about 110 petawatt-hours.

KILO = 1000
MEGA = 1 million
GIGA = 1 billion
TERA = 1 trillion
PETA = 1 quadrillion

BUT WHY IS THIS IMPORTANT?

IT'S ALL ABOUT THE DIFFERENCE BETWEEN

ELECTRICITY CAPACITY & ELECTRICITY GENERATION (A.K.A. SUPPLY)

The term capacity describes the amount of electricity that would flow *at any one moment* if a power plant is operating at full tilt. It is measured in MW. Here, we're talking about power.

When the wind doesn't blow or the sun doesn't shine, then the electricity provided from wind turbines or solar panels is diminished, or even halted.

OR

At other times, there is too much wind or more sun than we need. This can mean the curtailment of other sources of electricity, a very expensive waste of energy.

As a result, electricity-producing assets sourcing variable energy such as wind and solar are rarely used at full capacity. So when the media reports that a new solar or wind farm has the capacity to service a certain number of homes, they mean at any one moment and *under the best of conditions*.

Electricity generation (sometimes called 'supply') is the total amount of electricity produced on the grid. It is measured in MWh. Here, we're talking about energy.

In principle, we can store some of the excess electricity from variable renewable energy sources to be used later.

Storage is also measured in MWh because the electricity has been produced and is a supply ready to be tapped at any time.

One of the simplest, cheapest, most efficient, low-carbon 'batteries' we have is a water reservoir such as that behind a dam.

Water stored there can be released to turn a turbine when we need the electricity.

But the amount of reservoir we need to 'keep the lights on' at hospitals, factories and all the rest of a modern society is considerable.

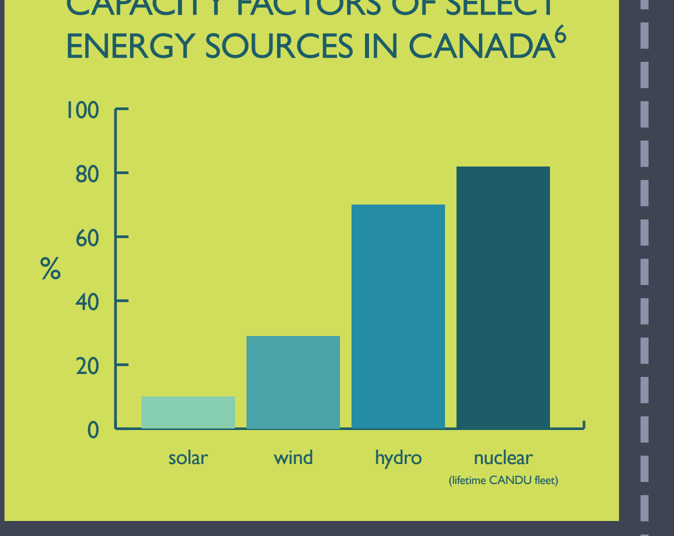
...AND ANOTHER BIT OF JARGON: CAPACITY FACTOR

$$\text{CAPACITY FACTOR} = \frac{\text{ACTUAL GENERATION}}{\text{NAMEPLATE CAPACITY}}$$

(multiply by 100 to get a percentage)

The ratio of what a plant actually generates to what it could potentially generate under a best-case scenario (which is referred to as nameplate capacity) is called its capacity factor.

Plants using non-variable sources of energy such as coal, gas, hydro or nuclear can run much closer to their full capacity because it is humans that decide when they will and will not produce electricity, not the weather.



SO WHEN WE TALK ABOUT NEW HYDRO DAMS, SOLAR FARMS, WIND TURBINES OR NUCLEAR REACTORS, WE NEED TO KNOW BOTH WHAT THEIR CAPACITY AND THEIR GENERATION WILL BE.

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5 International Energy Agency, *Key World Energy Statistics 2016*
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