10 Measurable parameters

A Supply, demand and capacity

The article below is from the technology section of a business magazine.

Technology

Calculating the **capacity** of an electricity grid – the amount of energy it needs to **supply** to users – might seem simple. Just add up the power supplied over a given **period** of time to give the total amount **consumed** by users. Then, divide the **cumulative** amount of power used during the whole period by the number of hours in the period. The result is an **average** level of **consumption** per hour. But there's one problem with this method – and it's a major one.

The **rate** of power consumption – the amount that's being consumed at a particular moment – is not **constant**. In other words, consumption does not stay at the same level all the time. So electricity **supply** requirements cannot simply be **averaged out** over time. People use more power at certain times of day, and less at other times, which means that **demand** for power **fluctuates** significantly. Generally, it rises to a maximum in the evening (**peak** demand is at evening mealtimes), and falls to its lowest levels during the night. These **fluctuations** are so big that at **peak times** consumption can be twice as high as it is during **off-peak times**. Clearly, the grid needs to have sufficient capacity to **meet demand** when consumption **peaks**. But since each peak is brief, the grid will only **run to capacity** – at or close to its maximum capability – for a few moments each day. This means, most of the time, it has significant **spare capacity**.

B Input, output and efficiency

Power lines and transformers are relatively **inefficient**, wasting energy – mainly by giving off heat. As a result, there is a difference between **input** – the amount of energy put into the grid by power stations, and **output** – the amount used by consumers. On a typical grid, the difference between input and output is about 7% – there is a 7% energy **loss**. But if electricity is generated at the place where it's consumed, and not transmitted through long-distance power lines, this loss can be avoided. Consequently, locally produced electricity is more **efficient** than grid-supplied power, as there is a **gain** in **efficiency** of around 7%.

Photovoltaic solar panels

One way to produce power locally is with photovoltaics (PVs) – often called solar panels. However, many PV installations are still connected to the electricity grid. This means that when there is **surplus** power – when electricity is being produced by the solar panels faster than it is needed in the home – it is fed <u>into</u> the grid. If consumption **exceeds** production – if electricity is being used in the home faster than the solar panels can produce it – then power is taken <u>from</u> the grid. Homes with low consumption may therefore become **net** producers of power, producing more electricity than they consume.

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Mark Ibbotson
Excerpt
More information

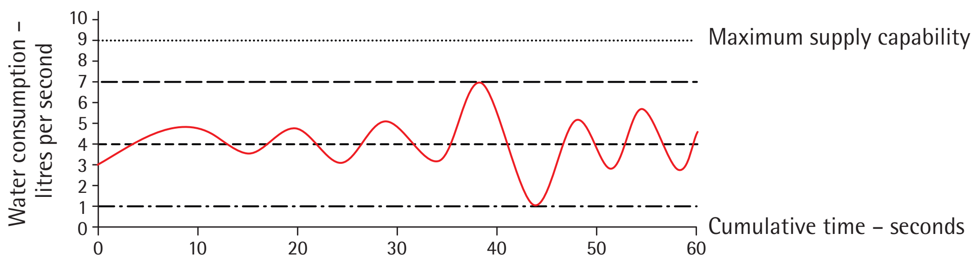
10.1 An engineer is talking to a colleague about the design of a fuel tank for a water pump. Complete the explanation using the words in the box. Look at A opposite to help you.

average	constant	consumption	duration
capacity	consume	cumulative	rate

Fuel (1) .... for this engine is about 1.5 litres per hour. Of course, sometimes it'll (2) .... a bit more, sometimes a bit less, depending on the workload. But 1.5 is an (3) .... figure. And let's say the (4) .... of a work shift is 8 hours. The pump will have to be stopped occasionally, to clean the intake filter, so it won't be 8 hours of (5) .... running. But we'll say 8 hours, to be on the safe side. So 8 hours of running at a (6) .... of 1.5 litres per hour gives 12 litres of (7) .... consumption over a shift. So if we want the pump to have sufficient fuel autonomy for an 8-hour shift, the (8) .... of the fuel tank needs to be 12 litres, minimum.

10.2 The graph below shows water consumption in a washing process at a manufacturing plant. Write figures to complete the comments. Look at A opposite to help you.

1 Water consumption fluctuated between .... and .... litres per second.
2 Averaged out over the period shown, consumption was roughly .... litres per second.
3 Consumption peaked at a rate of .... litres per second.
4 If the process ran to capacity, it could use water at a rate of .... litres per second.
5 When consumption peaked, the process had spare capacity of .... litres per second.



10.3 Choose the correct words from the brackets to complete the explanations from a guided tour of a manufacturing plant. Look at A and B opposite to help you.

1 A lot of heat is generated in this part of the process. And all of that (input / output) is recycled – it provides a (demand / supply) of heat for the next stage of the process. So it's quite an (efficient / inefficient) system.
2 Sometimes, there's (insufficient / surplus) heat, and it can't all be recycled. At other times there isn't quite enough recycled heat to keep up with (peak / off-peak) demand for heat energy further along the process.
3 Some material is lost in the washing process, but the mass of water absorbed is greater than the mass of material lost. So there's a net (loss / gain) in total mass.

Over to you

Think of an energy-consuming appliance you're familiar with. Imagine you are starting a project to redesign it, in order to improve its efficiency. Answer the following questions:

- How much energy does the appliance consume? Is consumption constant or fluctuating? Describe any fluctuations, in terms of average and peak consumption.
- How efficient is the appliance? What are the main reasons for inefficiencies? What are your first thoughts on how efficiency could be improved?

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13 Non-ferrous metals

A Common non-ferrous engineering metals

These website extracts look at the engineering applications of some **non-ferrous metals** – that is, metals that do not contain iron.

Aluminium is widely used, often in alloy forms. An example is duralumin, an alloy used in aircraft manufacturing, which also contains **copper** (4.4%) and **magnesium** (1.5%). Aluminium can also be alloyed with **titanium** to produce very strong, lightweight metals.

Copper is an excellent electrical conductor, which makes it ideal for use in electric wires. Good ductility also makes it suitable for pipes. Copper is widely used in alloys, notably **brass** (copper and **zinc**) and **bronze** (copper and **tin**, and sometimes **lead**).

Silver is a **precious metal** – a reference to its high cost. It is a better electrical conductor than any other material, so it is often used for electronic connections. Another precious metal – **gold** – is also an excellent conductor, and is highly corrosion-resistant.

Notes: For more on metals and alloys, see Unit 11. For more on **ductility**, see Unit 18.
The chemical symbol for aluminium = Al, copper = Cu, magnesium = Mg, titanium = Ti, zinc = Zn, tin = Sn, lead = Pb, silver = Ag and gold = Au.

B Plating with non-ferrous metals

Non-ferrous metals can be used to protect steel from corrosion by **plating** it – that is, covering it with a thin layer of metal. An example is **galvanizing** (zinc plating).

Steel can be **hot-dip galvanized**, by placing it in **molten** (liquid) zinc. It can also be **electro-galvanized**, which is a type of **electroplating**. With this technique, the steel component is placed in a liquid (often an acid) – called the **electrolyte** – and connected to the **negative terminal** (–) of an electrical supply, to become the **cathode** (the negative side). A piece of zinc is also placed in the electrolyte, and is connected to the **positive terminal** (+) of the supply. This then becomes the **anode** (the positive side). An electric current then flows between the pieces of metal, through the electrolyte. This causes a chemical reaction, which deposits zinc on the cathode, plating the component.

A related process, called **anodizing**, is used to protect aluminium. The component to be **anodized** is connected to the positive terminal (to become the anode) and placed in an electrolyte, with a cathode. As electricity flows, **aluminium oxide** is deposited on the anode. As this is harder than aluminium metal, it provides protection.

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13.1 Make correct sentences using one part from each column. Look at A opposite to help you. The first one has been done for you.

1 Duralumin	can be mixed with copper to make	silver.
2 Titanium	resists corrosion better than the other precious metal,	brass.
3 Zinc	has a high strength-to-weight ratio and is often alloyed with	aluminium.
4 Copper	is an aluminium alloy that also contains copper and	bronze.
5 Gold	can be mixed with tin and lead to produce	magnesium.

13.2 Complete the word groups below using the names of the metals in 13.1 above. You will need to write some names more than once. Look at A opposite to help you.

Metal elements	
Alloys	
Precious metals	

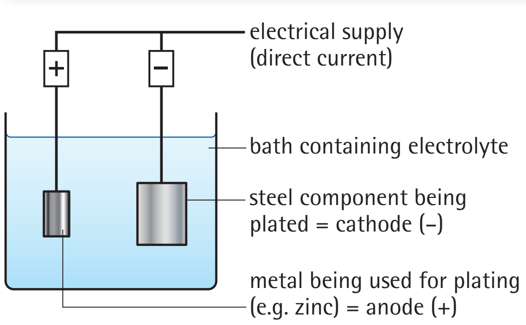
13.3 Complete the checklist for electroplating using the words in the box. Look at B opposite to help you.

anode	electrolyte	galvanizing	plated
cathode	electroplating	negative	positive

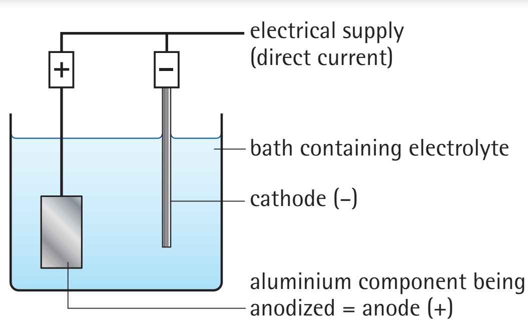
✓ Check that there is sufficient (1) .... in the bath to completely cover the component, in order to ensure that the component will subsequently be (2) .... over its entire surface area.

✓ Ensure that the component is connected to the (3) .... terminal of the electrical supply. During the (4) .... process, the component should function as the (5) ....

✓ Ensure that the metal being used for plating – e.g. zinc for (6) .... – is connected to the (7) .... terminal of the electrical supply. During the process, it should function as the (8) ....



Electroplating



Anodizing

Over to you

How are non-ferrous metals used in your industry, or an industry you're familiar with? Is electroplating common? If so, what kinds of metals are used for plating, and why are these specific metals chosen?