HOW ENERGY ACTUALLY WORKS AND ESSENTIAL TERMINOLOGY

About this Factsheet

Festival organisers, production managers, festival staff and power users commonly report being bamboozled by technical language about energy. Smart approaches to energy management require baseline knowledge about how temporary power works between many stakeholders. This factsheet, produced with energy consultancy Entersys, provides an explanation of phrases and terms and some know-how to help everyone take part in conversations more confidently.

What is Efficiency?

Energy efficiency is simply the process of doing more with less. In the context of this guide efficiency can be considered and measured in several ways:

- The amount of usable power (kilowatt hours / kWh) generated per litre of fuel consumed.
- The overall 'fuel per audience day' (or litres of diesel used per person per day) at the event.*
- Either of the above compared to figures from the previous year.
- How well matched the generator size is to the load.

Generators consume a baseline of fuel regardless of the size of their load. The relationship between 'fuel consumed' and 'power generated' is not linear; the efficiency of the generator is largely determined by the load. A good rule of thumb is that around 75-80% load is perfect (optimum). Going downwards, anything between 50-75% load is still good as reductions in efficiency are marginal, but as you go down to 25-50% efficiency reduces significantly. A load below 25% is low efficiency and is wasteful of both fuel and costs.

*YOU CAN CHECK HOW YOUR EVENT COMPARES WITH UK AVERAGES USING THE FESTIVAL FUEL TOOL

FESTIVAL FUEL TOOL SUPPORTED BY THE AIF

Voltage, Current and Power

These are basic electrical terms but can be quite confusing at times, so let's take a brief look at each one:

Voltage

The force that makes electricity flow through a wire. Its unit of measurement is the Volt (V). For our purposes most items are designed to run on 230V AC. Occasionally we may come across items designed for 110V AC (using a yellow plug) and 400V AC (using a red plug). A higher voltage isn't necessarily 'better' – the output voltage of the generator needs to match the working voltage of the appliances connected to it.

Current

The amount of energy that flows through a wire over a given time. The thickness of the wire restricts its flow. Plugs and sockets are rated up to a certain current carrying capacity – 13 A domestic, 16 A & 32 A etc. The symbol for current is (I) and the unit of measurement is the Amp (A).

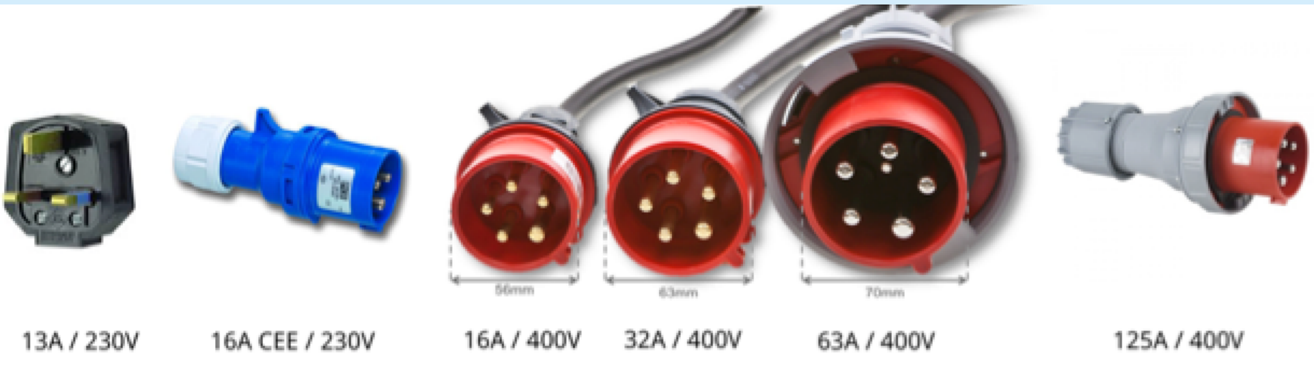

Photo credit: ZAP Concepts

Power

The rate at which energy is consumed by a system. We can consider it in two ways, either the amount of power a machine can produce – a generator for example; or the amount of power a system consumes – a kettle for instance. Power is measured in Watts (W).

The Relationship Between Voltage (V), Current (I) and Power (P)

Power is simply the product of voltage across and current flowing through an item, as in the following formula:

$$P\ (W) = I\ (A) \times V\ (V)$$

A light bulb is designed to run at a voltage of 230 V and consumes 40 W of power. What current will flow through it? We can work this out as follows:

$$I = P / V = 0.17\ A$$

Practically, most items run at 230 V. All items sold in the UK will have a rating plate on them somewhere, stating what voltage they are designed to operate at and what power they will consume. From this we can establish the power requirement for a system by simply adding up the power of each item. If the power isn't given but the current is, we can convert it to power using the above formula.

So, for a production office we can work out how much power we need as follows:

2x	Desk Lamps	@ 40 W	= 80 W
1x	Laptop	@ 90 W	= 90 W
1x	Laminator	@ 6 A	= 6 A x 230 V = 1,380 W
1x	Coffee machine	@ 3 kW	= 3,000 W
1x	Radio charger	@ 460 W	= 460 W
Total	**= 5,010 W**		

We can convert the Laminator into Power (W) from Current (A) by using the above formula to find it is 1,380 W or 1.38 kW.

We now know our office consumes 5.01 kW. So we need a 5 kW generator right? Well, yes we would, if we were to be running all the appliances at once. In catering that may be the case, especially over a show weekend where they are pre-cooking and running long serving sessions.

But we need to apply a little experience: because we know our office appliances don't all run at once, let's allow for 75% at any one time, which reduces our demand to approx. 3.75 kW or 16 A.

Generators, kW, kVA and kWh

Due to the physics of AC power generation and consumption, generators are sized in kVA rather than kW. In most instances we can consider that:

$$1\ kVA = 0.8\ kW$$

Current measurements on a generator are instantaneous – a snapshot of the current supplied when we happen to look at the meter on the front panel; just as our car speedometer only shows the instantaneous speed at which we are travelling when we happen to glance down at it. So, in order to show the cumulative energy produced we need to view it as energy produced over time. This is measured in kilowatt-hours (kWh).

KWh is the common unit used to bill electricity to consumers. For example, a 60-Watt light bulb that burns for one hour uses 0.06 kWh. Over 10 hours it would be 0.6 kWh.

Due to the nature of AC power generation, generators generally have three separate power outputs called 'phases'. For example if a 100-kVA generator could supply a total current of 420 Amps, there would be 140 A x 3 outputs. It is important to keep the load on each phase as equal as possible to allow the engine to run smoothly. Putting all the load on one phase causes engine wear and damages the machine.

Communicating with Your Power Company

Power companies are run by engineers who tend to talk in engineering terms, which can seem both exclusive and confusing. So let's run through a few of the more common ones to explain them:

Bunded Tank

All generators have a fuel tank inside of them and this will allow them to run for a certain time at full load — the generator manufacturer will specify for how long. In order to increase the running time many suppliers will supply an external tank that holds more fuel, to increase running time and save time on refuelling. These are double skinned or 'bunded' which is a fail-safe in case one of the skins becomes pierced. The tank should also contain the fuel if it is tipped over.

Residual Current Device (RCDs)

Special circuit breakers designed to operate in the event of a fault. They are designed to protect people against electric shock. A correctly designed system may contain several RCDs set at differing sensitivities, so shock protection is maintained but if one trips it won't turn off whole areas of an installation. Beware of the term 'nuisance tripping' — unless the RCD is at fault itself they don't 'nuisance trip', they trip because they sense a fault, the cause of which should be investigated.

Distro Box

Simply an electrical box used to distribute the generator outputs. This will contain the circuit breakers to protect the circuits in the event of a fault. Modern units are generally black plastic cubes with sockets on one side and clear windows containing the breakers on the other.

Uninterruptable Power Supply (UPS)

A device from the computer industry, which will provide power to a circuit should the generator fail. They are often used on ticketing cabins, CCTV and Internet infrastructure where a simple generator failure would cause disruption to site communications etc.

Fuel Filter

Before the diesel is fed into the engine it is filtered to remove any moisture and dirt to and protect the engine. Over time, these filters can become blocked and choke the flow of fuel, causing the engine to run erratically. They can also cause plumes of white smoke to emit from the machine. This is not a concern from a fire safety perspective but the machine does need immediate attention.