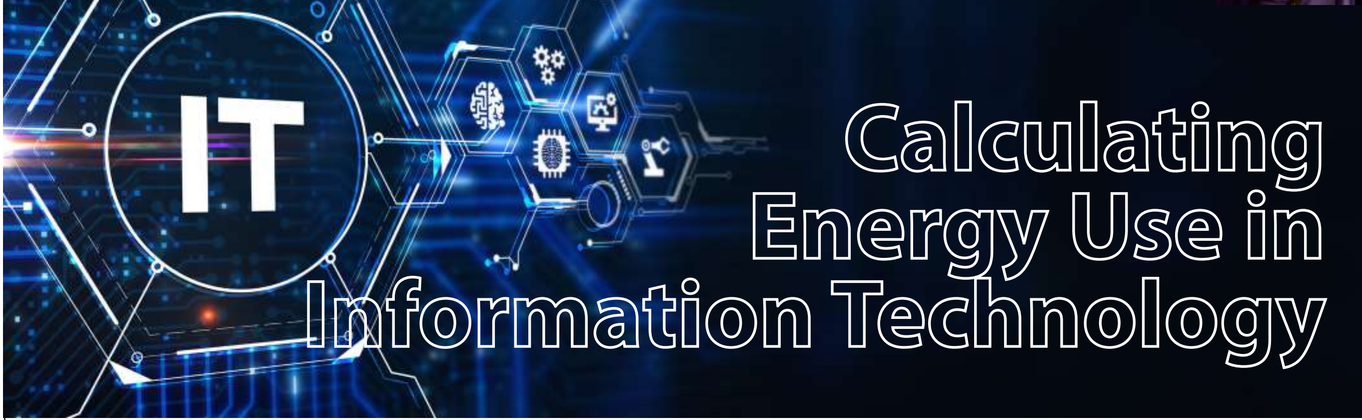
By David Coxon, Energy Manager at Newcastle upon Tyne Hospitals NHS Foundation Trust



Calculating Energy Use in Information Technology

Changes within Information Technology

The past 50 years have seen significant changes in Information Technology (IT). Mainframe computers of the 1970s were typically large enough to fill a room, but by the 1980s, we had entered the age of personal computing. Computers had come down in both the size and cost, and were starting to appear in people's homes as well as their businesses. Through the 90s, computers continued to get smaller and more affordable, with internet connected laptops becoming common place. Since the turn of the millennium, the speed at which IT has developed has been unprecedented. Today's devices no longer need to be plugged into computers to connect to the internet, with technologies like GPRS, Wi-Fi and Bluetooth, making IT ubiquitous in every walk of life, whether it's the offices we work in, the cars we drive, phones in our hands, the shopping we have delivered and even the waste we dispose of. Tech is everywhere.

IT and the Global Demand for Energy

It has been estimated that IT accounted for between 4 and 6 percent of all electricity use in 2020.

As far back as 1965, Gordon Moore (co-founder of Intel) predicted that the number of transistors that could fit on an integrated circuit board would double every two years. This rule of thumb, known as Moore's Law still holds true today, computers have become capable of processing twice as quickly every 18-24 months.

Despite computers becoming more efficient, global demand for energy from the IT sector has been growing steadily over the past few decades. This may be due to another rule, known as Jevons Paradox, which states that the more efficient technology becomes, the more affordable it will be, and the more demand there will be for it. Somewhat surprisingly, English economist William Stanley Jevons came up with his paradox in 1865, exactly 100 years before Moore came up with his Law.

Energy Use within IT

Studies suggest that user devices consume more energy than networks and data centres combined, with one study attributing 60% of electrical consumption to user devices.

Communication networks used to connect devices and transfer data, including wired, wireless and mobile networks are thought to account for 20-25% of the energy used within the IT sector.

The remaining portion of the energy usage in the IT sector is attributable to data centres. Research by the International Energy Agency (IEA) report that data centre energy use accounted for about 1% of global electricity demand in 2020. Cooling in particular accounts for a large proportion of this use. A typical data centre can consume up to 100 times more energy than a standard office building of the same size.

The Challenges of Calculating the Energy Used by IT

Challenge 1 – Definition

Possibly the greatest challenge faced when attempting to calculate the energy used by our IT systems is defining exactly what we mean by our IT systems. We could think of IT as simply our computers, servers, desktops and laptops. However, then we have mobile devices, tablets and mobiles, and what about - printers, copiers, scanners, cameras, projectors, disk drives, and the vast array of sensors we use to collect data.

Challenge 2 – Performance data inconsistency

The next problem is that in much the same way that our mobile phone batteries run down more quickly the more we use them, other IT devices also use more power the more processing they are performing. So, we can't simply take a figure for how much power a device uses per hour and multiply it by the number of hours the device is likely to be used. We also need to factor in how heavily the device will be used or work out some way to estimate the average.

Challenge 3 - Data storage location and management

Another problem comes from the use of hosted services like online data storage, back-ups or social media. The energy use will not only vary with the volume of use, but it will also vary depending on where these services are located and how they are operated, which is beyond our control.

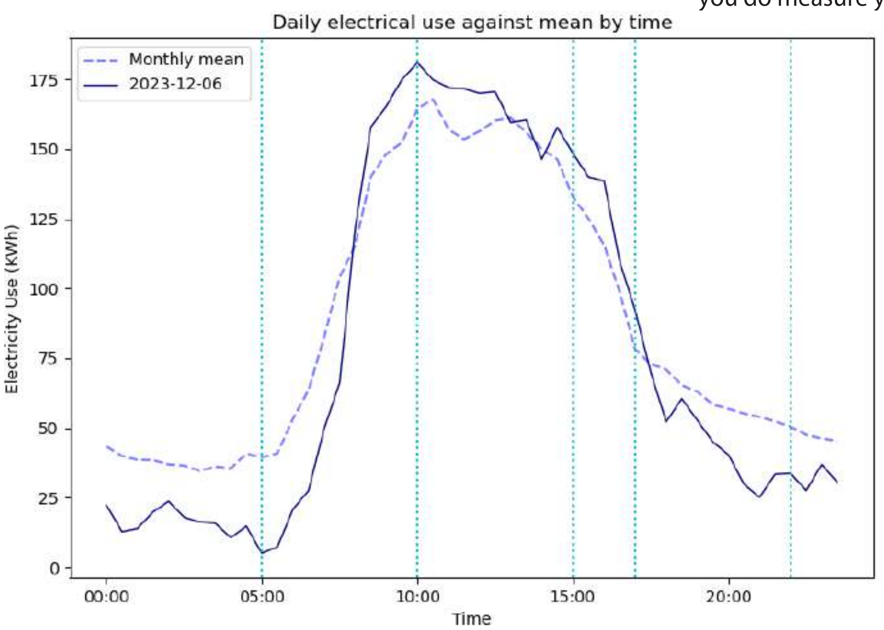
Challenge 4 – Users

The final problem that I'd like to consider is that of flexible working. These days it's becoming increasingly common for staff to want to choose where and how they work. Some will want to work from the office, some will want to work from home, some staff will prefer to work on a company desktop computer, others will want to use a laptop, tablet or even a mobile phone, while others still will want to use their own devices. This adds additional levels of complexity to trying to calculate energy use as you will have to come up with a way of understanding this mix of different use patterns before you begin.

Ways of Measuring Energy Use within your IT Environment

The amount of power used by IT devices will vary based, not only on the type of device, but also on factors such as the efficiency of that particular make and model of the device, whether the device is running or in standby, or whether any form of power saving mode is enabled. It will also vary depending on the level and type of activity. For example, whether a computer is accessing data from a disk drive or processing calculations, and whether a printer is an ink jet or a laser printer, printing 70 pages a minute or 1 an hour. The best way to understand the energy use of your own organisation is to measure it, this will give you real data relating to your actual usage.

There are a number of ways with which you can physically measure the electricity use by IT equipment using meters. If you have your own data centre, with its own electric supply, then you could use half hourly data from an Automated Meter Reading (AMR) meter. If you have an on-premise server room with a dedicated electrical circuit, then you could use a sub-meter in the Distribution Board (DB) to monitor power usage.



The diagram above shows a typical usage profile based on ½ hourly AMR readings. This gives a good indication of how much energy your devices are using and how that varies during the day. In this diagram, I have compared a single day with the mean values at each time, demonstrating how typical usage in the day shown.

Portable Data Loggers are another great way to capture power use. Data loggers typically clip to the outside of a mains cable and use very accurate sensors to record electricity used, which can then be downloaded and analysed. One of the key advantages of this type of metering is that it's cheap and easy to install. Over a period of time you could move the data loggers around, capturing use across your whole site to identify areas of the highest use.

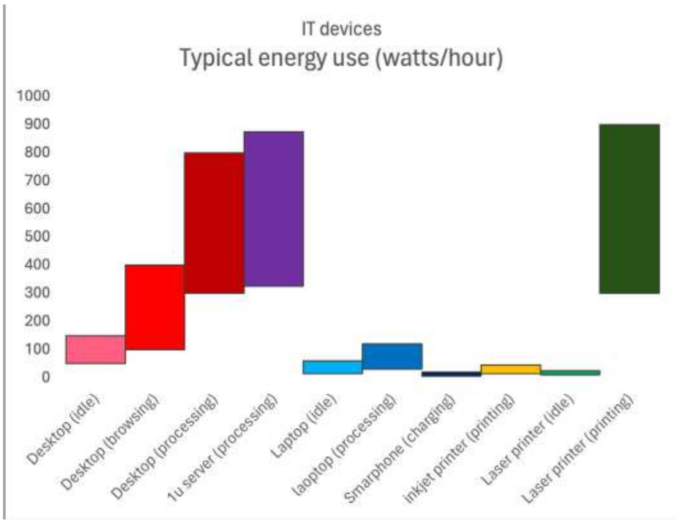
On a more granular level, if you want to understand how much electricity a device is using, for example a server, a copier or a network switch, then installing something like a simple in-line socket meter may be a viable option. This would allow you to measure how much energy the device uses per hour, day or week.

It's important to remember that if you do measure your data using a meter, this data will only give you a snapshot of the power used at the time you measured it. If you want a deeper understanding of your energy use relating to IT equipment, continually measuring your use and monitoring those readings is essential.

Ways of Estimating the Use of Energy within your IT Environment

It may not always be possible or practical to measure the energy used by devices, in which case you may need to estimate usage. Based for example on the number of users or devices you have, the average hours the devices are used for and the average energy used by the device. If you are calculating the overall energy used by your organisation, one way to do this is to create a spreadsheet, listing all of the possible uses of energy in the rows and listing the number of devices, the average hours the devices are used and the average hourly energy used by each device in the columns to calculate the total energy use.

You can usually find data about the power used by a device included in the technical specifications, listed on manufacturers website. There are also a number of websites that publish the results of standard power usage tests, so that you can compare power use across a range of devices.



If you are producing a business case for investing in new technologies, it's good practice to estimate the different power usages for each proposed IT solution when calculating Return on Investment and payback periods.

Carbon Emissions Relating to IT

Because the renewable energy component of the energy mix is increasing, and the vast majority of the energy used within IT is electrical energy, carbon emission relating to IT are generally falling.

When we think about the total carbon emissions associated with IT, we also need to consider the embodied energy, that is to say, the carbon emissions that go into manufacturing, transportation, maintenance and disposal of the IT assets we are using.

Studies estimated that embedded emissions make up around 20%-30% of the IT sector's total carbon emissions. For user devices, the embodied emissions account for an even larger proportion of overall emissions, estimated at around 50%. This is partly due to the comparatively short lifetimes of hardware use.

Reducing Energy Use within your IT Environment

To a large extent changing the behaviour of the user sitting in front of the keyboard will have a higher impact on energy used than any changes you make to the device itself. Ensuring that staff get the right training and fostering a culture of good practice is essential to reducing energy use.

If we are looking at overall energy use, including embedded energy, then extending the working life of user devices by installing additional RAM, larger disk drives or faster processors may be a viable option.

If the life of assets can't be extended then we need to ensure that whenever we purchase new IT equipment, whether that's servers, laptops or monitors we consider the energy rating of that equipment. If we consider overall energy saving for the whole organisation, even if we are able only to replace a device with a new device that is one energy rating higher, the savings may be significant over the lifetime of those assets.

Finally, looking at power profiles, scheduling devices to go into a standby mode after a period of inactivity wherever possible may be another easy win.

Drawing Some Conclusions

When it comes to quantifying energy used by our IT systems, in the majority of cases, it's going to be a best estimate, based on a large number of complex variables.

While there are a variety of ways in which we can reduce operating energy, these choices are far from simple as reductions in operating energy may well be at the cost of embedded energy. IT managers may also be faced with a difficult choice between energy savings and performance decreases.

Even if we could accurately estimate the energy used by our IT assets, these estimates are likely to very quickly become unrepresentative, due to the rate of change in technology.

It's likely that over the next decade, the majority of growth in demand for energy will come from the growing processing requirements of the machine learning and artificial intelligence. But it's also entirely possible that the level of energy used within the sector will decrease, due to advancements in electrical efficiency created by these new technologies.

Author's profile:

David is passionate about Energy, Decarbonisation and Sustainability. Although relatively new to his role in Energy Management within the NHS, he has 20 years of experience working in IT, having headed up the IT Team at Baltic Centre for Contemporary Art in Gateshead. Working closely with the facilities team at Baltic, David used data analysis to support system optimisation, leading to a 50% reduction in energy consumption and associated carbon emissions over 5 years.