Tutorial – Sustainability

In this tutorial our aim is to measure or estimate the power consumption of our workstations (PC or laptop, including additional monitors and other peripherals).

If you are an on-campus student, you can use the power monitoring devices to get an accurate energy consumption reading. Those students studying online can estimate their power consumption using the information printed on the labels of your computer, monitor, and peripherals.

Once you have collected all of this data, discuss each of the short-answer questions at the end of this tutorial as a class. Once you have formed a consensus as a class, record your class answers and submit this tutorial to your teacher for assessment.

This exercise requires your in-class participation. Failure to contribute to the in-class discussion will result in additional assessment tasks.

Measuring the Power Consumption of Your PC (On-Campus Students):

Equipment Required:

> power meter (available at all physical campuses)

Goal:

> Measure the power consumption of a PC workstation under normal conditions when *no* power conservation action is taken. Then measure when taking action to conserve power.

Outcome:

> Obtain 2 accurate kWh measurements.

Method:

1. Use the power meter to measure the exact power usage of a PC over a 48 hour period. This will be the 'control'.
2. Use the power meter to measure the exact power usage of a PC over a 48 hour period when taking measures to conserve power. This is the experiment to see if power conservation measures a) reduce power consumption and b) have an effect on productivity.
3. Compare the results and make conclusions.

Measuring Power Consumption (The Control):

1. Connect the power meter.
   (Make sure you connect it to the power board – as opposed to just the PC power cord – so that the monitor(s), PC and any peripherals are measured at the same time).
2. Start the PC at exactly 09:00
3. Do not turn off the PC
4. Use the PC normally
5. 48 hours later (at exactly 09:00) record the reading on the power meter.

**Turn on Power Management Options:**

We are attempting to see if we can take steps to reduce the power consumption of our workstation.

As a first step, we will activate the power management options of the operating system.

1. From the Windows Start Menu, open the Control Panel. Search for "Power".
2. Select 'Choose a power plan'

3. Set the power management options (as shown in the picture).
   Note, we are just attempting to minimise power consumption when the PC is not in use.
   We are _not_ attempting to cripple the PC and make it unusable (we still want you to be productive).
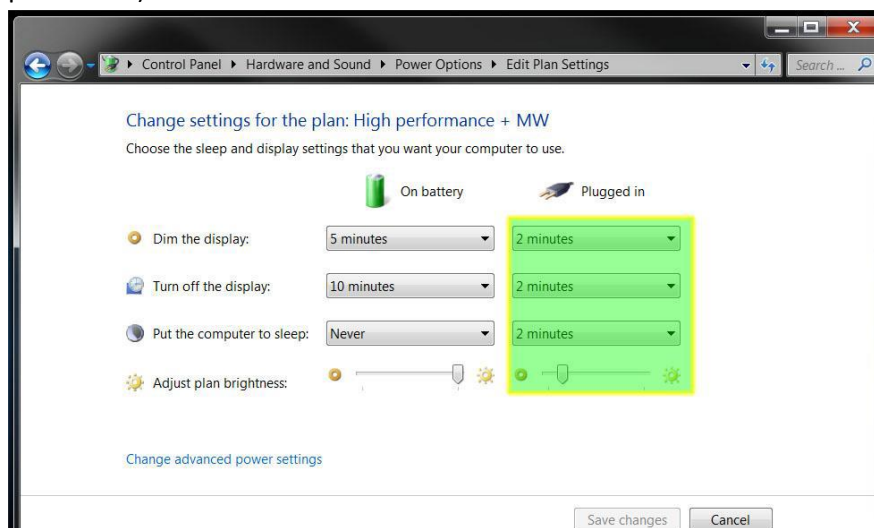
Conservative Work Practices:

During the next phase (when measuring power consumption while trying to conserve power) you will need to actively engage in mildly conservative work practices to help minimise power consumption.

1. Attempt to avoid putting the PC into a max-load state.
   This means minimise the number of software applications that are running at any one time.
2. Ensure the PC goes into a "sleep" state (wither automatically or manually) when you are not using it.
3. At the end of the day, shutdown the workstation and unplug the computer (or turn off at the wall if practical).
   Your computer will still consume a very small amount of power even when it is turned off. Unplugging the machine (and monitors) will avoid this.

Measuring Power Consumption (The Experiment):

Conduct the measuring activity again. Start at exactly 09:00 and monitor power consumption for 48 hours. Record your results.

Estimating the Power Consumption of Your PC (Online Students):

Without a power meter (a device that sits between the electrical outlet and the plug for your computer) it isn't possible to accurately measure the power consumption of your computer.

But using the information on the power label it is possible to calculate the maximum power consumption of your computer and some peripherals.

Take a photo of the power label on your computer or power brick.

This image shows the power label on the power brick for a laptop.

If you have monitors or other peripherals (like a Wacom) attached to your computer that require a separate power supply (that is, they don't draw their power from a USB port), then take a photo of the power labels on these devices also.

This image shows the power label on the underside of a monitor.

There are two figure we will need to calculate the watt usage of the devices.

On the label, find the *Output* specification. It will look something like this:

There are two numbers that are important here: the volts (V) and the amps (A).

In the image above the output reading specifies 19.5 Volts, and 7.7 Amps.

To calculate the watts, the power *P* in watts (W) is equal to the current *I* in amps (A) multiplied by the voltage *V* in volts (V):

$$P_{(W)} = I_{(A)} \times V_{(V)}$$

If we plug the figures above into this formula we get:

$$P_{(W)} = 7.7 \times 19.5$$

This gives us a total power of 150 Watts.

But a power reading in watts is not very helpful when our power company bills us in kilowatt-hours (kWh). Luckily we have a formula for that too!

The energy E in kilowatt-hours (kWh) is equal to the power P in watts (W) multiplied by the time period *t* in hours (hr) divided by 1000:

$$E_{(kWh)} = P_{(W)} \times t_{(hr)} / 1000$$

Say we were running our machine for 8 hours, that would give us:

$$E_{(kWh)} = 150 \times 8 / 1000$$

For a total of 1.2 kilowatt-hours.

Perform these calculations on each device connected to your computer that requires a standalone power supply. Add these figures together to get the total power usage of your computer in kilowatt-hours.

Now that you know the power consumption of your machine in kilowatt-hours for a given period of time, calculate how much your machine will cost to run during that time period.

For that you will need to know how much your power company charges you per kilowatt-hour. You can find this figure on your power bill or on you power company's web site.

Questions:

Form your own opinion on the following questions so that you can contribute to the in-class discussion.

Discuss each question as a class. Do all students agree? As a class try to agree on a point of view, and list changes that you can all agree on that will reduce your class' energy use.

When your class has discussed each question, record the outcome of the discussion in the spaces provided and submit these answers to your teacher for assessment.

What is the power consumption for 1 day (8 hours) for your workstation?

Answer in kWhs.

Do high-end PC workstations use too much power?

Use the data you have collected to support your answer.

Is it possible to do the same work and use less power?

Use the data you have collected to support your answer.

Recommend some changes that you could implement to reduce the use of energy and resources in the workplace.

List some recommendations that would be practical to implement.

Challenge:

For on-campus students, try to implement some or all of your recommendations and measure your power consumption again. Did you see any improvements? Record your results.