How Green is Your PC?

Background

Between melting nuclear plants, electric cars, peak oil and wind farms, you might have gotten the impression that most energy issues are big, distant and largely intractable. However, this isn't always true – many energy conservation matters that are within our grasp can actually make a difference, albeit a small one in overall energy consumption. This project is an example.

Like every other electrical appliance, personal computers use electricity, and although PC's use a lot less electricity than say, clothes dryers or water heaters, their sheer numbers do add up.

How much?

> " ...we know that computing sector consumes about 2.61% of all the electricity. Hence, the contribution of the computing sector to the global CO2 emissions is 0.31 billion tons of CO2. Therefore, even though the computing sector electricity consumption is 0.31% of the global energy consumption, this fragment contributes to 1% of global CO2 emissions. Thus, achieving even a modest 5% decrease in computing sector electricity consumption with efficient practices can prevent about 5.5 million tons of CO2 emissions per year. *Therefore computing sector presents a very attractive opportunity in the global race to control greenhouse emissions."* [Italics original] (Somavat Pavel, Shraddha Jadhav, Vinod Namboodiri. "Accounting for the Energy Consumption of Personal Computing including Portable Devices", In Proceedings of the 1st International Conference on Energy-Efficient Computing and Networking (e-Energy), Passau, Germany, April 2010.)

Computer manufacturers are already at work reducing the power demands of computers and their

component chips of course. The Federal Government's Energy Star program represents one of these attempts.

But how much electricity does your computer actually use, and what can you do to minimize its power consumption? Does that gaming machine you put together use a lot more electricity than your laptop? How much electricity would Valencia save if all the computers in the Computing Lab went into "sleep mode" between classes? How much more electricity does your laptop or desktop PC use when it's say, playing a video, versus when it's just idling?

This project is about finding some answers to these and other questions by conducting some experimental measurements of just how much electricity various computers actually consume. To do this, we'll need:

- A *sensor* – and there are a couple of possibilities. One is a precision current transformer, a device that safely monitors the amount of current drawn by an electrical appliance. Another is to adapt (i.e. "hack") an inexpensive digital ammeter so that it can connect to a monitoring computer. The sensor lets us monitor the amount of electricity the PC under test is using from second to second.

- A *monitoring system* – to make displaying and analyzing the information about power consumption by the PC under test, we'll use another PC and software we develop to record and display the information.

- *Software* – we'll put together some custom programming to record analyze and visualize the power consumption data we collect. This is a good example of a data visualization application and it's a good opportunity for some creative programming.

Connections

The software we'll be developing here will let us make connections to other areas of science and technology. And that's important since programming courses are mostly about technique, but applications are what really count. I think it is analogous to painting:

> "The professional dedicates himself to mastering technique not because he believes technique is a substitute for inspiration but because he wants to be in possession of the full arsenal of skills when inspiration does come." (Steven Pressfield)

Clearly this project is related to Physics, more specifically to the principles of electromagnetic fields. We'll be measuring electric current, and calculating electrical power by factoring in the voltage involved. The current transformer works by measuring alternating current, an important theoretical as well as practical concept.

We may also need some filtering to smooth the data so that the overall trend in electrical consumption is more obvious. This connects to both statistics and to the area of engineering (and programming) known as Digital Signal Processing (DSP).

Some of the variables that we'll change to see the effect on PC energy consumption include type of PC (desktop or laptop, PC or Mac), effect of various power management options (e.g. sleep mode) and what sort of application the machine is running (word processing versus playing a video).

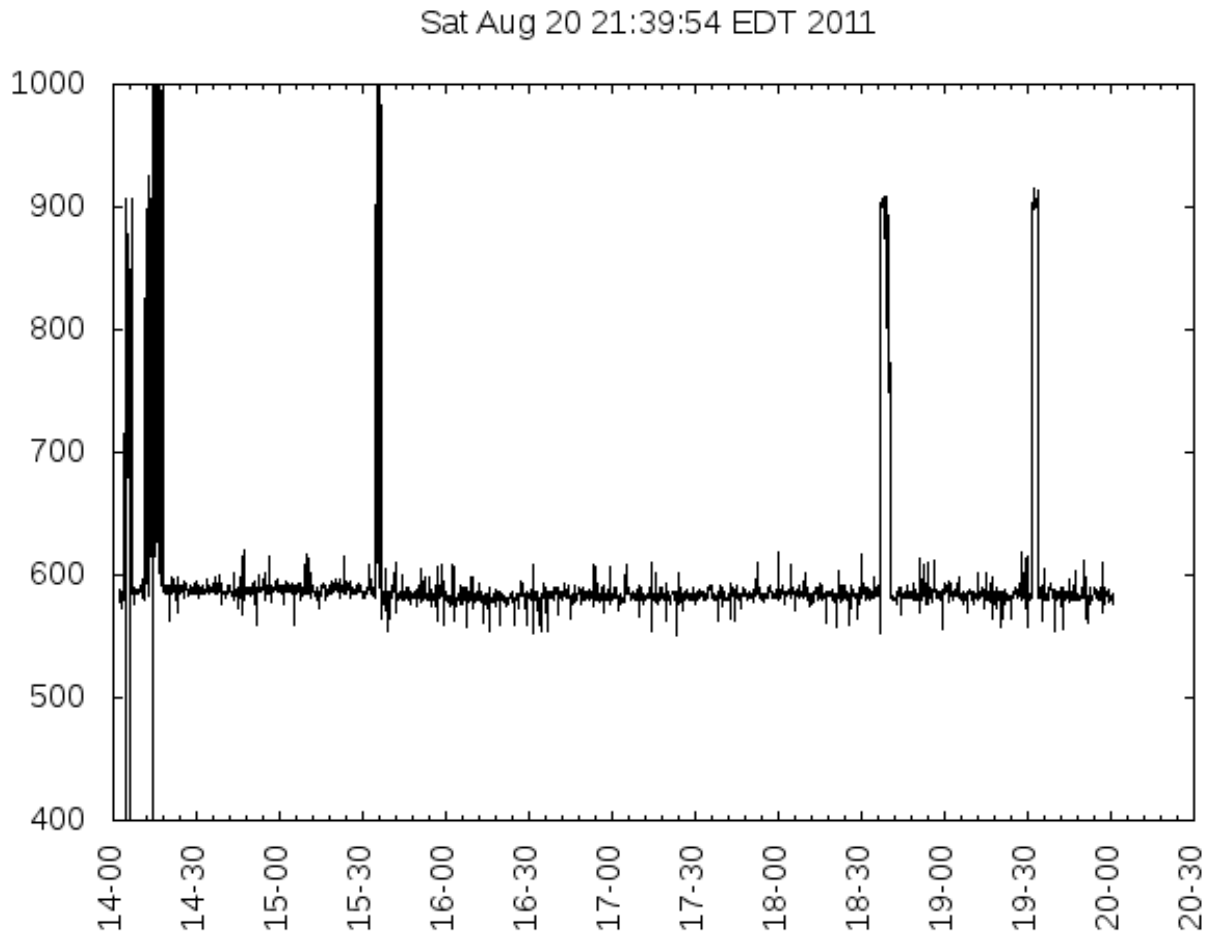
Hopefully one of these connections will provide your inspiration for some entertaining programming.

Prototype

As a test of the sensor, I collected some data using a crude prototype program. Here's a graph I produced with Gnuplot. It shows the electrical consumption of an older desktop PC I use as a server. The spikes occur when I issue some command to the Linux OS that results in a lot of disk activity.

Note that the Y axis is uncalibrated – one of our tasks in our program will be to calibrate the sensor so our software can display the power consumption in watts.

And this graph is static – the visualizations we produce with out program will run and update in real time so everyone can see the results of our experiments immediately displayed.



Project Details

TBA

Sensors

TBA

Calibration

TBA

Visualization

TBA

Experiments

TBA

Extensions, Spin-Offs, etc.

TBA