Feb 10, 2007

Fresh Data in the Classroom

P3 International
KillA Watt

Student-owned data for studying the environment

Participants are invited to consider using modern data-loggers to measure their environment, providing an engaging tool for inquiry.

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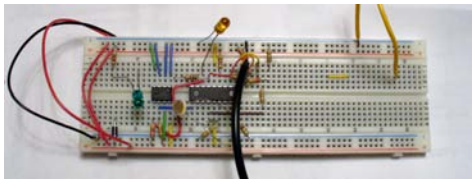
Hobo Family

LogTag

Equipment

There are several companies manufacturing datalog-gers from $50 to $500, all which take measurements and record them either internally or provide them to a computer or calculator. Internally-logging equipment comes with a certain amount of memory and usually batteries for weeks to months of measurements. Equipment that instantaneously puts data to a computer or calculator can't be placed in harsher environments, but their user-interface lends itself to easier analysis. For the intrepid, it is possible to build a datalogger from electronic components and wires; the labor is arduous, but the price is right–I've made a logger for about $10 in materials.



Parameters

Loggers can measure temperature, light, voltage, current, humidity, pH, and events, to name the most popular. "Events" can include the tipping of a rain-gauge, times of day that a light is turned on, students walking into a room, irrigation switching on/off, or anything you can turn into an electrical switch.

Example

Refrigerators, from tiny dorm-room refrigerators to several-ton dairy units, use some input energy to move more energy from the items to be cooled; anyone who pays the bills would be interested in reducing that input energy. For example, dairies in CA in 1995 produced between 14 and 30 kg milk/kWh, using that electricity to operate vacuum pumps, lights, and coolers; the

cost of that electricity was less than 2% of the total cost of production.[1] Analysis revealed, among other results, that dairies with larger herds used slightly more power per cow, but didn't consistently produce more milk per unit energy.

All sorts of discussions and clarifications can follow from such a published report; but, if students created such a report themselves, their learning is much more valuable. Last fall, to model what I would expect of my students, I set up my own inquiry, asking what the conditions would be in my own refrigerator, and how energy input related to those conditions. I made no guess/hypothesis, leaving it to the data to do the talking.

Two solar cookers in below-freezing tests

Inside my refrigerator, I placed a logger that measured the temperature and humidity every minute. I placed a duplicate of that logger outside the refrigerator. I also plugged the refrigerator into a logger that measured the power, power factor, current, and voltage every second. Analyses and inferences are found in an article in Energy Teachers Community News.[2]

Pushing 180 in the pot

On a day a few degrees below freezing, I managed to cook frozen (!) vegetables in a solar cooker you see on the right of the photo above. The tool in this case was an oven thermometer. I also used thermocouple probes to test the temperature at different places inside and outside the oven; the reader I used doesn't record, so I took recordings the old way with pencil and paper, not a necessarily a bad thing. My study was inspired by Solar Cooking International, a research organization that main-

Thermocouple reader

[1] Collar et al, 1996. California Dairy Energy Project, Dairy and Livestock Research Report, Sacramento, CA. http://www.energy.ca.gov/process/pubs/calif_dairy_energy.pdf

[2] Reeves, S. 2006. Energy Teachers Community News, Newton, MA. http://energyteachers.org/ReadArticle.php?id=146

tains lots of documents on their web site.[3]

Nuts and Bolts

There are a few things you need to know to get dataloggers to work in your classroom. Most loggers use button-sized batteries, and some loggers will let you know if their battery needs replacing or how long it will last. Loggers communicate with their host-computers through serial (inexpensive), **USB** (standard), **optical** (safe), **ethernet** (fast), or **wireless** (expensive) ports. Before you acquire a logger, you should make sure that it can communicate with whatever computer/calculator you will have. You should also make sure that the host can run the software that comes with the logger or that you can easily purchase software that is compatible.

Host software will usually let you set up an experiment in several ways:

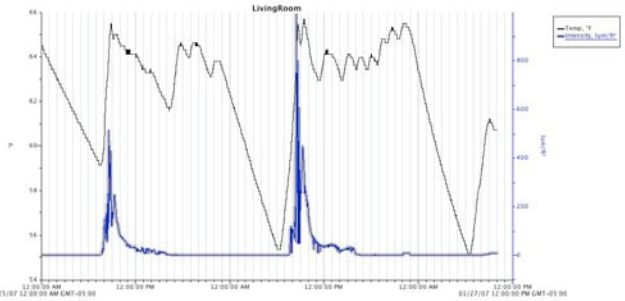
1. Set the time interval between measurements, from once per second to once per day or longer.

2. Tell the logger, if it has multiple channels, which to record. If you have a logger that can measure temperature, light, and relative humidity, but humidity isn't important to you, you can turn off that channel, allowing more measurements of the other two.

3. Set a start delay. You might not want the measurements to start until midnight or some other time/day.

4. Stop measuring when memory is full, or record over oldest data.

Then, when the measurement is done, you can connect the logger to a computer that will communicate with the logger, request the data, and, if you like, relaunch the logging feature. Software from the manufacturers makes multiple-variable graphs easy.



Graph of living room light and temperature over two and a half days, starting at 12 AM. Notice the light in the morning, since my living room faces west.

[3] http://www.solarcooking.org