CS BITS & BYTES
National Science Foundation

CS Bits & Bytes is a bi-weekly newsletter highlighting innovative computer science research. It is our hope that you will use CS Bits & Bytes to engage in the multi-faceted world of computer science to become not just a user, but a creator of technology. Please visit our website at: http://www.nsf.gov/cise/csbytes.

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Smart Grids

Have you ever wondered how much energy it takes to watch television? Play a video game? Or do your homework on your computer? User-friendly, energy sensors can pick up individual activity patterns to calculate how much energy your devices are using.

A map of the Earth at night from space. Lights show energy usage and thus, population centers. Photo courtesy of NASA.

These sensors can provide information in real time and wirelessly – innovations enabled by computer science research! When a device is turned on or off, the switching process generates changes in the overall electrical signal in your house. The noise in the electrical signal, like static on a radio, can be detected and analyzed to determine what appliance has just been turned on or off. When this record is compared with electricity usage, you can see what device uses the most energy.

Learn how two students changed the energy consumption at their school by smart monitoring and find ideas for what you can do at your school at http://www.smartpowered.org.

Throughout the nation: We create a large demand for electricity at varying times throughout the day. For example, when we go to bed, much of our energy use subsides. In addition to variable demands, some energy sources - like wind and solar - have uneven availability. The changing demand and availability of energy makes it difficult for suppliers to make sure that the electricity we want is there when we want it.

Smart Grid technology is a new way to manage and distribute electricity based on availability and consumption, thereby **enabling energy to flow where and when it is needed**. These digitally enabled electrical grids can deal with downed power lines, uneven production, and spikes in energy use. They can even incorporate energy storage (like car batteries) to take advantage of intermittent energy sources.

Smart Grids require access to real-time production and usage information. As a result, many utility companies are moving to smart meters, an electrical meter that records consumption in small time increments like 1 hour and reports the information to the electric company at least once a day, to give more feedback about energy usage.

MUST SEE!

What is the Smart Grid? Click here to watch the video at:
http://www.nsf.gov/news/special_reports/eng_mill/energy/smart_grid/

Professor Shwetak Patel. Photo courtesy of Shwetak Patel.

Who thinks of this stuff? Shwetak Patel is a Professor of computer science and electrical engineering at the University of Washington who is working to make energy consumption information easily accessible. He develops sophisticated, user-friendly energy sensors for homes and offices. Some of the technology he has developed is now being put to use in Belkin power strips. His sensors can also be used to monitor human motion in a building, with applications in elder care and home security. He was recently recognized as a 2011 MacArthur Fellow, receiving a five-year $500,000 grant. Professor Patel likes to travel, snowboard, work on cars, and build and race remote control cars and planes.

Links:

Learn more about Smart Grid technology at: http://energy.gov/oe/technology-development/smart-grid.

Read about energy devices at: http://www.usnews.com/science/articles/2011/10/14/device-to-measure-energy-use.html.

Learn more about Professor Patel's lab at: http://ubicomplab.cs.washington.edu/wiki/Main_Page.

Visit www.coolschoolchallenge.org for more ideas to reduce energy usage at your school!

Classroom Activity:

This activity will help students realize how a Smart Grid could work.

1. Form groups of roughly six students and provide each group with a roll of string and pair of scissors.
2. Have all but one student, who will serve as the observer, stand in a circle and pass the roll of string around. It should not just be passed circularly, but rather cross through the center. The string should go back to a student more than once.
3. Announce that the string represents power lines.
4. Have the observer pick two students in the circle and map the most efficient route for energy to travel.
5. Now have the observer start cutting some strings randomly (a storm has knocked down some power lines or a station is overloaded with requests).
6. Have the observer look again at the paths between the two students and have the groups discuss the following questions: (1) Can energy still flow? (2) Is the energy flow as efficient as before?

At Home Activity:

This activity will help students realize their own energy use:

Keep a journal to log the times you connect to the power grid. Any time you turn on or turn off something that uses electricity, keep track of it. Note that many appliances indicate wattage and the cost /kW hour can be found on an energy bill. How many appliances do you use that are always on? Your alarm clock? Cable box? Refrigerator? After tracking for a set amount of time (a day or a week), try to determine your energy consumption.

A sample journal table:

Device / Appliance	Time On	Time Off	Time Used	Wattage	Cost/kW hour

Once stuents have completed this at home, have a class discussion about energy use.

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