During the fall 2014 Assessment Day activity, Lucas Myers led an exercise evaluating the validity of evidence provided in a case study (attached to this document) about different types of lightbulbs. Faculty participants were encouraged to think about finding ways to get their students to evaluate whether or not their answers make sense.

A few ideas that came out of the morning included:

- Project for English 102. Students will select an infographic related to their research topic for the final essay. They will research to "fact check" the information and ask questions about the validity of the data; including questioning what is included and excluded. Further, they will perform rhetorical (visual) analysis and assess the overall effectiveness of the display.
- Project for Nursing: drug calculation test will be revised to include the following questions after each item:
    - Does this answer make sense in terms of:
        - Practicality? (This would means that it would be impractical to give $1/50^{th}$ of a pill, or three liters of cough medicine, etc.)
        - Concentration? (If the medication is 10 mg/pill and your dose is 25 mg, you should be giving more than one pill.)
        - Answering the question? (If the question is asking for how many mls you would give, don't answer in milligrams.)

NATIONAL CENTER FOR CASE STUDY TEACHING IN SCIENCE

A Green Light for CFLs?

by
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It was Saturday afternoon and Alessandro, Judy, and Carmela were at the MegaMart grocery store near campus. It was their turn to do the weekly shopping for the TreeHouse—the campus theme house occupied and run by students in the Environmental Studies program. As the students entered the store, they went their separate ways to get the different items on their list. Alessandro headed towards the bakery section, and on his way, he passed an extensive selection of light bulbs. Remembering that one of the lights in the living room was out, he stopped to peruse the display.

The array of choices was a bit overwhelming—incandescent and compact fluorescent bulbs in a range of shapes, sizes, and wattages, and even some other alternatives like LEDs. For a moment, Alessandro was confused by the assortment and didn't know what he should choose.

"I keep hearing about these CFLs," he thought. "They're supposed to be much more efficient. I think I even remember reading that the government is requiring that incandescent bulbs be phased out in favor of CFLs. If they're that much better for the environment, it seems like we should have them in the TreeHouse."

Alessandro picked out a compact fluorescent lamp that said it was equivalent to the 75-watt bulb they needed to replace in the living room. He scanned the packaging.

"Hmm…," he thought to himself. "Lasts ten times as long, uses less energy…. It's kind of pricey, but maybe it will be worth it in the long run. Looks kind of goofy, though. I wonder if it will fit in the lamp?"

Deciding to give it a try, Alessandro put the CFL in the cart and was ready to head for the bagels when Judy passed by on her way to find chips and salsa.

"Hey Judy!" said Alessandro. "Look what I got to replace that light in the living room that's out."

"Ugh!" said Judy. "A CFL? Haven't you learned anything from your Environmental Studies classes? Those things are just greenwashing—they claim to be better, but they're actually worse for the environment."

"No way!" proclaimed Alessandro. "Read the package: These bulbs use 75% less energy than those old incandescent bulbs. Most of the energy used to power those goes to heat instead of light."

"Here," said Judy, handing Alessandro an incandescent bulb, "compare the weight of these two. Incandescent bulbs are simple to make, while CFLs need complicated electronics in their bases to make them work. The manufacturing process for CFLs is complex and energy-intensive. When you add it all up, the process uses so much energy that it outweighs the benefits of using the stupid things. You'd be better off just sticking to regular old incandescent bulbs, and besides they're way cheaper."

Alessandro was stung. "Now wait a minute," he said. "CFLs may cost more but they last 10 times as long as regular bulbs. Not only will that save us replacement costs, but it will also save us money in the long run on our electric bill. Plus, if we're using less electricity, we're generating fewer greenhouse gases. That has to be better, right?"

"Only if the energy you save with CFLs is greater than the extra energy it takes to make them," said Judy, "and I just can't see how it could be. Feel how heavy that is. Besides, fluorescent lights are meant to be left on for long periods of time. Turning them on and off shortens their lifespan. So you either leave the light on all the time, which wastes energy, or you turn it on and off and it doesn't last as long. I say stick with the incandescents."

"Here comes Carmela." said Alessandro, "I know she'll agree with me on this one. Here Carmela, catch!" Alessandro tossed Carmela his great, green find.

"Ack! Alessandro! Don't toss those things around like that! What if it broke? What are you trying to do, give me mercury poisoning?" Carmela was clearly not impressed.

"What do you mean, mercury poisoning?" Asked Alessandro. "Do those things have mercury in them?"

"Yes," replied Carmela, "And that's something to worry about. Suppose it gets broken at home? Then people, including kids, and their pets are exposed to mercury. Most people don't know the proper way to clean it up. Also, when CFLs burn out they're supposed to be recycled, but that doesn't usually happen. Most people just toss them in the trash, where they break. Now the garbage workers are at risk, and when the bulb finally ends up in a landfill, it can break and leak mercury into the environment and even the ground water. Sure, they're more efficient. I'm just not sure they are the better choice."

"See, Alessandro," Judy chimed in, "CFLs are bad for the environment in all sorts of ways. They may say they're green but if you look at the big picture that's not really the case. Go trade it for an incandescent."

"But if CFLs are so bad," argued Alessandro, "why are governments all over the world, including our own, passing legislation phasing out incandescent bulbs? The EPA says that if everyone in the U.S. replaced just one bulb in their house with a CFL that would save enough energy to light more than 2.5 million homes for a year and prevent greenhouse gases equivalent to the emissions of nearly 800,000 cars. I think we should do our part. Now I still have to go get bagels."

He placed the CFL in the cart and the three students separated to continue their shopping. But they were all a bit unsettled about the decision. Carmela was worried about the mercury inside the CFL, but couldn't deny their efficiency. Judy was angry that Alessandro was wasting his money on the CFL. She was certain its manufacturing process canceled out its efficiency benefits, and the longer lifetime was questionable. Alessandro was happy he was going green with the purchase of a CFL, but was he really making the right decision? Judy and Carmela's arguments had put some doubt in his mind. He clearly needed more information.

Has Alessandro made the right decision in purchasing a CFL for the TreeHouse? How would you know?

References

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Lower Columbia College -- September 2014

JULIE ANN WRIGLEY GLOBAL INSTITUTE of SUSTAINABILITY

Why Use CFLs?

Lighting accounts for close to 20 percent of the average home's electric bill. ENERGY STAR-qualified CFLs use up to 75 percent less electricity than incandescent light bulbs, last up to 10 times longer, cost little up front, and provide a quick return on investment.

For more information about compact fluorescent bulbs, visit http://www.energystar.gov/cfls (http://www.energystar.gov/cfls)

If every American home replaced just one light bulb with an ENERGY STAR qualified bulb, we could save enough energy to light more than 3 million homes for a year, more than $600 million in energy costs, and prevent greenhouse gases equivalent to the emissions of more than 800,000 cars.

In 2007, Americans saved $1.5 billion by switching to ENERGY STAR qualified CFLs. The energy saved could light all the households in a city the size of Washington, D.C., for over 30 years. Put another way, changing these bulbs removes as much greenhouse gas pollution as planting 2.85 million acres of trees or taking 2 million cars off the road each year.

Using ENERGY STAR qualified CFLs results in less mercury in our environment. Coal-fired power plants are the largest source of human-caused mercury emissions in the United States. A coal-fired power plant produces 13.6 mg of mercury to power one 60 watt incandescent bulb, but only 3.3 mg to power an equivalent CFL. Even with 5 mg of mercury inside, using CFLs results in 5.3 fewer milligrams of mercury compared to incandescent bulbs.

The average ENERGY STAR qualified light bulb is designed to last 8,000 hours – more than 7 years based on typical household use. That's long enough to earn an undergraduate and graduate degree at ASU.

Yes, CFLs contain mercury

CFLs contain a very small amount of mercury sealed within the glass tubing – an average of 4 milligrams. By comparison, older thermometers contain about 500 milligrams of mercury – an amount equal to the mercury in 125 CFLs. Mercury is an essential part of CFLs; it allows the bulb to be an efficient light source. No mercury is released when the bulbs are intact (not broken) or in use.

Most makers of light bulbs have reduced mercury in their fluorescent lighting products. Thanks to technology advances and a commitment from members of the National Electrical Manufacturers Association, the average mercury content in CFLs has dropped at least 20 percent in the past year. Some manufacturers have even made further reductions, dropping mercury

More about mercury emissions

EPA estimates the U.S. is responsible for the release of 104 metric tons of mercury emissions each year. Coal-fired power generation accounts for roughly 40 percent of those mercury emissions. Mercury released into the air is the main way that mercury gets into water and bio-accumulates in fish. (Eating fish contaminated with mercury is the main way for humans to be exposed.)

Most mercury vapor inside fluorescent light bulbs becomes bound to the inside of the light bulb as it is used. EPA estimates that the rest of the mercury within a CFL – about 14 percent or 0.6 mg – is released into air or water when it is sent to a landfill, assuming the light bulb is broken. Therefore, if all 290 million CFLs sold in 2007 were sent to a landfill (versus recycled, as a worst case) – they would add 0.16 metric tons, or 0.16 percent, to U.S. mercury emissions caused by humans.

For more information on all sources of mercury, visit http://www.epa.gov/mercury (http://www.epa.gov/mercury)

Mercury math

Electricity use is the main source of mercury emissions in the U.S. CFLs use less electricity than incandescent lights, meaning CFLs reduce the amount of mercury into the environment. As shown in the table below, a 13-watt, 8,000-rated-hour-life CFL (60-watt equivalent; a common light bulb type) will save 376 kWh over its lifetime, thus avoiding 4.6 mg of mercury. If the bulb goes to a landfill, overall emissions savings would drop a little, to 4.0 mg. EPA recommends that CFLs are recycled where possible, to maximize mercury savings.

Light Bulb Type	Watts
CFL	13
Incandescent	60

Because CFLs also help to reduce greenhouse gasses, other pollutants associated with electricity production, and landfill waste (because the bulbs last longer), they are clearly the environmental winner when compared to traditional incandescent light bulbs.

Lower Columbia College -- September 2014

Handle CFLs with care

CFLs are made of glass and can break if dropped or roughly handled. Be careful when removing the bulb from its packaging, installing it, or replacing it. Always screw and unscrew the light bulb by its base (not the glass), and never forcefully twist the CFL into a light socket. If a CFL breaks in your home, follow the EPA's recommendations (http://www.energystar.gov/ia/products/lighting/cfls/downloads/CFL_Cleanup_and_Disposal.pdf) . If a CFL breaks in your ASU residence hall, call your front desk for immediate cleanup. Used CFLs should be disposed of properly (recycled) according to EPA recommendations (http://www.energystar.gov/ia/products/lighting/cfls/downloads/CFL_Cleanup_and_Disposal.pdf) , or by placing a Residence Hall service request.

Can a broken CFL cause mercury poisoning?

Mercury is toxic in high doses. CFLs contain an average of 4 mg of mercury – an amount that would fit on the head of a pin. While that amount is not likely to present excessive risk, any mercury spill should be handled carefully (see EPA recommendations (http://www.energystar.gov/ia/products/lighting/cfls/downloads/CFL_Cleanup_and_Disposal.pdf)).

Every situation is unique. That said, we like the way this article by Harvard professor Helen Suh MacIntosh (http://www.treehugger.com/files/2007/05/ask_treehugger_14.php) breaks it down:

"A CFL containing 5 mg of mercury breaks in a bedroom that has a volume of about 25 m3 (which corresponds to a medium sized bedroom). The entire 5 mg of mercury vaporizes immediately (an unlikely occurrence), resulting in an airborne mercury concentration in this room of 0.2 mg/m3. This concentration will decrease with time, as air in the room leaves and is replaced by air from outside or from a different room. As a result, concentrations of mercury in the room will likely approach zero after about an hour or so."

"Under these relatively conservative assumptions, this level and duration of mercury exposure is not likely to be dangerous, as it is lower than the US Occupational Safety and Health Administration (OSHA) standard of 0.05 mg/m3 of metallic mercury vapor averaged over eight hours. [To equate these values, we could estimate the average indoor airborne mercury concentration for 8 hours, beginning post-spill at an estimated starting value of 0.2 mg/m3 and decreasing from there. If one assumes that the air exchanges completely in one hour (a fairly standard assumption), then the 8-hour average concentration would be 0.025 mg/m3.]"

Sources:

http://www.energystar.gov/cfls (http://www.energystar.gov/cfls)

http://www.energystar.gov/ia/partners/promotions/change_light/downloads/Fact_Sheet_Mercury.pdf (http://www.energystar.gov/ia/partners/promotions/change_light/downloads/Fact_Sheet_Mercury.pdf)

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