A Flicker of Light: Using Mobile Experiences to Educate Consumers about Energy Efficiency

Sable Sellick
Graduate Assistant
Department of Agricultural Education, Communications and Technology
University of Arkansas
205 Agriculture Building
Fayetteville, AR 72701
479-575-2035
ssellick@email.uark.edu

Janviere Umuhoza
Graduate Assistant
Department of Electrical Engineering
jumuhoza@email.uark.edu

Catherine W. Shoulders
Assistant Professor
Department of Agricultural Education, Communications and Technology
cshoulde@uark.edu

University of Arkansas
205 Agriculture Building
Fayetteville, AR 72701

A Flicker of Light: Using Mobile Experiences to Educate Consumers about Energy Efficiency

Introduction/Need for Innovation

In 2007, the United States Congress passed legislation calling for significant improvement in the efficiency of incandescent light bulbs beginning in 2012. A study by Di Maria, Ferreira, and Lazarova (2009) found that a major barrier to adoption of energy-conserving measures, such as more efficient light bulbs, was a "lack of awareness of benefits" (p. 13). Five years later, a study by Min et al. (2014) found that U.S. consumers were less likely to adopt energy efficient light bulbs as opposed to other energy efficient appliances and technology. Supporting this view, an examination of energy policy by Fuchs and Arentsen (2002) found that consumers lacked knowledge about electrical consumption and its associated effect on the environment. The National 25x'25 Agriculture/Forestry Steering Committee (2008) listed consumer education about renewable energy as one of its priority education needs, in addition to creation of curriculum for "incorporat[ing] energy concepts into instruction programs" (p. 59).

There is a need to create awareness in consumers about electricity consumption and renewable energy options. van't Hooft (2005) found that students perceive hands-on learning as more effective, and Johnson, Wardlow, and Franklin (1997) discovered that hands-on activities were associated with more positive attitudes toward science-centered subject matter. In an investigation of student awareness of biodiesel, Sallee, Edgar, and Johnson (2013) found that a demonstration method of instruction increased student interest in the lesson compared to a lecture. A hands-on demonstration of solar power and energy consumption may be useful in increasing consumers' awareness of renewable energy sources and energy usage.

How It Works

We developed the Mobile Energy Efficiency Manipulator to assist educators in engaging learners in experimentation and inquiry regarding energy efficiency (Figure 1).

Figure 1. Mobile Energy Efficiency Manipulator

The Mobile Energy Efficiency Manipulator uses a 320-watt solar array to power 14 lamp bases and two electrical outlets displayed on an artificial wall. Contrary to a wall in a home, the artificial wall will only supply electricity to loads that do not require more electricity than is being generated by the attached solar array. This static electricity source allows consumers to

experiment with the number of lightbulbs that can be powered by the array, very clearly displaying the difference in electrical loads required of incandescents, compact flourescents (CFLs), and light-emitting diodes (LEDs). As the learner flips on more light-switches, the bulbs begin to flicker or brown out when the load becomes greater than the solar energy input. The solar array does not have a battery backup system, which enables learners to experience the efficiency of renewable energy technology to convert solar energy in to electricity; as clouds block sunlight, the number of lightbulbs that can be powered changes rapidly.

Results to Date/Implications

The Mobile Energy Efficiency Manipulator was tested numerous times and proved successful at demonstrating energy use of all three types of light bulbs. We discovered that with clear, sunny conditions, the solar array was able to power a single 60-watt dimmable incandescent bulb and as more of the incandescent bulbs were switched on, every bulb dimmed. Eight CFLs were able to be powered; the eight working CFLs began to flicker and dim as more bulbs were turned on. It was discovered that non-dimmable LED bulbs were not well-suited to the purpose of the board as one or two of the bulbs would shut off completely as the power was distributed among all the loads. However, with dimmable LEDs, all 14 light bulbs would operate. The setup was used at a homesteader's conference and was well-received by learners, who used the board as a model for determining off-grid energy efficiency in their own homes.

Future Plans/Advice to Others

The development of the Mobile Energy Efficiency Manipulator proved to be a challenge, even for external renewable energy consultants. In order for solar energy, which is captured as direct current electricity to be converted to alternating current electricity, the unit required a solar micro-inverter, which, in available models, uses a battery. In our setup, the micro-inverter's battery would supply the artificial wall with additional electricity as the number of light bulbs turned on exceeded the supply from the solar array, causing the entire manipulator to fail in its purpose. We overcame this issue by collaborating with a graduate assistant specializing in Electrical Engineering, who was able to invent a battery-free micro-inverter specifically for use with the manipulator. We are currently in the process of constructing three more manipulators, which can be borrowed, free of charge, from the [University] [Renewable Energy Program]. Because these boards were both costly and challenging to construct, we recommend interested parties borrow one of the existing manipulators; however, we are happy to provide plans for the construction of the manipulators (excluding the micro-inverters, as they are patent-protected), should interested parties wish to construct the board themselves.

Costs/Resources Needed

The total cost for materials for one complete setup was approximately $1000. The solar panels used in this project were donated by the [University] Office for Sustainability, which may be an added cost for anyone wanting to replicate the manipulator. A complete list of resources and instructions will be provided to interested parties. Should interested parties wish to borrow an existing manipulator through the [University] [Renewable Energy Program], the only resources needed would be a cargo van and the time to transfer the manipulator to the desired location.

References

Acker, D. (2008). Research and education priorities in agriculture, forestry and energy to achieve the 25x'25 renewable energy vision. *NACTA Journal, 52*(1), 55-59.

Di Maria, C., Ferreira, S., & Lazarova, E. (2010). Shedding light on the light bulb puzzle: The role of attitudes and perceptions in the adoption of energy efficient light bulbs. *Scottish Journal of Political Economy, 57*(1), 48-67. doi: 10.2139/ssrn.141948

Fuchs, D., & Arentsen, M. (2002). Green electricity in the market place: The policy challenge. *Energy Policy, 30*(6), 525-538. doi: 10.1016/S0301-4215(01)00120-3

Johnson, D., Wardlow, G., & Franklin, T. (1997). Hands-on activities versus worksheets in reinforcing physical science principles: Effects on student achievement and attitude. *Journal of Agricultural Education, 38*(3), 9-17. doi: 10.5032/jae.1997.03009

Min, J., Azevedo, I., Michalek, J., & de Bruin, W. (2014). Labeling energy cost on light bulbs lowers implicit discount rates. *Ecological Economics, 97*, 42-50. doi: 10.1016/j.ecolecon.2013.10.015

Sallee, C., Edgar, D., & Johnson, D. (2013). Student perceptions of instructional methods towards alternative energy education. *Journal of Agricultural Education, 54*(2), 130-142. doi: 10.5032/jae.2013.02130

van't Hooft, M. (2005). The effect of the "Ohio Schools Going Solar" project on student perceptions of the quality of learning in middle school science. *Journal of Research on Technology in Education, 37*(3), 221-243. doi: 10.1080/15391523.2005.10782435