Replace or wait? Study says swap all incandescent bulbs now, but hold on to CFLs

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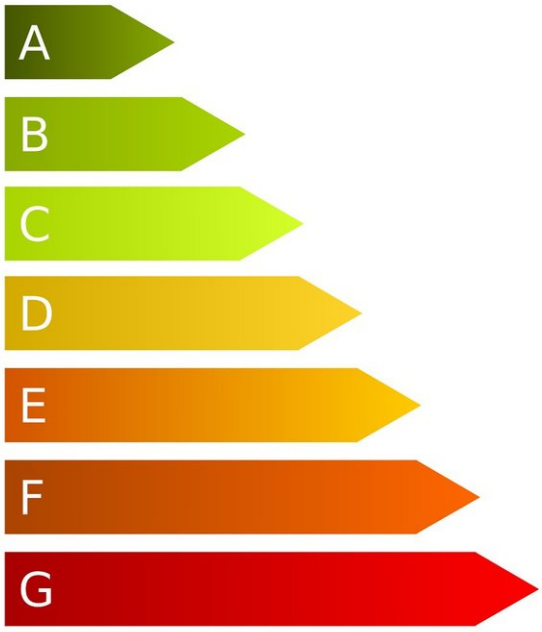

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LED light bulbs are getting cheaper and more energy efficient every year. So, does it make sense to replace less-efficient bulbs with the latest light-emitting diodes now, or should you wait for future improvements and even lower costs?

A new study from University of Michigan researchers recommends

replacing all incandescent and halogen light bulbs in your home now with compact fluorescent lamps (CFLs) or LEDs.

But immediate replacement is not advised for existing CFLs and LEDs, unless your main concern is helping to reduce power-plant emissions, according to the study scheduled for publication Nov. 15 in *Environmental Research Letters*.

"Estimating the right time to switch over to LEDs is not a straightforward problem. If your goal is to help reduce carbon dioxide emissions, then maybe you should switch to LEDs now," said Lixi Liu, first author of the study and a doctoral student at the U-M School for Environment and Sustainability and at the Department of Mechanical Engineering.

"But if your main concern is lowering costs and home energy use, then holding on to existing CFLs and LEDs, and waiting until LEDs use even less energy and are even lower in cost, may be desirable."

For a CFL that's used an average of three hours per day, it may be best—both economically and energetically—to delay the adoption of LEDs until 2020, she said.

Lighting accounted for 10 percent of U.S. residential energy use in 2016. Home lighting upgrades are an easy way to lower your utility bill, reduce energy use and help cut greenhouse gas emissions.

LEDs are long-lasting light bulbs that use less energy than incandescent, halogen or fluorescent bulbs to provide the same light output. But the initial purchase price for LEDs is higher than other types of bulbs, so many consumers haven't made the switch.

Previous studies have noted that LEDs reduce spending on energy over

time and are a cost-effective alternative to other light bulbs. But those studies did not look at the best time to replace an existing bulb.

In their newly published study, the U-M researchers examined cost, energy use and greenhouse gas emissions for different types of 60-watt-equivalent bulbs and created a computer model to generate multiple replacement scenarios, which were then analyzed.

Specifically, they used a method called life cycle optimization to construct a lighting replacement optimization model. The life cycle optimization method has previously been used by researchers at U-M's Center for Sustainable Systems to study replacement of automobiles, refrigerators, washing machines and air conditioners.

"Replacement decisions can be complex and often confusing," said Gregory Keoleian, director of the center and a co-author of the *Environmental Research Letters* lighting paper.

"Research at the Center for Sustainable Systems over the past dozen years has focused on helping consumers navigate this complexity and identify opportunities for cost savings and lower environmental impact," said Keoleian, who is also a professor at the School for Environment and Sustainability.

In the lighting study, the U-M researchers considered factors such as how often the current bulb is used and its condition. And they looked at trajectories for lighting technology and energy generation: light bulb technologies are improving, costs continue to drop, and electricity generation in this country is becoming cleaner.

By 2040, the share of U.S. electricity from natural gas is expected to increase by 6 percent, and the share from renewables is expected to increase 13 percent. By 2040, the share of U.S. electricity from nuclear

power is expected to decrease by 4 percent, and the share from coal is expected to decrease 15 percent.

The new lighting study provides specific replacement strategies for maximizing the cost, energy and emissions savings from home lighting.

"It was a challenging optimization problem to solve accurately," said Kazuhiro Saitou, a U-M mechanical engineering professor and the other co-author of the *Environmental Research Letters* paper. "Because it involved various types of decision variables—years of use, number of replacements and type of lighting technology—and multiple objectives—cost, energy and emissions—that can compete with each other."

In addition to the previously mentioned results, the study finds that:

- In general, bulbs that are used more often should be replaced first to maximize energy savings.
- Replacing a bulb before it burns out may seem wasteful, but consumers can cut energy use by doing so.
- Strategies for replacing light bulbs vary from place to place, depending on regional energy costs and the power-generation mix (i.e., coal, natural gas, nuclear and renewables).
- In general, LED upgrades should be made earlier and more frequently in places—such as California, Washington, D.C., and Hawaii—where electricity costs are high.

Provided by University of Michigan