Study finds need for better awareness around timing of electricity usage among customers

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A new study published in *Nature Energy* found that electricity customers often lack awareness of their daily energy-use patterns at home, which could have a serious financial impact as utility companies move toward

time-of-use energy pricing models.

If utilities change their pricing structures, consumers need to understand how and when they're using electricity so they can make informed decisions about billing choices, the study's authors say.

"Energy systems and the grid are undergoing drastic changes right now, and we need to update the way we talk to people about their energy use," said study co-author Hilary Boudet, an associate professor of sociology and public policy in Oregon State University's College of Liberal Arts. "From this work, it seems that people are not aware that when you use energy may be just as important as how much energy you use."

Incorporating renewable energy sources into the electricity system means the timing of electricity generation often conflicts with the timing of consumers' energy use, Boudet explained. This mismatch causes problems for the electrical grid because options for storing electricity are limited, so utilities are moving toward rate plans that charge higher prices during peak hours.

The study, conducted by researchers from OSU and Stanford University, analyzed energy-usage patterns from 186 California residents who granted access to their households' smart meter data, which tracks hourly variation as well as overall energy use. Study participants also completed questionnaires about what they believed their daily energy-use patterns looked like, which researchers then compared to their households' actual energy-use patterns.

Researchers wanted to know if participants could accurately describe their home's dominant "load shape," the curve on a graph reflecting what period of the day had the highest amount of energy use. The study examined participants' energy data and load shape awareness before and during California's shelter-in-place orders in the early days of the

COVID-19 pandemic.

Most homes had an "evening peak" load shape, with roughly two-thirds of households exhibiting this shape before and during shelter-in-place. Only a small percentage of households exhibited a "morning peak" during either period. The remainder were split between "midday peak" and "dual peak," with midday peak increasing during shelter-in-place and dual peak becoming slightly less common.

During the pre-shelter-in-place period, 51.1% of participants correctly identified their load shape, compared with 30.6% for the shelter-in-place period.

Evening peak is the most common load shape primarily because that's when people working a 9-to-5 schedule return home and start cooking, cleaning and running heat and air conditioning, Boudet said. Heating and cooling, especially heating water, are some of a home's biggest energy users.

These peak hours are also when many forms of renewable energy, such as solar power, are less available, leading utilities to turn to "peaker plants" that kick on to address the evening surge in demand and often rely on dirtier fuel sources, Boudet said. As utility companies start implementing "demand response" programs like time-of-use pricing, which charges higher rates during peak hours, evening usage will cost customers more.

"You're asking customers to respond to a price signal without real information about how they're using energy," said Chad Zanocco, lead author of the study and a postdoctoral scholar at Stanford University. "We need to incorporate this consideration of time into our conversations around energy use, so that people understand that it matters when energy is being produced, in terms of emissions."

Boudet recommends that people learn about their energy use by looking at their smart meter reports, if available through their utility, to look for ways to shift their usage patterns out of late afternoon and evening hours. For instance, cleaning or running laundry earlier in the day would reduce energy use during evening peak hours. Boudet said residents can also look into more energy-efficient appliances so their overall energy use is lower.

However, she said this kind of intervention can place an undue burden on lower income households, pushing them to adjust their behavior to keep their bills affordable, while more affluent customers may purchase things like smart-home appliances that automatically adjust temperature settings or improve energy efficiency.

Co-authors included Gregory Stelmach from OSU and Tao Sun, June Flora and Ram Rajagopal from Stanford University.

More information: Chad Zanocco, Assessing Californians' awareness of their daily electricity use patterns, *Nature Energy* (2022). DOI: 10.1038/s41560-022-01156-w.
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