Climate models may significantly overestimate savings from improved energy efficiency

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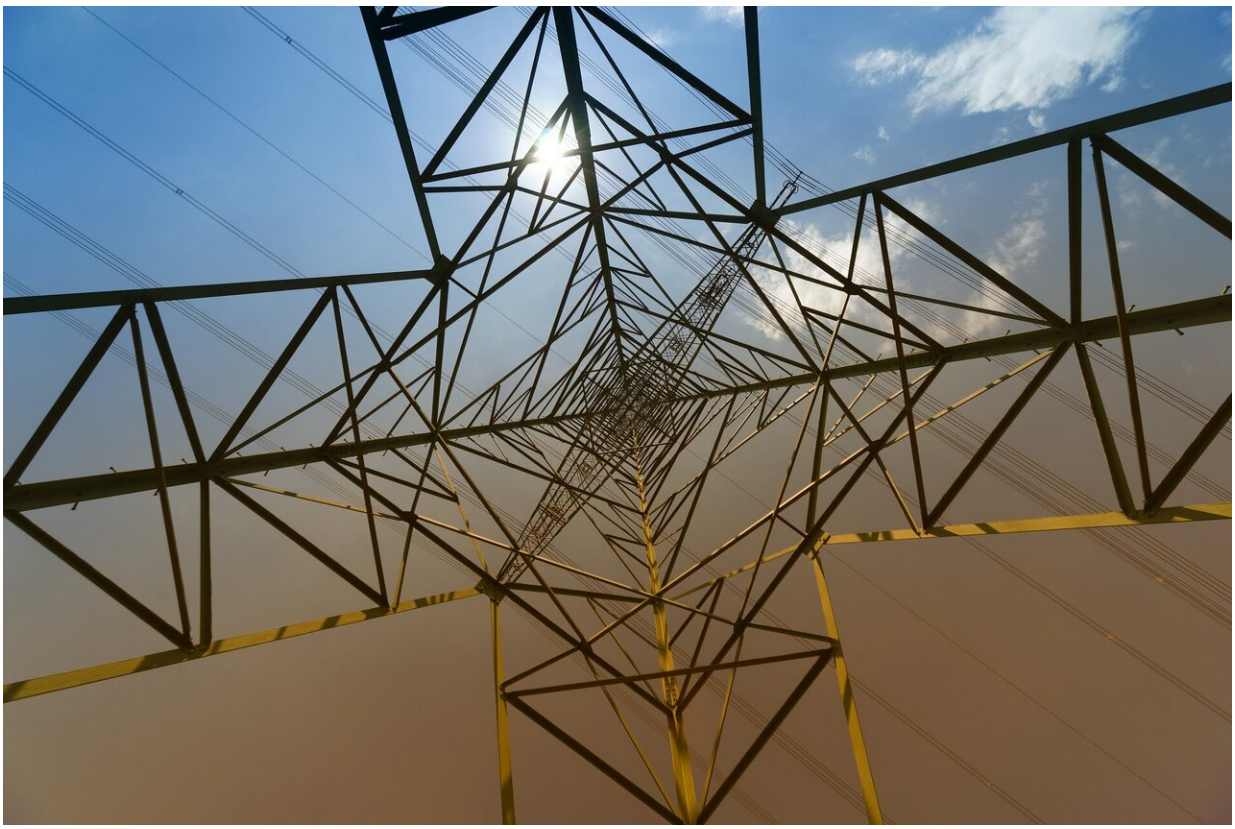

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The models used to produce global climate scenarios may overestimate the energy and emission savings from improved energy efficiency, warns

new research led by academics at the University of Sussex Business School and the University of Leeds.

In a review of 33 studies, the researchers find that economy wide rebound effects may erode around half of the energy and emission savings from improved energy efficiency.

These rebound effects result from individuals and businesses responding to the benefits of improved energy efficiency—such as cheaper heating, lighting and travel. These responses improve quality-of-life, raise productivity and boost industrial competitiveness, but they also reduce the economy-wide energy savings.

The new study argues that economy-wide rebound effects are larger than commonly assumed, which may partly explain the close links between energy consumption and GDP over the past 100 years.

Improved energy efficiency is expected to play a central role in meeting the goals of the Paris Agreement, contributing up to 40% of the envisaged reductions in global greenhouse gas (GHG) emissions over the next two decades.

However, the new research suggests that the models used by the Intergovernmental Panel on Climate Change (IPCC), the International Energy Agency (IEA) and others fail to adequately capture these rebound effects. As a result, their scenarios may underestimate future global energy demand. In the absence of policies to mitigate rebound effects, this could make the Paris Agreement targets harder to achieve.

The authors argue that global energy modelers need to take rebound effects more seriously, and to find ways of capturing the full range of effects within their scenarios. They also recommend the use of carbon pricing to limit rebound effects and the targeting of energy efficiency

policies to maximize their economic and environmental benefits.

Steve Sorrell, Professor of Energy Policy in the Science Policy Research Unit (SPRU) at the University of Sussex Business School, said: "Rebound effects are notoriously difficult to estimate, but our understanding has improved enormously over the last decade. What we show here is that 33 studies from different countries using very different methodologies all reach broadly the same conclusion—namely that economy-wide rebound effects are large. Unfortunately, the models we rely upon to produce global energy and climate scenarios do not adequately capture these effects. This needs to change."

Dr. Paul Brockway, University Academic Fellow in the School of Earth and Environment at the University of Leeds, said: "If global energy use is higher than we expect, we may need to place more reliance on low-carbon energy supply and negative emission technologies to meet our climate goals. This will require political will, ambitious policies, large-scale investment, extensive land use, and crucially, significant lead times. We therefore need to take rebound effects seriously—and to find ways to maximize energy savings whilst continuing to improve quality-of-life."

In a new paper published today in *Renewable and Sustainable Energy Reviews*, the researchers find that many of the global energy scenarios that meet the Paris Agreement goals anticipate little or no growth in global energy demand despite continued growth in incomes.

However, there is little precedent for such significant 'decoupling' of energy consumption from GDP. Only a small number of countries have managed to grow their economies whilst reducing energy use, and then for only short periods of time. Current global trends are in the opposite direction with global energy consumption rising rapidly in the years prior to the Covid pandemic.

The team of researchers, comprising academics from the University of Leeds, University of Sussex, University of Massachusetts Amhurst, Calvin University, IFP Energies Nouvelles and Institut Louis Bachelier, reviewed 21 studies that used macroeconomic models to estimate the economy-wide rebound effects from a variety of energy efficiency improvements in different countries and sectors.

They found that 13 of the 21 studies using a common approach of 'computable general equilibrium' modeling estimated rebound effects of 50% or more—implying that over half the potential energy savings were 'taken back' by various economic and behavioral responses. The mean estimate of rebound effects from these studies was 58% and the median estimate was 55%, with some studies finding that the energy savings were eliminated altogether.

The team also reviewed 12 other studies that used a variety of other methods to estimate economy-wide rebound effects, and found these gave an even larger mean estimate of 71%.

The team then reviewed four of the 'integrated assessment models' used by the IPCC, together with the global energy models used by bp, Shell, the International Energy Agency (IEA) and the US Energy Information Administration (EIA). They found that most of these models only captured some of the mechanisms contributing to rebound effects, or included them in a simplified manner. Moreover, in some cases the process of calibrating scenarios largely precluded the investigation of rebound effects.

Dr. Gregor Semieniuk, Assistant Research Professor at the University of Massachusetts Amherst, said: "Global energy models risk overestimating the potential for energy savings if they do not fully account for the multiple channels of the economy wide rebound. Nearly all the scenarios for keeping global temperature increase to a manageable level rely on

heavily improved energy efficiency so understanding the potential for rebound—and what mitigates it—is critical. Now is the time to re-examine rebounds in global climate scenarios to ensure that our expectations for energy savings are well-founded."

More information: Paul E. Brockway et al, Energy efficiency and economy-wide rebound effects: A review of the evidence and its implications, *Renewable and Sustainable Energy Reviews* (2021). DOI: 10.1016/j.rser.2021.110781

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