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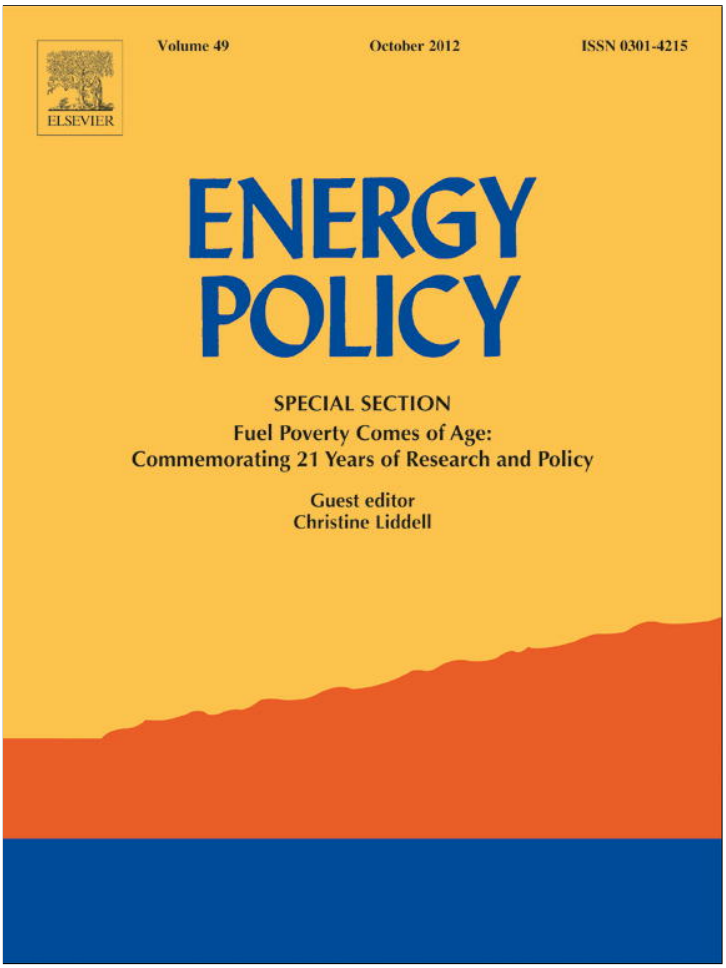

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Rebound effects for lighting ☆

Harry D. Saunders [a,*,1], Jeffrey Y. Tsao [b]

[a] Decision Processes Incorporated and Senior Fellow, The Breakthrough Institute, United States
[b] Energy Frontier Research Center for Solid-State Lighting Science, Sandia National Laboratories, PO Box 5800, Albuquerque NM 87185, United States

HIGHLIGHTS

- ▸ We clarify confusion about our 2010 Journal of Physics article on lighting.
- ▸ Over 3 centuries, increases in lighting energy efficiency have led to 100% rebound.
- ▸ Such gains create economic benefits despite the nominal absence of climate benefits.
- ▸ We argue that improved lighting technologies should be pursued vigorously.

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ABSTRACT

In this Communication, we seek to clarify confusion regarding our 2010 Journal of Physics article on historical rebound effects for lighting, which showed that global energy use for lighting has experienced 100% rebound over 300 years, six continents, and five technologies. We argue that our results have been misunderstood by some to mean lighting efficiency gains are counterproductive, and we instead argue for vigorously promoting improved lighting technologies.

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1. Introduction

Our 2010 article on solid-state lighting in the Journal of Physics with several colleagues (Tsao et al., 2010) has generated considerable interest (and confusion, unfortunately) in the popular press[2] and in the blogosphere.[3] This Communication seeks to clarify some of this confusion for the particular benefit of energy economists and energy policy specialists.

For such readers, the relevant conclusions of our article are

1. Over three centuries, six continents, and five technologies, and over data spanning several orders of magnitude, our analysis indicates that the world spends about 0.72% of its GDP on light.
2. Over the past three centuries, and even today, the world spends about 0.54% of its GDP on the consumption of energy associated with light—about 6.5% of the world's total consumption of primary energy.
3. Energy intensity (physical energy use per unit GDP) for lighting has been unaffected by energy efficiency gains in lighting.
4. These relationships are extremely stable, despite massive historical gains in luminous efficacy (energy efficiency of lighting).

The implications of these conclusions for the reader of Energy Policy include

1. The result of increases in luminous efficacy has been an increase in demand for energy used for lighting that nearly exactly offsets the efficiency gains—essentially a 100% rebound in energy use.
2. Projections of lighting demand into the future, when considering the prospective energy efficiency gains associated with new technologies such as solid-state lighting, need to take this observed behavior into account.

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* Corresponding author. Tel.: +1 925 743 8400; fax: +1 925 743 8406.
E-mail addresses: hsaunders@decisionprocessesinc.com (H.D. Saunders), jytsao@sandia.gov (J.Y. Tsao).
[1] Present address: 2308 Saddleback Drive, Danville, CA 94506, United States.

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[3] For instance, Conservation Magazine, "The efficiency catch-22," Fall 2011. At: http://www.conservationmagazine.org/2011/09/the-efficiency-catch-22/?utm_source=Conservation+Magazine&utm_campaign=d9b2896d45-Fall_2011_New_Issue_Announcement8_31_2011&utm_medium=email.

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Rebound analysts in particular should be aware that the observed rebound effects include direct but not indirect effects. Also included are frontier effects—it is likely that a significant part of rebound has resulted from lighting efficiency gains creating opportunities for new products, applications and even whole new industries. When lighting becomes cheaper, economic agents become very creative in devising new ways to use it.

A further technical consideration for rebound analysts is that our data seem to fit exceptionally well with a Cobb–Douglas depiction of global energy consumption for lighting. As shown elsewhere, such a depiction automatically leads to 100% rebound (minor "backfire," to be more accurate) (Saunders, 2008). This is described more fully in our original article.

2. Illuminating the confusion

The primary confusion over our article seems to have arisen in connection with the perceived value of new lighting technologies. Specifically, some have called into question the value of these technologies given our research, on the basis that such technologies are unlikely to provide reductions in energy consumption and so stand to have little to no effect on restraining greenhouse gas emissions. The Economist column cited above concludes its narrative with the following sentence: "So, for those who truly wish to reduce the amount of energy expended on lighting the answer may not be to ban old-fashioned incandescent bulbs, as is the current trend, but to make them compulsory."

We do not at all see this as the appropriate conclusion to be drawn from our work. True, if long-established historical trends prevail into the future, the introduction of new, more efficient, lighting technologies is unlikely to restrain energy use for this purpose and thus is unlikely to contribute much to climate change mitigation policy on the demand side. But, importantly, such energy efficiency gains also carry with them improvements in economic welfare as they enable consumption of lighting services not previously available, or at minimum, not available at new, lower cost. Especially when it comes to the economic welfare needs of developing countries—but also the implied economic welfare gains accruing to industrialized countries—this benefit from more efficient lighting technologies must be weighed against the environmental costs of not restraining their associated energy use.

Moreover, such welfare gains, and their associated energy use, should not be seen as simply continuing a pattern of wasteful energy use. All welfare-enhancing technologies (including energy-efficiency-enhancing technologies like solid-state lighting and, eventually, smart solid-state lighting) can directly benefit climate change mitigation (or adaptation) because they provide humanity with new approaches (and the wealth to implement both new and old approaches) to these problems.

Very large and long-prevailing energy rebound effects associated with new lighting technologies must be weighed against their substantial benefits. New lighting technologies may well be a double-edged sword, but they should not be mistaken for a single-edged one. On the whole, we interpret our results to mean that improved lighting technologies should be pursued vigorously.

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