Executive summary for Energy, expenditure, and consumption aspects of rebound, Part II: Applications of the framework

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Motivations underlying the research

Widespread implementation of energy efficiency is a key greenhouse gas emissions mitigation measure, but rebound can "take back" energy savings. However, the absence of solid analytical foundations hinders empirical determination of the size of rebound. A new clarity is needed, one that is built upon solid analytical frameworks involving both economics and energy analysis. In particular, a way to visualize energy, expenditure, and consumption aspects of rebound will be helpful for communication across the disciplines and to wider audiences. The development of software tools for rebound analysis will be a welcome resource to rebound analysts. And demonstration of the rigorous analytical framework developed in Part I via detailed numerical examples will be a benefit to energy analysts.

Short account of the research performed

In this paper (Part II of a two-part paper), we develop and demonstrate energy, expenditure, and consumption rebound planes, a novel, mutually consistent, and numerically precise way to visualize and illustrate those three aspects of rebound. Further, we perform the first calibration of the macro factor for macroeconomic rebound, finding $k \approx 3$. We apply the rigorous analytical framework developed in Part I and the visualization advances described in Part II to calculate and show total rebound for two case studies: energy efficiency upgrades of a car (47%) and an electric lamp (67%). Comparison of our rebound values to previously reported values in the literature is provided. Finally, we provide information about new open source software tools for calculating magnitudes and visualizing rebound effects using the framework.

Main conclusions

From the application of the rebound framework in Part II, we draw two important conclusions. First, the car and lamp examples show that the framework enables quantification of rebound magnitudes at microeconomic and macroeconomic levels, including energy, expenditure, and consumption aspects of direct and indirect rebound for emplacement, substitution, income, and macro effects. Second, the examples show that magnitudes of all rebound effects vary with the type of EEU performed.

Potential benefits, applications and policy implications

The key benefit of this paper is that it advances empirical in the field of energy rebound, such that practitioners now have both methods and tools to undertake their further rebound studies. In turn, there are two implications of this work for energy analysis and policy. First, the magnitude of every rebound effect is different between the car and lamp examples. The implication is that every EEU needs to be analyzed separately. Values for rebound effects for one EEU should never be assumed to apply to a different EEU. Second, one cannot know *a-priori* which rebound effects will be large and which will be small for a given EEU. Furthermore, some rebound effects are dependent upon economic parameters, such as energy intensity of the economy. Thus, it is important to calculate the magnitude of all rebound effects for each EEU in each economy.