

# ***LIVING UP TO EXPECTATIONS: ESTIMATING DIRECT AND INDIRECT REBOUND EFFECTS FOR UK HOUSEHOLDS***

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## **Overview**

Policymakers expect improved energy efficiency to play a key role in reducing GHG emissions. However, the energy and emissions savings from such improvements may be less than simple calculations suggest, owing to a variety of mechanisms that go under the heading of *rebound effects* (Sorrell 2010).

*Direct* rebound effects result from increased demand for cheaper energy services: for example, insulation lowers heating costs and encourages households to heat their homes for longer and/or to higher temperatures. *Indirect* rebound effects result from re-spending the resulting cost savings on other goods and services: for example clothes that are manufactured in China and shipped to the UK. Energy efficiency improvements, such as cavity wall insulation, lead to both types of effect, while conservation measures such as lowering the thermostat lead only to indirect effects. In combination, they can be significant (Druckman et. al. 2011).

## **Methods**

In this paper, we simulate a number of energy efficiency improvements and conservation measures by UK households and estimate the resulting direct and indirect rebound effects. The measures considered include insulation improvements, energy efficient lighting, fuel-efficient cars and walking/cycling instead of driving. We explore how rebound effects may vary between different income groups, and investigate how allowing for the capital cost and ‘embodied GHGs’ of the relevant measure can affect the results obtained.

We first estimate the GHG and cost savings from the different measures assuming that the demand for energy services remains unchanged (Firth et. al. 2009). We then simulate the re-spending of these cost savings on different goods and services, calculate the implications for emissions and use these to estimate the rebound effects averaged over a period of ten years. Our calculations combine estimates of the GHG intensity and expenditure elasticity of different categories of household goods and services. The former are derived from an environmentally extended input output model (Druckman and Jackson 2009) and the latter from Engel curves estimated from cross-sectional data on UK household expenditure.

## **Results**

Our results suggest that:

- If the capital cost and embodied GHGs of the relevant measures are ignored, ‘heating’ and ‘lighting’ measures have an average rebound effect of around 14%, while the ‘transport’ measures have an average rebound effect of around 36%.
- Additionally allowing for embodied GHGs of the relevant measures increases the average rebound effect for the heating measures to 26% and that for the lighting measures to 17%.
- Additionally allowing for the capital cost of the measures reduces the average rebound effect for the heating measures to -3% and that for the lighting measures to 5%
- Additionally allowing for government subsidies on capital investment increases the average rebound effect for the heating measures to 17% and that for the lighting measures to 11%
- Rebound effects vary with household income and are higher for lower income groups.

## **Conclusions**

Our results show that the magnitude of the rebound effect varies widely according to the actions taken, depending upon the cost of implementing the measure and the embodied GHGs involved. Rebound effects tend to be relatively moderate for measures to improve heating and lighting efficiency, but are significantly larger for measures to improve transport efficiency. This difference results from the lower GHG intensity of expenditure on vehicle fuels relative to expenditure on gas or electricity. Rebound effects tend to be higher for lower income groups, due to the relatively high proportion of their expenditure on gas and electricity.

Solar thermal and loft insulation were found to have relatively high rebound effects when capital costs were ignored; owing to the substantial embodied GHGs associated with these measures. When capital costs are included the rebound is generally reduced, as households have less money to re-spend. Government subsidies off-set capital costs and so increases the rebound effect, but without subsidies low income groups would often not be able to implement the energy efficiency measures at all. Therefore, even though there is a rebound effect, our results show that because it is generally less than 100%, the measures are still worthwhile.

Overall, our results demonstrate the importance of taking account of rebound effects when estimating the impact of energy efficiency measures.

## References

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