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Increased household energy efficiency:
Can it boost the UK economy?

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POLICY BRIEF

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Increased household energy efficiency: can it boost the UK economy?

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Abstract

Improving UK household energy efficiency has positive effects on the UK economy by households spending their savings from lower energy bills to buy non-energy goods and services and thereby stimulating demand in the wider economy.

However, the combination of cheaper energy and increased spending on non-energy goods and services will partially offset the energy savings from more energy efficient households. This is the so-called 'rebound effect`.

In contrast to previous economy-wide rebound research that has noted that energy efficiency improvements in industry sectors leads to an increase in productivity, this research concludes that greater household energy efficiency is likely to lead to a demand-driven economic expansion, increasing employment and reducing unemployment.

1 Introduction

This Policy Brief summarises key results from a recent study (supported by the UK ESRC[1]) on the economic effects of increased efficiency in UK household energy use. The research was conducted by a team of researchers from the Centre for Energy Policy (CEP) and the Fraser of Allander Institute (FAI) at the University of Strathclyde, and published in the journal *Ecological Economics* (Lecca *et al*. 2014).

The study by Lecca *et al.* (2014) suggests that improving the energy efficiency of UK households has positive effects for the wider economy as households are likely to spend the savings from reduced energy bills on other non-energy goods and services, thereby stimulating increased demand in the wider economy.

[1] For details of and outputs from this ESRC funded research please see http://www.esrc.ac.uk/my-esrc/grants/RES-061-25-0010/read

However, the *actual* economy-wide energy savings are less than may be initially expected. First, increased energy efficiency means that energy becomes less expensive. Second, the reduced need for energy increases household real income and this translates into additional demand for non-energy goods and services leading to an increase in production in non-energy sectors. These effects combine to partially offset the energy "saved" by having more energy efficient homes. This phenomenon, known as the 'rebound effect', was initially observed by the English economist William Stanley Jevons in the nineteenth century, and it is a major current issue for policymakers who focus on energy efficiency improvements, whether in industry or in the household sector.

2 The study

Lecca *et al*. (2014) identify the connection between the increased energy efficiency of UK households and its impact on the wider UK economy by using a system-wide model of the UK economy. Specifically, the research explores the impact of a 5% increase in household energy efficiency through, for example, the use of a more efficient boiler that allows a household to maintain the same temperature and use less gas.

Intuitively, the new boiler should allow the household to consume 5% less gas than previously, therefore cutting its energy bill by 5%. However, this 'engineering effect' does not take into account the behavioural response of households nor the wider consequences of their behaviour on the rest of the economy.

For instance, given that the new boiler is more efficient, people might simply decide to leave it on for more hours per day and enjoy a warmer home, generating a 'direct rebound' effect. On the other hand, they might decide to use the money saved from their energy bill to buy more non-energy goods and services (clothing, leisure, etc.); however, these goods and services usually embody energy use at different stages of their production and supply chains and thus their purchase generates an 'indirect rebound effect'. On the other hand, the supply of energy may involve more energy intensive supply chain activities so that the net indirect rebound effect is negative.

The overall rebound effect is a combination of these direct and indirect rebound effects, plus a succession of economic consequences triggered by the new consumption decisions of the household. For this reason, Lecca *et al*. (2014) are interested in the 'economy-wide' rebound effect, which occurs when the increase in energy efficiency triggers a series of 'demand' and 'supply' responses in the markets of goods and services that affects the *net* energy used by consumers and producers.

As increasing household energy efficiency has wider economic consequences (economy-wide effects), this research uses data on the economic activities of 21 different industries, including four energy supply industries: gas, electricity, refined oil (mainly petrol and diesel) and coal. It also captures the interaction between these activities and the UK households, the Government, and markets outside the UK (imports and exports).

3 Results

Results from the model simulations suggest that a 5% improvement in household energy efficiency would have a positive effect on the UK economy. There are two main reasons for this. First, the increased expenditure in non-energy sectors has a bigger economic impact than the same amount of spending on energy sectors. This is because producers of non-energy commodities usually utilise less energy and more labour in production, than producers of energy. Therefore, greater non-energy production stimulates the creation of new jobs. Second, the initial decrease in demand for energy puts downward pressure on the price that energy suppliers can charge.

However, the impacts vary over time. The introduction of the 5% efficiency improvement represents an initial 'shock' to the economy that activates a series of economic consequences. When energy efficiency is increased, households and firms start to react by changing their behaviour and decisions. For example, households may decide they want to defer additional consumption into the future (i.e. to save) as a result of being slightly wealthier due to relatively cheaper energy. On the other hand, as the economy grows, workers may try to bargain for higher salaries, while energy suppliers will try to maintain their revenues and returns to investors by raising their prices again.

Moreover, not all these decisions would happen at the same time, and for this reason the model simulations are conducted on a year-by-year basis, and results are reported for important time frames, the short term and the long term. For example, if a firm wants to produce more goods, it needs to buy new machinery or replace old ones. But this process is generally slow and requires time to be completed. For this reason, after one year from the shock, in the short term, the level of capital equipment would not change. However, as time passes, new equipment would start to accumulate and would continue to do so until the level desired by the firm is achieved. At this point, the economic impact of the initial efficiency shock achieved its full long term impact.

It is over the long term that the greatest economic benefits are observed. In fact, results from the research show that GDP could increase by 0.1% (over and above what it would be

otherwise) in response to increased non-energy household expenditure and to the consequent incentive for producers to meet this additional demand. Households would consume 0.25% more goods and services, thanks to an increase in workers' wages and salaries. Indeed, in our model, wages increase by 0.04%, 0.1% extra people are employed and unemployment drops by 0.4%.

The results also show that households will consume 2.64% less energy in the short term. This decrease reduces to -1.62% in the long term, when economic expansion would drive up energy consumption again. However, this greater demand from households raises consumption prices, making goods produced in the UK less attractive to foreign buyers, and thereby decreasing exports.

Energy consumption would drop also in the production sector (even with improved energy efficiency only in the household sector). Here the research pays particular attention to producers of energy. Energy production is a very energy-intensive process itself, because a large quantity of energy is required to extract and process coal, oil or gas, and/or to generate electricity. Therefore, the transfer of demand from energy to other sectors leads to a general drop in energy use. For this reason, the demand for energy from all the 21 sectors would fall by 1.07% in the short term and 0.7% in the long term.

In the long run, the overall rebound effect is calculated to be 59.3%, reflecting the combination of direct, indirect and economy-wide rebound effects. In other words, nearly 60% (59.3%) of the initial 5% expected energy saving (in engineering terms) is traded off against economic benefits, which involve a 'rebound' through changes in the total use of energy as the economy expands. Additionally, a higher total rebound effect is observed in the household sector, where 67.1% of the potential energy savings is offset by the combination of cheaper energy services and increased demand for non-energy products and services.

4 Comparing effects of increased energy efficiency effects in industry and households

In the past, the Strathclyde team has widely explored the impact of energy efficiency improvements in the production side of the economy using the same 'general equilibrium' techniques.

For example, in studies such as Allan *et al*. (2007) and Turner (2009 it was found that increasing energy efficiency in the industrial use positively impacts on the economy and increases the competitiveness of UK industries, both those where energy efficiency improves and their down-stream supply chain partners. Industries use energy as input to production,

along with capital, labour and materials. Hence, when energy use is more efficient, firms can operate at the same level of output as previously and use less energy. Consequently, firms become more productive and are able to sell their products at lower prices to other firms and/or households, both at home and abroad. Moreover, these effects are amplified the more energy-intensive is the production sector where the improvement in energy efficiency occurs.

The extension of the team's work to consider increased energy efficiency in UK households helps policy makers take a more holistic view of the economic impacts of increased energy efficiency. The central basic conclusion in comparing the industrial and household cases is that the former involves productivity-led growth while the latter generates demand-led growth that may involve reducing international competitiveness.

However, Lecca *et al* (2014) also consider the implications of increased efficiency in household energy use on the cost of living, which should be reflected in lower market prices of goods and services. The key issue is whether this is reflected in reduced pressure on wages as the economy grows. If it is, labour becomes less expensive for firms so that they can afford to hire more workers and produce more output. In comparison to the results discussed above, wage increases are lower over the long term, with a greater boost to employment and reduction in unemployment.

As the cost of living falls and employment rises, household consumption of different goods and services rises by more over time (a 0.29% increase compared to 0.25% above). Moreover, unlike the previous case, lower prices mean that UK firms are more competitive and export demand from the rest of the world increases. Overall, GDP increases in the short term by 0.1% and in long term by 0.24%, exceeding the long term 0.1% increase in GDP in the previous case.

On the other hand, industries would require more energy in production, reducing actual energy savings. This is a very important point because it underlines that the higher the economic benefits of the increased energy efficiency, the lower would be the energy saving, representing a trade-off between energy saving and economic well-being. Consequently, the long term economy-wide rebound effect would be 63.9%, while it was 59.3% in the previous case.

5 New research at CEP and FAI

Certainly, the scenarios explored in these studies are not exhaustive, and there is still much work to do in this area. The Strathclyde Centre for Energy Policy and Fraser of Allander

Institute who have authored these studies are well aware of this and are engaged in improving the understanding of rebound effects and communicating this to a wide range of stakeholders. A new project funded by the Engineering and Physical Sciences Research Council (EPSRC) entitled 'Energy Saving Innovations and Economy-Wide Rebound Effects' began in March 2015, involving collaboration with the Centre on Innovation and Energy Demand (CIED) at the University of Sussex. A primary aim of the project is to include stakeholders in the investigation process.

The project, organised in 5 'work packages', is specifically designed to expand the horizon of the existing research and to tackle some critical points of past studies, looking both at the consumption and at the production side of the economy.

For example, from the consumption side, the study discussed above is based on a scenario that households would improve by 5% their consumption of all types of energy (electricity, gas, coal and refined oil). This is a plausible assumption for a first consideration of the issue because it generates intuition on the response of people and firms to a basic improvement in energy efficiency. However, it is likely that in reality, a family would never be able to improve efficiency in all uses of energy, but rather it would gradually replace energy intensive appliances with more efficient ones, thereby impacting particular types of energy use. For this reason, in the first work package, the new project will analyse the effects of improving energy efficiency in private transportation activity (involving the use of cars or motorbikes). The research then extends in two of the other works packages to consider the effects of energy efficiency improvements for different industrial scenarios and to develop a more sophisticated and realistic treatment of energy supply responses.

However, in the context of the focus on this Policy Brief and the study of improved efficiency in energy use by families in UK households, one of the work packages focuses specifically on the need for investment to enable uptake and implementation of energy saving innovations. For example, to make their home more energy efficient, people may have to buy a new fridge, a new boiler, or a new car. These are expensive goods, but ones that last over time. The research will focus on understanding what happens when an energy efficiency improvement (e.g. in household gas use) is embedded in and thus requires investment in a durable good (e.g. a new boiler). It will also look closely at what happens when energy efficiency improvements are made in households with different incomes, and consider how both rebound and welfare effects vary across different income groups.

6 Conclusions

Clearly, great progress has been made since Jevons first identified the rebound effect in the nineteenth century. However, this issue has been largely neglected by policy makers in recent times, increasing the need to better understand and communicate the nature and scale of rebound effect and their economy-wide implications. In this context, Lecca *et al*. (2014) along with past studies and the new EPSRC project, represent a significant move towards a more reliable and self-aware energy policy.

Concretely, Lecca *et al*. (2014) suggests that there are good reasons for UK households to adopt a more efficient use of energy. However, the saving of energy and emissions' reductions are lower than might initially be expected. For this reason, policy makers face a trade-off between mitigating the rebound effect, perhaps by using other measures to reduce emissions (such as a carbon tax, for example), and losing the beneficial macroeconomic effects, or take advantage of the welfare effect of energy efficiency improvements, and promoting a policy that aims simultaneously to reduce energy use and stimulate economic growth.

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