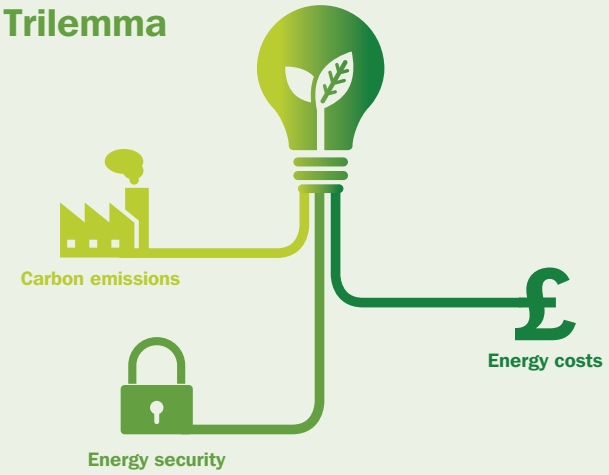
Energy saving innovations and economy wide rebound effects

Research Briefing 01

April 2015

Energy Trilemma



Improved energy efficiency is generally recognised as the most important and cost-effective route to addressing the energy trilemma. The IEA estimate that energy efficiency gains could contribute approximately 70% of global emission reductions in the period to 2020, and ~50% in the period to 2035. EU member states have agreed legally binding targets to improve energy efficiency and the UK has developed a wide-ranging energy efficiency strategy that includes policies for all sectors of the economy.

But economies are complex and dynamic systems and energy efficiency improvements frequently fail to deliver the anticipated energy and emission savings. This is largely due to a variety of mechanisms known as 'rebound effects' which can reduce the energy and emission savings achieved. In some cases, rebound effects may even lead to an overall increase in energy consumption. Unless such effects are better understood and addressed, the UK and other countries may fail to meet their energy and emission targets.

The Centre on Innovation and Energy Demand (CIED) is investigating the source, nature and magnitude of rebound effects in a number of UK sectors. Led by the Centre for Energy Policy at the University of Strathclyde, this new project on economy wide rebound effects significantly extends CIED's work. The project investigates the impact of energy efficiency improvements throughout the UK economy and along international supply chains, as well as using sophisticated multi-sector macroeconomic models to capture a much wider range of economic effects.

Who is this project of interest to?

Rebound effects have been widely neglected, partly because of the limited evidence base that is available, and partly because of the complexity of the topic and the tendency towards polarised debate. This project therefore aims to engage with stakeholders and present results and implications in an accessible form. The results should be of interest to a wide range of groups, including:

- UK policy makers in DECC, the Treasury and other departments
- UK devolved governments with responsibility for sustainable development
- European policymakers and politicians
- International energy organisations
- Energy users concerned with policy responses to and/or support of actions to improve energy efficiency
- Think tanks and NGO's working to promote a low carbon economy
- Academics

Centre on Innovation and Energy Demand

UNIVERSITY of STRATHCLYDE
INTERNATIONAL PUBLIC POLICY INSTITUTE
CENTRE FOR ENERGY POLICY

Rebound effects – what do we know and what remains to be understood?

Direct

Cost-effective efficiency improvements make energy services cheaper, thereby encouraging increased consumption of those services.

Indirect

Cost savings from energy efficiency improvements may be spent on other goods and services whose provision involves energy use and emissions at different stages of their international supply chains. For example, savings on gasoline bills may be used to purchase laptops made in Asia and shipped to the UK.

Economy-wide

Shifts in consumption patterns may trigger multiple changes in prices, investments and incomes in both domestic and international markets. Energy efficiency improvements by firms may lower output prices, boost productivity and competiveness, encourage economic expansion and thereby increase energy consumption.

Transformational

In some cases, efficiency improvements may help open up markets for new technologies and systems, triggering entirely new energy-using applications, products and industries.

Impacts of low-energy innovations are uncertain and often unexpected.

Rebounds represent real benefits to producers and consumers, such as warmer homes, lower fuel bills, increased productivity and cheaper goods. So they should not be viewed negatively, but instead should spur efforts to fully understand the system-wide impacts of efficiency improvements and to incorporate these within policy appraisals. This cannot be done with the engineering-based and partial equilibrium assessments that have dominated the appraisal of energy efficiency policy to date. Instead, it requires the utilisation of multi-sector macroeconomic modelling tools that can adequately capture these complex, overlapping and frequently counterintuitive effects.

Centre on Innovation and Energy Demand

UNIVERSITY of STRATHCLYDE
INTERNATIONAL PUBLIC POLICY INSTITUTE
CENTRE FOR ENERGY POLICY

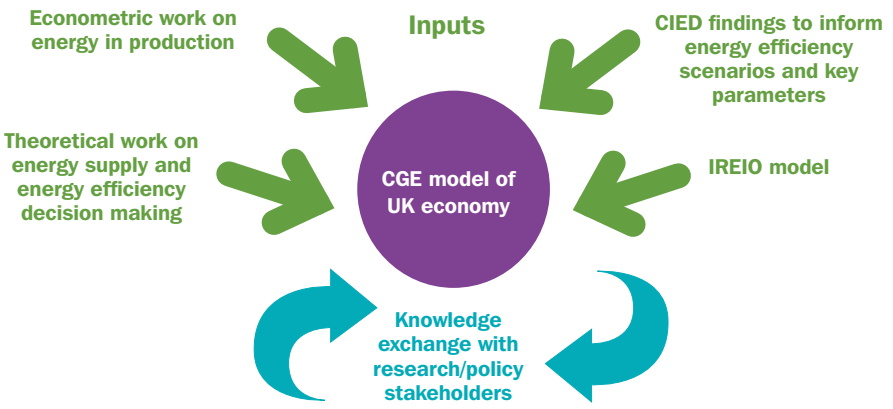
Why study economy wide rebound effects?

Most research to date has focused upon direct rebounds for a limited number of energy services which only captures part of the story. Quantifying indirect and economy wide rebound effects is more challenging since they involve changes in supply and demand in multiple markets, both within the country where the energy efficiency improvement occurs and overseas. The magnitude and importance of such effects may be expected to vary with the nature and location of the energy efficiency improvement, and to change over time as economies adjust – with factors that both amplify and dampen rebound effects coming into play. If analysts only consider a subset of these mechanisms over limited periods of time, they are likely to overestimate future energy and emission savings.

This project aims to: understand the full range of mechanisms contributing to rebound effects; assess their net effect on energy use and emissions at both the UK and global level; explore how these processes develop and interact over different periods of time; and improve the robustness, credibility and transparency of the evidence base in this area.

The working hypothesis is that, in many cases, the net impact of these rebound effects will significantly reduce the anticipated energy and emission savings. Rebound effects are also expected to be larger for energy efficiency improvements by producers - especially when these occur in energy intensive sectors and/or in parallel with other productivity gains - and greater over the longer term.

Research strategy



The research team is employing and developing a multi-sector economy-wide Computable General Equilibrium (CGE) model of the UK economy that permits the investigation of the complex interactions between various markets for goods, services and primary inputs to industrial production, together with imports and exports. This will be linked to an 'interregional environmentally-extended input output model' (IREIO) that permits accurate estimation of the carbon and energy embodied within traded goods and takes full account of the variations in energy and carbon intensity between different supplier regions.

Research programme

WP1 – Applying the existing model to estimate energy savings and rebound effects in UK road transport

WP2 – Developing the model database and extending to international supply chains

WP3 – Exploring the implications of improving the specification of the energy sector in the model

WP4 – Modelling energy savings and rebound effects following energy efficiency improvements by households

WP5 – Modelling energy savings and rebound effects following energy efficiency improvements by producers

WP6 – Integration and stakeholder engagement

Institutions

The project 'Energy saving innovations and economy wide rebound effects' is funded by the EPSRC under the 'Working with the End Use Energy Demand Centres call'.

The project is led by Professor Karen Turner, Director of the new **Centre for Energy Policy (CEP)** at the **University of Strathclyde International Public Policy Institute**. The project involves researchers from the Centre for Energy Policy, as well as from the EPSRC-funded Centre on Innovation and Energy Demand based in SPRU, University of Sussex.

The project commenced in March 2015 and will complete in 2017.

Further reading

ESRC Project and outputs: 'An empirical general equilibrium analysis of the factors that govern the extent of energy rebound effects in the UK economy'

Turner, K. (2013,) 'Rebound effects from increased energy efficiency: a time to pause and reflect', *The Energy Journal*, 34(4), 25-42

Turner, K. (2009), 'Negative rebound and disinvestment effects in response to an improvement in energy efficiency in the UK Economy', *Energy Economics*, 31, 648-666

Koesler, S., K. Swales and K. Turner (2015), 'Increased energy efficiency in Germany: international spillover and rebound effects', Occasional Paper, International Public Policy Institute, University of Strathclyde

Sorrell, S. (2007) 'The rebound effect: An assessment of the evidence for economy wide energy savings from improved energy efficiency', UK Energy Research Centre, London

How to engage with us

Engaging with stakeholders is a core element of this work and we would be interested to hear from anyone who would like to find out more about the project – including individuals or organisations that would like to be represented on the project Advisory Group and/or take part in stakeholder workshops.

For more information please contact

Professor Karen Turner
Principal Investigator
E karen.turner@strath.ac.uk

Dr Steve Sorrell
Director of the Centre on Innovation and Energy Demand
E s.r.sorrell@susssex.ac.uk

Centre on Innovation and Energy Demand

University of Strathclyde International Public Policy Institute – Centre for Energy Policy

University of Sussex – SPRU – Science Policy Research Unit

Research Councils UK Energy – For a Low Carbon Future