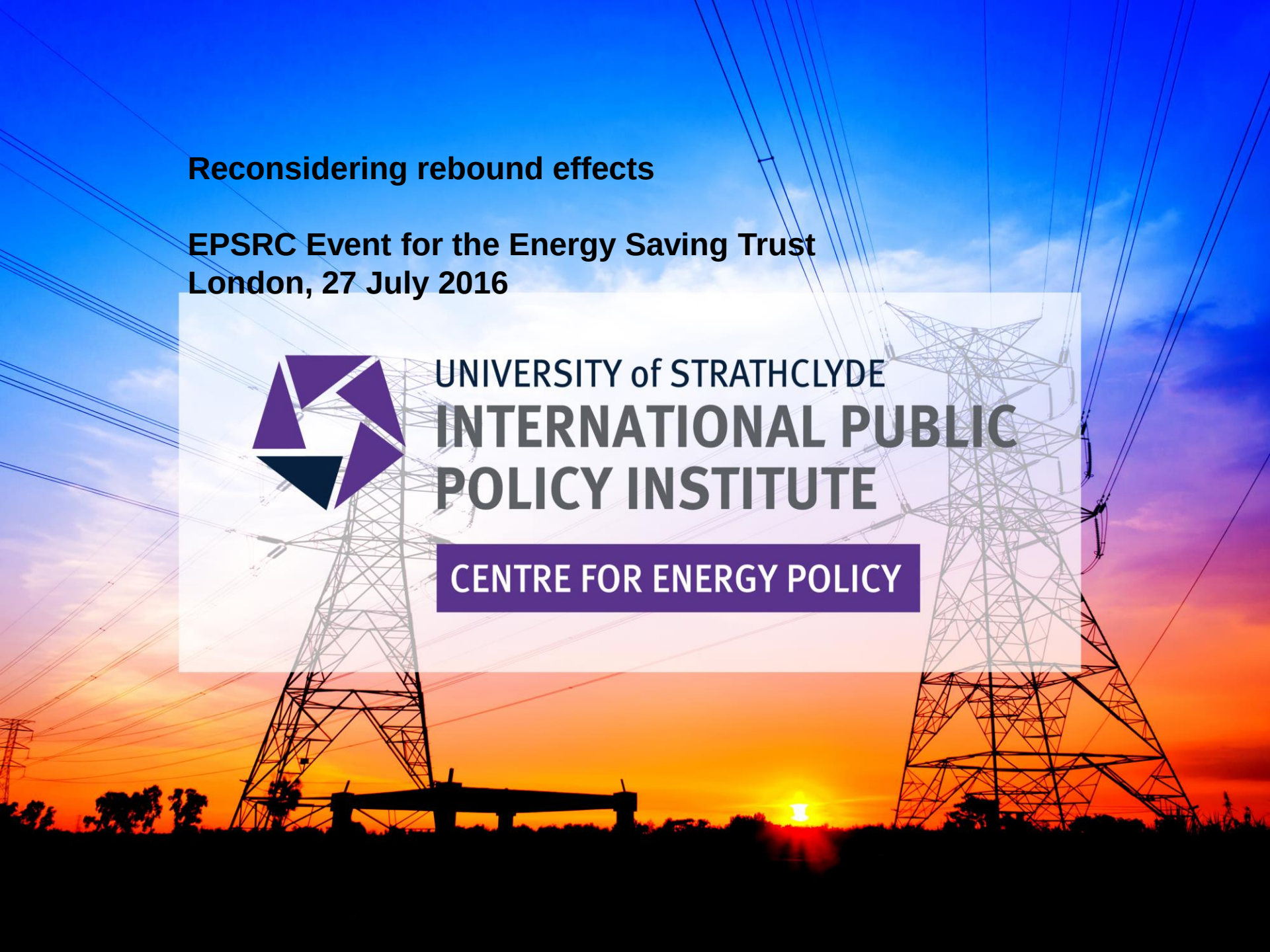
Reconsidering rebound effects

EPSRC Event for the Energy Saving Trust
London, 27 July 2016



UNIVERSITY of STRATHCLYDE
INTERNATIONAL PUBLIC POLICY INSTITUTE

CENTRE FOR ENERGY POLICY

UNIVERSITY of STRATHCLYDE
INTERNATIONAL PUBLIC POLICY INSTITUTE
CENTRE FOR ENERGY POLICY

Overview

THIS SESSION:

- Introduction to our project and partners
- Focus of the project: energy efficiency, multiple benefits and the rebound effect
- Some results and examples
- The way forward for policy relevant research – impacting decision makers in policy and industry, and potentially household behaviour?

Later today:

- How useful would a multiplier tool be in considering energy/carbon impacts of different types of spending?
- How feasible is the development of such a tool for use by EST customers?

Research Councils UK Energy For a Low Carbon Future

University of Strathclyde Business School

FRASER OF ALLANDER INSTITUTE

Centre on Innovation and Energy Demand

UNIVERSITY of STRATHCLYDE
INTERNATIONAL PUBLIC POLICY INSTITUTE
CENTRE FOR ENERGY POLICY

Our project

EPSRC EUED project 'Energy saving innovations and economy-wide rebound effects'

Project web-page:
http://cied.ac.uk/research/impacts/energysavinginnovations

Project partners: EUED CIED centre at Sussex and Fraser of Allander Institute (Strathclyde); external collaborators on different WP (Dublin, Sassari, Zaragoza)

Research Councils UK Energy For a Low Carbon Future

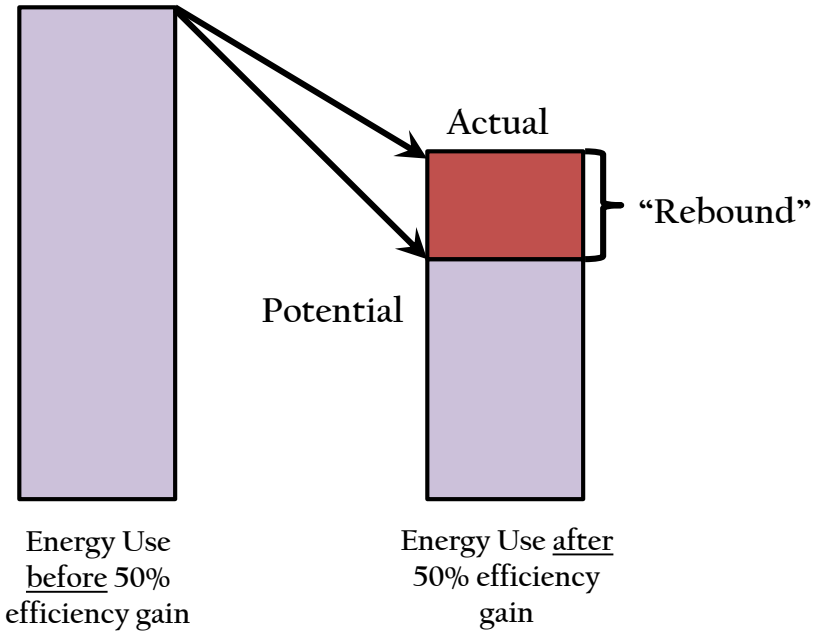
University of Strathclyde Business School

FRASER OF ALLANDER INSTITUTE

Centre on Innovation and Energy Demand

UNIVERSITY of STRATHCLYDE
INTERNATIONAL PUBLIC POLICY INSTITUTE
CENTRE FOR ENERGY POLICY

What is rebound?

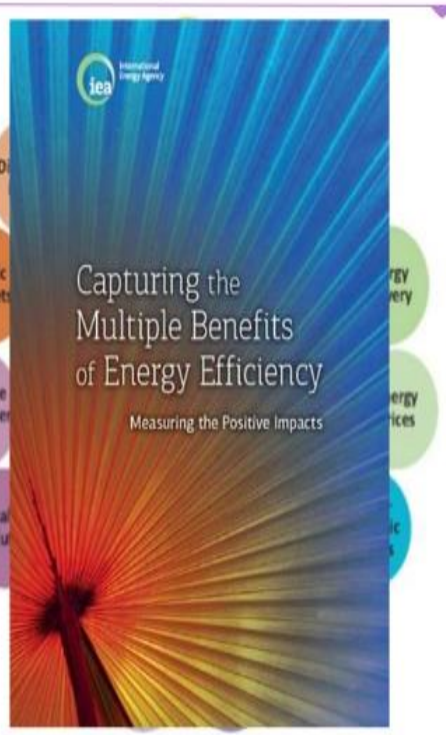


UNIVERSITY of STRATHCLYDE
INTERNATIONAL PUBLIC POLICY INSTITUTE

CENTRE FOR ENERGY POLICY

EE has multiple benefits

DATABUILD



IEA (2014), *Capturing the Multiple Benefits of Energy Efficiency*, OECD/IEA, Paris.

European Commission

Science for Environment Policy

SfEP Logo.jpg

Household energy efficiency could help boost the economy

Improving the energy efficiency of homes could have positive economy-wide impacts, recent UK research suggests. It would allow householders to spend the money they save on energy on other products and services. Although this additional demand and the associated production in non-energy sectors would partly offset the energy saved in the home, this 'rebound effect' does not completely outweigh the household energy savings.

June 2015
Thematic Issue 49

Exploring the Links between Energy Efficiency and Resource Efficiency

This study explored the links between increased energy efficiency of UK households and the wider UK economy using 'general equilibrium' modelling. In particular, researchers investigated a potential 5% improvement in energy efficiency, which they assumed would occur as a result of technological improvements (e.g. more efficient appliances) that allow a household to continue operating at the same capacity, but using less energy.

Financial savings from this lower energy use will probably mean that householders use their appliances more than before, creating 'direct rebound effects'. This study also considered 'indirect rebound effects'. These occur because the cost savings allow householders to spend more money on goods and services other than energy. The energy used by other sectors that provide these goods and services can reduce the overall benefits of the initial improvement in household efficiency. To understand these rebound effects, the researchers assessed the energy usage of 21 economic sectors. These included four energy sectors (1. coal; 2. refined oil (and also nuclear fuel that goes to the electricity generation sector - analysed together with oil, as these two sectors were integrated in the study's source of data); 3. gas; 4. electricity) and 17 other sectors, including food, textiles/clothing and finance.

The model's results suggest that the 5% improvement would have positive effects on the national economy, because increased real income and spending on non-energy sectors has a

Source: Lecca, P., McGregor, P. G., Swales, J. K., & Turner, K. (2014). The added value from a general equilibrium analysis of increased efficiency in household energy use. *Ecological Economics*. 100, 51–62. Doi:10.1016/j.ecolecon.2014.01.008.

UNIVERSITY of STRATHCLYDE
INTERNATIONAL PUBLIC POLICY INSTITUTE
CENTRE FOR ENERGY POLICY

What is rebound?

- Rebound triggered by fact that reduced physical energy requirement reduces price of delivering energy service
- Most obvious is ‘direct rebound’ – e.g. costs £X less to run heating at 20 degrees for 1 hour, we may heat the house for longer and/or higher temperature
- But will trigger series of economic responses
- Zero rebound would imply no economic response whatsoever
- Our research focuses on wider chain of economic responses

UNIVERSITY of STRATHCLYDE
INTERNATIONAL PUBLIC POLICY INSTITUTE
CENTRE FOR ENERGY POLICY

Calculating rebound

$$R = \left(1 - \frac{AES}{PES}\right) x100$$

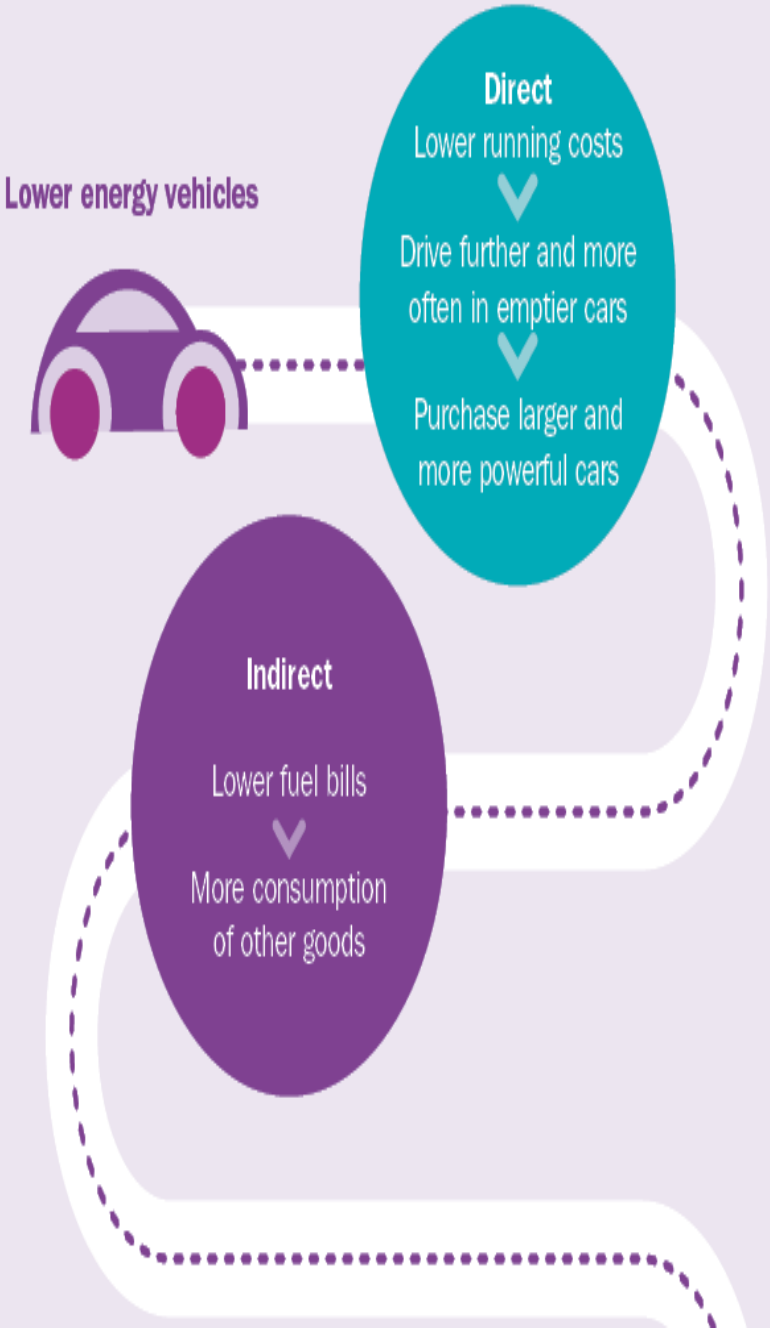
- Ratio of **actual energy savings** to **potential energy savings** following an **energy efficiency** improvement
- AES depends on focus – direct, indirect or economy-wide
- PES generally stated in terms of potential **engineering or technical savings**
- Increase efficiency by 10%, require 10% less physical energy input to produce same level of production output or consumption utility
- But debate over PES…..
- Here, if PES is say 100 terajoules and AES is 70 terajoules, we have R=30%

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.

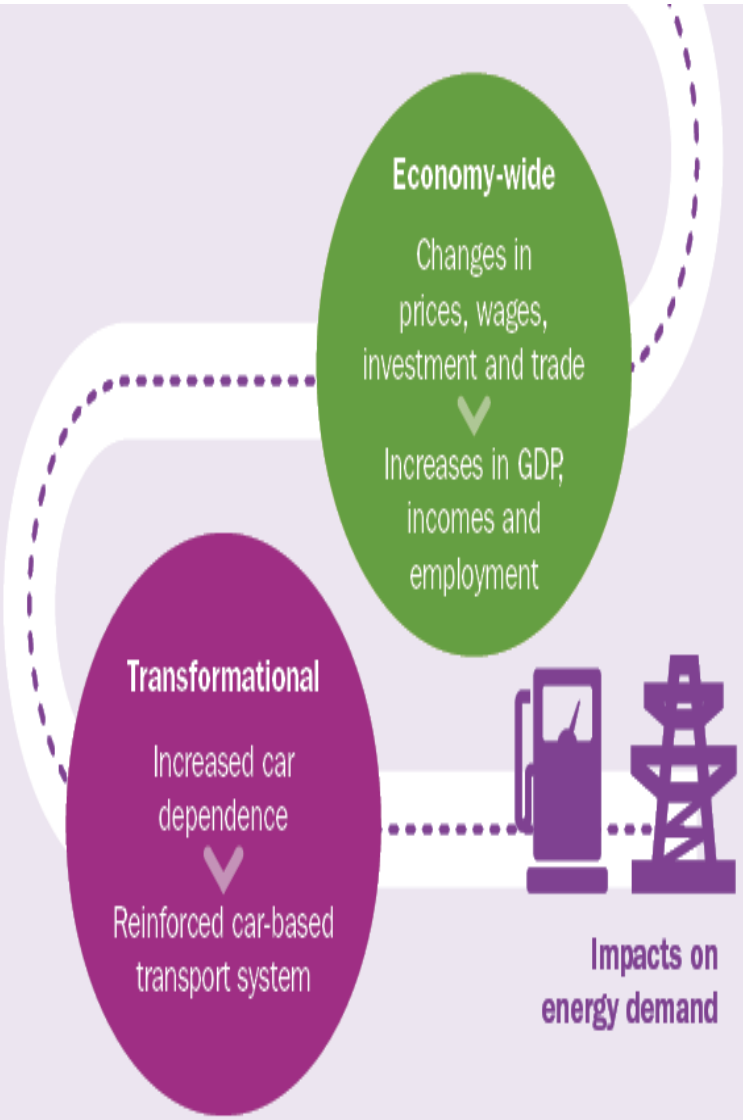


Economy-wide

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.

UNIVERSITY of STRATHCLYDE
INTERNATIONAL PUBLIC POLICY INSTITUTE
CENTRE FOR ENERGY POLICY

Multi-sector economy-wide modelling

- Computable general equilibrium (CGE) model of the UK economy
- HM Treasury use the multi-sector economy-wide CGE model of HMRC, mainly for fiscal issues but DECC use to assess implications of carbon budgets
- Key current area of project stakeholder engagement – input to current UK Parliament enquiry on ‘HM Treasury and Sustainability’
- International research and policy interest in soft-linking between CGE and other models, particularly energy systems models such as TIMES

UNIVERSITY of STRATHCLYDE
INTERNATIONAL PUBLIC POLICY INSTITUTE
CENTRE FOR ENERGY POLICY

Key result – decoupling economy-wide rebound and economic expansion

- Household consumption function with public vs. private transport decision
- Increase energy efficiency in Road and Rail public (and freight) transport sector
- The more households respond to change in relative price/attractiveness of public over private options that may result from energy cost savings
- Economy-wide rebound reduced while retaining macroeconomic benefits
- Key – ***composition*** of household transport activity
- Dematerialisation agenda – focus on efficiency of delivery (and use) of energy (using) ***service*** options to deliver low carbon expansion
- Breakthrough area in rebound research – joint paper forthcoming with Lisa Ryan (University College Dublin, IEA Multiple Benefits project) and short paper accepted for publication in IAEE Energy Policy Forum

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

UNIVERSITY of STRATHCLYDE
INTERNATIONAL PUBLIC POLICY INSTITUTE
CENTRE FOR ENERGY POLICY

More basic multi-sector analysis to attribute wider positive and negative energy and CO2 savings

- WIOD input-output database
- Focus on quantity adjustments in energy supply chains underlying ***negative rebound*** effects
- Use of multiplier analysis to consider UK and international energy use and carbon impacts of different spending allocations
- WIOD permits ***full 'carbon footprint'*** analysis with impacts broken down by industries within countries

- Policy brief – focus on ***restating rebound*** in terms of initial ***energy/carbon savings multiplier*** that is then eroded (but not wiped out) by positive rebound effects

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

UNIVERSITY of STRATHCLYDE
INTERNATIONAL PUBLIC POLICY INSTITUTE
CENTRE FOR ENERGY POLICY

Energy supply response to increased efficiency in use

- Key results from previous CGE work
- 'Disinvestment' effect dampens rebound over time
- Response to changing revenue and return on capital
- But now examining more closely previous assumptions about energy supplier behaviour (price and capacity decisions)
- Ultimately, possible interaction with **TIMES model**
- ***CGE informs TIMES*** about ***changes in demand*** following an efficiency improvement
- ***TIMES informs CGE*** about nature of ***energy supply curve***
- CGE informs TIMES about resulting impacting on demand across economy…..and so on

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

UNIVERSITY of STRATHCLYDE
INTERNATIONAL PUBLIC POLICY INSTITUTE
CENTRE FOR ENERGY POLICY

Energy efficiency in service delivery, household income and fuel poverty impacts

- How do energy efficiency improvements happen?
- Focus initially on private transport
- Increase in efficiency resulting from (investment in) and use of fuel in a more energy efficient car

- Impacts of energy efficiency improvements in and on different household income groups?
- More energy intensive households – bigger income effects, bigger rebound
- Different households use different types of fuels with different intensities – electricity/gas vs. refined fuel use
- Importance of energy supply response

UNIVERSITY of STRATHCLYDE
INTERNATIONAL PUBLIC POLICY INSTITUTE
CENTRE FOR ENERGY POLICY

Increased efficiency in industrial energy use

- Previous work for UK (DEFRA, EPSRC and ESRC projects) and Scotland (Scottish Government 2007)
- Nature of expansion and rebound from energy efficiency improvements in different types of production sectors
- Importance of supply conditions in general (including energy supply)
- International focus and collaborations
  - German industry/global rebound work published in *Energy Economics* (Koesler)
  - Current Italian case study work (Giovanni Mandras, Sassari)
- Focus on introducing econometric specification of structure and parameters of production functions
- And lessons on energy supply from WP3

UNIVERSITY of STRATHCLYDE
INTERNATIONAL PUBLIC POLICY INSTITUTE
CENTRE FOR ENERGY POLICY

Knowledge exchange and impact of the research

- Talking to people about focus and design of current research
- How can we have real impact with outcomes of research at Scottish, UK, European and wider international levels
- Impact in terms of informing policy analysis and decision making
- And also future research and knowledge exchange activity
- Not just in our area of modelling – throwing up issues and questions that will involve other types of modelling, research methods, multi-disciplinary activity

UNIVERSITY of STRATHCLYDE
INTERNATIONAL PUBLIC POLICY INSTITUTE
CENTRE FOR ENERGY POLICY

Example of analysis so far

Research question:

- **Can we decouple economy-wide rebound and economic expansion?**

- Economy-wide rebound driven by same processes as economic expansion
- Does this make rebound a necessary ‘evil’?
- **Can we reduce rebound without sacrificing macroeconomic benefits of increased energy efficiency?**
- Focus of energy efficiency often simply on the most energy intensive activities
- **What if we increase energy efficiency in something that is a competitor for a relatively energy-intensive activity?**

UNIVERSITY of STRATHCLYDE
INTERNATIONAL PUBLIC POLICY INSTITUTE
CENTRE FOR ENERGY POLICY

Remember..
multiple benefits

- Economic expansion following an energy efficiency improvement

- Key:
- Change in ***what*** is consumed
- And ***level*** of consumption – incomes boosted by falling energy costs and increased economic activity

UNIVERSITY of STRATHCLYDE
INTERNATIONAL PUBLIC POLICY INSTITUTE
CENTRE FOR ENERGY POLICY

For example, public vs. private transport in delivering mobility

- Experiment with UK CGE model: increase energy efficiency by 10% in UK ‘Road and Rail’ public (and freight) transport sector

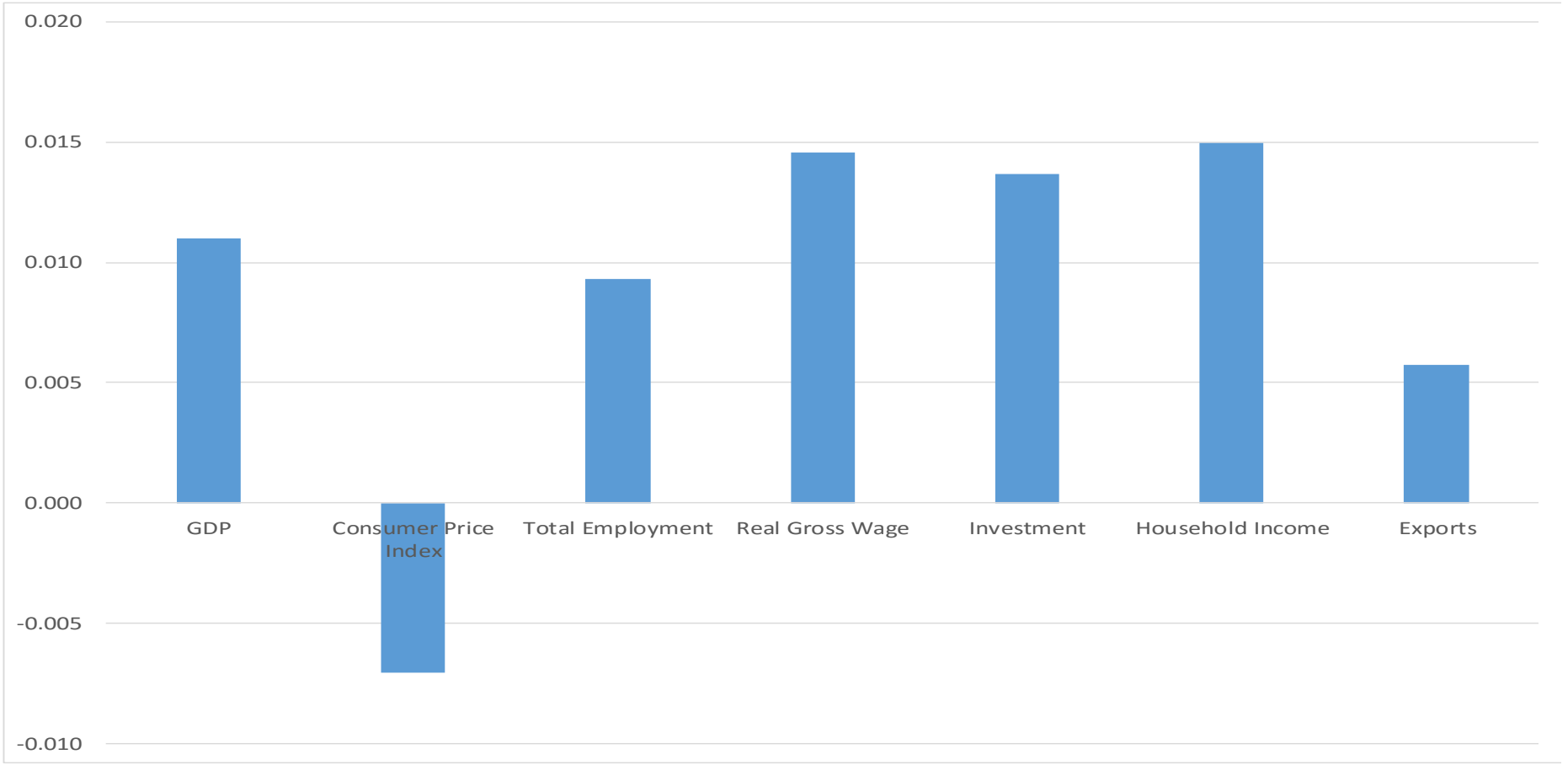
- Delivers expected benefits of a productivity led expansion – positive impact on GDP, aggregate investment, employment, exports, household income and consumption

- However, expansion accompanied by rebound in energy use across economy

UNIVERSITY of STRATHCLYDE
INTERNATIONAL PUBLIC POLICY INSTITUTE

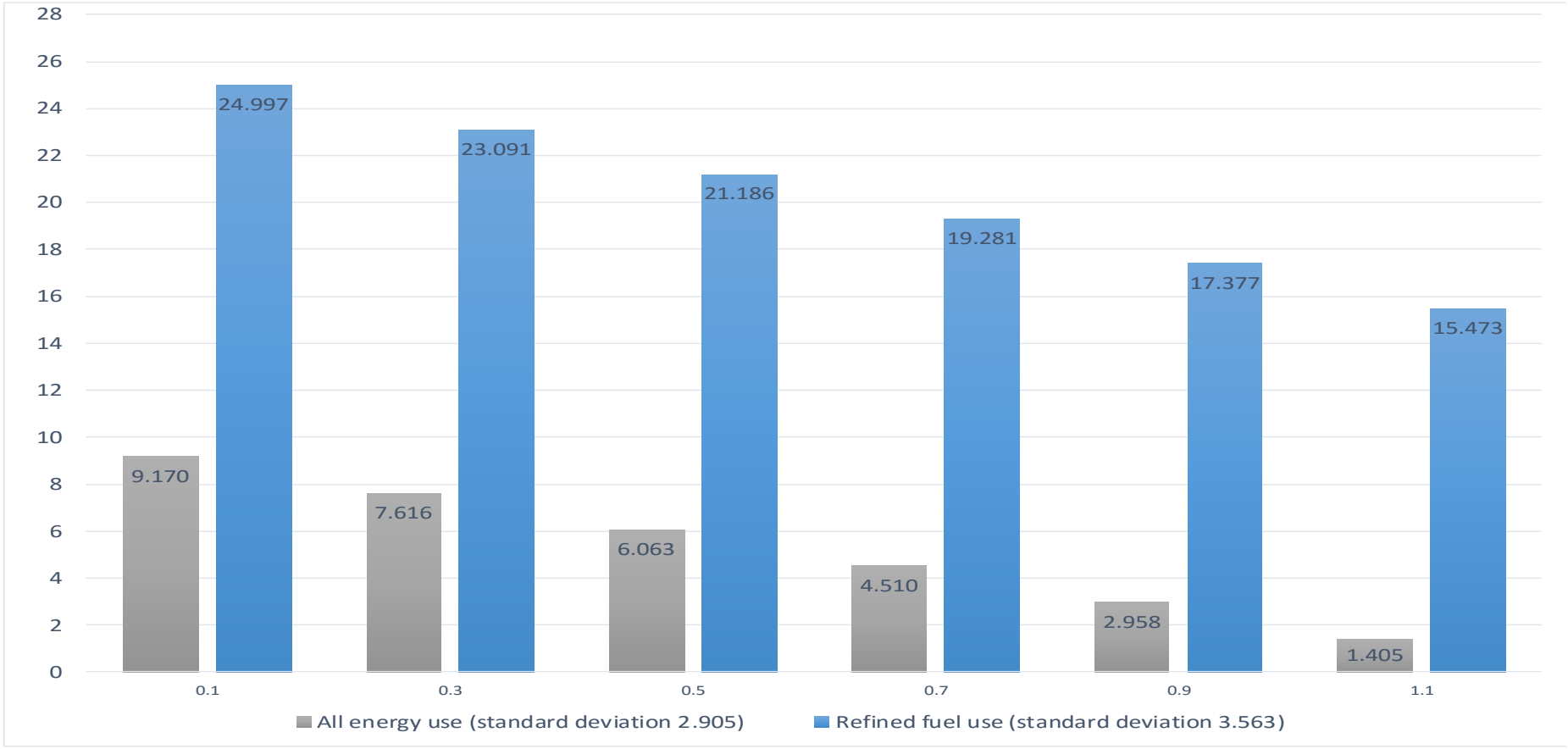
CENTRE FOR ENERGY POLICY

Figure 1. Key long-run macroeconomic impacts (% change from base values) of a 10% increase in energy efficiency in the UK 'Road and Rail Transport' sector



UNIVERSITY of STRATHCLYDE
INTERNATIONAL PUBLIC POLICY INSTITUTE
CENTRE FOR ENERGY POLICY

Figure 2. Impact on long-run rebound effects (%) of varying elasticity of substitution between public and private transport options in the household consumption choice



UNIVERSITY of STRATHCLYDE
INTERNATIONAL PUBLIC POLICY INSTITUTE
CENTRE FOR ENERGY POLICY

Key result

- As we make households more willing to substitute in favour of public option
- Economy-wide rebound reduced while retaining macroeconomic benefits

- Key – ***composition*** of household transport activity
- Dematerialisation agenda – focus on efficiency of delivery (and use) of energy (using) ***service*** options to deliver low carbon expansion

- Could the same argument apply to delivery of heating services?
- Gas vs. low carbon electricity?

UNIVERSITY of STRATHCLYDE
INTERNATIONAL PUBLIC POLICY INSTITUTE
CENTRE FOR ENERGY POLICY

More general conclusion

- Counter argument to 'limits to growth'
- Focus on *the composition* rather than level of economic activity
- Focus on *demand for service* rather than demand for fuel itself
- Technologies with low energy/carbon properties *relative to other means of delivering service*….
- …can deliver wider social benefits through economic expansion with *lower and less damaging rebound effects*

UNIVERSITY of STRATHCLYDE
INTERNATIONAL PUBLIC POLICY INSTITUTE
CENTRE FOR ENERGY POLICY

Current work (Spanish case study)

- Need to renewables production to become more efficient and competitive in reduced/no subsidy environment
- Initial work considering scenarios where
- (a) households become more efficient in electricity use
- (b) renewable electricity generation becomes more efficient and competitive
- Greater economic expansion, slightly larger rebound
- But change in composition of electricity production – ***backfire*** in renewables

UNIVERSITY of STRATHCLYDE
INTERNATIONAL PUBLIC POLICY INSTITUTE

CENTRE FOR ENERGY POLICY

The way forward for policy relevant research?

How do we use research findings and tools to impact both decision makers in policy and industry, and household user behaviour?

UNIVERSITY of STRATHCLYDE
INTERNATIONAL PUBLIC POLICY INSTITUTE
CENTRE FOR ENERGY POLICY

The way forward….

- Interest in our work both in terms of
- Findings/results and their implications
- The models themselves
  - Informing development of currently used CGE models to focus on energy and the economy generally, and energy efficiency in particular
  - Development of useful tools, particularly with simpler input-output models at back end

Research Councils UK Energy For a Low Carbon Future

UNIVERSITY of STRATHCLYDE
INTERNATIONAL PUBLIC POLICY INSTITUTE
CENTRE FOR ENERGY POLICY

Thank you for listening!

karen.turner@strath.ac.uk

http://cied.ac.uk/research/impacts/energysavinginnovations

University of Strathclyde Business School
FRASER OF ALLANDER INSTITUTE

Centre on Innovation and Energy Demand