Institution: University of Leeds

Unit of Assessment: 7 - Earth Systems and Environmental Sciences

Title of case study: Transforming UK Energy Policy, Resources and Waste Strategy, and Industrial Strategy

Period when the underpinning research was undertaken: 2011 - 2020

Details of staff conducting the underpinning research from the submitting unit:

Name(s):	Role(s) (e.g. job title):	Period(s) employed by submitting HEI:
John Barrett	Professor	07/02/2011 to present
Kate Scott	Senior Research Fellow	27/10/2011 to 01/10/2018
Anne Owen	University Academic Fellow	12/09/2011 to present
Jannik Giesekam	Research Fellow	01/11/2015 to present

Period when the claimed impact occurred: 2013 - 2020

Is this case study continued from a case study submitted in 2014? N

1. Summary of the impact (indicative maximum 100 words)

Leeds researchers have developed a new UK carbon footprint indicator, and improved measures of material footprint and resource productivity, which have provided the evidence needed to shape and transform UK government strategies, policies and investments. The research connected the development of the government's Resource and Waste Strategy and Industrial Strategy in taking account of the need for material efficiency and decarbonisation whilst developing opportunities for economic growth through efficient resource use. The whole-systems approach has enabled UK Government departments and advisory bodies to address the global climate challenge by bringing together previously disparate government objectives related to climate change, resource use, industrial strategy, and a fair and prosperous economy.

2. Underpinning research (indicative maximum 500 words)

Leeds researchers, led by Professor Barrett, have undertaken co-created research with UK Government departments and industrial partners to transform UK Energy Policy, the Resources and Waste Strategy, and the Industrial Strategy.

As part of the global climate change effort, the UK has reduced greenhouse gas (GHG) emissions by 40% between 1990 and 2016 (Department for Business, Energy and Industrial Strategy (BEIS), 2018). However, GHG emissions allocated to the UK occur within the territory of the country and ignore emissions embodied in the imports and exports of goods and services. The UK has seen significant structural change in the economy between 1990 and 2020, with a reduction in energy-intensive manufacturing and a rise in service industries. At the same time, the demand for energy-intensive materials has continued to increase in the UK, and more goods are imported with the associated emissions falling under the jurisdiction of the country of production.

The research was the first to calculate the UK's GHG emissions using a consumption-based approach. The UK's GHG emissions between 1990 and 2016 had in fact only declined by 13% with many of the emissions being outsourced to other countries [1]. Leeds researchers developed a complex environment / economy trade model, known as a Multi-Regional Input-Output Model (MRIO) [1, 2] to more accurately reflect UK GHG emissions. As well as understanding the past, the researchers have developed approaches to forecast the UK's future GHG emissions from a consumption perspective [3].

In addition to GHG emissions, the MRIO model was extended to identify critical supply chains and the material, energy and water implications of final products consumed in the UK [4]. This was the first analysis to go beyond carbon and consider the global environmental impacts of UK consumption for other environmental pressures.

The MRIO model showed the UK's historical impact back to 1990. However, it is essential to understand future potential impacts of UK consumption to mitigate climate change. Leeds research combined the existing MRIO model with economic forecasting techniques. Using econometric forecasting and technology-driven scenarios, the research provided the first projection of the UK's global impact from consumption [2]. The ability to project future emissions has led to important research on the potential of resource consumption measures to deliver a reduction in emissions, providing the most comprehensive and robust assessment to date [5]. Leeds researchers have consistently conducted inter-disciplinary research by not only considering the potential strategies and policies to reduce emissions, but also by combining this analysis with social science techniques to evaluate public perceptions and attitudes [6].

The research team have been funded primarily through the UK Energy Research Centre (UKERC) [1, 2, 3] and the Centre for Industrial Energy, Materials and Products (CIE-MAP) [4, 5, 6], and continues under the Centre for Research into Energy Demand Solutions (CREDS) Theme 3 led by the University of Leeds.

3. References to the research (indicative maximum of six references)

1. Barrett. J., Peters, G., Wiedmann, T., Scott, K., Lenzen, M., Roelich, K., Le Quéré, C., 2013. Consumption-based GHG emission accounting: A UK case study. *Climate Policy,* 13, pp. 451-470. http://dx.doi.org/10.1080/14693062.2013.788858
2. Scott, K.A., Barrett, J.R., 2015. An integration of net imported emissions into climate change targets. *Environmental Science & Policy*, 52, pp. 150-157. http://dx.doi.org/10.1016/j.envsci.2015.05.016
3. Scott, K., Daly, H., Barrett, J., Strachan, N., 2016. National climate policy implications of mitigating embodied energy system emissions. *Climatic Change*, 136, pp. 325-338. http://dx.doi.org/10.1007/s10584-016-1618-0
4. Owen, A., Scott, K., Barrett, J., 2018. Identifying critical supply chains and final products: An input-output approach to exploring the energy-water-food nexus. *Applied Energy*, 210, pp. 632-642. http://dx.doi.org/10.1016/j.apenergy.2017.09.069
5. Scott, K., Giesekam, J., Barrett, J., Owen, A., 2019. Bridging the climate mitigation gap with economy-wide material productivity. *Journal of Industrial Ecology,* 23, pp. 918–931. https://doi.org/10.1111/jiec.12831
6. Cherry, C., Scott, K., Barrett, J., Pidgeon, N., 2018. Public acceptance of resource-efficiency strategies to mitigate climate change. *Nature Climate Change*, 8, pp. 1007–1012. https://doi.org/10.1038/s41558-018-0298-3

Research Funding

- EPSRC UK Energy Research Centre Phase 3 (2014-2019), GBP13.5mllion (GBP718K, to Leeds)
- EPSRC Centre for Industrial Energy Materials and Products (2015-2018), GBP3million (GBP1.4million to Leeds)
- EPSRC Centre for Research into Energy Demand Solutions (2018 – 2023), GBP19.4million, with Theme 3 led by Leeds (GBP1.8million)

4. Details of the impact (indicative maximum 750 words)

Consumption-based emission accounting

A new accounting approach was introduced in 2015, exclusively utilising the Leeds MRIO model. This indicator (consumption-based accounting, commonly referred as the "Carbon Footprint") has been developed as one of the Government's headline indicators for climate change. This was a

direct result of research undertaken at the University of Leeds, combined with extensive engagement with Parliamentary Select Committees, government advisory bodies (Committee on Climate Change (CCC)), and government departments and agencies including BEIS, Department for Environment, Food and Rural Affairs (Defra) and the Office for National Statistics (ONS).

"Evidence and policy teams in Defra have very much welcomed this collaboration as your team's work has helped shape the resource agenda by providing three very valuable indicators"...[including]*..."carbon footprint (consumption-based emissions)...a new indicator"* [A].

"…changing the carbon accounting approach to consider the broader capture of carbon, including emissions embedded in imports has informed policymakers of the importance of embedded emissions and of thinking beyond territorial domestic emissions." [A].

The research evidence received Parliamentary attention in 2016, when the Energy and Climate Change Select Committee held an inquiry into the UK's 5th Carbon Budget, Professor Barrett was the only academic invited to provide oral evidence. His evidence was cited 5 times, and emphasised the importance of consumption-based emissions analysis and the Committee's report recommended that: "*DECC* (Department for Energy and Climate Change) *work with the CCC to explore options for incorporating consumption-based emissions data into their policy making process and the potential for including these in future carbon budgets."* [B].

The UK was the first country in the world to officially monitor net-imported GHG emissions on an annual basis. The Leeds team was appointed as the official provider of the UK Government headline indicator on consumption-based emissions. *"The University of Leeds provides estimates of the UK's carbon footprint by an agreement with Defra."* [C]. Previously, the UK government had no adequate measure to capture the emissions that had been outsourced to other countries. This annually updated indicator was introduced because of our research in 2015, and exclusively used the Leeds model up to and including the most recent report in 2020.

Informing the Resources and Waste Strategy and the UK Industrial Strategy

The research into consumption-based emissions highlighted that addressing climate change required a fundamental shift in the use of materials and products. Working closely with Defra from 2014 onwards, Leeds researchers revised and developed new metrics to inform and shape the Government's Resources and Waste Strategy [D] including improved indicators for material footprint and resource productivity compared to older data based on less refined methodology [A]. Defra stated that the research has *"…helped influence the shape of the Resources and Waste Strategy and is providing a sound evidence base on which to set goals and monitor progress in terms of greater resource productivity and reduced carbon and material footprints."* [A]. Ongoing research by Leeds has informed discussions on the development of a resource productivity target for the UK, and Barrett was invited to become a member of the newly formed Government Advisory Group to establish the target. The Leeds research team will also be undertaking the required quantitative analysis. [A]

Further targeted engagement strategies included the production of a policy brief [E] in partnership with Green Alliance, a prominent UK think tank. The climate implications of resource productivity is considered in the Clean Growth Strategy, aligning with Resources and Waste Strategy. As a result of our collaboration, the Department for Business, Energy and Industrial Strategy (BEIS) has said it is better able to deliver Government objectives. The research *"…has contributed to the better understanding of energy efficiency and material efficiency to help the eight most heat-intensive industries decarbonise and increase their energy efficiency while remaining competitive."* [F]. This has helped to shape sectoral action plans and influenced the Government's Industrial Strategy, which aims to support industry to become resource efficient while minimising the negative consequences of extraction, use and disposal. Research from CIE-MAP [4, 5, 6] was used to underpin the UK government's decision to make an investment of GBP66,000,000 as part of the Industrial Strategy Challenge Fund Wave 3, to drive forward *"…recycling and reuse technologies using collaborative R&D programmes on material substitution, industrial symbiosis,*

recycling and reuse, developing new sustainable materials, developing new process technology and addressing cross-cutting themes" [F]

The analysis conducted by Leeds researchers indicated that industrial energy demand is a key factor in addressing these challenges and identified opportunities for progress. As a result of the team's work, BEIS *"…understand better the UK's industrial energy demand, material flows and resource efficiency in the industrial supply chains and economy as a whole. This has helped us to develop and implement policies to deliver Government's objectives."* [F], and Defra state that the (Resources and Waste) *"…Strategy, the 25yr Environment Plan and the Industrial and Clean Growth Strategies all commit to double resource productivity by 2050"* [A].

Scenarios for a net zero future

By identifying the need for transformative change to deliver longer-term climate goals, the research has influenced long-term thinking, and contributed evidence and analysis to the Committee on Climate Change (CCC) to support its oversight and scrutiny function. Our modelling enabled the CCC to develop a scenario of the UK's emissions that would otherwise not have been considered (i.e., emissions from imports to satisfy UK consumption). Leeds' model has exclusively provided the consumption-based emissions data for the CCC progress reports.

The CCC said: *"The development of this model and the regular engagement and access to it provided by Professor Barrett's team have been essential for consumption emissions to feature within the CCC's annual progress reports, including the 2020, 2019 and 2018 Progress Reports of Parliament and the 2020 Scotland Progress Report."* [G]. In response to recommendations informed by Barrett following the fifth carbon budget, the research was used in the CCC's advice on the sixth carbon budget [H] "…*to provide a high-level projection for future trajectories of consumption emissions*." [G].

In addition, our research has contributed analyses of energy demand to the CCC's Net Zero report [I] and their subsequent progress report to parliament. This has ensured that resource efficiency was, for the first time, seen as a strategy to deliver emissions reductions in UK industry giving it a prominent focus in their Net Zero scenario. *"The CCC drew on the University of Leeds' work under the CIE-MAP project on resource efficiency as part of assessment of how to reduce emissions from the UK's industry sector to zero as part of our advice to the Government on setting a UK Net Zero target, summarised in* [I]*."* [G].

In parallel, Leeds has maintained collaboration with BEIS supporting analysis of future energy demand and GHG emissions in the UK by *"re-estimating the equations related to industrial energy within the department's Energy Demand Model."* [J]. *"This model is an important tool for the Government for providing an analysis of future energy demand and GHG emissions for the UK. The model underpins one of our key publications, the Energy and Emissions Projections report."* [J]. The report informs the government of their progress on reducing emissions.

5. Sources to corroborate the impact (indicative maximum of 10 references)

A. Letter from Environmental Quality Directorate, Department for Environment, Food and Rural Affairs.
B. Report. UK Parliament Energy and Climate Change Committee. *Setting the fifth carbon budget.* April 2016. Section 28, p. 15.
C. Report. Department for Environment, Food and Rural Affairs Official Statistics. *UK's carbon footprint 1997 – 2017.* Published online 2020.
D. Strategy document. Defra. *Our waste, our resources: a strategy for England.* 18 December 2018. Evidence annex pages 10, 15, and 21 reference University of Leeds and CIE-MAP.
E. Report/Policy Brief. Green Alliance. *Using Resource Efficiency to Cut Carbon and Benefit the Economy.* 2018. Co-produced by CIE-MAP, University of Leeds.
F. Letter from Assistant Director for Energy Policy, Department for Business, Energy and Industrial Strategy (BEIS).

G. Letter from Senior Analyst, UK Committee on Climate Change (CCC).
H. Report. Climate Change Committee. *6th Carbon Budget*. December 2020.See Chapter 3 (p125-133), Chapter 7 (p344-349), and appended supporting materials (CREDS).
I. Report. UK Committee on Climate Change. *Net Zero – The UK's contributions to stopping global warming.* May 2019. Chapter 5 p. 164 and acknowledgements.
J. Letter from Head of Central Modelling Team, Department for Business, Energy and Industrial Strategy (BEIS). Corroborates modelling input for the Energy Demand Model.