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***“The Class Politics of Net Zero: A SAM Multiplier  
Analysis of the UK's Energy Transition”***

by

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**Abstract:** Distributional analyses of decarbonisation often rely on income, obscuring the politically salient cleavages of social class. This study analyses the class-based impacts of the UK’s energy transition, arguing that the shift to capital-intensive renewables creates distributionally regressive outcomes that favour professional classes, despite boosting aggregate GDP. Using a multiplier model based on a novel 2018 Social Accounting Matrix that disaggregates households by socio-economic class and the power sector by production technology, the analysis models a fiscally neutral investment shift from gas-fired power to wind and nuclear. Results show professional classes capture the largest income gains, while economic activity is re-routed from traditional industrial sectors towards high-tech and service industries. These findings reveal a material basis for working-class scepticism towards climate policy and show that a politically credible energy transition will require a class-conscious industrial strategy.

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## Chapter 1: Introduction

The United Kingdom's net zero obligation, legally entrenched by the 2008 Climate Change Act, is not simply a technical goal but a deeply political one, marking the biggest economic restructuring since the Industrial Revolution (CCC, 2020a). The power sector, responsible for 10% of UK emissions in 2024 (DESNZ, 2025), aims to decarbonise by 2035 (Government Office for Science, 2025) while simultaneously expanding its capacity to accommodate for the electrification of transport, heating, and industrial processes. To achieve this transformation, annual government investment will need to reach £50bn by 2030 (CCC, 2020a). The effects of such investment will not be neutral. Industries will decline, capital will change hands, and there will be winners and losers (Beramendi *et al.*, 2015). Identifying the distributional impacts of this change is therefore of paramount analytical and political importance.

This paper is motivated by the belief that the best research is both socially useful and advances conceptual understanding (Stokes, 1997). It treats decarbonisation as a constraint, not a debate. Its purpose is to analyse the socioeconomic consequences of realising that constraint.

### 1.1 The Research Problem

Technical decarbonisation pathways are extensively modelled in the academic literature, though quantitative analyses of distributional impacts are more limited (Farrell, 2017; Ohlendorf *et al.*, 2021) and costs are generally assessed across income strata (Rausch, Metcalf and Reilly, 2011; Goulder *et al.*, 2018). This points to a methodological weakness in the literature. The failure is one of operationalisation: the thick concept of socioeconomic location within a broader socio-technical regime is reduced to the thin measurand of current income. But income is an *outcome* of an individual's position within the economic structure, not the structure itself. It is a volatile, non-stationary measure which fails to capture the structural determinants of life chances, such as economic security, work autonomy, and employment relations (Evans and Tilley, 2017). A salaried professional and a self-employed tradesperson may share the same income quintile, but a clean air zone policy can generate intense political conflict by imposing a significant capital cost on the tradesperson's essential work vehicle while having no material impact on the professional. A retired homeowner and a young family in rented accommodation may both occupy a middle-income bracket, but face entirely different vulnerabilities to rising energy costs (Burke *et al.*, 2020; Drescher and Janzen, 2021).

Consequently, distributional analyses based on income only crudely capture the mechanisms behind observed results and often lack political relevance (Bouzarovski and Petrova, 2015; Jenkins, Sovacool and McCauley, 2018). To analyse the complex process of decarbonisation through the one-dimensional lens of income is to miss the essential nature of the social dynamics at play.

### 1.2 Rationale for a Class-Based Analysis

To overcome this weakness, this paper analyses distributional impacts using the UK's National Statistics Socio-economic Classification (NS-SEC) (ONS, 2023b), a widely used proxy for socio-economic class (Rose and Pevalin, 2003; Savage *et al.*, 2013; Maclean *et al.*, 2020). The conceptual foundation of the NS-SEC schema is the nature of the employment relationship, which is derived using details of the individual's Standard Occupational Classification (SOC), skill level,

employment status (employer, self-employed, employee), organisation size, and supervisory status. Income is an outcome of these variables, not a determinant.

Class has a substantial effect on life chances (Kitschelt and Rehm, 2014) and is a salient political cleavage, especially in the UK (Evans and Tilley, 2017). As such, it is particularly well suited to analysing a transition defined by a transformation of employment itself, rather than a simple transfer of income (CCC, 2025). By observing how exogenous shocks affect internally stable and politically salient social categories, one can directly engage with debates surrounding the political feasibility of a ‘just transition’ (Newell and Mulvaney, 2013).

### **1.3 Methodology in Brief**

The analytical architecture of this paper is the Social Accounting Matrix (SAM). A SAM provides a snapshot of all economic transactions in a given period, mapping the circular flow of income from productive activities, to factors of production and the institutions that own them (Pyatt, 1988). To answer the research questions, a 2018 UK SAM was disaggregated by socioeconomic class and electricity technology to produce the UK 2018 Socio-Energy Social Accounting Matrix (SE-SAM). This SAM has eight electricity technologies representing the ‘Electricity’ sector and ten NS-SEC classes representing the ‘Household’ account.

The methodology rejects forecasting and commits to comparative static analysis. A fixed-price, Leontief-based SAM multiplier model is exceptionally useful for understanding an economy’s structure and for conducting controlled experiments to isolate causal mechanisms. However, it is a deeply flawed instrument for predicting the economy’s future state due to fixed-price, fixed-technology assumptions and deep, ‘Knightian’ uncertainty surrounding future possibilities (Marchau *et al.*, 2019). The analysis does not ask, “What will the UK economy look like in 2030?” It asks, “How would the UK’s economic structure and distributional outcomes differ under a specific decarbonisation policy compared to a baseline, holding all else constant?”

### **1.4 Contribution to Knowledge**

The paper contributes to the state-of-the-art in three important ways. It enhances rigour, operationalising a sociologically robust concept within a macroeconomic framework and bridging the disciplinary divide between political sociology and macroeconomic modelling. It is methodologically novel, creating a new tool – the SE-SAM – which can be used in future studies to answer a range of distributional questions. It is also empirically novel, providing the first quantitative, economy-wide estimates of the class-based impacts of UK power sector decarbonisation.

### **1.5 Research Questions and Structure**

This paper engages with the core political economy questions of transition – ‘who wins, who loses, how, and why’ (Newell and Mulvaney, 2013) – by addressing one primary and three secondary research questions:

- PQ1: What are the impacts of UK power sector decarbonisation on the economic standing of different socio-economic classes?
  - SQ1: What are the specific mechanisms that drive these class-based outcomes?

- SQ2: How do these impacts vary according to the choice of generation technology?
- SQ3: What are the implications for designing a robust decarbonisation strategy?

The paper is structured as follows. Chapter 2 synthesises the literature on SAMs, the political economy of a ‘just transition’, and the sociology of class, building the theoretical case for the chosen methodology. Chapter 3 details the construction of the SE-SAM, including data sources and estimation and balancing techniques. Chapter 4 presents the scenarios and results of the analysis. Chapter 5 discusses the implications of the results along with methodological limitations and recommendations for future research. Chapter 6 concludes.

## Chapter 2: Theoretical Foundations

This chapter brings together three distinct yet complementary areas of literature, covering the Social Accounting Matrix (SAM), the political economy of climate policy, and the political sociology of modern Britain. As Accetti (2021) argues, climate policy discourse is often stuck between pure technocratic environmentalism, which presents climate action as an objective scientific problem, and populist anti-environmentalism, which rejects it as an elite conspiracy. This paper seeks to move beyond this binary, showing how politics and science are interlinked. The chapter’s main proposition is that the structural and political nature of the energy transition make the SE-SAM the best method to analyse the distributional consequences of decarbonisation policies.

### 2.1 The SAM Framework

The analytical core of this paper is the SAM. A SAM is a single-entry accounting system, with each macroeconomic account represented by a column for outgoings (expenditure), and a row for incomings (receipts) (Round, 2003). Every column total must be equal to its corresponding row total, since all outgoings must be accounted for by incomings. The final form of the SAM is a square matrix which represents the entire circular flow of money between productive activities, factors of production (labour, capital), and institutions (households, corporations, government, and the rest of the world). A stylised representation of the SE-SAM used for this analysis is shown in Table 2.1. The utility of SAMs is demonstrated by their varied applications, having been used to assess agricultural policy in Ghana (Ferreira *et al.*, 2022), energy and environmental policies in Chile (Mardones and Brevis, 2021), the impacts of trade liberalisation in Vietnam (Jensen and Tarp, 2005), and the effects of COVID-19 in China (Zhang *et al.*, 2020), to name but a few.

**Table 2.1: Stylised Representation of the SE-SAM**

Payments → ↓ Receipts	Activities (Production)	Factors (Labour & Capital)	Institutions (HH, Corps, Govt)	Capital Account (Saving/Investment)	Rest of the World (Trade)	Total Receipts
Activities (Production)	<b>Intermediate Demand</b> Firms buying from firms	Zero	<b>Final Consumption</b> (C + G)	<b>Investment</b> (I)	<b>Exports</b> (X)	<b>Total Output</b>
Factors (Labour & Capital)	<b>Value Added</b> Wages & Profits	Zero	Zero	Zero	<b>Factor Income from RoW</b>	<b>Total Factor Income</b>
Institutions (HH, Corps, Govt)	<b>Net Indirect Taxes</b> Taxes on products	<b>Primary Income</b> Distribution of wages/profits	<b>Direct Taxes &amp; Transfers</b> e.g., Income tax, benefits	Zero	<b>Current Transfers from RoW</b>	<b>Total Institutional Income</b>
Capital Account (Saving/Investment)	Zero	Zero	<b>National Saving</b> (S)	Zero	<b>Net Foreign Saving</b> Capital Inflows	<b>Total Saving</b>
Rest of the World (Trade)	<b>Imports</b> (M) - for production	<b>Factor Payments to RoW</b>	<b>Imports</b> (M) - for consumption	Zero	Zero	<b>Total Payments to RoW</b>
<b>Total Payments</b>	<b>Total Production Cost</b>	<b>Total Factor Payments</b>	<b>Total Institutional Outlay</b>	<b>Total Investment</b>	<b>Total Payments from RoW</b>	<b>Grand Total</b>

Theoretically, the SAM is rooted in a structuralist economic perspective which emphasises the importance of institutions and interdependencies in economic outcomes (Isard *et al.*, 2017). SAMs mark a progression of the Input-Output (I-O) tables pioneered by Wassily Leontief (Leontief, 2010), which provide a snapshot of an economy's production structure. Stone (1966) integrated these I-O tables with the full System of National Accounts (SNA) to describe the main structural characteristics of the UK economy, endogenising the transmission of value from production activities to factors of production, and from factors of production to institutional actors such as households. Individual SAM accounts can be disaggregated to reflect specific policy concerns, making them highly flexible tools. Households, for instance, might be disaggregated according to income, education, class, or region, allowing for detailed distributional analysis (Katris and Figus, 2017).

By 'closing the circle' of income, the SAM goes from being a data repository to being an analytical model in its own right. The assumption of fixed average expenditure propensities allows for the construction of a 'multiplier matrix' which quantifies how exogenous demand shocks spread through the economy. Multipliers reflect not just the direct and indirect (inter-industry) effects of a shock but also the induced effect arising from the new factor income spent by households, which decays exponentially as the shock ripples through the economy (Emonts-Holley, Ross and Swales, 2021). Techniques such as Multiplier Decomposition and Structural Path Analysis (SPA) are used to deconstruct these multipliers and trace how an external demand injection travels through the economy. This can be used to determine the mechanisms by which a shock in one sector affects a particular type of household (Defourny and Thorbecke, 1984).

The framework's flexibility allows one to trace how a policy shock, such as a large-scale government investment in offshore wind, is transmitted to different household types. The direct link between macroeconomic activity and household income makes the SAM well-suited for distributional analysis.

## **2.2 The Political Economy of a 'Just Transition'**

The necessity of a 'just transition' has become a central feature of climate policy discourse (Eurofound, 2021). The concept acknowledges that in order to be politically viable, climate policy must be enacted in line with principles of justice, navigating trade-offs between those currently living in energy poverty and those whose livelihoods depend on the fossil fuel economy (Newell and Mulvaney, 2013). Of particular importance is whether costs and benefits are, and are perceived to be, fairly distributed (Lamb *et al.*, 2020). These distributive impacts can be split into two channels: effects on the 'uses' of income (consumer prices) and on the 'sources' of income (employment and wages).

The academic literature has, with good reason, extensively analysed the 'uses' channel, showing that carbon and energy taxes tend to be regressive because lower-income households spend a larger proportion of their budget on energy essentials (Chester, 2014; Roberts, Vera-Toscano and Phimister, 2015; Advani and Stoye, 2017; Farrell, 2017). However, a complete understanding of the political challenge requires these 'uses' to be considered in conjunction with impacts on the 'sources'. While the price effects of a carbon tax can be offset with fiscal transfers like revenue recycling mechanisms (Sajeewani, Siriwardana and Mcneill, 2015; Pizer and Sexton, 2019; O'Malley, Roantree and Curtis, 2020), the decline of entire industries cannot be easily compensated. New 'green jobs' are created, such as in wind turbine manufacturing and energy efficiency retrofitting, but there is no guarantee of a smooth transition for displaced workers, who may lack the requisite skills or geographic mobility to adapt (CCC, 2025).

The historical experience of deindustrialisation in Britain shows that such shocks can result in large-scale unemployment and persistent regional decline, with social costs extending over generations (Turnheim and Geels, 2012; Andrews, 2020). The threat is not solely a matter of financial loss (a ‘pocketbook’ effect), but an experience of relative status decline. Ansell et al. (2022) describe this as a ‘geotropic’ effect, where economic shocks create a sense that one’s entire community has been left behind relative to booming metropolitan centres. This can be a more potent driver of political grievance than direct income effects alone, as it speaks to fundamental questions of identity, dignity, and place (Darby, 2017).

The political consequences of these grievances can be observed in the rise of radical right parties (RRPs) across Europe, which have successfully mobilised working-class constituencies disproportionately harmed by the decline of carbon-intensive industries (Lockwood, 2018). The political appeal to these voters is not always based on outright climate denialism. Instead, it often employs a strategy of ‘far-right localism’, which champions national environmental protection while vehemently rejecting ‘globalist’ projects like the Green Deal and its associated economic restructuring (Marschner *et al.*, 2024). This frame allows political entrepreneurs to portray decarbonisation as a project of detached metropolitan elites imposing costs on traditional industrial heartlands (Atkins, 2023), a narrative that resonates with the lived experience of communities facing industrial decline (Beramendi *et al.*, 2015; Caiani and Lubarda, 2024).

The economic shock of decarbonisation thus risks catalysing a political realignment that undercuts its own objectives. A technically optimal but politically naïve pathway will be a dead end if it leads to climate-sceptical governments. Accordingly, a political economy lens cannot be an afterthought; it must be a fundamental part of the policy design. This requires an analytical framework that connects structural economic change not just to income brackets, but to groups with meaningful political identities.

### **2.3 The Sociology of Class in Modern Britain**

Socio-economic class is the concept that best captures the political conflicts of the energy transition (Huber, 2022). Unlike income, which is volatile and often poorly reflective of socio-economic position, class captures more lasting determinants of life chances such as wealth, job security, work autonomy, and promotion prospects (Marshall *et al.*, 2005). This paper operationalises class using the National Statistics Socio-economic Classification (NS-SEC), which follows the work of John Goldthorpe (Goldthorpe, 2010) to define class based on the nature of the employment relationship (Rose and Pevalin, 2003).

The NS-SEC’s core conceptual distinction is between the ‘service relationship’ and the ‘labour contract’ (Rose and Harrison, 2007). The service relationship is characteristic of professional and managerial occupations (NS-SEC Classes 1 and 2), where the principal-agent exchange is broadly specified and long-term in its arrangement. In return for delegated authority or specialist knowledge, employees are granted rewards such as promotions and additional job security. In contrast, the labour contract entails a more discrete, short-term exchange of wages for effort, usually under direct supervision. This is the typical work logic in routine and semi-routine occupations (NS-SEC Classes 6 and 7), often called the Working Class. The schism in the experience of work between these groups – prospective security versus transactional precarity – shapes both material outcomes and experiences of autonomy, leading to different social imaginaries (Taylor, 2004) and divergent political values (Sani, 2008; Kitschelt and Rehm, 2014). These values are central to the political economy of

decarbonisation. Oesch and Rennwald (2018) characterise the salaried middle class, particularly socio-cultural professionals, as holding ‘libertarian-universalistic’ values that favour international integration and global environmental cooperation. In contrast, the working classes and small business owners tend toward ‘traditionalist-communitarian’ values that prioritise cultural demarcation and national traditions, inclining them to be sceptical of transnational climate projects. Therefore, environmental policy becomes a battleground not just for material resources, but for the competing worldviews rooted in the lived experience of class.

While some commentators have argued for the declining salience of class, contemporary research shows that it remains a strong predictor of political behaviour in the UK (Heath, 2015; Evans and Mellon, 2016; Evans and Tilley, 2017). The traditional bipolar cleavage has not disappeared, but realigned within a tripolar field of competition (Bornschiefer and Kriesi, 2012). This is largely due to long-term structural change, such as the expansion of higher education and increasing geographical segregation (Ford and Jennings, 2020), prompting strategic repositioning by political parties. Elections are now contested on both a traditional economic axis (redistribution versus free market), and a newer cultural axis (liberal/cosmopolitan versus authoritarian/nationalist) (Langsæther, 2019; Vachudova, 2019). Within this environment, traditional centrist parties like the Conservatives and Labour are challenged by new parties on the populist right, such as Reform UK.

The populist right competes with traditional parties on two fronts: the traditional working class (NS-SEC 6 and 7), historically a centre-left preserve, and small business owners (NS-SEC 4), traditionally a centre-right group (Rydgren, 2012; Oesch and Rennwald, 2018). By disaggregating households along class lines, the constructed SE-SAM can be used to determine whether decarbonisation policies impose absolute or relative economic losses on these politically key classes. Should such losses materialise, these policies risk fomenting economic grievances ripe for populist mobilisation.

## **2.4 Argumentative Synthesis**

The decarbonisation of the UK power sector is a major structural shock whose most politically consequential impacts will be felt by workers and industries. As Section 2.1 detailed, the SAM provides the necessary architecture for this macroeconomic analysis. Yet, to grasp the true political economy of a ‘just transition’, as Section 2.2 emphasised, we must focus on ‘source’ effects, recognising that disruptions to employment and industrial legacy are the primary engines of political grievance. Section 2.3 anchored this political economy within the measurable taxonomy of the NS-SEC, demonstrating the enduring, class-based foundation of contemporary political conflict.

Establishing this class-based lens is analytically essential, as alternative frameworks consistently misdiagnose the political vulnerabilities of the transition. For instance, while direct analysis of income groups remains essential for questions of poverty alleviation, an exclusively income-based framework fails to capture the dynamics of political coalition-building. By aggregating individuals with entirely distinct employment relations and political allegiances into financial deciles, it renders the unique political features of each group invisible. Similarly, prominent institutionalist approaches argue that the primary obstacle to decarbonisation is not class conflict, but the strategic challenge of overcoming the fossil fuel industry via elite ‘policy sequencing’ (Meckling, Sterner and Wagner, 2017). But this perspective overlooks the deeper class composition of the voting blocs whose sustained consent is required to enact and uphold such a policy sequence in the first place.

To ignore the political incentives of the energy transition is to construct a castle upon sand. What is required, therefore, is an analytical framework capable of linking the shock of decarbonisation directly to the distribution of income across the specific, contested classes that define the UK's electoral landscape. A class-disaggregated SAM is distinctly suited to this task. It allows macroeconomic shocks to be traced through industries not merely to corporate actors, but to the politically mobilised groups whose electoral support is essential for the transition to succeed.

## **Chapter 3: Methodology**

The 2018 UK Socio-Energy Social Accounting Matrix (SE-SAM) features a detailed disaggregation of both the 'Electricity' sector (into eight generation technologies plus transmission and distribution) and the 'Household' account (into ten NS-SEC classes). This allows the analysis to move beyond partial equilibrium analysis and capture the direct, indirect, and induced effects of decarbonisation. By comparing economic equilibria before and after a policy shock, the mechanisms driving distributional outcomes can be isolated.

This chapter outlines the methodology undertaken to construct the SE-SAM. The credibility of the subsequent analysis depends on the transparency and validity of the procedures outlined here. The narrative is structured sequentially to ensure clarity, providing a granular account of each stage of the disaggregation process and outlining the mathematical framework of the SAM multiplier model that will be deployed in Chapter 4.

### **3.1 Foundational Data**

The first stage was to source an existing UK SAM for disaggregation. The Fraser of Allander Institute's (FAI) UK 2018 SAM was chosen for the analysis, provided by Dr. Katris (personal communication, 2025). The year 2018 is the most recent, complete, and 'stable' pre-pandemic economic baseline available at the time of research.

The FAI 2018 SAM has 43 accounts. The SE-SAM extends this to 60 accounts: 42 production sectors, 2 factor accounts (Labour and Capital), and 16 institutional and other accounts. The final structure is detailed in Table 3.1.

**Table 3.1: Structure of the Final 60x60 UK Socio-Energy Social Accounting Matrix (SE-SAM)**

Category	Account No.	Number of Accounts	Description / Illustrative Examples
<b>I. Production Activities</b>	<b>1-42</b>	<b>42</b>	<b>Total Production Sectors</b>
	1-17	17	<i>Non-Energy Sectors (A):</i> Agriculture, Mining (excl. fuels), Manufacturing, Construction, etc.
	18, 27	2	<i>Energy Sectors - Distribution:</i> Electricity transmission/distribution, Gas Distribution
	19-26	8	<i>Energy Sectors - Generation:</i> Nuclear, Coal, Gas (CCGT), Wind, Hydroelectric, Other renewable, Oil, Solar
	28-42	15	<i>Non-Energy Sectors (B):</i> Wholesale & Retail Trade, Transport, Financial Services, Public Admin, etc.
<b>II. Factors of Production</b>	<b>43-44</b>	<b>2</b>	<b>Total Factors</b>
	43	1	Labour (Compensation of Employees)
	44	1	Capital (Gross Operating Surplus)
<b>III. Institutions</b>	<b>45-57</b>	<b>13</b>	<b>Total Institutions</b>
	45-54	10	<i>Households (by NS-SEC)</i>
	55-57	3	<i>Other Institutions:</i> Net Indirect Taxes, Corporations, Government
<b>IV. Other Accounts</b>	<b>58-60</b>	<b>3</b>	<b>Total Other Accounts</b>
	58-60	3	Capital Formation (Investment), Stock (Changes in Inventories), Rest of the World
<b>Total Accounts</b>	<b>1-60</b>	<b>60</b>	

### 3.2 Disaggregation of Households by NS-SEC

The first and most significant step was to disaggregate the single, representative household account into ten sociological subtypes. As established in Chapter 2, the NS-SEC schema was chosen to operationalise class within the model. NS-SEC can be used at several levels of aggregation, with the most common being eight ‘analytic’ classes. However, this schema combines students, the long-term unemployed, and the remaining economically inactive (such as pensioners and those with unclassified occupations) into a single category (ONS, 2010) which would be unacceptable for a distributional analysis.

The ten classes ultimately chosen are displayed in Table 3.2.

**Table 3.2: Description of SE-SAM Households**

<b>Code</b>	<b>NS-SEC Class Description</b>	<b>Defining Employment Relationship</b>
<b>HH1</b>	Higher Managerial and Professional Occupations	Service Relationship
<b>HH2</b>	Lower Managerial and Professional Occupations	Attenuated Service Relationship
<b>HH3</b>	Intermediate Occupations	Intermediate Employment Contract
<b>HH4</b>	Small Employers and Own Account Workers	Ownership and Control
<b>HH5</b>	Lower Supervisory and Technical Occupations	Modified Labour Contract
<b>HH6</b>	Semi-Routine Occupations	Slightly Modified Labour Contract
<b>HH7</b>	Routine Occupations	Labour Contract
<b>HH8</b>	Never Worked and Long-Term Unemployed	Exclusion from Employment Relations
<b>HH9</b>	Full-Time Students	Engagement in Education
<b>HH10</b>	Economically Inactive and Other	Primary Income from Transfers or Past Employment

### 3.2.1 Disaggregation of Household Final Demand

The disaggregation of household final demand followed the peer-reviewed methodology of Katris and Figus (2017), adapted for the NS-SEC schema. The aim of the process was to produce a matrix showing the expenditure of the ten NS-SEC classes on the outputs of the 34 industrial sectors (prior to electricity sector disaggregation).

Household spending surveys are categorised by the ‘Classification of Individual Consumption by Purpose’ (COICOP), whereas the national accounts classify economic activity by product (Classification of Products by Activity, CPA) and industry (Standard Industrial Classification, SIC). A direct mapping between these systems at a disaggregated household level does not exist. To bridge this gap, the primary data source was the ‘HHFCe’ (Household Final Consumption Expenditure) matrix (ONS, 2019), which maps COICOP spending to CPA categories. This served as a crucial translator between the two classification systems. After constructing a correspondence matrix between the CPA categories and SIC codes, the *HHFCe* matrix was transformed into the *C* matrix, which showed how consumption in COICOP categories mapped onto spending by SIC code. This was normalised to obtain the *B* matrix, with each column showing the income received by each of the 104 industries for every pound of spending in that consumption category.

The second stage required disaggregating the *B* matrix. The primary data source was Table A22 from the Family Spending survey (ONS, 2020), which contains the total expenditure by each NS-SEC household group on each of the twelve COICOP consumption categories. This data was processed by converting weekly totals into annual totals, scaling according to the weighted number of households, and combining the top two professional classes. The result was a 12x10 *K* matrix detailing the expenditure of the ten household classes on the twelve consumption categories. Multiplying the *B* matrix by the *K* matrix produced the initial estimate of disaggregated household demand, the *hhT*

matrix, but the use of survey data in Table A22 meant that it was not yet consistent with the national accounts.

To ensure the matrix preserved the relative spending patterns while being fully consistent with the national accounts, the rows of the *hhT* matrix were normalised and scaled to the national totals. This involved converting it into a matrix of proportional shares (*hhF*), before multiplying these shares by the control totals for household expenditure provided by the official 2018 Input-Output Tables (specifically, the P3 S14 column) (ONS, 2019). The resulting 104 SIC codes were then aggregated into the 34 SAM production sectors, to obtain the final, 34x10 matrix of disaggregated household demand.

The full mathematical process is outlined in Appendix B.

### **3.2.2 Disaggregation of Income and Other Expenditures**

The final step in developing the household accounts was to allocate the remaining expenditure flows and sources of household income. For income, five sources were disaggregated: ‘Labour income’, ‘Gross Operating Surplus’ (capital), ‘Corporations’, ‘Government’, and the ‘Rest of the World’. Table A43 in the ONS Family Spending survey (ONS, 2015) provided detailed information on the income sources of each NS-SEC class, allowing for the derivation of income shares for each household type. The use of 2014 data was a necessary compromise due to the unavailability of more contemporary data sources. The validity of using this slightly older data is supported by the theoretical premise of class persistence outlined in Chapter 2, which implies that different classes’ income sources should be stable over the medium-term. This is supported by a review of the same ONS table from earlier years, which show little variation with the 2014 sample.

The methodology of Katris and Figus (2017) was followed to disaggregate the expenditure side. For transfers to ‘Corporations’, ‘Government’, and ‘Capital Formation’ (household savings), 2018 Living Costs and Food Survey (LCFS) microdata was used (ONS, 2023a). A Stata script was constructed to classify each household into its NS-SEC group and then sum the specific LCFS variables for each category (see Appendix A). After applying official survey weights, the script calculated the proportion of each account's income attributable to each of the ten NS-SEC classes. Since the LCFS microdata does not include variables for ‘Net Indirect Taxes’ and payments to ‘Rest of the World’, spending on these categories was taken from the 2018 UK Input-Output table (ONS, 2025) and disaggregated using the share of total household consumption for each NS-SEC class as a proxy.

### **3.3 Disaggregation of Energy Sector**

The second major disaggregation was of the single ‘Electricity’ sector into nine sub-sectors: ‘Electricity transmission/distribution’, ‘Nuclear’, ‘Coal’, ‘Gas (CCGT)’, ‘Wind’, ‘Hydroelectric’, ‘Other renewable’, ‘Oil’, and ‘Solar’. The ‘Other renewable’ sector in this model includes technologies such as biomass and energy-from-waste, which, while renewable, are associated with direct carbon emissions.

Since the UK national accounts lacked the required technological detail, the initial proportional cost structures – the input coefficients defining the ‘recipe’ for each technology – were derived from the Global Trade Analysis Project (GTAP)-Power database (2017 version) (Chepeliev, 2023). The GTAP database combines national accounts with specialist energy data (e.g. from the IEA) to enhance the

level of technological detail. The use of the 2017 GTAP data as a structural prior for the 2018 SAM was justified on the basis that the relative input cost structure of a technology is highly stable over a one-year period. This was validated by confirming that no major regulatory shifts or energy technology price shocks occurred in the UK in 2017/18.

A challenge arose in reconciling the Product-by-Product (PxP) GTAP dataset with the Industry-by-Industry (IxI) FAI SAM. An IxI framework tracks all inputs and outputs from a specific industry (e.g. the ‘solar power generation industry’), whereas a PxP framework tracks all inputs required to create a homogeneous product (e.g. ‘solar generated electricity’) irrespective of the industry that produced it. Combining the two without adjustment would typically be an accounting error.

The use of PxP proportions as a proxy for IxI proportions was justified on the basis of ‘sectoral purity’: for the highly specialised and technologically homogenous activity of electricity generation, the distinction between the ‘product’ and ‘industry’ is negligible. Unlike a sector such as manufacturing, a wind farm or power plant has minimal secondary production and is organised to produce a single, homogenous product (electricity). Therefore, the proportional cost structure of the product is a valid proxy for the proportional cost structure of the industry.

To ground this assumption, UK PxP and IxI tables from 2017-2019 were compared to identify any structural differences (ONS, 2025). This confirmed one important discrepancy: the low recorded payments from households to the ‘Gas distribution’ industry was a result of natural gas also being purchased from the ‘Wholesale/retail’ sector. The PxP and IxI tables for the ‘Electricity’ sector, however, were near-identical. Additional benchmarking against other energy-disaggregated SAMs for the UK in 2010 (Allan, Connolly and Ross, 2019) and Germany in 2020 (Stadler *et al.*, 2021) showed that the SE-SAM’s cost proportions are comparable to other peer-reviewed sources.

The GTAP cost structures were mapped onto the SAM using a manually constructed correspondence matrix. This resulted in a 60x9 matrix showing the production input costs for each electricity sub-sector. However, since the GTAP SAM and the FAI SAM are compiled from different sources, the row sums of this matrix were not consistent with the control totals for the ‘Electricity’ sector. The Stochastic Cross-Entropy (CE) method was identified as the most statistically sound method for reconciling this discrepancy (Robinson, Cattaneo and El-Said, 2001; Kroese, Rubinstein and Glynn, 2013). The CE method adjusts a ‘prior’ matrix (the 60x9 GTAP-constructed matrix) to satisfy a set of known constraints (the 60x1 national account totals), identifying the most likely new matrix that meets these constraints while minimising the introduction of unsupported information, thereby preserving the proportions from the GTAP prior as much as possible. The method is ‘stochastic’ because it treats the national totals as random variables, permitting some slack based on relative confidence in different data sources. The CE script was written in GAMS and can be found in Appendix A.

### **3.4 Balancing**

It is common when disaggregating a SAM for small discrepancies to arise between the column totals and row totals of corresponding accounts, due to data imperfections and imperfect correspondence of categories (Pyatt, 1999). However, column totals and row totals must be identical for the SAM to be a

complete mapping of the economy, with all expenditure accounted for by income. To restore this identity, a balancing procedure is required.

Prior to balancing, key ratios were scrutinised (e.g. labour share of value added, proportion of income from government) to ensure that the initial disaggregation did not produce figures that were economically nonsensical or radically out of line with established knowledge. Following this, the SAM was balanced using an  $L_1$  Norm minimisation method, which minimises the sum of absolute differences between the unbalanced and balanced matrices (J. Round, 2003; Lee, 2014). This approach best matched the prior data, where the presence of negative values made CE methods impossible, and high confidence in the initial structure rendered  $L_2$  Norm minimisation undesirable due to its tendency to spread adjustments across the SAM. As the pre-balanced SAM was already close to a balanced state, changes were minor. The GAMS balancing code is provided in Appendix A.

### 3.5 Environmental Extension

To analyse the environmental effects of the decarbonisation scenarios, the SE-SAM was extended with a non-monetary satellite account for GHG emissions. This involved creating a vector of emissions intensities (see Appendix B) for the 42 production sectors.

Two datasets were used to create the emission intensity vector. The primary source was the UK's official emissions data for 2018 (BEIS, 2020), which provided a breakdown of emissions by SIC code. The second source was the emissions data from the GTAP-Power (2017) database, broken down by industry and fuel type, which was used to disaggregate total emissions from the electricity sector into the specific generation technologies. The same correspondence matrix used to disaggregate household demand was used to map the calculated emissions intensities onto the SE-SAM sectors and obtain the final  $42 \times 1$  emission intensity vector.

### 3.6 The Multiplier Model

The final methodological step was to prepare the balanced SE-SAM for analysis by transforming it into a fixed-price, Leontief-based multiplier model (Leontief, 2010). The first stage of this process was to derive the ' $A$ -matrix'. Each column in this matrix is calculated by dividing the entries within the SAM's endogenous accounts by that column's corresponding total output. The resulting coefficients,  $a_{ij}$ , represent the value of inputs from endogenous account  $i$  required to produce one monetary unit of output in endogenous account  $j$ .

The  $A$ -matrix shows the production technology of the economy, but it does not capture links between sectors. To account for the complete effects of a policy shock, the Leontief inverse, or multiplier matrix, must be calculated:

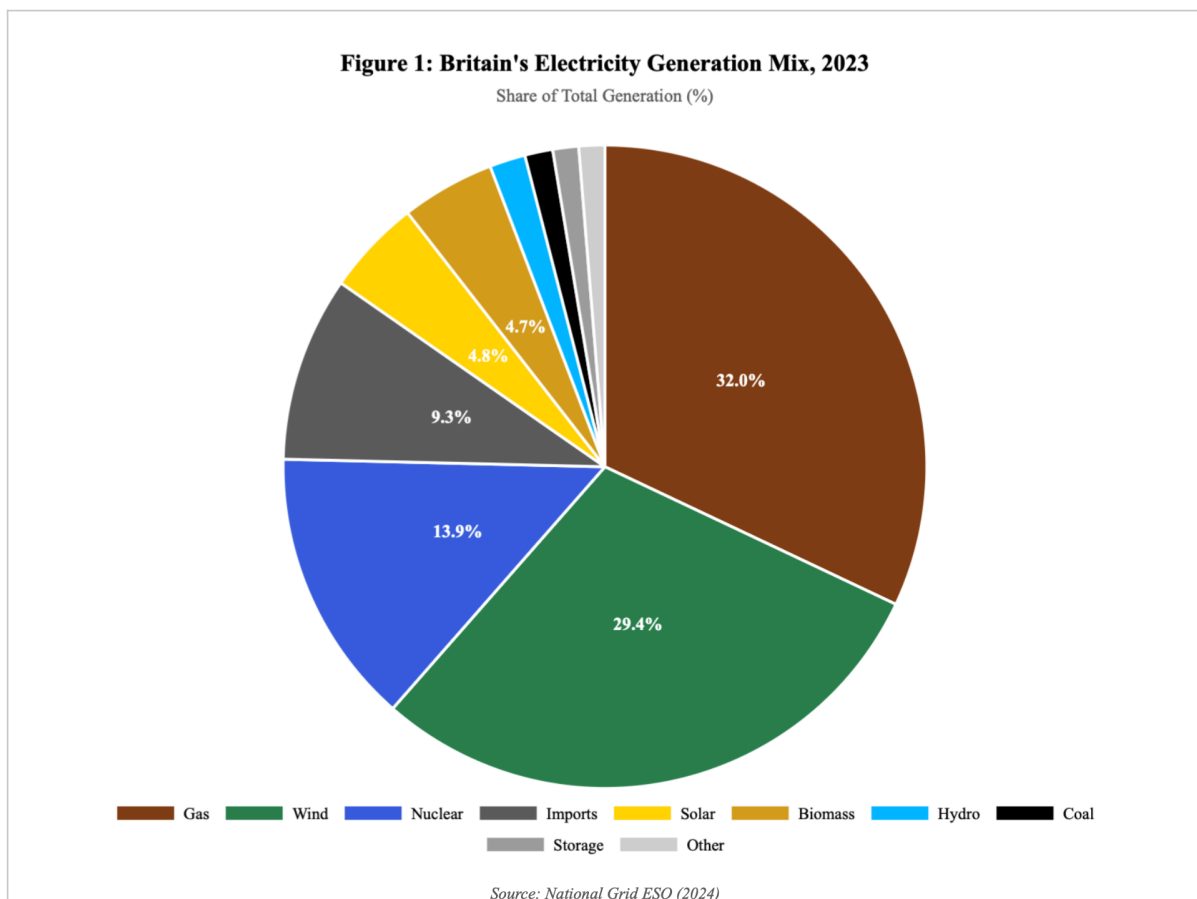
$$M = (I - A)^{-1}$$

where  $I$  is an identity matrix of the same dimension as  $A$ . Each element,  $m_{ij}$ , of this multiplier matrix represents the total value of output required from sector  $i$  to satisfy one monetary unit of final demand for the output of sector  $j$ .

Exogenous shocks, such as new government investment, are specified as a vector of changes to final demand. This vector is then pre-multiplied by the multiplier matrix  $M$ . The result is a new vector that quantifies the total change in output across all endogenous sectors required to meet the initial change in demand. It captures the direct, indirect (inter-industry supply chain), and induced (household re-spending of income) effects that ripple through the economy following an exogenous shock.

## Chapter 4: Results

This chapter presents the core findings of the analysis, showing how decarbonisation alters the material status of different classes. The chapter begins by using the SE-SAM to establish the baseline class inequalities that might challenge the net zero project. It then looks at a fiscally neutral £14bn investment shock, modelled as an exogenous demand adjustment from gas to wind or nuclear. The shock size is designed to meet the UK's 2030 emissions target for gas-fired (CCGT) power generation (CCC, 2020b), which specifies a reduction from 245gCO<sub>2</sub>/kWh to 50gCO<sub>2</sub>/kWh. A £14bn reduction in gas demand results in an equivalent reduction in direct CCGT-related emissions (calculated from the environmental satellite account) of 21.7 MtCO<sub>2</sub> from a baseline of 27.3 MtCO<sub>2</sub>. The analysis focuses on gas, wind, and nuclear because they represent the core technologies for baseload and variable renewable power in the UK, as shown in Figure 1 (NESO, 2024). The focus on the UK's 2030 target is justified by the contemporary political focus of the research, and an awareness of exponential uncertainty in very long-term time horizons. The fixed-price and fixed-technology assumptions of the static Leontief model are appropriate for analysing structural impacts in the medium-term, but become less tenable for forecasting where significant technological change is expected (Breisinger, Thomas and Thurlow, 2009; Marchau *et al.*, 2019).



The aggregate results are deconstructed through two experiments: a simplified Structural Path Analysis (SPA) to trace the 're-routing' of industrial value, and a multiplier decomposition to quantify the wider (induced) community benefits. For clarity and political relevance, the results will focus on three class blocs: the Professional Classes (NS-SEC 1 and 2), Small Employers (NS-SEC 4), and the Working Classes (NS-SEC 6 and 7). These groups are politically contested strongholds with distinct

employment relations, making them key actors in the UK’s political economy. As shown in Table 4.1, they have fundamentally different relationships to the factors of production. The professional classes, comprising 36.4% of households, capture the majority of both labour and capital income; in contrast, the working classes (18.3% of households) are almost wholly reliant on a disproportionately small share of wages, while the smaller group of employers (8.3% of households) depends primarily on returns from capital.

**Table 4.1: Factor Income by Class**

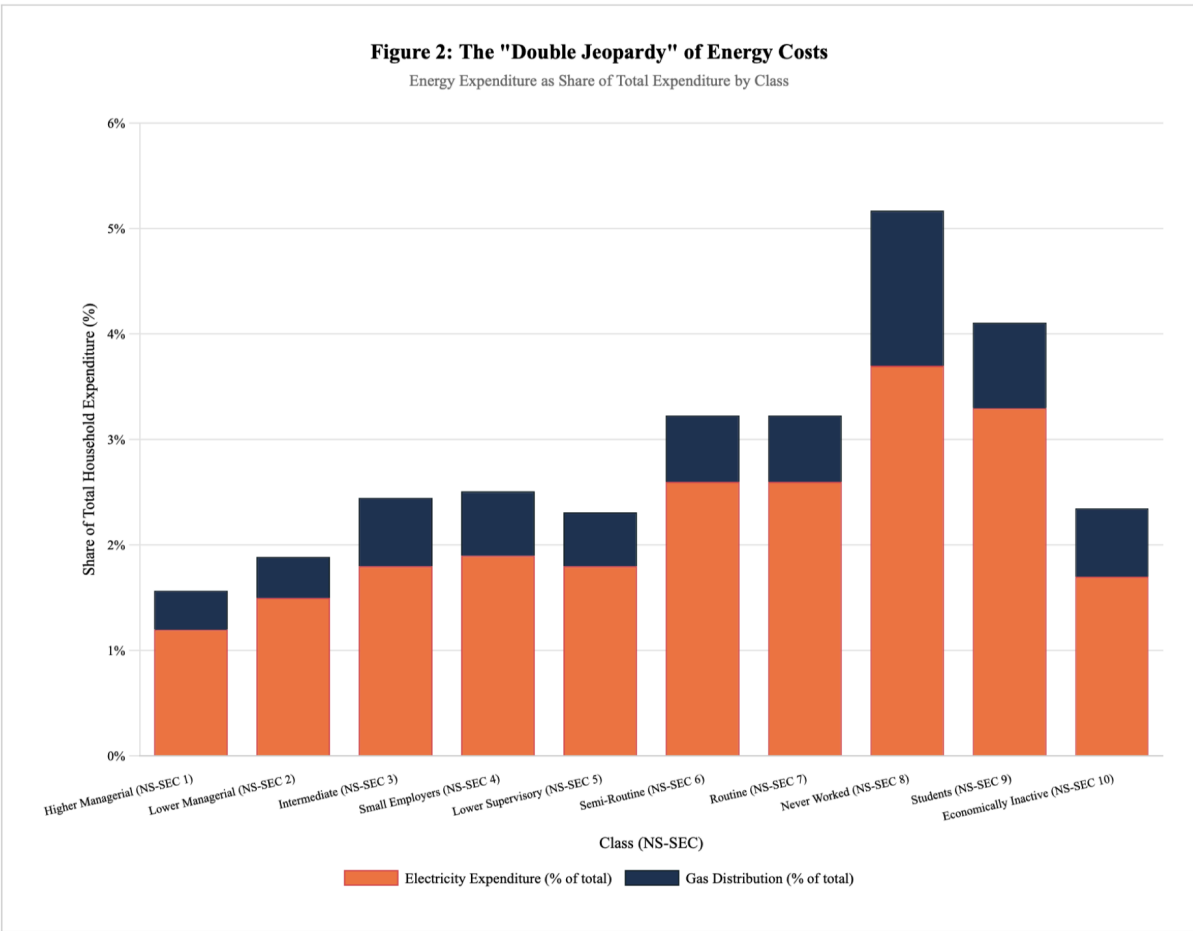
<b>Class Grouping</b>	<b>Share of Total Labour Income</b>	<b>Share of Total GOS to Households</b>
Professional Classes (NS-SEC 1 & 2)	63.3%	55.5%
Small Employers (NS-SEC 4)	2.6%	19.6%
Working Classes (NS-SEC 6 & 7)	13.2%	8.1%

#### **4.1 Baseline Analysis**

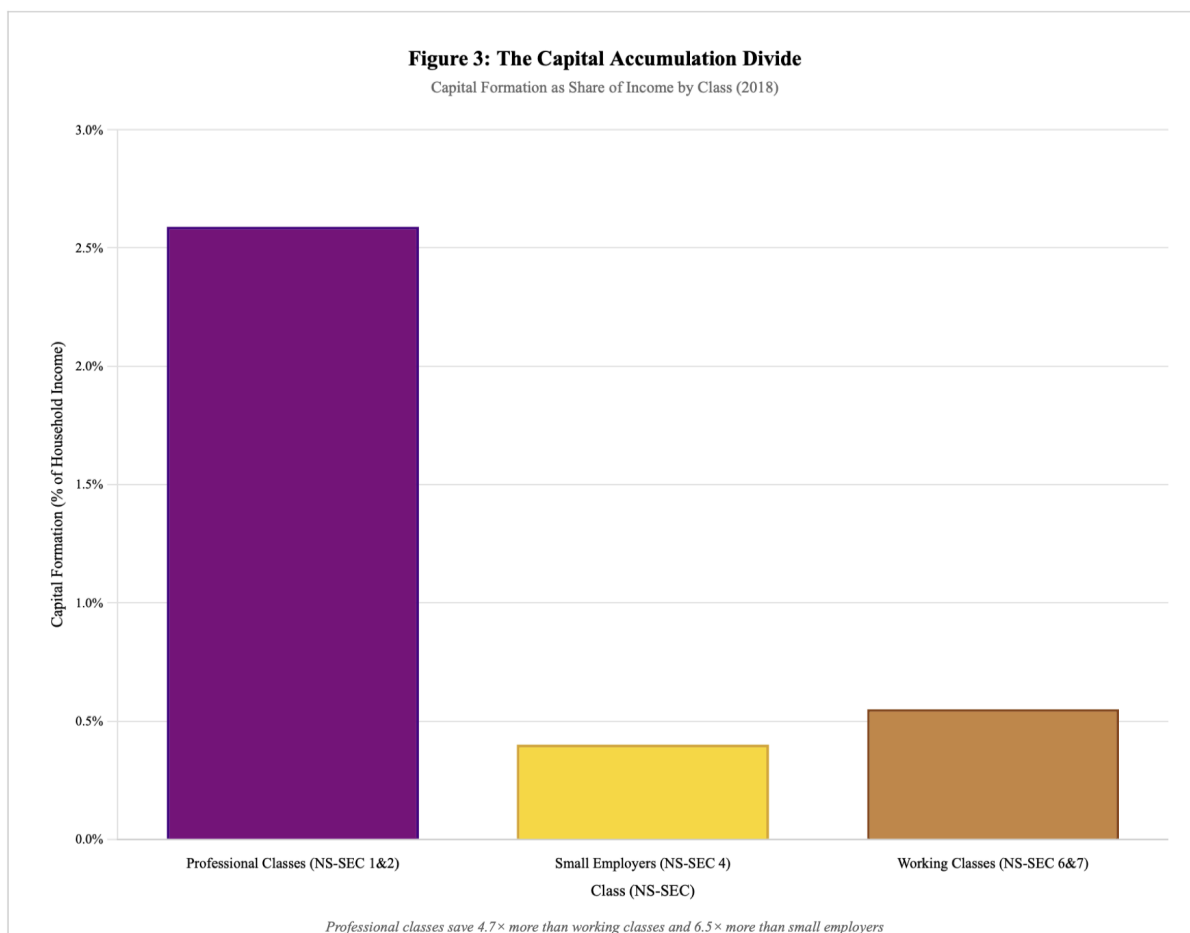
The SE-SAM shows that the working classes (HH6&7) face a ‘double jeopardy’. Not only is their income more precarious, but they are proportionally more burdened by expenditure on essentials like electricity and food, as shown in Table 4.2 and Figure 2.

**Table 4.2: Spending Patterns by Household Type**

	<b>HH1</b>	<b>HH2</b>	<b>HH3</b>	<b>HH4</b>	<b>HH5</b>	<b>HH6</b>	<b>HH7</b>	<b>HH8</b>	<b>HH9</b>	<b>HH10</b>
<b>Electricity</b>	1.17%	1.50%	1.80%	1.88%	1.78%	2.58%	2.59%	3.75%	3.33%	1.69%
<b>Food/Drink</b>	1.27%	1.39%	1.63%	1.87%	1.69%	2.11%	2.25%	3.00%	1.15%	2.87%
<b>Capital formation</b>	2.32%	2.86%	1.06%	0.40%	1.19%	0.68%	0.42%	0.86%	0.50%	1.27%



Furthermore, the professional classes (HH1&2) spend a weighted average of 2.6% of their income on capital formation (savings and investments): around 4.7 times more than the working classes and 6.5 times more than small employers (HH4). Thus, the working classes and small employers are alike in their exclusion from wealth accumulation, offering a material justification for their vulnerability to populist rhetoric.



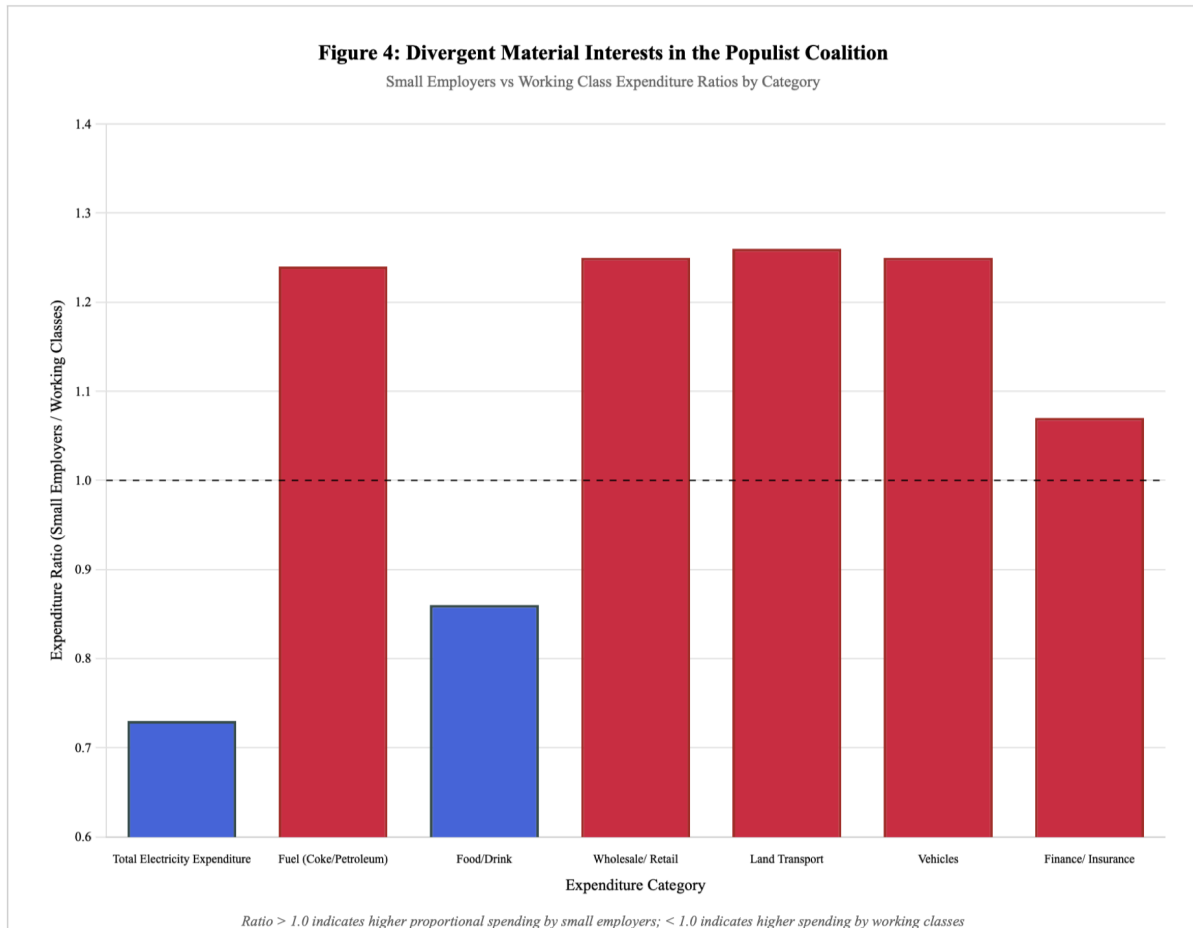
However, this populist coalition is fragile. Though both groups are excluded from capital accumulation, their underlying material interests diverge sharply. The working classes' primary focus is on minimising essential household costs. For small employers, the priority is minimising business input costs. To quantify this, a 'Populist Fracture Index' was calculated, showing the ratio of spending between the two groups for different goods (Table 4.3).

**Table 4.3: 'Populist Fracture Index'**

Consumption Category	Populist Fracture Index (HH4/HH6&7)
Crude oil/gas	1.35
Food/drink	0.86
Coke/refined petroleum	1.24
Electricity	0.73
Wholesale/retail	1.25
Rest of the World	1.32

Small employers spend a far greater proportion of their income on business inputs, such as fuel, wholesale goods, and imports (Rest of the World). The working classes spend proportionally more on

essentials, such as food and electricity. As shown in Table 4.1, their interests also diverge on the ‘sources’ of income: the working classes are almost entirely dependent on labour income, while small employers are primarily interested in capital returns. This contradiction of material interests is partly why populists must resort to cultural cleavages to mobilise both groups. The energy transition, by forcing a confrontation with these underlying material realities, creates a political opportunity for pro-transition actors to address the distinct material needs of each group.



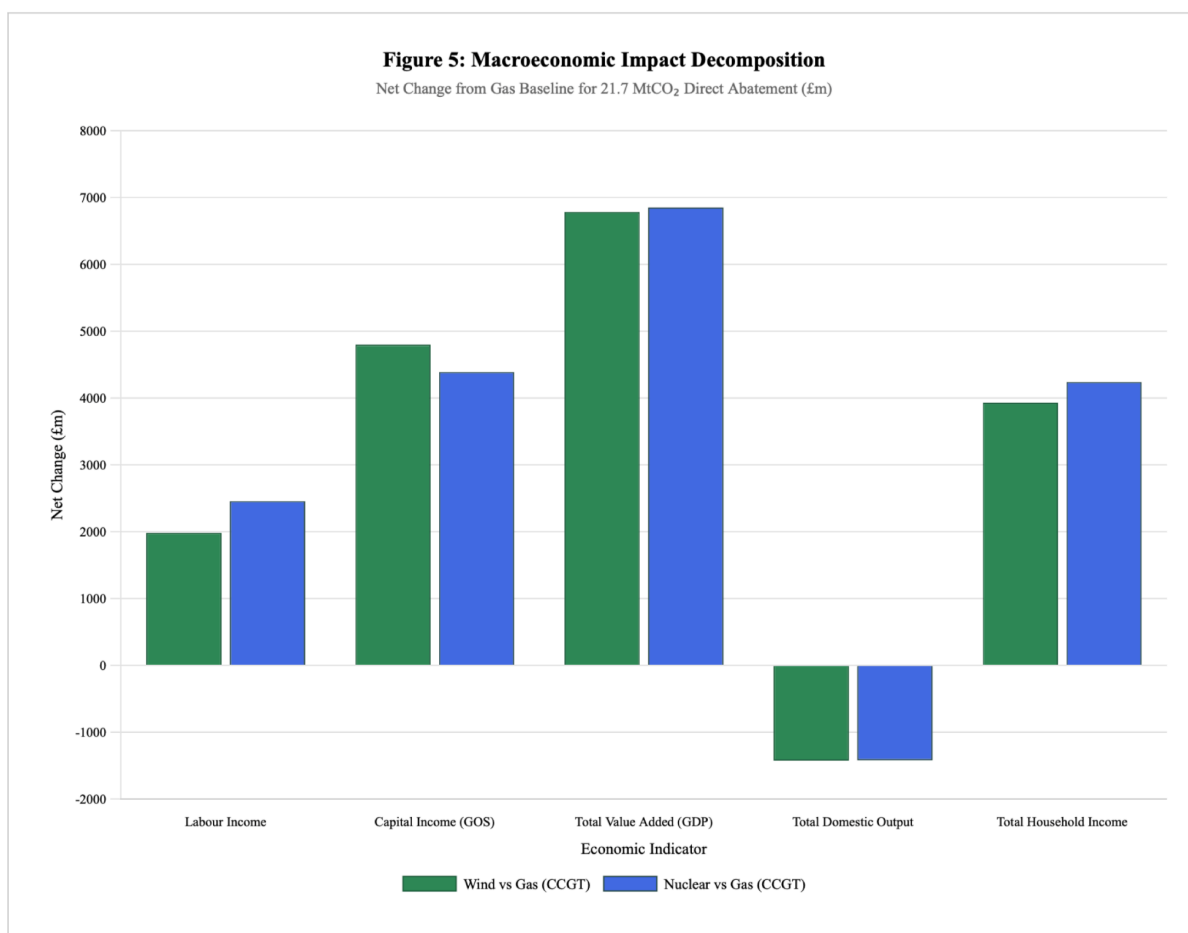
## 4.2 The Decarbonisation Dividend

The central experiment models two transition pathways: a shift from gas to wind (the ‘WG’ scenario) and a shift from gas to nuclear (the ‘NG’ scenario). As shown in Table 4.4, both transition paths yield a significant benefit for the UK economy.

**Table 4.4: Headline Scenario Results**

<b>Impact Category</b>	<b>WG</b>	<b>NG</b>
<i>Value Added (GDP) Breakdown</i>		
↳ Labour Income (£m)	+£1,986	+£2,462
↳ Capital Income (GOS) (£m)	+£4,800	+£4,393
Total Value Added (GDP) (£m)	+£6,786	+£6,854
<i>Other Macroeconomic Indicators</i>		
Total Domestic Output (£m)	-£1,424	-£1,419
Total Household Income (£m)	+£3,932	+£4,243
<i>Environmental Impact</i>		
Net Emissions Reduction (MtCO <sub>2</sub> )	-25.0	-25.0

The scenarios produce an almost identical increase in GDP and outperform the 21.7 MtCO<sub>2</sub> emission reduction target, suggesting that supply chains for wind and nuclear are less carbon-intensive than those of the gas (CCGT) industry. The reduction in total domestic output despite GDP increasing indicates that these industries have fewer intermediate transactions than gas and are less integrated into the wider domestic economy. Two further features stand out: in both scenarios, the majority of GDP gains go to the owners of capital, but in the NG scenario the value added for labour is approximately 20% higher than in the WG scenario. This suggests that, while both generation technologies are capital intensive, nuclear is, superficially, more ‘labour-friendly’ than wind at the aggregate level.



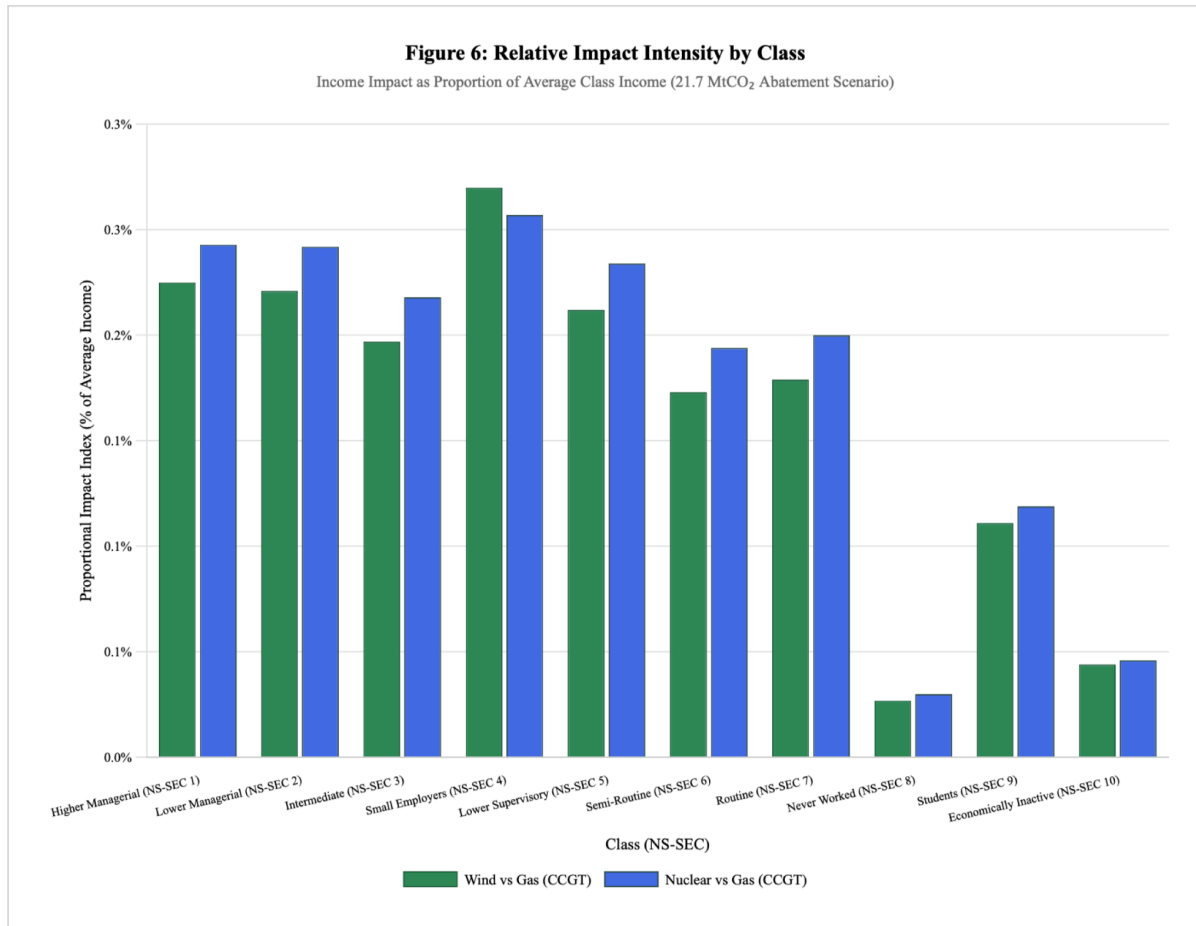
For political perception, however, the proportional impact per household is arguably what matters most, since this directly shapes the psychological perception of gains relative to an individual's established reference point (Kahneman and Tversky, 1979). To assess this, a 'Proportional Impact Index' was created, showing the per-household income gain as a percentage of baseline income (Table 4.5). This index serves as a quantitative proxy for the distributive justice of each pathway, since a transition where proportional gains are highly unequal will generally be less fair.

**Table 4.5: 'Proportional Impact Index'**

Household Type	WG: Impact (£)/HH	WG: Proportional Impact Index	NG: Impact (£)/HH	NG: Proportional Impact Index
HH1	£284.85	0.225%	£308.40	0.243%
HH2	£213.12	0.221%	£233.49	0.242%
HH4	£195.91	0.270%	£186.92	0.257%
HH6	£87.63	0.173%	£97.97	0.194%
HH7	£84.18	0.179%	£94.08	0.200%

In both scenarios, the working classes experience the smallest proportional gains among the economically active population, exacerbating the absolute income gap. For instance, in the WG

scenario, a 0.225% gain for a higher professional (HH1) equates to an annual income increase of £285, whereas the 0.173% gain for a semi-routine worker (HH6) is just £88. This creates a powerful sense of relative deprivation, a key driver of political resentment and policy opposition (Ansell *et al.*, 2022). While the absolute percentages appear modest, the analysis is based on a fiscally neutral shock; the magnitude of the redistribution at stake is far greater when considering the full scope of government investment.



### 4.3 Industrial Pathways

Decarbonisation is not simply a substitution of energy sources; it is a re-routing of economic value from one industrial ecosystem to another. Although the preceding results show that the benefits of decarbonisation are asymmetrically distributed, it is equally important to understand the mechanisms through which income reaches households, since these reveal the effects on workers in specific industries. To this end, a simplified Structural Path Analysis (SPA) was used to trace a £1bn shock through two channels: a ‘Traditional Industrial’ path (extraction, heavy manufacturing, logistics) and a ‘High-Tech & Services’ path (electronics, finance, professional services). The results are presented in Table 4.6.

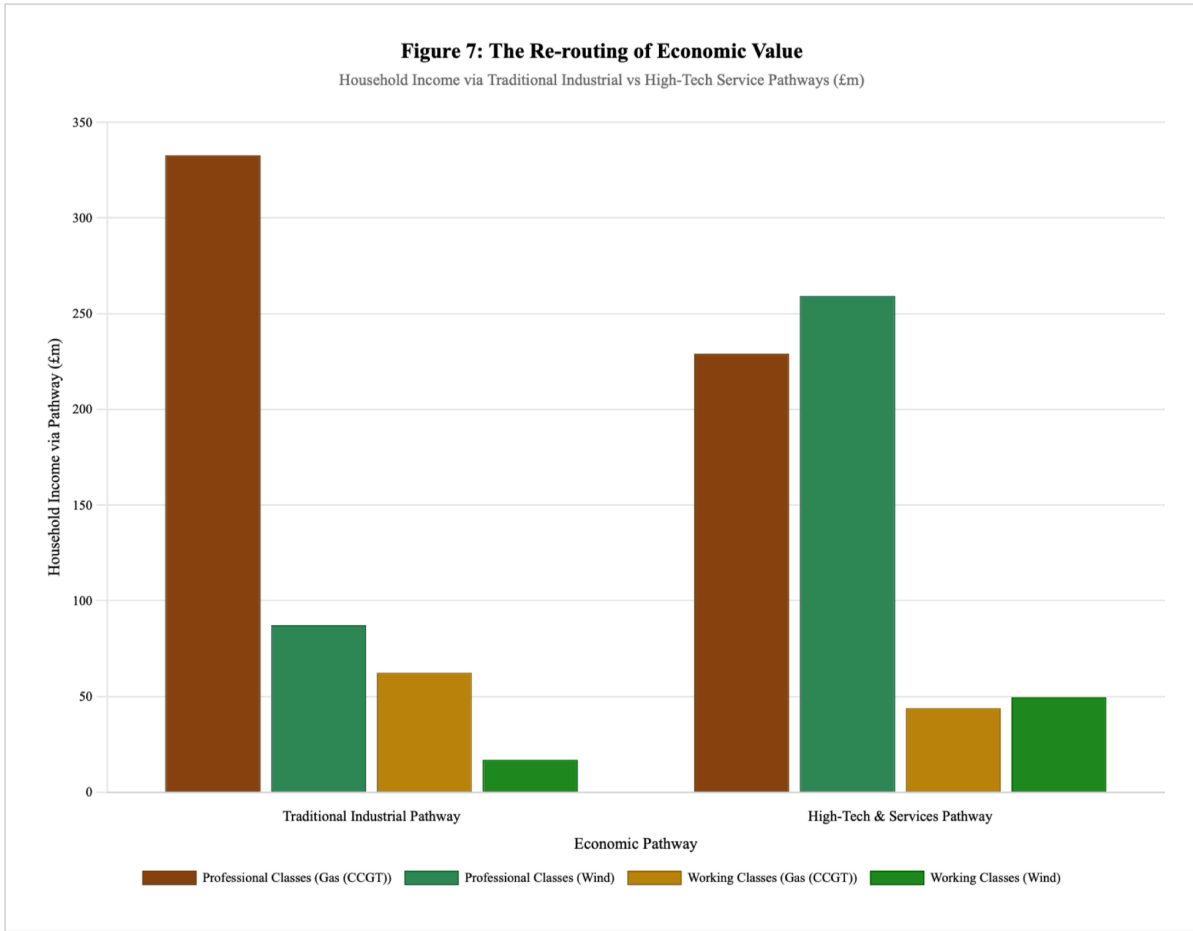
**Table 4.6: Simplified Pathway Analysis**

<b>Class Grouping</b>	<b>Gas Pathway</b>	<b>Wind Pathway</b>	<b>Nuclear Pathway</b>
<i>Household Income via 'Traditional Industrial' Path</i>			
Professional Classes (HH1&2)	£332.80m	£87.29m	£86.31m
Small Employers (HH4)	£47.48m	£10.19m	£10.06m
Working Classes (HH6&7)	£62.46m	£16.84m	£16.65m
<i>Household Income via 'High-Tech &amp; Services' Path</i>			
Professional Classes (HH1&2)	£229.04m	£259.32m	£260.63m
Small Employers (HH4)	£29.60m	£32.63m	£32.89m
Working Classes (HH6&7)	£43.82m	£49.55m	£49.78m

When the multiplier effect is limited to these industries, the results are dramatic: the gas pathway generates £442.74m of income through traditional industries, compared with just £114.32m for wind and £113.02m for nuclear. Table 4.7 and Figure 7 show how this re-routing affects the working class in the WG scenario: the £45.62m loss of income generated by gas through traditional industries is compensated for by a meagre £5.73m gain in the highly skilled sectors. Thus, although wind generates more income for these groups overall, it generates losses for the traditional industrial channels that have historically supported working-class livelihoods. This is precisely the kind of 'source' effect used by the populist right to weaken support for net zero policies.

**Table 4.7: The Re-routing of the Working-Class Dividend (WG Scenario)**

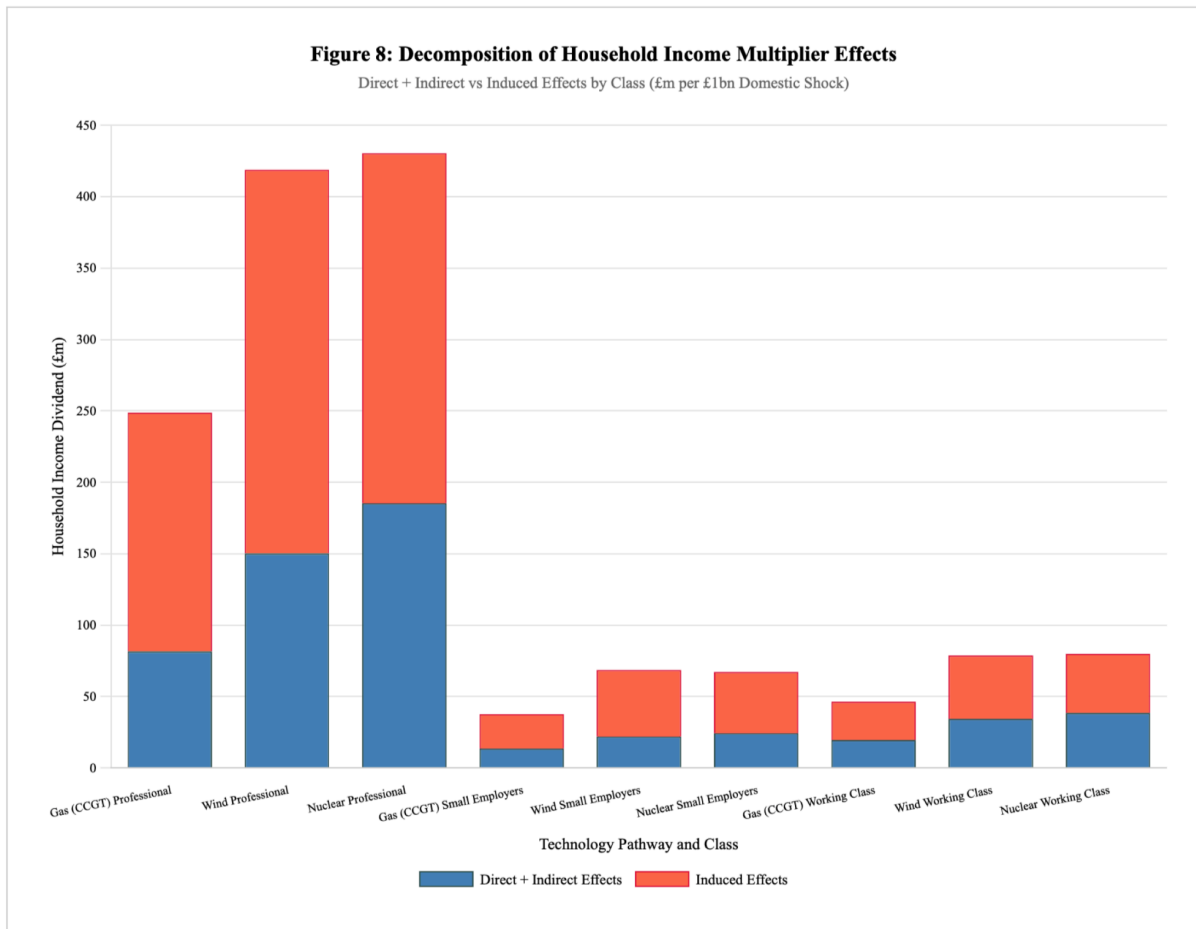
<b>Industrial Path</b>	<b>Net Change in Income for Working Classes (HH6&amp;7)</b>
'Traditional Industrial' Path	-£45.62m
'High-Tech & Services' Path	+£5.73m



The results of the SPA quantify a central challenge in achieving a just transition: the promise of ‘green jobs’ is not a lie, but it is a partial truth. The new economy creates wealth, but it routes it through new channels, and, without intentional policy intervention, the benefits will flow disproportionately to the capital-owning classes. The distribution has a clear spatial dimension: the declining working-class industries are often geographically concentrated (e.g. North Sea oil and gas), while the gains in industries like financial services and advanced manufacturing are likely to flow to urban centres. For communities whose economies have historically relied on traditional industries, the transition risks creating stranded assets and workers, exacerbating regional inequalities. This dynamic provides empirical weight to the political narrative of a ‘left behind’ industrial working class: a narrative that has proven highly effective at mobilising voters against net zero.

#### 4.4 Community Dividends

Leontief multipliers can be decomposed into three effects: the direct effect (the shock), indirect effects (on the supply chain and institutions), and induced effects, which emerge from households re-spending the income they gain from the first two effects. Induced effects are critical as they show how benefits spread through the wider economy, beyond the specific supply chain where the shock occurred. To compare the induced effects of electricity generation technologies, a multiplier decomposition was performed for each pathway using an identical £1bn shock.



As shown in Figure 8, the induced effects for the wind and nuclear pathways are substantially larger than the induced effect for the gas pathway. This is because the gas industry follows an extractive industrial model, with value leaking abroad to pay for imported fuel and refining, whereas the low-carbon pathways tend to create and recirculate value within the domestic economy.

While the total benefits for the working class are similar for wind and nuclear, the ratio of ‘induced’ effects to ‘direct and indirect’ effects is larger for the nuclear pathway. To explore this further, a new scenario was constructed which controlled for import leakages, thus simulating an equivalent domestic stimulus. A ‘Community Dividend Ratio’ (CDR) was calculated to illustrate the proportion of benefits coming from the induced channel. The CDR is a simple ratio of the induced economic effects to the combined direct and indirect effects. A higher CDR signifies that a given level of internal industry activity generates a more substantial multiplier effect across the broader economy.

**Table 4.8: ‘Community Dividend Ratio’ for Key Industries**

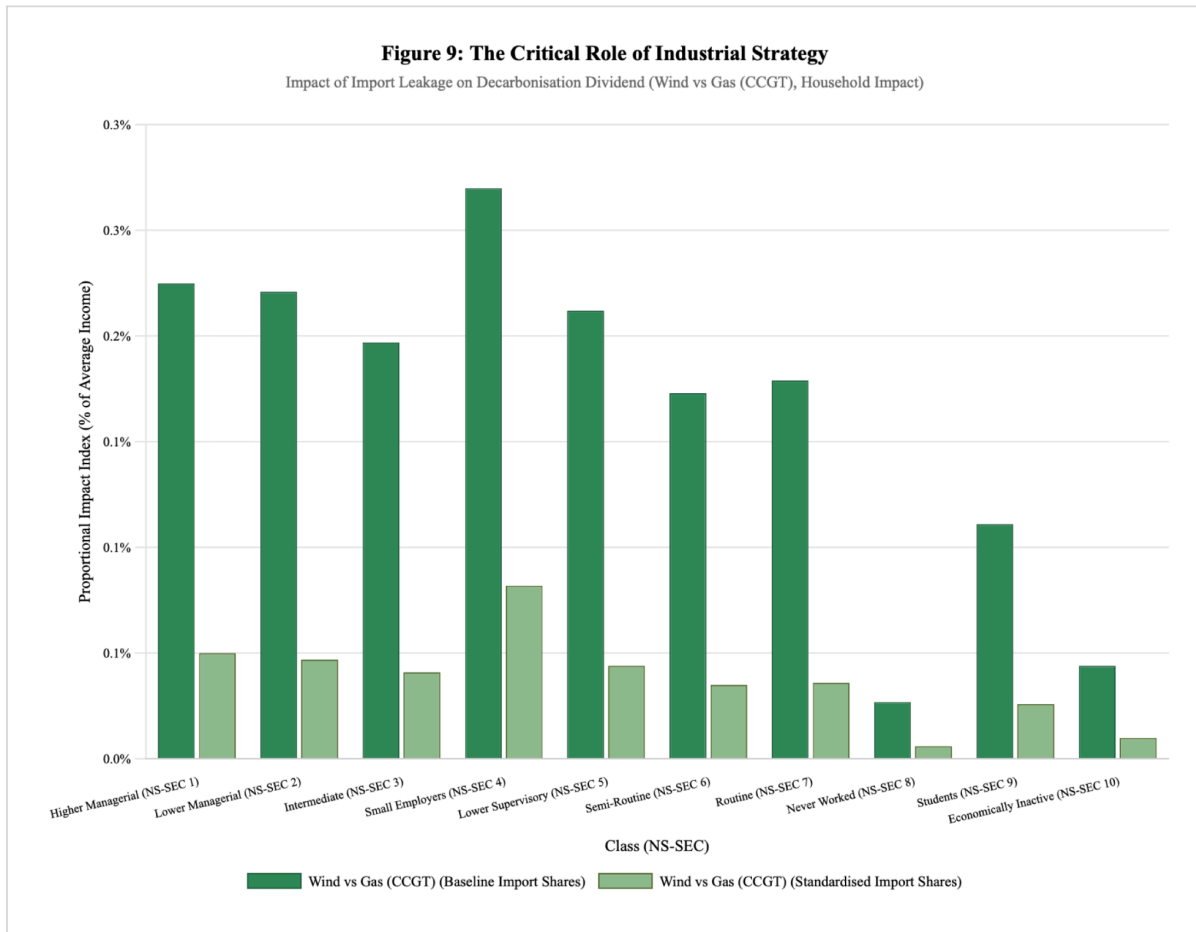
<b>Industrial Sector</b>	<b>Pathway</b>	<b>Direct &amp; Indirect (D+I) Effects (£m)</b>	<b>Community Dividend Ratio (CDR)</b>
<i>Transport equipment</i>	Gas	£55.63	0.14
	Wind	£41.13	0.22
	Nuclear	£40.20	0.24
<i>Electrical/electronic</i>	Gas	£29.38	0.12
	Wind	£50.04	0.08
	Nuclear	£48.49	0.09
<i>Services</i>	Gas	£67.12	2.09
	Wind	£49.38	3.29
	Nuclear	£48.47	3.47

Table 4.8 shows the key results. On the one hand, the gas pathway stimulates more direct and indirect activity in established sectors, such as ‘Transport equipment’ and ‘Services’, than either renewable pathway. This suggests the transition to low-carbon energy poses a threat to parts of the UK’s existing industrial specialisation. On the other hand, the low-carbon pathways allow for the development of new industrial specialisms, with wind and nuclear stimulating over 70% more activity in ‘Electrical/electronic’ manufacturing than gas. While wind generates marginally higher absolute direct and indirect effects in this specific manufacturing sector (£50.04m versus £48.49m), the nuclear pathway possesses a consistently higher CDR. This indicates that nuclear investment is most effective at dispersing its economic benefits through the induced channel, generating wider community-level dividends.

#### **4.5 Policy Dilemmas**

The findings of this chapter reveal a series of political trade-offs, showing that the success of the transition depends as much on industrial strategy as technology. Two points stand out.

The first is that the benefits of decarbonisation are highly dependent on a domestic industrial strategy. A sensitivity analysis, visualised below, models a ‘policy failure’ scenario where the wind sector’s import share is artificially increased to match that of gas (35.8%). Figure 9 shows how this alters the ‘Proportional Impact Index’ in the WG scenario.



GDP gains collapse by over 73% under this adjustment. Notably, the dividend for labour shows a greater proportional decline than overall GDP, falling from £1,986m to just £243m. This reflects the high proportion of *induced* benefits. As more intermediate inputs are imported, the induced effects diminish exponentially, suggesting that benefits for workers are strongly reliant on the UK capturing the entire value chain.

The second standout point pertains to the relative benefits of wind and nuclear, linking to the distinction between income ‘uses’ and ‘sources’ discussed in Chapter 2.

Wind offers the greatest benefits to consumers. Its primary advantage lies in its low Levelised Cost of Electricity (LCOE), which is projected to be substantially cheaper than new nuclear (£44/MWh vs. £109/MWh in 2025 prices (DESNZ, 2023)). With energy costs being a higher proportion of spending for the working classes (see Figure 2), cheaper electricity is a profoundly progressive outcome.

Conversely, the nuclear pathway offers greater benefits on the ‘sources’ side. While it is a more expensive generation technology, the NG scenario generates 20% more labour income than the WG scenario (Table 4.4). The only class that benefits more from wind is small employers (NS-SEC 4), due to their high capital income and low labour income. The multiplier decomposition analysis in Table 4.8 further suggests that nuclear power excels at integrating its domestic supply chains into the wider economy. An industrial strategy that prioritises nuclear therefore favours the creation of domestic jobs, but at the cost of higher consumer prices.

Given their distinct roles in power generation (wind being variable, nuclear being balancing), the conclusion cannot be to choose one approach. Determining the optimal mix requires navigating a core political trade-off: the diffuse benefit of lower costs for all versus the concentrated promise of local jobs. Policymakers must therefore balance broad public interests against the specific economic concerns of affected communities.

## **4.6 Summary**

This chapter has demonstrated that decarbonisation, when viewed through a class-based lens, is not a benign economic substitution but a fundamental re-routing of value that alters the material status of social classes. The SE-SAM empirically confirms that the working classes face a ‘double jeopardy’, bearing the concentrated friction of carbon-intensive industrial decline while being structurally bypassed by the capital-intensive dividends of green growth, which accrue overwhelmingly to the professional and managerial classes.

Crucially, the multiplier decomposition exposes the mechanism of this ‘source’ effect. The economic multipliers of low-carbon technologies circumvent the traditional heavy industries that have historically anchored working-class communities, flowing instead into high-tech and service sectors. This material dislocation provides the empirical scaffolding required by populist political entrepreneurs to frame net zero as a predatory elite project. Consequently, relying on market-led green growth is a political dead end. A class-conscious, interventionist industrial strategy is not a supplementary social objective, but a prerequisite for preventing a populist veto against decarbonisation.

## Chapter 5: Discussion

The results underscore that decarbonisation pathways are inherently political, creating winners and losers and reshaping socio-economic cleavages.

### 5.1 Core Findings

While the transition to a low-carbon power sector offers substantial aggregate benefits to the UK economy, this conceals a distributionally regressive outcome. The professional classes (NS-SEC 1&2) are the major beneficiaries, while the working classes (NS-SEC 6&7) experience the smallest proportional gains. This widens the income gap between them, corroborating other studies' findings that climate policies often exacerbate existing inequalities (Advani and Stoye, 2017; Lamb *et al.*, 2020; Ohlendorf *et al.*, 2021).

This regressivity partly stems from the fact that lower-income households spend a larger proportion of their income on essential energy (Parry, 2015; Farrell, 2017; Fragkos *et al.*, 2021). The results of this study suggest an additional dimension: the shift from fuel-intensive technologies (gas) to capital-intensive technologies (wind and nuclear) generates a larger dividend for the owners of capital, reinforcing the economic position of the already affluent and widening the income gap between them and the working classes. These aggregate impacts are further reinforced by a 're-routing' of industrial value. As shown by the SPA, the energy transition entails a redirection of economic activity away from the traditional industrial sectors that have historically sustained working-class communities, towards high-tech and service-based occupations that are, to a greater extent, the domain of the professional classes. This provides an empirical basis for scepticism towards decarbonisation among the 'old working class', consisting of those working in manual industries such as manufacturing and construction (Langsæther, 2019).

Conversely, the analysis of the induced effects showed that the wider economic benefits are far superior for low-carbon pathways compared to gas, even when the shocks are normalised to account for import shares. This is largely a function of the higher value added by these new technologies (Allan *et al.*, 2007). However, this aggregate gain risks fuelling 'relative deprivation', as the professional classes capture the vast majority of the benefits. Chilvers *et al.*'s (2017) 'Thousand Flowers' pathway, which focuses on decentralised solutions and local ownership, exemplifies a model that explicitly encourages wider civic participation and the local capture of value, which could mitigate inter-group conflict through 'bridging' social capital (Putnam, 2020).

The 'Populist Fracture Index' revealed the divergent material interests of the working classes and small employers: groups often brought together in populist coalitions. The working classes primarily seek secure jobs and lower energy bills, while small employers are disproportionately exposed to business input costs. The income structures of the two groups also diverge sharply, with small employers' incomes dominated by capital and the incomes of the working classes being predominantly wage-based. This contradiction helps to explain populist parties' attempts to redefine political cleavages along new metrics, such as the liberal/cosmopolitan versus authoritarian/nationalist continuum (Evans and Graaf, 2013; Beramendi *et al.*, 2015). On this axis, environmentalism is often portrayed as the preoccupation of a metropolitan elite, reframing the pursuit of net zero as a divisive, class-specific agenda.

## 5.2 Policy Recommendations

Successfully navigating these dynamics to enable a just transition requires state intervention. The objective is to ensure that the would-be ‘losers’ of the transition (in relative and absolute terms) still feel the benefits of decarbonisation. This section provides recommendations for a strategy that moves beyond a ‘green jobs’ narrative to directly address the concerns of different classes.

To counter the challenge of re-routed wealth, the UK must employ a class-conscious industrial strategy that builds domestic supply chains and employment opportunities for the working classes. This requires tying public subsidies for renewable projects to fair wage agreements, and investing in skills and apprenticeships to ensure that new high-value jobs are accessible to marginalised groups (CCC, 2020a). Concerns about ‘picking winners’ should be tempered by considerations of the political risk of inaction: alienating key working-class constituencies and creating a political backlash against net zero itself (Rodrik, 2014; Aklin and Mildenerger, 2020).

Policymakers should also recognise that net zero represents a shift away from the old fossil fuel hegemony, and dominant actors will not cede power easily (Acemoglu and Robinson, 2000). Incumbents may attempt a *trasformismo*, where low local content in wind or nuclear means that, while the technological base of the energy system might change, the financial beneficiaries might not (Newell, 2019; Szabo, 2022; Nyberg and Wright, 2025). To prevent this, the state must actively work to construct a new alignment of domestic manufacturers, skilled labourers, local communities, and financial backers. This resembles the institutionalist strategy of building a ‘winning coalition’ (Meckling, Sterner and Wagner, 2017), with the caveat that class-considerations are a prerequisite for the approach’s sustainability over electoral cycles.

The induced benefits from low-carbon pathways present an opportunity for regional rebalancing. However, this requires actively steering investment in green manufacturing towards neglected regions. There are several options here: dedicated regional funds, community and municipal ownership models, local content requirements. Ensuring that a portion of profits is retained by the community itself is also vital for building broad democratic support (Chilvers *et al.*, 2017).

To cleave the populist coalition, policymakers must actively confront the reservations of the working classes and small employers (Protzer and Summerville, 2021). For the working classes, the offer should focus on security and industrial opportunity, combining the supply-side policies mentioned above with revenue recycling for carbon taxes and electricity market reform to decouple energy prices from the marginal price of gas (CCGT) (Grubb, 2022). This will allow the working classes to experience the benefits of cheaper renewable electricity first-hand, recognising their interest in minimising household costs.

For small employers, policymakers should emphasise entrepreneurship and growth, citing the huge potential offered by net zero for domestic innovation and operating costs (Stern and Valero, 2021). Grants for electric vehicles, simplified procurement for SMEs in the green supply chain, and tax incentives for green investment would directly address this class’s sensitivity to business input costs and its strong interest in capital returns (Hampton *et al.*, 2024).

### 5.3 Limitations and Future Extensions

The SAM multiplier model is a linear model that operates under a set of limiting assumptions: fixed prices, fixed technology, and excess capacity in all sectors. It does not account for potential supply-side constraints, endogenous technological change, or behavioural responses to price signals (e.g. the Jevons Paradox) (Thorbecke, 2000; Rezai, Taylor and Foley, 2018). The results are therefore best interpreted as comparative statics rather than precise forecasts: a ‘what-if’ analysis of the likely first-order effects of decarbonisation policies, conditioned by the 2018 structure of the UK economy (Babatunde, Begum and Said, 2017).

Future research could build upon these findings by employing dynamic Computable General Equilibrium (CGE) models. CGE models can incorporate price elasticities, model resource constraints, and capture structural adjustments, providing a more complete picture of how impacts evolve over time (Vrontisi *et al.*, 2016; Matsumoto and Fujimori, 2019). Emerging research sees CGE models combined with micro-simulation techniques, adding additional behavioural nuance to modelled outcomes. This arguably represents the frontier of dynamic modelling (Giulia, 2008; Davies, 2009), and could facilitate the direct computational investigation of class conflict.

While superior to income deciles for this study's purpose, the NS-SEC framework also has its limitations. The classification of an entire household is based on the occupation of a single Household Reference Person (HRP), masking intra-household class differences. It is also a static measure that does not capture life-course trajectory or social mobility. Finally, as an occupation-based schema, it does not directly measure existing assets or inherited wealth and struggles to adequately classify the growing number of workers in the ‘gig economy’ whose employment relationships are complex and precarious (Kalleberg, 2009). Future research could further disaggregate households, distinguishing between the ‘old’ and ‘new’ working classes and adding other crucial dimensions such as race, gender, and age to measure compounded vulnerabilities and intersectional inequalities (Köhler *et al.*, 2019), recognising that identity categories cannot truly be measured in isolation (Roccas and Brewer, 2002; Yildirim, 2022). Alongside these social dimensions, geographical disaggregation using sub-national or multi-regional SAMs would provide insights into how the ‘community dividend’ is distributed across specific local economies (Álvarez-Martínez and Mainar-Causapé, 2021).

Finally, this study's focus on the power sector, while justified by its foundational role in the energy transition, represents a necessary narrowing of scope. A valuable extension of this research would be to apply the same class-based analytical framework to the decarbonisation of other critical sectors, such as transport, agriculture, and the built environment, each of which presents its own unique set of distributional challenges.

## Chapter 6: Conclusion

The United Kingdom's transition to a net zero power sector is, first and foremost, a political project. Moving from fuel-intensive gas generation to capital-intensive renewables will reshape the nation's class structure, alter its political economy, and create substantial new wealth. This paper has shown that, despite GDP gains and emissions reductions, the outcome of these changes will likely be distributionally regressive. The professional classes stand to capture the largest share of the benefits, not just through their dominance as capital owners and suppliers of skilled labour, but also via the re-routing of economic value away from traditional working-class industries.

Viewed through this lens, climate-scepticism can be understood not as an irrational stance, but as a coherent response to relative deprivation: the outcome of a process managed without genuine negotiation over its distributional consequences. In turn, these dynamics help explain the successful politicisation of climate policy by the populist right. To prevent the net zero agenda from capitulating to this pressure, policymakers must move beyond the 'green jobs' narrative to a strategy that asks *why* certain groups are resistant, rather than presuming their opposition is illegitimate. This means substituting technocratic solutions for a form of policymaking that earns, rather than presumes, democratic consent.

## References

- Accetti, C.I. (2021) 'Repoliticizing environmentalism: beyond technocracy and populism', *Critical Review*, 33(1), pp. 47–73. Available at: <https://doi.org/10.1080/08913811.2021.1908023>.
- Acemoglu, D. and Robinson, J.A. (2000) 'Political losers as a barrier to economic development', *American Economic Review*, 90(2), pp. 126–130. Available at: <https://doi.org/10.1257/aer.90.2.126>.
- Advani, A. and Stoye, G. (2017) 'Cheaper, greener and more efficient: rationalising UK carbon prices', *Fiscal Studies*, 38(2), pp. 269–299. Available at: <https://doi.org/10.1111/1475-5890.12097>.
- Aklin, M. and Mildenerger, M. (2020) 'Prisoners of the wrong dilemma: why distributive conflict, not collective action, characterizes the politics of climate change', *Global Environmental Politics*, 20(4), pp. 4–27. Available at: [https://doi.org/10.1162/glep\\_a\\_00578](https://doi.org/10.1162/glep_a_00578).
- Allan, G. *et al.* (2007) 'Impact of alternative electricity generation technologies on the scottish economy: an illustrative input–output analysis', *Proceedings of the Institution of Mechanical Engineers, Part A: Journal of Power and Energy*, 221(2), pp. 243–254. Available at: <https://doi.org/10.1243/09576509JPE301>.
- Allan, G., Connolly, K. and Ross, A. (2019) 'UK input-output table disaggregated by electricity production sectors'. University of Strathclyde. Available at: <https://doi.org/10.15129/03734143-205D-4152-97AF-104196CFE50D>.
- Álvarez-Martínez, M.T. and Mainar-Causapé, A.J. (2021) 'The GHG emissions generating capacity by productive sectors in the EU: a SAM analysis', *Sustainability*, 13(4), p. 2363. Available at: <https://doi.org/10.3390/su13042363>.
- Andrews, A. (2020) 'Dereliction, decay and the problem of de-industrialization in Britain, c. 1968–1977', *Urban History*, 47(2), pp. 236–256. Available at: <https://doi.org/10.1017/S0963926819000245>.
- Ansell, B. *et al.* (2022) 'Sheltering populists? House prices and the support for populist parties', *The Journal of Politics*, 84(3), pp. 1420–1436. Available at: <https://doi.org/10.1086/718354>.
- Atkins, E. (2023) *A just energy transition: getting decarbonisation right in a time of crisis*. Bristol: Bristol University Press.
- Babatunde, K.A., Begum, R.A. and Said, F.F. (2017) 'Application of computable general equilibrium (CGE) to climate change mitigation policy: a systematic review', *Renewable and Sustainable Energy Reviews*, 78, pp. 61–71. Available at: <https://doi.org/10.1016/j.rser.2017.04.064>.
- BEIS (2020) 'Final UK greenhouse gas emissions national statistics: 1990 to 2018'. Available at: <https://www.gov.uk/government/statistics/final-uk-greenhouse-gas-emissions-national-statistics-1990-to-2018>.
- Beramendi, P. *et al.* (eds) (2015) *The politics of advanced capitalism*. 1st edn. Cambridge University Press. Available at: <https://doi.org/10.1017/CBO9781316163245>.
- Bornschier, S. and Kriesi, H. (2012) 'The populist right, the working class, and the changing face of class politics', in *Class Politics and the Radical Right*. Routledge, pp. 10–30.
- Bouzarovski, S. and Petrova, S. (2015) 'A global perspective on domestic energy deprivation: overcoming the energy poverty–fuel poverty binary', *Energy Research & Social Science*, 10, pp. 31–40. Available at: <https://doi.org/10.1016/j.erss.2015.06.007>.
- Breisinger, C., Thomas, M. and Thurlow, J. (2009) *Social accounting matrices and multiplier analysis: an introduction with exercises*. Intl Food Policy Res Inst. Available at: <https://doi.org/10.2499/0896297680>.
- Burke, J. *et al.* (2020) *Distributional impacts of a carbon tax in the UK: report 1: analysis by household type*. London: Grantham Research Institute on Climate Change and the Environment and Centre for Climate Change Economics and Policy, London School of Economics and Political Science and Vivid Economics. Available at: <http://www.lse.ac.uk/GranthamInstitute/publications>.
- Caiani, M. and Lubarda, B. (2024) 'Conditional environmentalism of right-wing populism in power: ideology and/or opportunities?', *Environmental Politics*, 33(4), pp. 591–611. Available at: <https://doi.org/10.1080/09644016.2023.2242749>.
- CCC (2020a) *Policies for the sixth carbon budget and net zero*. London: Committee on Climate Change. Available at: <http://www.theccc.org.uk/publications>.
- CCC (2020b) *The sixth carbon budget: the UK's path to net zero*. CCC. Available at: <https://www.theccc.org.uk/publication/sixth-carbon-budget/>.
- CCC (2025) *The seventh carbon budget*. The Climate Change Committee. Available at: <https://www.theccc.org.uk/publication/the-seventh-carbon-budget/>.
- Chepeliev, M. (2023) 'GTAP-power data base: version 11', *Journal of Global Economic Analysis*, 8(2), pp. 101–135. Available at: <https://doi.org/10.21642/JGEA.080203AF>.
- Chester, L. (2014) 'Energy impoverishment: addressing capitalism's new driver of inequality'. Available at: <https://doi.org/10.2753/JEI0021-3624480213>.
- Chilvers, J. *et al.* (2017) 'Realising transition pathways for a more electric, low-carbon energy system in the United Kingdom: challenges, insights and opportunities', *Proceedings of the Institution of Mechanical Engineers*,

- Part A: *Journal of Power and Energy*, 231(6), pp. 440–477. Available at: <https://doi.org/10.1177/0957650917695448>.
- Darby, S.J. (2017) ‘Coal fires, steel houses and the man in the moon: local experiences of energy transition’, *Energy Research & Social Science*, 31, pp. 120–127. Available at: <https://doi.org/10.1016/j.erss.2017.05.025>.
- Davies, J.B. (2009) ‘Combining microsimulation with CGE and macro modelling for distributional analysis in developing and transition countries’, *International Journal of Microsimulation*, 2(1), pp. 49–65. Available at: <https://doi.org/10.34196/ijm.00011>.
- Defourny, J. and Thorbecke, E. (1984) ‘Structural path analysis and multiplier decomposition within a social accounting matrix framework’, *The Economic Journal*, 94(373), p. 111. Available at: <https://doi.org/10.2307/2232220>.
- DESNZ (2023) *Electricity generation costs 2023*. London: HM Government. Available at: <https://www.gov.uk/government/publications/electricity-generation-costs-2023>.
- DESNZ (2025) *2024 provisional greenhouse gas emissions statistics: statistical release*. London: Department for Energy Security and Net Zero. Available at: <https://assets.publishing.service.gov.uk/media/67e4060df356a2dc0e39b4cd/2024-provisional-greenhouse-gas-emissions-statistics-statistical-release.pdf>.
- Drescher, K. and Janzen, B. (2021) ‘Determinants, persistence, and dynamics of energy poverty: an empirical assessment using german household survey data’, *Energy Economics*, 102, p. 105433. Available at: <https://doi.org/10.1016/j.eneco.2021.105433>.
- Emonts-Holley, T., Ross, A. and Swales, K. (2021) ‘Estimating induced effects in IO impact analysis: variation in the methods for calculating the type II leontief multipliers’, *Economic Systems Research*, 33(4), pp. 429–445. Available at: <https://doi.org/10.1080/09535314.2020.1837741>.
- Eurofound (2021) *Distributional impacts of climate policies in Europe*. Available at: <https://data.europa.eu/doi/10.2806/58878> (Accessed: 10 September 2025).
- Evans, G. and Graaf, N.D. de (eds) (2013) *Political choice matters: explaining the strength of class and religious cleavages in cross-national perspective*. 1st ed. Oxford: Oxford University Press.
- Evans, G. and Mellon, J. (2016) ‘Social class: identity, awareness and political attitudes: why are we still working class?’, *British Social Attitudes*, 33.
- Evans, G. and Tilley, J. (2017) *The new politics of class: the political exclusion of the british working class*. Oxford University Press. Available at: <https://doi.org/10.1093/acprof:oso/9780198755753.001.0001>.
- Farrell, N. (2017) ‘What factors drive inequalities in carbon tax incidence? Decomposing socioeconomic inequalities in carbon tax incidence in Ireland’, *Ecological Economics*, 142, pp. 31–45. Available at: <https://doi.org/10.1016/j.ecolecon.2017.04.004>.
- Ferreira, V. *et al.* (2022) ‘The role of the agricultural sector in ghanaiian development: a multiregional SAM-based analysis’, *Journal of Economic Structures*, 11(1), p. 6. Available at: <https://doi.org/10.1186/s40008-022-00265-9>.
- Ford, R. and Jennings, W. (2020) ‘The changing cleavage politics of western Europe’, *Annual Review of Political Science*, 23(1), pp. 295–314. Available at: <https://doi.org/10.1146/annurev-polisci-052217-104957>.
- Fragkos, P. *et al.* (2021) ‘Equity implications of climate policy: assessing the social and distributional impacts of emission reduction targets in the european union’, *Energy*, 237, p. 121591. Available at: <https://doi.org/10.1016/j.energy.2021.121591>.
- Giulia, C. (2008) ‘Linking CGE and microsimulation models: a comparison of different approaches’, *SSRN Electronic Journal* [Preprint]. Available at: <https://doi.org/10.2139/ssrn.1222562>.
- Goldthorpe, J.H. (2010) ‘Analysing social inequality: a critique of two recent contributions from economics and epidemiology’, *European Sociological Review*, 26(6), pp. 731–744. Available at: <https://doi.org/10.1093/esr/jcp046>.
- Goulder, L.H. *et al.* (2018) *Impacts of a carbon tax across US household income groups: what are the equity-efficiency trade-offs?* NBER Working Papers 25181. National Bureau of Economic Research, Inc. Available at: <https://doi.org/None>.
- Government Office for Science (2025) *Net zero technology outlook*. Government Office for Science. Available at: <https://www.gov.uk/government/publications/net-zero-technology-outlook-report/net-zero-technology-outlook> (Accessed: 21 August 2025).
- Grubb, M. (2022) ‘Navigating the crises in european energy: price inflation, marginal cost pricing, and principles for electricity market redesign in an era of low-carbon transition’, *Institute for New Economic Thinking Working Paper Series* [Preprint], (191).
- Hampton, S. *et al.* (2024) ‘Where next for smes and net zero?’ [oro.open.ac.uk](https://oro.open.ac.uk/98859/). Available at: <https://oro.open.ac.uk/98859/>.
- Heath, O. (2015) ‘Policy representation, social representation and class voting in britain’, *British Journal of Political Science*, 45(1), pp. 173–193. Available at: <https://doi.org/10.1017/S0007123413000318>.

- Huber, M.T. (2022) *Climate change as class war: building socialism on a warming planet*. London ; New York: Verso.
- Isard, W. *et al.* (2017) *Methods of interregional and regional analysis*. 1st edn. Routledge. Available at: <https://doi.org/10.4324/9781315249056>.
- Jenkins, K., Sovacool, B.K. and McCauley, D. (2018) ‘Humanizing sociotechnical transitions through energy justice: an ethical framework for global transformative change’, *Energy Policy*, 117, pp. 66–74. Available at: <https://doi.org/10.1016/j.enpol.2018.02.036>.
- Jensen, H.T. and Tarp, F. (2005) ‘Trade liberalization and spatial inequality: a methodological innovation in a vietnamese perspective’, *Review of Development Economics*, 9(1), pp. 69–86. Available at: <https://doi.org/10.1111/j.1467-9361.2005.00264.x>.
- Kahneman, D. and Tversky, A. (1979) ‘Prospect theory: an analysis of decision under risk’, *Econometrica*, 47(2), p. 263. Available at: <https://doi.org/10.2307/1914185>.
- Kalleberg, A.L. (2009) ‘Precarious work, insecure workers: employment relations in transition’, *American Sociological Review*, 74(1), pp. 1–22. Available at: <https://doi.org/10.1177/000312240907400101>.
- Katris, A. and Figus, G. (2017) *Disaggregation of the 2010 UK social accounting matrix to report household income quintiles*. 17–08. Glasgow: Department of Economics, University of Strathclyde. Available at: <https://doi.org/10.15129/cbb132d-d970-4c39-bf48-5d0c1720b0a1>.
- Kitschelt, H. and Rehm, P. (2014) ‘Occupations as a site of political preference formation’, *Comparative Political Studies*, 47(12), pp. 1670–1706. Available at: <https://doi.org/10.1177/0010414013516066>.
- Köhler, J. *et al.* (2019) ‘An agenda for sustainability transitions research: state of the art and future directions’, *Environmental Innovation and Societal Transitions*, 31, pp. 1–32. Available at: <https://doi.org/10.1016/j.eist.2019.01.004>.
- Kroese, D.P., Rubinstein, R.Y. and Glynn, P.W. (2013) ‘The cross-entropy method for estimation’, in *Handbook of Statistics*. Elsevier, pp. 19–34. Available at: <https://doi.org/10.1016/B978-0-444-53859-8.00002-3>.
- Lamb, W.F. *et al.* (2020) ‘What are the social outcomes of climate policies? A systematic map and review of the ex-post literature’, *Environmental Research Letters*, 15(11), p. 113006. Available at: <https://doi.org/10.1088/1748-9326/abc11f>.
- Langsæther, P.E. (2019) ‘Class voting and the differential role of political values: evidence from 12 west-european countries’, *Journal of Elections, Public Opinion and Parties*, 29(1), pp. 125–142. Available at: <https://doi.org/10.1080/17457289.2018.1464015>.
- Lee, M.-C. (2014) ‘Social accounting matrix balanced based on mathematical optimization method and general algebraic modeling system’, *British Journal of Economics, Management & Trade*, 4, pp. 1174–1190. Available at: <https://doi.org/10.9734/BJEMT/2014/8942>.
- Leontief, W.W. (ed.) (2010) *Input-output economics*. 2nd ed. New York: Oxford University Press.
- Lockwood, M. (2018) ‘Right-wing populism and the climate change agenda: exploring the linkages’, *Environmental Politics*, 27(4), pp. 712–732. Available at: <https://doi.org/10.1080/09644016.2018.1458411>.
- Maclean, C. *et al.* (2020) *Social divisions: inequality and diversity in Britain*. Policy Press.
- Marchau, V.A.W.J. *et al.* (eds) (2019) *Decision making under deep uncertainty: from theory to practice*. Cham: Springer International Publishing.
- Mardones, C. and Brevis, C. (2021) ‘Constructing a SAMEA to analyze energy and environmental policies in Chile’, *Economic Systems Research*, 33(4), pp. 576–602. Available at: <https://doi.org/10.1080/09535314.2020.1839386>.
- Marschner, N. *et al.* (eds) (2024) *Contested climate justice – challenged democracy: international perspectives*. Campus Verlag. Available at: <https://doi.org/10.12907/978-3-593-45820-5>.
- Marshall, G. *et al.* (2005) *Social class in modern Britain*. 0 edn. Routledge. Available at: <https://doi.org/10.4324/9780203986172>.
- Matsumoto, K. and Fujimori, S. (2019) ‘CGE models in energy economics’, in U. Soytaş and R. Sarı (eds) *Routledge Handbook of Energy Economics*. 1st edn. Routledge, pp. 433–445.
- Meckling, J., Sterner, T. and Wagner, G. (2017) ‘Policy sequencing toward decarbonization’, *Nature Energy*, 2(12), pp. 918–922. Available at: <https://doi.org/10.1038/s41560-017-0025-8>.
- NESO (2024) *Britain’s electricity explained: 2023 review*. Available at: <https://www.neso.energy/news/britains-electricity-explained-2023-review>.
- Newell, P. (2019) ‘Trasformismo or transformation? The global political economy of energy transitions’, *Review of International Political Economy*, 26(1), pp. 25–48. Available at: <https://doi.org/10.1080/09692290.2018.1511448>.
- Newell, P. and Mulvaney, D. (2013) ‘The political economy of the “just transition”’, *Geographical Journal*, 179(2), pp. 132–140. Available at: <https://doi.org/10.1111/geoj.12008>.
- Nyberg, D. and Wright, C. (2025) ‘Confronting the climate crisis: fossil fuel hegemony and the need for decarbonization, degrowth, and democracy’, *Journal of Management Studies* [Preprint]. Available at: <https://doi.org/10.1111/joms.13198>.

- Oesch, D. and Rennwald, L. (2018) 'Electoral competition in Europe's new tripolar political space: class voting for the left, centre-right and radical right', *European Journal of Political Research*, 57(4), pp. 783–807. Available at: <https://doi.org/10.1111/1475-6765.12259>.
- Ohlendorf, N. *et al.* (2021) 'Distributional impacts of carbon pricing: a meta-analysis', *Environmental and Resource Economics*, 78(1), pp. 1–42. Available at: <https://doi.org/10.1007/s10640-020-00521-1>.
- O'Malley, S., Roantree, B. and Curtis, J. (2020) *Carbon taxes, poverty and compensation options*. ESRI. Available at: <https://doi.org/doi.org/10.26504/sustat98>.
- ONS (2010) *Standard occupational classification 2010 volume 3: the national statistics socio-economic classification (rebased on the SOC2010) user manual*. Office for National Statistics. Available at: <https://www.ons.gov.uk/methodology/classificationsandstandards/standardoccupationalclassificationsoc/soc2010/soc2010volume3thenationalstatistics socioeconomicclassificationnssecrebasedonsoc2010> (Accessed: 10 September 2025).
- ONS (2015) 'Family spending: 2015 reference tables'. Available at: [https://www.ons.gov.uk/file?uri=/peoplepopulationandcommunity/personalandhouseholdfinances/incomeandwealth/compendium/familyspending/2015/familyspending2015referencetables/a43final2014\\_tcm77-423517.xls](https://www.ons.gov.uk/file?uri=/peoplepopulationandcommunity/personalandhouseholdfinances/incomeandwealth/compendium/familyspending/2015/familyspending2015referencetables/a43final2014_tcm77-423517.xls) (Accessed: 10 September 2025).
- ONS (2019) 'UK national accounts, the blue book 2019'. Available at: <https://www.ons.gov.uk/economy/nationalaccounts/supplyandusetables/datasets/inputoutputsupplyandusetables/current> (Accessed: 10 September 2025).
- ONS (2020) 'Family spending in the UK: april 2018 to March 2019'. Available at: <https://www.ons.gov.uk/peoplepopulationandcommunity/personalandhouseholdfinances/expenditure/datasets/familyspendingworkbook4expenditurebyhouseholdcharacteristic> (Accessed: 10 September 2025).
- ONS (2023a) 'LCF; LCFSLiving costs and food survey, 2001-living costs and food survey, 2018-2019'. UK Data Service. Available at: <https://doi.org/10.5255/UKDA-SN-8686-4>.
- ONS (2023b) *SOC 2020 volume 3: the national statistics socio-economic classification (NS-SEC) rebased on the SOC 2020*. Office for National Statistics. Available at: <https://www.ons.gov.uk/methodology/classificationsandstandards/standardoccupationalclassificationsoc/soc2020/soc2020volume3thenationalstatistics socioeconomicclassificationnssecrebasedonthesoc2020>.
- ONS (2025) 'UK input-output analytical tables: 2018'. Available at: <https://www.ons.gov.uk/economy/nationalaccounts/supplyandusetables/datasets/ukinputoutputanalyticaltablesindustrybyindustry/current> (Accessed: 10 September 2025).
- Parry, I. (2015) 'Carbon tax burdens on low-income households: a reason for delaying climate policy?', *SSRN Electronic Journal* [Preprint]. Available at: <https://doi.org/10.2139/ssrn.2661433>.
- Pizer, W.A. and Sexton, S. (2019) 'The distributional impacts of energy taxes', *Review of Environmental Economics and Policy*, 13(1), pp. 104–123. Available at: <https://doi.org/10.1093/reep/rey021>.
- Protzer, E. and Summerville, P. (2021) *Reclaiming populism: how economic fairness can win back disenchanted voters*. John Wiley & Sons.
- Putnam, R.D. (2020) *The upswing: how we came together a century ago and how we can do it again*. Rugby: Swift Press.
- Pyatt, G. (1988) 'A SAM approach to modeling', *Journal of Policy Modeling*, 10(3), pp. 327–352. Available at: [https://doi.org/10.1016/0161-8938\(88\)90026-9](https://doi.org/10.1016/0161-8938(88)90026-9).
- Pyatt, G. (1999) 'Some relationships between T-accounts, input–output tables and social accounting matrices', *Economic Systems Research*, 11(4), pp. 365–387. Available at: <https://doi.org/10.1080/09535319900000027>.
- Rausch, S., Metcalf, G.E. and Reilly, J.M. (2011) 'Distributional impacts of carbon pricing: a general equilibrium approach with micro-data for households', *Energy Economics*, 33, pp. S20–S33. Available at: <https://doi.org/10.1016/j.eneco.2011.07.023>.
- Rezai, A., Taylor, L. and Foley, D. (2018) 'Economic growth, income distribution, and climate change', *Ecological Economics*, 146, pp. 164–172. Available at: <https://doi.org/10.1016/j.ecolecon.2017.10.020>.
- Roberts, D., Vera-Toscano, E. and Phimister, E. (2015) 'Energy poverty in the UK: is there a difference between rural and urban areas?'
- Robinson, S., Cattaneo, A. and El-Said, M. (2001) 'Updating and estimating a social accounting matrix using cross entropy methods', *Economic Systems Research*, 13(1), pp. 47–64. Available at: <https://doi.org/10.1080/09535310120026247>.
- Roccas, S. and Brewer, M.B. (2002) 'Social identity complexity', *Personality and Social Psychology Review*, 6(2), pp. 88–106. Available at: [https://doi.org/10.1207/S15327957PSPR0602\\_01](https://doi.org/10.1207/S15327957PSPR0602_01).
- Rodrik, D. (2014) 'Green industrial policy', *Oxford review of economic policy*, 30(3), pp. 469–491. Available at: <https://doi.org/10.1093/oxrep/gru025>.

- Rose, D. and Harrison, E. (2007) 'The european socio-economic classification: a new social class schema for comparative european research', *European Societies*, 9(3), pp. 459–490. Available at: <https://doi.org/10.1080/14616690701336518>.
- Rose, D. and Pevalin, D. (2003) *A researcher's guide to the national statistics socio-economic classification*. 6 Bonhill Street, London England EC2A 4PU United Kingdom: SAGE Publications, Ltd. Available at: <https://doi.org/10.4135/9780857024725>.
- Round, J. (2003) 'Constructing SAMs for development policy analysis: lessons learned and challenges ahead', *Economic Systems Research*, 15(2), pp. 161–183. Available at: <https://doi.org/10.1080/0953531032000091153>.
- Round, J.I. (2003) 'Social accounting matrices and SAM-based multiplier analysis', in *The Impact of Economic Policies on Poverty and Income Distribution: Evaluation Techniques and Tools*. World Bank and Oxford University Press, pp. 301–324. Available at: <https://openknowledge.worldbank.org/handle/10986/14391>.
- Rydgren, J. (ed.) (2012) *Class politics and the radical right*. 0 edn. Routledge. Available at: <https://doi.org/10.4324/9780203079546>.
- Sajeewani, D., Siriwardana, M. and McNeill, J. (2015) 'Household distributional and revenue recycling effects of the carbon price in Australia', *Climate Change Economics*, 6(3), p. 1550012. Available at: <https://doi.org/10.1142/S2010007815500128>.
- Sani, F. (2008) 'Schism in groups: a social psychological account', *Social and Personality Psychology Compass*, 2(2), pp. 718–732. Available at: <https://doi.org/10.1111/j.1751-9004.2007.00073.x>.
- Savage, M. *et al.* (2013) 'A new model of social class? Findings from the BBC's great british class survey experiment', *Sociology*, 47(2), pp. 219–250. Available at: <https://doi.org/10.1177/0038038513481128>.
- Stadler, K. *et al.* (2021) 'Exiobase 3'. Zenodo. Available at: <https://doi.org/10.5281/ZENODO.5589597>.
- Stern, N. and Valero, A. (2021) 'Innovation, growth and the transition to net-zero emissions', *Research Policy*, 50(9), p. 104321. Available at: <https://doi.org/10.1016/j.respol.2021.104293>.
- Stokes, D.E. (1997) *Pasteur's quadrant: basic science and technological innovation*. Washington: Brookings Institution Press.
- Stone, R. (1966) 'THE SOCIAL ACCOUNTS FROM A CONSUMER'S POINT OF VIEW', *Review of Income and Wealth*, 12(1), pp. 1–33. Available at: <https://doi.org/10.1111/j.1475-4991.1966.tb00709.x>.
- Szabo, J. (2022) 'Energy transition or transformation? Power and politics in the european natural gas industry's trasformismo', *Energy Research & Social Science*, 84, p. 102391. Available at: <https://doi.org/10.1016/j.erss.2021.102391>.
- Taylor, C. (2004) *Modern social imaginaries*. Durham: Duke University Press (Public planet books).
- Thorbecke, E. (2000) 'The use of social accounting matrices in modeling', in *26th General Conference of the International Association for Research in Income and Wealth Cracow, Poland*.
- Turnheim, B. and Geels, F.W. (2012) 'Regime destabilisation as the flipside of energy transitions: lessons from the history of the british coal industry (1913–1997)', *Energy Policy*, 50, pp. 35–49. Available at: <https://doi.org/10.1016/j.enpol.2012.04.060>.
- Vachudova, M.A. (2019) 'From competition to polarization in central europe: how populists change party systems and the european union', *Polity*, 51(4), pp. 689–706. Available at: <https://doi.org/10.1086/705704>.
- Vrontisi, Z. *et al.* (2016) 'Economic impacts of EU clean air policies assessed in a CGE framework', *Environmental Science & Policy*, 55, pp. 54–64. Available at: <https://doi.org/10.1016/j.envsci.2015.07.004>.
- Yildirim, T.M. (2022) 'Rethinking women's interests: an inductive and intersectional approach to defining women's policy priorities', *British Journal of Political Science*, 52(3), pp. 1240–1257. Available at: <https://doi.org/10.1017/S0007123421000235>.
- Zhang, Y. *et al.* (2020) 'Impact of COVID-19 on China's macroeconomy and agri-food system – an economy-wide multiplier model analysis', *China Agricultural Economic Review*, 12(3), pp. 387–407. Available at: <https://doi.org/10.1108/CAER-04-2020-0063>.

# Appendices

---

## Appendix A: Core Methodological Scripts

This appendix includes the key programming scripts used to disaggregate, reconcile, and balance the SE-SAM.

### *A.1: Stata Script for LCFS Household Expenditure Disaggregation*

```
1 Stata
2
3 /*
4 * Title: Household Expenditure Disaggregation from LCFS Data
5 * Author: REDACTED
6 * Date: September 2025
7 *
8 * Purpose: This script processes data from the Living Costs and Food
9 Survey
10 * (LCFS) to calculate expenditure shares for payments to Corporations,
11 * Government, and Capital Formation across the ten household classes.
12 */
13
14 * --- 1. SETUP AND DATA PREPARATION ---
15
16 clear all
17
18 cd "[placeholder for file path]"
19
20 capture log close
21
22 log using "[placeholder for log file path]", replace
23
24 di in yellow "Starting: Calculating LCFS-derived expenditure shares..."
25
26 * Load the primary LCFS household data file
27
28 use "[placeholder for data file path]", clear
29
30 * Generate the 10-group NS-SEC household classification from the source
31 variable A094
32
33 gen nssec10 = A094
34
35 recode nssec10 (1 2=1) (3=2) (4=3) (5=4) (6=5) (7=6) (8=7) (9=8) (10=9)
36 (11 12=10)
37
38 label define nssec10_label 1 "HH_1_HigherMan" 2 "HH_2_LowerMan" 3
39 "HH_3_Intermediate" 4 "HH_4_SmallEmp" 5 "HH_5_LowerSuper" 6
40 "HH_6_SemiRoutine" 7 "HH_7_Routine" 8 "HH_8_NeverWork" 9 "HH_9_Students"
41 10 "HH_10_OtherInactive"
```

```

42
43 label values nssec10 nssec10_label
44
45 * Keep only valid observations
46
47 keep if !missing(weighta) & weighta > 0 & !missing(nssec10)
48
49 * Define the list of LCFS expenditure variables to be processed
50
51 local expenditure_components ///
52
53     B200 B237 P431p B228 CC5111c CC5312c CC5511c CK5116t P071h ///
54
55     P392p P388p B387hp B391hp P029hp P073hp P068h CK5411c CK5412c CK3111t
56 CK3112t ///
57
58     B1961 B199 B205 CK2111t CK5111t CK5113t
59
60 * Replace any missing values for these variables with zero
61
62 foreach var of local expenditure_components {
63     replace `var' = 0 if missing(`var')
64 }
65
66 * --- 2. CALCULATE AGGREGATE WEIGHTED EXPENDITURE FLOWS ---
67
68 di in yellow "Calculating weighted expenditure flows..."
69
70 * Aggregate the detailed LCFS variables into the three target categories
71 and apply survey weights
72
73 gen double w_corp_pay = (B200 + B237 + P431p + B228 + CC5111c + CC5312c
74 + CC5511c + CK5116t + P071h + B1961 + B199 + B205) * weighta
75
76 gen double w_gov_pay = (P392p + P388p + B387hp + B391hp + P029hp +
77 P073hp + P068h + CK5411c + CK5412c + CK3111t + CK3112t) * weighta
78
79 gen double w_cap_pay = (CK2111t + CK5111t + CK5113t) * weighta
80
81 * Collapse the data to get a total for each NS-SEC class
82
83 collapse (sum) w_corp_pay w_gov_pay w_cap_pay, by(nssec10)
84
85 di in green "Expenditure flows collapsed by household type."
86
87 * --- 3. CALCULATE FINAL SHARES AND EXPORT ---
88
89 di in yellow "Calculating final shares for export..."
90
91 * Define the list of the three aggregated flows
92
93 local expenditure_flows w_corp_pay w_gov_pay w_cap_pay
94

```

```

95 * Loop through each flow to calculate the proportional share for each
96 NS-SEC class
97
98 foreach var of local expenditure_flows {
99
100     egen total_`var' = total(`var')
101
102     gen share_`var' = `var' / total_`var'
103
104     drop total_`var'
105 }
106
107 * Prepare variables for the final output file
108
109 keep nssec10 share_*
110
111 rename share_w_corp_pay share_pay_corp
112 rename share_w_gov_pay share_pay_gov
113 rename share_w_cap_pay share_pay_capital
114
115 * Order variables, sort, display, and export the final shares to a CSV
116 file
117
118 order nssec10 share_pay_corp share_pay_gov share_pay_capital
119
120 sort nssec10
121
122 di ""
123
124 di in green "Final Corrected Shares (LCFS-derived only):"
125
126 list, clean noobs
127
128 export delimited using "[placeholder for output file name]", replace
129
130 di ""
131
132 di in green
133 "======"
134
135 di in green "SUCCESS: LCFS-derived expenditure share script complete."
136
137 di in green "The output file contains shares for Corporations,
138 Government, and Capital."
139
140 di in green
141 "======"
142 log close
143
144
145

```

## A.2: GAMS Script for Stochastic Cross-Entropy (CE) Estimation

```
1 Gams
2
3 * -----
4 * Title: GAMS Script for Stochastic Cross-Entropy (CE) Method
5 * Author: REDACTED
6 * Date: September 2025
7 *
8 * Purpose: To estimate the cost structure of 9 electricity sub-sectors by
9 * reconciling a prior matrix with known SAM control totals. The objective
10 * function minimises the entropy distance between the prior and the
11 result.
12
13 * -----
14
15 * --- SETS ---
16
17 Set i 'Input accounts' / afaf, cal, coage, ..., raops /;
18
19 Set j 'Disaggregated electricity sectors' / Ele_TnD, Ele_Nuclear, ...,
20 Ele_Solar /;
21
22 * --- PARAMETERS and INPUT DATA ---
23
24 Table prior(i,j) 'Prior cost structure matrix';
25
26 $ondelim
27
28 $include prior_matrix.csv
29
30 $offdelim
31
32 ;
33
34 Parameter row_con(i) 'Row control totals (SAM constraints)';
35
36 /
37
38 $include sam_constraints.csv
39
40 /;
41
42 Parameter col_con(j) 'Column control totals (Output constraints)';
43
44 /
45
46 $include new_row_totals_constraints.csv
47
48 /;
49
50 * --- VARIABLES ---
```

```

51
52 Variable
53
54     x(i,j) 'The final, estimated transaction matrix'
55
56     H      'The objective function value (Entropy)';
57
58 Positive Variable x;
59
60 * --- EQUATIONS ---
61
62 Equation
63
64     Objective          'Cross-Entropy objective function'
65
66     RowConstraint(i)  'Ensures estimated rows sum to known control totals'
67
68     ColConstraint(j)  'Ensures estimated columns sum to known control
69 totals';
70
71 Objective..          H =e= sum((i,j), x(i,j) * (log(x(i,j) / prior(i,j)) -
72 1));
73
74 RowConstraint(i)..  sum(j, x(i,j)) =e= row_con(i);
75
76 ColConstraint(j)..  sum(i, x(i,j)) =e= col_con(j);
77
78 * --- MODEL AND SOLVE ---
79
80 Model CE_Electricity /all/;
81
82 Solve CE_Electricity using NLP minimizing H;
83
84
85

```

### A.3: GAMS Script for $L_1$ Norm Balancing Procedure

```
1 Gams
2
3 * -----
4 * Title: GAMS Script for L1 Norm Balancing Procedure
5 * Author: REDACTED
6 * Date: September 2025
7
8 *
9
10 * Purpose: To balance the final 60x60 SE-SAM by minimizing the sum of
11
12 * absolute adjustments, subject to the constraint that row sums must equal
13
14 * column sums for all accounts.
15
16 *
17 -----
18 ---
19
20 * --- SETS ---
21
22 Set i 'All SAM accounts (rows and columns)' / Agri, CoalExt, ..., RoW /;
23
24 Alias(i,j);
25
26 * --- PARAMETERS ---
27
28 Table T0(i,j) 'Initial Unbalanced SAM';
29
30 $ondelim
31
32 $include unbalanced_sam.csv
33
34 $offdelim
35
36 * --- VARIABLES ---
37
38 Variable
39
40     T(i,j) 'Final Balanced SAM'
41
42     p(i,j) 'Positive adjustment to T0'
43
44     q(i,j) 'Negative adjustment to T0'
45
46     Obj    'Objective function value';
47
48 Positive Variables T, p, q;
49
50 * --- EQUATIONS ---
```

```

51
52 Equation
53
54     ObjectiveDef           'Defines the L1 Norm objective'
55
56     BalanceConstraint(i) 'Enforces row sums equal column sums'
57
58     AdjustmentDef(i,j)   'Links final matrix to adjustments';
59
60 ObjectiveDef..           Obj =e= sum((i,j), p(i,j) + q(i,j));
61
62 BalanceConstraint(i)..   sum(j, T(i,j)) =e= sum(j, T(j,i));
63
64 AdjustmentDef(i,j)..    T(i,j) =e= T0(i,j) + p(i,j) - q(i,j);
65
66 * --- MODEL AND SOLVE ---
67
68 Model SAM_Balance /all/;
69
70 Solve SAM_Balance using LP minimizing Obj;
71

```

## Appendix B: Supplementary Data

Table B.1: Matrix Calculation Pathway for Household Final Demand Disaggregation

Symbol	Descriptive Title	Dimensions	Calculation / Source	Function
<b>Part 1: Construction of the Consumption-to-Industry Bridge Matrix</b>				
HHFCE	Household Consumption by Product Matrix	36×103	ONS Supply & Use Tables	Source matrix mapping 36 detailed consumption categories to 103 CPA products.
A <sub>1</sub>	Consumption Aggregation Matrix	36×12	Derived from ONS data structures	Aggregates the 36 detailed consumption categories to the 12 broad COICOP/LCFS categories.
LA	Product-to-Consumption Bridge Matrix	103×12	HHFCE <sup>T</sup> × A <sub>1</sub>	Links the 103 products to the 12 broad consumption categories in monetary terms.
A <sub>2</sub>	Product-to-Industry Concordance	104×103	Author-constructed	Maps the 103 CPA product classifications to 104 SIC industrial sectors.
C	Industry-to-Consumption Bridge Matrix (Values)	104×12	A <sub>2</sub> × LA	Links the 104 industries to the 12 broad consumption categories in absolute monetary values.
A <sub>3</sub> <sup>-1</sup>	Column Normalisation Matrix	12×12	Inverse of column sums of C	Diagonal matrix used to convert the absolute values in C to column proportions.
B	Industry-to-Consumption Bridge Matrix (Proportions)	104×12	C × A <sub>3</sub> <sup>-1</sup>	The final bridge matrix. Each column shows the proportional sourcing from the 104 industries for £1 of spending in a given consumption category.
<b>Part 2: Disaggregation and Reconciliation of Household Demand</b>				
K	Household Expenditure Matrix	12×10	ONS LCFS (Table a22)	Contains total annual expenditure by each of the 10 NS-SEC household groups on each of the 12 consumption categories.
hhT	Initial Disaggregated Demand	104×10	B × K	An initial estimate of total consumption by each of the 10 household classes from each of the 104 industries.
A <sub>4</sub>	Row Normalisation Matrix	104×104	Inverse of row sums of hhT	Diagonal matrix used to convert the absolute demand values in hhT into row-wise proportions.
hhF	Household Demand Share Matrix	104×10	A <sub>4</sub> × hhT	Shows for each industry the share of its total household demand attributable to each of the 10 household classes. Each row sums to 1.
ixi□□	Industry Control Totals Matrix	104×104	ONS I-O Tables (P3s14)	Diagonal matrix of the official Control Totals for aggregate household consumption from each of the 104 industries.
HHD <sub>fi</sub> □ <sub>a</sub> □	Reconciled Disaggregated Demand	104×10	ixi□□ × hhF	The final, scaled matrix of household demand at the 104-sector level, consistent with national accounts control totals.
<b>Part 3: Final Aggregation for the SAM</b>				
A <sub>6</sub>	Industry Aggregation Concordance	34×104	Author-constructed	Aggregates the 104 detailed SIC industries to the 34 final SAM sectors.
HHD□ <sub>a</sub> □	Final SAM Disaggregated Demand	34×10	A <sub>6</sub> × HHD <sub>fi</sub> □ <sub>a</sub> □	The final matrix for insertion into the SAM, showing expenditure by 10 household classes on 34 industries.

Table B.2: LCFS Variable Key for Expenditure Disaggregation

From dataset 2018 dvhh ukanon

SAM Expenditure Category	LCFS Variable Code	Description from Data Dictionary	
<b>Corporations</b>	B200	Mortgage interest / principle - last payment	
	B237	Credit card interest payments	
	P431p	Main source of household income - value - top-coded	
	B228	Personal pension	
	CC5111c	Life, death, non-house endowment - children	
	CC5312c	Accident, sickness, redundancy, animal insurance, etc. - children	
	CC5511c	Other insurance - children	
	CK5116t	Widow's / Dependant's / Orphan's fund - children and adults	
	P071h	Pension and superannuation contributions - household	
	B1961	Life insurance premium - amount premium	
	B199	Insurance for household and electrical appliances	
	B205	Friendly society subscriptions - deductions from main pay	
	<b>Government</b>	P392p	Income tax, payments less refunds - top-coded
		P388p	NI employees contribution - current - top-coded
		B387hp	Income tax paid direct - household - top-coded
B391hp		Self-employment tax paid - household - top-coded	
P029hp		NI contributions paid by non-employees - household - top-coded	
P073hp		Tax paid on bonuses - household - top-coded	
P068h		Tax deducted from pensions, investments, annuities - household	
CK5411c		Income tax payment - children	
CK5412c		National insurance contribution - children	
CK3111t		Stamp duty, licences and fines (excluding motoring fines)	
CK3112t		Motoring Fines - children and adults	
<b>Capital Formation</b>		CK2111t	Food stamps, other food related expenditure
	CK5111t	Savings, investments (excluding AVCs) - children and adults	
	CK5113t	Additional Voluntary Contributions - children and adults	

*Table B.3: Final Greenhouse Gas (GHG) Emissions Coefficients (c<sub>i</sub>)*

<b>SE-SAM Sector</b>	<b>Greenhouse Gas Coefficient (ktCO<sub>2</sub>e/£M)</b>
Agriculture/forestry/fishing	1.548
Coal extraction	1.465
Crude oil/gas	0.619
Mining/quarrying/mining support	0.140
Food/drink mfr	0.069
Textiles/leather/wood	0.078
Paper/printing	0.079
Coke/refined petroleum	0.442
Chemicals	0.302
Pharmaceuticals	0.022
Rubber/plastic	0.152
Cement/lime/glass	0.769
Iron/steel	0.602
Fabricated metal	0.086
Electrical/electronic	0.033
Vehicles	0.016
Transport equipment/other mfr	0.028

Electricity transmission/distribution	0.007
Nuclear power	0.000
Coal power	3.102
Gas power (CCGT)	1.553
Wind power	0.000
Hydroelectric power	0.000
Other power	3.462
Oil power	1.934
Solar power	0.000
Gas distribution	0.258
Water treatment/supply	0.029
Waste management/sewage	0.756
Construction	0.032
Wholesale/retail	0.041
Land transport	0.336
Other transport	0.098
Transport support	0.060
Accommodation/food	0.043
Communication	0.004

Finance/insurance	0.001
Architectural services	0.006
Services	0.008
Public admin/education/defence	0.026
Health and social work	0.027
Recreation/other private services	0.020

## **Appendix C: Supporting Datasets and Statement of Integrity**

### *C.1: The Final 2018 Socio-Energy Social Accounting Matrix (SE-SAM)*

The complete, balanced 60x60 SE-SAM for the UK (2018) is the primary data output of this dissertation. Due to its size, it has been submitted as a supplementary digital file in Microsoft Excel format ([UK\\_SE\\_SAM\\_2018.xlsx](#)) alongside the main dissertation document. The dataset is also available from the author upon reasonable request.

### *C.2: Correspondence and Aggregation Matrices*

The construction of the SE-SAM required the creation of several correspondence and aggregation matrices to map data between different classification systems. These include the matrix to map GTAP-Power sectors to the SE-SAM electricity sectors, and the concordance to aggregate 104 SIC 2007 industries to the 34 final SE-SAM production sectors. These detailed matrices are available from the author upon reasonable request.

### *C.3: Statement on the Use of Artificial Intelligence*

This dissertation has been written and prepared by the author. To aid in the writing and composition process, the research made use of Gemini 2.5 (Google, <https://gemini.google.com/app>). This was solely used to generate ideas for research, proofread the written draft, suggest appropriate structural elements for chapters and appendices, and support citation formatting and mathematical notation.

The LLM was not used to generate original arguments or write any substantive intellectual content. The methodological design, the execution of the modelling, the interpretation of the results, and the core academic contributions of this work remain the author's own.