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Of embodied emissions and inequality: Rethinking energy consumption

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ABSTRACT

This paper situates concepts of energy consumption within the context of growing research on embodied emissions. Using the UK as a case study I unpack the global socio-economic and ecological inequalities inherent in the measurement of greenhouse gas emissions on a territorial basis under the international climate change framework. In so doing, I problematise questions of distribution, allocation and responsibility with regards to the pressing need to reduce global GHG emissions and the consumption that generates them. I challenge the disproportionate emphasis that energy policy places on supply as opposed to demand, as well as its overriding focus on the national scale. Consequently I argue that any low carbon transition, in addition to a technological process, is also a geographical one that will involve the reconfiguration of "current spatial patterns of economic and social activity" (Bridge et al., 2013:331), as well as relationships both within countries and regions and between them.

1. Introduction

In what Bradshaw ([1]:12) refers to as the difference between industrial production and domestic consumption, wealthy countries have to a large extent exported or outsourced their climate and energy crisis to low and middle-income countries, deliberately or otherwise. Broadly speaking, while GHG emissions have stabilised in developed countries, they are growing in developing countries [2]. Bohm [3] describes this phenomenon as 'carbon colonialism' and Oxfam [4] as 'extreme carbon inequality', estimating that half of the world's population, approximately 3.5 billion people, of which the majority in regions most vulnerable to climate change, emit only about 10% of total global emissions attributed to individual consumption. In contrast, approximately 50% of the world's greenhouse gas emissions (GHG) can be attributed to consumption by the world's richest 10 per cent, with the average carbon footprint of the richest one per cent being 175 times higher than that of the poorest 10 per cent ([4]:1). As this paper explores, the nature of this distribution constitutes a case of 'ecologically unequal exchange' [5].

The term 'embodied emissions' [6–8] is used here to refer to the approximately one quarter of global GHG emissions embodied within goods, services and commodities imported and consumed by the world's high-income consumers [9]. Related terms include 'consumption-based emissions', 'embodied energy' and 'embodied carbon'. This paper explores the ecological and socio-economic inequalities inherent within this structural configuration and argues that embodied emissions are a fundamental yet largely overlooked aspect of energy policy and climate change mitigation. Not least, the global commitment made at the UNFCCC conference in Paris in December 2015 is too ambitious to be achieved without addressing them [10]. Secondly, an exploration into consumption-based emissions unearths "large social and political patterns of inequality" [11] within and between nations, and between generations [12].

While energy consumption is generally associated with measureable units for the purposes of electricity, heating and transport, including kWh, joules, gallons, tonnes of oil equivalent and litres, this paper problematises a much less visible and less quantifiable aspect. That is, the embodiment of energy and its associated emissions within goods, services and commodities consumed by industry, commerce, the household and the individual. In particular the paper asks: what key theoretical approaches enable an analysis of the inequalities inherent in embodied emissions? What are the problems inherent in their measurement? How, if at all, are consumption-based emissions accounted for in policy, and what are the challenges in allocating responsibility for them?

Academic research and policy interventions to reduce energy demand has failed to account for the complexity of economic systems (Sorrell 2014:75), including how energy is embodied within circuits of global capital, industrial infrastructures and systems of production and consumption [14,11,15]. With this in mind, I situate consumption-based emissions within the theoretical context of ecologically unequal exchange. Doing so raises questions over how the increasingly popular and ubiquitous concept of the low-carbon or energy 'transition' (which involves a shift away from fossil fuels towards cleaner energy supplies coupled with increased efficiency in use and demand reduction) found within the sphere of academia [16], policy [17], industry [18] and civil society [19] should be conceptualised and implemented.

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This research uses the UK as a poignant example: while it has one of the least energy-intensive economies in the developed world, in part due to the decline of its industrial sector in recent decades, the country has one of the highest net imports of emissions in the world and is among the highest in terms of per capita emissions [20]. Yet there is limited acknowledgement that the bulk of energy consumed by households in the UK is in fact "embodied in non-energy goods and services" ([13]:77). As Bridge [14] argues, the consumption of energy in high-income contexts has been 'dematerialised' not only via electrification or gasification but also the import of consumer goods such as cars and fridges in which energy-intensive intermediate products such as steel, plastics, cement, and aluminium are incorporated and industrial infrastructure such as roads and buildings in which significant amounts of GHG emissions are embodied. In each case, the small-scale and large-scale consumer has been removed from the numerous and significant material inputs and processes, which include not only energy and natural resource extraction but also labour. Consequently, and as this paper concludes, a deeper understanding is needed of how energy and its associated emissions are embodied within "the context of a chain of processes and structures" [21].

The theoretical approach of this paper draws from two main bodies of literature: ecologically unequal exchange (e.g [5,22]), and consumption-based emissions accounting (e.g [23,7]). While the former is relatively theoretical and sits within the overlap of political ecology, ecological economics and Marxist political economy, the latter is statistically-informed and draws from climate science, engineering and emissions modelling. These two bodies of literature come from very different disciplines and are rarely linked directly, with a possible key tension between them being that the latter is evidence-driven and problem-oriented and by implication leans towards a more pragmatic and policy response, while the former is more analytically focussed and concerned with theoretical nuance and historical exploration. In linking these literatures and while accepting inevitable limitations, I hope to enrich both perspectives whilst speaking to audiences on both sides. Not least, both call for a greater understanding of cross border material resource flows and the global distribution of energy consumption and associated emissions. Responding to this call, I further draw on contributions from economic and human geography which emphasise the role of global interdependencies and the need for a more spatial and relational understanding of energy production and consumption [24]. In bringing together such literatures, I advocate for a creative synthesis of various traditions rather than a concise 'reconciliation' between them.

Empirically, the research draws from a desk-based analysis of grey literature, including reports from UK government departments such as the former Departments for Energy and Climate Change (DECC) and Business Innovation and Skills (DBIS), many of whose functions were taken over the Department for Business, Energy and Industrial Strategy (BEIS) established in July 2016, and the Department for Environment, Food and Rural Affairs (DEFRA); parliamentary bodies such as the UK House of Commons Energy and Climate Change Committee; independent bodies such as the Committee on Climate Change (CCC); and think tanks and information services such as *Carbon Brief*, the *Carbon Trust* and *Energy Live News*. The research also includes compilation of statistics, from the World Bank Development indicators' database and the UK Office for National Statistics.

The paper's structure is as follows. Section 2 discusses evolving concepts of energy and theoretical perspectives behind ecologically unequal exchange, including how the notion of consumption-based or embodied emissions sits within this. Section 3 problematises the measurement of GHG emissions on a territorial and/or production basis for its failure to account for the nature of embodied energy consumption. Section 4 examines the example of the UK which is followed in Section 5 with a consideration of the challenges inherent in a more equitable measurement and allocation of responsibility for consumption-based emissions. Section 6 concludes.

2. Rethinking energy and embodied emissions

While the standard scientific and physical definition of the term energy means "the capacity do work: that is, to move an object against a resisting force" (Boyle et al. [90]:6), the term has since become subject to a myriad of interpretations. These include: as a natural resource e.g coal; a technology e.g a solar panel; a networked infrastructure e.g a transmission grid; a commodity that can be bought and sold on the financial markets [27]; and a 'geopolitical object', central to discourses of security and scarcity ([11]:2). Acknowledging such multi-faceted diversity, in this paper I draw from Marxist concepts of energy as a social relation "enmeshed in dense networks of power and socio-ecological change" ([28]:106). Such an approach analyses energy as embedded within broader social, economic and political forces and processes and "a particular historical phenomenon inextricably tied up with unequal exchange" ([15]:102).

As the papers in this special issue demonstrate, concepts of 'spatial' in relation to energy are diverse and wide-ranging. Here, I speak to a spatial concept of energy by examining how the consumption of energy embodied in goods, services and commodities has become thoroughly separated and dislocated from its production. Such a separation illustrates the restructuring of global space in recent decades which, following Smith, includes processes of uneven development and shifting production across borders, particularly in the form of industrialisation in low and middle-income countries and deindustrialisation in high income countries ([29]:122). A spatial examination of energy further includes a consideration of the often under-theorised relationship between energy and labour. Not least, as the global mobility of capital has enabled the relocation of industry and technological production (and by consequence GHG emissions) to other geographical locations ([30]:334) labour has remained 'spatially trapped' ([31]:472).

By adopting such an approach I offer a challenge to the academic literature[1] on the low-carbon transition. While this literature has made valuable contributions to the understanding of socio-technological change, energy policy and innovation, it can also be criticised for its spatial blindness and its implicit overemphasis of "the national level at the expense of other geographical levels" ([32]:3); for its overriding focus on the individual in the residential sector as opposed to large energy-intensive and organisational consumers, which gives us "an unrealistic view into the kinds of transformation of energy consumption patterns that are needed" [11]; and for its heavy focus on energy supply as opposed to energy demand and/or the relationship between the two [32,13].

With this in mind, I now turn to embodied emissions as ecologically unequal exchange.

2.1. Embodied emissions as ecologically unequal exchange

> *"'Dirty' Industries: Just between you and me, shouldn't the World Bank be encouraging MORE migration of the dirty industries to the LDCs [Less Developed Countries]? I can think of three reasons: …"* Excerpt from leaked memo 12 December 1991, by Larry Summers, then World Bank chief economist,[2]

In the above citation, Larry Summers, then chief economist at the World Bank, justified his proposal for the offshoring of 'dirty industries' to less developed countries on the basis of economic arguments. These included: the removal of 'health impairing pollution' to the country with the lowest cost; that poorer countries are 'under-polluted'; and that the demand for a 'clean environment for aesthetic and health reasons' increases with levels of income. I include this citation here because it rationalises an economic growth model based on the export of polluting industries to low and middle-income countries, and the subsequent import of embodied

[1] Including socio-technical transitions [86], sustainability transitions [87] and the energy transition [16].

[2] Available: http://www.whirledbank.org/ourwords/summers.html.