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Energy embodied in household cookery: the missing part of a sustainable food system? Part 1: A method to survey and calculate representative recipes

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Abstract

This paper firstly reviews the current state of knowledge on sustainable cookery and the environmental impacts of the food consumption phase. It then uses the example of a dish of roast beef and Yorkshire pudding to explore energy use in food production and consumption. Part 1 of this paper conducts a meta-analysis of 33 roast beef and Yorkshire pudding recipes in order to create a representative recipe for analysis. Part 2 of this paper then uses life cycle assessment and energy use data is coupled with the representative recipe of roast beef and Yorkshire pudding, to calculate the embodied energy of the meal. Seven interventions are modelled to illustrate how sustainable cookery can play a role as part of a sustainable food system. Interventions show that sustainable cookery has the potential to reduce cookery related energy use by 18%, and integrating sustainable cookery within a sustainable food system has the potential to reduce the total energy use by 55%. Finally, the paper discusses the issue of how the adoption of the sustainable cookery agenda may help or hinder attempts to shift consumers towards sustainable diets.

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Keywords: Energy demand and resource use in food consumption; life cycle assessment; cooking; home-made meals; Environmental impacts; LCA; food; meal; food energy and water nexus; energy and resource use in food consumption

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1. Introduction

The production, transport, and consumption of food uses energy and has global environmental impacts [6,8,25,35,67,70]. One of the major environmental impacts is anthropomorphic climate change. This is caused by greenhouse gas emissions (GHGE) related to human activity – such as food production and consumption. Climatic change will affect many aspects of global life, including the food system; altering crop production rates due to extreme weather events (floods and droughts) leading to food shortages and hunger [66].

A way to reduce GHGE is to change our production methods and consumption patterns to be less GHGE intensive. Currently food production and consumption is interlinked with GHGE generating energy generation methods (such as coal and gas), with the UK food system estimated to contribute about 9% and 20% of total UK GHGE from agriculture (in 2015) and the total food system (in 2008), respectively[2,13,30]. The latest UK GHGE reduction targets – as outlined in the 5th Carbon Budget and the Paris Agreement – are a 57% reduction from 1990 GHGE values by 2032, and an 80% reduction by 2050 [13]. Change towards a lower energy use, and lower GHGE generating food production and consumption system is necessary to meet the UK's legally binding GHGE reduction targets [65].

UK agricultural production systems are increasing in energy efficiency, and there is growing consumer awareness of what makes a sustainable healthy diet [3,7,40,62], with other countries adopting sustainable national dietary guidelines[26,29,33,37,46,47]. This shift towards a sustainable low energy food system is occurring to a lesser extent within household cooking practices. There has been less of a connection in the minds of consumers, industry, and government policy between cookery practices and their environmental impacts, even though the household cookery and storage phase may be up to half the total energy use in a food product's life cycle [10]. This is a missed opportunity and a necessary step to create a sustainable food system.

Currently 10% of yearly UK household energy use is related to cooking, while 13.8% is related to cold appliances. In addition, 20% of peak UK load is used for cooking and 10% for cold appliances [19,52]. This is less than it was 40 years ago, with the household energy use associated with cooking having more than halved since the 1970s [14]. However, these gains have not typically come from energy efficiency increases in cooking methods and cold storage appliances. Instead, gains in energy efficiency have come from the adoption of more efficient cooking devices (such as microwaves – more energy efficient when compared to traditional oven usage [45]), and the expansion in 'ready meals' and takeaways being eaten at home, and an increase in the number of meals eaten outside the home [14,22].

Previous research has used life cycle assessment methods to compare the energy and environmental impacts of homemade, ready meals, and takeaways. Examples of meals compared include a roast chicken dinner [57,58]; a chicken ready meal [17]; a cottage pie [20,21]; a hamburger [11]; a meatball meal [60,61]; ready meals of pork chops, sausages, pea chops, or pea burgers [18]; and a pasta meal, lamb meal, sausage meal, chicken fillet meal, and tortellini meal [5]. In addition, the energy impact of the typical Spanish diet [48] and the UK diet [39] have been modelled, along with the energy impacts of a variety of ingredients [10,44,68] and cooking methods [28]. Due to the number of variables to consider the results are mixed as to if home cooking or ready meals are more energy efficient. What is certain is that the consumption at home of 'ready meals' and takeaways, and the increase in eating outside the home is shifting energy use away from household into the rest of the food system.

Eating out in the UK is on the rise [64], with 75% of the population eating out of home at least once in seven days in 2014, rising from 65% in 2010. However, the majority (63%) of the 75% who do eat out, only do so once or twice a week. Only 14% of the 75% who do eat out (11% of the total UK population), do so with any frequency (6 times a week or more), and 23% eat out 3 to 5 times per week [41]. It is known that the energy consumption of the hospitality sector is different to that of households, with industry being motivated to reduce energy consumption due to financial drivers [1,9,11,16,34,51]. An Australian study has modelled that the consumption of food outside the home has lower energy, water, GHGE and waste footprints than household food consumption [56]. However, there is an overall lack of research examining the sustainability and energy implications of eating outside the home compared to eating at home and the implications of this demand shift.

At home the methods of cooking food have changed little over the last forty years with either baking in an oven (convection), frying on the stove top (conduction), or cooking in a microwave (radiation) being the most popular methods of cooking [14,31,42,43,71]. In addition, the majority of home cooking is still being performed at peak energy demand times [24,42]. It has now been identified that different consumers do cook differently and have differing relationships with food production, shopping, cooking and consumption, and these differences lead to different energy