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eCook: What behavioural challenges await this potentially transformative concept?

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ABSTRACT

This paper aims to identify and understand the challenges that may confront the scaling up of a proposed battery electric cooking concept (Batchelor 2013), eCook, which offers the potential for emission free cooking, with time/money savings and broader environmental benefits from reduced fuelwood/charcoal consumption. By drawing on the literature on the transition to electric cooking in South Africa and more broadly, literature from across the Global South analysing the uptake of ICS (improved cookstoves), LPG (liquid petroleum gas) and solar home systems, this study identifies the factors (e.g. successful delivery models and marketing strategies) that have enabled these innovations to reach scale. This knowledge is then related to the eCook concept, by identifying the potential users of this promising technology and outlining potential marketing strategies, as well as a user-focused iterative design process, that will enable social enterprises to reach them. Uptake is predicted to be most rapid in hot climates where fuelwood/charcoal is purchased and low energy diets and low power cooking devices are the standard. Mobile enabled fee-for-service (utility) business models, the establishment of a service network, awareness raising campaigns on the benefits of clean cooking, female-focussed training programmes and bundling eCook systems with locally appropriate appliances to enable productive activities are seen as key to reaching scale.

Introduction and research objectives

This paper is situated at the intersection between two major global challenges; the continued use of biomass for cooking amongst large swathes of the global population which is harmful to health and to the environment, and the challenge to extend modern energy access to all (encapsulated within the seventh Sustainable Development Goal). A burgeoning literature (reviewed by [67,68]) details the significant human costs that high levels of dependence upon traditional cooking methods bring for households across the continent. These include the enormous health toll of exposure to black carbon and other particulates present in the smoke from cooking fires [28,57], burns and the impact of firewood collection itself, the economic costs of high fuel expenditure and the time lost in gathering fuel, as well as the environmental implications of GreenHouse Gas (GHG) emissions, forest degradation and deforestation from unsustainable practices. The international community has not been inactive in the face of these challenges and over the past decades there have been a succession of initiatives which have sought to promote the uptake of improved cookstoves and modern cooking fuels. Nevertheless, by 2015 the uptake of clean cooking solutions (transition to LPG, renewable fuels or improved efficiency biomass cookstoves) remains as low as 10% in Sub-Saharan Africa (compared with 27% in South Asia, 41% in Southeast Asia, 51% in East Asia and 80% in Latin America: World Bank [67,68]).

The electric cooking concept put forward in this paper is based upon the premise that by 2020 the cost of using solar photovoltaic (PV) panels (or potentially any other off-grid, mini-grid or unreliable grid power source) to charge a battery, and then using the battery for cooking as and when required, is likely to be comparable to the monthly cost of cooking with charcoal and wood in most parts of the Global South [4]. The use of electric cooking systems could meet the twin goals of both increasing access to modern energy services, and providing a means of truly clean cooking to households across the Global South. In fact, some [66] suggest that highly insulated, very low power stoves (100 W, $100 purchase price) are

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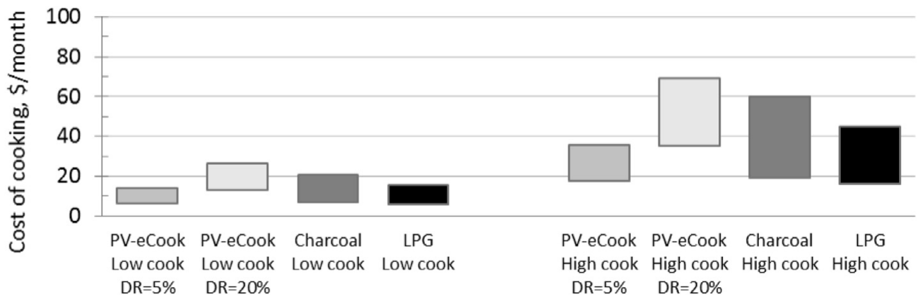

Fig. 1. Predicted comparative cooking costs in 2020 [35]. DR = Discount Rate.

already cost effective in the Ugandan context. However, the behavioural change challenges of cooking with insulated utensils are clearly much greater than on a conventional electric hob.

In what follows, we explore the potential contribution of a basic electric cooking concept, eCook, which consists of a simple battery and 500 W electric hob [3], towards meeting these twin goals. Whilst induction hobs may offer higher efficiencies [39], a cold hob magnetically heating specialist pots/pans (with a high ferrous content) requires greater behavioural change to transition from fuelwood/charcoal. However, although we are initially focussing on the simple hotplate, induction hobs are expected to play an important role in the future evolution of the eCook concept.

The battery storage is the key eCook system component, as it enables households with unreliable electricity supplies to cook at a time that is convenient to them. The concept is not a specific product, more a potential future configuration of existing components and has initially been proposed in two forms:

- packaged with solar PV panels[1] in a similar format to the popular Solar Home Systems (SHS) and referred to here as PV-eCook; and
- packaged with a battery charger[2] for grid or mini-/micro-/nano-grid connections, referred to as B-eCook.

Our particular focus concerns the social/behavioural implications that will need to be addressed in the development of this concept. This work was commissioned by the UK Department for International Development (DfID) alongside two other studies, which were undertaken in parallel, addressing specific aspects of the economic and technical feasibility of the eCook concept.

The first study [35] modelled the economics of the PV-eCook concept. Whilst a bigger battery and a more powerful hotplate would certainly enhance the usability of the product, their model showed that the majority of the upfront costs would be invested in the battery for the system, which therefore means that optimising the size of this component is critical. They take the necessary useful energy for cooking and work 'back' to what size the battery would need to be, before finally taking two scenarios of insolation and working out what size a photovoltaic array would be required to keep the battery charged. In order to benchmark the cost of PV-eCook, Leach and Oduro [35] compare the outputs with equivalent energy consumption (and cost) data for cooking with charcoal or LPG. They created eight generalised scenarios: a 'low cook' scenario with Discount Rates (DRs) of 5% and 20%, and a 'high cook' scenario with the same DRs, modelled at 2015 and 2020 prices. 'Low/high cook' accounts for the cultural differences in cooking practices that result in lower or higher energy and power requirements. Their calculations illustrate that, while today in 2015 the range of monthly costs for the PV-eCook system is certainly higher than for most charcoal and LPG markets, if current price trends continue, by 2020, the monthly cost of PV-eCook is likely to be comparable to that of charcoal and LPG (see Fig. 1). The initial purchase cost of the optimistic (5% DR) 'low cook' scenario is predicted to be US $718, implying that innovative financing mechanisms will be required to enable poor households to access the technology. As well as concerns over the cost of the battery, there were also questions about the durability and lifetime of currently available batteries. Accordingly, a second study was specifically commissioned on the technical capabilities of current and emerging battery chemistries relevant to the eCook proposition. This second study [56] concluded that currently available LiFePO4 batteries should be viable for the proposition, although it also drew attention to the absence of independent data on battery performance in high temperature and high discharge conditions.

Although the technical, social and economic dimensions are clearly intertwined, the rest of this paper is conducted on the assumption that the eCook concept will be both technically and economically feasible[3] and instead focuses on the social/behavioural implications that will need to be considered in its development by specifically addressing the following two research questions posed by DfID in the remit for their original study:

- "What are the possible intra and inter household dynamics among African households (including the very poor) that may affect the uptake of [the proposed eCook concept]?"
- "What are the behavioural change challenges that should be understood and investigated through longer term research that may affect the [further development] of the concept?"

Our specific focus in the paper concerns the potential uptake of the eCook concept within the Sub-Saharan African (SSA) context although, where appropriate, we draw upon relevant examples from other parts of the Global South (and beyond). In what follows we draw upon both the original report presented to DfID on behavioural change by Brown and Sumanik-Leary [11][4] and the synthesis of all three of the studies written by Batchelor [5].

The first part of the paper comprises a literature review focusing on four related energy transitions, with the aim of drawing out the key lessons learned and highlighting their relevance to the proposed eCook concept. These comprise:

a. Electric cooking in South Africa, the only SSA country which has had considerable uptake of electric cooking to date.
b. Improved cookstoves, which have been adopted to varying degrees across the Global South.

[1] i.e. battery, charge controller, PV panels and electric hob.
[2] i.e. battery, AC battery charger and electric hob.

[3] Readers interested in more detailed discussion of the technical and economic dimensions should consult [35] and [56]. For further information on the genesis of the eCook concept see [4]

[4] The report for DFID goes into the issues raised in what follows in far more detail than we are able to do in this relatively concise paper.

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