Scale up analysis: modelling method and assumptions

eCooking Market Assessments

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The MECS/EnDev eCooking Market Assessments

This study is part of a series of publications produced jointly by Energising Development (EnDev) and the Modern Energy Cooking Services (MECS) Programme. This series of market assessments offer strategic insight on the current state of electricity access and clean cooking in eight countries across sub-Saharan Africa and South Asia. These studies identify the key opportunities and challenges to the scale up of electric cooking in the coming decade and conclude with a series of recommendations for targeted interventions that could support the development of emerging eCooking sectors. The market assessments are structured according to the MECS transition theory of change (TToC), which consists of three interrelated dimensions: the enabling environment, consumer demand and the supply chain.

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1 Introduction

For the GIZ market assessments, we want to estimate the impacts that will occur if electric cooking is scaled up in each country, compared to continued use of current cooking appliances and fuels. Impacts include costs and changes in subsidies (to the consumer, to government and to other funders etc); health benefits; climate and other environmental impacts; reduction in use of non-renewable biomass; and reductions in time spent gathering fuel.

This requires (a) defining one or more scenarios for level of uptake of eCooking in the country and (b) methods to calculate associated impacts.

The World Health Organisation (WHO) released a revised version of their "Benefits of Action to Reduce Household Air Pollution" (BAR-HAP) tool in July 2021[1], as part of their Clean Household Energy Solutions Toolkit (CHEST). Initial testing suggested the BAR-HAP tool offers an excellent platform for the impact assessments needed. The tool was applied for the individual countries in the market assessments or GIZ.

The BAR-HAP tool includes databases of demographics, population health, current cooking methods and national energy systems for all low- and middle-income countries, and technical assumptions for all of the traditional cooking appliances and fuels and for clean cooking options including LPG and electricity. Electric cooking is given as a single option, without any detail on devices such as EPC. We have made some additions to the original tool with respect to electric cooking in particular.

The tool could be applied without any input from the teams undertaking the country assessments, if we adopted some generic scenario for scale-up of eCooking. However some of the data built-in to the tool may not be as detailed as MECS would wish, and/or may not represent the segments of a country's population that we are focused on. Many of the data are also from 2018, and where more recent evidence was available, this was used instead.

This note provides an overview of the BAR-HAP tool, and then describes how it has been used for the scale-up analysis. Key data specific to a country are given in the relevant country report, but this note provides an overview of the types of additional data added to the original tool.

2 Overview of BAR-HAP

The tool was developed by Dr. Marc Jeuland and Dr. Ipsita Das at Duke University, with support from various others. Quoting from WHO[1]: "BAR-HAP tool is a planning tool for assessing the costs and benefits of different interventions that aim to reduce cooking-related household air pollution. The tool includes 16 different cleaner cooking transitions from more polluting stoves and fuels to cleaner options, including both transitional options (that offer some health benefits) and clean options (that meet emissions levels in the WHO Guidelines for indoor air quality: household fuel combustion). For each cooking transition, users can also select a policy intervention that will be applied, such as stove or fuel subsidy, financing, intensive behavior change campaign, or a technology ban." Figure 1 illustrates the range of options at each stage.

The BAR-HAP tool is a static model and its treatment of changes over time is not sophisticated. Many parameters are fixed values: eg emission factors for grid electricity are single fixed values so you can't include a scenario for decarbonisation of electricity supply. But you can change the emission factors, so we can implement our own assumption for 2030 grid mix by country. It is not based on a life-cycle approach to impacts, but focused on the

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1 https://www.who.int/tools/benefits-of-action-to-reduce-household-air-pollution-tool

effects of the emissions associated with direct combustion of the fuel for cooking or for generation of the electricity used.

The tool does not attempt to report how things change over time for a scenario: a transition is effected by choosing from a defined set of policy measures, and there are in-built (but adjustable) factors that define the uptake rates depending on the policy. You can specify the number of years over which a transition takes place, and some values for initial setup delays, but the actual uptake of clean cooking per year as the policy measure takes hold is not shown. The results are in terms of total present value over the full period, or impact per year for just one year. It is not possible to define a specific uptake level for eCook by, say 2030, but we will be able to do trial-and-error tinkering with the policy drivers until we get the sort of uptake level we want for our scale-up scenario.

The tool is implemented in a large spreadsheet, with clear instructions and suggested workflow. Default values are included for all parameters, many of them country-specific, but most can also be adjusted. A journal paper is available that describes the tool in detail, although this is the original version, not the July 2021 update[2]. The models calculating the different impacts are mostly replicated from those described in an earlier publication from some of the same team[3]. A user manual is available, alongside the spreadsheet tool[4].

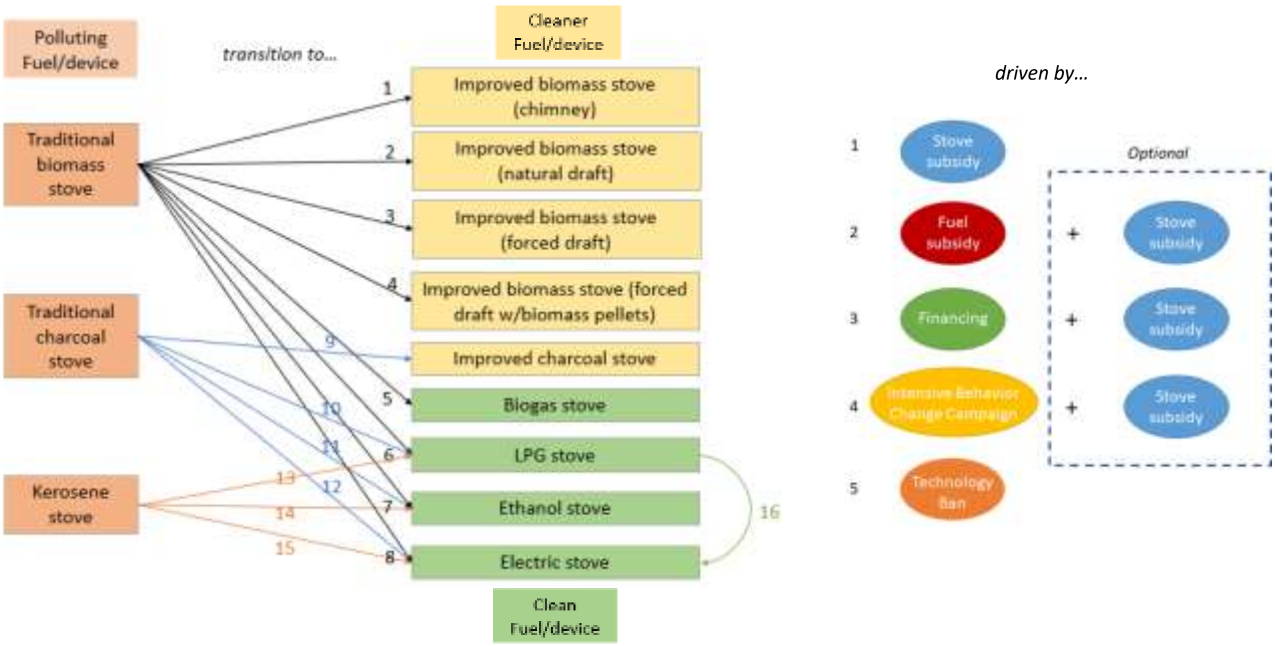

Figure 1 BAR-HAP tool schematic
Source: Adapted from WHO (2021)

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[2] Das I, Lewis JJ, Ludolph R, Bertram M, Adair-Rohani H, JeulandM (2021) The benefits of action to reduce household air pollution (BARHAP) model: A new decision support tool. PLoS ONE 16(1): e0245729. https://doi.org/10.1371/journal.pone.0245729

[3] Jeuland M, Soo JS, Shindell D. The need for policies to reduce the costs of cleaner cooking in low income settings: Implications from systematic analysis of costs and benefits. Energy policy. 2018 Oct. 1;121:275–85. https://doi.org/10.1016/j.enpol.2018.06.031

[4] WHO (2021). Benefits of Action to Reduce Household Air Pollution (BAR-HAP) Tool. Version 2. Geneva, World Health Organization. https://www.who.int/publications/m/item/manual-for-benefits-of-action-to-reduce-household-air-pollution-(bar-hap)-tool-(version-2-july-2021)

3 Assumptions and data needed for this analysis

3.1 Scenarios for scale-up

A scenario for scale-up in each country was chosen to represent just one important opportunity for electric cooking in the national context. The scenarios were all developed to be consistent with the broad MECS "40, 60 by 2030" objective[5]: 40% of all households connected to grid or off-grid electricity to be using it for cooking by 2030 and 60% of those utilising modern energy for cooking to be utilising energy generated from low carbon sources by 2030. However, since the scenarios are considering just selected segments of the cooking system, they do not capure the breadth of the above objectives.

3.2 Country-level data

The BAR-HAP Tool can be used without any additional country-specific data/information; however, the user has the option to amend the country-specific data/information. Since we are applying the tool to multiple countries, and in a relatively rapid timeframe, we retained many of the default values. Detail of the tool and all its data can be found in the links earlier to the tool itself, its manual and the article by its authors. Below are key parameters that were considered specifically for the country assessments, and for which updates to defaults were made in some cases to better reflect the local situation. The key assumptions for each country are given in the relevant national assessment reports.

Cooking time per day using traditional fuels: default is 2.6 hours.

The assumption is that transitioning households are fuel stacking, with 20% of cooking still delivered using the traditional fuel.

To be consistent with eCook taking over 80% of daily cooking for a household, the assumption is that a household gets some form of hotplate or induction hob, plus an electric pressure cooker.

The package of eCook devices are assumed to cost $80 and to have an average efficiency of 75% (MJ input to MJ useful heat output).

eCooking is assumed to save 30% of the typical cooking time per day (2.6 hours by default, as above).

The full costs of the new eCook devices have been assumed to be paid for by the Government, as a convenient simplification for this illustration.

Firewood collection time, hours/day. Default is 1 hour.

Percentage of users who pay for fuel. Defaults are Biomass 23%, charcoal 100%, kerosene 100%.

Fuel costs for all main fuels, Defaults are: biomass $0.05/kg, charcoal $0.25/kg, kerosene $0.89/kg.

National electricity generation mix now, and what is expected for 2030

[5] https://mecs.org.uk/global-challenge-calling-on-international-leaders-to-achieve-4060-by-2030-for-clean-cooking/

BAR-HAP does not use generation mix directly, but includes emission factors for all fuels, including electricity. The electricity emission factors are intended to be country-specific, but data are lacking for most countries, and very general averages are used. We made offline estimates of national emission factors based on evidence on the generation mix and how hat might change.

We did not make much use of the features in BAR-HAP that allow exploration of costs and benefits of effecting transitions using different policy types. For this study we adopted one simple common policy type to drive the transition for each of the countries: a ban on use of the relevant traditional fuel, which comes in gradually from 2020 to 2030. This is clearly not a realistic policy and is simply used here to effect the transition wanted for a scenario, and giving clarity about the impacts and where costs fall; it can be regarded as a proxy for other specific actions used to mobilise a major transition from a traditional fuel to eCooking. Other policy options that could have been modelled would see a different distribution of stove and fuel costs and savings between parties