Electrification and cooking: A case of mutual neglect?

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Loughborough University

ESMAP Energy Sector Management Assistance Program

UKaid from the British people

Abstract

This working paper addresses a puzzle regarding the electrification of cooking. While important advances have been made in the provision of clean cooking on the one hand, and there have been heightened efforts to increase rates of electrification throughout the world on the other, the two policy objectives are often not integrated, despite the overlapping health, environmental and economic benefits of doing so. Energy policy often overlooks electric cooking as part of broader electrification strategies and forecasts, while clean cooking advocates often omit electrification from their initiatives. This means significant progress in meeting cooking needs through electrification is being frustrated. Drawing on insights from practitioners and researchers and informed by a review of relevant academic and grey literature, here we explore how political economy analysis can shed light on this mutual neglect by providing an understanding of the ways in which power, politics and governance shape the current landscape of MECS (Modern Energy Cooking Services) provision and e-cooking in particular; but also how, reconfigured, they have the potential for disruption and change towards a pathway of greater electrification. Informed by the preceding analysis, we suggest some potential intervention points and levers for change moving forward.

List of abbreviations

CCA - Clean Cooking Alliance

ECCH- Efficient Clean Cooking and Heating

ESMAP - Energy Sector Management Assistance Program

FCDO - Foreign Commonwealth and Development Office

GIZ - Deutsche Gesellschaft für Internationale Zusammenarbeit (German Development Agency)

IEA - International Energy Agency

IRENA - International Renewable Energy Agency

LCCM - Levelised Cost for Cooking a Meal

LPG - Liquefied Petroleum Gas

MECS - Modern Energy Cooking Services

MLP - Multi-Level Perspective

PAYG - 'Pay-as-you-go'

PEA - Political Economy Analysis

PV - Photovoltaic

SE4ALL - Sustainable Energy for All

SEFA- Sustainable Energy Fund for Africa

SHS - Solar Home System

WHO - World Health Organization

Electrification and cooking: A case of mutual neglect

1 Introduction

There is nothing new about electric cooking. In 1893 the Chicago World Fair showcased a futuristic all-electric kitchen with an electric oven as the centrepiece. But it took a further thirty to forty years before electricity grids became sufficiently widespread and robust for the technology to be widely adopted. *Thermo-Electrical Cooking Made Easy*, the world's first book on how to cook electrically, was published in March 1907. The first mass use devices used resistive heating coils to heat iron hotplates on which the pans were placed. By the 1970s these started to be replaced by glass-ceramic tops.[1] The current need to move beyond using gas for cooking and heating as part of ambitious decarbonisation plans has brought renewed interest in electric cooking in the global North. But until recently in the global South, cooking transitions have been fragmented, siloed and set apart from discussions about broader transitions for modern energy services. Batchelor (2020: 4) quotes the IEA as stating that "If we are to witness the kind of progress expected on electricity, clean cooking must be placed on a par with electricity access on the policy agenda", or better still, explicitly integrated with that agenda. But thus far this has not happened, so why?

Until recently the idea of electric cooking powered by on-grid or off-grid renewable electricity looked like a fanciful proposition for reasons to do with cost, poor grid connectivity and ingrained cultural and social attachments to cooking with biomass, especially in rural areas and among older generations. A series of technical and economic shifts have radically changed that landscape, however. There is now a lot going for electric cooking, despite progress to date being modest. Leary et al. (forthcoming) show that battery-supported electric cooking can be cost competitive with current expenditures on cooking fuels and battery costs are coming down.[2] Energy storage, ICT-enabled payment systems, new business and service models from utility companies, as well as cost and efficiency improvements in manufacturing technologies, such as solar photovoltaics (solar PV), should make e-cooking more attractive. Batchelor (2013) claims that ongoing price reductions in solar photovoltaics (PV) and lithium ion batteries mean that a Solar Home System (SHS) appropriate for cooking (a solar-battery-eCook) could be developed with a monthly cost of $12, which puts it on a par with the expenditures of more than one billion people using more polluting cooking fuels. More recent research from Zubi et al. (2016) found that a SHS used alongside energy efficient appliances could cover the household power demand for LED lighting, a multicooker, mini-fridge and the charging of portable electronic devices. Furthermore, a detailed study from Lombardi et al. (2019) on e-cooking in Tanzania proved the cost-competitiveness of e-cooking, especially under a community-service model. The authors concluded that the range of 'Levelised Cost for Cooking a Meal' (LCCM) for e-cooking lies within $0.16 and $0.70 per meal (Lombardi et al. 2019). This is a range of cost comparable with all other cooking options, including firewood and charcoal when bought, and is far more cost-competitive than LPG.

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[1] The Association of Manufacturers of Domestic Appliances https://www.amdea.org.uk/industry-information/our-members-products/cooking-appliances/

[2] ESMAP (2019) predict that the falling cost of battery storage and PV, combined with optimised planning and implementation, will bring down typical tariffs by 55% by 2025.

Other work has shown that a battery-supported cooker (without the PV), even when connected to an unreliable or weak electricity grid, could enable affordable and reliable clean cooking (Leach & Oduro 2015). These technologies can be adapted to different energy needs and types of energy access such that Solar-battery-eCook works for regions where no grid infrastructure exists such as rural off-grid households, while the key market for grid-battery-eCook is those living at the fringes of the grid (Leary et al. forthcoming). A combination of improvements in efficiency of electric cooking appliances (especially Electric Pressure Cookers, worldwide sales of which totaled 8 million units in 2018 (ESMAP 2020)), improved clean cooking technologies and more responsive business models suggest 'there is a growing potential to enable modern energy-efficient electric cooking with grid and off-grid electricity, enhancing both reliability and access' (ESMAP 2020: xiii). Efforts to raise awareness about these innovations, their affordability and co-benefits are being led by actors like SE4ALL through their clean cooking data platform and co-benefits toolkits working alongside the World Health Organisation (WHO). Yet while considerable progress is being made in electricity access through grid extension, mini-grids and SHS (Ockwell & Bryne 2017), in many cases these are designed to only be able to deliver lower power end-uses (lighting, radio, mobile phone charging) and often overlook the role of cooking as a source of consistent demand for electricity, both now and in future energy forecasting and planning. As a recent World Bank report showed, while '2.8 billion people globally are still cooking with solid biomass, just 789 million are now without access to electricity. This implies that approximately 2 billion people now have access to some form of electricity, but continue to cook with biomass' (ESMAP 2020).

So what's holding back progress on the electrification of cooking?

Political economy analysis might not seem an obvious place to start when so many structural, financial and technical barriers seem to afford all the necessary explanations, from the cost of buying e-cooking equipment (when biomass is free, despite incurring human and environmental costs), and the corresponding lack of finance to make the purchase of a stove or cooker, to the unreliable supply of electricity through the grid (and its high cost in many contexts) and lack of grid connectivity in many parts of sub-Saharan Africa. Many studies focussed on improved cookstoves show income to be the most significant explanatory variable in accounting for the uptake of clean cooking (Jan 2012). Yet some research suggests that when economic barriers for households are removed through subsidies, novel financing models, new service models and gifts, cookstove adoption rates still do not appear to increase (Troncoso et al. 2007; Romieu et al. 2009; Lindgren 2020). A practitioner we spoke to for this research noted how in India and elsewhere, heavily subsidised and even free cookstoves did not incite sustained usage, suggesting at the very least that cost is only one barrier among many. One informant referred to this as 'gift bias', where when products are given to people for free they don't value them. Kar and Zerriffi (2018) highlight, moreover, the fragility of the entire clean cooking transition as adoption and sustained usage are impacted by both the seasonal shifts, which alter household demands on fuels and the viability of some e-cooking technologies, and the no-cost reversal to solid fuels such as firewood. To overcome this, Kar and Zerriffi argue that long-term monitoring should be the backbone of any clean cooking intervention in order to sustain usage, lock-in the climate and health gains and understand why the shift in cooking practices has taken place (2018). Towards this end, SE4ALL's clean cooking programme is attaching sensors to clean cooking devices to track and monitor clean cooking behaviour by trialling this on a World Bank project in Uganda, while those involved in the Clean Cooking Alliance have suggested having air quality sensors in homes to be able to quantify benefits. The MECS programme too has launched its Gold Standard for e-cooking and metered cooking appliances, which seeks to reduce monitoring requirements and transaction costs for initiatives using an approved methodology and accreditation system. However, sensors can only go so far in improving our understanding of what factors make cooking intervention successful, as they produce data on *what* is happening rather than *why* it is happening.

In this paper, we argue that political economy analysis can help inform analysis of issues of emulation, diffusion and scaling: why uptake has been more positive in some contexts (such as South Africa and Nepal) and not others (Uganda, Tanzania and Kenya) by looking at the political and social barriers to change and opportunities for realignment. E-cooking introduced competition between different providers of energy cooking services that seek to use their market and political power to protect their preferred energy pathway. Electricity competes with several other modern energy carriers that can be used for cooking, such as liquified petroleum gas (LPG), ethanol and biogas, upon which business models and infrastructures are based and livelihoods depend, both formally and informally, especially charcoal production and use in the case of the latter. We suggest below that work in the political economy of energy transitions on incumbency and regime resistance can shed light on the dynamics of resistance to e-cooking interventions and the mutual neglect between electrification and e-cooking.

Though governments and international institutions bear the primary responsibility for governing MECS, political economy analysis can also be applied to the private sphere: business supply chains, modes of governance, investment flows, innovation, business incubation and business interests (Ponte 2019). This is important because as ESMAP (2020: xiii) note, 'The uptake of eCooking will depend substantially on the willingness of the private sector— in particular solar companies, mini-grid operators and utilities—to adopt the technology as part of the suite of services it offers its customers'. Businesses and business foundations (such as the Shell Foundation) are playing important enabling roles in building and de-risking the necessary parts of the business model for e-cooking, from making finance available to consumers and businesses, to generating demand and organising the key parts of the supply chain.[3] As ESMAP's *Cooking with Electricity* report notes, 'Financial institutions also have an important role to play, as financing will be needed across the value chain to offset the high upfront costs of eCooking solutions' while 'End-users will require credit to allow them to pay for the high upfront cost of eCooking devices in affordable installments' (2020: xiii). Transitions require complex assemblages of actors, institutions and infrastructures that need to be governed and oriented towards specific societal goals: in this case clean energy access for cooking.

In transition terms, political economy analysis can shed light on landscape factors (the role of donors and MDBs in supporting (or not) the electrification of cooking), the persistence of dominant regimes for cooking by looking at incumbent power, as well as the scope for niche penetration by actors seeking to engineer a wider transition to electric cooking. Broader political economy accounts can also help us to understand the cultural practices and behaviours associated with dominant energy cultures and cooking practices as they are laden with uneven power relations and often heavily gendered.

Regarding the first contribution to understanding landscape actors, a growing number of global and regional institutions have mandates and programmes that address MECS in both direct and indirect ways, many of which overlap and intersect at different levels of governance. Since MECS is one service within modern energy provision, and depends on the infrastructure of modern energy and the diffusion of end-user technologies, there are many agencies aiming to improve access to modern energy and reduce energy poverty that are relevant to this inquiry. From SE4ALL to the World Bank and GEF, regional development banks (Sustainable Energy Fund for Africa (SEFA), for instance, at the African Development Bank (AfDB)) and institutions (African Union) through to IRENA, REN21, UN-Energy, GIZ and the IEA, many institutions are active in this space. Beyond the world of public institutions, a range of public-private partnerships, alliances (most prominently the Clean Cooking Alliance), initiatives and philanthropic foundations have also sprung up to address the clear health, gender, economic and

[3] https://shellfoundation.org/portfolio/

sustainability imperatives driving transitions in cooking. Together, these form a regime complex around (clean) cooking, which we examine in further detail below as it relates to e-cooking.

The siloed nature of the discussion about cooking has generated bespoke organisations, such as the Clean Cooking Alliance. However, it has also created division within each of many of the named institutions. For example, ESMAP (World Bank) differentiates between its ECCH (Efficient Clean Cooking and Heating) programme, which has now pivoted to the Clean Cooking Fund, and its work on off-grid and on -grid electrification. Even within a single organisation, there are dangers that the two departments are poorly coordinated and have fragmented work streams, frustrating efforts to scale up and integrate both electrification and e-cooking, ultimately entrenching the mutual neglect of these two agendas. This proliferation of actors raises a range of governance issues around bureaucratic turf-wars, battles over the same pools of resources, mandates and authority, coordination and coherence among the stakeholders and institutions active within this space. It also impacts upon issues as diverse as adoption, infrastructures, social and economic viability, standards and regulatory frameworks and supply chains - all of which play a vital role in the development and diffusion of new technologies. As one informant put it: 'The fact electrification and clean cooking are very siloed flows from donor siloes'.

In seeking to understand and engage with some of these dynamics, we argue that a political economy analysis can help to: (1) Provide an account of how and why MECS are addressed by these actors at the moment by mapping, analysing and explaining existing configurations of institutions, ideas, power and influence. In particular, it can help to explain whether and how they deal with the role of electrification in providing MECS and why the mutual neglect of electric cooking has occurred and (2) Explore the political pathways to their uptake and support that might be possible in future by exploring strategies for realising the potential of electrification for MECS through, for example, new funding streams, mandates, alliances and coalitions.

The research for this paper is based on a (i) a *literature review* of academic research and grey literature on the global and regional governance of energy systems and electrification; work on cooking transitions in general and electrifying cooking in particular (ii) *online interviews* with individuals in some of the key institutions active in this space including SE4ALL, the Clean Cooking Alliance, FCDO, the Shell foundation, the MECs programme and e-cooking manufacturers. These included people working on specific clean cooking and electrification programmes within international institutions, donors working for governments leading on electric cooking, business entrepreneurs and foundations and civil society organisations as well as other researchers on the MECs programme and academics that have studied clean cooking in Africa and Asia. These were identified by snowballing: following up references in existing academic and grey literature and recommendations from key informants. This multi-method approach was crucial to filling in gaps and understanding the power dynamics that are producing current outcomes, as well as understanding whether and how they might be changed to bring about a greater unification between the provision of MECS and electric cooking in particular. Though we have sought to draw on research and interviewed people working in other countries and regions of the world, the study does reflect the dominant focus of the MECS programme in Africa.

1.1 Cooking and electrification: The story so far

One of the goals of this transition is to increase the electrification of cooking using mainly solar powered batteries that can be used to power indoor stoves and hobs for cooking, but also including items such as electric pressure cookers and rice cookers. This is especially important for homes without access to the electricity grid or with unreliable access to electricity as it enables households to cook when they want to. Our analysis covers on and off-grid uses, which is particularly important in sub-Saharan Africa where grid connectivity remains low

in many areas and the number of people cooking with biomass has increased due to the lack of alternative solutions and population growth (IEA 2017; Zubi et al. 2020).

Key drivers of the transition to electric cooking include the need to address the general lack of success to date, the low uptake in some of the poorest regions and a failure to realise potential co-benefits (environmental, health, gender) in supporting access to sustainable energy. As Brown et al. note (2017: 106), despite the efforts of a number of international initiatives, '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'. Energy access and poverty alleviation are therefore key rationales as articulated in SDG7 and SE4ALL, embodied in the title of the conferences 'Pathways to Clean Cooking 2050: Leaving No-one Behind'.[4]

While progress is being made in places like India and Uganda, elsewhere levels of access are lower. If the goal is to displace biomass use, the solution is not just extending the grid or providing access to electrification as in some countries (such as Uganda) rates of access to electricity are comparably high, but charcoal use for cooking is still dominant. According to some estimates, only one percent of the Ugandan population have access to clean cooking options, while Tanzania's access rate is three percent and Ethiopia's is five percent, respectively (Byrne et al. 2020). Likewise in Kenya, there is surplus electricity created by the centralised grid, but access and consumption of clean cooking fuels falls below the global average at ten percent of the population, with Kenya ranking among the top 20 countries that are deficient in clean cooking sources (WHO 2016). Biomass fuels still constitute the largest share of primary energy consumption among households in Kenya, accounting for roughly 69% of the total primary energy consumption and more than 90% for rural households (Mbaka 2021).

1.2 The developmental case for e-cooking

Development benefits feature highly among proponents of clean cooking. The CCA states, 'By developing a thriving global market for cleaner, more modern stoves and fuels, we can change the way the world cooks and transform lives, protect the climate and the environment, empower women, and help millions of people around the world save time and money. Clean cooking can contribute to an enabling environment for achieving the entire Agenda 2030 and directly deliver across 10 of the 17 SDGs'.[5]

Employment benefits are one of the key development benefits of a move towards electric cooking, although this differs from context to context and depends on the clean cooking technology in question. One informant cited the political contestation that can arise when governments import technologies without considering the impacts on domestic employment, industry and cost. There are, however, still significant gaps in the available data on the employment benefits of e-cooking (Shirley et al. 2020). Brown et al (2017: 109) point to significant potential to manufacture stoves locally by building a valuable production base and, as a result, 'giving communities the opportunity to participate in the design and delivery of locally appropriate stoves; boosting the local economy; building capacity for after-sales service and creating local jobs'. However, the short-term and near-term employment benefits of electric cooking may not be significant and there are other sectors of the domestic economy that could deliver more local jobs faster than electric cooking. As a result, pursuing

[4] https://ccacoalition.org/en/event/pathways-clean-cooking-2050-leaving-no-one-behind

[5] https://www.cleancookingalliance.org/feature/delivering-on-the-sustainable-development-goals-through-clean-cooking.html

employment benefits as a sole end for electric cooking interventions may not be as successful as those prioritising health, gender and climate mitigation benefits.

There are also concerns among development practitioners and government officials that incumbent e-cooking technologies are usually assembled and imported, meaning that the proliferation of the technologies does little to promote domestic employment, stimulate and shape new markets and industries, or replace jobs that may be displaced by energy transitions. As developing economies look to bolster domestic industry, trade and industrial policy may be useful levers to support domestic e-cooking transitions and help bridge the mutual neglect between the electrification and e-cooking agendas. Moreover, when comparing employment in the off-grid solar and clean cooking sectors in Kenya, Shirley et al. (2020) argue that jobs in the clean cooking sector have a higher potential of reaching the poorest, as scaling up the industry requires a less skillful and more localised workforce, with training programmes focused on creating local masons and metalsmiths to boost the manufacture of stoves. Multiple informants stressed the point that e-cooking requires fewer supporting and complementary infrastructures, compared to LPG for instance, so there is potential to scale up the domestic industries at pace and at a relatively lower cost. However, in order to build coalitions of the 'willing and winning' behind e-cooking transitions, fostering the industrial capacity to manufacture and repair e-cooking technologies domestically, and the business models to supply them, appears to be vital, and is something we propose as key future intervention point, below.

The developmental case for e-cooking rests on a number of grounds. There are a range of social, health and environmental impacts associated with indoor cooking and the collection of fuel to service it which have been reviewed elsewhere. They include the fact that nearly 4 million premature deaths each year are attributable to the household air pollution caused by polluting stoves using solid fuels or kerosene, most of which are women and children (WHO, 2018), and that over half of all wood harvested worldwide is used as fuel, supplying ~9% of global primary energy (Bailis et al. 2017:1). According to the WHO, indoor air pollution is one of the largest environmental risk factors for female mortality and children due to the amount of time spent near the domestic cooking appliance (WHO 2018). For children under the age of five, exposure to indoor air pollution doubles the risk of developing childhood pneumonia and is responsible for 45% of pneumonia deaths in this age group (WHO 2018). In addition, indoor air pollution is the eighth-leading contributor to the overall global disease burden causing respiratory and cardiovascular damage, as well as tuberculosis and cancer (Forum of International Respiratory Societies 2017).

Environmentally, by depleting stocks of woody biomass, unsustainable harvesting can contribute to forest degradation, deforestation and climate change (Bailis et al. 2015: 266). Meanwhile, black carbon is the second most important factor in climate warming after carbon dioxide, and it is estimated that 20% of global emissions are from the incomplete combustion of biomass used in cooking (Batchelor 2020). In addition to these health and environmental benefits, a strong case can and should be made around the economic savings to be made by reducing health impacts and costs to under-resourced health systems. According to Kar et al. (2019), the millions of avoidable deaths caused by indoor air pollution each year results in a global welfare loss of roughly US$1.5 trillion.

Moreover, women and children can be disproportionately impacted economically and socially by continued use of biomass for cooking, as in some cases the burden for fuel procurement can fall on their shoulders. Collecting firewood is often framed as a laborious task that incurs temporal and economic burdens, such as preventing other productive or paid work for women and keeping children unenrolled in education as they are often expected to help (Lindgren 2020). In Kenya, Shirley et al. (2020) found that, on average, women spend around 58 hours a week collecting fuel and cooking with biomass. As one informant stressed, transitioning away from

biomass and charcoal to e-cooking can bring huge time-saving benefits. Moreover, when employed in the clean cooking sector, research suggests that women achieve higher levels of performance than their male counterparts, reporting higher rates of sales (Dutta 2018). Yet, other researchers have highlighted that the negative effects of collecting firewood are not the same in every country and community, emphasising the contextual aspects of cooking practices and warning against the creation of grand narratives for cooking transitions (Mazzone et al. 2021). In rural Mexico, for instance, Troncoso et al. found that 70% of the women they interviewed said that the responsibility of collecting firewood was that of the husband or the males within the household (2007). Through a socio-cultural lens, collecting firewood is often a vital and necessary part of local knowledge, farming practices and ethno-botanical knowledge; constituting a form of cultural heritage and cultural capital (Cardoso et al. 2012).

Beyond the economical impact is the physical one, with women and children more likely to incur physiological injuries from transporting large quantities of biomass (Matinga 2010). Women and children are also at higher risk of accidents and hazardous events such as burns, fires and explosions from cooking devices (WHO n.d). Some research also suggests that when women are expected to fulfill this domestic role they can face a higher risk of gendered violence from partners due to delayed or poorly prepared food, disagreements over cooking and heating expenditures (Guzmán et al. 2020). Through fieldwork in Uganda, the same study found a reduction in self-reported violence within households when they were provided with clean cookstoves (Guzmán et al. 2020). Methods of policy creation, implementation and assessment that seek to address the mutual neglect between electrification and e-cooking, as well as promoting the sustained usage of e-cooking technologies, must be cognisant of these contextual, cultural and place-based sensitivities.

As the main procurers and end-users of cooking fuels, women have been the primary target for research into clean cooking transitions. The results are largely positive in so far as women aspire to use clean fuels (Smith & Dutta 2011) and use clean fuels when they are free or near-free (Pillarisetti et al. 2019; Gould et al. 2018). However, these behavioural approaches in both research and practice have been widely criticised for using a perspective on behaviour change where desired behavioural outcomes are mostly dependent on individual efforts with supportive external factors or structures (Kar 2021). However, a growing evidence base suggests that affordability, decision-making autonomy, social acceptance, and physical access can pose significant barriers to a typical female cook in a low or middle income country, despite their individual intentions or preferences (Lewis & Pattanayak 2012; Lindgren 2020; Puzzolo et al. 2016; Miller & Mobarak 2013). Both Kar (2021) and Lindgren (2020) call for a shift in focus towards household level behaviour change and decision making, rather than framing the issue as a matter of individual agency and, in particular, the responsibility of women.

The emphasis on women in clean cooking interventions and research has all but removed men from the conversation around uptake and sustained use, despite their varying role within households across different locales and contexts. A study by Ochieng et al. (2021) found that men are highly aware of the barriers and challenges surrounding clean cooking due to their experience as children. While awareness does not always translate into action and adoption of clean cooking practices, men cite their childhood experiences as formative of their views of cooking, bolstering calls from Lindgren (2020) and others for a more active engagement with youth in cooking transitions. Ochieng et al. report that men who wield substantial power over the decision to acquire cleaner cookstoves view them as status symbols, unnecessary and unattainable, therefore limiting opportunities for scaled up household adoption (2021). This is a worrying trend when considering the fact that various other studies, across a diverse range of contexts, found that men had the decision making power when it came to the acquisition of cookstoves (Person et al. 2012; Thompson et al. 2018; Sesan et al. 2019). Ochieng et al. recommend that “programs should equally target men with clean cookstoves messaging, bundle

cookstoves with other products that men value, and take advantage of women's groups as a source of collective bargaining power for women in the acquisition of CCS [clean cook stoves]" (2021:1). This has an important implication for framing around the benefits of e-cooking which should avoid reproducing gender stereotypes and reinforcing gendered divisions of labour.

It is so far unclear whether these gender dynamics, distributional impacts and procedural aspects are reflected in the drive towards electrification, although initial research is beginning to show that household electrification, and the purchasing of electrical goods and products, can both reinforce gender dynamics and transform them in different contexts. Research from Winther et al. (2020) found that women generally had less decision making power than men over matters of electrification and household appliances in rural communities, although the extent of these power imbalances ranged from context to context. These findings partly counter the dominant perception in development policy that the provision of electricity will benefit all members of the household, but especially women due to the amount of time spent in the home (Winther et al. 2017). For clean cooking interventions thus far, these could amount to missed opportunities for the further empowerment of women - opportunities in which e-cooking interventions could be better tailor to recognise and target. Moreover, Winther et al. also found that subscriptions to electricity - grid, mini-grid and also custody of SHS - tended to be in the name of the owner of the house, who is normally a man, and men are often the primary bill payer, although there are instances of women servicing electricity payments even if they are not the ones registered as subscribers or owners (2020). However, the empirical base is currently too weak around these issues and large questions still remain over where the responsibility lies for signing up for grid access and the purchasing of e-cooking products, as well as the differences between rural and urban settings.

Gender relations and power dynamics in the realm of cooking transitions may also be changing in line with increasing urbanization. Ochieng et al. cite that in urban Africa, where women are more engaged in salaried employment, women of lower socio-economic status are fulfilling the cooking role and therefore directly experience the negative impacts of cooking with biomass, while having limited agency or power to make the decision to change to a cleaner cooking practice (2021). As mentioned above, while disparities in decision-making power over spending on clean cooking technologies pose a major barrier to widespread uptake and sustained use of clean cooking technologies, the added layer of complexity wrought by shifting gender norms, heterogeneous decision-making and intersectional power dynamics emphasises how substantial the challenge of scaling up e-cooking is in practice.

1.3 The uneven geographies and practices of cooking

When it comes to cooking and electrification, the differences between urban, peri-urban and rural settings present a unique challenge for steering and governing cooking transitions, suggesting the need for interventions that work across these spaces. Approximately 55% of humanity now live in urban settlements (UNFPA 2018). This is expected to rise to 60% of humanity in 2030 and by 2050 will be around 70%, respectively (UN 2014). In Sub-Saharan Africa, where the MECS programme has a significant focus, the average annual rate of urbanisation is around 4.1% but in some countries can be as high as 5.7% (World Bank n.d). Worryingly, analysis suggests that a 1% rise in urbanisation can increase charcoal consumption by up to 14% (Adam Smith International n.d). In light of this, e-cooking transitions are in a race against mass urbanisation. And, as one informant admitted, the vast majority of e-cooking technologies are being designed specifically to target urban markets, but in order to work at scale also need to meet the needs of rural populations.

Adding another layer of complexity, many of the urban settlements within developing countries are deemed 'informal', which are defined as residential housing built in both planned and unplanned areas that often lack formal planning approval. Informal settlements are characterised by low quality homes and a lack of adequate

infrastructures and social services, although they are by no means homogenous around the world (Nassar & Elsayed 2018). What's more, there have been consistent policy failures within informal urban settlements in recognising energy as a basic service (Singh et al. 2014). At the time of writing, over one billion people currently live in informal urban settlements, slightly less than one third of the global urban population and this number is growing by 500,000 a week (Njoroge et al. 2020). In Sub-Saharan Africa, around 59% of the urban population live in informal settlements (Njoroge et al. 2020) where energy poverty is ubiquitous (UN-Habitat/GENUS 2009). For instance, studies on informal settlements in Nairobi, Kenya, found that households were spending on average 26% of their monthly income on energy, with a maximum of 34% and a minimum of 15% (UN-Habitat/GENUS 2009). Energy poverty is said to exist when the percentage of monthly income spent on energy services is above 10%.[6]

The profligacy of informal settlements presents an array of challenges for electrification and e-cooking by extension. For instance, in urban informal settlements issues of energy access are dominant, yet illicit grid connection is also common where electricity is not metered or provided through a utility company. According to Njoroge et al. (2020), the primary driver for illegal grid connection in Nairobi, Kenya, is price point. However, the authors also note that resilience plays a role too, as households procure and stack a variety of fuels in order to hedge against market volatility and price hikes (Njoroge et al. 2020). Depuru et al. note that a lack of regular income is also a major barrier to formal grid connection, with many families opting to share meters with neighbours or turn to unlicensed electricians and local cartels to provide illegal grid access and energy services (2011). This form of illicit grid connection is believed to damage both the utility operators and households within informal settlements, as utilities experience substantial insolvency rates and households suffer from voltage outages caused by irregular load demands (Butera et al. 2019). Crucially, research suggests that illicit grid connection, which provides virtually free connection, induces inefficient usage habits and waste (Butera et al. 2019). Koepke et al.'s (2021) work in Dar es Salaam, Tanzania, highlights the need for stakeholders to better understand the heterogeneity of urban infrastructures and energy transitions. As the fastest growing urban region in East Africa, Dar es Salaam illustrates how patterns of urban growth and electricity provision co-evolve. As a result of splintered patterns of physical grid coverage, the unreliable provision of electricity services and unaffordable tariffs, a heterogeneous socio-technical alternative has emerged, combining individual off-grid installations, specific landlord-tenant arrangements and illegal network extensions (Koepke et al. 2021:2). The experience of energy transition in Dar es Salaam shows how official, top-down urban energy policies "focus primarily on incrementally catching up with ideals of a uniform and universal electricity grid, yet efforts to do so tend to disregard the complex interplay with service co-provision beyond or complementary to the conventional grid" (Koepke et al. 2021:2). E-cooking transitions must, therefore, actively engage with the heterogeneity of urban electricity systems, both in terms of its spatialities and its socio-technical regimes, to enable a supportive policy environment for both uptake and sustained use. The potential for utilities and private businesses to provide a suite of clean technologies, as part of a 'clean stack', could help meet cooking needs within heterogeneous urban infrastructures, as would the introduction of new service and financing models to overcome barriers such as regular income being a prerequisite for formal grid connection. We discuss these potential pathways in more detail below.

This research suggests that despite the clear rural and urban split in electrification terms, as well as the heterogeneity of urban electricity systems, many of the barriers and obstacles to e-cooking uptake and usage can be found in both settings. It also underscores the need for e-cooking transitions to engage more directly

[6] https://ec.europa.eu/energy/eu-buildings-factsheets-topics-tree/energy-poverty_en

with the specific state of electrification in certain cases, and how interventions must be cognisant of these contextual supply-side considerations in order to maximise the potential of success. For instance, in an urban setting with grid connection and excess generation capacity, like Kenya, e-cooking interventions should put the onus on the diffusion of e-cooking technologies and services to stimulate demand for the surplus electricity and maintain usage. In an urban setting with weak grid connectivity accustomed to load shedding, e-cooking interventions would need to put the onus on household battery storage to mitigate load shedding and fuel stacking with biomass (ESMAP 2020). Household battery storage may also be prioritised in e-cooking interventions in rural settings to alleviate peak loading constraints on micro and mini-grids and ensure sustained usage of e-cooking technologies (ESMAP 2020). As these examples emphasise, bridging the mutual neglect between e-cooking and electrification agendas could streamline e-cooking interventions and accelerate uptake.

Indeed, the e-cooking transition may never be total as households often combine fuel and energy sources to meet different and evolving needs. This relates to the phenomena of energy or fuel stacking: the parallel use of multiple fuels for various purposes such as cooking, lighting and heating, according to factors such as availability, cost and even perceived differences in taste - although this is more common among older generations of end users (Bhojvaid et al. 2014). Research has found that even in cases where a supply of clean energy has been attained, households continue to use other fuels to meet some of their needs (Quinn et al. 2018).

The phenomenon of fuel stacking has led to calls for a greater focus on practices, behaviours and stakeholder engagement around cooking in an effort to better understand the specific contexts in which cooking takes place, which varies greatly from location to location (Cundale et al. 2017). Yet as Iessa et al. (2017) note, these contextuals factors, like culture, personal choice and tradition, are often framed as barriers to the uptake and sustained use of clean cooking technologies, rather than an evidence-base to shape policy design, determine business and service models and bolster adoption strategies (see also Lingren 2020). Looking at the use of firewood for cooking, Mazzone et al. argue that the majority of existing studies on culture and fuel use for cooking tend to conceptualise local cultures as “homogenous, predictable and static” (2021:2), thereby omitting the dynamic contextual aspects that determine cooking outcomes. This predilection towards viewing all local cultures as homogenous limits the potential effectiveness of both electrification and e-cooking interventions and highlights the need for novel approaches and initiatives to address the mutual neglect. In response to this, MECS launched their Modern Eating (ME) workstream in 2019 to explore how urban diets and cooking habits are changing, and the energy implications of these changes (MECS 2020). By exploring a dynamic range of foods, embedded cultures and habitual cooking practices - both old and new - it is possible to gain an understanding of how these shifts and changes may impact the displacement and adoption of certain cooking fuels. As one informant stressed, many of the private business stakeholders targeting the e-cooking sector are looking to create a ‘clean stack’ of fuels, whereby companies offer a suite of clean cooking technologies and services to fulfill a range of end user needs and dietary preferences, at a variety of price points. By providing a suite of clean technologies, these stakeholders are not looking to prevent fuel stacking through the penetration of one single technology that may negate the contextual factors of cooking, but rather to meet the dynamism and fungibility of fuel stacking practices through clean technologies. We turn our attention to the potential of the clean stack in regards to bridging the mutual neglect in section 5.

On one level, the challenge facing the electrification of cooking is a generic and daunting one that involves a range of governance actors. On another level, efforts need to be focussed in a relatively small number of countries. Around 80% of the 3 billion people without access to clean cooking live in just 20 countries.[7] In

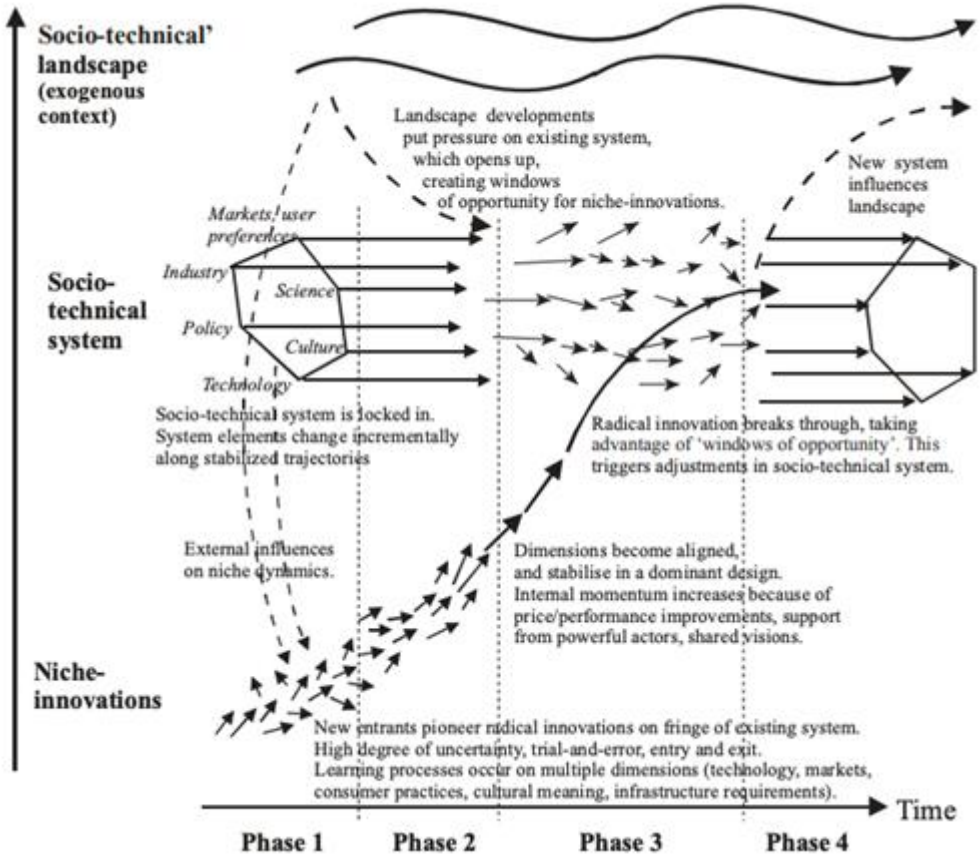
[7] http://energyaccessplatform.org/index.php/focus-areas/clean-cooking

addition to the broader political economy account we provide here, understanding and engaging with the political economy of those countries, therefore, becomes important to assessing the prospects of a transition towards the electrification of cooking.

2 The political economies of MECS

What is political economy analysis and how can it help to understand the dynamics of electric cooking? There are many traditions of political economy which date back to key contributions from Smith, Marx, Ricardo, Mill and many others. Essentially, it centres on questions of distribution (who wins, who loses?) and procedure (how and why?). This requires an account of power, politics and governance: in this context, the politics of technology, finance and decision-making that shape outcomes around electrification and cooking, as well as questions of political ecology pertaining to climate change mitigation (Sovacool 2021). Narrower political economy analysis (PEA) aims to understand and identify the barriers to change and opportunities for reform, while deeper political economy accounts focus on power relations and the nature of incumbency (Newell 2021). In more economistic accounts, PEA can be reduced to a proxy for understanding why the most 'rational' and 'cost-effective' paths are not taken (Barnett & McCulloch 2019). It is borne from a frustration that politics often gets in the way of the 'smooth' operation of the market.

Our approach here is different. We seek to bring an understanding of power, politics and governance into the discussion about the relationship between programmes targeting electrification on the one hand and cooking on the other. This builds on a growing body of work on the politics, governance and political economy of energy transitions (Baker et al. 2014; Power et al. 2016; Lockwood 2015; Newell 2021; Sovacool 2021). Our entry point is to look at the political 'landscape' in terms of the Multi-Level Perspective (MLP) (Geels 2002) and the ways in which it interacts with, supports and frustrates niche developments around electric cooking. MLP lends itself to this (see figure 1).



Source: Reproduced from Geels et al. (2017)

Here the use of electrification for modern energy cooking is seen as a *niche* intervention competing with dominant *regimes* around cooking with international organisations, financial institutions and donors operating as *landscape* actors that can create openings for disruptive and accelerated change by applying pressure to - and ultimately disrupting - the incumbent regime. This requires a political economy account that can traverse these sites linking macro landscape trends with small-scale and rooted innovations and niches in disparate locations and varied contexts, often far removed from the political centres of gravity. This is perhaps a classic case of multi-level governance: trying to govern from local to global across states, regional, national and global bodies. A successful e-cooking transition will require shifts in culture and practice, in financing and business models, in models of innovation and service, as well as in the regulatory and policy environment. How these socio-technical, and we would add political elements, combine is a key focus of transitions research.

But political economy analysis is useful for understanding many of the key dimensions that are essential to the electrification of cooking beyond governing, including financing and production, technological innovation, access, ownership, geo-political considerations pertaining to energy security, questions of social acceptance and behaviour change, as well as knowledge creation and policy making. It addresses the peculiar political economy of both energy in general and cooking in particular, where there is scope for more cultural political economy analysis which draws attention to norms, behaviours, practices and the production of desire and aspiration. This approach understands processes of lock-in (Unruh 2000) not just as technological or socio-technical phenomena, but also looks as tensions between competing pathways as intrinsically political (Scoones et al. 2015) because of the stakeholder interests in question and the uneven distribution of losses and gains generated

from divergent pathways. It helps to understand pathways taken and not taken - those opened up and closed down - as well as the systematic forces that make it difficult to change the pathway of existing techno-institutional systems (Unruh 2000). For example, LPG advocates make the case for it serving as a 'transition fuel' between biomass and electrification, but its roll-out requires large new infrastructures and significant investment, whereas electricity wires have already been laid in many cases allowing 'leap-frogging' straight to electrification for many low and middle income households, while issues of fuel stacking, social acceptance and ownership can impact the efficacy and longevity of particular pathways for certain groups. In sum, therefore, a political economy can provide both a rich source of explanations for the ongoing mutual neglect between e-cooking and electrification and suggest ways forward by highlighting barriers to change that can be removed.

3 Landscapes of power: Governance from above

Our first entry point in terms of understanding the political economy of the e-cooking transition is to look at the political 'landscape' in MLP terms and the ways in which it interacts with, supports and frustrates niche developments around the electrification of cooking. As noted above, in MLP terms clean cooking can be seen as a niche intervention competing with dominant regimes and international organisations operating as landscape actors that can create openings for disruptive change. In particular, there is an emerging 'regime complex' around electrification as a subset of a broader global regime complex around energy (Colgan et al. 2011). This helps to understand the distribution and exercise of power between institutions: how and why issues such as cooking are screened in and out of debates and some aspects of the nexus between energy poverty-security/development and sustainability garner more attention than others (Falkner 2014), where often the latter gets neglected. This means that understanding power imbalances between institutions is vitally important for exposing this mutual neglect and closing the existing gap. A 'regime complex' helps to describe the relations between actors and institutions in a way which provides the basis of an account of who wields power over what, where spheres of influence and power overlap and what the consequences are for both broader electrification strategies and the electrification of cooking in particular. This type of analysis, therefore, helps to shed light on alternative intervention points for electrification strategies and e-cooking initiatives by extension.

Such an understanding can be derived from a growing body of work on the global governance of energy (Florini & Sovacool 2009; Van de Graaf 2013), including energy poverty (Bazilian et al. 2014) and a smaller body of scholarship looking at the global governance of energy transitions (Bradshaw et al. 2019) which we draw on to make sense of these developments. Such an approach goes beyond attention to the importance of local institutions (Ortiz et al. 2012) which might be thought to be a more obvious point of departure for analysing cooking and helps to address the neglect of the global governance of energy poverty noted by Bazilian et al. which, as they suggest, is significant 'in view of the sheer scale of energy service deprivation – billions of people still lack access to modern energy services with consequences for economic development, health, education, environment, and gender equality' (Bazilian et al. 2014: 217).

To reiterate, this is a classic case of multi-level governance: trying to govern from local to global across states, regional, national and global bodies. Across these levels, nested and transgovernmental networks often operate with transition brokers and intermediaries working across scales through these initiatives, exercising uneven power and influence over outcomes with respect to the electrification of cooking (Sovacool et al. 2020). For example, there are more than forty-six dedicated transnational multi-stakeholder partnerships on sustainable energy. These seek to enable knowledge dissemination and technology transfer, building of institutional capacity and training, and technical implementation and innovation with some seeking to create new energy infrastructures on the ground (Szulecki et al. 2011), though few address e-cooking explicitly.

There are a range of different global actors and agencies that have a role to play and exercise influence in governing MECS. They include MDBs (World Bank, ESMAP, SE4All, IEA, WHO, UNEP, UNDP, GEF), donors (FCDO, GIZ, USAID etc), bilaterals and partnerships (Energising Development Programme (EnDEV), SNV, BFZ, and the Africa-EU Renewable Energy Cooperation Programme (RECP), Africa-European Union Energy Partnership), private actors (financiers, philanthropic organisations, offset providers doing cook stoves such as Climate Care and the Shell Foundation), and NGOs such as Clean Cooking Alliance, Climate and Clean Air Coalition and Practical Action. Key governance functions of these actors include coordination of interventions, building markets and innovation networks and mobilising finance for e-cooking.

The connection to electrification certainly broadens the range of actors that are involved in governance of this space. As Batchelor notes, 'When action on the enduring problem of biomass cooking was considered as its own 'cooking sector problem', actors could focus on a relatively limited number of key constraints – the charcoal industry, deforestation, air pollution, labour constraints, gender inequities. While these are all important constraints they tend to focus at the household or land ownership level' (2020:10). Once it also becomes a problem of electrification the range of actors and interests broaden and the level of politicisation intensifies in the space where the political economies of clean cooking and electrification encounter one another. There are broader sets of literature on electrification, often related to power sector reform (Tellam 2000; Dubash et al. 2018) which shed light on the dynamics of donor-recipient relations around reform of the energy system. This helps to understand the observed disconnect that prevails between donors and civil society organisations (such as Practical Action) and alliances (such as the Clean Cooking Alliance) working on clean cooking and improved cookstoves and actors such as the World Bank driving power sector reform programmes where incentives to disperse large sums of money for infrastructural projects such as roads and dams are at times in tension with support to the dispersed diffusion of a micro-technology such as e-cooking stoves.

In this regard, informants working at this level told us that the lack of integration to date is a function of cooking and electrification being on 'divergent' tracks, with the latter progressing much faster than the former. There has been a dearth of financing for clean cooking, whereas there has been much more momentum around electrification. The stakeholders in each sector are also very different. With electrification, there are fewer key actors but they are located in Ministries of Power or Energy, for example, which historically wield more political influence, whereas with cooking there are a multitude of actors, spread over a range of different institutions and offices and a lack of coordination between them. It matters, therefore, where within the state Clean Cooking Units and e-cooking champions are located to avoid them being seen as marginal to the work of ministries of Power and Energy, for example.

It is also the case that the e-cooking sector is at a more embryonic stage of development and so it is to be expected that, as a coherent set of actors and interest groups, it enjoys less institutional embeddedness and visibility in energy policy and planning discussions than other actors with a clear stake in gaining market access or preserving market share for existing energy technologies and their associated pathways. Due to e-cooking still being considered a niche intervention within the socio-technical system, there is growing potential to cultivate and maintain transition intermediaries to help connect the diverse groups of actors involved in cooking transitions and overcome some of the barriers currently slowing down the uptake and sustained usage of e-cooking technologies (Sovacool et al. 2020).

The clean cooking sector is characterised as 'fragmented and dispersed', in part because it cuts across many departments (health, environment, gender, energy etc). One of the roles of initiatives such as SE4ALL, therefore, is to 'build bridges' between them by, for example, building a common tool and platform for cooking and electrification. Other informants expressed a concern that, as one donor put it, e-cooking 'falls between the

cracks'. It is often seen as a local environmental, health, gender or climate issue, whereas in reality it is all of those things. There have been attempts to improve coordination between actors, but with limited results to date. One observer noted that efforts along these lines between, for example, the World Bank, Clean Cooking Alliance and SE4ALL are very 'scattered' and a lot of confusion remains regarding who is doing what, when and where. There have been meetings between ESMAP, EnDev, GIZ, SE4ALL and others where it has been agreed to coordinate activities, with all actors willing to collaborate, but then nothing has happened to overcome the mutual neglect.

It has been suggested that the World Bank would like to be the coordinator, but they have an interest in this and it needs to be someone 'neutral'. Moreover, informants cited the fact that their organisation's new CEO was very passionate about cleaner cooking technologies, and that this heightened interest would be reflected in their new organisational strategy going forward. While this is a promising development for e-cooking as a sector, as it shows that institutional lock-in can be overcome, it also highlights that changes in leadership could just as well be to the detriment of e-cooking technologies if there is not a long-term, collaborative strategy in place to build capacity in the sector. Garnering a deeper understanding of how these organisations engage with e-cooking as a niche intervention, and how these organisations interact with one another, is crucial for informing interventions which seek to address the mutual neglect between electrification and clean cooking. Since each of these actors - EnDev, ESMAP, CCA, SE4ALL - compete with one another for resources from the same pool, this leads to fragmentation and ultimately creates parallel pathways, strategies and initiatives that actors pursue to further e-cooking, creating distinct silos and workstreams. Again, it is clear that identifying and supporting transition intermediaries within the e-cooking space could help facilitate more collaborative relationships between actors in order to overcome the siloed and fragmented nature of the e-cooking sector.

Previous experience of MDB support to programmes, like Lighting Africa (with the support of the IFC), can provide useful insights about the challenges of making and regulating markets on a large scale with such a diversity of producers and consumers and where informal economies often dominate. MECS is sometimes described tellingly as the 'LED for cooking'. Some of the similarity lies in the market liberal and market enabling vision adopted by institutions such as the World Bank and the Power Africa initiative. Some actors have an explicit aim of market building. The CCA for example has a CIC- Clean Cooking Industry Catalyst with venture catalyst, market catalyst and demand catalyst elements and an 'Industry Acceleration Programme'. The Shell Foundation also invests in a range of activities that could be supportive of e-cooking including financing platforms (such as Nithio and M-Kopa) seeking to unlock scalable investment in the off-grid solar sector and beyond with "precision financing" to match commercial sources of capital to the customers with high ability to pay as well as providing direct grant support. But they also provide direct support to manufacturers (such as Orb), to sell, install and export its own range of solar PV panels, rooftop solar systems and solar water heating systems in India, Kenya and elsewhere in Africa. This includes investments in clean cookstove businesses such as Envirofit that designs, produces and markets affordable stoves designed to address customer needs in Africa and Asia. On the monitoring and metering side of things, the foundation supports SparkMeter provides high-quality, affordable smart metering solutions to mini-grid and central grid operators in developing rural markets around the world.

As well as direct support to industry, key donor roles are data collection, monitoring of e-cooking benefits which is seen as a prerequisite to what was referred to as the 'monetisation of the impacts of clean cooking' as part of results-based financing: commodifying a range of carbon and health benefits, for example, that can then qualify for funding from carbon trading and offsets. Building the business model means adopting what one informant called a 'total market approach to electricity access' with alignment of the models and incentives for businesses to deliver e-cooking. This would be an 'end-to-end' model: technology,

finance, demand and preferences. There is a huge market opportunity here when 2.1 billion people have some level of access to electricity but still use dirty fuels (ESMAP 2020), so the question, as one clean cooking practitioner put it, is 'Why are investors not chomping at the bit?'

3.1 Where global meets national

The issue is not just top down pressure and support from global institutions, however. Cultures of energy planning (centralised grid mentality) at national level coincide with and reinforce donor preferences and lender incentives to support big energy infrastructures over decentralised and often smaller household transitions. One informant put this bluntly, stating that "big isn't always better" in terms of uptake and sustained use of cleaner technologies, but big projects attract funding, press and popular support. What's more, many centralised energy planning initiatives at the state level fail to consider e-cooking as a long-term source of electricity demand, thereby locking-out e-cooking and other complementary technologies and services from future energy scenarios. One source expanded on this point, citing the fact that governments and particular ministries often have preferences for specific cooking technologies which often reflect the dynamics of incumbency as well as legacies of donor-recipient relations. Again, it is clear that the specific mitigation and technology pathways chosen within broader cooking transitions are intrinsically political and rarely reflect a 'rational' assessment of the costs and benefits of different pathways, despite claims to the contrary.

From a political economy perspective, there are key issues around how much 'policy autonomy' or 'developmental space' countries exercise to chart their own electrification strategies, as opposed to negotiating these with donors willing to finance them. Through the MECS programme itself, the UK government is a key actor and perhaps the principal advocate of e-cooking. One donor described the Foreign and Commonwealth Development Office (FCDO) as being 'out on a limb' in this sense, with other donors watching and waiting to determine whether they would back e-cooking depending on the results it manages to achieve. Far from being a hands-off developmental intervention, the Programme 'works closely with the private and third sector to develop business models and financing methods that will help get electric and gas cooking appliances into the market' (Byrne et al. 2020a: 14). The World Bank is very active too and has a long history of working in countries like Kenya on energy reform programmes (Newell & Phillips 2016). The World Bank has extended a credit facility of USD 150 million to enable marginalised communities in Kenya to access modern energy services through off-grid solar. Funding is being channelled through the Kenya Off-Grid Solar Access Project (KOSAP) (Byrne 2020). Other donors such as GIZ are financing businesses by providing financial inducements for companies in solar, cookstoves, mini-grids, street lighting, biogas and grid connection to set up businesses in 25 off-grid areas, though as noted, clean cooking and electrification agendas are often not fully integrated.

Policy autonomy is also an issue, however, in relation to the broader pressures from international trade and investment bodies such as the World Trade Organisation (WTO) (Gallagher 2005): to pursue particular trade and industrial policies where governments might want to adopt policies for infant industry protection, subsidies, looser Intellectual Property protection, VAT exemptions and the like to support the growth of niche sectors like e-cooking. This has been a site of controversy in Kenya with the implementation of more protectionist import policies, such as the government's recent move to introduce 14% VAT on off-grid solar products. VAT was introduced on off-grid solar equipment and accessories and is 'expected to negatively affect efforts to extend energy access in off-grid areas', possibly 'stifling' efforts to 'stimulate adoption of e-cooking appliances in solar-powered mini-grids, micro-grids and solar home systems' (Byrne 2020:30). One informant referred more generally to these trade pressures in light of concerns over lock-in (Unruh 2000), pointing to the fact that certain aid donors often favour specific technologies, infrastructures and fuel types where their domestic economy has

a competitive advantage and, therefore, an economic interest in furthering their reach and opening up new frontier markets, such as in the production of LPG or photovoltaics.

As discussed below in section 5 on future intervention points, what flows from this analysis is firstly, the need for greater coherence and orchestration of activities between donors and global governance institutions active in this space including greater efforts to integrate policy objectives around cooking and electrification to prevent the further entrenchment of silos. Secondly, addressing this element of policy economy suggests the need to actively bolster with analysis, financial support and access to international policy networks those actors, ministries and policy networks within the state seeking to advance the e-cooking agenda where currently they are clearly isolated and marginalised. Donors themselves might play an important convening role in building communities of practice among policymakers in different countries faced with common challenges in trying to advance this agenda.

4 The multiple political economies of MECS: Regimes of resistance

In this section we seek to explain the mutual neglect of clean cooking and electrification with a particular focus on the role of the state. The notion of a regime in the literature on socio-technical transitions cannot be reduced to the state, but the state nevertheless serves as the centre of gravity and key site of power over the contestation and decision-making over energy futures. There is increasing attention to the role of the state in general (Johnstone & Newell 2018) and different aspects of state power and policy making processes for the nature and course of (energy) transitions. This includes work on interests, institutions, coalitions and policy networks, elites and intermediaries (Kuzemko et al. 2016; Sovacool & Brisbois 2019; Sovacool et al. 2020). Here we highlight a series of dimensions that help to understand how the interface between electrification and cooking is governed and ungoverned (neglected), which is in itself an exercise of power (a choice *not* to do things differently) (Phillips & Newell 2013).

4.1 States of electrification

Firstly, it is worth noting the political and symbolic importance of electrification to state power (Gore 2017) in a literal and symbolic sense. Access to electricity is seen as a signifier of development progress and of course provides a gateway to meeting a range of social and economic needs, as per the energy ladder hypothesis. It is often a key issue at election times and controversies over load shedding, outages and blackouts create crises of credibility and legitimacy for governing actors expected to 'keep the lights on' for both consumers and industry. As noted above, it is often the focus of lending programmes for infrastructure. But such programmes are not neutral with respect to how, by whom and for what the electricity is provided. It often comes with an assumed critique of the efficiency of state owned utilities and power companies and the need for 'unbundling' of generation and transmission functions for example, and with demands to open up the power sector to private investment and foreign capital. It intersects with 'electric capitalism' (McDonald 2019) and broader politics of power sector reform (Dubash et al. 2018; Newell & Phillips 2016) that political economy scholars have highlighted. There is also a political economy of who gets access to the grid and on whose terms, where there are often ethnic and regional dimensions to access based on which regions vote for the ruling party (Pueyo 2018). As one informant put it, 'politicians get votes for electrification but not for clean cooking'. However, in many Latin American countries, governments have directly distributed ICS and used this intervention to further their electoral appeal (Banerjee & Schelly 2018). Efforts to scale up e-cooking will have to navigate these

dynamics, which are clearly country-specific, and ensure that the poorest and most marginalised groups benefit from electrification for cooking.

Secondly, we need to look within the state for clues about the origins of the mutual neglect between cooking and electrification. Political scientists often analyse *bureaucratic turf-wars* captured in Allison's famous phrase that 'where you stand depends on where you sit' (Allison 1971): in other words, positions on policies (and pathways) often reflect which part of government you represent, the different mandates they have and the constituencies they purport to serve. From this perspective, the lack of integration of mandates and fragmented work streams *within* the same organisation would be unsurprising, creating as it does policy silos. One practitioner told us e-cooking requires 'national level champions' for clean cooking that have been missing to date, where responsibility has instead been spread across government ministries and civil society organisations. For example, in the case of Ghana, it has been observed: "You have one arm of government or ministry promoting a green agenda and the other doing something that contradicts it. Ghana signed up to the Sustainable Energy for All initiative and our president chaired a session in the UN on sustainable energy, but we are talking about coal. So there is a disconnection between various government agencies leading on policies on energy and environmental sustainability."[8] We suggest below, however, that such champions will only be effective if they have support and buy-in to e-cooking across government. Otherwise, the silos persist.

There are also tensions between utility providers and price regulators. For instance, in the case of the Kenya Power and Lighting Company (KPLC) and the Energy and Petroleum Regulatory Authority (EPRA), where KPLC insisted that it was unfeasible to provide lower electricity tariffs for those communities living in urban informal settlements, but the EPRA maintained that it was in fact possible to provide lower prices (Njoroge et al. 2020). As Njoroge et al. (2020:9) note, this "lack of consensus between the two key actors in the energy sector hinders collaborative efforts towards enhancing the transition to clean energy in informal settlements", as communities are only willing to get legal connections if the cost of connection and monthly bills were affordable. What's more, the perceived lack of consensus between key electrification stakeholders propagates a general mistrust amongst the public towards government actors and utility providers that they would act in the interest of communities. In turn, this could undermine the legitimacy of the e-cooking initiatives of utility companies or state-led actors, slow-down the diffusion of new technologies, or even prevent the sustained use of e-cooking technologies when made available. While navigating tensions between emergent niche technologies and established regimes is a central theme within transitions research, scholarship exploring these tensions within the e-cooking space is limited.

Such bureaucratic tussles are significant not only in terms of who wields power and sets the terms of transition at the national level, but because they have tangible material impacts on the livelihoods of the poor. An example of where bureaucratic politics have concrete (gendered) impacts is provided by Batchelor who suggests (2020: 17) 'one of the reasons that there has been so little investment in the enduring problem of cooking with biomass, is that it is a women's issue. The national planning of energy access falls under the Ministry of Energy or the equivalent, while the issues of gender equality and the well being of women (may) fall under a Ministry responsible for "Gender and Women's Affairs" such that 'the technical infrastructure of energy access is often discussed and planned without due consideration of gender issues.' This reiterates the need to work across government in future e-cooking interventions as well as challenge the gender biases in dominant energy policy strategies.

[8] A senior officer at KITE quoted by Bawakyillenuo.

Bureaucracies also have different cultures which might make them more or less open or resistant to the e-cooking model. There is also an important knowledge politics at play around modelling, assumptions about load profiles, training of energy planners and engineers where the focus is on feeding a centralised national grid which means the role of cooking is often overlooked and not integrated into broader electrification strategies. This helps to explain the systematic neglect and the un-politics of cooking. What's more, and as mentioned above, bureaucracies may have favoured technologies or utility partners that reflect the dynamics of incumbency and legacies of donor-recipient relations that ultimately determines the electrification or cooking pathway(s) taken, while actively excluding alternative pathways. Unravelling (and exposing) the preferences around favoured incumbent technologies and the inertia of energy planning at government level will be essential for stimulating e-cooking transitions.

4.2 Political economy of incumbency

Though bureaucratic politics are important in accounting for mutual neglect between electrification and clean cooking agendas, ministries do not operate in isolation and are often situated within broader relations of power which shape outcomes. Here the *political economy of incumbency* is an important part of the story that points to the ways in which dominant actors in the current cooking and broader energy regime seek to protect their power (and market position) by shaping policy and seeking to restrict opportunities for new market entrants by both adding to and creating novel barriers to entry. Proposals to redirect existing expenditures on biomass fuels into payments for cooking services threaten incumbents that benefit from those support mechanisms. These dynamics are observable in relation to resistance to the reform of fossil fuel subsidies - including for LPG and kerosene (Shenoy 2010) and control of market access. Incumbent actors can also include civil society actors that can engender regime resistance (Ford and Newell 2021). These dynamics are prevalent in the ICS sector, where an ecosystem of NGOs currently depend on the promotion and uptake of ICS technology to justify their organisation's existence; a practice which disincentivises the promotion and diffusion of alternative technologies.

Literature on 'regime resistance' is helpful here (Geels & Turnheim 2017). It helps to understand processes of lock-in (Unruh 2000) not just as a technological or socio-technical phenomena, but also looks at tensions between competing pathways as intrinsically political (Scoones et al. 2015) because of the interests at stake and the uneven distribution of losses and gains from different pathways: those taken and not taken; opened up and closed down (Stirling 2005). Hence support for e-cooking also creates beneficiaries and winners by enabling access to modern energy for households whilst simultaneously increasing revenues for utilities, mini-grid developers and solar home system companies alike, as well as creating employment opportunities along the value and supply chains. We suggest below that building alliances and coalitions based on an appreciation of these shared interests will be crucial to advancing e-cooking. Cultivating and encouraging the creation of transition intermediaries within the e-cooking sector could also help garner new collaborations, facilitate technology transfer (especially to the poorest households) and overcome the fragmented and siloed nature of the e-cooking sector.

Patterns of regime resistance depend a lot on how disruptive they are: whether new hardware can be slotted into existing systems and infrastructures or requires more far-reaching change - the 'plug and play' phenomena Newell and Martin (2020) refer to and which we see in other areas (such as the hydrogen lobby's claim that they can replace gas without having to change infrastructures for home heating and cooking). A key dynamic then in terms of political resistance is whether MECS displace or substitute existing systems or merely add to them. Batchelor concludes that (2020:30) 'Modern energy cooking services may operate with either the older infrastructural system or with new systems, and as such is not necessarily a major threat to the existing rent

seekers'. This highlights key political economy themes of the balance between winners and losers of new proposals and whether strategies can create a political 'tipping point' (Otto et al. 2020) to accelerate change. As we explore below, for this to happen a convergence would need to occur in terms of support for the niche (e-cooking), decreasing returns and reduced viability of existing cooking and energy systems (those dependent on fossil fuels or biomass part of the current regime) and increased pressure from above (at the landscape level) in the form of international commitments on climate change and energy access, for example, the falling price of solar, new financing models, and business and service model innovations.

Lobbying is one of the ways niche and incumbent actors mobilise to back policy interventions which benefit them or to quash those threatening their interests. There is a large literature on lobbying, particularly focussed on larger multinationals or business associations (Levy & Newell 2005). One concern in relation to e-cooking is the relative weakness of the clean cooking lobby and a lack of representation in discussions on electrification; a trend exacerbated by the siloed nature of decision-making and the divergent paths of clean cooking and electrification discussed above. As one informant put it, many e-cooking interventions and initiatives "feel like solo-runs" from private businesses and manufacturers active in this space, rather than cohesive sectoral pushes. These 'solo-runs' have a negative multiplier effect too, as the same informant noted, where individual businesses run their own studies on usage, adoption and customer satisfaction that further entrenches the siloed nature of e-cooking instead of fostering broader multi-stakeholder engagement with cooking transitions. Indeed, some informants were retricent to disclose any details on e-cooking pilots without us signing non-disclosure agreements beforehand (NDAs). Once again it is clear that there is huge potential for fostering transition intermediaries that can integrate these 'solo-runs' from private business and connect their initiatives in a way that presents unified demands for the sector as a whole. In this instance, intermediaries would not only act as go-betweens to overcoming collective action problems and clashes of interests, but would also play a role in negotiating and configuring innovation process between the niche interventions and their end-users (Grandclément et al. 2015; Hyysalo et al. 2018). Multiple informants working with private business emphasised the urgent need to better understand end-users and how they interact with e-cooking products in order to accelerate e-cooking transitions, facilitate clean technology transfer and address asymmetries between incumbents and market entrants.

A crucial part of the story of political influence, therefore, seems to be the lack of coherent voice from the potential beneficiaries of the electrification of cooking compared with those seeking to protect markets using conventional fuels and technologies. One informant lamented: 'Clean cooking associations are not very engaged in e-cooking so far'. Few private-led clean cooking associations seem to be very active or networked (with the exception of the Kenyan Clean Cooking Association) and it is notable anecdotally that many of the weblinks to business associations on the Clean Cooking Alliance website are no longer active. As one e-cooking producer told us, EPCs and e-cooking are primarily at the pilot phase rather than the manufacturing phase in most cases, so business associations that make the case for e-cooking in policy discussions do not yet exist. The voices of beneficiaries may be heard more indirectly through the business oriented work of the Clean Cooking Alliance or representations from groups like the Shell Foundation.

One latent incumbent actor in this regard is the charcoal industry. The charcoal industry employs large numbers of people in many African countries, from a variety of income groups and in a variety of capacities (Jones et al. 2016). Some estimates of the value of the charcoal industry stretch to $10 billion a year (interview material) but finding exact figures is difficult due to the ad-hoc nature of charcoal production (Jones et al. 2016). Shirley et al. (2020) estimate that the charcoal industry in Kenya employs an estimated 900,000 people in production and sales, contributing $1.6bn to the Kenyan economy in 2013. As of 2018, the charcoal sector in Kenya provided work for 180 people per every 1000 households, while the LPG sector in Kenya provides just seven jobs per 1000

households (Shirley et al. 2020). In Mozambique, the number of people involved in the production, trade and sale of charcoal could be as high as 3 million, which is around 15% of the total population (Cuvilas et al. 2010). There is also a divide between urban and rural employment in the charcoal industry as three-quarters of people employed within woodfuel markets are based rurally (Openshaw 2010), with up to half of the revenues generated being retained in rural areas (IEA 2014). The rural concentration of charcoal and biomass production, compared to its consumption, emphasises the need to scale up alternative clean cooking industries in rural settings to capture the potential jobs that will be displaced from a move away from these dirtier fuels to cleaner options.

The huge employment gap between the sectors such as charcoal and emerging cleaner fuels highlights the complexity and difficulty involved in cooking transitions regarding the displacement of domestic jobs. Batchelor (2020) suggests, most charcoal producers are not well connected politically, but other observers have noted politicians are acutely aware of the number of people that would be affected by loss of livelihood if displaced by the drive towards e-cooking. They mentioned conversations with West African government officials who admitted they were scared of the social fallout of livelihood loss in the charcoal sector. These concerns are compounded by observations that e-cooking products, and complementary technologies such as SHS, are manufactured overseas and then imported, limiting the e-cooking sector's ability to significantly engage with the charcoal industry's value chain to replace the jobs that could be displaced. One informant told us: 'The thing with e-cooking is that large scale production will probably be done in China or India so it will be hard to retain charcoal producers. There is a lack of livelihood alternatives so they would be 'truly left behind'.'

The composition of the charcoal sector makes addressing the barriers it poses to e-cooking uptake even more complex. Contrary to previous work on the charcoal sector that understood it as a safety net (Arnold et al. 2006) or as a "last-resort type of livelihood activity" (Cavanagh et al. 2015: 77) for those workers that shift jobs as agriculture becomes a less reliable source of income (Levy & Kaufman 2014), it can be understood as an ad-hoc and flexible source of household income. As Jones et al. (2016) argue in the case of Mozambique, the 'last-resort' framing begets the highly contextual nature of the charcoal sector where there are both large commercial producers, using substantial pools of labour, and smaller, more diffuse and intermittent smallholder producers that use charcoal as a flexible income. When considering the phase out of charcoal production and combustion in favour of e-cooking technologies, initiatives must be cognisant of these contextual livelihood factors and their political manifestations.

Reactions to changes in the subsidy regime for kerosene for example, also point to more powerful lobbies being at play, especially where a large and politically significant constituency is built around a particular (fossil fuel) subsidy regime, such as farmers in India (Shenoy 2010). Subsides to fuels such as kerosene are much easier to put in place than to take away (Sovacool 2017). Incumbents also use discursive power to accommodate threats to their foothold in the market and protect their position of power (Newell & Johnstone 2018). This is observable in the framing of LPG as a 'transition fuel' to reduce black carbon emissions. Indeed, LPG was recommended by the 2018 Intergovernmental Panel on Climate Change in this regard despite it creating a degree of emissions and infrastructural lock-in (Unruh 2000) and concerns about its mitigation impacts under everyday use conditions.

Political economy literature on rent-seeking and clientelism also points to collusion between elites and business groups over lucrative deals funded by public money including in the energy sector (Hicken 2011). There is often a lack of transparency around procurement and contracting for energy services which often incentivises centrally negotiated deals which governments can control. One informant echoed this sentiment, noting that large, headline-grabbing infrastructure projects were favoured over smaller, more decentralised energy

initiatives due to the attention and opportunities they presented for elites and business groups, regardless of whether the project was an effective and efficient way of improving energy access or the uptake of e-cooking. It has been argued that this explains the observed resistance towards relinquishing power over energy policy and electricity provision to local and regional governments who would then capture the rents themselves (Newell & Phillips 2016). Those political actors with a presence in the capital and who enjoy regular contact with decision-makers have an advantage in that regard, perhaps affording another explanation for the lack of interest in e-cooking, where beneficiaries are diverse and poorly mobilised and, as a result, under-represented in policy discussions. We argue below in section 5 that there is a role for donors in supporting e-cooking business associations, as well as supporting initiatives to improve the transparency of decision-making over energy by the state, to shift this balance of power.

It is important here to distinguish between *governance in theory* and *governance in practice*. Alongside ministries and institutions with formal mandates and responsibilities making official policy, there is often an informal political economy of cooking service provision: delivery and installation of stoves, repair and upkeep and the 'murky' political economy of deal brokering and rent extraction at work which is not talked about, but which shapes outcomes and questions of access in important ways. Batchelor comments (2020:13) 'the backdrop of the modern energy sector is one of unstable policy environments, ad hoc political interference and rampant rent seeking that puts off long-term investments and makes effective day to day management of the grid harder than it already is'. In a more direct way around extraction and coercion, Batchelor notes how rent seekers operate along the value chain. He notes 'In Malawi, as charcoal is moved from point of production to the markets traders experience a private taxation by public officials. These officials include people on duty at roadblocks [such as Traffic Police], who often demand payments in cash or in kind before they will allow charcoal traders to pass' (2020:22). In regard to e-cooking in urban informal settlements, there is clearly an informal political economy at play in the sequencing of utility companies' policies, where land ownership acts as a precursor for official grid connection. Njoroge et al. (2020) note that within informal urban settlements in Kenya a lack of secure land tenure prevents many low and middle income houses from gaining access to cleaner sources of energy, further cementing their reliance on dirtier fuels. Here we see how the business and service models of large utility companies can act as a barrier to the penetration and uptake of e-cooking technologies, despite them potentially opening up new revenue streams for utilities through increased predictable demand and aiding the uptake of niche technologies.

One aim of lobbying by incumbents is to shape regulations and standards in ways which favour their business models and corporate strategies. A central way in which this plays out is around questions of market access in relation to standards for equipment, VAT and tax. In Kenya, for example, struggles over the import of equipment for solar PV played out over VAT on imported equipment and the standards applied by government agencies to solar lighting, for example (Ockwell & Byrne 2017; Ockwell et al. 2017; Newell & Phillips 2016). As documented by Byrne et al. (2020a: 18), this became an issue again recently when the Kenyan government introduced measures that raise the VAT rating of several products used in the assembly, manufacture or repair of clean cookstoves. Formerly zero-rated, VAT on these products was raised in the 2020 Finance Bill to the standard 14% rate, ostensibly to raise state revenue for responses to the Covid-19 pandemic. One of the issues was larger firms raising the entry barrier for smaller firms, a dynamic which could be replicated around the policy environment for the electrification of cooking. Manufacturers of e-cooking devices such as BURN are in regular contact with the government over these issues, but once policies are put in place it takes time and resources to undo them.

4.3 Social and cultural political economies of e-cooking

Political economy analysis is useful for understanding many of the key dimensions that are essential to a clean cooking transition beyond governing, including financing and production, technological innovation and uptake, and questions of social acceptance and behaviour change. The greater uptake of e-cooking requires shifts in social practices (Byrne et al. 2020, 2020a). But also in relations of social power. The gender dimensions of cooking mean it is often overlooked by organisations with mandates for increasing electrification. There is also the issue of policy-makers disinterest in cooking for reasons of gender blindness and bias (conscious or otherwise) in patriarchal societies, as well as the perceived sensitivity of proscribing how people should cook: an area imbued with granular cultural, personal and religious sensitivities that are by no means homogenous across governance landscapes.

Political scientists see this sort of anticipated (negative) reaction as something which deters action; it is a second dimension of power identified by Lukes (Lukes 1974; Crenson 1971). In other words, some policy options are either vetoed or not even considered because of their sensitivity, or the anticipated pushback from challenging ingrained behaviours and social and cultural norms. The example above of the anticipated reaction of those working in the charcoal sector diminishing support for electric cooking amongst policy-makers in West Africa would be a case in point. There are positive examples, however, of working with women's organisations to build support for e-cooking innovations. Byrne (2020) cites the case of the support Practical Action has been providing to women entrepreneurs involved in the distribution of cookstoves, solar lanterns, solar home systems, and briquettes as part of a project called the Women in Energy Enterprises in Kenya (WEEK). Lindgren (2021) also highlights novel ways of engaging communities in cooking transitions with a solar schools initiative in Namibia, where younger people were the focus of the project to build support for e-cooking among demographics that are often overlooked in cooking transitions. These examples suggest ways of overcoming another barrier to electrification noted by Batidzirai et al. (2021): the limited value that utility companies attach to thoroughly understanding communities' energy needs. Indeed, this is a critique that could be extended to top-down electrification and e-cooking initiatives more broadly, which we turn our attention to in section 5.

Cultural political economy analysis with its attention to norms, behaviours, production of desire, aspiration, when combined with sociological work on practice theory (Shove et al. 2012), provides a useful entry point for understanding why e-cooking interventions have achieved limited success to date. Here an 'energy cultures' framework might be illustrative (Jürisooet al. 2019). It lends weight to Ockwell and Bryne's (2017) argument about going beyond a technology 'hardware' approach to look at the importance of 'software': capabilities, agency, local knowledge and being attentive to local power dynamics, especially gender. Energy needs and practices are not linear, especially around cooking. So even for those that have access to electricity of some form, many continue to cook with traditional fuels such as wood and other solid biomass for reasons of tradition, ritual, ease of access or taste. As Leary et al. suggest (forthcoming) 'Given that approximately 2.6 billion people still use biomass as their primary cooking fuel yet only 0.86 billion are without electricity access (IEA, 2019), this implies that some 1.7 billion are connected to electricity, yet do not cook with it'. One informant for this research put it as follows: 'The interaction between the technology and the end-user is key. Otherwise it will remain a donor-led solution unless you fix that'. In turn, the continued prominence of donors could create dependencies that entrench donor-recipient relations, rather than fostering viable industries, business models and financing mechanisms. While the benefits of e-cooking are apparent around time-savings, which can be quite dramatic, as well as scope for e-cooking to expand the 'productive' use of energy for sale by cooking large batches of food quickly (which can provide a livelihood option for street vendors), one of the challenges 'is that people are not used to EPCs - there is a lack of education about how to use them' as one informant noted.

However, some behavioural approaches to cooking transitions have been criticised for their onus on individual agency (Lindgren 2020; Kar 2021), which de-contextualises the practice of cooking from the material conditions in which it takes place, and often puts the responsibility on the shoulders of women as the main cooks. Indeed, a behavioural approach to cooking transitions must take into account the choice architecture, complementing infrastructures and the provision of services that enable behaviours and practices - all of which are susceptible to power dynamics (Newell, Daley & Twena 2021). For instance, a household in an informal urban settlement in Kenya might be unable to pursue e-cooking as a habitual practice due to prohibitive tariff pricing and a lack of secure tenure as a prerequisite for formal grid connection. In this example, the agency of the cook is far less relevant than the structural barriers that delimit that agency.

5 From niche to mainstream: Towards the electrification of cooking

Though political economy analysis is often best and most often deployed to explain the absence of change and the success of regime resistance in much the way we have used it above, it also points to openings, fissures in regime stability and the possibility of transition. This is consistent with the goal of some transitions scholarship which seeks to understand the ways in which pressures from above and below can 'lead to cracks, tensions and windows of opportunity' (Geels 2010: 495). Here then, we firstly suggest some openings for alternative pathways before identifying some of the enabling conditions for the electrification of cooking based on previous research and our interview material.

5.1 Openings for alternative pathways

So far we have explored many of the reasons why e-cooking may not have achieved the level of success hoped for, placing emphasis on political economy explanations. But it is worth recalling that **rapid transitions in cooking are possible**. We know this because they have happened before (Sovacool 2016; Thoday et al. 2018). The case of Brazil is interesting. Jannuzzi and Sanga (2004) present data on the penetration of LPG (from 18 percent of households in 1960 to 98 percent in 2004) and the associated decline of traditional fuel use in the Brazilian residential sector. In the period 1960–85, penetration of fuelwood and kerosene fell from 61 and 20 percent, respectively, to 28 and 7 percent, indicating a shift away from these fuels for cooking and lighting. Interestingly, in the same report trumpeting such achievements the section covering cooking is followed by one on electricity where it is noted that 'Electricity is an ideal medium for such end-uses as lighting; use of appliances such as radios, televisions, and equipment and devices used in numerous industrial and commercial establishments; and communication devices' (Modi et al 2006: 50), while failing to mention cooking.

Any alternative pathway has to start from a recognition of the situation users face and the level of decision-making autonomy (or the lack of it) that they have to adopt e-cooking. Jan and Lohano challenge, for example, 'energy choice theory' which embodies the notion of 'multiple fuels multiple choices' whereas as they note 'In rural areas of developing countries, however, people do not have multiple choices when it comes to clean fuels. Instead, they mostly depend on traditional biomass fuels' (2021:2). Determinants of uptake also vary from one context to another and are shaped by factors such as levels of income and education, access to finance, as well, as noted above, perceptions of the cost of e-cooking technologies. The nature and depth of civil society and donor engagement will also shape the feasibility of alternative pathways. For instance, in some contexts of active and embedded civil society organisations there may be scope to enrol NGOs in awareness raising initiatives or behavioural interventions to support e-cooking transitions, while elsewhere civil society actors reliant on the continued diffusion and up-take of conventional technologies will slow the transition. As Byrne et al. (2020a:27) suggest, 'women's self-help groups play an essential role in educating, empowering, and financing women in

the decision to acquire kitchen implements, among them cooking appliances'. A study on the uptake of more efficient cookstoves in Pakistan also found that 'the presence of NGO promoting EECs has the largest influence on EEC adoption as it increases the probability of switching from traditional cookstoves to EECs' (Jan & Lohano 2021:1). There are vital contextual differences that interventions and initiatives must be cognisant of.

Challenging incumbency will mean building coalitions of the 'willing and the winning' from this transition. Clean cooking associations which include a range of relevant actors, where they exist, are an obvious point of departure. But providing finance for business associations to amplify their voice and presence in energy policy debates will be crucial to slowly building a different energy future and a more accommodating policy landscape, especially at what is still an early state of development of e-cooking in many contexts when plans, policies and business models are still being designed and assembled. The contribution of e-cooking to a number of the SDGs needs to be emphasised as a way of building a broad-based coalition of support able to disrupt dominant regimes and scale up the sustained use of e-cooking technologies. As one informant noted, there is scope for much more advocacy with groups working on each of the SDGs that relate to clean cooking (energy, health, gender, protection of forests etc.). This coalition needs to go beyond those businesses and actors that directly and materially benefit from an e-cooking transition if broader social traction is to be secured and the mutual neglect between e-cooking and broader electrification agendas is to be bridged.

More fundamentally, **it may require a different approach to the provision of energy infrastructures** which some elites may resist or seek to delay, including the use of mini-grids and smart grids and decentralised solutions that reduce the pressure on the central grid during peak times (Lee & Hess, 2019). For example, one source of resistance to e-cooking is the fear that a major cooking transition towards e-cooking could further destabilise what are often already fragile distribution networks by creating time-bound loads that are likely to collide with peak times. Yet, as one investor pointed out, the reality is that cooking provides predictable demand loads roughly three times a day, at similar times and should therefore be possible to manage with smart grids. In this sense, **the push for electrification should go hand in hand with the e-cooking transition**. Currently, they are not. Instead, infrastructures for electrification are being rolled out that are not fit for e-cooking, which in the cases of Nepal and India (with it's 'Go Electric' programme), for example, has meant having to retrofit transformers since 300MW connections are not enough for e-cooking. Efforts to promote alternative pathways have to recognize both the high politics of electricity and the powerful actors, interests and narratives that have to be engaged with, and the perceived status of cooking as low priority and 'low politics': not amongst a growing set of donors, international institutions and financiers working in this space, but at the level of national priority-setting and decision-making. In this regard, the disconnect and mutual neglect is not so surprising. It suggests the need, therefore, for cultural work around aspirations, nurturing new norms and behaviours, while also working to create supportive and enabling environments for the supply of infrastructures and equipment to sustain the electrification of cooking.

Building an e-cooking transition will require the mobilisation of multiple intervention points. It is important not to think of the governance landscape in static terms or of organisations as monolithic units, but as fundamentally dynamic. There are differences and tensions within organisations even down to the level of individuals, where some are supportive of MECS through electrification and others fail to accept or understand its potential. Interviewees point to differences within ESMAP and the CCA along these lines, for example. Recognising this provides the basis for building new alliances and 'coalitions of the willing' that support accelerated moves towards the electrification of cooking. Undertaking the sort of 'power mapping' exercise mentioned above provides a useful first entry point for identifying allies and moments of change, as well as where blockages and opponents exist and how they might be overcome. Political economy analysis such as this can help underpin such an exercise.

If demand is to be generated from below for the electrification of cooking, greater attention will have to be paid to 'choice architectures' and the links between individual and system change, whereby individual change is both a driver for - and a consequence of - systems change (Newell, Daley and Twena 2021; Leventon et al. 2021). Decisions about cooking are not isolated and based on atomised individual choices. They take place within structural systems and have to be understood as operating within social and cultural contexts and an economy characterised by sharp inequalities of energy access, income and ability to diversity. This raises questions about how far household behaviours can be changed 'from above' by policy or donor interventions alone (Kar 2021). Especially with regard to food, it is very personal, strongly influenced by family, community and culture, as well as being heavily gendered. There are cultural patterns of cooking and eating, including religious connotations about how food is prepared (preference for smoked cooked foods for festivities and special occasions etc) such that transitions 'from above' are harder to accelerate. Jan and Lohano (2021:3) note, for example, 'The preference for the traditional cookstove appears to be more influenced by cultural than economic reasons as it was not so much the cost but the belief that food prepared on traditional cookstoves tastes better which underlies the choice of cookstove'.

There are many studies looking at the issue of uptake and social acceptance of cookstoves and the key drivers of this (Jan 2012; Carter et al. 2019). But the issue is often framed as a question of individual choice devoid of context (Lindgren 2020; Kar 2021). Batchelor suggests (2020:7) 'When we consider the role of modern energy cooking services, this can mainly be characterised as a series of consumer choices'. These choices, however, are constrained and enabled by social inequalities, exclusions and prevailing political and economic conditions. Nudge approaches (Thaler and Sunstein 2009) are unlikely to be successful in this area, unless they engage with a fuller appreciation of the actual circumstance in which people make deeply habitual and social choices about cooking.

It is clearly important to articulate and disseminate new narratives to support alternative pathways. Myths and narratives can be articulated and reinforced with material consequences for energy access. The myth that electric cooking is necessarily more expensive and that burning trees is 'carbon neutral', or around the cost of electricity, serves to discourage uptake. A critical focus will not only be the environmental and health benefits, but in contexts of high poverty and unemployment, the jobs potential of alternative pathways. For example, shifting from biomass based cooking will result in a potential loss of jobs in the charcoal and wood industry which provides livelihoods for some - or the small holder farmers who currently supplement their income by selling fuel to their neighbours (Batchelor 2020). The collection of firewood is time intensive, but free, and does not involve upfront payments, maintenance costs or the use of electricity. Even Pay as you Go systems struggle to overcome this opportunity cost. Notwithstanding the fact that biogas, bioLPG and assembly of PV systems could all generate local economy jobs, Batchelor suggests (2020:10):

> '*modern energy solutions rely on technology from the global market. In the case of LPG, the product in some countries is a by-product from their domestic oil production (e.g Ghana). However, even there, substantial profits are taken by international players, and the creation of unskilled jobs is very limited. LPG distribution systems tend to require more substantial retail skills and assets e.g. cylinder filling stations, trucks than the average charcoal seller. When we then consider electrical cooking on the grid, the appliances tend to be made outside the country*'.

Transitions, including around cooking, need to be just transitions attentive to issues of labour and challenges of social displacement that might arise from a shift in service provision (Newell & Mulvaney 2013). In areas of unemployment, low levels of investment and widespread poverty, building a local industrial base for e-cooking provides a key intervention point for accelerating the transition to e-cooking. This can be supported with

national and local state level industrial policy (through the use of tax, VAT regimes, subsidies and innovation grants) and the proactive design of regional development plans which seek to support an industrial cluster in this area. In the case of Kenya, for example, Byrne et al. suggest that if an enabling policy environment were to be created (2020a:18), 'the government could consider reintroducing or extending the incentives it introduced to bolster the adoption of clean cookstoves: e.g. reducing the import duty on e-cooking equipment; implementing a zero rating for tax on electric cooker parts; and creating VAT exemptions for the inputs used for the manufacture and assembly of cooking technologies'.

Alongside this, however, is the **need to quantify, measure and present the co-benefits of e-cooking** in order to create political buy-in at the top and move beyond the dominant framings of public health (which have had limited impact to date on creating sustained use of improved cookstoves). One practitioner that we spoke to agreed that by better capturing and sharing the co-benefits of e-cooking, organisations could create both the top-down political will for e-cooking transition and the enabling policy environment. SE4ALL are currently working on a co-benefits tool to do exactly this. Donors also have a role to play in supporting awareness raising through local civil society organisations (about the benefits of e-cooking and the dangers of indoor biomass cooking), building business associations around e-cooking to represent their interests in national policy debates and to boost their capacity to engage with donors and to help construct the supply chain, as well as directly subsidising the cost of e-cooking devices for the very poorest.

There is power at work in terms of which discourses and narratives dominante and take hold and why. When the push for energy access is combined or embedded within a neo-liberal ideological frame, some exclusions may be reinforced and some solutions to the challenge sidelined because of their lack of ideological fit. As with Lighting Africa, some approaches are informed by 'bottom-of-the pyramid' (B.O.P) thinking (Prahalad & Hart 2002) about targeting products and services to the poor to incorporate them more fully into market society. There is a clear market expansion (as well as development) logic to this. For Brown et al. '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' (2017: 106). The underlying assumption here is that insufficient productive work is currently taking place and by implication productive work is that which is for the market. Social marketing meanwhile is employed to enroll new consumers into the market and persuasion of new adopters are key drivers of this too (Shell Foundation 2013). Women in particular are targeted. As Brown et al. (2017: 113) suggest 'in many contexts, training programmes may be most effective if focussed on women, as they are likely to be the primary beneficiaries and will therefore have the greatest motivation to see the technology succeed'. However, as outlined above, there are a variety of issues that can arise from targeting women specifically as conduits for broader cooking transitions.

In terms of those who currently benefit from e-cooking, the answer appears to be higher end consumers in urban areas, therefore suggesting that **the poverty alleviation potential of e-cooking technologies is not yet being realised**. This is in spite of frequently made claims that the main beneficiaries are women, children and low income groups (Jan 2011). Though this is changing as more people get connected to the grid, in the case of Kenya, for example, Byrne (2020:33) note that 'e-cooking appliances have generally been targeted at urban dwellers who are connected to the national grid. This is evident based on the type of electrical appliances imported into Kenya. For instance, the focus has been on LPG-electric cookers and microwave ovens, and specialised appliances such as mixers, food processors and blenders'. Cash-based systems where people pay up front for appliances also privileges relatively wealthier customers with both liquid cash and relatively stable incomes.

All this underscores the **need for new financing and service models**, where instalments can be paid in quotas, for instance, or through the use of micro-finance mechanisms. The implicit model is one of getting middle class consumers to adopt e-cooking in the hope that their status in society will generate broader aspirations to adopt clean cooking. Demonstrations in elite shopping malls in cities like Nairobi suggest this is the (often unsaid) business model at work, despite the claims about e-cooking being primarily aimed at the poor. Moreover, as noted above, initiatives which seek to spur on cooking transitions that leverage aspirations as a driving force for shifting behaviours are at risk of falling into the individualising perspective of behaviour change, which omits structural and contextual factors that can determine cooking practice outcomes.

From a more critical political economy perspective, there are also concerns about the economic lock-in that B.O.P models try to achieve. Mobile money and other schemes give greater access to credit, but also raise levels of indebtedness and create new dependencies which did not previously exist. One interviewee for this research suggested that e-cooking might be an attractive proposition for soaking up the surplus power that utility companies such as Kenya Power have. This of course was the driver behind the electrification of cooking in the UK in the latter part of the twentieth century: finding outlets and generating demand for greater electricity consumption. This is supported by Mbaka's study which argues that 'In order to increase electricity consumption for basic services and productive activities, energy access programs should be implemented simultaneously with campaigns that create awareness and provide incentives for electrical equipment to spur productive electricity benefits that are unique to each county' (Mbaka 2021: 27).

Interventions in this space are consistent with broader neo-liberal energy transitions in the region regarding how and by whom energy services should be provided, and which ones should be prioritised (Newell and Phillips 2016). There is often an exaggerated and inflated role of private entrepreneurs in such narratives, around Solar Home Systems for example, which are challenged with reference to 'innovation histories' that show a key for donors and governments in building and supporting innovation networks and value chains for emerging technologies (Ockwell & Bryne 2017). There are resonances of this type of narrative with e-cooking. The e-cooking manufacturer BURN provides the following account of its history:

> '*In 1990, Peter Scott was traveling through Zaire when he witnessed the deforestation caused by charcoal production for household cooking. At that moment, he committed his life to save forests in Sub-Saharan Africa through the design and manufacture of fuel-efficient cookstoves….On a shoestring budget, BURN assembled a team of world-class designers and engineers who were also committed to designing the world's most fuel-efficient cookstoves….When BURN started there was little faith in the cookstove sector to deliver tangible results. Over the last 10 years, BURN has built a successful business while proving that cookstoves can deliver transformative social, financial, and environmental impacts.*'[9]

A broader critique of the assumed developmental approach here would focus on the problematic nature of such framings by the development industry: what and who is defined as modern; what counts as productive; the dangers of fetishising technological interventions (rather than provision of housing with ventilation); entrenching dependency on external technology and service provision, thereby undermining self-sufficiency; and focussing on the behaviour and practices of the poor to fix a climate crisis which is largely driven by richer nations and classes (Kenner 2019; Wiedmann et al. 2020). Alternative pathways to achieve the e-cooking

[9] https://burnstoves.com/about

transition need then to be embedded in local empowerment and benefits to users rather than building markets and creating investment opportunities for technology providers alone.

5.2 Enabling conditions

Political economy analysis can help inform analysis of issues of emulation and scaling: why uptake has been so positive in some contexts and not others by looking at the political barriers to change and opportunities for realignment. While acknowledging the embryonic nature of the sector, this section therefore looks at enabling conditions in places that show some signs of success in combining electrification and cooking and whether and how these could be generalised and scaled. For example, the two areas are more effectively and productively integrated in South Africa, Zambia and Ethiopia, there have been rapid increases in South Korea, while East and Southern Africa have been found by some scholars to offer the most favourable conditions for solar-battery-eCook, with South/Southeast Asia also attractive for grid-battery-eCook (Leary et al. forthcoming).

5.2.1 A supportive state

For ESMAP (2020: xxv), there is a need to support policy makers 'to create an enabling environment that crosses the division between the electrification and clean cooking sectors'. In practice this refers to a range of strategies which include the need to:

- 'Create interministerial spaces (committees, working groups, and so forth) to develop single investment strategies that align with existing political objectives';
- 'Create a space for dialogue between stakeholders in the clean cooking and electrification sectors';
- 'Reduce the relative cost of cooking with electricity by diverting fossil fuel subsidies to energy access programs';
- 'Strengthen the case for the poor through strategic use of lifeline tariffs financed by cross-subsidies or targeted subsidy programs'.

What brings these elements together is the **need to engineer a power shift:** boosting the voices of those that will benefit from an e-cooking transition and pushing back against actors keen to maintain the status quo. Informed by political economy analysis, power mapping conducted with a cross-section of relevant stakeholders can help identify where sympathetic individuals, units and departments lie within government, who potential allies are in the donor and broader funding community and which business and civil society organisations might make viable partners that can accelerate a shift in policy (Newell et al. 2014).

There is also a clear need to create more **responsive modes of governance** that are able to adapt to changing circumstances around price signals, availability of finance, the pace of technological innovation and shifting consumer demands. This might require the creation of easily accessible public (and donor supported) funds to support particular innovations aimed at supporting the roll-out of e-cooking in the form of grants or loans to businesses, infrastructural improvements or training and advisory services. To be effective, the day to day governance of the transition will have, in part, to be decentralised (to avoid overloading stretched central bureaucrats to enable those closer to on the ground interventions to judge their potential) with delegated governance functions to engage diverse local settings and respond to needs in a timely fashion.

National steering is, nevertheless, important. We know that **ambitious policy goals that set the direction of travel can serve to catalyse innovation and finance necessary to deliver on these aims**. Work on visioning within energy transitions (Miller & Richter 2014; Torvanger & Meadowcroft 2011) illustrates the importance of developing alternative scenarios of how energy transitions might unfold over time, the role that specific technologies could play in the process and the type of leadership required in different contexts (Torvanger &

Meadowcroft, 2011). India's national 'Solar Mission' sought to do precisely that (Phillips & Newell 2013). Around e-cooking, some governments have taken progressive stances. The Nepal Electricity Authority (NEA) has developed a dedicated electricity tariff designed to incentivise electric cooking with a 20% discount for consumption above 150 kWh/month. According to some informants, Nepal was chosen because of the low electricity prices and tariffs and an abundance of hydro and micro hydro-power energy generation, which key institutions such as the World Bank are keen to promote.

In terms of ambitious policy goals, Nepal has enshrined e-cooking into its Nationally Determined Contributions (NDC). Tanzania too has also made a national commitment to support clean cookstoves and fuels. The work that SE4ALL and others are doing on 'integrated energy plans' and 'integrated electrification pathways' which includes stronger commitments to clean cooking, including e-cooking, can play an important role in building policy capacity which integrates the two agendas and is scalable. The extent to which governments can set bold visions and realise them in a way that secures buy-in across government, in part by offering inducements to engage (increased budgets to play an active part in an e-cooking transition), will depend on their power and resources to assemble a new coalition of actors behind a new vision of e-cooking, as well as how centralised the state is (as opposed to federal in structure) and able to directly oversee such changes.

Policies which support access to affordable electricity are also key for enabling e-cooking transitions to meet poorer peoples' needs. For example, though doubts have been raised about its long-term success, the existence of the Free Basic Electricity programme in South Africa is seen as vital to the successful uptake of electric cooking in South Africa (Brown et al. 2017) which is a product of social movement mobilisation by labour and other groups (McDonald 2009).[10] The latter point underscores the need to build coalitions of the 'winning and the willing': getting trade unions behind proposals to build jobs and industrial capacity behind solar cooking, resourcing and amplifying the voice of the beneficiaries of solar cooking, such as manufacturers and retailers of e-cooking appliances, and crafting targeted consumer messages to engage the diverse demographics required for e-cooking transitions.

In markets where e-cooking is starting to emerge as an industry, like Kenya, the initial employment findings are promising despite clear data blindspots. Shirley et al. (2020) argue that direct jobs in the cooking sector are highly skilled, especially those jobs in the LPG and e-cooking sectors with an estimated 80% considered skilled. Equally, the level of compensation for employment is highest in the LGP and e-cooking sectors, with non-managerial staff earning an average income of around $200 a month (Shirley et al. 2020). In the Kenyan charcoal sector, the average income is $60 a month (Putti et al. 2015). Despite the substantial challenges of job displacement in cooking transitions, initial findings suggest that e-cooking (amongst other clean cooking technologies) can provide higher, more secure incomes with a greater endowment of skills. One informant active in the manufacturing space echoed these sentiments, stating that the domestic skills base for the manufacture and dissemination of e-cooking technologies is improving every year, highlighting the growing potential to scale up domestic value and supply chains. Indeed, this informant noted the tangible potential to use e-cooking as a 'trojan horse' for creating and scaling up the manufacturing base required for broader transitions, for instance in e-mobility, as part of a comprehensive 'clean energy infrastructure'. The same informant mentioned that

[10] The longer term legacy of the policy is contested because of 'spiralling illegalities and non-payment have undermined service delivery', leading some to claim 'the current rollout of services is unsustainable when large numbers of people are unemployed and cannot afford the services' (Ruiters 2011: 119). Another recent study also found 'Despite having a small rural population relative to African levels, the National Electrification Program (NEP)'s goal of delivering 100% access of subsidized electricity to low-income households by 2003 remains unrealised' (Lawrence 2020: 2).

government industrial strategy is not yet aligned with the push to build modern manufacturing capacity to meet a range of developmental needs. However, there is a clear complementarity between e-cooking and electrification agendas, whereby scaling up modern manufacturing capability can aid the production of goods that are needed for transition in other realms such as transport and energy generation.

Industrial policy needs to support a base of local manufacturing and training for building, transporting, installing and repairing e-cooking systems. This can ride on the back of an expanding solar production base in some African economies, such as Kenya and Uganda, where within 10 years the sector has expanded from a handful of solar companies to over 30 enterprises in the sector (Twaha et al. 2016). In these contexts, and others, the provision of battery storage used to support rural, solar, micro-hydro mini grids could also provide the foundation for higher rates of household uptake and usage of e-cooking technologies and services. Yet building an industrial base and an adequate and affordable supply chain is key to the scaling up and diffusion of e-cooking technologies. Some 'artisanal electric stove producers' have entered the production of e-cooking devices, especially hotplates in the informal sector (Byrne et al. 2020a: 25). Ethiopia provides an example of the latter form of low-tech production enabled by the low cost of electricity (interview material). This means building demand for e-cooking while addressing the supply side of the equation: the value chains, supply chains and industrial capacity that requires a supportive policy environment, including the use of subsidies, tax breaks and grants. One investor we spoke to referred to the need for a 'healthy private sector ecosystem' which can be achieved by supporting and subsidising 'firms until they can secure commercial capital and become independent'. Subsidy schemes are key to this in building up and de-risking sectors in the nascent stage, but in the end, it has to be consumer driven: the technology will succeed if people are made aware of it, want it and can use it effectively. From this perspective, the key is to 'unlock financing and capital in uniting the cooking and electrification agendas'.

Previous studies on support for solar PV in many of the countries in which the MECS programme is currently working suggest this is a contentious area with controversies over the rate at which feed-in-tariffs are set and accusations that some government officials even deliberately set the rate low to inhibit the sector (Newell et al. 2014). At the moment, as Byrne et al. (2020a:4) suggest 'The policy context is quite weak in its support for e-cooking, where favourable policy can only be inferred because there are some aspirations to promote clean cooking (although this often means cleaner biomass cookstoves)'. The authors continue that 'at the national level, although energy-related policies in Kenya touch on clean cooking, none addresses e-cooking explicitly. Instead, they address clean cookstoves and technologies such as LPG, biogas and bioethanol-based solutions' (Byrne et al 2020a: 14). This underscores the sentiment of a number of key actors we spoke to about this issue that the business model for e-cooking is still seen as unproven and unviable. It needs to move beyond pilots and donor-driven interventions if it is to achieve scale and realise its potential, which requires an industrial policy framework that seeks to intertwine e-cooking and electrification. Likewise in many contexts, regulation of standards and quality assurance for e-cooking appliances is lacking and to be effective might need to be adapted to regional and local contexts given uneven grid stability and differing infrastructures.

The industrial policy framework required to both scale up e-cooking technologies and services, while also bridging the gap between e-cooking and electrification agendas, would need to be extensive, ambitious and far-reaching. Such a policy framework would need to guide the direction of domestic e-cooking markets to ensure alignment with the roll out of electricity infrastructure. For instance, the uptake of e-cooking technologies will be dependent on whether the grid connection provides sufficient power to sustain their use. If the two agendas are not aligned, costly retrofitting could set both back. It is important to stress, however, that an industrial policy which prioritises directionality is not one that pursues strong top-down policy, but rather seeks to galvanise bottom-up partnerships and collaboration between private and state actors to support the development of new

technologies, service models and, more generally, novel techno-economic paradigms (Perez 2000; Aiginer & Rodrik 2020). E-cooking, clean cooking and energy business and trade associations, both within countries and across whole regions, as well as individual firms, have a pivotal role to play in developing industrial roadmaps that showcase the possible options for scaling up e-cooking markets. However, a strong sense of direction will inevitably create winners and losers (Sovacool 2021), so must be accompanied by measures such as re-skilling or upskilling programmes, as well as job creation initiatives, to ensure that the industry policy framework maintains legitimacy and acceptance throughout the populace (Nilsson et al. 2021).

5.2.2 Business model and service innovation

The ESMAP Cooking with Electricity report highlights the following forms of private sector support that might be necessary to support e-cooking:

- 'Enable utilities and minigrid developers to pilot, and scale up eCooking services that are compatible with their existing business models;
- Enable solar home system companies to develop, pilot, and scale up innovative new eCooking products and services;
- Incentivize appliance manufacturers to develop products targeted at the bottom of the pyramid; Enable players in the existing clean cooking value chain to expand their product range to include eCooking appliances;
- Empower women entrepreneurs to lead the development and dissemination of innovative eCooking solutions; Identify viable business models that will both unlock consumer responses and meet private sector financing needs;
- Bridge initial cost–viability gaps in new markets by combining financing instruments, including grants, social impact investment and results-based financing tied to environmental, gender equity, and health outcomes' (2020: xvi).

What might be required, as one actor told us who works with businesses, is '**synergies across business models**' where there is 'scope for greater alignment' between clean cooking and electrification. Impact investing and greater vertical integration are key to this. He noted increasing scope for specialisation and optimisation as differences between and within the sectors diminish. Some companies are focussing on 'last mile distribution' – targeting hard to reach areas with solar home systems, mobile money and the like. To build on this means breaking out of siloes so that companies provide a 'clean stack' of technologies and services options for clean cooking - LPG, e-cooking, fridges, cooling etc. Stacking has traditionally been seen as negative, whereby people use multiple fuels for cooking. Yet ESMAP and others are now showing that 'clean stacking' could be an opportunity as part of a 'portfolio' approach that could be leveraged by utilities with excess generating capacity to stimulate demand.

Key to this is fostering an **understanding of the range of user needs**, where differentiation comes from meeting needs through a portfolio of appliances. There is still scope for non-electric appliances using ethanol and LPG, for instance, where a whole 'bundle of products' combine to provide high and low tech solutions. In this scenario, companies become appliance and service providers rather than only providers of SHSs or electric pressure cookers, for instance. To do this, though, financial institutions need to provide finance solutions and mechanisms to offset the potentially prohibitively high up-front costs of this 'clean stack' and support the development of the value chain (ESMAP, 2020). However, it's important to stress that this type of intervention might only work in contexts where there is already an interested - and invested - domestic private sector looking to drive usage and uptake of e-cooking and clean cooking technologies, offering both devices and service

models. Otherwise, scaling up the production and stimulating the demand for a 'clean stack' would mean that benefits would not be captured in the near-term, nor create the value chain required to sustain it.

There is potentially a huge growth opportunity here through the 'commercialisation of electrons'. 'Pay as you go' (PAYG) financing models are a foundational element to this. For off-grid solar and clean cooking, PAYG has been the 'connective tissue' between demand and supply - all enabled via mobile money. PAYG models in the realm of LPG provision have proven to be effective at sustaining the usage of clean(er) cooking fuels and overcoming many of the initial barriers to LPG access. Shupler et al.'s (2021) study on PAYG LPG programmes in informal Kenyan settlements found that the model, enabled through mobile money and smart metering, improved logistical issues through streamlined monitoring, improved the safety outcomes of LPG through more transparent monitoring, reduced the risk of illegal cylinder refills, saved time and allowed households the flexibility of payment required to maintain clean cooking throughout periods of fluctuating household incomes. What's more, the same study found that instances of clean cooking using PAYG LPG increased by 60% during COVID-19 and payment frequency increased by 50%, while the average non-PAYG LPG usage in Kenya actually declined by 75% during the COVID-19 (Shupler et al., 2021). As scholarship around energy transitions has argued, the alignment of novel PAYG finance and services models with existing social practices of paying for energy could explain their early success and potential longevity relative to traditional finance models (Rolffs et al. 2015).

While mobile money has increased its penetration in recent years, concerns still remain over infrastructural deficiency, the security of private data, the cost of services and the often poor complaints resolution (Tonuchi 2020). However, research does suggest that the global COVID-19 pandemic has accelerated the use of digital technologies, including digital currencies and mobile money, as part of more structural shifts in patterns around working, travelling and communication against the backdrop of increased viral risk (De' et al. 2020). The acceleration of mobile money was also encouraged and enabled by many of the governments where the MECS programme is active. Chadha et al. (2020) argue that policy measures to support the widespread use of mobile money were put in place to ensure the continued flow of money through African countries during the COVID-19 pandemic. These measures are in addition to the already impressive availability of mobile money across the African continent, with mobile money technology having 26 times the reach of ATMs and 58 times the reach of physical bank branches (Ahmad et al. 2020). While there are still questions over mobile money's effectiveness in promoting financial inclusion (Ahmad et al. 2020), ensuring proper consumer protections (De' et al. 2020) and whether its effectiveness will be compromised by macro-economic obstacles (Aron 2018), it is clear that its pervasiveness could be leveraged for e-cooking transitions. However, a robust payment model is a prerequisite for scaling up the penetration of e-cooking technologies. Some actors are using smart meters to control access remotely. In addition to this, there are also lower tech solutions such as 'pay gas' in South Africa where you can do small top-ups of gas cylinders at refilling stations. If you can't afford $10 for a full refill, you can pay $1 or $2 for a partial refill: a 'pay as you cook' model.

5.2.3 Building innovation networks

Building innovation networks is also key to supporting transitions (Byrne et al. 2020, 2020a), including around cooking, and previous work charting innovation histories has shown that donors have played an important role in nurturing innovation networks around solar home systems, for example (Ockwell & Byrne 2017). Clearly in some instances it is a case of connecting to actors already in the e-cooking space: the improved cookstove (ICS) sector and its associated networks, capabilities and infrastructure at the local level. SE4ALL and others are constructing platforms to do this, building on earlier networks of energy practitioners, for example (interview material). This connective function could also be fulfilled by transition intermediaries, serving as go-betweens within the clean cooking sector with a specific focus on catalysing innovation within the e-cooking space. As

mentioned above, and reiterated throughout interviews with informants, there is a distinct need for e-cooking manufacturers and private businesses to collaborate to avoid further fragmentation and strengthen e-cooking as a social-technical niche - this gap could be bridged by transition intermediaries.

There is also a clear need for a more robust industrial policy framework to accelerate the creation of knowledge and innovation networks, both within nations and region-wide. State-led investment into research and development (R&S), which could also be joint-investments with the aid and donor stakeholders, could be an effective way of incentivising firms through establishing intellectual property rights, for instance (Nilsson et al. 2021). This would also create an opportunity to broaden the reach of the coalitions of 'the willing and the winning', bringing universities, research institutes, public sector actors and other intermediary organisations together to further both the electrification and e-cooking agenda. This might be particularly effective on the electrification side in contexts with on-grid connection and excess generation capacity, as these contexts are usually dominated by a few large actors with high capital intensity and limited R&D investment pipelines. Public R&D programmes could therefore help large utilities and individual e-cooking businesses overcome the cost barrier of pursuing business model and product innovation. These R&D programmes could range from demonstration manufacturing facilities to education and training initiatives (Schot & Steinmueller 2018). Although difficult to target and replicate, these programmes are likely to create knowledge spillovers between the firms and organisations involved, enabling other businesses within domestic economies and markets to capture the benefits of innovation without paying the upfront development costs (Nemet et al. 2018).

Moreover, there is some basic network building to be done to address the fact, as Byrne et al. (2020a: vi) suggests, there is a 'lack of information on 'who is doing what' and where, how to source EPCs, and the outcomes of laboratory efficiency, safety and quality tests of e-cooking appliances'. These are issues in spite of a country like Kenya having a head start in many ways regarding high up-take of solar PV where in 2019, close to a million solar PV units were sold in a six-month reporting period (GOGLA et al. 2019) and where over the last 10 years, Kenya has significantly improved its electrification rate through the national grid (Byrne et al. 2020a) where according to the World Bank, the percentage of the Kenyan population with electricity access has risen from around 19% in 2010 to 75% in 2018[11] and where the majority of that electricity is generated from renewable energy sources including hydro, geothermal, wind and solar (Klagge & Nweke-Eze 2020). Despite this favourable situation, as Byrne et al. (2020a:13) suggest:

> '*little of this electricity is used for cooking. Overall, 75% of Kenyan households use charcoal or firewood as their primary cooking fuels, which increases to 93.2% in rural areas (ROK & CCAK, 2019). Only 3% of households own an electric cooking appliance, the vast majority in urban areas. But, even among these users, liquified petroleum gas (LPG) tends to be the primary cooking fuel. Cooking with electricity is generally considered to be expensive, based on household experiences with hot plates and convection ovens in urban areas'*.

Distribution is a key part of the puzzle that needs to be addressed if the energy needs of the rural poor are to be effectively met. Distribution remains one of the most expensive dimensions of the business given the infrastructural constraints that rural and remote areas face (Byrne et al. 2020a). Donors have a key role to play here in supporting infrastructures, as well as providing and levering further finance and supporting policy innovations around renewable energy and clean cooking, and most importantly connecting and integrating these two policy objectives. Examples include the World Bank's 'Energy for Rural Transformation' programme

[11] https://data.worldbank.org/indicator/EG.ELC.ACCS.ZS?locations=KE

and SE4ALL's work on 'Integrated electrification pathways' for universal access to electricity and 'Integrated Energy Plans'. The former involves what SE4ALL calls a 'full systems approach' to electrification planning. One informant noted that in order to address the issue of rural electrification, there is a push towards more decentralised distribution models for e-cooking, as centralised, single-donor led or government-led initiatives appear to be too slow. The same informant also suggested that addressing rural cooking needs could be leveraged to further both the e-cooking and electrification agendas, as is the case in Nepal.

5.2.4 Creating demand

If the supply of e-cooking hardware, software and infrastructure is to increase, demand also needs to be created. Byrne et al. (2020a) discuss the example of energy utility Kenya Power commissioning the TV series Pika na Power (Cook with Electricity), which promoted electric cooking and was broadcast on national TV and through social media. Meanwhile, they note, electric cooking in rural areas is being promoted through *Shamba Shape Up*, a reality TV series aired on Citizen TV, which is the largest media house in Kenya. Exposure, showcasing and getting people used to the potential of the technology is thought to be key especially among households in off-grid areas where people often have little experience with using electrical appliances apart from lighting, televisions, radios and mobile phones. One informant noted that the success of e-cooking uptake and usage in Nepal was in part due to traditional pressure cooker usage being widespread, meaning households were already well acquainted with the technology to begin with. Some entrepreneurs working in the e-cooking space are sceptical, nevertheless, about the value of such interventions describing them as a 'waste of time', when the real issue is that the cost is still too high and that is the key barrier to accelerating an e-cooking transition and overcoming entrenched narratives around unaffordability. According to ESMAP, however, 'By 2025, expected increases in charcoal prices and the falling costs of battery-supported solutions suggest that the cost of eCooking will likely be comparable to the cost of cooking with charcoal in weak-grid and off-grid contexts' (2020: xxiii).

There is also significant perceived latent demand. In Uganda, it has been suggested 'Solar cooking also holds significant potential in the country, with a large number of the population living in well-radiated areas, without access to energy services' (Twaha et al. 2016: 786). Moreover, there have been efforts to sensitize people to the use of solar energy and small PV in the country including the Joint Energy and Environment Projects (JEEP) Uganda Nordic 'Folke center', supported by a Danish civil society foundation[12] working in the areas of Arua, Luwero and Tororo. Deep rooted political economy explanations for the lack of uptake of solar or e-cooking might not be thought to be necessary when underlying structural conditions provide adequate answers: the fact for example that Uganda has one of the lowest electricity penetration levels with only 9–12% of the total population having electricity access; 2–3% of them living in rural communities (Twaha et al. 2016). Based on fieldwork on clean cooking in Southern Africa, one informant mentioned the importance of engaging children in cooking transitions to generate future demand for e-cooking technologies. Surveys suggest that the families of children that attended sustainable development camps are much more interested in improved stoves. In this sense, children can be key agents of change within cooking transitions. Some of the objections to cooking transitions come from older people who object that food doesn't taste as good if not cooked on fire. Younger people often don't have those objections.

As discussed above, there is also latent potential for utility companies and private businesses to provide a suite of clean technologies and services, or a 'clean stack', to meet different needs at a range of price points. There's also scope to bundle products together to target a variety of end users and decision makers. A variety of

[12] http://jeepfolkecenter.org/index.php

informants all stressed the need to better understand the user experience of the products and how customers and end-users interact with niche technologies to aid the stimulation of demand. Furthermore, transition intermediaries could play a vital role in this regard as catalysts of bottom-up scaling through a variety of avenues - economic, cultural and social - in order to both stimulate and shape the demand for e-cooking, ensuring sustained usage and disrupting existing practices around cooking. While the scholarship on transition intermediaries is heavily Eurocentric, it has identified the potential of transition intermediaries across the entire product value chain - from marketing, to sales, installations and maintenance, and even internet forums (Sovacool et al. 2020; Hyysalo et al. 2018). As the domestic value chains around e-cooking grow, and as the penetration of e-cooking technologies broadens, there is scope to heightened the influence of intermediaries in order to cater to growing consumer markets and consumer awareness.

There is also a significant scope for states' industrial policy to create and reshape e-cooking markets. Governments could do this through regulatory frameworks that shape access to these nascent markets, as well as introducing political goals (such as a percentage of population using e-cooking technologies by 2030, for instance), supporting the development of new products and social practices, helping them get to market (van den Bergh 2006). Stimulating demand for e-cooking technology and services could also be achieved through reassessing fossil fuel subsidies and other choice architectures to reduce the risk faced by new market entrants and products, as well as helping to overcome the high degree of lock-in of current cooking technologies (Unruh 2000). In fact, reforming fossil fuel subsidies could be a unifying force for both the electrification agenda and e-cooking interventions in certain contexts. Moreover, industrial policy can create demand and shape markets by targeting both the supply side, such as incentives for manufacturers, and the demand side, through quotes, procurement guidelines and standards (Nilsson et al. 2021).

5.2.5 Reclaiming the narrative

Positive and counteracting narratives are required to underpin efforts to generate demand described above. One of the key issues confronting advocates of electric cooking is the perception that other near term solutions and transition fuels are preferable politically and more socially acceptable than electric cooking, which depends on longer time frames for grid extension and connection, even if off-grid options are viable. As Lietaer and Zaccai suggest, in Uganda 'development of a sustainable national grid has all too long been portrayed as something for the longer term' (2017:2). Even in the case of South Africa, for example, a major study found 'PV systems are not very useful—they cannot be used for purposes such as cooking or heating water' (Roy et al. 2010: 5).

Perceptions of high price of electricity and high grid connection fees are regularly identified as barriers to e-cooking in on-grid scenarios. Indeed, Batidzirai et al. (2021) identified concerns around the prepaid service model and the lack of ongoing support after new technologies are installed. Proposals to get round this include that the high upfront costs of a battery-eCook system could be paid by a service provider, who would then charge a fee to the household, which could even include the connection fee for grid systems. Novel service models like this could help overcome some of the more structural barriers to e-cooking uptake and electrification, such as insecure land ownership and encourage sustained use of e-cooking technologies (Njoroge et al. 2020). Cloke et al. (2017) echo this sentiment by stressing the need for energy companies to focus on the needs of end-users, rather than solely on technological solutions.

The MECS programme has a central role to play in reclaiming the narrative around electrification and e-cooking and, in the process, could be instrumental in addressing their mutual neglect. As Batchelor et al. (2019: 9) state, MECS seeks "to 'change the narrative' of the cooking sector, to facilitate the international community to integrate more effectively the agendas on climate change, increased access to modern energy and the alleviation of the burdens of cooking with biomass". Reclaiming, or changing, the narrative in this way will be an

iterative process that brings together divergent actors to develop an understanding of what they envisage the cooking transition to be and in what direction it could develop in both off-grid and on-grid contexts. Focusing on the role that e-cooking can play in future energy scenarios, either as a predictable demand load for fostering grid stability, or as a 'trojan horse' for scaling up the modern manufacturing base necessary for broader socio-technical transitions, will challenge enduring narratives that cooking is a fringe issue, or a 'women's issue', and instead highlight the co-benefits that will be accrued from a more integrated agenda around electrification and e-cooking.

5.2.6 Focusing on the (co)benefits

Alongside constructing positive narratives, attention also needs to be focussed on the costs of conventional pathways in terms of human health and sustainability. In other words, if the costs of conventional cooking options were internalised and made more transparent and providers of kerosene or charcoal were to have to account for those impacts, the playing field would look a lot more level. For some actors in the clean cooking space this is about the 'monetisation of the impacts of clean cooking' to capture health benefits, carbon savings (that can generate revenue from the sale of offsets) as part of a move towards 'results-based financing'. Significant hope is vested in the prospects of accessing carbon finance from the Clean Development Mechanism (or its new incarnation the Sustainable Development Mechanism under the Paris agreement) under the climate regime, as well as the selling of offset credits on the voluntary carbon market if an e-cooking methodology can be approved. Despite some frustrations with the process, e-cooking entrepreneurs are developing a voluntary market VERA methodology and MECS are helping with this alongside carbon consultants. The commodification of avoided emissions requires careful monitoring and verification of course. Some energy sector practitioners are optimistic that the installation of air quality monitors in homes will help to provide the data that further supports the case for the benefits of e-cooking and human health and environmental costs of conventional cooking practices.

Further research and advocacy work comparing the costs and benefits of different pathways (of the sort being conducted under the MECS programme and by SE4ALL as part of co-benefits toolkits) and seeking to engage mass and social media with their findings might help to shift the debate in favour of e-cooking. Not all such narratives have to be narrowly focussed on the benefits of e-cooking per se, and should be tailored to the political and economic contexts in which the interventions are taking place if they are to resonate socially and culturally.

There are a series of supply and demand issues in terms of: affordable electricity and or access to solar PV technologies that can be maintained; demand and willingness to adopt an alternative system; issues of access to finance and credit, as well as a broader economic enabling environment. 'Life tariffs for inclusive cooking' as proposed by Leary et al. (forthcoming) make a lot of sense in that regard. Overall, many of the success factors which apply to clean cooking in general also apply to electric cooking: the need for 'clean cooking champions' where these have been particularly missing at national level according to informants, supportive development programs including financing through loans and grants, capacity-building and awareness-raising, as well as ambitious policies and targets exist with appropriate regulation in the form of quality standards, for example, and their implementation (Lietaer & Zaccai 2017).

6 Conclusions and future directions

This paper has highlighted, drawing on diverse strands of political economy analysis, where we are now and why and what could change in terms of the prospects for developing an alternative strategy for MECS driven by electrification. This includes realignments in governance (around financing, coordination, policy support,

stakeholder engagement) that would be required to close the gap and how they could be brought about at every level of governance. Bridging policy responses and better aligning the (global and regional) governance of electrification on the one hand and clean cooking on the other represents a critical first step. Ultimately, however, it is less a question of governance and more one of power. In this regard, power shifts associated with more decentralized systems of energy provision, including the democratisation of energy systems to both improve energy access and autonomy through self-generation by 'prosumers' (Brisbois 2020; 2020a) might help to break some of the impasses we have described above. But just switching scale may not be the answer as local institutions are also often subject to capture (Blair 2000). The same may be true of energy systems where Batchelor (2020: 13) suggests 'in reality, undemocratic forms of centralised control may simply be replaced by undemocratic forms of local control', as for example with elites in counties in Kenya that have gained power through the new constitution and seek to secure their rent from new systems of energy provision. So it is not just a question of localising measures for the electrification of cooking or moving power and authority from one level to another, but rather challenging power at various sites simultaneously and building support for an alternative through the multiple arenas of power we have explored here operating at the niche, regime and landscape level.

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