Kenya National electric Cooking Study (KNeCS) Workshop Report

Date: June 30, 2023

Venue: Nairobi Kenya

Report prepared by Nuvoni Centre for Innovation Research (NCIR)

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Executive Summary

On 30 June 2023, Nuvoni Centre for Innovation Research, in collaboration with the Ministry of Energy and Petroleum and the Modern Energy Cooking Services programme held a stakeholder workshop bringing together various actors related to electric cooking in Kenya. The workshop aimed to validate the findings of the Kenya National Electric Cooking Study (KNeCS), to receive feedback on ongoing scenario modeling for scaling electric cooking in Kenya, and to provide a forum for a collective envisioning exercise to define and chart the course for a sustainable and inclusive future for electric cooking in Kenya. The workshop was opened by Dr Faith Wandera, the Deputy Director for Renewable Energy at the Ministry of Energy.

In Session 1, which focused on "*Validation of KNeCS Findings*", researchers from Nuvoni summarized the findings of the Kenya National eCooking Study (KNeCS), detailing Kenya's electrification progress, household connectivity, and electric cooking appliances' status. Among the findings were that while 75% of Kenyans have access to electricity, eCooking adoption remains low. The most common electric cooking appliances were water heaters, kettles, and microwaves. Electric cooking appliance ownership has risen to 23.9% nationally, but mainly for specific tasks rather than main meals. The study also revealed households frequently use multiple cooking fuels and appliances simultaneously, and that while there's potential in electric cooking, various factors like affordability, convenience, and availability influence the decision-making process in both urban and rural households. Findings on the eCooking appliance supply chain in Kenya revealed significant opportunities for scaling up eCooking appliance distribution, but also revealed challenges like high upfront costs, low import volumes, and poor-quality imports. Financing options for electric cooking appliances include cash and carry, asset financing loans, and PayGo models, and highlighted various supply-side financing mechanisms that could accelerate eCooking such as results based financing and carbon financing. The study also highlighted the need for better coordination across health, environmental, and energy policies to promote clean cooking solutions in Kenya.

Session 1's stakeholder feedback session raised questions about the study's methodologies, appliance awareness, and implications for clean cooking. During the stakeholder feedback session on the KNeCS findings, stakeholders raised several important issues. For example, they questioned the definition of a household in the study, were keen to understand the sampling method, and the definition of eCooking, stove stacking, distribution channels, and the potential role of carbon financing. These questions were addressed during the session, and stakeholders were encouraged to review the detailed report for deeper insights.

Session 2 focused on "*Clean Cooking and Electrification Modelling"*. Participants had the chance to explore the capabilities of OSeMOSYS and OnStove and the Energy Access Explorer and how they could be used to address research questions pertinent to the forthcoming eCooking strategy. Nuvoni highlighted two ongoing modelling exercises that involved collaboration with partner institutions: one with University College London and Kenya Power focusing on the OSeMOSYS tool which aids in Least Cost Power Development Planning, and the other centering on the OnStove and Energy Access Explorer tools, in collaboration with the KTH Institute in Sweden and the World Resources Institute. The OSeMOSYS model provides a comprehensive energy system configuration, considering various sectors and energy demands over the time frame 2019-2050. On the other hand, the OnStove tool offers a geospatial, cost-benefit analysis, breaking down Kenya's regions to prioritize different cooking solutions. The Energy Access Explorer by the World Resources Institute offers a visualization of spatial data on energy demand and supply. The session touched upon different policy scenarios that these tools were being used to model.

Overall, Session 2's feedback session provided valuable insights into the modeling process, including considerations of grid impact, regional variations, optimal solutions, risk analysis, fuel stacking, and cost-effective fuel mix. The modeling tools will be continuously refined and adapted to address specific questions and provide guidance for policy development and decision-making.

Session 3 focused on "*Backcasting for a Sustainable Electric Cooking Future*", where participants defined what a sustainable and inclusive future looks like for electric cooking in Kenya. The workshop adopted the innovative Back casting Methodology. Stakeholders provided their insights into how they envision a transition to electric cooking as a primary fuel/technology in a clean cooking stack and a critical driver of demand for electricity could take place. Participants then collaboratively developed a roadmap to accelerate the transition outlining the strategies, actions, and policies needed to achieve this future. There were 7 thematic areas of discussion in this session, and below are the highlights from each theme:

- Electrification: By 2050, both rural and urban Kenya will be fully electrified, utilizing a blend of mini-grids and the primary grid, powered predominantly by renewables. Strategies to achieve this vision include minimizing power losses, enhancing smart grid connectivity, advancing smart metering, fostering regional connectivity, and revising current energy policies to address unreliable supply and lack of incentives for private suppliers.
- Cost: By 2050, eCooking will be the most economical and dominant cooking method in Kenyan households. Achieving this vision involves revising electricity tariffs, cutting eCooking appliance prices, boosting appliance availability, offering innovative financing models, and leveraging eCooking benefits. Encouraging efficiency research, managing electricity demand, raising awareness about eCooking, and monetizing its benefits will provide incentives for consumers.
- Technology: By 2050, advanced technologies will be integrated into eCooking, such as in-built appliance meters, leading to 100% eCooking adoption. Implementation requires robust policies for top-quality appliances, clean cooking subsidies, broad-based capacity building, and overcoming barriers like finance access, grid quality, cultural norms, and supply chain hurdles.
- Consumer Behaviour: By 2050, universal eCooking adoption will transform societal cooking habits, reduce health hazards, environmental impacts, and see increased male participation. This vision requires embedding eCooking in educational curriculums, heightening awareness through community engagements, digital integration in eCooking appliances for cost clarity, and ensuring affordability and reliability of electrification and appliances. Addressing high off-grid solution expenses and appliance costliness is crucial.
- Supply Chain (Importation and Local Manufacturing): By 2050, a robust supply chain will support electric cooking adoption in Kenya, with a focus on local manufacturing and alignment with global climate policies. Realization requires intensive R&D, capacity building, policy support, reduced manufacturing costs, funding for local innovations, and strategies to increase eCooking appliance demand.
- Supply Chain (Distribution and Retail): The future envisages increased demand for EPCs, widespread eCooking hubs, and enhanced local repair capacities. Leveraging digital tools for awareness, tax reductions, Pay-Go models, improved infrastructure, and policies to phase out polluting fuels while standardizing EPCs will help realize this vision.
- Policy: By 2050, electric cooking will be the main fuel for most Kenyans, reducing dependence on firewood and kerosene. Achieving this future entails promoting universal electricity access, boosting local manufacturing, and setting strict standards and labelling for eCooking appliances, ensuring they're efficient, safe, and emit low pollutants.

Overall, the workshop proved to be an enriching and valuable platform for engaging stakeholders on the KNeCS study, eCooking modelling efforts and collective visioning for electric cooking. Thus, the workshop successfully served its purpose of progressing the national conversation on electric cooking while facilitating multi-stakeholder knowledge exchange. The workshop also laid the foundation for further research, analysis, and collaboration on electric cooking.

1. Introduction

1.1. Background

Over the past decade, Kenya has made remarkable strides in electrification, with coverage surging from a mere 19% to an impressive 75% in 2022[1]. Most of the nation's grid electricity now comes from renewable sources, primarily geothermal and hydro. However, despite these achievements, most Kenyans still rely on polluting fuels such as firewood, charcoal, and kerosene for cooking[2].

Biomass fuels are significant contributors to Household Air Pollution (HAP) and major sources of Greenhouse Gas (GHG) emissions. The Ministry of Health has linked indoor air pollution to 21,500 premature deaths annually[3]. Further, the continued reliance on traditional biomass energy, coupled with population growth, places a strain on agricultural land, leading to reduced fuelwood supply. This, in turn, contributes to deforestation, famine, desertification, and land degradation[4]. Women and girls are disproportionately impacted, facing higher exposure to cooking smoke and the burden of collecting fuel—sacrificing educational and economic opportunities in the process[5].

In light of the environmental, social, economic and health impacts of traditional cooking practices, there is need for a paradigm shift towards clean cooking solutions. Electric cooking presents a potentially transformative cooking solution that not only lowers the cost of cooking, but reduces the negative impact of traditional fuels on the environment, creates time savings for households, and reduces negative health impacts and drudgery. Now is the ideal time to leverage the momentum around electrification and renewable energy to promote electric cooking. Bringing stakeholders together for a workshop at this juncture presents an opportunity to align various stakeholders—policymakers, researchers, developers, and users—on the development and promotion of a cohesive electric cooking strategy. The insights from this workshop will be invaluable in shaping the eCooking strategy development process.

1.2. Workshop Objectives and Expected Outcomes

The workshop was designed to achieve three main objectives: Firstly, it aimed at validating the findings of the Kenya National Electric Cooking Study (KNeCS), focusing on aspects such as household electrification, adoption of electric cooking appliances, cooking practices, the supply chain for eCooking appliances and the enabling environment. Secondly, the workshop served as a platform for the start of efforts to coordinate clean cooking and electrification modeling efforts, allowing participants to examine various tools, frame research questions, and explore policy scenarios. Lastly, through a Backcasting Methodology, participants engaged in a collective envisioning exercise to define

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[1] IEA, IRENA, UNSD, World Bank, WHO. 2023. Tracking SDG 7: The Energy Progress Report. World Bank, Washington DC. Retrieved from https://data.worldbank.org/indicator/EG.ELC.ACCS.ZS?locations=KE

[2] Ministry of Energy and Petroleum. (2019). Kenya Cooking Sector Study: Assessment of the Supply and Demand of Cooking Solutions at the Household Level. Ministry of Energy and Petroleum. https://eedadvisory.com/wp-content/uploads/2020/09/MoE-2019-Kenya-Cooking-Sector-Study-compressed.pdf

[3] Bhalla, N. (2019). Kenya vows to cut emissions as dirty stoves and fuels kill 21,500 a year. Retrieved from https://www.reuters.com/article/us-kenya-energy-cooking-trfn-idUSKBN1XF2D4

[4] Schiefer, T. (2021). The Kenyan Cooking Sector-Opportunities For Climate Action And Sustainable Development. NewClimate Institute. Retrieved from https://newclimate.org/sites/default/files/2022-03/a2a_kenya_cleancookingstudy_july2021.pdf

[5] Dida GO, Lutta PO, Abuom PO, Mestrovic T, Anyona DN. Factors predisposing women and children to indoor air pollution in rural villages, Western Kenya. Arch Public Health. 2022 Jan 29;80(1):46. doi: 10.1186/s13690-022-00791-9. PMID: 35093174; PMCID: PMC8801101.

and chart the course for a sustainable and inclusive future for electric cooking in Kenya, creating a roadmap with strategies, actions, and policies necessary to transition from the current state to the desired future.

The following were the key outcomes expected from the workshop:

- A presentation and collective validation of the data and findings from the Kenya National eCooking Study (KNeCS), ensuring that it reflects the realities on the ground and can be reliably used for policy development.
- Enhanced coordination of clean cooking and electrification modelling efforts to answer the key research questions surrounding the uptake of electric cooking. Stakeholders will have a clearer understanding of the capabilities and limitations of various tools, and an understanding on how to synergize these tools for effective scenario modelling.
- A shared research agenda with input from diverse stakeholders, which will guide future investigations and data gathering critical for the scaling of electric cooking in Kenya.
- A shared vision for a sustainable electric cooking future in Kenya, and a preliminary roadmap for transitioning to electric cooking in the long term.
- Enhanced relationships and networks among stakeholders which will facilitate ongoing collaboration, knowledge sharing, and concerted efforts in promoting electric cooking in Kenya.

2. Workshop Proceedings

2.1. Opening remarks

Dr Faith Wandera giving her remarks during the opening session

The Kenya National Electric Cooking Study (KNeCS) Stakeholder Workshop kicked off with opening remarks from Dr Faith Wandera, the Deputy Director for Renewable Energy at the Ministry of Energy, who is at the forefront of coordinating clean cooking initiatives within the ministry. She highlighted the importance of the workshop, which aimed to refine the eCooking Strategy based on input from participants and the findings of the Nuvoni study, and to define a clear roadmap for integrating electricity into the national cooking energy mix.

Dr Wandera highlighted the Ministry of Energy's commitment to promoting access to clean cooking solutions, with a target of achieving universal cooking by 2028. Despite Kenya's high electricity access, it is underutilized for cooking, prompting the need to dispel misconceptions and demystify the benefits of electric cooking. She acknowledged advancements in innovation that have resulted in efficient eCooking equipment and manageable energy consumption. She also recognized the efforts of Kenya

Power in improving reliability of the power grid, which will facilitate wider adoption of eCooking technologies.

The importance of the private sector in scaling up clean cooking was emphasized, with its role in driving product acquisition, setting competitive prices, and establishing business models that make clean cooking equipment affordable and accessible Dr. Wandera highlighted the multiple benefits of clean cooking, including employment opportunities, cost savings, and reduced drudgery for women who primarily bear the responsibility of cooking and are disproportionately affected by the use of solid biomass fuels. It also improves health and the environment, which aligns with the set targets in the eCooking Strategy of reducing the 23,000 deaths associated with household air pollution and national tree planting targets.

The Kenya National eCooking Strategy (KNeCS) was also highlighted as a pioneering effort, setting targets for achieving universal clean cooking by 2028 and aligning with national commitments to SDG 7—ensuring access to affordable, reliable, sustainable and modern energy for all—and Kenya's Nationally Determined Contributions (NDC) targets such as reducing greenhouse gas emissions by 32%.

Dr. Wandera acknowledged the Ministry's partnerships with organizations such as UK-PACT, MECS, CCAK, KPLC, GIZ, and SETA. These partners have been instrumental in advancing the clean cooking agenda through initiatives such as eCooking hubs and capacity building.

With these opening remarks, the forum was officially declared open, and the stage was set for engaging discussions and collaboration among all stakeholders to shape a sustainable and inclusive future for electric cooking in Kenya.

Dr Jon Leary giving his remarks during the opening session

Dr. Jon Leary from the Modern Energy Cooking Services (MECS) Programme highlighted the transformation of Kenya's electric cooking landscape over the past years, as shown in Figure 1. While LPG and improved cookstoves were previously considered default clean cooking solutions, electric cooking was not widely viewed as a credible option or a driver for expanding sustainable power infrastructure. MECS conducted initial pilots to assess the feasibility of cooking all dishes with electricity. In 2021, the Ministry called for support from the international community to develop the National Clean Cooking Strategy (KNCCS) and National Electric Cooking Strategy (KNeCS). MECS and UK-PACT responded to this call and has since supported Nuvoni's work over the last six months to explore the current status of eCooking in Kenya and envision its future.

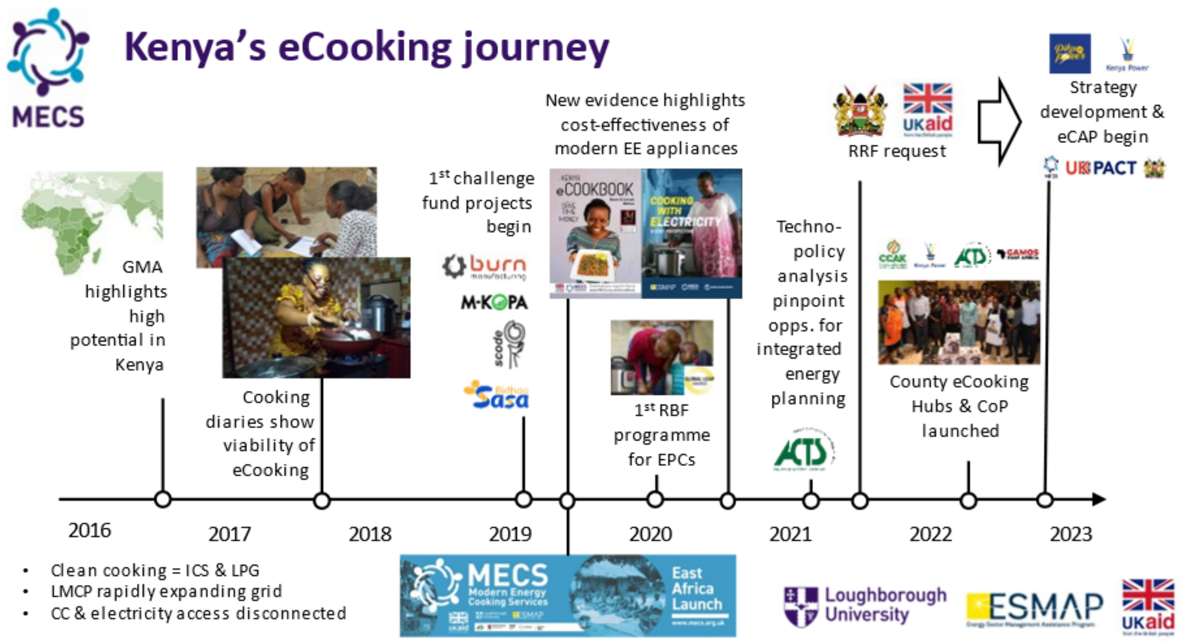

Figure 1. Highlights on developments around eCooking in Kenya

A notable comparison between biomass and electricity expenditure was shared, revealing that the annual market value of charcoal consumed by the residential sector alone in Kenya amounts to approximately KES 68 billion, nearly 40% more than what all domestic customers paid to Kenya Power in 2018. Converting these existing expenditures on charcoal into electricity unit sales presents a lucrative additional revenue stream for Kenya Power.

Given current developments and momentum in the sector, Dr. Leary presented a hypothesis on the potential future progress in the field of electrification and clean cooking, as depicted in Figure 2:

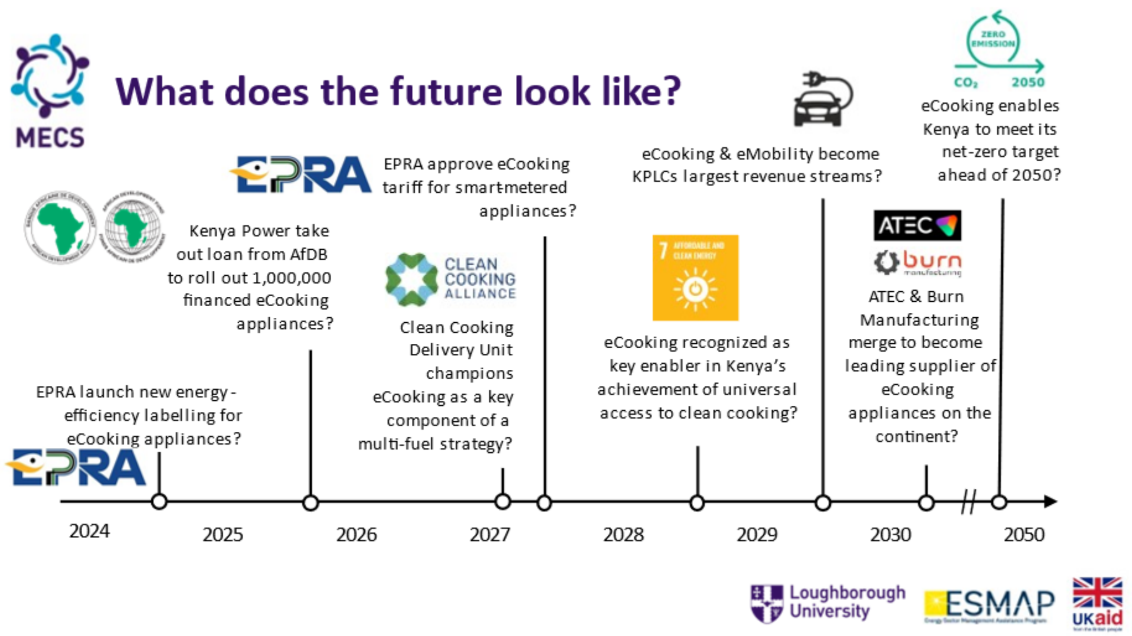

Figure 2. Highlights on the potential developments on eCooking in Kenya

Dr Elsie Onsongo giving her remarks during the opening session

In concluding the opening remarks, Dr. Elsie Onsongo, Director of NCIR, welcomed all participants to the workshop. She emphasized the importance of active participation in all of the sessions, stressing that the richness of the dialogue and outcomes would be predicated on the collective insights and experiences of everyone present. She also encouraged participants to provide constructive feedback on Nuvoni's approach to the Kenya National eCooking Study and the subsequent modeling of electric cooking scenarios, and in the collective visioning of an electric cooking future for Kenya. Dr. Onsongo expressed her anticipation for the innovative ideas and strategic directions that would emerge from this meeting, setting the tone for the rest of the workshop.

2.2. Session 1: Validation of KNeCS Findings

The objective of this session was to validate the findings of the KNeCS, which offers an in-depth analysis of various aspects of electric cooking in Kenya. These include the state of household electrification, the adoption and usage of electric cooking appliances, household cooking practices, the supply chain for electric cooking appliances, and the policy environment that could enable electric cooking. The workshop was expected to provide a platform for stakeholders to discuss how these findings can inform policy options and assist in the development of the eCooking strategy.

2.2.1. Highlights from the KNeCS Presentation

Mr Kevin Nayema from NCIR discussed the electrification progress in Kenya, sources of household electricity, household connectivity, electric cooking appliances, ownership, willingness to pay for appliances, and appliance usage.

The study findings aimed to map the status quo of eCooking in Kenya, evaluate the enabling environment, develop scenarios for eCooking, and create a feasible roadmap for implementation. The study employed mixed methods, including interviews, survey, focus group discussions, and analysis of secondary literature.

Survey Methodology

The survey approach was adopted from the National Clean Cooking Sector 2019 approach but modified to specifically focus on electric cooking aspects. A total of 2,432 households were interviewed using a 10-module questionnaire that covered various aspects of household cooking practices and energy mix. Mr Nayema explained that the key variable used to determine the sample size was eCooking prevalence. According to the latest national census report, the prevalence rate of eCooking was 0.9% and 0.2% for main grid and solar/eCooking respectively. Based on this rate, the sample size needed to generate valid results would be 26,220 households. However, due to resource constraints, the team narrowed down the sample size using the cluster analysis technique, which involved creating sampling units of highly similar counties using a multivariate statistical procedure. As a result, the algorithm produced 10 clusters, among them two independent counties which were termed as outliers, as shown in Figure 3. Counties within each cluster were homogenous, with some being geographically non-contiguous but still grouped together due to similar characteristics that influence household cooking practices, such as high urbanization rate and high grid connectivity. The selected county allowed the team to extrapolate and generalize results for other counties within the same cluster. Thus, the sample size was significantly reduced from 26,200 to 2,432 households, making the study feasible within the available resources.

Counties	Characteristics	Name
Kericho (35)Kilifi (3)-Meru (12)-Trans-Nzoia (26)-Vihiga (38)-Kisii (45) cluster	high crop, high irrigation	Other region
Lamu (5)	Outlier	Pwani region
Tana River (4)-Turkana (23)-Wajir (8)-Mandera (9)-Garissa (7)-Marsabit (10)-West Pokot (24)-Samburu (25) cluster	highest household size, lowest education, lowest livestock, low urbanization, highest grid ecooking, highest solar ecooking, lowest grid connectivity, low battery use, highest generator	Frontier regions
Taita Taveta (6)-Machakos (16)-Embu (14)-Nyandarua (18)-Laikipia (31)- Tharaka Nithi (13)-Makueni (17) cluster	High irrigation, lowest grid ecooking, high generator	Eastern & Southeastern region
Isiolo (11)	Outlier	Frontier 1 region
Nandi (29)-Elgeyo Marakwet (28)-Kwale (2)-Baringo (30) cluster	high household size, least urbanised, low grid eCooking, low generator	North rift Region
Mombasa (1)-Kiambu (22)-Nairobi (47) cluster	lowest hhousehold size, Highest education, Highest urbanisation, High grid ecooking, highest grid connectivity,	Highly urbanised region
Nyeri (19)-Kirinyaga (20)-Murang'a (21)-Kajiado (34)-Uasin Gishu (27)-Nakuru (32) cluster	low household size, high livestock, highest irrigation, high grid connectivity	Central/Aberdares region
Kitui (15)-Narok (33)-Bomet (36)-Migori (44)-Bungoma (39)-Kakamega (37)-Busia (40) cluster	highest crop, highest livestock, low grid ecooking, low grid connectivity, highest solar connectivity, highest battery use	Western region
Siaya (41)-Homa Bay (43)-Kisumu (42), Nyamira (46) cluster	highest fishing, high solar connectivity, high battery use	Lake region

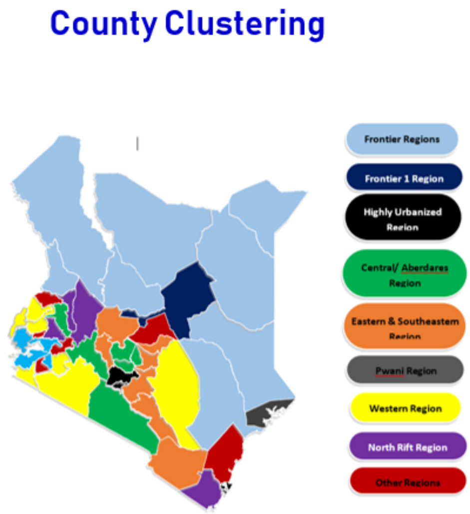

Figure 3: Sample clustering indicating counties selected for the study

Electrification in Kenya

In Kenya, the progress of electrification has been significant, with a predominantly main grid-dominated electricity supply reaching 75% of the population. Despite this high electrification rate, the adoption of electric cooking remains remarkably low. The study considered grid connectivity to include the national grid and public mini grids, with solar emerging as a backup source and an essential electricity supply for many households. However, reliable electricity supply is crucial for any successful transition to electric cooking, as most households lacked backup power options. The team used the Multi-tier Framework (MTF) approach, developed and operationalized by the World Bank, to analyze household connectivity and their capacity for electric cooking comprehensively. The MTF approach does not treat electrification as a binary variable (connected or not), but rather considers various attributes such as capacity, availability, reliability, and affordability. All regions demonstrated decent levels of electricity connectivity. Availability of electricity over a 24-hour period and a 4-hour evening period, which is crucial for supper preparation in Kenyan households, was analyzed.

Surprisingly, about 75% of households did not face acute challenges in terms of availability, raising questions about the factors influencing the lack of electric cooking adoption despite electricity being available. The study revealed that Solar Home Systems (SHS) in Kenya are limited in capacity, classified as Tier 2, capable of powering only light-use appliances like TVs and phone charging. However, efficient electric cooking appliances like rice cookers require Tier 3 and above. Thus, there is a need to increase the capacity of SHS to support electric cooking and encourage its adoption among Kenyan households.

Electric cooking appliances

There has been considerable underreporting of forms of clean cooking such as electricity for cooking in previous national surveys, with the latest statistics from the 2019 Kenya Cooking Sector Study showing that 1% of households using it as a primary cooking fuel, and 3% of households owning an electric cooking appliance such as mixed LPG-electric stove, electric coil stove and microwave (GOK, 2019). These studies did not adequately capture e-cooking prevalence as part of cooking stacking strategies, or the use of task-specific electric cooking appliances such as kettles, hence the need to conduct the Kenya National eCooking Study (KNeCS) to establish the status quo of e-Cooking in Kenya.

Electric cooking appliances ownership in Kenya has shown a significant increase, with 23.9% of households now owning such appliances nationally. This marks a significant increase from the 3% ownership reported in the 2019 sector study, which covered only a limited number of appliances. The research delved into 15 different electric cooking appliances, with water heaters, electric kettles, and microwaves emerging as the most popular choices in that order. Connection to the main grid appeared to be the primary driver of appliance ownership, alongside factors like urbanization rates and household income. The study also explored households' willingness to pay for electric cooking appliances, employing the van Westendorp approach to determine a price range within which households would feel comfortable paying. The analysis indicated that households were willing to pay between 3,000 to 15,500 Kenyan Shillings, providing valuable insights for designing affordable electric cooking appliances to target different household segments.

Ownership patterns based on gender showed that male-headed households had higher ownership of electric cooking appliances. In terms of appliance usage, there was a concentration on heating and boiling tasks, with households primarily using the appliances for specific purposes. The study highlighted the need for interventions to encourage households to move from task-specific usage to more general utilization of the appliances to cook main meals. Moreover, factors influencing appliance choice differed between urban and rural households, with affordability, convenience, and availability playing significant roles in their decision-making process.

The study further delved into stove stacking as illustrated in Figure 4, revealing that households use multiple fuels and technologies for cooking, and ecooking appliances played a bigger role as a secondary or tertiary stove. This highlights the complexity of the cooking landscape and the need for multifaceted strategies to address clean cooking solutions effectively.

Stove stacking

- Stacking of cooking solutions:
  - Stacking is a common practice in Kenyan kitchens.
  - Cookstove stacking: Use of multiple energy solutions to meet a single energy need
  - Fuel stacking: Use of multiple types of fuel for cooking
  - Three categories in this study: One cookstove, two-cookstove stack, and three cookstove stack
  - Dominant cookstoves: Three Stone Open Fire, Charcoal Stove, LPG Stove

		As the Only Cookstove	Primary Cookstove in Stack of 3	Secondary Cookstove in Stack of 3	Tertiary Cookstove in Stack of 3
Clean Cookstoves	LPG Stove	**20.13%**	**31.82%**	**20.62%**	8.80%
	Mixed LPG-Electric Stove	0.42%	1.78%	0.78%	0.75%
	Water Heater Coil	0.00%	0.00%	0.02%	0.06%
	Electric Kettle	0.00%	0.00%	0.15%	0.38%
	Microwave	0.00%	0.00%	0.13%	0.19%
	Induction Stove	0.00%	0.00%	0.06%	0.09%
	Hot Plate	0.09%	0.00%	0.00%	0.06%
	Rice Cooker		0.00%	0.10%	0.16%
	Electric Oven	0.00%	0.06%	0.23%	0.15%
	Electric Hob	0.13%	0.04%	0.11%	
	Electric Pressure Cooker		0.00%	0.40%	0.10%
	Electric Coil Stove	0.11%	0.18%	0.17%	0.07%
	Biogas Stove	0.18%	0.12%	0.31%	
	Biofuel Stove	0.93%	0.89%	1.76%	0.81%
Improved Cookstoves	Improved Charcoal Stove	**11.15%**	**14.07%**	**24.99%**	3.02%
	Improved Firewood Stove	1.83%	5.01%	2.84%	1.22%
Polluting Cookstoves	Metallic Charcoal Stove	5.37%	5.85%	**26.14%**	7.50%
	Three Stone Open Fire	**57.18%**	**39.39%**	**13.81%**	6.41%
	Kerosene Stove	2.50%	0.80%	7.18%	2.83%

Figure 4: A snapshot of the study results on stove stacking

Supply Chain and Enabling Environment

Dr Abigael Okoko from NCIR highlighted the supply chain of electric cooking appliances in Kenya. There is a wide range of eCooking appliances available in Kenyan households, each with its own cost. The study revealed that the importation process of these appliances involves various key players such as manufacturers, suppliers, distributors, freight forwarders, customs brokers, Kenya Bureau of Standards (KEBS), and Kenya Revenue Authority (KRA). The supply chain involves component manufacturing, assembly, quality control and testing, packaging and shipping, import and customs clearance, distribution and warehousing, and ultimately retail.

This supply chain experiences various challenges such as high upfront costs, price fluctuations, rapidly changing appliance models, low import volumes, lack of appliance customization, poor quality imports, and limited capacity of Electric Pressure Cookers (EPCs). To address these challenges, collaboration among manufacturers, distributors, and policymakers is crucial. Investments in local manufacturing, improved supply chain management and targeted interventions are necessary to create a more conducive market for the adoption of electric cooking appliances in Kenya.

There are various local delivery models existing in the country, such as physical retail outlets (e.g., supermarkets), authorized dealers and distributors, online shops, door-to-door sales, agency models and regional hubs, and distribution through *chamas* (self-help groups). Marketing methods used for eCooking appliances primarily involved media adverts, followed by social media and online advertising, word of mouth, and referral marketing. Regional eCooking hubs had also been established in Nakuru, Kitui, Makueni and Kisumu during the time of study to promote eCooking.

Financing options for electric cooking appliances were explored, including cash and carry models, asset financing loans, PayGo models, layaway savings, chamas (self-help groups), and gifts. On the supply side, grants, equity and impact investments, results-based financing, smart-meter-enabled carbon financing, and utility-led financing were identified as potential sources of financing.

The supply chain also includes after-sales service such as installation, repair, maintenance, and warranty support for eCooking appliances. Different service providers were available, with some having service shops or customer care centers for repair services. However, challenges included low demand for such services in rural areas, hence hindering investments in service centers, and the need for access to quality spare parts across the country.

Energy service companies, utility companies, and mini-grid providers play a significant role in electrification and price setting, infrastructure development, and promoting renewable energy sources, which influences the uptake of eCooking. Dr Okoko also touched on the quality assessment of eCooking appliances. Currently, there are no specific quality measures for eCooking appliances in the country apart from the Global LEAP award system that is being used. Efforts were underway by organizations like Kijani Testing and KEBS to ensure quality appliances.

Dr Onsongo also briefly discussed the enabling environment, noting a lack of intense coordination across health policies, environmental policies, and energy policies related to clean cooking. There is a need for better coordination and target setting across different ministries and state departments to drive a holistic approach towards clean cooking. Mindset shifts are needed in the policy sphere to address skepticism about electric cooking.

Pictures from Session 1 of the workshop

2.2.2. *Stakeholder feedback session*

Table 1 below summarises the feedback session by outlining the questions posed by the audience, and the answers provided by the presenters of the session.

Table 1. Summary of the Q&A session after presentation of the KNeCS Findings

Questions	Answers/Information
What was the decision-making process, costs, and the role of the head of the household in appliance ownership?	The study's definition of household includes people sharing a living space and subscribing to one person as the head of the household. This person is not limited to the patriarchal definition and could include any individual who contributes to cooking arrangements. The financial and expenditure decisions made by the head of the household were assessed.
What was the sampling method within regions, the definition of eCooking, and the assessment of secondary fuel use?	Counties were grouped into clusters for sampling using a random number generator. Both Mombasa and Nairobi were classified as fully urban with no significant data variation. eCooking was defined as the application of heat (sourced from electricity) to food. The study examined households' energy stacks but did not extensively assess secondary eCooking appliances use.
How were survey results extrapolated to the entire population, what was the breakdown of fuels used, and how was carbon finance approached?	The results were based on the sample size and were derived from weighting the sample to represent the national population. The study found that households tended to stack different fuels for specific uses.
What was the mean age of respondents and their awareness of electric cooking appliances?	The mean age reported in the study resulted from a random sample. The survey included a module on awareness and perceptions, but this aspect was not extensively covered in the presentation due to time constraints.
What was the correlation between eCooking adoption and literacy levels?	The questionnaire asked about willingness to switch to eCooking appliances, and approximately 65% were willing. There was a positive correlation between the level of education and the willingness to adopt eCooking appliances.
Was cooking separated from water heating in the study?	Separating water heating from the definition of cooking was suggested. Kenya had a policy promoting solar water heating. The climate difference between Mombasa and Nairobi could affect the applications of solar home systems for heating water.
How was the sample weighting conducted?	The weight applied in the study was determined through a multi-stage cluster sampling approach based on county population and electrification levels.
Was there an examination of historical trends and what is the availability of open access data?	Historical trends were not explicitly examined, but existing data were analyzed. The stakeholders have yet to agree on clear data sharing guidelines. Most data is owned by MoE.
What were the findings about stove stacking and the unit economics of carbon financing?	The study included robust data on stove stacking guided by three key questions: what participants cook, what they cook with, and how often they cook using specific appliances. However, the study did not extensively explore carbon financing.

What were the common cookware sizes and materials, and what were the channels of trade?	Most common sizes of cookware in the market is around 6 liters in capacity. The distribution space for electric cooking appliances is currently robust, with some distributors expanding to areas outside Nairobi.
What were the most common appliances used for water heating?	Water heaters and kettles were the most commonly used appliances for water heating according to the study.

2.3. Session 2: Coordination of Clean Cooking and Electrification Modelling

The objective of this session was to offer a forum to begin efforts to coordinate clean cooking modelling, particularly with a focus on electric cooking. Clean cooking models on several tools and platforms are at different stages of development. Participants had the chance to explore the capabilities of OSeMOSYS and OnStove and the Energy Access Explorer and how they could be used to address research questions pertinent to the forthcoming eCooking strategy. In collaboration with the respective modelling teams, Nuvoni presented preliminary findings of policy scenarios for validation by participants.

2.3.1. Highlights from the OSeMOSYS and OnStove/EAE presentations

Dr Onsongo introduced the session by highlighting the ongoing efforts by different teams in developing modeling tools for clean cooking and electrification. There was a debate within the organization on whether to develop a new model or leverage the existing ones. Nuvoni has been closely working with two teams:

- The first collaboration centers around the OSeMOSYS tool, in close cooperation with colleagues from University College London (UCL) in the United Kingdom (UK) and Kenya Power. The OSeMOSYS tool has been instrumental in the Least Cost Power Development Planning (LCPDP) process.
- The second collaboration focuses on utilizing the OnStove and Energy Access Explorer (EAE) tools. This work is conducted in collaboration with colleagues from the KTH Institute in Sweden and the World Resources Institute (WRI). The application of these tools facilitates a detailed cost-benefit analysis in their approach.

The teams have been refining the data inputs into both models and exploring different scenarios that can be modeled. They are also assessing the capabilities of the different tools and the research questions they can address, which revolve around developing policy options for upscaling of electric cooking. Dr Onsongo acknowledged that electric cooking cannot be modeled in isolation, as it is part of the broader clean cooking stack, hence a coordinated approach is required.

The OSeMOSYS model

Mr Pietro Lubello from UCL presented the OSeMOSYS model, an open-source energy system modeling tool which involves developing a Power Sector Model (PSM) that is integrated into the Whole Energy System Model (WESM). The WESM considers not only electricity, but also all sectors that consume energy. The team has conducted capacity-building workshops and bilateral meetings with stakeholders to improve the model's structure and data. The goals of the model include building in-country capacity, accessing international financing through the Data-to-Deal (D2D) process, and finding a role for WESM in the Integrated National Energy Plan (INEP) process.

OSeMOSYS tool determines the least-cost energy system configuration over a given time horizon, considering constraints such as demand, available technologies, costs, emissions, resources, and targets. The WESM aims to facilitate national planning, consider sector interactions, enable discussions between stakeholders, and provide insights for future energy system planning.

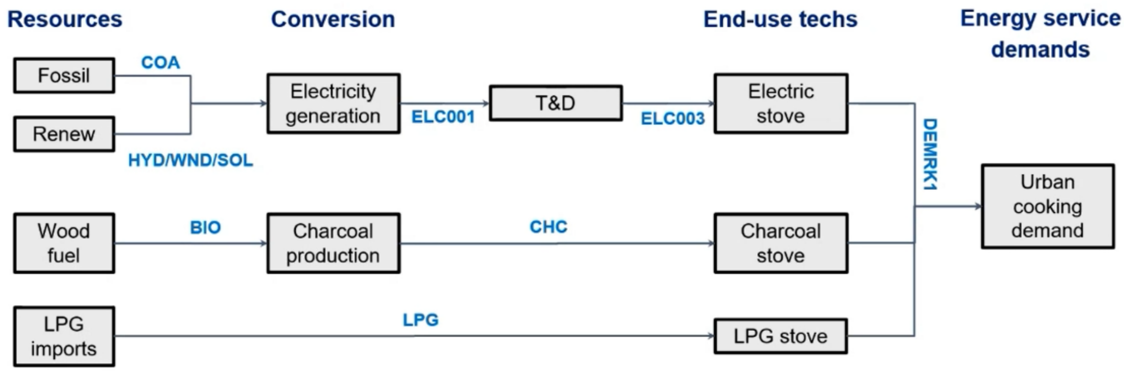

Figure 5. An overview of the clean cooking model as captured in the whole energy system in the OSeMOSYS tool

The WESM takes into account resources (e.g., domestic/imported fossil fuels, renewable/bioenergy resources), power sector generation (e.g., electricity generation), and energy demand across different sectors, over a time horizon of 2019-2050. Scenarios that have been modeled so far include:

- **Business-as-usual scenario**, which uses the current trends in the sector as reference point. Some assumptions made in the scenario are; electric cookstoves are used in 2.9% and 1.6% of urban and rural populations respectively, eCooking increases at a rate of 0.3% annually, kerosene as a cooking fuel will be phased out by 2030, et cetera.

- **Net-zero high electrification scenario**, which considers transitions in the cooking sector from traditional fuels to electric cooking technologies powered by renewable energy. Some assumptions made are; zero emissions of CO_2 from the cooking sector by 2050, 100% Tier 4+ electricity access in urban areas, 25% Tier 4+ electricity access in rural areas, solid biomass use completely phased out by 2050, et cetera.

OnStove Model

Mr Babak Khavari from KTH Royal Institute of Technology presented the OnStove tool, which is an open-source, geospatial, cost-benefit analysis tool developed in collaboration with the Clean Cooking Alliance, World Resources Institute, and other partners.

Rather than simplify the study area into one unit, the tool divides the study area (in this case, Kenya) into square kilometers to analyze the costs and benefits of different cooking solutions. The tool considers various stoves, including clean cooking options (such as biogas, LPG, and electric stoves), improved cookstoves, and traditional options (such as biomass and charcoal), and calculates the net benefit of each cooking technology. It is a flexible model that allows for the addition or removal of stoves based on specific scenarios.

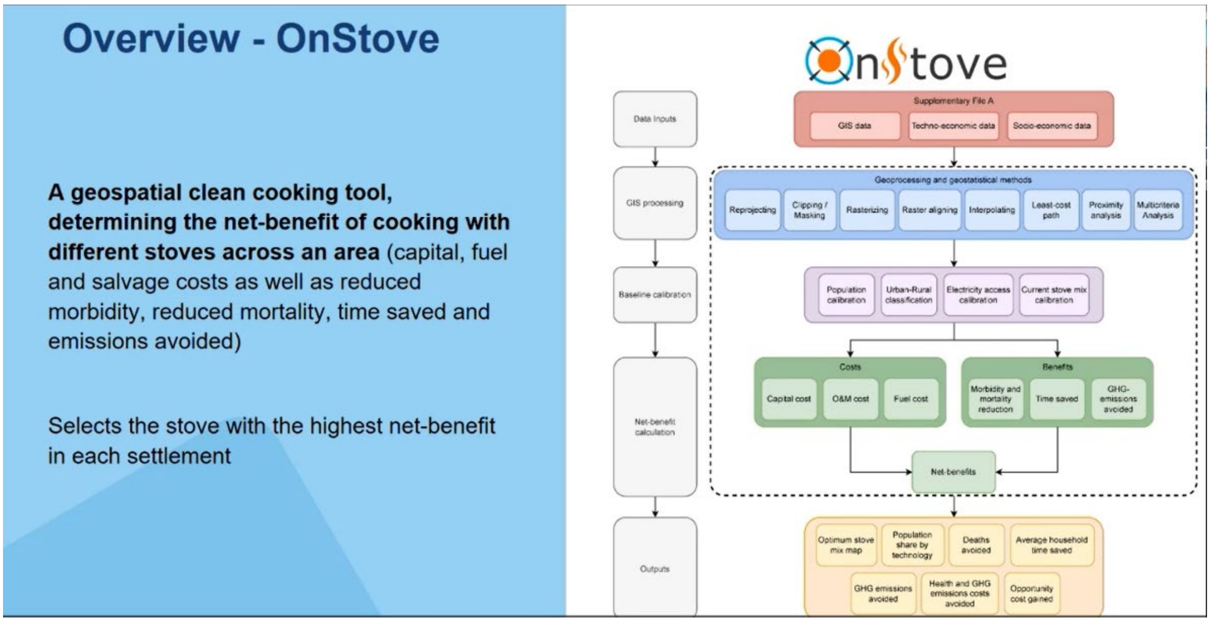

Figure 6. An overview of OnStove clean cooking modelling tool

The benefits analyzed by OnStove include reductions in morbidity and mortality from diseases linked to household air pollution, emission reductions, and time saved. These benefits are compared to the current situation, providing insights into the potential positive impacts of adopting different cooking technologies. OnStove also considers costs such as capital costs, operational and maintenance costs, fuel costs, and salvage costs. Health was identified as the most prominent benefit, while fuel costs were the most expensive. In all scenarios, the benefits of transitioning to cleaner cooking technologies far outweighed the costs. By subtracting the costs from the benefits, the tool calculates the net benefit for each technology in each square kilometer, enabling the selection of the cooking technology with the highest net benefit.

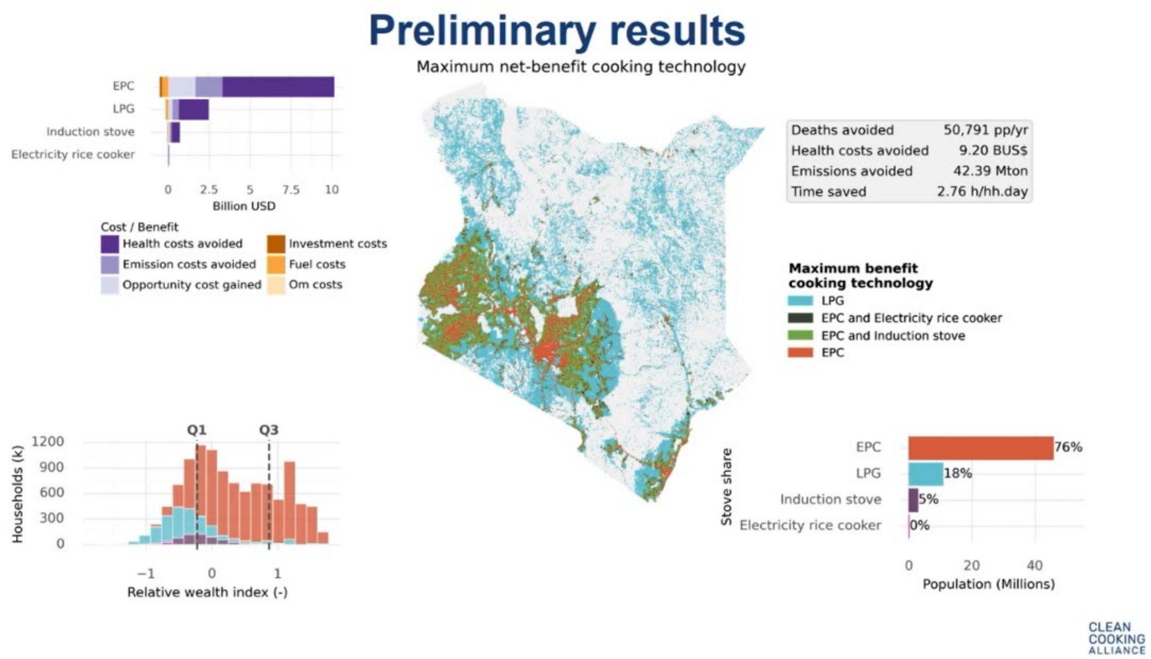

Figure 7. Preliminary results of the OnStove model capturing net social benefits of scaling eCooking in Kenya

The preliminary results from the first iteration scenario showed a strong emphasis on electric pressure cookers (EPCs) due to their significant net benefit as shown in Figure 7. LPG was also shown to be widely used, particularly in Northern Kenya, where population densities are lower. However, the data is still being recalibrated and continuously refined to ensure accuracy.

Mr Khavari highlighted that OnStove focuses on calculating net benefits and does not explicitly consider specific goals set by Kenya regarding stove transitions. However, the tool can be combined with other tools such as Energy Access Explorer (EAE) to maximize impact. The analysis showed that the benefits of transitioning to cleaner cooking technologies outweigh the costs in all scenarios.

Furthermore, Mr Khavari mentioned the connection of OnStove with other tools. It heavily relies on geospatial data and can be integrated with the OnSSET tool, which estimates the costs of cooking with different electric appliances and considers various electricity generation technologies. Additionally, OnStove can be used in conjunction with OSeMOSYS, which estimates the costs and emissions associated with electricity generation in the central power grid. Its integration with other tools enables a more comprehensive assessment of the costs, benefits, and impacts associated with clean cooking and electrification in specific geographic areas.

The EAE Platform

Mr Douglas Rono from the World Resources Institute (WRI) presented the Energy Access Explorer (EAE) tool, which is an online and open-source interactive platform used to visualize spatial data on energy demand and supply. The tool serves as a repository for energy-related data.

The data in EAE is grouped into different categories such as demand indicators, which include population density within a square kilometer and distribution of social and productive uses, such as hospitals and schools, that heavily rely on cooking appliances. On the supply side, the tool allows for overlaying data sets such as distribution lines and grid networks, solar potential based on global horizontal irradiation, wind speed, and more. The tool also incorporates electrification statistics extracted from census data and visualizes them at the subcounty level.

EAE works in tandem with outputs from other tools such as OnStove and OnSSET and visualizes them on the platform. This integration enables spatial-based multi-criteria analysis by considering various data sets. For example, to identify areas in Kenya that are suitable for cooking using electricity, one would need data on population density, demand indicators like schools and hospitals, census data indicating the prevalence of households using firewood or charcoal, relative wealth index data to assess affordability, and OnStove data on costs, among others.

Overall, Mr Rono highlighted the capabilities of the Energy Access Explorer tool in utilizing and visualizing spatial data to support analysis related to energy access, demand, and supply. By integrating various data sets, the tool enables a comprehensive assessment of different criteria for evaluating the potential for clean cooking and electrification solutions in specific areas of Kenya.

Modelling policy scenarios

Towards the end of the session, Dr Onsongo briefly discussed on the different policy scenarios that can be modeled using the above tools. These scenarios provide insights into potential outcomes based on different policy interventions and approaches. The scenarios mentioned include:

- *Business-as-usual scenario:* This scenario assumes a continuation of past trends with no significant interventions. It represents a baseline reference for comparison against other scenarios.

- *Net-zero scenario:* This scenario aims to achieve limited emissions by using the cleanest cooking appliances powered by renewable energy sources. It focuses on reducing greenhouse gas emissions and promoting sustainable cooking solutions.
- *Stated policy scenario:* This scenario models the current policy framework by considering the implementation of existing policies and regulations. It helps understand the potential dynamics and outcomes that can be expected if these policies are fully enacted.
- *Speculative scenarios:* These scenarios involve modeling specific interventions or policy measures that are currently not part of existing policy framework to assess their potential impact. Examples include modeling subsidies for electric pressure cookers (EPCs) or induction cookers to understand the outcomes and benefits of such interventions. Various policy options, such as tax incentives, disincentives, and behavior change campaigns, can be explored through these scenarios.

Additionally, Dr Onsongo mentioned that combined scenarios can also be considered, which involve combining multiple policy interventions or approaches to analyze their collective impact.

The selection of scenarios to be modeled depends on the desired output and the balance between time and effort. The iterative process of modeling allows for refining and exploring different scenarios to gain valuable insights into the potential outcomes and implications of various policy options. The modeling effort is ongoing, and lessons learned include the intensive nature of modeling in terms of time, labor, and data requirements. As such, the model tool provides guidance for policy design rather than prescribing exact actions. Dr Onsongo highlighted the critical importance of data quality in the modeling tools, emphasizing the principle of "garbage in, garbage out." In other words, if the input data used in the models is flawed or inaccurate, the outcomes and scenarios generated by the models will also be unreliable. The proposals and recommendations derived from these models must therefore be based on feasible and trustworthy data. It is crucial to ensure that the data used in the models accurately reflect the real-world context and dynamics of the clean cooking and electrification sectors in Kenya. Dr Onsongo expressed the intention to keep participants informed about the outputs and findings that will be generated through the modeling process.

2.3.2. Stakeholder feedback on clean cooking and electrification modelling

The participants several important points regarding the modeling process and its implications. Here are the key highlights summarized in Tables 2, 3, 4 and 5:

Table 2. Discussion on Modelling Considerations and Tools

Topic	Discussion
Grid Impact	There is need to consider the impact on the grid when scaling up electric cooking. With a significant increase in electricity demand, the capacity and constraints of the existing power system need to be taken into account. The OSeMOSYS model, integrated with the power sector model in the WESM, allows for the incorporation of grid constraints in the modelling process.
Regional Variations	It's important to consider regional variations in the modelling process. Different regions may have varying levels of power supply challenges, and it is crucial to identify potential bottlenecks and areas that would be easier to

	electrify. This micro-level analysis helps to identify the feasibility and challenges of scaling up electric cooking in different regions of the country.
Optimal Solutions	Capabilities of OSeMOSYS as an optimization model was questioned. Ideally, the objective of the modelling exercise is to find optimal solutions by refining scenarios and interventions based on the insights gained from the models.
Risk Analysis	A participant inquired on the consideration of risks associated with transitioning to renewable cooking solutions, such as e-waste management for appliances like electric pressure cookers. The modelling process primarily focuses on finding the optimal capacity mix and meeting demand, rather than addressing the afterlife of different technologies. However, the results from the models can inform further analysis and considerations regarding the environmental impacts and management of end-of-life appliances.
Integration of Modeling Tools	The overall plan is to integrate the modelling results from OnStove with other tools such as OnSSET and OSeMOSYS. The Energy Access Explorer (EAE) serves as a data repository tool that utilizes data from various sources and can be linked to other modelling tools.

Table 3: Summary of discussion on Model Features and Questions

Topic	Discussion
Fuel Stacking, Baseline Fuels and Cost-Effective Fuel Mix	Questions were raised on how fuel stacking is represented in the model and the determination of the most cost-effective fuel mix. The model can incorporate assumptions about fuel stacking and the technologies that can cover different fuel stacks. It also optimizes the capacity mix and dispatches fuels to determine the most cost-effective mix based on the installed technologies. The OnStove model takes into account the baseline fuels and estimates the percentage of population by using different stoves. The baseline includes more than just traditional stoves, with considerations for transitions such as moving from LPG to electricity.
Solar Electric Cooking and Efficiency Gains	This covered the inclusion of solar electric cooking in the model and whether it assumes efficient or inefficient eCooking. While off-grid solar is not directly part of the model, solar as an energy source is considered. The model is flexible enough to potentially incorporate off-grid solar and different efficiencies of electric cooking technologies. Changes in energy demand due to efficiency gains can be taken into account.
Fuel Savings and Discount Rate	A participant commented on omission of fuel savings from the OnStove model. It was clarified that fuel savings are indeed taken into account, but in certain scenarios, the fuel costs may be higher due to factors like increased expenditure on more efficient appliances. The model considers present value future benefits and costs using an input discount rate of 13.5% in the socioeconomic specification file. This rate could however be adjusted as needed

Difference between Cookstoves Adoption	A participant expressed surprise at the differences in net benefit results of EPCs (76%) and rice cookers (0%). The underlying assumptions leading to the results were not explicitly mentioned, but it was suggested that factors such as emissions, efficiency rates and cooking times play a role in determining net benefit of each appliance. The differences could also be attributed to the different types of foods modelled as being cooked with each stove.
Consideration of Black Carbon and Number of Cookstove Burners	The question was raised about whether the OnStove model accounts for black carbon emissions and the number of burners on the stove. It was explained that the model considers all emissions in the Kyoto Protocol, including black carbon, organic carbon and carbon monoxide. The number of burners is not explicitly modelled in the current approach, but it could be included by modifying the stove-related data in the technoeconomic specification file.
Data Sources and Frequency of Updating Data on OnStove	The data used in OnStove is informed by sources such as the Global Burden of Disease database and Oliver Stoner's academic efforts on modelling cooking solutions. The mortality rates of the diseases modelled are based on these sources. The data on current stove use is from 1980 to 2030. The information is not real-time and does not reflect the latest figures.
Ethanol as a Stove Option	Ethanol is currently being considered as an option and is planned to be included in OnStove. The tool aims to encompass a wide range of cooking solutions and their associated costs and benefits.

Table 4: Policy, Strategy and Planning Implications

Topic	Discussion
National Climate Change Action Plan (NCCAP) and Integration of Modeling Information	The information generated from the modelling process can feed into NCCAP III currently under development by providing insights and scenarios for clean cooking solutions. The modelling results can help inform the development of policies and strategies related to clean cooking and energy transition.
Expansion of Energy Access Explorer (EAE)	Douglas mentioned that the EAE was initially developed for three countries and has since expanded to six African countries, as well as India and Nepal. The plan is to further expand the tool to eight additional countries in Africa. The expansion is a collaborative process that involves stakeholder engagement and data collection efforts.
Data Availability and Collaboration with KNBS	It was suggested that involving officers from the Kenya National Bureau of Statistics (KNBS) in the modelling sessions would be beneficial to access the required data. Collaboration with KNBS, Kenya Power and other relevant organizations can provide valuable insights and data for the modelling process.
Usability of EAE	Feedback was given regarding the missing menu on OnStove and OnSSET interfaces. Douglas clarified that there are two interfaces of

	the EAE: a publicly available version, and a staging version used for testing new data. The menu tabs will be made available in the public interface in the near future, thereby improving the usability of the tool.

Table 5: Analysis and Measurement in OnStove

Topic	Discussion
Indoor Air Quality versus Ambient Air Quality in OnStove	Babak explained that the assumptions regarding indoor and ambient air quality are based on the concentration estimates derived from the work and publications of Daniel Pope. The model does not explicitly differentiate between the exposure of men, women, and children to indoor air pollution. However, there are demographic and health surveys available that provide insights into these differences, which could be incorporated into future versions of the model.
Cost of Inaction and Quantifying Benefits	The cost of inaction has not been explicitly quantified in OnStove. However, Babak mentioned that the Tracking SDG 7 report by the International Energy Agency estimates the cost of inaction at $2.4 trillion annually. OnStove can project costs related to benefits, opportunity costs, and emissions reductions, which can contribute to understanding the implications of inaction.
Cost versus benefit in OnStove	The calculation of net benefits in OnStove involves translating the benefits into costs. The specific cost calculations are not diversified within countries, and national values or social costs are used for comparison with the cost of adoption. The tool does not differentiate costs at a sub-national level.

These discussions emphasized the importance of data sources, stakeholder collaboration, and continuous improvement of the modeling tools to enhance their accuracy, usability, and applicability in informing policy decisions and actions related to clean cooking and energy access.

Overall, the Q&A session provided valuable insights into the modeling process, including considerations of grid impact, regional variations, optimal solutions, risk analysis, fuel stacking, and cost-effective fuel mix. The modeling tools will be continuously refined and adapted to address specific questions and provide guidance for policy development and decision-making.

2.4. Session 3: Backcasting for a Sustainable Electric Cooking Future

The workshop provided an opportunity for collective envisioning of a desired future, whereby stakeholders defined what a sustainable and inclusive future looks like for electric cooking in Kenya. The workshop adopted the innovative Back casting Methodology, which unlike forecasting that extrapolates future trends based on current data, starts with a desired future scenario and works backwards to understand what needs to change to achieve this vision. Stakeholders provided their insights into how they envision a transition to electric cooking as a primary fuel/technology in a clean cooking stack and a critical driver of demand for electricity could take place. Participants then collaboratively developed a roadmap to accelerate the transition outlining the strategies, actions, and policies needed to achieve this future. This includes considering the steps needed to bridge the gap between the present state and the desired future, identifying potential challenges, and outlining the support required at various stages.

There were 7 thematic areas of discussion in this session. These themes include cost (tariffs and appliances), technology, consumer behaviour, supply chain (local manufacturing and importation) supply chain (retail and distribution), policy and electrification. These are common factors that will influence the adoption of eCooking in Kenyan households.

Pictures from Session 3 of the workshop

2.4.1. Table 1: Cost

Cost is one of barriers towards transition from traditional cooking methods (TCMs) to eCooking. The net cost for the transition is affected by the cost of eCooking appliances and the cost of electricity tariff structures.

The upfront cost of purchasing eCooking appliances such as electric pressure cookers (EPCs) can be higher compared to TCMs like using biomass and fossil fuels. Many households in Kenya have limited financial resources and may find it difficult to afford the initial investment. The cost of extending electricity lines to remote areas can be high too.

The cost of electricity in Kenya plays a crucial role in the affordability of eCooking. If the cost of electricity is high, it may deter households from using electricity in cooking due to concerns about increased monthly utility bills. Affordability is particularly important in lower-income households, which may prioritize cheaper TCMs.

Interventions such as favourable government policies and incentives can influence the uptake of eCooking. If the government subsidizes the cost of eCooking appliances and/ or provides incentives to promote their use, it can make them more affordable and encourage households to switch.

Vision

The world café group discussion participant envisioned to have the cost of eCooking being most competitive cooking means in most Kenyan households by the year 2050. This means that the cost of eCooking will be cheaper than TCMs. In such a case households will go for the eCooking options.

Pathways

The participants noted several interventions and strategies necessary to achieve this dream. These include the following:

- **Electricity tariff structure:** For eCooking to be affordable to many Kenyan consumers, electricity tariffs must be affordable too. This means that money used to cook using a particular amount of and type of food using either fossil or biomass fuel must buy electricity units that can cook at least more food than what has been cooked on the same amount through TCMs.
- **eCooking appliances' cost:** The upfront cost of purchasing an appliance must be affordable. Interventions to make the cost of repair and maintenance of the appliances must also be considerable affordable. Initial efforts to make this happen must be deliberate to accelerate the uptake of eCooking before which the market factors will positively influence the cost thereafter.
- **Availability of eCooking appliances in the local market:** Currently eCooking appliances are not readily available in the Kenya local market. This is because the demand for the appliances is yet to be attractive to businesspeople. A consumer may decide to buy an ECA but because of the hustle involved before getting to a trusted dealer, they may give up and that becomes a postponed uptake.
- **Financing models**: During the time the cost of eCooking appliances is still high, consumers will have to pool together financial resources such that they make bulky purchase of eCooking appliances for economies of scale benefits. Alternatively, consumers can adopt group financing mechanisms.
- **Expanded benefits:** eCooking can offer various benefits in Kenya. These include environmental sustainability, improved health and safety especially for women and children who spend a significant amount of time near the cooking area and extra savings from fuel cost. By promoting the adoption of energy-efficient cooking solutions, the country can make significant strides towards sustainable development and improved quality of life for its population.
- **Business models:** For businesses dealing with eCooking appliances, plans such as pay as you go will work in encouraging uptake.
- **Research and innovations**: This will work toward lowering the cost of electrification, electricity connection and eCooking appliances. The research focused also on the efficiency of the eCooking appliances is also necessary. Improved efficiency in electricity usage and multi-purpose eCooking appliances tailored for local dishes are also important in dealing with the cost of eCooking.
- **Demand side management:** This was explained to be initiated by the electricity suppliers in which consumers can use electricity to cook when demand for the electricity by other competing needs is low. This should give the consumers an opportunity for tariffs that then cost less than usual.

- **Sensitization and capacity building:** Creating awareness about the direct and indirect benefits of eCooking to the Kenyan household will deal a blow to the belief that, food cooked by electricity is less delicious than the one cooked by TCMs and the health benefits of in reducing the harmful household air pollution (HAP).
- **Monetizing the benefits of eCooking:** Households are known to be enticed by money and they will always lean toward monetary benefits. If health, convenience and efficiency benefits are monetized, more households will be encouraged to adopt to tap into the monetary benefits. The benefits can then be redeployment to other sectors of the economy with direct benefits to the eCooking consumers.

2.4.2. ***Table 2: Supply Chain - Importation and Local Manufacturing***

Visioning

Supply chain in relation to importation and local manufacturing envisions a future in 2050 where the supply chain process is well-developed and supports the widespread adoption of electric cooking appliances. Here are the key elements and ingredients that paint the picture of a utopian supply chain in electric cooking:

- **Local manufacturing and affordability:** Local manufacturing processes play a vital role in achieving the affordable products hence it is very important to incentivising local appliance production and assembly. Companies like BURN demonstrate the potential for local manufacturers and assemblers to contribute to the supply chain.
- **Privatization of power supply and distribution:** Privatizing electricity sector can devoid negative impacts of politics in the sector with promotion of a liberal market. Careful consideration of such endeavour can devoid Kenya from the chaotic scenario being experienced in Nigeria.
- **Non-monopolization:** Breaking the monopoly in the power sector is crucial for a more efficient and dynamic industry. This applies to both price setters (e.g., EPRA) and distributors (e.g., KPLC). A diversified and competitive market would lead to better employment opportunities and improved service quality.
- **Distributed energy and renewable sources:** In 2050, envisioning 100% electricity availability requires efforts to connect every person in Kenya to a reliable and sustainable energy source. Mini grids such as solar home systems (SHS) and leveraging renewable energy sources can improve affordability and accessibility.
- **Climate change and carbon market:** The global shift toward addressing climate change and clean cooking presents opportunities in the supply chain. By fully transitioning to renewable energy and clean cooking through biofuels like ethanol and moving away from biomass, Kenya can align with global climate policies. Carbon credits can be integrated into the supply chain, creating new value chains and financial opportunities in the eCooking market.

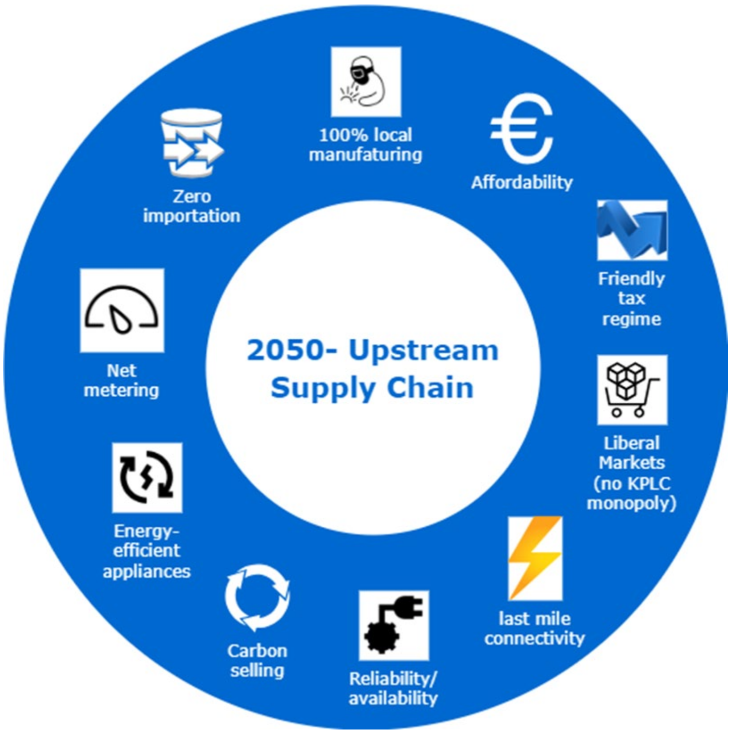

Figure 8: *Key elements and ingredients that paint the picture of a utopian supply chain in eCooking.*

Pathways

To achieve the envisioned future of a robust supply chain for electric cooking, several pathways can be pursued:

- **Robust research and development:** Investment in research and development (R&D) to drive innovation in electric cooking technologies, improve efficiency, and develop cost-effective solutions that meet the needs of consumers.
- **Capacity building at all levels:** This entails enhancement of skills and knowledge of individuals and organizations involved in the supply chain, including manufacturers, distributors, technicians, and policymakers through training programs, workshops, and knowledge-sharing initiatives.
- **Conducive financing and policy environment:** It entails creation of finance and policy related supportive environment to encourage investment in the electric cooking. This includes providing access to affordable financing options, offering incentives for businesses, and developing regulations that promote the adoption of electric cooking appliances.
- **Reducing manufacturing costs:** Manufacturing costs of Ecooking appliances can be lowered by incentivizing the importation of raw materials, supporting local production, and implementing measures to streamline production processes. Incentives can include tax breaks, duty waivers, or streamlined customs procedures.
- **Incentivize local production and private sector:** Tax incentives, subsidies, and grants on local production of eCooking appliances can promote job creation, technology transfer, and economic growth. Enabling environment for private sector participation in the eCooking sector by offering incentives and support can be done by giving access to financing and partnerships with government agencies is equally crucial.
- **Education:** Integrate eCooking into the school curriculum, with a focus on STEM (Science, Technology, Engineering, and Mathematics) education. This can help raise awareness and knowledge about electric cooking among future generations.

- **Financing local innovation and research:** Providing financial support and funding opportunities for local innovation and research in the electric cooking sector can spur the development of new technologies, business models, and solutions.
- **Driving demand:** Develop strategies to increase demand for electric cooking appliances, such as integrating eCooking appliances into government initiatives like housing projects can be achieved through policies that require the installation of electric cooking appliances in new homes or through awareness campaigns and consumer education.

By focusing on these pathways, Kenya can work towards achieving a sustainable and efficient supply chain for electric cooking, thereby promoting the widespread adoption of Ecooking appliances contributing to a cleaner, more affordable, and accessible energy future.

2.4.3. ***Table 3: Technology***

In this thematic area, participants note the current technological position. Then, they classified timelines into now, 2030, 2040 and in the end 2050.

For now, they envisioned in-built meters in appliances to monitor power usage in every moment of a cooking session. These data can then be relayed back to manufacturers, researchers, and policy makers to inform the next component that require improve for an improved appliance efficiency, inform research and development efforts, and support policy decisions related to energy consumption and efficiency.

The group envisioned the following by the year 2030:

- Rigorous testing and certification processes of eCooking appliances to ensure their safety, efficiency, and adherence to quality standards,
- A dedicated feedback platform that enables users of eCooking appliances to provide valuable insights, share their experiences, and suggest improvements to platform for fostering continuous innovation and customer-centric design.
- eCooking competitions among clean-cooking companies, particularly in the eCooking sector which can drive companies to constantly enhance their appliance designs, functionalities, and overall performance to gain a competitive edge.
- A robust data ecosystem where various stakeholders rely on available data to make informed decisions. This ecosystem will facilitate better understanding of consumer preferences, market trends, and overall industry dynamics, enabling companies to optimize their strategies and offerings.
- Significant advancements in technology aimed at minimizing emissions associated with the production and usage of electric cooking appliances. These innovations will prioritize sustainability and eco-friendliness, contributing to a cleaner and greener cooking environment.
- A greater emphasis on efficient waste disposal and recycling methods for eCooking appliances. This will involve the development of more effective and sustainable waste management systems, ensuring that discarded appliances are properly recycled, and their components reused wherever possible.

By the year 2040, the group envisioned a future where:

- Every household in the country uses electricity, at a 100% eCooking adoption rate by the year 2040.

- Electric Pressure Cookers (EPCs) and Induction Cookers have become the primary cookstoves in nearly every household and all dirty fuels have been phased out.
- Vehicles are equipped with fully functional kitchens powered by the moving vehicle itself with food preparation happening while on move.
- All institutions, commercial establishments, schools, hospitals, and other public facilities will transition to electric cooking thus improved air quality, reduced carbon emissions, and a healthier cooking environment for staff, students, patients, and the public.

By the year 2050, it was the anticipation of the group that there will be:

- Highly efficient eCooking appliances designed to minimize energy consumption, reduce waste, and optimize cooking processes, contributing to a sustainable and cost-effective will be accessible to every household.
- Wirelessly powered eCooking appliances will be available in the market to eliminate the need for traditional power cords hence great flexibility in kitchen layouts and seamless integration of cooking appliances into smart home systems.
- Improved microwaves with the capability to cook multiple foods simultaneously.
- Development and widespread availability of standalone electric cooking systems powered by solar and wind energy for efficient, effective, and affordable alternative to TCMs, reducing reliance on the grid and enabling environmentally friendly cooking options for households.
- Locally manufactured eCooking appliances with the assistance of robotics to streamline production processes and reduce costs.
- EPCs that can prepare multiple foods simultaneously saving energy and time taken to cook.
- eCooking appliances with 100% efficiency in the market optimize energy usage, resulting in minimal waste and maximum cooking performance. Moreover, they will save considerable time, reducing cooking durations by up to 70%. This will enable users to prepare meals more quickly, allowing for greater efficiency in their daily routines.
- Robots integrated in eCooking appliances to automate the cooking process.

Actions, strategies, and policies.

Policies

For the group aspiration to be achieved within the given timelines, the following need to happen:

- **Implementation of policies and standards for high-quality appliances:** Effective immediately, strong policies and requirements should be established to ensure that only the best electric cooking appliances are released in the market.
- **Strong implementation of policies to reduce usage of dirty fuels**: Robust policies should be implemented to effectively reduce the prevalence and usage of dirty fuels. This includes stricter enforcement of the policies to avoid repeat of what happened to the charcoal ban on specific trees, which was aimed ensuring the protection of endangered species and never fully reinforced.
- **Increased subsidies for clean cooking options:** The government should introduce and expand subsidies for electricity and other clean cooking alternatives like LPG to discourage households from reverting to the use of dirty fuels. These subsidies will help make these clean cooking options affordable to many households.
- **Removal of taxes on electric cooking technologies**: The government should eliminate taxes on electric cooking technologies and any other measures that hinder the adoption and affordability of these technologies, encouraging their widespread use.

- **Enabling environment for electric cooking players:** The government should create a conducive environment for electric cooking players to operate smoothly in the country by 2030. This includes favorable policies, streamlined regulations, and supportive incentives for the growth and sustainability of the electric cooking industry.
- **Waste disposal policies for electric cooking**: Immediate policies should be implemented to regulate the proper disposal of waste generated from electric cooking. These policies should address recycling, waste management systems, and promote environmentally friendly practices.
- **Establishment of research and development institutions:** By 2030, it is crucial to set up dedicated research and development institutions focused on designing and improving electric cooking technologies. These institutions will drive innovation and develop more advanced appliances among others.
- **Increased awareness creation for electric cooking:** Immediate efforts should be made to raise widespread awareness about electric cooking technologies, emphasizing their benefits and encouraging greater uptake. Awareness campaigns mainly targeting consumers will play a vital role in increasing adoption and understanding of electric cooking. This should happen immediately.
- **Development of financing models for electric cooking**: There is an immediate need to develop financing models that specifically address the consumption and management aspects of electric cooking. These models should provide accessible and affordable financing options for consumers, enabling them to transition to electric cooking systems.

Strategies

The following are strategies that were noted to be key in revolutionizing the eCooking in Kenya:

- **Inclusive capacity building involving all sector stakeholders:** Starting immediately, capacity-building initiatives should be undertaken, involving all relevant stakeholders, to accelerate the adoption of electric cooking technologies. This includes training programs, workshops, and knowledge sharing platforms to equip individuals, communities, and organizations with the necessary skills and understanding of electric cooking.
- **Multilingual appliance manuals:** There is need to have electric cooking appliances which come with manuals available in different languages to ensure that they are easily understood and accessible to everyone, regardless of their language and proficiency levels.
- **Implementation of policies and standards for high-quality appliances:** There is a need for strong policies and requirements to ensure that only the best electric cooking appliances are released in the market. These policies should focus on safety, efficiency, and performance standards, providing consumers with reliable and high-quality products. This will in turn encourage electric cooking appliance manufacturers to improve the quality and efficiency of their appliances.
- **Establishment of repair and spare parts shops:** Companies involved in electric cooking should develop strategies to set up dedicated repair shops at different locations nationwide. Additionally, other entities should be encouraged to establish repair and spare parts shops to ensure easy access to maintenance and repairs by 2033.
- **Inclusive capacity building involving all sector stakeholders**: Beginning immediately, all capacity building initiatives undertaken should involve all relevant stakeholders, to accelerate the adoption of electric cooking technologies.
- **Inclusive planning and learning from leading nations:** Plans should be developed to include all groups, communities, tribes, and religions in the planning process for electric cooking

adoption. Furthermore, valuable insights and experiences from leading nations such as South Africa should be considered to inform and enhance local electric cooking initiatives.

- **Reduction of electricity prices:** The government should explore measures to reduce the price of electricity, making it more affordable for households and encouraging the uptake of electric cooking technologies.
- **Increased carbon financing:** Effective immediately, plans should be implemented to increase carbon financing, encouraging investment in clean energy solutions, including electric cooking technologies. These efforts will contribute to carbon reduction targets.
- **Behavioral change through sensitization and capacity building**: Efforts should be made to change consumption behavior by promoting electric cooking through sensitization campaigns and capacity building initiatives. These programs should emphasize the benefits of electric cooking and provide practical guidance on transitioning from traditional cooking methods.
- **Venture capital and development partner support:** Venture capitalists and development partners should actively finance startups in the electric cooking sector, supporting local manufacturing and production of these products.
- **Integration of electric cooking in education:** The government should incorporate electric cooking and clean energy into the curriculum of the Kenyan education system, ensuring that students are educated about these technologies and their benefits from an early age.

Barriers

These are barriers that are likely to challenge the vision:

- **Access to Finance**: Acquiring electric cooking appliances is likely to be challenging for many households due to financial constraints. To address this issue, implementing proper financing mechanisms without imposing taxes and subsidies on these appliances is crucial. By providing affordable financing options, households will have increased access to finance, enabling them to afford electric cooking appliances.
- **Grid Quality and Access**: Ensuring reliable grid quality and access to everyone is likely to be a challenge we might face but through taking electric cooking into account when doing grid forecasting will be vital in estimating electricity demand accurately. Additionally, extending the grid to unserved regions will play a vital role in enabling households to switch to electric cooking.
- **Cultural Barriers**: Cultural norms and beliefs may impede the complete transition to electric cooking. To address this challenge, conducting sensitization and awareness campaigns will be needed. Educating consumers about the benefits of electric cooking, such as reduced emissions and improved indoor air quality, will help overcome this barrier.
- **Supply Chain Challenges:** The supply chain presents another potential barrier to the widespread adoption of electric cooking. However, establishing robust and efficient supply chains can mitigate this issue.

2.4.4. Table 4: Supply Chain (Distribution and Retail)

The supply chain for electric appliances is complex and has several stages, from raw material extraction to the end consumer. The process can vary based on the specific appliance and the companies involved. Our group discussed the distribution and retail stages of the electric appliance supply chain. Distributors and wholesalers manage the inventory, storage, and distribution of the appliances to retailers nationwide. Retailers purchase electric appliances from distributors or wholesalers and sell them to the end consumer.

Solar company (Sunking) has ventured into retailing EPCs through PayGo and the pilot showed that EPC is the most affordable in the long run, albeit with a high initial cost.

Vision

This group envisioned an increase in demand for EPCs, after sales support, nationwide eCooking hubs, local capacity to repair and dumping technology for the same.

However, the group noted inadequate awareness of the transition opportunity, unaffordable cost of the EPCs and inadequate infrastructure as notable barriers which need to be broken to reach to the future.

PATHWAYS (actions, strategies, and policies)

The participants discussed strategies, actions, and policies to address the challenges highlighted and what was required to achieve the envisioned future. Top among the solutions include:

Leverage digital tools to reach broader coverage with short videos on TikTok or YouTube to show how the appliances are used. EPCs retailers such as Sayona sells convenience to create club effects in adopting EPC. For example, demonstration on TV that cooking Githeri using EPCs gets ready within 18 minutes vis a vis other cookstoves such as LPG, charcoal, or firewood ones. Training on usage in the eCooking hubs or centers set up countrywide can ensure that the consumers appreciate the benefits of eCooking. Devolving the Kenya Power *Pika na* Power hub beyond Nairobi City can be a game change in the awareness creation. The manual could also be translated into local languages for people to understand.

To have affordable cost for the Ecooking appliances, this group recommended that the government lower the tax rate to accommodate the (**3000-15000**) WTP range illuminate in the KNeCS report. The high taxation rate affects EPC landing costs. This can be achieved by providing Carbon credit. Pay-Go models for those who may not be able to pay upfront can also work.

Other pathways include having:

- For adequate infrastructure, electrification, enhancement of road connectivity, and general construction of eCooking hubs must be countrywide.
- For induction stoves to be favoured in adoption, they should have their energy saving sufurias.
- Policies to counter electric appliance dumping, given the evolving technology. Establishment of a body like KEBS that regulates EPC standards.
- Phasing out polluting fuels like kerosene and firewood. This should have a timeline, say by 2030 (like the plastic paper ban)
- Promoting the political will on the transition to eCooking (as is the case of e-transport by the Kenya Kwanza government).

2.4.5. Table 5: Policy

Existing policies

The existing policy that are connected to electric cooking were highlighted as follows:

- SDG 7
- Sustainable development action agenda
- Energy policy
- Energy act
- Gender policy-national
- National cooking strategy
- Electric cooking strategy
- Connection policy-KPLC
- Gender policy
- National climate change action plan
- Green incentives fiscal inceptives policy
- INEP framework contributing to the integration of energy planning (expired but there are plans to review it)
- KNES

Vision

The group envisioned the following:

- Reduce reliance on firewood and kerosene given the health and environment impacts of the reliance on firewood and charcoal, the vision is to reduce their use in cooking.
- We envision a country where cooking using with kerosene is eliminated by 2028 due to its detrimental effects to the health of the people.
- We envision a progressive uptake of eCooking which will be achieved by encouraging then adoption of electric cooking first as a secondary fuel and adopt a progress approach to its adoption to a primary fuel for majority of Kenyans by 2050.
- We envision an environment where there is full enforcement of charcoal regulations.

The entire vision would be achieved at different timelines including those which were outlined as short-term (2028), medium and long (2050) term.

Strategies

The strategies that were discussed in achieving the vision touches on electrification, local manufacturing and standards and labelling.

For electrification:

- Universal electricity access by 2026 should be encouraged by either extending the national grid or embedding off grid electricity generation.
- Policies to encourage more independent power producers to plug into the electrification system will ensure a stable and reliable electricity supply.
- Policies must shift from monopoly power distribution by encouraging other stakeholders such as REREC to give the service to dispel Kenya Power loads that seems to be overwhelming to the company.
- Policies should make Kenya Power more of essential public entity than a profit company.
- Policies must aim to remove taxes and customs on SHS and fuel that run power generating turbines.
- Policies to encourage and support innovations around batteries for SHS, eCooking appliances and electricity distribution to enable more households to adopt.

On local manufacturing, policies should be formulated to:

- To give a grace period of 5-10 years for start-up to start to pay taxes and other statutory payments. Currently, the tax environment does not allow growth for startups. We need policies that will give room for innovative start up on energy technologies to mature before they can start paying tax. Many startups end up going under after a few years because of the hefty taxation weighed upon them immediately they register their business or immediately they come to the KRA radar.
- Development of strategic incubation centers across the country to encourage innovation of clean cooking appliances. This will encourage innovation, grow local capacities, and reduce the reliance on importation of appliances from abroad.
- Ensure outputs gotten from the local institutions are submitted to the parent ministries, and they are supported for incubation and further development.
- Support investments and create a conducive environment for research and development in the solar industry and innovative start-ups by those which are funding energy oriented.
- Support development of innovation Centers and securing funds for them.
- Enhance the capacity of our institutions e.g., KIRDI to enhance local innovation and incubation.

For standards and labelling, policies should:

- Formulate standards and label of eCooking appliances to phase out inefficient appliances and develop a star rating system.
- Help in coming up with QR codes to verify products approval a Kenyan self-verification system to ensure that products that Kenyans buy and have been imported from abroad meet the required safety and emission standards.

Ensure strict adherence to the standard with serious regulation of the market to reduce the influx of substandard good e.g., deterrent penalties that will block distribution of product chains that will be found to be substandard.

2.4.6. ***Table 6: Electrification***

With Kenya gearing towards a 24-hour economy, the centrality of electrification cannot be gainsaid. On one hand, the actualization of regional interconnectivity amidst financing deficits threatens to sabotage full electrification across the country. On the other hand, it seems inevitable that a balance must be struck between access and affordability on one end of the spectrum, and reliability and convenience on the other end. A characteristic of this delicate position is that the country is yet to fully utilize its electricity generation capacity whereas alternative power supplies, through independent power producers, face inefficient pricing.

We acknowledge that Kenya's electrification landscape breeds both interesting narratives worth sharing as well as pitiable circumstances. For instance, greater access to electricity as evidenced by greater penetration of electrification has not translated into reliable power supply. As a result, households and businesses must grapple with unreliable, and, at times, overpriced power; a scenario that presents loopholes for illegal power connections manned by community rackets. At the same time, a transition to alternative sources of green energy such as solar power produced at the household level faces financing constraints. Suggestively, power consumers in Kenya are presented with a dilemma; either rely on overpriced electricity that is also unreliable or cough up large sums of money towards own power generation at the household and firm-level.

This panel, therefore, sought to visualize electrification in Kenya in the year 2050 within the context of prevailing circumstances and global commitment by various stakeholders and partners towards the fruition of a green economy, "The Kenya We Want". The panel consisted of 3 sessions, with each session constituting an interdependent panel. That is, session 2 panel put into consideration the deliberations of session 1 panel while session 3 panel reviewed the conclusions arrived at in the previous two panel sessions. To avoid repetitive discussions, session 1's panel deliberated over visioning in which participants conceptualized an ideal electrification future [in year 2050] with an intermittent 2035 consideration; in session 2, pathways were coarsely defined in highlighting actions, strategies, and policies, and; the last session teased together how integration could be realized within the policy and technological space. This was followed by a summative presentation to the workshop executed by the panel chair. It is important to note that sessions 1, 2, and 3, had 8, 5, and 8 participants, respectively. Table 1 presents some of the highlights.

Table 1: Key Highlights

Round 1 **Vision: 2050**	**Round 2** **Vision: 2035**	**Round 3**
Zero waiting time Disrupted built environment. Zero power disruptions Near negligible stacking	Zero vandalism 30GW grid=f(demand) 3 major grids Stable storage systems	Integrated power supply Open access power Cost harmonization
The 24-hour economy Wireless electrification Regional interconnectivity	Balanced resources Radiation/ wireless transmission Smart Grid/ hydrogen green grid	Tap tech. Incentives for affordability
Mega-structure complexity	Loss minimization	Leveraging on technology

Session I: Visioning

The idea was that participants imagined themselves traveling into the future with a target 2050 in mind. However, we enjoyed a soft landing in 2035; at which point we reflected on the status of electrification. Among the nirvana highlights were the following:

i. Having transited to a 24-hour economy with full regional electrification interconnectivity, the 2035 rural setup twins the urban landscape. Here, it was visualized that electrification dynamics revolve around three game changers. That is, recognizing that power demand is a function of customer appliances which are exponentially increasing given the pace of technical progress, independent actors enter the power generation arena to tap on any positive spillovers. As a result, the supply of power rises which depresses both the cost of power generation, cost of power consumption, and waiting time downwards. With a declining power production cost and increasing power output, the country witnesses greater power stability.

i. Since power defragmentation offsets economic inefficiencies through system failures and leakages, mini grids exist alongside major grids. Any leakages from the mini-grids are absorbed within the mega-structure whereas inefficiencies from the mega-structure are taken care of by mini-grids. This ensures seamless work-home office balance as well as facilitate tele-working and cost minimization. Furthermore, it was anticipated that call centers will be innumerable with the mandate of not only coordinating communication between mini-grids and the mega-structure but also serve as a feedback mechanism. Mini grids are feeding on windmills, geothermal, and solar storage systems.

ii. With full electrification both at home and at the workplace, there is a balance in the sense that it no longer matters where the 'load' is; i.e., you can work either from home or the office without power disruptions. This is reinforced by the presence of fully initialized capacitor banks with a 45-year life span.

Note: customers=appliances

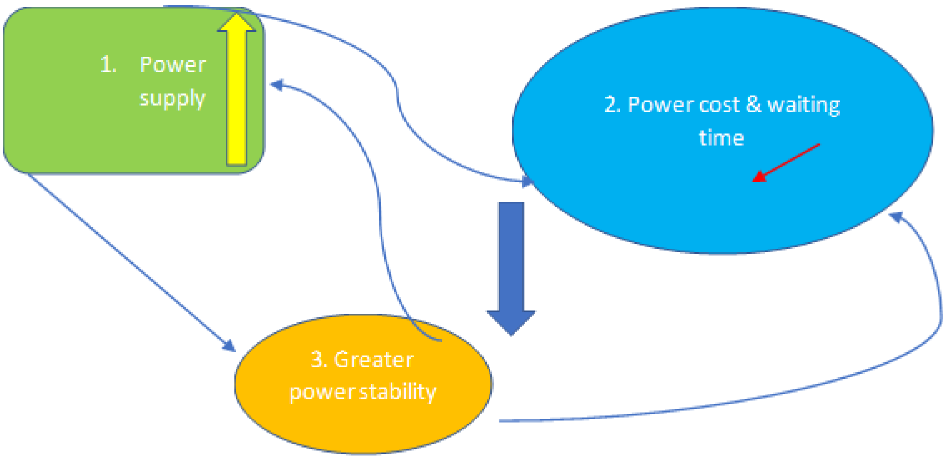

Figure 2: The Game Changer Dynamic

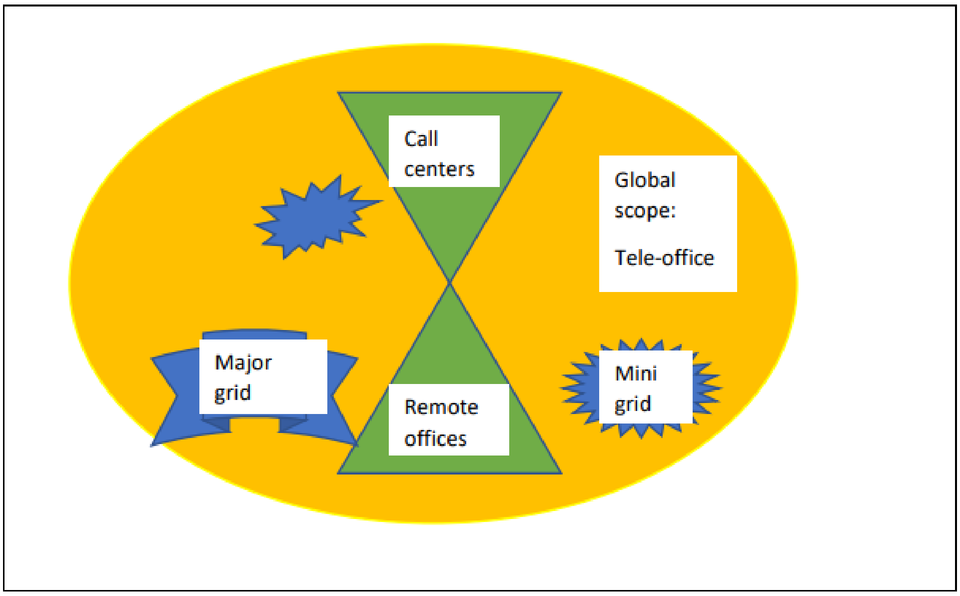

Figure 3: Mega-structure complexity

Session II: Pathways

From session I, participants indicated the following key considerations: power loss minimization, smart grid connectivity, scratch card power, and radiation/ wireless transmission alongside hydrogen green grid. These were dubbed 'aspirations' rather than actions with the following targets: zero vandalism, 30 Giga watt grid being a function of demand for electricity, 3 major grids that mimic China, and stable storage system, as well as marketing of power. It was suggested that aspirations need to be backed by power to avoid a standard gauge railway-like situation. The strategies (level 1), actions (level 2), and policies (level 3) are summarized in Figure 3.

Figure 4: Pathways

An additional two strategies were identified alongside actions. To address off-peak demand, stabilizing the grid and cost harmonization were deemed viable strategies that could be acted upon via night production such as in charging electric buses. Policy-wise, it is important to revise the Energy Act to reduce night electricity tariffs. To address peak demand, cost harmonization and education/ customer capacity building were carefully considered with actionable plans being time-dependent pricing and efficient power utilization that leverages on technology.

Note: participants indicated that demand/ off-peak demand is dictated upon by customers, and not industries.

Session III: Integration

Participants recognized a disconnect between the 2035 We Want and the 2023 We Live In. For instance, it was revealed that a disjoint exists between the rural low-consuming customer and the 2035 consumer who is envisioned to be much better than the present-day urban high-consuming customer. Lastly, participants came up with drivers towards integration and explained how the drivers could work out. This is summarized in Table 2.

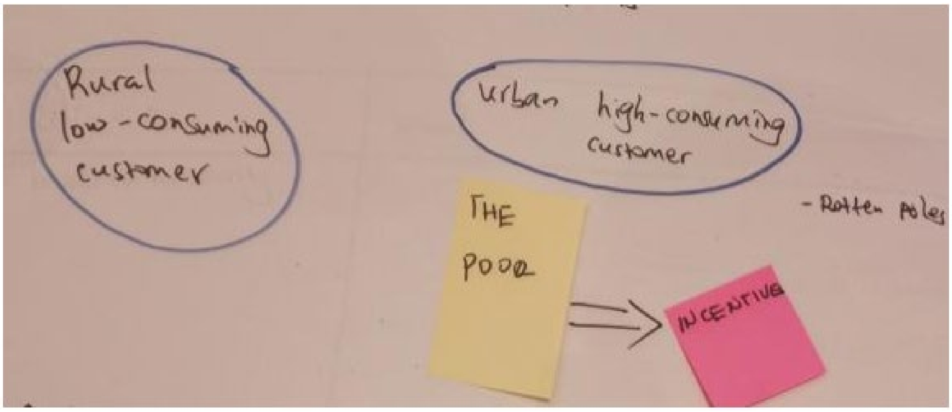

Figure 4: The Geographical Disconnect

Table 2: Drivers of Integration

Drivers	How?	Status quo
Right incentives	Higher mark up for the rich regardless of consumption level.	Tariffs based on the level of consumption.
Eco-friendly poles	Composite poles	Wooden poles/ concrete poles
Wireless power	Radiation power	Wired power
Smart grid + tap technology + scratch card power	Awareness/ knowledge Innovations Curriculum revisitation	
Expand the scope of players	Unbundle power supply Private sector's involvement	
Home-work office balance	Tariff adjustments, e.g., tariffs going up during peak hours such as cooking hours	
Reduction of power installation cost	Increase the number of players	
Regional interconnectivity		

Lastly, it was concluded that addressing affordability will require deliberately painful policy decisions such as directing climate funds to enhance electric power affordability. Climate funds could be sourced from carbon credit to support cost of access to electricity. Among the barriers identified were reliability of supply and system failure, and prevailing market condition such as tokenism and inadequate incentives to private suppliers.

2.4.7. Table 7: Consumer Behaviour

Vision

By 2050, digital technology will dominate our homes, making eCooking more accessible through digitized functions in appliances that will promote more consumer awareness of all benefits of eCooking.

Clean cooking will be embedded in the education curriculum while men involvement in cooking will increase and thus cooking burden on women will be significantly reduced. As a result, lower mortality rates will reduce tied up with reduced healthcare costs due to improved health translating to increased life expectancy due to widespread adoption of eCooking.

A significant uptake of clean cooking in rural areas will be experienced because of universal electrification with a drastic decline in deforestation. The uptake will save time for other activities of health and economic importance.

Society will embrace tree planting as a norm with great benefit from carbon credits and a green economic growth model. This will cause a shift in culture regarding preference for taste and smoky flavors in food prepared with biomass. Further the transition to eCooking may result in a loss of food preparation culture. Children born after 2050 will have a generational awareness of eCooking the common charcoal vendors that are everywhere in our estates will transition to selling clean cooking fuels.

Group 2: Pathways

- **Inclusion of eCooking in the education curriculum**: This will enhance learning and encourage adoption through schools. Consumer education is crucial for promoting behaviour change.
- **Sensitization and capacity building**: Awareness creation through churches, other religious gatherings and community gatherings (baraza) can successfully make more consumers aware of the existence of a fancier cooking method. Promotion efficient use of eCooking appliances, like soaking beans before cooking can also be emphasized in such fora. Introducing a "Men Cooking Day" as a special occasion will encourage men's involvement in cooking. Capacity building and upskilling programs, particularly in rural areas, will empower households to operate eCooking appliances.
- **Digitization of eCooking appliances**: This can be done by incorporating energy meters so that households understand the true cost of eCooking and influence behaviour towards adoption.
- **Affordable and reliable electrification:** To achieve this, the cost of off-grid solutions, including batteries for solar home systems, should be made affordable. This will easily shift biomass users to eCooking. **Availability of eCooking appliances**: This entails the appliances to be available in the market and also affordable to most energy consumers. This is cited as the last mile will encourage adoption.

Group 3: Integration

The high cost of off-grid solutions hinders the adoption of eCooking among off-grid households. Unnecessary taxes on electricity bills make electricity expensive.

Addressing the perception that electricity is costly through awareness creation, such as regularly announcing kilowatt-hour prices in the same way petroleum prices are announced, can help.

Expensive upfront appliance costs should be tackled by offering instalment payment options for households unable to afford a one-time payment.

2.5. Way Forward

The reporting session of the backcasting exercise yielded several action points, designed to propel the ecooking agenda forward based on insights and findings from the exercise, among them:

- Availing reliable, affordable and convenient electricity to every household in Kenya.
- Promoting local manufacturing of ecooking appliances matching the local needs that arises from the types of food that are common in the Kenyan households.
- Favourable tax regimes for local ecooking appliance manufacturers who are just venturing into this line of production in Kenya.
- Accelerating the universal electrification in Kenya through grid and off grid electricity generation.
- All-inclusive capacity building across all electric cooking stakeholders such as manufacturers, policy makers, distributors, wholesalers, retailers and those who can do repair and maintenance for ecooking appliances.
- Consistent research, innovations and developments toward the electric cooking industry in Kenya.
- Integrating electric cooking into education curriculum in primary to secondary schools.

- Amplifying the indirect benefit of electric cooking among Kenyan household such as health, good taste of food, climate wellness etc.

Below are some responsibilities that various stakeholders have committed to or are considering in order to advance electric cooking initiatives and electricity reliability in Kenya:

- **Universal electric cooking:** Ministry of Energy and Petroleum is committed toward electrical standards and guidelines specific to Kenya by the year 2028. This will enhance enjoyment of the benefits of convenience, precision, and safety that electric appliances offer.
- **Electricity reliability:** The government and Kenya Power continue to work towards further enhancing the reliability of electricity supply in Kenya by continuously curbing transmission losses, illegal connections, and financial constraints. These efforts in the electricity sector aim to provide reliable and affordable electricity to all Kenyan citizens.
- **Energy efficient labelling of eCooking appliances:** Energy efficiency labeling is a common practice implemented by many countries to promote energy-saving appliances and inform consumers about their energy consumption and efficiency. Such labels typically provide information about energy consumption, efficiency ratings, and other relevant details of appliances. Energy and Petroleum Regulatory Authority (EPRA) plan to launch new energy efficient labelling for eCooking appliances by the year 2024 is something to applaud when it comes to eCooking in Kenya
- **eCooking tariff for smart metered eCooking appliances:** EPRA being responsible for regulating and overseeing the energy sector in Kenya, including setting tariffs for electricity consumption is expected to work on policy developments or changes related to eCooking appliances or smart metering. EPRA should also go ahead to approve such eCooking tariff for smart metered appliances by 2028.
- **Clean cooking delivery unit:** Creation of a clean cooking delivery unit to champion eCooking as a key component of a multi-fuel strategy 2030 involving international organizations collaborating with local partners and stakeholders can improve access to clean cooking technologies, raise awareness, and provide training on their usage and benefits.

3. Conclusions

3.1. Summary of the workshop's achievements.

Validation of KNeCS Findings: The workshop served as an opportunity to validate and further explore the findings of the Kenya National electric Cooking Study (KNeCS). Participants discussed the KNeCS data, including adoption rates, willingness to switch to electric cooking, and factors influencing adoption. This validation exercise added credibility to the modeling outcomes and helped in refining assumptions and parameters.

Stakeholder feedback: The workshop facilitated active engagement and feedback from various stakeholders, including representatives from academia, government agencies, research institutions, and industry. This exchange of ideas and perspectives enriched the discussions and enhanced the modeling process. Stakeholders had the opportunity to share their expertise, raise important questions, and provide valuable insights, which contributed to a more comprehensive understanding of electric cooking sector.

Understanding the modelling tools: The participants gained a preliminary understanding of the modeling tools presented, including OnStove, a geospatial cost-benefit tool, EAE, an online data repository for spatial energy data, and OSeMOSYS, an optimization model for energy systems. They gained insights into the capacities, data inputs, and outputs of each tool and their roles in analyzing different aspects of the electric cooking transition.

Envisioning an Electric Cooking Future: Through the backcasting exercise, participants were able to envision a future where electric cooking is widely adopted in Kenya. This exercise helped in setting ambitious targets and identifying the necessary interventions and policy frameworks to achieve the desired outcome.

Overall, the workshop proved to be an enriching and valuable platform for engaging stakeholders on the KNeCS study, ecooking modelling efforts and collective visioning for electric cooking. Thus, the workshop successfully served its purpose of progressing the national conversation on electric cooking while facilitating multi-stakeholder knowledge exchange. The workshop also laid the foundation for further research, analysis, and collaboration in the sphere of electric cooking..

3.2. Follow-up activities

Following the conclusion of the workshop, several follow-up activities were to be set in motion to continue the collaborative process and maximize the impact of the sessions.

- The compilation of the slides will be shared with the participants through their respective emails. After receiving the slides, participants are expected to provide their feedback within approximately a week.
- Participants were encouraged to provide feedback on the workshop through an electronic evaluation form.
- A workshop to validate the draft eCooking strategy will be organized in August or September 2023, to which participants will be invited.
- The Ministry of Energy and Nuvoni Research will consider data sharing mechanisms with stakeholders.

4. Appendices

4.1. List of Participants: - Names and affiliations.

Full Name	Name of Organisation
Karlijn Groen	SNV
Martin Mutembei	Strathmore University - Energy Research Centre
Kelvin Mutua Kingoo	Makueni County
Lewis Kabiru Gichane	Sunking
Beryl Onjala	GAMOS
Adele Boadzo	AfDB
Ujunwa Ojemeni	E3G
Michelle Akute Liza	Kenya Power and Lighting Company
Matthew Leach	MECS
Stewart Craine	Village Infrastructure Angels
Eng. Nickson Bukachi	Energy and Petroleum Regulatory Authority
Douglas Ronoh	World Resources Institute
Naomi Kabena	Hotpoint Appliances Ltd
David Disch	Bidhaa Sasa
Eng Ephantus Kamweru	Rural Electrification and Renewable Energy Corporation (REREC)
Caroline Ochieng	SEforALL
Ruth Gichuhi	EED Advisory
Okova Kagia	Kenya Power
Emmanuel Ngeywo	LUEL
Nigel Scott	Gamos
Jacob Fodio Todd	MECS
Simon Batchelor	MECS
Dancan Mwangi	Sayonapps/Nagoya holding limited
Victor Viluwa Kenga	Kenya Industrial Research and Development Institute (KIRDI)
John Maina	Scode
Pauline Njoroge Nduta	Groupe Seb
Murefu Barasa	EED Advisory
Joanita Tumaini Mudambo	State department of environment and climate change
Wangui Kagumba	Verst Carbon
Jisas Lemasagarai	GSMA
Christina Wanjiku Kiwiri	Kenya Power
Charles Mwangi Waweru	Verst Carbon
Catrine Shroff	Mwangaza Light
Jon Leary	MECS
Myra Mukulu	KOSAP
Andrew Amadi	KEREA
Sarah Odera	Strathmore University
Patrick Gichuki Thimba	Private Financing Advisory Network
Grace Omwenga	KPLC
Andrew Ochieng	ESAK
Patrick Mwangi	KPLC-IESR

Daniel Gombe	KPLC
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Diana Masika	MoEP
Willah Simiyu	KEMRI
Thomas A Kamau	REREC
John Kapolon	REREC
Valerie Ontoya	MoE
Dylan Nyamole	MoE
Mijide Kemoli	Keeke Art
Babak Khavari	KTH Royal Institute of Technology
Camilo Ramirez	KTH Royal Institute of Technology
Zoltán Müller-Karpe	atmosfair gGmbH
Jechoniah kitala	SETA
Danson Ligare	EPBP LTD/ KCREN INITIATIVE
Michael Golomb	BioLite
Joseph Irungu	Kijani Testing com
Irene Wanjohi	Kenya Power
Kevin Maina	SCODE
Anastacia Kamau	SCODE
Pietro Lubello	UCL
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Sheila Muthoni	KYCTV
Peter Ndichu	KYCTV
Pauline Waigumo	Ghetto Foundation
Doreen Irungu	SETA
Elvira Nalyanya	CLASP
Collins Oneko	BURN MANUFACTURING
Victor Thomas Otieno	World Resources Institute
Lindsay Umalla	CCA
Mbeo Calvince	SEI
Elsie Onsongo	NCIR
Millicent Ochieng	NCIR
Bethuel Kinyanjui	NCIR
Kevin Nayema	NCIR
Abigael Okoko	NCIR
Kefa Simiyu	NCIR
Edward Kariuki	NCIR
Mourice Kausya	NCIR
Ann Njuguna	NCIR
Judy Kaaria	NCIR

4.2. Workshop Concept Note:

Ministry of Energy

Kenya National electric Cooking Study (KNeCS) Stakeholder Workshop:

Validating the eCooking Baseline Study, Exploring Policy Scenarios for scaling eCooking in Kenya, and Backcasting a sustainable eCooking future

Date: Friday, 30 June 2023
Venue: Radisson Blu Hotel, Nairobi Upper Hill

1. Background:

Kenya is at a critical juncture in its transition towards universal energy access. While over 71% of households rely on woodstoves, over 75% of households are electrified, indicating significant potential for the promotion of electric cooking. Despite this, our recent survey data shows that only about 2% of households primarily cook with electricity. However, there is reason for optimism: Kenya's electricity generation capacity is on the rise, and with an energy mix that is nearly 89% renewable, electricity has the potential to become a game-changer for clean cooking.

The Kenya National eCooking Study (KNeCS) commissioned by the Ministry of Energy and Petroleum and funded by the Modern Energy Cooking Services programme, Climate Compatible Growth programme and UK PACT, provides a comprehensive overview of the current state of electric cooking in Kenya. Its purpose is to inform the development of the Kenya National eCooking Strategy, with the ultimate aim of accelerating the adoption of electricity as a cooking fuel. This shift has significant potential to reduce CO2 emissions and combat climate change.

The KNeCS Stakeholder Workshop aims to bring together key players from the clean cooking and electrification sectors to comprehensively analyze the current landscape, validate emerging data from the KNeCS baseline study, and harness this evidence for impactful policymaking. Through collective engagement, stakeholders will formulate contextually relevant research questions, interrogate models for practical policy scenarios, and develop a shared vision and roadmap for scaling electric cooking in Kenya towards a sustainable and inclusive future.

2. Workshop objectives

a. Validation of KNeCS Findings:

The workshop aims to validate the findings of the KNeCS, which offers an in-depth analysis of various aspects of electric cooking in Kenya. These include the state of household electrification, the adoption and usage of electric cooking appliances, household cooking practices, the supply chain for electric cooking appliances, and the policy environment that could enable electric cooking. The workshop will provide a platform for stakeholders to discuss how these findings can inform policy options, contribute to scenario modelling for scaling electric cooking in Kenya, and assist in the development of the eCooking strategy.

b. Coordination of Efforts Around Clean Cooking and Electrification Modelling:

This workshop will be a forum to coordinate efforts around clean cooking modelling, particularly with a focus on electric cooking. Clean cooking models on several tools and platforms are at different stages of development. Participants will have the opportunity to explore the strengths, capabilities, and limitations of some of these tools and how they can be utilized to answer research questions related to the upcoming eCooking strategy. Participants will also help in framing these research questions, and discuss how the available tools can help derive policy options and develop scenarios for scaling clean cooking in Kenya. In collaboration with the respective modelling teams, Nuvoni will present preliminary findings of policy scenarios for validation by participants. These inputs will be invaluable in ensuring that the modelling efforts are contextually grounded, to ascertain that generated policy scenarios are practical, viable, and tailored to the local needs and conditions.

c. Charting the Course: Backcasting for a Sustainable Electric Cooking Future

The workshop provides an opportunity for collective envisioning of a desired future, whereby stakeholders can define what a sustainable and inclusive future looks like for electric cooking in Kenya. The workshop will also adopt the innovative Backcasting Methodology, which unlike forecasting that extrapolates future trends based on current data, starts with a desired future scenario and works backwards to understand what needs to change to achieve this vision. Stakeholders will provide their insights into how they envision a transition to electric cooking as a primary fuel/technology in a clean cooking stack and a critical driver of demand for electricity could take place. Participants can then collaboratively develop a roadmap to accelerate the transition outlining the strategies, actions, and policies needed to achieve this future. This includes considering the steps needed to bridge the gap between the present state and the desired future, identifying potential challenges, and outlining the support required at various stages.

3. Expected Outcomes

The following are the key outcomes expected from this workshop:

- A presentation and collective validation of the data and findings from the Kenya National eCooking Study (KNeCS), ensuring that it reflects the realities on the ground and can be reliably used for policy development.
- Enhanced coordination of clean cooking and electrification modelling efforts to answer the key research questions surrounding the uptake of electric cooking. Stakeholders will have a clearer understanding of the capabilities and limitations of various tools, and an understanding on how to synergize these tools for effective scenario modelling.
- A shared research agenda with input from diverse stakeholders, which will guide future investigations and data gathering critical for the scaling of electric cooking in Kenya.
- A shared vision for a sustainable electric cooking future in Kenya, and a preliminary roadmap for transitioning to electric cooking in the long term.
- Enhanced relationships and networks among stakeholders which will facilitate ongoing collaboration, knowledge sharing, and concerted efforts in promoting electric cooking in Kenya.

4. Workshop format

The proposed workshop will combine in-person and virtual participation, utilizing presentations, World Café group discussions, and plenary sessions to encourage interaction and collaboration. The day will commence with welcome remarks, followed by sessions for validation of KneCS findings, exploration of modelling tools, and an introduction to the Backcasting methodology. Participants will engage in brainstorming and discussions. The day will conclude with an interactive session for action planning and roadmap development, final reflections, and gathering workshop evaluation and feedback.

5. Target participants

The KneCS Stakeholder Workshop seeks to bring together a diverse group of individuals and organizations for a comprehensive exploration of sustainable pathways to scale electric cooking in Kenya. Participants will include government representatives from relevant ministries such as Energy, Environment and Health, and agencies such as Statistics and Standards, non-governmental organizations involved in clean energy and sustainability, international development agencies, and researchers specializing in energy and policy. We also target representation from clean cooking, electrification and renewable energy industry professionals, energy service companies, technology developers involved in electric cooking solutions, testing labs, distributors and retailers of electric cooking appliances, financial institutions and civil society.

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KNeCS Stakeholder Workshop- Programme

Date: Friday, 30 June 2023
Venue: Radisson Blu Hotel, Nairobi Upper Hill

Time	Activity
8:30	Arrival and registration
09.00	**Opening Session** • Welcome remarks (MoEP, MECS, Nuvoni)
Session 1: Validation of KNeCS Findings	
09.30	• Presentation of KNeCS findings. • Plenary discussion to critique findings
10.45	**Coffee Break**
Session 2: Exploring Modelling Tools	

11.00	• Framing research questions for clean cooking modelling using interactive tools.
	• Brief demonstrations by representatives of various modelling platforms and tools, and presentation of preliminary scenarios for eCooking in collaboration with Nuvoni Research.
	• Plenary discussion to explore:
	  ○ the tools' capabilities, limitations, and possible applications.
	  ○ the proposed policy scenarios

13.15	**Lunch**
Session 3: Backcasting - Charting the Course	
14.00	• Introduction to backcasting • World Café group discussions for Backcasting exercise: ○ Identify steps needed to achieve the desired future, potential challenges, and support needed • Plenary session to present table summaries and reflection
16.00	**Coffee Break**
Session 4: Closing Session	
16.15	• Revisiting research questions for clean cooking modelling • Acknowledgements and closing remarks. • Workshop evaluation and feedback collection.