Nepal
eCooking Market Assessment

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This version is intended for public disclosure

The MECS/EnDev eCooking Market Assessments

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

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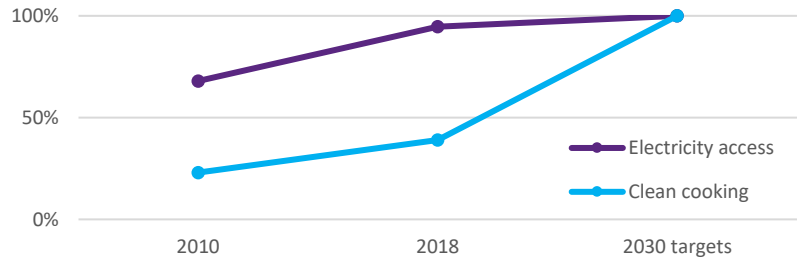
Executive Summary

The Government of Nepal (GoN) has adopted an **integrated electrification-clean cooking approach** with a 2020 NDC target of 25% of all households using electricity as a primary mode of cooking by 2030. The country has made massive strides in its electrification with current access to electricity close to **95%** with **71.7%** of households **grid-connected** and **23% off-grid**. In 2018-2028 the GoN announced as the Decade of Energy and Hydropower to realize the dream of 'Prosperous Nepal, Happy Nepali' and included in this was the **aim to provide electricity access to every household by 2022**. Yet **52.4%** of households rely on **firewood** as their main fuel for cooking (35.4% urban; 65.8% rural). **Currently 0.4% of Nepali households use electricity as their primary cooking fuel.** The country's increasing investment in **renewable generation capacity** and expected **surplus capacity** means that **cooking with electricity is a viable option** (and will become increasingly so), particularly for those connected to the grid. In 2020/21, the GoN's Alternative Energy Promotion Centre (AEPC) aimed to promote e-cooking in 100,000 households and the Nepal Electricity Authority (NEA) launched a dedicated eCooking tariff.

Nepal data snapshot from MECS eCooking Global Market Assessment:

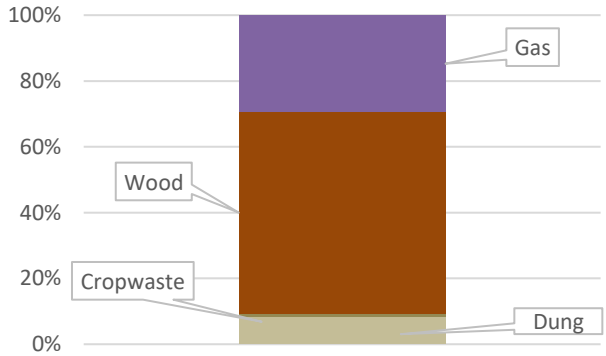


56% now connected to electricity, but still primarily cooking with polluting fuels

Cooking energy

Primary fuel use:

0% cook primarily with electricity

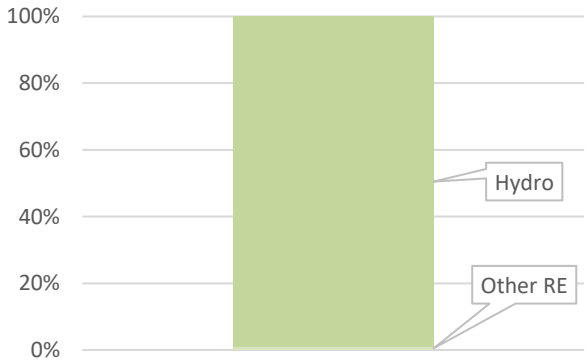


0% cook primarily with commercialized polluting fuels

Electricity generation

On-grid:

100% renewable



200-600MW surplus power generation

Variable Reliability: **47.4%** hh receive almost 24 hours supply; **5%** hh have **8-16 hrs** p/day, whilst **47.7%** receive **16-23 hrs** p/day.

Off-grid:

World leading mini-grid & off-grid sectors: 23% mini-grid customers, 880 mini-grid developers, 1.5 off-grid lighting/appliance customers

eCooking GMA viability scores/rankings

Overall: 2nd/130	On-grid eCooking: 0.54 – 54th/130	Mini-grid eCooking: 0.42 – 7th/130	Off-grid eCooking: 0.48 – 16th/130

Key opportunities:

- GoN are committed to addressing policy for an integrated approach of electricity access and clean cooking sectors;
- Dedicated eCooking tariff already in place;
- Expected surplus generation capacity;
- Most mini-grid systems hydro powered - more appropriate than solar for electric cooking;
- Large body of past/ongoing research.

Key challenges:

- New eCooking tariff disincentivises low-income households from adopting electric cooking;
- Grid supply and reliability issues (blackouts, low voltage);
- Lack of awareness of clean cooking options;
- Constrained financial resources among households using traditional stoves.

Potential impacts of scaled uptake in most viable market segment

If 40% of Nepal's grid-connected firewood users (2.7m ppl, 650,000 HHs) switched to eCooking, the WHO's BAR-HAP tool suggests that

- 11,881 DALYs/yr avoided
- 1.8m tonnes/yr CO2eq emissions reduced
- 1m tonnes/yr reduction in unsustainable wood harvest
- 286m hrs/yr of women's time saved (438hrs/HH/yr)
- 6 months payback for eCooking appliances (80$/HH upfront cost, 165$/HH/yr savings on fuel energy costs)
- 571 GWh demand for electricity stimulated

For further detail, please see Appendix 1: Impact of Scaled Uptake.

1 Introduction

Clean cooking and electricity access in Nepal

Nepal has a population of 28.6m and transitioned to a lower-middle income country in 2020. Whilst there is close to universal access to electricity (95% from hydropower), quality and reliability of electricity supply is an issue. Households have relied heavily on solid biomass (firewood, cow dung, plant residue) as cooking fuel, with an estimated 52.4% of households (35.4% urban; 65.8% rural) continuing to use firewood as the main fuel source for cooking.[1] Clean fuels are increasingly prevalent in Nepal, with around 33% using Liquified Petroleum Gas (LPG) (54.1% in urban; 16.5% in rural) and 3.1% using biogas.[2]

The Government of Nepal announced 2018-2028 as the Decade of Energy and Hydropower to realize the dream of 'Prosperous Nepal, Happy Nepali' and aim to provide electricity access to every household by 2022, thus promote electric cooking in across all households. The GoN's commitment to increased electricity access also makes inclusion for electric cooking, with a 2020 NDC target of 25% of all households using ecooking as a primary mode of cooking by 2030, and thus signalling an integrated approach. Around two thirds of households (71,7%) are connected to the national grid, and a further 23% of households are connected to off-grid sources. However, despite various attempts to encourage the use of clean cooking solutions, a comparison of energy-usage statistics from 2001 to 2016 indicated that solid fuels remained the country's overwhelming choice of cooking fuel (Paudel et.al 2021).[3] The country's increasing investment in renewable generation capacity and expected surplus capacity means that cooking with electricity is a viable option (and will become increasingly so), particularly for those connected to the grid.

[1] MTF Nepal (ESMAP)
[2] Ibid
[3] HEART report - forthcoming

2 Enabling environment

eCooking policy outlook: GoN are committed to addressing policy for an integrated approach of electricity access and clean cooking sectors, with key policy makers starting to create an integrated policy framework that cuts across the two sectors.

Key policy stakeholders include Nepal Electricity Authority (NEA), Alternative Energy Promotion Centre (AEPC), National Association of Community Electricity Users-Nepal (NAECUN), Kathmandu Alternative Power and Energy Group (KAPEG), ENERGIA, Clean Cooking Alliance, Practical Action, Practical Action Consulting, PEEDA, Winrock, IRADe.

RISE (Regulatory Indicators for Sustainable Energy) scores:

64%	74%	42%	27%
Electricity Access	Clean Cooking	Renewable Energy	Energy Efficiency

Targets [4]:

Electricity access	Clean cooking
100% electricity access by 2030 (grid/off-grid)	72% clean cooking access by 2030
100% renewable grid electricity by 2030	25% modern energy cooking access by 2030

Key government/NGO programmes creating the enabling environment in which eCooking can scale:

- The Nepal Electricity Authority (NEA) is committed to achieving electricity for all by 2023. "In November 2017, the Government of Nepal and several development partners set up the National Renewable Energy Framework (NREF). The NREF is a mechanism under which the Alternative Energy Promotion Centre (AEPC) coordinates all the renewable energy activities with various stakeholders, such as tracking results from various initiatives, engaging stakeholders, and helping to mobilize finance. Renewable energy under this framework covers hydropower up to 10MW, solar energy, wind energy, and bio-energy systems for cooking, heating, and generating electricity."
- The Government of Nepal have taken an integrated approach to electrification and clean cooking within policy/planning, and the country joined the UN's SE4ALL initiative in 2012. The GoN MoEWRI "Current Status and the Roadmap for the Future" White Paper[5] made provision for electric cooking, which has been included in the long-term vision of AEPC activities and the 15th Plan Approach paper (2019/20-2023/24) and the Clean Cooking Solution for All (CCS4ALL). This White Paper in particular provides directives for promoting cooking with electricity across households under the "one stove in every household" mandate. Short to medium term policies focus on improving the efficiency of cooking with biomass, with long-term aims to transition to electricity as signalled by the 2020 "Second Nationally Determined Contributions (NDCs) Policy" which sets a target of 25% of households using electricity as their primary cooking fuel by 2030.
- Meanwhile, the 15th Plan Approach is a five-year plan with a dual aim: (1) smokeless kitchens with suitable electricity tariffs for e-cooking; (2) standards and efficiency of electric cookstoves to be established prior to household dissemination. Further, in "2019/20, AEPC planned to promote around 10,000 induction cookstoves and 65,700 biomass cookstoves in the Terai districts (MoFE, 2021). In 2020/21, the AEPC target was to promote e-cooking in an additional 100,000 households. As of February

[4] https://www.unescap.org/sites/default/d8files/knowledge-products/SDG7%20roadmap%20for%20Nepal-FINAL.pdf
[5] GoN Ministry of Energy, Water Resources, and Irrigation. 2018. Current Status and the Roadmap for the Future. White Paper. Kathmandu

2020, about 1,200 induction cookstoves have been distributed under different piloting and research projects in Nepal."[6]

- The AEPC have driven the promotion of renewable energy technologies including clean cooking solutions. The GoN have also established the Terai Clean Cooking Programme which aims to replace traditional fuels with tier 3 or better cookstoves in 22 districts of the Terai region.
- Clean Cooking Programme funded by ESMAP/World Bank – a 5-year project to promote e-cooking across 0.7 million households.
- Five-year programme in conjunction with the Green Climate Fund which hopes to accelerate cooking solutions, including electric cooking.[7]

Key barriers/drivers in the enabling environment:

Drivers

- Favourable and integrated electrification-ecooking policy and future outlook;
- The electric cooking appliance market has rapidly grown since 2018 in Nepal[8];
- As of October 2021, the Electricity Regulatory Commission has reduced the tariff for households consuming over 150 units with the hope of encouraging the use of electric ovens to increase power consumption and reduce wastage;
- Under the revised tariffs, HHs are currently able to upgrade their meters for free.

Barriers

- Lack of awareness;
- Affordability of both electricity and initial upfront investment for low-income hh;
- Variable and unstable electricity supply.

For further detail, please see Appendix 2: Enabling Environment.

[6] HEART Nepal - forthcoming

[7] GoN. Assessment of electric cooking targets for Nepal's 2020 NDCs.

[8] MECS ECO Market Assessment report by Practical Action - forthcoming

3 Consumer demand

What's on the menu?
In an average week, a typical Nepali household might prepare:

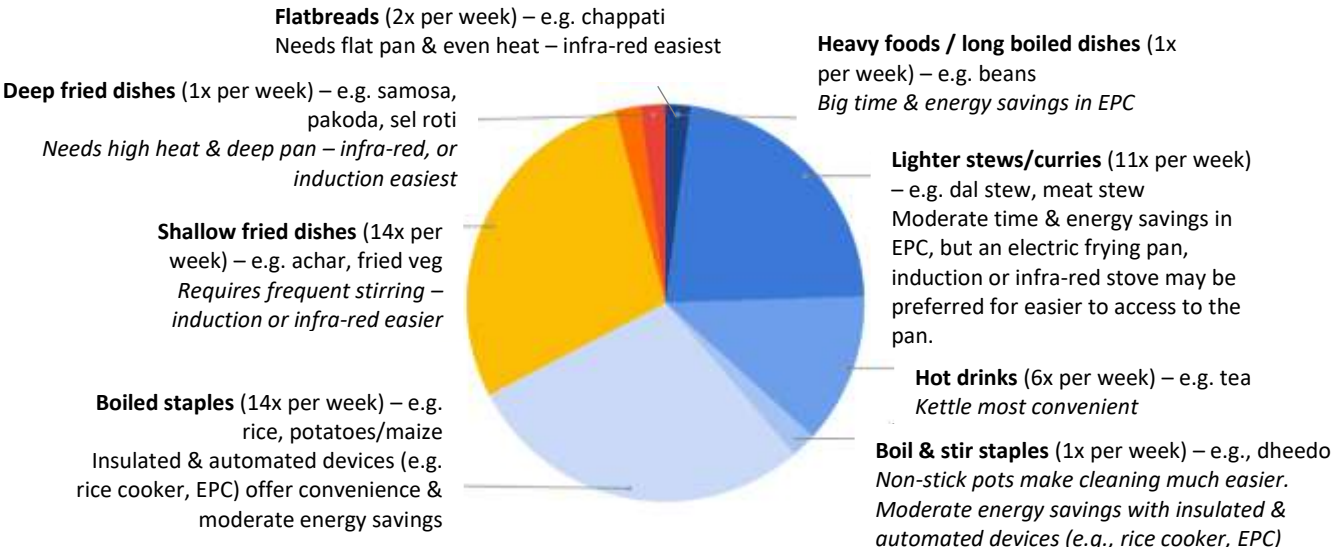


Figure 1: Visualisation of the results of a culinary analysis carried out during this market assessment by asking local team members to map out the dishes that a typical Nepalese household might prepare in an average week and assessing their compatibility with modern energy-efficient appliances.

- A typical meal will most often consist of *dal* (lentil soup), *bhat* (boiled rice) and *tarkari* (curried vegetables) or chicken (or meat) curry. Rice is the major staple, so rice cookers are very useful for Nepali households. Dal and curries can be cooked in an EPC, however boiling times generally don't exceed an hour, so there are only moderate energy and time savings from pressurisation. Induction/infra-red stoves are an increasingly popular choice, as shallow pans can be used, making frying easier.
- *Dheedo* (or *Dhido*), a thick porridge prepared by boiling ground cornmeal or buckwheat or millet flour with salt and water, is a staple in rural diets and often eaten with butter, vegetable curries, pickles, and yoghurt (as part of *Dhido Thali*). It's very easy to cook in an EPC or rice cooker and the non-stick pot is much easier to clean, although most people won't believe you until you show them.
- Meals are often accompanied by roti or *chappati* and *achar*. Chappati is a flatbread that requires a flat pan with even heating, meaning that an infra-red stove is best, but an induction stove with a thick-bottomed pan can also work.
- Most meals are prepared at home, and most dishes take on average 20-60 minutes to prepare.

Most viable energy-efficient appliances: **Induction cookers**, **Infrared cookstoves, Rice cookers** and **Electric Pressure Cookers**.[9]

Key marketing messages: **energy-efficient appliances offer substantial time and cost savings and enable multi-tasking, whilst improving household health. EPCs are the cheapest and most convenient way to cook foods that are time and energy consuming**.

[9] MECS internal report

Key demand side barriers/drivers:

Drivers

- Improved health due to reduced HAP;
- Cleaner pots and kitchens due to reduced smoke/soot;
- Less time spent on fuel collection means increased time spent on other activities (whatever they may be);
- Shortened cooking time (instant heat for cooking) and increased convenience;
- Environmental benefits (deforestation/environmental degradation is reduced);
- Cost competitiveness versus LPG.

Barriers

- Firewood remains freely available;
- High initial investment and monthly costs;
- Concerns around safety of the technology;
- (Initial) concerns around learnability of new appliances;
- Cold climate in mountainous regions - fire from cooking also acts as heat for room.

However, perceptions could be easily addressed through improved awareness and marketing campaigns – especially as the NEA are committed to an integrated electrification and e-cooking approach. Support is already at government level.

Key demand creation programmes: N/a

Key market segments:

- *Firewood* – Around **73.5%** of Nepali households relay on firewood for cooking, and firewood makes up a considerable portion of the fuel stack (see table in appendix 3). Firewood is often freely collected. Households in rural areas rely more heavily on firewood (78.5%) than urban households (54.8%).
- *Other* biomass fuels, the mix consists of dung (5.4%), crop residue (4.9%), charcoal (0.2%), processed biomass (0.2%), and saw dust (0.5%).
- *LPG* – Around **34.9%** of households in Nepal use LPG and, conversely, it is more popular in urban areas (56.5%) to rural households (29.1%).
- Electricity – substantially small with under **1%** of the population using electricity or solar cookers.[10]

For further detail, please see Appendix 3: Consumer Demand.

[10] MTF Nepal

4 Supply chain

Key domestic eCooking appliance manufacturers: CG is a local brand, but they manufacture in China.

Key eCooking appliance distributors: n/a, but popular international brands include CG (given what is stated above), Baltra, GEEPAS, Urban, Kenwood, Sonesta & Philips

Innovative eCooking pilot projects:

- MECS Technology Research Innovation for International Development (TRIID) with PEEDA, KAPEG, University of Bristol and coordinated with RERL/AEPC: Assessing electric cooking potential in micro-hydropower microgrids in Nepal
- **5 Electric Cooking Outreach Projects** over two themes which aim to provide a critical evidence base to inform policy on the current opportunities to scale up electric cooking.
  - **4 Community scale pilot studies addressing** whether efficient electric pressure cookers (EPCs) fit the cultural cooking processes and electricity supply in different communities in Nepal?

Key supply side barriers/drivers:
Barriers

- Electric cookstoves do not seem to be locally manufactured;
- Poor after sales service (i.e. poor access to repair and maintenance);
- Issues around quality and stability of electricity supply;

Drivers

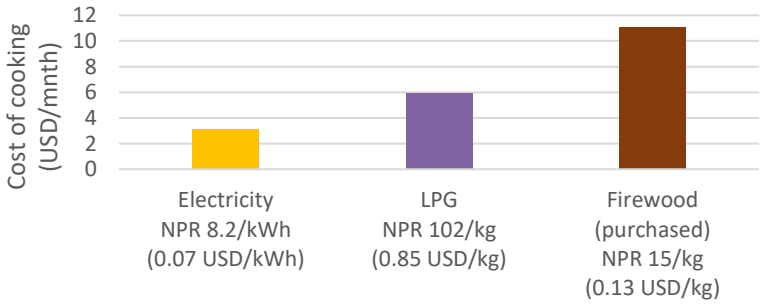
- Electric cooking appliances have increasingly been adopted by high-income urban Nepali households;
- Induction cookstoves are the most popular appliance in hh[11];
- NCS endorsed the Electric Cooktop Standards in 2019 to set safety and standard requirements for household electrical cooking appliances;
- Electric Cooktop Standards of 2019 is aimed to improve the appliance market with better quality and standardised electric cooking devices;
- During the COVID-19 pandemic, the GoN encouraged the adoption of e-cooking by waiving custom duties on induction cookstove imports and by "providing a 25% discount on electricity consumption of up to 150kWh per month".[12]

Popular appliances in Nepal today: Induction stoves, Hot plates, Infrared stoves, electric rice cookers, microwave ovens, roti maker, electric kettle, electric pressure cookers (nascent).
Relative costs of cooking with electricity & popular cooking fuels:

- Clean energy sources such as LPG and electricity are perceived to be expensive in comparison to freely available fuelwood or cheaper agricultural residue.
- It is difficult to compare the cost of cooking with LPG or electricity accurately as most households do not pay for firewood.
- Additionally, NEA uses a block tariff making it difficult to accurately predict the cost of ecooking without knowing which tariff hh are on.

[11] GoN. Assessment of electric cooking targets for Nepal's 2020 NDCs
[12] GoN. Assessment of electric cooking targets for Nepal's 2020 NDCs.

- Ability to afford the monthly electricity tariff is the major barrier to adoption of electrical cooking, especially in rural areas.
- Electric cooking appliances are far more efficient (70-95% efficiency) versus gas stoves (40-55%).
- Controlled Cooking Trials conducted by PEEDA have shown that electric cooking on all electric cooking stoves is cheaper than LPG – with EPCs being over half as cheap due to higher efficiency.
- It seems more feasible that urban households with higher income levels and disposable cash are more likely able to purchase appliances and afford the monthly tariffs.
- Small households with low consumption (around 200 units) would benefit financially by shifting from LPG to electricity for cooking.
- However, in October 2021, the Electricity Regulatory Commission has reduced the electricity tariff for households consuming over 150 units so as to encourage the use of electric ovens (and other electric kitchen appliances) to increase power consumption and reduce wastage.



Grid electricity tariffs:

- Avg estimate: 8.38 NPR/kWh (0.07 $/kWh)
- Mini-grid tariffs: don't have data as costs vary

Figure 2: Cost comparison of different cooking fuels based on international averages for cooking energy demand from ESMAP (2020) and local electricity/fuel prices obtained during this market assessment.

For further detail, please see Appendix 4: Supply Chain.

5 Recommendations for interventions

Table 1: Decision matrix/board highlighting key factors and viability of specific interventions.

		Current status	Recommended interventions
Market segments	*On-grid*	Two thirds of households are grid connected and increasing surplus generation capacity is expected in the near future – with electric cooking seen by the GoN as a critical load for the coming surplus. Reliability of supply is a key issue and outages are frequent, particularly in the dry season when hydro power resources are low.	Advocate to National Clean Cooking Strategy and GoN of the importance of demand side management being prioritised within electrification strategies to address seasonal fluctuations in supply. Encourage GoN to consider ways of transitioning all hh – not only those cooking with LPG – to eCooking. Strengthen the role of CREEs. Increase installed electricity generation capacity to cope with increased demand for eCooking.
	Mini grid	Strong mini-grid infrastructure: 23% of households connected to off-grid sources crucial to expanding rural electricity access. Most are micro-hydro projects which are more appropriate than solar for electric cooking. Initial research indicates battery storage is key to upscaling eCooking on MHP systems.	Explore viability of various payment models and carbon finance to mitigate costs both upfront and ongoing.
	Off-grid (SHS)	Current lack of comprehensive data. Further research required.	Explore viability of off-grid SHS to support electric cooking in Nepal.
TToC dimensions	*Supply chain*	The Electric Cooktop Standards of 2019 should improve the appliance market with better quality and standardised electric cooking devices. Lack of domestic manufacture and after sales services (e.g., repair and maintenance) for electric cooking.	Lobby government to provide public funding or develop an RBF to support ecooking in areas which are more commercially challenging for the private sector. Targeted local capacity building to develop a more geographically even spread of after sales services for electric cooking. Encourage development and regulating of safety standards and capacity of testing of appliance.
	Consumer demand	Electric cooking appliance market has rapidly grown since 2018.[13] Majority of cuisine can be cooked on electricity. Affordability (both upfront and monthly) is the main barriers to uptake, especially in rural areas. There are also some consumer perceptions that electric cooking appliances are unsafe.	Explore viability of various payment models and carbon finance to mitigate costs both upfront and ongoing. Set up campaigns to increase awareness of electric cooking as a clean cooking option. Use campaigns to highlight socio-economic and health benefits and address consumer concerns on safety and usability of ecooking.
	Enabling environment	Current policy framework has an integrated approach to electrification and clean cooking with clear and ambitious ecooking targets.	Support National Clean Cooking Strategy currently being developed by CCA by raising awareness of key findings from completed and ongoing electric cooking projects from MECS and other development organisations.

[13] MECS ECO Market Assessment report by Practical Action - forthcoming

		Under the revised tariffs, hhs are currently (as of October 2021) are able to upgrade their meters for free.	Electricity distribution infrastructure in rural areas is a limiting factor to uptake; this needs addressing. There needs to be improved coordination across national and local government entities, as well as private stakeholders/entities. Lobby for increased research and consideration of climate change impacts through the continued use of biomass fuels (especially black carbon).

Appendices

Appendix 1: Impact of Scaled Uptake

This section explores the likely costs and benefits for one simple illustrative scenario of scale-up of eCooking in selected key segments. The World Health Organisation (WHO) revised "Benefits of Action to Reduce Household Air Pollution" (BAR-HAP) tool[36] has been applied to quantify the expected financial costs, health, and environmental benefits of the scale-up.

The scenario modelled is chosen to consistent with the MECS programme's suggested "40, 60, by 2030" goals: a target of 40% for all households connected to grid or off-grid electricity in low- and middle-income countries to be using it for cooking by 2030, and a target of 60% of households utilising modern energy for cooking to be utilising energy generated from low carbon sources by 2030 (low carbon interpreted here to include electricity coming from relatively low carbon fuel mix, and excluding fossil-derived LPG). For this illustrative analysis of costs and benefits, the focus is just on urban households that are grid connected, but currently cooking with firewood, which they purchase. While specific data are not available for this demographic, an estimate was made based on the evidence earlier in the report about different categories of users, suggesting approximately 650,000 households. Details are in the first part of the table. BAR-HAP models a ramp-up of transitioning households over the first 5 years to 2025 and then a further 5 years operation.

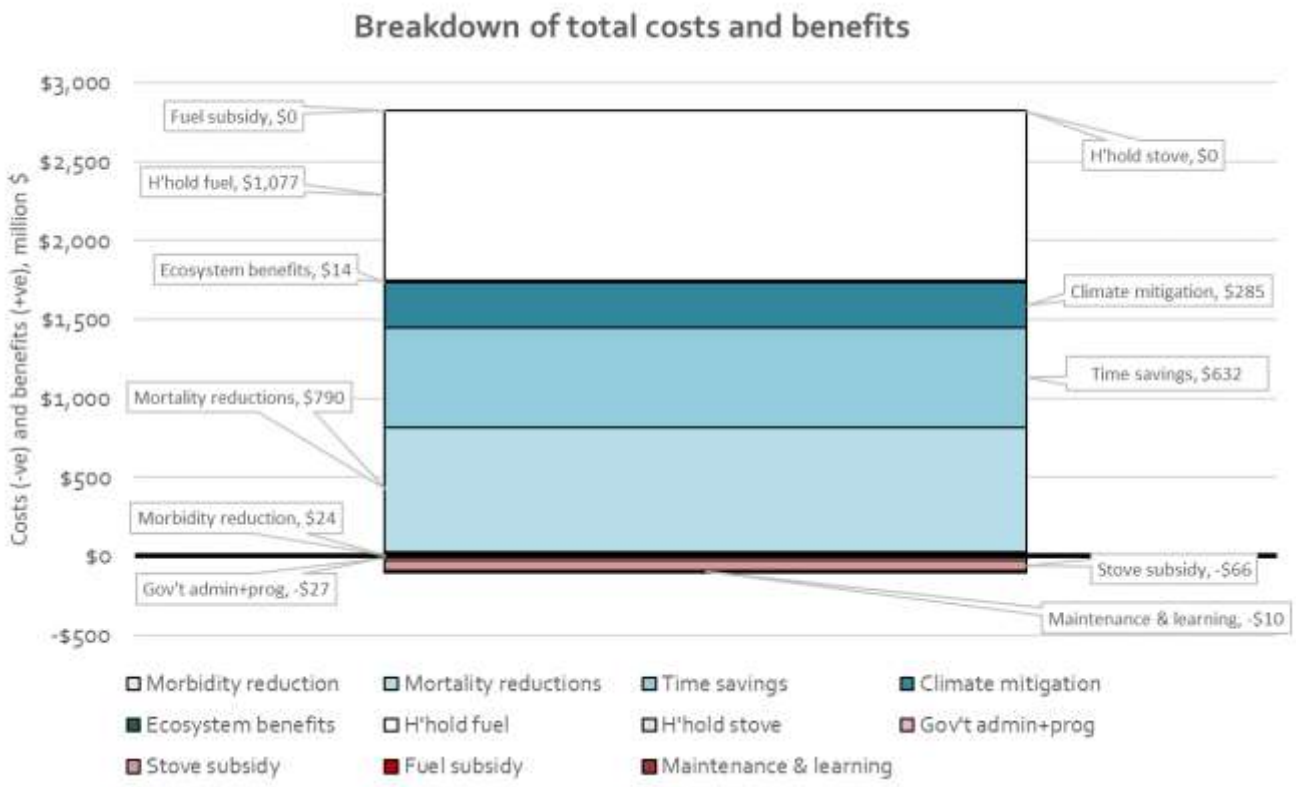
BAR-HAP has been implemented here using its policy option of a ban on firewood use, which comes in gradually from 2020 to 2030. This is clearly not a realistic policy and is simply used here to affect the transition wanted for this illustration, with clarity about the impacts and where costs fall; it can be regarded as a proxy for other specific actions used to mobilise a major transition from wood to eCooking. The assumption is that transitioning households are fuel stacking, with 20% of cooking still delivered using firewood. The full costs of the new MECS devices have been assumed to be paid for by the Government, as a convenient simplification for this illustration. Other policy options that could have been modelled would see a different distribution of stove and fuel costs and savings between parties. eCook devices are assumed to cost $80 and to have an average efficiency of 75% (MJ input to MJ useful heat output). eCooking is assumed to save 30% of the typical 4 hours cooking per day. Nepal's grid electricity generation mix comprises mainly hydro; BAR-HAP includes specific emission factors for Nepal. The lower part of the table shows the outputs of BAR-HAP for the modelled scenario. The chart shows the structure of costs and benefits.

Table 5. Targets and BAR-HAP modelled scenario.

Firewood users in urban areas		Population (millions)	households (millions)				
National population, 2020		28,608,715	6,748,350				
Urban population, 2020		6,200,000	1,462,483				
Of which, grid connected		5,084,000	1,199,236				
Of which, using firewood		2,786,032	657,182				
Scenario modelled		Population (millions)	households (millions)				
Transition from firewood to eCooking		2,786,032	657,182				
Costing (costs are -ve, benefits are +ve)				$/yr	$/yr per household transitioning	$M total	$total per household
Total present value (ie net social benefits of the transition)				279,473,464	428	2,795	4277
					0		
Total costs of transition, government+private				97,489,509	149	975	1492
Private cost to housholds: total				106,783,055	163	1,068	1634
Stove				*0*	0	0	0
Fuel				*107,738,368*	165	1,077	1649
Maintenance				*-955,313*	-1	-10	-15
					0		
Costs to government: total				-9,293,546	-14	-93	-142
Stove				*-6,564,637*	-10	-66	-100
Fuel				*0*	0		
Admin+Programme				*-2,728,908*	-4	-27	-42
					0		
Health, Time, and Environmental Benefits: total		Physical: change/yr	Physical: % of national cooking total	181,983,955	278	1,820	2785
Health impacts total: DALYs avoided	DALYs	11,881		81,432,209	125	814	1246
Mortality reduction	*YLL*	*7,776*	1.5%	*78,995,567*	121	*790*	1209
Mortality reduction	*Lives*	*772*	2.3%				
Morbidity reduction	*YLD*	*4,105*	3.2%	*2,436,642*	4	*24*	37
Morbidity reduction	*Cases*	*22,258*	2.8%				
Time savings	Hours	286,223,064	12.2%	63,217,281	97	632	967
Time savings per adopting household	*Hours/HH*	*438*					
Electricity use	*MWh*	*571,661*					
CO2-eq reduction (CO2,CH4,N2O)	Tonnes	1,867,166	10.9%	28,509,149	44	285	436
Unsustainable wood harvest reduction	Tonnes	1,065,269	12.2%	8,825,316	14	21	32
Note: costs are discounted across programme period.							
Totals are Net Present values; costs/year are NPV divided by the ten years of the programme							

The table shows that while this transition would cost government some $140 per household for equipment and programme costs, it would save households **11** times that in reduced energy bills over the ten years of the program. Furthermore, health benefits would include more than 700 lives saved per year. Some 12% of current unsustainable wood harvesting would be avoided and greenhouse gas emissions from the national cooking sector would be reduced by more than 10%. These impacts may seem modest, but this scenario is targeting less than 10% of the total population.

Figure 2. Breakdown of total costs and benefits.



The figure summaries the various physical and financial impacts of the transition in monetary terms. Nepal's electricity mix is almost 100% renewables and hence the greenhouse gas emission benefits of switch from firewood to electricity are positive. However, the social benefits from avoided time spent cooking are much larger, reflecting mainly time savings using an EPC, and the opportunity cost for peoples' time, as used in BAR-HAP. A further large economic benefit is related to reduction in deaths from avoided indoor air pollution. The largest benefit though comes from reduced fuel costs to households, as the affected households are paying for firewood before transition, and Nepal's electricity is relatively inexpensive. The largest element of cost is for the purchase of modern stoves by government; households are assumed to benefit further by avoiding the need to pay for their traditional firewood stoves.

This is an impact analysis for one simple scenario for just one particular segment (grid connected charcoal users) of Nepal's population. However, it demonstrates very significant net benefits that could be achieved, based on the WHO's physical impact and impact monetisation methodologies.

Appendix 2: Enabling Environment

Development Partners

The Clean Cooking Alliance (CCA), GIZ and MECS in collaboration with local partners have all undertaken piloting initiatives to understand and promote the adoption of e-cooking in Nepal. These are detailed below:

CCA:

- Collaborative project with local partners, entitled "Maximising the Health Benefits of Clean Household Energy in Urban Nepal: A Demonstration Project", which aimed at combating HAP through the promotion of smoke-free kitchens and promotion of e-cooking.
- Creation of a Country Action Plan for Transforming the Cookstoves and Fuels Market in Nepal (by request of the GoN) which is informed by the Health Demonstration Project (2022-21). The plan is a holistic guide for the path forward over the next 5 years and aims to leverage the momentum of Nepal's broader energy access goals, especially those related to the promotion of electric cooking.
- Development of the **Clean Cooking Explorer**: an online, open-source and interactive geospatial data platform.
- Collaborative project with Winrock, VRock and NEA Engineering Company which conducted research assessing the readiness for widespread adoption of electric cooking in Nepal. (The report is forthcoming.)

GIZ EnDev:

- Supported a pilot project entitled "Market-led promotion of e-cooking in Timal Community Rural Electrification Area" alongside local partners, Ajummery Bikas Foundation, and the National Association of Community Electricity Users Nepal (NACEUN).
- Ongoing project "Private-Community Partnership for Upscaling Promotion of Electric Cooking in Community Rural Electrification Areas of Bagmati Province in Nepal" alongside local partners, Ajummery Bikas Foundation, and the National Association of Community Electricity Users Nepal (NACEUN)
- Preparation of "Market activation of electric cooking in Nepal" to be implemented by Practical Action.

MECS:

- Gender Responsive Electric Clean Cooking in Nepal which aimed to understand the barriers and opportunities to transition to mecs from women's perspectives.
    - Energia/Practical Action Consulting and 60 Decibels
- MECS Technology Research Innovation for International Development (TRIID) project: Assessing electric cooking potential in micro-hydropower microgrids in Nepal
    - PEEDA, KAPEG, University of Bristol and coordinated with RERL/AEPC
- **5 Electric Cooking Outreach Projects** over two themes which aim to provide a critical evidence base to inform policy on the current opportunities to scale up electric cooking.
    - **4 Community scale pilot studies addressing** whether efficient electric pressure cookers (EPCs) fit the cultural cooking processes and electricity supply in different communities in Nepal?
        - PEEDA
        - IRADe
        - Practical Action Consulting
        - Winrock
    - **1 Market Assessment** aimed at gathering market intelligence on the opportunities emerging for efficient electric cooking appliances in Nepal.
        - Practical Action

WHO (with support from MECS):

- Opportunities for Transitioning to Clean Household Energy: Household Energy Assessment Rapid Tool (HEART) in Nepal.

Other

- Ajummery Bikas Foundation, Radio Sagarmatha and NACEUN have initiated a national market-led campaign to promote e-cooking in community electrification areas.

Appendix 3: Consumer Demand

Relative costs of cooking and willingness/ability to pay for appliances
The national cooking energy mix of Nepal
Nepali households remain reliant on biomass fuels for cooking, with firewood being the most widely used cooking fuel in 73.5% of households, followed by 34.9% of households relying on LPG.[10] Of biomass fuels, the mix consists of dung (5.4%), crop residue (4.9%), charcoal (0.2%), processed biomass (0.2%), and saw dust (0.5%). Of the clean cooking fuel mix, aside from LPG, biogas accounts for 3% of households and cooking with electricity or solar accounts for only 0.4%.

According to the MTF data, around 71.6% of Nepali households use **biomass stoves** as their primary cookstove: 15.1% cook using an open fire stove; 47.6% cook using a traditional stove, and 8.9% use an improved stove. Meanwhile, 26.3% of households cook using LPG, 2% use biogas stoves, and "a very small portion of the population uses electric or solar cookers" (under 1%).[11]

Fuel stacking
Fuel stacking is widespread and common across most Nepali households. Studies have shown that a combination of different fuel or energy sources are used throughout the day, including biomass, biogas, LPG, and electricity. Additionally, the use of biomass fuels is seasonal: wood fuel use is higher during the winter months for cooking and space heating, but biogas and LPG use increase during monsoon and summer months when biomass collection is difficult, and fuelwood takes longer to burn. The most common combination of stacking is wood and LPG as cooking fuels – even though clean fuels are part of the stacking mix, biomass remains the dominant fuel source for households.[12] See Table X for further details on how LPG (clean fuel) is stacked with polluting fuels[14]:

LPG +	Wood	Wood + dung	Wood + crop residue	Wood + biogas	Wood + crop residue	Electric	Wood + saw dust	Wood + dung
	7.9%	4.1%	2.3%	1.6%	0.8%	0.4%	0.4%	0.4%

Costs associated with fuels
Firewood is often collected for free, and "on average, households spend an annualized monthly cost of 1087 Nepalese Rupees (US $10.54) on LPG."[13] Clean energy sources such as LPG and electricity are perceived to be expensive in comparison to freely available fuelwood or cheaper agricultural residue. Thus, the ability to afford the monthly electricity tariff is the major barrier to adoption of electrical cooking, especially in rural areas. According to MTF data, cooking fuel costs account for more than 5% of monthly spending for 14.3% of households nationwide. Additionally, the use of a combination of fuels is associated with low-income households as a result of limited disposable income and the unaffordability of certain fuels, and the upfront costs of electrical appliances is a further barrier to adoption.

[14] MTF Nepal

Electric cooking appliances are far more efficient (70-95% efficiency) versus gas stoves (40-55%). When costs and efficiency are correlated, it's estimated that using LPG will cost around NPR13.5 per unit versus NPR 11.5 per unit.[14] Similarly, Controlled Cooking Trials conducted by PEEDA have shown that electric cooking on all electric cooking stoves is cheaper than LPG – with EPCs being over half as cheap due to higher efficiency.
The NEA employs a block tariff system where the unit rate of electricity consumed increases with an increase in total energy consumed by meter (see Table 1[15]). Although this structure enables low-energy consuming households to pay lower rates for electricity and is designed to encourage energy efficient consumption, it can also serve to discourage electric cooking as the extra load often requires households to move to a more expensive band, which in turn can lead to ecooking being more expensive than LPG[16]. What this conflicting data shows is that it is not possible to accurately predict the cost of cooking with electricity in Nepal without knowing which tariffs households are on, and when the data is considering cooking in isolation – not overall load of household.

Table 1: Nepal Electricity tariffs in NPR (NERC, 2020)

Units	5 Amp	15 Amp	30 Amp	60 Amp
0-20	0	4	5	6
21-30	3	4	5	6
31-50	6.5	6.5	6.5	6.5
51-150	8	8	8	8
151-250	9.5	9.5	9.5	9.5
251-400	9.5	9.5	9.5	9.5
400+	12	12	12	12

Looking at these scenarios, it seems more feasible that urban households with higher income levels and disposable cash are more likely able to purchase appliances and afford the monthly tariffs. Further, small households with low consumption (around 200 units) would benefit financially by shifting from LPG to electricity for cooking. Large low-income households with high consumption loads may find this shift financially more constraining.

The GIZ-supported Market-led Promotion of Electric Cooking in Timal Community Rural Electrification Entity (CREE) programme: 569 induction stoves (including pots) were distributed with a discount of 19%. The price for customers was reduced from the market price of NRs. 6,850 to NRs. 4,750, which became possible due to bulk purchasing, and NRs. 1,100 project incentive per household; and an electricity bill discount of NRs. 150 per month for the first six months. This discount was for households with an increase in electricity consumption of at least 20kWh per month.
The Gender Responsive Electric Clean Cooking in Nepal study found that loans were taken to purchase induction stoves by families in low- and middle-income groups. The only loans taken were by women affiliated to a savings and credit group.

Appendix 4: Supply Chain

Issues around electricity supply and electrical appliances
Issues around the unavailability of after sales services (repair and maintenance) and around electricity supply (quality and stability of electricity supply on one hand; LPG is not always available in a timely manner as it's imported from afar) need further consideration and exploration. Further to this, rural supply chains for electric cooking are particularly weak – retailers, after sales services, and repair centres are less frequently found compared to urban spaces.[15] Additionally, generation capacity is of concern. If generation increases as planned, electricity capacity would allow only 15% of Nepali households to use electricity for cooking.[16] This is

[15] Practical Action/MECS ECO Market Assessment – forthcoming
[16] CCA Report - forthcoming

still a substantial number of households, and the NEA's commitment to access for all should mean that issues of supply and quality will result in improved access. Similarly, the Electric Cooktop Standards of 2019 is aimed to improve the appliance market with better quality and standardised electric cooking devices.

When it comes to electricity there is definitely potential for wider use of single purpose cooking devices such as rice cookers or kettles. The quality of a household's electricity supply does seem to be a barrier to electric cookstove use, along with the capacity of their connection; however, these barriers seem to be a direct result of households paying cheaper set up fees for their grid connection. If the government were to subsidise the initial cost of good quality meters, then more households would be able to overcome the initial cost of setting up a good quality connection and start using a higher capacity, more reliable grid connection.[17]

Appliance availability

Electric cooking appliances have increasingly been adopted by high-income urban households over the last few years, with many owning a combination of kettles, rice cookers, electric cookstoves, microwave ovens, EPCs, and, on occasion, roti makers. In terms of electric cookstoves available in the market, these are: infrared, resistance type and induction cookstoves. Induction cookstoves are the more popular of these.[18] During the COVID-19 pandemic, the GoN encouraged the adoption of e-cooking by waiving custom duties on induction cookstove imports and by "providing a 25% discount on electricity consumption of up to 150kWh per month".[19]

Electric cookstoves do not seem to be locally manufactured, and, indeed, one recommendation is to **encourage** domestic manufacturing and widespread national availability (i.e., beyond cities). By way of example: Practical Action found that even Nepali companies, such as Chaudhary Group, which has a 30-40% market share in the total sales of electric cooking appliances, manufacture products in China. Additionally, whilst they have 200 dealers distributed across Nepal, only a handful sell electric cooking appliances and keep limited stock on hand.[20] Thus, the market seems to be predominantly in urban areas, with very little peri-urban and rural reach, and dealers/suppliers/retailer networks being located in cities. The implications of repair and maintenance being that fewer households outside of cities are likely to purchase appliances that cannot be fixed, due to lack of after-sales services, if they were to break.

What is of note, is that the NCS endorsed the Electric Cooktop Standards in 2019 to set safety and standard requirements for household electrical cooking appliances.

e-waste

A growing concern in country is that as purchasing power rises, Nepal (and especially its major cities) faces the growing issue of e-waste. This is of significant importance if e-cooking is to be encouraged and eventually adopted at scale. A study conducted by Nepal's Department of Environment found that 18,000 metric tons of e-waste was discarded in Kathmandu alone in 2017.[21] Most of this waste ends up on landfills with other trash. The Nepali Times claimed that "increasing purchasing power, planned obsolescence of electronic gadgets and the lack of strict regulation on disposal has eroded the Nepali culture of repairing, reusing. and recycling."[22] The decade of severe power cuts in Nepal resulted in an accumulated estimated 25,000 tons of battery waste – 10,000 of which were from inverters and 8,000 from solar systems.[23]

[17] MTF analysis: Jones, Barnard-Tallier - forthcoming
[18] GoN. Assessment of electric cooking targets for Nepal's 2020 NDCs
[19] GoN. Assessment of electric cooking targets for Nepal's 2020 NDCs
[20] MECS ECO Market Assessment report by Practical - forthcoming
[21] http://doenv.gov.np/index.php
[22] https://www.nepalitimes.com/banner/what-will-nepal-do-with-its-e-waste/
[23] Ibid

Whilst the Solid Waste Management Act of 2011 addresses hazardous and industrial waste, it makes no inclusion of e-waste. Thus, what doesn't end up on the landfills is sold to scrap dealers. A Hazardous Waste Regulation is being drafted, which is supposedly said to address the control and management of e-waste and ban illegal importation of electronic goods.[24]

[24] Ibid