NEPAL: COUNTRY LEVEL LIFE CYCLE ASSESSMENT

An assessment of impacts on health, ecosystems and resource use of the transition to e-cook.

Authors own image.
Copyright J Lee 2022

Recipe ingredients, Beans Porridge and Fried Plantain.Copyright of Ekomobong Samuel, Nigeria eCookbook, 2024

The transition to e-cook from traditional cooking fuels can deliver a range of benefits (and possible impacts) to human health, ecosystems and resource use. Using a Life Cycle Assessment approach, these have been analysed across the full life cycle of cooking, from raw material extraction to final disposal of the cooking devices and the different fuels used. This analysis takes into account the split between rural and urban populations, and their access to electricity.

Loughborough University

ESMAP
Energy Sector Management Assistance Program

www.mecs.org.uk

BACKGROUND INFORMATION

Taking 2019 as the base year, Nepal had a population of just under 29 million, with an average family size of 4.25 people. The population was split 80% rural and 20% urban, with 88.8% of the rural population having access to electricity and 94.2% of the urban population able to access electricity (World Bank). The three main fuels used for cooking were firewood, LPG, dung and electricity, see Table 1 (dung has not been included in this analysis).

	% Rural pop	% Urban pop	% Total pop
Firewood	80.3	40.6	69.3
LPG	17.3	58.4	28.8
Electricity	0.1	0.1	0

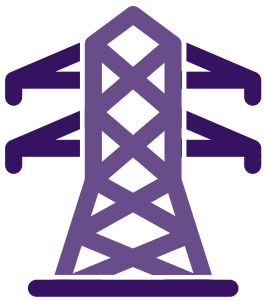
(WHO: Primary reliance on fuels and technologies for cooking, 2021)

Table 2 shows the daily fuel consumption per household, assuming no fuel stacking.

	Per HH per day
Firewood	5.06 Kg
LPG	0.21 Kg
Electricity	1.25 KWh

(Market assessment of efficient cooking devices in Nepal. https://mecs.org.uk/wp-content/uploads/2022/01/Market-Assessment-of-Efficient-Electric-Cooking-Appliances-in-Nepal.pdf)

Table 2: Daily single fuel consumption per household



88.8% RURAL ACCESS TO ELECTRICITY

94.2% URBAN ACCESS TO ELECTRICITY

ASSUMPTIONS

Nine different scenarios were analysed in comparison to the base case (S0) using the following assumptions:

(a) it was assumed that each household utilised a single fuel for cooking (i.e. no fuel stacking),
(b) access to electricity is synonymous with a suitable grid supply to use electricity for cooking,
(c) for rural population, if 88.8% have access and only 0.1% currently use electricity for cooking, then there is capacity for a further 88.7% of rural population to transition to electricity,
(d) for urban population, if 94.2% have access and only 0.1% currently use electricity for cooking, then there is capacity for a further 94.1% of the urban population to transition to electricity,
(e) two hypothetical scenarios have been evaluated: 100% LPG cooking and 100% electric cooking. These are not realistic scenarios and have been included to provide an indication of the maximum possible benefits that could be achieved.

SCENARIOS EVALUATED

- Base case, in 2019 (S0)
- Shift all wood users to electricity (S1)
- Shift rural wood users to electricity (S2)
- Shift urban wood users to electricity (S3)
- Shift all LPG users to electricity (S4)
- Shift all urban wood users and LPG (where possible) to electricity (S5)
- Shift all rural wood users and LPG (where possible) to electricity (S6)
- Shift all wood users to LPG (S7)
- All LPG cooking (S8)
- All electric cooking (S9)

IMPACTS ASSESSED

The impacts evaluated were improvement in CO_2 emissions, effect on human health, ecosystems and resource use. These are defined as:

- **CO_2e emissions,** expressed as the change in CO_2 equivalent emissions for the country as a whole. Negative change suggests an improvement in CO_2 emissions, a positive change suggests an increased impact from CO_2 emissions
- **Human Health,** expressed as the number of year life lost and the number of years lived disabled. These are combined as Disability Adjusted Life Years (DALYs). The unit is years.
- **Ecosystems,** expressed as the loss of species over a certain area, during a certain time. The unit is years
- **Resource scarcity,** expressed as the extra costs of future resource production over an infinitive timeframe (assuming constant annual production), considering a 3% discount rate. The unit is USD2013.

FINDINGS

1) The effect of the cooking devices was seen to be negligible, and the results are dominated by the fuel type.
2) Switching firewood users to electric cooking (S1) delivers an over 80% reduction in CO_2e emissions. This is predominantly achieved by shifting rural firewood users (S2). This scenario also offers the greatest benefits in improved human health and ecosystems outcomes, but at a cost of a marginal increase in resource use.
3) The increase in resource impact that results from the shift to electric cooking from firewood could be explained by the assumption in the model that firewood is essentially a 'free' resource, i.e.: it is collected via natural wood harvesting (fallen wood) as opposed to a system where wood is managed and harvested in an plantation type environment as part of a business, (with associated material and energy inputs). Thus, shifting from the 'free' resource to that of resources needed for electricity production (infrastructure, materials and fuels) leads to the negative impact for resource use.
4) Shifting all existing LPG users to electric cooking (S4) delivers practically no improvement in CO_2e emissions, health or ecosystem outcomes but does deliver a substantial improvement in resource use. This is expected given that Nepals' domestic generation is based on renewable resources, whereas LPG has significant infrastructure and material (oil or gas) requirements.

Figure (1) Effect on CO_2e emissions

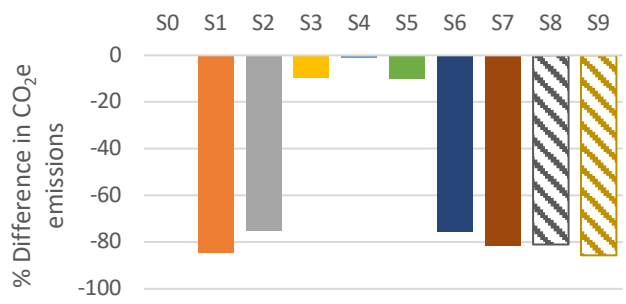


Figure (2) Human health: DALY

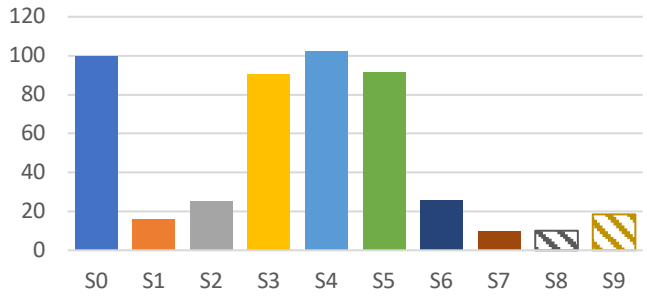


Figure (3) Ecosystems: species.yr

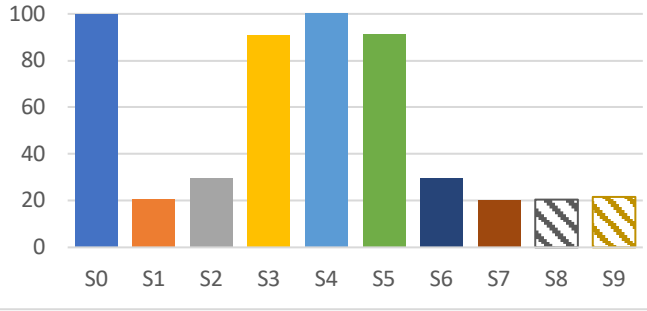
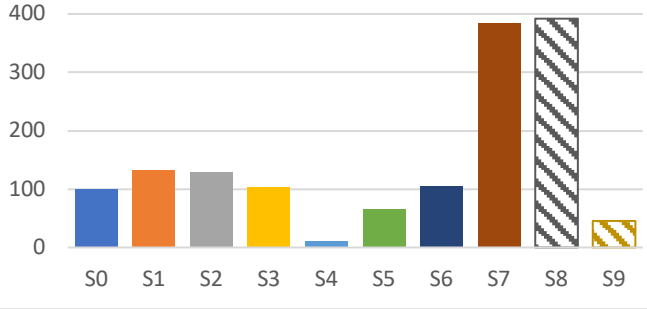


Figure (4) Resources: USD2013



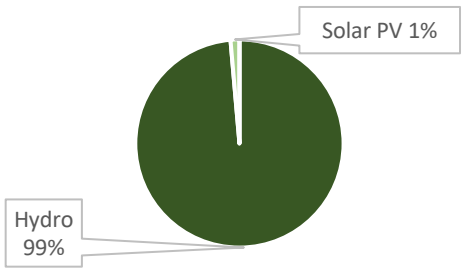
For figures (2), (3) and (4): Base case (S0) = 100

5) Moving all urban firewood and LPG users to electric cooking (S5) delivers small benefits to CO2e emissions (approximately 10%), human health, ecosystems and resource use.
6) Moving all rural firewood and LPG users to electric cooking (S6), also delivers exceptional benefits for CO_2e emissions reduction (approximately 80% reduction), and improvement in human health and ecosystems outcomes. It marginally increases the resource use in comparison to the base case.
7) An over 70% benefit in CO_2e outcomes can be realised by shifting all firewood users to LPG (S7) This also delivers beneficial outcomes for human health and ecosystem, but there is an almost 4- fold increase in resource use associated with this option.
8) Exploring the effect of the hypothetical scenarios of all LPG (S8) or all electric cooking (S9) shows that whilst both options provide significant improvements in CO_2e emissions, health and ecosystems, shifting to an all LPG scenario would have considerable negative implications for resource use, similar to S7.
9) The results normalised against global damage show that the human health impacts are more significant than those for ecosystems and resource use.

CONCLUSIONS

The results show that moving away from firewood for rural users to either electricity or LPG will generate significant savings in CO_2e emissions, but in the case of LPG, this will substantially increase resource use. This is primarily due to the fact that domestic electricity generation is driven by hydro (although in 2019 Nepal imported approximately 35% of its power from India, which is fuelled by coal reserves) (IEA: https://www.iea.org/countries/nepal/electricity).

The findings from this study suggest that the focus should be on moving rural firewood users to electric cooking. Households that use LPG for cooking should not be a primary target group for a transition to electric cooking.



Domestic electricity generation by source 2021 (IEA.org)

How to use the data

This analysis uses a number of very broad assumptions that are not necessarily representative of all situations; no fuel stacking, that access to electricity is synonymous with a supply that is suitable and can support electric cooking, and that access will be to the grid system. In addition, it is assumed that the grid supply will expand using similar sources for energy generation, e.g. if electricity is mainly produced by hydro sources, then the increase in supply needed to match the uptake in electric cooking will also be supplied from hydro sources.

The results themselves are a combination of influencing factors: access to electricity (the number of households that can transition), and carbon intensity of the fuels.

As such, these results should be viewed as generic trend data, as opposed to specific values for the country assessed. The results aim to provide a broad brush assessment of the likely direction of travel for the impact categories chosen (CO_2e emissions, human health, ecosystem degradation, and resource use), as a result of a transition to electric cooking.

Loughborough University
ESMAP Energy Sector Management Assistance Program

This material has been funded by UK aid from the UK government; however, the views expressed do not necessarily reflect the UK government's official policies.

Modern Energy Cooking Services (MECS) Programme | Authors: Martin Price, Tom Jones, Nigel Scott | martin@gamos.org |