KENYA: COUNTRY LEVEL LIFE CYCLE ASSESSMENT

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

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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.

UKaid from the British people
MECS Modern Energy Cooking Services
Loughborough University
ESMAP Energy Sector Management Assistance Program

BACKGROUND INFORMATION

Taking 2019 as the base year, Kenya had a population of 51 million, with an average family size of 3.9 people. The population was split 72% rural and 28% urban, with 61.9% of the rural population having access to electricity and 90.8% of the urban population able to access electricity (World Bank). The main fuels used for cooking were firewood, charcoal, kerosene, LPG, and electricity.

	% Rural pop	% Urban pop	% Total pop
Kerosene	0.7	12.8	4.1
LPG	2.3	22.2	7.9
Electricity	0.1	1.5	0.5
Firewood	86.7	30.5	71
Charcoal	9.3	27.4	14.4

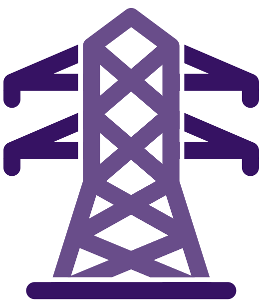
(WHO: Primary reliance on fuels and technologies for cooking, 2021)

Table 1: Fuel type used per % of population

	Per HH per day
Kerosene	0.23 Kg
LPG	0.21 Kg
Electricity	1.78 KWh
Firewood	3.25
Charcoal	1.63

(Calculated from Leach et al, Energies 2021, 14, 3371. https://doi.org/10.3390/en14123371)

Table 2: Daily single fuel consumption per household



61.9% RURAL ACCESS TO ELECTRICITY

90.8% URBAN ACCESS TO ELECTRICITY

ASSUMPTIONS

Eleven 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 61.9% have access and only 0.1% currently use electricity for cooking, then there is capacity for a further 61.8% of rural population to transition to electricity,
(d) for urban population, if 90.8% have access and only 1.5% currently use electricity for cooking, then there is capacity for a further 89.3% 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 limits to possible benefits that could be achieved.

SCENARIOS EVALUATED

- Base case, in 2019 (S0)
- Shift all charcoal users to electricity (S1)
- Shift rural charcoal users to electricity (S2)
- Shift urban charcoal users to electricity (S3)
- Shift all wood users to electricity (S4)
- Shift all rural wood users to electricity (S5)
- Shift all urban wood users to electricity (S6)
- Shift all urban firewood and as many urban charcoal users as possible to electricity (S7)
- Shift all rural firewood and as many rural charcoal users as possible to electricity (S8)
- Shift all kerosene and LPG users to electricity (S9)
- All LPG cooking (S10)
- All electric cooking (S11)

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 from charcoal to electricity (S1) delivers up to a 30% reduction in CO_2e emissions, and is driven more or less equally by both rural (S2) and urban (S3) users. This switch also delivers improved health and ecosystem and resource outcomes.
3) Switching from firewood to electricity (S4) delivers a much greater improvement (just under 50%) in CO_2e emissions than that from charcoal. In this case, it is driven predominantly by rural firewood users (S5) , with only approximately 10% from urban wood users (S6). This switch also delivers benefits for health and ecosystems in comparison to S0, but results in an increase in impact for resource use.
4) 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.
5) Focussing on all urban users (S7), there is capacity for all charcoal and firewood users to move to electric cooking. This results in a reduction of CO_2e emissions of just under

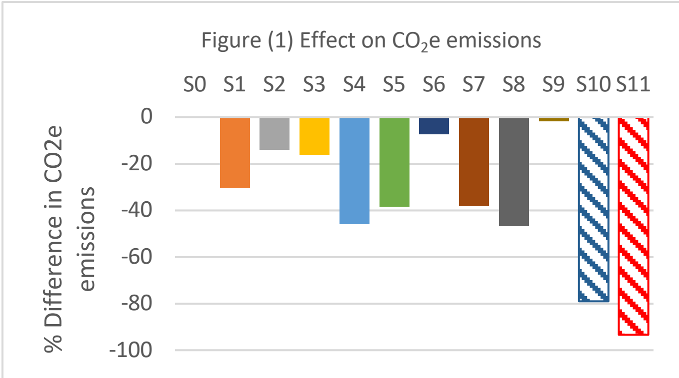


Figure (1) Effect on CO_2e emissions

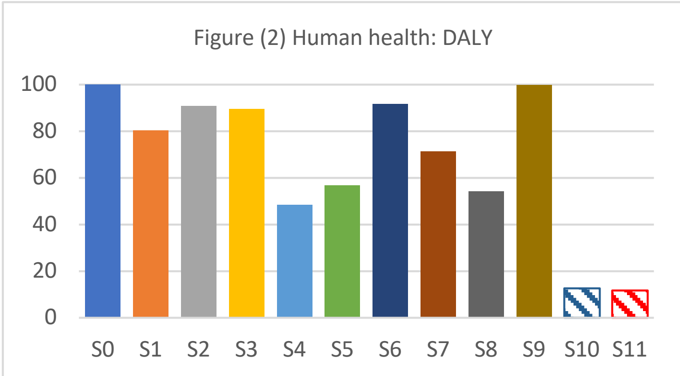


Figure (2) Human health: DALY

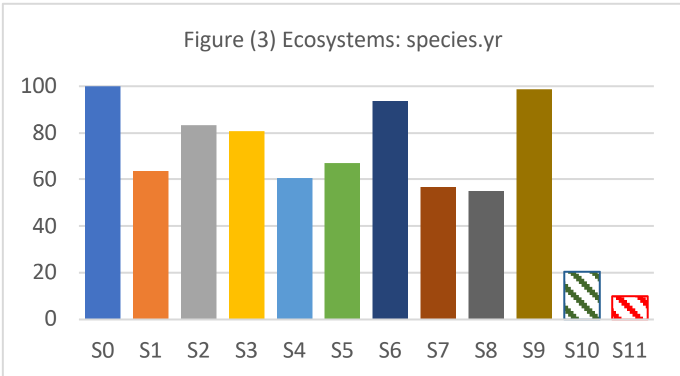


Figure (3) Ecosystems: species.yr

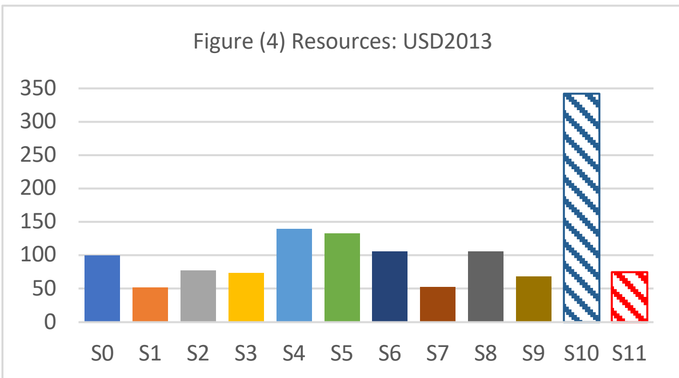


Figure (4) Resources: USD2013

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

40%, with accompanying benefits for human health, ecosystems and resource use.

6) Considering the options for rural users, here there is capacity for all charcoal and two thirds of firewood users to shift to electric cooking. This results in an almost 50% reduction in CO_2e emissions, and benefits for human health and ecosystems. However, it also results in an increase in resource use, similar to S6.
7) Looking at the hypothetical case of all LPG (S10) and all electric cooking (S11) shows that electric cooking would deliver better CO_2e emissions, health, ecosystem and resource use outcomes than S0.
8) The results normalised against global damage show that the human health impacts are more significant than those for ecosystems and resource use.

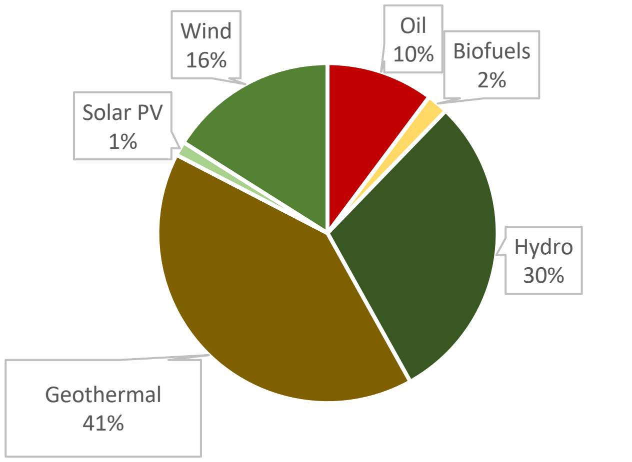
CONCLUSIONS

Kenya domestic electricity generation is predominantly hydro and geothermal, (IEA: https://www.iea.org/countries/kenya/electricity) and this supports the reduction in CO_2 emissions from cooking using grid electricity.

The results suggest that the greatest benefits for CO_2e emissions, and improved human health, ecosystem and resource use outcomes would be realised from shifting rural firewood and charcoal users to electric cooking (S8).

Kenya has a relatively high rural electrification rate, thus a proportionately larger beneficial effect could be achieved if the rural firewood users shifted directly to electric cooking, without transitioning through improved charcoal burners. In additional, the lower carbon intensity of the grid system would suggest that grid connection would be appropriate to retain low CO_2e emissions from cooking.

Once rural cooking has transitioned to electricity, it would then be appropriate to focus on urban charcoal users.



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.

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