ETHIOPIA: 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.

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BACKGROUND INFORMATION

Taking 2019 as the base year, Ethiopia had a population of just over 114 million, with an average family size of 5.76 people. The population was split 79% rural and 21% urban, with 36% of the rural population having access to electricity and 92.7% of the urban population able to access electricity (World Bank). The main fuels used for cooking were kerosene, LPG, electricity, firewood and charcoal, see Table 1 below.

	% Rural pop	% Urban pop	% Total pop
Kerosene	0.2	0.7	0.3
LPG	0.1	0.8	0.2
Electricity	0.1	23.5	5.1
Firewood	96.3	43.5	85.1
Charcoal	1.3	27.8	6.9

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

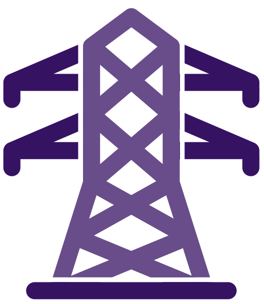
Table 1: Fuel type used per % of population

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

	Per HH per day
Kerosene	0.66 Kg
LPG	0.55 Kg
Electricity	3.68 kWh
Firewood	6.4 Kg
Charcoal	2.59 Kg

(Based on data from Ecook reports)

Table 2: Daily single fuel consumption per household



36% RURAL ACCESS TO ELECTRICITY

92.7% 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 suitable supply to use electricity for cooking,
(c) for rural population, if 36% have access and only 0.1% currently use electricity for cooking, then there is capacity for a further 35.9% of rural population to transition to electricity,
(d) for urban population, 92.7% have access and only 23.5% currently use electricity for cooking, then there is capacity for a further 69.2% 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 rural charcoal to electricity (S1)
- Shift urban charcoal to electricity (S2)
- Shift rural and urban charcoal users to electricity (S3)
- Shift rural firewood to electricity (S4)
- Shift urban firewood to electricity (S5)
- Shift rural and urban firewood users to electricity (S6)
- Shift urban charcoal and firewood users to electricity (S7)
- Shift rural charcoal and firewood users to electricity (S8)
- Shift rural and urban 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 surplus 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) Moving charcoal users to electricity (S3) will deliver some benefit in CO_2e emission reductions (just over 10%), and this is driven mainly by shifting the urban users of charcoal (S2). This shift also results in a corresponding improvement in human health, ecosystems and resource use.
3) Given the high numbers of firewood users, it is unsurprising that shifting firewood users (S6) will have a greater impact than moving charcoal users, resulting in nearly 40% reduction in CO2e emissions. In this case it is driven by transitioning the rural community (S4).
4) Whilst the shift from firewood to electricity also delivers significant improved outcomes for human health and ecosystems, it also causes a very small increase in resource use.
5) A focus on rural transition (S8) delivers slightly better outcomes for all categories, rather than on urban communities (S7).
6) Shifting kerosene and LPG users to electricity (S9) delivers only small benefits for resource use and little benefit in CO_2e reduction.
7) Comparing the hypothetical scenarios of all LPG (S10) or all electric cooking (S11) shows that grid connected electric cooking would deliver better CO_2e savings and improved health, ecosystem and resource use outcomes. This suggests that rural users

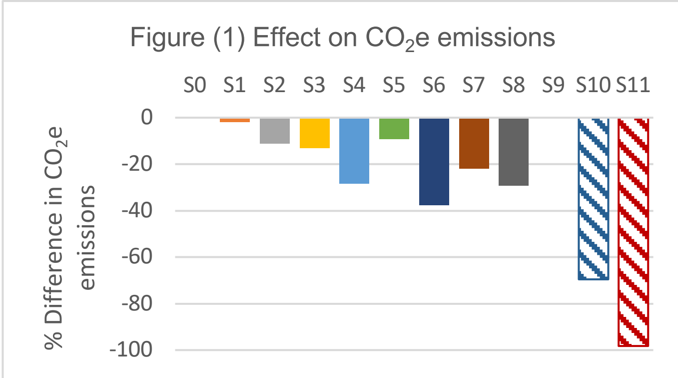


Figure (1) Effect on CO_2e emissions

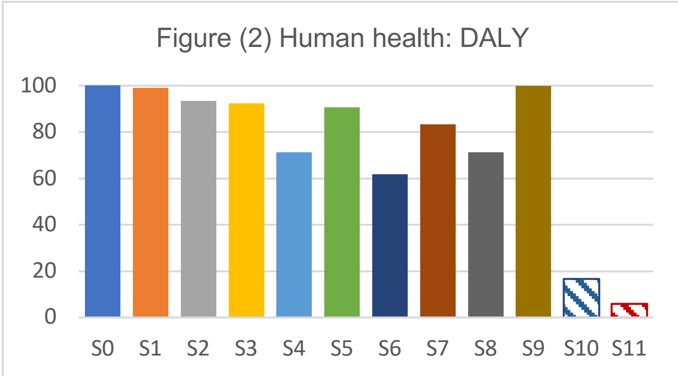


Figure (2) Human health: DALY

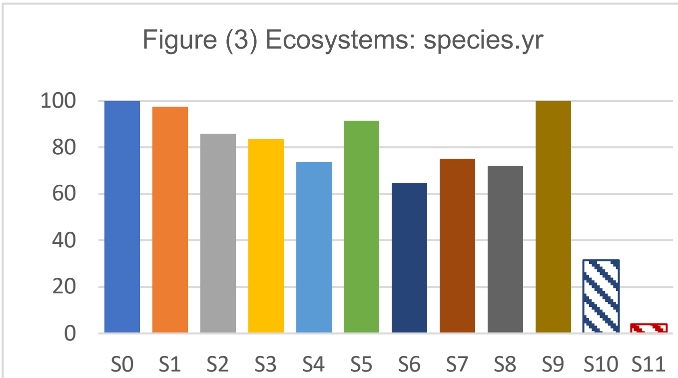


Figure (3) Ecosystems: species.yr

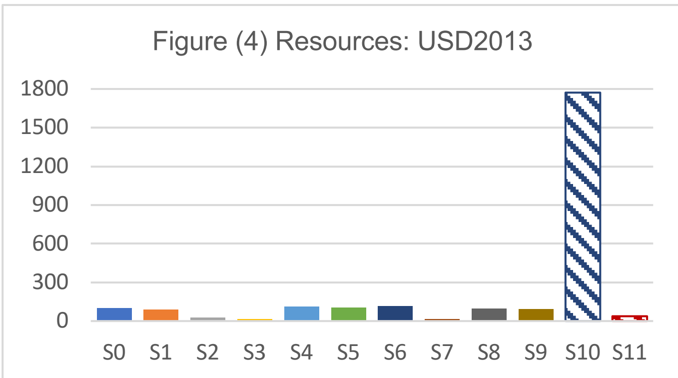


Figure (4) Resources: USD2013

For figures (2), (3) and (4): Base case (S0) = 100F could be connected to the grid electrical system, rather than local mini-grids.

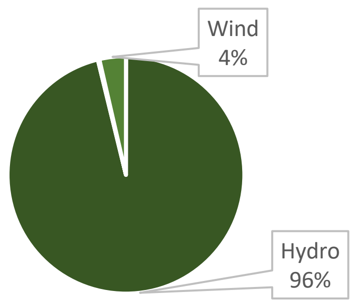
8) Whilst shifting to LPG cooking does deliver significant savings for CO_2e, health and ecosystems, it also leads to an 18-fold increase in resource use impact.
9) The results normalised against global damage shows that human health impacts are more significant than those for ecosystems or resources.

CONCLUSIONS

Ethiopia generates its domestic electricity from renewable resources, and thus electric cooking is a low carbon option (IEA: https://www.iea.org/countries/ethiopia/electricity) and that wherever possible, users should be grid connected.

This assessment suggests that, despite the current low levels of access to electricity in the rural population, initial efforts should be guided towards shifting rural firewood users (S6) to electric cooking, followed by urban users of both charcoal and firewood (S7).

The limited CO_2e benefits, human health and ecosystem impacts of switching existing kerosene and LPG users to electric cooking (S9) suggest that these users should not, at the current time, be the primary focus for transitioning to electric cooking.



Domestic electricity generation sources 2021, IEA

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 via 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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