ZAMBIA: COUNTRY LEVEL LCA ASSESSMENT

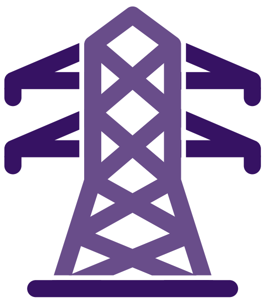
An assessment of impacts on health, ecosystems and resource use of the transition to e-cook.

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.

Taking 2019 as the base year, Zambia had a population of 18 million, with an average family size of 6.47 people. The population was split 56% rural and 44% urban, with 14% of the rural population having access to electricity and 79.5% of the urban population able to access electricity (World Bank). The three main fuels used for cooking were firewood, charcoal and electricity (LPG has been discounted as it accounts for <1% of cooking fuels).

	% Rural pop	% Urban pop	% Total pop
Firewood	83.6	6	46.7
Charcoal	14.5	61.2	36.6
Electricity	1.9	32.5	16.5

(Luzi et al, Zambia beyond connections, ESMAP 2019)



14% RURAL ACCESS TO ELECTRICITY

79.5% URBAN ACCESS TO ELECTRICITY

The daily fuel consumption per household is given below. The value for wood had been calculated on an equivalent MJ value for charcoal used, assuming calorific value of wood to be 14.76MJ/Kg.

	Per HH per day
Firewood	2 Kg
Charcoal	1.04 Kg
Electricity	0.87 KWh

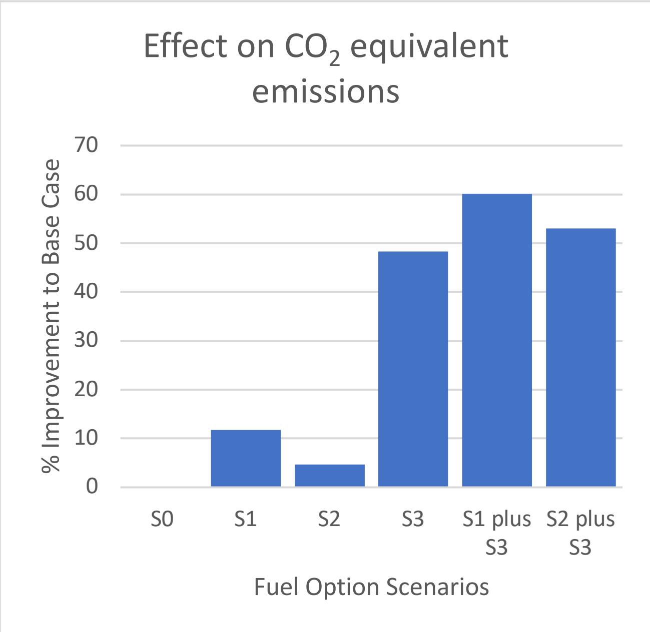
(Leach et al, Energies 2021, 14, 3371. https://doi.org/10.3390/en14123371)

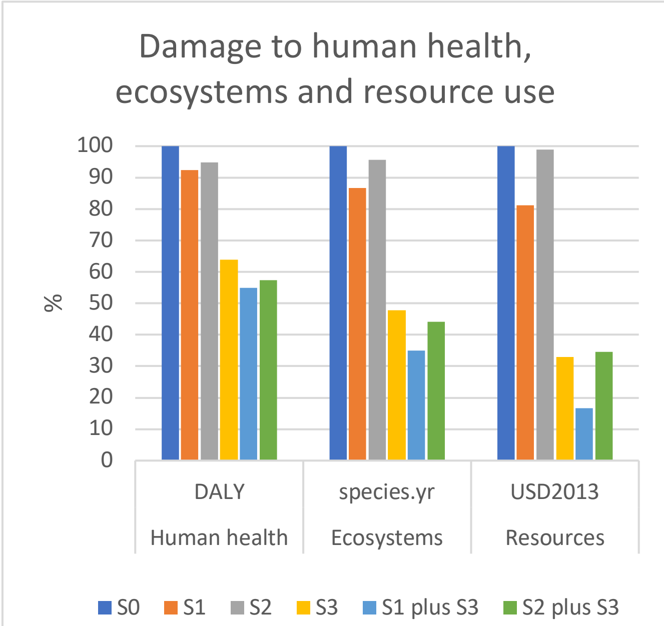
Assumptions

Six different scenarios were analysed using the following assumptions: (a) access to electricity is synonymous with suitable supply to use electricity for cooking, (b) for rural population, if 14% have access and only 1.9% currently use electricity for cooking, then there is capacity for a further 12.1% of rural population to transition to electricity, (c) for urban population, if 79.5% have access and only 32.5% currently use electricity for cooking, then there is capacity for a further 47% of the urban population to transition to electricity.

- Base case, in 2019 (S0)
- Shift rural charcoal users to electricity (S1)
- Shift rural firewood users to electricity (S2)
- Shift urban charcoal and firewood users to electricity (S3)
- Shift urban charcoal and firewood users to electricity, plus rural charcoal users (S1 plus S3)
- Shift urban charcoal and firewood users to electricity, plus rural firewood users (S2 plus S3)

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





- **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) As shown in the effect on CO_2 emissions graph, the scenario which offers the greatest improvement in CO_2 emissions, is a combination of transitioning all urban charcoal and firewood users to electricity, alongside rural charcoal users (S1 plus S3).
3) From the damage to heath, ecosystems and resource use, it can be seen that the same scenario also produces the least impact on all three impact categories (S1 plus S3).
4) Scenario S2, the shift of rural firewood users to electric cooking, reduces CO_2 emissions by the least amount, and also reduces the impact on health, ecosystems and resource use by the least amount.
5) The results normalised against global damage show that the human health impacts are more significant than those for ecosystems and resource use.

CONCLUSIONS

The life cycle approach includes the effects of the fuel production, which, in the case of charcoal, are significant. The use of earth mound kilns to create charcoal releases gases, including methane, which have a larger effect on GWP than CO_2. These gases are also significant contributors to human health and ecosystems.

The findings from this study suggest that, given the current electrification rates, the shift from traditional fuels to electric cooking should initially focus on moving urban populations away from traditional fuels to electric cooking. The secondary focus should be to shift rural charcoal users to electric, and finally rural firewood users to electric.

Given the current low level of rural electrification, an increase in access to electricity in these areas could have a proportionately larger beneficial effect, especially if the rural firewood users shifted directly to electric cooking, without transitioning through improved charcoal burners.

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