INDIA: 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.

Loughborough University

ESMAP
Energy Sector Management Assistance Program

www.mecs.org.uk

BACKGROUND INFORMATION

Taking 2019 as the base year, India had a population of 1.4 billion, with an average family size of 4.45 people. The population was split 66% rural and 34% urban, with 93.8% of the rural population having access to electricity and 99.8% of the urban population able to access electricity (World Bank). The main fuels used for cooking were kerosene, LPG, electricity, firewood and coal, see Table 1 below.

	% Rural pop	% Urban pop	% Total pop
Kerosene	0.5	2.4	1.1
LPG	28.5	79.4	45.8
Electricity	0.4	0.8	0.5
Firewood	67.9	12.9	49.2
Coal	0.8	1.4	1

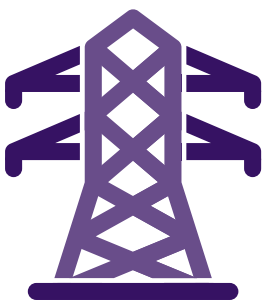
(WHO: Primary reliance on fuels and technologies for cooking, 2021)

Table 1: Fuel type used per % of population

A very small percentage (0.1% of urban population) used charcoal for cooking. This has not been included in this analysis. Table 2 shows the daily fuel consumption per household, assuming no fuel stacking.

ASSUMPTIONS

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



93.8% RURAL ACCESS TO ELECTRICITY

99.8% URBAN ACCESS TO ELECTRICITY

	Per HH per day
Kerosene	0.33 Kg
LPG	0.27 Kg
Electricity	1.83 KWh
Firewood	3.19 Kg
Coal	1.37 Kg

(Based on data from Ecook reports)

Table 2: Daily single fuel consumption per household

(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 supply to use electricity for cooking,
(c) for rural population, if 93.8% have access and only 0.4% currently use electricity for cooking, then there is capacity for a further 93.4% of rural population to transition to electricity,
(d) for urban population, if 99.8% have access and only 0.8% currently use electricity for cooking, then there is capacity for a further 99% 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 urban wood users to electricity (S2)
- Shift rural wood users to electricity (S3)
- Shift kerosene and LPG users to electricity (S4)
- Shift all coal and firewood users to electricity (S5)
- Shift all coal, firewood and as much LPG as possible to electricity (S6)
- All LPG cooking (S7)
- All electric cooking (S8)

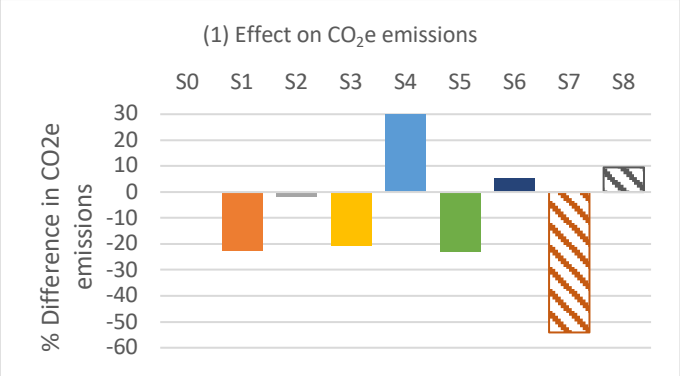
IMPACTS ASSESSED

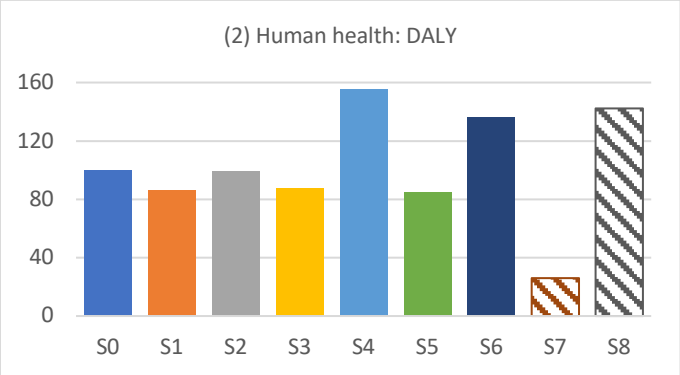
The impacts evaluated were improvement in CO_2 emissions, effect on human health, ecosystems and resource use. These are defined as:

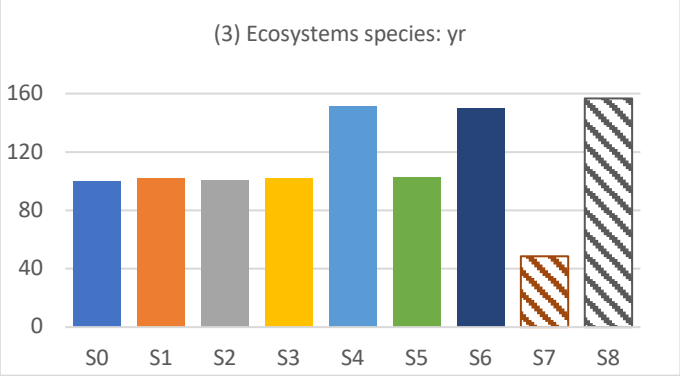
- **CO_2e emissions,** expressed as the change in CO_2 equivalent emissions for the country as a whole. Negative change suggests an improvement in CO_2 emissions, a positive change suggests an increased impact from CO_2 emissions
- **Human Health,** expressed as the number of year life lost and the number 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

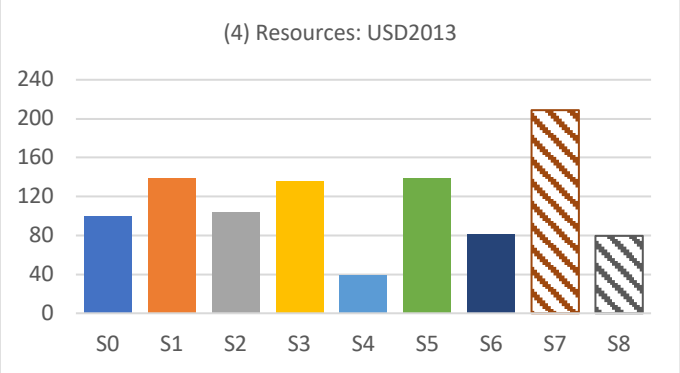
FINDINGS

1) The effect of the cooking devices was seen to be negligible, and the results are dominated by the fuel type.
2) Transitioning firewood users to electricity delivers approximately 25% improvement in CO_2e emission (S1), driven almost exclusively by the rural community (S3). This is accompanied by slight improvement in health outcomes and slightly worsening resource use. The increasing resource use impact is likely resulting from the resources needed to supply the fossil based fuels predominantly used for domestic electricity production.
3) Moving existing LPG and kerosene users to electricity (S4) results in an increase in CO_2e emissions, damage to human health and ecosystems, but a significant reduction in resource use (around 60%). This can be primarily explained by the high dependency on fossil fuels for domestic electricity generation and its efficiency.
4) Transitioning all coal and firewood users to electricity (S5) results in an approximately 25% improvement in CO_2e, driven









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

predominantly by the shift in firewood users, accompanied by a small improvement in health outcomes.

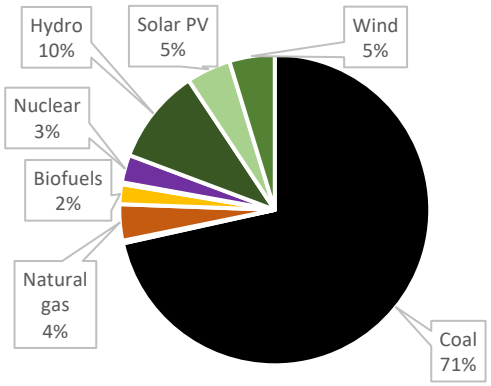
5) If coal, firewood and as many LPG users as possible are moved to electric cooking, this results in an increase in CO_2e emissions (S6). This suggests that the benefits accrued from the transition of coal and wood, are outweighed by the impacts caused by shifting LPG to electricity. This is as a result of the heavily fossil based domestic supply.
6) Switching all cooking to LPG (S7) offers the greatest savings in CO_2e emissions and reduces damage to human health and ecosystems. However, it doubles the impact for resource use.
7) Exploring further the hypothetical scenarios of moving to all LPG (S7) or all electric cooking (S8), the results show that all electric results in an increase in CO_2e emissions, and worsening health and ecosystem outputs. Resource use is, however, improved.
8) The results normalised against global damage show that the human health impacts (Figure 2) are more significant than those for ecosystems and resource use.

CONCLUSIONS

The results show clearly that a shift to LPG cooking would result in improved CO_2e, human health and ecosystems impact for India. This is because the generation of electricity in India is dominated by fossil fuels, particularly coal, (IEA: https://www.iea.org/countries/india/electricity).

Despite the high levels of access to electricity, scenario 4 suggests that shifting to electric cooking, may not be the best solution with the current domestic electricity grid production fuels.

Given the current fossil fuel-based electricity generation in India, this assessment would suggest that, given the current carbon intensity of the domestic grid, there is a significant hit to resource use from choosing LPG as the main cooking fuel, but the benefits for CO_2e impact, human health and ecosystems are significant. These may be further enhanced by the generation and use of low carbon LPG type gases. Additionally, a national program to decarbonise the domestic grid alongside switching rural firewood users to renewable mini-grid electricity could be investigated.



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 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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