BANGLADESH: 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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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.

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ESMAP
Energy Sector Management Assistance Program

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BACKGROUND INFORMATION

Taking 2019 as the base year, Bangladesh had a population of 164 million with an average family size of 4.26 people. The population was split 63% rural and 37% urban, with 88.9% of the rural population having access to electricity and 97.8% of the urban population able to access electricity (World Bank). The main fuels used for cooking were kerosene, LPG, electricity, and firewood, see table 1 below.

	% Rural pop	% Urban pop	% Total pop
Kerosene	0.4	0.3	0.4
LPG	9.7	60.1	28.3
Electricity	0.2	1.4	0.6
Firewood	88.4	36.7	69.3

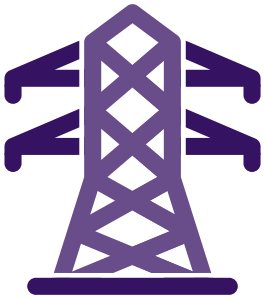
(WHO: Primary reliance on fuels and technologies for cooking, 2021)

Table 1: Fuel type used per % of population

	Per HH per day
Kerosene	0.13 Kg
LPG	0.11 Kg
Electricity	0.71 kWh
Firewood	1.24 Kg

(Based on data from Ecook reports)

Table 2: Daily single fuel consumption per household



88.9% RURAL ACCESS TO ELECTRICITY

97.8% URBAN ACCESS TO ELECTRICITY

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

ASSUMPTIONS

Seven 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 supply to use electricity for cooking,
(c) for rural population, if 88.9% have access and only 0.2% 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 97.8% have access and only 1.4% currently use electricity for cooking, then there is capacity for a further 96.4% 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.

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

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) Shifting firewood users results in an large improvement (approximately 50%) in CO_2e emissions, (S1), in this case it is driven by transitioning the rural community (S2). Whilst health and ecosystem outcomes are improved, this scenario results in a large increase in resource use impact.
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. Given that the domestic electricity production for Bangladesh is heavily reliant on fossil fuels, the increase in resources is not unexpected.
4) Shifting kerosene and LPG users to electricity (S4) results in an increase in CO_2e emissions, and slight increases in health, ecosystem and resource use impacts. This suggests that the carbon intensity of the grid electricity is slightly higher than that of LPG and kerosene.

Figure (1) Effect on CO_2e emissions

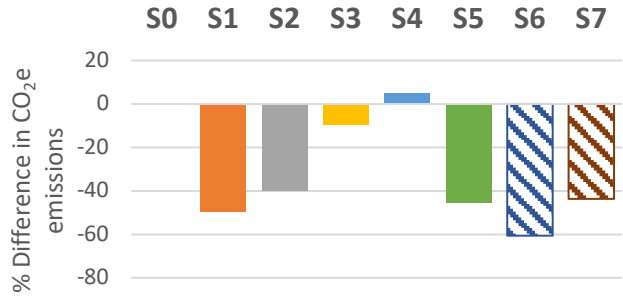


Figure (2) Human health: DALY

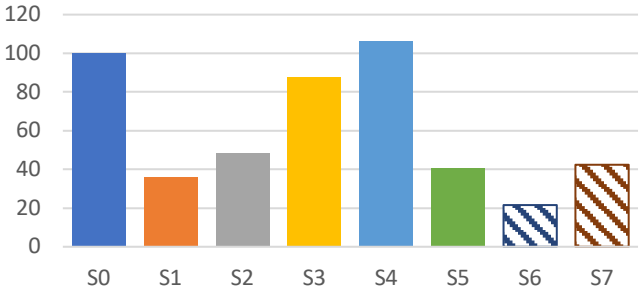


Figure (3) Ecosystems species: yr

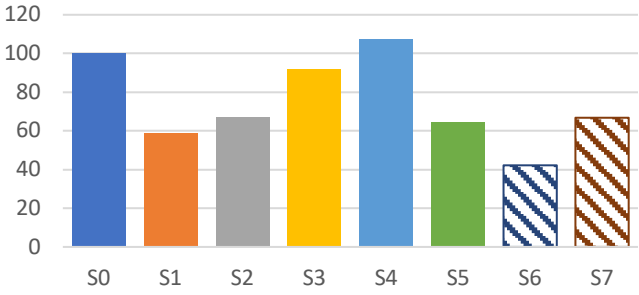
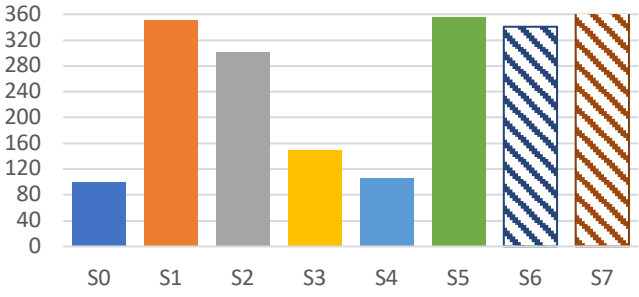


Figure (4) Resources: USD2013



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

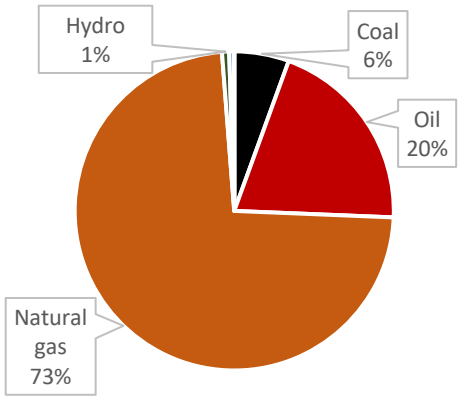
5) Shifting all wood users, and as much LPG and kerosene as possible to electricity (S5), results in large benefits for CO_2e emissions (approximately 50%), health and ecosystems, but causes a nearly four-fold increase in resource use impact.
6) Comparing the hypothetical scenarios of all LPG (S10) or all electric cooking (S11) shows that LPG cooking would deliver better CO_2e savings and improved health, ecosystem and resource use outcomes than for all electric cooking. Nevertheless, this does still result in a more than three-fold increase in resource use impact in comparison to the base case.
7) Despite the significant increase in resource use, the results normalised against global damage show that the human health impacts are more significant than those for ecosystems and resource use.

CONCLUSIONS

Bangladesh grid make up in 2019 relied heavily on fossil based fuels, dominated by natural gas (IEA: https://www.iea.org/countries/bangladesh/electricity). As a result, a shift to cooking with LPG (S6) has a benefit over cooking fully with electricity (S7), with the current grid generation sources.

At the current time, this assessment suggests that a focus on the rural community, shifting to either electricity or LPG will deliver better impact outcomes than the base case.

The impacts from the use of LPG for cooking, despite the potential for some negative health implications in the immediate vicinity of the cooking area, are less than the health impacts from the generation of electricity from fossil fuels. This suggest that consideration of renewably sourced mini-grids for rural connectivity would be an appropriate area for consideration, to act as a temporary solution until the main grid can decarbonise.



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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