Exemplar Case Study: Cradle to cradle assessment of an electric pressure cooker powered by grid in urban Nepal, stacked with a firewood cooker.

MECS Modern Energy Cooking Services

System Description

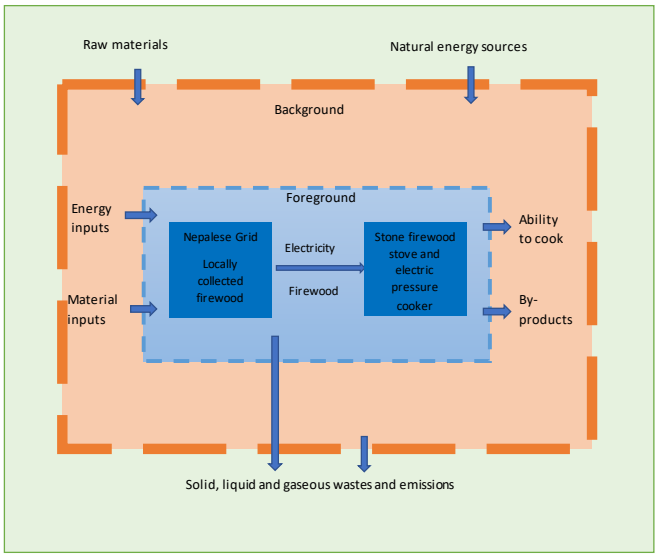
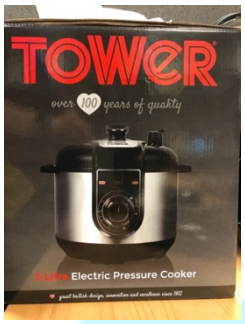


Figure 1: System diagram

This exemplar presents the results from a cradle to cradle assessment for urban Nepal. It assumes a system of fuel stacking, with a 50:50 split between a firewood stove and electric pressure cooker. The electric pressure cooker has been used as a proxy for a rice cooker, a common item in Nepalese kitchens. Both the EPC and rice cooker are made of similar materials (plastic and metal), and have simple electronic and heating systems. The power rating for rice cookers ranges from 300-1100W, again within a similar range to the EPC.



The functional unit is set to one days' cooking for one household.

Cooking Devices

Simple Electric Pressure Cooker (sEPC)

Tower Health One Pot Express Electric Pressure Cooker, 5 Litre, 900 Watt. This device has limited electronics, with no additional charging ports.

The main materials found in this device are polypropylene plastic, aluminium and steel. There is one circuit board, with associated wiring and connectors. A complete listing of materials can be found in this reference document.

The product has minimal decorative features.

Manufacturing processes mainly include pressing and stamping for the metal components and extrusion moulding for the plastic components.

Simple wood fire

A simple stone fireplace, with open burning of firewood is assumed.

Power/Fuel Sources

Wood is collected by hand, from local resources and transported to the home under human power. The composition of the Nepalese grid (2018) was used for electricity production.

Results

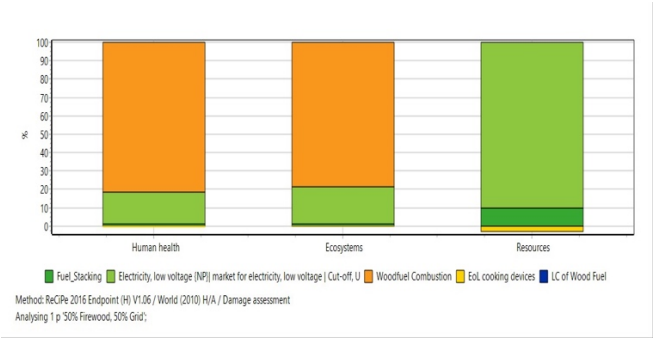


Figure 2: Endpoint impact category results

Figure 2 shows the impact of one days cooking on three end point indicator categories, Human health, Ecosystems and Resource use. For both human health and ecosystems, the greatest impact is caused by the combustion of woodfuel. For resource consumption the impact is derived from the production and delivery of electricity from the grid.

The manufacture of the electric cooking device contributes approximately 10% of impact on resources. There is no impact from the wood burning stove as this is assumed to be simple stone stove.

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There are few critical materials in this system, all within the electronics in the sEPC. The average gold and silver content per tonne of PCB is 250g and 1000g respectively. The PCB in the sEPC weighs just 4.5g.

Impact on Global Warming Potential (GWP)

The contribution to GWP, for one household is approximately 3.5kg CO_2 eq per day. This equates to 1.27tCO_2 eq per year per household.

In 2020, approximately 62.8% population had access to electricity (900,000 households) creating approx. 1.1 million tonnes CO_2eq per year from all cooking activities. If we assume the SDG 7 target is met in 2030 (100 % access to electricity) and assuming 100% use electricity for 50% of their cooking and firewood for the remainder, 1,960,000 urban households would create just over 2.5 million tonnes CO_2eq per year.

Impact at End of Life (EoL)

There are a few components that could be re-used from an EPC: the inner cooking pan, the heating element and the lid.

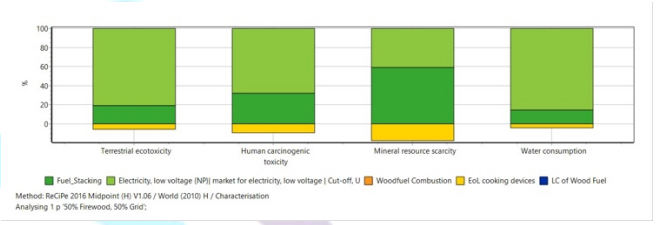

Figure 3: Selected Midpoint impact categories showing EoL benefits

From figure 3, the benefits from the component reuse can be seen (yellow), with the greatest benefits linked to resource scarcity, human carcinogenic toxicity, terrestrial ecotoxicity and water consumption.

Take Away Messages

The environmental impact of the cookstove is small in comparison to the impact from the fuels required to power them.

The greatest impact on health and ecosystem outcomes, is caused by the emissions that result from the burning of the fuelwood

At steady state by 2040, the shift to a 50:50 split firewood and electric cooking powered by the grid would cause approximately 0.5 million devices to enter the e-waste disposal system per year.

Assumptions and data sources

For 50:50 split between firewood and electric cooking:

Firewood consumption per day per hh: 2.55Kg

Electricity required per day per hh: 1 KWh

(From: Energy released from 2.55Kg fuelwood is 36.9MJ, assuming firewood stove efficiency of 10%, and 3.6MJ energy equates to 1KWh)

EoL: 50% of inner cooking pan, heating element and lid are reused. Remainder of EPC is sent to waste site metals, useful plastic fractions will be recovered and the rest will be burnt.

Expected life of sEPC: 5 years

This material has been funded by UKAid from the UK government; however the views expressed do not necessarily reflect the UK government's official policies.'