Exemplar Case Study: Cradle to cradle assessment of an electric pressure cooker powered by solar home system in rural Kenya, stacked with a street charcoal cooker.

MECS Modern Energy Cooking Services

System Description

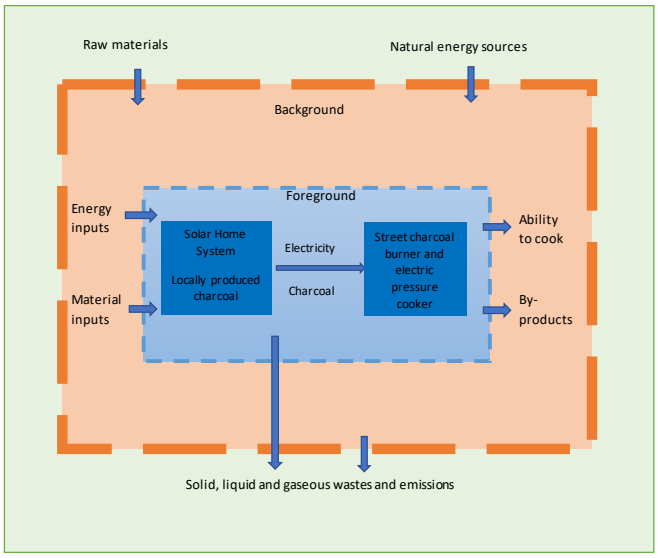
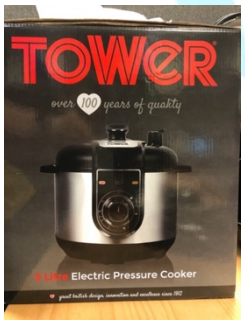


Figure 1: System diagram

This exemplar presents the results from a cradle to cradle assessment for Kenya. It assumes a system of fuel stacking, with a 50:50 split between a charcoal burner and electric pressure cooker.

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.

Street Charcoal Burner (sCHB)

The simple charcoal burner is assumed to be made from two materials, a steel outer case with supporting legs and a ceramic inner. These are produced by local tradesman, forming the steel outer using basic hand tools and shaping and baking the ceramic inner.

Power/Fuel Sources

Locally produced charcoal from an earth mound kiln is used as fuel for the charcoal burner. For the EPC, electricity is generated from an appropriately sized solar home system.

Results

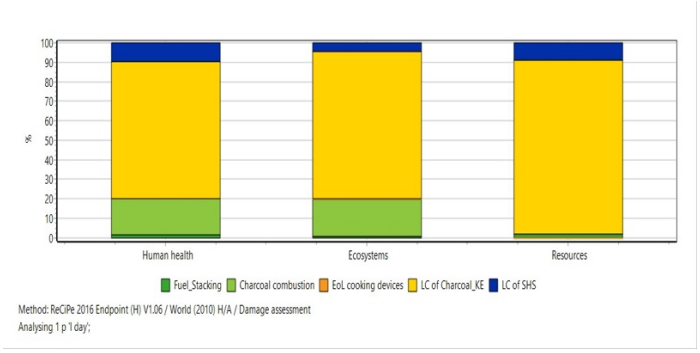


Figure 2: Endpoint indicator categories

Figure 2 shows the impact of one days cooking on three end point indicator categories, Human health, Ecosystems and Resource use. The main impact (between 70-85%) for all categories derives from the manufacture of the charcoal (yellow). The burning of the charcoal (light green) has some impact for human health and ecosystems (~ 20%). The manufacture of the SHS is the final activity that creates an appreciable impact.

The manufacture of the cooking devices themselves and the EoL activities do not add significant impact.

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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 4.5kg CO_2 eq per day. This equates to 1.6tCO_2 eq per year per household.

In 2020, approximately 4.7% of rural population had access to electricity (500,000 households) creating approx. 0.8 million tonnes CO_2eq per year. If we assume the SDG 7 target is met in 2030 (100 % access to electricity) and assuming and 100% use electricity for 50% of their cooking and charcoal for the remainder, 1,230,000 rural households would create just under 20 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.

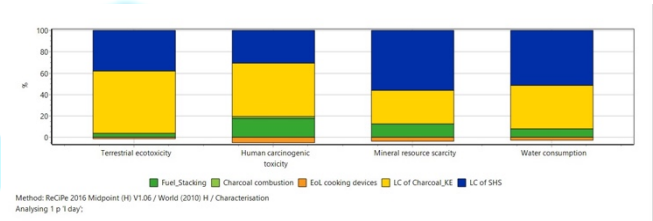

Figure 3: Selected Midpoint impact categories showing EoL benefits

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

As yet there is no established recycling for LFP or PV panels in this region. Hence the items are considered to be hibernated or stored until such time as a suitable EoL pathway is established.

Take Away Messages

The production and combustion of charcoal causes over 90% of the impacts on health and ecosystems.

By 2040 at steady state, the transition to 50% electric cooking by all rural households will create approximately 6 million devices per year requiring appropriate e-waste disposal activities

Assumptions and data sources

Charcoal consumption per day per hh: 0.87kg

SHS system: LFP battery size, 0.74KWh, PV panel size, 1.32 m^2, Inverter, 2.5KWh

Expected life of sCHB: 6 months

Expected life of sEPC: 5 years

Expected life of PV panels: 20 years

Expected life of LFP battery: 10 years

Expected life of Inverter: 10 years

EoL for EPC: 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.

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.'