SUSTAINABLE RECYCLING INDUSTRIES

Refrigerator recycling

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The Issue

Annually, about 173 millions of cooling appliances units or refrigerators are produced[1]. While the general public might expect domestic refrigerators to be dismantled and recycled responsibly and safely, in countries where international recommendations on extended producer practices[2] are not enforced their recycling journey all too often leads to landfill sites and scrapyards.

Discarded end-of-life refrigerators are often exported under the guise of "second-hand appliances" - whether they function or not which raises legal and as well as ethical questions. The manual dismantling of refrigerators for their steel, copper (Cu) and aluminium (Al) provides an important source of income for the urban poor working in the informal sector as well as for the formal recyclers. However, when dismantled incorrectly the refrigerant gases inside the cooling system released (deliberately or accidentally) to the atmosphere pose a significant environmental threat. Safe dismantling would allow for the recovery and reuse of these gases. Another worst practice also happens when burning cooling systems and isolating foams in open fires. Refrigerators also contain oil- and additives-based lubricants in their motors, but when dismantled incorrectly, contaminate soil and water sources.

Understanding and measuring the environmental footprint and impact on human health of proper and safe refrigerator recycling processes vs unsafe and uncontrolled practices can help policy and decision-makers to develop better legal and policy frameworks for responsible refrigerator recycling.

[1] Federico Magalini (2018), Sofies

[2] ISO IWA 19:2017. Guidance Principles for the Sustainable Management of Secondary Metals

The Environmental Footprint of Unsafe Dismantling of Refrigerators

The methodology and dataset used to measure the environmental footprint of refrigerator recycling was developed in partnership between the World Resources Forum's Sustainable Recycling Industries Programme (www.sustainable-recycling.org) and ecoinvent (www.ecoinvent.org), the latter an organisation specialising in providing data for life cycle assessment studies. The environmental footprint calculations were based on two scenarios. Scenario (i) unsafe and uncontrolled recycling (with uncontrolled emissions releasing) of used domestic refrigerators was compared with Scenario (ii) responsible refrigerator recycling practices of used domestic refrigerators (with no emissions to the environment). Both on based on average refrigerant amounts.

A typical domestic refrigerator contains on average 32 kg of steel, 1.3 kg of copper and 2.2 kg of aluminium. However, when workers manually dismantle refrigerators to recover these metals in an unsafe and uncontrolled way, extremely harmful gases such as Freon R-12, HCFC R123a, and Isobutane R600a are released to the atmosphere. These gases can be on average 3,000 times more damaging than CO2 and contribute significantly to global warming as well as depletion of the ozone layer. For example, a single kilogram of Freon R-12 has the same impact on global warming as 10,900 kg of CO_2.

In addition, a refrigerator's foam insulation contains 'blowing agents' (which is a type of gas used to make spongy products contained in the foam insulation in fridges) which escape into the atmosphere when the housing (the white outer casing of the refrigerators) is dismantled. The foam insulation is highly flammable and is often burned deliberately as a means to control the temperature of the fire.

A typical domestic refrigerator contains about 0.3 kg of refrigerants, which is equivalent to 661 kg CO_2 or a 2,160 km journey in a diesel car[3].

What is Good Practice?

Good practice starts with used refrigerators being returned by the general public to authorized collection centres and facilities, and if not existing, stored in proper centres. Before any treatment, fridges need to be separated based on the type of refrigerant gases they contain. Good practice includes tools fit-for-purpose, personal protective equipment and training, for workers to avoid personal injury. All this together ensure a higher quantity and

[3] Ecoinvent (2018). Assuming 0.303 kg CO2-eq per km as of ecoinvent, 2018, transport, passenger car medium size, diesel, EURO 5, RER, cut-off, IPCC GWP 100a, v3.4)

quality of metals.

The average recovery efficiency of these cooling system gases is up to 70% which can then be safely collected and either properly disposed of or reused in the manufacture of new refrigerators. Similarly, the foam insulation and oil- and additives-based lubricants can be carefully removed and disposed of properly. Oil- and additives-based lubricants can be partially re-used or recycled.

On average by implementing good recycling practices, 485 kg of CO_2 equivalent per refrigerator can be avoided[4]. This is equivalent to the emissions from 1,600 km diesel car journey[5].

Importantly, if good practice is not followed it may negate all the environmental gains of buying energy efficient refrigerators in the first place.

Measuring and actually reducing the environmental footprint of refrigerator recycling combined with understanding what good practice looks like provides a number of potential benefits, in particular to reduce harmful emissions to the atmosphere. However, this will only happen if decision-makers act to enable, enforce and improve the legal and policy frameworks to ensure responsible refrigerator recycling.

In addition to the significant benefits in terms of reduced global warming, responsible refrigerator recycling has a 4.7 times lower impact on stratospheric ozone depletion[6] and a 3.9 times lower impact on ecosystem quality[7] and human health[8].

[4] IPCC (2013), climate change, GWP100a in kg of CO2-eq

[5] Ecoinvent (2018). Working Title: Life cycle inventories of Worst Practices in secondary metals recovery.

[6] EDIP (2003). Stratospheric ozone depletion, ODP total in kg CFC-11-Eq

[7] ReCiPe Endpoint (H, A), ecosystem quality based on LCA (ISO 14040) modelling and measured in points. Ecoinvent (2018)

[8] ReCiPe Endpoint (H, A), human health based on LCA (ISO 14040) modelling and measured total in points. Ecoinvent (2018)

Improvements in the policy and operational spheres are needed and there is a role for stakeholders in the recycling chain. As even a strong regulatory environment can only deliver benefits when there is collaboration between the public sector, private sector and civil society.