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ICCRAM
INTERNATIONAL RESEARCH CENTER IN CRITICAL RAW
MATERIALS FOR ADVANCED INDUSTRIAL TECHNOLOGIES



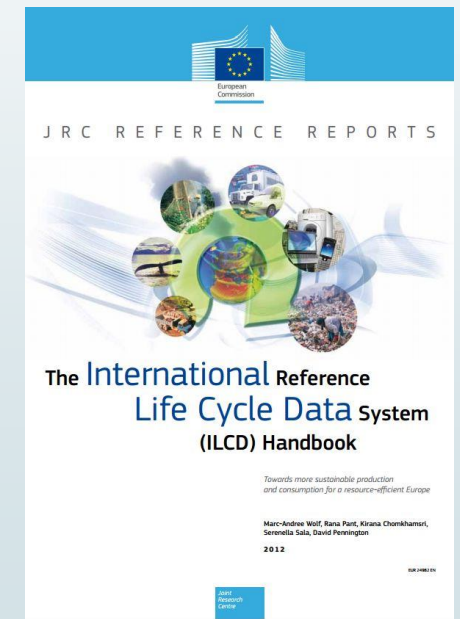
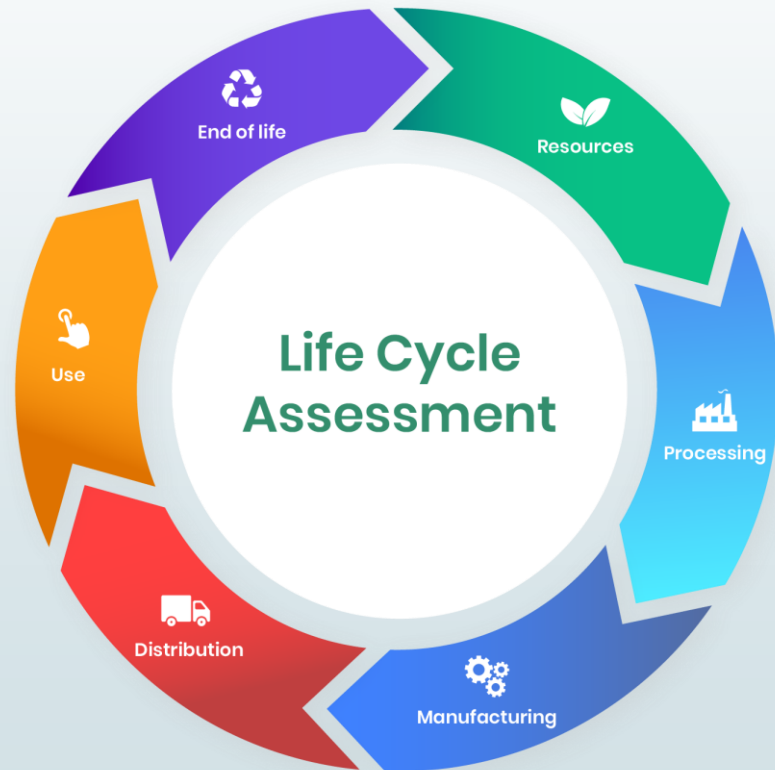
Life Cycle Assessment of the production of self-cleaning $\text{AlMg}_3\text{-TiO}_2$ metal matrix composite component. A manufacturing technologies' comparative.

Mario Santiago Herrera

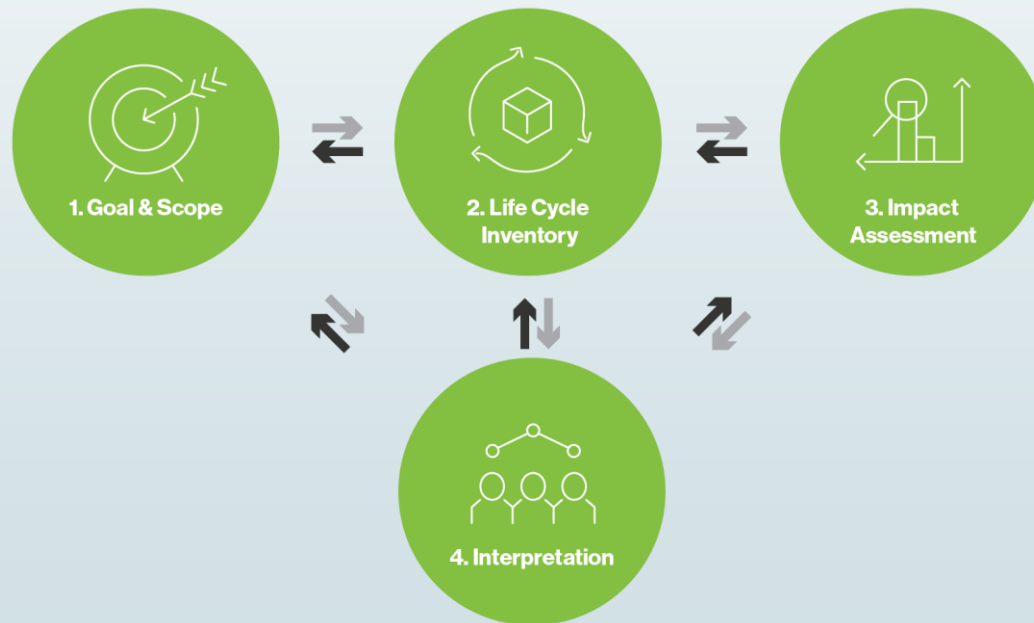
ICCRAM (International Research Center in Critical Raw Materials for Advanced Industrial Technologies) – Universidad de Burgos

- **Lightweight materials** can contribute to reduce greenhouse emissions and resources consumption.
- **Metal Matrix Composites** confer different functional characteristics that can help on this task.
- Different casting methods can vary the environmental impacts.
- Self-cleaning surfaces are an important research area.

- The LCA methodology used is according to the ISO framework (ISO 14040:2006) and referring to the recommendations and requirements given by the European ILCD guidelines.



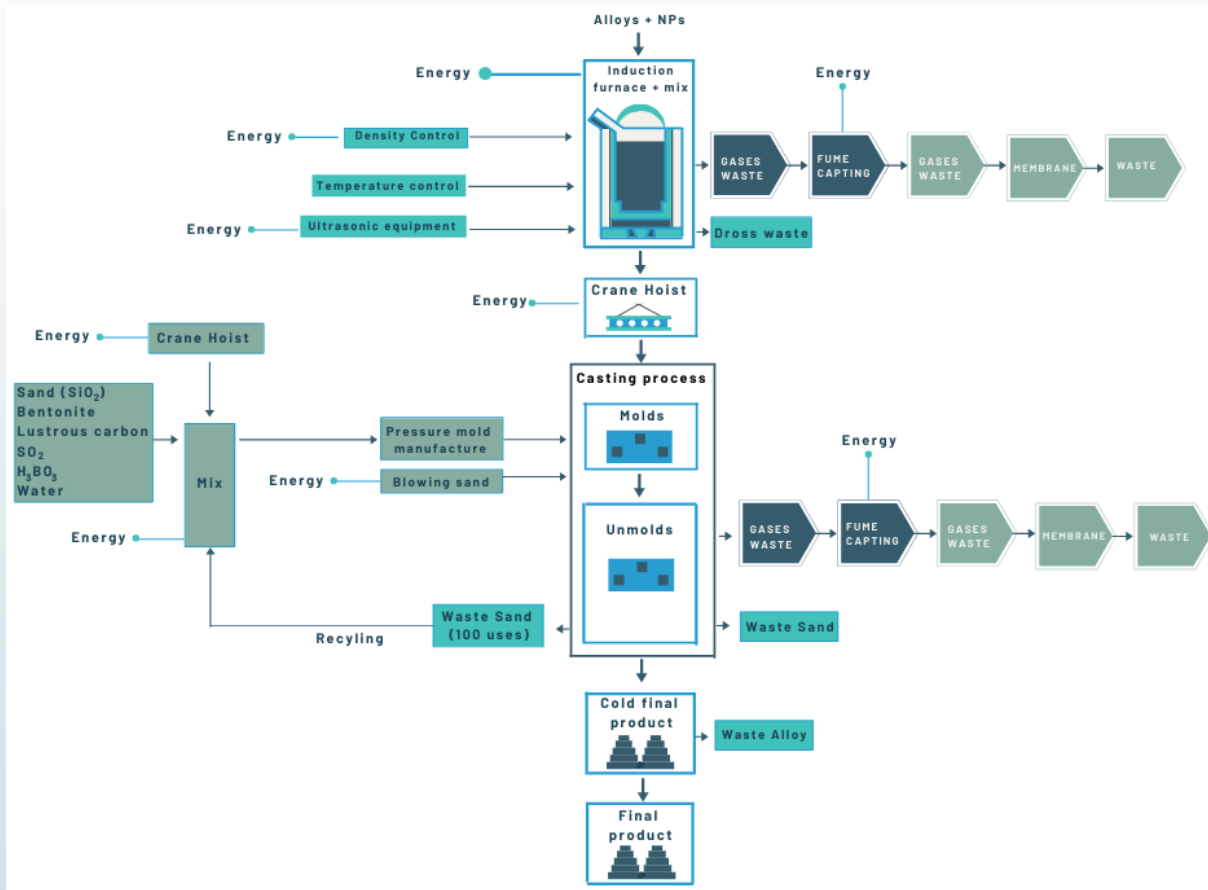
- The functional unit is the production of one doorknob piece, based in a gate-to-gate system boundary.
- The impact assessment method used is ILCD 2011 Midpoint, released by the Joint Research Centre (JRC) of the European Commission, comprised in 16 midpoint impact categories.
- SimaPro® 9.1, by Pre' Consultants, is the LCA software used.



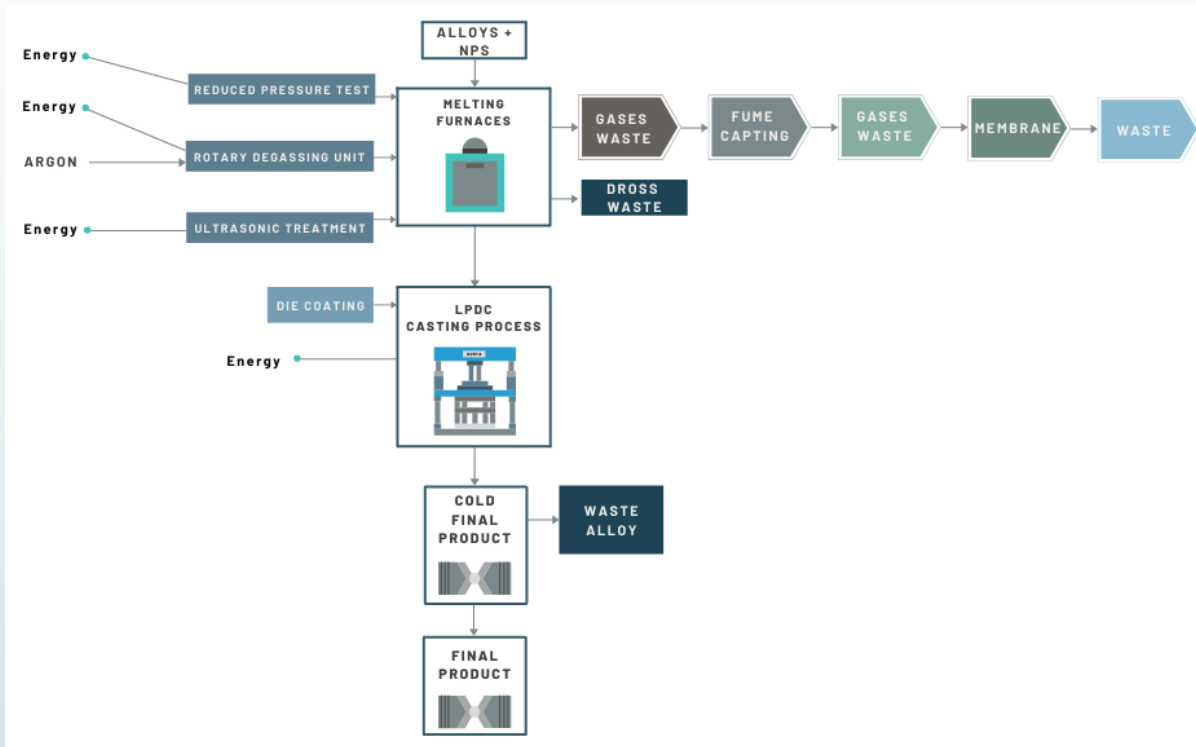
SímaPro

Green Sand Casting Process

- This process starts with the building of the mould cavity, using patterns to get the exact designed shape of the castings.
- The sand, mixed with bentonite clay, an appropriate amount of water, and some other additives is prepared and the mould is made using the pattern.
- Then, molten metal from the furnace is poured into the cavity, and is removed after solidification by breaking the sand mould.



Low Pressure Die Casting Process



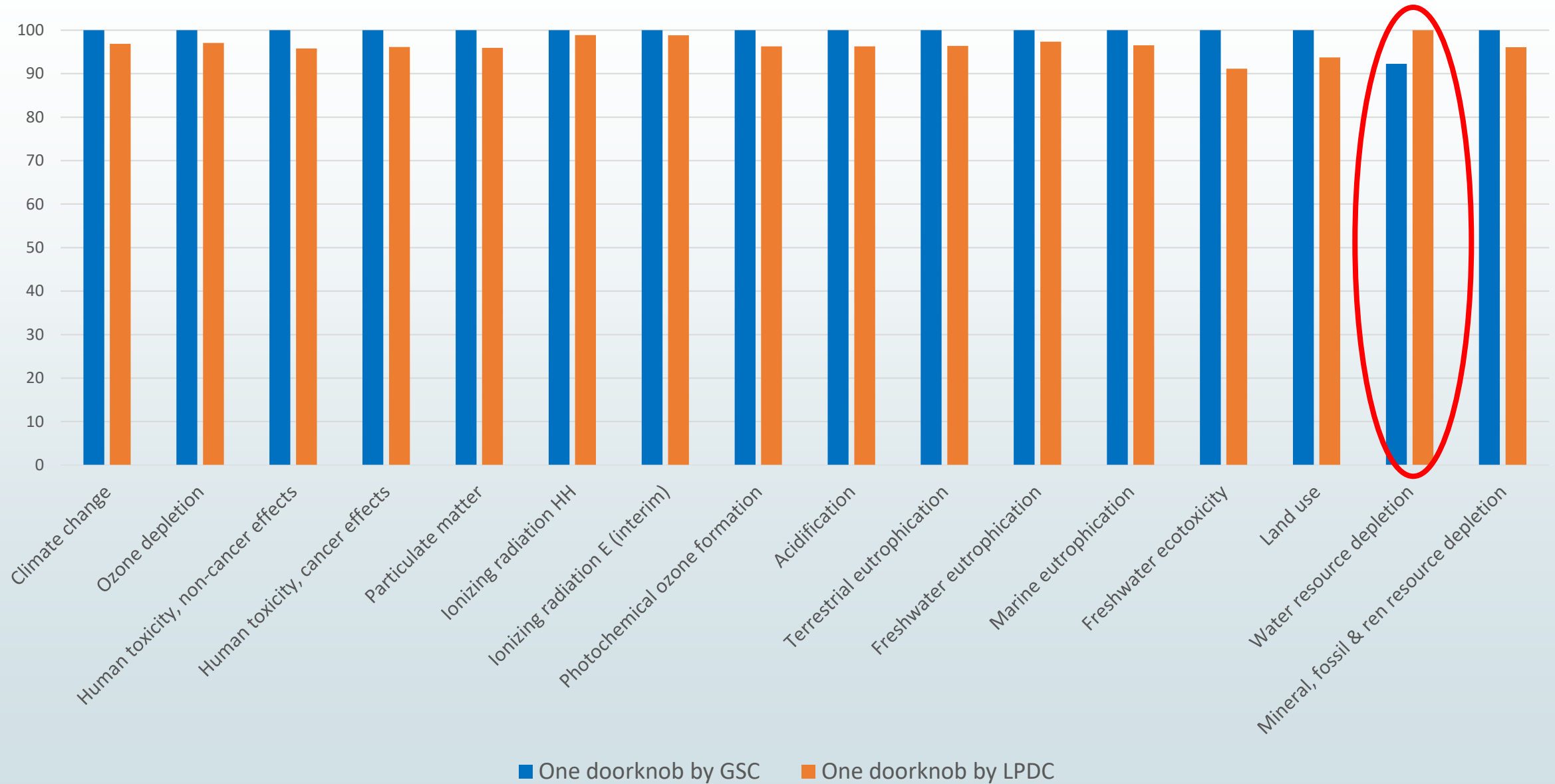
Process developed by Österreichisches Gießerei-Institut

- A die and a filling system are placed over a pressurized sealed melt furnaces, that contains the molten metal.
- This is forced by a pressurized gas to rise and consequently feed the die cavity, which is placed vertically above the riser tube.
- Once is filled and the metal have completely solidified, the pressure is released, the side dies open and the top die is raised.
- Then they close again to repeat the cycle.

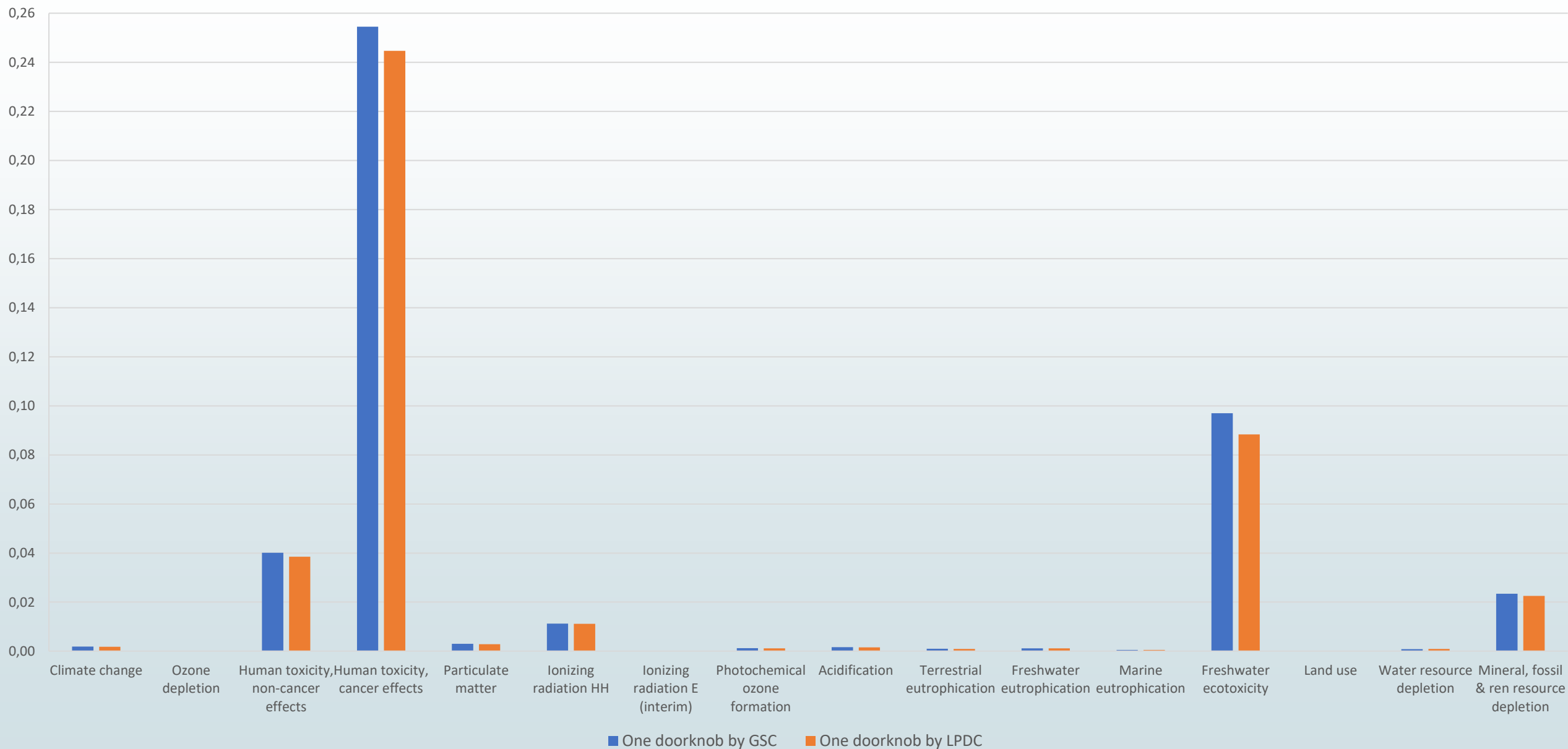
Results

Impact category	Unit	One doorknob by GSC	One doorknob by LPDC
Climate change	kg CO2 eq	13,0978	12,6836
Ozone depletion	kg CFC-11 eq	1,52E-06	1,47E-06
Human toxicity, non-cancer effects	CTUh	6,22E-06	5,96E-06
Human toxicity, cancer effects	CTUh	3,16E-06	3,03E-06
Particulate matter	kg PM2.5 eq	0,0152	0,0146
Ionizing radiation HH	kBq U235 eq	2,7174	2,6866
Ionizing radiation E (interim)	CTUe	7,23E-06	7,14E-06
Photochemical ozone formation	kg NMVOC eq	0,0553	0,0532
Acidification	molc H+ eq	0,0912	0,0878
Terrestrial eutrophication	molc N eq	0,1590	0,1532
Freshwater eutrophication	kg P eq	0,0078	0,0076
Marine eutrophication	kg N eq	0,0161	0,0156
Freshwater ecotoxicity	CTUe	362,7360	330,6313
Land use	kg C deficit	21,0725	19,7512
Water resource depletion	m3 water eq	0,0557	0,0604
Mineral, fossil & ren resource depletion	kg Sb eq	0,0045	0,0043

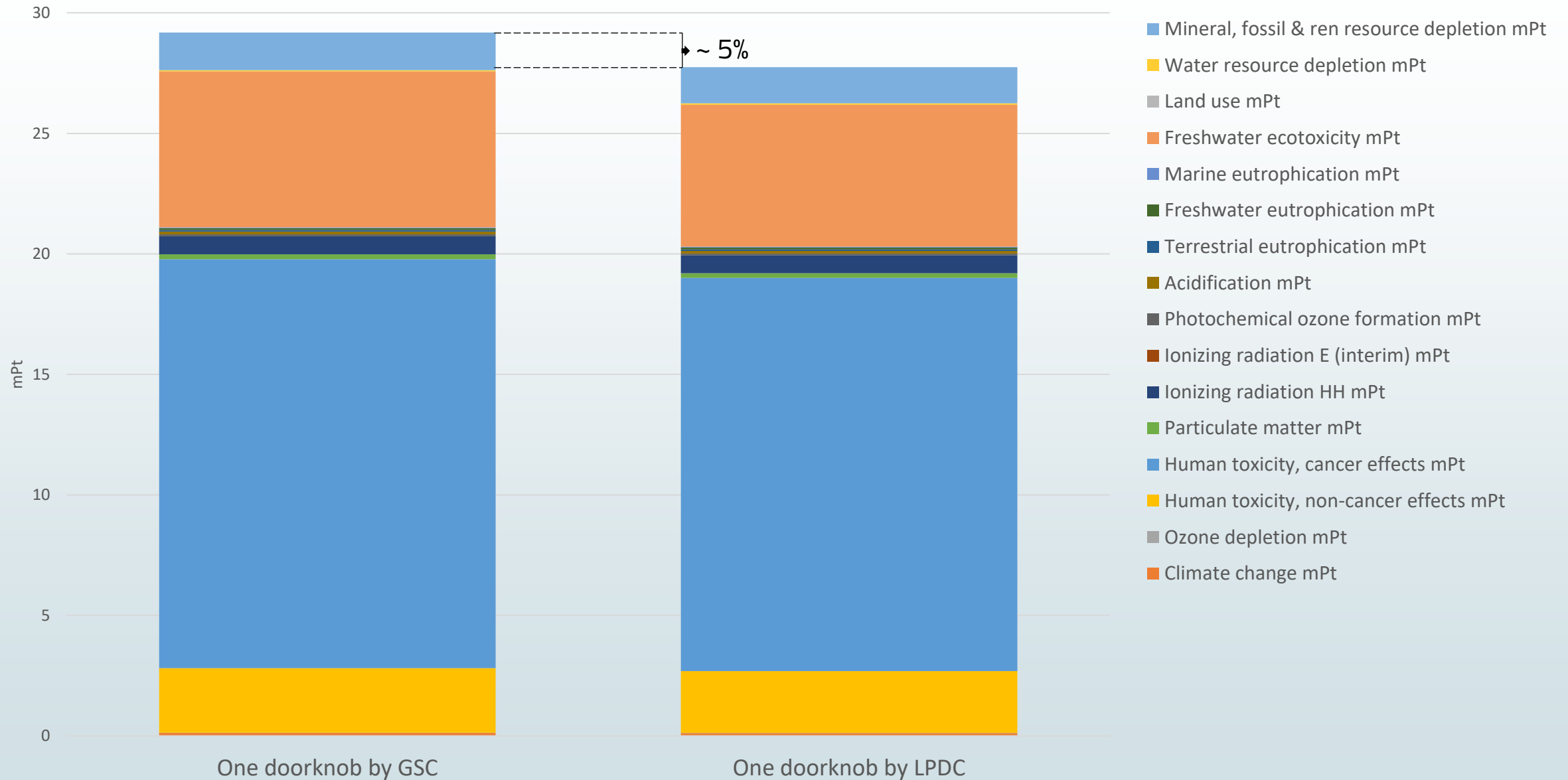
Results



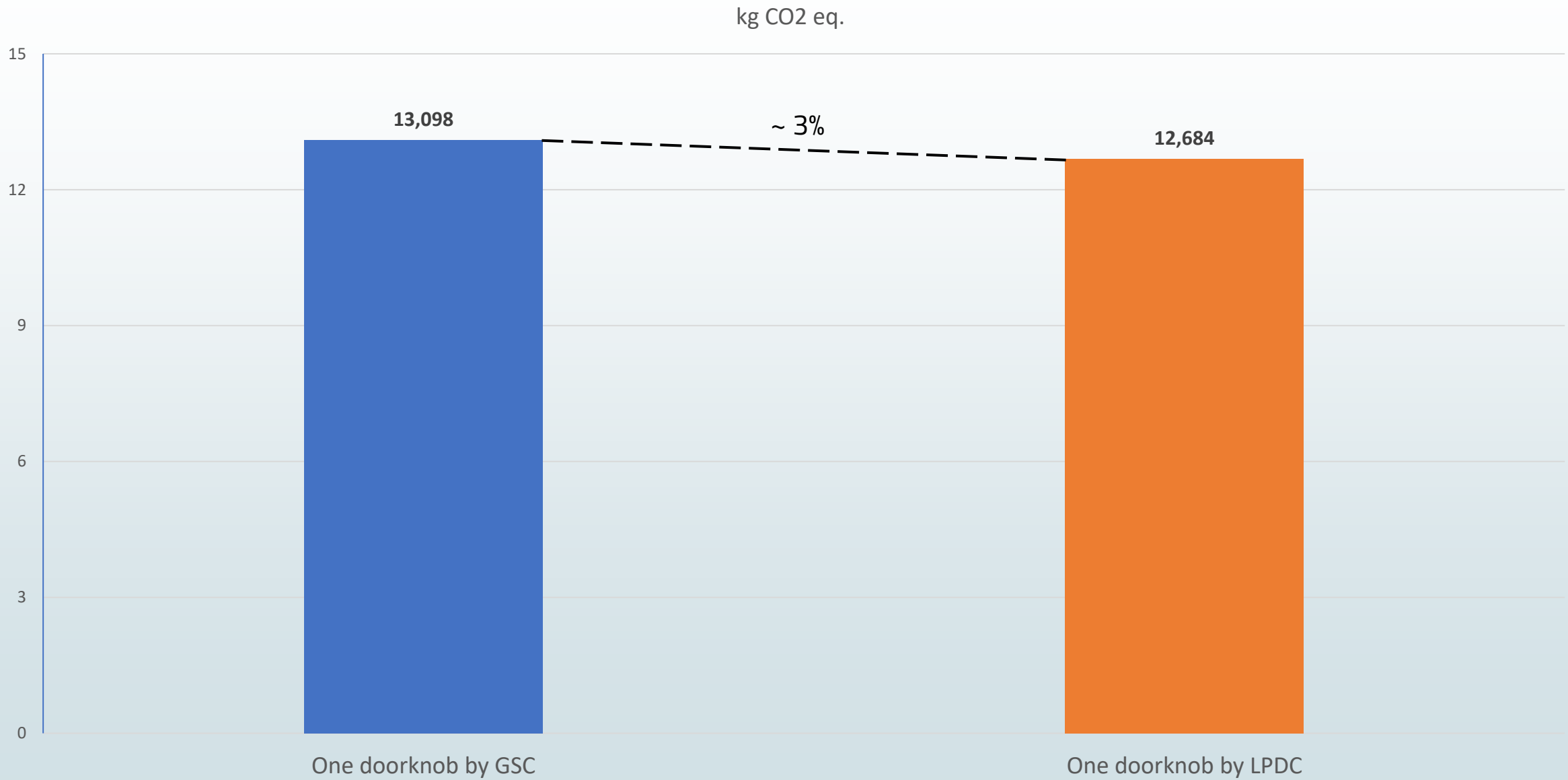
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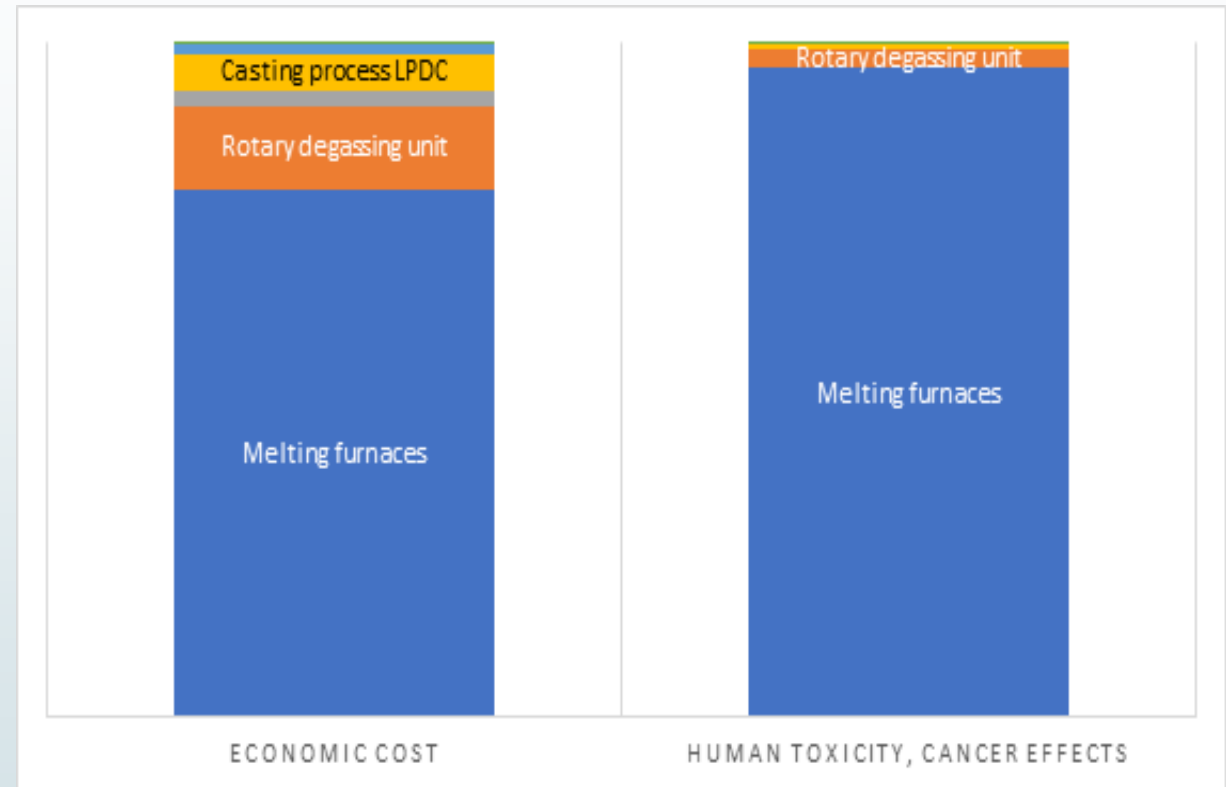
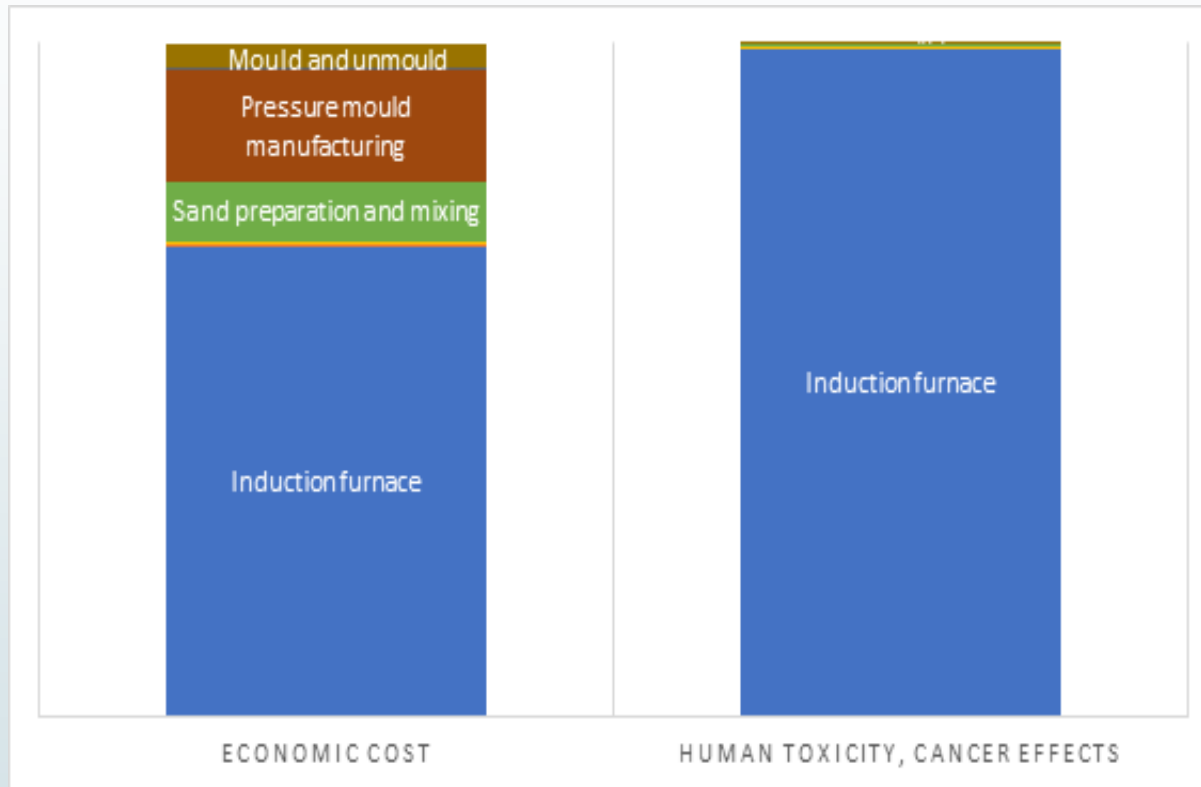
Results



Results



Results



GREEN SAND CASTING

Higher economic cost
Higher environmental cost

LOW PRESSURE DIE CASTING

Better ratios between both
variables
Process less environmentally
damaging and cost intensive



- **The production of one doorknob produces less environmental impact if its manufactured under the Low Pressure Die Casting instead that in the Green Sand Casting.**
- The biggest quantity of impacts is related with the extraction and production of aluminium.
- 'Human toxicity with cancer effects' and 'Freshwater ecotoxicity' are the most important categories.
- Update LCAs conducted on MMCs manufacturing technologies, identify hotspots and support future decisions with environmental implications.
- Further studies would be necessary to evaluate the process optimization and analyze other parts of the supply chain, like the use phase or the disposal.

Acknowledgements

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