UNIVERSIDAD DE BURGOS

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

Innovative methodology approach for integrating LCA and LCC. A metal lightweight material case study

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lightme

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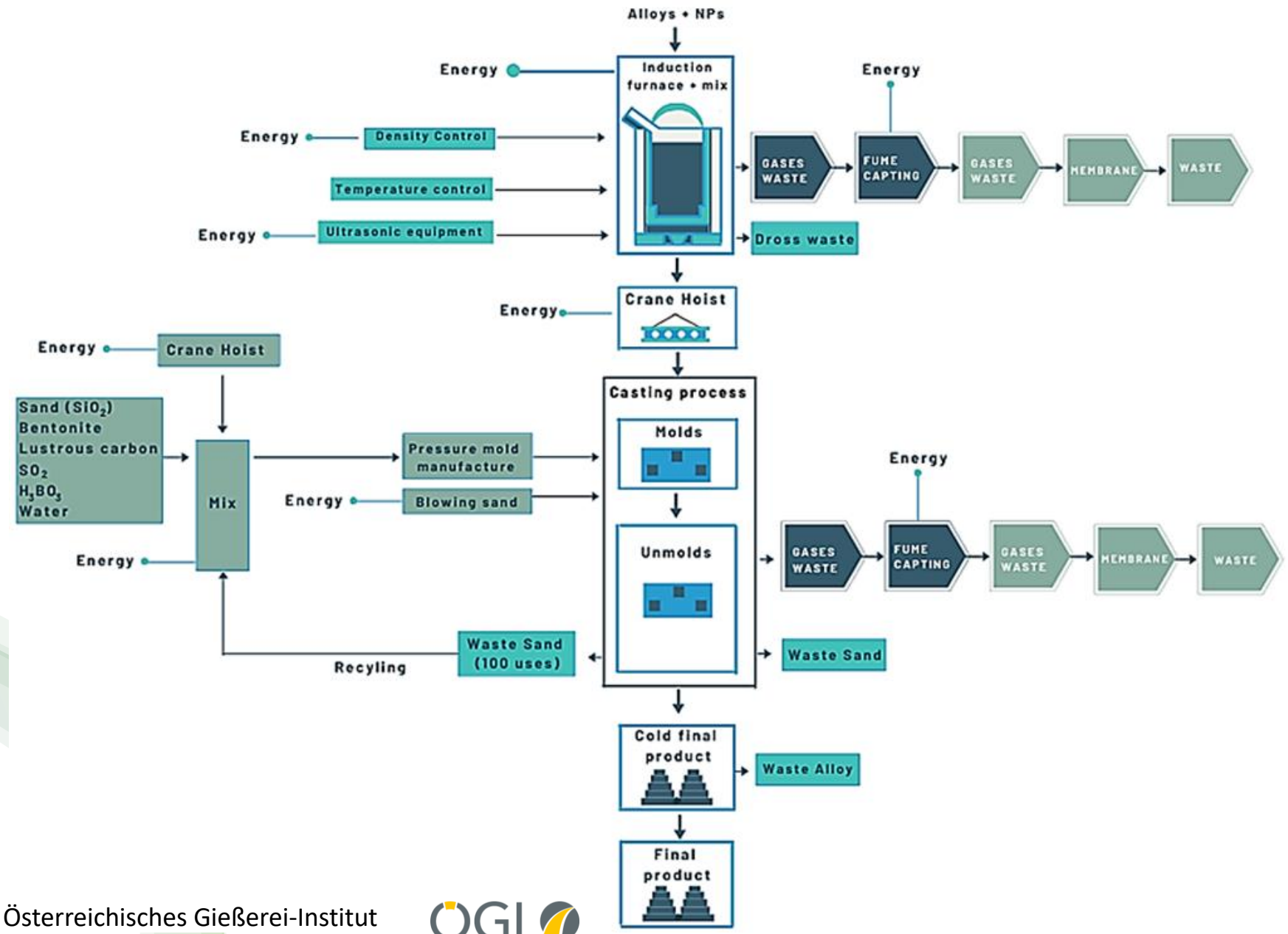
1. Methodology for LCA & LCC Integration

- S1 Understand the assessment's needs
- S2 Study the process to be assessed
- S3 Define the goal and scope
- S4 Environmental and economic inventories
- S5 Environmental and economic impact assessments
- S6 Sensitivity check and uncertainty analysis
- S7 Interpretation of the results according to the assessment's needs
- S8 Graphic representation of the results and comparative study
- S9 Process improvement proposal

2. Overview

- Lightweight materials in substitution of traditional ones seems to be a promise option from an environmental point of view.
- Metal Matrix Composites (MMCs) - metals reinforced with different constituents - can play and important role in these requirements.
- Self-cleaning surfaces are an important research area, and titanium dioxide (TiO_2) can be used to produce antiseptic and antibacterial components.
- Casting is one of the most energy demanding manufacturing methods and it is necessary to do a proper assess in order to make more sustainable choices.
- **This work compares the sustainability of the production of a self-cleaning metal doorknob by two different casting techniques.**

3.1. Study cases: Green Sand Casting



Process developed by Österreichisches Gießerei-Institut

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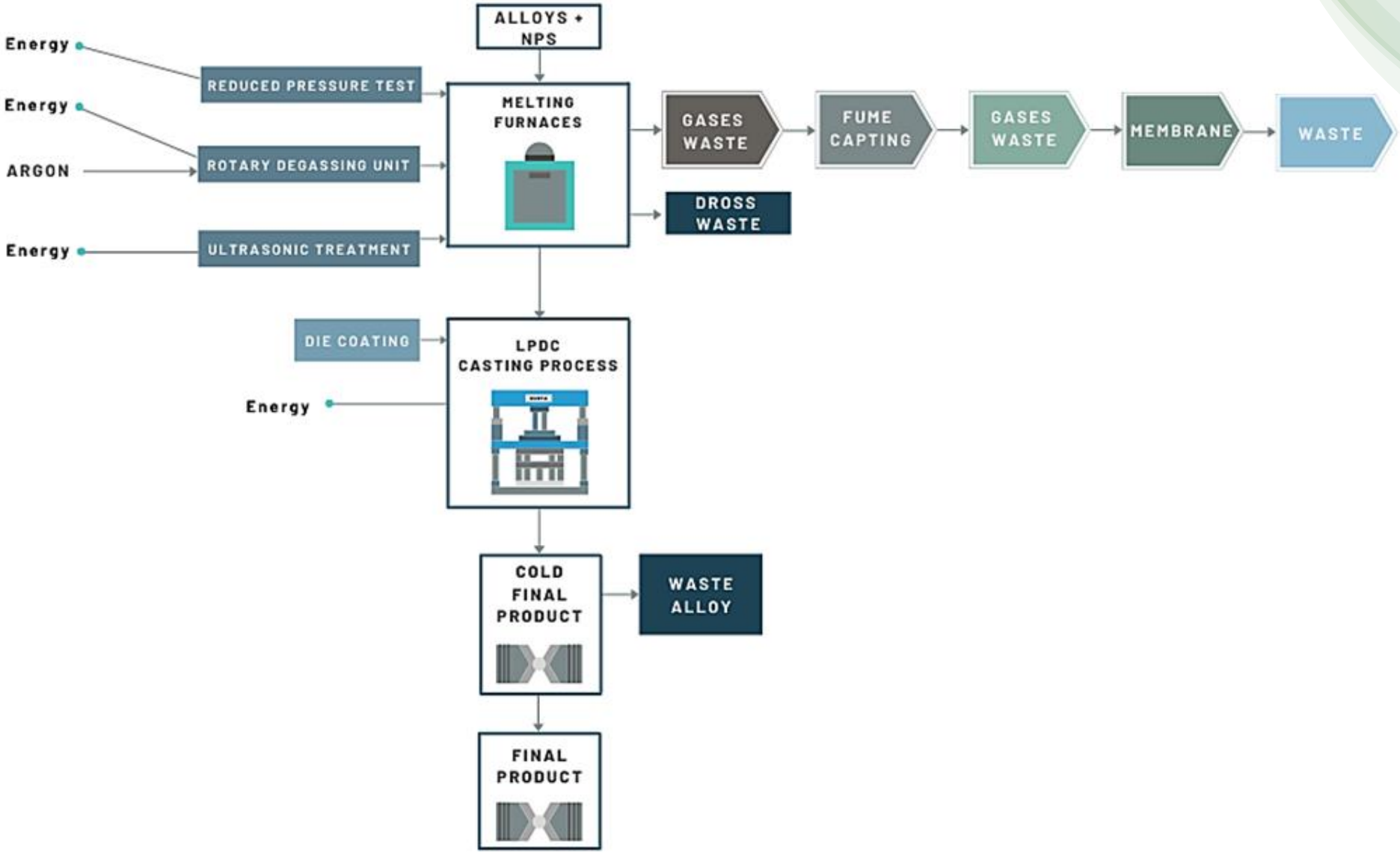
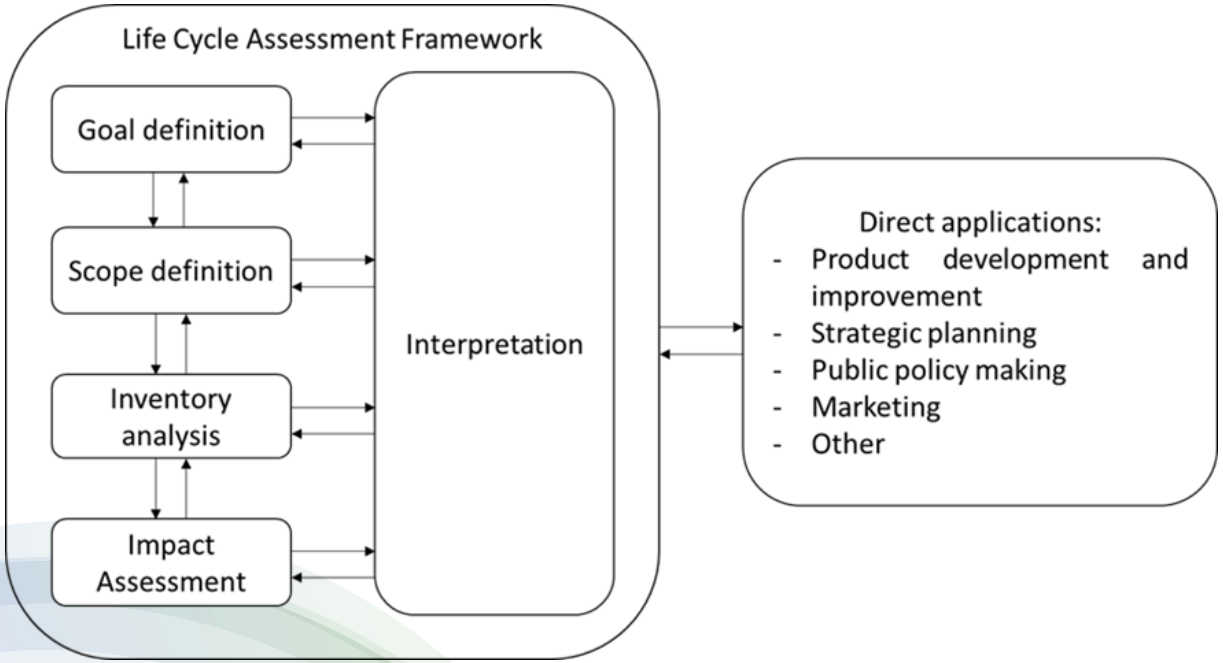
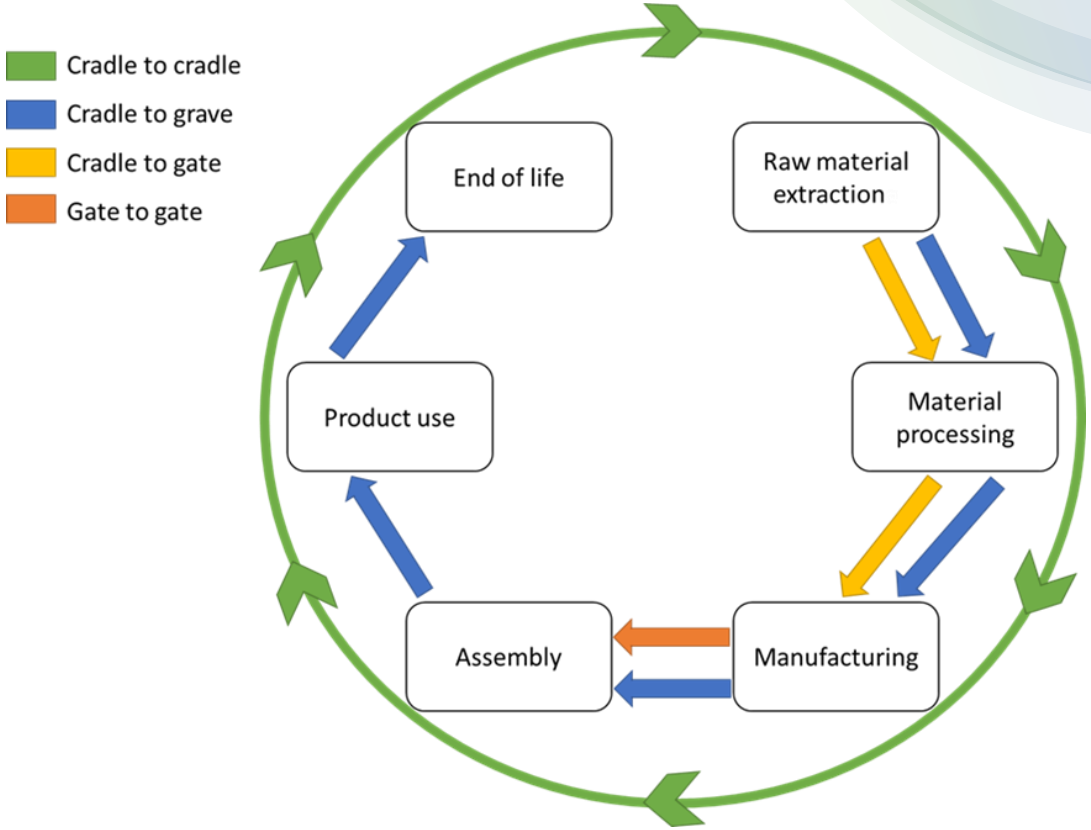
3.2. Study cases: Low Pressure Die Casting



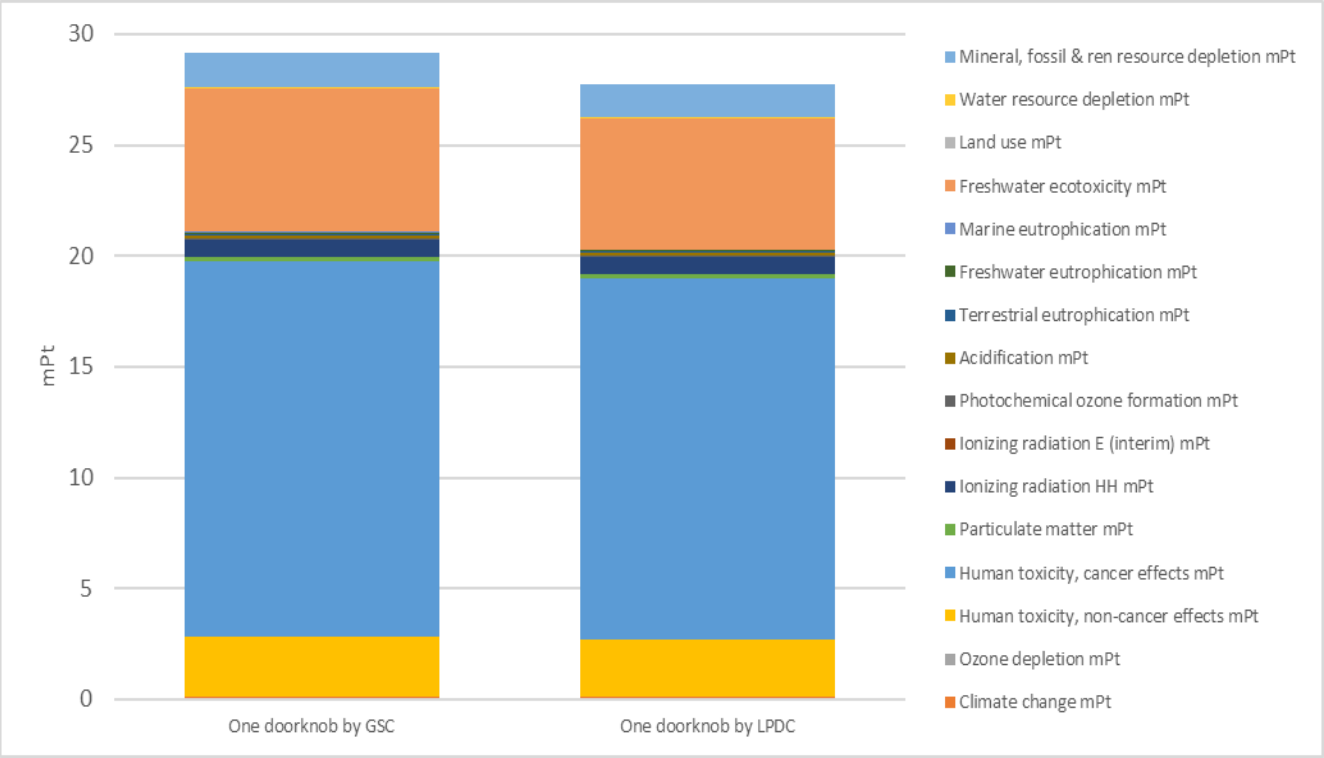
Process developed by Österreichisches Gießerei-Institut

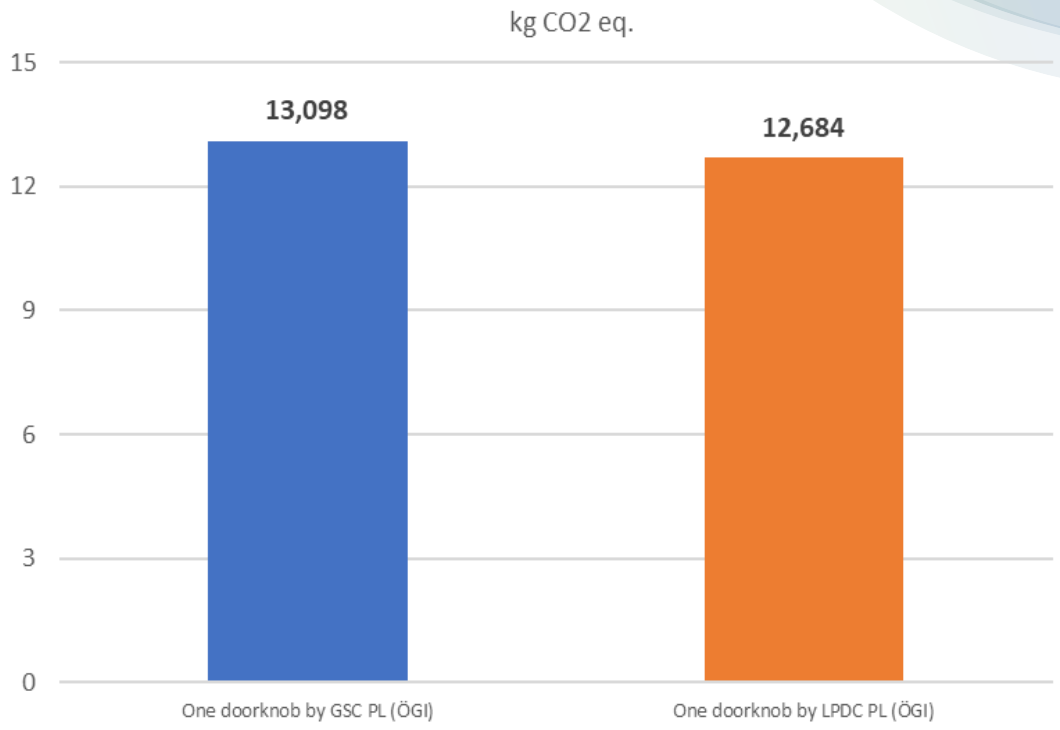
4.1. Life Cycle Assessment Methodology





4.2. Life Cycle Assessment Results





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5.1. Life Cycle Costing (LCC): Methods

- Activity Based Costing
- Total Cost of Ownership
- Cost Benefit Analysis
- Input-Output Assessment
- Techno-Economical Assessment
- Environmental Material Flow Cost Accounting

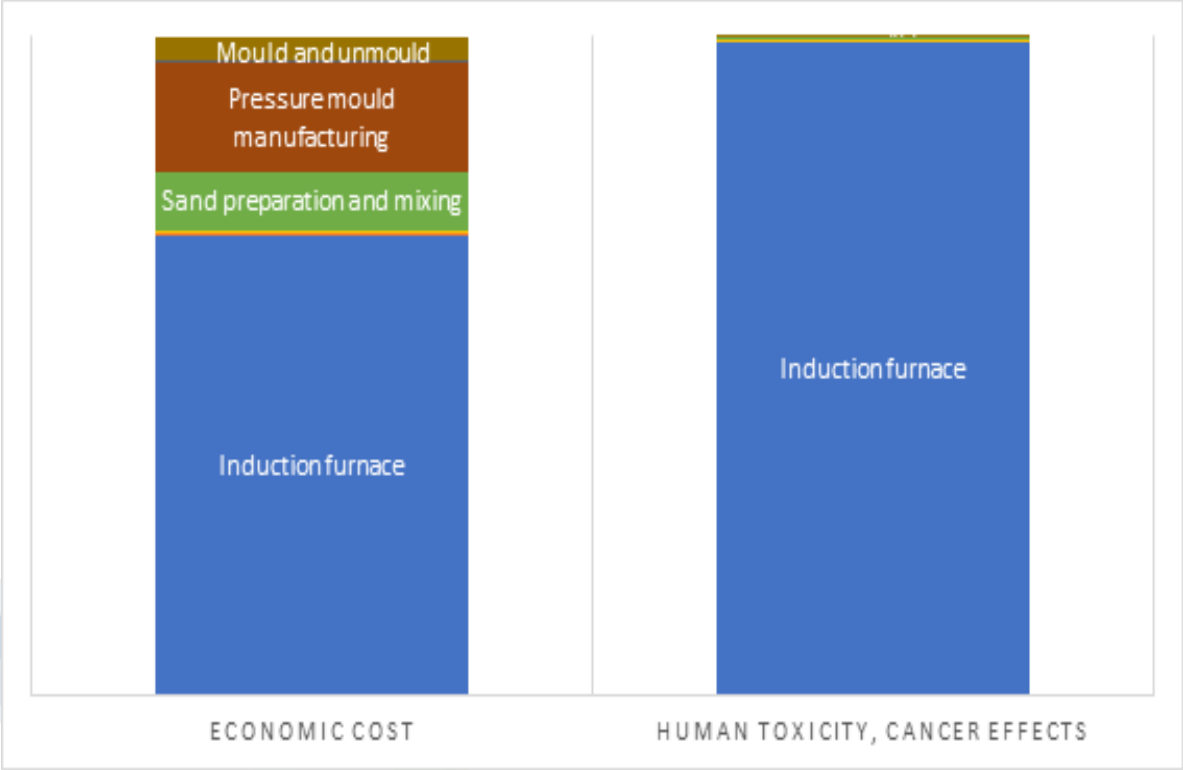
5.2. LCC results (Green Sand Casting)

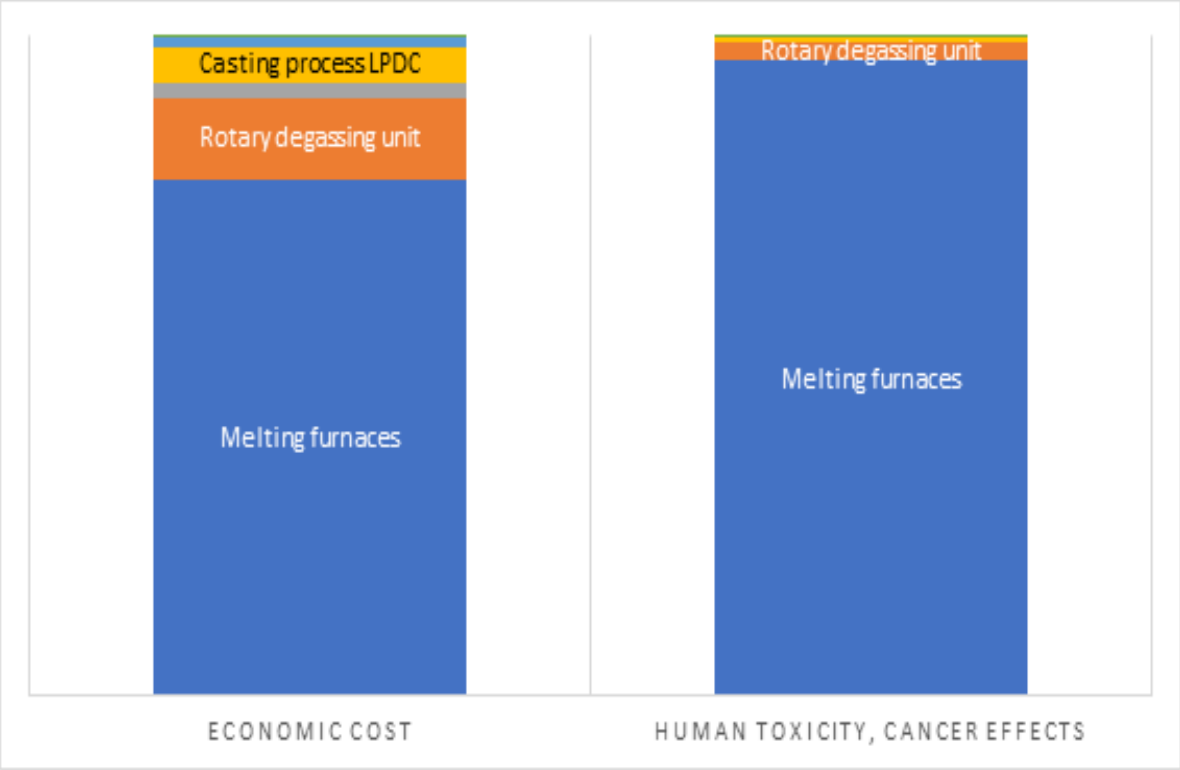
		Workforce dedication to the PL: 100%		Workforce dedication to the PL: 7,5%	
PROCESSES	**UNIT**	**Unitary cost if the plant is working 360 days**	**Unitary cost if the plant is working 20 days**	**Unitary cost if the plant is working 360 days**	**Unitary cost if the plant is working 20 days**
Induction furnace	€	7.75	8.73	6.24	7.21
Ultrasonic equipment	€	0.04	0.63	0.04	0.63
Density control	€	0.00	0.00	0.00	0.00
Fume capturing	€	0.02	0.18	0.02	0.18
Crane hoist (alloy)	€	0.01	0.06	0.00	0.11
Sand preparation and mixing	€	0.99	3.36	0.23	2.60
Crane hoist (sand)	€	0.01	0.06	0.00	0.06
Pressure mould manufacture	€	1.82	1.82	1.06	1.06
Blowing leftover sand	€	0.04	0.04	0.01	0.01
Moulds & unmoulds (casting)	€	0.41	0.41	0.03	0.03
Overheads	€	0.04	0.71	0.04	0.71
TOTAL	€	**11.12**	15.98	7.67	12.59

5.3. LCC results (Low Pressure Die Casting)

		Workforce dedication to the PL: 100%		Workforce dedication to the PL: 5%		Only 100 doorknobs are produced	
PROCESSES	**UNIT**	**Unitary cost if the plant is working 360 days**	**Unitary cost if the plant is working 15 days**	**Unitary cost if the plant is working 360 days**	**Unitary cost if the plant is working 15 days**	**Unitary cost if the plant is working 360 days and the workforce dedication is of 100%**	**Unitary cost if the plant is working 360 days and the workforce dedication is of 5%**
Melting furnace	€	7.23	7.33	5.74	5.83	8.65	7.15
Rotary degassing unit	€	1.14	2.31	1.02	2.18	1.43	1.27
Ultrasonic treatment	€	0.20	0.20	0.02	0.28	0.25	0.03
Casting process LPDC	€	0.51	7.31	0.35	7.15	0.64	0.43
Reduced pressure test	€	0.13	0.13	0.01	0.01	0.16	0.01
Fume capturing	€	0.01	0.01	0.01	0.01	0.01	0.01
Overheads	€	0.00	0.71	0.00	0.71	0.00	0.00
TOTAL	€	**9.23**	18.00	7.14	16.17	11.14	8.91

6.1. LCA & LCC Integration: Results





6.2. LCA & LCC Integration: Comparative results

Comparative analysis

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

7. Improvement proposal

IMPROVEMENT: Circularising the alloy

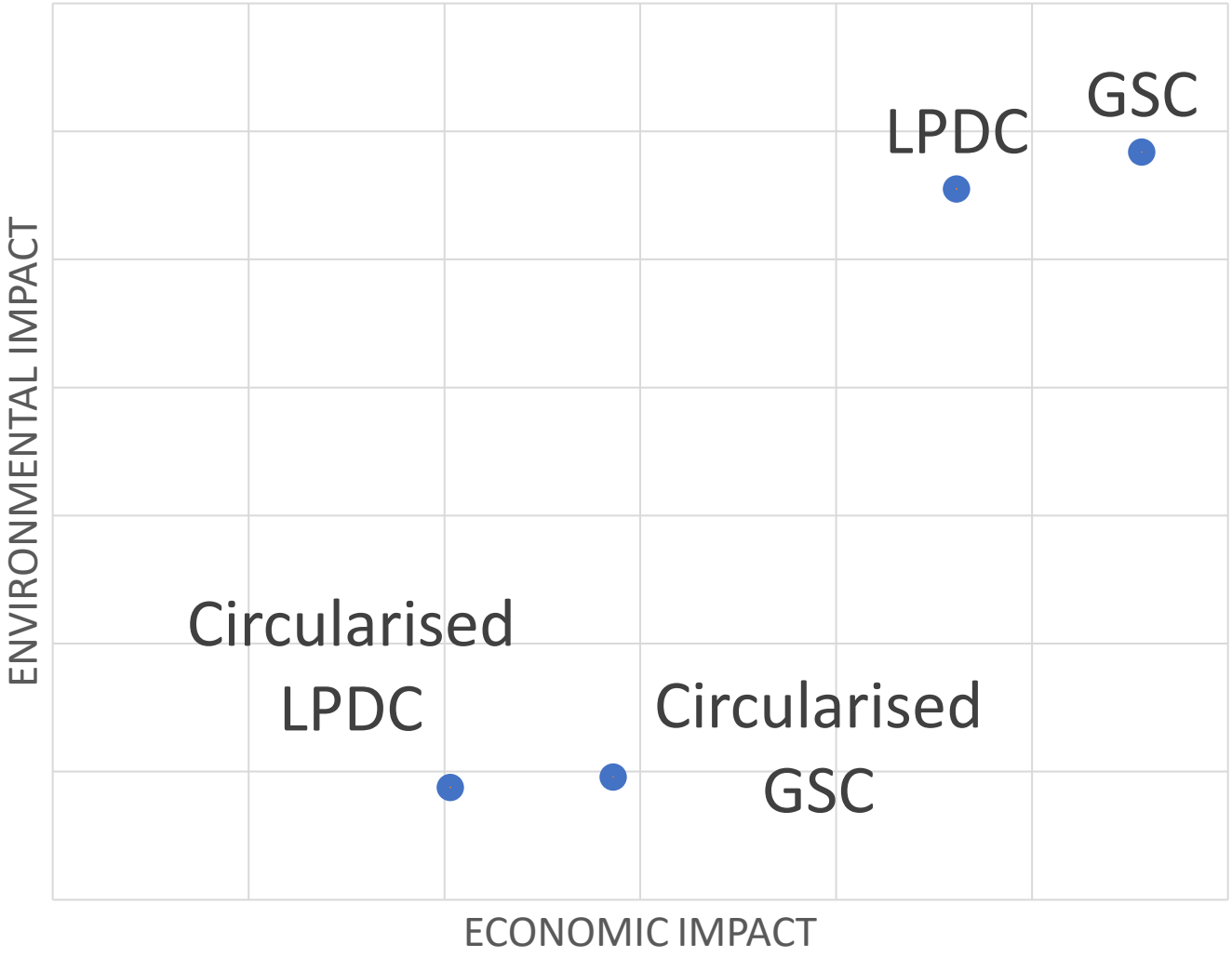
GREEN SAND CASTING

47.44 kg of waste per production cycle

LOW PRESSURE DIE CASTING

142 kg of waste per production cycle

The circularised Low Pressure Die Casting process is still the most efficient one from both, the economic and the environmental, perspectives.



8. Conclusions

- Less environmental impact produced under the Low Pressure Die Casting instead than in the Green Sand Casting.
- This study could be used to update LCAs conducted on MMCs manufacturing technologies, identify hotspots and support future decisions with environmental implications.
- Low Pressure Die Casting allows lower economic cost per unit produced than the Green Sand Casting.
- Integration methodology takes into consideration all the substantial information from the process, and permits a visual representation of the results, favoring an informed managerial decision-making.
- Is also efficient for identifying critical points from both assessments and organising the alternatives hierarchically.

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Thank you for your attention.

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