Magnesium Recycling in the EU

Executive Summary

This report, prepared on behalf of the International Magnesium Association (IMA), presents the findings of a comprehensive material flow analysis of magnesium (metal) in the EU for 2012. This study's findings supersede those presented for magnesium (metal) in the 2015 Material System Analysis (MSA) study produced for DG-GROW.[1] We suggest that this magnesium (metal) material flow analysis is superior to that in the MSA study for three key reasons:

- There is more official data now available on 2012 flows than when the MSA study was conducted.
- Input from industry stakeholders was sought for this study, and received.
- Valuable input and sense checks have been provided by the IMA steering board at each stage of the research.

Whilst alternative data sources were sought and estimates refined, the overall approach to the material flow analysis employed here was the same as in the MSA study in terms of flows, notations and definitions. The results of both studies can therefore be compared like-for-like. However, given that this study focusses on one material only, while the MSA study covered the 21 materials (or families of materials) identified as critical to the EU, this study is able to go into much more detail on individual streams.

As with the MSA study, one key output of this work is a high-level Sankey diagram (see Figure 1) of the inputs and end-fates of magnesium (metal) - hereafter referred to as Mg - in the EU. Even a brief inspection of the diagrams in Figure 1 highlight some of the main differences in the findings of this study compared to those reported in the MSA study:

- This study finds the figure for Mg imports into the EU is 18% higher than reported in the MSA study.[2]
- This study finds exports are over double those identified in the MSA study.
- Landfill in the EU is only 30% of that identified in the MSA study.
- The MSA study includes only old scrap functional recycling, while this study also quantified functional recycling of new scrap.[3]

[1] Study on Data for a Raw Material System Analysis: Roadmap and Test of the Fully Operational MSA for Raw Materials, DG GROW, 2015 https://ec.europa.eu/jrc/en/scientific-tool/msa

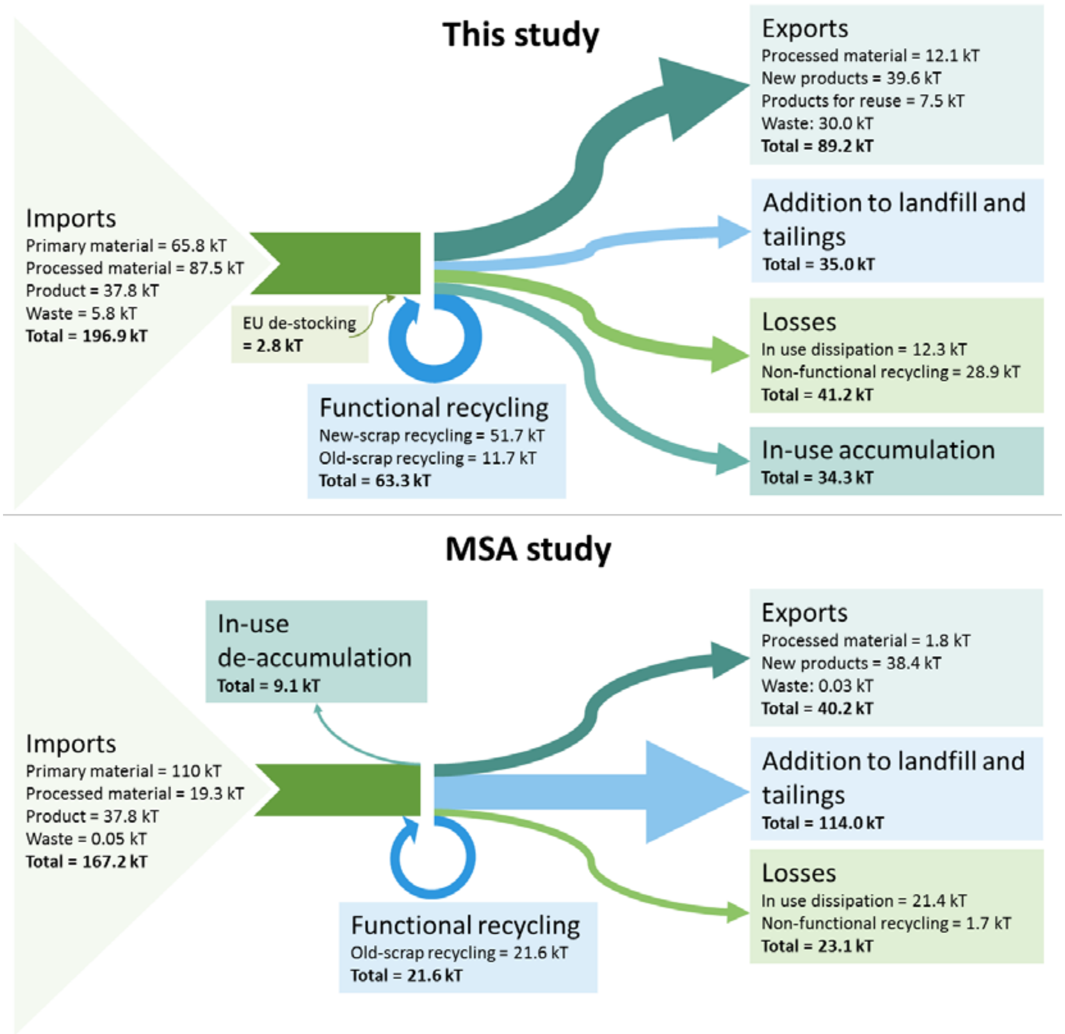
[2] The difference arises from the fact that the MSA study only used customs data to quantify imports and exports and they did not always use the same trade codes and assumptions as in this study. This study also used World Aluminium's 'Global Aluminium Flow' to assign values to some of the import and export flows.

[3] 'Old scrap refers to EoL, post-consumer scrap and 'new' scrap to the scrap generated in manufacturing processes which generally has a known composition and origin.

- Non-functional recycling of Mg is an order of magnitude higher than in the MSA study,
- Instead of 9 kT of de-accumulation as in the MSA study, this study found there were 34 kT of in-use Mg accumulation.[4]

Rather than justifying here each of these considerable differences between the material flow analysis derived in this study and that in the MSA study, readers with an interest in the data sources, calculations and estimates used are directed to the Results chapter of this report where each flow is described in detail. Though constraints posed by data availability did mean that there were cases where estimates, proxy measures and assumptions had to be employed to quantify flows, we are nevertheless confident that the material flow analysis derived here presents a more accurate picture of Mg use within the EU, than that in the MSA study.

Figure 1: High level Sankey diagram for magnesium (metal) produced in this study (Top) compared to that output from the MSA study (Bottom)

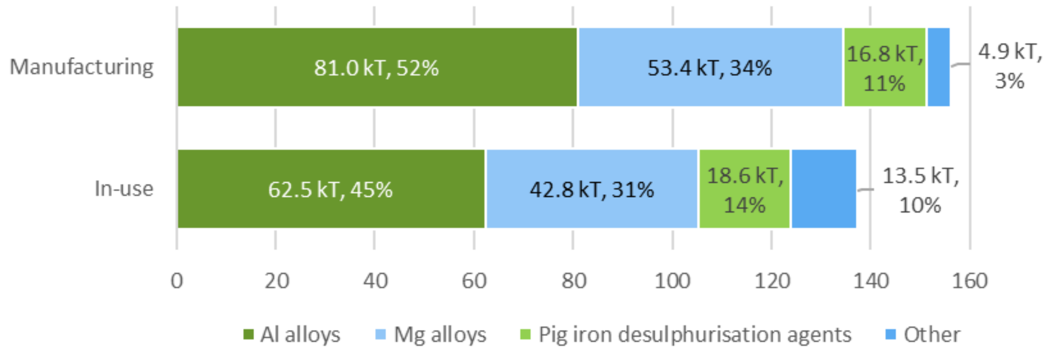


The bottom-up approach applied to developing the material flow analysis, i.e. quantifying each flow per application of Mg individually and then summing them together to get the values presented in Figure 1, meant that we could also determine how much Mg is used in which applications the EU.

[4] In-use accumulation/de-accumulation refers to the change, either positive or negative respectively, in Mg stockpiled in products being used in the EU in a given year.

Widely cited figures originating in a Roskill report allocate 40% of Mg in the EU to aluminium (Al) alloys, 39% to die-casting, 12% to pig iron desulphurisation and 9% to 'other' applications.[5] In deriving a similar application split from the material flow analysis we found that it was important to define which stage of the flow was being considered. Understandably, given the considerable imports and exports of finished Mg-containing products from the EU, the application split of the Mg used by the EU's manufacturing sector is different to that used in the EU by consumers (see Figure 2). Though this study allocated more Mg use to Al alloy applications than Mg alloy applications, the application split derived for Mg use in the EU is not that dissimilar to the Roskill figures.

Figure 2: Consumption of Mg in the EU in 2012 in manufacturing vs in the in-use stage



Note: 'Other' applications of Mg include the Mg powder applications (Grignard reagents, pyrotechnics and refractory materials) as well as the Mg used in nodular cast iron.

The End of Life - Recycling Input Rate (EoL-RIR) for Mg in the EU was also derived from the material flow analysis data. At 7% the EoL-RIR of Mg is low, lower than that of Al at 12% (global, not EU specific value). This was not unexpected given the dispersive nature of some of Mg's applications, and the collection and recycling inefficiencies discussed in detail in the relevant flows in the Results chapter of this report. The main improvements in collection and recycling efficiencies that could increase the recycling rate of Mg are:

- Greater dismantling of Al and Mg alloy components from ELVs.
- Even higher collection rate of EoL aluminium beverage cans.[6]
- Technological advances in the automated sorting of Al alloy fractions from shredding.
- Diverting more high Mg-containing Al alloys to remelters, who generally try to retain the Mg in their input materials, rather than by refiners, who do not.
- Diverting more segregated EoL Mg alloys to specialist Mg recyclers.
- Better slag utilisation by the Al and steel industries (non-functional recycling only).

This list highlights the fact that the recycling rate of Mg is very dependent on the activities of the aluminium and, to a lesser extent, the steel industries. Identifying best practice for Mg retention in Al alloy recycling requires further investigation in order to identify more targeted opportunities for its improvement. It would also be interesting to calculate what the maximum realistic recycling rate of Mg would be in the EU if current, and forecast, best practice methods for Mg retention were fully implemented.

[5] Application split used by IMA, from Roskill's report on magnesium metal: global industry markets and outlook (https://roskill.com/product/magnesium-metal-global-industry-markets-outlook/). Note, that there is slight confusion as to whether this is the use of Mg in the production of these products or this is the amount of Mg consumed in these products in the EU. Depending on the level of imports and exports of finished products the difference can be significant.

[6] Voluntary target of 80% by 2020 adopted by industry, up from approximately 70% in 2012. (http://european-aluminium.eu/media/1038/2016-01-21-european-aluminium-press-release-alubevcanrecycling_.pdf)

In spite of this reliance on other industries we predict that Mg recycling in the EU is increasing. Even since 2012, the baseline year for this study, the collection rate of EoL Al beverage cans has increased and there are policies being enacted, such as research into new technologies,[7] to improve the competitiveness of ELV processors. The policies concerning ELVs are driven by the ambitious recycling targets for ELVs in the EU. Meeting these targets is reliant on a strong ELV processing sector. However, the sector is facing an overall decline in the steel content of vehicles, which is a problem as the plastics and composites they are partly being replaced with are typically of a lower value and more difficult to recycle.[8] The material and value extraction from the Al and Mg alloys in ELVs will help offset the decrease in revenue from steel and contribute to the EU achieving its ELV recycling targets.

For additional information please contact:

David Parker, Oakdene Hollins, Ardenham Court, Oxford Road, Aylesbury, Bucks HP19 8HT
Tel: +44 (0)1296 423915 extn 115
Email: david.parker@oakdenehollins.com

Christian Payn, 343 Chemin de Durban, 84190 Beaumes de Venise, FRANCE
Tel: + 33 (0)6 79 91 44 37
Email: christian.payn@gmail.com

[7] For example, the EU funded projects REALCAR2 and REALITY and SHREDDERSORT
[8] Steel perspectives for the automotive industry, P. Blain (OICA) 2012 (https://www.oecd.org/industry/ind/50498824.pdf)