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CURRENT AND FUTURE RECYCLING POTENTIALS FOR ALUMINIUM IN AUSTRIA

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Introduction

Aluminium (Al) is the second-most widely used metal after iron due to its unique material properties in various aspects (lightweight, flexibility, corrosion resistance, conductibility). It is increasingly used in for light-weight construction in the building sector as well as in the automotive sector. Recycling is a key strategy to satisfy part of the Al demand in a resource efficient and environmentally friendly manner, because secondary Al production causes significantly lower emissions and requires only about 10% of the energy input compared to primary Al production. In Austria and many countries of the European Union, Al production is dependent on Al scrap as an input material and the share of metal scraps in the production process is expected to further increase in the future (cf. circular economy package of the European Union).

In the present study, Austria is chosen as a case study for investigating current and future Al flows and stocks using the method of Material Flow Analysis (Brunner and Rechberger 2016). Based on the analysis of the Austrian Al cycle from a quantitative (total amounts) and qualitative (groups of alloys) perspective, the focus is put on the use of Al in the packaging sector. A detailed account of Al packaging product flows in Austria is given and major recycling loops and losses along the product lifecycle are highlighted. Finally, strategies for increasing Al recycling levels in the packaging sector are identified and discussed based on a comparison of national recycling schemes for Al packaging across Europe.

The Austrian Al cycle: Quantity and quality

A detailed analysis of Al use in Austria is presented for the year 2010 (cf. Buchner et al. 2014), when around 200,000 Mg of metallic Al was consumed domestically. Around 60,000 Mg of Al were collected as wastes and 33,000 Mg of Al were exported via end-of-life vehicles. Hence, total end-of-life flows amount for less than half of domestic Al consumption. Al supply is therefore dependent on primary and secondary sources. This is aggravated by the fact, that not all waste Al is recycled, but around 20% of the collected Al wastes are lost to landfills or oxidized during waste incineration. The difference between consumption and end-of-life flows is added to the stock. The sectors with the largest annual stock increase are the building and infrastructure (+50,0000 Mg) and the transport sector (+25,000 Mg). The only major Al consuming sector with a very small stock increase is the packaging sector, because most packaging products have short lifetimes and, therefore, do not accumulate in the use phase.

The significant growth of Austria´s Al stock indicates that even in highly developed economies, metals stocks are growing at a significant rate. Although this growth will slow down in the coming decades, the total stock of Al in Austria is expected to grow from 360 kg/capita in 2012 to around 530 kg/capita in 2050 (cf. Buchner et al. 2015). During the same period Al scrap generation will more than double (from 14 kg/capita to 31 kg/capita). Hence, due to end-of-life Al flows growing faster than Al consumption (i.e. partial saturation of some metal stocks) metal self-supply via scrap will increase. Nevertheless, even in extreme scenarios a maximum of 2/3 of domestic final Al demand could be satisfied based on domestic scrap only. Furthermore, input of primary Aluminium, is not only required due to quantitative disparities between Al demand and scrap supply, but also because of qualitative constraints (alloy compositions, product specifications, etc.). The latter is a consequence of changing Al applications over time and thus different Al alloys demanded and arising as scrap (as well as scrap contamination with materials such as organics or other metals). In addition, qualitative constraints might be increased by the absence of alloy specific sorting of Al scrap (e.g. joint recovery of cast and wrought alloys from EOL vehicles). For instance, assuming a closed Austrian Al system, mixed (wrought and cast alloys not sorted) Al scrap generation in the transport sector would exceed the demand for cast Al alloy in Austria within the next 10 to 20 years (cf. Buchner et al. 2017). Therefore, higher domestic added value of Al scrap utilization could be generated by applying advanced sorting technologies to produce high quality (alloy specific) scrap, which could be utilized for defined product specifications and alloy compositions thereby facilitating high-value regional material cycles.

The Al packaging product cycle

Al is used ever more frequently for household goods and packaging material, which represents a readily available source for secondary Al due to its short lifetime. To investigate the extent to which this potential source for recycling of Al is already utilized in Austria, a detailed material flow analysis for Al used in packaging & household non-packaging in 2013 was conducted.

In practice, all Al flows starting from market entrance through waste collection and processing until its final recycling or disposal have been investigated. The results indicate that about 25,100 t/a (2.96 kg/cap/a) of Al packaging & household non-packaging arose as waste. At present about 9,800 t/a, or 39%, are recycled as secondary Al, of which 26% is regained from separate collection and sorting, 8% from bottom ash and 5% from mechanical treatment. The type of Al packaging & household non-packaging affects the recycling rate: 82% of the total recycled quantities come from rigid packaging & household non-packaging, while only 3% of the total recycled Al derives from flexible materials. A significant amount of Al was lost during thermal waste treatment due to oxidation (10%) and insufficient recovery of Al from both waste incineration bottom ash and municipal solid waste treated in mechanical biological treatment plants (49%) (Figure 1). Overall it can be concluded that once Al ends up in commingled waste the recovery of Al becomes less likely and its material quality is reduced. Although Austria can refer to a highly developed recycling system, the Austrian packaging industry, collection and recovery systems and waste management need to increase their efforts to comply with future recycling targets.

These recycling targets have become more ambitious within the European Union through the EU Action Plan for the Circular Economy, an initiative to increase the re-use and recycling and

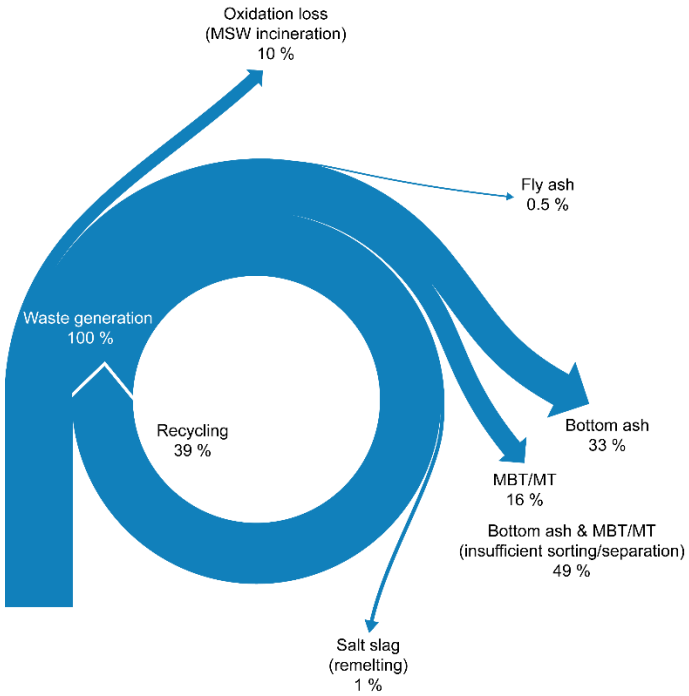

Figure 4. Circular representation of Al packaging & household non-packaging, Austria 2013.

recovery of manufactured goods and consumer goods (EC, 2014) in order to reduce the use of raw materials and associated (environmental) burdens. The proposal to amend the Packaging and Packaging Waste Directive requires that for Al packaging a recycling rate of 50% (2025), resp. 60% (2030) will be required (Official Journal L 150, 2018). A research project on waste management tried to evaluate the actual state of recycling quantities for Al packaging in comparison to the projected targets of the EU Circular Economy. As Al packaging is recovered through different systems (separate collection, deposit refund system, informal collection, bottom ash of MSWI or mechanical treatment), it was aimed to find out through which system and to what extent Al packaging was recovered.

The study examined the management of Al packaging in 16 selected European countries, with results for 11 countries. The results show that six out of 11 countries recycle at least 2/3 of the Al packaging from MSW and only three report very low recycling rates of 20-35%. The countries generate between 0.9 and 2.7 kg Al packaging per capita per year (Figure 2). Two countries (Sweden and Germany) use a deposit refund system (DRS) and have the overall highest rates of collected Al packaging (selective collection and DRS), whereof in Germany a larger part comes from selective collection. Other countries with similar or higher recycling rates (Belgium and the Netherlands) do not use DRS, but recover large volumes from bottom ash (BA) treatment from municipal solid waste incineration (MSWI). Low recovery rates can be correlated to high landfilling (50-84%), while the six countries with the highest recycling rates (except Italy) only deposit 1-3% of their MSW at landfills. No overall correlation between consumption and recycling rate could be demonstrated, as for example Germany has a low consumption rate (1.4 kg/cap) and a high recycling rate (88%), while the UK has a high consumption rate (2.7 kg/cap) and a medium recycling rate (50%).

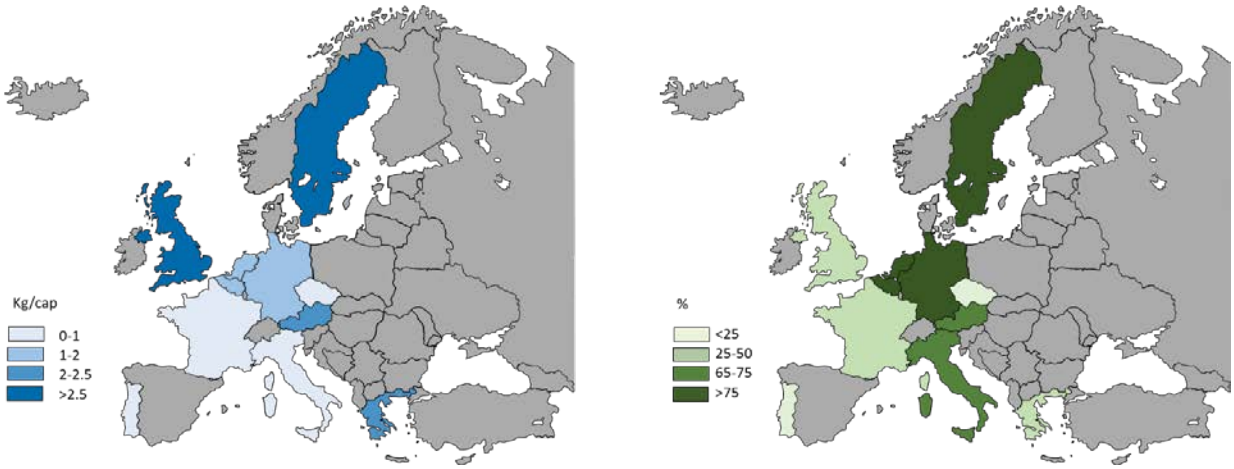

Figure 5. Al packaging in selected EU Member States. Market volumes (kg/cap) and recycling rates (%).

It was not the purpose of this work to question or review the data obtained. But the results show that the recycling rates in the various EU Member States are based on different assumptions and are therefore difficult to compare. The recovery from BA from MSWI e.g. is sometimes based on the assumption that 100% of the Al in BA is originating from Al packaging, while other consider less (Portugal 55%) or do not include recovery of Al from BA is in the recycling rate for Al packaging (Sweden). Furthermore, recovery rates from BA are mostly based on estimations of average recovery yields for non-ferrous and vary depending on particle size and degree of separation (e.g. 50% for Austria >4 mm; Netherlands 77% > 5.6 mm). Considerable quantities of waste are imported (e.g. Netherlands) from countries for which it is advantageous to be able to reduce their waste volumes. This leads to modified recycling rates both in the exporting country with a lower waste volume and in the importing country with a higher recycling rate (Eunomia, 2011).

Some countries gain almost the entire amount of recycled Al packaging through selective collection. Italy has thereby the highest rate of selectively collected Al packaging (67.8%) of all countries, which is remarkable as only 43% of the MSW is recycled and more than ¼ of Italy's waste is landfilled (EUROSTAT, 2017). To which extent e.g. non-related materials (impurities, adhesives) affect the recycling rates of the various EU Member States is not known. As the EC (2015) stated should the "weight of materials or substances that are not subject to a final recycling process […] remain below 10% of the total weight to be reported as recycled", but a survey by Eunomia (2016) indicated for Al packaging losses up to 60-70% during collection, sorting and recycling processes.

The study clearly demonstrates the differences in official data and the consequent need for a uniform and precisely formulated requirement for data collection. Finally, the question arises why the originally intended higher goals for Al packaging (70% for 2025) within the EU Action Plan for the Circular Economy (EC, 2015) were not realized as a lot of countries already reach these targets.

References:

Brunner, P.H., Rechberger, H. 2016. Handbook of Material Flow Analysis: For Environmental, Resource, and Waste Engineers.CRC Press - Taylor & Francis Group, Boca Raton – London - New York.

Buchner, H., Laner, D., Rechberger, H., Fellner, J. 2014. In-depth analysis of aluminum flows in Austria as a basis to increase resource efficiency. Resources, Conservation and Recycling 93 (0), 112-123.

Buchner, H., Laner, D., Rechberger, H., Fellner, J. 2015. Future Raw Material Supply: Opportunities and Limits of Aluminium Recycling in Austria. Journal of Sustainable Metallurgy 1(4), 253-262.

Buchner, H., Laner, D., Rechberger, H., Fellner, J. 2017. Potential recycling constraints due to future supply and demand of wrought and cast Al scrap—A closed system perspective on Austria. Resources, Conservation and Recycling 122, 135-142.

EC. (2015). Proposal for a DIRECTIVE OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL amending Directive 94/62/EC on packaging and packaging waste. In EUROPEAN COMMISSION (Ed.), 2015/0276 (COD) (Vol. COM(2015) 596 final). Brussels.

Eunomia. (2011). Options and Feasibility of a European Refund System for Beverage Cans. Final Report Appendix 2: Comparative Analysis of Collection Systems for Metal Beverage Cans.

Eunomia. (2016). Support to the waste target reviews. Final report Report for: DG Environment of the European Commission. Bristol: Eunomia Research & Consulting Ltd.

EUROSTAT. (2017). Generation and treatment of Municipal waste, by country, year and treatment type, in thousand tonnes, kg per inhabitant http://ec.europa.eu/eurostat/web/waste/transboundary-waste-shipments/key-waste-streams/municipal-waste (Zugriff am 18. 01. 2018).

Official Journal L 150. (2018). Official Journal of the European Union, L 150, 14 June 2018 Legislation.