

Economy-Wide Material Flow Accounting: Review and Application in the Italian Glass Industry

Salik Ahmed ¹, Marco Ciro Liscio ^{1,2}, Andrea Pelaggi ^{1,2}, Paolo Sospiro ^{1,2,4,5}

¹ EUAbout, Bruxelles, Bruxelles, 1000, Belgium

² Centro di Ricerca e Servizio sull'Innovazione e l'Imprenditorialità (C.I.I.) Università Politecnica delle Marche, Ancona, Marche, 60131, Italy

³ Dipartimento di Ingegneria Industriale, Università di Bologna, Bologna, Emilia-Romagna, 40126, Italy

⁴ CREAR/Dipartimento di Ingegneria Industriale, Università di Firenze, Firenze, Toscana, 50139, Italy;

⁵ Università Telematica eCampus, Novedrate (CO), Lombardia, 22060, Italy

Keywords: circular economy, EW-MFA, SPAR-4-SLR, waste management, glass value chain.

Presenting author email: m.c.liscio@pm.univpm.it

The transition from traditional waste management to sustainable practices within the European Union has prompted extensive research on resource extraction and waste utilization. This evolution aligns with the collective commitment among member states toward environmentally responsible waste management practices, as evidenced by ongoing enhancement and convergence (Chioatto & Sospiro, 2020). However, a critical challenge arises in reintegrating recovered materials into production processes to efficiently close resource cycles.

This paper explores the evolution of research in circular material flows analysis, with a specific focus on Economy-Wide Material Flow Accounting (EW-MFA) in the scientific literature, beginning from the notable contributions from OECD and EUROSTAT.

The OECD has played a pivotal role through a publication such as "Measuring Material Flows and Resource Productivity Volume I: The OECD Guide" (OECD, Measuring Material Flows and Resource Productivity Volume, 2004), offering a comprehensive overview of material flow (MF) approaches and measurement tools at the national level. Subsequent volumes include "Volume II: The Accounting Framework" (OECD, 2008), providing a theoretical and technical elucidation of material flow accounting concepts and methodologies, and "Volume III: Inventory of Countries' Activities" (OECD, 2008), which assesses ongoing or planned activities concerning the measurement and analysis of natural and material resource flows in OECD countries and select non-member economies.

Conversely, in 2018, EUROSTAT published a document titled "Secondary materials in European material flow accounts in raw material equivalents" (EUROSTAT, 2018), along with the Economy-wide material flow accounts manual, which introduced the EU Raw Material Equivalent (RME) model (EUROSTAT, 2018). The latter comprises statistics regarding the total amount of materials that flow into national economies, changes in the stocks of materials within the economic system, and the total amount of materials that are taken out from the economy and released into the environment.

The guidelines for the EW-MFA will be applied using the STAN software (Cencic & Rechberger, 2008). The application of the STAN software is essential for constructing a simulation model that emulates the intricate dynamics of the Italian national system, particularly in modelling the central actors associated with the glass industry and the related flows. With its user-friendly interface and analytical capabilities, STAN allows users to scrutinize the intricate connections between economic activities and their ecological consequences from a broader perspective. This is particularly helpful in aiding decision-makers in crafting sustainable strategies and policies.

In Figure 1 (Eurostat, 2001) below, the main scheme adopted for the analysis is presented. It represents the general considered flows, including air and water flows. Analysing the inputs and outputs, the "Domestic Extraction" is composed of fossil fuels, metal ores, industrial minerals, construction minerals and biomass. Each of these groups can be further broken down, for instance, fossil fuels into different fuel types or biomass into timber, agricultural

harvest, fish catch, etc. Moreover, to measure material inputs and outputs consistently, is critical to include in the various calculation the “Indirect flows” directly related to the physical upstream material flows associated to imports and outputs. Another significant feature for the analysis is to consider the sets of hidden flows, presented in the scheme as “Domestic Unused extraction” meaning the movements of the unused materials associated with the extraction of raw materials, both domestically and abroad.

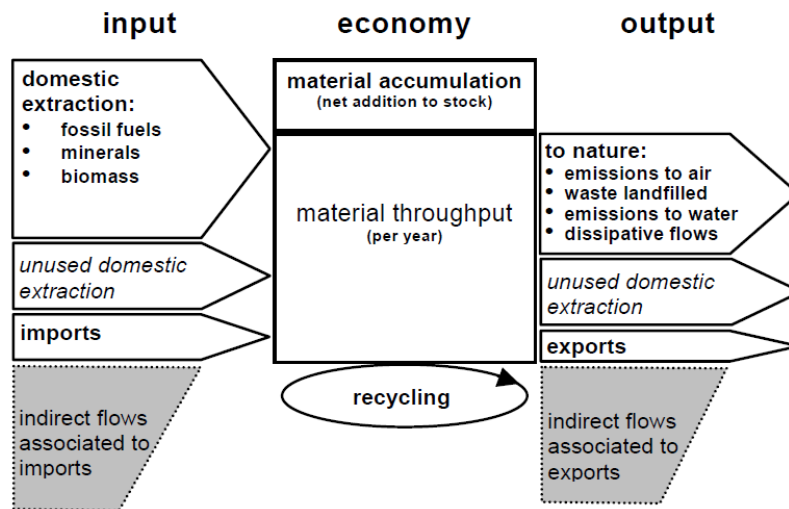


Figure 1. Economy-wide material balance scheme

The study examines the intricate processes involved in Italian glass production, from raw material extraction to end-of-life considerations. It dissects the complexities of the glass industry, shedding light on patterns, trends, and potential areas for improvement.

In conclusion, this research underscores the significance of EW-MFA as a tool for evaluating and advancing sustainable practices, tested within the glass industry. The aim is to provide valuable insights, serving as a resource for scholars, policymakers, and stakeholders promoting a comprehensive approach to environmental conservation. By quantifying material flows and environmental impact, the study contributes to the ongoing discourse on industrial sustainability, offering a roadmap for future research and practical applications within the broader context of sustainable resource management and the circular economy.

References

- Cencic, O., & Rechberger, H. (2008). *Material Flow Analysis with software STAN*.
- Chioatto, & Sospiro. (2020). *Transition from Waste Management to Circular Economy: The European Union*.
- Eurostat. (2001). *Economy wide material flow accounting and derived indicators*. Retrieved from <https://ec.europa.eu/eurostat/documents/1798247/6191533/3-Economy-wide-material-flow-accounts...-A-methodological-guide-2001-edition.pdf/>
- EUROSTAT. (2018). *Secondary materials in European material flow accounts in raw material equivalents*.
- EUROSTAT. (2018). *Economy-wide material flow accounts manual*.
- OECD. (2004). *Measuring Material Flows and Resource Productivity Volume*.
- OECD. (2008). *The Accounting Framework*.
- OECD. (2008). *Volume III - Inventory of Countries' Activities*.