Interreg Alpine Space

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CEFoodCycle

Adapting Agri-food Data for Environmental Footprinting in Regional Contexts in the Alpine Region: Part 2 - Processing to Retail

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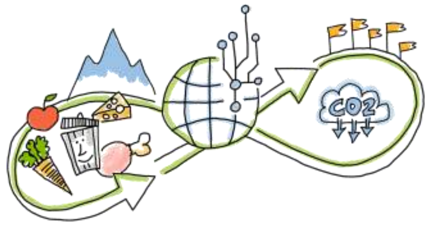

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Adapting Agri-food Data for Environmental Footprinting in Regional Contexts in the Alpine Region: Part 2 - Processing to Retail.

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Key Takeaways

01 Standardized Data Collection and Management:

Better and more standardized data collection and management is essential for improving the reliability of data in LCA tools. Expanding existing databases and collection processes can provide valuable insights for businesses and policymakers.

02 Strategic Regulation and Regional Decision-Making :

Strengthening the connection between regulatory strategies and regional decision-makers can enhance implementation on the ground. This alignment provides crucial insights into regional needs and supports more effective policy execution.

03 International Collaboration for Food System Efficiency:

National differences highlight significant potential for increasing efficiency in food systems. International collaboration and transregional knowledge transfers are key to driving this transition and achieving sustainable improvements.

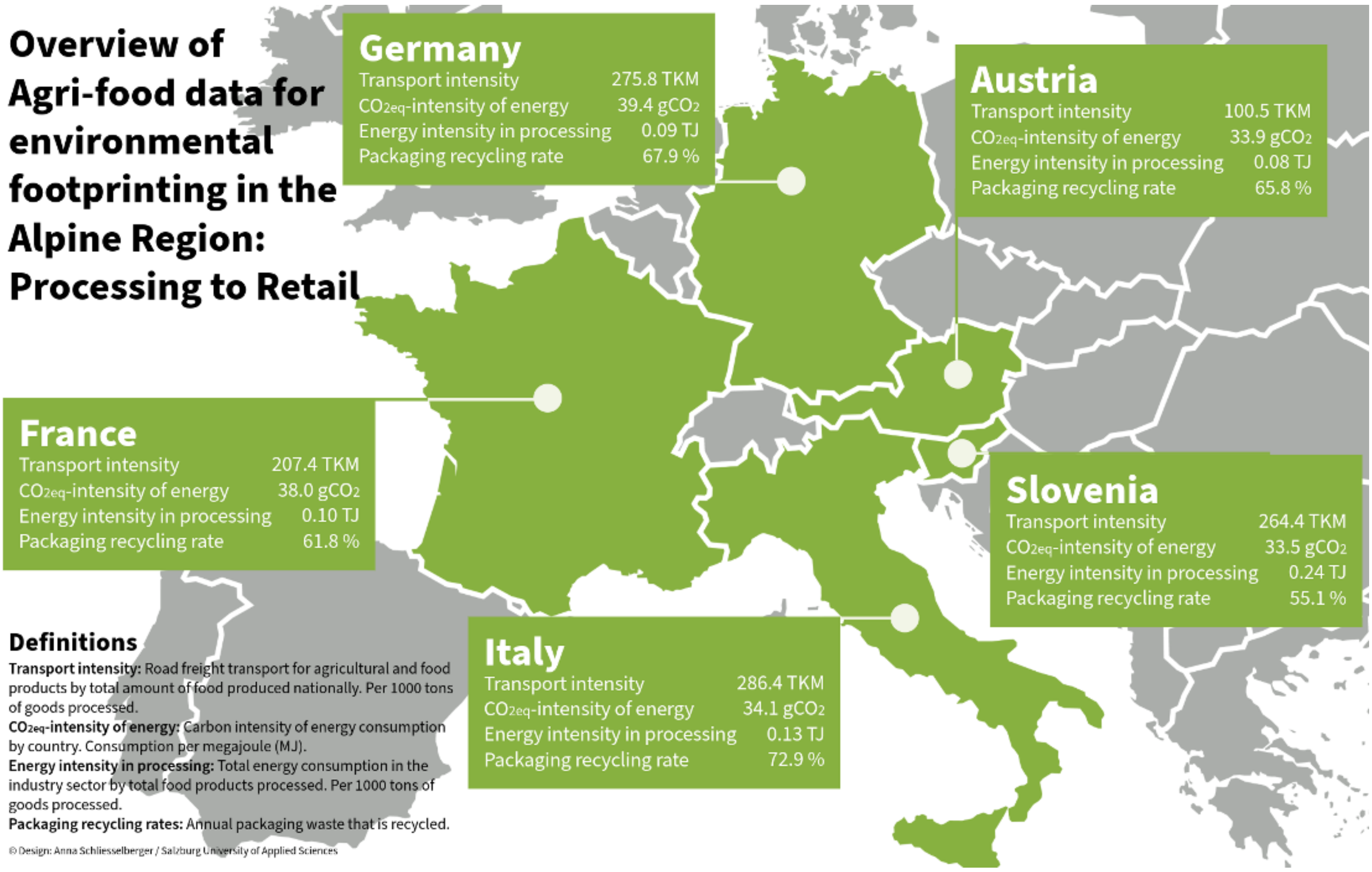

Fig. 1: Overview of agri-food data for environmental footprinting in the Alpine Region: Processing to Retail.

1. Introduction

On a global scale, one-third of food goes to waste (World Resources Institute, 2020).Food waste remains a critical issue in Europe, with staggering amounts of edible food being discarded at various stages of the supply chain (European Commission, 2019), agriculture being one of these stages. To foster the shift towards a Circular Economy in the agri-food sector, it is not only necessary to show food waste conversion pathways and related trade-offs and opportunities (Santagata et al., 2021) but also to measure the environmental burdens of food loss and waste (Gava et al., 2019). Only then relevant stakeholders are able to strategically tackle existing challenges, draft effective policy, and measure progress (Gava et al., 2019). Therefore, the efforts to express food waste and food system emissions in CO2-emission equivalents and other factors through **Life Cycle Analysis** (LCA) methods have increased in the last decade (Voglhuber-Slavinsky et al., 2022; Kaltenbrunner et al., 2024). Recent EU policies such as the Corporate Sustainability Reporting Directive (CSRD) and the EU-Taxonomy have evoked strong interest in businesses to measure and monitor their environmental burdens (Sala et al., 2021).

This report is written as part of the project CEFoodCycle (2024a) and therefore focuses especially on the Alpine regions in Austria, France, Germany, Italy, and Slovenia. The **Alpine Space** region is a complex economic area with agroecosystems providing a large amount of ecosystem services (Faccioni et al., 2019). The preservation of provisioning services for resources such as food or water as one of them is highly dependent on the environmental burdens of our farming practices. To assess the different practices and contexts within agricultural systems, relevant for environmental footprinting, a comparison of national and regional data was conducted as part of the project CEFoodCycle (2024a). Further data as regards the value chain structure in the five Alpine Space regions and food initiatives / regulations can be found in our report 'Blueprint for an emerging sustainable circular future in the food sector' (CEFoodCycle, 2024b).

Significant regional differences in environmental impact can be observed, both on national as well as on subnational (Wilting et al., 2021) levels. While previous studies have highlighted the global significance of food waste (e.g. United Nations Environment Programme, 2021) and the multiple benefits of transitioning to a Circular Economy (e.g. Ellen MacArthur Foundation, 2024a), there is a lack of detailed analysis focusing on how regional variations in the food value chain impact LCA metrics within the Alpine region. Therefore, we conducted a targeted, mixed-methods investigation with the aim to uncover national differences of key factors responsible for variations in environmental impacts within the retail sector in Austria, Germany, Italy, France and Slovenia applicable for LCA assessments. The key findings are made available in this report to support decision makers in the food sector (e.g. managers, policymakers, research institutions).

Furthermore, the findings of this study are used in order to tailor regional differences in the AI LCA-tool that is developed within the project (CEFoodCycle, 2024a). The tool is designed to connect companies to find solutions for their surplus food and food waste and compare them based on LCA metrics.

2. Methodology

The work described here encompasses the explorative research for national and regional differences in agri-food systems and the deduction and attempted quantification of possible impact factors, which could be integrated into LCA market data for the respective Alpine countries. The validation of the suggested factors and the integration into an LCA-tool might reveal more information about the applicability of the selected impact factors. However, this is out of scope for this study within the necessary process for the final integration into LCA-tools (see fig. 2).

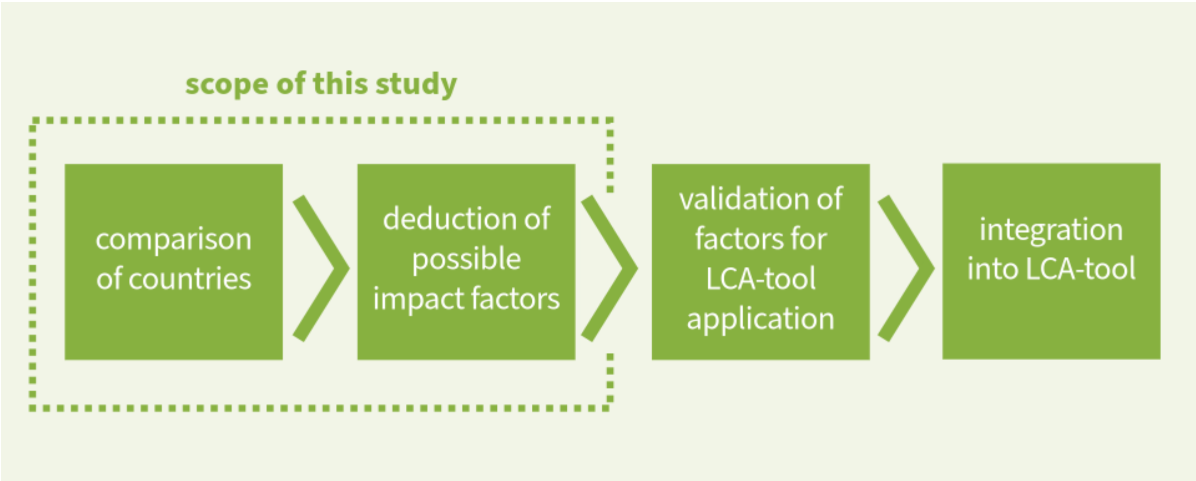

Fig. 2: Scope of this study.

Qualitative Approach

The majority of current LCA studies on agri-food products and processes rely on emission calculations derived from the extensive Agribalyse database, which is based on French market data and accessible free of charge. The international scientific community and governmental agencies are working to adapt the available data from Agribalyse to the context of other countries and regions.

Based on extensive research on national food industry data in the five countries and related food waste (CEFoodCycle, 2024b) as well as on LCA calculations in food streams (Kaltenbrunner et al. 2024), two exploratory interview guidelines were developed: One guideline focused on agricultural challenges and practices, addressing experts within the field of agriculture. The second guideline was established with the intent to gain knowledge on processing and retail, and thereby covering central steps in the food value chain. Specifically, the questions evolved around current practices in and use of key agricultural resources, the commonness of frontrunner methods, regional efficiency, and the existence and implementation of resource-relevant strategies in the food sector.

Feedback on the interview guidelines was collected from the transregional project consortium to make sure it was applicable for the different contexts. Regional retail and agriculture experts, in total 13 persons (8 male, 5 female) from universities, ministries and interest groups in Austria, Italy and Slovenia were selected based on their extensive knowledge and experience in the local food industry sector. The interviews were conducted online between March and May 2024. They were recorded and transcribed in national language and then translated to English to facilitate the following systematic interview analysis.

Quantifying National Differences

Based on the information given by expert interviews, desk research was conducted to find available national data that is relevant for LCA-factors and could be implemented into the structure of existing LCA-tools.

Based on information derived from international comparative studies (e.g. Crippa et al. 2021; Finnegan et al. 2018; Lam et al. 2018; Kaltenbrunner et al 2024)), an extensive list of 30 impact categories for both agricultural and processing to retail value-chains was compiled. This catalogue was reduced to a list of 9 factors with the highest environmental relevance (considered aspects: environmental burdens, anticipated national differences, impact on CO_{2eq}-emissions, water use, land use) and promising comparability (considered aspects: measurability, availability). In order to be applicable for the impact factor catalogue, the existing data had to fulfill the following prerequisites:

- availability for at least 4 out of the 5 selected countries
- suitability with the structure of existing LCA databases (e.g. Agribalyse)
- comparability of used methodology in compiling country data

This resulted in four final impact categories: **transport intensity, CO_{2eq}-intensity of energy use, energy intensity in food processing, and packaging recycling rates.**

Limitations in terms of data availability, differences in sectoral delimitation and additional uncertainty due to extrapolations have to be taken into account. The chosen system boundaries were the nationally procured food for consumption / intermediary products where possible, or the nationally produced food where total consumption data was not available. The factors evaluated were chosen along the food value chain from primary production to the point of sale.

Factors focusing on consumption and private preparation emissions (e.g. gas stove for cooking) were not taken into consideration. The circumstances explaining the observed national differences are out of scope of this study and are not discussed in detail. The authors distance themselves from giving general reasonings for these complex issues.

3. Regional Differences in Environmental Footprints

The five selected countries cover a wide range of food production goods from basic staple foods, over fruits and vegetables, sea and freshwater fish and meat and dairy products to highly processed foods (Eurostat 2024). The heterogeneity of the selected countries provided a good basis for building a methodology for comparison and a blueprint for eventually extending the scope to other European countries.

The regulatory environment is a major factor influencing food waste management and food waste initiatives and practices (see also CEFoodCycle, 2024b). In Italy, regulations are seen as essential for setting standards but can also be restrictive, limiting the flexibility needed for innovative solutions. Experts call for more adaptive regulatory frameworks that can evolve with emerging technologies and practices. Slovenian experts argue for stronger national legislation that aligns with sustainability goals, suggesting that significant progress can only be made through comprehensive governance.

The chosen quantifiable and LCA-applicable factors for the comparison of the intensity of the agri-food sector from processing to retail and different practices between the countries were **transport intensity, CO_{2eq}-intensity of energy use, energy intensity in food processing, and packaging recycling rates** (see table 1).

As regards to **transport intensity**, distances and mass of goods transported by the total amount of food produced in the different countries vary considerably. For this quantification, the road freight transport for agricultural and food products (data only available including hunting, forestry, fish and fishing as well as beverages and tobacco) in tonne-kilometers (TKM) was divided by the total amount of food produced nationally. Italy, Germany and Slovenia show the highest transport intensity in their food sectors with 286,371 TKM, 275,774 TKM, and 264,355 TKM per 1000t of food produced respectively. France shows a slightly lower transport-intensity with 207,365 TKM/1000t produced and Austria seems to have the most regional food system with only 100,454 TKM/1000t produced. (Eurostat, 2021b; FAO, 2021) The reasons for these differences are highly complex and show relationships with overarching factors such as national economic structures, economic growth, road transport intensity, and improvements in supply and transport systems (Alises & Vasallo, 2015).

Factors for Comparison	Quantification Method
Transport intensity	road freight transport for agricultural and food products (data only available including hunting, forestry, fish and fishing as well as beverages and tobacco) in TKM by total amount of food produced nationally (Eurostat, 2021b; FAO, 2021)
CO_{2eq}-intensity of energy use	carbon intensity of energy consumption by country (IEA, 2021)
Energy intensity in food processing	total energy consumption in the industry sector (food, beverages and tobacco) by total food products processed (Eurostat, 2021a; FAO, 2021)
Packaging recycling rates	recycling rates of packaging (paper and cardboard, plastic, wooden, metallic, and glass packaging) per country (Eurostat, 2021a)

Table 1: Quantification factors for national differences.

The interviewees in Italy reported a significant focus on the logistics of transporting surplus food to ensure it reaches those in need rather than going to waste. This involves optimizing routes and ensuring refrigerated transport to maintain food quality. Slovenian experts point out that while transport systems are in place, there is often a lack of coordination, leading to inefficiencies. In Austria, Germany, and France, the focus is on integrating technology to streamline transport logistics, reduce emissions, and improve tracking systems for better management of food resources. Interviewees confirmed available data on transport in the food industry, showing that food is mainly transported by road due to time sensitivity/ shelf life. The use of refrigerated trucks could differ due to differing climates (Meneghetti, Magno & Romagnoli, 2021).

Regarding **CO_{2eq}-intensity of energy use** the amount of greenhouse gases released per unit of energy used in the food processing industry varies by country, impacting the overall carbon footprint of food products. Germany and France have the highest carbon intensity of energy use in food processing with a value of 39.4 gCO2/MJ and 38.0 gCO2/MJ. Italy, Austria and Slovenia show slightly lower intensities, with carbon emissions of 34.1 gCO2/MJ, 33.9 gCO2/MJ, and 33.5 gCO2/MJ. (IEA, 2021) Key factors influencing emissions intensity of energy consumption in Europe are Non-fossil energy, economic growth, heating degree days, and crude oil price (Cheng et al. 2018).

Looking at the total **energy intensity in food processing** in the industry sector (food, beverages and tobacco) by the total amount of food products produced, slight national differences become visible. Slovenia has the highest energy consumption per 1000 t of food produced, with a value of 0.24 TJ, followed by Italy with 0.13 TJ. France, Germany, and Austria have a similar energy consumption in the food industry with a utilization of 0.10 TJ, 0.09 TJ, and 0.08 TJ per 1000 t of food produced. (Eurostat, 2021c; FAO, 2021) Energy consumption in food processing is dependent on a wide range of factors such as hygienic standards, use of thermal processes and types of food produced (Ladha-Sabur et al., 2019).

Recycling is the most widely available and industrialized strategy for **reducing packaging waste** and virgin production of packaging, thus the most preferable one for conducting a comparison between countries. While reusable packaging options would be preferable in many cases, the strategy has not yet penetrated the markets in the Alpine Space widely enough to allow a valid comparison of their impacts on LCA factors. Recycling rates for packaging materials in 2021 demonstrate varying levels of recycling efficiency. Higher recycling rates indicate better waste management practices and infrastructure, contributing to reduced environmental impact.

In 2021, Italy had the highest packaging recycling rate of the observed countries with 72.9 % followed by Germany (67.9 %) and Austria (65.8 %). France and Slovenia are in the lower range of the 5 countries with recycling rates of 61.8 % and 55.1 %. (Eurostat, 2021a) The differences in the recycling rates can be explained through disparities in economic wealth, environmental taxes, research and development expenditures, and urbanization (Kostakis & Tsagarakis, 2021).

4. Conclusion & Recommendations

Significant differences exist between the observed countries in transport intensity, CO2eq-intensity of energy use, energy intensity in food processing, and packaging recycling rates. These disparities reflect the diverse practices, climates, cultural factors, and infrastructures across the region, necessitating widely standardized strategies for measuring environmental burdens and region-specific ones to reduce them.

The conducted interviews and comparisons show that regulatory frameworks can significantly influence both data collection and sustainability practices in the retail sector. Adaptive and comprehensive governance is essential for facilitating innovative solutions and aligning national practices with broader sustainability goals.

While this study is only a first step in the implementation of regional differences of retail practices into environmental footprinting tools, the results and made considerations disclose first key obstacles that need to be overcome to provide a comprehensive and robust national or regional modelling.

The picture painted through the given overview of qualitative and quantitative data results in the following recommendations for businesses in processing and retail, as well as policymakers:

1) Better and more standardized data collection and management is essential. Expanding on existing databases and collection processes can help to better inform businesses, policymakers and enhance the reliability of data in LCA tools.

2) A stronger connection of strategy in regulations for data collection and regional decision-makers can provide valuable insights into the needs for implementation on the ground.

3) Demonstrated national differences show that there is a lot of potential for more efficiency in our food systems and international collaboration and transregional knowledge-transfers play a key role in the transition.

4) Future research should focus on expanding the dataset and refining the conversion factors to enhance the accuracy and applicability of LCA in diverse geographical contexts.

5. Where to get started for LCA?

- ☐ Understand LCA analysis (Kaltenbrunner et al. 2024)
- ☐ Read ISO guidelines: ISO 14044:2006, ISO 14040:2006
- ☐ Take educational courses & sign up for (online) seminars
- ☐ Study case studies, e.g. on the European Platform on LCA (2024), and guidelines, e.g. Life Cycle Assessment for the circular economy (Ellen MacArthur Foundation, 2024b)
- ☐ Look through LCA tools, e.g. Agribalyse, a database covering a wide range of data about food, agriculture and related factors based on products available in French supermarkets.
- ☐ Cooperate with experts to learn to use LCA software tools (SimaPro, Umberto, Open LCA)
- ☐ Find partners, e.g. with vcg.ai, which uses a data approach to generate meaningful value chains and to implement circular business models. It is a tool to identify specific industry solutions and possible partners.

References

Alises, A., & Vassallo, J. (2015). Comparison of road freight transport trends in Europe. Coupling and decoupling factors from an Input–Output structural decomposition analysis. Transportation Research Part A-policy and Practice, 82, 141-157. https://doi.org/10.1016/J.TRA.2015.09.013.

Agribalyse (2024). Homepage. https://agribalyse.ademe.fr/app (accessed 11.06.2024)

CEFoodCycle (2024a). Circular Economy: Mapping Food Streams and Identifying Potentials to Close the Food Cycle. Interreg Alpine Space project. https://www.alpine-space.eu/project/cefoodcycle/(accessed 13.06.2024).

CEFoodCycle (2024b). Blueprint for an emerging sustainable circular future in the food sector. Output 1.2. Part of the Interreg Alpine Space Project CEFoodCycle. Salzburg University of Applied Sciences, Salzburg / Puch, January 2024. https://www.alpine-space.eu/wp-content/uploads/2024/07/O.1.2-Whitepaper-final.pdf

Cheng, C., Ren, X., Wang, Z., & Shi, Y. (2018). The Impacts of Non-Fossil Energy, Economic Growth, Energy Consumption, and Oil Price on Carbon Intensity: Evidence from a Panel Quantile Regression Analysis of EU 28. Sustainability. https://doi.org/10.3390/SU10114067.

Crippa, M., Solazzo, E., Guizzardi, D., Monforti-Ferrario, F., Tubiello, F. N., & Leip, A. J. N. F. (2021). Food systems are responsible for a third of global anthropogenic GHG emissions. *Nature food*, *2*(3), 198-209.

Ellen MacArthur Foundation (2024a). What is a Circular Economy? https://www.ellenmacarthurfoundation.org/topics/circular-economy-introduction/overview (accessed 03.07.2024).

Ellen MacArthur Foundation (2024b). Life Cycle Assessment for the circular economy. https://www.ellenmacarthurfoundation.org/life-cycle-assessment-for-the-circular-economy (accessed 11.07.2024).

European Commission (2019). Redistribution of surplus food: Examples of practices in the Member States. Saving food together. EU Platform on Food Losses and Food Waste. https://food.ec.europa.eu/system/files/2019-06/fw_eu-actions_food-donation_ms-practices-food-redis.pdf (accessed 26.06.2024).

European Environmental Agency (EEA). (2021). Overview of national waste prevention programmes in Europe. https://www.eea.europa.eu/themes/waste/waste-prevention/countries/2023-waste-prevention-country-fact-sheets/france_waste_prevention_2023 (accessed 28.06.2024).

Eurostat (2021a). Recycling rate of packaging waste by type of packaging. https://ec.europa.eu/eurostat/databrowser/view/cei_wm020/default/table?lang=en (accessed 28.06.2024).

Eurostat (2021b). Road freight transport by type of goods and type of transport (t, tkm) - annual data. https://ec.europa.eu/eurostat/databrowser/view/ROAD_GO_TA_TG__custom_11913980/default/table?lang=en (accessed 28.06.2024).

Eurostat (2021c). Simplified energy balances. https://ec.europa.eu/eurostat/databrowser/view/nrg_bal_s/default/table?lang=en (accessed 28.06.2024).

European Platform on LCA (2024). Homepage. https://eplca.jrc.ec.europa.eu/ (accessed 11.07.2024).

Faccioni, G., Sturaro, E., Ramanzin, M., & Bernués, A. (2019). Socio-economic valuation of abandonment and intensification of Alpine agroecosystems and associated ecosystem services. Land use policy, 81, 453-462.

Finnegan, W.; Yan, M.; Holden, N.; Goggins, J. (2018): A review of environmental life cycle assessment studies examining cheese production. In: The International Journal of Life Cycle Assessment 23 (9), 1773–1787. DOI: 10.1007/s11367-017- 1407-7.

FAO (2021). Food Balances (2010). Food and Agriculture Organization. https://www.fao.org/faostat/en/#data/FBS (accessed 28.06.2024).

IEA (2021). Carbon intensity of energy consumption by country.International Energy Agency. https://www.iea.org/data-and-statistics/data-tools/energy-statistics-data-browser?country=ITALY&fuel=Energy%20consumption&indicator=CO2Industry (accessed 28.06.2024).

ISO 14044:2006 (2022). Environmental management. Life cycle assessment. Requirements and guidelines. https://www.iso.org/standard/38498.html (accessed 26.06.2024).

ISO 14040:2006 (2022). Environmental management. Life cycle assessment. Principles and framework. https://www.iso.org/standard/37456.html (accessed 26.06.2024).

Kaltenbrunner, K., Orth, D., Pladerer, C., Menedetter, V. (2024). Comparability of Life Cycle Analysis Studies on Food Waste and Food Products. A Review on the current Status of Food Waste Life Cycle Analysis and the used Methodology (Deliverable D1.1.1). Part of the Interreg Alpine Space Project CEFoodCycle. Österreichisches Ökologie-Institut, Vienna and Salzburg University of Applied Sciences, Salzburg / Puch, January 2024 https://www.alpine-space.eu/wp-content/uploads/2024/01/D1.1.1-20240125-Final-1.pdf (accessed 11.07.2024).

Kostakis, I., & Tsagarakis, K. (2021). Social and economic determinants of materials recycling and circularity in Europe: an empirical investigation. The Annals of Regional Science, 68, 263 - 281. https://doi.org/10.1007/s00168-021-01074-x.

Ladha-Sabur, A., Bakalis, S., Bakalis, S., Fryer, P., & Lopez-Quiroga, E. (2019). Mapping energy consumption in food manufacturing. Trends in Food Science & Technology. https://doi.org/10.1016/J.TIFS.2019.02.034.

Lam, C.; Yu, I.; Hsu, S.; Tsang, D. (2018): Lifecycle assessment on food waste valorisation to valueadded products. In: Journal of Cleaner Production 199, 840–848. DOI: 10.1016/j.jclepro.2018.07.199.

Légifrance (2016). LOI n° 2016-138 du 11 février 2016 relative à la lutte contre le gaspillage alimentaire. https://www.legifrance.gouv.fr/jorf/id/JORFTEXT000032036289/ (accessed 28.06.2024).

Meneghetti, A., Dal Magro, F., & Romagnoli, A. (2021). Renewable energy penetration in food delivery: Coupling photovoltaics with transport refrigerated units. Energy, 232, 120994.

Sala, S., Amadei, A. M., Beylot, A., & Ardente, F. (2021). The evolution of life cycle assessment in European policies over three decades. The International Journal of Life Cycle Assessment, 26, 2295-2314.

United Nations Environment Programme (2021). Food Waste Index Report 2021. Nairobi.https://www.unep.org/resources/report/unep-food-waste-index-report-2021 (accessed 03.07.2024).

vcg.ai (2024). Homepage. https://vcg.ai/ (accessed 11.07.2024).

Voglhuber-Slavinsky, A., Zicari, A., Smetana, S., Moller, B., Dönitz, E., Vranken, L., Zdravkovic, M., Aganovic, K. & Bahrs, E. (2022). Setting life cycle assessment (LCA) in a future-oriented context: the combination of qualitative scenarios and LCA in the agri-food sector. European Journal of Futures Research, 10(1), 15.

Wilting, H. C., Schipper, A. M., Ivanova, O., Ivanova, D., & Huijbregts, M. A. (2021). Subnational greenhouse gas and land‐based biodiversity footprints in the European Union. Journal of Industrial Ecology, 25(1), 79-94.

World Resources Institute (2020). SDG Target 12.3 on food loss and waste: 2020 progress report. https://food.ec.europa.eu/system/files/2021-04/fw_lib_wri-sdg-target_2020.pdf (accessed 26.06.2024).

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