



**Politecnico
di Torino**

Politecnico di Torino

Master's Degree Program in
ENGINEERING AND MANAGEMENT
A.a. 2025/2026
Graduation Session – July 2026

Forecasting Post-Consumer Textile Waste at EU National and NUTS2 Levels

Supervisor:
Prof. Andrea Tunì

Candidate:
Atefeh Golshan

Contents

Nomenclature	4
List of Tables	6
List of Figures.....	7
Abstract.....	8
1. Introduction.....	9
2. Background	12
2.1 <i>EU Textile Industry and Waste Generation Patterns</i>	12
2.2 <i>Definition and Classification of Post-Consumer Textile Waste</i>	13
2.3 <i>Reverse Supply Chains and Recovery Routes in the Textile Sector.....</i>	14
2.3.1 <i>Recovery Routes</i>	15
2.4 <i>Key Challenges in Textile Waste Management</i>	16
2.5 <i>EU Waste Legislation and the 2025 Separate Collection Requirements</i>	17
3. Literature Review	19
3.1 <i>Current Knowledge of Post-Consumer Textile Waste</i>	19
3.2 <i>Drivers of Waste Generation: Socio-Economic, Demographic, Consumption Factors</i>	20
3.2.1 <i>Economic Drivers.....</i>	21
3.2.2 <i>Demographic and Social Drivers</i>	22
3.2.3 <i>Psychological and Behavioral Drivers</i>	23
3.2.4 <i>Infrastructure-related Drivers.....</i>	24
3.3 <i>Insights and Strategies from Other Waste Streams</i>	24
3.4 <i>Forecasting Methods in Consumer Waste and Environmental Management</i>	26
3.4.1 <i>Traditional Time Series Models:.....</i>	27
3.4.2 <i>Regression-based Approaches:</i>	27
3.4.3 <i>System Dynamics:.....</i>	27
3.4.4 <i>Machine Learning</i>	28
3.4.5 <i>Hybrid Approaches for Policy and Scenario Planning.....</i>	28
3.5 <i>Data Gaps and Emerging Research Opportunities</i>	29
3.5.1 <i>Critical Data Gaps and Fragmentation</i>	29
3.5.2 <i>Emerging Research Opportunities:</i>	30
4 Methodology	32
4.1 <i>Justification for a Hybrid Forecasting Approach</i>	32
4.2 <i>Research Design and Overall Approach</i>	33
4.2.1 <i>Scope of Study and System Boundaries.....</i>	34
4.2.2 <i>Baseline and Temporal Scope</i>	36

4.2.3	Waste Definitions and Categories	36
4.3	<i>Data Sources</i>	36
4.4	<i>Data Cleaning and Handling</i>	38
4.5	<i>Material Flows and Construction of Apparent Consumption</i>	39
4.5.1	Reconciliation of Apparent Consumption for DPMFA Inflow	40
4.5.2	Selection of the Smoothing Parameter	41
4.5.3	Reconciliation' Residuals and Structural Consistency	42
4.6	<i>Dynamic Probabilistic Material Flow Analysis (D-PMFA) and Scenario Based Models</i>	43
4.6.1	Application of Lifetime Distributions to Estimate Discarded Textiles	43
4.6.2	Monte Carlo Simulation	44
4.6.3	Scenario Modeling	45
4.6.4	Downscaling the Results	47
5	Results and Validation.....	49
5.1	<i>Probabilistic Modeling and Monte Carlo Outputs</i>	49
5.1.1	Uncertainty Propagation in 2035 Forecasts	51
5.2	<i>Apparent Consumption: Macro-Level Baseline Validation</i>	54
5.3	<i>National Level Results and Disparities:</i>	55
5.4	<i>2035 National Forecasts and Policy Scenarios:</i>	59
5.5	<i>Regional Estimates</i>	68
5.6	<i>Separately Collected Textiles' Treatment Shares</i>	73
6	Discussion.....	75
6.1	<i>Theoretical Implications</i>	75
6.2	<i>Policy Implications and Strategic Recommendations</i>	75
7	Conclusions.....	78
7.1	<i>Synthesis of Key Findings</i>	78
7.2	<i>Limitations and Future Research Opportunities</i>	79
7.2.1	Data Availability and Statistical Uncertainty	79
7.2.2	Structural and Scope Limitation.....	80
	Appendix.....	82
	References.....	128

Nomenclature

Abbreviations and Acronyms	
AAW	Average Annual Wages
AI	Artificial Intelligence
ANN	Artificial Neural Networks
ARIMA	Autoregressive Integrated Moving Average
Bi-LSTM	Bidirectional Long-Short-Term Memory
CAGR	Compounded Annual Growth Rate
CAPEX	Capital Expenditure
CL	Country-Level
CN	Combined Nomenclature
COMEXT	Community External Trade Statistics
CP	Collection Point
CSI	Consumer Spending Index
DIWASS	Digital Waste Shipment System
DMFA	Dynamic Material Flow Analysis
DPMFA	Dynamic Probabilistic Material Flow Analysis
DPP	Digital Product Passport
EEA	European Environment Agency
EIB	European Investment Bank
EPR	Extended Producer Responsibility
ESPR	Ecodesign for Sustainable Product Regulation
EU	European Union
EURATEX	European Apparel and Textile Confederation
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GIS	Geographic Information Systems
GTOP	Game Theoretically Optimal
HS	Harmonized Commodity Description and Coding System
HTS	Hierarchical Time Series
IoT	Internet of Things
JRC	Joint Research Center
Kt	Kilotons
MFA	Material Flow Analysis
ML	Machine Learning
MLR	Multiple Linear Regression
MSW	Municipal Solid Waste
Mt	Million tons
NACE	Statistical Classification of Economic Activities in the European Community
NIR	Near-Infrared
NUTS 2	Nomenclature of Territorial Units for Statistics
OECD	Organization for Economic Co-operation and Development
OPEX	Operational Expenditure
OPH	One-Person Household
PCTW	Post-Consumer Textile Waste
PIC	Prior Informed Consent

PRO	Producer Responsibility Organization
PRODCOM	Production Communautaire
RF	Random Forest
RMSE	Root Mean Squared Error
SARIMA	Seasonal Autoregressive Integrated Moving Average
SD	System Dynamics
SES	Simple Exponential Smoothing
SSE	Sum of Squared Errors
SVM	Support Vector Machines
TEA	Techno-Economic Assessment
WCO	World Customs Organization
WEEE	Waste Electrical and Electronic Equipment
WFD	Waste Framework Directive
WSR	Waste Shipment Regulation
XGBoost	Extreme Gradient Boosting
Symbols and Indices	
t	Time Index (years)
Δt	Number of years after the baseline or anchor year
x_t	Raw apparent consumption
s_t	Reconciled inflow to the in-use stock
α	Simple exponential smoothing parameter
α^*	Optimal Global smoothing parameter
$\hat{x}_{t t-1}$	One-Step-Ahead reconciled value for period t based on data up to t-1
$e_t(\alpha)$	One-Step-Ahead smoothing error for a give alpha
<i>i</i>	Index representing a specific country-product time series
N	Total number of country-product time series
T_i	Total time length
M	Total number of one-step-ahead errors across all evaluated series
Arg min	Argument of the minimum (the parameter that minimizes the target function)
$r_t, r_{i,t}$	Reconciliation residuals (difference between inflow and raw consumption)
R	Cumulative adjustments (total structural deviation)
D_{rel}	Relative Deviation
g	Index representing a specific NUTS 2 geographical region
j	Summation index running over all NUTS 2 regions within a specific country
n	Index representing a specific member state at the national level
$Weight_g$	Unnormalized consumption intensity weighting factor for region g
$Population_g$	Total population of NUTS 2 region g
$Disposable Income_g$	Household disposable income of NUTS 2 region g
$Regional Share_g$	Normalized regional allocation share for region g
$REgional Waste_g$	Downscaled PCTW generation for NUTS 2 region g
$Nationa Waste_n$	Total aggregate PCTW generation for the respective Member State n

List of Tables

Table 1: Comparison of forecasting methods, weaknesses and Strength	28
Table 2: Summary of Research Opportunities Related to Each Challenge.....	31
Table 3: Summary of Forecasting Methods.....	33
Table 4: EU Member States; Separate Collection Rates for 2020 (EEA, 2024).....	62
Table 5: Top Generating NUTS2 Regions in 2035 (2024 Anchor Year)	70
Table 6: List of Finished Textile Products Considered in the Calculations, from PRODCOM LIST 2024; Conversion Factors to Kg, source (Napolano, 2025), and Life Expectancy of Finished Textile Products, sources: sources (Laitala K. K., 2018) and the (International Fair Claims Guide, 2015).....	82
Table 7: Codes not considered in the study compared to (Napolano, 2025), sources (EUROSTAT, 2026) (UK Office for National Statistics (ONS), 2026).....	88
Table 8: Selection of the Global Alpha for EU countries, Sensitivity Check, Cumulative Deviation Percentage	91
Table 9: Country-level Results of Reconciliation Procedure.....	92
Table 10: Selection of the Alpha for the EU-27 aggregate.....	92
Table 11: 2019 baseline Monte Carlo results	93
Table 12: 2035 Monte Carlo results considering two different anchor years (Mt).....	94
Table 13: CL Scenario 2020 anchor (Mt).....	95
Table 14: CL Scenario 2024 anchor (Mt).....	95
Table 15: EU scenario 2020 anchor (Mt)	96
Table 16: EU Scenario 2024 anchor (Mt).....	97
Table 17: NUTS2 Regions Population, Disposable Income, Regional Weight and Share	98
Table 18: NUTS2 Downscaling of Scenario CL	104
Table 19: NUTS2 Downscaling of Scenario EU	112
Table 20: Treatment Pathways Allocation to Separately Collected Textiles at National Level (Mt)	119
Table 21: Treatment Pathways Allocation to Separately Collected Textiles at NUTS2 Level (Mt)	120

List of Figures

Figure 1: Framework for regional-level PCTW forecasting and systemic drivers within the EU	10
Figure 2: Textile Value Chain	12
Figure 3: Recovery Routes Value Hierarchy	15
Figure 4: Main Drivers of Waste Generation	20
Figure 5: Methodological Steps of the Model	32
Figure 6: System Boundaries.....	34
Figure 7: Intermediate Products Exclusion.....	35
Figure 8: Representation of textile flows within EU system boundaries	40
Figure 9: Cohort-Based Structure	44
Figure 10: (a) Probability Distribution and (b) Uncertainty Distribution of EU-27 PCTW generated for 2019, 10,000 Monte Carlo iterations	50
Figure 11: Uncertainty Distribution of PCTW generation across EU member states in 2019, reflecting lifespan uncertainties.....	51
Figure 12: Monte Carlo Results for 2035 Projections (a) under 2020 anchor year (b) under 2024 anchor year	52
Figure 13: Uncertainty Distribution of Member States under (a) 2020 anchor year (b) 2024 anchor year	53
Figure 14: Comparison of Baseline Year (2019) Results with Napolano Study.....	55
Figure 15: PCTW volumes for individual EU countries for the baseline year of 2019	56
Figure 16: 2019 PCTW per person for individual EU Countries	57
Figure 17: Geographical Mapping of PCTW Generation.....	58
Figure 18: Country-level PCTW estimates for 2035 based on two different anchor years	60
Figure 19: Comparison of 2035 Results with Napolano Study.....	61
Figure 20: Results of CL scenario application (anchor year 2020)	64
Figure 21: Results of EU scenario application (anchor year 2020)	65
Figure 22: Results of CL scenario application (anchor year 2024)	66
Figure 23: Results of EU scenario application (anchor year 2024)	67
Figure 24: Comparison of Results between the CL and EU Scenarios (a) 2020 anchor year, (b) 2024 anchor year...	68
Figure 25: 2035 Regional PCTW generation (2024 Anchor Year)	69
Figure 26: Top 15 NUTS2 Regions in waste collection under CL scenario (2024 anchor)	71
Figure 27: Top 15 NUTS2 Regions in waste collection under EU scenario (2024 anchor year)	72
Figure 28: Comparison of Treatment Shares Under (a) CL 50% and (b) EU 50% Collection Scenario	74

Abstract

The transition toward a circular economy has prioritized the management of post-consumer textile waste (PCTW) within the European Union. However, fragmented data and inconsistent collection frameworks limit effective policy implementation, particularly ahead of the 2025 separate collection mandate under the Waste Framework Directive (WFD). This study aims to estimate PCTW generation and collection requirements across the EU-27 at both national and NUTS2 regional levels up to the year 2035.

To address the inherent uncertainties in waste flow forecasting, a six-step hybrid framework was developed. The methodology integrates macroeconomic statistics (PRODCOM and COMEXT) for 194 finished textile products and employs apparent consumption reconciliation alongside Dynamic Probabilistic Material Flow Analysis (DPMFA). Monte Carlo simulations (10,000 iterations) were utilized to account for product lifetime variabilities, and a spatial downscaling approach using household disposable income and population was applied to map national aggregates to regional resolutions.

The model establishes an EU-27 baseline generation of 9.93 Mt of PCTW for the reference year 2019. Projecting forward under a 3% compound annual growth rate (CAGR), while accounting for recent macroeconomic shocks, total PCTW generation is forecasted to surge to between 12.89 Mt and 14.1 Mt by 2035 depending on the selected anchor year. The spatial analysis demonstrates severe geographical polarization; nearly 60% of all waste is generated by Germany, France, Italy and Spain. At the NUTS2 level, specific metropolitan hotspots, prominently Île-de-France (FR10) and Lombardy (ITC4), overwhelmingly dominate generation and future collection burdens.

Scenario modeling highlights a critical policy divergence: incremental, country-level (CL) collection improvements fail structurally, leaving approximately 10 Mt of generated textile waste not separately collected in 2035. Conversely, harmonized EU-wide absolute targets successfully capture the 6.45 Mt textile waste necessary to sustain circularity. However, the allocation of these captured volumes exposes a profound downstream capacity shock, sending 2.9 Mt to reuse and 2.06 Mt toward recycling which highlights a critical recycling technological deficit. Ultimately, this research provides a geographically explicit forecasting baseline to support evidence-based infrastructure development and circular textile policy across European regions.

1. Introduction

The increasing volume of post-consumer textile waste (PCTW) has become a critical challenge for environmental policy, resource efficiency and waste management planning in the European Union (EU) (EEA, 2019). Higher levels of consumption, rapid product turnover and changing market dynamics have intensified pressure on the existing waste management systems, revealing a long-standing structural weakness in how textile waste is currently estimated, monitored and ultimately managed (European Commission, 2022). As textiles gain priority within the EU's circular economy agenda, the need for reliable and forward-looking assessments of PCTW generation has become increasingly urgent (Köhler, 2021).

In contrast to more established waste streams, PCTW is still characterized by substantial uncertainty regarding its overall scale, material composition and regional distribution. This uncertainty limits the ability of policymakers and planners to design effective collection, sorting and recycling systems, particularly considering the upcoming regulatory changes, as the EU Waste Framework Directive (WFD) mandates that “by 1 January 2025, Member States shall set up separate collection for textiles” (Directive (EU) 2018/851, 2024). The introduction of mandatory separate collection of textile waste from 2025 represents a significant shift in the governance of textile waste that will significantly increase the amount of collected used textiles and textile waste (EEA, 2024). While this measure is expected to change both the quality and quantity of textiles entering recovery pathways, its regional consequences remain insufficiently understood.

Effective implementation of waste management policy depends not only on regulatory ambition but also on the availability of reliable estimations of future waste flows. When forecasting is weak or incomplete, there is a risk of infrastructure systems being either underdeveloped and unable to cope with the increased collection volumes or improved in ways that lead to inefficient use of resources beyond actual needs. For textiles this risk is amplified by the sector's inherent heterogeneity, the diversity of consumption behaviors across regions and complex interaction between drivers and waste generation outcomes. Consequently, it is considered that aggregate or national-level estimates alone are insufficient to support evidence-based decision making.

Forecasting PCTW presents distinct methodological challenges as textile waste generation is not simply a function of historical disposal patterns, but a reflection of broader socio-economic, demographic and consumption dynamics that vary across regions and over time. In addition, structural policy interventions such as compulsory separate collection introduce discontinuities in the historical trends that cannot be captured through simple trend extrapolation. As a result, forecasting approaches must be capable of integrating multiple drivers while remaining robust under conditions of incomplete and fragmented data.

Existing research has mostly focused on understanding textile waste management practices, recovery routes and policy instruments (such as Extended Producer Responsibility (EPR), the EU Strategy for Sustainable and Circular Textiles, Ecodesign requirements and Landfill restrictions). However, fewer studies have considered developing forecasting methods that are geographically explicit and integrate regulatory changes. Where quantitative models have been applied, they often rely on limited datasets or focus on national aggregates, which limit their use for regional planning. This gap is particularly important in the EU where waste management responsibilities and infrastructural capacities vary considerably across regions.

Addressing these limitations requires methodological approaches that move beyond single datasets and purely descriptive analysis. Instead, there is a need for integrative frameworks that combine available

statistical data with socio-economic indicators and policy assumptions to generate plausible and policy relevant projections. Such frameworks are especially valuable in contexts where data limitations constrain the application of highly data-intensive models, yet decision makers still require forward-looking estimates to guide investment and regulatory design (Figure 1).

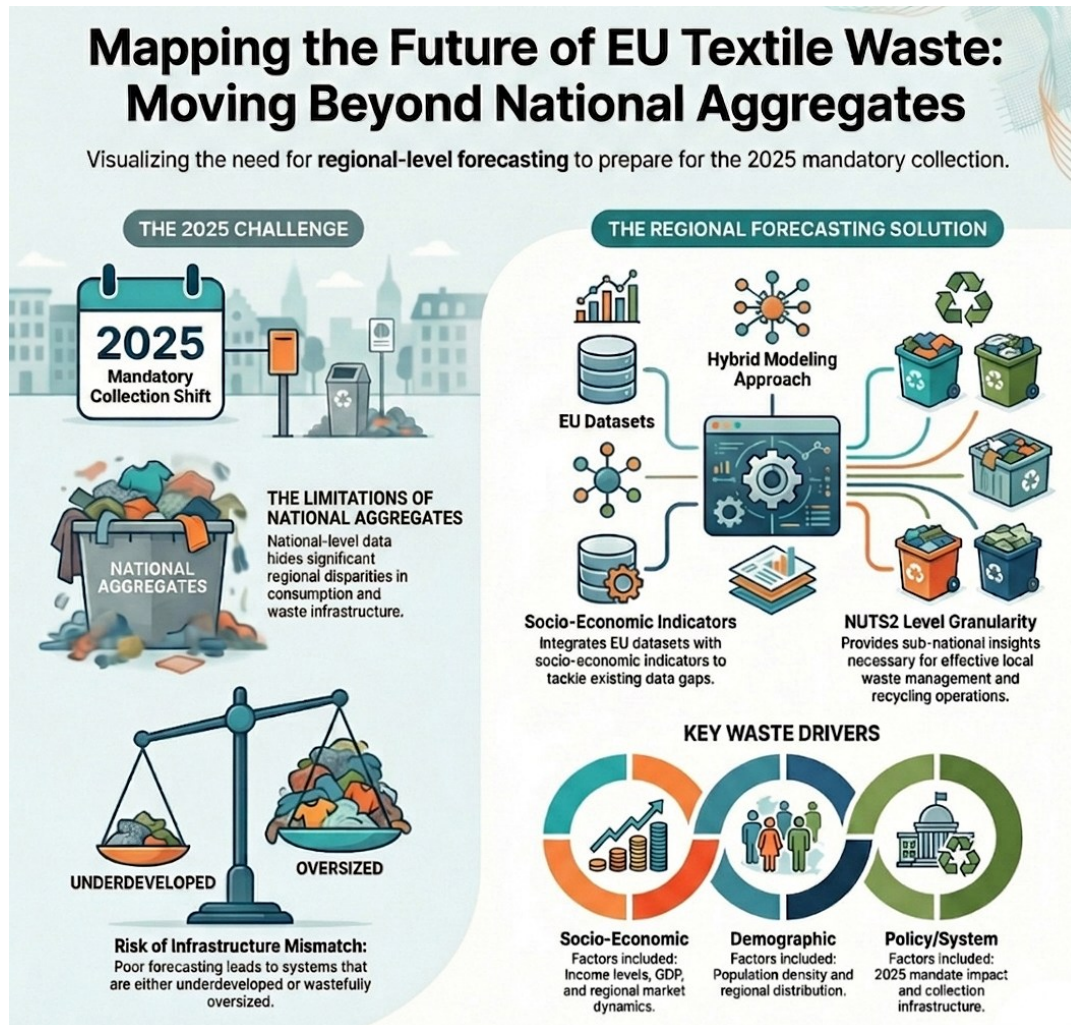


Figure 1: Framework for regional-level PCTW forecasting and systemic drivers within the EU

Considering this, the objective of this study is to estimate PCTW generation at EU NUTS2 regions to capture regional differences in waste generation patterns and provide insights that are directly applicable to sub-national planning. By integrating different drivers into a hybrid forecasting model, the research aims to assess both current waste generation levels and future developments under 2025 separate collection mandate.

While national aggregates provide a general overview, they usually hide substantial disparities within countries, including variations in consumption and waste infrastructure. By focusing on the NUTS2 level, this study connects EU-level data with the regional reality of waste management operations.

The central **research question** guiding this research is:

To what extent can forward-looking material flow models estimate the quantities and regional distribution of post-consumer textile waste (PCTW) across EU NUTS2 regions under the 2025 separate collection mandate?

To address this question, the study examines current regional waste generation patterns, evaluates the role of key drivers and assesses the performance of the proposed modeling framework in reproducing historical trends. Special emphasis is placed on understanding how regulatory changes may influence the availability and characteristics of textile waste entering recovery systems as well as identifying the main sources of uncertainty affecting the forecasted outcomes.

Methodologically, the study adopts a hybrid approach that combines available EU datasets with insights from academic and grey literature to address data limitations. Rather than aiming for precise prediction, the focus is placed on producing robust and transparent estimates that can inform strategic planning and policy evaluation. This approach allows for explicit consideration of uncertainty and structural change, which are central features of the textile waste system under study.

The primary contribution of this study lies in the provision of a regionally differentiated assessment of PCTW flows under the evolving policy conditions. The findings are intended to support policy makers and other stakeholders in anticipating the implications of regulatory change and in designing more resilient and effective waste management systems by linking socio-economic and consumption drivers to waste generation outcomes within the forecasting framework. The research offers methodological insights that can also be used in other complex and data constrained waste streams.

2. Background

2.1 EU Textile Industry and Waste Generation Patterns

The European textile and clothing industry is one of the most resource-intensive value chains within the EU market (EEA, 2026). The sector features vertically complex supply chains, with multiple tiers involved before a simple piece reaches consumers, starting from raw material sourcing - including both natural fiber cultivation and oil-based synthetic fiber production- all the way to manufacturing to trade and retail (European Commission, 2022). The value chain also extends into consumption and end-of-life management (Köhler, 2021) (Figure 2).

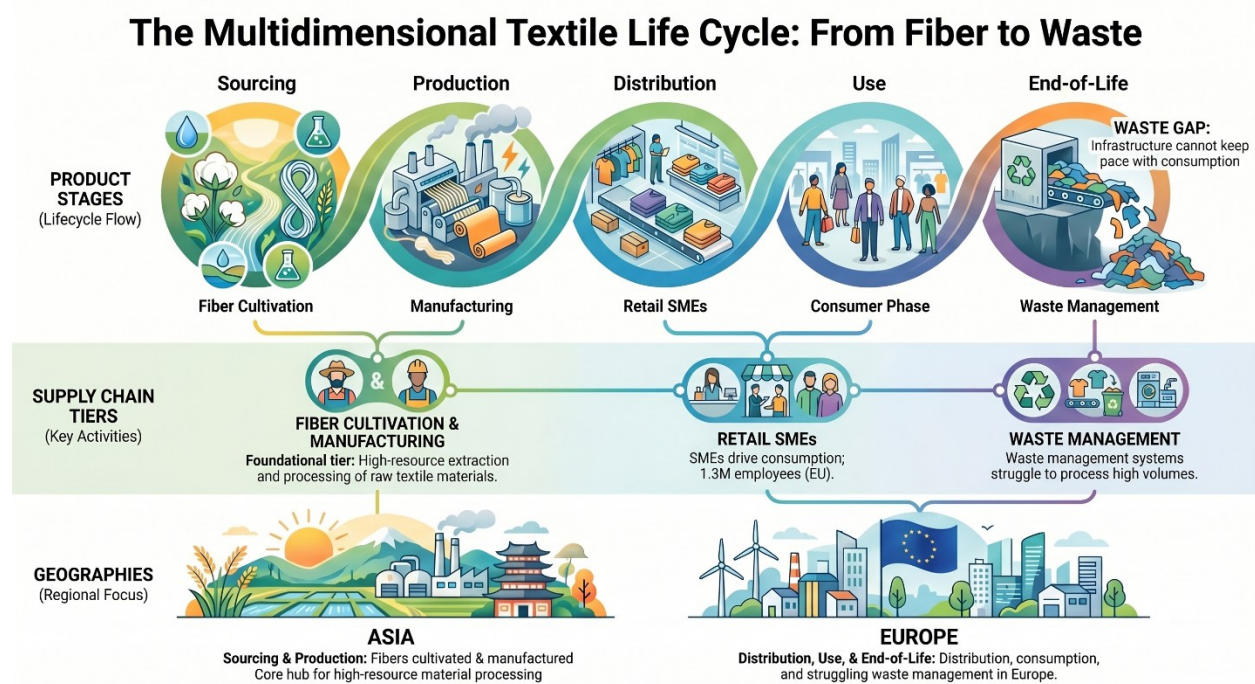


Figure 2: Textile Value Chain

Considering an economic perspective, this sector is one of the most significant contributors to the EU market. The European Apparel and Textile Confederation (EURATEX) reported an annual turnover of about 170€ billion in 2023 and employment of 1.3 million people (EURATEX, 2024). One of the main characteristics of this sector is the large number of small and medium-sized enterprises, especially in countries with strong established fashion operations such as Italy, France, Spain, and Portugal (EURATEX, 2024). These firms have a key role in design and production of textile products.

Despite its economic significance, the environmental impacts of the textile industry are substantial. The European Environment Agency (EEA) (2025) ranks textiles among twelve household consumption categories, as the fifth highest sector in raw material usage, GHG emissions, and water and land use in 2022. Textile production processes are energy-intensive and require large amounts of water and rely on chemical treatments during various stages, all of which contribute to pollution and environmental degradation (Šajin, 2022).

This industry has increasingly changed over the recent decades and outsourced much of the production processes beyond EU's borders, mainly in manufacturing centers in Asia and South Asia, such as China, Bangladesh, Turkey, Vietnam and India (European Parliament, 2020). As these regions provide cheaper labor, major brands often move their operations there. However, though this relocation has reduced the direct environmental impacts of production processes within the EU, it has increased dependence on imports and further separated production and consumption geographies. At the same time, the EU has seen growing domestic consumption due to globalization, lifestyle changes, online shopping, and especially the rise of fast fashion business models. As a result, high volumes of textile products enter the EU market each year, leading to higher level of textile waste generation within Europe (EEA, 2025). Additionally, despite the growing public and political attention towards Circular Economy in recent years, improvements in the infrastructure have not been able to keep pace with increasing textile consumption patterns, which has resulted in a significant share of the textiles leaving the value chain right after use across the EU.

Overall, the EU textile industry is facing a contrasting situation. While it offers solid economic prospects, cultural influence, and employment opportunities, there are significant environmental impacts that need to be addressed. Therefore, broader improvements and stronger mechanisms across the whole value chain are required to implement effective policies and interventions that support innovation and ultimately reduce the sector's environmental footprint while maintaining the economic situation.

2.2 Definition and Classification of Post-Consumer Textile Waste

A key challenge in understanding and quantifying Post-Consumer Textile Waste (PCTW) in Europe is the lack of a fully harmonized definition and classification framework across Member States. In practice, Member States use different definitions, reporting, and sorting processes that limit comparability among studies and countries. EEA (2024) notes that the lack of harmonization limits the effectiveness of policy measures, especially at a time the EU is preparing to introduce Extended Producer Responsibility (EPR) schemes for textiles. Therefore, policymakers and analysts are willing to use simplified yet functional categories that can capture key physical and functional characteristics while maintaining consistency with existing available data.

Generally, PCTW refers to textile products that have served their intended purpose and are no longer useful or desired by consumers or other end users, (Fashion Sustainability, 2025). This includes clothing, footwear, household textiles and other textile products that households as well as commercial, industrial and institutional end users discard because they are worn out, damaged, out of style or simply not wanted (OKON Recycling, 2025; Global Standard, 2025). The term “post-consumer” indicates that these textile products have been sold, used and discarded after entering the market, distinguishing them from “pre-consumer” textile waste which is generated much earlier in the supply chain through production cutoffs, defective items, or unsold inventory generated during manufacturing and distribution (Fashion Sustainability, 2025). This distinction is critical since the latter reflects production efficiency and industrial processes while PCTW is mainly influenced by consumption behavior, product lifetimes, and disposal practices.

Defining PCTW precisely is not always easy and straightforward. Even though there is a distinct category of waste for textiles in Eurostat, the actual amount of textile waste is unknown since even though the separate collection is mandatory in more than half of Member States, it is mostly to capture reusable textiles and only a fraction is collected separately, and the rest end up in mixed municipal waste (EEA, 2024). So, most textile waste is aggregated under broader categories. This approach makes national reporting easier

but hides some important differences between different textile types. However, researchers, policymakers and waste management bodies could use other classification systems, depending on the main purpose they pursue.

A common approach is classifying textile products by categories and subcategories, such as clothing, footwear, and home textiles, which is widely used in policy-oriented reporting and helps to reflect differences in use patterns, lifetimes and recovery potential (EEA, 2022). The second one is classification by material composition, breaking them into three main groups, natural fibers (cotton, wool, silk and linen), synthetic or man-made fibers (polyester, nylon, and acrylic) and blended materials that combine both (European Commission, 2021; Kim, 2025). As fiber type can affect the product lifespan, recyclability, and environmental impact, knowing each group's characteristics is important for collection, sorting, and recycling purposes.

Ultimately, establishing a clear and consistent definition of PCTW is crucial. It would not only improve data collection but also is fundamental for monitoring, forecasting, and the development of circular policies and clarifying responsibilities under the EU's waste management hierarchy. It could be said that a harmonized classification framework lays the groundwork for designing effective and useful recovery systems, promoting recycling technologies, and helping Europe transition toward a sustainable and circular economy.

2.3 Reverse Supply Chains and Recovery Routes in the Textile Sector

The Reverse Supply Chain is defined as the process of planning, implementing, and controlling the efficient, cost-effective flow of raw materials, in-process inventory, finished goods, and related information from the point of consumption to the point of origin for the purpose of recapturing value or proper disposal (Dale S. Rogers, 1998). In recent years, reverse supply chains have emerged as the key point of how to move toward a circular economy. Instead of following the traditional textile supply chain, which is typically linear - fibers are produced, processed into fabrics, manufactured into garments, sold to consumers, used for a period, and eventually thrown away - the aim here is to re-enter them into the value chain through reverse flows. This is essential, particularly because it extends the functional life of products and reduces the environmental impacts of producing new products or materials.

Considering textiles, reverse supply chains usually start with collection systems, which may include bring-banks or drop-off containers, donations, secondhand shops, local recycling centers, and retailer take-back schemes. The overall performance of the collection systems is affected by different factors, such as accessibility, convenience, and consumer awareness, which can subsequently influence the quantity and quality of the textiles entering the recovery routes (European Commission, 2022).

After collection, textiles are transported to sorting facilities and are separated based on wear level, material composition, color, and potential recovery value. Sorting is a critical step as it determines which items are suitable for reuse and recycling. Manual sorting is still widely used in Europe, despite being labor-intensive, time-consuming, and often fails at spotting blended fibers. Newer technologies, such as Product's Digital Passport, Fiber Tracking, Near-Infrared (NIR) spectroscopy, and AI-based identification tools, enable more precise identification of fiber types and material compositions. They are more important to address textile recycling challenges, especially at a time when the market is moving towards using mixed materials for making complex and modern textiles (Lanz, 2024).

2.3.1 Recovery Routes

As demonstrated in Figure 3, different recovery routes are associated with different levels of value.

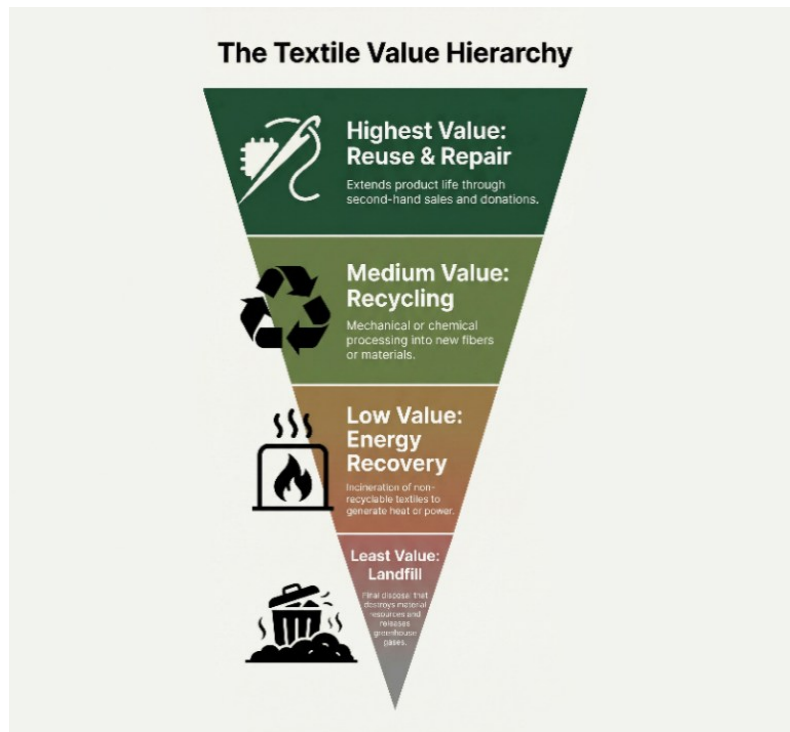


Figure 3: Recovery Routes Value Hierarchy

Reuse and repair are considered the most environmentally and socio-economically beneficial ways, especially reuse through second-hand sales, charity donations, or exports, which preserves the most value, reduces carbon emissions, water consumption, and resource extraction for new productions. However, it should be noted that the export of used clothes to some receiving countries that do not have suitable infrastructure to manage low-quality imports could lead to waste accumulation abroad (EEA, 2023).

The second recovery route is recycling, which uses either mechanical or chemical methods. Natural fibers could be composted or mechanically recycled, but it should be considered that repeated processing worsens their quality as it involves cutting, shredding, or pulling fabrics to make reusable fibers to re-spun into yarns or use in non-woven products, so though this approach keeps the chemical structure of the fiber, repeated processing weakens the performance (Ellen MacArthur Foundation, 2017).

As for synthetic fibers recycling, theoretically, polyesters can be chemically upcycled. In chemical recycling, polymers break down into their basic chemical components through depolymerization or dissolution, which enables making new fibers that are of the same quality as virgin materials. However, the infrastructure for chemical recycling at a large scale is still in early stages in Europe due to its cost (T-REX Project, 2025). Blended materials which are frequently used in fast fashion are the hardest to recycle since separating natural and man-made fibers requires advanced and often expensive technologies, for this reason they usually end up being downcycled or incinerated for energy recovery (Kim, 2025; Lanz, 2024; Enking, 2025; Seifali Abbas-Abadi M. B., 2025) .

Textiles not suitable for recycling usually are diverted to energy recovery by incineration or are landfilled. Although energy recovery can extract some value, it is still considered a low-ranked option as it releases greenhouse gases and destroys material resources (European Commission, 2022). Under the EU's waste directives, Member States are actively working to reduce landfill disposal, and an increasing number of Member States have introduced landfill bans for recyclable, combustible, or untreated waste (DIRECTIVE (EU) 2018/850, 2018).

It is crucial to improve these reverse supply chain and recovery systems while aligning with EU green targets, to achieve a closed-loop textile economy and create a more sustainable future for the sector.

2.4 Key Challenges in Textile Waste Management

Management of textile waste in Europe is not without difficulty; there are several structural, technical, and policy-related challenges across the entire value chain that limit the effectiveness of waste management systems. These challenges are not just single isolated issues but the result of the interaction between high consumption volumes, complex material composition, and uneven institutional capacity across Member States.

One of the major challenges is the uneven availability and coverage of sufficient separate collection systems across the EU, which is another problem. Despite the mandatory separate collection policy, required by the Waste Framework Directive, the amount of separately collected textiles indicates that these systems are unevenly developed across Member States. There are also significant differences in collection models, accessibility, and public participation among different countries which has resulted in the disposal of a significant share of textiles into mixed municipal waste, where recovery is no longer possible. (EEA, 2024; European Commission, 2025).

Another challenge concerns the downstream capacity limitations; existing sorting and recycling infrastructures are limited, and considering the complexity of textile flows, many of them usually fail to match the volume of the collected textiles. Current recycling capacity is insufficient to manage the projected textile waste flows and material composition makes this situation even more complicated, as they cannot easily identify blended fibers, dyes, coatings, finishes, and other non-textile components of clothing, which reduce recyclability. This situation results in low-quality recycling and lower-value recovery. (Loo, 2023; Seifali Abbas-Abadi M., 2025).

Beyond technical issues, economic factors further limit the development of advanced recycling. While mechanical recycling usually produces lower market value, chemical recycling technologies are capital-intensive and not widely used. As a result, other treatment options, such as landfill and incineration, remain economically viable, reducing incentives for investments in recycling infrastructures and slowing the progress of circular economy.

Another structural challenge is the international trade of used textiles. A significant share of the collected textiles is traded internationally due to limitations of domestic reuse and recycling (EEA, 2023). The fate of low-quality textiles being exported to other countries that do not have sufficient capacity introduces uncertainty, which could result in burden shifting beyond EU borders (EEA, 2023).

Finally, inconsistencies in definitions, data collection methods, and reporting frameworks represent another important challenge that largely affects the effectiveness of textile waste management in Europe. As Member States use various definitions for “used textiles”, “textile waste”, and “reusable textiles”,

assessment of system performance and comparability is limited, making it difficult to set realistic targets, let alone design Extended Producer Responsibility (EPR) schemes. (EEA, 2024; ETC-CE, 2024).

Addressing these systematic challenges is essential for effective implementation of separate collection regulation and transition towards a circular textile economy.

2.5 EU Waste Legislation and the 2025 Separate Collection Requirements

One of the main goals of the European Union is to move from the traditional linear model to a circular economy, and this is the primary reason the EU's waste policy has seen some significant changes in recent years. Due to the environmental and economic importance of textile waste streams, they are considered a priority, resulting in the definition of several legislative instruments to provide a legal pathway for improving textile waste management.

The original Waste Framework Directive (Directive 2008/98/EC, 2008) established the foundational legal framework and core principles for waste management in the EU, such as the five-step waste hierarchy, but it lacked specific mandates for certain high-impact waste streams. To address these gaps, the revised Waste Framework Directive (WFD) introduced a series of new criteria to improve waste management across the EU Member States. This revision addresses textiles for the first time, and according to Article 11(1), to prevent textile waste from entering mixed municipal waste, EU Member States must establish textile separate collection by January 1, 2025, (Directive (EU) 2018/851, 2024).

The main purpose of this mandate is to divert textiles from mixed waste streams, increase reuse and provide a suitable input stream for recycling through high-quality sorting (European Commission, 2022). Mixed waste streams generally limit circularity due to contamination, resulting in more incineration or landfill instead of reusing or recycling (EEA, 2019). However, as there are many countries that still do not have the necessary infrastructures for collection, sorting, and recycling, the Member States' preparedness for meeting the 2025 obligations varies considerably.

In addition to the WFD, the EU Strategy for Sustainable and Circular Textiles states that textiles must be "long-lived, repairable, recyclable, and largely made of recycled fibers" and to achieve this, stronger EPR systems are needed (European Commission, 2022). To realize the vision, the strategy is built upon several core pillars: introducing strict Ecodesign requirements to ensure durability, implementing a Digital Product Passport for full supply chain traceability, taking action to tackle microplastic pollutions, and establishing stricter controls against greenwashing. Crucially, to achieve these systemic changes and handle the end-of-life phase, stronger Extended Producer Responsibility (EPR) systems are needed. For this reason, the European Commission openly supports harmonized EPR schemes for textiles across EU Member States, as they are expected to become the key mechanism to make producers financially responsible for post-consumer textile waste management. Several Member States such as France and the Netherlands have already started preparing EPRs, while others are still at early stages (ETC-CE, 2024) .

As detailed by the European Commission (2025) regarding the newest official update of the WFD, which entered into force on October 16, 2025, mandatory EPR schemes for textile and footwear products were introduced under common implementation rules. Under this framework, producers will be asked to pay fees for each product they place on the EU market to finance collection and management of the collected textiles. An eco-modulation approach is carried out to adjust these fees to reflect sustainable criteria such as durability and recyclability. In this way, producers pay based on the sustainability of their products and are encouraged to use more circular designs and make more environmentally friendly products. This revision

also mandates that all separately collected textiles must be legally considered as waste before reuse or export to reduce mislabeling, prevent illegal waste shipments, and to ensure that the sorting operations meet the minimum quality and traceability standards. Because countries establishing EPRs could create unequal market conditions and make cross-border textile circulation challenging, transparent reporting rules, harmonized eco-modulation principles, and consistent financial procedures are required across Member States (European Commission , 2025).

To successfully implement these obligations, Member States will need to expand their logistics systems, make more investments in infrastructures, and even improve cross-border cooperation. This also requires improved data collection and digital tracking systems, which are essential for estimating waste generation and scaling the infrastructures. Finally, consumer behavior and market readiness also have influence on whether the separate collection policy is a success or not. To shift consumers towards separate collection of textiles, public awareness campaigns, convenient collection points, and incentives for returning used textiles are crucial. Downstream systems are also important, as higher collection rates will not be of much help if there are no end markets for products made from recycled textile materials (EEA, 2023).

3. Literature Review

3.1 *Current Knowledge of Post-Consumer Textile Waste*

Literature on post-consumer textile waste in Europe has expanded significantly over the past years, especially from 2021, reflecting the growing policy attention and prioritization of textiles waste streams within the circular economy. While early research mainly addressed the environmental impacts of textile production, more recent studies have shifted the focus to end-of-life waste flows, such as collection systems, reuse, recycling strategies, and sustainable waste management (Shamsuzzaman, 2025).

In 2022, approximately 92 million tons of fashion-related and textile waste were generated globally, and the figure is expected to rise to 150 million tons by 2050 (Shamsuzzaman, 2025). However, despite the growing attention, the majority of these textiles are discarded into mixed municipal waste streams. According to Shamsuzzaman (2025), reported estimates indicate only 15% of this volume is collected, 5-10% is reused or recycled, while the remainder is either landfilled (57%) or incinerated (25%). Even in countries with established waste management systems, textiles usually remain a “hidden” fraction within residual waste streams, making it difficult to recover them (Shamsuzzaman, 2025).

The literature also indicates that while separate collection is widely recognized as a necessary condition for circularity, it is not enough for recovery improvement alone, especially where sorting capacity and end markets are underdeveloped. A comparative analysis of Flanders and the Netherlands in 2018 shows this gap, even though separate collection rates have increased to 58% and 44%, local reuse remained low with only 4% in Flanders and 2% in the Netherlands. At the same time the share of incinerated PCTW was 52% in Flanders and 62% in the Netherlands. These figures support the fact that higher separate collection rates do not necessarily yield higher reuse rates without improved downstream capacity (Vermeyen, 2024).

Across studies, the transition of the textile industry towards a circular economy faces several barriers, particularly in the management and reduction of post-consumer textile waste. Key challenges are lack of effective collection systems, limited consumer participation, and technological difficulties in processing complex materials. Economic viability of textile recycling is another issue, which has resulted in reliance on lower-value routes for waste. These obstacles are reinforced by the gaps between theoretical frameworks and practical implementation of strategies, causing the industry to be far from achieving full application of circular-economy practices (Abdelmeguid, 2024).

The textile and apparel industry is widely recognized as one of the world’s most polluting sectors, particularly due to the immense amount of energy and water used in fabric production, alongside the generation of hazardous waste. Wastewater from wet processing contains harmful chemical substances that, if not managed properly, can lead to serious ecological damage through water pollution, waste gases emissions, and fabric contamination. Once these contaminated fabrics are discarded by end-users, they become post-consumer textile waste (PCTW), carrying these environmental impacts into the disposal phase. The landfilled portion of textile waste that contains synthetic fibers could persist for decades or even centuries, causing further environmental degradation. Therefore, the industry still faces major challenges in reducing its environmental footprint due to low recycling rates and the absence of effective tracking systems for post-consumer textiles (Jia, 2020).

According to recent United Nations (2024) data, the total volume of globally traded discarded has increased almost sevenfold over the past three decades. The data indicates that the European Union was the world’s

leading exporter of second-hand textiles in 2021, accounting for 30% of the global figures, followed by China (16%) and the United States (15%). Furthermore, while approximately 55% of the collected textiles are considered reusable, only 5% of this fraction is actually sold on domestic EU markets (EEA, 2023). The remainder is exported primarily to developing countries in Africa and Asia. In 2021 alone, the EU's exports of second-hand clothes exceeded 1.8 million tons and 75% of this volume originating from five major hubs: Belgium, Germany, Italy, the Netherlands and Poland (EEA, 2023). These figures demonstrate the significance of the EU's central role in the global second-hand textile market but also underscore the challenges of ensuring the fate of exported textiles (United Nations, 2024).

This reliance on exports as a disposal valve underscores the urgent need for internal capacity planning. Forecasting is not merely a statistical exercise but a precondition for developing the domestic sorting and recycling infrastructure required to manage these volumes within the EU's borders.

3.2 Drivers of Waste Generation: Socio-Economic, Demographic, Consumption Factors

Understanding post-consumer textile waste generation requires an upstream perspective that considers more than just end-of-life choices and assesses the broader conditions that influence consumption. Literature increasingly conceptualizes waste generation not just as a byproduct of individual behaviors but as the result of interactions between a mix of social, economic, demographic, industrial, and consumption-related factors that affect both the quantity and quality of the discarded textiles (Richard Gardiner, Petr Hajek, 2020). These factors could have both direct and indirect influences on PCTW generation, affecting consumption and the amount of waste or by mediating disposal decisions and end-of-life fate. Four main groups of factors are discussed as follows (Figure 4):



Figure 4: Main Drivers of Waste Generation

3.2.1 Economic Drivers

Economic factors are consistently identified as the most influential drivers of waste generation, and this relationship is generally positive.

Gross Domestic Product (GDP): Economic growth is usually measured by GDP and is associated with higher production, consumption, and higher overall material throughput (Richard Gardiner, Petr Hajek, 2020). In the European Union, economic growth is the main reason for the increase in solid waste production, as studies illustrate that a 1% increase in economic activity can raise waste generation by approximately 0.067% (Yasmeen, 2023). High income countries usually generate more waste per capita compared to low-income ones (Zheng Xuan Hoy, 2024) ,however, recent studies in the European Union suggest that this relationship is not necessarily linear, and in some advanced countries, despite GDP growth, waste generation is more stable or even declining, which indicates a partial decoupling effect resulting from efficiency improvements. (Konstantinos-Georgios Namlis, 2019)

Income and Wages: While GDP reflects the overall economic development of a country, household disposable income and average annual wages (AAW) are considered more direct drivers of waste generation, because they determine the immediate purchasing power of individuals and higher purchasing power encourages people to acquire and replace goods more often (Smailbegovic, 2025). It must be mentioned that even though higher income leads to more consumption, specific indices like the Consumer Spending Index (CSI) suggest that higher spending power sometimes correlates with the purchase of higher-quality and durable goods that last longer (Sharmin Jahan Mim, 2025).

Tourism: Tourism has a complex and dual influence on waste generation, acting as both a significant reason and a catalyst for improved management. There is a general positive correlation between tourist activity and waste production; specific studies in Mallorca indicated that a 1% increase in tourist arrivals correlated with a 1.25% increase in MSW, while in Menorca, the tourism sector is responsible for 24% of total plastic trash (Afsana Akther, 2025; Rakesh Kumar, 2021). This is largely driven by the hospitality industry's reliance on disposable items and high turnover rates, as well as the generation of specific "hospitality textiles" such as uniforms, bed linens, and towels (Napolano, 2025; Biyada, 2025). On the other hand, recent analysis across 33 EU nations have also observed a negative correlation, suggesting that tourist-intensive regions may enforce better waste management practices to preserve environmental aesthetics (Afsana Akther, 2025).

Retail and International Trade: The textile sector operates through a highly complex, globally dispersed value chain where production and consumption are geographically separated. Beyond production, the rise of e-commerce introduced a major source for pre-consumer waste; online returns are estimated at approximately 20%, and roughly about one-third of these returned items are destroyed rather than being resold, because of the inspection and repackaging costs (Theresa Mörsen, 2024). Additionally, international trade has a major role as the European apparel industry is heavily dependent on sales of imported goods, which account for 72% (Fiona Charnley, 2024). As exports of used textiles from the EU tripled between 2000 and 2019, usually shipped under customs codes "worn clothing" (HS 6309) to bypass waste regulations, it could be indicated that these channels serve as a disposal route for post-consumer waste (European Environment Bureau, 2025) . Up to 40% of these exported textiles intended for reuse are of low quality and cannot be reused. (JRC, 2025)

Consumption Models and Fast Fashion: The textile economy is dominated by “fast fashion” business model which has altered the consumption patterns fundamentally. These models are characterized by high production volumes, rapid design-to-shelf cycles and low cost, changing the industry from two-season calendars into offering up to 24 micro-collections annually (Šajn, 2022). These frequent collections have created a throw away culture where consumers look at clothing as disposable assets. Consequently, while global fiber consumption and garment purchasing have almost doubled in the last two decades, their lifespan has shortened, some low-cost garments are usually discarded after only seven to ten uses (Polajnar Horvat, 2021). This behavior is the result of low prices and more affordable products which leads to more impulse purchasing and disposal (Bo Zhang, 2021) .

3.2.2 Demographic and Social Drivers

Population dynamics are fundamental to waste modelling as they often serve as the baseline for pre-capita waste rates.

Population and Density: Population size and “build area” are identified as the most significant predictors of MSW generation, often more important than climate variables (Adu, 2025). Population is also the most statistically significant cause of waste volume as more people inevitably produce more waste (X. Cuong Nguyen a, 2021). High urbanized and dense areas are likely to produce higher waste per capita due to higher commercial activity and different consumption patterns compared to rural areas (E. B. Priyanka). However, density can also create efficiency opportunity, in Florida (USA), urban countries with higher residential have the highest rates of textile recycling (20.1%) and reuse (71%). This indicates that while limited storage space does not necessarily reduce the overall volume of end-of-life textiles generation, it leads to better utilization of them. Residents in these dense areas utilize donation and diversion channels much more frequently, compared to rural areas that mostly rely on landfilling as a cost-efficient option (Sharmin Jahan Mim, 2025).

Household Structure: Smaller households, in particular one-person households (OPH), generate more waste per capita than families because there are no economies of scale in their consumption. In high income European countries, the share of one-person households has been identified as a dominant driver of MSW generation (Smailbegovic, 2025) . In the case of textiles, the situation is slightly different, smaller households usually have higher rates for reuse and donation due to limited space availability, while larger families especially those with children are more likely to engage in internal reuse (hand-me-downs) or accept used clothing and store textiles for longer periods. (Sharmin Jahan Mim, 2025; Polajnar Horvat, 2021).

Age and Gender: Different age categories of a population have different consumption patterns. In general, women are more involved in purchasing and disposal of clothing compared to men, whose clothing has a longer use and lifetime. According to data from Laitala and Klepp (2015) the absolute average lifetime of adult women’s clothing is approximately 5.5 years, whereas adult men’s clothing lasts about 1.5 years longer, reaching an average lifespan of 7 years (Sharmin Jahan Mim, 2025). The working-age share (15-65 years) usually generates higher levels of waste because of higher consumption levels, workforce participation, and more active lifestyles (Smailbegovic, 2025). Younger generations (15 to 24 years) present a distinct challenge, as they are the primary target of the fast fashion industry and have limited knowledge on the environmental impacts of the textile industry, they are associated with higher levels of purchase, online orders, returns, and easier and more frequent disposal of clothing (Beatriz Soares a, 2024).

Conversely, older people generally prefer comfort and quality over trends and tend to retain items for longer, as a result, regions with older populations generate less waste per capita (Delre, 2024; Korica, 2020).

Education: Education is far more complex and plays a dual role in waste generation. Higher education is usually linked to better environmental awareness and recycling incentives. In the US, regions with higher educational levels have lower landfilling rates (27%) and higher recycling participation and reuse (Sharmin Jahan Mim, 2025). Simultaneously, as higher education usually corresponds with higher income and improved living, it leads to higher consumption and ultimately higher volumes of waste (Predrag Korica, 2020).

3.2.3 Psychological and Behavioral Drivers

While economic and demographic factors set the baseline, psychological and behavioral factors shape the disposal behavior. They act like a mediator between consumer's background and their actual environmental impacts.

Awareness-Action Gap: A central concept identified in the literature is “awareness-action” gap which is the disconnect between environmental awareness and actual real-world disposal behavior. Studies indicate that while consumers usually express high levels of concern towards environment, this does not automatically lead to sustainable purchasing and disposal decisions (Wagner, 2020; Polajnar Horvat, 2021; Bo Zhang, 2021). Even people with high environmental knowledge prioritize convenience, time efficiency and easier disposal over sustainability and if the separate collection infrastructures are perceived as inconvenient or difficult to use, participation drops significantly. For this reason, textile waste is discarded into mixed waste streams (Knickmeyer, 2020; United Nations, 2024). The quantitative impact of this gap is significant: on a global scale, 73% of used clothing is disposed of general garbage- either incinerated or landfilled- with the EU specifically recording that 62% of used textiles follow this same disposal pathway (United Nations, 2024).

Perceived Quality and Social Stigma: Psychological barriers considering used textiles can also be a challenge for circularity as many consumers associate wearing used cloth with lower social status or poverty and therefore are discouraged from participating in circular practices even if these options are more affordable and accessible (United Nations, 2024). Furthermore, secondhand and recycled cloth could be considered unclean considering previous owners or the degree of contamination by some consumers (Wagner, 2020). Price is another factor associated with quality; cheaper apparel perceived as having lower value which leads to faster disposal while higher-priced clothing is retained for longer regardless of their actual durability (Delre, 2024).

Cultural Orientation and Social Value: The cultural norms and social expectations act as powerful drivers of consumption and disposal behavior. Fast fashion models have a significant role in this matter, shaping the social culture through embedding novelty and being fashionable, which leads to a conflicting situation where the desire for new trends outweighs extending the lifespan of clothing. In societies influenced by status-driven purchasing, wearing used clothing could be unacceptable. In these cases, the psychological reward of buying new items is usually preferred over the moral motivation to reduce waste, which consequently leads to easier and higher rates of disposal (Polajnar Horvat, 2021; Bo Zhang, 2021).

Information Transparency and Trust in the System: Trust is considered a fundamental element for effective waste management. When consumers are uncertain about the destination of donated or separately collected textiles, it is less likely that they will consider participating in separate collection processes

(Soares, 2024). “System trust” which means the belief that the local authority will manage the waste effectively, is a significant driver of recycling behavior, and lack of trust results in lower degree of recycling commitment (Knickmeyer, 2020). Clear communication regarding sorting rules, collection locations, and the subsequent treatment of materials is an essential key to lowering uncertainty and encourage separate collection participation (Mercogliano, 2024).

3.2.4 Infrastructure-related Drivers

The condition of the waste management systems can affect the amount of waste generated. Current facilities usually are based on the traditional linear model rather than a circular one.

Collection Density and Infrastructure Type: Availability and proximity of the collection points could influence waste disposal behavior, as low density of collection bins in some regions is directly correlated to higher disposal into mixed waste. A case study in Cascais, Portugal, revealed a collection point density of 0.98 CP per km², corresponding to one collection point per 2254 residents, which is significantly below the recommended established targets, France has 1 CP per 1500 residents, while Flanders aims at 1 CP per 1000 residents (Soares, 2024). The method of collection is also important, as some of them yield higher participation, such as door-to-door collection, however, this method accounts for only 0.5% of the collections in France, while bring-backs or drop-off systems – where consumers transport items to centralized collection points - share is 69% (Fiona Charnley, 2024).

Sorting Capacity: Even if the collection infrastructure is sufficient, there is a significant mismatch between collection and sorting capacities. While the current sorting capacity of Europe is estimated to be approximately 1.5 million tons annually, it can only cover a fraction of the projected collected volumes (EEA, 2024). Significant disparities exist across EU Member States. The Netherlands and Poland are considered major sorting hubs with 234,000 and 300,000 tons; respectively, on the other hand, Germany collects over one million tons of textiles but has a sorting capacity of 190,000 to 210,000 tons (EEA, 2024).

Recycling Capacity: The infrastructure gap is even more significant in recycling. The current EU’s recycling capacity is estimated to be between 0.7 and 0.85 million tons per year, a figure that remains insufficient to handle the volumes of textile waste generation. A critical limitation of this capacity is that the vast majority relies on mechanical downcycling rather than high value fiber-to-fiber recycling, which currently remains less than 1% (Delre, 2024; Theresa Mörsen, 2024). Similar to sorting, recycling capacity is highly centralized in specific regions, creating further logistical dependencies for Member States lacking domestic facilities. It is estimated that achieving the capability to recycle 18-26% of textile waste by 2030 requires an investment of 6 to 7 billion euros (JRC, 2025).

As PCTW generation is a multi-layered process resulting from the interaction of different factors, it indicates that policies that focus only on end-of-life without addressing other conditions are ineffective, and to reduce PCTW, integrated approaches are needed.

3.3 *Insights and Strategies from Other Waste Streams*

When emerging waste streams such as textiles face different challenges in governance, infrastructure, and data availability, it is useful to do cross-stream learning, especially from those waste streams that encountered these issues earlier in time, such as packaging, Waste Electrical and Electronic Equipment (WEEE), and biowaste. As these streams are more mature, they can offer useful insights about regulating

instruments, economic incentives, and system design. Reviewing other waste streams' strategies could help find means to strengthen textile waste governance (D'Adamo I. M., 2022).

Packaging waste management represents one of the most established applications of Extended Producer Responsibility (EPR) in the EU, demonstrating that mandatory producer financing of collection and treatment can significantly improve the recycling rates and reduce reliance on disposal (Šajn, 2022) (Juanga-Labayen, 2022). EPR effectiveness depends not only on fee collection but also on transparent governance, performance-based targets, and enforcement mechanisms to ensure cost-effectiveness and accountability (J. Malinauskaite, 2017). These findings are highly important for textiles as related EPR schemes are still emerging, and clear allocation of financial and operational responsibility is critical (EEA, 2024; Schumacher, 2022). To fully leverage this mechanism for a circular economy, proposed harmonized schemes focus on integrating eco-modulated fees that adjust the fees based on environmental performance to incentivize design for durability, recyclability, and waste prevention (Delre, 2024; Theresa Mörsen, 2024).

The EU's recent updates of packaging rules indicate that it is not possible to only rely on recycling to fix the waste problem and that waste prevention and recyclability must start at the design stage. Harmonized design requirements such as material simplification and labeling standards are necessary to improve the sorting efficiency and recycling results as they ensure products are produced considering end-of-life phases in mind (Jia, 2020; Chenavaz, 2024). Using this for textiles indicates that without upstream design constraints, particularly reducing blend fibers, additives, and complex constructions, downstream recycling system faces persistent technical and economic limitations (Solis, 2024).

The WEEE streams provide a robust example of how mandatory separate collection, combined with treatment standards and reporting obligations, can increase recovery and recycling performance. The WEEE Directives in the European Union have significantly reduced e-waste generation by enforcing strict penalties on non-compliant procedures and establishing efficient collection systems where manufacturers oversee the entire life cycle.

However, considering the electronics sector and research on plastic waste, it is highlighted that collection targets alone are insufficient unless supported by clear definitions of treatment outcomes and certified operations - specifically independently audited facilities that utilize standardized, environmentally sound technologies for disassembly, material recovery and downstream traceability, which are essential to transform collected items into high quality secondary raw materials. Furthermore, it is indicated that when domestic recycling capacity lags behind collection efforts, the result is usually leakage and burden shifting to regions with weaker infrastructures, a dynamic that is directly applicable to the textile sector (Willis, 2025; Quinto, 2025).

As for textiles, insights suggest that separate collection requirements should be accompanied by minimum sorting and treatment standards (Soares, 2024; Vermeyen, 2024). To ensure that collected materials are directed towards high-value recovery routes rather than disposal or export, the textile sector can use the WEEE and plastic approaches of trade governance, specifically harmonized "Prior Informed Consent" (PIC) procedure under the Basel Convention, which would require exporting countries to get explicit permission from the receiving nations before shipping waste materials (European Environment Bureau, 2025). Additionally, establishing harmonized "End-of-Waste" criteria similar to those used to distinguish used electronics from e-waste is essential to prevent low-quality textile waste from being shipped as reusable goods and subsequently dumped in non-OECD countries (D'Adamo I. M., 2022; Theresa Mörsen,

2024). Enforcing these standards is essential to close the existing loopholes that allow low-quality, often unsellable items to be shipped without verifying the recipient's management capacity.

Evidence from WEEE and bulky waste streams also highlights a recurring challenge; while reuse is often prioritized, it usually fails in practice without supportive measures (D'Adamo, Daraio, Di Leo, & Simar, 2024). Even though reuse delivers higher environmental benefits compared to recycling, particularly regarding climate change and resource depletion (Solis, 2024), it receives less investment and institutional support, often relying on tax incentives or volunteer workers. This insight could directly be used for textiles, where reuse is in favor of the environment but economically under-supported. So, dedicated reuse targets, financial incentives, and infrastructure are necessary to prevent reuse from being displaced by recycling or disposal-focused solutions (Fiona Charnley, 2024; Theresa Mörsen, 2024; Vermeyen, 2024) .

Finally, the management of biowaste offers additional insights into how binding targets and standardized measurements can divert material from disposal. The introduction of the EU Landfill Directive has mandated the reduction of biodegradable municipal waste sent to landfills compelling the Member States invest in separate collection systems and alternative treatments like composting and anaerobic digestion (Ghinea, 2016; Gouda, 2025). Considering textiles, this indicates that incoming mandatory separate collection must be accompanied by strict landfill constraints and comprehensive circularity targets – spanning reduction, reuse, and recycling, to achieve the same diversion success of biowaste (Smailbegovic, 2025). Additionally, biowaste management provides a blueprint for the “biological cycle” of textiles, in particular natural fibers like cotton and wool. Just as organic waste is valorized through anaerobic digestion to generate biogas and bio-fertilizers, similar biological treatments such as enzymatic hydrolysis and fermentation are increasingly identified as viable recycling routes for natural textile waste that is unsuitable for mechanical recycling (Biyada, 2025; Juanga-Labayen, 2022).

Across waste streams, literature converges on several transferable principles; EPR must be well-governed and performance-oriented; design requirements are essential for downstream circularity; reuse requires explicit policy support; and data and targets are foundational for system improvements. For textiles, these could mean that policy success is dependent on integrating collection obligations with design regulation, treatment standards, reuse incentives, and transparent reporting. All these together provide a critical foundation for evaluating forecasting approaches and identifying data needs.

3.4 Forecasting Methods in Consumer Waste and Environmental Management

Forecasting methodologies play a critical role in consumer waste and environmental management, serving as a basis for infrastructure optimization, policy evaluation, and investment decisions (Smailbegovic, 2025). Within the EU, accurate projections are essential to estimate future waste quantities, monitor compliance with regulatory targets, and guide the scaling of collection, sorting, and treatment capacity (Ghinea, 2016). This is especially important for priority streams such as post-consumer textile waste, which is undergoing a regulatory transformation. The implementation of mandatory separate collection by 2025 and the introduction of EPR schemes requiring precise data to manage the collected volumes and to design adequate recycling infrastructures that can handle diverse material flows (Vermeyen, 2024; Delre, 2024).

Literature identifies several challenges that complicate forecasting PCTW. While lessons from more homogeneous streams such as packaging and biowaste are transferable, their models are less effective without significant modification. Key challenges are heterogeneous product categories, variable lifetimes, mixed material composition, and significant cross-border flows of used textiles (Hoy, 2024; Solis, 2024).

Additionally, uncertainty considering the inconsistent classification of materials and incomplete capture of textiles in official waste statistics introduces further ambiguity, especially regarding cross-border flows (Vermeyen, 2024) .

Given these sector-specific challenges, accurate forecasting of PCTW requires methodologies capable of handling highly dynamic and non-linear variables. Consequently, it is necessary to critically evaluate the existing spectrum of waste prediction models to determine their applicability to the textile domain. The following sections review five methodological approaches commonly utilized in waste management to assess their respective strengths, limitations, and overall capacity to capture the unique complexities of textile waste generation.

3.4.1 Traditional Time Series Models:

Traditional forecasting methods used in municipal and consumer waste management have frequently relied on time-series models, such as Autoregressive Integrated Moving Average (ARIMA) models and its seasonal variations (SARIMA) (Cubillos, 2020; Ghinea, 2016). These approaches extrapolate historical trends to predict future waste generation and are valued for their transparency and relatively low data requirements (X. Cuong Nguyen a, 2021). However, the literature notes that time-series methods assume continuity of past trends and therefore struggle to capture non-linear structural changes, such as policy interventions, shifts in consumption patterns, or technological disruptions. This limitation is especially relevant for textiles, where regulatory changes are expected to alter disposal behavior significantly (Abdeljaber, 2025; Hoy, 2024; Napolano, 2025).

3.4.2 Regression-based Approaches:

Regression-based models represent another widely used approach for waste forecasting by establishing a quantitative relationship between waste volumes and socio-economic variables such as income, population, household size, and consumption expenditure (Smailbegovic, 2025; Ghinea, 2016). These models, especially Multiple Linear Regression (MLR), are attractive since they offer interpretability and simplicity as they allow explicit testing of driver-waste relationships, like identifying how population correlates with waste fractions (X. Cuong Nguyen a, 2021). Nevertheless, studies indicate that regression coefficients are often highly context-specific and may lose validity when behavioral norms and system conditions change or “structural breaks” occur in the economy (Gardiner, 2020; Zheng Xuan Hoy, 2024). Considering textile waste, where fast fashion, price, and behavioral drivers introduce non-linear dynamics that static regression models might not be able to capture, resulting in lower accuracy compared to AI-based alternatives that can handle complex interactions (Abdeljaber, 2025; Ramírez-Escamilla, 2024; Bo Zhang, 2021).

3.4.3 System Dynamics:

To address the limitation of static modeling, System Dynamics (SD) models are increasingly applied in environmental management to represent feedback loops and time-dependent interactions with complex systems (Korica, 2020). Unlike conventional methods in waste management, SD models are used to simulate how policy instruments, consumer behavior, infrastructure capacity, and market conditions change over time, which makes them a valuable tool for strategic long-term planning and policy evaluation. This can be used for scenario analysis, such as the interaction between rising consumption rates and the expansion of collection and recycling infrastructures. However, these models require extensive assumptions and calibration, and their results can be sensitive to parameter choices, which could be a barrier for their use in an environment with rapidly changing regulations or insufficient historical data (Abdeljaber, 2025).

3.4.4 Machine Learning

More recent studies have explored the application of Machine Learning (ML) techniques, including Artificial Neural Networks (ANN), Random Forest (RF), Support Vector Machines (SVM), and Extreme Gradient Boosting (XGBoost), in non-linear dynamics of waste generation that traditional methods failed to capture (Abdeljaber, 2025; Smailbegovic, 2025; Liu, 2025). These data-driven approaches can often achieve higher predictive accuracy; for instance, ANNs have demonstrated R^2 values exceeding 99% in multi-variable scenarios, while RF excel at handling outliers in datasets (Billal, 2025; Priyanka, 2025). However, it should be considered that these models are data-intensive and, due to their “black box” nature, are less interpretable (Priyanka, 2025; Liu, 2025). In the case of textile waste, fragmented data, inconsistent classifications, and short time series limit the application of a purely data-driven model (JRC, 2025; Napolano, 2025). Without high-quality historical data, complex models like Deep Learning risk overfitting, considering noise as patterns and fail to capture true generation trends (Chen, 2025; Abdeljaber, 2025).

3.4.5 Hybrid Approaches for Policy and Scenario Planning

To overcome the limitations of the above-mentioned methods, several studies have worked on **hybrid approaches** that combine statistical forecasting with system dynamics and scenario analysis. Hybrid models can use econometric or ML methods for short-term prediction while embedding policy assumptions and structural relationships through system dynamics or scenarios to account for interventions. This approach is particularly relevant for textiles, where upcoming regulations are expected to cause structural breaks in historical data trends (Eryganov, 2025). By integrating quantitative forecasting with scenario modeling, hybrid models allow decision-makers to determine future needs based on legislative targets rather than just consumption behaviors (Abdeljaber, 2025; Eryganov, 2025; Chen, 2025).

Table 1 summarizes these Methods and their related strengths, limitation and PCTW relevance.

Table 1: Comparison of forecasting methods, weaknesses and strength

Forecasting Method	Main Application	Key Strength	Main Limitation	Relevance for PCTW
Time Series	Short-term forecasting based on historical waste trends	• Simple structure • Transparent results • Low data requirements	• Assuming trend continuity • Unable to capture policy shocks or behavioral change	Low-inadequate under structural changes such as 2025 mandatory separate collection
Regression-Based	Estimating relationships between waste generation and socio-economic drivers	• Interpretable coefficients • Useful for identifying key drivers	• Context-specific • Limited ability to model non-linear dynamics	Moderate- useful for driver analysis but weak for long-term projections
System Dynamics (SD)	Long-term scenario analysis and policy evaluation	• Captures feedback loops • Accounts for time delays • Evaluates policy interactions	• Strong reliance on assumptions • Calibration sensitive	Moderate to high- suitable for policy scenarios but less precise quantitatively
Machine Learning	Non-linear forecasting with large multivariate datasets	• High predictive accuracy • Handles complex interactions	• Data-intensive • Limited interpretability • Risk of overfitting	Moderate- promising but constrained by fragmented textile waste data
Hybrid Approaches	Policy-relevant forecasting under uncertainty	• Combines interpretability with flexibility • Robust to data gaps and structural breaks	• Higher methodological complexity • Integration challenges	High- best suited for textile waste forecasting under evolving regulatory conditions

Overall, existing forecasting approaches offer valuable tools for waste management planning but require careful adaptation to the characteristics of textile waste under the mutating policy landscape and limited historical data availability. Considering this, no single method is sufficient, instead forecasting should integrate socio-economic drivers, policy scenarios and system constraints. To improve forecasting accuracy for textile waste, data quality and harmonization are as important as the method itself- an issue that is directly related to data gaps.

3.5 Data Gaps and Emerging Research Opportunities

3.5.1 Critical Data Gaps and Fragmentation

While advanced computational tools such as Artificial Intelligence (AI) and specific modelling techniques like Dynamic Probabilistic Material Flow Analysis (DPMFA) are evolving, their application is significantly limited by the quality and availability of input data (Chen, 2025). A consistent conclusion across the literature is that data availability for PCTW lags behind the more established waste streams like glass or paper, creating a “data desert” considering composition, generation rates, and final fate of the textiles (Napolano, 2025; Biyada, 2025; EEA, 2024). Current waste data originates from heterogeneous sources like official statistics, scientific models, or expert estimations, which usually rely on isolated values rather than structured and continuous time series (Vermeyen, 2024; Abdeljaber, 2025).

Fragmented data, inconsistent classification, and short time series limit the functionality of purely data-driven models (Chen, 2025). Within the textile sector, the lack of a consistent and general applicable definition of textile waste in EU legislation leads to Member States freely deciding on data collection methods that result in incomplete data considering absolute flows (Napolano, 2025).

Furthermore, research highlights specific information defects in existing datasets, specifically regarding semantic precision (clarity of meaning), representativeness (accuracy in representing the entity of interest), provenance (origin and collection method), and context (Vermeyen, 2024). There is a significant semantic ambiguity in reporting, especially when producers rely on inconsistent reporting practices, for instance, end-of-life pathways such as reuse, valorization, and composting are frequently aggregated under broader labels preventing accurate assessment of circularity strategies (Vergés, 2026).

The scarcity and reliability of data regarding some socio-economic drivers of waste generation is another major challenge (Hoy, 2024). Although many studies have identified the behavioral drivers of waste generation, comparable and longitudinal data remain limited. Differences in survey designs, cultural contexts, and measurement approaches make cross-country analysis and correlating socio-economic metrics with specific disposal behaviors difficult (Sharmin Jahan Mim, 2025). It is essential to fill the gap between social and physical aspects by integrating behavioral data into MFA, like “in-use-stock” dynamics of products, specifically how long consumers retain products and what triggers disposal, which is necessary for converting static consumption figures into dynamic waste generation rates (Napolano, 2025).

Lack of data transparency is more severe in cross-border movements, as current databases like EU COMEXT and UN COMTRADE are unable to capture the complexity of global flows. Current trade classification based on the Harmonized Commodity Description and Coding System (HS) – an international standardized numerical nomenclature developed by the World Customs Organization (WCO) to classify globally traded products for customs and statistical purposes (World Customs Organization, 2022) - does not adequately distinguish between reusable goods and waste, meaning that the final fate of exported used textiles is unclear, and once they are shipped outside EU, there is no means of tracing the fate of these used

textiles (JRC, 2025). Additionally, literature highlights that there is no official data available considering the total number of collection points, and no data regarding the quantity and quality of textiles entering municipal waste, specifying it as a significant unquantified loss of resources (Beatriz Soares a, 2024) .

Further uncertainty arises from limited quantification of the “informal sector” in waste collection and sorting, creating significant variance in global statistics, particularly in developing economies where it often dominates the market yet operates with basic recycling technologies and varying levels of commitment (Leal Filho, 2019; Quinto, 2025).

Finally, considering material properties, “opaque supply chains” and “proprietary information” prevent the collection of reliable data on fiber composition and chemical content, which is necessary to calculate the environmental impacts or design effective policies, especially adequate risk management measures for toxicity and resource management (D'Adamo I. M., 2022; Schumacher, 2022).

Without high-frequency data from IoT-enabled infrastructure or standardized waste composition audits, it will be difficult to decouple waste generation from economic growth or to validate the effectiveness of circular economy interventions (Sharmin Jahan Mim, 2025). However, current Near-Infrared (NIR) sorting technologies are aiming to automate the rapid identification and separation of textiles based on their fiber composition but, they have limitations in detecting fiber blends or disputes, leading to large error rates in determining recyclability and feedstock availability (JRC, 2025).

These infrastructural and technological limitations highlight critical blind spots in current forecasting capabilities. To overcome these barriers and improve systemic circularity, it is necessary to translate these structural gaps into integrated research opportunities.

3.5.2 Emerging Research Opportunities:

1. AI-Driven Forecasting and IoT Integration:

The integration of the Internet of Things (IoT) and AI represents a frontier of waste management research, as future research is focusing on coupling “IoT-enabled smart bins” that can provide real-time weigh and volume data with Deep Learning architectures like Bidirectional Long Short-Term Memory (Bi-LSTM) to capture “temporal dependencies” and nonlinear patterns. Recent studies illustrate that Automated Machine Learning (AutoML) frameworks can optimize multi-category waste forecasting with lower error rates (e.g. MAPE of 18.7%) compared to traditional models (Chen, 2025). Additionally, novel approaches like Game Theoretically Optimal (GTOP) reconciliation for Hierarchical Time Series (HTS) are emerging to model the correlation structure between different waste fractions, like the interaction of separate collections of paper, plastic, and mixed waste (Eryganov, 2025).

2. Hybrid Models and Behavioral Integration:

Hybrid approaches that can combine quantitative ML with system dynamics or scenario analysis are consistently discussed as a practical strategy to respond to fragmented and incomplete datasets (Abdeljaber, 2025). Integrating behavioral insights with MFA offers a promising way for advancing textile waste research, considering different performance assumptions, which supports more accurate projections of the in-use-stock and evaluation of policy impacts, like EPR schemes (Theresa Mörsen, 2024; Napolano, 2025; Vermeyen, 2024) .

3. Digital Traceability and Mass Regeneration:

To solve the issue of opaque supply chains, both academic research and legislative frameworks – most notably the EU Strategy for Sustainable and Circular Textiles- are driving a shift toward Digital Product Passports (DPP) and blockchain technology (Schumacher, 2022). Considering this, developing standardized data protocols for DPPs is crucial, as it can act as a mechanism for collecting and sharing product data throughout its entire life cycle, enabling better sorting and high-value recycling (Fiona Charnley, 2024). Investigating the use of blockchain to create “immutable ledgers” can enhance transparency and prevent illegal dumping of exports (Leal Filho, 2019). Finally, research suggests exploring “mass regeneration zones” in producer countries to leverage existing industrial capacity for circularity and therefore create a market for low-value textiles that competes with downcycling (Fiona Charnley, 2024).

Taken together, the identified data gaps and structural inconsistencies highlight that forecasting PCTW cannot rely only on conventional statistical models or fragmented official datasets. Data limitations, structural breaks, and policy-driven changes all introduce a high level of uncertainty into purely data-driven models. Additionally, although drivers of textile waste generation are well-identified at a qualitative level, the literature still lacks integrated regionally differentiated forecasting frameworks that translate these insights into policy projections. This highlights the need for approaches that combine multiple data sources while considering uncertainty, system constraints, and are adaptable to evolving governance conditions. Table 2 summarizes these challenges and related research opportunities.

Table 2: Summary of Research Opportunities Related to Each Challenge

Identified Challenge	Linked Research Opportunity
Lack of high-frequency data	Integration of “IoT-enabled smart bins” and Deep Learning to capture real-time weight and volume data
Limitations of NIR sorting	Implementation of DPPs as a mechanism to share product data and enable better sorting
Absence of standardized waste audits	Development of standardized data protocols and blockchain ledgers to accurately track lifecycles and prevent illegal dumping
Inability to capture non-linear dynamics	Application of advanced predictive models to capture temporal dependencies and behavioral insights

4 Methodology

To provide a comprehensive overview of the analytical framework used in this study, the research design is operationalized through six-stage hybrid methodology. This framework systematically processes fragmented macro-level trade statistics, filters historical volatility, applies probabilistic simulation engines, and downscales long-term projections into precise regional pathways. Figure 5 visually outlines these interconnected sequential steps, which bridges raw empirical data collection with validated socio-economic scenario outcomes.

The methodology begins with rigorous data harmonization and recursive exponential smoothing to build a mathematically consistent historical baseline. This smoothed baseline feeds directly into Dynamic Probabilistic Material Flow Analysis (DPMFA) powered by Monte Carlo simulations to model lifetime distributions. Future projections are then mapped across distinct scenarios up to the year 2035, downscaled to NUTS2 regional resolutions, and finally validated against empirical data models.



Figure 5: Methodological Steps of the Model

4.1 Justification for a Hybrid Forecasting Approach

Forecasting Post Consumer Textile Waste (PCTW) requires an approach that can capture both the physical structure of material flows and the uncertainty associated with product use and disposal behavior of people (Haberl, 2017). Waste generation is not just the result of current consumption levels; historical inflows, product lifetimes, consumer behavior, and policy implementation altogether affect waste generation (Esther Müller, 2014). Static MFA models provide a physical mass-balanced representation of material flows; however, they are limited in accounting for temporal dynamics and uncertainty. These models implicitly assume immediate disposal, which is inappropriate for textiles, which have various uncertain use durations (Brunner, Rechberger, 2016).

Dynamic Material Flow Analysis addresses this by modeling stocks, cohorts, and time-dependent outflows, recognizing that waste generation in any year is the aggregated result of multiple historical cohorts reaching end-of-life. However, though dynamic MFA captures the temporal structure, deterministic implementations rely on fixed parameters and fail to capture the heterogeneity and uncertainty of real-world systems, underrepresenting it (Brunner, Rechberger , 2016).

To resolve this situation, a **Probabilistic Dynamic Material Flow Analysis** (PDMFA) is adopted to allow representation of uncertainty while remaining computationally efficient. The DPMFA framework is also suitable for modeling future policy implementations, particularly the mandatory separate collection of textiles in the EU from 2025, as different projections could be added to the model to assess how different variations may affect future flows. (Napolano, 2025)

Other time-series or economic forecasting approaches were not selected since they lack physical mass balance constraints and cannot represent stock-driven delayed outflows (Brunner, Rechberger , 2016).

Overall, the hybrid model works by integrating deterministic mass-balance accounting, probabilistic lifetime, and scenario-based modeling to account for delayed effects, data gaps, and structural changes. Table 3 maps the core design criteria against the capabilities of each method.

Table 3: Summary of Forecasting Methods

Criteria\Method	Static MFA	Deterministic Dynamic MFA	Time Series / Economic Trends	Hybrid DPMFA Approach
Maintain Mass Balance	✓	✓		✓
Represent Stock-Driven Delayed Outflows		✓		✓
Modeling of Stocks, Cohorts, Time-dependent Outflows		✓		✓
Modeling of Future Policy Implementations			✓	✓
Captures Heterogeneity and uncertainty				✓

4.2 Research Design and Overall Approach

The goal of the study is to forecast the amount of PCTW at the **NUTS2** level; however, due to scarcity of granular regional modeling data, the forecasting is initially conducted at the country-level.

Regional estimates are calculated by downscaling national PCTW results Disposable Income of Private Households as a proxy for regional consumption intensity to allocate country waste quantities across regions. A detailed approach and allocation procedure will be discussed in section 4.6.4.

The rationale for selecting households' disposable income over Gross Domestic Product (GDP) is rooted in the distinct drivers of post-consumer waste. According to Eurostat GDP is an output metric recorded at the place of work, whereas household income is recorded at the place of residence. Using GDP for regional downscaling introduces severe distortions due to the “commuter effect” _ capital regions and major urban centers often report artificially inflated GDP levels driven by cross border or inter-regional commuters who generate output in the city but reside, consume and generate household waste in neighboring regions (EUROSTAT, 2025).

Furthermore, the substitution of GDP with household disposable income is strictly aligned with the macroeconomics frameworks established in the OECD which states GDP is an aggregate measure of the

value added generated through total economic production including corporate activities, government expenditure and net exports. Because GDP includes these broad macroeconomics variables, it can diverge significantly from the actual economic reality experienced by citizens. In contrast, household disposable income specifically defines the maximum amount households can consume without reducing their net wealth, thereby much more precise picture of households' material conditions and actual purchasing power. Since the generation of PCTW is fundamentally driven by private household consumption behaviors and the purchasing of finished goods, disposable income serves as a significantly more reliable and direct indicator for the spatial downscaling of waste flows. (OECD, 2026)

4.2.1 Scope of Study and System Boundaries

System boundaries include the use and disposal phases of textiles. Upstream processes, such as fiber production, fiber processing, and fabric manufacturing, as well as pre-consumer and industrial waste streams, are excluded from the study as they fall outside of the scope of this research.

However, production and trade statistics are used as input data to estimate the inflow to the use phase. Considering this, production data represents a proxy of products entering use phase. This ensures that the model estimates the volume of the entering products without extending the scope to the industrial manufacturing impact. Accordingly, the system explicitly considers the period when textile products are placed on the market and sold, up to the point they are discarded by end users. Unsold textiles are excluded from the calculations since they do not enter the use phase and count as pre-consumer waste and remain outside of the designated system boundaries. Similarly, returned items are excluded from the inflow because it cannot be clearly determined whether they will successfully re-enter the market or be discarded, meaning they are generally treated as unsold retail stock rather than post-consumer waste. Figure 6 illustrates the system boundaries of the study.

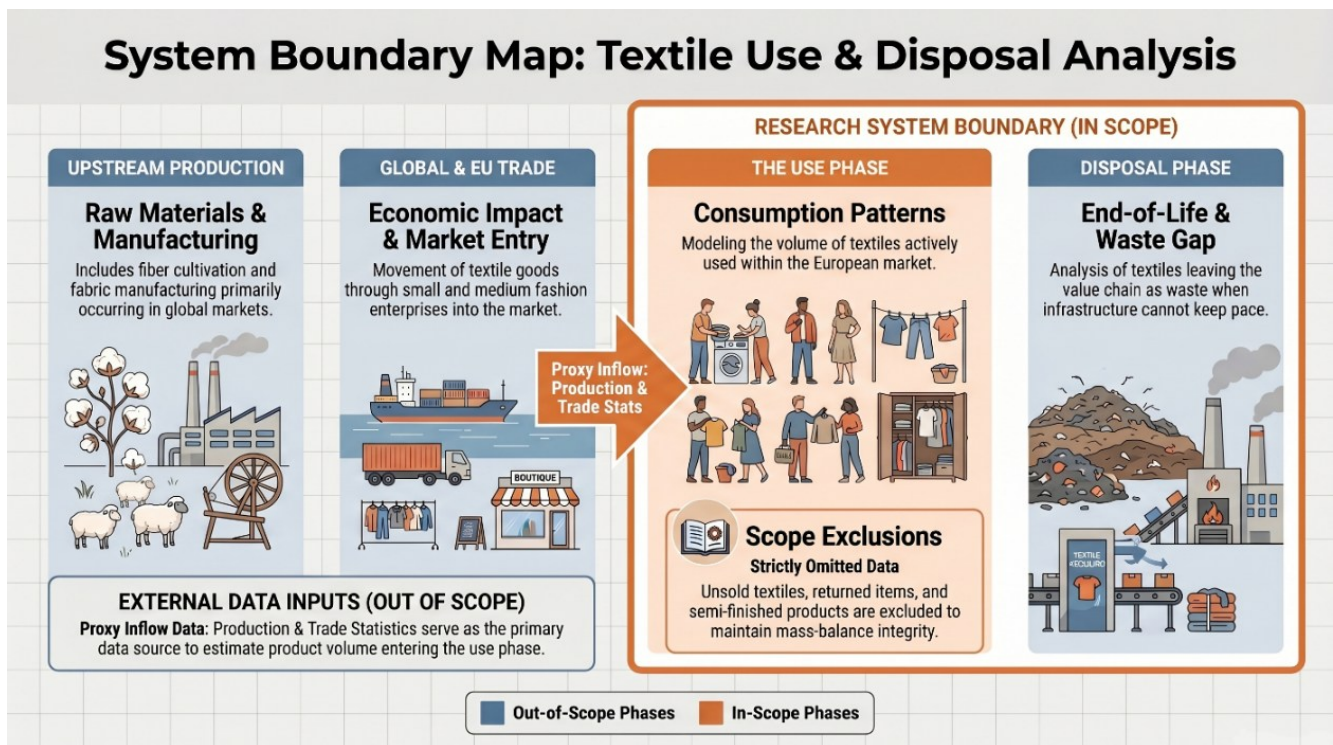


Figure 6: System Boundaries

To preserve the physical mass-balance integrity of Material Flow Analysis, intermediate and semi-finished products must be strictly excluded from the system boundaries. In MFA modeling, a fundamental structural risk is material double counting, which occurs when a single material’s mass is mistakenly quantified at multiple processing stages within the same domestic supply chain. Because the system boundary of this research explicitly considers the point where finished textile products enter use phase, tracking upstream industrial inputs would introduce distortions.

The explicit handling method to resolve this challenge involves a rigorous, code-by-code filtering process applied to the PRODCOM and COMEXT databases. Every product code designated as raw material, intermediate input or industrial subcomponent was excluded from the final input datasets. The theoretical justification for this complete omission relies on the physical transformation of goods as intermediate components move downstream through manufacturing loops and they are eventually converted into finished products (Figure 7). Consequently, their physical mass is fully embedded, aggregated and ultimately accounted for in the sold production and trade statistics of the final goods. As an example, quantifying a roll of non-wovens at production and then separately quantifying the finished jacket made of that nonwoven would duplicate the identical material mass within the system inflow.

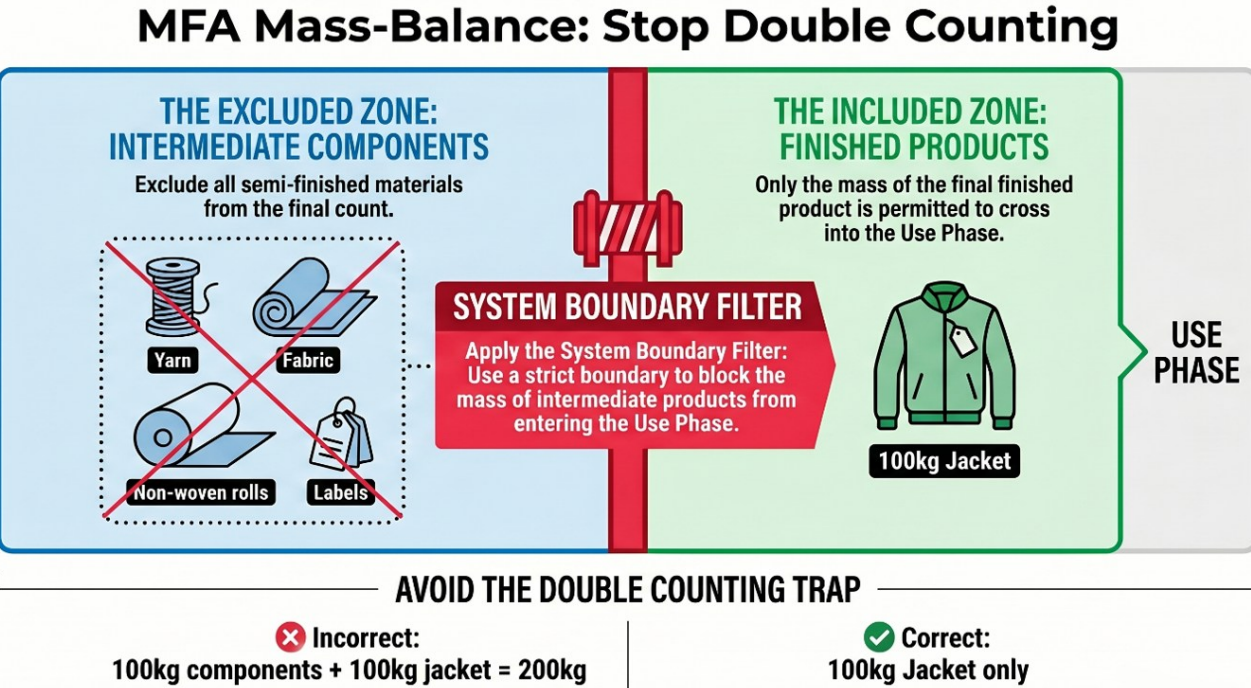


Figure 7: Intermediate Products Exclusion

To demonstrate the execution of this procedure, a comprehensive matrix was developed, as documented in the Appendix Table 7, specific intermediate categories that are typically embedded into other final products or act as raw material for secondary industries were intentionally filtered out; these include non-wovens, labels and badges, embroidery, hat forms and footwear uppers. Furthermore, this procedure robustly accommodates international trade dynamics: if EU-manufactured intermediate textiles are exported outside the block for final assembly, they completely bypass the domestic use phase and conversely, if those items are re-imported into EU market, their total mass is accurately captured via final import statistics.

Footwear is also considered, even though their non-textile share is usually more than 20% (e.g. rubber, plastic, metal, leather, etc.), they still contain a considerable amount of textile materials. Footwear's relevance is further supported by policy documents such as the Ecodesign for Sustainable Products and Energy Labelling Working Plan 2025-2030, which identifies footwear as a priority product group for sustainable interventions and recognizes the inclusion of footwear in analyses focusing on textiles and post-consumer waste generation (European Commission, 2025). Apparel articles and clothing accessories made of leather and fur have also been considered since they are typically collected, sorted, and managed together with other textile products.

4.2.2 Baseline and Temporal Scope

As exceptional market conditions could cause distortions, 2019 is selected as the baseline year to avoid the Covid-19 pandemic noticeable and uneven effects on the global economy and industrial activities, which cannot be easily determined and are outside of this study's scope (Napolano, 2025). At the same time, historical data from prior to 2019 (from 2004) are also incorporated into the model to construct dynamic cohort inflows and in-use stocks. This is necessary to represent waste generation as textiles enter use in earlier years and based on their lifetime become waste in the future.

4.2.3 Waste Definitions and Categories

Consistent to the newest Waste Framework Directive revision states, all separate collected textiles and footwear are considered as "waste" to make sure they go through sorting and therefore prevent the export of textile waste falsely labeled as reusable (Directorate-General for Environment, 2025). However, a significant limitation remains as a substantial volume of PCTW is not separately collected at the source but instead ends up incorrectly disposed of within mix municipal solid waste streams, bypassing specialized sorting infrastructures.

Post-consumer textile waste includes all finished textile products discarded by private consumers and end-users from three main categories. To ensure a comprehensive evaluation, all three of the following macro categories are considered, quantified and modeled within the scope of this study, restricted strictly to final and finished products (Napolano, 2025):

1. Clothing and Footwear: articles of apparel
2. Household Textiles: carpets, curtains, linens, etc.
3. Technical Textiles: finished functional textile products used in professional and household applications (excluding industrial intermediate components)

The system considers the period when textile products are placed on the market and sold, to the point they are discarded by end users. Unsold textiles are excluded since they do not enter the use phase and therefore count as pre-consumer waste and are outside of system boundaries. Returned items are excluded since it cannot be clearly determined whether they can re-enter the market or are discarded, so they are generally considered unsold stock and not post-consumer waste (EEA, 2024).

4.3 Data Sources

The PRODCOM database available on EUROSTAT (2025) is used to collect the production and trade data of finished textile products that become post-consumer waste after use.

A total of 194 products is considered in this study. The full list of the products considered can be found in Table 6 of the Appendix.

The PRODCOM list is revised periodically to reflect structural changes leading to some product codes merging, split or redefined. These revisions are formally documented, and the official correspondence tables are published by (EUROSTAT, 2026; UK Office for National Statistics (ONS), 2026) to map different codes between successive editions and ensure transparent code transition over time. As an example, product code 14132116 in the 2024 edition corresponds to codes 14132115 and 14132130 from the 2021 version (Table 7 of the Appendix).

In addition to tracking code revisions over time, it was also necessary to identify and exclude intermediate manufacturing inputs to prevent double-counting mass. The determination of an “intermediate product” was based directly on the official NACE Rev. 2 Explanatory Notes (2008), which explicitly distinguish raw industrial materials from final assembled consumer goods.

To support this mass-balance logic, the excluded codes were categorized into three groups based on their NACE definition:

1. **Unassembled Parts:** Codes representing isolated components (e.g., footwear uppers 15204020) were excluded, as their mass is fully accounted for once assembled into final consumer goods.
2. **Raw Textiles “In the Piece”:** The NACE manual defines Division 13 as textiles sold “in the piece” (uncut industrial rolls), structurally separating them from apparel. Therefore, raw non-woven rolls (e.g., code 13951010) were excluded.
3. **Manufacturing Trimmings:** Minor textile inputs that are physically sewn into final garments (e.g., labels 13961750) were excluded to prevent duplicating the mass of the finished products.

In this study, the 2024 version is used as a standard coding tool despite 2019 being considered as the reference year; however, while collecting data, the revisions are considered to ensure temporal consistency of the product definitions over time.

Three primary indicators were selected for each product code:

1. **SOLD PRODUCTION quantity:** only the indicator SOLD PRODUCTION is selected since, according to the European business statistics user’s manual for PRODCOM (EUROSTAT, 2023), “The Sold Production reported the value or the volume of production sold, i.e. excluding any production that the enterprise needed for further processing and the Total Production referred to the total volume of production, whether it was sold or used by the enterprise for further processing.” In this case, the unsold inventory, stored goods, and products not placed on the market are excluded.
2. **IMPORTS quantity:** mass of finished textile products imported. Since Eurostat data are on a national level, imports from extra-EU and intra-EU are considered.
3. **EXPORTS quantity:** mass of the finished textile products exported. Since Eurostat data are on a national level, this includes products that are manufactured inside any EU country and exported to either extra-EU countries or to other EU countries (intra-EU exports).

A critical challenge in textiles' mass-balance is the lack of distinction between new and used products in the trade statistics. While imports are generally assumed to contain mostly new products, a significant and growing share of the exports include used textiles. The (EEA, 2023) report indicates that the export of used textiles increased from just over 550,000 tons in the year 2000 to almost 1.7 million tons in 2019, corresponding to 3.8 kg per capita or 25% of annual textile consumption approximately. Therefore, a substantial share of textile exports from the EU includes used textiles that usually are exported for reuse and are not differentiated from new products' export which creates a "double counting" risk that could be a potential source of imbalance between production, trade, and use phase inflows.

Furthermore, while sold production data is used in this study, it must be noted that a portion of textile products never enters the active use phase as they might remain as unsold retail stock or be discarded after post-sale returns. According to EEA (2024), between 4-9% of textile products placed on the EU market are destroyed without being used, accounting for approximately 264,000 tons to 594,000 per year. These figures are documented by literature, however, not captured in EU-wide harmonized statistics and therefore they cannot be explicitly disaggregated in the accounting framework and consequently, these figures remain embedded in the apparent consumption calculations.

Given these data limitations, the actual quantity of textiles entering the use phase cannot be observed directly. All imports are considered as entering the domestic use phase. This simplification could lead to short-term distortions in apparent consumption such as negative values, which are the result of re-exports, stock change, and temporal mismatches. These issues are addressed by reconciliation of the apparent consumption time series to ensure long-term mass balance in line with DPMFA in section 4.5.1.

4.4 Data Cleaning and Handling

In cases where PRODCOM data for production or trades are incomplete or unavailable, the data handling procedure follows the same approach established by Napolano (2025). While PRODCOM is used as the primary data source, Eurostat COMEXT data are used as a supplementary data source to fill the gaps in the trades time series. However, since PRODCOM and COMEXTT use different product classification systems, to ensure consistency between the two datasets, a cross-mapping process is executed using official Combined Nomenclature (CN) correspondence tables provided within the PRODCOM classification framework. When a single PRODCOM product code corresponds to more than one CN code, all these trade codes are aggregated (EUROSTAT, 2024). In most cases, the PRODCOM code corresponds to one or more CN codes, so the data for all the corresponding CN headings is aggregated to get trade data for the PRODCOM code. The opposite case- where a single CN trade code splits across multiple PRODCOM codes- is structurally impossible under Eurostat classification rules, eliminating any risk of structural misallocation or double counting. If the PRODCOM product codes do not have an equivalent product in the trade figures (for instance industrial services) or if the PRODCOM product is a finer breakdown of a CN code, it is not possible to compare with the CN and no trade data is displayed (EUROSTAT, 2023).

The magnitude of the COMEXT supplementary data integrated into the model is quantified across both the product codes and the overall data grid. The baseline data matrix encompasses 27 EU Member States, 194 distinct product codes and a 21-year historical observation window. Since each product code requires three separate data points (sold production, imports and exports), the complete data set yields a total of 330,048 individual data points. 27 product codes of trade data were supplied from COMEXT, yielding 30,618 data points, which accounts for about 9.28% of the total observations in the model.

Additionally, as indicated in the manual (EUROSTAT, 2023), not all data are expressed in a single unit, and depending on the product, quantities may use kg or other units such as pairs or m². Therefore, to ensure consistency with MFA, all quantities are converted to kg by using conversion factors adopted by (Napolano, 2025) which are available at Table 6 of the appendix.

The remaining data gaps in the time series are filled in following the steps below:

- For each country-product pair, a raw baseline country-year matrix is constructed. To correctly represent cohort inflows and stock accumulation, raw data from 2004 to 2024 were collected for all country products. This step simply refers to reporting and mapping the raw, available PRODCOM and COMEXT trade data into an organized country-year matrix to establish a baseline grid. No missing data is filled in during this initial mapping step. These baseline time series were constructed first because using long historical time series increases the number of available observations, which reduces the influence of isolated data points and allows for more statistically robust estimations in the following steps, especially in heterogeneous material flows (Brunner, Rechberger, 2016).
- Internal Gap Imputation: If three or more valid observations are available, missing values are filled by using linear interpolation for internal gaps.
- Boundary Imputation: if the missing values are at the beginning or the end of the time series, the nearest available empirical value is used and held constant as a fixed boundary value (standard Last Observation Carried Forward or Next Observation Carried Backward techniques). This means the closest real data point is copied flat to the edges of the time series to prevent artificial trend drop-offs at the temporal limits.
- Scarcity Resolutions: If fewer than three observations are available, missing values are filled with the means of available observations.

Outliers are identified using the interquartile range rule and are treated as statistical inconsistencies rather than structural market changes. By using the same steps, these identified anomaly values are completely purged and replaced with values calculated via linear interpolation using the closest compliant, valid data points immediately preceding and following the outlier year. This combined method ensures a consistent and continuous dataset suitable for calculating apparent consumption, which is required for forecasting post-consumer textile waste.

4.5 Material Flows and Construction of Apparent Consumption

Inflows to the system are defined as the finished textile products- both domestically produced and imported- that are placed on the market, sold and entered the use phase. Outflows include the textiles that reach their end of useful life and become waste and exports of the textile products.

Considering the adopted system boundaries and acknowledging the logic of material flow analysis mass balance, secondhand exports are considered as an outflow from the in-use stock to ensure consistency of stock flow accounting and do not imply any assumption regarding waste management in destination countries. This approach is adopted, irrespective of item's classification as product or waste under the revised EU shipment regulation which mandates that all end-of-life textiles are classified as waste for better inspection and prior control of cross-border shipments (European Commission, 2025). From a mass-

balance perspective, these flows must be excluded to accurately represent the potential of PCTW generation. Furthermore, due to inherent limitations in tracking informal consumer behavior, the precise volume of the internal reuse loop is not mathematically quantified.

Apparent Consumption is then calculated as follows (Eq. (1)):

$$\text{Apparent Consumption}_t = \text{Sold Production}_t + \text{Imports}_t - \text{Exports}_t \quad (1)$$

Negative values may exist for some product\years but do not imply negative use; they simply reflect the limitation of supply-use accounting based on production and trade statistics. Negative Apparent Consumption typically arise when exports exceed the sum of current year's production and imports. This situation is driven by re-exports, exports from previous years' stock or temporal reporting mismatches. These challenges are explicitly recognized in the PRODCOM manual, which notes that Apparent Consumption derived from “sold production + imports - exports” could be affected by stock changes and re-exports and should therefore be interpreted with caution when using as a proxy for domestic use (EUROSTAT, 2023; Brunner, Rechberger, 2016). In the present study, these inconsistencies are addressed by using a data reconciliation procedure detailed in the next section.

Figure 8 illustrates the textile flows within the EU borders:

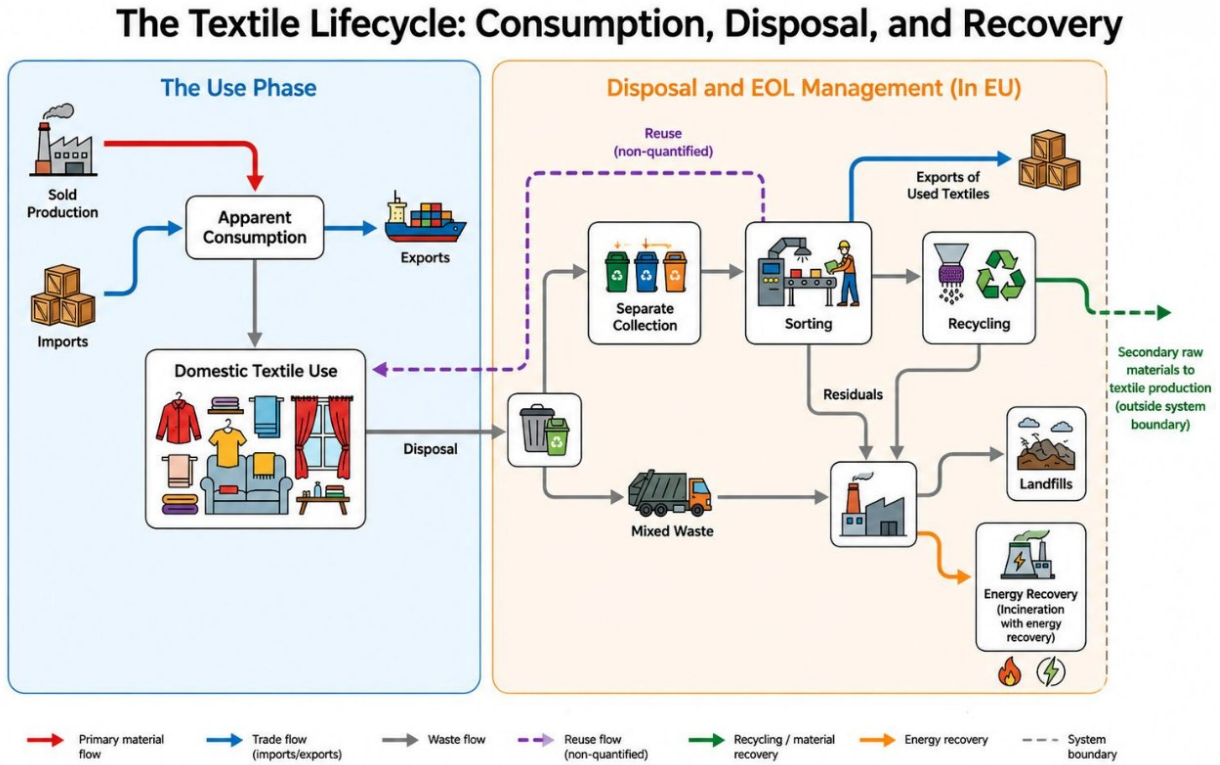


Figure 8: Representation of textile flows within EU system boundaries

4.5.1 Reconciliation of Apparent Consumption for DPMFA Inflow

Since no EU-wide official data exists for quantifying re-exports, stock change, or the share of sold imported used textiles, apparent consumption cannot be directly interpreted as the inflow to the use phase (JRC, 2025; Köhler, 2021). It is therefore considered a noisy proxy affected by trade-related inconsistencies,

which require to be reconciled to ensure physical plausibility and compatibility with the DPMFA framework (Wang, 2024). Following this logic, simple exponential smoothing as presented by (Paolo Brandimarte, Giulio Zotteri, 2007) is used as a filtering technique for noisy time series, and apparent consumption is reconciled to construct a physically meaningful inflow to the in-use stock.

As discussed by (Paolo Brandimarte, Giulio Zotteri, 2007), simple exponential smoothing is based on a recursive updating mechanism that combines the current observation with previous estimates through a weighting parameter. This approach allows the balancing of responsiveness to new data against the ability to filter irregular short-term fluctuations. A known implication of this recursive structure is that an outlier initial observation may influence the early part of the smoothed series, however, the effect progressively decreases over time at a rate governed by the smoothing parameter α .

In this study, exponential smoothing is not used as a forecasting tool, but as a reconciliation procedure with the goal of enforcing temporal coherence and consistency with the physical stock-flow relationships required by the DPMFA.

Considering x_t as the raw apparent consumption in year t , a reconciled inflow to the in-use stock, s_t , is constructed using exponential smoothing.

Applying a single-period initialization, the reconciled estimate for the first year is defined as per Eq. (2):

$$s_1 = \max(0, x_1) \quad (2)$$

And Eq. (3) calculates the reconciled for the subsequent years $t = 2, \dots, T$:

$$s_t = \max(0, \alpha x_t + (1 - \alpha)s_{t-1}) \quad 0 < \alpha < 1 \quad (3)$$

The operator $\max(0, \dots)$ enforces the physical feasibility condition to ensure the reconciliation procedure does not generate new negative values (Brunner, Rechberger, 2016).

4.5.2 Selection of the Smoothing Parameter

The smoothing parameter α controls the trade-off between responsiveness to year-to-year variations of apparent consumption and temporal stability of the inflow series, as discussed by (Paolo Brandimarte, Giulio Zotteri, 2007): lower values of the smoothing parameter provide stronger noise filtering, and higher values increase the reactivity to recent observations.

In the present study, the smoothing parameter is considered a statistical parameter and estimated in a data-driven manner. Following (Rob J Hyndman, George Athanasopoulos, 2021), the selection procedure is carried out through minimizing the one-step-ahead prediction error across all country-product time series for a “global” parameter.

Under the Simple Exponential Smoothing formulation, let $\hat{x}_{t|t-1}$ denote the one-step-ahead reconciled value for period t using data available up to period $t-1$. This reconciled value is equivalent to the smoothed state from the previous period, as given by equation (4):

$$\hat{x}_{t|t-1} = s_{t-1} \quad (4)$$

The corresponding one-step-ahead smoothing error for a given α , which represents the tracking deviation between the raw data and the model smoothed baseline for a single-year step ahead is therefore expressed as equation (5):

$$e_t(\alpha) = x_t - s_{t-1}(\alpha) \quad t = 2, \dots, T \quad (5)$$

Where:

$e_t(\alpha)$ represents the smoothing residuals at time t evaluated for a given value of alpha.

x_t is the raw unjustified empirical data point observed in the current period t

$s_{t-1}(\alpha)$ is the smoothed baseline level brought forward from the previous period, which is likewise a function of the selected alpha

The optimal smoothing parameter α^* is obtained by solving the Eq. (6):

$$\alpha^* = \text{argument min} \sum_{i=1}^N \sum_{t=2}^{T_i} e_{i,t}^2 \quad (6)$$

Where:

i is indexes country – product time series

N is the total number of series

T_i is the time length of series i

Minimizing the Root Mean Squared Error (RMSE) gives the same optimal parameter since :

$$RMSE(\alpha) = \sqrt{\frac{1}{M} \sum e^2} \quad (7)$$

Where M is the total number of one-step-ahead errors.

4.5.3 Reconciliation' Residuals and Structural Consistency

The difference between the inflow and raw apparent consumption is reconciliation residuals r_t as represented in Eq. (8):

$$r_t = s_t(\alpha^*) - x_t \quad (8)$$

To verify that the reconciliation primary goal is to correct short-term statistical inconsistencies rather than altering the structure of the material inflows, the cumulative adjustment is evaluated as Eq. (9):

$$R = \sum_{t=1}^{T_i} \sum_{i=1}^N r_{i,t} \quad (9)$$

Following common practices in MFA, this cumulative adjustment (R) is assessed relative to total reconciled throughput to calculate the relative deviation, as expressed in Eq. (10). This ensures transparency regarding the magnitude of the adjustments (Brunner, Rechberger , 2016).

$$D_{rel} = \frac{R}{\sum_{t=1}^{T_i} \sum_{i=1}^N s_{i,t}} \quad (10)$$

The cumulative deviation represents the percentage of total reconciled throughput and considering the inherent uncertainty in trade and production and total material flows, a small relative deviation indicates that the reconciliation procedure does not introduce meaningful structural bias in the aggregate inflow. In

this context, Simple Exponential Smoothing is a linear filtering technique which redistributes temporal fluctuations while preserving the underlying level of the series when applied consistently (Paolo Brandimarte, Guilio Zotteri, 2007; Rob J Hyndman, George Athanasopoulos, 2021). Consequently, evaluation of cumulative residuals with regard to the total throughput provides a quantitative verification that smoothing maintains consistent with MFA mass-balance principles.

Based on the multi-tiered validation approach, the reconciliation procedure achieved the following results across the 2004-2024 time series:

- The grid search optimization identified an optimal global alpha of 0.45. This value represents the global minimum for the one-step-ahead Root Mean Square Error (RMSE) across the entire multi-national data points, ensuring that the filter is neither too reactive nor too slow to catch the noise. Full empirical data of this optimization is documented in Appendix (Table 8).
- The procedure was essential to resolve errors in the raw trade data causing negative values. Without reconciliation some countries' data contain high number of physically impossible values. Notable examples are Bulgaria (1102 negatives), Slovakia (843 negatives) and Portugal (796 negatives). The enforcement of the non-negativity constraint successfully repaired these artifacts ensuring a plausible mass-flow.
- The global structural deviation between the raw and smoothed time series resulted in a macro-level net mass adjustment equivalent to 7.13% of the total reconciled inflow. This share represents the exact aggregate corrective mass required to offset the identified negative statistical artifacts embedded within the raw reporting records. The low magnitude of this net bias confirms that the Simple Exponential Smoothing (SES) successfully functions as a conservation-consistent linear filter that preserves the underlying material throughput while redistributing temporal fluctuations to satisfy the physical laws of MFA. A comprehensive country-by-country ledger detailing the raw baseline volumes, the reconciled flows, and the exact distribution of this 7.13% structural adjustments is provided in Appendix (Table 9). While the aggregated adjustment is low, the relative percentage changes for individual countries exhibit significant variance due to mass-weighting effect.

By resolving trade-related inconsistencies and enforcing physical plausibility, the reconciled series provides an inflow required for the subsequent DPMFA, where temporal lag between this consumption and eventual waste generation is modeled using probabilistic lifetime distributions.

4.6 Dynamic Probabilistic Material Flow Analysis (D-PMFA) and Scenario Based Models

4.6.1 Application of Lifetime Distributions to Estimate Discarded Textiles

Since textiles have a limited and heterogeneous lifespan before they are discarded, a single value cannot sufficiently represent their disposal. Given the quality of textiles, use patterns, and consumer behavior (Klepp, 2020), they could have a different lifetime, so probabilistic distribution is used to describe the likelihood of disposal after different years of use.

In practice, different lifetime distributions could be employed, such as Weibull, Log-normal, Gamma, and Exponential; however, due to limited available empirical data, a triangular distribution is used, which does

not require additional shape assumptions. The minimum, average and maximum lifetime of products are available from Laitala K. K.(2018) and the International Fair Claims Guide (2015). The full list is available in Table 6 of the appendix. This distribution accounts for variability in product longevity using the available data and avoids additional assumptions required by more complex parametric distributions and it is also efficient for Monte Carlo simulations (Brunner, Rechberger , 2016).

Lifetime parameters are specified per product category and are considered to remain constant over time due to lack of consistent data on changes in textile use duration. This assumption allows the model to capture aggregated stock-driven outflow dynamics rather than predicting individual disposal decisions.

4.6.2 Monte Carlo Simulation

Probabilistic lifetime distributions are applied within a DPMFA framework to explicitly account for uncertainty in the timing of PCTW generation. DPMFA extends conventional dynamic MFA by representing key model parameters as probability distributions rather than fixed values, allowing uncertainty to be propagated through the system using Monte Carlo simulations (Bornhöft, 2021)

The model follows a cohort-based structure, where each annual inflow cohort represents the quantity of textile products entering use phase within each individual country in a specific year Figure 9. This structure ensures that all data are systematically disaggregated by country, product category and time. This high level of resolution enables products introduced in different years, regions and categories to be tracked separately over time and to generate waste at different points in the future, preserving temporal heterogeneity in material flows and avoiding artificial smoothing of waste generation profiles (Bornhöft, 2021; Napolano, 2025).

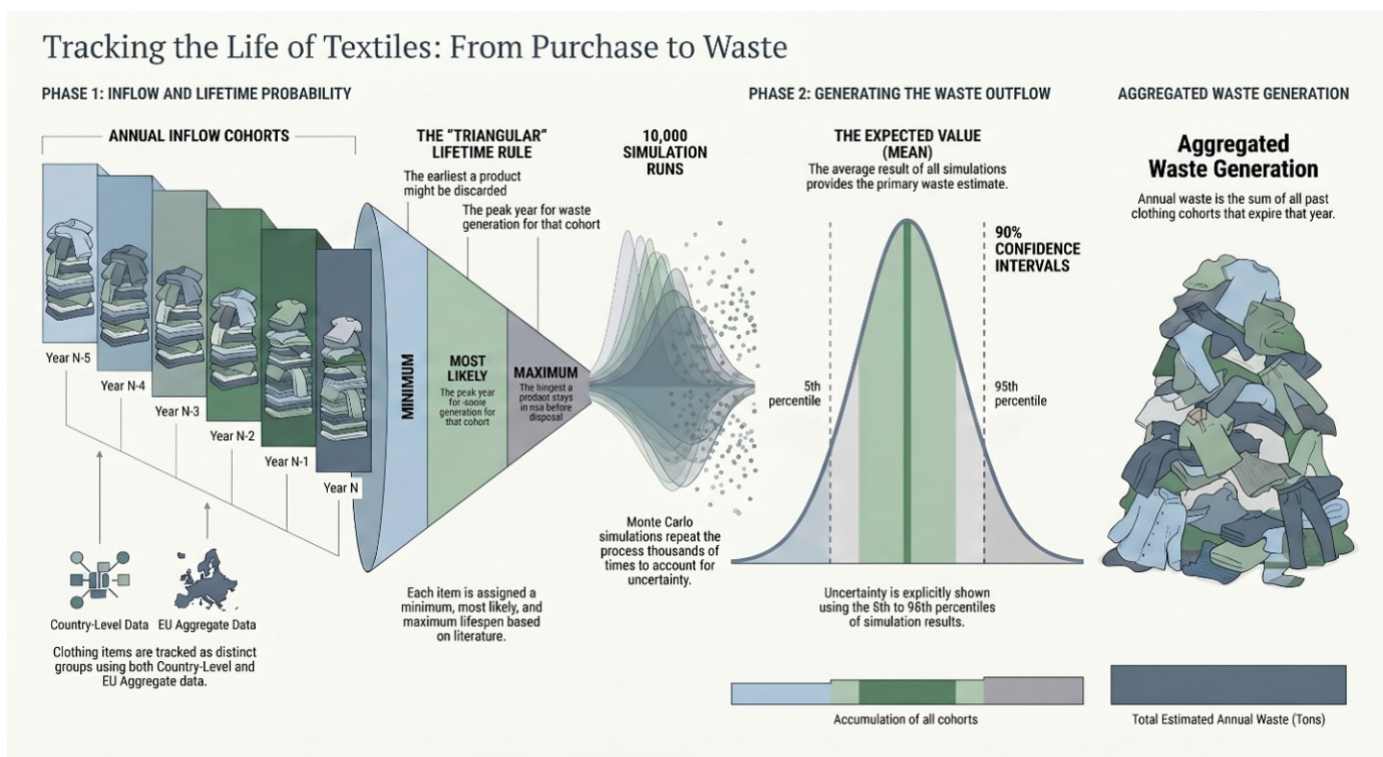


Figure 9: Cohort-Based Structure

Uncertainty is primarily associated with product lifetimes. For each country, product category and each annual inflow cohort, product lifetimes are modeled using a triangular probabilistic distribution, reflecting the minimum, most likely and maximum service life reported in the literature. For each Monte Carlo iteration, lifetimes parameters are sampled at the iteration level to account for parameter uncertainty across the simulation runs, rather than assigning a single deterministic lifetime to the entire time series. The sampled lifetimes determine the year in which each cohort reaches its end-of-life phase and exits the in-use stock and generate waste outflows. Annual PCTW is calculated by aggregating the outflows from all the historical inflows cohorts whose sampled lifetimes expire in the same calendar year (Abbasi, 2023)

The computational model and data pipeline are developed and executed within the JupyterLab environment using Python (version 3.11). The simulation utilizes the NumPy and Pandas libraries for high performance matrix data manipulation and structured data array operations. The Monte Carlo sampling is applied at the annual inflow cohorts independently for each individual product code within each country and repeated over many independent iterations (10,000 runs). This process produces a distribution of annual waste output rather than a single deterministic value, capturing the combined effects of lifetime variability and cohort-specific inflow dynamics at a granular country and product specific level. Such probabilistic representations are widely used in recent DMFA studies to improve the robustness and transparency of waste generation estimations. (Abbasi, 2023; Bornhöft, 2021).

The primary estimate of the annual PCTW is taken as the expected value (mean) of this distribution across all Monte Carlo simulation runs. Uncertainty ranges are quantified using 95% confidence intervals (e.g. 2.5th-97.5th percentiles) which provide a nonparametric and interpretable measure of uncertainty consistent with current practice in PDMFA (Abbasi, 2023; Napolano, 2025).

The expected values of the Monte Carlo are used as the main outputs of the model in scenario analysis and regional downscaling, while associated uncertainty intervals are reported to reflect the probabilistic nature of the results and to support robust interpretation in policy and planning context.

This Monte Carlo procedure is first applied to baseline year 2019, quantifying the national waste volume under observed historical textile inflows. By calculating the expected value and the 95% confidence intervals for this reference year, the model provides a starting point that accounts for the cumulative effect of the previous 15 years of consumption. This baseline results serve as the primary mathematical anchor for the study; it is used as the benchmark for comparing future waste volumes under different scenario-based models.

4.6.3 Scenario Modeling

To extend the estimation beyond the most recent observed year (2024), forward projections are developed. The objective is first to forecast waste generation under business-as-usual conditions and evaluate the impact of policy-driven collection scenarios introduced under the 2025 mandate.

- Future inflow to use is projected using a constant compound annual growth rate (CAGR) of 3% consistent with the outlook of the EU Strategy for Sustainable and Circular Textile and stakeholder expectations reported in the JRC workshop (European Commission, 2022). Projected inflows after 2024 are calculated using Eq. (11)

$$Inflow_{2035} = Inflow_{2024}(1 + CAGR)^{\Delta t} \quad (11)$$

Where Δt denotes the number of years after 2024.

As previously noted in section 4.2.2, market fluctuations caused by COVID-19 fell beyond the scope of this study. However, to provide comparative analysis, the 3% CAGR (European Commission, 2022) was applied from two different anchor years, 2020 and 2024, to observe the reality of market during the pandemic against theoretical assumptions. The results demonstrated a significant divergence; using the real official data for 2020 to 2024 resulted in a lower amount of waste for 2035, while applying the 3% growth rate from 2020 led to higher amount of future waste generation bypassing the effects of the pandemic.

- To guarantee consistency across scenarios every structural parameter of the model remains unchanged during the analysis. This encompasses the system boundaries, product range, baseline year selection, imports and exports treatment, lifetime distribution parameters and the approach for downscaling national to NUTS2 level. By maintaining these structural variables as constants, any observed variations between scenarios can be primarily attributed to changes in policy parameters, combined with the probabilistic uncertainty and variance introduced through the Monte Carlo simulation, which transforms a standard deterministic framework into a robust stochastic analysis.

Using these projected inflows, the Monte Carlo simulation described in 4.6.2 is applied to estimate annual PCTW for each country up to the target year 2035. The baseline scenario represents a continuation of current trends in textile consumption and waste generation serving therefore as the reference pathway against which alternative policy scenarios are evaluated.

The latest available country-level separate collection rates of 2020 from (EEA, 2024) are used as baseline rates. From 2025 onward, collection rates are assumed to increase linearly from the 2020 levels to scenario-specific target levels by 2035.

The baseline PCTW figures obtained from the model are used as inputs to the policy scenarios which do not alter waste generation but determine the share entering collection and treatment pathways.

Two main scenarios are considered:

1) **Country-Level independent waste collection (CL)**

Following established methodological approaches that contrast country-level baseline models against EU-wide harmonized policy scenarios (Trivyza, 2025), each country's latest available separate collection rates referring to year 2020, as reported by EEA (2024) are taken as a baseline and increased by 10%, 20% or 50% to represent gradual improvements following the mandatory separate collection. However, for countries that reported a baseline collection rate of zero for the reference year, the lowest non-zero rate among the countries was adopted as a proxy baseline to enable the calculation of gradual future improvements.

2) **EU-Wide harmonized separate waste collection (EU)**

Absolute EU-wide benchmark levels- 50%, 75% or 100% of separate collection rates for textiles are applied horizontally to all EU countries, representing a scenario with coordinated implementation of the policy. Unlike the baseline values, these benchmark levels are defined ex-ante to consider the policy pathways regardless of uneven national reporting. For countries already reached the benchmark, the higher existing rate is considered.

After estimating national and regional PCTW volumes, scenario-based collection rates are applied to determine the quantities entering separate collection systems. This study focuses exclusively on the treatment pathways of these separately collected volumes. The collected amounts are allocated to treatment pathways (e.g. recycling, landfill, incineration, reuse) using EU-level textile-specific end-of-life shares derived from European Commission (2023). Under this framework, 45% of collected textiles are allocated to reuse, 32% to recycling which is primarily downcycling, and 5-10% to energy recovery or landfill (no distinct percentage mentioned for landfill and incineration) and 13-18% to unaccounted pathways in 2019.

This approach ensures that the allocation of collected textile waste to treatment pathways is textile specific and avoids the methodological limitations of using mixed municipal waste proxies, which can significantly overestimate textile recycling rates due to higher recyclability of other materials like paper and plastic in the mixed waste, providing a more accurate estimate of textile circularity.

For the remaining fraction of PCTW that is not separately collected (disposed of in mixed waste), the majority is incinerated or landfilled. In 2019, 45% of total textile waste including mixed waste was incinerated for energy recovery, with the remainder landfilled (exact share not specified) (European Commission, 2023).

4.6.4 Downscaling the Results

To gain a more regional understanding of textile waste generation, national level estimates are downscaled to NUTS2 using population and household disposable income indicators. These variables are selected to reflect regional differences in both the number of consumers and their actual purchasing power, while maintaining consistency and comparability across countries (Blagoeva, 2023).

Population is used as a primary scaling variable since waste generation is correlated to the number of people living in a region. It is reasonable to assume that areas with larger populations will produce proportionally more textile waste simply because more consumers are present and therefore more textile products enter the use and eventually leave the use phase.

Household disposable income is used as a complementary indicator to capture the regional differences in income and purchasing behavior that are not captured by population. While Gross Domestic Product (GDP) measures the overall economic output-including corporate, government and industrial activities- household disposable income accurately reflects the actual money available to private consumers for spending. Higher income levels usually lead to higher aggregate material consumption; however, it must be considered that the relationship between income and textile purchasing is not linear across different consumer groups and regions. For instance, fast fashion is highly prevalent among lower-to-middle income consumers, which can lead to faster replacement cycles. Nevertheless, regions with higher average disposable income possess greater overall purchasing power, which ultimately drives higher total textile consumption, accelerated turnover rates, and increased waste generation.

Considering this complexity, household disposable income is not used to directly determine the replacement rates and acts as a weighting factor that adjusts population-based allocations to better reflect economic variations across regions, providing a more realistic representation of textile waste flows. The combination of population and household disposable income provides a transparent and harmonized basis for regional downscaling and avoids complex behavioral assumptions.

Other criteria such as retail density, urbanization rates, or demographic structure could theoretically improve the accuracy of the downscaling however their limited data availability and lack of standardization at the NUTS2 level makes population and household disposable income the most feasible proxies.

Allocation of national PCTW is performed using household disposable income at NUTS2 level, available via Eurostat, acting as an indicator of regional consumption intensity while population accounts for differences in market size in regions. For each NUTS2 region g , a weighting factor is computed as the product of regional population and regional household disposable income (Eq. (12)). These weights are normalized by dividing each regional weight by the sum of all NUTS2 regions' weights within the country to derive the specific regional allocation shares as per Eq. (13).

$$Weight_g = Population_g \times Disposable Income_g \quad (12)$$

$$Regional Share_r = \frac{Weight_g}{\sum_j Weight_j} \quad (13)$$

g : NUTS2 region

j : summation index running over all NUTS2 regions within a country

Finally, by multiplying the national waste figures by regional shares, we obtain the regional PCTW (Eq. (14)). In this way national PCTW is accurately distributed across NUTS2 regions while strictly preserving the national mass balance.

$$Regional Waste_g = Regional Share_g \times National Waste_n \quad (14)$$

5 Results and Validation

This chapter presents the comprehensive results generated by the Dynamic Probabilistic Material Flow Analysis (DPMFA) framework. While previous institutional studies have provided valuable estimates of PCTW generation and management across Europe, they have primarily focused on EU aggregate level flows (Napolano, 2025; Amicarelli, 2022; Köhler, 2021), the primary objective of this research is to disaggregate these flows to identify national and regional infrastructure bottlenecks and to evaluate future waste generation trajectories under different policy scenarios.

Before analyzing spatial distribution and future projections, the model outputs must be assessed to ensure that the framework produces internally consistent and externally plausible results. Direct empirical validation of macro-level textile waste flows remains challenging due to the limited availability of harmonized end-of-life textile data across Europe. Furthermore, because future waste generation cannot be observed in the present, the credibility of long-term forecasts depends on the model's ability to produce realistic historical conditions.

To manage the inherent uncertainties of forecasting without perfect empirical data this framework explicitly addresses uncertainty through two distinct mechanisms:

1. **Parametric Uncertainty through Monte Carlo Simulations:** Uncertainty regarding the lifetimes is explicitly modeled within a probabilistic framework through Monte Carlo Simulations, which gives the 95% confidence intervals that serve as the primary indicator of systemic resilience under uncertain assumptions. This step establishes the probabilistic distribution of total PCTW generation.
2. **Structural Uncertainty through Scenario Analysis:** Future socio-technical developments and NUTS2 downscaling are addressed through scenario analysis. It must be explicitly noted that the Monte Carlo simulations and scenario analysis are applied sequentially, not simultaneously. The expected generation values (means) derived from the probabilistic Monte Carlo model serve as inputs for evaluating the distinct collection policy scenarios.

5.1 Probabilistic Modeling and Monte Carlo Outputs

The estimation of PCTW generation is inherently associated with uncertainty, primarily due to variations in textile product lifetimes and fluctuating consumption inflows. To account for this variability, Monte Carlo simulations were conducted for each of the 27 Member States producing comprehensive probability distributions rather than relying on single deterministic estimates.

As illustrated in Figure 10, the simulation estimates the total PCTW generated across the EU-27 in 2019 at a mean of 9.93 Mt with a 95% confidence interval ranging from 8.68 Mt to 11.28 Mt. While individual product categories were initially modeled using triangular distributions, the aggregated probability distribution for the entire EU-27 market closely approximates a normal distribution (figure 10a). This statistical convergence is a direct manifestation of the Central Limit Theorem. Furthermore, the slightly multimodal profile of the aggregated curve accurately reflects the deep heterogeneity of the EU textile market, capturing distinct product lifetime characteristics and discard behaviors across different regions. Figure 10b further highlights the concentration of results around the median. The absence of extreme outliers suggests that the estimated uncertainty remains bounded within a highly plausible range. While

variability is integral to the modeling framework, the simulation does not yield highly unstable or unrealistic outcomes.

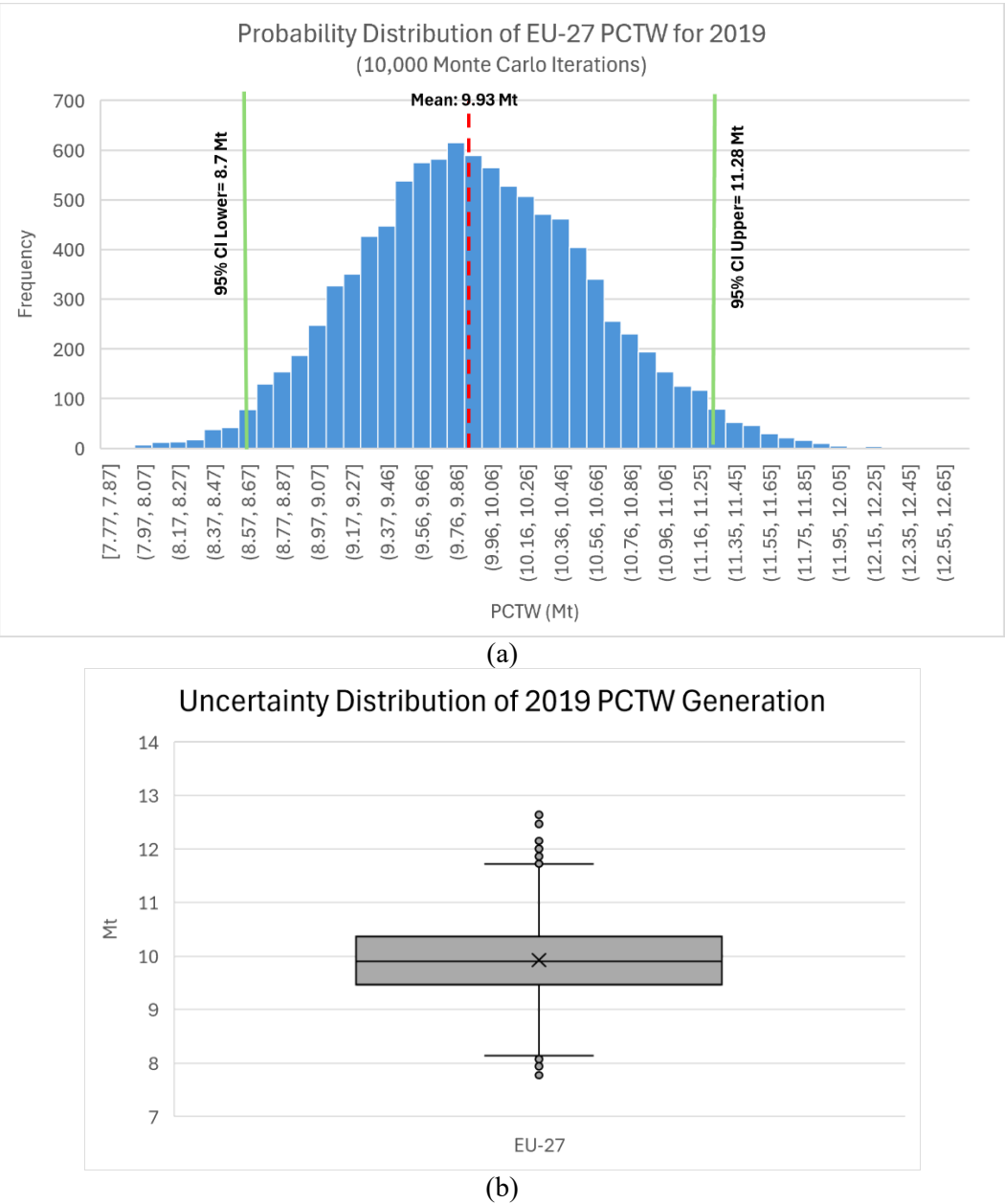


Figure 10: (a) Probability Distribution and (b) Uncertainty Distribution of EU-27 PCTW generated for 2019, 10,000 Monte Carlo iterations

Examining the national breakdown in Figure 11 shows how the total EU-27 uncertainty is distributed across the 27 Member States. Since same lifetime distributions are applied across all Member States, a country’s absolute uncertainty range is naturally proportional to its market size. As a result, largest consuming markets display the widest ranges in waste generation. The chart clearly provides the fact that while the total EU-27 uncertainty is the combined result of all 27 nations together, any shift in consumer behavior within the top markets will cause the most significant disruptions to the overall EU-27 waste totals.

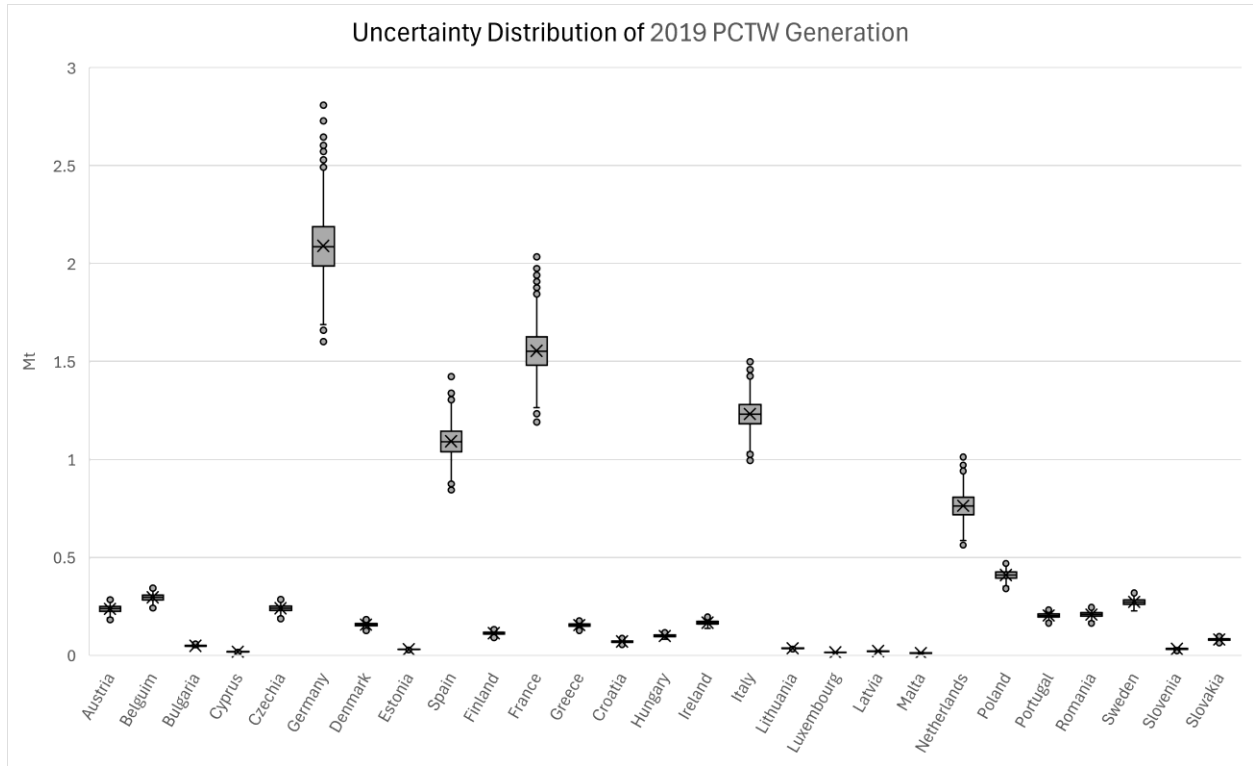


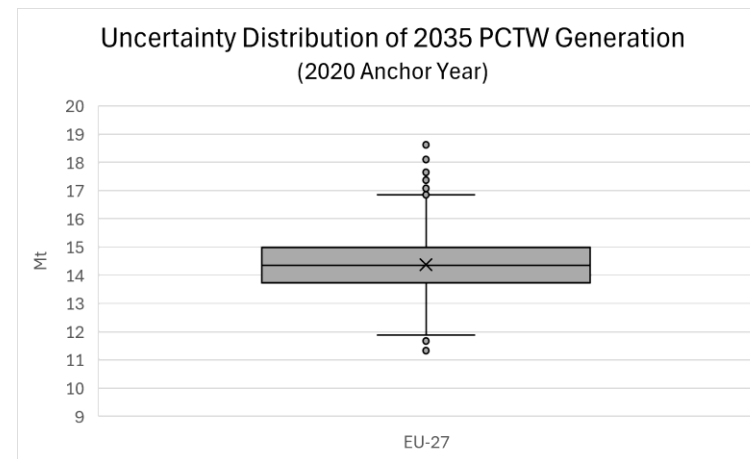
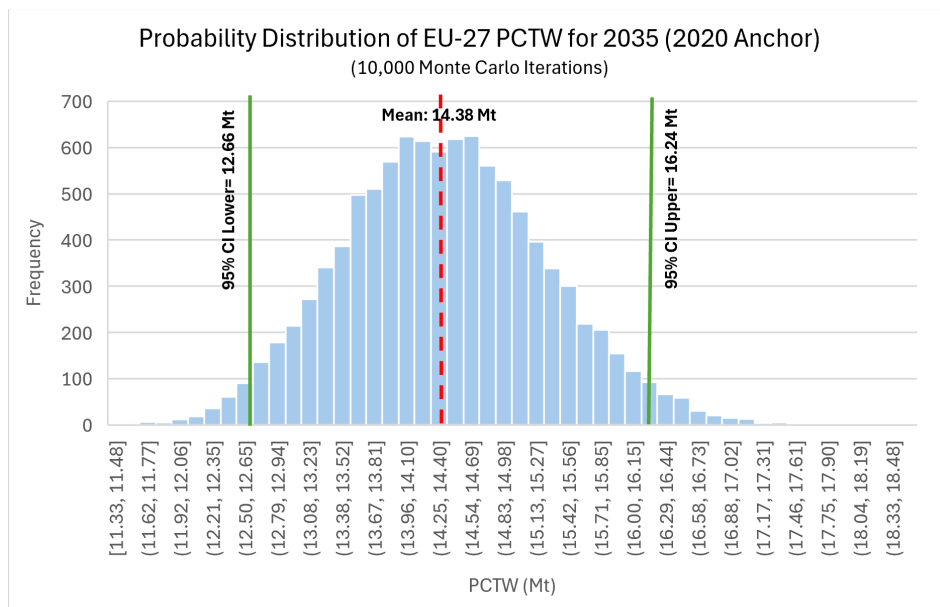
Figure 11: Uncertainty Distribution of PCTW generation across EU member states in 2019, reflecting lifespan uncertainties.

5.1.1 Uncertainty Propagation in 2035 Forecasts

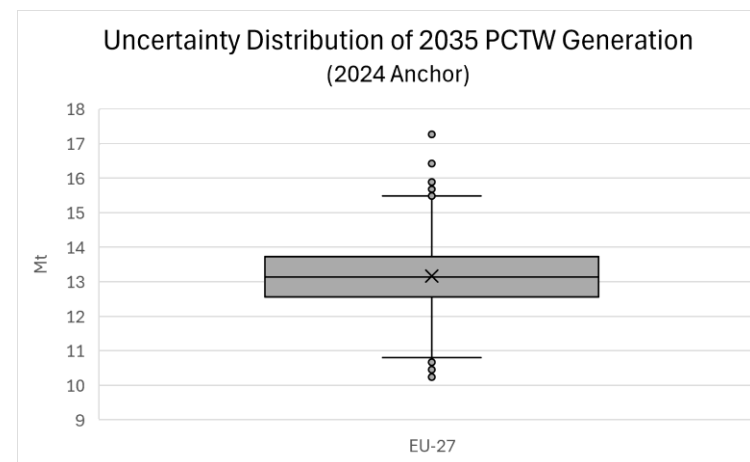
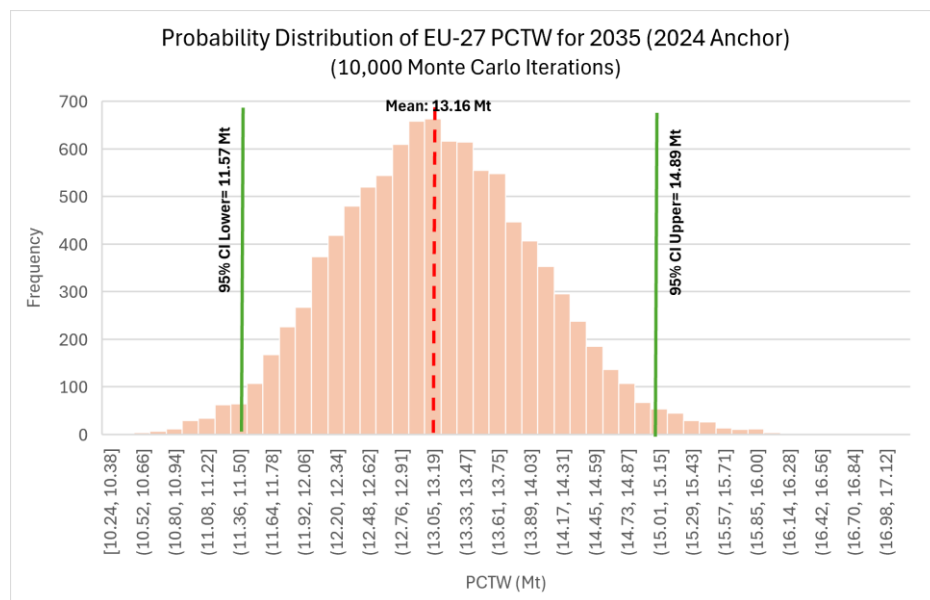
Extending the probabilistic framework to the 2035 forecasting horizon reveals the critical phenomenon of uncertainty propagation. The compounding effect of the Monte Carlo lifespan distributions over a 15-year period visually manifests in the widening of both the histograms and interquartile ranges (Figure 12).

Furthermore, the notable divergence in expected means between the 2020 and 2024 anchor years captures the lingering disruption of macroeconomic shocks on material flows. This variance proves that long-term PCTW generation is highly sensitive to fluctuations in purchasing power and consumption rates.

Translating this uncertainty propagation to the national level (Figure 13) demonstrates that this volatility is not uniformly distributed. Instead, the expansion of interquartile ranges is disproportionately magnified within high-consuming demographic hubs. As the lifetime distributions propagate through the simulation, the absolute variance in nations like Germany expands significantly across both anchor years. This uneven magnification confirms that fluctuations in localized economic drivers can rapidly push actual waste generation toward the extreme upper bounds of these forecasted distributions in major markets.

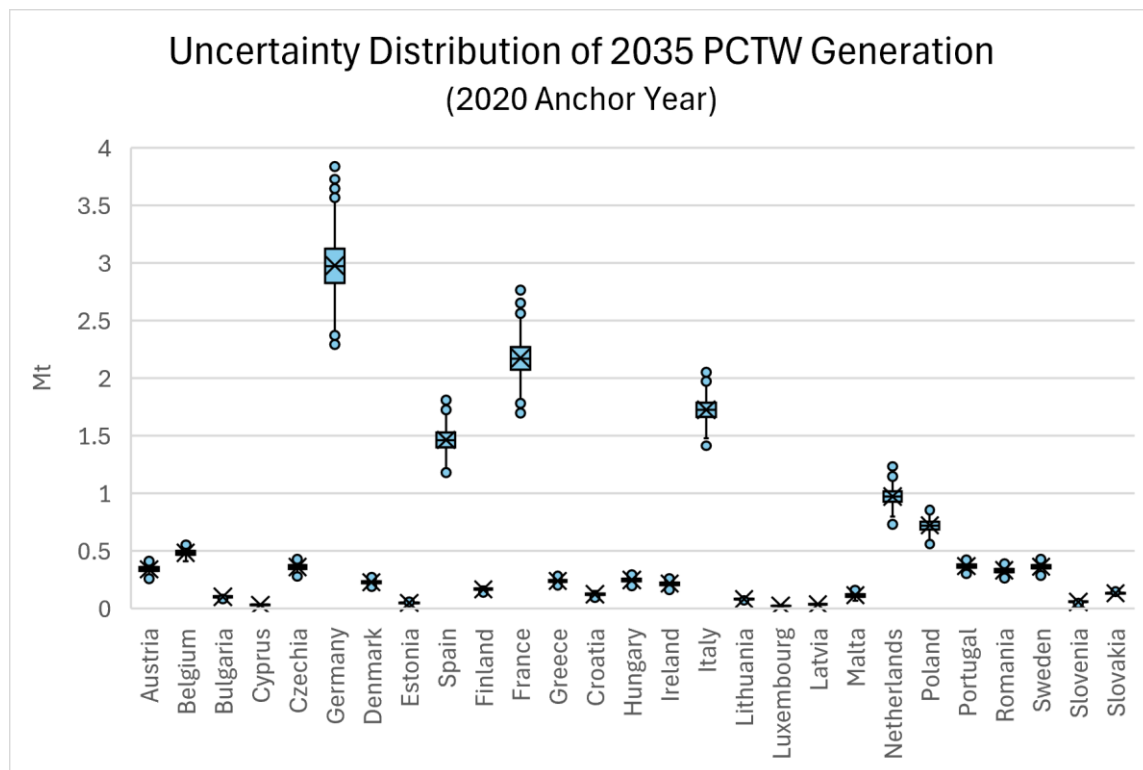


(a)

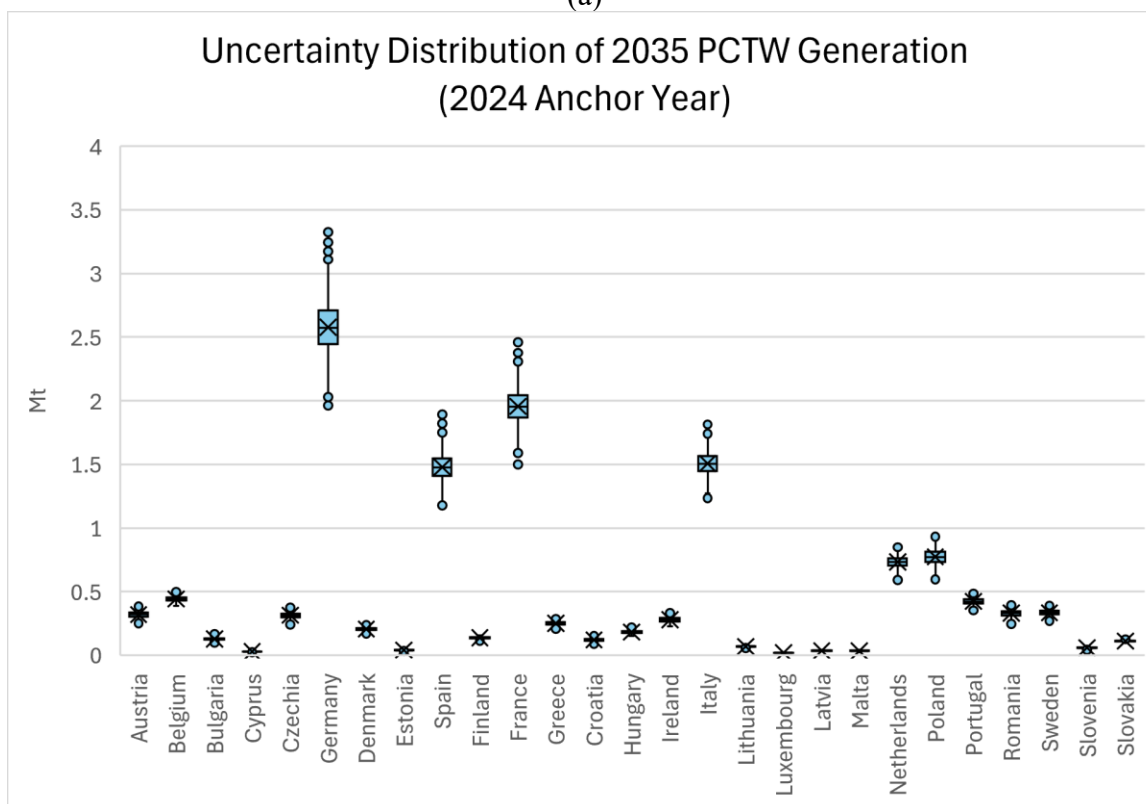


(b)

Figure 12: Monte Carlo Results for 2035 Projections (a) under 2020 anchor year (b) under 2024 anchor year



(a)



(b)

Figure 13: Uncertainty Distribution of Member States under (a) 2020 anchor year (b) 2024 anchor year

Consequently, these findings highlight the fragility of utilizing single-point deterministic estimates for policy design. European waste directives must abandon static forecasting and instead integrate dynamic review mechanisms capable of managing these broad probabilistic boundaries. For a comprehensive numerical breakdown of these projections, the complete set of Monte Carlo results is provided in the Appendix Table 11 and Table 12.

Having established the probabilistic boundaries of the Monte Carlo simulations, the figures and analyses in the subsequent sections present the expected mean values. This approach is adopted strictly to ensure visual clarity and facilitate straightforward comparison across spatial mappings and policy scenarios.

5.2 Apparent Consumption: Macro-Level Baseline Validation

The model's estimate regarding consumption of new textile products (reconciled apparent consumption) equals 24.6 kg person⁻¹ year⁻¹ for 2019 baseline which is consistent with previous studies in literature (EURATEX, 2020; EEA, 2022) that reports the consumption range from 24 to 29.3 kg person⁻¹ year⁻¹ for the year 2019.

The EU-27 PCTW estimate for the reference year 2019 was calculated by the DPMFA model in two different independent pathways.

1. A bottom-up approach: data reconciliation procedures and Monte Carlo simulations were performed separately for each of the 27 Member States. The resulting national estimates were then aggregated to produce an EU-wide total equal to 9.65 Mt, with a 95% confidence interval ranging from 8.45 Mt to 10.96 Mt.
2. A top-down application: the same reconciliation and simulation procedures were applied directly to the aggregated EU-27 dataset which produced a mean estimate of 9.93 Mt with 95% confidence interval ranging from 8.68 Mt to 11.31 Mt.

The difference between the two estimates amounts to 0.28 Mt, representing less than 3% of total EU-wide generation. Such variation is expected because the recursive smoothing and reconciliation procedures operate on datasets with different statistical characteristics. Applying the methodology to multiple heterogeneous national datasets may produce slightly different parameter adjustments than applying to a single aggregated dataset. Nevertheless, the close correspondence between the two results indicates that the framework remains stable across different aggregation scales and does not introduce significant systemic distortions during the modeling process.

While this comparison supports the internal consistency of the framework, it does not on its own demonstrate that the resulting estimates are representative of real-world conditions. Therefore, the aggregate EU-27 baseline was benchmarked against the DPMFA study conducted by Napolano (2025).

As illustrated in Figure 14, the institutional baseline estimate reported by Napolano (2025) is 10.92 Mt, which falls between the 95% confidence intervals generated by the present model. The difference between the two estimates is approximately 1 Mt, corresponding to a deviation of around 10%. Given the inherent uncertainty associated with macro-level textile waste quantification, this level of agreement can be considered reasonably close. Although both studies utilize comparable underlying datasets, differences in model structure may contribute to the observed variations. Napolano (2025) models textile flows across broader value chain, whereas the present study focuses specifically on the use and disposal phases.

Consequently, differences in system representation, data reconciliation procedures and uncertainty treatment may influence the resulting estimates.

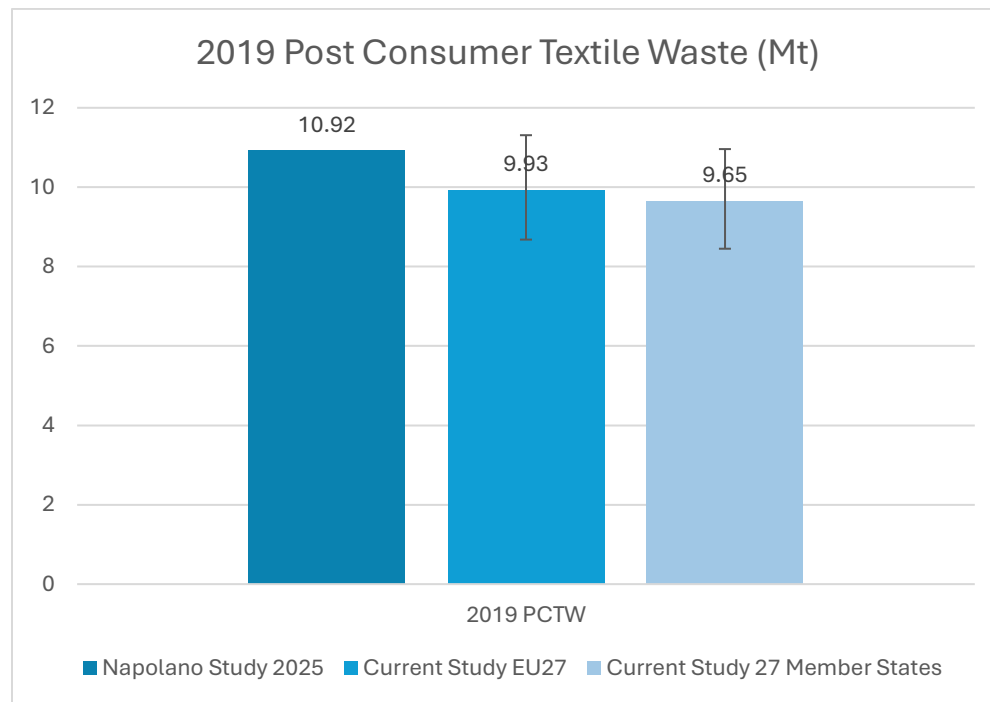


Figure 14: Comparison of Baseline Year (2019) Results with Napolano Study

Overall, the agreement between the benchmark value and the confidence range generated by the present study provides evidence that the framework produces plausible estimates of EU-27 PCTW generation. This validated baseline forms the foundation for the subsequent national, regional and future scenario analysis presented in the following sections.

Following the validation of the baseline year results, the chapter presents the main findings of the study, including:

- i) national level post-consumer textile waste generation across the EU-27 in 2019 (section 5.3)
- ii) projected future trajectories for 2035 under different policy scenarios (section 5.4)
- iii) the spatial downscaling of the results to the NUTS2 regional level (section 5.5)
- iv) treatment pathways share of separately collected textiles considering EU average rates (section 5.6)

5.3 National Level Results and Disparities:

While EU-wide aggregates provide an important and useful overview of PCTW generation, the implementation of the Waste Framework Directive (WFD) ultimately occurs at the Member State level. A key contribution of this study is therefore the estimation of national-level PCTW flows, which enables the identification of geographical disparities in waste generation and the assessment of country-specific infrastructure requirements.

The results reveal substantial variations in PCTW generation across the EU-27, as illustrated in Figure 15. The highest generation volumes are concentrated in the largest European economies, with Germany generating an estimated 2.09 Mt of PCTW in 2019, followed by France (1.55 Mt), Italy (1.23 Mt), Spain (1.09 Mt). Collectively, these four countries account for approximately 5.96 Mt of PCTW, representing nearly 60% of total EU-27 generation. This concentration implies that the success of the EU's circular transition is disproportionately reliant on the logistical and industrial performance of these few key economies. At the opposite end of the distribution, Member States with relatively small populations generate considerably lower volumes. Malta and Luxembourg, for example, each generate approximately 0.01 Mt of PCTW annually. The resulting distribution highlights a strong geographical concentration of textile waste generation within a limited number of countries.

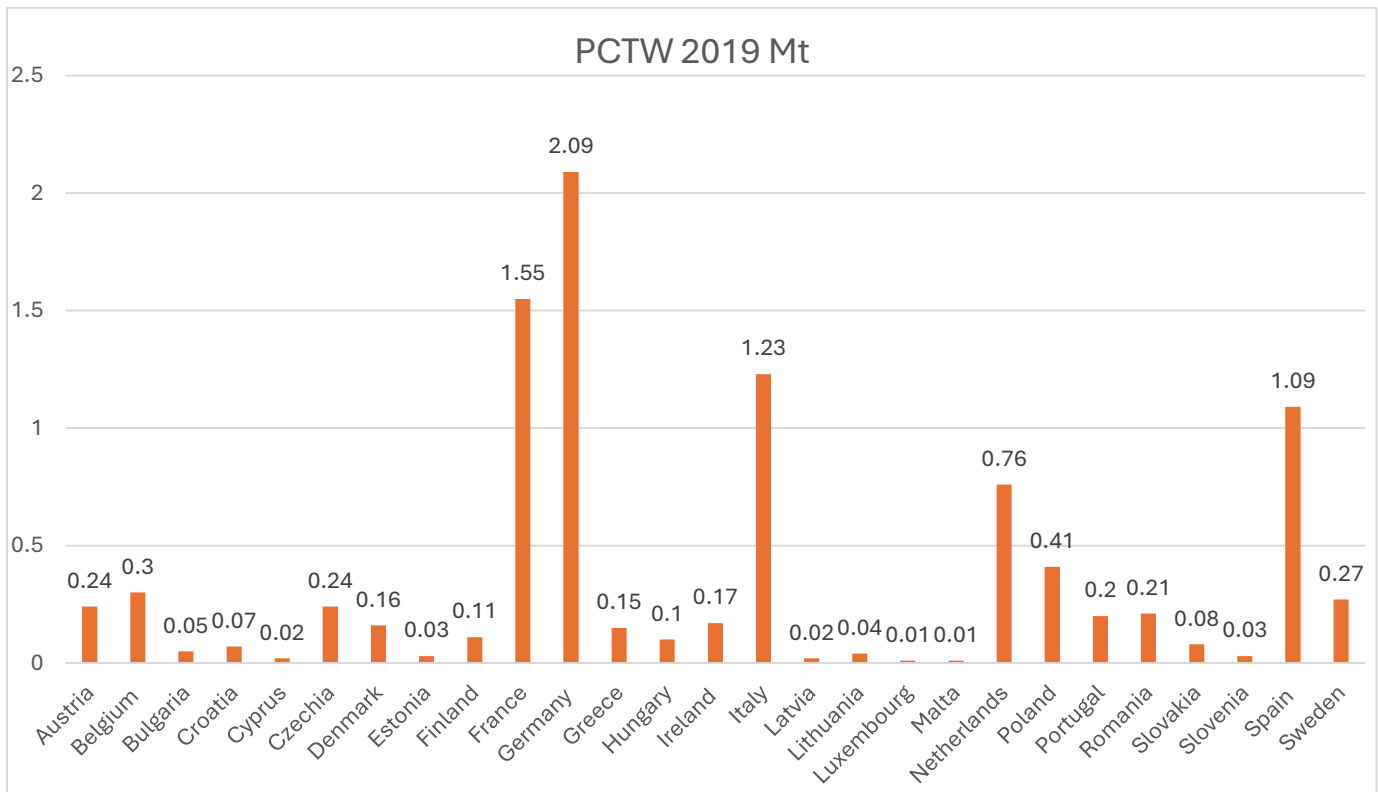


Figure 15: PCTW volumes for individual EU countries for the baseline year of 2019

Shifting the functional unit from absolute volumes to per person generation (Figure 16), the analysis successfully decouples demographic size from waste behavior. This normalization shows that textile waste generation is not uniform across the EU but is instead deeply tied to national economic conditions and distinct consumer habits.

Countries at the upper end of the spectrum, such as the Netherlands and Ireland, exhibit high per person waste generation. This reflects a high consumption velocity driven by greater purchasing power, faster garment turnover rates, and a prevalent fast fashion culture that leads to significantly shorter product lifespans. This demonstrates that high per-capita waste acts as a clear indicator of linear market intensity, where the economic speed of the fashion cycles inherently outpaces current recovery capabilities.

In contrast, countries like Bulgaria and Romania, generate a fraction of the textile waste per person. This disparity implies different structural behaviors, such as the extended active use of clothing, established cultures of garment repair, and lower disposable income that naturally limit rapid wardrobe replacement. Consequently, these countries represent a circular legacy where pre-existing behaviors act as a natural buffer against linear waste generation, suggesting that policy should focus on preserving these practices rather than imposing heavy-industrial collection models.

Ultimately, this wide variance demonstrates that a universal approach to EU textile waste management will be inefficient. High-generating nations will require immediate, large-scale investments in automated sorting and recycling infrastructure, whereas lower generating nations would benefit more from policies that protect and support their existing reuse and repair networks. This highlights that a successful EU-wide strategy must be spatially differentiated, calibrating infrastructure investments to the specific consumption velocity of each Member State.

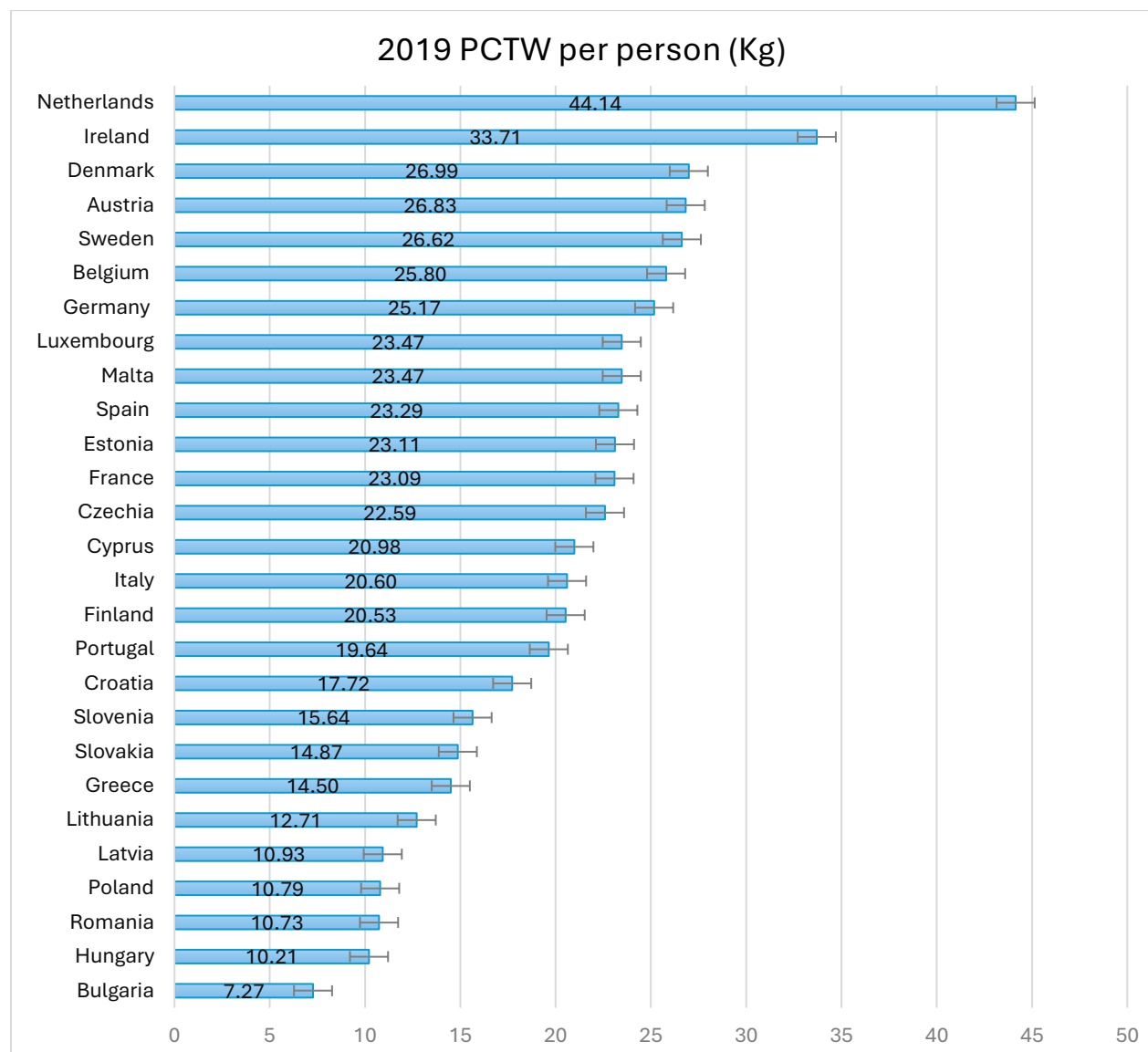


Figure 16: 2019 PCTW per person for individual EU Countries

As mapped geographically in Figure 17, the concentration of waste generation has important implications for infrastructure planning, the results suggest that future collection, sorting and recycling capacity requirements are unlikely to distribute evenly across Europe. Instead, a relatively small number of countries are expected to manage disproportionately large share of total textile waste generation. This confirms that infrastructure strategy must be spatially differentiated; applying uniform capacity targets across the EU would lead to systemic under investment in high generating hubs and capital redundancy in lower intensity countries.

The observed generation hierarchy is broadly consistent with institutional statistics on textile consumption and waste generation. According to European Environment Agency (2026), the average European citizen generated approximately 16 kg of textile waste in 2020. Given the population size of Germany, France, Italy and Spain, their prominence among the highest-generating countries is consistent with broader demographic and consumption patterns. While some differences are observed among lower-ranking Member States, such variations are expected may partly reflect country-specific characteristics represented within the DPMFA framework, including variations in estimated discard behavior and consumption patterns.

Overall, the results indicate that textile waste generation within EU is highly concentrated geographically. This concentration suggests that future policy interventions and infrastructure investments may need to be differentiated according to national waste generation profiles rather than relying on a uniform approach across all the Member States. Ultimately, this underscores that material sovereignty in the EU's ability to achieve a circular economy is dependent on localized, data-driven planning rather than abstract centralized targets.

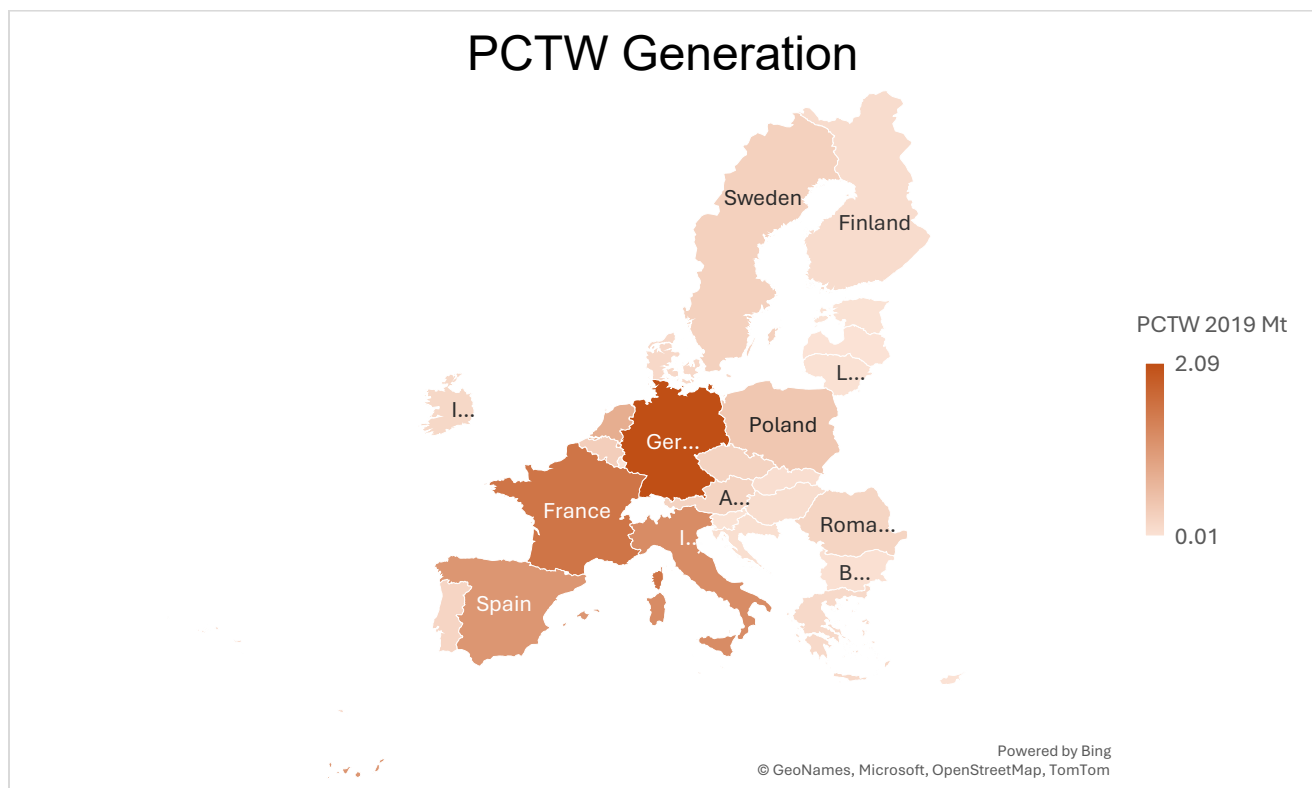


Figure 17: Geographical Mapping of PCTW Generation

5.4 2035 National Forecasts and Policy Scenarios:

Building on the validated 2019 baseline, the model is extended to project PCTW generation to the year 2035 at the national level. These projections are designed to support an assessment of future infrastructure requirements under different policy and growth assumptions. To estimate future waste generation, national baselines were projected forward using an assumed CAGR of 3% (European Commission, 2022). To account for uncertainty in the choice of temporal anchoring, the projection was implemented using two alternative reference configurations: a 2020 anchor year and a 2024 anchor year incorporating observed post-pandemic consumption dynamics.

Under the 2020 anchor year, total EU-27 PCTW generation (sum of 27 countries) reaches 14.1 Mt by 2035 (CI: 12.4 Mt to 15.9 Mt), corresponding to a substantial increase of 44.8% relative to the 2019 baseline. Figure 18 illustrates this growth across countries, with the largest economies continuing to dominate total waste generation. Germany is forecasted to produce 2.98 Mt, followed by France (2.17 Mt), Italy (1.72 Mt), and Spain (1.46 Mt). This projected growth suggests that substantially larger volumes of PCTW will need to be managed by national collection, sorting and treatment systems. Consequently, countries generating the largest waste volumes may require significant expansions in waste management and recycling infrastructure to accommodate future material flows.

When shifting the anchor year to 2024, incorporating officially recorded market data for the period of 2020 to 2024, the aggregate EU-27 estimate decreases to 12.89 Mt in 2035 (CI: 11.3 Mt to 14.6 Mt). This 1.21 Mt variance clearly indicates that the macroeconomic shocks of the COVID-19 pandemic temporarily suppressed consumption, causing the realized CAGR during these years to fall below the theoretical 3%. This variance indicates that long-term waste generation is highly sensitive to localized economic disruptions, cautioning against reliance on rigid, long-term deterministic growth rates for policy design.

Despite differences in absolute levels, both anchor years indicate a sustained increase in textile waste generation across all Member States. This convergence shows that regardless of short-term economic volatility, the structural upward trajectory of PCTW generation is a stable feature of the EU market, which reinforces a fundamental shift from reactive waste management to proactive, industrial scale material recovery.

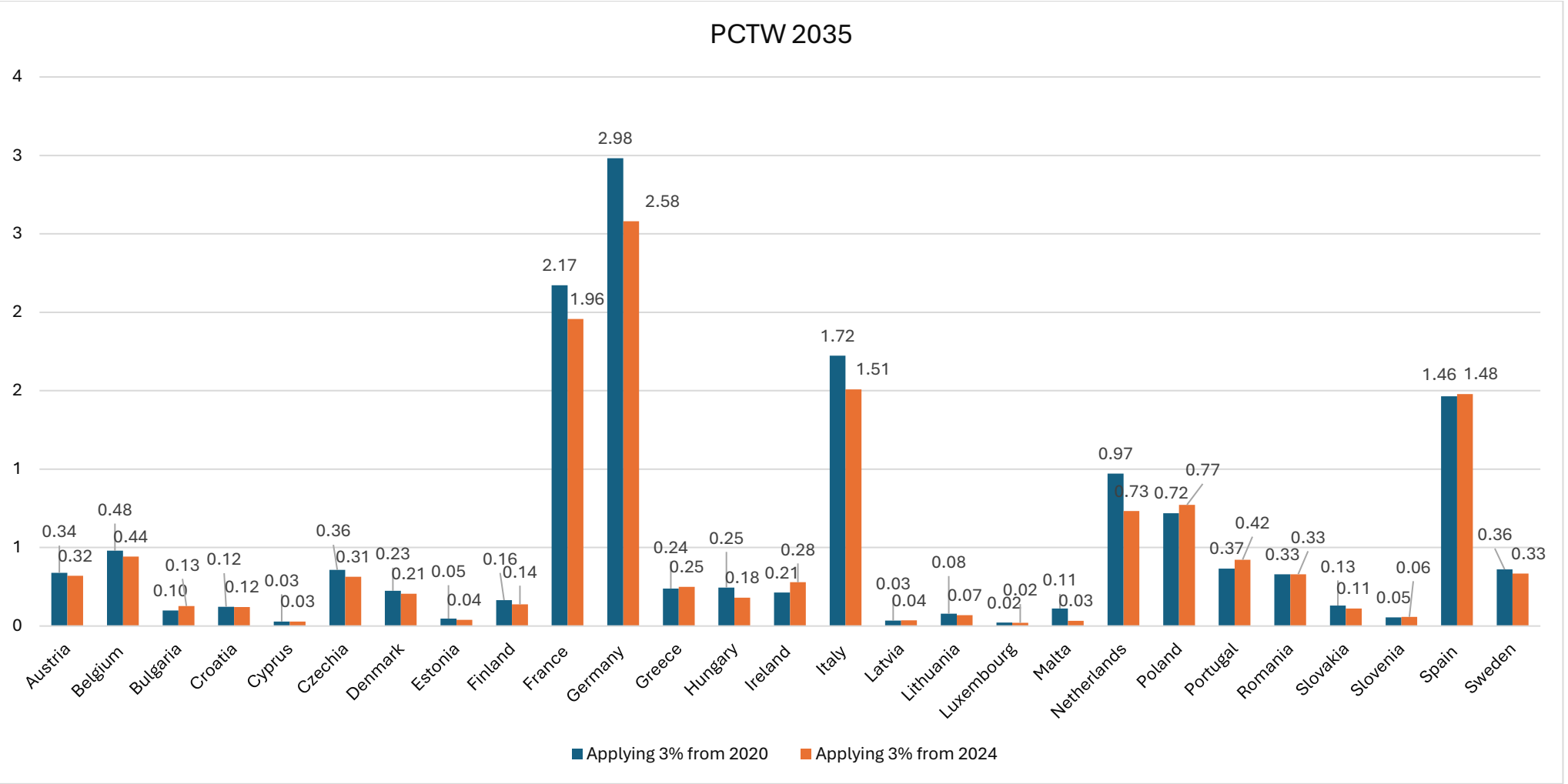


Figure 18: Country-level PCTW estimates for 2035 based on two different anchor years

The long-term validity of these projections is further supported by external literature, as depicted in Figure 19. When comparing this study's 2035 forecast (14.1 Mt under the 2020 anchor) with the Napolano (2025) forecast of 15.5 Mt, the model shows strong alignment. The approximately difference of 1.4 Mt is a similar magnitude to the deviation observed in the 2019 baseline. Furthermore, propagating the uncertainty parameters through the 15-years forecast horizon demonstrates that this external benchmark closely aligns with the 95% confidence intervals generated by the present model. This indicates that while different methodologies in calibration and uncertainty treatment naturally produce slight variations, both models capture the same underlying trajectory of textile waste expansion, thereby validating the plausibility of the projected 2035 PCTW estimates.

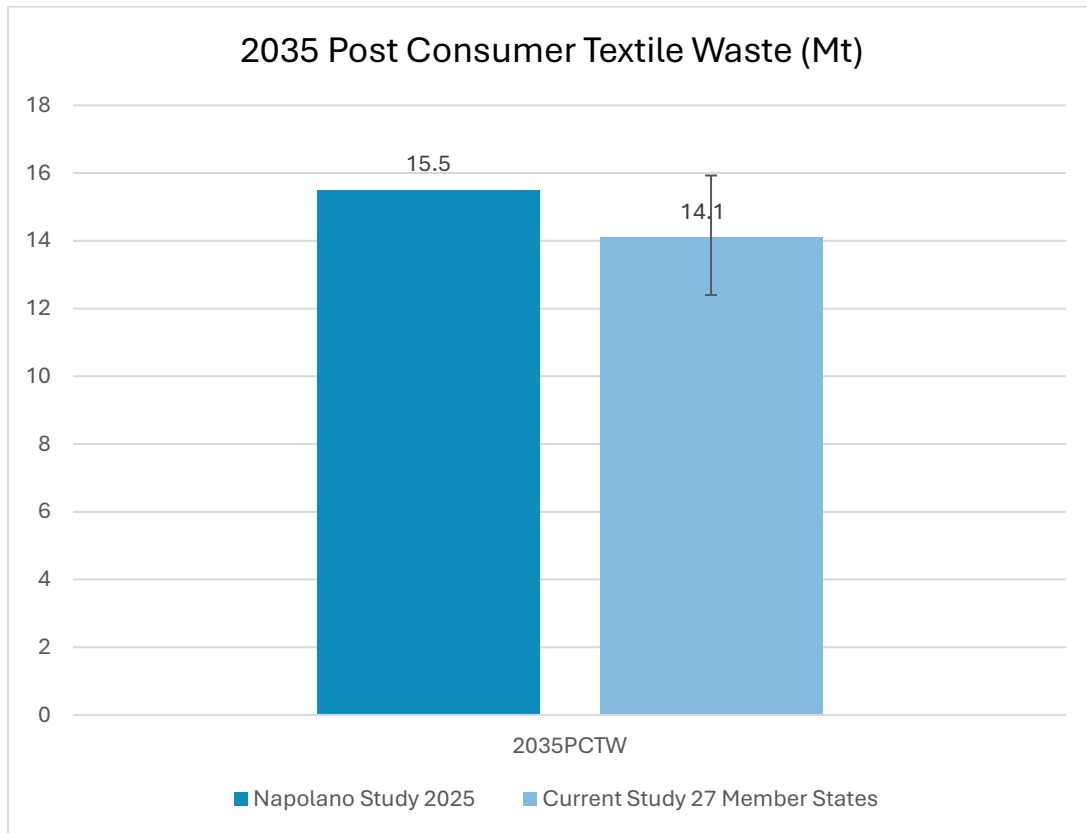


Figure 19: Comparison of 2035 Results with Napolano Study

Building up on the 2035 waste generation forecasts, the model evaluated the physical volumes of PCTW that would successfully enter separate collection streams under two distinct policy scenarios: the Country - Level (CL) and EU-wide (EU) scenario. Considering policy-driven recovery highlights the critical structural paradoxes inherent in Europe's current collection system.

As illustrated in Figure 20, there is a noticeable divergence in outcomes between incremental national policies and harmonized European targets. Under the CL scenario, which applies relative improvements to existing 2020 national collection baselines (presented in Table 4) collection volumes remain tethered to historical performance rather than actual generation. While this approach allows historically high-performance countries to maintain significant collection throughput, it shows a systemic limitation in major consumer markets.

Table 4: EU Member States; Separate Collection Rates for 2020 (EEA, 2024)

Countries	Separate Collection
Austria	30%
Belgium	50%
Bulgaria	1%
Croatia	9%
Cyprus	11%
Czechia	25%
Denmark	11%
Estonia	5%
Finland	0%
France	24%
Germany	18%
Greece	2%
Hungary	0%
Ireland	1%
Italy	14%
Latvia	0%
Lithuania	8%
Luxembourg	50%
Malta	19%
Netherlands	37%
Poland	0%
Portugal	0%
Romania	1%
Slovenia	7%
Slovakia	6%
Spain	4%
Sweden	5%

For example, with a 50% relative improvement, compared to the initial reported collection rate of 37%, the Netherlands successfully collects over 534 kt of PCTW but for Germany (18% baseline rate) it yields approximately 805 Kt of separately collected textiles. Despite representing a large absolute volume, this capture for Germany is only a fraction of projected 2.98 Mt. This gap of over 2.1 million not separately collected textiles illustrates that collection volumes generated under CL scenario remain substantially below the quantities implied by projected waste generation, as a result the availability of separately collected textiles for downstream sorting and recycling activities would be considerably lower than under more ambitious collection pathways.

In contrast, the application of absolute collection targets highlights the scale of material flows that collection and sorting systems would need to manage by 2035. Figure 21 highlights that achieving a 50% absolute EU-wide collection target places an unprecedented volume burden directly on the top generating countries. Under the 2020 anchor year assumptions, national separate collection systems must scale rapidly to capture 1.49 Mt in Germany, 1.09 Mt in France, 0.86 Mt in Italy and 0.73 Mt in Spain.

A deeper meaning emerges when directly contrasting the absolute generation quantities (Figure 18) to the resulting collection shares under the CL scenario presented in Figure 20. This comparison identifies a structural mismatch within the European waste management landscape regarding the countries that produce the most waste and the countries that actually collect the textile waste. Notably, countries such as Austria,

Belgium, and the Netherlands capture disproportionately large volumes relative to their demographic size and total generation output. This is driven by their historically higher national baseline collection rates. Consequently, the immediate impact on their infrastructure is clear: since the larger European countries fail to collect significant volumes under the CL scenario, the European circular economy's supply chain becomes heavily dependent on these northern Member States. This dynamic effectively positions them as primary, concentrated processing hubs, forcing their domestic sorting and recycling facilities to handle an outsized share of Europe's total recovered textiles.

On the other hand, major demographic and economic centers like Italy and Spain take a significant step back under this progressive CL framework. Despite ranking among the top four highest generators of PCTW in Europe (as illustrated in Figure 18), their low historical collection rates mean they capture only a fraction of their available waste, locking them into a low-recovery trajectory. While this lower collection volume shields their regional infrastructure from immediate pressure seen in the EU scenario, it represents a critical loss of resources. Millions of tons of recoverable textiles in these countries remain in the mixed waste streams, undermining the scale needed to sustain a profitable, high-capacity domestic recycling industry. Ultimately, an absolute collection mandate such as the EU scenario is vital for decentralizing the circular economy and ensuring high-generating regions do not lag behind.

In contrast, the EU-wide scenario fixes this geographical imbalance by linking collection targets directly to total waste generation. Under this approach large waste producers are required to collect volumes that match their actual generation size which creates a much-needed decentralization of waste management. Not only does this approach prevent infrastructure overloads but also ensures that major regions scale the local facilities to support a true circular economy in Europe.

Gradual Increase of Separate Collection (Mt)
Anchor Year 2020

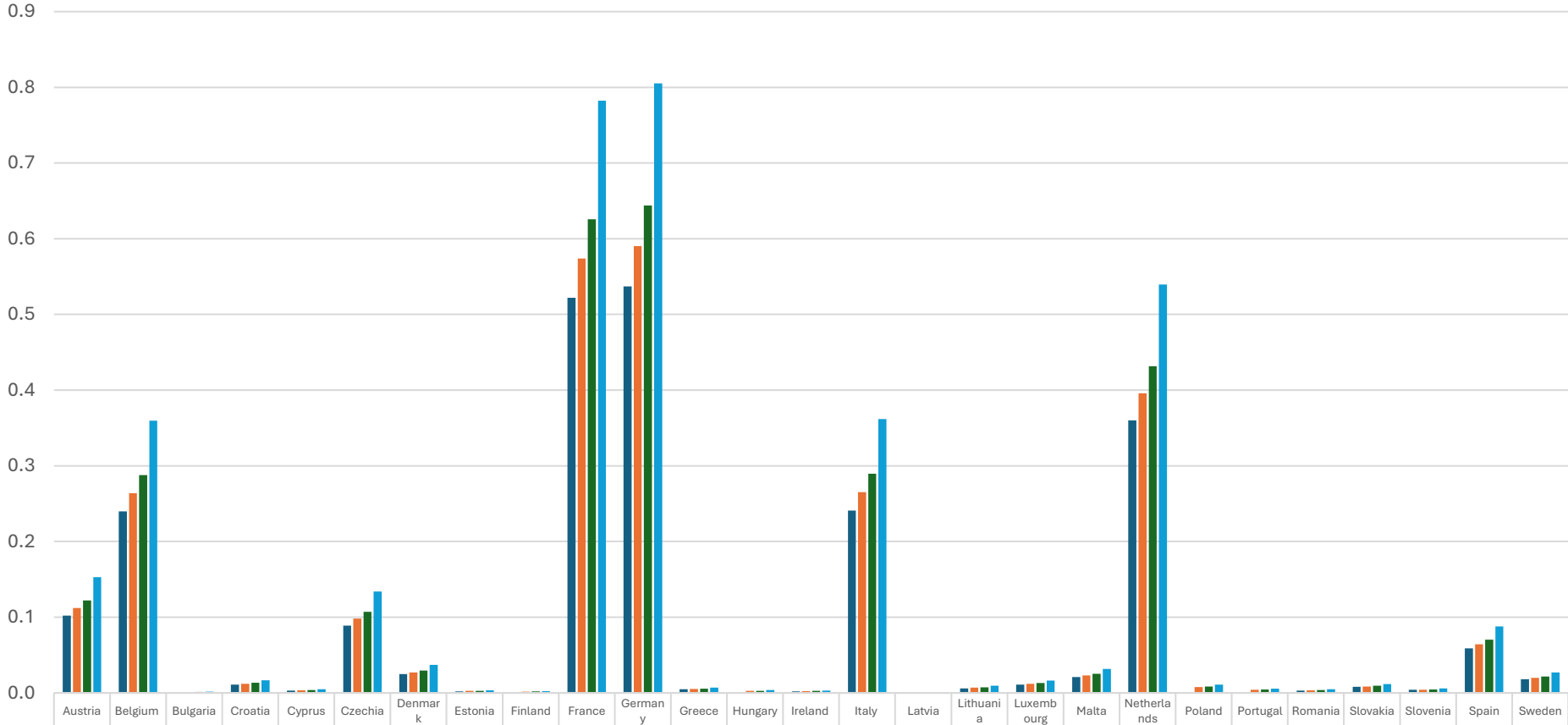


Figure 20: Results of CL scenario application (anchor year 2020)

Absolute Increase of Separate Collection (Mt) Anchor Year 2020

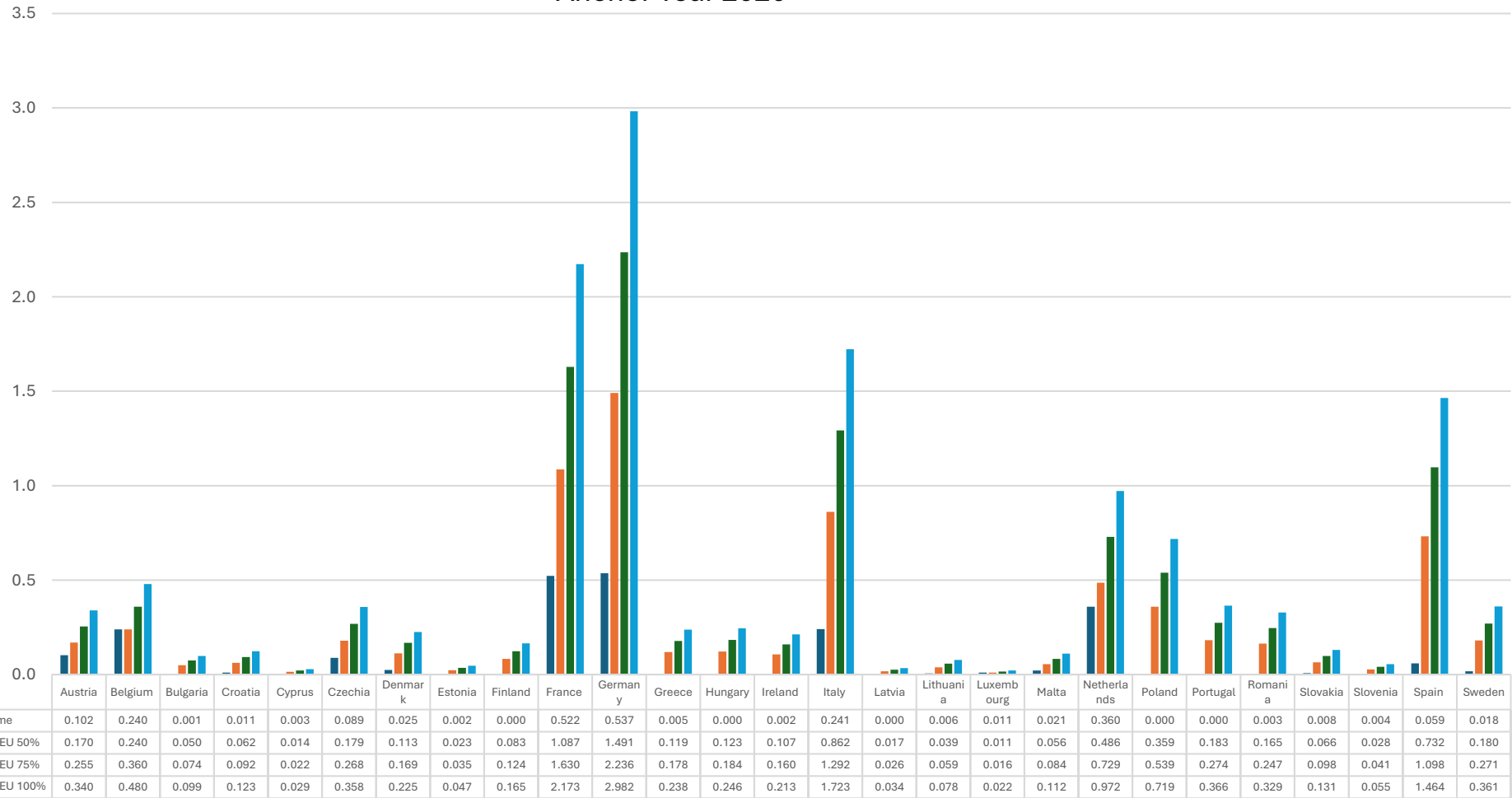


Figure 21: Results of EU scenario application (anchor year 2020)

Shifting the anchor year to 2024 provides a refined baseline that accounts for post-pandemic volatility and deviations in PCTW generation. Figure 22 and Figure 23 display the projected collection volumes under CL and EU scenarios respectively.



Figure 22: Results of CL scenario application (anchor year 2024)

Absolute Increase of Separate Collection (Mt)
Anchor Year 2024

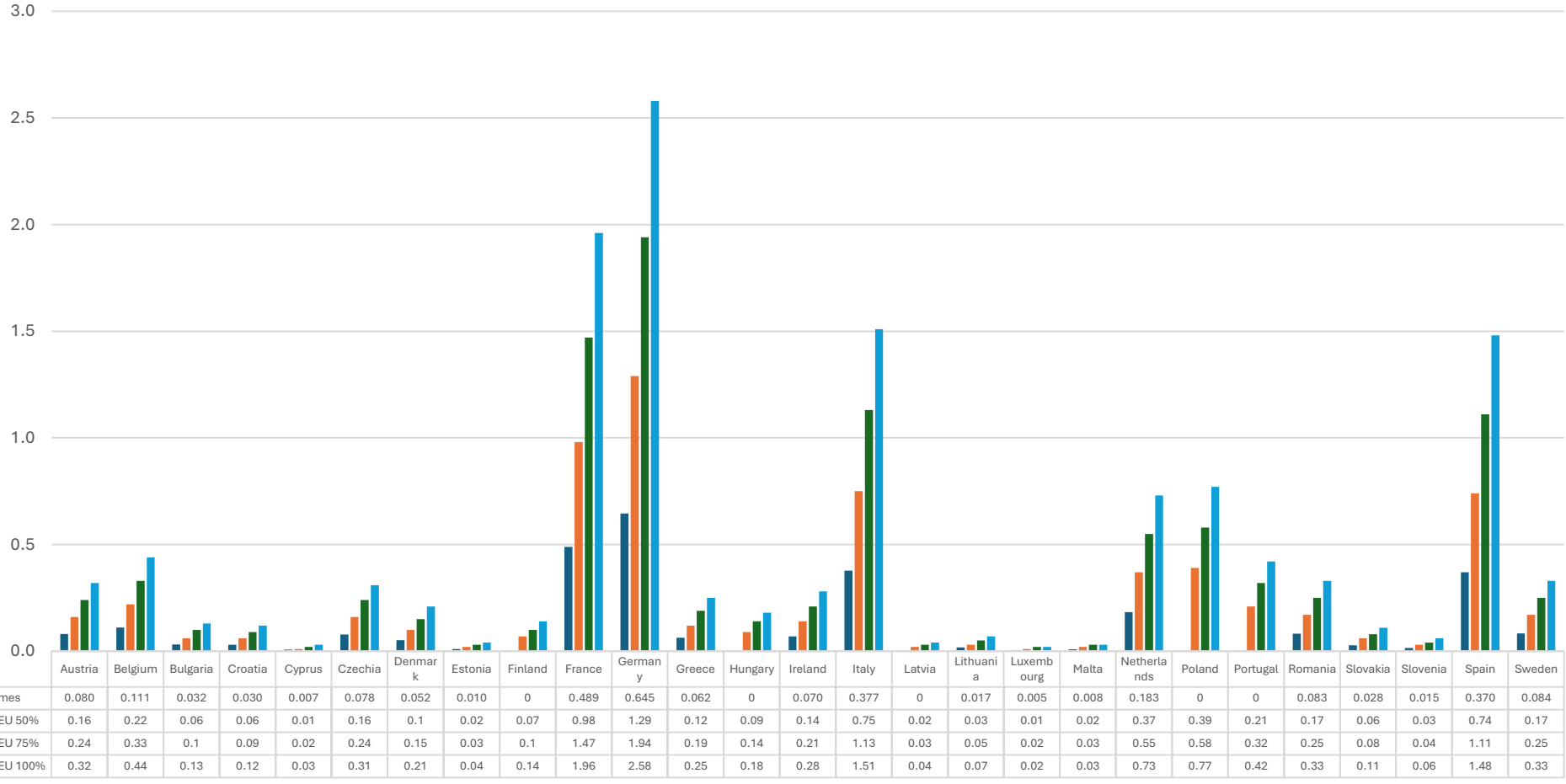


Figure 23: Results of EU scenario application (anchor year 2024)

To synthesize these findings, Figure 24 provides a direct visual comparison of the collection volumes projected under both the Country-Level (CL) and EU-wide scenarios for the year 2035. This comparison shows the differences in collection outcomes produced by two policy approaches. While the EU scenario generates collection volumes that are broadly proportional to projected waste generation, the CL scenario produces lower collection volumes due to its reliance on progressive improvements from country-specific baseline collection rates. As a result, the EU scenario would provide a considerably larger supply of separately collected textiles for reuse and recycling activities. These findings demonstrate that the choice of policy pathway can significantly influence the quantity of material entering future circular textile systems.

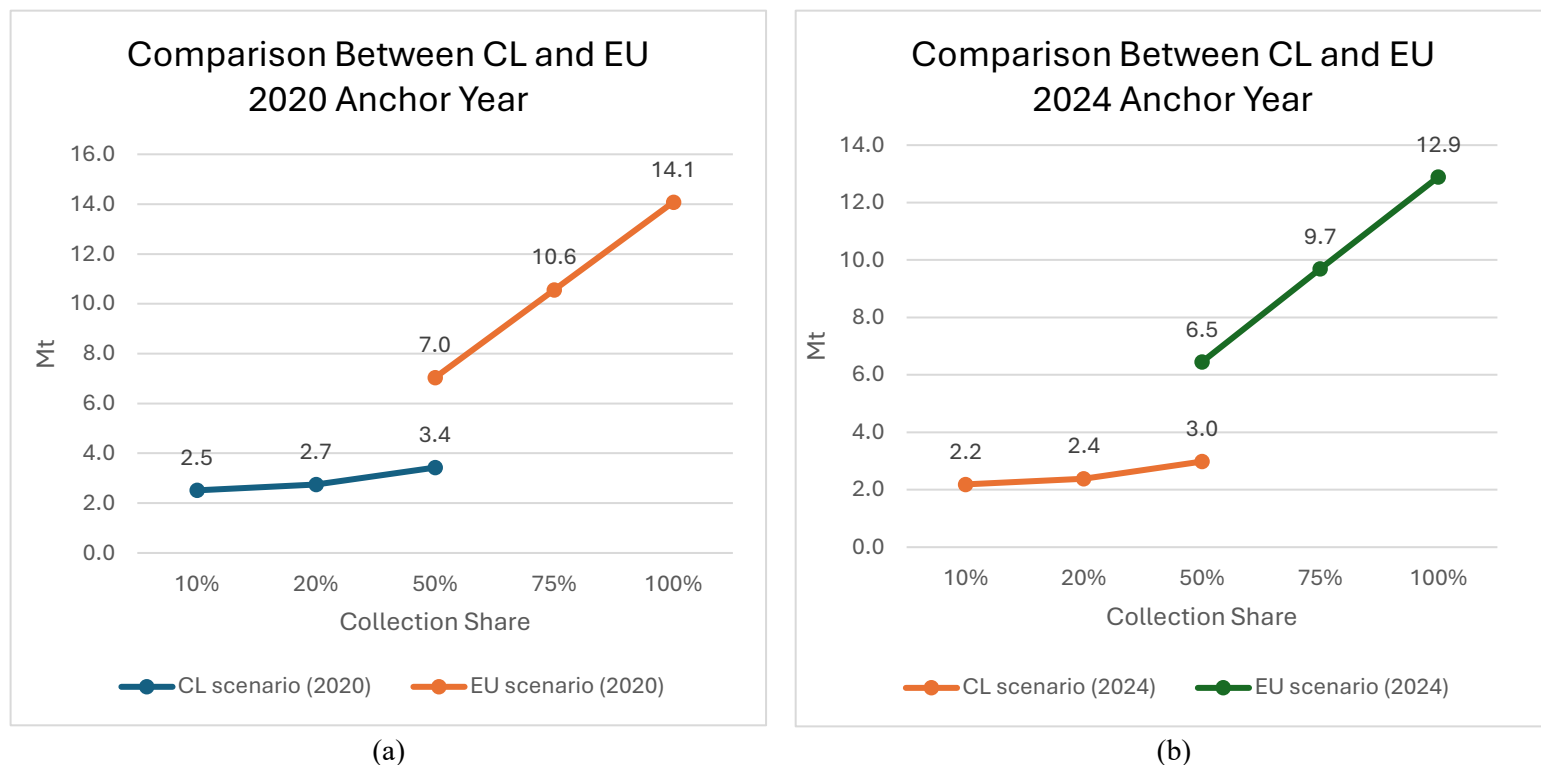


Figure 24: Comparison of Results between the CL and EU Scenarios (a) 2020 anchor year, (b) 2024 anchor year

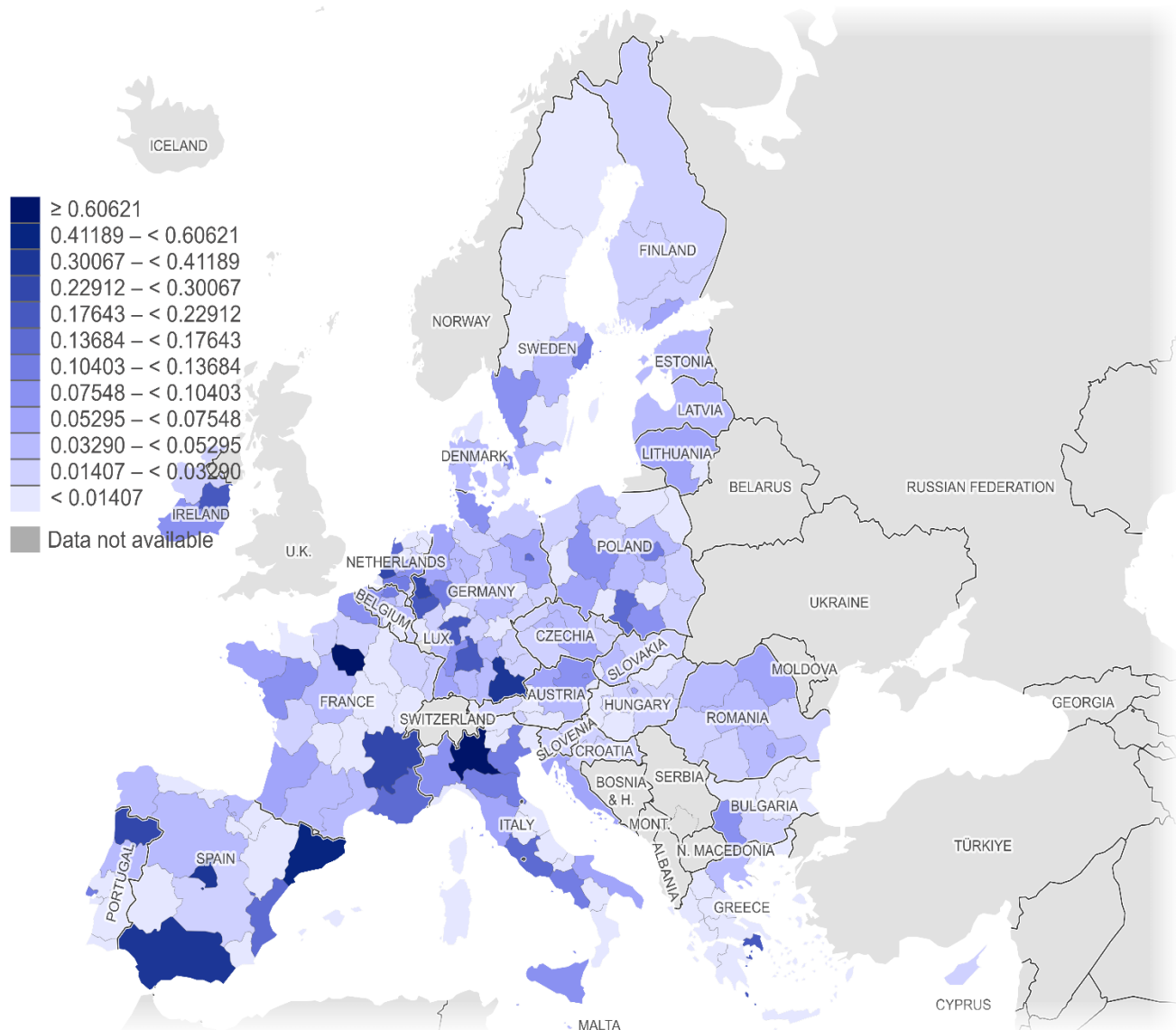
5.5 Regional Estimates

While the national-level analyses utilized both 2020 and 2024 anchor years to establish a comparative foundation, the subsequent NUTS2 regional estimates prioritize the 2024 anchor year. Although the 2020 anchor initially served as a theoretical starting point for the model, incorporating the empirical dataset from 2020 to 2024 provides a more updated and realistic foundation for the regional downscaling. By anchoring the spatial analysis to 2024, the model accounts for recent, observed material flows rather than relying on uninterrupted historical projections. This methodological choice reduces the overall forecasting window and offers a more grounded estimate for the 2035 infrastructural demands.

The regional distribution of projected PCTW generation in 2035 reveals substantial spatial heterogeneity across Europe, as presented in Figure 25. Waste generation is concentrated within a limited number of highly populated and economically active regions (Table 5). FR10 (Île-de-France) is projected to be the largest contributor, generating approximately 0.99 Mt of PCTW in 2035. ITC4 (Lombardy) follows with

roughly 606 Kt, while several Spanish (ES51, ES30, ES61), German (DE21, DEA1), and Dutch (NL36) regions also rank among the highest generators. This confirms a fundamental structural reality that PCTW is primarily an urban phenomenon driven by local purchasing power and population, rather than a uniform national issue spread evenly across a country. Consequently, the overwhelming demand for future waste management will disproportionately fall on these major metropolitan centers.

2035 NUTS2 Regions PCTW Generation (Mt), 2024 Anchor Year



Administrative boundaries: © EuroGeographics © OpenStreetMap
Cartography: Eurostat – IMAGE, 06/2026

Figure 25: 2035 Regional PCTW generation (2024 Anchor Year)

Table 5: Top Generating NUTS2 Regions in 2035 (2024 Anchor Year)

NUTS 2 Code	Country	Region Name	NUTS2 PCTW 2035 Mt
FR10	France	Ile de France	0.994
ITC4	Italy	Lombardia	0.606
ES51	Spain	Cataluña	0.412
ES30	Spain	Comunidad de Madrid	0.357
ES61	Spain	Andalucía	0.351
DE21	Germany	Oberbayern	0.301
DEA1	Germany	Düsseldorf	0.287
NL36	Netherlands	Zuid-Holland	0.258
FRK2	France	Rhône-Alpes	0.250
PT11	Portugal	Norte	0.229

Shifting the focus from total generation to collection scenarios further illustrates this logistical challenge. Figure 26 and Figure 27 present top 15 NUTS2 regions with the highest collection volumes under the CL 50% and EU 50% scenarios, respectively. Under the progressive CL 50% scenario, collected volumes remain relatively constrained, with the highest-ranking region (FR10) processing approximately 0.4 Mt and subsequent regions dropping off rapidly. In contrast, the harmonized EU 50% scenario forces a substantially larger physical scale. FR10's operational burden surges to 0.5 Mt, while Lombardy (ITC4) more than doubles its collection from 0.13 Mt to 0.30 Mt. This demonstrates that absolute EU targets impose a vastly heavier material burden on regional infrastructure, requiring industrial-scale capacity upgrades.

Considering the EU scenario highlights how alternate policy pathways shift the operational burden and regional rankings. The consistent appearance of regions such as Île-de-France (FR10), Lombardy (ITC4), Upper Bavaria (DE21), Düsseldorf (DEA1), and South Holland (NL36) across both scenarios indicates that these core demographic hubs will play a central role in future PCTW management regardless of the policy. However, noticeable position changes happen. Under the CL scenario, smaller regions in Belgium (BE21, BE23) and the Netherlands (NL32, NL41, NL22) appear in the top 15 purely due to their high historical baseline collection rates. Conversely, under the EU scenario, these regions are entirely displaced. When targets are tied to absolute generation, major Southern European regions like Cataluña (ES51), Madrid (ES30), Andalusia (ES61), and Northern Portugal (PT11) enter the top 15. This confirms a significant geographical shift in infrastructural demand from historically efficient Northern countries to highly populated consumer markets of Southern Europe.

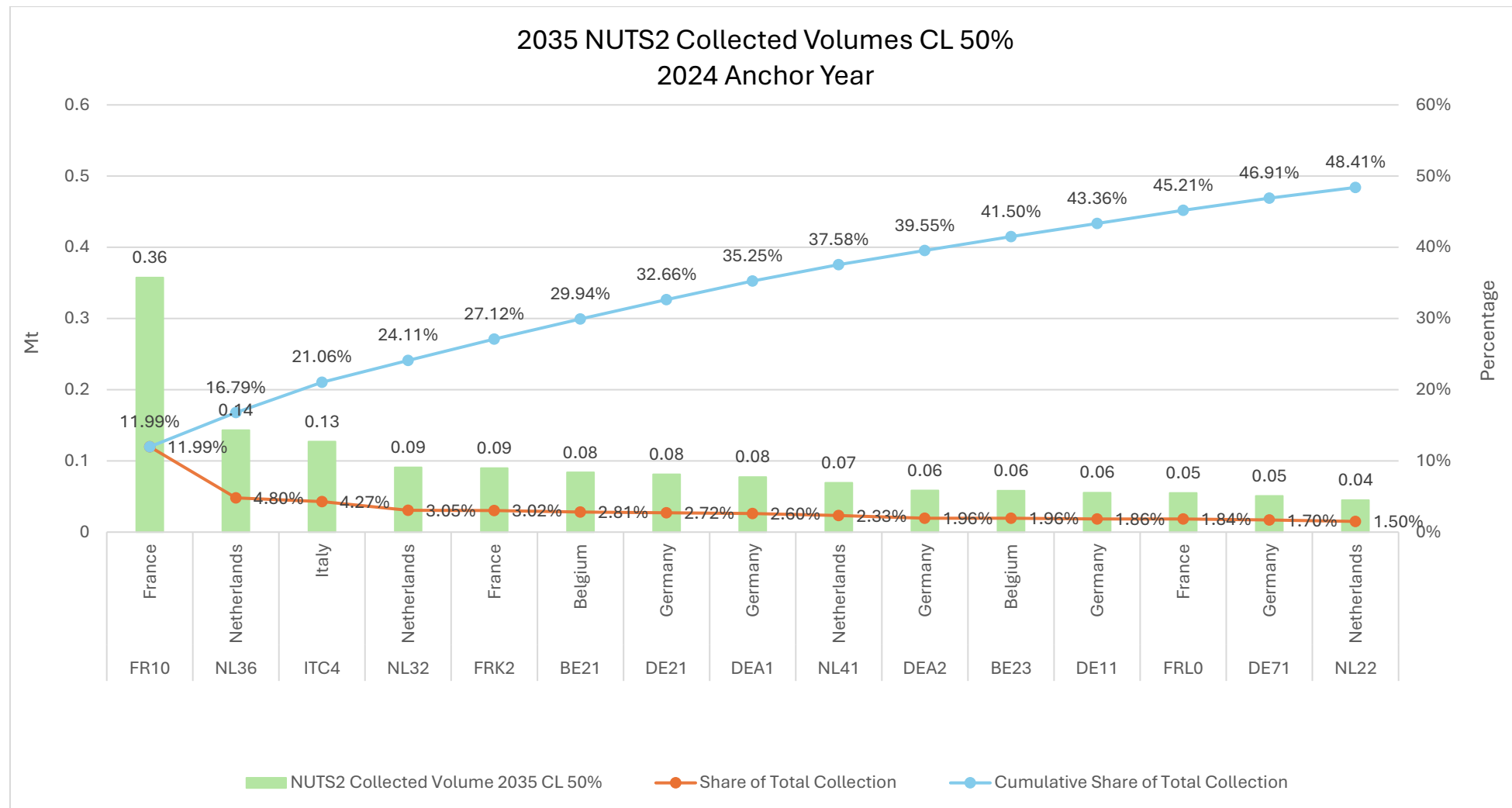


Figure 26: Top 15 NUTS2 Regions in waste collection under CL scenario (2024 anchor)

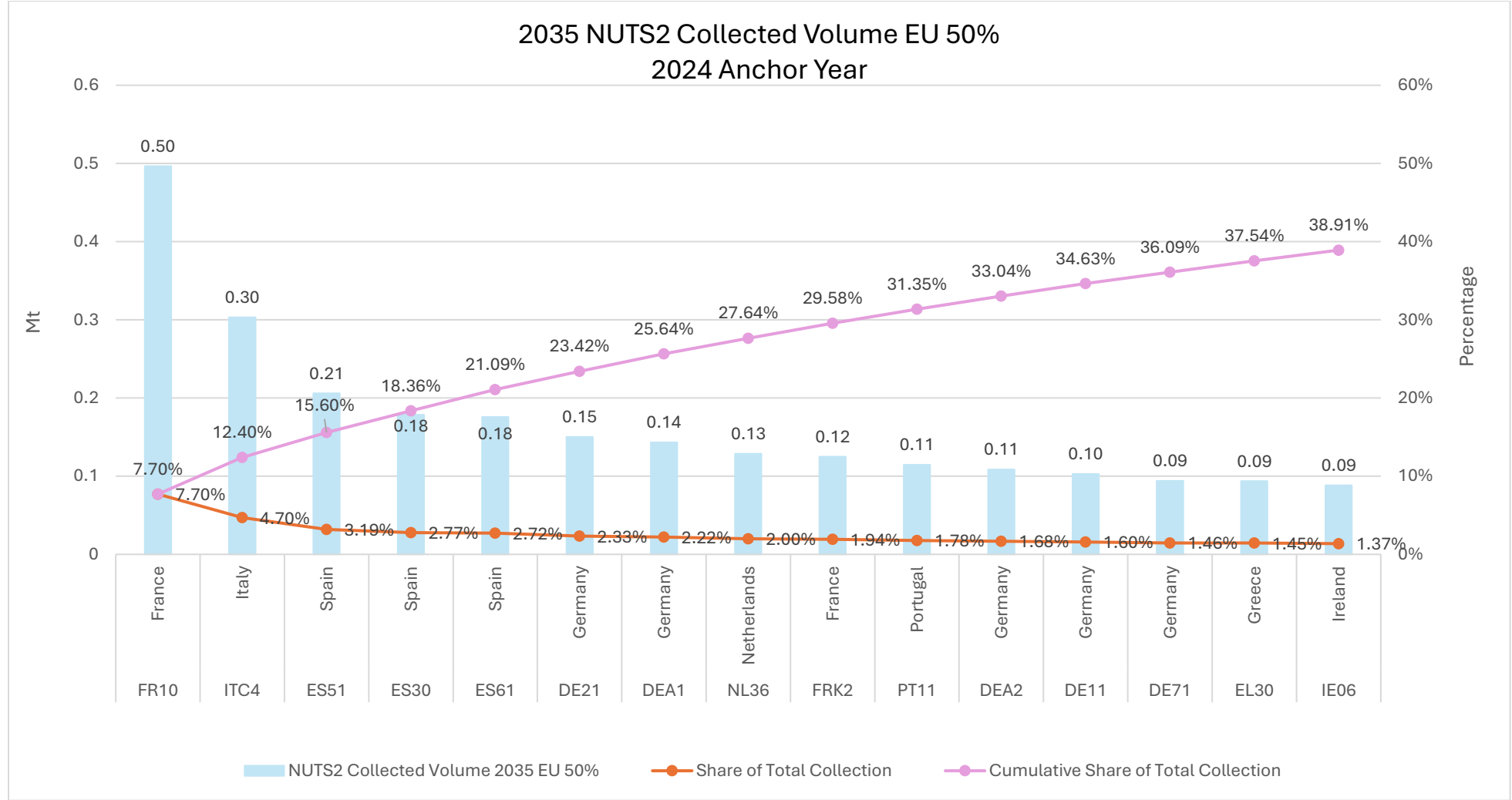


Figure 27: Top 15 NUTS2 Regions in waste collection under EU scenario (2024 anchor year)

Furthermore, assessing the proportional weight of these hotspots is critical to understand the concentration of infrastructural demand. Under the EU 50% scenario, the top 15 individually represents between 1.37% (IE06) and 7.7% (FR10) of the total separately collected waste. Cumulatively, these 15 regions (out of 244) represent 38.91% of the collected textiles. This concentration means that nearly 40% of Europe's entire logistical and recycling burden will fall on a small fraction of its regions, underscoring the necessity for highly targeted, localized infrastructure investments.

Crucially, comparing the relative share of total collected waste between the two scenarios shows a shift in the concentration of the collection. Under the CL 50% scenario, the top regions are forced to process nearly half of the entire EU collected volume, reaching a cumulative share of 48.41%, with FR10 alone accounting for 11.99%. However, under the EU 50%, this cumulative percentage drops to 38.91% and FR10 share falls to 7.7%. Since the actual physical volumes are much larger in the EU scenario, this cumulative percentage drop proves that harmonized EU policies lead to a relatively more balanced distribution of the infrastructure burden. By tying collection mandates strictly to local generation, the EU scenario ensures that the logistical responsibility is spread more evenly across all EU regions, alleviating the extreme, unsustainable bottlenecks that would otherwise cripple a few concentrated hotspots under the CL approach.

5.6 Separately Collected Textiles' Treatment Shares

Applying the established end-of-life treatment pathways to the projected 2035 collection volumes indicates the absolute physical scale of infrastructure required across Europe. The results demonstrate that maximizing collection directly translates into a massive influx of material into downstream sorting, reuse and recycling networks. Figure 28 illustrates the treatment shares under CL 50% and EU 50% collection scenarios, considering 2024 anchor year.

Under the EU 50% scenario, the total separately collected volume of 6.45 Mt generates extreme operational demands. Approximately 2.9 Mt of separately collected PCTW will be channeled into preparation for reuse, representing the largest single destination. This outcome highlights the necessity for significant expansion in second-hand market throughput and high-capacity sorting operations. Concurrently, 2.06 Mt is directed towards recycling facilities, underscoring the critical need for immediate, industrial scale investments in both open and closed loop recycling technologies. The remaining collected volumes include 0.64 Mt routed to energy recovery and a significant portion categorized as sorting residuals and unaccounted systemic leakage.

Considering this with the CL 50% scenario highlights the physical limitation of relying on historical national baselines. Under this progressive approach, the constrained collection volumes severely limit downstream material recovery. Only 1.34 Mt successfully reaches the reuse pathway, and a mere 0.95 Mt enters the recycling stream. While the absolute capacity demands on formal sorting infrastructure are substantially lower in this scenario, the results show a systemic inefficiency: nearly 10 Mt of generated PCTW is entirely excluded from the formal recovery network and lost in mixed waste under this scenario.

Ultimately, evaluating these treatment shares at the aggregated EU level provides three critical structural vulnerabilities in the current circular economy framework.

1. First, the projection of 2.9 Mt designated for preparation for reuse points to imminent market saturation suggesting that the theoretical recovery target is functionally reliant on massive export channels that are increasingly constrained by global trade restrictions.

2. Second, the 2.06 Mt allocated to recycling exposes a major technological gap. Because the current European industry is dominated by low-value open-loop downcycling, safely absorbing this allocation requires a rapid transition to commercial-scale leap in closed-loop, fiber-to-fiber recycling technologies.
3. Finally, the stark contrast with the CL scenario- where nearly 10 Mt of textiles remain locked in mixed waste- proves a fundamental industrial reality: while localized separate collection initiates the circular economy, the ultimate challenge is the severe lack of aggregated continental capacity to physically process and absorb this massive secondary material shock.

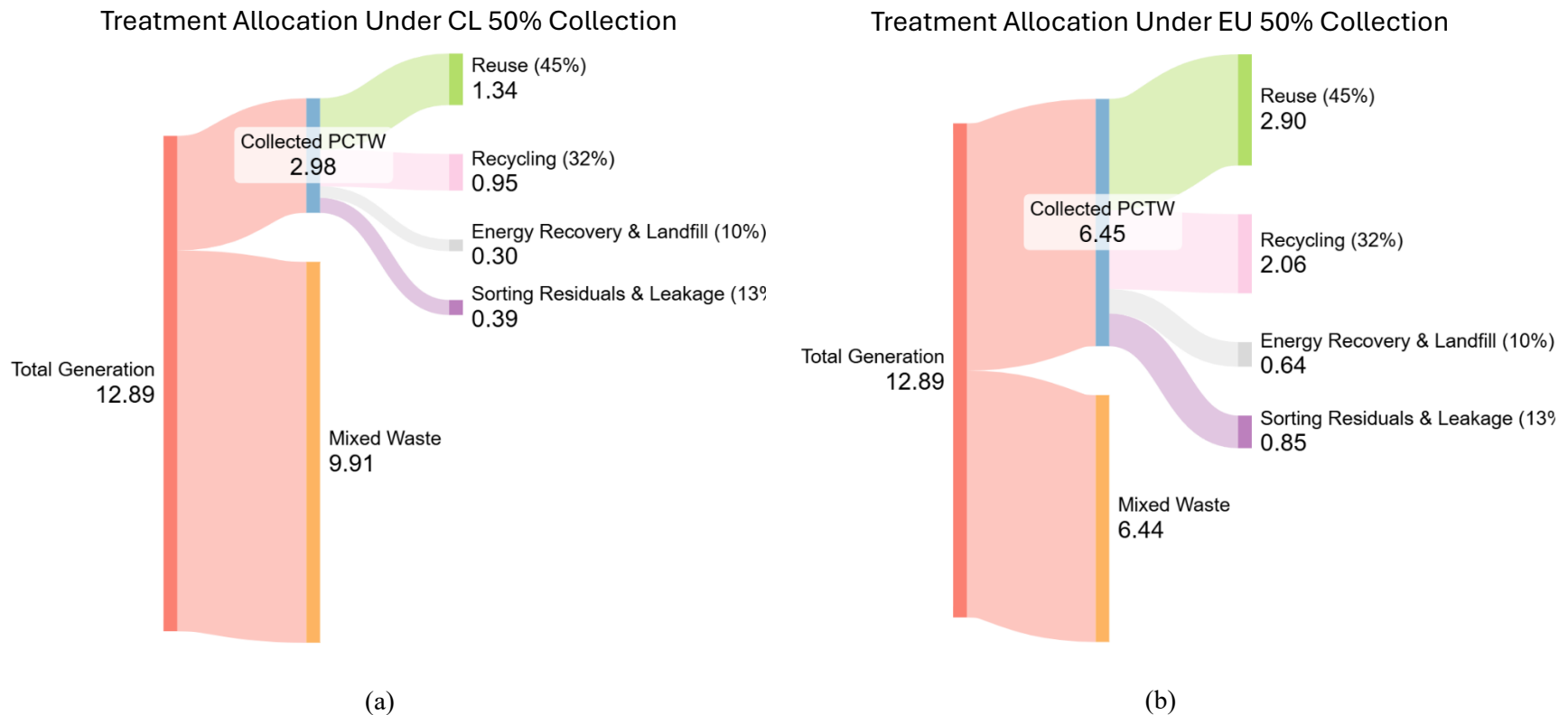


Figure 28: Comparison of Treatment Shares Under (a) CL 50% and (b) EU 50% Collection Scenario

6 Discussion

This section contextualizes the empirical findings of the DPMFA framework within the broader academic discourse and translates the modeled scenarios into actionable evidence-based recommendations for European policymakers.

6.1 Theoretical Implications

This study significantly advances academic literature by establishing a regionally differentiated forecasting framework for PCTW. While previous institutional studies have largely established material flows at an aggregated EU-27 level, this research successfully integrates DPMFA with socio-economic downscaling to disaggregate flows to the national and NUTS2 regional levels. This theoretically bridges the critical gap between macroeconomic national data and localized infrastructure planning.

A critical theoretical contribution of this research lies in the refinement of the socio-economic drivers utilized for spatial downscaling. Traditional environmental literature frequently relies on GDP per capita as a blanket proxy for waste generation. However, this study theoretically establishes that utilizing Household Disposable Income provides a significantly more accurate metric for capturing regional consumption velocity. This methodological shift proves that localized textile discard behaviors are fundamentally tied to actual consumer purchasing power, rather than abstract national industrial output or corporate revenues, thereby offering a more precise tool for future environmental modeling.

Furthermore, by embedding Monte Carlo simulations focused on product lifetimes across a 15-year forecasting time frame, this work theoretically demonstrates how absolute uncertainty scales with increased material throughput. It mathematically proves that long-term PCTW generation is not a linear extrapolation of static consumption, but a highly volatile variable where absolute variance expands proportionally as total market volumes grow. This fundamentally challenges the inherent fragility of utilizing single point deterministic estimates, proving that future circular economy models must systematically incorporate probabilistic boundaries to remain robust against market volatility and unpredictable discard behaviors.

When comparing these findings to prominent existing literature, such as comprehensive work by Napolano, this study provides a highly specialized perspective. While Napolano model's textile flows across the broader value chain, the present research focuses exclusively and deeply on the use and disposal phases. Crucially, this study adds actionable resolutions to Napolano's work by translating macro-estimates into national and localized regional results and introduces probabilistic risk boundaries.

Despite structural differences, this work corroborates and strengthens Napolano's findings. Napolano's 2019 baseline estimate of 10.92 Mt falls safely within this model's 95% confidence intervals. Furthermore, propagating the forecast to 2035 shows strong alignment; this study's projection of 14.1 Mt (under the 2020 anchor year) closely mirrors Napolano's forecast of 15.5 Mt. Thus, this research not only validates existing top-down estimates but equips policymakers with localized, data driven tools actually required for infrastructure planning.

6.2 Policy Implications and Strategic Recommendations

The empirical evidence generated by the scenario analysis has implications for the implementation of the Waste Framework Directive (WFD) and the design of future Extended Producer Responsibility (EPR) schemes. The noticeable divergence in collection volumes between Country-Level scenario and EU-wide

scenario highlights a fundamental vulnerability in current regulatory approaches. Achieving a resilient and capable textile waste management system requires abandoning uniform, block-wide assumptions in favor of hyper-local, data driven interventions. Based on the model's outputs, the following expanded strategic actions are recommended for policymakers and industry stakeholders:

- **Shift from National Aggregates to Targeted Regional Investment:** Because the operational demands of collection and sorting will be overwhelmingly concentrated in specific NUTS2 hotspots, infrastructure funding and planning cannot rely only on national averages. Instead, European and municipal policymakers must utilize Geographic Information Systems (GIS) and spatial mass-balance modeling to identify regional concentration patterns and direct Capital Expenditure (CAPEX) explicitly to the identified mega-regions (e.g., Île-de-France, Lombardy, Cataluña). This spatial approach is strongly supported by the JRC's research for the EU, which proves that textile waste generation does not distribute evenly across national territories but scales exponentially with population and GDP density. By using GIS mapping to track these localized generation baselines, researchers and planners can provide the exact geographical coordinates of generating regions, where the absolute volume burden will accumulate, providing the foundational spatial data required to target physical capacity before bottlenecks collapse local logistics.
- **Shift to Absolute, Harmonized EU Targets:** The scenario analysis demonstrates that policy pathways based on relative, incremental improvements from national baselines yield significantly lower collection volumes compared to absolute targets. To capture the necessary material for industrial-scale recycling, the harmonized collection requirements must be horizontally mandated across all Member States. Establishing this universal standard is essential to guarantee a reliable, high-volume supply of secondary raw materials for the emerging fiber-to-fiber recycling industry.

Executing this horizontal mandate requires structurally de-risking compliance for lower maturity economies through the targeted revision of the Waste Framework Directive, which legally requires operational national Extended Producer Responsibility (EPR) schemes by April 2028. Rather than straining municipal budgets, emerging Producer Responsibility Organizations (PROs) can finance decentralized collection networks through aggressive eco-modulation fees levied on non-recyclable products. For high-volume NUTS2 hotspots, the high upfront capital expenditure (CAPEX) of automated sorting hubs can be mitigated by combining EU Cohesion Policy funding for circular economy with European Investment Bank (EIB) loans. Finally, operational capacity can be rapidly and cost-effectively scaled by formally contracting pre-existing social economy enterprises and charitable collection networks, particularly in Italy and Spain-under explicit protective frameworks established within the revised directive.

- **Plan Infrastructure Investments using Techno-Economic Assessment (TEA):** The 2025 mandatory separate collection requirement under the Waste Framework Directive (Directive (EU) 2018/851, 2024) assumes that infrastructural capacity will scale synchronously with policy mandates. This assumption ignores the reality of implementation friction and localized logistical bottlenecks. To prevent the massive volumes of newly collected textiles from simply being stockpiled or incinerated, the EU must legally mandate Regional Techno-Economic Assessments (TEA). Standardized under the methodological frameworks of the European Commission's Joint

Research Center (JRC), these TEAs must explicitly map localized capital expenditure (CAPEX) requirements and the multi-year temporal lags associated with permitting, constructing, and calibrating advanced, high-capacity Near-Infrared (NIR) sorting facilities. Without localized TEAs to systematically synchronize physical capacity deployment with regional generation baselines, policy mandates will outpace industrial reality.

- **Enforce Digital Traceability to Secure the Supply Chain:** To effectively manage the millions of tons of projected PCTW, the physical flows of textiles must be structurally coupled with transparent digital tracking. This framework is transitioning into an active regulatory mandate under the EU's Ecodesign for Sustainable Products Regulation (ESPR) (REGULATION (EU) 2024/1781, 2024) and the revised Waste Shipment Regulation (WSR) (REGULATION (EU) 2024/1157, 2024). Specifically, the ESPR's centralized registry launches in July 2026, paving the way for mandatory textile Digital Product Passports (DPP) via delegated acts expected by 2027/2028, while the WSR activates the electronic Digital Waste Shipment System (DIWASS) for intra-EU tracking on May 21, 2026. By digitally distinguishing between "used textiles intended for reuse" and true "post-consumer textile waste" at the customs level – operationalized by these digital tracking platforms and harmonized "End-of-Waste" criteria – the EU can eliminate structural ambiguities in cross-border trade. Consequently, backed by the upcoming May 21, 2027, export ban that restricts non-hazardous textile waste shipments to non-OECD countries unless strict environmental criteria are met, this integrated framework will prevent the illegal dumping of low-quality waste in developing countries and secure high-quality feedstock for domestic European recyclers.
- **Leverage Existing Social Economy and Charitable Networks:** The success of localized infrastructure deployment heavily depends on the formal integration of existing social economy enterprises and charitable collection networks. The DPMFA scenario analysis suggests that relying exclusively on new, industrial-scale logistics to achieve high collection shares is financially and operationally prohibitive. The pre-existing networks already possess the deep-rooted logistics experience and public trust required for effective collection. By formally contracting these entities under the protective frameworks mandated by WFD, Member States can rapidly scale operational capacity without multi-year lead times for new public procurement.

Ultimately, this research underscores that the transition toward a circular textile economy is fundamentally a logistical and geographical challenge. By shifting from broad national estimates to localized, proactive capacity planning, Europe can effectively convert its mounting textile waste stream from a profound environmental liability into a scalable circular resource.

7 Conclusions

This study aimed at establishing a regionally differentiated forecasting framework for post-consumer textile waste (PCTW) across the EU, bridging the gap between national macroeconomic data and localized infrastructure planning. By integrating Dynamic Probabilistic Material Flow Analysis (DPMFA) with socio-economic downscaling and Monte Carlo simulations, the research quantified both historical baseline and future waste trajectories under competing policy scenarios up to the year 2035.

7.1 *Synthesis of Key Findings*

The results of the DPMFA model highlight a severe and growing material burden that current European waste management systems are not equipped to handle. The analysis yielded three critical insights into the future of PCTW:

1. **Robust Baselines and Massive Volume Growth:** To establish a rigorous 2019 baseline, the model evaluated waste flows through two independent pathways: a bottom-up summation of all 27 individual Member States (estimating 9.65 Mt) and a top-down evaluation utilizing the EU-27 aggregate dataset (estimating 9.93 Mt). The EU-27 aggregate result provides a closer and more reliable estimate, as the superior consolidation and availability of trade data at the macro-European level effectively resolves the reporting fragmentation and data gaps prevalent in individual national datasets. Projecting forward from this baseline—and accounting for the dampening macroeconomic effects of the COVID-19 pandemic—total EU generation is expected to surge to between 13.17 Mt and 14.1 Mt by 2035. This represents a sustained, systemic increase in material throughput that will overwhelm existing processing pathways.
2. **Extreme Geographical Polarization:** Textile waste generation is not distributed evenly across the European bloc. Approximately 60% of all EU-wide PCTW is generated by just four Member States: Germany, France, Italy, and Spain. When downscaled to the NUTS2 level, this polarization becomes even more acute. A concentrated region—most notably Île-de-France (FR10) and Lombardy (ITC4)—emerge as absolute dominant hotspots. These specific regions will bear an exceptional operational burden in the future.
3. **Downstream Treatment and Recovery Pathways:** Evaluating the fate of 6.45 Mt of separately collected textiles under EU 50% scenario revealed critical infrastructure thresholds. The projected allocation pathways show that 2.9 Mt will be channeled to reuse, creating a massive reliance on global exports due to limited intra-EU demand. Concurrently 2.06 Mt is designated for recycling, underscoring an urgent need for commercial-scale, closed-loop fiber-to-fiber technologies rather than current downcycling capacities. Furthermore, the remaining volumes – 0.64 Mt directed to incineration or landfill, and a substantial share lost as sorting residuals and systemic leakage – highlight the unavoidable technical inefficiencies embedded within the recovery networks.
4. **The Inadequacy of Incremental Policy:** The scenario analysis showed a severe divergence in outcomes between incremental, country-level policies (the CL scenario) and harmonized, absolute European targets (the EU scenario). Applying progressive, relative improvements to historical national baselines (CL) leaves approximately 10 Mt of textiles, corresponding to 76% of total EU textile waste generation, outside separate collection systems by 2035. The results

therefore indicate that gradual national improvements are insufficient to achieve the collection volumes required for a circular textile economy. In contrast, only absolute, EU-wide harmonized targets generate the collection volumes necessary to feed a genuinely circular textile economy.

7.2 *Limitations and Future Research Opportunities*

While the present study provides a comprehensive assessment of post-consumer textile waste (PCTW) generation and collection requirements across the EU, several methodological and structural limitations should be acknowledged when interpreting the results. These factors directly influence the magnitude and spatial distribution of projected waste generation and represent the highest priorities for future methodological improvements.

7.2.1 Data Availability and Statistical Uncertainty

First, the DPMFA development faced significant data scarcity in the field of textile manufacturing, international trade, and end-of-life waste generation. Importantly, future efforts in data collection could address the following topics to significantly improve model robustness:

1. **Data granularity and trade ambiguity:** A critical limitation originates from the inability of current EU trade statistics (e.g., PRODCOM and COMEXTT) to differentiate between new textile products and used textiles. As reported by EAA (2023), the export of used textiles increased from approximately 550,000 tons in 2000 to nearly 1.7 million tons in 2019, accounting for roughly 25% of annual textile consumption. However, since these volumes are not statistically differentiated from the export of new textile products, the model faces a significant double-counting risk; exported used textiles may be incorrectly subtracted as system outflows, creating an imbalance between production and use-phase inflows. Future research must prioritize advanced predictive analytics to statistically isolate bulk second-hand exports.
2. **Retail Stock Destruction:** The model assumes that all textiles entering the EU market proceed to the consumer use phase. However, evidence indicates that a portion of textile never enters active use. According to EEA (2024), between 4% and 9% of textile products placed on the market – approximately 264,000 to 594,000 tons per year- are destroyed as unsold retail stock or post-sale returns. These figures, while documented in literature, are not captured in harmonized statistics and remain embedded in apparent consumption calculations, potentially distorting the precise timing and volume of waste flows. Crucially, this operational blind spot faces imminent regulatory disruption under the EU's Ecodesign for Sustainable Products Regulation as the European Commission has enacted a binding ban on the destruction of unsold apparel, clothing accessories and footwear, which takes effect on July 19, 2026, for large enterprises and extends to medium-size companies by 2030 (REGULATION (EU) 2024/1781, 2024).
3. **Inflow reconciliation:** Apparent consumption values often contain inconsistencies incompatible with physical stock-flow relationships (e.g., negative values). These are statistical artifacts reflecting re-exports or reporting delays. While Simple Exponential Smoothing (SES) was implemented to enforce non-negativity and temporal coherence with minimal bias, it remains a statistical approximation rather than a direct measurement of real consumption patterns. Further studies may improve this aspect through the development of more detailed datasets on stock

accumulation, re-export activities, and retail inventories, thereby reducing reliance on statistical reconciliation procedures.

4. **Product life-expectancy:** While the integration of Monte Carlo simulations successfully quantifies the mathematical uncertainty of future waste flows, the underlying triangular distributions inherently simplify real world behavior. The specific limitation lies in the assumption that the parameters of the distribution (e.g., minimum, maximum and most likely) remain constant from baseline year through to 2035. Although the current probabilistic framework captures the uncertainty of present-day disposal patterns, keeping these parameters static overlooks the dynamic temporal shifts in consumer behavior. The growth of fast fashion may contract average product lifetimes, whereas repair initiatives, resale platforms, and circular economy policies aim to extend them (Ellen MacArthur Foundation, 2017). Future models should incorporate dynamic, time-series lifetime distributions derived from empirical data from consumer behavior surveys and resale platforms to allow the probabilistic parameters contract or expand dynamically across the simulations.
5. **Reuse networks and secondary markets:** The European textile system contains extensive formal and informal reuse networks including charity organizations, second-hand retailers, online marketplaces, peer-to-peer exchanges, and international exports. Domestic reuse activities occurring within national borders are largely invisible within official statistical systems. The inability to quantify these pathways introduces uncertainty regarding the actual duration of product use; textiles that experience multiple ownership cycles may remain in circulation for substantially longer periods than suggested by average lifetime estimates. Although exports were incorporated as outflows within the material flow framework, the final destination and subsequent use of exported textiles often remain unknown, as they may be redirected through multiple international trade chains. Improved monitoring of these networks represents a critical field for future studies to enhance the accuracy of DPMFA applications.

7.2.2 Structural and Scope Limitation

1. **Model Validation Constraints:** Although the framework was evaluated through multiple validation procedures, including bottom-up versus top-down consistency testing, benchmarking against independent DPMFA estimates, and comparison with literature-reported consumption levels, direct empirical validation remains inherently constrained. Harmonized EU-wide datasets describing actual post-consumer textile waste generation at national and NUTS2 regional levels are currently unavailable. Consequently, the credibility of the model relies primarily on indirect validation techniques and external benchmarking rather than direct observation of real-world waste flows (Beigl, 2008). Future research should investigate the sensitivity of results to alternative reconciliation methods, probability distributions and regional allocation approaches.
2. **Spatial downscaling and proxy variables:** The regionalization procedure represents one of the most innovative components of this research, but it also introduces additional uncertainty. The selection of population and household disposable income as proxies was driven by their linkage to consumption capacity; however, alternative indicators such as GDP per capita, industrial value-added or composite socioeconomic indices if available could capture regional differences. The choice of proxy variables inevitably introduces structural uncertainty into spatial allocation of

results (Beigl, 2008). Future studies could focus on sensitivity analysis of regional waste distributions to different downscaling assumption and proxies. Furthermore, these proxies fail to account for the geographical placement of legacy waste infrastructures. Future iterations of DPMFA should integrate Geographic Information Systems (GIS) mapping to replace these proxies with geographical coordinates of existing facilities.

3. **Scenario volatility and implementation friction:** Forecasting long-term trends to 2035 using a 3% CAGR from a 2020 baseline intentionally bypasses the economic disruptions of the COVID-19 pandemic. Comparative analysis demonstrates that utilizing real disrupted data from the 2020 to 2024 period results in lower volume of projected waste for 2035, confirming that this constant growth assumption carries a risk of overestimating (Beigl, 2008). Furthermore, the Monte Carlo simulation utilizes probabilistic distributions to introduce real-world variance into policy targets, which inherently assumes that infrastructural leaps occur synchronously with the policy mandate. The model measures the physical mass gap, but it lacks a friction coefficient to simulate the temporal lag of infrastructure development (Beigl, 2008). In reality, transitioning a region from baseline to targeted mandates requires years of capital expenditure, permitting, and the construction of advanced facilities. Future studies should apply Regional Techno-Economic Assessment (TEA) to these regional mass flows by utilizing Capital Expenditure and Operational Expenditure metrics to determine the exact financial investments required by specific municipalities to build the mandated capacity.
4. **Treatment pathway simplifications and homogeneous recycling:** The analysis of treatment pathways relies on EU-level textile-specific end-of-life shares, which forces the model to oversimplify the recycling process by treating it as a singular, basic step (Beigl, 2008). Applying generalized EU-wide shares obscures significant disparities in local waste management systems across different Member States. In reality, modern textile recycling is highly fragmented, and the study does not differentiate between open-loop downcycling and closed-loop fiber-to-fiber recycling. Furthermore, the model cannot account for the technical mass losses associated with complex fiber blends which currently lack scalable separation technologies and often result in incineration losses. Building upon these data gaps, future research must partition the textile inflow by material composition, assessing specific sorting yields and chemical or mechanical recycling efficiencies for discrete fiber types to move beyond generic mass recovery and quantify the true circularity potential, and work on the development of national and regional treatment metrics for more accurate comparison.
5. **System boundaries of textile classification:** The system boundaries of this research intentionally exclude industrial intermediate textile products in order to maintain consistency with the objective of forecasting post-consumer textile waste flows. Consequently, the results should not be interpreted as representing the complete industrial textile footprint of the European textile sector (Beigl, 2008). Future research may expand these boundaries to incorporate upstream industrial textile flows within broader circular economy assessments.

Finally, this work clearly highlights the importance of a detailed description of the study scope in textile MFA studies, involving both the description of value-chain stages included and the type of textile products included in the system boundaries. This will allow good comparability of results and correct interpretation for future research, policymaking, and infrastructure planning.

Appendix

Table 6: List of Finished Textile Products Considered in the Calculations, from PRODCOM LIST 2024; Conversion Factors to Kg, source (Napolano, 2025), and Life Expectancy of Finished Textile Products, sources: sources (Laitala K. K., 2018) and the (International Fair Claims Guide, 2015)

PRODCOM code	Product description	Unit of Measure	Conversion Factor to kg	Lifetime		
				min	average	max
13921130	Blankets and travelling rugs of wool or fine animal hair (excluding electric blankets)	p/st	0.5	10	10	10
13921150	Blankets and travelling rugs of synthetic fibres (excluding electric blankets)	p/st	0.5	5	5	5
13921190	Blankets (excluding electric blankets) and travelling rugs of textile materials (excluding of wool or fine animal hair, of synthetic fibres)	p/st	0.5	5	5	5
13921230	Bed linen of knitted or crocheted textiles	Kg		3	3	3
13921253	Bed linen of cotton (excluding knitted or crocheted)	Kg		3	3	3
13921255	Bed linen of flax or ramie (excluding knitted or crocheted)	Kg		3	3	3
13921259	Bed linen of woven textiles (excluding of cotton, of flax or ramie)	Kg		3	3	3
13921270	Bed linen of non-woven man-made fibres (excluding knitted or crocheted)	Kg		3	3	3
13921330	Table linen of knitted or crocheted textiles	Kg		2	2	2
13921353	Table linen of cotton (excluding knitted or crocheted)	Kg		3	3	3
13921355	Table linen of flax (excluding knitted or crocheted)	Kg		2	2	2
13921359	Table linen of woven man-made fibres and of other woven or non-woven textiles (excluding of cotton, of flax)	Kg		2	2	2
13921370	Table linen of non-woven man-made fibres	Kg		2	2	2
13921430	Toilet linen and kitchen linen, of terry towelling or similar terry fabrics of cotton	Kg		3	3	3
13921450	Woven toilet linen and kitchen linen, of textiles (excluding terry towelling or similar terry fabrics of cotton)	Kg		2	2	2
13921470	Toilet linen and kitchen linen, of non-woven man-made fibres	Kg		3	3	3
13921530	Curtains and interior blinds, curtain or bed valances, of knitted or crocheted materials	m2	0.25	4	4	4
13921550	Curtains and interior blinds, curtain or bed valances, of woven materials	m2	0.25	4	4	4
13921570	Curtains and interior blinds, curtain or bed valances, of non-woven materials	m2	0.25	4	4	4
13921620	Hand-woven tapestries of the type Gobelins, Flanders, Aubusson, Beauvais, and needle-worked tapestries (including petit point, cross-stitch) whether or not made up	Kg		4	4	4
13921640	Bedspreads (excluding eiderdowns)	p/st (pair/items)	0.5	3	3	3
13921660	Furnishing articles including furniture and cushion covers as well as cushion covers, etc. for car seats (excluding blankets, travelling rugs, bed linen, table linen, toilet linen, kitchen linen, curtains, blinds, valances and bedspreads)	Kg		3	3	3
13921680	Sets of woven fabrics and yarns for making up into rugs, tapestries, embroidered table cloths, serviettes, or similar textile articles, p.r.s.	Kg		4	4	4
13922130	Sacks and bags, of cotton, used for packing goods	Kg		1	1	1
13922150	Sacks and bags, of knitted or crocheted polyethylene or polypropylene strip, used for packing goods	Kg		1	1	1
13922170	Sacks and bags, of polyethylene or polypropylene strip, used for packing goods (excluding knitted or crocheted)	Kg		1	1	1
13922190	Sacks and bags, used for packing goods (excluding of cotton, polyethylene or polypropylene strip)	Kg		1	1	1

13922210	Tarpaulins, awnings and sunblinds (excluding caravan awnings)	Kg		4	4	4
13922230	Tents (including caravan awnings)	Kg		4	4	4
13922250	Sails	Kg		3	3	3
13922270	Pneumatic mattresses and other camping goods (excluding caravan awnings, tents, sleeping bags)	Kg		3	3.5	4
13922300	Parachutes and rotochutes, parts and accessories (including dirigible parachutes)	Kg		10	10	10
13922430	Sleeping bags	p/st	0.5	5	5	5
13922493	Articles of bedding of feathers or down (including quilts and eiderdowns, cushions, pouffes, pillows) (excluding mattresses, sleeping bags)	p/st @	0.5	5	5	5
13922499	Articles of bedding filled other than with feathers or down (including quilts and eiderdowns, cushions, pouffes, pillows) (excluding mattresses, sleeping bags)	p/st @ (unit differs from CN unit)	0.5	5	5	5
13922953	Floor-cloths, dish-cloths, dusters and similar cleaning cloths, of non-woven textiles	Kg		2	2	2
13922957	Floor-cloths, dish-cloths, dusters and similar cleaning cloths (excluding knitted or crocheted, articles of non-woven textiles)	Kg		2	2	2
13922998	Floor-cloths, dish-cloths, dusters and similar cleaning cloths, knitted or crocheted; life-jackets, life-belts and other made up articles (excluding protective face masks, sanitary towels and napkins and similar articles)	Kg		2	2	2
13931100	Knotted carpets and other knotted textile floor coverings	m2	1.6	5	5	5
13931200	Woven carpets and other woven textile coverings (excluding tufted or flocked)	m2	1.6	5	5	5
13931300	Tufted carpets and other tufted textile floor coverings	m2	1.38	5	5	5
13931930	Needlefelt carpets and other needlefelt textile floor coverings (excluding tufted or flocked)	m2	1.6	5	5	5
13931990	Carpets and other textile floor coverings (excluding knotted, woven, tufted, needlefelt)	m2	1.6	5	5	5
13941130	Twine, cordage, rope or cables, of sisal or other textile fibres of 'agave', of jute or other textile bast fibres and hard leaf fibres (excluding binder or baler twine)	Kg		10	10	10
13941153	Sisal binder or baler (agricultural) twines	Kg		10	10	10
13941155	Polyethylene or polypropylene binder or baler (agricultural) twines	Kg		10	10	10
13941160	Cordage, ropes or cables of polyethylene, polypropylene, nylon or other polyamides or of polyesters measuring > 50 000 decitex, of other synthetic fibres (excluding binder or baler twine)	Kg		10	10	10
13941170	Twines of polyethylene or polypropylene, of nylon or other polyamides or polyesters measuring <= 50 000 decitex (5 g/m) (excluding binder or baler twine)	Kg		10	10	10
13941190	Twines, cordage, rope and cables of textile materials (excluding jute and other textile bast fibres, sisal, abaca or other hard leaf fibres, synthetic fibres)	Kg		10	10	10
13941233	Made-up fishing nets from twine, cordage or rope of man-made fibres (excluding fish landing nets)	Kg		10	10	10
13941235	Made-up fishing nets from yarn of man-made fibres (excluding fish landing nets)	Kg		10	10	10
13941253	Made-up nets from twine, cable or rope of nylon or other polyamides (excluding netting in the piece produced by crochet, hairnets, sports and fishing nets)	Kg		10	10	10
13941255	Made-up nets of nylon or other polyamides (excluding netting in the piece produced by crochet, hairnets, sports and fishing nets, those made from twine, cable or rope)	Kg		10	10	10
13941259	Knotted netting of textile materials (excluding made-up fishing nets of man-made textiles, other made-up nets of nylon or other polyamides)	Kg		10	10	10
13941280	Articles of twine, cordage, rope or cables	Kg		10	10	10
13961620	Textile hose piping and similar textile tubing, whether or not impregnated or coated, with or without lining, armour or accessories of other materials	Kg		10	10	10

13961650	Textile wicks, conveyor belts or belting (including reinforced with metal or other material)	Kg		10	10	10
13991900	Powder-puffs and pads for the application of cosmetics or toilet preparations	p/st @	0.5	1	1	1
14111000	Articles of apparel of leather or of composition leather (including coats and overcoats) (excluding clothing accessories, headgear, footwear)	p/st @	0.9	5	5	5
14121120	Men's or boys' ensembles, of cotton or man-made fibres, for industrial and occupational wear	p/st	0.5	8.7	8.7	8.7
14121130	Men's or boys' jackets and blazers, of cotton or man-made fibres, for industrial and occupational wear	p/st	0.95	4	6.8	11.5
14121240	Men's or boys' trousers and breeches, of cotton or man-made fibres, for industrial or occupational wear	p/st	0.45	2	2.5	6.2
14121250	Men's or boys' bib and brace overalls, of cotton or man-made fibres, for industrial or occupational wear	p/st	0.45	2.5	4.7	6.2
14122120	Women's or girls' ensembles, of cotton or man-made fibres, for industrial or occupational wear	p/st	0.5	4.5	4.6	4.7
14122130	Women's or girls' jackets and blazers, of cotton or man-made fibres, for industrial or occupational wear	p/st	0.95	4	6.8	11.5
14122240	Women's or girls' trousers and breeches, of cotton or man-made fibres, for industrial or occupational wear	p/st	0.45	2.5	4.7	6.2
14122250	Women's or girls' bib and brace overalls, of cotton or man-made fibres, for industrial or occupational wear	p/st	0.45	2.5	4.7	6.2
14123013	Men's or boys' other garments, of cotton or man-made fibres, for industrial or occupational wear	p/st @	0.5	4.7	4.7	4.7
14123023	Women's or girls' other garments, of cotton or man-made fibres, for industrial or occupational wear	p/st @	0.5	2.4	3.1	4.4
14131110	Men's or boys' overcoats, car-coats, capes, cloaks and similar articles, of knitted or crocheted textiles (excluding jackets and blazers, anoraks, wind-cheaters and wind-jackets)	p/st	0.95	4	6.8	11.5
14131120	Men's or boys' waistcoats, anoraks, ski-jackets, wind-cheaters, wind-jackets and similar articles, of knitted or crocheted textiles (excluding jackets and blazers)	p/st	0.95	4	6.8	11.5
14131230	Men's or boys' jackets and blazers, of knitted or crocheted textiles	p/st	0.95	4	6.8	11.5
14131260	Men's or boys' suits and ensembles, of knitted or crocheted textiles	p/st	0.5	8.7	8.7	8.7
14131270	Men's or boys' trousers, breeches, shorts, bib and brace overalls, of knitted or crocheted textiles	p/st	0.45	2.5	4.7	6.2
14131310	Women's or girls' overcoats, car-coats, capes, cloaks and similar articles, of knitted or crocheted textiles (excluding jackets and blazers)	p/st	0.95	4	6.8	11.5
14131320	Women's or girls' waistcoats, anoraks, ski-jackets, wind-cheaters, wind-jackets and similar articles, of knitted or crocheted textiles (excluding jackets and blazers)	p/st	0.95	4	6.8	11.5
14131430	Women's or girls' jackets and blazers, of knitted or crocheted textiles	p/st	0.95	4	6.8	11.5
14131460	Women's or girls' suits and ensembles, of knitted or crocheted textiles	p/st	0.5	8.7	8.7	8.7
14131470	Women's or girls' dresses, of knitted or crocheted textiles	p/st	0.3	4.5	4.6	4.7
14131480	Women's or girls' skirts and divided skirts, of knitted or crocheted textiles	p/st	0.25	4.1	5.2	6.9
14131490	Women's or girls' trousers, breeches, shorts, bib and brace overalls, of knitted or crocheted textiles	p/st	0.45	2.5	4.7	6.2
14132116	Men's or boys' overcoats, car coats, capes, cloaks, anoraks (including ski-jackets), wind cheaters, wind-jackets and similar articles (excluding suits, ensembles, jackets, blazers, trousers, bib and brace overalls, breeches and shorts)	p/st	0.725	4	7	11.6
14132200	Men's or boys' suits & ensembles (excluding knitted or crocheted)	p/st	0.5	8.7	8.7	8.7
14132300	Men's or boys' jackets and blazers (excluding knitted or crocheted)	p/st	0.95	4	6.8	11.5
14132442	Men's or boys' trousers and breeches, of denim (excluding for industrial or occupational wear)	p/st	0.45	2.5	3.5	4.3

14132444	Men's or boys' trousers, breeches and shorts, of wool or fine animal hair (excluding knitted or crocheted, for industrial or occupational wear)	p/st	0.45	2.5	4.7	6.2
14132445	Men's or boys' trousers and breeches, of man-made fibres (excluding knitted or crocheted, for industrial or occupational wear)	p/st	0.45	2.5	4.7	6.2
14132448	Men's or boys' trousers and breeches, of cotton (excluding denim, knitted or crocheted)	p/st	0.45	2	2.5	6.2
14132449	Men's or boys' trousers, breeches, shorts and bib and brace overalls (excluding of wool, cotton and man-made fibres, knitted or crocheted)	p/st	0.45	2.5	4.7	6.2
14132455	Men's or boys' bib and brace overalls (excluding knitted or crocheted, for industrial or occupational wear)	p/st	0.45	2.5	4.7	6.2
14132460	Men's or boys' shorts, of cotton or man-made fibres (excluding knitted or crocheted)	p/st	0.45	2.5	4.7	6.2
14133116	Women's or girls' overcoats, car-coats, capes, cloaks, anoraks (including ski jackets), wind-cheaters, wind-jackets and similar articles (excluding suits, ensembles, jackets, blazers, dresses, skirts, divided skirts, trousers, bib and brace overalls, breeches and shorts)	p/st	0.725	4	7	11.6
14133200	Women's or girls' suits & ensembles (excluding knitted or crocheted)	p/st	0.5	8.7	8.7	8.7
14133330	Women's or girls' jackets and blazers (excluding knitted or crocheted)	p/st	0.95	4	6.8	11.5
14133470	Women's or girls' dresses (excluding knitted or crocheted)	p/st	0.3	4.5	4.6	4.7
14133480	Women's or girls' skirts and divided skirts (excluding knitted or crocheted)	p/st	0.25	4.1	5.2	6.9
14133542	Women's or girls' trousers and breeches, of denim (excluding for industrial or occupational wear)	p/st	0.45	2.5	3.5	4.3
14133548	Women's or girls' trousers and breeches, of cotton (excluding denim, for industrial or occupational wear)	p/st	0.45	2.5	4.7	6.2
14133549	Women's or girls' trousers and breeches, of wool or fine animal hair or man-made fibres (excluding knitted or crocheted and for industrial and occupational wear)	p/st	0.45	2.5	4	6.2
14133551	Women's or girls' bib and brace overalls, of cotton (excluding knitted or crocheted, for industrial or occupational wear)	p/st	0.45	2.5	4.7	6.2
14133561	Women's or girls' shorts, of cotton (excluding knitted and crocheted)	p/st	0.45	2.5	4.7	6.2
14133563	Women's or girls' bib and brace overalls, of wool or fine animal hair and man-made fibres (excluding cotton, knitted or crocheted, for industrial or occupational wear) and women's or girls' shorts, of wool or fine animal hair (excluding knitted or crocheted)	p/st	0.45	2.5	4.7	6.2
14133565	Women's or girls' shorts, of man-made fibres (excluding knitted or crocheted)	p/st	0.45	2.5	4.7	6.2
14133569	Women's or girls' trousers, breeches, bib and brace overalls, of textiles (excluding cotton, wool or fine animal hair, man-made fibres, knitted or crocheted)	p/st	0.45	2.5	4.7	6.2
14141100	Men's or boys' shirts, knitted or crocheted	p/st	0.25	3.3	4.8	7.2
14141220	Men's or boys' underpants and briefs, of knitted or crocheted textiles (including boxer shorts)	p/st	0.08	2.4	3.1	4.4
14141230	Men's or boys' nightshirts and pyjamas, of knitted or crocheted textiles	p/st	0.15	2.4	3.1	4.4
14141240	Men's or boys' dressing gowns, bathrobes and similar articles, of knitted or crocheted textiles	p/st	0.3	2.4	3.1	4.4
14141310	Women's or girls' blouses, shirts and shirt-blouses, of knitted or crocheted textiles	p/st	0.25	3.3	4.8	7.2
14141420	Women's or girls' briefs and panties, of knitted or crocheted textiles (including boxer shorts)	p/st	0.08	2.4	3.1	4.4
14141430	Women's or girls' nighties and pyjamas, of knitted or crocheted textiles	p/st	0.15	2.4	3.1	4.4
14141440	Women's or girls' negligees, bathrobes, dressing gowns and similar articles, of knitted or crocheted textiles	p/st	0.3	2.4	3.1	4.4
14141450	Women's or girls' slips and petticoats, of knitted or crocheted textiles	p/st	0.5	2.4	3.1	4.4
14142100	Men's or boys' shirts (excluding knitted or crocheted)	p/st	0.25	3.3	4.8	7.2

14142220	Men's or boys' underpants and briefs (including boxer shorts) (excluding knitted or crocheted)	p/st	0.08	2.4	3.1	4.4
14142230	Men's or boys' nightshirts and pyjamas (excluding knitted or crocheted)	p/st	0.15	2.4	3.1	4.4
14142240	Men's or boys' singlets, vests, bathrobes, dressing gowns and similar articles (excluding knitted or crocheted)	p/st @	0.3	2.4	3.1	4.4
14142300	Women's or girls' blouses, shirts and shirt-blouses (excluding knitted or crocheted)	p/st	0.25	3.3	4.8	7.2
14142430	Women's or girls' nightdresses and pyjamas (excluding knitted or crocheted)	p/st	0.3	2.4	3.1	4.4
14142450	Women's or girls' slips and petticoats (excluding knitted or crocheted)	p/st	0.5	2.4	3.1	4.4
14142460	Women's or girls' singlets and other vests, briefs, panties, negligees, bathrobes, dressing gowns, housecoats and similar articles of cotton (excluding knitted or crocheted)	p/st @	0.08	2.4	3.1	4.4
14142480	Women's or girls' negligees, bathrobes, dressing gowns, singlets, vests, briefs and panties (including boxer shorts), of man-made fibres (excluding knitted or crocheted)	p/st @	0.08	2.4	3.1	4.4
14142489	Women's or girls' singlets, vests, briefs, panties, negligees, bathrobes, dressing gowns and similar articles, of textiles (excluding cotton, man-made fibres, knitted or crocheted)	p/st @	0.08	2.4	3.1	4.4
14142530	Brassieres	p/st	0.05	3	3.5	4.4
14142550	Girdles, panty-girdles and corselettes (including bodies with adjustable straps)	p/st	0.5	3	3.5	4.4
14142570	Braces, suspenders, garters and similar articles and parts thereof	Kg		3	3.5	4.4
14143000	T-shirts, singlets and vests, knitted or crocheted	p/st	0.17	3.3	4.6	6.8
14191100	Babies' garments and clothing accessories, knitted or crocheted including vests, rompers, underpants, stretch-suits, gloves or mittens or mitts, outerwear (for children of height <= 86 cm)	Kg		2.4	3.1	4.4
14191210	Track-suits, of knitted or crocheted textiles	p/st	0.5	3.7	5.4	7.1
14191230	Ski-suits, of knitted or crocheted textiles	p/st @	0.5	8.7	8.7	8.7
14191240	Men's or boys' swimwear, of knitted or crocheted textiles	p/st	0.12	2	2	2
14191250	Women's or girls' swimwear, of knitted or crocheted textiles	p/st	0.12	2	2	2
14191290	Other garments, knitted or crocheted (including bodies with a proper sleeve)	Kg		4.7	4.7	4.7
14191300	Gloves, mittens and mitts, of knitted or crocheted textiles	pa	0.1	1	1	1
14191930	Shawls, scarves, mufflers, mantillas, veils and the like, of knitted or crocheted textiles	p/st @	0.1	2	2	2
14191960	Clothing accessories and parts thereof, of knitted or crocheted textiles (excluding gloves, mittens, shawls, scarves, mufflers, mantillas and veils)	Kg		1	1	1
14192150	Babies clothing and accessories, of textiles, not knitted or crocheted (for children of height <= 86 cm) including vests, rompers, underpants, stretch-suits, gloves, mittens and outerwear (excluding sanitary towels and napkins and similar articles)	Kg		2.4	3.1	4.4
14192210	Other men's or boys' apparel n.e.c., including tracksuits and jogging suits (excluding waistcoats, ski-suits, knitted or crocheted)	p/st @	0.5	3.7	5.4	7.1
14192220	Other women's or girls' apparel n.e.c., including tracksuits and jogging suits (excluding waistcoats, ski-suits, knitted or crocheted)	p/st @	0.5	3.7	5.4	7.1
14192230	Ski-suits (excluding of knitted or crocheted textiles)	p/st	0.5	8.7	8.7	8.7
14192240	Men's or boys' swimwear (excluding of knitted or crocheted textiles)	p/st	0.12	2	2	2
14192250	Women's or girls' swimwear (excluding of knitted or crocheted textiles)	p/st	0.12	2	2	2
14192310	Handkerchiefs	p/st	0.5	2	2	2
14192333	Shawls, scarves, mufflers, mantillas, veils and the like (excluding articles of silk or silk waste, knitted or crocheted)	p/st	0.15	2	2	2
14192338	Shawls, scarves, mufflers, mantillas, veils and the like, of silk or silk waste (excluding knitted or crocheted)	p/st	0.15	2	2	2

14192353	Ties, bow ties and cravats (excluding articles of silk or silk waste, knitted or crocheted)	p/st	0.15	1	1	1
14192358	Ties, bow ties and cravats, of silk or silk waste (excluding knitted or crocheted)	p/st	0.15	1	1	1
14192370	Gloves, mittens and mitts (excluding knitted or crocheted)	pa	0.1	1	1	1
14192396	Clothing accessories, parts of garments or of clothing accessories, of textiles, n.e.c. and parts thereof, (excluding shawls, scarves and mufflers, mantillas and veils, ties, bow-ties and cravats, gloves, mittens and mitts and parts thereof; bras, girdles and corsets, braces, suspenders and garters)	Kg		1	1	1
14193175	Gloves, mittens and mitts, of leather or composition leather (excluding for sport, protective for all trades)	pa	0.1	1	1	1
14193180	Belts and bandoliers, of leather or composition leather	p/st @	0.1	4	6.5	7
14193190	Clothing accessories of leather or composition leather (excluding gloves, mittens and mitts, belts and bandoliers)	Kg		3	4	5
14193200	Garments made up of felt or non-wovens, textile fabrics impregnated or coated	p/st @	0.1	4.7	4.7	4.7
14194230	Felt hats and other felt headgear, made from hat bodies or hoods and plateaux	p/st	0.1	2	2	2
14194250	Hats and other headgear, plaited or made by assembling strips of any material	p/st	0.1	2	2	2
14194270	Hats and other headgear, knitted or crocheted or made-up from lace, felt or other textile fabric in the piece (but not in strips); hair-nets of any material	p/st @	0.1	2	2	2
14194300	Other headgear (except headgear of rubber or of plastics, safety headgear and asbestos headgear); headbands, linings, covers, hat foundations, hat frames, peaks and chinstraps, for headgear	Kg		2	2	2
14201030	Articles of apparel and clothing accessories, of furskins (excluding hats and headgear)	Kg		5	6.5	8
14311033	Panty hose and tights, of knitted or crocheted synthetic fibres, measuring per single yarn < 67 decitex	p/st	0.07	1.8	2.6	3.6
14311035	Panty hose and tights, of knitted or crocheted synthetic fibres, measuring per single yarn >= 67 decitex	p/st	0.07	1.8	2.6	3.6
14311037	Pantyhose and tights of textile materials, knitted or crocheted (excl. graduated compression hosiery, those of synthetic fibres and hosiery for babies)	p/st	0.07	1.8	2.6	3.6
14311050	Women's full-length or knee-length knitted or crocheted hosiery, measuring per single yarn < 67 decitex	pa	0.01	2.4	3.1	4.4
14311090	Knitted or crocheted hosiery and footwear (including socks; excluding women's full-length/knee-length hosiery, measuring <67decitex, panty-hose and tights, footwear with applied soles)	pa @	0.07	1.8	2.6	3.6
14391031	Men's or boys' jerseys, pullovers, sweatshirts, waistcoats and cardigans, of wool or fine animal hair (excluding jerseys and pullovers containing >= 50 % of wool and weighing >= 600 g)	p/st	0.5	3.7	5.4	7.1
14391032	Women's or girls' jerseys, pullovers, sweatshirts, waistcoats and cardigans, of wool or fine animal hair (excluding jerseys and pullovers containing >= 50 % of wool and weighing >= 600 g)	p/st	0.5	3.7	5.4	7.1
14391033	Jerseys and pullovers, containing >= 50 % by weight of wool and weighing >= 600 g per article	p/st	0.3	3.7	5.4	7.1
14391053	Lightweight fine knit roll, polo or turtle neck jumpers and pullovers, of cotton	p/st	0.5	3.7	5.4	7.1
14391055	Lightweight fine knit roll, polo or turtle neck jumpers and pullovers, of man-made fibres	p/st	0.5	3.7	5.4	7.1
14391061	Men's or boys' jerseys, pullovers, sweatshirts, waistcoats and cardigans, of cotton (excluding lightweight fine knit roll, polo or turtle neck jumpers and pullovers)	p/st	0.5	3.7	5.4	7.1
14391062	Women's or girls' jerseys, pullovers, sweatshirts, waistcoats and cardigans, of cotton (excluding lightweight fine knit roll, polo or turtle neck jumpers and pullovers)	p/st	0.5	3.7	5.4	7.1
14391071	Men's or boys' jerseys, pullovers, sweatshirts, waistcoats and cardigans, of man-made fibres (excluding lightweight fine knit roll, polo or turtle neck jumpers and pullovers)	p/st	0.5	3.7	5.4	7.1

14391072	Women's or girls' jerseys, pullovers, sweatshirts, waistcoats and cardigans, of man-made fibres (excluding lightweight fine knit roll, polo or turtle neck jumpers and pullovers)	p/st	0.5	3.7	5.4	7.1
14391090	Jerseys, pullovers, sweatshirts, waistcoats and cardigans, of textile materials (excluding those of wool or fine animal hair, cotton, man-made fibres)	p/st	0.5	3.7	5.4	7.1
15201100	Waterproof footwear, with uppers in rubber or plastics (excluding incorporating a protective metal toecap)	pa	0.9	4.7	4.7	4.7
15201210	Sandals with rubber or plastic outer soles and uppers (including thong-type sandals, flip flops)	pa	0.5	4.7	4.7	4.7
15201231	Town footwear with rubber or plastic uppers	pa	0.9	4.7	4.7	4.7
15201237	Slippers and other indoor footwear with rubber or plastic outer soles and plastic uppers (including bedroom and dancing slippers, mules)	pa	0.35	4.7	4.7	4.7
15201330	Footwear with a wooden base and leather uppers (including clogs) (excluding with an inner sole or a protective metal toe-cap)	pa	0.9	4.7	4.7	4.7
15201351	Men's town footwear with leather uppers (including boots and shoes; excluding waterproof footwear, footwear with a protective metal toe-cap)	pa	0.9	4.7	4.7	4.7
15201352	Women's town footwear with leather uppers (including boots and shoes; excluding waterproof footwear, footwear with a protective metal toe-cap)	pa	0.9	4.7	4.7	4.7
15201353	Children's town footwear with leather uppers (including boots and shoes; excluding waterproof footwear, footwear with a protective metal toe-cap)	pa	0.9	4.7	4.7	4.7
15201361	Men's sandals with leather uppers (including thong type sandals, flip flops)	pa	0.5	4.7	4.7	4.7
15201362	Women's sandals with leather uppers (including thong type sandals, flip flops)	pa	0.5	4.7	4.7	4.7
15201363	Children's sandals with leather uppers (including thong type sandals, flip flops)	pa	0.5	4.7	4.7	4.7
15201370	Slippers and other indoor footwear with rubber, plastic or leather outer soles and leather uppers (including dancing and bedroom slippers, mules)	pa	0.35	4.7	4.7	4.7
15201380	Footwear with wood, cork or other outer soles and leather uppers (excluding outer soles of rubber, plastics or leather)	pa	0.9	4.7	4.7	4.7
15201444	Slippers and other indoor footwear (including dancing and bedroom slippers, mules) with uppers of textile materials	pa	0.35	4.7	4.7	4.7
15201445	Footwear with rubber, plastic or leather outer soles and textile uppers (excluding slippers and other indoor footwear, sports footwear)	pa	0.9	4.7	4.7	4.7
15201446	Footwear with textile uppers (excluding slippers and other indoor footwear as well as footwear with outer soles of rubber, plastics, leather or composition leather)	pa	0.9	4.7	4.7	4.7
15202100	Sports footwear with rubber or plastic outer soles and textile uppers (including tennis shoes, basketball shoes, gym shoes, training shoes and the like)	pa	0.9	4.7	4.7	4.7
15202900	Other sports footwear, except snow-ski footwear and skating boots	pa	0.9	4.7	4.7	4.7
15203120	Footwear (including waterproof footwear), incorporating a protective metal toecap, with outer soles and uppers of rubber or of plastics	pa	0.9	4.7	4.7	4.7
15203150	Footwear with rubber, plastic or leather outer soles and leather uppers, and with a protective metal toe-cap	pa	0.9	4.7	4.7	4.7
15203200	Wooden footwear, miscellaneous special footwear and other footwear n.e.c.	pa	0.9	4.7	4.7	4.7

Table 7: Codes not considered in the study compared to (Napolano, 2025), sources (EUROSTAT, 2026) (UK Office for National Statistics (ONS), 2026)

PRODCOM Code	Year	description	Exclusion reason	Revised Code	Year	Used Code
13922173	2008	Sacks and bags, of polyethylene or polypropylene strip, weighing <= 120 g/m2, used for packing goods (excluding knitted or crocheted)	Revised Code considered in data collection	13922170	2009	13922170
13922175	2008	Sacks and bags, of polyethylene or polypropylene strip, weighing > 120 g/m2, used for packing goods (excluding knitted or crocheted)				

13922990	2011	Floor-cloths, dish-cloths, dusters and similar cleaning cloths, knitted or crocheted; life-jackets, life-belts and other made up articles	Revised Code considered in data collection	13922999	2012	139922998
13922999	2020	Floor-cloths, dish-cloths, dusters and similar cleaning cloths, knitted or crocheted; life-jackets, life-belts and other made up articles (excluding sanitary towels and napkins and similar articles)		139922998	2021	
13922993		Sanitary towels, tampons and similar article of textile materials (excluding wadding)	Revised Code not considered in textile waste	Exclusion from textiles Hygiene waste		
13922997		Napkins and napkin liners for babies and similar article of textile materials (excluding wadding)				
13941133	2008	Twine, cordage, rope or cables, of sisal or other textile fibres of 'agave' measuring >100,000 decitex, of jute or other textile bast fibres and hard leaf fibres (excluding binder or baler twine)	Revised Code considered in data collection	13941130	2009	13941130
13941135	2008	Twines of sisal measuring <= 100,000 decitex (10 g/m) (excluding binder or baler twine)				
13951010		Non-wovens of a weight <= 25 g/m ² (including articles made from non-wovens) (excluding articles of apparel, coated or covered)	Intermediate Product/ avoid double counting			
13951020		Non-wovens of a weight of > 25 g/m ² but <= 70 g/m ² (including articles made from non-wovens) (excluding articles of apparel, coated or covered)	Intermediate Product/ avoid double counting			
13951030		Non-wovens of a weight of > 70 g/m ² but <= 150 g/m ² (including articles made from non-wovens) (excluding articles of apparel, coated or covered)	Intermediate Product/ avoid double counting			
13951050		Non-wovens of a weight of > 150 g/m ² (including articles made from non-wovens) (excluding articles of apparel, coated or covered)	Intermediate Product/ avoid double counting			
13951070		Non-wovens, coated or covered (including articles made from non-wovens) (excluding articles of apparel)	Intermediate Product/ avoid double counting			
13961750		Labels, badges and similar articles in textile materials (excluding embroidered)	Intermediate Product/ avoid double counting			
13961770		Braids in the piece; tassels and pompons, ornamental trimmings (excluding knitted or crocheted)	Intermediate Product/ avoid double counting			
13991230		Embroidery (without visible ground) in the piece, in strips or in motifs	Intermediate Product/ avoid double counting			
13991250		Cotton embroidery in the piece, in strips or in motifs (excluding embroidery without visible ground)	Intermediate Product/ avoid double counting			
13991270		Embroidery of textiles in the piece, in strips or in motifs (excluding without visible ground, cotton)	Intermediate Product/ avoid double counting			
13991600		Quilted textile products in the piece (excluding embroidery)	Used in final products/ avoid double counting			
14132110	2012	Men's or boys' raincoats	Revised Code considered in data collection	14132115	2013	14132116
14132120	2012	Men's or boys' overcoats, car-coats, capes, etc	Revised Code considered in data collection			
14132115	2021	Men's or boys' raincoats, overcoats, car-coats, capes, etc.	Revised Code considered in data collection			

14132130	2021	Men’s or boys’ waistcoats, anoraks, ski-jackets, wind-jackets and similar articles (excluding jackets and blazers, knitted or crocheted, impregnated, coated, covered, laminated or rubberised)	Revised Code considered in data collection			
14132210	2012	Men's or boys' suits (excluding knitted or crocheted)	Revised Code considered in data collection	14132200	2013	14132200
14132220	2012	Men's or boys' ensembles (excluding knitted or crocheted)	Revised Code considered in data collection			
14133110	2012	Woman's or girls' raincoats	Revised Code considered in data collection	14133115	2013	14133116
14133120	2012	Woman's or girls' overcoats, etc	Revised Code considered in data collection			
14133115	2021	Woman’s or girls’ raincoats and overcoats, etc	Revised Code considered in data collection	14133116	2022	
14133130	2021	Women’s or girls’ waistcoats, anoraks, ski-jackets, wind-jackets and similar articles (excluding jackets and blazers, knitted or crocheted, impregnated, coated, covered, laminated or rubberised)	Revised Code considered in data collection			
14133210	2012	Women's or girls' suits (excluding knitted or crocheted)	Revised Code considered in data collection	14133200	2013	
14133220	2012	Women's or girls' ensembles (excluding knitted or crocheted)	Revised Code considered in data collection			
14192100	2011	Babies' clothing and accessories, of textiles, not knitted or crocheted (for children of height <= 86 cm) including vests, rompers, underpants, stretch-suits, napkins, gloves, mittens and outerwear	Revised Code considered in data collection	14192150	2012	14192150
14192393	2014	Clothing accessories of textiles (excluding shawls, scarves and mufflers, mantillas and veils, ties, bow-ties and cravats, gloves, mittens and mitts, knitted or crocheted)	Revised Code considered in data collection	14192396	2015	14192396
14192395	2014	Parts of garments or of clothing accessories, of textiles (excluding bras, girdles and corsets, braces, suspenders and garters, knitted or crocheted)	Revised Code considered in data collection			
14194130		Hat-forms, hat bodies and hoods, plateaux and manchons of felt (including slit manchons) (excluding those blocked to shape, those with made brims)	Intermediate Product/ avoid double counting			
14194150		Hat-shapes, plaited or made by assembling strips of any material (excluding those blocked to shape, those with made brims, those lined or trimmed)	Intermediate Product/ avoid double counting			
15204020		Leather uppers and parts thereof of footwear (excluding stiffeners)	Intermediate Product/ avoid double counting			
15204050		Uppers and parts thereof of footwear (excluding stiffeners, of leather)	Intermediate Product/ avoid double counting			
15204080		Parts of footwear (excluding uppers) other materials	Intermediate Product/ avoid double counting			

Table 8: Selection of the Global Alpha for EU countries, Sensitivity Check, Cumulative Deviation Percentage

Alpha	RMSE	Alpha	RMSE
0.2	4959689.004	0.5	4697815.006
0.21	4928911.621	0.51	4700102.731
0.22	4901396.93	0.52	4702737.486
0.23	4876640.798	0.53	4705708.095
0.24	4854366.809	0.54	4709003.35
0.25	4834311.244	0.55	4712613.306
0.26	4816233.975	0.56	4716529.103
0.27	4799974.14	0.57	4720743.415
0.28	4785385.038	0.58	4725248.435
0.29	4772267.426	0.59	4730038.071
0.3	4760495.157	0.6	4735101.785
0.31	4749955.75	0.61	4740437.385
0.32	4740608.887	0.62	4746042.375
0.33	4732317.836	0.63	4751912.256
0.34	4724985.762	0.64	4758058.539
0.35	4718540.614	0.65	4764470.025
0.36	4712918.849	0.66	4771130.826
0.37	4708065.954	0.67	4778038.976
0.38	4703931.45	0.68	4785192.716
0.39	4700469.843	0.69	4792590.363
0.4	4697673.403	0.7	4800230.926
0.41	4695510.017	0.71	4808110.884
0.42	4693899.189	0.72	4816231.475
0.43	4692811.543	0.73	4824582.725
0.44	4692218.446	0.74	4833168.745
0.45	4692095.337	0.75	4841996.947
0.46	4692419.165	0.76	4851067.762
0.47	4693173.169	0.77	4860381.934
0.48	4694335.571	0.78	4869940.254
0.49	4695887.884	0.79	4879743.713
Metric		Value	
Best global alpha		0.448	
One-step-ahead SSE		2306359240769340000	
One-step-ahead RMSE		4692083.50	
Total SES (Sum INFLOW SES)		203293456608.188	
Total RAW (Sum apparent consumption)		188797919327.947	
Net Bias = Sum (SES-RAW)		14495537280.2411	
Net Bias/Total SES (%)		7.13035113	

Table 9: Country-level Results of Reconciliation Procedure

Country	Total Raw Mass (t)	Total Smoothed (t)	Net Bias (SES - RAW)	Percentage of Change (%)	Count of Negative Values
Austria	4.186594731	4.661934592	0.475339862	0.101961933	199
Belgium	4.868743639	6.946428687	2.077685047	0.299101184	676
Bulgaria	0.328921842	1.187418358	0.858496517	0.722994141	1102
Cyprus	0.430880618	0.424066762	-0.006813856	-0.016067885	63
Czechia	4.586322252	5.266959128	0.680636876	0.129227674	501
Germany	41.80303347	42.45137599	0.648342521	0.015272591	170
Denmark	3.103796465	3.320281338	0.216484872	0.065200762	285
Estonia	0.101739774	0.609424576	0.507684802	0.833056004	458
Spain	23.47119457	23.43889337	-0.0323012	-0.001378103	293
Finland	2.395700744	2.379932039	-0.015768705	-0.006625695	75
France	30.99420781	30.73840538	-0.255802429	-0.008321916	148
Greece	3.026287053	3.746825661	0.720538608	0.192306414	237
Croatia	1.402809371	1.470105272	0.067295901	0.045776246	246
Hungary	2.334545307	2.615134347	0.28058904	0.107294312	559
Ireland	3.597053795	3.586426083	-0.010627712	-0.002963315	158
Italy	25.15243362	28.17810517	3.025671553	0.107376686	358
Lithuania	0.604568223	0.913048491	0.308480268	0.337857487	604
Luxembourg	0.28617377	0.29953262	0.01335885	0.044598983	156
Latvia	0.348753955	0.461497077	0.112743122	0.24429867	401
Malta	0.783450155	0.76957994	-0.013870215	-0.018023098	172
Netherlands	12.30147197	13.44223549	1.140763521	0.084864123	492
Poland	7.888651781	8.877629148	0.988977368	0.111401068	532
Portugal	2.983574046	4.462043381	1.478469335	0.331343559	796
Romania	4.706957466	5.247728051	0.540770585	0.103048515	443
Sweden	5.263755517	5.197616788	-0.066138729	-0.012724818	223
Slovenia	0.40536067	0.716040352	0.310679682	0.433885718	463
Slovakia	1.440936716	1.884788513	0.443851796	0.235491565	843

Table 10: Selection of the Alpha for the EU-27 aggregate

Metric	Value
Optimized Global Alpha	0.523
One-Step-Ahead SSE	2890437774363720000
One-Step-Ahead RMSE	27293922.2
Total Raw Consumption	212072591249.175
Total Reconciled Inflow	209742869435.761
Global Net Bias (SES - RAW)	-2329721813
Global Percentage Change (%)	-1.110751378

Table 11: 2019 baseline Monte Carlo results

Country	Mean	Median	Variance	Std Dev	Min Simulated	Max Simulated	CI Lower 5th	CI Upper 95th
Austria	0.24	0.24	288852.00	0.017	0.18	0.30	0.21	0.27
Belgium	0.30	0.29	295327.00	0.017	0.24	0.36	0.26	0.33
Bulgaria	0.05	0.05	9928.68	0.003	0.04	0.06	0.04	0.05
Croatia	0.07	0.07	24812.20	0.005	0.05	0.09	0.06	0.08
Cyprus	0.02	0.02	1303.41	0.001	0.02	0.02	0.02	0.02
Czechia	0.24	0.24	283448.00	0.017	0.19	0.30	0.21	0.27
Denmark	0.16	0.16	85678.60	0.009	0.13	0.20	0.14	0.18
Estonia	0.03	0.03	1124.43	0.001	0.03	0.03	0.03	0.03
Finland	0.11	0.11	48983.50	0.007	0.09	0.14	0.10	0.13
France	1.56	1.55	11500000.00	0.107	1.19	2.03	1.35	1.78
Germany	2.09	2.09	21200000.00	0.146	1.60	2.81	1.82	2.38
Greece	0.15	0.15	68947.20	0.008	0.13	0.18	0.14	0.17
Hungary	0.10	0.10	36440.90	0.006	0.08	0.13	0.09	0.11
Ireland	0.17	0.17	113511.00	0.011	0.13	0.21	0.15	0.19
Italy	1.23	1.23	5169050.00	0.072	0.99	1.51	1.10	1.38
Latvia	0.02	0.02	1078.39	0.001	0.02	0.02	0.02	0.02
Lithuania	0.04	0.04	1686.93	0.001	0.03	0.04	0.03	0.04
Luxembourg	0.01	0.01	949.94	0.001	0.01	0.02	0.01	0.02
Malta	0.01	0.01	2106.47	0.001	0.01	0.02	0.01	0.01
Netherlands	0.76	0.76	4244350.00	0.065	0.56	1.03	0.64	0.90
Poland	0.41	0.41	473467.00	0.022	0.34	0.49	0.37	0.45
Portugal	0.20	0.20	118748.00	0.011	0.16	0.25	0.18	0.22
Romania	0.21	0.21	177108.00	0.013	0.16	0.26	0.18	0.24
Slovakia	0.08	0.08	23636.10	0.005	0.06	0.10	0.07	0.09
Slovenia	0.03	0.03	8137.42	0.003	0.02	0.05	0.03	0.04
Spain	1.09	1.09	6023700.00	0.078	0.84	1.42	0.95	1.25
Sweden	0.27	0.27	277291.00	0.017	0.22	0.34	0.24	0.31
TOTAL	9.65	9.64	50500000.00	0.225	7.54	12.43	8.45	10.97
EU	9.93	9.90	437315795.86	0.66	7.77	12.75	8.70	11.28

Table 12: 2035 Monte Carlo results considering two different anchor years (Mt)

Country	Applying 3% from 2020								Applying 3% from 2024							
	Mean	Median	Variance	Std Dev	Min Simulated	Max Simulated	CI Lower 5th	CI Upper 95th	Mean	Median	Variance	Std Dev	Min Simulated	Max Simulated	CI Lower 5th	CI Upper 95th
Austria	0.34	0.34	614214.00	0.025	0.26	0.44	0.29	0.39	0.32	0.32	528426.00	0.023	0.25	0.42	0.28	0.37
Belgium	0.48	0.48	678642.00	0.026	0.40	0.58	0.43	0.53	0.44	0.44	399676.00	0.020	0.37	0.52	0.40	0.48
Bulgaria	0.10	0.10	43065.10	0.007	0.08	0.13	0.09	0.11	0.13	0.13	84078.80	0.009	0.10	0.17	0.11	0.15
Croatia	0.12	0.12	75231.20	0.009	0.10	0.16	0.11	0.14	0.12	0.12	84698.10	0.009	0.09	0.16	0.10	0.14
Cyprus	0.03	0.03	3853.36	0.002	0.02	0.04	0.03	0.03	0.03	0.03	3073.64	0.002	0.02	0.04	0.03	0.03
Czechia	0.36	0.36	642458.00	0.025	0.28	0.46	0.31	0.41	0.31	0.31	525756.00	0.023	0.24	0.40	0.27	0.36
Denmark	0.22	0.22	145698.00	0.012	0.19	0.28	0.20	0.25	0.21	0.21	138504.00	0.012	0.17	0.25	0.18	0.23
Estonia	0.05	0.05	3917.11	0.002	0.04	0.05	0.04	0.05	0.04	0.04	3234.47	0.002	0.03	0.05	0.04	0.04
Finland	0.16	0.16	75902.80	0.009	0.14	0.21	0.15	0.18	0.14	0.14	54452.70	0.007	0.11	0.17	0.12	0.15
France	2.17	2.17	20500000.00	0.143	1.70	2.76	1.91	2.46	1.96	1.96	16200000.00	0.127	1.50	2.46	1.72	2.21
Germany	2.98	2.97	47300000.00	0.217	2.29	3.87	2.57	3.42	2.58	2.57	38400000.00	0.196	1.96	3.38	2.21	2.98
Greece	0.24	0.24	145845.00	0.012	0.20	0.28	0.22	0.26	0.25	0.25	139193.00	0.012	0.21	0.30	0.23	0.27
Hungary	0.25	0.25	251591.00	0.016	0.20	0.31	0.22	0.28	0.18	0.18	106697.00	0.010	0.15	0.22	0.16	0.20
Ireland	0.21	0.21	249740.00	0.016	0.16	0.28	0.18	0.24	0.28	0.28	353533.00	0.019	0.21	0.35	0.24	0.32
Italy	1.72	1.72	8290960.00	0.091	1.41	2.10	1.55	1.91	1.51	1.51	7241940.00	0.085	1.23	1.86	1.35	1.68
Latvia	0.03	0.03	3004.14	0.002	0.03	0.04	0.03	0.04	0.04	0.04	3946.90	0.002	0.03	0.04	0.03	0.04
Lithuania	0.08	0.08	7968.50	0.003	0.07	0.09	0.07	0.08	0.07	0.07	8311.82	0.003	0.06	0.08	0.06	0.07
Luxembourg	0.02	0.02	1704.34	0.001	0.02	0.03	0.02	0.02	0.02	0.02	1640.89	0.001	0.02	0.02	0.02	0.02
Malta	0.11	0.11	281459.00	0.017	0.06	0.17	0.08	0.15	0.03	0.03	13197.70	0.004	0.02	0.05	0.03	0.04
Netherlands	0.97	0.97	4154690.00	0.064	0.73	1.24	0.85	1.10	0.73	0.73	1881390.00	0.043	0.59	0.90	0.65	0.82
Poland	0.72	0.72	2337450.00	0.048	0.56	0.91	0.63	0.82	0.77	0.77	3507720.00	0.059	0.60	0.99	0.66	0.89
Portugal	0.36	0.36	366321.00	0.019	0.30	0.44	0.33	0.40	0.42	0.42	533949.00	0.023	0.35	0.51	0.38	0.47
Romania	0.33	0.33	430834.00	0.021	0.26	0.42	0.29	0.37	0.33	0.33	547107.00	0.023	0.25	0.43	0.29	0.38
Slovakia	0.13	0.13	26738.00	0.005	0.11	0.15	0.12	0.14	0.11	0.11	24948.00	0.005	0.09	0.13	0.10	0.12
Slovenia	0.06	0.05	21281.00	0.005	0.04	0.07	0.05	0.06	0.06	0.06	21833.90	0.005	0.04	0.08	0.05	0.07
Spain	1.46	1.46	9213930.00	0.096	1.18	1.82	1.28	1.66	1.48	1.48	10600000.00	0.103	1.18	1.89	1.28	1.69
Sweden	0.36	0.36	534531.00	0.023	0.29	0.46	0.32	0.41	0.33	0.33	427764.00	0.021	0.27	0.41	0.30	0.38
TOTAL	14.07	14.04	96300000.00	0.310	11.09	17.79	12.36	15.93	12.89	12.87	81900000.00	0.286	10.15	16.29	11.30	14.61
EU-27	14.38	14.35	835000000.00	0.91	11.33	18.63	12.66	16.24	13.16	13.13	738000000.00	0.86	10.24	17.26	11.57	14.89

Table 13: CL Scenario 2020 anchor (Mt)

Country	PCTW 2035 Mean	Base Collection Rate	CL Baseline	Target Rate CL 10	Collected Volume 2035 CL 10%	Target Rate CL 20	Collected Volume 2035 CL 20%	Target Rate CL 50	Collected Volume 2035 CL 50%
Austria	0.340	0.3	0.3	0.33	0.112	0.36	0.122	0.45	0.153
Belgium	0.480	0.5	0.5	0.55	0.264	0.6	0.288	0.75	0.360
Bulgaria	0.099	0.01	0.01	0.01	0.001	0.01	0.001	0.02	0.002
Croatia	0.123	0.09	0.09	0.1	0.012	0.11	0.013	0.14	0.017
Cyprus	0.029	0.11	0.11	0.12	0.003	0.13	0.004	0.17	0.005
Czechia	0.358	0.25	0.25	0.28	0.098	0.3	0.108	0.38	0.137
Denmark	0.225	0.11	0.11	0.12	0.027	0.13	0.030	0.17	0.039
Estonia	0.047	0.05	0.05	0.06	0.003	0.06	0.003	0.08	0.004
Finland	0.165	0	0.01	0.01	0.002	0.01	0.002	0.02	0.003
France	2.173	0.24	0.24	0.26	0.574	0.29	0.629	0.36	0.781
Germany	2.982	0.18	0.18	0.2	0.59	0.22	0.656	0.27	0.805
Greece	0.238	0.02	0.02	0.02	0.005	0.02	0.005	0.03	0.007
Hungary	0.246	0	0.01	0.01	0.003	0.01	0.003	0.02	0.005
Ireland	0.213	0.01	0.01	0.01	0.002	0.01	0.002	0.02	0.004
Italy	1.723	0.14	0.14	0.15	0.265	0.17	0.292	0.21	0.361
Latvia	0.034	0	0.01	0.01	0.0003	0.01	0.0003	0.02	0.001
Lithuania	0.078	0.08	0.08	0.09	0.007	0.1	0.008	0.12	0.010
Luxembourg	0.022	0.5	0.5	0.55	0.011	0.6	0.012	0.75	0.015
Malta	0.112	0.19	0.19	0.21	0.023	0.23	0.025	0.29	0.032
Netherlands	0.972	0.37	0.37	0.41	0.398	0.44	0.427	0.55	0.534
Poland	0.719	0	0.01	0.01	0.007	0.01	0.007	0.02	0.014
Portugal	0.366	0	0.01	0.01	0.004	0.01	0.004	0.02	0.007
Romania	0.329	0.01	0.01	0.01	0.003	0.01	0.003	0.02	0.007
Slovakia	0.131	0.06	0.06	0.07	0.009	0.07	0.009	0.09	0.012
Slovenia	0.055	0.07	0.07	0.08	0.004	0.08	0.004	0.11	0.006
Spain	1.464	0.04	0.04	0.04	0.058	0.05	0.073	0.06	0.088
Sweden	0.361	0.05	0.05	0.06	0.022	0.06	0.022	0.08	0.029

Table 14: CL Scenario 2024 anchor (Mt)

Country	PCTW 2035 Mean kg	Base Collection Rate	CL Baseline	Target Rate CL 10	Collected Volume 2035 CL 10	Target Rate CL 20	Collected Volume 2035 CL 20	Target Rate CL 50	Collected Volume 2035 CL 50
Austria	0.320	0.3	0.3	0.33	0.106	0.36	0.120	0.45	0.144
Belgium	0.440	0.5	0.5	0.55	0.242	0.6	0.270	0.75	0.33
Bulgaria	0.130	0.01	0.01	0.011	0.001	0.012	0.002	0.015	0.00195
Croatia	0.120	0.09	0.09	0.099	0.012	0.108	0.013	0.135	0.0162
Cyprus	0.030	0.11	0.11	0.121	0.004	0.132	0.004	0.165	0.00495
Czechia	0.310	0.25	0.25	0.275	0.085	0.3	0.093	0.375	0.11625

Denmark	0.210	0.11	0.11	0.121	0.025	0.132	0.028	0.165	0.03465
Estonia	0.040	0.05	0.05	0.055	0.002	0.06	0.002	0.075	0.003
Finland	0.140	0	0.01	0.011	0.002	0.012	0.002	0.015	0.0021
France	1.960	0.24	0.24	0.264	0.517	0.288	0.564	0.36	0.7056
Germany	2.580	0.18	0.18	0.198	0.511	0.216	0.557	0.27	0.6966
Greece	0.250	0.02	0.02	0.022	0.006	0.024	0.006	0.03	0.0075
Hungary	0.180	0	0.01	0.011	0.002	0.012	0.002	0.015	0.0027
Ireland	0.280	0.01	0.01	0.011	0.003	0.012	0.003	0.015	0.0042
Italy	1.510	0.14	0.14	0.154	0.233	0.168	0.254	0.21	0.3171
Latvia	0.040	0	0.01	0.011	0.0004	0.012	0.000	0.015	0.0006
Lithuania	0.070	0.08	0.08	0.088	0.006	0.096	0.007	0.12	0.0084
Luxembourg	0.020	0.5	0.5	0.55	0.011	0.6	0.012	0.75	0.015
Malta	0.030	0.19	0.19	0.209	0.006	0.228	0.007	0.285	0.00855
Netherlands	0.730	0.37	0.37	0.407	0.297	0.444	0.324	0.555	0.40515
Poland	0.770	0	0.01	0.011	0.008	0.012	0.009	0.015	0.01155
Portugal	0.420	0	0.01	0.011	0.005	0.012	0.005	0.015	0.0063
Romania	0.330	0.01	0.01	0.011	0.004	0.012	0.004	0.015	0.00495
Slovakia	0.110	0.06	0.06	0.066	0.007	0.072	0.008	0.09	0.0099
Slovenia	0.060	0.07	0.07	0.077	0.005	0.084	0.005	0.105	0.0063
Spain	1.480	0.04	0.04	0.044	0.065	0.048	0.071	0.06	0.0888
Sweden	0.330	0.05	0.05	0.055	0.018	0.06	0.020	0.075	0.02475

Table 15: EU scenario 2020 anchor (Mt)

Country	PCTW 2035 Mean	Base Collection Rate 2020	Target Rate EU 50	Collected Volume 2035 EU 50	Target Rate EU 75	Collected Volume 2035 EU 75	Target Rate EU 100	Collected Volume 2035 EU 100
Austria	0.340	0.3	0.5	0.170	0.75	0.250	1	0.340
Belgium	0.480	0.5	0.5	0.240	0.75	0.360	1	0.480
Bulgaria	0.100	0.01	0.5	0.050	0.75	0.070	1	0.100
Croatia	0.120	0.09	0.5	0.060	0.75	0.090	1	0.120
Cyprus	0.030	0.11	0.5	0.010	0.75	0.020	1	0.030
Czechia	0.360	0.25	0.5	0.180	0.75	0.270	1	0.360
Denmark	0.230	0.11	0.5	0.110	0.75	0.170	1	0.230
Estonia	0.050	0.05	0.5	0.020	0.75	0.040	1	0.050
Finland	0.160	0	0.5	0.080	0.75	0.120	1	0.160
France	2.170	0.24	0.5	1.090	0.75	1.630	1	2.170
Germany	2.980	0.18	0.5	1.490	0.75	2.240	1	2.980
Greece	0.240	0.02	0.5	0.120	0.75	0.180	1	0.240
Hungary	0.250	0	0.5	0.120	0.75	0.180	1	0.250
Ireland	0.210	0.01	0.5	0.110	0.75	0.160	1	0.210
Italy	1.720	0.14	0.5	0.860	0.75	1.290	1	1.720
Latvia	0.030	0	0.5	0.020	0.75	0.030	1	0.030
Lithuania	0.080	0.08	0.5	0.040	0.75	0.060	1	0.080

Luxembourg	0.020	0.5	0.5	0.010	0.75	0.020	1	0.020
Malta	0.110	0.19	0.5	0.060	0.75	0.080	1	0.110
Netherlands	0.970	0.37	0.5	0.490	0.75	0.730	1	0.970
Poland	0.720	0	0.5	0.360	0.75	0.540	1	0.720
Portugal	0.370	0	0.5	0.180	0.75	0.270	1	0.370
Romania	0.330	0.01	0.5	0.160	0.75	0.250	1	0.330
Slovakia	0.130	0.06	0.5	0.070	0.75	0.100	1	0.130
Slovenia	0.050	0.07	0.5	0.030	0.75	0.040	1	0.050
Spain	1.460	0.04	0.5	0.730	0.75	1.100	1	1.460
Sweden	0.360	0.05	0.5	0.180	0.75	0.270	1	0.360

Table 16: EU Scenario 2024 anchor (Mt)

Country	PCTW 2035 Mean kg	Base Collection Rate 2020	Target Rate EU 50	Collected Volume 035 EU 50	Target Rate EU 75	Collected Volume 035 EU 75	Target Rate EU 100	Collected Volume 2035 EU 100
Austria	0.321	0.3	0.5	0.160	0.75	0.240	1	0.321
Belgium	0.443	0.5	0.5	0.220	0.75	0.330	1	0.443
Bulgaria	0.127	0.01	0.5	0.060	0.75	0.100	1	0.127
Croatia	0.121	0.09	0.5	0.060	0.75	0.090	1	0.121
Cyprus	0.029	0.11	0.5	0.010	0.75	0.020	1	0.029
Czechia	0.314	0.25	0.5	0.160	0.75	0.240	1	0.314
Denmark	0.206	0.11	0.5	0.100	0.75	0.150	1	0.206
Estonia	0.040	0.05	0.5	0.020	0.75	0.030	1	0.04
Finland	0.137	0	0.5	0.070	0.75	0.100	1	0.137
France	1.958	0.24	0.5	0.980	0.75	1.470	1	1.958
Germany	2.581	0.18	0.5	1.290	0.75	1.940	1	2.581
Greece	0.250	0.02	0.5	0.120	0.75	0.190	1	0.25
Hungary	0.181	0	0.5	0.090	0.75	0.140	1	0.181
Ireland	0.279	0.01	0.5	0.140	0.75	0.210	1	0.279
Italy	1.509	0.14	0.5	0.750	0.75	1.130	1	1.509
Latvia	0.036	0	0.5	0.020	0.75	0.030	1	0.036
Lithuania	0.069	0.08	0.5	0.030	0.75	0.050	1	0.069
Luxembourg	0.020	0.5	0.5	0.010	0.75	0.020	1	0.02
Malta	0.034	0.19	0.5	0.020	0.75	0.030	1	0.034
Netherlands	0.733	0.37	0.5	0.370	0.75	0.550	1	0.733
Poland	0.773	0	0.5	0.390	0.75	0.580	1	0.773
Portugal	0.423	0	0.5	0.210	0.75	0.320	1	0.423
Romania	0.330	0.01	0.5	0.170	0.75	0.250	1	0.33
Slovakia	0.112	0.06	0.5	0.060	0.75	0.080	1	0.112
Slovenia	0.059	0.07	0.5	0.030	0.75	0.040	1	0.059
Spain	1.479	0.04	0.5	0.740	0.75	1.110	1	1.479
Sweden	0.335	0.05	0.5	0.170	0.75	0.250	1	0.335

Table 17: NUTS2 Regions Population, Disposable Income, Regional Weight and Share

NUTS 2 Code	Region Name	Country	Population	Disposable Income	Regional Weight	Regional Share
BE10	Région de Bruxelles-Capitale / Brussels Hoofdstedelijk Gewest	Belgium	1271709	26953.02	34276398111.18	0.0937403
BE21	Prov. Antwerpen	Belgium	1947973	47414.79	92362730720.67	0.2525967
BE22	Prov. Limburg (BE)	Belgium	909455	21132.15	19218739478.25	0.0525601
BE23	Prov. Oost-Vlaanderen	Belgium	1586436	40475.97	64212535942.92	0.1756106
BE24	Prov. Vlaams-Brabant	Belgium	1205743	32308.69	38955976806.67	0.1065381
BE25	Prov. West-Vlaanderen	Belgium	1234664	31964.35	39465232228.40	0.1079309
BE31	Prov. Brabant Wallon	Belgium	416504	10819.97	4506560784.88	0.0123247
BE32	Prov. Hainaut	Belgium	1369741	27607.49	37815110960.09	0.1034180
BE33	Prov. Liège	Belgium	1131687	24012.09	27174170095.83	0.0743168
BE34	Prov. Luxembourg (BE)	Belgium	299812	6802.32	2039417163.84	0.0055775
BE35	Prov. Namur	Belgium	509771	11036.44	5626057055.24	0.0153863
BG31	Severozapaden	Bulgaria	655430	6883.21	4511462330.30	0.0363042
BG32	Severen tsentralen	Bulgaria	673331	7496.61	5047699907.91	0.0406194
BG33	Severoiztochen	Bulgaria	826742	9413.55	7782577154.10	0.0626273
BG34	Yugoiztochen	Bulgaria	952383	9947.78	9474096559.74	0.0762391
BG41	Yugozapaden	Bulgaria	2022982	38643.86	78175833190.52	0.6290898
BG42	Yuzhen tsentralen	Bulgaria	1306492	14754.39	19276492499.88	0.1551201
CZ01	Praha	Czechia	1397880	30072.52	42037774257.60	0.1588688
CZ02	Střední Čechy	Czechia	1466215	27219.31	39909360611.65	0.1508252
CZ03	Jihozápad	Czechia	1267867	21059.41	26700530978.47	0.1009065
CZ04	Severozápad	Czechia	1101551	17085.22	18820241176.22	0.0711253
CZ05	Severovýchod	Czechia	1535886	25200.88	38705678779.68	0.1462762
CZ06	Jihovýchod	Czechia	1746990	29995.55	52401925894.50	0.1980370
CZ07	Střední Morava	Czechia	1210498	19699.94	23846737970.12	0.0901214
CZ08	Moravskoslezsko	Czechia	1182613	18758.91	22184530831.83	0.0838396
DK01	Hovedstaden	Denmark	1930793	39833.38	76910011270.34	0.4821950
DK02	Sjælland	Denmark	854902	16129.49	13789133259.98	0.0864523
DK03	Syddanmark	Denmark	1240472	22301.25	27664076190.00	0.1734427
DK04	Midtjylland	Denmark	1373799	25294.10	34749009285.90	0.2178624
DK05	Nordjylland	Denmark	592768	10775.87	6387590908.16	0.0400476
DE11	Stuttgart	Germany	4167550	117328.27	488971431638.50	0.0797344
DE12	Karlsruhe	Germany	2848413	75869.05	216106388317.65	0.0352395
DE13	Freiburg	Germany	2325856	61713.56	143536853807.36	0.0234059
DE14	Tübingen	Germany	1904079	52072.84	99150801114.36	0.0161681
DE21	Oberbayern	Germany	4764548	149959.04	714487044113.92	0.1165083
DE22	Niederbayern	Germany	1259204	33520.72	42209424706.88	0.0068829
DE23	Oberpfalz	Germany	1121379	29824.22	33444253999.38	0.0054536
DE24	Oberfranken	Germany	1055758	28159.50	29729617401.00	0.0048479
DE25	Mittelfranken	Germany	1795909	49211.26	88378944735.34	0.0144116
DE26	Unterfranken	Germany	1318817	35917.95	47369203065.15	0.0077243

DE27	Schwaben	Germany	1933313	52864.22	102203083760.86	0.0166658
DE30	Berlin	Germany	3685265	88237.36	325178054500.40	0.0530254
DE40	Brandenburg	Germany	2556747	60838.49	155548626792.03	0.0253646
DE50	Bremen	Germany	704881	16035.42	11303062885.02	0.0018431
DE60	Hamburg	Germany	1862565	50533.21	94121388283.65	0.0153480
DE71	Darmstadt	Germany	4039611	110623.71	446876755776.81	0.0728702
DE72	Gießen	Germany	1040290	25325.53	26345895603.70	0.0042961
DE73	Kassel	Germany	1200892	29577.00	35518782684.00	0.0057919
DE80	Mecklenburg-Vorpommern	Germany	1573597	36700.11	57751182995.67	0.0094172
DE91	Braunschweig	Germany	1589423	39166.05	62251420689.15	0.0101511
DE92	Hannover	Germany	2123689	52951.05	112451562423.45	0.0183370
DE93	Lüneburg	Germany	1721892	44732.08	77023810695.36	0.0125599
DE94	Weser-Ems	Germany	2569485	63550.87	163293007201.95	0.0266275
DEA1	Düsseldorf	Germany	5244379	129964.39	681582517663.81	0.1111427
DEA2	Köln	Germany	4486282	114936.74	515638627800.68	0.0840829
DEA3	Münster	Germany	2659034	65458.17	174055499607.78	0.0283825
DEA4	Detmold	Germany	2072861	53127.23	110125363105.03	0.0179577
DEA5	Arnsberg	Germany	3571898	87355.93	312026471655.14	0.0508808
DEB1	Koblenz	Germany	1530208	38533.06	58963596676.48	0.0096149
DEB2	Trier	Germany	525583	13317.66	6999535695.78	0.0011414
DEB3	Rheinhausen-Pfalz	Germany	2073778	52506.19	108886181685.82	0.0177556
DEC0	Saarland	Germany	1012141	23225.91	23507895773.31	0.0038333
DED2	Dresden	Germany	1584687	37176.71	58913449039.77	0.0096068
DED4	Chemnitz	Germany	1386336	32672.85	45295548177.60	0.0073861
DED5	Leipzig	Germany	1071399	24151.54	25875935804.46	0.0042195
DEE0	Sachsen-Anhalt	Germany	2135597	48783.04	104180913874.88	0.0169883
DEF0	Schleswig-Holstein	Germany	2959517	77933.87	230646613140.79	0.0376105
DEG0	Thüringen	Germany	2100277	48827.36	102550981178.72	0.0167225
EE00	Eesti	Estonia	1369995	19767.71	27081663861.45	1.0000000
IE04	Northern and Western	Ireland	958925	17844.26	17111307020.50	0.0757808
IE05	Southern	Ireland	1805942	36561.15	66027316353.30	0.2924149
IE06	Eastern and Midland	Ireland	2675411	53323.20	142661475835.20	0.6318043
EL30	Attiki	Greece	3764272	65556.80	246773626649.60	0.7488783
EL41	Voreio Aigaio	Greece	207927	2962.10	615900566.70	0.0018691
EL42	Notio Aigaio	Greece	327036	6430.45	2102988646.20	0.0063819
EL43	Kriti	Greece	621121	9367.72	5818487614.12	0.0176572
EL51	Anatoliki Makedonia, Thraki	Greece	565195	7574.76	4281216478.20	0.0129921
EL52	Kentriki Makedonia	Greece	1772400	26555.96	47067783504.00	0.1428355
EL53	Dytiki Makedonia	Greece	243575	3976.60	968600345.00	0.0029394
EL54	Ipeiros	Greece	324061	4722.16	1530267891.76	0.0046439
EL61	Thessalia	Greece	676040	9523.36	6438172294.40	0.0195378
EL62	Ionia Nisia	Greece	198421	3878.76	769627437.96	0.0023356
EL63	Dytiki Ellada	Greece	635954	8301.10	5279117749.40	0.0160204
EL64	Stereia Ellada	Greece	507168	7279.60	3691980172.80	0.0112040

EL65	Peloponnisos	Greece	529165	7911.66	4186573563.90	0.0127049
ES11	Galicia	Spain	2714741	53404.53	144979467176.73	0.0282798
ES12	Principado de Asturias	Spain	1015128	21773.26	22102645877.28	0.0043114
ES13	Cantabria	Spain	593623	11980.29	7111775690.67	0.0013872
ES21	País Vasco	Spain	2242343	59603.22	133650863144.46	0.0260700
ES22	Comunidad Foral de Navarra	Spain	683854	16001.74	10942853905.96	0.0021345
ES23	La Rioja	Spain	326803	6776.06	2214436736.18	0.0004319
ES24	Aragón	Spain	1364621	29676.60	40497311568.60	0.0078994
ES30	Comunidad de Madrid	Spain	7113886	173951.71	1237472634445.06	0.2413822
ES41	Castilla y León	Spain	2401221	48854.67	117310859552.07	0.0228827
ES42	Castilla-La Mancha	Spain	2126378	36772.02	78191214343.56	0.0152520
ES43	Extremadura	Spain	1053345	17772.30	18720363343.50	0.0036516
ES51	Cataluña	Spain	8124126	175748.64	1427804095688.64	0.2785084
ES52	Comunitat Valenciana	Spain	5425182	93437.75	506916799420.50	0.0988795
ES53	Illes Balears	Spain	1249844	25775.11	32214866582.84	0.0062839
ES61	Andalucía	Spain	8676713	140321.68	1217530945037.83	0.2374924
ES62	Región de Murcia	Spain	1586989	27383.61	43457487850.29	0.0084768
ES63	Ciudad de Ceuta	Spain	83567	1480.10	123687516.70	0.0000241
ES64	Ciudad de Melilla	Spain	87067	1411.75	122916837.25	0.0000240
ES70	Canarias	Spain	2258866	37737.90	85244859221.40	0.0166279
FR10	Ile de France	France	12549288	329774.71	4138437810906.48	0.5074688
FRB0	Centre — Val de Loire	France	2588306	54243.99	140400044780.94	0.0172163
FRC1	Bourgogne	France	1621320	33482.60	54286009032.00	0.0066567
FRC2	Franche-Comté	France	1175558	24039.38	28259685474.04	0.0034653
FRD1	Basse-Normandie	France	1486036	30701.48	45623504533.28	0.0055945
FRD2	Haute-Normandie	France	1864946	38315.60	71456524957.60	0.0087622
FRE1	Nord-Pas de Calais	France	4065757	77333.49	314419178301.93	0.0385551
FRE2	Picardie	France	1908690	37714.32	71984945440.80	0.0088270
FRF1	Alsace	France	1941726	40351.99	78352508134.74	0.0096078
FRF2	Champagne-Ardenne	France	1296360	26426.15	34257803814.00	0.0042008
FRF3	Lorraine	France	2312069	47161.39	109040387815.91	0.0133709
FRG0	Pays de la Loire	France	3945359	81748.33	322526509500.47	0.0395493
FRH0	Bretagne	France	3489252	72720.14	253738893935.28	0.0311143
FRI1	Aquitaine	France	3635159	76885.87	279492362303.33	0.0342723
FRI2	Limousin	France	729224	15093.84	11006790380.16	0.0013497
FRI3	Poitou-Charentes	France	1846456	38293.22	70706745828.32	0.0086703
FRJ1	Languedoc-Roussillon	France	2997570	58962.73	176744910566.10	0.0216730
FRJ2	Midi-Pyrénées	France	3208005	67139.01	215382279775.05	0.0264109
FRK1	Auvergne	France	1368441	28806.30	39419721978.30	0.0048338
FRK2	Rhône-Alpes	France	6901647	150748.94	1040415969504.18	0.1275792
FRL0	Provence-Alpes-Côte d’Azur	France	5285125	120282.87	635710003308.75	0.0779528
FRM0	Corse	France	362253	7663.19	2776013567.07	0.0003404
FRY1	Guadeloupe	France	413791	6974.25	2885881881.75	0.0003539
FRY2	Martinique	France	359419	6549.45	2353996769.55	0.0002887

FRY3	Guyane	France	297455	3167.41	942161941.55	0.0001155
FRY4	La Réunion	France	904180	15163.42	13710461095.60	0.0016812
FRY5	Mayotte	France	329208	2210.55	727730744.40	0.0000892
HR02	Panonska Hrvatska	Croatia	982159	13547.58	13305877625.22	0.2281485
HR03	Jadranska Hrvatska	Croatia	1322482	19246.17	25452713393.94	0.4364235
HR05	Grad Zagreb	Croatia	777359	13524.83	10513648323.97	0.1802717
HR06	Sjeverna Hrvatska	Croatia	792350	11420.33	9048898475.50	0.1551564
ITC1	Piemonte	Italy	4251868	101783.26	432768986129.68	0.0653800
ITC2	Valle d'Aosta/Vallée d'Aoste	Italy	122532	2836.26	347532610.32	0.0000525
ITC3	Liguria	Italy	1510143	35676.63	53876813058.09	0.0081394
ITC4	Lombardia	Italy	10033918	265057.81	2659568330799.58	0.4017908
ITF1	Abruzzo	Italy	1269118	24647.93	31281131625.74	0.0047258
ITF2	Molise	Italy	287814	5252.35	1511699862.90	0.0002284
ITF3	Campania	Italy	5582337	88998.64	496820401021.68	0.0750565
ITF4	Puglia	Italy	3877395	66086.63	256243968728.85	0.0387117
ITF5	Basilicata	Italy	530004	9225.15	4889366400.60	0.0007387
ITF6	Calabria	Italy	1834646	29652.31	54401491932.26	0.0082186
ITG1	Sicilia	Italy	4787390	78878.70	377623099593.00	0.0570489
ITG2	Sardegna	Italy	1562381	29293.86	45768170280.66	0.0069144
ITH1	Provincia Autonoma di Bolzano/Bozen	Italy	539679	16089.59	8683213841.61	0.0013118
ITH2	Provincia Autonoma di Trento	Italy	546573	12814.20	7003895736.60	0.0010581
ITH3	Veneto	Italy	4853472	113176.42	549298585530.24	0.0829846
ITH4	Friuli-Venezia Giulia	Italy	1193284	28141.61	33580932947.24	0.0050732
ITH5	Emilia-Romagna	Italy	4461998	112818.28	503394939723.44	0.0760497
ITI1	Toscana	Italy	3657716	83092.74	303929644581.84	0.0459158
ITI2	Umbria	Italy	851473	18486.81	15741019571.13	0.0023781
ITI3	Marche	Italy	1480545	32067.69	47477658091.05	0.0071726
ITI4	Lazio	Italy	5709178	128753.33	735075679062.74	0.1110506
CY00	Kýpros	Cyprus	982966	19517.80	19185333794.80	1.0000000
LV00	Latvija	Latvia	1860565	25117.29	46732350668.85	1.0000000
LT01	Sostinės regionas	Lithuania	876727	18009.73	15789616553.71	0.1970015
LT02	Vidurio ir vakarų Lietuvos regionas	Lithuania	2013937	31957.37	64360129865.69	0.8029985
LU00	Luxembourg	Luxembourg	681973	20124.98	13724692985.54	1.0000000
HU11	Budapest	Hungary	1685209	42096.59	70941552337.31	0.3650992
HU12	Pest	Hungary	1336134	20764.18	27743726880.12	0.1427825
HU21	Közép-Dunántúl	Hungary	1051169	15727.31	16532060725.39	0.0850819
HU22	Nyugat-Dunántúl	Hungary	974617	13993.39	13638195781.63	0.0701887
HU23	Dél-Dunántúl	Hungary	845970	10658.15	9016475155.50	0.0464031
HU31	Észak-Magyarország	Hungary	1072232	12744.33	13664878444.56	0.0703260
HU32	Észak-Alföld	Hungary	1390406	17619.35	24498049956.10	0.1260787
HU33	Dél-Alföld	Hungary	1183765	15436.08	18272691241.20	0.0940400
MT00	Malta	Malta	574250	11685.28	6710272040.00	1.0000000
NL11	Groningen	Netherlands	602833	12466.92	7515470784.36	0.0078092

NL12	Friesland (NL)	Netherlands	664222	14182.91	9420600846.02	0.0097888
NL13	Drenthe	Netherlands	506529	11149.65	5647621064.85	0.0058683
NL21	Overijssel	Netherlands	1195789	26217.37	31350442654.93	0.0325756
NL22	Gelderland	Netherlands	2161358	49113.46	106151769678.68	0.1103002
NL23	Flevoland	Netherlands	456395	9742.43	4446396339.85	0.0046202
NL32	Noord-Holland	Netherlands	2992016	71868.57	215031911337.12	0.2234354
NL34	Zeeland	Netherlands	392969	8707.99	3421970122.31	0.0035557
NL35	Utrecht	Netherlands	1409144	34473.87	48578647067.28	0.0504771
NL36	Zuid-Holland	Netherlands	3863397	87612.66	338482487806.02	0.3517105
NL41	Noord-Brabant	Netherlands	2664047	61609.78	164131349579.66	0.1705457
NL42	Limburg (NL)	Netherlands	1135328	24848.21	28210868562.88	0.0293134
AT11	Burgenland	Austria	301790	7854.45	2370394465.50	0.0075293
AT12	Niederösterreich	Austria	1727514	45579.46	78739155262.44	0.2501065
AT13	Wien	Austria	2028289	47145.51	95624719332.39	0.3037417
AT21	Kärnten	Austria	570095	14272.90	8136908925.50	0.0258460
AT22	Steiermark	Austria	1271716	32350.59	41140762912.44	0.1306792
AT31	Oberösterreich	Austria	1535519	39422.02	60533260728.38	0.1922775
AT32	Salzburg	Austria	572846	14915.11	8544061103.06	0.0271393
AT33	Tirol	Austria	777660	19736.12	15347991079.20	0.0487513
AT34	Vorarlberg	Austria	411784	10649.29	4385207233.36	0.0139291
PL21	Małopolskie	Poland	3319792	54281.29	180202592291.68	0.1057867
PL22	Śląskie	Poland	4190666	80900.61	339027435706.26	0.1990238
PL41	Wielkopolskie	Poland	3433354	61016.95	209492789350.30	0.1229814
PL42	Zachodniopomorskie	Poland	1571895	26899.68	42283472493.60	0.0248222
PL43	Lubuskie	Poland	943794	14682.27	13857038332.38	0.0081347
PL51	Dolnośląskie	Poland	2798300	50127.75	140272482825.00	0.0823460
PL52	Opolskie	Poland	884774	14627.69	12942199792.06	0.0075976
PL61	Kujawsko-pomorskie	Poland	1920440	31469.58	60435440215.20	0.0354782
PL62	Warmińsko-mazurskie	Poland	1286015	20499.63	26362831674.45	0.0154761
PL63	Pomorskie	Poland	2297741	38083.15	87505215164.15	0.0513694
PL71	Łódzkie	Poland	2312616	42060.01	97268652086.16	0.0571009
PL72	Świętokrzyskie	Poland	1112681	17950.78	19973491841.18	0.0117253
PL81	Lubelskie	Poland	1920632	30410.44	58407264198.08	0.0342876
PL82	Podkarpackie	Poland	1947062	28026.33	54569002142.46	0.0320344
PL84	Podlaskie	Poland	1073623	16809.60	18047173180.80	0.0105945
PL91	Warszawski stołeczny	Poland	3298955	77149.53	254512827741.15	0.1494101
PL92	Mazowiecki regionalny	Poland	2185155	40405.24	88291712212.20	0.0518311
PT11	Norte	Portugal	3692842	58561.98	216260139347.16	0.5419773
PT15	Algarve	Portugal	492747	10376.22	5112851276.34	0.0128135
PT19	Centro (PT)	Portugal	1717560	28261.58	48540959344.80	0.1216502
PT1A	Grande Lisboa	Portugal	2156612	45528.56	98187438838.72	0.2460711
PT1B	Península de Setúbal	Portugal	848507	14489.02	12294034893.14	0.0308105
PT1C	Alentejo	Portugal	474894	8698.14	4130694497.16	0.0103521
PT1D	Oeste e Vale do Tejo	Portugal	865315	14158.70	12251735490.50	0.0307045

PT20	Região Autónoma dos Açores	Portugal	241718	4288.40	1036583471.20	0.0025978
PT30	Região Autónoma da Madeira	Portugal	259440	4649.33	1206222175.20	0.0030230
RO11	Nord-Vest	Romania	2544010	37494.04	95385212700.40	0.1367836
RO12	Centru	Romania	2291551	34040.70	78006000125.70	0.1118616
RO21	Nord-Est	Romania	3218218	37501.89	120689257432.02	0.1730699
RO22	Sud-Est	Romania	2331165	29383.22	68497134051.30	0.0982257
RO31	Sud-Muntenia	Romania	2825694	34147.86	96491403114.84	0.1383699
RO32	București-Ilfov	Romania	2313455	65541.55	151627426555.25	0.2174356
RO41	Sud-Vest Oltenia	Romania	1848028	22639.93	41839224558.04	0.0599980
RO42	Vest	Romania	1671030	26814.80	44808335244.00	0.0642557
SI03	Vzhodna Slovenija	Slovenia	1113731	20078.26	22361780588.06	0.5389552
SI04	Zahodna Slovenija	Slovenia	1017119	18807.24	19129201141.56	0.4610448
SK01	Bratislavský kraj	Slovakia	736385	16486.56	12140455485.60	0.1031600
SK02	Západné Slovensko	Slovakia	1797072	25717.89	46216900018.08	0.3927146
SK03	Stredné Slovensko	Slovakia	1297187	19426.55	25199868114.85	0.2141285
SK04	Východné Slovensko	Slovakia	1588807	21480.58	34128495868.06	0.2899969
FI1B	Helsinki-Uusimaa	Finland	1782300	40745.80	72621239340.00	0.4477394
FI1C	Etelä-Suomi	Finland	1151434	21972.49	25299872050.66	0.1559840
FI1D	Pohjois- ja Itä-Suomi	Finland	1272126	22381.11	28471591939.86	0.1755389
FI19	Länsi-Suomi	Finland	1399457	25568.60	35782156250.20	0.2206115
FI20	Åland	Finland	30654	668.07	20479017.78	0.0001263
SE11	Stockholm	Sweden	2473307	59636.05	147498259917.35	0.3810561
SE12	Östra Mellansverige	Sweden	1771433	34194.80	60573797148.40	0.1564901
SE21	Småland med öarna	Sweden	880683	16929.27	14909320291.41	0.0385177
SE22	Sydsverige	Sweden	1585849	31414.48	49818621693.52	0.1287045
SE23	Västsverige	Sweden	2117895	43507.30	92143893133.50	0.2380502
SE31	Norra Mellansverige	Sweden	854488	16295.79	13924557005.52	0.0359736
SE32	Mellersta Norrland	Sweden	374297	7206.82	2697491105.54	0.0069689
SE33	Övre Norrland	Sweden	529758	10404.04	5511623422.32	0.0142391

Table 18: NUTS2 Downscaling of Scenario CL

NUTS 2 Code	Region Name	Country	Regional Share	2020 Anchor Year					2024 Anchor Year				
				PCTW 2035 Mean	NUTS2 PCTW 2035 Mean	NUTS2 Collected Volume 2035 CL 10	NUTS2 Collected Volume 2035 CL 20	NUTS2 Collected Volume 2035 CL 50	PCTW 2035 Mean	NUTS2 PCTW 2035 Mean	NUTS2 Collected Volume 2035 CL 10	NUTS2 Collected Volume 2035 CL 20	NUTS2 Collected Volume 2035 CL 50
BE10	Région de Bruxelles-Capitale / Brussels Hoofdstedelijk Gewest	Belgium	0.093740253	0.479691513	0.044966404	0.02473	0.02698	0.03372	0.442649978	0.041494121	0.022822	0.024896	0.031121
BE21	Prov. Antwerpen	Belgium	0.25259672	0.479691513	0.121168503	0.06664	0.07270	0.09088	0.442649978	0.111811933	0.061497	0.067087	0.083859
BE22	Prov. Limburg (BE)	Belgium	0.052560059	0.479691513	0.025212614	0.01387	0.01513	0.01891	0.442649978	0.023265709	0.012796	0.013959	0.017449
BE23	Prov. Oost-Vlaanderen	Belgium	0.175610615	0.479691513	0.084238922	0.04633	0.05054	0.06318	0.442649978	0.077734035	0.042754	0.046640	0.058301
BE24	Prov. Vlaams-Brabant	Belgium	0.106538123	0.479691513	0.051105434	0.02811	0.03066	0.03833	0.442649978	0.047159098	0.025938	0.028295	0.035369
BE25	Prov. West-Vlaanderen	Belgium	0.107930852	0.479691513	0.051773514	0.02848	0.03106	0.03883	0.442649978	0.047775589	0.026277	0.028665	0.035832
BE31	Prov. Brabant Wallon	Belgium	0.012324695	0.479691513	0.005912052	0.00325	0.00355	0.00443	0.442649978	0.005455526	0.003001	0.003273	0.004092
BE32	Prov. Hainaut	Belgium	0.103418045	0.479691513	0.049608758	0.02728	0.02977	0.03721	0.442649978	0.045777995	0.025178	0.027467	0.034333
BE33	Prov. Liège	Belgium	0.07431684	0.479691513	0.035649157	0.01961	0.02139	0.02674	0.442649978	0.032896348	0.018093	0.019738	0.024672
BE34	Prov. Luxembourg (BE)	Belgium	0.005577467	0.479691513	0.002675464	0.00147	0.00161	0.00201	0.442649978	0.002468866	0.001358	0.001481	0.001852
BE35	Prov. Namur	Belgium	0.015386331	0.479691513	0.007380692	0.00406	0.00443	0.00554	0.442649978	0.006810759	0.003746	0.004086	0.005108
BG31	Severozapaden	Bulgaria	0.036304249	0.099065828	0.003596511	0.00004	0.00004	0.00005	0.127332272	0.004622703	0.000051	0.000055	0.000069
BG32	Severen tsentralen	Bulgaria	0.040619414	0.099065828	0.004023996	0.00004	0.00005	0.00006	0.127332272	0.005172162	0.000057	0.000062	0.000078
BG33	Severoiztochen	Bulgaria	0.062627282	0.099065828	0.006204224	0.00007	0.00007	0.00009	0.127332272	0.007974474	0.000088	0.000096	0.000120
BG34	Yugoiztochen	Bulgaria	0.07623913	0.099065828	0.007552693	0.00008	0.00009	0.00011	0.127332272	0.009707702	0.000107	0.000116	0.000146
BG41	Yugozapaden	Bulgaria	0.629089802	0.099065828	0.062321302	0.00069	0.00075	0.00093	0.127332272	0.080103434	0.000881	0.000961	0.001202
BG42	Yuzhen tsentralen	Bulgaria	0.155120123	0.099065828	0.015367103	0.00017	0.00018	0.00023	0.127332272	0.019751798	0.000217	0.000237	0.000296
CZ01	Praha	Czechia	0.158868847	0.357616601	0.056814137	0.01562	0.01704	0.02131	0.313861194	0.049862766	0.013712	0.014959	0.018699
CZ02	Střední Čechy	Czechia	0.150825162	0.357616601	0.053937582	0.01483	0.01618	0.02023	0.313861194	0.047338165	0.013018	0.014201	0.017752
CZ03	Jihozápad	Czechia	0.10090645	0.357616601	0.036085822	0.00992	0.01083	0.01353	0.313861194	0.031670619	0.008709	0.009501	0.011876
CZ04	Severozápad	Czechia	0.071125317	0.357616601	0.025435594	0.00699	0.00763	0.00954	0.313861194	0.022323477	0.006139	0.006697	0.008371
CZ05	Severovýchod	Czechia	0.146276217	0.357616601	0.052310803	0.01439	0.01569	0.01962	0.313861194	0.045910428	0.012625	0.013773	0.017216
CZ06	Jihovýchod	Czechia	0.198036973	0.357616601	0.070821309	0.01948	0.02125	0.02656	0.313861194	0.062156121	0.017093	0.018647	0.023309
CZ07	Střední Morava	Czechia	0.090121417	0.357616601	0.032228915	0.00886	0.00967	0.01209	0.313861194	0.028285616	0.007779	0.008486	0.010607

CZ08	Moravskoslezsko	Czechia	0.083839616	0.357616601	0.029982438	0.00825	0.00899	0.01124	0.313861194	0.026314002	0.007236	0.007894	0.009868
DK01	Hovedstaden	Denmark	0.482194969	0.225024079	0.108505479	0.01313	0.01432	0.01790	0.206305672	0.099479557	0.012037	0.013131	0.016414
DK02	Sjælland	Denmark	0.086452343	0.225024079	0.019453859	0.00235	0.00257	0.00321	0.206305672	0.017835609	0.002158	0.002354	0.002943
DK03	Syddanmark	Denmark	0.173442679	0.225024079	0.039028779	0.00472	0.00515	0.00644	0.206305672	0.035782208	0.004330	0.004723	0.005904
DK04	Midtjylland	Denmark	0.217862372	0.225024079	0.04902428	0.00593	0.00647	0.00809	0.206305672	0.044946243	0.005438	0.005933	0.007416
DK05	Nordjylland	Denmark	0.040047637	0.225024079	0.009011683	0.00109	0.00119	0.00149	0.206305672	0.008262055	0.001000	0.001091	0.001363
DE11	Stuttgart	Germany	0.07973444	2.981758248	0.237748824	0.04707	0.05135	0.06419	2.580671179	0.205768371	0.040742	0.044446	0.055557
DE12	Karlsruhe	Germany	0.035239527	2.981758248	0.10507575	0.02080	0.02270	0.02837	2.580671179	0.090941632	0.018006	0.019643	0.024554
DE13	Freiburg	Germany	0.023405929	2.981758248	0.069790822	0.01382	0.01507	0.01884	2.580671179	0.060403006	0.011960	0.013047	0.016309
DE14	Tübingen	Germany	0.016168089	2.981758248	0.048209333	0.00955	0.01041	0.01302	2.580671179	0.041724521	0.008261	0.009012	0.011266
DE21	Oberbayern	Germany	0.116508288	2.981758248	0.347399549	0.06879	0.07504	0.09380	2.580671179	0.300669581	0.059533	0.064945	0.081181
DE22	Niederbayern	Germany	0.006882907	2.981758248	0.020523164	0.00406	0.00443	0.00554	2.580671179	0.01776252	0.003517	0.003837	0.004796
DE23	Oberpfalz	Germany	0.005453609	2.981758248	0.016261343	0.00322	0.00351	0.00439	2.580671179	0.014073972	0.002787	0.003040	0.003800
DE24	Oberfranken	Germany	0.004847879	2.981758248	0.014455204	0.00286	0.00312	0.00390	2.580671179	0.012510782	0.002477	0.002702	0.003378
DE25	Mittelfranken	Germany	0.014411569	2.981758248	0.042971816	0.00851	0.00928	0.01160	2.580671179	0.037191521	0.007364	0.008033	0.010042
DE26	Unterfranken	Germany	0.007724289	2.981758248	0.023031964	0.00456	0.00497	0.00622	2.580671179	0.01993385	0.003947	0.004306	0.005382
DE27	Schwaben	Germany	0.016665811	2.981758248	0.049693421	0.00984	0.01073	0.01342	2.580671179	0.043008978	0.008516	0.009290	0.011612
DE30	Berlin	Germany	0.053025368	2.981758248	0.158108828	0.03131	0.03415	0.04269	2.580671179	0.136841039	0.027095	0.029558	0.036947
DE40	Brandenburg	Germany	0.025364637	2.981758248	0.075631214	0.01497	0.01634	0.02042	2.580671179	0.065457788	0.012961	0.014139	0.017674
DE50	Bremen	Germany	0.001843141	2.981758248	0.005495801	0.00109	0.00119	0.00148	2.580671179	0.004756541	0.000942	0.001027	0.001284
DE60	Hamburg	Germany	0.015347965	2.981758248	0.04576392	0.00906	0.00989	0.01236	2.580671179	0.039608051	0.007842	0.008555	0.010694
DE71	Darmstadt	Germany	0.072870245	2.981758248	0.217281453	0.04302	0.04693	0.05867	2.580671179	0.188054141	0.037235	0.040620	0.050775
DE72	Gießen	Germany	0.00429611	2.981758248	0.012809963	0.00254	0.00277	0.00346	2.580671179	0.011086847	0.002195	0.002395	0.002993
DE73	Kassel	Germany	0.005791893	2.981758248	0.017270025	0.00342	0.00373	0.00466	2.580671179	0.014946971	0.002960	0.003229	0.004036
DE80	Mecklenburg-Vorpommern	Germany	0.009417234	2.981758248	0.028079914	0.00556	0.00607	0.00758	2.580671179	0.024302784	0.004812	0.005249	0.006562
DE91	Braunschweig	Germany	0.010151068	2.981758248	0.03026803	0.00599	0.00654	0.00817	2.580671179	0.026196569	0.005187	0.005658	0.007073
DE92	Hannover	Germany	0.018336986	2.981758248	0.05467646	0.01083	0.01181	0.01476	2.580671179	0.047321731	0.009370	0.010221	0.012777
DE93	Lüneburg	Germany	0.012559937	2.981758248	0.037450696	0.00742	0.00809	0.01011	2.580671179	0.032413067	0.006418	0.007001	0.008752
DE94	Weser-Ems	Germany	0.026627479	2.981758248	0.079396705	0.01572	0.01715	0.02144	2.580671179	0.068716768	0.013606	0.014843	0.018554
DEA1	Düsseldorf	Germany	0.11114269	2.981758248	0.331400633	0.06562	0.07158	0.08948	2.580671179	0.286822737	0.056791	0.061954	0.077442
DEA2	Köln	Germany	0.084082943	2.981758248	0.25071501	0.04964	0.05415	0.06769	2.580671179	0.216990428	0.042964	0.046870	0.058587
DEA3	Münster	Germany	0.028382472	2.981758248	0.084629669	0.01676	0.01828	0.02285	2.580671179	0.073245827	0.014503	0.015821	0.019776
DEA4	Detmold	Germany	0.017957663	2.981758248	0.05354541	0.01060	0.01157	0.01446	2.580671179	0.046342823	0.009176	0.010010	0.012513

DEA5	Arnsberg	Germany	0.050880797	2.981758248	0.151714235	0.03004	0.03277	0.04096	2.580671179	0.131306606	0.025999	0.028362	0.035453
DEB1	Koblenz	Germany	0.009614937	2.981758248	0.028669417	0.00568	0.00619	0.00774	2.580671179	0.024812991	0.004913	0.005360	0.006700
DEB2	Trier	Germany	0.001141384	2.981758248	0.00340333	0.00067	0.00074	0.00092	2.580671179	0.002945537	0.000583	0.000636	0.000795
DEB3	Rhein Hessen-Pfalz	Germany	0.017755595	2.981758248	0.052942892	0.01048	0.01144	0.01429	2.580671179	0.045821352	0.009073	0.009897	0.012372
DEC0	Saarland	Germany	0.00383333	2.981758248	0.011430064	0.00226	0.00247	0.00309	2.580671179	0.009892564	0.001959	0.002137	0.002671
DED2	Dresden	Germany	0.009606759	2.981758248	0.028645034	0.00567	0.00619	0.00773	2.580671179	0.024791886	0.004909	0.005355	0.006694
DED4	Chemnitz	Germany	0.007386148	2.981758248	0.022023707	0.00436	0.00476	0.00595	2.580671179	0.019061219	0.003774	0.004117	0.005147
DED5	Leipzig	Germany	0.004219476	2.981758248	0.012581458	0.00249	0.00272	0.00340	2.580671179	0.01088908	0.002156	0.002352	0.002940
DEE0	Sachsen-Anhalt	Germany	0.016988328	2.981758248	0.050655086	0.01003	0.01094	0.01368	2.580671179	0.043841288	0.008681	0.009470	0.011837
DEF0	Schleswig-Holstein	Germany	0.037610538	2.981758248	0.112145531	0.02220	0.02422	0.03028	2.580671179	0.097060431	0.019218	0.020965	0.026206
DEG0	Thüringen	Germany	0.016722541	2.981758248	0.049862576	0.00987	0.01077	0.01346	2.580671179	0.04315538	0.008545	0.009322	0.011652
EE00	Eesti	Estonia	1	0.046720403	0.046720403	0.00257	0.00280	0.00350	0.039847046	0.039847046	0.002192	0.002391	0.002989
IE04	Northern and Western	Ireland	0.075780777	0.213252265	0.016160422	0.00018	0.00019	0.00024	0.279250001	0.021161782	0.000233	0.000254	0.000317
IE05	Southern	Ireland	0.292414913	0.213252265	0.062358142	0.00069	0.00075	0.00094	0.279250001	0.081656865	0.000898	0.000980	0.001225
IE06	Eastern and Midland	Ireland	0.63180431	0.213252265	0.1347337	0.00148	0.00162	0.00202	0.279250001	0.176431354	0.001941	0.002117	0.002646
EL30	Attiki	Greece	0.748878291	0.237928093	0.178179184	0.00392	0.00428	0.00535	0.24995875	0.187188681	0.004118	0.004493	0.005616
EL41	Voreio Aigaio	Greece	0.001869059	0.237928093	0.000444702	0.00001	0.00001	0.00001	0.24995875	0.000467188	0.000010	0.000011	0.000014
EL42	Notio Aigaio	Greece	0.006381892	0.237928093	0.001518431	0.00003	0.00004	0.00005	0.24995875	0.00159521	0.000035	0.000038	0.000048
EL43	Kriti	Greece	0.017657232	0.237928093	0.004201151	0.00009	0.00010	0.00013	0.24995875	0.00441358	0.000097	0.000106	0.000132
EL51	Anatoliki Makedonia, Thraki	Greece	0.01299211	0.237928093	0.003091188	0.00007	0.00007	0.00009	0.24995875	0.003247492	0.000071	0.000078	0.000097
EL52	Kentriki Makedonia	Greece	0.142835528	0.237928093	0.033984585	0.00075	0.00082	0.00102	0.24995875	0.03570299	0.000785	0.000857	0.001071
EL53	Dytiki Makedonia	Greece	0.002939389	0.237928093	0.000699363	0.00002	0.00002	0.00002	0.24995875	0.000734726	0.000016	0.000018	0.000022
EL54	Ipeiros	Greece	0.004643869	0.237928093	0.001104907	0.00002	0.00003	0.00003	0.24995875	0.001160776	0.000026	0.000028	0.000035
EL61	Thessalia	Greece	0.019537774	0.237928093	0.004648585	0.00010	0.00011	0.00014	0.24995875	0.004883638	0.000107	0.000117	0.000147
EL62	Ionia Nisia	Greece	0.002335571	0.237928093	0.000555698	0.00001	0.00001	0.00002	0.24995875	0.000583796	0.000013	0.000014	0.000018
EL63	Dytiki Ellada	Greece	0.016020418	0.237928093	0.003811708	0.00008	0.00009	0.00011	0.24995875	0.004004444	0.000088	0.000096	0.000120
EL64	Stereia Ellada	Greece	0.011203968	0.237928093	0.002665739	0.00006	0.00006	0.00008	0.24995875	0.00280053	0.000062	0.000067	0.000084
EL65	Peloponnisos	Greece	0.012704899	0.237928093	0.003022852	0.00007	0.00007	0.00009	0.24995875	0.003175701	0.000070	0.000076	0.000095
ES11	Galicia	Spain	0.028279792	1.463657537	0.041391931	0.00182	0.00199	0.00248	1.478931433	0.041823873	0.001840	0.002008	0.002509
ES12	Principado de Asturias	Spain	0.004311357	1.463657537	0.00631035	0.00028	0.00030	0.00038	1.478931433	0.006376201	0.000281	0.000306	0.000383
ES13	Cantabria	Spain	0.001387228	1.463657537	0.002030426	0.00009	0.00010	0.00012	1.478931433	0.002051615	0.000090	0.000098	0.000123
ES21	País Vasco	Spain	0.026070027	1.463657537	0.038157591	0.00168	0.00183	0.00229	1.478931433	0.038555782	0.001696	0.001851	0.002313

ES22	Comunidad Foral de Navarra	Spain	0.00213452	1.463657537	0.003124207	0.00014	0.00015	0.00019	1.478931433	0.003156809	0.000139	0.000152	0.000189
ES23	La Rioja	Spain	0.00043195	1.463657537	0.000632226	0.00003	0.00003	0.00004	1.478931433	0.000638824	0.000028	0.000031	0.000038
ES24	Aragón	Spain	0.007899433	1.463657537	0.011562064	0.00051	0.00055	0.00069	1.478931433	0.01168272	0.000514	0.000561	0.000701
ES30	Comunidad de Madrid	Spain	0.241382242	1.463657537	0.353300937	0.01555	0.01696	0.02120	1.478931433	0.356987785	0.015707	0.017135	0.021419
ES41	Castilla y León	Spain	0.022882735	1.463657537	0.033492487	0.00147	0.00161	0.00201	1.478931433	0.033841996	0.001489	0.001624	0.002031
ES42	Castilla-La Mancha	Spain	0.015252031	1.463657537	0.02232375	0.00098	0.00107	0.00134	1.478931433	0.022556708	0.000992	0.001083	0.001353
ES43	Extremadura	Spain	0.003651607	1.463657537	0.005344702	0.00024	0.00026	0.00032	1.478931433	0.005400476	0.000238	0.000259	0.000324
ES51	Cataluña	Spain	0.278508424	1.463657537	0.407640954	0.01794	0.01957	0.02446	1.478931433	0.411894863	0.018123	0.019771	0.024714
ES52	Comunitat Valenciana	Spain	0.098879531	1.463657537	0.14472577	0.00637	0.00695	0.00868	1.478931433	0.146236046	0.006434	0.007019	0.008774
ES53	Illes Balears	Spain	0.006283853	1.463657537	0.009197409	0.00040	0.00044	0.00055	1.478931433	0.009293388	0.000409	0.000446	0.000558
ES61	Andalucía	Spain	0.237492402	1.463657537	0.347607545	0.01529	0.01669	0.02086	1.478931433	0.351234978	0.015454	0.016859	0.021074
ES62	Región de Murcia	Spain	0.008476847	1.463657537	0.012407201	0.00055	0.00060	0.00074	1.478931433	0.012536675	0.000552	0.000602	0.000752
ES63	Ciudad de Ceuta	Spain	0.0000240	1.463657537	0.0000353	0.00000	0.00000	0.00000	1.478931433	0.0000351	0.000002	0.000002	0.000002
ES64	Ciudad de Melilla	Spain	0.0000240	1.463657537	0.0000351	0.00000	0.00000	0.00000	1.478931433	0.0000351	0.000002	0.000002	0.000002
ES70	Canarias	Spain	0.016627919	1.463657537	0.02433758	0.00107	0.00117	0.00146	1.478931433	0.024591552	0.001082	0.001180	0.001475
FR10	Ile de France	France	0.507468786	2.172973084	1.102716014	0.29112	0.31758	0.39698	1.957668014	0.99345541	0.262272	0.286115	0.357644
FRB0	Centre — Val de Loire	France	0.017216313	2.172973084	0.037410585	0.00988	0.01077	0.01347	1.957668014	0.033703825	0.008898	0.009707	0.012133
FRC1	Bourgogne	France	0.006656728	2.172973084	0.014464891	0.00382	0.00417	0.00521	1.957668014	0.013031663	0.003440	0.003753	0.004691
FRC2	Franche-Comté	France	0.003465295	2.172973084	0.007529993	0.00199	0.00217	0.00271	1.957668014	0.006783897	0.001791	0.001954	0.002442
FRD1	Basse-Normandie	France	0.005594503	2.172973084	0.012156705	0.00321	0.00350	0.00438	1.957668014	0.01095218	0.002891	0.003154	0.003943
FRD2	Haute-Normandie	France	0.008762233	2.172973084	0.019040096	0.00503	0.00548	0.00685	1.957668014	0.017153543	0.004529	0.004940	0.006175
FRE1	Nord-Pas de Calais	France	0.038555109	2.172973084	0.083779213	0.02212	0.02413	0.03016	1.957668014	0.075478104	0.019926	0.021738	0.027172
FRE2	Picardie	France	0.00882703	2.172973084	0.019180898	0.00506	0.00552	0.00691	1.957668014	0.017280394	0.004562	0.004977	0.006221
FRF1	Alsace	France	0.009607841	2.172973084	0.02087758	0.00551	0.00601	0.00752	1.957668014	0.018808963	0.004966	0.005417	0.006771
FRF2	Champagne-Ardenne	France	0.004200804	2.172973084	0.009128234	0.00241	0.00263	0.00329	1.957668014	0.00822378	0.002171	0.002368	0.002961
FRF3	Lorraine	France	0.013370889	2.172973084	0.029054582	0.00767	0.00837	0.01046	1.957668014	0.026175762	0.006910	0.007539	0.009423
FRG0	Pays de la Loire	France	0.039549256	2.172973084	0.085939469	0.02269	0.02475	0.03094	1.957668014	0.077424313	0.020440	0.022298	0.027873
FRH0	Bretagne	France	0.031114293	2.172973084	0.067610522	0.01785	0.01947	0.02434	1.957668014	0.060911456	0.016081	0.017542	0.021928
FRI1	Aquitaine	France	0.034272268	2.172973084	0.074472716	0.01966	0.02145	0.02681	1.957668014	0.067093723	0.017713	0.019323	0.024154
FRI2	Limousin	France	0.001349689	2.172973084	0.002932837	0.00077	0.00084	0.00106	1.957668014	0.002642243	0.000698	0.000761	0.000951
FRI3	Poitou-Charentes	France	0.008670293	2.172973084	0.018840312	0.00497	0.00543	0.00678	1.957668014	0.016973555	0.004481	0.004888	0.006110
FRJ1	Languedoc-Roussillon	France	0.021673039	2.172973084	0.047094931	0.01243	0.01356	0.01695	1.957668014	0.042428615	0.011201	0.012219	0.015274
FRJ2	Midi-Pyrénées	France	0.02641088	2.172973084	0.057390131	0.01515	0.01653	0.02066	1.957668014	0.051703735	0.013650	0.014891	0.018613

FRK1	Auvergne	France	0.004833775	2.172973084	0.010503664	0.00277	0.00303	0.00378	1.957668014	0.009462927	0.002498	0.002725	0.003407
FRK2	Rhône-Alpes	France	0.127579211	2.172973084	0.277226191	0.07319	0.07984	0.09980	1.957668014	0.249757741	0.065936	0.071930	0.089913
FRL0	Provence-Alpes-Côte d'Azur	France	0.077952841	2.172973084	0.169389425	0.04472	0.04878	0.06098	1.957668014	0.152605783	0.040288	0.043950	0.054938
FRM0	Corse	France	0.000340404	2.172973084	0.000739688	0.00020	0.00021	0.00027	1.957668014	0.000666398	0.000176	0.000192	0.000240
FRY1	Guadeloupe	France	0.000353876	2.172973084	0.000768964	0.00020	0.00022	0.00028	1.957668014	0.000692772	0.000183	0.000200	0.000249
FRY2	Martinique	France	0.000288655	2.172973084	0.000627239	0.00017	0.00018	0.00023	1.957668014	0.000565091	0.000149	0.000163	0.000203
FRY3	Guyane	France	0.000115531	2.172973084	0.000251046	0.00007	0.00007	0.00009	1.957668014	0.000226171	0.000060	0.000065	0.000081
FRY4	La Réunion	France	0.001681222	2.172973084	0.003653249	0.00096	0.00105	0.00132	1.957668014	0.003291275	0.000869	0.000948	0.001185
FRY5	Mayotte	France	0.000089	2.172973084	0.000193909	0.00005	0.00006	0.00007	1.957668014	0.000174624	0.000046	0.000050	0.000063
HR02	Panonska Hrvatska	Croatia	0.228148457	0.123042066	0.028071857	0.00278	0.00303	0.00379	0.121319159	0.027678779	0.002740	0.002989	0.003737
HR03	Jadranska Hrvatska	Croatia	0.436423471	0.123042066	0.053698445	0.00532	0.00580	0.00725	0.121319159	0.052946528	0.005242	0.005718	0.007148
HR05	Grad Zagreb	Croatia	0.18027166	0.123042066	0.022180997	0.00220	0.00240	0.00299	0.121319159	0.021870406	0.002165	0.002362	0.002953
HR06	Sjeverna Hrvatska	Croatia	0.155156412	0.123042066	0.019090765	0.00189	0.00206	0.00258	0.121319159	0.018823445	0.001864	0.002033	0.002541
ITC1	Piemonte	Italy	0.065380005	1.722995005	0.112649421	0.01735	0.01893	0.02366	1.508770266	0.098643408	0.015191	0.016572	0.020715
ITC2	Valle d'Aosta/Vallée d'Aoste	Italy	0.000053	1.722995005	0.00009	0.00001	0.00002	0.00002	1.508770266	0.00008	0.000012	0.000013	0.000017
ITC3	Liguria	Italy	0.008139369	1.722995005	0.014024091	0.00216	0.00236	0.00295	1.508770266	0.012280438	0.001891	0.002063	0.002579
ITC4	Lombardia	Italy	0.401790783	1.722995005	0.692283512	0.10661	0.11630	0.14538	1.508770266	0.606209987	0.093356	0.101843	0.127304
ITF1	Abruzzo	Italy	0.004725756	1.722995005	0.008142454	0.00125	0.00137	0.00171	1.508770266	0.00713008	0.001098	0.001198	0.001497
ITF2	Molise	Italy	0.000228378	1.722995005	0.000393494	0.00006	0.00007	0.00008	1.508770266	0.00034457	0.000053	0.000058	0.000072
ITF3	Campania	Italy	0.075056488	1.722995005	0.129321954	0.01992	0.02173	0.02716	1.508770266	0.113242997	0.017439	0.019025	0.023781
ITF4	Puglia	Italy	0.038711172	1.722995005	0.0667001	0.01027	0.01121	0.01401	1.508770266	0.058407092	0.008995	0.009812	0.012265
ITF5	Basilicata	Italy	0.000738655	1.722995005	0.001272698	0.00020	0.00021	0.00027	1.508770266	0.001114461	0.000172	0.000187	0.000234
ITF6	Calabria	Italy	0.008218634	1.722995005	0.014160665	0.00218	0.00238	0.00297	1.508770266	0.012400031	0.001910	0.002083	0.002604
ITG1	Sicilia	Italy	0.057048912	1.722995005	0.098294991	0.01514	0.01651	0.02064	1.508770266	0.086073702	0.013255	0.014460	0.018075
ITG2	Sardegna	Italy	0.006914366	1.722995005	0.011913418	0.00183	0.00200	0.00250	1.508770266	0.01043219	0.001607	0.001753	0.002191
ITH1	Provincia Autonoma di Bolzano/Bozen	Italy	0.001311805	1.722995005	0.002260234	0.00035	0.00038	0.00047	1.508770266	0.001979212	0.000305	0.000333	0.000416
ITH2	Provincia Autonoma di Trento	Italy	0.001058104	1.722995005	0.001823108	0.00028	0.00031	0.00038	1.508770266	0.001596436	0.000246	0.000268	0.000335
ITH3	Veneto	Italy	0.08298456	1.722995005	0.142981983	0.02202	0.02402	0.03003	1.508770266	0.125204637	0.019282	0.021034	0.026293
ITH4	Friuli-Venezia Giulia	Italy	0.005073195	1.722995005	0.00874109	0.00135	0.00147	0.00184	1.508770266	0.007654286	0.001179	0.001286	0.001607
ITH5	Emilia-Romagna	Italy	0.076049728	1.722995005	0.131033301	0.02018	0.02201	0.02752	1.508770266	0.114741568	0.017670	0.019277	0.024096
ITI1	Toscana	Italy	0.045915771	1.722995005	0.079112644	0.01218	0.01329	0.01661	1.508770266	0.06927635	0.010669	0.011638	0.014548

ITI2	Umbria	Italy	0.002378054	1.722995005	0.004097375	0.00063	0.00069	0.00086	1.508770266	0.003587937	0.000553	0.000603	0.000753
ITI3	Marche	Italy	0.007172625	1.722995005	0.012358396	0.00190	0.00208	0.00260	1.508770266	0.010821843	0.001667	0.001818	0.002273
ITI4	Lazio	Italy	0.11105059	1.722995005	0.191339612	0.02947	0.03215	0.04018	1.508770266	0.167549828	0.025803	0.028148	0.035185
CY00	Kýpros	Cyprus	1	0.028899057	0.028899057	0.00350	0.00381	0.00477	0.028802363	0.028802363	0.003485	0.003802	0.004752
LV00	Latvija	Latvia	1	0.03425727	0.03425727	0.00038	0.00041	0.00051	0.03624853	0.03624853	0.000399	0.000435	0.000544
LT01	Sostinės regionas	Lithuania	0.197001454	0.078033306	0.015372675	0.00135	0.00148	0.00184	0.069152361	0.013623116	0.001199	0.001308	0.001635
LT02	Vidurio ir vakarų Lietuvos regionas	Lithuania	0.802998546	0.078033306	0.062660632	0.00551	0.00602	0.00752	0.069152361	0.055529246	0.004887	0.005331	0.006664
LU00	Luxembourg	Luxembourg	1	0.021756114	0.021756114	0.01197	0.01305	0.01632	0.020062703	0.020062703	0.011034	0.012038	0.015047
HU11	Budapest	Hungary	0.365099158	0.245573283	0.089658599	0.00099	0.00108	0.00134	0.181222008	0.066164003	0.000728	0.000794	0.000992
HU12	Pest	Hungary	0.142782488	0.245573283	0.035063564	0.00039	0.00042	0.00053	0.181222008	0.025875329	0.000285	0.000311	0.000388
HU21	Közép-Dunántúl	Hungary	0.085081891	0.245573283	0.020893839	0.00023	0.00025	0.00031	0.181222008	0.015418711	0.000170	0.000185	0.000231
HU22	Nyugat-Dunántúl	Hungary	0.070188678	0.245573283	0.017236464	0.00019	0.00021	0.00026	0.181222008	0.012719733	0.000140	0.000153	0.000191
HU23	Dél-Dunántúl	Hungary	0.046403094	0.245573283	0.01139536	0.00013	0.00014	0.00017	0.181222008	0.008409262	0.000093	0.000101	0.000126
HU31	Észak-Magyarország	Hungary	0.070326	0.245573283	0.017270187	0.00019	0.00021	0.00026	0.181222008	0.012744619	0.000140	0.000153	0.000191
HU32	Észak-Alföld	Hungary	0.126078682	0.245573283	0.030961556	0.00034	0.00037	0.00046	0.181222008	0.022848232	0.000251	0.000274	0.000343
HU33	Dél-Alföld	Hungary	0.094040009	0.245573283	0.023093714	0.00025	0.00028	0.00035	0.181222008	0.017042119	0.000187	0.000205	0.000256
MT00	Malta	Malta	1	0.111600406	0.111600406	0.02332	0.02544	0.03181	0.033642493	0.033642493	0.007031	0.007670	0.009588
NL11	Groningen	Netherlands	0.007809178	0.971880521	0.007589588	0.00309	0.00337	0.00421	0.732906755	0.005723399	0.002329	0.002541	0.003176
NL12	Friesland (NL)	Netherlands	0.009788761	0.971880521	0.009513506	0.00387	0.00422	0.00528	0.732906755	0.007174249	0.002920	0.003185	0.003982
NL13	Drenthe	Netherlands	0.005868332	0.971880521	0.005703317	0.00232	0.00253	0.00317	0.732906755	0.00430094	0.001750	0.001910	0.002387
NL21	Overijssel	Netherlands	0.032575627	0.971880521	0.031659617	0.01289	0.01406	0.01757	0.732906755	0.023874897	0.009717	0.010600	0.013251
NL22	Gelderland	Netherlands	0.110300212	0.971880521	0.107198627	0.04363	0.04760	0.05950	0.732906755	0.08083977	0.032902	0.035893	0.044866
NL23	Flevoland	Netherlands	0.004620163	0.971880521	0.004490246	0.00183	0.00199	0.00249	0.732906755	0.003386149	0.001378	0.001503	0.001879
NL32	Noord-Holland	Netherlands	0.223435421	0.971880521	0.217152534	0.08838	0.09642	0.12052	0.732906755	0.163757329	0.066649	0.072708	0.090885
NL34	Zeeland	Netherlands	0.003555702	0.971880521	0.003455717	0.00141	0.00153	0.00192	0.732906755	0.002605998	0.001061	0.001157	0.001446
NL35	Utrecht	Netherlands	0.050477115	0.971880521	0.049057725	0.01997	0.02178	0.02723	0.732906755	0.036995019	0.015057	0.016426	0.020532
NL36	Zuid-Holland	Netherlands	0.351710482	0.971880521	0.341820567	0.13912	0.15177	0.18971	0.732906755	0.257770988	0.104913	0.114450	0.143063
NL41	Noord-Brabant	Netherlands	0.170545651	0.971880521	0.165749996	0.06746	0.07359	0.09199	0.732906755	0.12499406	0.050873	0.055497	0.069372
NL42	Limburg (NL)	Netherlands	0.029313358	0.971880521	0.028489081	0.01160	0.01265	0.01581	0.732906755	0.021483958	0.008744	0.009539	0.011924
AT11	Burgenland	Austria	0.007529305	0.339509823	0.002556273	0.00084	0.00092	0.00115	0.320579899	0.002413744	0.000797	0.000869	0.001086
AT12	Niederösterreich	Austria	0.250106536	0.339509823	0.084913626	0.02802	0.03057	0.03821	0.320579899	0.080179128	0.026459	0.028864	0.036081
AT13	Wien	Austria	0.303741731	0.339509823	0.103123301	0.03403	0.03712	0.04641	0.320579899	0.097373494	0.032133	0.035054	0.043818
AT21	Kärnten	Austria	0.025846024	0.339509823	0.008774979	0.00290	0.00316	0.00395	0.320579899	0.008285716	0.002734	0.002983	0.003729

AT22	Steiermark	Austria	0.130679249	0.339509823	0.044366889	0.01464	0.01597	0.01997	0.320579899	0.04189314	0.013825	0.015082	0.018852
AT31	Oberösterreich	Austria	0.192277452	0.339509823	0.065280084	0.02154	0.02350	0.02938	0.320579899	0.061640286	0.020341	0.022191	0.027738
AT32	Salzburg	Austria	0.0271393	0.339509823	0.009214059	0.00304	0.00332	0.00415	0.320579899	0.008700314	0.002871	0.003132	0.003915
AT33	Tirol	Austria	0.048751258	0.339509823	0.016551531	0.00546	0.00596	0.00745	0.320579899	0.015628673	0.005157	0.005626	0.007033
AT34	Vorarlberg	Austria	0.013929143	0.339509823	0.004729081	0.00156	0.00170	0.00213	0.320579899	0.004465403	0.001474	0.001608	0.002009
PL21	Małopolskie	Poland	0.105786739	0.718540479	0.076012054	0.00084	0.00091	0.00114	0.77298663	0.081771735	0.000899	0.000981	0.001227
PL22	Śląskie	Poland	0.199023812	0.718540479	0.143006666	0.00157	0.00172	0.00215	0.77298663	0.153842746	0.001692	0.001846	0.002308
PL41	Wielkopolskie	Poland	0.122981355	0.718540479	0.088367082	0.00097	0.00106	0.00133	0.77298663	0.095062943	0.001046	0.001141	0.001426
PL42	Zachodniopomorskie	Poland	0.024822233	0.718540479	0.017835779	0.00020	0.00021	0.00027	0.77298663	0.019187254	0.000211	0.000230	0.000288
PL43	Lubuskie	Poland	0.008134683	0.718540479	0.005845099	0.00006	0.00007	0.00009	0.77298663	0.006288001	0.000069	0.000075	0.000094
PL51	Dolnośląskie	Poland	0.082346033	0.718540479	0.059168958	0.00065	0.00071	0.00089	0.77298663	0.063652383	0.000700	0.000764	0.000955
PL52	Opolskie	Poland	0.007597633	0.718540479	0.005459207	0.00006	0.00007	0.00008	0.77298663	0.005872869	0.000065	0.000070	0.000088
PL61	Kujawsko-pomorskie	Poland	0.035478225	0.718540479	0.025492541	0.00028	0.00031	0.00038	0.77298663	0.027424194	0.000302	0.000329	0.000411
PL62	Warmińsko-mazurskie	Poland	0.015476126	0.718540479	0.011120223	0.00012	0.00013	0.00017	0.77298663	0.011962838	0.000132	0.000144	0.000179
PL63	Pomorskie	Poland	0.051369357	0.718540479	0.036910963	0.00041	0.00044	0.00055	0.77298663	0.039707826	0.000437	0.000476	0.000596
PL71	Łódzkie	Poland	0.057100918	0.718540479	0.041029321	0.00045	0.00049	0.00062	0.77298663	0.044138246	0.000486	0.000530	0.000662
PL72	Świętokrzyskie	Poland	0.011725306	0.718540479	0.008425107	0.00009	0.00010	0.00013	0.77298663	0.009063505	0.000100	0.000109	0.000136
PL81	Lubelskie	Poland	0.034287598	0.718540479	0.024637027	0.00027	0.00030	0.00037	0.77298663	0.026503855	0.000292	0.000318	0.000398
PL82	Podkarpackie	Poland	0.032034372	0.718540479	0.023017993	0.00025	0.00028	0.00035	0.77298663	0.024762141	0.000272	0.000297	0.000371
PL84	Podlaskie	Poland	0.010594474	0.718540479	0.007612558	0.00008	0.00009	0.00011	0.77298663	0.008189387	0.000090	0.000098	0.000123
PL91	Warszawski stołeczny	Poland	0.149410071	0.718540479	0.107357184	0.00118	0.00129	0.00161	0.77298663	0.115491987	0.001270	0.001386	0.001732
PL92	Mazowiecki regionalny	Poland	0.051831065	0.718540479	0.037242719	0.00041	0.00045	0.00056	0.77298663	0.04006472	0.000441	0.000481	0.000601
PT11	Norte	Portugal	0.541977299	0.365538644	0.198113647	0.00218	0.00238	0.00297	0.422751139	0.22912152	0.002520	0.002749	0.003437
PT15	Algarve	Portugal	0.0128135	0.365538644	0.004683829	0.00005	0.00006	0.00007	0.422751139	0.005416922	0.000060	0.000065	0.000081
PT19	Centro (PT)	Portugal	0.121650241	0.365538644	0.044467864	0.00049	0.00053	0.00067	0.422751139	0.051427778	0.000566	0.000617	0.000771
PT1A	Grande Lisboa	Portugal	0.246071066	0.365538644	0.089948484	0.00099	0.00108	0.00135	0.422751139	0.104026823	0.001144	0.001248	0.001560
PT1B	Península de Setúbal	Portugal	0.030810522	0.365538644	0.011262437	0.00012	0.00014	0.00017	0.422751139	0.013025183	0.000143	0.000156	0.000195
PT1C	Alentejo	Portugal	0.010352082	0.365538644	0.003784086	0.00004	0.00005	0.00006	0.422751139	0.004376354	0.000048	0.000053	0.000066
PT1D	Oeste e Vale do Tejo	Portugal	0.030704514	0.365538644	0.011223686	0.00012	0.00013	0.00017	0.422751139	0.012980368	0.000143	0.000156	0.000195
PT20	Região Autónoma dos Açores	Portugal	0.002597819	0.365538644	0.000949603	0.00001	0.00001	0.00001	0.422751139	0.001098231	0.000012	0.000013	0.000016
PT30	Região Autónoma da Madeira	Portugal	0.003022957	0.365538644	0.001105007	0.00001	0.00001	0.00002	0.422751139	0.001277959	0.000014	0.000015	0.000019

RO11	Nord-Vest	Romania	0.136783587	0.329033929	0.045006441	0.00050	0.00054	0.00068	0.330349175	0.045186345	0.000497	0.000542	0.000678
RO12	Centru	Romania	0.111861579	0.329033929	0.036806255	0.00040	0.00044	0.00055	0.330349175	0.03695338	0.000406	0.000443	0.000554
RO21	Nord-Est	Romania	0.173069903	0.329033929	0.05694587	0.00063	0.00068	0.00085	0.330349175	0.0571735	0.000629	0.000686	0.000858
RO22	Sud-Est	Romania	0.098225746	0.329033929	0.032319603	0.00036	0.00039	0.00048	0.330349175	0.032448794	0.000357	0.000389	0.000487
RO31	Sud-Muntenia	Romania	0.138369878	0.329033929	0.045528385	0.00050	0.00055	0.00068	0.330349175	0.045710375	0.000503	0.000549	0.000686
RO32	Bucureşti-Ilfov	Romania	0.217435624	0.329033929	0.071543698	0.00079	0.00086	0.00107	0.330349175	0.071829679	0.000790	0.000862	0.001077
RO41	Sud-Vest Oltenia	Romania	0.059997971	0.329033929	0.019741368	0.00022	0.00024	0.00030	0.330349175	0.01982028	0.000218	0.000238	0.000297
RO42	Vest	Romania	0.064255713	0.329033929	0.02114231	0.00023	0.00025	0.00032	0.330349175	0.021226822	0.000233	0.000255	0.000318
SI03	Vzhodna Slovenija	Slovenia	0.538955206	0.054955263	0.029618425	0.00228	0.00249	0.00311	0.058621805	0.031594527	0.002433	0.002654	0.003317
SI04	Zahodna Slovenija	Slovenia	0.461044794	0.054955263	0.025336838	0.00195	0.00213	0.00266	0.058621805	0.027027278	0.002081	0.002270	0.002838
SK01	Bratislavský kraj	Slovakia	0.103159972	0.130906994	0.013504362	0.00089	0.00097	0.00122	0.111512127	0.011503588	0.000759	0.000828	0.001035
SK02	Západné Slovensko	Slovakia	0.392714598	0.130906994	0.051409088	0.00339	0.00370	0.00463	0.111512127	0.04379244	0.002890	0.003153	0.003941
SK03	Stredné Slovensko	Slovakia	0.214128513	0.130906994	0.02803092	0.00185	0.00202	0.00252	0.111512127	0.023877926	0.001576	0.001719	0.002149
SK04	Východné Slovensko	Slovakia	0.289996917	0.130906994	0.037962625	0.00251	0.00273	0.00342	0.111512127	0.032338173	0.002134	0.002328	0.002910
FI1B	Helsinki-Uusimaa	Finland	0.447739374	0.16493954	0.073849927	0.00081	0.00089	0.00111	0.137487729	0.06155867	0.000677	0.000739	0.000923
FI1C	Etelä-Suomi	Finland	0.155983965	0.16493954	0.025727924	0.00028	0.00031	0.00039	0.137487729	0.021445881	0.000236	0.000257	0.000322
FI1D	Pohjois- ja Itä-Suomi	Finland	0.175538904	0.16493954	0.028953306	0.00032	0.00035	0.00043	0.137487729	0.024134445	0.000265	0.000290	0.000362
FI19	Länsi-Suomi	Finland	0.220611496	0.16493954	0.036387559	0.00040	0.00044	0.00055	0.137487729	0.030331374	0.000334	0.000364	0.000455
FI20	Åland	Finland	0.000126261	0.16493954	0.0000208	0.00000	0.00000	0.00000	0.137487729	0.0000173	0.000000	0.000000	0.000000
SE11	Stockholm	Sweden	0.381056082	0.360868354	0.137511081	0.00756	0.00825	0.01031	0.334591396	0.127498086	0.007012	0.007650	0.009562
SE12	Östra Mellansverige	Sweden	0.156490075	0.360868354	0.056472316	0.00311	0.00339	0.00424	0.334591396	0.052360233	0.002880	0.003142	0.003927
SE21	Småland med öarna	Sweden	0.038517656	0.360868354	0.013899803	0.00076	0.00083	0.00104	0.334591396	0.012887676	0.000709	0.000773	0.000967
SE22	Sydsverige	Sweden	0.128704493	0.360868354	0.046445379	0.00255	0.00279	0.00348	0.334591396	0.043063416	0.002368	0.002584	0.003230
SE23	Västsverige	Sweden	0.238050204	0.360868354	0.085904785	0.00472	0.00515	0.00644	0.334591396	0.07964955	0.004381	0.004779	0.005974
SE31	Norra Mellansverige	Sweden	0.035973558	0.360868354	0.012981719	0.00071	0.00078	0.00097	0.334591396	0.012036443	0.000662	0.000722	0.000903
SE32	Mellersta Norrland	Sweden	0.006968865	0.360868354	0.002514843	0.00014	0.00015	0.00019	0.334591396	0.002331722	0.000128	0.000140	0.000175
SE33	Övre Norrland	Sweden	0.014239067	0.360868354	0.005138429	0.00028	0.00031	0.00039	0.334591396	0.004764269	0.000262	0.000286	0.000357

Table 19: NUTS2 Downscaling of Scenario EU

NUTS 2 Code	Region Name	Country	Regional Share	2020 Anchor Year				2024 Anchor Year			
				PCTW 2035 Mean	NUTS2 PCTW 2035 Mean	NUTS2 Collected Volume 2035 EU 50	NUTS2 Collected Volume 2035 EU 75	PCTW 2035 Mean	NUTS2 PCTW 2035 Mean	NUTS2 Collected Volume 2035 EU 50	NUTS2 Collected Volume 2035 EU 75
BE10	Région de Bruxelles-Capitale / Brussels Hoofdstedelijk Gewest	Belgium	0.093740253	0.479691513	0.044966404	0.022483	0.033725	0.442649978	0.041494121	0.020747	0.031121
BE21	Prov. Antwerpen	Belgium	0.25259672	0.479691513	0.121168503	0.060584	0.090876	0.442649978	0.111811933	0.055906	0.083859
BE22	Prov. Limburg (BE)	Belgium	0.052560059	0.479691513	0.025212614	0.012606	0.018909	0.442649978	0.023265709	0.011633	0.017449
BE23	Prov. Oost-Vlaanderen	Belgium	0.175610615	0.479691513	0.084238922	0.042119	0.063179	0.442649978	0.077734035	0.038867	0.058301
BE24	Prov. Vlaams-Brabant	Belgium	0.106538123	0.479691513	0.051105434	0.025553	0.038329	0.442649978	0.047159098	0.02358	0.035369
BE25	Prov. West-Vlaanderen	Belgium	0.107930852	0.479691513	0.051773514	0.025887	0.038830	0.442649978	0.047775589	0.023888	0.035832
BE31	Prov. Brabant Wallon	Belgium	0.012324695	0.479691513	0.005912052	0.002956	0.004434	0.442649978	0.005455526	0.002728	0.004092
BE32	Prov. Hainaut	Belgium	0.103418045	0.479691513	0.049608758	0.024804	0.037207	0.442649978	0.045777995	0.022889	0.034333
BE33	Prov. Liège	Belgium	0.07431684	0.479691513	0.035649157	0.017825	0.026737	0.442649978	0.032896348	0.016448	0.024672
BE34	Prov. Luxembourg (BE)	Belgium	0.005577467	0.479691513	0.002675464	0.001338	0.002007	0.442649978	0.002468866	0.001234	0.001852
BE35	Prov. Namur	Belgium	0.015386331	0.479691513	0.007380692	0.003690	0.005536	0.442649978	0.006810759	0.003405	0.005108
BG31	Severozapaden	Bulgaria	0.036304249	0.099065828	0.003596511	0.001798	0.002697	0.127332272	0.004622703	0.002311	0.003467
BG32	Severen tsentralen	Bulgaria	0.040619414	0.099065828	0.004023996	0.002012	0.003018	0.127332272	0.005172162	0.002586	0.003879
BG33	Severoiztochen	Bulgaria	0.062627282	0.099065828	0.006204224	0.003102	0.004653	0.127332272	0.007974474	0.003987	0.005981
BG34	Yugoiztochen	Bulgaria	0.07623913	0.099065828	0.007552693	0.003776	0.005665	0.127332272	0.009707702	0.004854	0.007281
BG41	Yugozapaden	Bulgaria	0.629089802	0.099065828	0.062321302	0.031161	0.046741	0.127332272	0.080103434	0.040052	0.060078
BG42	Yuzhen tsentralen	Bulgaria	0.155120123	0.099065828	0.015367103	0.007684	0.011525	0.127332272	0.019751798	0.009876	0.014814
CZ01	Praha	Czechia	0.158868847	0.357616601	0.056814137	0.028407	0.042611	0.313861194	0.049862766	0.024931	0.037397
CZ02	Střední Čechy	Czechia	0.150825162	0.357616601	0.053937582	0.026969	0.040453	0.313861194	0.047338165	0.023669	0.035504
CZ03	Jihozápad	Czechia	0.10090645	0.357616601	0.036085822	0.018043	0.027064	0.313861194	0.031670619	0.015835	0.023753
CZ04	Severozápad	Czechia	0.071125317	0.357616601	0.025435594	0.012718	0.019077	0.313861194	0.022323477	0.011162	0.016743
CZ05	Severovýchod	Czechia	0.146276217	0.357616601	0.052310803	0.026155	0.039233	0.313861194	0.045910428	0.022955	0.034433
CZ06	Jihovýchod	Czechia	0.198036973	0.357616601	0.070821309	0.035411	0.053116	0.313861194	0.062156121	0.031078	0.046617
CZ07	Střední Morava	Czechia	0.090121417	0.357616601	0.032228915	0.016114	0.024172	0.313861194	0.028285616	0.014143	0.021214
CZ08	Moravskoslezsko	Czechia	0.083839616	0.357616601	0.029982438	0.014991	0.022487	0.313861194	0.026314002	0.013157	0.019736
DK01	Hovedstaden	Denmark	0.482194969	0.225024079	0.108505479	0.054253	0.081379	0.206305672	0.099479557	0.04974	0.074610
DK02	Sjælland	Denmark	0.086452343	0.225024079	0.019453859	0.009727	0.014590	0.206305672	0.017835609	0.008918	0.013377
DK03	Syddanmark	Denmark	0.173442679	0.225024079	0.039028779	0.019514	0.029272	0.206305672	0.035782208	0.017891	0.026837
DK04	Midtjylland	Denmark	0.217862372	0.225024079	0.04902428	0.024512	0.036768	0.206305672	0.044946243	0.022473	0.033710
DK05	Nordjylland	Denmark	0.040047637	0.225024079	0.009011683	0.004506	0.006759	0.206305672	0.008262055	0.004131	0.006197
DE11	Stuttgart	Germany	0.07973444	2.981758248	0.237748824	0.118874	0.178312	2.580671179	0.205768371	0.102884	0.154326

DE12	Karlsruhe	Germany	0.035239527	2.981758248	0.10507575	0.052538	0.078807	2.580671179	0.090941632	0.045471	0.068206
DE13	Freiburg	Germany	0.023405929	2.981758248	0.069790822	0.034895	0.052343	2.580671179	0.060403006	0.030202	0.045302
DE14	Tübingen	Germany	0.016168089	2.981758248	0.048209333	0.024105	0.036157	2.580671179	0.041724521	0.020862	0.031293
DE21	Oberbayern	Germany	0.116508288	2.981758248	0.347399549	0.173700	0.260550	2.580671179	0.300669581	0.150335	0.225502
DE22	Niederbayern	Germany	0.006882907	2.981758248	0.020523164	0.010262	0.015392	2.580671179	0.01776252	0.008881	0.013322
DE23	Oberpfalz	Germany	0.005453609	2.981758248	0.016261343	0.008131	0.012196	2.580671179	0.014073972	0.007037	0.010555
DE24	Oberfranken	Germany	0.004847879	2.981758248	0.014455204	0.007228	0.010841	2.580671179	0.012510782	0.006255	0.009383
DE25	Mittelfranken	Germany	0.014411569	2.981758248	0.042971816	0.021486	0.032229	2.580671179	0.037191521	0.018596	0.027894
DE26	Unterfranken	Germany	0.007724289	2.981758248	0.023031964	0.011516	0.017274	2.580671179	0.01993385	0.009967	0.014950
DE27	Schwaben	Germany	0.016665811	2.981758248	0.049693421	0.024847	0.037270	2.580671179	0.043008978	0.021504	0.032257
DE30	Berlin	Germany	0.053025368	2.981758248	0.158108828	0.079054	0.118582	2.580671179	0.136841039	0.068421	0.102631
DE40	Brandenburg	Germany	0.025364637	2.981758248	0.075631214	0.037816	0.056723	2.580671179	0.065457788	0.032729	0.049093
DE50	Bremen	Germany	0.001843141	2.981758248	0.005495801	0.002748	0.004122	2.580671179	0.004756541	0.002378	0.003567
DE60	Hamburg	Germany	0.015347965	2.981758248	0.04576392	0.022882	0.034323	2.580671179	0.039608051	0.019804	0.029706
DE71	Darmstadt	Germany	0.072870245	2.981758248	0.217281453	0.108641	0.162961	2.580671179	0.188054141	0.094027	0.141041
DE72	Gießen	Germany	0.00429611	2.981758248	0.012809963	0.006405	0.009607	2.580671179	0.011086847	0.005543	0.008315
DE73	Kassel	Germany	0.005791893	2.981758248	0.017270025	0.008635	0.012953	2.580671179	0.014946971	0.007473	0.011210
DE80	Mecklenburg-Vorpommern	Germany	0.009417234	2.981758248	0.028079914	0.014040	0.021060	2.580671179	0.024302784	0.012151	0.018227
DE91	Braunschweig	Germany	0.010151068	2.981758248	0.03026803	0.015134	0.022701	2.580671179	0.026196569	0.013098	0.019647
DE92	Hannover	Germany	0.018336986	2.981758248	0.05467646	0.027338	0.041007	2.580671179	0.047321731	0.023661	0.035491
DE93	Lüneburg	Germany	0.012559937	2.981758248	0.037450696	0.018725	0.028088	2.580671179	0.032413067	0.016207	0.024310
DE94	Weser-Ems	Germany	0.026627479	2.981758248	0.079396705	0.039698	0.059548	2.580671179	0.068716768	0.034358	0.051538
DEA1	Düsseldorf	Germany	0.11114269	2.981758248	0.331400633	0.165700	0.248550	2.580671179	0.286822737	0.143411	0.215117
DEA2	Köln	Germany	0.084082943	2.981758248	0.25071501	0.125358	0.188036	2.580671179	0.216990428	0.108495	0.162743
DEA3	Münster	Germany	0.028382472	2.981758248	0.084629669	0.042315	0.063472	2.580671179	0.073245827	0.036623	0.054934
DEA4	Detmold	Germany	0.017957663	2.981758248	0.05354541	0.026773	0.040159	2.580671179	0.046342823	0.023171	0.034757
DEA5	Arnsberg	Germany	0.050880797	2.981758248	0.151714235	0.075857	0.113786	2.580671179	0.131306606	0.065653	0.098480
DEB1	Koblenz	Germany	0.009614937	2.981758248	0.028669417	0.014335	0.021502	2.580671179	0.024812991	0.012406	0.018610
DEB2	Trier	Germany	0.001141384	2.981758248	0.00340333	0.001702	0.002552	2.580671179	0.002945537	0.001473	0.002209
DEB3	Rhein Hessen-Pfalz	Germany	0.017755595	2.981758248	0.052942892	0.026471	0.039707	2.580671179	0.045821352	0.022911	0.034366
DEC0	Saarland	Germany	0.00383333	2.981758248	0.011430064	0.005715	0.008573	2.580671179	0.009892564	0.004946	0.007419
DED2	Dresden	Germany	0.009606759	2.981758248	0.028645034	0.014323	0.021484	2.580671179	0.024791886	0.012396	0.018594
DED4	Chemnitz	Germany	0.007386148	2.981758248	0.022023707	0.011012	0.016518	2.580671179	0.019061219	0.009531	0.014296
DED5	Leipzig	Germany	0.004219476	2.981758248	0.012581458	0.006291	0.009436	2.580671179	0.01088908	0.005445	0.008167
DEE0	Sachsen-Anhalt	Germany	0.016988328	2.981758248	0.050655086	0.025328	0.037991	2.580671179	0.043841288	0.021921	0.032881
DEF0	Schleswig-Holstein	Germany	0.037610538	2.981758248	0.112145531	0.056073	0.084109	2.580671179	0.097060431	0.04853	0.072795
DEG0	Thüringen	Germany	0.016722541	2.981758248	0.049862576	0.024931	0.037397	2.580671179	0.04315538	0.021578	0.032367
EE00	Eesti	Estonia	1	0.046720403	0.046720403	0.023360	0.035040	0.039847046	0.039847046	0.019924	0.029885
IE04	Northern and Western	Ireland	0.075780777	0.213252265	0.016160422	0.008080	0.012120	0.279250001	0.021161782	0.010581	0.015871

IE05	Southern	Ireland	0.292414913	0.213252265	0.062358142	0.031179	0.046769	0.279250001	0.081656865	0.040828	0.061243
IE06	Eastern and Midland	Ireland	0.63180431	0.213252265	0.1347337	0.067367	0.101050	0.279250001	0.176431354	0.088216	0.132324
EL30	Attiki	Greece	0.748878291	0.237928093	0.178179184	0.089090	0.133634	0.24995875	0.187188681	0.093594	0.140392
EL41	Voreio Aigaio	Greece	0.001869059	0.237928093	0.000444702	0.000222	0.000334	0.24995875	0.000467188	0.000234	0.000350
EL42	Notio Aigaio	Greece	0.006381892	0.237928093	0.001518431	0.000759	0.001139	0.24995875	0.00159521	0.000798	0.001196
EL43	Kriti	Greece	0.017657232	0.237928093	0.004201151	0.002101	0.003151	0.24995875	0.00441358	0.002207	0.003310
EL51	Anatoliki Makedonia, Thraki	Greece	0.01299211	0.237928093	0.003091188	0.001546	0.002318	0.24995875	0.003247492	0.001624	0.002436
EL52	Kentriki Makedonia	Greece	0.142835528	0.237928093	0.033984585	0.016992	0.025488	0.24995875	0.03570299	0.017851	0.026777
EL53	Dytiki Makedonia	Greece	0.002939389	0.237928093	0.000699363	0.000350	0.000525	0.24995875	0.000734726	0.000367	0.000551
EL54	Ipeiros	Greece	0.004643869	0.237928093	0.001104907	0.000552	0.000829	0.24995875	0.001160776	0.00058	0.000871
EL61	Thessalia	Greece	0.019537774	0.237928093	0.004648585	0.002324	0.003486	0.24995875	0.004883638	0.002442	0.003663
EL62	Ionia Nisia	Greece	0.002335571	0.237928093	0.000555698	0.000278	0.000417	0.24995875	0.000583796	0.000292	0.000438
EL63	Dytiki Ellada	Greece	0.016020418	0.237928093	0.003811708	0.001906	0.002859	0.24995875	0.004004444	0.002002	0.003003
EL64	Stereia Ellada	Greece	0.011203968	0.237928093	0.002665739	0.001333	0.001999	0.24995875	0.00280053	0.0014	0.002100
EL65	Peloponnisos	Greece	0.012704899	0.237928093	0.003022852	0.001511	0.002267	0.24995875	0.003175701	0.001588	0.002382
ES11	Galicia	Spain	0.028279792	1.463657537	0.041391931	0.020696	0.031044	1.478931433	0.041823873	0.020912	0.031368
ES12	Principado de Asturias	Spain	0.004311357	1.463657537	0.00631035	0.003155	0.004733	1.478931433	0.006376201	0.003188	0.004782
ES13	Cantabria	Spain	0.001387228	1.463657537	0.002030426	0.001015	0.001523	1.478931433	0.002051615	0.001026	0.001539
ES21	País Vasco	Spain	0.026070027	1.463657537	0.038157591	0.019079	0.028618	1.478931433	0.038555782	0.019278	0.028917
ES22	Comunidad Foral de Navarra	Spain	0.00213452	1.463657537	0.003124207	0.001562	0.002343	1.478931433	0.003156809	0.001578	0.002368
ES23	La Rioja	Spain	0.00043195	1.463657537	0.000632226	0.000316	0.000474	1.478931433	0.000638824	0.000319	0.000479
ES24	Aragón	Spain	0.007899433	1.463657537	0.011562064	0.005781	0.008672	1.478931433	0.01168272	0.005841	0.008762
ES30	Comunidad de Madrid	Spain	0.241382242	1.463657537	0.353300937	0.176650	0.264976	1.478931433	0.356987785	0.178494	0.267741
ES41	Castilla y León	Spain	0.022882735	1.463657537	0.033492487	0.016746	0.025119	1.478931433	0.033841996	0.016921	0.025381
ES42	Castilla-La Mancha	Spain	0.015252031	1.463657537	0.02232375	0.011162	0.016743	1.478931433	0.022556708	0.011278	0.016918
ES43	Extremadura	Spain	0.003651607	1.463657537	0.005344702	0.002672	0.004009	1.478931433	0.005400476	0.0027	0.004050
ES51	Cataluña	Spain	0.278508424	1.463657537	0.407640954	0.203820	0.305731	1.478931433	0.411894863	0.205947	0.308921
ES52	Comunitat Valenciana	Spain	0.098879531	1.463657537	0.14472577	0.072363	0.108544	1.478931433	0.146236046	0.073118	0.109677
ES53	Illes Balears	Spain	0.006283853	1.463657537	0.009197409	0.004599	0.006898	1.478931433	0.009293388	0.004647	0.006970
ES61	Andalucía	Spain	0.237492402	1.463657537	0.347607545	0.173804	0.260706	1.478931433	0.351234978	0.175617	0.263426
ES62	Región de Murcia	Spain	0.008476847	1.463657537	0.012407201	0.006204	0.009305	1.478931433	0.012536675	0.006268	0.009403
ES63	Ciudad de Ceuta	Spain	0.00002	1.463657537	0.00004	0.000018	0.000026	1.478931433	0.00004	0.00002	0.000027
ES64	Ciudad de Melilla	Spain	0.00002	1.463657537	0.00004	0.000018	0.000026	1.478931433	0.00004	0.00002	0.000027
ES70	Canarias	Spain	0.016627919	1.463657537	0.02433758	0.012169	0.018253	1.478931433	0.024591552	0.012296	0.018444
FR10	Ile de France	France	0.507468786	2.172973084	1.102716014	0.551358	0.827037	1.957668014	0.99345541	0.496728	0.745092
FRB0	Centre — Val de Loire	France	0.017216313	2.172973084	0.037410585	0.018705	0.028058	1.957668014	0.033703825	0.016852	0.025278
FRC1	Bourgogne	France	0.006656728	2.172973084	0.014464891	0.007232	0.010849	1.957668014	0.013031663	0.006516	0.009774
FRC2	Franche-Comté	France	0.003465295	2.172973084	0.007529993	0.003765	0.005647	1.957668014	0.006783897	0.003392	0.005088

FRD1	Basse-Normandie	France	0.005594503	2.172973084	0.012156705	0.006078	0.009118	1.957668014	0.01095218	0.005476	0.008214
FRD2	Haute-Normandie	France	0.008762233	2.172973084	0.019040096	0.009520	0.014280	1.957668014	0.017153543	0.008577	0.012865
FRE1	Nord-Pas de Calais	France	0.038555109	2.172973084	0.083779213	0.041890	0.062834	1.957668014	0.075478104	0.037739	0.056609
FRE2	Picardie	France	0.00882703	2.172973084	0.019180898	0.009590	0.014386	1.957668014	0.017280394	0.00864	0.012960
FRF1	Alsace	France	0.009607841	2.172973084	0.02087758	0.010439	0.015658	1.957668014	0.018808963	0.009404	0.014107
FRF2	Champagne-Ardenne	France	0.004200804	2.172973084	0.009128234	0.004564	0.006846	1.957668014	0.00822378	0.004112	0.006168
FRF3	Lorraine	France	0.013370889	2.172973084	0.029054582	0.014527	0.021791	1.957668014	0.026175762	0.013088	0.019632
FRG0	Pays de la Loire	France	0.039549256	2.172973084	0.085939469	0.042970	0.064455	1.957668014	0.077424313	0.038712	0.058068
FRH0	Bretagne	France	0.031114293	2.172973084	0.067610522	0.033805	0.050708	1.957668014	0.060911456	0.030456	0.045684
FRI1	Aquitaine	France	0.034272268	2.172973084	0.074472716	0.037236	0.055855	1.957668014	0.067093723	0.033547	0.050320
FRI2	Limousin	France	0.001349689	2.172973084	0.002932837	0.001466	0.002200	1.957668014	0.002642243	0.001321	0.001982
FRI3	Poitou-Charentes	France	0.008670293	2.172973084	0.018840312	0.009420	0.014130	1.957668014	0.016973555	0.008487	0.012730
FRJ1	Languedoc-Roussillon	France	0.021673039	2.172973084	0.047094931	0.023547	0.035321	1.957668014	0.042428615	0.021214	0.031821
FRJ2	Midi-Pyrénées	France	0.02641088	2.172973084	0.057390131	0.028695	0.043043	1.957668014	0.051703735	0.025852	0.038778
FRK1	Auvergne	France	0.004833775	2.172973084	0.010503664	0.005252	0.007878	1.957668014	0.009462927	0.004731	0.007097
FRK2	Rhône-Alpes	France	0.127579211	2.172973084	0.277226191	0.138613	0.207920	1.957668014	0.249757741	0.124879	0.187318
FRL0	Provence-Alpes-Côte d'Azur	France	0.077952841	2.172973084	0.169389425	0.084695	0.127042	1.957668014	0.152605783	0.076303	0.114454
FRM0	Corse	France	0.000340404	2.172973084	0.000739688	0.000370	0.000555	1.957668014	0.000666398	0.000333	0.000500
FRY1	Guadeloupe	France	0.000353876	2.172973084	0.000768964	0.000384	0.000577	1.957668014	0.000692772	0.000346	0.000520
FRY2	Martinique	France	0.000288655	2.172973084	0.000627239	0.000314	0.000470	1.957668014	0.000565091	0.000283	0.000424
FRY3	Guyane	France	0.000115531	2.172973084	0.000251046	0.000126	0.000188	1.957668014	0.000226171	0.000113	0.000170
FRY4	La Réunion	France	0.001681222	2.172973084	0.003653249	0.001827	0.002740	1.957668014	0.003291275	0.001646	0.002468
FRY5	Mayotte	France	0.00009	2.172973084	0.000193909	0.000097	0.000145	1.957668014	0.000174624	0.00009	0.000131
HR02	Panonska Hrvatska	Croatia	0.228148457	0.123042066	0.028071857	0.014036	0.021054	0.121319159	0.027678779	0.013839	0.020759
HR03	Jadranska Hrvatska	Croatia	0.436423471	0.123042066	0.053698445	0.026849	0.040274	0.121319159	0.052946528	0.026473	0.039710
HR05	Grad Zagreb	Croatia	0.18027166	0.123042066	0.022180997	0.011090	0.016636	0.121319159	0.021870406	0.010935	0.016403
HR06	Sjeverna Hrvatska	Croatia	0.155156412	0.123042066	0.019090765	0.009545	0.014318	0.121319159	0.018823445	0.009412	0.014118
ITC1	Piemonte	Italy	0.065380005	1.722995005	0.112649421	0.056325	0.084487	1.508770266	0.098643408	0.049322	0.073983
ITC2	Valle d'Aosta/Vallée d'Aoste	Italy	0.00005	1.722995005	0.00009	0.000045	0.000068	1.508770266	0.00008	0.00004	0.000059
ITC3	Liguria	Italy	0.008139369	1.722995005	0.014024091	0.007012	0.010518	1.508770266	0.012280438	0.00614	0.009210
ITC4	Lombardia	Italy	0.401790783	1.722995005	0.692283512	0.346142	0.519213	1.508770266	0.606209987	0.303105	0.454657
ITF1	Abruzzo	Italy	0.004725756	1.722995005	0.008142454	0.004071	0.006107	1.508770266	0.00713008	0.003565	0.005348
ITF2	Molise	Italy	0.000228378	1.722995005	0.000393494	0.000197	0.000295	1.508770266	0.00034457	0.000172	0.000258
ITF3	Campania	Italy	0.075056488	1.722995005	0.129321954	0.064661	0.096991	1.508770266	0.113242997	0.056621	0.084932
ITF4	Puglia	Italy	0.03871172	1.722995005	0.0667001	0.033350	0.050025	1.508770266	0.058407092	0.029204	0.043805
ITF5	Basilicata	Italy	0.000738655	1.722995005	0.001272698	0.000636	0.000955	1.508770266	0.001114461	0.000557	0.000836
ITF6	Calabria	Italy	0.008218634	1.722995005	0.014160665	0.007080	0.010620	1.508770266	0.012400031	0.0062	0.009300
ITG1	Sicilia	Italy	0.057048912	1.722995005	0.098294991	0.049147	0.073721	1.508770266	0.086073702	0.043037	0.064555

ITG2	Sardegna	Italy	0.006914366	1.722995005	0.011913418	0.005957	0.008935	1.508770266	0.01043219	0.005216	0.007824
ITH1	Provincia Autonoma di Bolzano/Bozen	Italy	0.001311805	1.722995005	0.002260234	0.001130	0.001695	1.508770266	0.001979212	0.00099	0.001484
ITH2	Provincia Autonoma di Trento	Italy	0.001058104	1.722995005	0.001823108	0.000912	0.001367	1.508770266	0.001596436	0.000798	0.001197
ITH3	Veneto	Italy	0.08298456	1.722995005	0.142981983	0.071491	0.107236	1.508770266	0.125204637	0.062602	0.093903
ITH4	Friuli-Venezia Giulia	Italy	0.005073195	1.722995005	0.00874109	0.004371	0.006556	1.508770266	0.007654286	0.003827	0.005741
ITH5	Emilia-Romagna	Italy	0.076049728	1.722995005	0.131033301	0.065517	0.098275	1.508770266	0.114741568	0.057371	0.086056
ITI1	Toscana	Italy	0.045915771	1.722995005	0.079112644	0.039556	0.059334	1.508770266	0.06927635	0.034638	0.051957
ITI2	Umbria	Italy	0.002378054	1.722995005	0.004097375	0.002049	0.003073	1.508770266	0.003587937	0.001794	0.002691
ITI3	Marche	Italy	0.007172625	1.722995005	0.012358396	0.006179	0.009269	1.508770266	0.010821843	0.005411	0.008116
ITI4	Lazio	Italy	0.11105059	1.722995005	0.191339612	0.095670	0.143505	1.508770266	0.167549828	0.083775	0.125662
CY00	Kýpros	Cyprus	1	0.028899057	0.028899057	0.014450	0.021674	0.028802363	0.028802363	0.014401	0.021602
LV00	Latvija	Latvia	1	0.03425727	0.03425727	0.017129	0.025693	0.03624853	0.03624853	0.018124	0.027186
LT01	Sostinės regionas	Lithuania	0.197001454	0.078033306	0.015372675	0.007686	0.011530	0.069152361	0.013623116	0.006812	0.010217
LT02	Vidurio ir vakarų Lietuvos regionas	Lithuania	0.802998546	0.078033306	0.062660632	0.031330	0.046995	0.069152361	0.055529246	0.027765	0.041647
LU00	Luxembourg	Luxembourg	1	0.021756114	0.021756114	0.010878	0.016317	0.020062703	0.020062703	0.010031	0.015047
HU11	Budapest	Hungary	0.365099158	0.245573283	0.089658599	0.044829	0.067244	0.181222008	0.066164003	0.033082	0.049623
HU12	Pest	Hungary	0.142782488	0.245573283	0.035063564	0.017532	0.026298	0.181222008	0.025875329	0.012938	0.019406
HU21	Közép-Dunántúl	Hungary	0.085081891	0.245573283	0.020893839	0.010447	0.015670	0.181222008	0.015418711	0.007709	0.011564
HU22	Nyugat-Dunántúl	Hungary	0.070188678	0.245573283	0.017236464	0.008618	0.012927	0.181222008	0.012719733	0.00636	0.009540
HU23	Dél-Dunántúl	Hungary	0.046403094	0.245573283	0.01139536	0.005698	0.008547	0.181222008	0.008409262	0.004205	0.006307
HU31	Észak-Magyarország	Hungary	0.070326	0.245573283	0.017270187	0.008635	0.012953	0.181222008	0.012744619	0.006372	0.009558
HU32	Észak-Alföld	Hungary	0.126078682	0.245573283	0.030961556	0.015481	0.023221	0.181222008	0.022848232	0.011424	0.017136
HU33	Dél-Alföld	Hungary	0.094040009	0.245573283	0.023093714	0.011547	0.017320	0.181222008	0.017042119	0.008521	0.012782
MT00	Malta	Malta	1	0.111600406	0.111600406	0.055800	0.083700	0.033642493	0.033642493	0.016821	0.025232
NL11	Groningen	Netherlands	0.007809178	0.971880521	0.007589588	0.003795	0.005692	0.732906755	0.005723399	0.002862	0.004293
NL12	Friesland (NL)	Netherlands	0.009788761	0.971880521	0.009513506	0.004757	0.007135	0.732906755	0.007174249	0.003587	0.005381
NL13	Drenthe	Netherlands	0.005868332	0.971880521	0.005703317	0.002852	0.004277	0.732906755	0.00430094	0.00215	0.003226
NL21	Overijssel	Netherlands	0.032575627	0.971880521	0.031659617	0.015830	0.023745	0.732906755	0.023874897	0.011937	0.017906
NL22	Gelderland	Netherlands	0.110300212	0.971880521	0.107198627	0.053599	0.080399	0.732906755	0.08083977	0.04042	0.060630
NL23	Flevoland	Netherlands	0.004620163	0.971880521	0.004490246	0.002245	0.003368	0.732906755	0.003386149	0.001693	0.002540
NL32	Noord-Holland	Netherlands	0.223435421	0.971880521	0.217152534	0.108576	0.162864	0.732906755	0.163757329	0.081879	0.122818
NL34	Zeeland	Netherlands	0.003555702	0.971880521	0.003455717	0.001728	0.002592	0.732906755	0.002605998	0.001303	0.001954
NL35	Utrecht	Netherlands	0.050477115	0.971880521	0.049057725	0.024529	0.036793	0.732906755	0.036995019	0.018498	0.027746
NL36	Zuid-Holland	Netherlands	0.351710482	0.971880521	0.341820567	0.170910	0.256365	0.732906755	0.257770988	0.128885	0.193328
NL41	Noord-Brabant	Netherlands	0.170545651	0.971880521	0.165749996	0.082875	0.124312	0.732906755	0.12499406	0.062497	0.093746
NL42	Limburg (NL)	Netherlands	0.029313358	0.971880521	0.028489081	0.014245	0.021367	0.732906755	0.021483958	0.010742	0.016113
AT11	Burgenland	Austria	0.007529305	0.339509823	0.002556273	0.001278	0.001917	0.320579899	0.002413744	0.001207	0.001810

AT12	Niederösterreich	Austria	0.250106536	0.339509823	0.084913626	0.042457	0.063685	0.320579899	0.080179128	0.04009	0.060134
AT13	Wien	Austria	0.303741731	0.339509823	0.103123301	0.051562	0.077342	0.320579899	0.097373494	0.048687	0.073030
AT21	Kärnten	Austria	0.025846024	0.339509823	0.008774979	0.004387	0.006581	0.320579899	0.008285716	0.004143	0.006214
AT22	Steiermark	Austria	0.130679249	0.339509823	0.044366889	0.022183	0.033275	0.320579899	0.04189314	0.020947	0.031420
AT31	Oberösterreich	Austria	0.192277452	0.339509823	0.065280084	0.032640	0.048960	0.320579899	0.061640286	0.03082	0.046230
AT32	Salzburg	Austria	0.0271393	0.339509823	0.009214059	0.004607	0.006911	0.320579899	0.008700314	0.00435	0.006525
AT33	Tirol	Austria	0.048751258	0.339509823	0.016551531	0.008276	0.012414	0.320579899	0.015628673	0.007814	0.011722
AT34	Vorarlberg	Austria	0.013929143	0.339509823	0.004729081	0.002365	0.003547	0.320579899	0.004465403	0.002233	0.003349
PL21	Małopolskie	Poland	0.105786739	0.718540479	0.076012054	0.038006	0.057009	0.77298663	0.081771735	0.040886	0.061329
PL22	Śląskie	Poland	0.199023812	0.718540479	0.143006666	0.071503	0.107255	0.77298663	0.153842746	0.076921	0.115382
PL41	Wielkopolskie	Poland	0.122981355	0.718540479	0.088367082	0.044184	0.066275	0.77298663	0.095062943	0.047531	0.071297
PL42	Zachodniopomorskie	Poland	0.024822233	0.718540479	0.017835779	0.008918	0.013377	0.77298663	0.019187254	0.009594	0.014390
PL43	Lubuskie	Poland	0.008134683	0.718540479	0.005845099	0.002923	0.004384	0.77298663	0.006288001	0.003144	0.004716
PL51	Dolnośląskie	Poland	0.082346033	0.718540479	0.059168958	0.029584	0.044377	0.77298663	0.063652383	0.031826	0.047739
PL52	Opolskie	Poland	0.007597633	0.718540479	0.005459207	0.002730	0.004094	0.77298663	0.005872869	0.002936	0.004405
PL61	Kujawsko-pomorskie	Poland	0.035478225	0.718540479	0.025492541	0.012746	0.019119	0.77298663	0.027424194	0.013712	0.020568
PL62	Warmińsko-mazurskie	Poland	0.015476126	0.718540479	0.011120223	0.005560	0.008340	0.77298663	0.011962838	0.005981	0.008972
PL63	Pomorskie	Poland	0.051369357	0.718540479	0.036910963	0.018455	0.027683	0.77298663	0.039707826	0.019854	0.029781
PL71	Łódzkie	Poland	0.057100918	0.718540479	0.041029321	0.020515	0.030772	0.77298663	0.044138246	0.022069	0.033104
PL72	Świętokrzyskie	Poland	0.011725306	0.718540479	0.008425107	0.004213	0.006319	0.77298663	0.009063505	0.004532	0.006798
PL81	Lubelskie	Poland	0.034287598	0.718540479	0.024637027	0.012319	0.018478	0.77298663	0.026503855	0.013252	0.019878
PL82	Podkarpackie	Poland	0.032034372	0.718540479	0.023017993	0.011509	0.017263	0.77298663	0.024762141	0.012381	0.018572
PL84	Podlaskie	Poland	0.010594474	0.718540479	0.007612558	0.003806	0.005709	0.77298663	0.008189387	0.004095	0.006142
PL91	Warszawski stołeczny	Poland	0.149410071	0.718540479	0.107357184	0.053679	0.080518	0.77298663	0.115491987	0.057746	0.086619
PL92	Mazowiecki regionalny	Poland	0.051831065	0.718540479	0.037242719	0.018621	0.027932	0.77298663	0.04006472	0.020032	0.030049
PT11	Norte	Portugal	0.541977299	0.365538644	0.198113647	0.099057	0.148585	0.422751139	0.22912152	0.114561	0.171841
PT15	Algarve	Portugal	0.0128135	0.365538644	0.004683829	0.002342	0.003513	0.422751139	0.005416922	0.002708	0.004063
PT19	Centro (PT)	Portugal	0.121650241	0.365538644	0.044467864	0.022234	0.033351	0.422751139	0.051427778	0.025714	0.038571
PT1A	Grande Lisboa	Portugal	0.246071066	0.365538644	0.089948484	0.044974	0.067461	0.422751139	0.104026823	0.052013	0.078020
PT1B	Península de Setúbal	Portugal	0.030810522	0.365538644	0.011262437	0.005631	0.008447	0.422751139	0.013025183	0.006513	0.009769
PT1C	Alentejo	Portugal	0.010352082	0.365538644	0.003784086	0.001892	0.002838	0.422751139	0.004376354	0.002188	0.003282
PT1D	Oeste e Vale do Tejo	Portugal	0.030704514	0.365538644	0.011223686	0.005612	0.008418	0.422751139	0.012980368	0.00649	0.009735
PT20	Região Autónoma dos Açores	Portugal	0.002597819	0.365538644	0.000949603	0.000475	0.000712	0.422751139	0.001098231	0.000549	0.000824
PT30	Região Autónoma da Madeira	Portugal	0.003022957	0.365538644	0.001105007	0.000553	0.000829	0.422751139	0.001277959	0.000639	0.000958
RO11	Nord-Vest	Romania	0.136783587	0.329033929	0.045006441	0.022503	0.033755	0.330349175	0.045186345	0.022593	0.033890
RO12	Centru	Romania	0.111861579	0.329033929	0.036806255	0.018403	0.027605	0.330349175	0.03695338	0.018477	0.027715
RO21	Nord-Est	Romania	0.173069903	0.329033929	0.05694587	0.028473	0.042709	0.330349175	0.0571735	0.028587	0.042880
RO22	Sud-Est	Romania	0.098225746	0.329033929	0.032319603	0.016160	0.024240	0.330349175	0.032448794	0.016224	0.024337

RO31	Sud-Muntenia	Romania	0.138369878	0.329033929	0.045528385	0.022764	0.034146	0.330349175	0.045710375	0.022855	0.034283
RO32	București-Ilfov	Romania	0.217435624	0.329033929	0.071543698	0.035772	0.053658	0.330349175	0.071829679	0.035915	0.053872
RO41	Sud-Vest Oltenia	Romania	0.059997971	0.329033929	0.019741368	0.009871	0.014806	0.330349175	0.01982028	0.00991	0.014865
RO42	Vest	Romania	0.064255713	0.329033929	0.02114231	0.010571	0.015857	0.330349175	0.021226822	0.010613	0.015920
SI03	Vzhodna Slovenija	Slovenia	0.538955206	0.054955263	0.029618425	0.014809	0.022214	0.058621805	0.031594527	0.015797	0.023696
SI04	Zahodna Slovenija	Slovenia	0.461044794	0.054955263	0.025336838	0.012668	0.019003	0.058621805	0.027027278	0.013514	0.020270
SK01	Bratislavský kraj	Slovakia	0.103159972	0.130906994	0.013504362	0.006752	0.010128	0.111512127	0.011503588	0.005752	0.008628
SK02	Západné Slovensko	Slovakia	0.392714598	0.130906994	0.051409088	0.025705	0.038557	0.111512127	0.04379244	0.021896	0.032844
SK03	Stredné Slovensko	Slovakia	0.214128513	0.130906994	0.02803092	0.014015	0.021023	0.111512127	0.023877926	0.011939	0.017908
SK04	Východné Slovensko	Slovakia	0.289996917	0.130906994	0.037962625	0.018981	0.028472	0.111512127	0.032338173	0.016169	0.024254
FI1B	Helsinki-Uusimaa	Finland	0.447739374	0.16493954	0.073849927	0.036925	0.055387	0.137487729	0.06155867	0.030779	0.046169
FI1C	Etelä-Suomi	Finland	0.155983965	0.16493954	0.025727924	0.012864	0.019296	0.137487729	0.021445881	0.010723	0.016084
FI1D	Pohjois- ja Itä-Suomi	Finland	0.175538904	0.16493954	0.028953306	0.014477	0.021715	0.137487729	0.024134445	0.0003	0.018101
FI19	Länsi-Suomi	Finland	0.220611496	0.16493954	0.036387559	0.018194	0.027291	0.137487729	0.030331374	0.0003	0.022749
FI20	Åland	Finland	0.000126261	0.16493954	0.0000208	0.000010	0.000016	0.137487729	0.0000174	0.0000	0.000013
SE11	Stockholm	Sweden	0.381056082	0.360868354	0.137511081	0.068756	0.103133	0.334591396	0.127498086	0.0070	0.095624
SE12	Östra Mellansverige	Sweden	0.156490075	0.360868354	0.056472316	0.028236	0.042354	0.334591396	0.052360233	0.0029	0.039270
SE21	Småland med öarna	Sweden	0.038517656	0.360868354	0.013899803	0.006950	0.010425	0.334591396	0.012887676	0.0007	0.009666
SE22	Sydsverige	Sweden	0.128704493	0.360868354	0.046445379	0.023223	0.034834	0.334591396	0.043063416	0.0024	0.032298
SE23	Västsverige	Sweden	0.238050204	0.360868354	0.085904785	0.042952	0.064429	0.334591396	0.07964955	0.0044	0.059737
SE31	Norra Mellansverige	Sweden	0.035973558	0.360868354	0.012981719	0.006491	0.009736	0.334591396	0.012036443	0.0007	0.009027
SE32	Mellersta Norrland	Sweden	0.006968865	0.360868354	0.002514843	0.001257	0.001886	0.334591396	0.002331722	0.0001	0.001749
SE33	Övre Norrland	Sweden	0.014239067	0.360868354	0.005138429	0.002569	0.003854	0.334591396	0.004764269	0.0003	0.003573

Table 20: Treatment Pathways Allocation to Separately Collected Textiles at National Level (Mt)

Country	PCTW 2035 Mean	Collected Volume 2035 CL 50	Reuse 45%	Recycling 32%	Energy Recovery /Landfill Min 5%	Energy Recovery /Landfill Max 10%	Collected Volume 2035 EU 50	Reuse 45%	Recycling 32%	Energy Recovery /Landfill Min 5%	Energy Recovery /Landfill Max 10%
Austria	0.320579899	0.144260955	0.06491743	0.046163506	0.007213048	0.014426095	0.16028995	0.072130477	0.051292784	0.008014497	0.016028995
Belgium	0.442649978	0.331987483	0.149394368	0.106235995	0.016599374	0.033198748	0.221324989	0.099596245	0.070823996	0.011066249	0.022132499
Bulgaria	0.127332272	0.001909984	0.000859493	0.000611195	0.000095	0.000190998	0.063666136	0.028649761	0.020373164	0.003183307	0.006366614
Croatia	0.121319159	0.016378086	0.007370139	0.005240988	0.000818904	0.001637809	0.06065958	0.027296811	0.019411065	0.003032979	0.006065958
Cyprus	0.028802363	0.00475239	0.002138575	0.001520765	0.000237619	0.000475239	0.014401181	0.006480532	0.004608378	0.000720059	0.001440118
Czechia	0.313861194	0.117697948	0.052964077	0.037663343	0.005884897	0.011769795	0.156930597	0.070618769	0.050217791	0.00784653	0.01569306
Denmark	0.206305672	0.034040436	0.015318196	0.010892939	0.001702022	0.003404044	0.103152836	0.046418776	0.033008907	0.005157642	0.010315284
Estonia	0.039847046	0.002988528	0.001344838	0.000956329	0.000149426	0.000298853	0.019923523	0.008965585	0.006375527	0.000996176	0.001992352
Finland	0.137487729	0.002062316	0.000928042	0.000659941	0.000103116	0.000206232	0.068743865	0.030934739	0.021998037	0.003437193	0.006874386
France	1.957668014	0.704760485	0.317142218	0.225523355	0.035238024	0.070476049	0.978834007	0.440475303	0.313226882	0.0489417	0.097883401
Germany	2.580671179	0.696781218	0.313551548	0.22296999	0.034839061	0.069678122	1.29033559	0.580651016	0.412907389	0.06451678	0.129033559
Greece	0.24995875	0.007498762	0.003374443	0.002399604	0.000374938	0.000749876	0.124979375	0.056240719	0.0399934	0.006248969	0.012497937
Hungary	0.181222008	0.00271833	0.001223249	0.000869866	0.000135917	0.000271833	0.090611004	0.040774952	0.028995521	0.00453055	0.0090611
Ireland	0.279250001	0.00418875	0.001884938	0.0013404	0.000209438	0.000418875	0.139625	0.06283125	0.04468	0.00698125	0.0139625
Italy	1.508770266	0.316841756	0.14257879	0.101389362	0.015842088	0.031684176	0.754385133	0.33947331	0.241403243	0.037719257	0.075438513
Latvia	0.03624853	0.000543728	0.000244678	0.000173993	0.00003	0.00005	0.018124265	0.008155919	0.005799765	0.000906213	0.001812427
Lithuania	0.069152361	0.008298283	0.003734228	0.002655451	0.000414914	0.000829828	0.034576181	0.015559281	0.011064378	0.001728809	0.003457618
Luxembourg	0.020062703	0.015047028	0.006771162	0.004815049	0.000752351	0.001504703	0.010031352	0.004514108	0.003210033	0.000501568	0.001003135
Malta	0.033642493	0.009588111	0.00431465	0.003068195	0.000479406	0.000958811	0.016821247	0.007569561	0.005382799	0.000841062	0.001682125
Netherlands	0.732906755	0.406763249	0.183043462	0.13016424	0.020338162	0.040676325	0.366453378	0.16490402	0.117265081	0.018322669	0.036645338
Poland	0.77298663	0.011594799	0.00521766	0.003710336	0.00057974	0.00115948	0.386493315	0.173921992	0.123677861	0.019324666	0.038649332
Portugal	0.422751139	0.006341267	0.00285357	0.002029205	0.000317063	0.000634127	0.211375569	0.095119006	0.067640182	0.010568778	0.021137557
Romania	0.330349175	0.004955238	0.002229857	0.001585676	0.000247762	0.000495524	0.165174587	0.074328564	0.052855868	0.008258729	0.016517459
Slovakia	0.111512127	0.010036091	0.004516241	0.003211549	0.000501805	0.001003609	0.055756064	0.025090229	0.01784194	0.002787803	0.005575606
Slovenia	0.058621805	0.00615529	0.00276988	0.001969693	0.000307764	0.000615529	0.029310903	0.013189906	0.009379489	0.001465545	0.00293109
Spain	1.478931433	0.088735886	0.039931149	0.028395484	0.004436794	0.008873589	0.739465717	0.332759573	0.236629029	0.036973286	0.073946572
Sweden	0.334591396	0.025094355	0.01129246	0.008030194	0.001254718	0.002509435	0.167295698	0.075283064	0.053534623	0.008364785	0.01672957
EU-27 Total	12.90	2.98	1.34	0.95	0.15	0.30	6.45	2.90	2.06	0.32	0.64

Table 21: Treatment Pathways Allocation to Separately Collected Textiles at NUTS2 Level (Mt)

NUTS 2 Code	Region Name	Country	NUTS2 Collected Volume 2035 CL50	Reuse 45%	Recycling 32%	Energy Recovery /Landfill Min 5%	Energy Recovery /Landfill Max 10%	NUTS2 Collected Volume 2035 EU50	Reuse 45%	Recycling 32%	Energy Recovery /Landfill Min 5%	Energy Recovery /Landfill Max 10%
BE10	Région de Bruxelles- Capitale / Brussels Hoofdstedelijk Gewest	Belgium	0.0311206	0.0140043	0.0099586	0.0015560	0.0031121	0.0207471	0.0093362	0.0066391	0.0010374	0.0020747
BE21	Prov. Antwerpen	Belgium	0.0838589	0.0377365	0.0268349	0.0041929	0.0083859	0.0559060	0.0251577	0.0178899	0.0027953	0.0055906
BE22	Prov. Limburg (BE)	Belgium	0.0174493	0.0078522	0.0055838	0.0008725	0.0017449	0.0116329	0.0052348	0.0037225	0.0005816	0.0011633
BE23	Prov. Oost-Vlaanderen	Belgium	0.0583005	0.0262352	0.0186562	0.0029150	0.0058301	0.0388670	0.0174902	0.0124374	0.0019434	0.0038867
BE24	Prov. Vlaams-Brabant	Belgium	0.0353693	0.0159162	0.0113182	0.0017685	0.0035369	0.0235795	0.0106108	0.0075455	0.0011790	0.0023580
BE25	Prov. West-Vlaanderen	Belgium	0.0358317	0.0161243	0.0114661	0.0017916	0.0035832	0.0238878	0.0107495	0.0076441	0.0011944	0.0023888
BE31	Prov. Brabant Wallon	Belgium	0.0040916	0.0018412	0.0013093	0.0002046	0.0004092	0.0027278	0.0012275	0.0008729	0.0001364	0.0002728
BE32	Prov. Hainaut	Belgium	0.0343335	0.0154501	0.0109867	0.0017167	0.0034333	0.0228890	0.0103000	0.0073245	0.0011445	0.0022889
BE33	Prov. Liège	Belgium	0.0246723	0.0111025	0.0078951	0.0012336	0.0024672	0.0164482	0.0074017	0.0052634	0.0008224	0.0016448
BE34	Prov. Luxembourg (BE)	Belgium	0.0018516	0.0008332	0.0005925	0.0000926	0.0001852	0.0012344	0.0005555	0.0003950	0.0000617	0.0001234
BE35	Prov. Namur	Belgium	0.0051081	0.0022986	0.0016346	0.0002554	0.0005108	0.0034054	0.0015324	0.0010897	0.0001703	0.0003405
BG31	Severozapaden	Bulgaria	0.0000693	0.0000312	0.0000222	0.0000035	0.0000069	0.0023114	0.0010401	0.0007396	0.0001156	0.0002311
BG32	Severen tsentralen	Bulgaria	0.0000776	0.0000349	0.0000248	0.0000039	0.0000078	0.0025861	0.0011637	0.0008275	0.0001293	0.0002586
BG33	Severoiztochen	Bulgaria	0.0001196	0.0000538	0.0000383	0.0000060	0.0000120	0.0039872	0.0017943	0.0012759	0.0001994	0.0003987
BG34	Yugoiztochen	Bulgaria	0.0001456	0.0000655	0.0000466	0.0000073	0.0000146	0.0048539	0.0021842	0.0015532	0.0002427	0.0004854
BG41	Yugozapaden	Bulgaria	0.0012016	0.0005407	0.0003845	0.0000601	0.0001202	0.0400517	0.0180233	0.0128165	0.0020026	0.0040052
BG42	Yuzhen tsentralen	Bulgaria	0.0002963	0.0001333	0.0000948	0.0000148	0.0000296	0.0098759	0.0044442	0.0031603	0.0004938	0.0009876
CZ01	Praha	Czechia	0.0186985	0.0084143	0.0059835	0.0009349	0.0018699	0.0249314	0.0112191	0.0079780	0.0012466	0.0024931
CZ02	Střední Čechy	Czechia	0.0177518	0.0079883	0.0056806	0.0008876	0.0017752	0.0236691	0.0106511	0.0075741	0.0011835	0.0023669
CZ03	Jihozápad	Czechia	0.0118765	0.0053444	0.0038005	0.0005938	0.0011876	0.0158353	0.0071259	0.0050673	0.0007918	0.0015835
CZ04	Severozápad	Czechia	0.0083713	0.0037671	0.0026788	0.0004186	0.0008371	0.0111617	0.0050228	0.0035718	0.0005581	0.0011162
CZ05	Severovýchod	Czechia	0.0172164	0.0077474	0.0055093	0.0008608	0.0017216	0.0229552	0.0103298	0.0073457	0.0011478	0.0022955
CZ06	Jihovýchod	Czechia	0.0233085	0.0104888	0.0074587	0.0011654	0.0023309	0.0310781	0.0139851	0.0099450	0.0015539	0.0031078
CZ07	Střední Morava	Czechia	0.0106071	0.0047732	0.0033943	0.0005304	0.0010607	0.0141428	0.0063643	0.0045257	0.0007071	0.0014143
CZ08	Moravskoslezsko	Czechia	0.0098678	0.0044405	0.0031577	0.0004934	0.0009868	0.0131570	0.0059207	0.0042102	0.0006579	0.0013157
DK01	Hovedstaden	Denmark	0.0164141	0.0073864	0.0052525	0.0008207	0.0016414	0.0497398	0.0223829	0.0159167	0.0024870	0.0049740

DK02	Sjælland	Denmark	0.0029429	0.0013243	0.0009417	0.0001471	0.0002943	0.0089178	0.0040130	0.0028537	0.0004459	0.0008918
DK03	Syddanmark	Denmark	0.0059041	0.0026568	0.0018893	0.0002952	0.0005904	0.0178911	0.0080510	0.0057252	0.0008946	0.0017891
DK04	Midtjylland	Denmark	0.0074161	0.0033373	0.0023732	0.0003708	0.0007416	0.0224731	0.0101129	0.0071914	0.0011237	0.0022473
DK05	Nordjylland	Denmark	0.0013632	0.0006135	0.0004362	0.0000682	0.0001363	0.0041310	0.0018590	0.0013219	0.0002066	0.0004131
DE11	Stuttgart	Germany	0.0555575	0.0250009	0.0177784	0.0027779	0.0055557	0.1028842	0.0462979	0.0329229	0.0051442	0.0102884
DE12	Karlsruhe	Germany	0.0245542	0.0110494	0.0078574	0.0012277	0.0024554	0.0454708	0.0204619	0.0145507	0.0022735	0.0045471
DE13	Freiburg	Germany	0.0163088	0.0073390	0.0052188	0.0008154	0.0016309	0.0302015	0.0135907	0.0096645	0.0015101	0.0030202
DE14	Tübingen	Germany	0.0112656	0.0050695	0.0036050	0.0005633	0.0011266	0.0208623	0.0093880	0.0066759	0.0010431	0.0020862
DE21	Oberbayern	Germany	0.0811808	0.0365314	0.0259779	0.0040590	0.0081181	0.1503348	0.0676507	0.0481071	0.0075167	0.0150335
DE22	Niederbayern	Germany	0.0047959	0.0021581	0.0015347	0.0002398	0.0004796	0.0088813	0.0039966	0.0028420	0.0004441	0.0008881
DE23	Oberpfalz	Germany	0.0038000	0.0017100	0.0012160	0.0001900	0.0003800	0.0070370	0.0031666	0.0022518	0.0003518	0.0007037
DE24	Oberfranken	Germany	0.0033779	0.0015201	0.0010809	0.0001689	0.0003378	0.0062554	0.0028149	0.0020017	0.0003128	0.0006255
DE25	Mittelfranken	Germany	0.0100417	0.0045188	0.0032133	0.0005021	0.0010042	0.0185958	0.0083681	0.0059506	0.0009298	0.0018596
DE26	Unterfranken	Germany	0.0053821	0.0024220	0.0017223	0.0002691	0.0005382	0.0099669	0.0044851	0.0031894	0.0004983	0.0009967
DE27	Schwaben	Germany	0.0116124	0.0052256	0.0037160	0.0005806	0.0011612	0.0215045	0.0096770	0.0068814	0.0010752	0.0021504
DE30	Berlin	Germany	0.0369471	0.0166262	0.0118231	0.0018474	0.0036947	0.0684205	0.0307892	0.0218946	0.0034210	0.0068421
DE40	Brandenburg	Germany	0.0176736	0.0079531	0.0056556	0.0008837	0.0017674	0.0327289	0.0147280	0.0104732	0.0016364	0.0032729
DE50	Bremen	Germany	0.0012843	0.0005779	0.0004110	0.0000642	0.0001284	0.0023783	0.0010702	0.0007610	0.0001189	0.0002378
DE60	Hamburg	Germany	0.0106942	0.0048124	0.0034221	0.0005347	0.0010694	0.0198040	0.0089118	0.0063373	0.0009902	0.0019804
DE71	Darmstadt	Germany	0.0507746	0.0228486	0.0162479	0.0025387	0.0050775	0.0940271	0.0423122	0.0300887	0.0047014	0.0094027
DE72	Gießen	Germany	0.0029934	0.0013471	0.0009579	0.0001497	0.0002993	0.0055434	0.0024945	0.0017739	0.0002772	0.0005543
DE73	Kassel	Germany	0.0040357	0.0018161	0.0012914	0.0002018	0.0004036	0.0074735	0.0033631	0.0023915	0.0003737	0.0007473
DE80	Mecklenburg-Vorpommern	Germany	0.0065618	0.0029528	0.0020998	0.0003281	0.0006562	0.0121514	0.0054681	0.0038884	0.0006076	0.0012151
DE91	Braunschweig	Germany	0.0070731	0.0031829	0.0022634	0.0003537	0.0007073	0.0130983	0.0058942	0.0041915	0.0006549	0.0013098
DE92	Hannover	Germany	0.0127769	0.0057496	0.0040886	0.0006388	0.0012777	0.0236609	0.0106474	0.0075715	0.0011830	0.0023661
DE93	Lüneburg	Germany	0.0087515	0.0039382	0.0028005	0.0004376	0.0008752	0.0162065	0.0072929	0.0051861	0.0008103	0.0016207
DE94	Weser-Ems	Germany	0.0185535	0.0083491	0.0059371	0.0009277	0.0018554	0.0343584	0.0154613	0.0109947	0.0017179	0.0034358
DEA1	Düsseldorf	Germany	0.0774421	0.0348490	0.0247815	0.0038721	0.0077442	0.1434114	0.0645351	0.0458916	0.0071706	0.0143411
DEA2	Köln	Germany	0.0585874	0.0263643	0.0187480	0.0029294	0.0058587	0.1084952	0.0488228	0.0347185	0.0054248	0.0108495
DEA3	Münster	Germany	0.0197764	0.0088994	0.0063284	0.0009888	0.0019776	0.0366229	0.0164803	0.0117193	0.0018311	0.0036623
DEA4	Detmold	Germany	0.0125126	0.0056307	0.0040040	0.0006256	0.0012513	0.0231714	0.0104271	0.0074149	0.0011586	0.0023171
DEA5	Arnsberg	Germany	0.0354528	0.0159538	0.0113449	0.0017726	0.0035453	0.0656533	0.0295440	0.0210091	0.0032827	0.0065653
DEB1	Koblenz	Germany	0.0066995	0.0030148	0.0021438	0.0003350	0.0006700	0.0124065	0.0055829	0.0039701	0.0006203	0.0012407

DEB2	Trier	Germany	0.0007953	0.0003579	0.0002545	0.0000398	0.0000795	0.0014728	0.0006627	0.0004713	0.0000736	0.0001473
DEB3	Rheinessen-Pfalz	Germany	0.0123718	0.0055673	0.0039590	0.0006186	0.0012372	0.0229107	0.0103098	0.0073314	0.0011455	0.0022911
DC00	Saarland	Germany	0.0026710	0.0012019	0.0008547	0.0001335	0.0002671	0.0049463	0.0022258	0.0015828	0.0002473	0.0004946
DED2	Dresden	Germany	0.0066938	0.0030122	0.0021420	0.0003347	0.0006694	0.0123959	0.0055782	0.0039667	0.0006198	0.0012396
DED4	Chemnitz	Germany	0.0051465	0.0023159	0.0016469	0.0002573	0.0005147	0.0095306	0.0042888	0.0030498	0.0004765	0.0009531
DED5	Leipzig	Germany	0.0029401	0.0013230	0.0009408	0.0001470	0.0002940	0.0054445	0.0024500	0.0017423	0.0002722	0.0005445
DEE0	Sachsen-Anhalt	Germany	0.0118371	0.0053267	0.0037879	0.0005919	0.0011837	0.0219206	0.0098643	0.0070146	0.0010960	0.0021921
DEF0	Schleswig-Holstein	Germany	0.0262063	0.0117928	0.0083860	0.0013103	0.0026206	0.0485302	0.0218386	0.0155297	0.0024265	0.0048530
DEG0	Thüringen	Germany	0.0116520	0.0052434	0.0037286	0.0005826	0.0011652	0.0215777	0.0097100	0.0069049	0.0010789	0.0021578
EE00	Eesti	Estonia	0.0029885	0.0013448	0.0009563	0.0001494	0.0002989	0.0199235	0.0089656	0.0063755	0.0009962	0.0019924
IE04	Northern and Western	Ireland	0.0003174	0.0001428	0.0001016	0.0000159	0.0000317	0.0105809	0.0047614	0.0033859	0.0005290	0.0010581
IE05	Southern	Ireland	0.0012249	0.0005512	0.0003920	0.0000612	0.0001225	0.0408284	0.0183728	0.0130651	0.0020414	0.0040828
IE06	Eastern and Midland	Ireland	0.0026465	0.0011909	0.0008469	0.0001323	0.0002646	0.0882157	0.0396971	0.0282290	0.0044108	0.0088216
EL30	Attiki	Greece	0.0056157	0.0025270	0.0017970	0.0002808	0.0005616	0.0935943	0.0421175	0.0299502	0.0046797	0.0093594
EL41	Voreio Aigaio	Greece	0.0000140	0.0000063	0.0000045	0.0000007	0.0000014	0.0002336	0.0001051	0.0000748	0.0000117	0.0000234
EL42	Notio Aigaio	Greece	0.0000479	0.0000215	0.0000153	0.0000024	0.0000048	0.0007976	0.0003589	0.0002552	0.0000399	0.0000798
EL43	Kriti	Greece	0.0001324	0.0000596	0.0000424	0.0000066	0.0000132	0.0022068	0.0009931	0.0007062	0.0001103	0.0002207
EL51	Anatoliki Makedonia, Thraki	Greece	0.0000974	0.0000438	0.0000312	0.0000049	0.0000097	0.0016237	0.0007307	0.0005196	0.0000812	0.0001624
EL52	Kentriki Makedonia	Greece	0.0010711	0.0004820	0.0003427	0.0000536	0.0001071	0.0178515	0.0080332	0.0057125	0.0008926	0.0017852
EL53	Dytiki Makedonia	Greece	0.0000220	0.0000099	0.0000071	0.0000011	0.0000022	0.0003674	0.0001653	0.0001176	0.0000184	0.0000367
EL54	Ipeiros	Greece	0.0000348	0.0000157	0.0000111	0.0000017	0.0000035	0.0005804	0.0002612	0.0001857	0.0000290	0.0000580
EL61	Thessalia	Greece	0.0001465	0.0000659	0.0000469	0.0000073	0.0000147	0.0024418	0.0010988	0.0007814	0.0001221	0.0002442
EL62	Ionia Nisia	Greece	0.0000175	0.0000079	0.0000056	0.0000009	0.0000018	0.0002919	0.0001314	0.0000934	0.0000146	0.0000292
EL63	Dytiki Ellada	Greece	0.0001201	0.0000541	0.0000384	0.0000060	0.0000120	0.0020022	0.0009010	0.0006407	0.0001001	0.0002002
EL64	Stereia Ellada	Greece	0.0000840	0.0000378	0.0000269	0.0000042	0.0000084	0.0014003	0.0006301	0.0004481	0.0000700	0.0001400
EL65	Peloponnisos	Greece	0.0000953	0.0000429	0.0000305	0.0000048	0.0000095	0.0015879	0.0007145	0.0005081	0.0000794	0.0001588
ES11	Galicia	Spain	0.0025094	0.0011292	0.0008030	0.0001255	0.0002509	0.0209119	0.0094104	0.0066918	0.0010456	0.0020912
ES12	Principado de Asturias	Spain	0.0003826	0.0001722	0.0001224	0.0000191	0.0000383	0.0031881	0.0014346	0.0010202	0.0001594	0.0003188
ES13	Cantabria	Spain	0.0001231	0.0000554	0.0000394	0.0000062	0.0000123	0.0010258	0.0004616	0.0003283	0.0000513	0.0001026
ES21	País Vasco	Spain	0.0023133	0.0010410	0.0007403	0.0001157	0.0002313	0.0192779	0.0086751	0.0061689	0.0009639	0.0019278
ES22	Comunidad Foral de Navarra	Spain	0.0001894	0.0000852	0.0000606	0.0000095	0.0000189	0.0015784	0.0007103	0.0005051	0.0000789	0.0001578
ES23	La Rioja	Spain	0.0000383	0.0000172	0.0000123	0.0000019	0.0000038	0.0003194	0.0001437	0.0001022	0.0000160	0.0000319
ES24	Aragón	Spain	0.0007010	0.0003154	0.0002243	0.0000350	0.0000701	0.0058414	0.0026286	0.0018692	0.0002921	0.0005841

ES30	Comunidad de Madrid	Spain	0.0214193	0.0096387	0.0068542	0.0010710	0.0021419	0.1784939	0.0803223	0.0571180	0.0089247	0.0178494
ES41	Castilla y León	Spain	0.0020305	0.0009137	0.0006498	0.0001015	0.0002031	0.0169210	0.0076144	0.0054147	0.0008461	0.0016921
ES42	Castilla-La Mancha	Spain	0.0013534	0.0006090	0.0004331	0.0000677	0.0001353	0.0112784	0.0050753	0.0036091	0.0005639	0.0011278
ES43	Extremadura	Spain	0.0003240	0.0001458	0.0001037	0.0000162	0.0000324	0.0027002	0.0012151	0.0008641	0.0001350	0.0002700
ES51	Cataluña	Spain	0.0247137	0.0111212	0.0079084	0.0012357	0.0024714	0.2059474	0.0926763	0.0659032	0.0102974	0.0205947
ES52	Comunitat Valenciana	Spain	0.0087742	0.0039484	0.0028077	0.0004387	0.0008774	0.0731180	0.0329031	0.0233978	0.0036559	0.0073118
ES53	Illes Balears	Spain	0.0005576	0.0002509	0.0001784	0.0000279	0.0000558	0.0046467	0.0020910	0.0014869	0.0002323	0.0004647
ES61	Andalucía	Spain	0.0210741	0.0094833	0.0067437	0.0010537	0.0021074	0.1756175	0.0790279	0.0561976	0.0087809	0.0175617
ES62	Región de Murcia	Spain	0.0007522	0.0003385	0.0002407	0.0000376	0.0000752	0.0062683	0.0028208	0.0020059	0.0003134	0.0006268
ES63	Ciudad de Ceuta	Spain	0.0000021	0.0000010	0.0000007	0.0000001	0.0000002	0.0000178	0.0000080	0.0000057	0.0000009	0.0000018
ES64	Ciudad de Melilla	Spain	0.0000021	0.0000010	0.0000007	0.0000001	0.0000002	0.0000177	0.0000080	0.0000057	0.0000009	0.0000018
ES70	Canarias	Spain	0.0014755	0.0006640	0.0004722	0.0000738	0.0001475	0.0122958	0.0055331	0.0039346	0.0006148	0.0012296
FR10	Ile de France	France	0.3576439	0.1609398	0.1144461	0.0178822	0.0357644	0.4967277	0.2235275	0.1589529	0.0248364	0.0496728
FRB0	Centre — Val de Loire	France	0.0121334	0.0054600	0.0038827	0.0006067	0.0012133	0.0168519	0.0075834	0.0053926	0.0008426	0.0016852
FRC1	Bourgogne	France	0.0046914	0.0021111	0.0015012	0.0002346	0.0004691	0.0065158	0.0029321	0.0020851	0.0003258	0.0006516
FRC2	Franche-Comté	France	0.0024422	0.0010990	0.0007815	0.0001221	0.0002442	0.0033919	0.0015264	0.0010854	0.0001696	0.0003392
FRD1	Basse-Normandie	France	0.0039428	0.0017743	0.0012617	0.0001971	0.0003943	0.0054761	0.0024642	0.0017523	0.0002738	0.0005476
FRD2	Haute-Normandie	France	0.0061753	0.0027789	0.0019761	0.0003088	0.0006175	0.0085768	0.0038595	0.0027446	0.0004288	0.0008577
FRE1	Nord-Pas de Calais	France	0.0271721	0.0122275	0.0086951	0.0013586	0.0027172	0.0377391	0.0169826	0.0120765	0.0018870	0.0037739
FRE2	Picardie	France	0.0062209	0.0027994	0.0019907	0.0003110	0.0006221	0.0086402	0.0038881	0.0027649	0.0004320	0.0008640
FRF1	Alsace	France	0.0067712	0.0030471	0.0021668	0.0003386	0.0006771	0.0094045	0.0042320	0.0030094	0.0004702	0.0009404
FRF2	Champagne-Ardenne	France	0.0029606	0.0013323	0.0009474	0.0001480	0.0002961	0.0041119	0.0018504	0.0013158	0.0002056	0.0004112
FRF3	Lorraine	France	0.0094233	0.0042405	0.0030154	0.0004712	0.0009423	0.0130879	0.0058895	0.0041881	0.0006544	0.0013088
FRG0	Pays de la Loire	France	0.0278728	0.0125427	0.0089193	0.0013936	0.0027873	0.0387122	0.0174205	0.0123879	0.0019356	0.0038712
FRH0	Bretagne	France	0.0219281	0.0098677	0.0070170	0.0010964	0.0021928	0.0304557	0.0137051	0.0097458	0.0015228	0.0030456
FRI1	Aquitaine	France	0.0241537	0.0108692	0.0077292	0.0012077	0.0024154	0.0335469	0.0150961	0.0107350	0.0016773	0.0033547
FRI2	Limousin	France	0.0009512	0.0004280	0.0003044	0.0000476	0.0000951	0.0013211	0.0005945	0.0004228	0.0000661	0.0001321
FRI3	Poitou-Charentes	France	0.0061105	0.0027497	0.0019554	0.0003055	0.0006110	0.0084868	0.0038191	0.0027158	0.0004243	0.0008487
FRJ1	Languedoc-Roussillon	France	0.0152743	0.0068734	0.0048878	0.0007637	0.0015274	0.0212143	0.0095464	0.0067886	0.0010607	0.0021214
FRJ2	Midi-Pyrénées	France	0.0186133	0.0083760	0.0059563	0.0009307	0.0018613	0.0258519	0.0116333	0.0082726	0.0012926	0.0025852
FRK1	Auvergne	France	0.0034067	0.0015330	0.0010901	0.0001703	0.0003407	0.0047315	0.0021292	0.0015141	0.0002366	0.0004731
FRK2	Rhône-Alpes	France	0.0899128	0.0404608	0.0287721	0.0044956	0.0089913	0.1248789	0.0561955	0.0399612	0.0062439	0.0124879
FRL0	Provence-Alpes-Côte d'Azur	France	0.0549381	0.0247221	0.0175802	0.0027469	0.0054938	0.0763029	0.0343363	0.0244169	0.0038151	0.0076303

FRM0	Corse	France	0.0002399	0.0001080	0.0000768	0.0000120	0.0000240	0.0003332	0.0001499	0.0001066	0.0000167	0.0000333
FRY1	Guadeloupe	France	0.0002494	0.0001122	0.0000798	0.0000125	0.0000249	0.0003464	0.0001559	0.0001108	0.0000173	0.0000346
FRY2	Martinique	France	0.0002034	0.0000915	0.0000651	0.0000102	0.0000203	0.0002825	0.0001271	0.0000904	0.0000141	0.0000283
FRY3	Guyane	France	0.0000814	0.0000366	0.0000261	0.0000041	0.0000081	0.0001131	0.0000509	0.0000362	0.0000057	0.0000113
FRY4	La Réunion	France	0.0011849	0.0005332	0.0003792	0.0000592	0.0001185	0.0016456	0.0007405	0.0005266	0.0000823	0.0001646
FRY5	Mayotte	France	0.0000629	0.0000283	0.0000201	0.0000031	0.0000063	0.0000873	0.0000393	0.0000279	0.0000044	0.0000087
HR02	Panonska Hrvatska	Croatia	0.0037366	0.0016815	0.0011957	0.0001868	0.0003737	0.0138394	0.0062277	0.0044286	0.0006920	0.0013839
HR03	Jadranska Hrvatska	Croatia	0.0071478	0.0032165	0.0022873	0.0003574	0.0007148	0.0264733	0.0119130	0.0084714	0.0013237	0.0026473
HR05	Grad Zagreb	Croatia	0.0029525	0.0013286	0.0009448	0.0001476	0.0002953	0.0109352	0.0049208	0.0034993	0.0005468	0.0010935
HR06	Sjeverna Hrvatska	Croatia	0.0025412	0.0011435	0.0008132	0.0001271	0.0002541	0.0094117	0.0042353	0.0030118	0.0004706	0.0009412
ITC1	Piemonte	Italy	0.0207151	0.0093218	0.0066288	0.0010358	0.0020715	0.0493217	0.0221948	0.0157829	0.0024661	0.0049322
ITC2	Valle d'Aosta/Vallée d'Aoste	Italy	0.0000166	0.0000075	0.0000053	0.0000008	0.0000017	0.0000396	0.0000178	0.0000127	0.0000020	0.0000040
ITC3	Liguria	Italy	0.0025789	0.0011605	0.0008252	0.0001289	0.0002579	0.0061402	0.0027631	0.0019649	0.0003070	0.0006140
ITC4	Lombardia	Italy	0.1273041	0.0572868	0.0407373	0.0063652	0.0127304	0.3031050	0.1363972	0.0969936	0.0151553	0.0303105
ITF1	Abruzzo	Italy	0.0014973	0.0006738	0.0004791	0.0000749	0.0001497	0.0035650	0.0016043	0.0011408	0.0001783	0.0003565
ITF2	Molise	Italy	0.0000724	0.0000326	0.0000232	0.0000036	0.0000072	0.0001723	0.0000775	0.0000551	0.0000086	0.0000172
ITF3	Campania	Italy	0.0237810	0.0107015	0.0076099	0.0011891	0.0023781	0.0566215	0.0254797	0.0181189	0.0028311	0.0056622
ITF4	Puglia	Italy	0.0122655	0.0055195	0.0039250	0.0006133	0.0012265	0.0292035	0.0131416	0.0093451	0.0014602	0.0029204
ITF5	Basilicata	Italy	0.0002340	0.0001053	0.0000749	0.0000117	0.0000234	0.0005572	0.0002508	0.0001783	0.0000279	0.0000557
ITF6	Calabria	Italy	0.0026040	0.0011718	0.0008333	0.0001302	0.0002604	0.0062000	0.0027900	0.0019840	0.0003100	0.0006200
ITG1	Sicilia	Italy	0.0180755	0.0081340	0.0057842	0.0009038	0.0018075	0.0430369	0.0193666	0.0137718	0.0021518	0.0043037
ITG2	Sardegna	Italy	0.0021908	0.0009858	0.0007010	0.0001095	0.0002191	0.0052161	0.0023472	0.0016692	0.0002608	0.0005216
ITH1	Provincia Autonoma di Bolzano/Bozen	Italy	0.0004156	0.0001870	0.0001330	0.0000208	0.0000416	0.0009896	0.0004453	0.0003167	0.0000495	0.0000990
ITH2	Provincia Autonoma di Trento	Italy	0.0003353	0.0001509	0.0001073	0.0000168	0.0000335	0.0007982	0.0003592	0.0002554	0.0000399	0.0000798
ITH3	Veneto	Italy	0.0262930	0.0118318	0.0084138	0.0013146	0.0026293	0.0626023	0.0281710	0.0200327	0.0031301	0.0062602
ITH4	Friuli-Venezia Giulia	Italy	0.0016074	0.0007233	0.0005144	0.0000804	0.0001607	0.0038271	0.0017222	0.0012247	0.0001914	0.0003827
ITH5	Emilia-Romagna	Italy	0.0240957	0.0108431	0.0077106	0.0012048	0.0024096	0.0573708	0.0258169	0.0183587	0.0028685	0.0057371
ITI1	Toscana	Italy	0.0145480	0.0065466	0.0046554	0.0007274	0.0014548	0.0346382	0.0155872	0.0110842	0.0017319	0.0034638
ITI2	Umbria	Italy	0.0007535	0.0003391	0.0002411	0.0000377	0.0000753	0.0017940	0.0008073	0.0005741	0.0000897	0.0001794
ITI3	Marche	Italy	0.0022726	0.0010227	0.0007272	0.0001136	0.0002273	0.0054109	0.0024349	0.0017315	0.0002705	0.0005411
ITI4	Lazio	Italy	0.0351855	0.0158335	0.0112593	0.0017593	0.0035185	0.0837749	0.0376987	0.0268080	0.0041887	0.0083775
CY00	Kýpros	Cyprus	0.0047524	0.0021386	0.0015208	0.0002376	0.0004752	0.0144012	0.0064805	0.0046084	0.0007201	0.0014401

LV00	Latvija	Latvia	0.0005437	0.0002447	0.0001740	0.0000272	0.0000544	0.0181243	0.0081559	0.0057998	0.0009062	0.0018124
LT01	Sostinės regionas	Lithuania	0.0016348	0.0007356	0.0005231	0.0000817	0.0001635	0.0068116	0.0030652	0.0021797	0.0003406	0.0006812
LT02	Vidurio ir vakarų Lietuvos regionas	Lithuania	0.0066635	0.0029986	0.0021323	0.0003332	0.0006664	0.0277646	0.0124941	0.0088847	0.0013882	0.0027765
LU00	Luxembourg	Luxembourg	0.0150470	0.0067712	0.0048150	0.0007524	0.0015047	0.0100314	0.0045141	0.0032100	0.0005016	0.0010031
HU11	Budapest	Hungary	0.0009925	0.0004466	0.0003176	0.0000496	0.0000992	0.0330820	0.0148869	0.0105862	0.0016541	0.0033082
HU12	Pest	Hungary	0.0003881	0.0001747	0.0001242	0.0000194	0.0000388	0.0129377	0.0058219	0.0041401	0.0006469	0.0012938
HU21	Közép-Dunántúl	Hungary	0.0002313	0.0001041	0.0000740	0.0000116	0.0000231	0.0077094	0.0034692	0.0024670	0.0003855	0.0007709
HU22	Nyugat-Dunántúl	Hungary	0.0001908	0.0000859	0.0000611	0.0000095	0.0000191	0.0063599	0.0028619	0.0020352	0.0003180	0.0006360
HU23	Dél-Dunántúl	Hungary	0.0001261	0.0000568	0.0000404	0.0000063	0.0000126	0.0042046	0.0018921	0.0013455	0.0002102	0.0004205
HU31	Észak-Magyarország	Hungary	0.0001912	0.0000860	0.0000612	0.0000096	0.0000191	0.0063723	0.0028675	0.0020391	0.0003186	0.0006372
HU32	Észak-Alföld	Hungary	0.0003427	0.0001542	0.0001097	0.0000171	0.0000343	0.0114241	0.0051409	0.0036557	0.0005712	0.0011424
HU33	Dél-Alföld	Hungary	0.0002556	0.0001150	0.0000818	0.0000128	0.0000256	0.0085211	0.0038345	0.0027267	0.0004261	0.0008521
MT00	Malta	Malta	0.0095881	0.0043146	0.0030682	0.0004794	0.0009588	0.0168212	0.0075696	0.0053828	0.0008411	0.0016821
NL11	Groningen	Netherlands	0.0031765	0.0014294	0.0010165	0.0001588	0.0003176	0.0028617	0.0012878	0.0009157	0.0001431	0.0002862
NL12	Friesland (NL)	Netherlands	0.0039817	0.0017918	0.0012741	0.0001991	0.0003982	0.0035871	0.0016142	0.0011479	0.0001794	0.0003587
NL13	Drenthe	Netherlands	0.0023870	0.0010742	0.0007638	0.0001194	0.0002387	0.0021505	0.0009677	0.0006882	0.0001075	0.0002150
NL21	Overijssel	Netherlands	0.0132506	0.0059628	0.0042402	0.0006625	0.0013251	0.0119374	0.0053719	0.0038200	0.0005969	0.0011937
NL22	Gelderland	Netherlands	0.0448661	0.0201897	0.0143571	0.0022433	0.0044866	0.0404199	0.0181889	0.0129344	0.0020210	0.0040420
NL23	Flevoland	Netherlands	0.0018793	0.0008457	0.0006014	0.0000940	0.0001879	0.0016931	0.0007619	0.0005418	0.0000847	0.0001693
NL32	Noord-Holland	Netherlands	0.0908853	0.0408984	0.0290833	0.0045443	0.0090885	0.0818787	0.0368454	0.0262012	0.0040939	0.0081879
NL34	Zeeland	Netherlands	0.0014463	0.0006508	0.0004628	0.0000723	0.0001446	0.0013030	0.0005864	0.0004170	0.0000652	0.0001303
NL35	Utrecht	Netherlands	0.0205322	0.0092395	0.0065703	0.0010266	0.0020532	0.0184975	0.0083239	0.0059192	0.0009249	0.0018498
NL36	Zuid-Holland	Netherlands	0.1430629	0.0643783	0.0457801	0.0071531	0.0143063	0.1288855	0.0579985	0.0412434	0.0064443	0.0128885
NL41	Noord-Brabant	Netherlands	0.0693717	0.0312173	0.0221989	0.0034686	0.0069372	0.0624970	0.0281237	0.0199991	0.0031249	0.0062497
NL42	Limburg (NL)	Netherlands	0.0119236	0.0053656	0.0038156	0.0005962	0.0011924	0.0107420	0.0048339	0.0034374	0.0005371	0.0010742
AT11	Burgenland	Austria	0.0010862	0.0004888	0.0003476	0.0000543	0.0001086	0.0012069	0.0005431	0.0003862	0.0000603	0.0001207
AT12	Niederösterreich	Austria	0.0360806	0.0162363	0.0115458	0.0018040	0.0036081	0.0400896	0.0180403	0.0128287	0.0020045	0.0040090
AT13	Wien	Austria	0.0438181	0.0197181	0.0140218	0.0021909	0.0043818	0.0486867	0.0219090	0.0155798	0.0024343	0.0048687
AT21	Kärnten	Austria	0.0037286	0.0016779	0.0011931	0.0001864	0.0003729	0.0041429	0.0018643	0.0013257	0.0002071	0.0004143
AT22	Steiermark	Austria	0.0188519	0.0084834	0.0060326	0.0009426	0.0018852	0.0209466	0.0094260	0.0067029	0.0010473	0.0020947
AT31	Oberösterreich	Austria	0.0277381	0.0124822	0.0088762	0.0013869	0.0027738	0.0308201	0.0138691	0.0098624	0.0015410	0.0030820
AT32	Salzburg	Austria	0.0039151	0.0017618	0.0012528	0.0001958	0.0003915	0.0043502	0.0019576	0.0013921	0.0002175	0.0004350
AT33	Tirol	Austria	0.0070329	0.0031648	0.0022505	0.0003516	0.0007033	0.0078143	0.0035165	0.0025006	0.0003907	0.0007814

AT34	Vorarlberg	Austria	0.0020094	0.0009042	0.0006430	0.0001005	0.0002009	0.0022327	0.0010047	0.0007145	0.0001116	0.0002233
PL21	Małopolskie	Poland	0.0012266	0.0005520	0.0003925	0.0000613	0.0001227	0.0408859	0.0183986	0.0130835	0.0020443	0.0040886
PL22	Śląskie	Poland	0.0023076	0.0010384	0.0007384	0.0001154	0.0002308	0.0769214	0.0346146	0.0246148	0.0038461	0.0076921
PL41	Wielkopolskie	Poland	0.0014259	0.0006417	0.0004563	0.0000713	0.0001426	0.0475315	0.0213892	0.0152101	0.0023766	0.0047531
PL42	Zachodniopomorskie	Poland	0.0002878	0.0001295	0.0000921	0.0000144	0.0000288	0.0095936	0.0043171	0.0030700	0.0004797	0.0009594
PL43	Lubuskie	Poland	0.0000943	0.0000424	0.0000302	0.0000047	0.0000094	0.0031440	0.0014148	0.0010061	0.0001572	0.0003144
PL51	Dolnośląskie	Poland	0.0009548	0.0004297	0.0003055	0.0000477	0.0000955	0.0318262	0.0143218	0.0101844	0.0015913	0.0031826
PL52	Opolskie	Poland	0.0000881	0.0000396	0.0000282	0.0000044	0.0000088	0.0029364	0.0013214	0.0009397	0.0001468	0.0002936
PL61	Kujawsko-pomorskie	Poland	0.0004114	0.0001851	0.0001316	0.0000206	0.0000411	0.0137121	0.0061704	0.0043879	0.0006856	0.0013712
PL62	Warmińsko-mazurskie	Poland	0.0001794	0.0000807	0.0000574	0.0000090	0.0000179	0.0059814	0.0026916	0.0019141	0.0002991	0.0005981
PL63	Pomorskie	Poland	0.0005956	0.0002680	0.0001906	0.0000298	0.0000596	0.0198539	0.0089343	0.0063533	0.0009927	0.0019854
PL71	Łódzkie	Poland	0.0006621	0.0002979	0.0002119	0.0000331	0.0000662	0.0220691	0.0099311	0.0070621	0.0011035	0.0022069
PL72	Świętokrzyskie	Poland	0.0001360	0.0000612	0.0000435	0.0000068	0.0000136	0.0045318	0.0020393	0.0014502	0.0002266	0.0004532
PL81	Lubelskie	Poland	0.0003976	0.0001789	0.0001272	0.0000199	0.0000398	0.0132519	0.0059634	0.0042406	0.0006626	0.0013252
PL82	Podkarpackie	Poland	0.0003714	0.0001671	0.0001189	0.0000186	0.0000371	0.0123811	0.0055715	0.0039619	0.0006191	0.0012381
PL84	Podlaskie	Poland	0.0001228	0.0000553	0.0000393	0.0000061	0.0000123	0.0040947	0.0018426	0.0013103	0.0002047	0.0004095
PL91	Warszawski stołeczny	Poland	0.0017324	0.0007796	0.0005544	0.0000866	0.0001732	0.0577460	0.0259857	0.0184787	0.0028873	0.0057746
PL92	Mazowiecki regionalny	Poland	0.0006010	0.0002704	0.0001923	0.0000300	0.0000601	0.0200324	0.0090146	0.0064104	0.0010016	0.0020032
PT11	Norte	Portugal	0.0034368	0.0015466	0.0010998	0.0001718	0.0003437	0.1145608	0.0515523	0.0366594	0.0057280	0.0114561
PT15	Algarve	Portugal	0.0000813	0.0000366	0.0000260	0.0000041	0.0000081	0.0027085	0.0012188	0.0008667	0.0001354	0.0002708
PT19	Centro (PT)	Portugal	0.0007714	0.0003471	0.0002469	0.0000386	0.0000771	0.0257139	0.0115713	0.0082284	0.0012857	0.0025714
PT1A	Grande Lisboa	Portugal	0.0015604	0.0007022	0.0004993	0.0000780	0.0001560	0.0520134	0.0234060	0.0166443	0.0026007	0.0052013
PT1B	Península de Setúbal	Portugal	0.0001954	0.0000879	0.0000625	0.0000098	0.0000195	0.0065126	0.0029307	0.0020840	0.0003256	0.0006513
PT1C	Alentejo	Portugal	0.0000656	0.0000295	0.0000210	0.0000033	0.0000066	0.0021882	0.0009847	0.0007002	0.0001094	0.0002188
PT1D	Oeste e Vale do Tejo	Portugal	0.0001947	0.0000876	0.0000623	0.0000097	0.0000195	0.0064902	0.0029206	0.0020769	0.0003245	0.0006490
PT20	Região Autónoma dos Açores	Portugal	0.0000165	0.0000074	0.0000053	0.0000008	0.0000016	0.0005491	0.0002471	0.0001757	0.0000275	0.0000549
PT30	Região Autónoma da Madeira	Portugal	0.0000192	0.0000086	0.0000061	0.0000010	0.0000019	0.0006390	0.0002875	0.0002045	0.0000319	0.0000639
RO11	Nord-Vest	Romania	0.0006778	0.0003050	0.0002169	0.0000339	0.0000678	0.0225932	0.0101669	0.0072298	0.0011297	0.0022593
RO12	Centru	Romania	0.0005543	0.0002494	0.0001774	0.0000277	0.0000554	0.0184767	0.0083145	0.0059125	0.0009238	0.0018477
RO21	Nord-Est	Romania	0.0008576	0.0003859	0.0002744	0.0000429	0.0000858	0.0285868	0.0128640	0.0091478	0.0014293	0.0028587
RO22	Sud-Est	Romania	0.0004867	0.0002190	0.0001558	0.0000243	0.0000487	0.0162244	0.0073010	0.0051918	0.0008112	0.0016224
RO31	Sud-Muntenia	Romania	0.0006857	0.0003085	0.0002194	0.0000343	0.0000686	0.0228552	0.0102848	0.0073137	0.0011428	0.0022855
RO32	București-Ilfov	Romania	0.0010774	0.0004849	0.0003448	0.0000539	0.0001077	0.0359148	0.0161617	0.0114927	0.0017957	0.0035915

RO41	Sud-Vest Oltenia	Romania	0.0002973	0.0001338	0.0000951	0.0000149	0.0000297	0.0099101	0.0044596	0.0031712	0.0004955	0.0009910
RO42	Vest	Romania	0.0003184	0.0001433	0.0001019	0.0000159	0.0000318	0.0106134	0.0047760	0.0033963	0.0005307	0.0010613
SI03	Vzhodna Slovenija	Slovenia	0.0033174	0.0014928	0.0010616	0.0001659	0.0003317	0.0157973	0.0071088	0.0050551	0.0007899	0.0015797
SI04	Zahodna Slovenija	Slovenia	0.0028379	0.0012770	0.0009081	0.0001419	0.0002838	0.0135136	0.0060811	0.0043244	0.0006757	0.0013514
SK01	Bratislavský kraj	Slovakia	0.0010353	0.0004659	0.0003313	0.0000518	0.0001035	0.0057518	0.0025883	0.0018406	0.0002876	0.0005752
SK02	Západné Slovensko	Slovakia	0.0039413	0.0017736	0.0012612	0.0001971	0.0003941	0.0218962	0.0098533	0.0070068	0.0010948	0.0021896
SK03	Stredné Slovensko	Slovakia	0.0021490	0.0009671	0.0006877	0.0001075	0.0002149	0.0119390	0.0053725	0.0038205	0.0005969	0.0011939
SK04	Východné Slovensko	Slovakia	0.0029104	0.0013097	0.0009313	0.0001455	0.0002910	0.0161691	0.0072761	0.0051741	0.0008085	0.0016169
FI1B	Helsinki-Uusimaa	Finland	0.0009234	0.0004155	0.0002955	0.0000462	0.0000923	0.0307793	0.0138507	0.0098494	0.0015390	0.0030779
FI1C	Etelä-Suomi	Finland	0.0003217	0.0001448	0.0001029	0.0000161	0.0000322	0.0107229	0.0048253	0.0034313	0.0005361	0.0010723
FI1D	Pohjois- ja Itä-Suomi	Finland	0.0003620	0.0001629	0.0001158	0.0000181	0.0000362	0.0120672	0.0054303	0.0038615	0.0006034	0.0012067
FI19	Länsi-Suomi	Finland	0.0004550	0.0002047	0.0001456	0.0000227	0.0000455	0.0151657	0.0068246	0.0048530	0.0007583	0.0015166
FI20	Åland	Finland	0.0000003	0.0000001	0.0000001	0.0000000	0.0000000	0.0000087	0.0000039	0.0000028	0.0000004	0.0000009
SE11	Stockholm	Sweden	0.0095624	0.0043031	0.0030600	0.0004781	0.0009562	0.0637490	0.0286871	0.0203997	0.0031875	0.0063749
SE12	Östra Mellansverige	Sweden	0.0039270	0.0017672	0.0012566	0.0001964	0.0003927	0.0261801	0.0117811	0.0083776	0.0013090	0.0026180
SE21	Småland med öarna	Sweden	0.0009666	0.0004350	0.0003093	0.0000483	0.0000967	0.0064438	0.0028997	0.0020620	0.0003222	0.0006444
SE22	Sydsverige	Sweden	0.0032298	0.0014534	0.0010335	0.0001615	0.0003230	0.0215317	0.0096893	0.0068901	0.0010766	0.0021532
SE23	Västsverige	Sweden	0.0059737	0.0026882	0.0019116	0.0002987	0.0005974	0.0398248	0.0179211	0.0127439	0.0019912	0.0039825
SE31	Norra Mellansverige	Sweden	0.0009027	0.0004062	0.0002889	0.0000451	0.0000903	0.0060182	0.0027082	0.0019258	0.0003009	0.0006018
SE32	Mellersta Norrland	Sweden	0.0001749	0.0000787	0.0000560	0.0000087	0.0000175	0.0011659	0.0005246	0.0003731	0.0000583	0.0001166
SE33	Övre Norrland	Sweden	0.0003573	0.0001608	0.0001143	0.0000179	0.0000357	0.0023821	0.0010720	0.0007623	0.0001191	0.0002382

References

- REGULATION (EU) 2024/1781. (2024). *REGULATION (EU) 2024/1781 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL*. Official Journal of European Union. Retrieved from <https://eur-lex.europa.eu/eli/reg/2024/1781/oj/eng>
- Abbasi, G. H. (2023). A high-resolution dynamic probabilistic material flow analysis of seven plastic polymers; A case study of Norway. *Environment International*. doi:10.1016/j.envint.2022.107693
- Abdeljaber, A. A. (2025). Comparative analysis of machine learning and conventional methods for waste generation forecasting. *Cleaner Engineering and Technology*. doi:10.1016/j.clet.2025.100992
- Abdelmeguid, A. A.-S. (2024). Towards circular fashion: Management strategies promoting circular behaviour along the value chain. *Sustainable Production and Consumption*. doi:10.1016/j.spc.2024.05.010
- Adu, T. F. (2025). Forecasting municipal solid waste generation and composition using machine learning and GIS techniques: A case study of Cape Coast, Ghana. *Cleaner Waste Systems*. doi:10.1016/j.clwas.2025.100218
- Afsana Akther, F. T. (2025). Municipal solid waste dynamics: Economic, environmental, and technological determinants in Europe. *Cleaner Engineering and Technology*.
- Amicarelli, V. B. (2022). Quantifying textile streams and recycling prospects in Europe by material flow analysis. *Environmental Impact Assessment Review*. doi:10.1016/j.eiar.2022.106878
- Beatriz Soares a, M. R. (2024). Factors to consider for the implementation of a municipal scheme for the separate collection of textile waste. *Sustainable Features*.
- Beigl, P. L. (2008). Modelling municipal solid waste generation: A review. *Waste Management*. doi:10.1016/j.wasman.2006.12.011
- Billal, M. M. (2025). Forecasting residential and nonresidential solid waste generation, disposal, and diversion using three machine learning approaches. *Biofuels, Bioproducts and Biorefining*. doi:10.1002/bbb.70010
- Biyada, S. U. (2025). Circularity in textile waste: Challenges and pathways to sustainability. *Cleaner Engineering and Technology*. doi:10.1016/j.clet.2025.100905
- Blagoeva, N. G. (2023). Relationship between GDP and Municipal Waste: Regional Disparities and Implication for Waste Management Policies. *Sustainability*. doi:10.3390/su152115193
- Bo Zhang, Y. Z. (2021). Consumer Attitude towards Sustainability of Fast Fashion Products in the UK. *Sustainability*.
- Bornhöft, N. A. (2021). Representation, Propagation, and Interpretation of Uncertain Knowledge in Dynamic Probabilistic Material Flow Models. *Environmental Modeling and Assessment*. doi:10.1007/s10666-021-09775-5
- Brunner, Rechberger . (2016). *Handbook of Material Flow Analysis*.
- Chen, J. W. (2025). A Novel IoT-based deep learning framework for real-time waste forecasting: Optimizing multi-waste categories using AutoML. *Resources, Conservation and Recycling*. doi:10.1016/j.resconrec.2025.108378
- Chenavaz, R. Y. (2024). From waste to wealth: Policies to promote the circular economy. *Journal of Cleaner Production*. doi:10.1016/j.jclepro.2024.141086

- Cubillos, M. (2020). Multi-site household waste generation forecasting using a deep learning approach. *Waste Management*. doi:10.1016/j.wasman.2020.06.046
- D'Adamo, I. M. (2022). Assessing the relation between waste management policies and circular economy goals. *Waste Management*. doi:10.1016/j.wasman.2022.09.031
- D'Adamo, I., Daraio, C., Di Leo, S., & Simar, L. (2024). A Flexible and Sustainable Analysis of Waste Efficiency at the European Level. *Global Journal of Flexible Systems Management*. doi:10.1007/s40171-024-00416-w
- Dale S. Rogers, R. S.-L. (1998). *Going Backwards: Reverse Logistics Trends and Practices*. Reverse Logistics Executive Council. Retrieved from <https://www.icesi.edu.co/blogs/gestionresiduossolidos/files/2008/11/libro-lr.pdf>
- Delre, A. A. (2024). *Preparatory study on textiles for product policy instruments Ecodesign EU Green Public Procurement EU Ecolabel 1 st milestone*. European Commission .
- DIRECTIVE (EU) 2018/850 . (2018). *DIRECTIVE (EU) 2018/850 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL*. European Union. Retrieved from <https://eur-lex.europa.eu/eli/dir/2018/850/oj>
- Directive (EU) 2018/851. (2024). *Waste Framework Directive (WFD) - Directive (EU) 2018/851*. European Commission. doi:<https://circular-cities-and-regions.ec.europa.eu/support-materials/eu-regulations-legislation/waste-framework-directive-wfd-directive-eu-2018851-0>
- (2008). *Directive 2008/98/EC*. European Union. Retrieved from <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32008L0098>
- Directorate-General for Environment. (2025). *Revised Waste Framework Directive enters into force to boost circularity of textile sector and slash food waste*. European Commission. Retrieved from https://environment.ec.europa.eu/news/revised-waste-framework-directive-enters-force-2025-10-16_en
- E. B. Priyanka, S. V. (n.d.). Prediction of waste generation forecast and emission potential on the Erode City solid waste dump yards based on machine learning approach.
- EEA. (2019). *Textiles in Europe's circular economy*. Retrieved from <https://www.eea.europa.eu/en/analysis/publications/textiles-in-europes-circular-economy>
- EEA. (2022). *Textiles and the Environment: the role of design in Europe's circular economy*. European Environment Agency. Retrieved from <https://www.eea.europa.eu/en/analysis/publications/textiles-and-the-environment-the-role-of-design-in-europes-circular-economy->
- EEA. (2023). *EU exports of used textiles in Europe's Circular Economy*. European Environment Agency. Retrieved from <https://www.eea.europa.eu/en/analysis/publications/eu-exports-of-used-textiles>
- EEA. (2024). *Management of used and waste textiles in Europe's circular economy*. European Environment Agency. Retrieved from https://www.eea.europa.eu/en/analysis/publications/management-of-used-and-waste-textiles-in-europes-circular-economy?utm_source
- EEA. (2024). *The destruction of returned and unsold textiles in Europe's circular economy*. European Environment Agency. Retrieved from <https://www.eea.europa.eu/en/analysis/publications/the-destruction-of-retained-and-unsold-textiles-in-europes-circular-economy>
- EEA. (2025). *Circularity of the EU textiles value chain in numbers*. European Environment Agency. Retrieved November 25, 2025, from https://www.eea.europa.eu/en/analysis/publications/circularity-of-the-eu-textiles-value-chain-in-numbers?utm_source

- EEA. (2025). *Consumption of clothing, footwear, other textiles in the EU reaches new record high*. European Environment Agency. Retrieved from https://www.eea.europa.eu/en/newsroom/news/consumption-of-clothing-footwear-other-textiles-in-the-eu-reaches-new-record-high?utm_source
- EEA. (2026). *Textils*. European Environment Agency. Retrieved from <https://www.eea.europa.eu/en/topics/in-depth/textiles>
- Ellen MacArthur Foundation. (2017). *A NEW TEXTILES ECONOMY: REDESIGNING FASHION'S FUTURE*. Ellen MacArthur Foundation.
- Enking, J. A. (2025). Recycling processes of polyester-containing textile waste—A review. *Resources, Conservation and Recycling*. doi:10.1016/j.resconrec.2025.108256
- Eryganov, I. R. (2025). Forecasting the waste production hierarchical time series with correlation structure. *Optimization and Engineering*. doi:10.1007/s11081-024-09898-0
- Esther Müller, L. M. (2014). Modeling metal stocks and flows: A review of dynamic material flow analysis methods. *Environmental Science and Technology*. doi:10.1021/es403506a
- ETC-CE. (2024). *Textile waste management in Europe's circular*.
- EURATEX. (2020). *ReHubs: a joint initiative for industrial upcycling of textile waste streams & circular materials*. Retrieved from <https://euratex.eu/wp-content/uploads/Recycling-Hubs-FIN-LQ.pdf>
- EURATEX. (2024). *facts and key figures 2024*. EURATEX. Retrieved from https://euratex.eu/wp-content/uploads/EURATEX-Facts-Key-Figures-2024.pdf?utm_source
- European Commission . (2025). *Update of the Waste Framework Directive: Textile and food waste*. European Parliament. Retrieved from https://environment.ec.europa.eu/news/revised-waste-framework-directive-enters-force-2025-10-16_en
- European Commission. (2021). *Study on the technical, regulatory, economic and environmental effectiveness of textile fibres recycling*. Retrieved from <https://op.europa.eu/en/publication-detail/-/publication/739a1cca-6145-11ec-9c6c-01aa75ed71a1>
- European Commission. (2022). *EU Strategy for Sustainable and Circular Textiles*. Retrieved from https://eur-lex.europa.eu/resource.html?uri=cellar:9d2e47d1-b0f3-11ec-83e1-01aa75ed71a1.0001.02/DOC_1&format=PDF
- European Commission. (2023). *Commission Staff Working Document: Impact Assessment Report - Accompanying the document Directive of the European Parliament and of the Council amending Directive 2008/98/EC on waste*. European Commssion. Retrieved from [https://ec.europa.eu/transparency/documents-register/detail?ref=SWD\(2023\)421&lang=en](https://ec.europa.eu/transparency/documents-register/detail?ref=SWD(2023)421&lang=en)
- European Commission,. (2025). *Ecodesign for Sustainable Products and Energy Labelling Working Plan 2025-2030*. European Union. Retrieved from https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex:52025DC0187&utm_source
- European Environment Agency. (2024). *The Destruction of returned and unsold textiles in Europe's circular economy*.
- European Environment Bureau. (2025). *Redefining used textiles*. Brussels.
- European Parliament. (2020). European Parliament. doi:https://www.europarl.europa.eu/RegData/etudes/BRIE/2020/652025/EPRS_BRI%282020%29652025_EN.pdf

- EUROSTAT. (2008). *NACE Rev. 2 - Statistical classification of economic activities*. EUROSTAT. Retrieved from <https://ec.europa.eu/eurostat/web/products-manuals-and-guidelines/-/ks-ra-07-015>
- EUROSTAT. (2023). *European business statistics user's manual for PRODCOM*. Retrieved from https://ec.europa.eu/eurostat/documents/3859598/16130157/KS-GQ-22-014-EN-N.pdf/3751d778-9c44-2f51-0b20-49a1fd053f04?t=1676566349800&version=2.0&utm_source
- EUROSTAT. (2024). *PRODCOM List 2024*. European Commission.
- EUROSTAT. (2025). *Economy at Regional Level*. Retrieved from EUROSTAT: https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Economy_at_regional_level
- EUROSTAT. (2025). *EUROSTAT*. Retrieved from <https://ec.europa.eu/eurostat/web/prodcom/database>
- EUROSTAT. (2026). *EU Vocabularies / ShowVoc*. Retrieved from <https://showvoc.op.europa.eu/#/datasets>
- Fashion Sustainability. (2025). *sustainability directory*. Retrieved from https://fashion.sustainability-directory.com/term/post-consumer-textile-waste/?utm_source
- Fiona Charnley, R. C. (2024). Retaining product value in post-consumer textiles: How to scale a closed-loop system. *Resources, Conservation and Recycling*.
- Gardiner, R. H. (2020). Municipal waste generation, R&D intensity, and economic growth nexus – A case of EU regions. *Waste Management*. doi:10.1016/j.wasman.2020.06.038
- Ghinea, C. D. (2016). Forecasting municipal solid waste generation using prognostic tools and regression analysis. *Journal of Environmental Management*. doi:10.1016/j.jenvman.2016.07.026
- Global Standard. (2025). *post cosumer textile waste*. Retrieved from https://global-standard.org/glossary/post-consumer-waste?utm_source
- Gouda, A. M. (2025). Sustainable Strategies for Converting Organic, Electronic, and Plastic Waste From Municipal Solid Waste Into Functional Materials. *Global Challenges*. doi:10.1002/gch2.202400240
- Haberl, H. W. (2017). The material stock-flow-service nexus: A new approach for tackling the decoupling conundrum. *Sustainability*. doi:10.3390/su9071049
- Hoy, Z. X. (2024). Municipal solid waste management for low-carbon transition: A systematic review of artificial neural network applications for trend prediction. *Environmental Pollution*. doi:10.1016/j.envpol.2024.123386
- International Fair Claims Guide. (2015). *International Fair Claims Guide for consumers of textile products*. Drycleaner Institute of Australia.
- J. Malinauskaitė, H. J.-M. (2017). Municipal solid waste management and waste-to-energy in the context of a circular economy and energy recycling in Europe. *Energy*. doi:10.1016/j.energy.2017.11.128
- Jia, F. Y. (2020). The circular economy in the textile and apparel industry: A systematic literature review. *Journal of Cleaner Production*. doi:10.1016/j.jclepro.2020.120728
- JRC. (2025). *Fate and Composition of Textile Waste from Italy, the Czech Republic and Romania*. JRC.
- Juanga-Labayen, J. P. (2022). A Review on Textile Recycling Practices and Challenges. *Textiles*. doi:10.3390/textiles2010010

- Kim, E. H. (2025). Comprehensive Review of Textile Waste Recycling: From Origins to Innovations. *Fibers and Polymers*.
- Klepp, I. G. (2020). Clothing lifespans: What should be measured and how. *Sustainability*. doi:10.3390/su12156219
- Knickmeyer, D. (2020). Social factors influencing household waste separation: A literature review on good practices to improve the recycling performance of urban areas. *Journal of Cleaner Production*. doi:10.1016/j.jclepro.2019.118605
- Köhler, A. W. (2021). *Circular economy perspectives in the EU textile sector : final report*. Publications Office of the European Union.
- Konstantinos-Georgios Namlis, D. K. (2019). Influence of four socioeconomic indices and the impact of economic crisis on solid waste generation in Europe. *Waste Management*.
- Korica, P. C. (2020). Are We Reversing the Trend in Waste Generation: Panel Data Analyses of Municipal Waste Generation in Regard to the Socio-Economic Factors in European Countries. *Economic and Business Review*. doi:10.15458/ebri106
- Laitala, K. . (2015). *Age and active life of clothing*. National institute for consumer research. Retrieved from https://www.researchgate.net/profile/Kirsi-Laitala/publication/281034702_Age_and_active_life_of_clothing/links/55d2224308ae7fb244f4105f/Age-and-active-life-of-clothing.pdf
- Laitala, K. K. (2018). Does use matter? Comparison of environmental impacts of clothing based on fiber type. *Sustainability*. doi:10.3390/su10072524
- Lanz, I. E. (2024). A Mapping of Textile Waste Recycling Technologies in Europe and Spain. *Textiles*. doi:10.3390/textiles4030022
- Leal Filho, W. E. (2019). A review of the socio-economic advantages of textile recycling. *Journal of Cleaner Production*. doi:10.1016/j.jclepro.2019.01.210
- Liu, X. Z. (2025). Enhancing performance prediction of municipal solid waste generation: a strategic management. *Frontiers in Environmental Science*. doi:10.3389/fenvs.2025.1553121
- Loo, S. L. (2023). Tackling critical challenges in textile circularity: A review on strategies for recycling cellulose and polyester from blended fabrics. *Journal of Environmental Chemical Engineering*. doi:10.1016/j.jece.2023.110482
- Mercogliano, N. Z. (2024). Assessing the Effect of Citizens' Behaviour in Textile Waste Separate Collection: An Agent-based Simulation Model. *International Conference on Modeling and Applied Simulation, MAS*. doi:10.46354/i3m.2024.mas.007
- Napolano, L. F. (2025). Understanding textile value chains: Dynamic Probabilistic Material Flow Analysis of textile in the European Union. *Resources, Conservation and Recycling*. doi:10.1016/j.resconrec.2024.107888
- OECD. (2026). *OECD Quarterly Sector Accounts*. OECD. Retrieved from <https://www.oecd.org/content/dam/oecd/en/data/methods/QSA-Methodological-Note.pdf>
- OKON Recycling. (2025). *Pre consumer vs.post consumer*. Retrieved from https://www.okonrecycling.com/consumer-recycling-initiatives/learn-about-recycling/difference-pre-consumer-post-consumer-waste/?utm_source
- Paolo Brandimarte, Guilio Zotteri. (2007). *Introduction to Distribution Logistics: A Quantitative Approach*.

- Polajnar Horvat, K. Š. (2021). Issues surrounding behavior towards discarded textiles and garments in Ljubljana. *Sustainability*. doi:10.3390/su13116491
- Predrag Korica, A. C. (2020). Analyses of Municipal Waste Generation in Regard to the Socio-economic Factors in European Counties. *Economic and Business Review*.
- Priyanka, E. B. (2025). Prediction of waste generation forecast and emission potential on the Erode City solid waste dump yards based on machine learning approach. *Scientific Reports*. doi:10.1038/s41598-025-19288-w
- Quinto, S. L. (2025). Exploring the E-Waste Crisis: Strategies for Sustainable Recycling and Circular Economy Integration. *Recycling*. doi:10.3390/recycling10020072
- Rakesh Kumar, A. V. (2021). Impacts of plastic pollution on ecosystem services, sustainable development goals, and need to focus on circular economy and policy interventions. *Sustainability*. doi:10.3390/su13179963
- Ramírez-Escamilla, H. G.-R.-R.-S.-V. (2024). Advancing Toward Sustainability: A Systematic Review of Circular Economy Strategies in the Textile Industry. *Recycling*. doi:10.3390/recycling9050095
- REGULATION (EU) 2024/1157. (2024). *REGULATION (EU) 2024/1157 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL*. Official Journal of the European Union. Retrieved from <https://eur-lex.europa.eu/eli/reg/2024/1157/oj>
- Richard Gardiner, Petr Hajek. (2020). Municipal waste generation, R&D intensity, and economic growth nexus – A case of EU regions. *Waste Management*.
- Rob J Hyndman, George Athanasopoulos. (2021). *Forecasting: Principles and Practice*. Monash University, Australia.
- Šajin, N. (2022). *Textiles and the environment*. EPRS | European Parliamentary Research Service, European Parliament. Retrieved from [https://www.europarl.europa.eu/RegData/etudes/BRIE/2022/729405/EPRS_BRI\(2022\)729405_EN.pdf](https://www.europarl.europa.eu/RegData/etudes/BRIE/2022/729405/EPRS_BRI(2022)729405_EN.pdf)
- Schumacher, K. F. (2022). Facilitating a Circular Economy for Textiles workshop report. *National Institute of Standards and Technology*. doi:10.6028/NIST.SP.1500-207
- Seifali Abbas-Abadi, M. (2025). Advancing Textile Waste Recycling: Challenges and Opportunities Across Polymer and Non-Polymer Fiber Types. *Polymers*. doi:10.3390/polym17050628
- Seifali Abbas-Abadi, M. B. (2025). Advancing Textile Waste Recycling: Challenges and Opportunities Across Polymer and Non-Polymer Fiber Types. *Polymers*. doi:10.3390/polym17050628
- Shamsuzzaman, M. I. (2025). Fashion and textile waste management in the circular economy: A systematic review. *Cleaner Waste Systems*. doi:10.1016/j.clwas.2025.100268
- Sharmin Jahan Mim, R. C. (2025). Decoding spatiotemporal dynamics of post-consumer textile waste generation and management using ternary plots. *Environmental Technology and Innovation*. doi:10.1016/j.eti.2025.104331
- Smailbegovic, U. K.-C. (2025). Assessing the determinants of municipal solid waste generation in Europe: A machine learning approach. *Waste Management*. doi:10.1016/j.wasman.2025.115033
- Soares, B. R. (2024). Factors to consider for the implementation of a municipal scheme for the separate collection of textile waste. *Sustainable Futures*. doi:10.1016/j.sftr.2024.100203
- Solis, M. H. (2024). Management of textile waste in Europe: An environmental and a socio-economic assessment of current and future scenarios. *Resources, Conservation and Recycling*. doi:10.1016/j.resconrec.2024.107693

- Theresa Mörsen, L. V. (2024). *A Zero Waste Vision for Textiles*.
- T-REX Project. (2025). *Business models and financial viability report for textile-to-textile recycling*. European Union Horizon Europe Programme. Retrieved from <https://trexproject.eu/wp-content/uploads/2025/06/T-REX-Business-Models-Financial-Viability-Report.pdf>
- Trivyza, N. L. (2025). Towards circularity in the wind industry: Optimal reverse supply network design under various policy scenarios. *Waste Management*. doi:10.1016/j.wasman.2024.11.024
- UK Office for National Statistics (ONS). (2026). Retrieved from https://www.ons.gov.uk/businessindustryandtrade/manufacturingandproductionindustry/methodologies/ukmanufacturerssalesbyproductprodcom?utm_source
- United Nations. (2024). *Reversing direction in the used clothing crisis: Global, European, and Chilean perspectives*. United Nations.
- Vergés, R. G. (2026). A novel approach to forecasting product end-of-life circularity from material compositions using a hybrid autoencoder-predictor model. *Resources, Conservation and Recycling*. doi:10.1016/j.resconrec.2025.108573
- Vermeyen, V. A. (2024). Threads untangled: Regional mapping of post-consumer textile management. *Cleaner Waste Systems*. doi:10.1016/j.clwas.2024.100181
- Wagner, M. M. (2020). Human perceptions of recycled textiles and circular fashion: A systematic literature review. *Sustainability*. doi:10.3390/su122410599
- Wang, J. R.-P. (2024). Bayesian material flow analysis for systems with multiple levels of disaggregation and high dimensional data. *Journal of Industrial Ecology*. doi:10.1111/jiec.13550
- Willis, K. A. (2025). Focusing plastic solutions up the waste hierarchy: Pathways for a more circular economy. *iScience*. doi:10.1016/j.isci.2025.113217
- World Customs Organization. (2022). *What is the Harmonized System (HS)?* World Customs Organization. Retrieved from <https://www.wcoomd.org/en/topics/nomenclature/overview/what-is-the-harmonized-system.aspx>
- X. Cuong Nguyen a, b. T. (2021). Development of machine learning - based models to forecast solid waste generation in residential areas: A case study from Vietnam. *Resources, Conservation & Recycling* .
- Yasmeen, R. S.-F. (2023). The impact of public awareness, infrastructure, and technological development with economic growth on solid waste management of European countries: does governance quality matters. *Environmental Science and Pollution Research*. doi:10.1007/s11356-023-30356-4
- Zheng Xuan Hoy, Z. X. (2024). Municipal solid waste management for low-carbon transition: A systematic review of artificial neural network applications for trend prediction. *Environmental Pollution* .