# Sustainable Procurement in the Rosental Model Region

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**Kurzfassung**

Der vorliegende Bericht enthält die Beschreibung, Methodik und Ergebnisse des Projekts "Nachhaltige Beschaffung in der Klima-Modellregion Carnica Rosental" in Kärnten. In dieser Forschungskooperation haben Repräsentant:innen der Klima- und Energiemodellregion Carnica Rosental gemeinsam mit Nachhaltigkeits-Forscher:innen und Studierenden der Informationstechnologie der Universität Klagenfurt innovative Ansatzpunkte identifiziert, mittels welcher Beschaffungsstrategien die mit der kommunalen Beschaffung verbundenen CO2-Emissionen reduziert werden könnten. Das Projekt basierte auf Prinzipien transdisziplinärer Forschung, wonach Expert:innen aus Praxis und Wissenschaft gemeinsam die Forschungsfrage erarbeiten, neues Wissen kreieren und für den jeweiligen Kontext geeignete Strategien bzw. Lösungen entwickeln. Die Vorgehensweise wurde in einem Kick-off-Meeting gemeinsam aufgesetzt und auch geklärt. Der Schwerpunkt lag auf der Modellierung potenziell nachhaltigerer Beschaffungsstrategien auf Basis bestehender Beschaffungsformen. Von zwei höchst unterschiedlichen Pilot-Gemeinden wurden die Beschaffungsdaten der vergangenen 5 Jahre erhoben und analysiert. Ziel war es, die Daten sowohl hinsichtlich ihrer CO2-Relevanz als auch ihrer ökonomischen Relevanz zu sortieren, wobei der Fokus auf -Gebrauchsgütern und weniger auf Verbrauchsgütern lag. Mithilfe von ABC- und XYZ-Analysemodellen sollen die zur Verfügung gestellten Daten ausgewertet und die Gebrauchsgüter kategorisiert werden. Gleich am Beginn des Projektes stellte sich heraus, dass die Art der Datenführung der beiden Pilot-Gemeinden in sich nicht streng homogen ist und es große Unterschiede zwischen den beiden Pilotgemeinden gab. Die weit mehr als 10.000 Datensätze (je Pilotgemeinde) überstiegen die Möglichkeiten händischer Auswertung, waren aber für eine maschinelle Auswertung viel zu uneinheitlich.

Daher nahm die Vorverarbeitung der Rohdaten viel Zeit und vor allem auch informationstechnisches Know how in Anspruch um ausgehend von den zur Verfügung gestellten Datentabellen konsistente und verarbeitbare Informationen herzustellen. Die Einteilung der Produkte in Warenkategorien ermöglichte eine umfassendere Analyse, und die CO2-Äquivalenzbewertung pro Warengruppe eine Quantifizierung ihrer CO2-Relevanz. Das Projekt nutzte danach die ABC-Analyse, um die am CO2-relevantesten Waren zu identifizieren, und die XYZ-Analyse, um Strategien für eine rasche Anpassung der Beschaffungsroutinen zu entwickeln. Dieser Ansatz zeigt auch auf, wie die Kommunen ihre Daten auch in Hinblick auf Veränderungspotenziale besser erfassen und auswerten könnten. Obwohl das Projekt auf Herausforderungen wie uneinheitliche Produktnomenklatur, fehlende Mengenangaben und Komplexität bei der Bestimmung des CO2-Werts stieß, bietet es Grundlagen für verbesserte nachhaltige Beschaffungspraktiken.

Der Einsatz bestehender informationstechnischer Tools und die Implementierung neuer projektspezifischer Tools in der programmiersprache Python spielten eine wesentliche Rolle bei der Handhabung und Verarbeitung großer Datenmengen und ermöglichten so eine effizientere Analyse. Damit unterstreicht dieses Projekt die Bedeutung standardisierter Daten, verbesserten Datenerfassungsprozessen und praktischen Instrumenten – auch für die Verbesserung kommunaler Beschaffungspraxis. Künftige informationstechnologische Forschungsarbeiten könnten auch die Suche nach alternativen Produkten und das Entwicklungspotenzial von Produktgruppen im Hinblick auf ein umweltbewusstes und effizienteres Ressourcenmanagement untersuchen. Die Analyse der Ausgaben von 2018-2022 zeigte eine Long-Tail-Verteilung der kommunalen Ausgaben, wobei ein erheblicher Prozentsatz der Ausgaben in beiden Pilot-Gemeinden innerhalb von zwei Größenordnungen liegt. Das Projekt ermittelte den CO2-Äquivalenzwert für einen beträchtlichen Teil der Ausgaben in beiden Gemeinden und trug so dazu bei, die Hauptquellen der CO2-Emissionen und Strategien zur Verringerung der CO2-Emissionen zu identifizieren. Dieses Projekt unterstreicht die Bedeutung von standardisierten Daten, verbesserten Datenerfassungsprozessen und praktischen Instrumenten für eine klimabewusste Beschaffungspraxis. Künftige informationstechnologische Forschungsarbeiten könnten auch die Suche nach alternativen Produkten und das Entwicklungspotenzial von Produktgruppen im Hinblick auf ein umweltbewusstes und effizienteres Ressourcenmanagement untersuchen.

**Exceutive Summary**

This report contains the description, methodology and results of the project "Sustainable Procurement in the Climate Model Region Carnica Rosental" in Carinthia. In this research cooperation, representatives of the Carnica Rosental climate and energy model region worked together with sustainability researchers and information technology students from the University of Klagenfurt to identify innovative approaches for reducing the CO2 emissions associated with municipal procurement. The project was based on the principles of transdisciplinary research, according to which experts from practice and science jointly develop the research question, create new knowledge and develop suitable strategies or solutions for the respective context. The approach was jointly set up and also clarified in a kick-off meeting. The focus was on modeling potentially more sustainable procurement strategies based on existing procurement forms. The procurement data of the past 5 years were collected and analyzed from two very different pilot municipalities. The aim was to sort the data in terms of both CO2 relevance and economic relevance, with a focus on -consumer goods and less on consumer goods. With the help of ABC and XYZ analysis models, the data provided were to be evaluated and the consumer goods categorized. Right at the beginning of the project, it became apparent that the way in which the two pilot communities kept their data was not strictly homogeneous in itself and that there were major differences between the two pilot communities. The far more than 10,000 data records (per pilot community) exceeded the possibilities of manual evaluation, but were far too inconsistent for machine evaluation.

Therefore, the pre-processing of the raw data required a lot of time and, above all, information technology know-how in order to produce consistent and processable information based on the data tables provided. The classification of the products into commodity categories enabled a more comprehensive analysis, and the CO2 equivalence rating per commodity group enabled a quantification of their CO2 relevance. The project then used ABC analysis to identify the most CO2-relevant goods and XYZ analysis to develop strategies for rapidly adapting procurement routines. This approach also highlights how municipalities could better collect and analyze their data, including in terms of potential for change. Although the project encountered challenges such as inconsistent product nomenclature, lack of quantity data, and complexity in determining CO2 value, it provides foundations for improved sustainable procurement methods.

The use of existing information technology tools and the implementation of new project-specific tools in the Python programming language played an essential role in handling and processing large amounts of data, thus enabling more efficient analysis. Thus, this project underscores the importance of standardized data, improved data collection processes, and practical tools-including for improving municipal employment practices.

Future information technology research could also investigate the search for alternative products and the development potential of product groups in terms of environmentally conscious and more efficient resource management.

Analysis of 2018-2022 expenditures showed a long-tail distribution of municipal expenditures, with a significant percentage of expenditures in both pilot municipalities falling within two orders of magnitude. The project determined the CO2 equivalent value for a significant portion of expenditures in both communities, helping to identify the main sources of CO2 emissions and strategies to reduce CO2 emissions. This project highlights the importance of standardized data, improved data collection processes, and practical tools for climate-conscious procurement planning. Future information technology research could also explore the search for alternative products and the development potential of product groups in terms of environmentally conscious and more efficient resource management.

# Contents

# 1 Introduction and Motivation

In the climate and energy model region Carnica Rosental, there is great potential for innovations that serve climate protection. One possibility is the modeling of sustainable procurement strategies and their potential for regional value creation and a climate-specific impact assessment. For this purpose, the cooperation partners Climate and Energy Model Region Carnica and the NES and IUS two institutes of the University of Klagenfurt have collected concrete data from the procurement systems of two municipalities within the framework of a joint research project and analyzed the products that municipalities procure categorized into durable and non-durable goods regarding the related CO2- emmissions.

The involvement of the practice partners in the research enables a transdisciplinary research approach that allows scientists and experts from different disciplines to work together on concrete solutions for the challenges of climate protection. The close cooperation between the Carnica Rosental Climate and Energy Model Region, the municipalities, and the University of Klagenfurt creates a valuable platform where theory and practice merge The two pilot municipalities differ widely: Ferlachis a small city with primary high school as well as industries and is surrounded by rural structured areas. Ferlachis a village spread on small hills, dominated by two factors: agricultural structures on the one hand and a lot of people commuting to the city nearby to work, education, shopping, medical care and so on.

The data collected from municipal procurement could provide a solid basis for the development of sustainable procurement strategies. By analyzing the carbon footprint of non-durable and durable goods, it becomes clear how procurement decisions affect the environment and climate. This enables those responsible to take targeted measures to reduce the region's ecological footprint.

The results of this joint project not only contribute to advancing climate protection in the Carnica Rosental climate and energy model region and serve as a model for other regions pursuing similar goals. The transdisciplinary approach and close collaboration between science and practice are key to success in addressing the pressing challenges of climate change. This project demonstrates how information technological approaches can help shape a sustainable and climate-friendly future.

In particular, the following steps were taken in the project to achieve the goal of developing sustainable sourcing strategies. First, the preprocessing of the data tables is carried out in order to eliminate any problems in the data set provided and to ensure that the data quality is guaranteed. Here, the data provided, by two pilot municipalities, was complete but not consistently documented. In this case, the opportunity for feedback questions was used in case of ambiguities. Subsequently, the goods are sub-grouped into more specific categories of goods, which allows for a better overview and analysis. The CO2 equivalence per commodity group is assessed to quantify the environmental impact of each group. ABC analysis is used to identify the durable and non-durable goods that have the most significant CO2 equivalent value and, therefore, have the most considerable environmental impact. In addition, an XYZ analysis is performed to identify frequently procured goods as candidates for fast changes in a procurement strategy. This detailing approach makes it possible to propose measures to facilitate future captures and evaluations and, on the other hand, to minimize the region's carbon footprint.

# 2 Methodology

The performed CO2 equivalence analysis performed on the two provided data sets was divided up into specific steps:

**Preprocessing data** tables to fix issues in the given data set

**Grouping up goods** into generalized goods groups

**Evaluating CO2 equivalence** per goods group

**Applying ABC analysis** to find goods with most CO2 equivalence

**Applying XYZ analysis** to find candidates for speedy changes

### Preprocessing data tables to fix issues in the given data set

The municipalities, Ferlachand Köttmannsdorf, shared Excel spreadsheets comprising their low-value assets. Initially, we augmented these spreadsheets by adding a new column to categorize the contents into three distinct categories: 1. durables (multiple use possible), 2. consumables (single use) and 3. fuels( a consumable) as a separate category. We recognized that the $CO_2$ emissions associated with fuels would likely be substantial, warranting separate analysis to ensure meaningful results.

Following the previous data preprocessing, it was found that the Excel spreadsheet often presented the challenge of multiple assets being combined into a single cell entry. This occurred when multiple items were acquired simultaneously and entered as a single row into the spreadsheet, resulting in a consolidated entry listing only one amount of expenses for several goods. To conduct a precise analysis, it was necessary to split these entries into multiple data rows. In order to achieve the best possible separation of entries, a thorough manual examination and analysis about each type of goods was conducted. Various methods were applied to separate the assets and divide up the expenditure values as precise as possible, but due to the complexity of certain entries, complete separation was not always feasible. Entries for which a meaningful splitting approach could not be identified were discarded for analysis purposes. This step was taken to ensure the accuracy of subsequent evaluations and to avoid distortions caused by incomplete or misleading data.

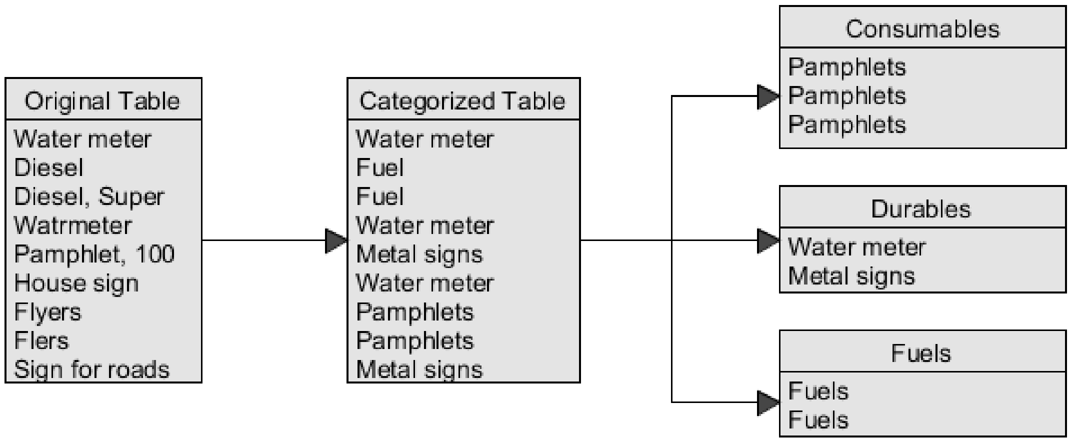


Figure 2: Categorization of data table, only goods labels are shown

### Grouping up goods into generalized goods groups

For the analysis of the Excel tables from communities A and B, a custom program was developed using the Python programming language. This tailored program received the two Excel tables received from the two pilot municipalities Ferlachand Köttmannsdorfas input and facilitated the systematic processing of the data. A key challenge involved the inconsistent representation of goods in the tables, such as using synonyms and colloquial terms for the same type of goods or spelling errors. To establish a consistent basis for further investigations, the program used a text-based grouping algorithm to sort the entries into specific categories of goods.

During this step we also discarded any entry which had item descriptions which were too vague for any CO2 equivalence analysis, such as *presents* or *miscellaneous items for daily use.*

### Evaluating CO2 equivalence per goods group

To calculate the CO2 equivalent emissions for each category of goods, extensive research was conducted. Information from relevant literature was utilized to ensure precise and reliable data. In addition, the expertise and experience of Dr. Michael Has (Université Grenoble Alpes), an expert in the field, were consulted to further enhance the quality of the results. Furthermore, the tool CCaLC2 was employed alongside the research and expert consultation to calculate the CO2 equivalent emissions associated with the production and delivery of the goods categories. CCaLC2 is a recognized and reliable tool commonly used in environmental research for estimating CO2 emissions and developed by the University of Manchester.

To calculate the CO2 consumption of the entire low-value assets, it was crucial to determine the weight of individual items, as most CO2 equivalences in literature are given as *kg CO2 / kg ware material*. To achieve this, we engaged in further consultations with communities Ferlachand Köttmannsdorfto obtain precise information regarding the weight of each low-value asset. Moreover, comprehensive research was conducted to determine the weights of items for which precise information was not provided by the communities.

In many cases however neither weight nor amount of goods were given, but only the expenditures. For these cases we decided to calculate estimated CO2 equivalence values by meticulously searching through various reputable and reliable supply firms and online shops in Austria for same or equivalent goods and looking up the weight of these goods. Once the weight is known, a CO2 equivalence per €can be calculated with

$X€ = item$

Substitute item for its weight in materials

$X€ = kg\ weight$

Divide by X to get weight of materials per €

$\frac{1€}{X} = \frac{kg\ Weight}{X}$

Which gives the amount of material weight per €

$1€ = kg\ weight\ per\ €$

Substitute weight with Co2 equivalence to get CO2 equivalence per €

$1€ = kg\ CO2\ equivalence$

This rough estimation of CO2 equivalence was used for data row entries where only the expenses were given.

Once the weights of individual items were established, the calculation of CO2 equivalent emissions for each item was carried out. This involved associating the previously researched CO2 emission equivalents for the production and delivery of specific categories of goods with the weight of each item. The resulting calculations were then entered into an additional column in the Excel spreadsheets, providing a comprehensive overview of the CO2 consumption of all low-value assets. It is essential to emphasize that these data and calculations are based on carefully collected information and have undergone thorough scrutiny. Regular verification and cross-referencing with the underlying data sources were conducted to ensure the accuracy of the results.

### Applying ABC analysis

After having evaluated CO2 equivalence values for all goods we could find equivalence values for, our Python program performed two times an ABC analysis on the data set, once to find those goods with the most CO2 equivalence and another time and another time to find the goods with the highest total expenditures over the given time frame.

According to the methods applied in materials management the ABC analysis (Pareto principle), 20% of the goods should cause 80% of total CO2 equivalent emissions, meaning in the case of an ABC analysis on CO2 equivalence there are three categories, where 20% of all goods cause 80% of the total CO2 emissions, being the highest pollutants (Category A). Of the other goods, again 20% would be 80% of the CO2 equivalent emissions (Category B) and having a medium amount of total CO2 equivalence, with the rest having low emissions or bring emission-free (Category C).

To find a good ratio to split the data set into ABC categories with, we can apply the following: All categories add up to a total of 100% and, since A being 20%, B and C are adding up to the rest 80%

$$A + B + C = 1 \tag{1}$$

$$A = 0.2 \tag{2}$$

$$B + C = 0.8 \tag{3}$$

The ratio of category A to B should be the same as B to C (20%/80%).

$$\frac{A}{B} = \frac{B}{C} \tag{4}$$

with A being 20% follows

$$\frac{0.2}{B} = \frac{B}{C} \tag{5}$$

which can be transformed into

$$C = \frac{B^2}{0.2} \tag{6}$$

combined with adding equation 3 resulting in

$$C - (B + C) = \frac{B^2}{0.2} - (B + C) \tag{7}$$

$$-B = \frac{B^2}{0.2} - 0.8 \tag{8}$$

$$B + \frac{B^2}{0.2} - 0.8 = 0 \tag{9}$$

$$B^2 + \frac{B}{5} - \frac{0.8}{5} = 0 \tag{10}$$

Solving for B

$$B_{1,2} = -0.1 \pm \sqrt{0.1^2 + 0.16} = \{-0.5; 0.3\} \tag{11}$$

with -0.5 being an invalid ratio, therefore B = 0.3 and, due to equation 3, C = 0.2.

With these values all measured goods are categorized into three categories, with A meaning *very important*, B representing *somewhat relevant* and C indicating *mostly irrelevant*, with these assignments done for both CO2 equivalence and expenditures.

Combining both analyses allows us to easily assess which goods are most relevant for closer inspection regarding reducing cost and / or CO2 equivalence.

### Applying XYZ analysis

With an XYZ, a tool often used in material management in companies, analysis the predictability of aquisitions of goods can be estimated, meaning goods can be categorized depending on how much a good is aquired on a regular basis with relatively the same amount each time (Category X, very predictable) to being aquired in a very irregular interval or amount (Category Z).

Using XYZ analysis allowed us to identify goods for which changes in aquisition, and thus CO2 equivalence reduction, can be made in a very timely since the next aquisition can be expected to happen very soon (Category X).

However, unlike with ABC analysis category C meaning *mostly irrelevant*, category Z does not imply irrelevancy but just irregularity, meaning a goods group of category Z which may be aquired only once a year but with a high one-time volume may still be worth looking into and planning for, for when the next high-volume aquisition comes around.
The XYZ categories for expenditures were calculated as follows:

Calculating the total expenditures by summing up all expenditure of that good over all months in the time frame

$$SumCost(good) = \sum_{month=1}^{\#months} good(month)_{Cost} \tag{12}$$

The average expenditure per month for a good is the total expenditure for that good divided total number of months in the time frame

$$AvgCost(good) = \frac{SumCost(good)}{\#Months} \tag{13}$$

The covariance for a good is the standard deviation of the expenditure for that good divided by the average monthly cost of that good

$$Cov(good) = \frac{StdCost(good)}{AvgCost(good)} \tag{14}$$

A XYZ category was assigned by comparing the good's covariance with the highest covariance of any good

$$XYZCategory(good) = \begin{cases} X, Cov(good) \leq Max(any\,Cov(good)) * 0.5 \\ Y, Cov(good) \leq Max(any\,Cov(good)) * 0.8 \\ Z, otherwise \end{cases} \tag{15}$$

meaning those goods with a relatively low covariance, and therefore relatively higher regularity per month, were assigned to category X, while those with relatively high covariance, implying higher irregularity, received category Z.

The XYZ categorization for CO2 equivalence per good group was done analogous, but using CO2 equivalence amount values instead of expenditures.

# 3 Challenges within the Project

Throughout the project, we encountered a multitude of challenges that significantly delayed the timeline. These challenges can be categorized into two primary areas, with a central issue revolving around the nature of the Excel spreadsheets received:

- **Inconsistent Product Nomenclature:**Significant challenges lay in the inconsistent product nomenclature within the tables. Varied spellings and designations for identical products presented considerable difficulties in the uniform allocation and classification of assets.

- **Missing Quantity Information:** Another issue was the absence of quantity information. Without precise details on the quantity of acquired assets, it was challenging to calculate $CO_2$ emissions and costs accurately.

- **Multiple Products in a Single Row:** The practice of combining multiple products in a single row complicated the allocation and categorization into the respective categories.

- **Tax Categorization:** Another challenge in carving out the CO2-relevance of goods by using the CO2-intensity per procured Euro, revolved around determining the tax categorization of the assets. This challenge primarily stemmed from variations in the use of abbreviations and the lack of detailed descriptions, making it difficult to ascertain the precise tax classifications for the goods.

In addition to these challenges within the provided Excel spreadsheets, further issues arose during the project:

- **$CO_2$ Value Determination:** Obtaining precise $CO_2$ values for certain assets proved time-consuming and posed a challenge.

- **Rough Estimates for Some Products:** In some instances, rough estimates were necessary to determine $CO_2$ values and costs, impacting the accuracy of the analyses.

- **Price Fluctuations:** Price fluctuations for assets throughout the study period complicated the assessment of financial impacts and the calculation of consistent $CO_2$ equivalent emissions.

### Addressing Challenges and Issues

All these challenges significantly complicated the evaluation and analysis of the data. To overcome these challenges, we pursued various approaches:

- **Manual Examination and Data Segmentation:** In order to tackle the initial challenge, we embarked on a meticulous manual examination of the Excel tables received from both Ferlachand Köttmannsdorf. The primary objective of this examination was to categorize each item into one of three key categories: Consumables, Durables, or Fuel. Than we reviewed the excel tables again to resolve any ambiguities in product nomenclature, and segmenting the data into further meaningful categories. This process was greatly facilitated by the development of a custom Python script specifically designed to analyse and categorize the table entries. The Python script systematically processed each entry within the tables, leveraging predefined criteria to assign items to appropriate categories. This automation not only expedited the categorization process but also minimized the potential for human error, ensuring a more accurate and consistent classification of products. This process is explained in more detail in Section 3.

- **Establishing Contact with the Communities:** In our pursuit of precise data, we initiated contact with both Communities, Ferlachand Köttmannsdorf, to acquire detailed tax categorization information.
  Furthermore, to address the issue of missing quantity information, a specific approach was adopted for Ferlach. Recognizing the importance of obtaining accurate quantity data, we undertook an on-site visit to Ferlach. During this visit, we conducted systematic, random sampling to ascertain the quantities of low-value assets, supplementing the existing data with empirical measurements. This on-site verification process not only enriched our dataset but also enhanced the overall reliability of our analyses.
  The combination of these efforts allowed us to establish a comprehensive and accurate foundation for our analysis, enabling a more robust evaluation of the $CO_2$ emissions associated with the financial activities of both Communities.

- **Inclusion of Expert Michael Has:** We integrated Michael Has, an expert in the field of $CO_2$ value determination, into our team. His expertise greatly contributed to the accuracy of $CO_2$ emissions determination and the refinement of estimations.

# 4 Results

## Ferlach

## Entire timespan (2018 to 2022)

In figure 3 gives an overview of all expenses sorted by the amount from the year 2018 to 2022.

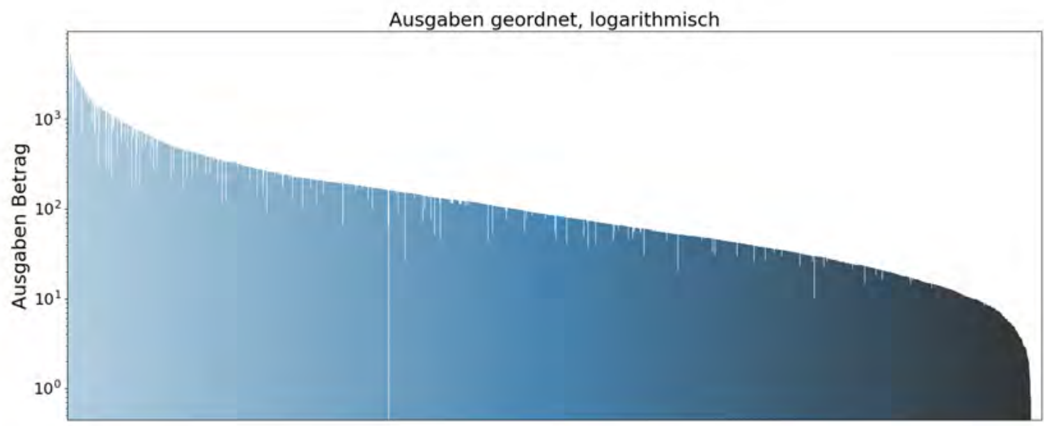


Figure 3: Overview of all expenses, sorted by amount, 2018 to 2022

The Tables 1 and 2 provide a summary of durable and non-durable goods from the periode 2018.

| Gut | Ausgaben (Euro) | ABC Cost | XYZ Cost | Menge (kg) | Kg CO2 Equiv | ABC CO2 | XYZ CO2 |
|---|---|---|---|---|---|---|---|
| Flockungsmittel | 100549.82 | A | Z | 109803.612 | 208407.255576 | A | Z |
| HeizOel | 24177.66 | A | Z | 18810.21948 | 65835.76818 | A | Z |
| Schrauben | 11026.79 | B | Z | 18143.88453 | 23587.049889 | A | Z |
| Müllsäcke | 17656.74 | B | X | 3839.34268 | 7678.68536 | A | X |
| Splitt | 18125.64 | A | X | 848777.417 | 7638.996753 | A | X |
| Styroporsäcke | 1326 | C | X | 88.00662 | 5562.018384 | A | X |
| MotorOel | 7740.43 | B | Y | 815.8896 | 2855.6136 | A | Y |
| Desinfektionsmittel | 1909.95 | C | Y | 194.8149 | 1948.149 | A | Y |
| Broschüren und Flyer | 9481.82 | B | Z | 2278.00847 | 1480.7055055 | B | Z |
| Aluminiumchlorid | 18265.16 | A | X | 182.651 | 1461.208 | B | Y |
| Reaktivperlen | 20088.08 | A | Z | 1916.402832 | 1264.82586912 | B | Z |
| Toilettenpapier | 10198.91 | B | X | 1819.80648 | 1182.874212 | B | X |
| Waschmittel | 1460.64 | C | X | 460.9452705 | 783.60695985 | B | Y |
| Klebstoff | 774.74 | C | Z | 182.391695 | 729.56678 | B | Z |
| Beton | 7606.8 | B | Y | 400.345884 | 720.6225912 | B | Y |
| Toner | 11858.55 | B | Y | 77.22718 | 617.81744 | B | Y |
| Hydroxidchlorid | 6160 | B | Z | 720.72 | 387.02664 | B | Z |
| Laminierhüllen | 1093.97 | C | Y | 152.05578 | 304.11156 | B | Z |
| Küvettentests | 37974.25 | A | Y | 111.644295 | 189.7953015 | B | Y |
| Pflanzen und Blumenerde | 53913.21 | A | Y | 18361.2645888 | 165.2513812992 | C | Y |
| Geschirrspüler | 1038.27 | C | Y | 343.56279 | 154.6032555 | C | Y |
| Auftausalz | 62680.87 | A | Y | 1537.05307 | 153.705307 | C | Z |
| Bleichmittel | 3384.29 | C | Z | 65.655226 | 137.8759746 | C | Z |
| Waschpulver | 157.18 | C | Y | 72.767 | 123.7039 | C | Y |
| Etiketten | 5116.5 | C | X | 55.11625 | 121.25575 | C | X |
| Kreide | 1063.24 | C | Y | 372.134 | 111.6402 | C | Y |
| Absperrband | 838.7 | C | X | 54.697327484785 | 106.605091267846 | C | X |
| Papier und Pappe | 16560.01 | B | Y | 94.375613 | 61.34414845 | C | Y |
| Kuverts | 5678.72 | C | X | 47.133376 | 30.6366944 | C | X |
| Luftballons | 390.22 | C | Y | 7.8044 | 22.63276 | C | Y |
| Druckerpatronen | 1025.57 | C | X | 2.54220084 | 11.43990378 | C | X |
| Kerzen | 265.04 | C | X | 2.0911656 | 6.2734968 | C | X |
| Pellets | 13168.58 | B | X | 48167.989998 | 5.69779153686342 | C | X |
| Eisen-II-chlorid | 15649.2 | B | X | 21338.94 | 3.8410092 | C | X |
| Batterien | 2423.27 | C | X | 121.1635 | 0.645074474 | C | X |
| Mikrofasertücher | 776.08 | C | Y | 21.652632 | 0.151568424 | C | Y |
| AdBlue | 653.88 | C | Z | 0.0666 | 0.068598 | C | Z |

Table 1: Ferlach, Gebrauchsgüter, 2018 bis 2022

| Gut | Ausgaben (Euro) | ABC Cost | XYZ Cost | Menge (kg) | Kg CO2 Equiv | ABC CO2 | XYZ CO2 |
|---|---|---|---|---|---|---|---|
| Wasserzähler | 104400.13 | A | X | 7717.01236800264 | 265928.246201371 | A | X |
| Reifen | 1665.43 | C | Y | 34.62407 | 20556.310359 | A | X |
| LED Belichtung | 16458.09 | B | Z | 129.8543301 | 4415.0472234 | A | Z |
| Gußeisen (Schachtabdeckung) | 18264.47 | A | X | 3901.38793 | 3901.38793 | A | X |
| Lampen | 2506.56 | C | Y | 102.0909568 | 3518.054371328 | A | Y |
| Bücher | 8272.97 | B | X | 2456.22078595 | 2456.22078595 | B | X |
| Einbaugarnitur | 33581.91 | A | X | 777.101902 | 1554.203804 | B | X |
| PVC-Artikel | 1252.59 | C | X | 305.0999805 | 1351.592913615 | B | X |
| Stiefel | 24528.95 | A | X | 278.124249063571 | 806.560322284357 | B | X |
| Ordner und Hefter | 6910.76 | B | Y | 947.2763678 | 615.72963907 | B | Y |
| Schotter | 7194.06 | B | Y | 55336.70952 | 498.03038568 | B | X |
| Hausanschlussschieber | 14940.04 | B | Y | 373.501 | 485.5513 | B | Y |
| Bewegungsmelder | 1784.71 | C | X | 8.7316434 | 300.892431564 | B | X |
| Schilder | 37628.31 | A | Y | 209.5425162 | 272.40527106 | C | Y |
| Klarsichthüllen | 1069.23 | C | X | 77.561759 | 155.123518 | C | X |
| Schläuche | 588.59 | C | X | 57.341348 | 114.682696 | C | X |
| Sperrschelle | 4988.6 | C | X | 82.57125 | 107.342625 | C | X |
| Bohrer | 375.57 | C | X | 78.90975 | 102.582675 | C | X |
| Verkehrsspiegel | 10846.5 | B | Z | 57.48645 | 74.732385 | C | Z |
| Mähfaden | 385.58 | C | X | 10.757682 | 34.4245824 | C | X |
| Schlüssel | 1076.65 | C | Y | 1.07665 | 1.399645 | C | Y |
| Jacken | 14891.23 | B | X | 71.6591177818676 | 0.501613824473073 | C | X |
| Besen | 650.81 | C | X | 3.33048363306424 | 0.393962908955169 | C | X |
| Akkus | 8639.64 | B | Y | 62.99515 | 0.36707273905 | C | Y |
| Arbeitshose | 2593.05 | C | X | 13.5536676209234 | 0.094875673346464 | C | X |

Table 2: Ferlach, Verbrauchsgüter, 2018 bis 2022

In the following six graphs (Figures 4-9), the $CO_2$ equivalent emissions of the durable goods for the period 2018-2022 are depicted. The individual groups of the ABC analysis of $CO_2$ equivalent emissions are presented separately to enhance clarity. Additionally, for each group in the ABC analysis, there is a second graph that represents the results on a logarithmic scale to facilitate the identification of products with lower $CO_2$ equivalent emissions.

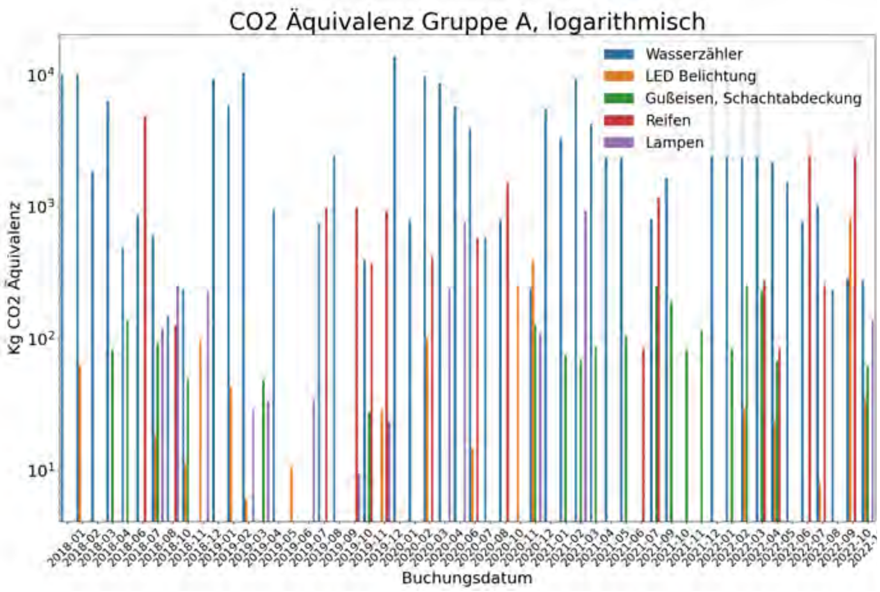


Figure 4: $CO_2$ Äquivalenz Gebrauchsgüter Gruppe A logarithmisch (2018-2022

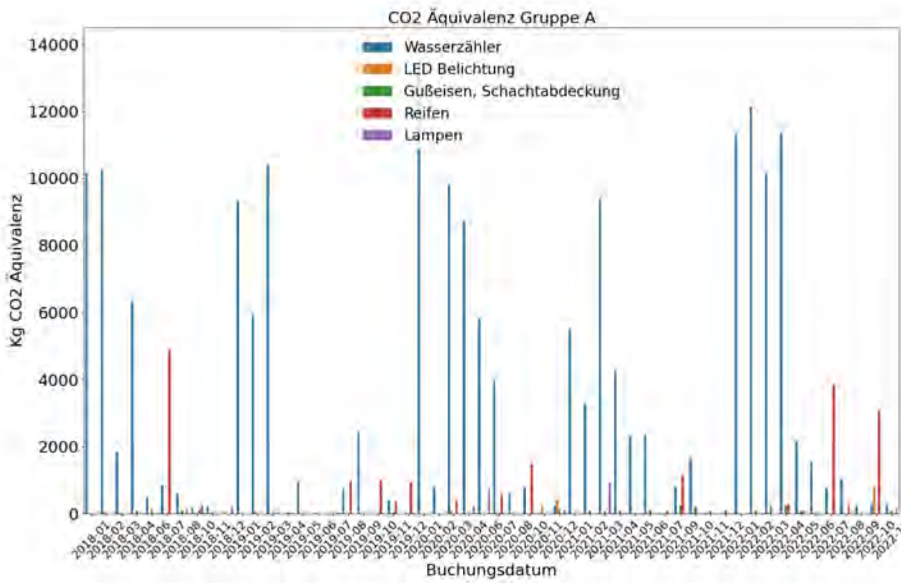


Figure 5: $CO_2$ Äquivalenz Gebrauchsgüter Gruppe A (2018-2022

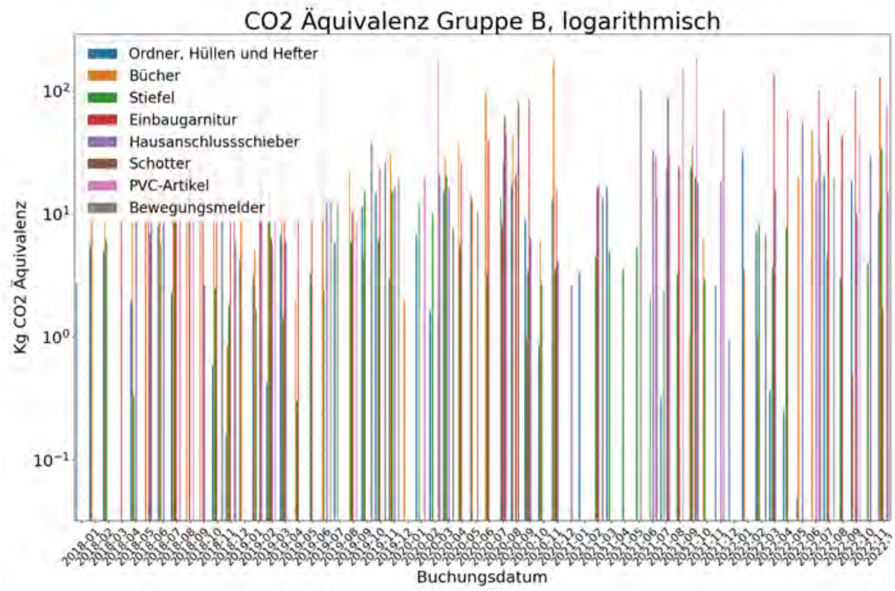


Figure 6: $CO_2$ Äquivalenz Gebrauchsgüter Gruppe B logarithmisch (2018-2022

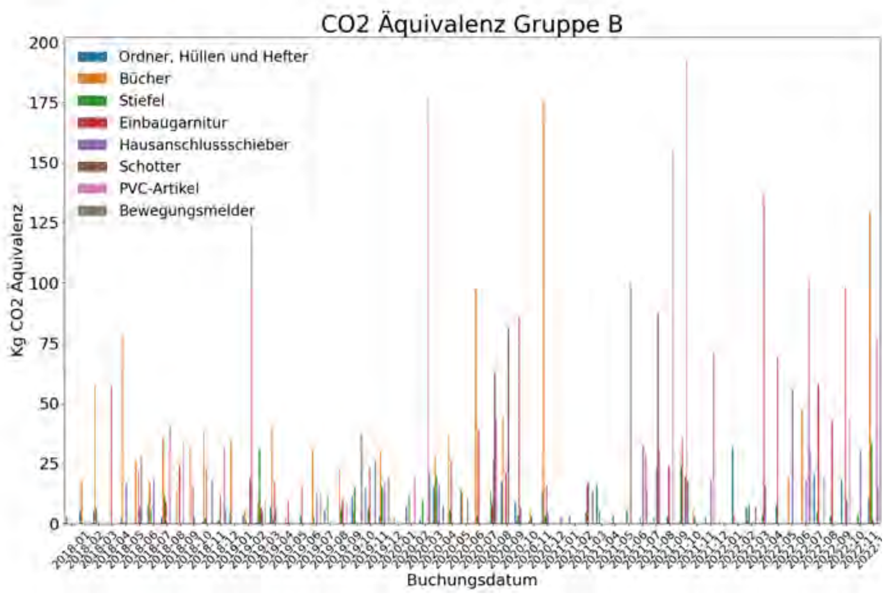


Figure 7: $CO_2$ Äquivalenz Gebrauchsgüter Gruppe B (2018-2022

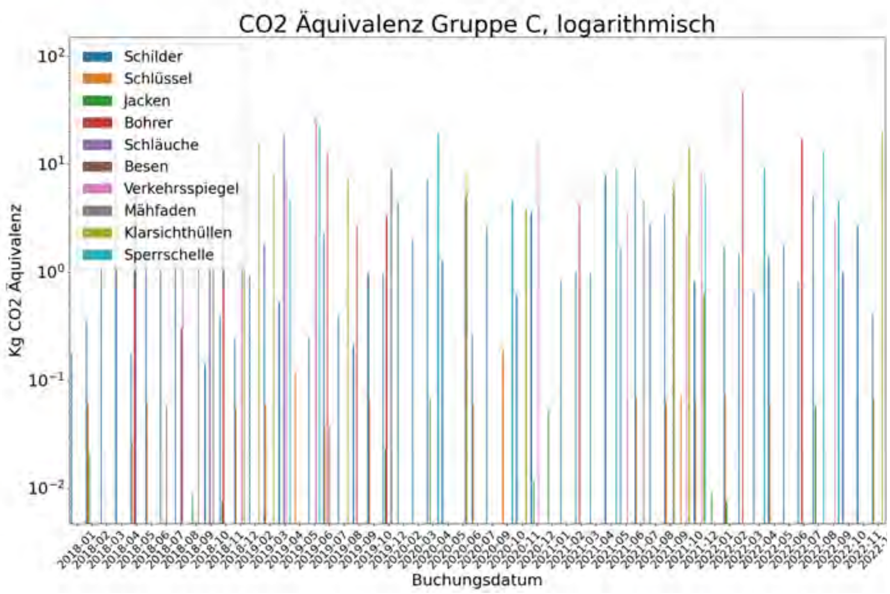


Figure 8: $CO_2$ Äquivalenz Gebrauchsgüter Gruppe C logarithmisch (2018-2022

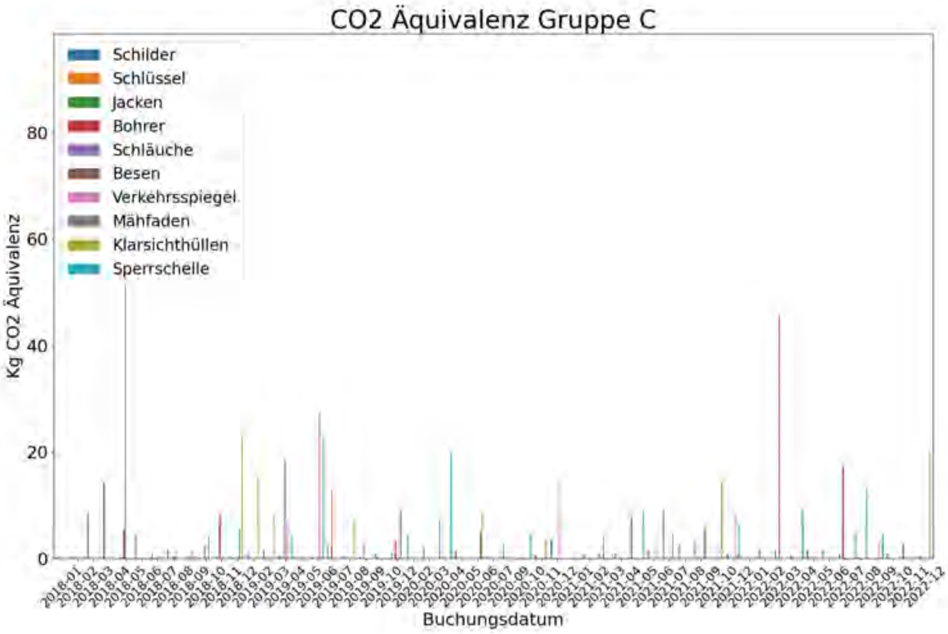


Figure 9: $CO_2$ Äquivalenz Gebrauchsgüter Gruppe C (2018-2022

In the subsequent graphs, labeled 10-15, we present the $CO_2$ equivalent emissions of non-durable goods over the period from 2018 to 2022. These graphs provide a segmented representation of the distinct categories within the ABC analysis of $CO_2$ equivalent emissions, aiming to enhance clarity and comprehensibility. Additionally, for each category within the ABC analysis, a secondary graph is included, which employs a logarithmic scale to facilitate the identification of products with lower $CO_2$ equivalent emissions.

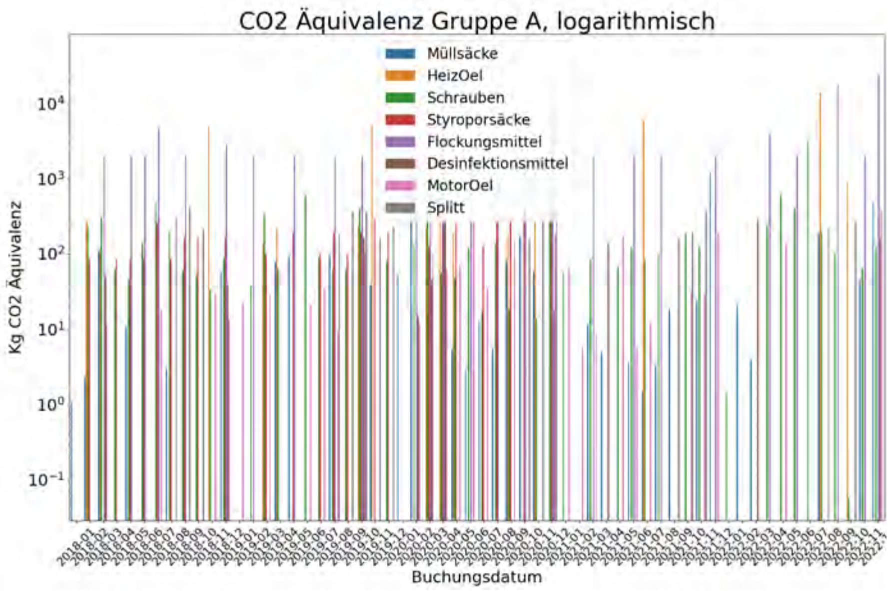


Figure 10: $CO_2$ Äquivalenz Verbrauchsgüter Gruppe A logarithmisch (2018-2022

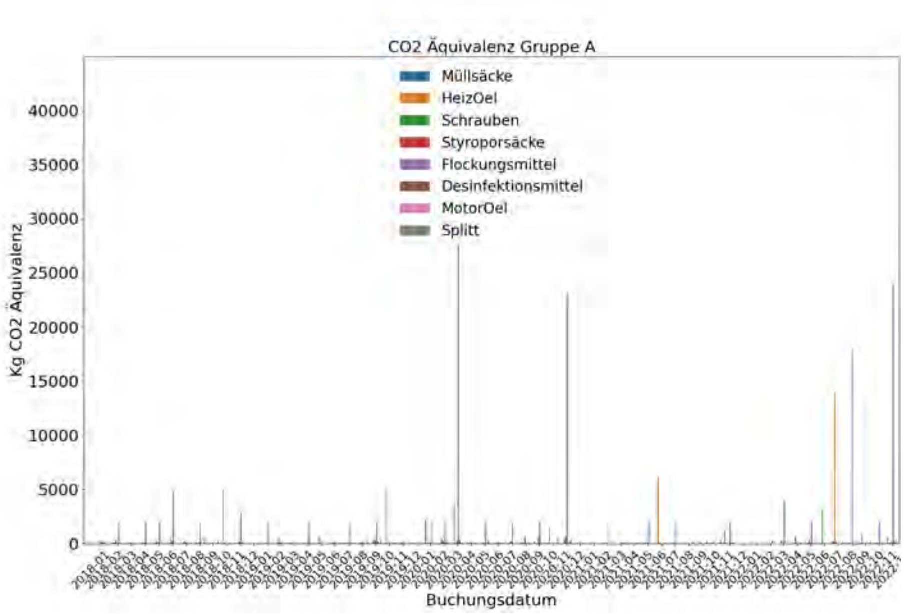


Figure 11: $CO_2$ Äquivalenz Verbrauchsgüter Gruppe A (2018-2022

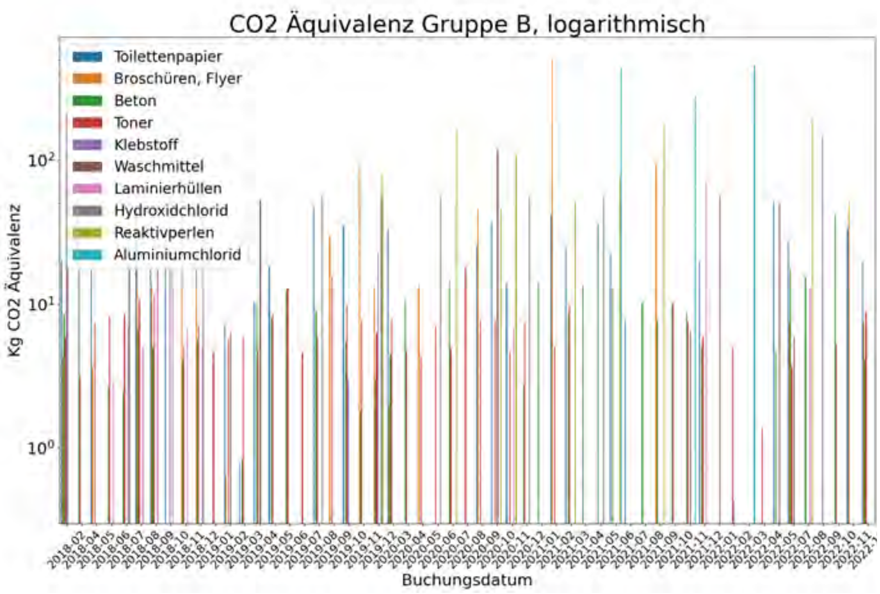


Figure 12: $CO_2$ Äquivalenz Verbrauchsgüter Gruppe B logarithmisch (2018-2022

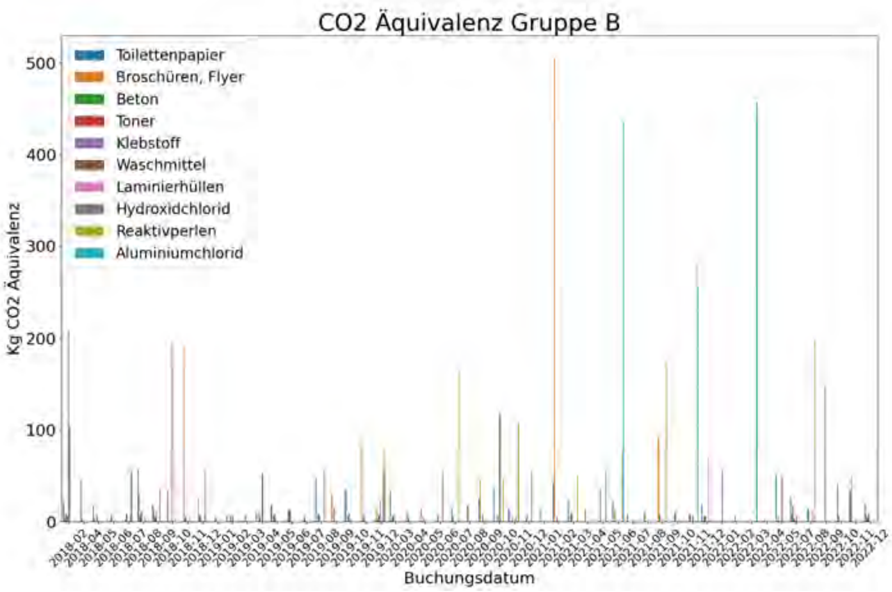


Figure 13: $CO_2$ Äquivalenz Verbrauchsgüter Gruppe B (2018-2022

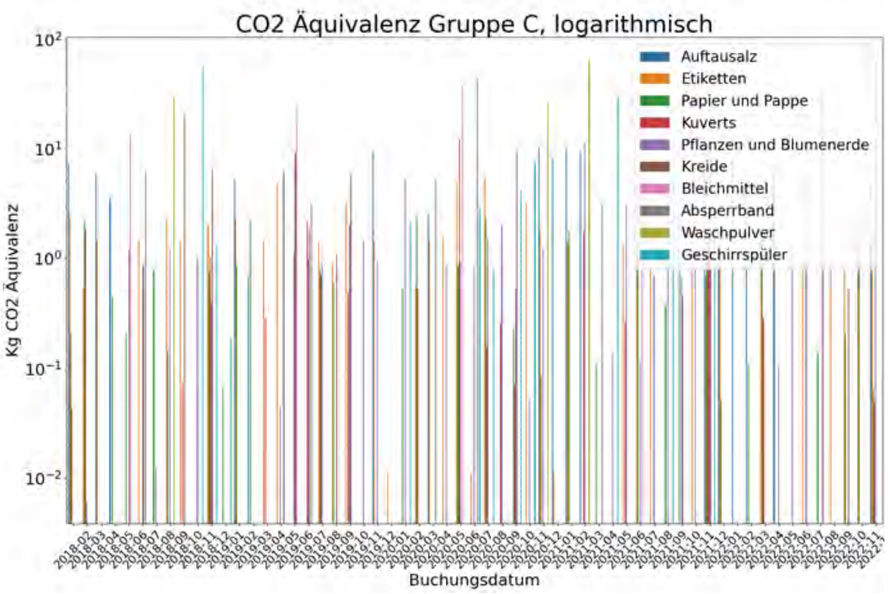


Figure 14: $CO_2$ Äquivalenz Verbrauchsgüter Gruppe C logarithmisch (2018-2022

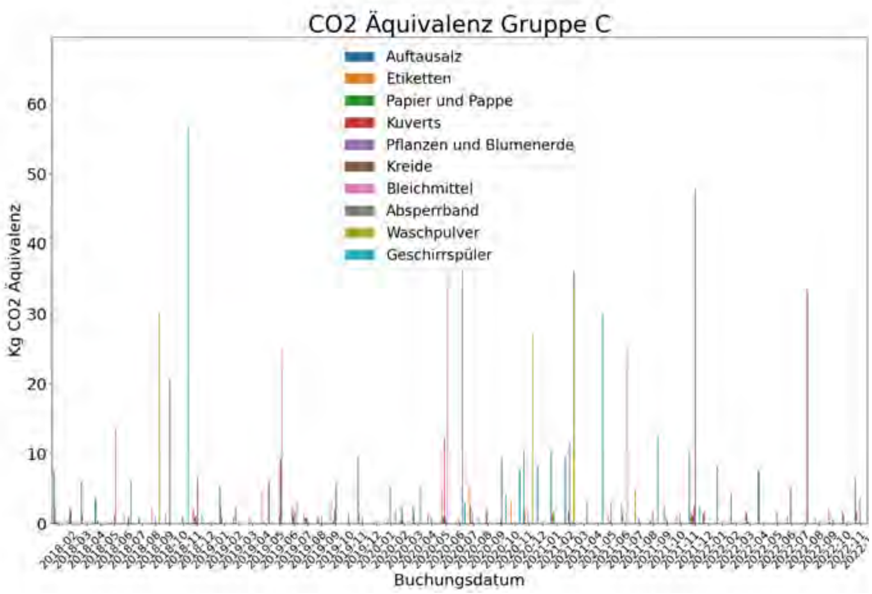


Figure 15: $CO_2$ Äquivalenz Verbrauchsgüter Gruppe C (2018-2022

The following heatmaps depict the results of the ABC and XYZ analyses. The first two show the results from the analysis of the non-durable goods, the second two the results from the analysis of the durable goods

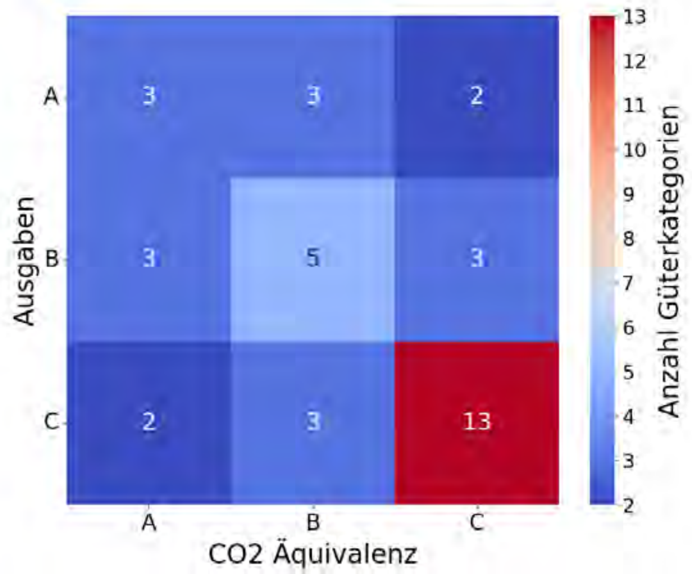


Figure 16: Heatmap ABC-Analyse Ausgaben und ABC-Analyse $CO_2$ Äquivalenzen der Verbrauchsgüter

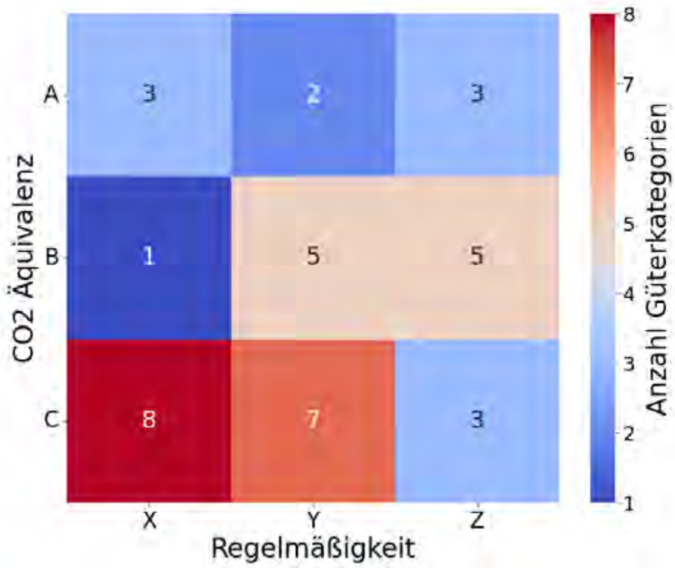


Figure 17: Heatmap ABC-Analyse $CO_2$ Äquivalenzen und XYZ-Analyse Regelmäßigkeit der Verbrauchsgüter

In Figure 16, the ABC analysis of expenditures is juxtaposed with the ABC analysis of $CO_2$ equivalences of the non-durable goods. The individual cells represent the number of product categories contained within these groups.
Figure 17 illustrates the results of the ABC analysis of $CO2_2$ equivalences and those of the XYZ analysis of regularity concerning them.

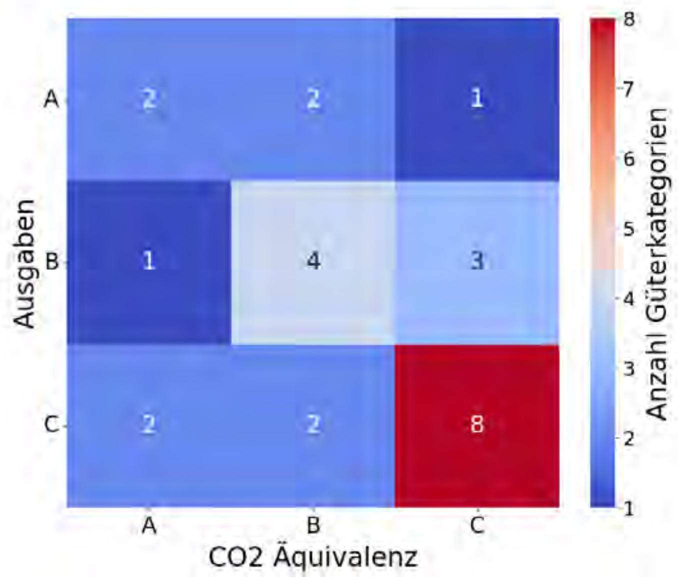


Figure 18: Heatmap ABC-Analyse Ausgaben und ABC-Analyse $CO_2$ Äquivalenzen der Gebrauchsgüter

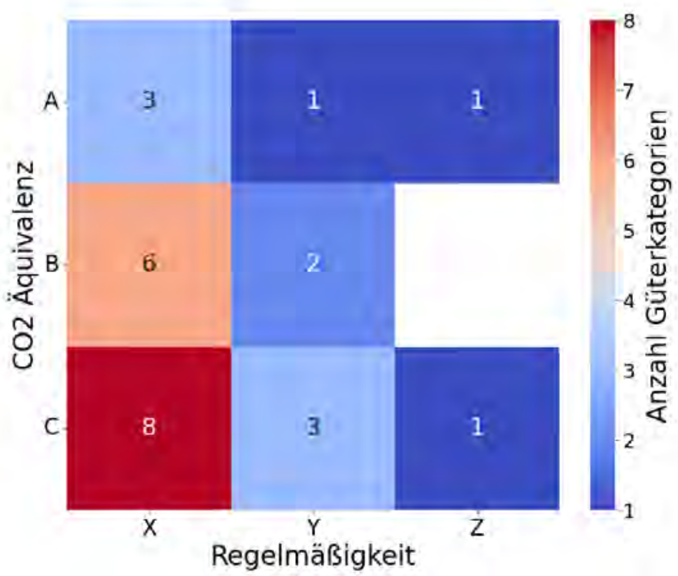


Figure 19: Heatmap ABC-Analyse $CO_2$ Äquivalenzen und XYZ-Analyse Regelmäßigkeit der Gebrauchsgüter

In Figure 18, we can observe a comparison between the ABC analysis of expenses and the ABC analysis of $CO_2$ emissions associated with durable goods. Each cell

within the figure indicates the quantity of product categories encompassed by these respective groups.
Figure 19, it provides a visual representation of the outcomes derived from the ABC analysis of $CO_2$ emissions and the XYZ analysis of their regularity.

## 2018

The following paragraph addresses the results of the analysis of the municipality Ferlachfor the year 2018.

The Tables 4 and 3 provide a summary of durable and non-durable goods from the year 2018.

| Gut | Ausgaben (Euro) | ABC Cost | XYZ Cost | Menge (kg) | Kg CO2 Equiv | ABC CO2 | XYZ CO2 |
|---|---|---|---|---|---|---|---|
| Flockungsmittel | 27313.1 | A | Z | 12283.612 | 23314.295576 | A | Z |
| HeizOel | 5661.27 | A | Y | 4404.46806 | 15415.63821 | A | Y |
| Schrauben | 1971.78 | B | X | 3881.07615 | 5045.398995 | A | X |
| Styroporsäcke | 320 | C | X | 21.2384 | 1342.26688 | A | X |
| Splitt | 2793.96 | B | Z | 138589.038 | 1247.301342 | A | Z |
| Klebstoff | 290 | C | X | 101.5 | 406 | A | Y |
| Broschüren und Flyer | 2778.56 | B | Y | 543.97788 | 353.585622 | A | Y |
| Müllsäcke | 682.25 | C | Z | 130.30975 | 260.6195 | B | Z |
| Toilettenpapier | 1914.92 | B | X | 340.85576 | 221.556244 | B | X |
| Toner | 3949.63 | A | X | 26.5181592 | 212.1452736 | B | X |
| Waschmittel | 397.22 | C | Z | 124.389443 | 211.4620531 | B | Z |
| Desinfektionsmittel | 187.6 | C | Z | 19.1352 | 191.352 | B | Z |
| Beton | 1571.15 | B | Y | 82.6896245 | 148.8413241 | B | Y |
| Laminierhüllen | 731.27 | B | Z | 68.00811 | 136.01622 | B | Z |
| Hydroxidchlorid | 1760 | B | Y | 205.92 | 110.57904 | B | Y |
| MotorOel | 173.22 | C | Y | 20.7864 | 72.7524 | B | Y |
| Geschirrspüler | 394.36 | C | Y | 129.14076 | 58.113342 | B | Y |
| Küvettentests | 8958.07 | A | Y | 26.3367258 | 44.77243386 | C | Y |
| Waschpulver | 38.41 | C | X | 17.783 | 30.2311 | C | X |
| Auftausalz | 12008.56 | A | Y | 301.26026 | 30.126026 | C | Y |
| Kreide | 278.92 | C | Y | 97.622 | 29.2866 | C | Y |
| Etiketten | 764.76 | B | X | 8.36575 | 18.40465 | C | X |
| Luftballons | 245.36 | C | Y | 4.9072 | 14.23088 | C | Y |
| Bleichmittel | 334.65 | C | X | 6.49221 | 13.633641 | C | X |
| Absperrband | 100.53 | C | Z | 6.3649 | 12.4051901 | C | Z |
| Papier und Pappe | 2933.16 | A | Y | 16.719012 | 10.8673578 | C | Y |
| Pflanzen und Blumenerde | 8872.34 | A | X | 557.023756 | 5.013213804 | C | X |
| Kuverts | 553.6 | C | Y | 4.59488 | 2.986672 | C | Y |
| Kerzen | 40.12 | C | X | 0.3165468 | 0.9496404 | C | X |
| Pellets | 1623.19 | B | X | 6156.922 | 0.72830230338 | C | X |
| Druckerpatronen | 95.31 | C | X | 0.12704823 | 0.571717035 | C | X |
| Batterien | 1056.19 | B | Z | 52.8095 | 0.281157778 | C | Z |
| Mikrofasertücher | 141.84 | C | Z | 3.957336 | 0.027701352 | C | Z |

Table 3: Ferlach, Verbrauchsgüter, 2018

| Gut | Ausgaben (Euro) | ABC Cost | XYZ Cost | Menge (kg) | Kg CO2 Equiv | ABC CO2 | XYZ CO2 |
|---|---|---|---|---|---|---|---|
| Wasserzähler | 16299.46 | A | X | 1186.45707012257 | 40885.3106364237 | A | X |
| Reifen | 147.32 | C | Y | 8.42266 | 5000.533242 | A | Y |
| Lampen | 652.32 | C | Z | 30.9330144 | 1065.951676224 | A | Z |
| Bücher | 2555.4 | A | Z | 755.23418595 | 755.23418595 | A | Z |
| Gußeisen (Schachtabdeckung) | 3592.56 | A | Y | 732.25537 | 732.25537 | A | Y |
| LED Belichtung | 1501.41 | B | X | 11.8461249 | 402.7682466 | B | X |
| Einbaugarnitur | 7656.85 | A | X | 176.10755 | 352.2151 | B | X |
| PVC-Artikel | 84.55 | C | Y | 23.92765 | 105.9994895 | B | Y |
| Schläuche | 168.59 | C | Y | 48.101348 | 96.202696 | B | Y |
| Ordner und Hefter | 1072.93 | B | Y | 124.767168 | 81.0986592 | B | Y |
| Schilder | 6745.61 | A | Z | 44.631733 | 58.0212529 | B | Z |
| Klarsichthüllen | 136.32 | C | Y | 22.954255 | 45.90851 | B | Y |
| Hausanschlussschieber | 1387.92 | B | Y | 34.698 | 45.1074 | C | Y |
| Stiefel | 1792.75 | B | Y | 14.4358208 | 41.86388032 | C | Y |
| Bewegungsmelder | 396.51 | C | X | 1.214252 | 41.84312392 | C | X |
| Schotter | 408.6 | C | Y | 3142.9512 | 28.2865608 | C | Y |
| Bohrer | 29.7 | C | Z | 10.53285 | 13.692705 | C | Z |
| Verkehrsspiegel | 1147.4 | B | X | 6.08122 | 7.905586 | C | X |
| Mähfaden | 59.54 | C | Z | 1.661166 | 5.3157312 | C | Z |
| Besen | 585.29 | C | X | 3.01598763306424 | 0.356761177115169 | C | X |
| Schlüssel | 177.89 | C | Z | 0.17789 | 0.231257 | C | Z |
| Akkus | 1615.85 | B | X | 13.27605 | 0.07735954335 | C | X |
| Jacken | 1348.39 | B | Y | 6.488640098819 | 0.045420480691733 | C | Y |
| Arbeitshose | 417.18 | C | X | 2.18056692238746 | 0.015263968456712 | C | X |

Table 4: Ferlach, Gebrauchsgüter, 2018

The following six graphs (Figures 20-25) show the $CO_2$ equivalent emissions of the durable goods for the year 2018. The individual groups of the ABC analysis of $CO_2$ equivalent emissions are presented separately to enhance clarity. Additionally, for each group in the ABC analysis, there is a second graph that represents the results on a logarithmic scale to facilitate the identification of products with lower $CO_2$ equivalent emissions.

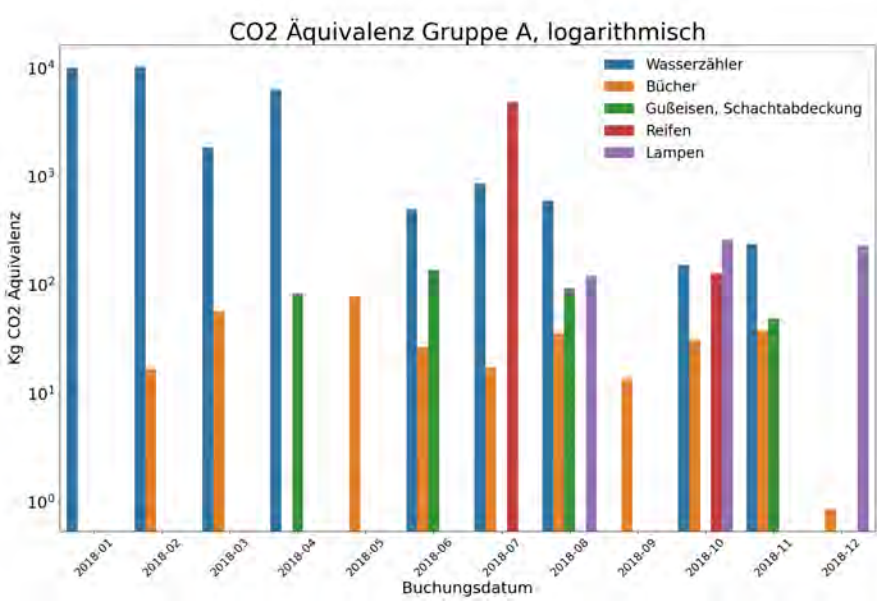


Figure 20: $CO_2$ Äquivalenz Gebrauchsgüter Gruppe A logarithmisch (2018)

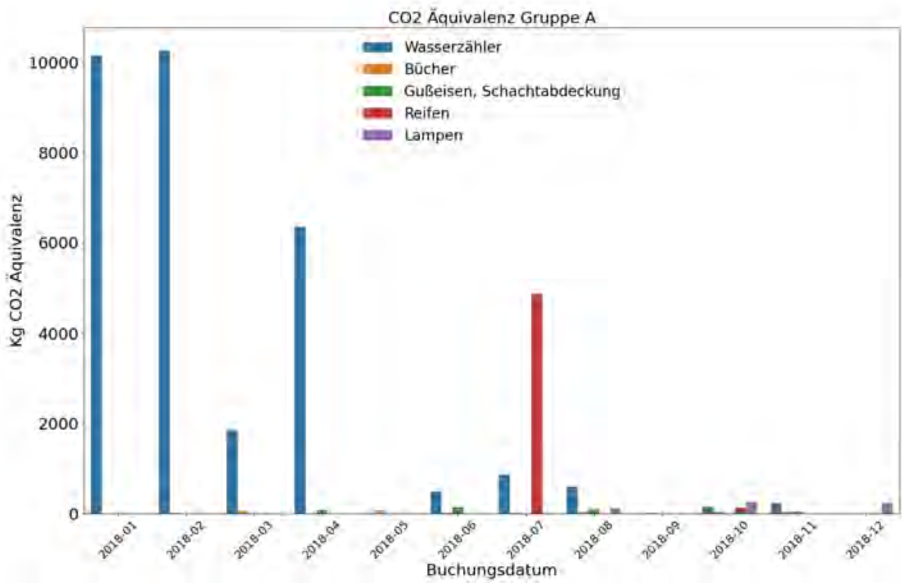


Figure 21: $CO_2$ Äquivalenz Gebrauchsgüter Gruppe A (2018)

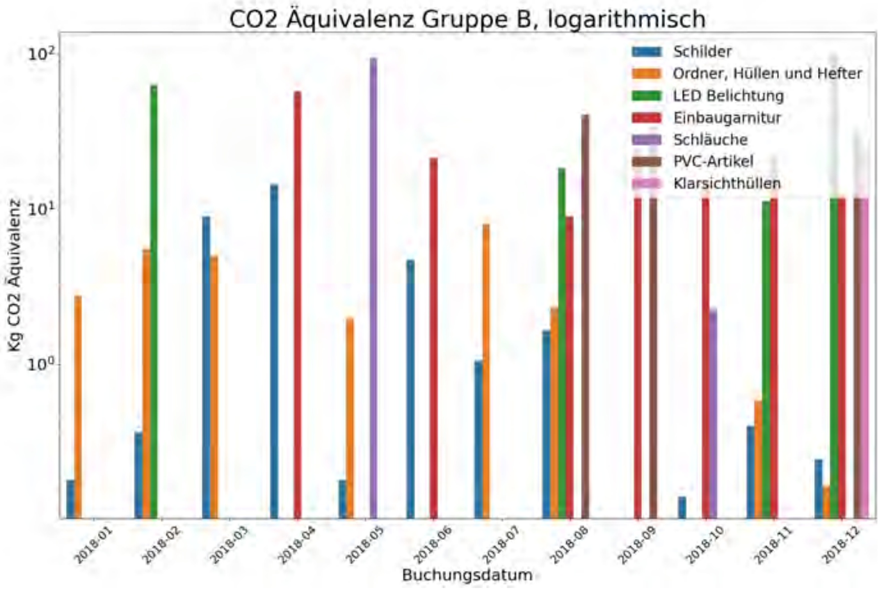


Figure 22: $CO_2$ Äquivalenz Gebrauchsgüter Gruppe B logarithmisch (2018)

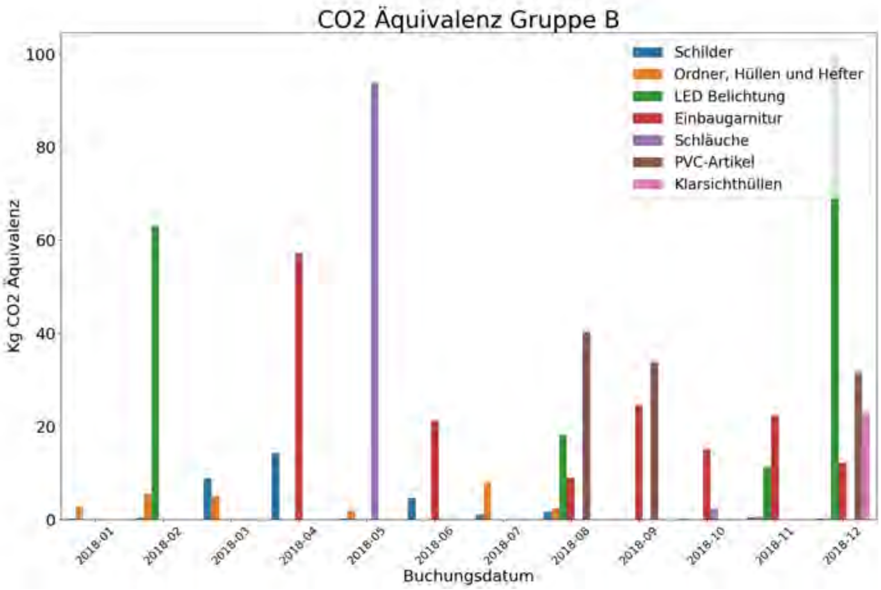


Figure 23: $CO_2$ Äquivalenz Gebrauchsgüter Gruppe B (2018)

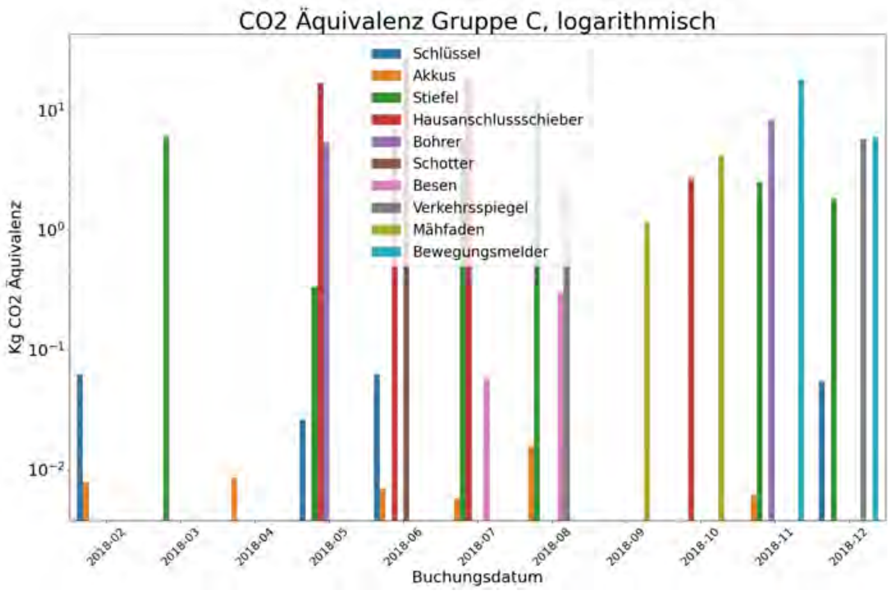


Figure 24: $CO_2$ Äquivalenz Gebrauchsgüter Gruppe C logarithmisch (2018)

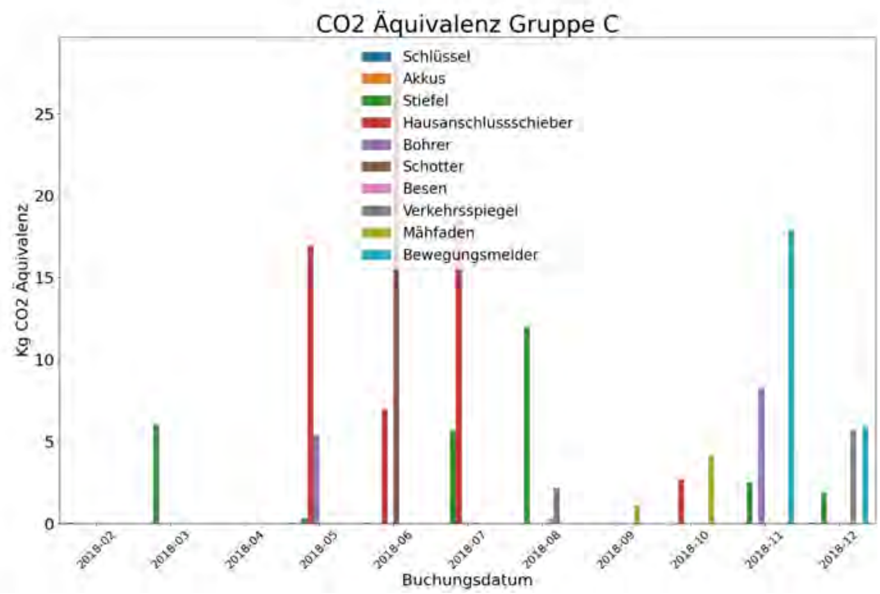


Figure 25: $CO_2$ Äquivalenz Gebrauchsgüter Gruppe C (2018)

In the following graphs, labeled 26-31, we present the $CO_2$ equivalent emissions of non-durable goods in the year 2018. These graphs provide a segmented representation of the distinct categories within the ABC analysis of $CO_2$ equivalent emissions, aiming to enhance clarity and comprehensibility. Additionally, for each category within the ABC analysis, a secondary graph is included, which employs a logarithmic scale to facilitate the identification of products with lower $CO_2$ equivalent emissions.

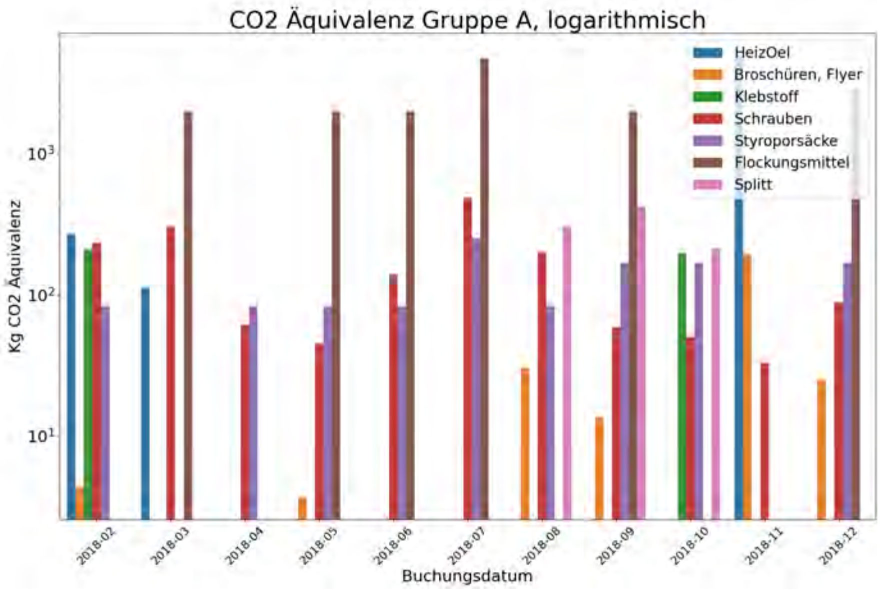


Figure 26: $CO_2$ Äquivalenz Verbrauchsgüter Gruppe A logarithmisch (2018)

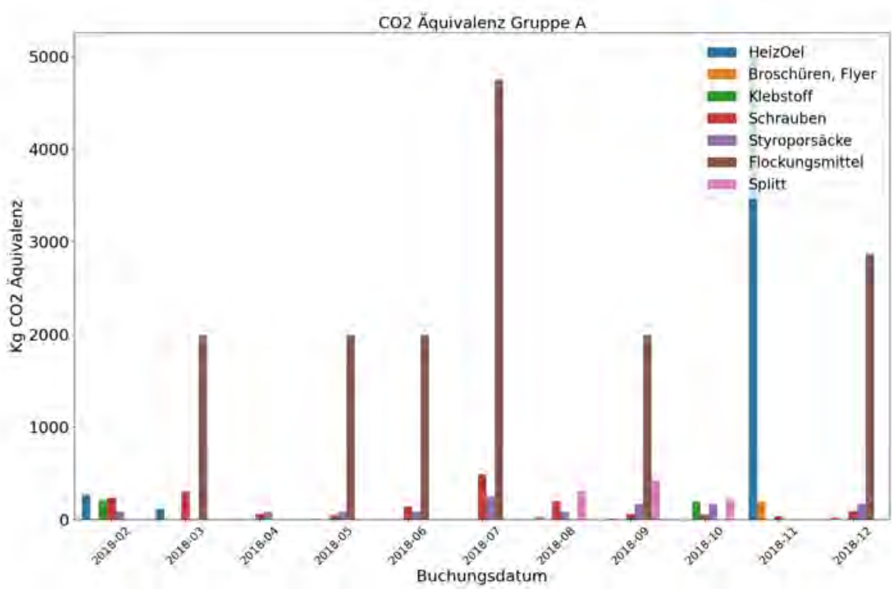


Figure 27: $CO_2$ Äquivalenz Verbrauchsgüter Gruppe A (2018)

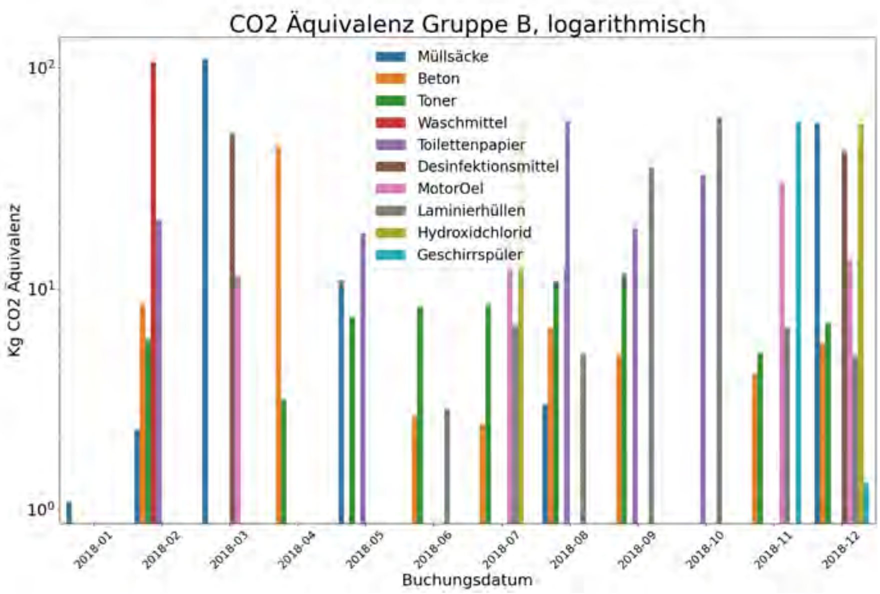


Figure 28: $CO_2$ Äquivalenz Verbrauchsgüter Gruppe B logarithmisch (2018)

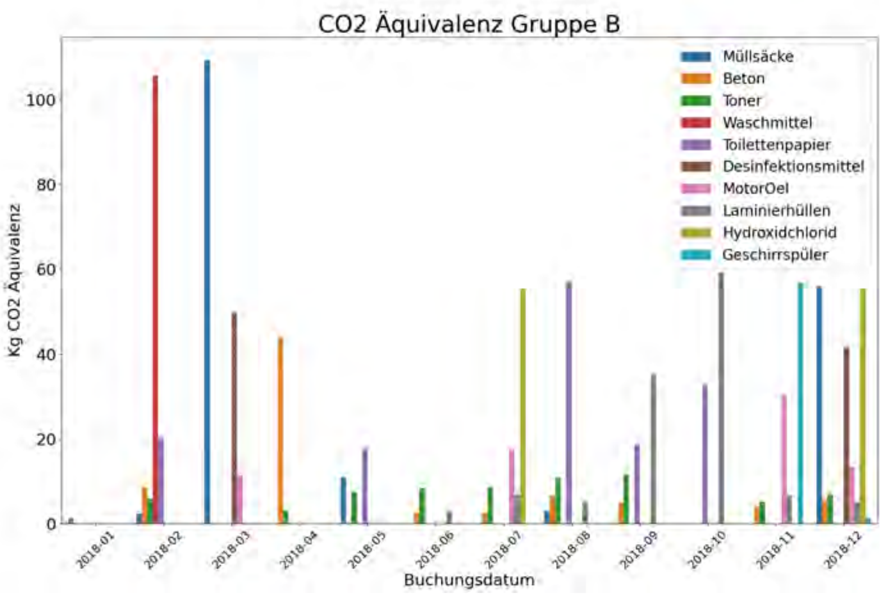


Figure 29: $CO_2$ Äquivalenz Verbrauchsgüter Gruppe B (2018)

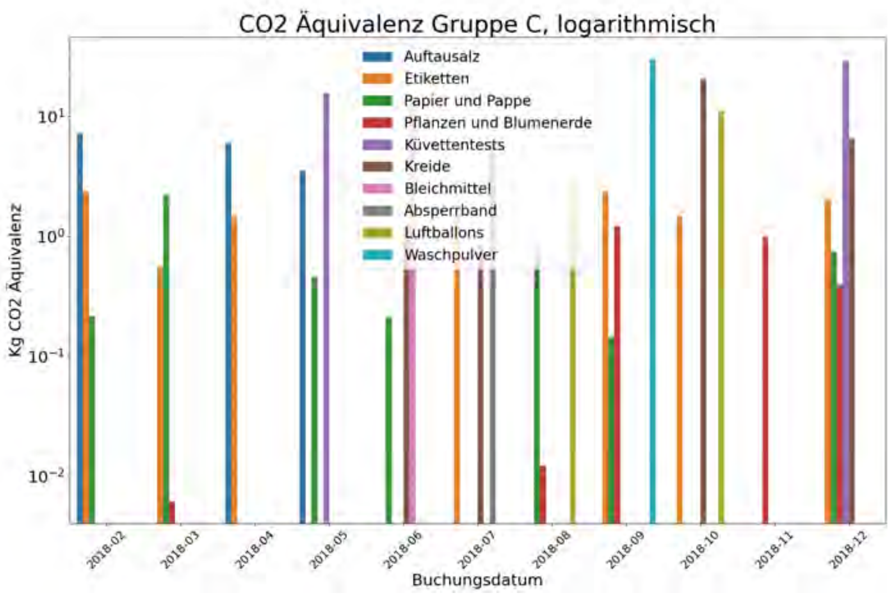


Figure 30: $CO_2$ Äquivalenz Verbrauchsgüter Gruppe C logarithmisch (2018)

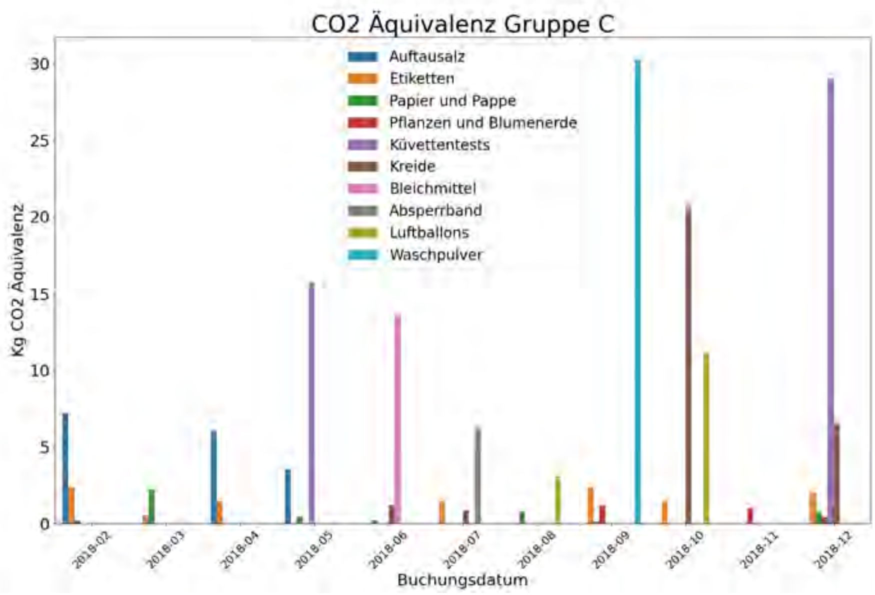


Figure 31: $CO_2$ Äquivalenz Verbrauchsgüter Gruppe C (2018)

## 2019

The following paragraph addresses the results of the analysis of the municipality Ferlachfor the year 2019.

The Tables 6 and 5 provide a summary of durable and non-durable goods from the year 2019.

| Gut | Ausgaben (Euro) | ABC Cost | XYZ Cost | Menge (kg) | Kg CO2 Equiv | ABC CO2 | XYZ CO2 |
|---|---|---|---|---|---|---|---|
| HeizOel | 3989.78 | A | Y | 3104.04884 | 10864.17094 | A | Y |
| Flockungsmittel | 9954 | A | Y | 4200 | 7971.6 | A | Y |
| Schrauben | 1643.93 | B | X | 2680.35445 | 3484.460785 | A | X |
| Splitt | 4018.92 | A | Y | 189748.728 | 1707.738552 | A | Y |
| Styroporsäcke | 345 | C | Z | 22.89765 | 1447.13148 | A | Z |
| Müllsäcke | 1281.97 | B | Y | 244.85627 | 489.71254 | A | Y |
| Toilettenpapier | 2864.22 | B | Z | 509.83116 | 331.390254 | A | Z |
| Broschüren und Flyer | 1760.42 | B | Y | 469.20306 | 304.981989 | B | Z |
| MotorOel | 723.27 | C | Y | 86.7924 | 303.7734 | B | Y |
| Toner | 3724.24 | B | X | 23.7285516 | 189.8284128 | B | X |
| Desinfektionsmittel | 160.13 | C | X | 16.33326 | 163.3326 | B | X |
| Waschmittel | 198.77 | C | Z | 65.579873 | 111.4857841 | B | Z |
| Hydroxidchlorid | 1760 | B | Z | 205.92 | 110.57904 | B | Z |
| Beton | 1009.48 | C | Y | 53.1289324 | 95.63207832 | B | Y |
| Reaktivperlen | 1308.02 | B | Z | 124.785108 | 82.35817128 | B | Z |
| Pflanzen und Blumenerde | 10418.75 | A | Y | 3974.901132 | 35.774110188 | B | Z |
| Klebstoff | 207.34 | C | Y | 7.16775 | 28.671 | B | Y |
| Etiketten | 1206.89 | C | Y | 12.866125 | 28.305475 | C | Y |
| Auftausalz | 12953.88 | A | Z | 269.016916 | 26.9016916 | C | Z |
| Bleichmittel | 616.92 | C | Z | 11.968248 | 25.1333208 | C | Z |
| Küvettentests | 5006.47 | A | Y | 14.7190218 | 25.02233706 | C | Y |
| Kreide | 227.86 | C | X | 79.751 | 23.9253 | C | X |
| Papier und Pappe | 2815.53 | B | Y | 16.048521 | 10.43153865 | C | Y |
| Absperrband | 62.07 | C | Y | 4.84146 | 9.43600554 | C | X |
| Kuverts | 1259.3 | B | Y | 10.45219 | 6.7939235 | C | Z |
| Druckerpatronen | 207.24 | C | X | 0.80470159 | 3.621157155 | C | X |
| Eisen-II-chlorid | 10520.2 | A | Z | 13132.54 | 2.3638572 | C | Z |
| Kerzen | 41.31 | C | X | 0.3259359 | 0.9778077 | C | X |
| Luftballons | 14.7 | C | X | 0.294 | 0.8526 | C | X |
| Pellets | 1760.17 | B | X | 5002.199998 | 0.59171023776342 | C | X |
| Geschirrspüler | 1.28 | C | Y | 0.42624 | 0.191808 | C | Y |
| Batterien | 326 | C | X | 16.3 | 0.0867812 | C | X |
| Mikrofasertücher | 81.85 | C | Z | 2.283615 | 0.015985305 | C | Z |

Table 5: Ferlach, Verbrauchsgüter, 2019

| Gut | Ausgaben (Euro) | ABC Cost | XYZ Cost | Menge (kg) | Kg CO2 Equiv | ABC CO2 | XYZ CO2 |
|---|---|---|---|---|---|---|---|
| Wasserzähler | 17307.6 | A | Y | 1174.13618375345 | 40460.7328921439 | A | Y |
| Reifen | 574.36 | C | Z | 7.1795 | 4262.46915 | A | Z |
| Bücher | 1490.46 | B | Z | 368.9665 | 368.9665 | A | Z |
| Stiefel | 7443.9 | A | X | 93.24024666658 | 270.396715333082 | A | X |
| Lampen | 189.73 | C | Y | 4.778355 | 164.6621133 | A | Y |
| Einbaugarnitur | 3196.39 | A | X | 75.908282 | 151.816564 | B | X |
| PVC-Artikel | 118.03 | C | X | 33.40249 | 147.9730307 | B | X |
| LED Belichtung | 546.4 | C | Y | 4.311096 | 146.577264 | B | Y |
| Gußeisen (Schachtabdeckung) | 579.18 | B | X | 125.10288 | 125.10288 | B | X |
| Ordner und Hefter | 1095.62 | B | Z | 173.134893 | 112.53768045 | B | Z |
| Bewegungsmelder | 536.66 | C | Y | 2.790632 | 96.16517872 | B | Y |
| Klarsichthüllen | 234.42 | C | Y | 23.080075 | 46.16015 | B | Y |
| Hausanschlussschieber | 1252.73 | B | Y | 31.31825 | 40.713725 | B | X |
| Verkehrsspiegel | 5011.44 | A | Z | 26.560632 | 34.5288216 | C | Z |
| Sperrschelle | 851.01 | B | X | 20.96575 | 27.255475 | C | X |
| Schilder | 3469.55 | A | Z | 18.388615 | 23.9051995 | C | Z |
| Bohrer | 144.87 | C | Y | 16.599 | 21.5787 | C | Y |
| Schotter | 275 | C | X | 2115.3 | 19.0377 | C | X |
| Schläuche | 420 | C | Z | 9.24 | 18.48 | C | Z |
| Mähfaden | 101.58 | C | X | 2.834082 | 9.0690624 | C | X |
| Schlüssel | 244.58 | C | Z | 0.24458 | 0.317954 | C | Z |
| Akkus | 2357.65 | B | Z | 17.14425 | 0.09989954475 | C | Z |
| Arbeitshose | 1062.18 | B | X | 5.55193099770246 | 0.038863516983917 | C | X |
| Besen | 65.52 | C | Y | 0.314496 | 0.03720173184 | C | Y |
| Jacken | 693.6 | B | X | 3.337722613644 | 0.023364058295508 | C | X |

Table 6: Ferlach, Gebrauchsgüter, 2019

The following six graphs (Figures 32-37) show the $CO_2$ equivalent emissions of the durable goods for the year 2019. The individual groups of the ABC analysis of $CO_2$ equivalent emissions are presented separately to enhance clarity. Additionally, for each group in the ABC analysis, there is a second graph that represents the results on a logarithmic scale to facilitate the identification of products with lower $CO_2$ equivalent emissions.

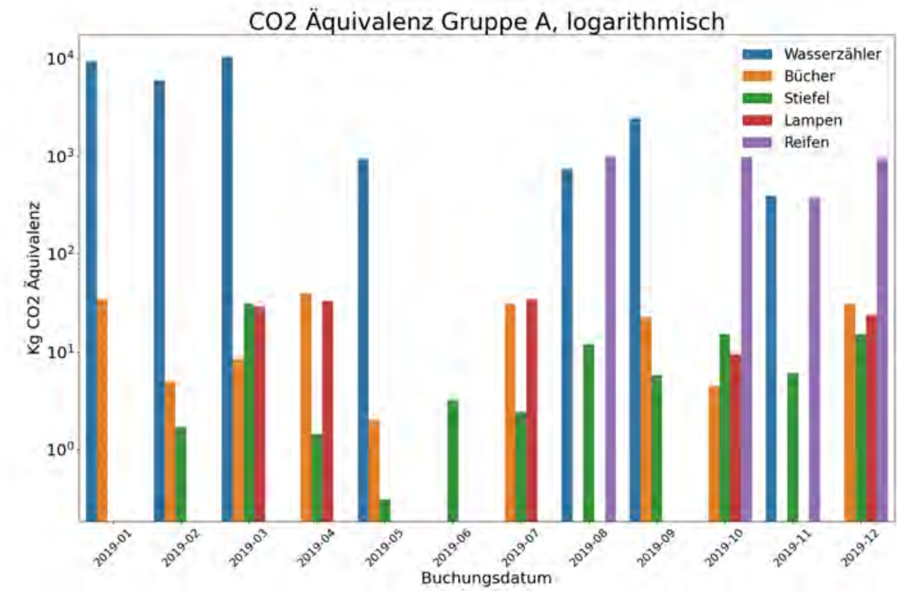


Figure 32: $CO_2$ Äquivalenz Gebrauchsgüter Gruppe A logarithmisch (2019)

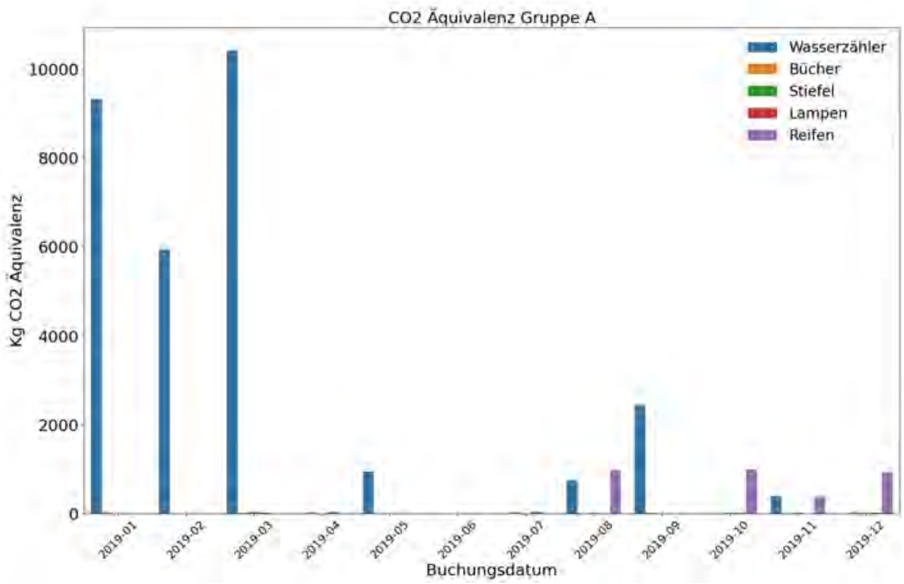


Figure 33: $CO_2$ Äquivalenz Gebrauchsgüter Gruppe A (2019)

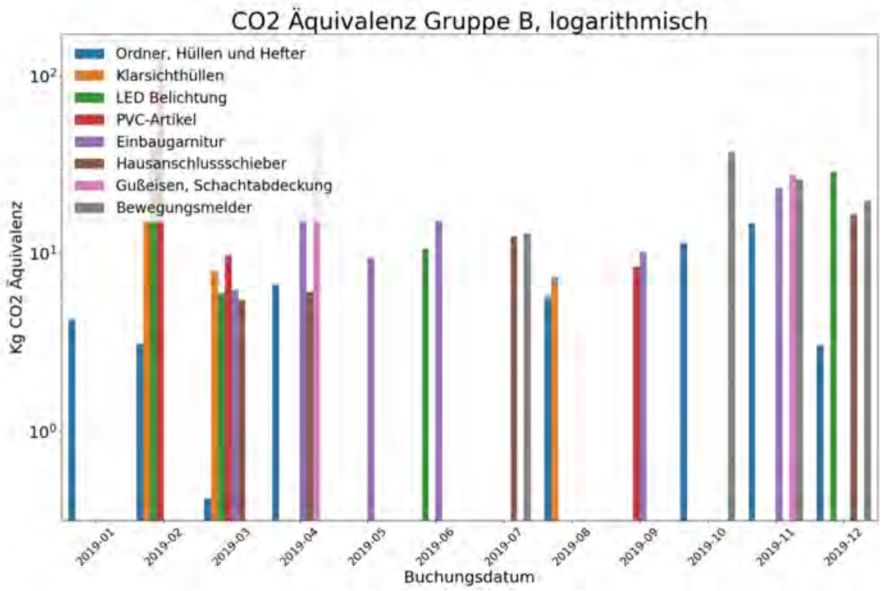


Figure 34: $CO_2$ Äquivalenz Gebrauchsgüter Gruppe B logarithmisch (2019)

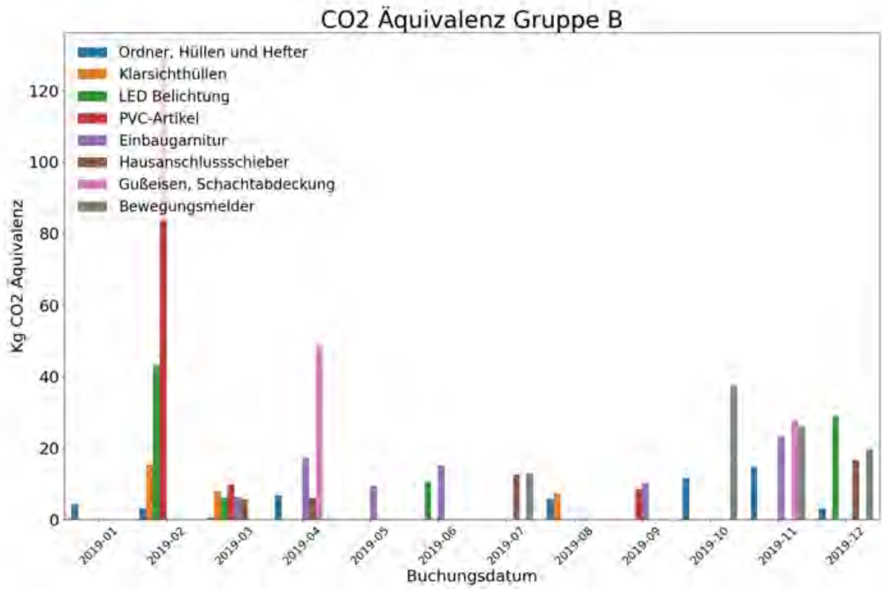


Figure 35: $CO_2$ Äquivalenz Gebrauchsgüter Gruppe B (2019)

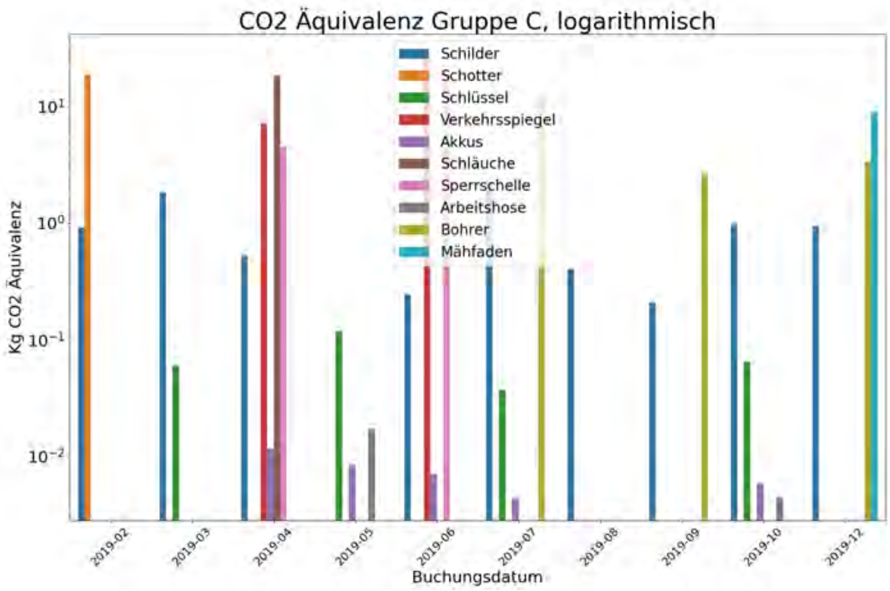


Figure 36: $CO_2$ Äquivalenz Gebrauchsgüter Gruppe C logarithmisch (2019)

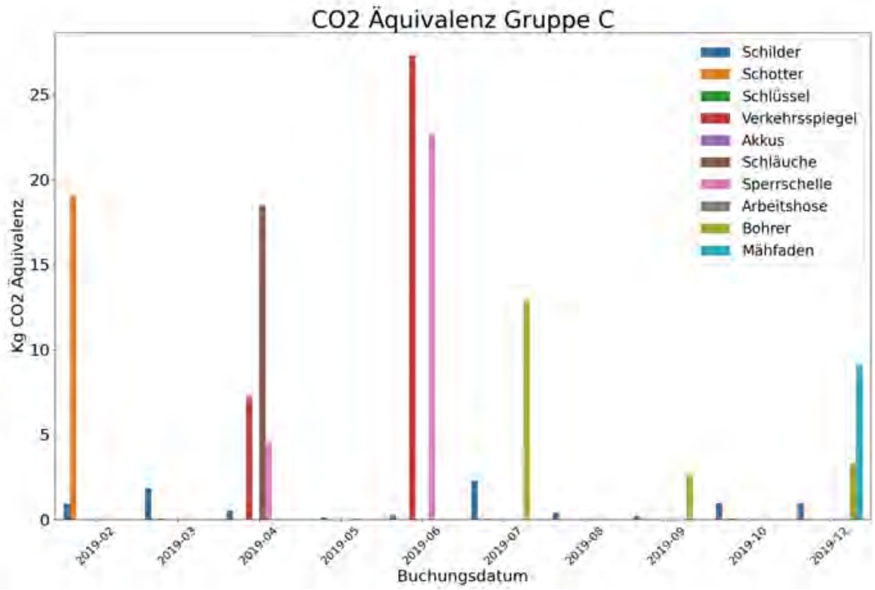


Figure 37: $CO_2$ Äquivalenz Gebrauchsgüter Gruppe C (2019)

In the following graphs, labeled 38-43, we present the $CO_2$ equivalent emissions of non-durable goods in the year 2019. These graphs provide a segmented representation of the distinct categories within the ABC analysis of $CO_2$ equivalent emissions, aiming to enhance clarity and comprehensibility. Additionally, for each category within the ABC analysis, a secondary graph is included, which employs a logarithmic scale to facilitate the identification of products with lower $CO_2$ equivalent emissions.

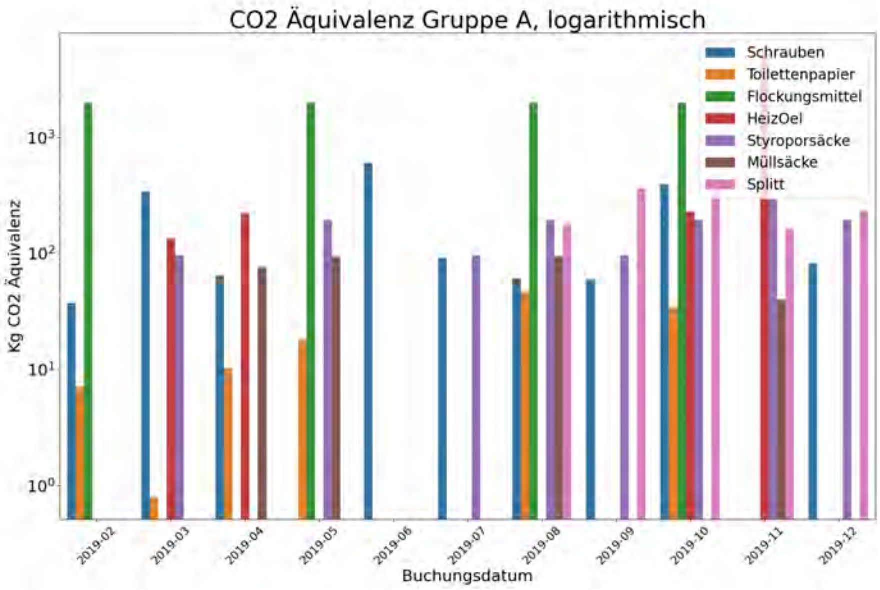


Figure 38: $CO_2$ Äquivalenz Verbrauchsgüter Gruppe A logarithmisch (2019)

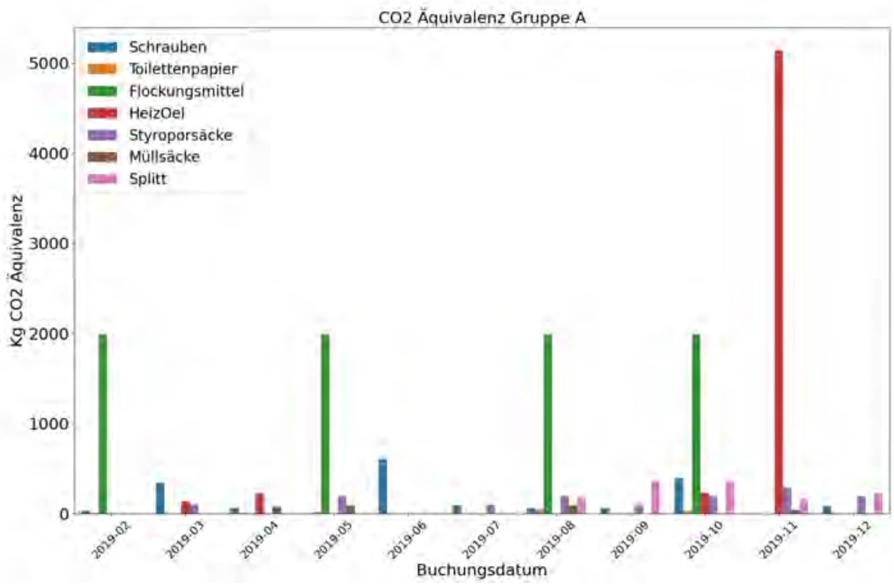


Figure 39: $CO_2$ Äquivalenz Verbrauchsgüter Gruppe A (2019)

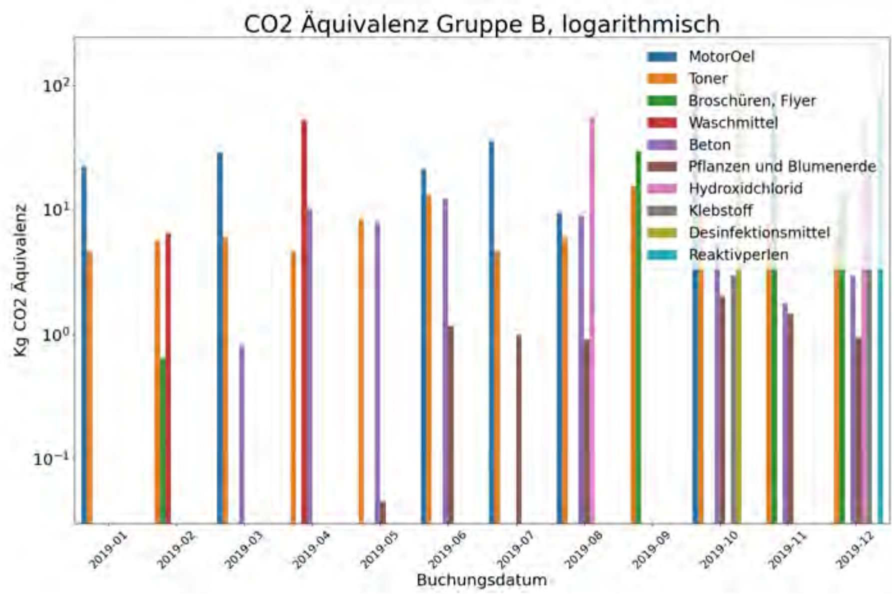


Figure 40: $CO_2$ Äquivalenz Verbrauchsgüter Gruppe B logarithmisch (2019)

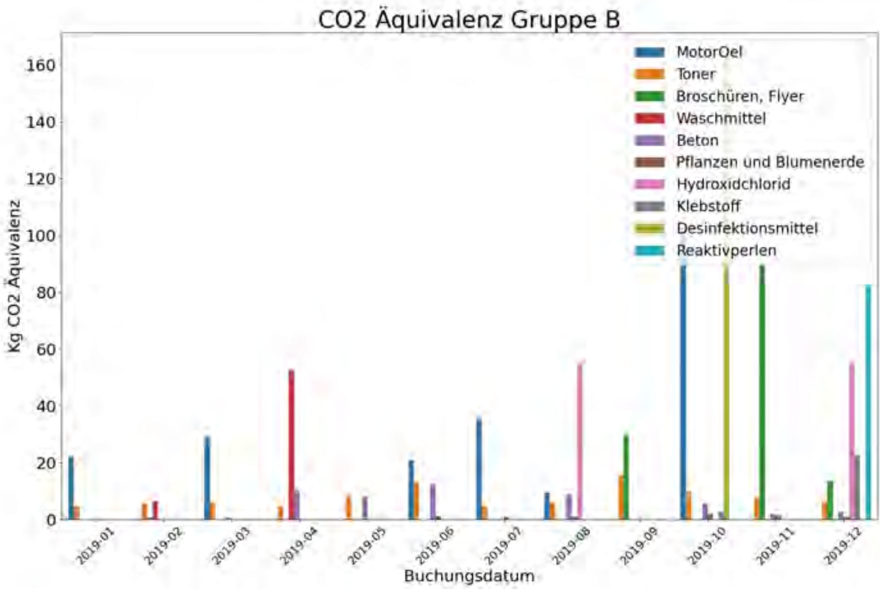


Figure 41: $CO_2$ Äquivalenz Verbrauchsgüter Gruppe B (2019)

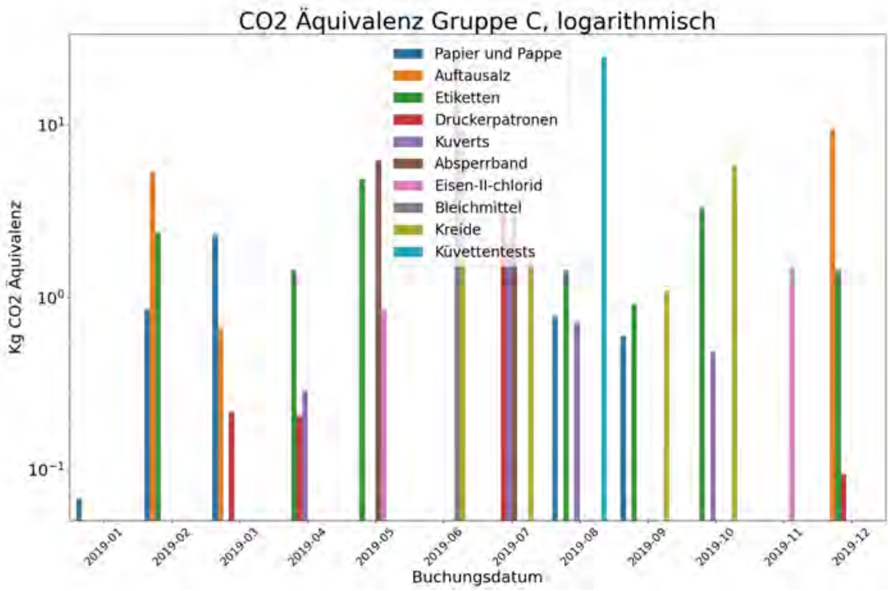


Figure 42: $CO_2$ Äquivalenz Verbrauchsgüter Gruppe C logarithmisch (2019)

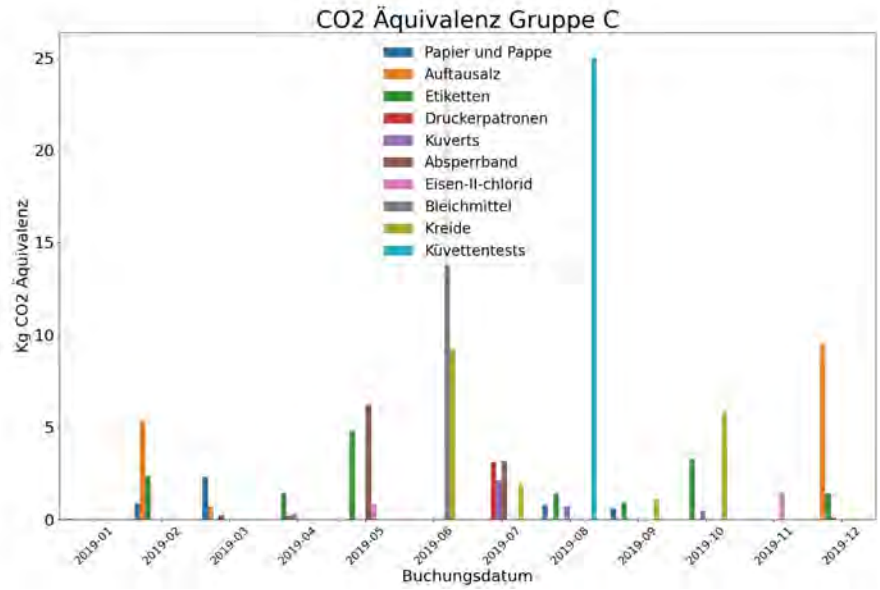


Figure 43: $CO_2$ Äquivalenz Verbrauchsgüter Gruppe C (2019)

## 2020

The following paragraph addresses the results of the analysis of the municipality Ferlachfor the year 2020.

The Tables 8 and 20 provide a summary of durable and non-durable goods from the year 2020.

| Gut | Ausgaben (Euro) | ABC Cost | XYZ Cost | Menge (kg) | Kg CO2 Equiv | ABC CO2 | XYZ CO2 |
|---|---|---|---|---|---|---|---|
| Flockungsmittel | 25501.73 | A | Z | 52260 | 99189.48 | A | Z |
| HeizOel | 3533.89 | B | Z | 2749.36642 | 9622.78247 | A | Z |
| Schrauben | 1636.65 | B | Y | 2632.41236 | 3422.136068 | A | Z |
| Müllsäcke | 7746.87 | A | X | 1479.65217 | 2959.30434 | A | X |
| Styroporsäcke | 661 | C | Y | 43.87057 | 2772.620024 | A | Y |
| Splitt | 2728.2 | B | Z | 125009.753 | 1125.087777 | A | Z |
| MotorOel | 3452.29 | B | Y | 301.7244 | 1056.0354 | A | Z |
| Desinfektionsmittel | 996.69 | C | Z | 101.66238 | 1016.6238 | B | Z |
| Reaktivperlen | 7656.78 | A | Y | 730.456812 | 482.10149592 | B | Y |
| Waschmittel | 443.74 | C | Z | 138.957181 | 236.2272077 | B | Z |
| Toilettenpapier | 1690.94 | B | X | 300.98732 | 195.641758 | B | X |
| Toner | 2501.61 | B | X | 16.2445464 | 129.9563712 | B | Y |
| Hydroxidchlorid | 1760 | B | X | 205.92 | 110.57904 | B | X |
| Broschüren und Flyer | 882.18 | C | Y | 165.22515 | 107.3963475 | B | Y |
| Beton | 611.34 | C | Y | 32.1748242 | 57.91468356 | B | Y |
| Absperrband | 319.8 | C | Z | 24.9444 | 48.6166356 | B | Z |
| Bleichmittel | 951.53 | C | Z | 18.459682 | 38.7653322 | B | Z |
| Küvettentests | 7652.48 | A | Z | 22.4982912 | 38.24709504 | C | Z |
| Pflanzen und Blumenerde | 9684.3 | A | Y | 3873.72 | 34.86348 | C | Y |
| Etiketten | 1281.2 | C | Z | 14.76875 | 32.49125 | C | Z |
| Waschpulver | 34.57 | C | Y | 16 | 27.2 | C | Y |
| Geschirrspüler | 138.19 | C | X | 46.01727 | 20.7077715 | C | X |
| Kuverts | 2569.66 | B | Y | 21.328178 | 13.8633157 | C | Y |
| Laminierhüllen | 73.43 | C | X | 6.82899 | 13.65798 | C | X |
| Auftausalz | 7599.93 | A | Z | 129.926894 | 12.9926894 | C | Z |
| Papier und Pappe | 2592.02 | B | X | 14.774514 | 9.6034341 | C | X |
| Kreide | 91 | C | Y | 31.85 | 9.555 | C | Y |
| Luftballons | 130.16 | C | X | 2.6032 | 7.54928 | C | X |
| Druckerpatronen | 360.83 | C | Y | 0.48098639 | 2.164438755 | C | Y |
| Eisen-II-chlorid | 5129 | A | X | 8206.4 | 1.477152 | C | X |
| Pellets | 1329.9 | B | X | 5044.443 | 0.59670716247 | C | X |
| Kerzen | 22.76 | C | X | 0.1795764 | 0.5387292 | C | X |
| Batterien | 635.88 | C | Z | 31.794 | 0.169271256 | C | Z |
| AdBlue | 113 | C | Z | 0.01 | 0.0103 | C | Z |

Table 7: Ferlach, Verbrauchsgüter, 2020

| Gut | Ausgaben (Euro) | ABC Cost | XYZ Cost | Menge (kg) | Kg CO2 Equiv | ABC CO2 | XYZ CO2 |
|---|---|---|---|---|---|---|---|
| Wasserzähler | 21444.14 | A | X | 1764.25185035915 | 60796.1187633764 | A | X |
| Reifen | 173.64 | C | Y | 4.1905 | 2487.89985 | A | Y |
| LED Belichtung | 7368.07 | A | Y | 58.1340723 | 1976.5584582 | A | Y |
| Lampen | 745.4 | C | X | 35.346868 | 1218.05307128 | A | X |
| Bücher | 2925.82 | B | X | 853.3361 | 853.3361 | A | X |
| Einbaugarnitur | 6122.97 | A | Z | 140.82831 | 281.65662 | B | Z |
| PVC-Artikel | 191.83 | C | Y | 54.28789 | 240.4953527 | B | Y |
| Stiefel | 5351.31 | A | Z | 67.8262767767152 | 196.696202652474 | B | Z |
| Schotter | 2235.13 | B | Z | 17192.61996 | 154.73357964 | B | Z |
| Ordner und Hefter | 1324.43 | B | Y | 225.101582 | 146.3160283 | B | Y |
| Gußeisen (Schachtabdeckung) | 595.35 | C | Y | 128.5956 | 128.5956 | B | Y |
| Hausanschlussschieber | 2159.77 | B | Z | 53.99425 | 70.192525 | C | Z |
| Schilder | 8511.73 | A | X | 45.112169 | 58.6458197 | C | X |
| Bewegungsmelder | 158.85 | C | Y | 0.82602 | 28.4646492 | C | Y |
| Sperrschelle | 1121.7 | C | Y | 18.5 | 24.05 | C | Y |
| Klarsichthüllen | 372.86 | C | X | 10.524294 | 21.048588 | C | X |
| Verkehrsspiegel | 2178.53 | B | Y | 11.546209 | 15.0100717 | C | Y |
| Mähfaden | 111.34 | C | Y | 3.106386 | 9.9404352 | C | Y |
| Schlüssel | 194.69 | C | Z | 0.19469 | 0.253097 | C | Z |
| Jacken | 4310.84 | B | X | 20.7445042557686 | 0.14521152979038 | C | X |
| Akkus | 638.18 | C | Z | 4.46726 | 0.02603072402 | C | Z |
| Arbeitshose | 332.97 | C | X | 1.74040790101959 | 0.012182855307137 | C | X |

Table 8: Ferlach, Gebrauchsgüter, 2020

The following six graphs (Figures 44-49) show the $CO_2$ equivalent emissions of the durable goods for the year 2020. The individual groups of the ABC analysis of $CO_2$ equivalent emissions are presented separately to enhance clarity. Additionally, for each group in the ABC analysis, there is a second graph that represents the results on a logarithmic scale to facilitate the identification of products with lower $CO_2$ equivalent emissions.

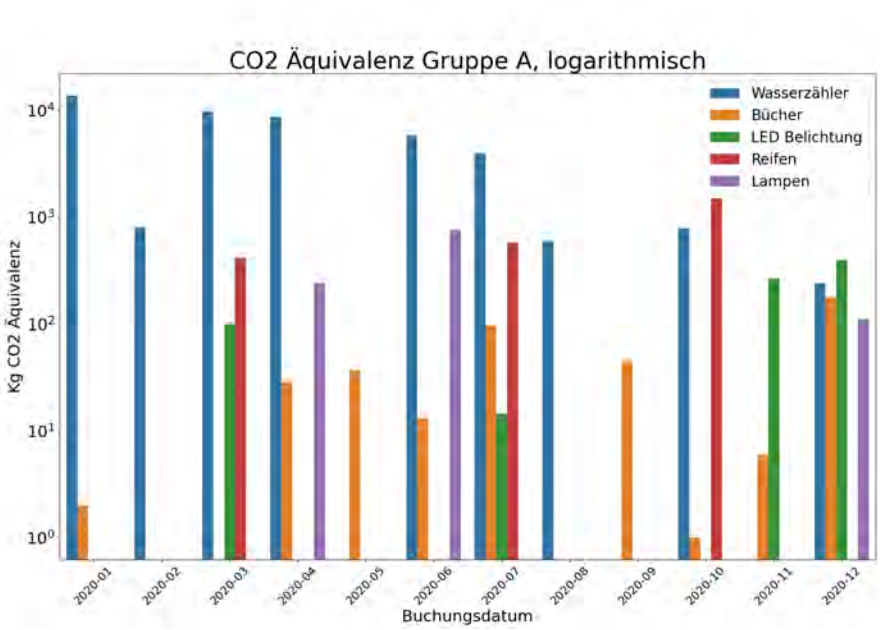


Figure 44: $CO_2$ Äquivalenz Gebrauchsgüter Gruppe A logarithmisch (2020)

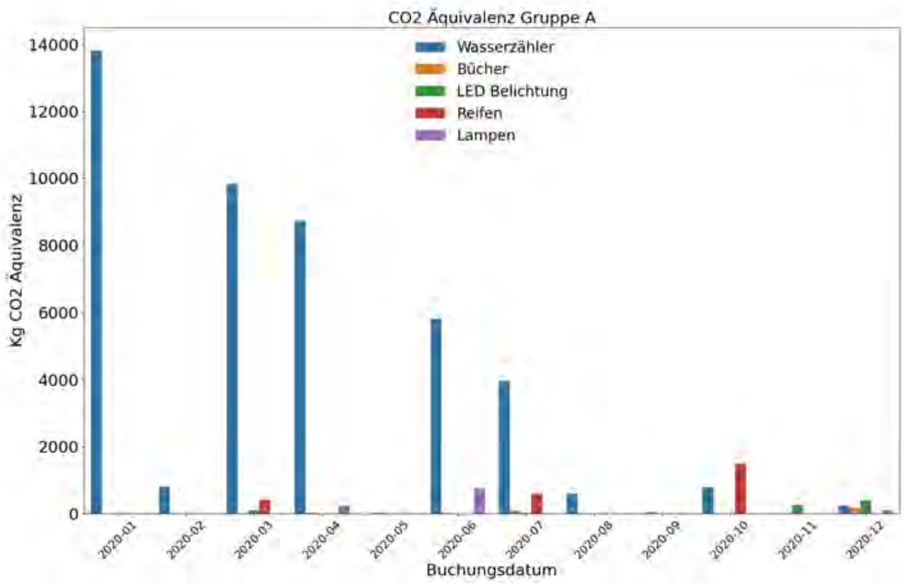


Figure 45: $CO_2$ Äquivalenz Gebrauchsgüter Gruppe A (2020)

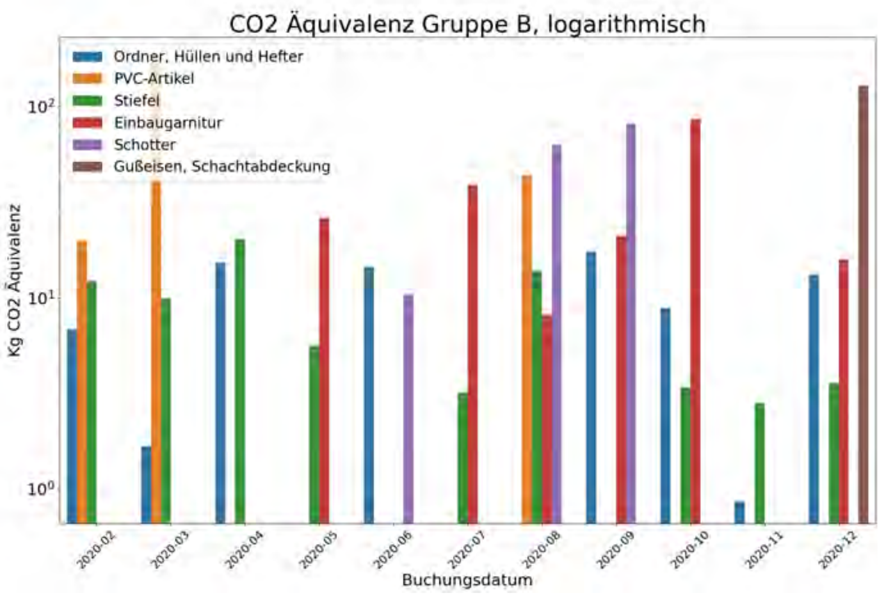


Figure 46: $CO_2$ Äquivalenz Gebrauchsgüter Gruppe B logarithmisch (2020)

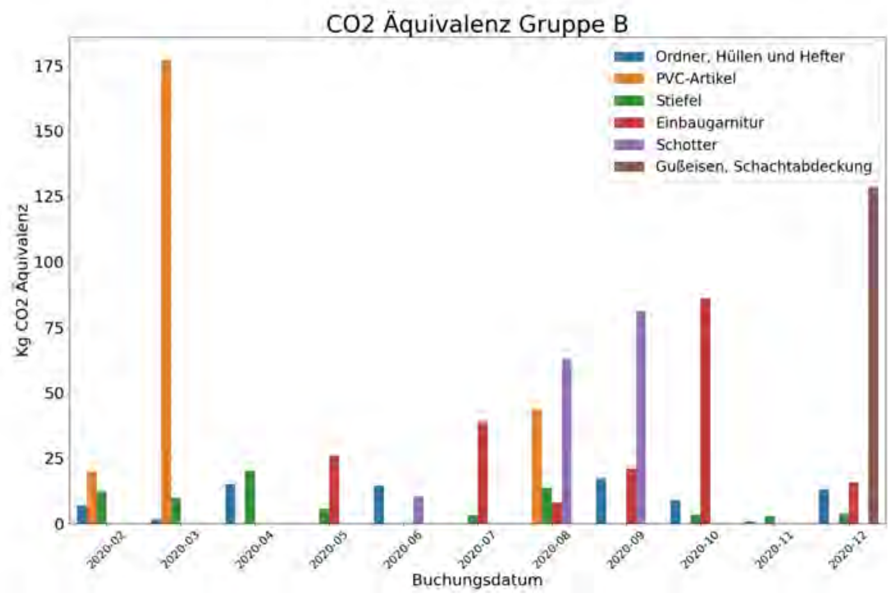


Figure 47: $CO_2$ Äquivalenz Gebrauchsgüter Gruppe B (2020)

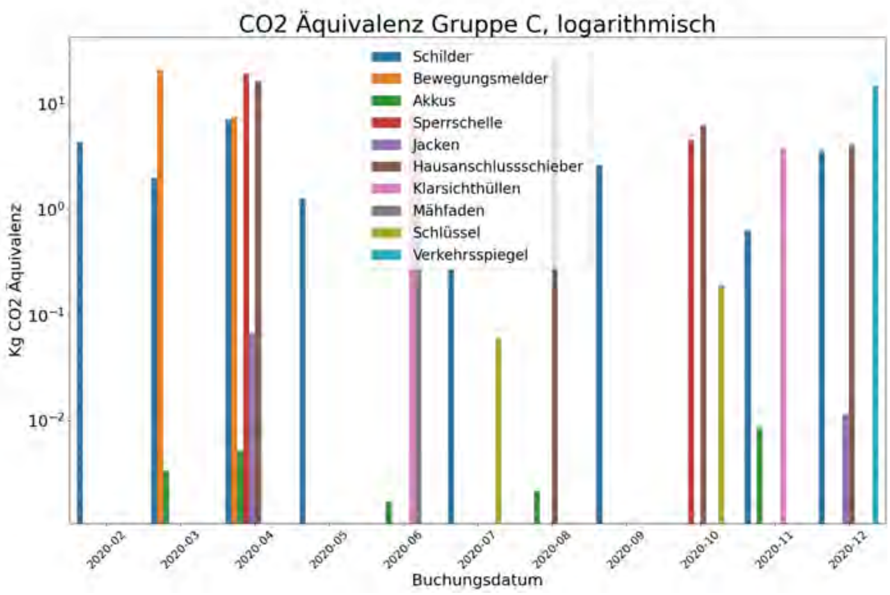


Figure 48: $CO_2$ Äquivalenz Gebrauchsgüter Gruppe C logarithmisch (2020)

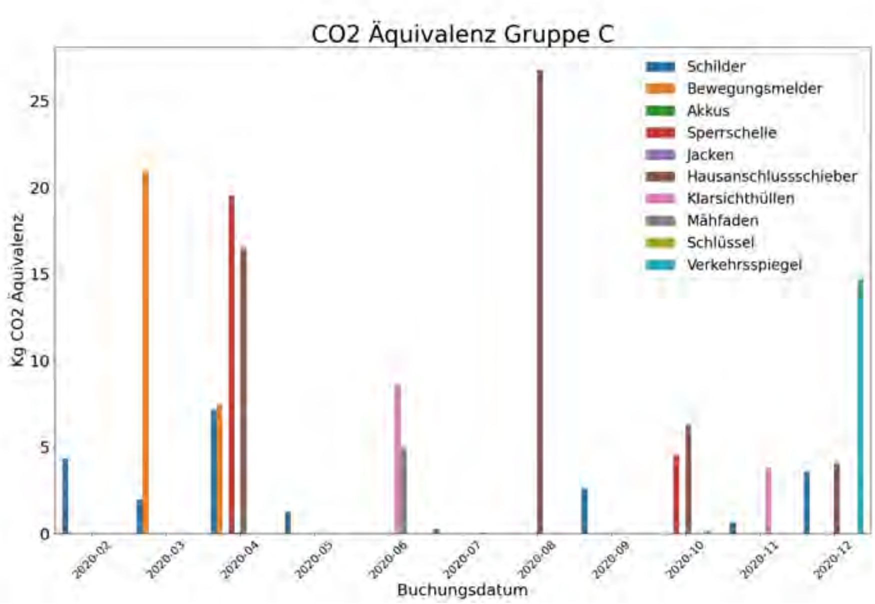


Figure 49: $CO_2$ Äquivalenz Gebrauchsgüter Gruppe C (2020)

In the following graphs, labeled 50-79, we present the $CO_2$ equivalent emissions of non-durable goods in the year 2022. These graphs provide a segmented representation of the distinct categories within the ABC analysis of $CO_2$ equivalent emissions, aiming to enhance clarity and comprehensibility. Additionally, for each category within the ABC analysis, a secondary graph is included, which employs a logarithmic scale to facilitate the identification of products with lower $CO_2$ equivalent emissions.

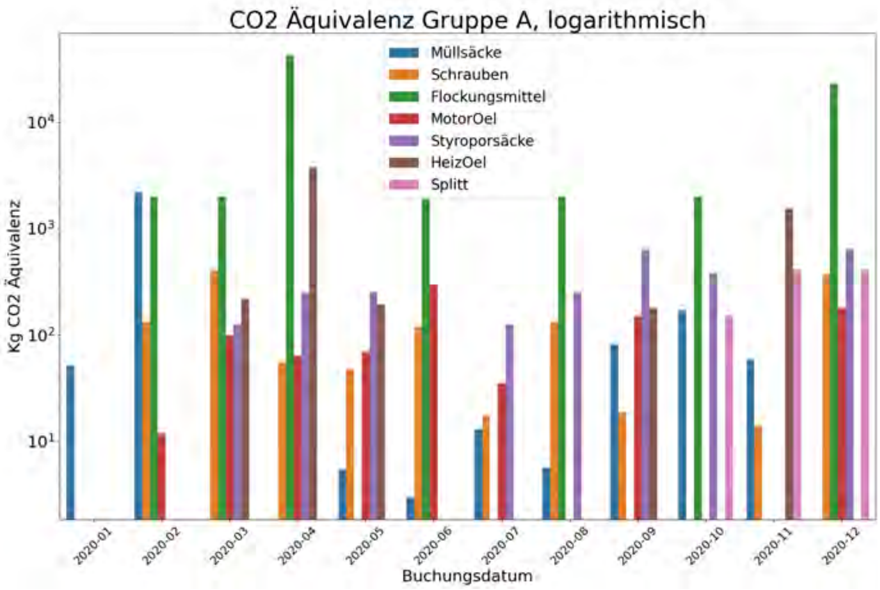


Figure 50: $CO_2$ Äquivalenz Verbrauchsgüter Gruppe A logarithmisch (2020)

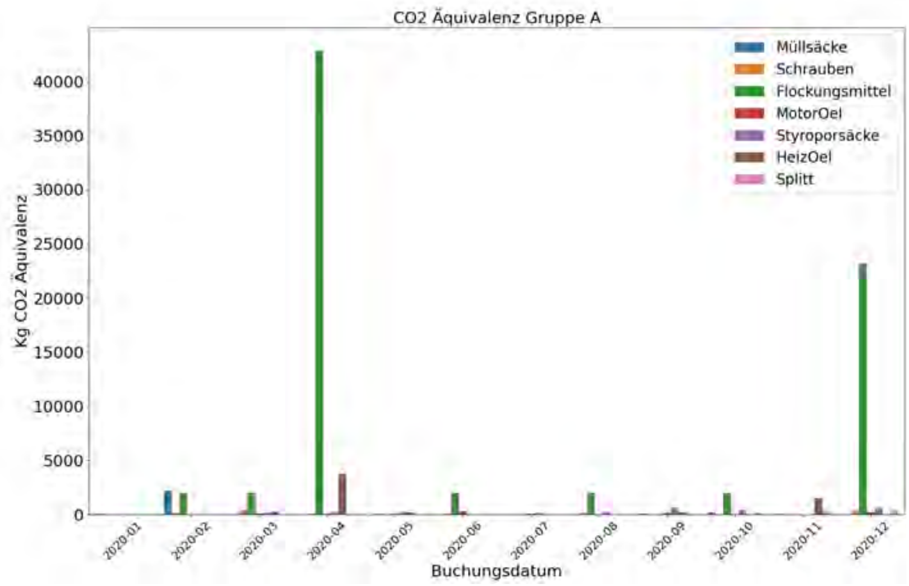


Figure 51: $CO_2$ Äquivalenz Verbrauchsgüter Gruppe A (2020)

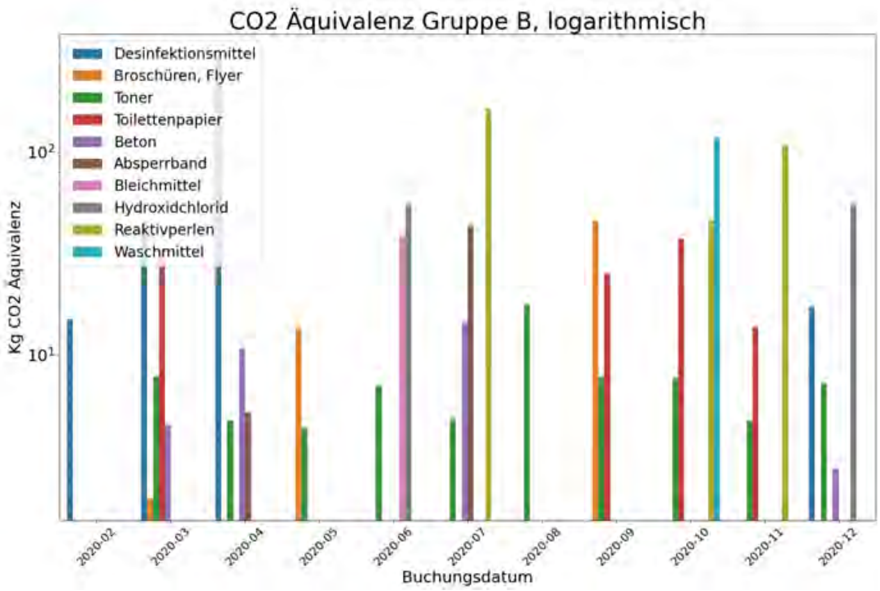


Figure 52: $CO_2$ Äquivalenz Verbrauchsgüter Gruppe B logarithmisch (2020)

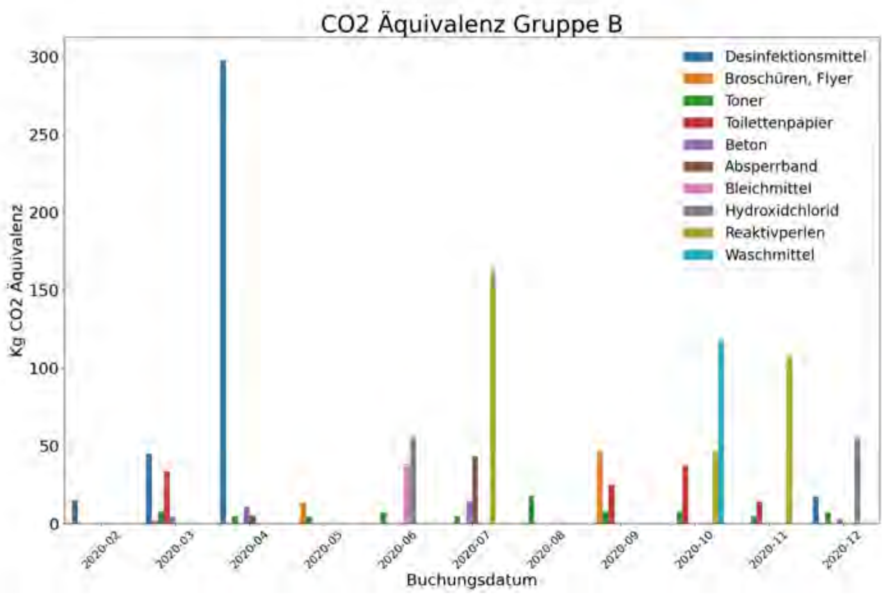


Figure 53: $CO_2$ Äquivalenz Verbrauchsgüter Gruppe B (2020)

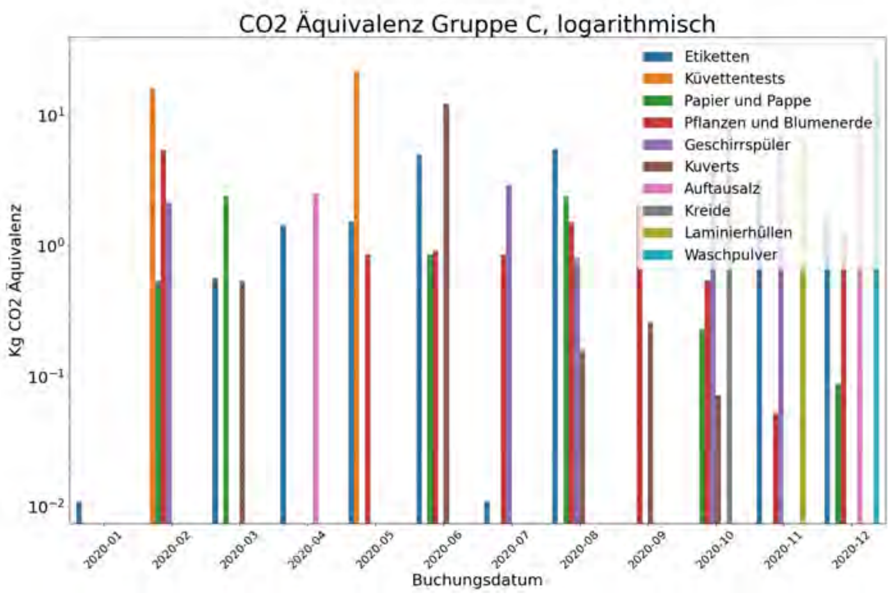


Figure 54: $CO_2$ Äquivalenz Verbrauchsgüter Gruppe C logarithmisch (2020)

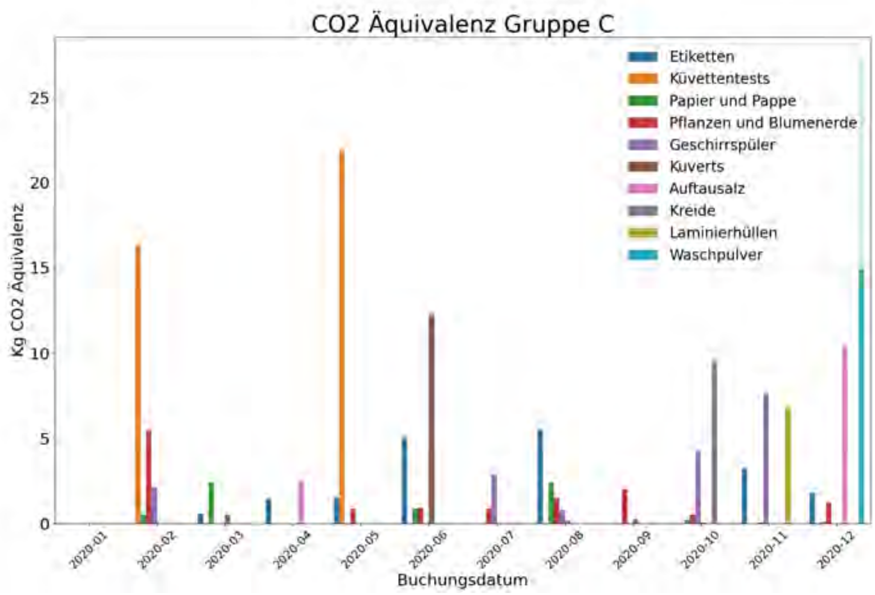


Figure 55: $CO_2$ Äquivalenz Verbrauchsgüter Gruppe C (2020)

## 2021

The following paragraph addresses the results of the analysis of the municipality Ferlachfor the year 2021.

The Tables 10 and 9 provide a summary of durable and non-durable goods from the year 2021.

| Gut | Ausgaben (Euro) | ABC Cost | XYZ Cost | Menge (kg) | Kg CO2 Equiv | ABC CO2 | XYZ CO2 |
|---|---|---|---|---|---|---|---|
| HeizOel | 4554.15 | B | Z | 3543.1287 | 12400.95045 | A | Z |
| Flockungsmittel | 12768 | A | Y | 5250 | 9964.5 | A | Y |
| Splitt | 4797.36 | A | X | 227429.84 | 2046.86856 | A | X |
| Schrauben | 1090.71 | C | Y | 1563.57652 | 2032.649476 | A | Y |
| Müllsäcke | 2424.73 | B | X | 672.22343 | 1344.44686 | A | X |
| Aluminiumchlorid | 12556.2 | A | Z | 125.562 | 1004.496 | A | Z |
| MotorOel | 2158.61 | B | Z | 258.6216 | 905.1756 | A | Z |
| Broschüren und Flyer | 3131.14 | B | Z | 917.42402 | 596.325613 | B | Z |
| Reaktivperlen | 4825.68 | A | Y | 460.369872 | 303.84411552 | B | Y |
| Beton | 2531.92 | B | X | 133.2549496 | 239.85890928 | B | X |
| Toilettenpapier | 1723.43 | B | X | 311.17104 | 202.261176 | B | X |
| Laminierhüllen | 217.98 | C | Y | 70.58871 | 141.17742 | B | Y |
| Desinfektionsmittel | 134.4 | C | Z | 13.7088 | 137.088 | B | Z |
| Geschirrspüler | 504.44 | C | Z | 167.97852 | 75.590334 | B | Z |
| Waschpulver | 84.2 | C | Z | 38.984 | 66.2728 | B | Z |
| Hydroxidchlorid | 880 | C | Z | 102.96 | 55.28952 | B | Z |
| Pflanzen und Blumenerde | 15029.67 | A | Y | 5992.3597008 | 53.9312373072 | C | Y |
| Kreide | 460.48 | C | Z | 161.168 | 48.3504 | C | Z |
| Toner | 920.5 | C | Z | 5.7751 | 46.2008 | C | Z |
| Auftausalz | 12700.08 | A | Z | 384.499 | 38.4499 | C | Z |
| Bleichmittel | 616.92 | C | Y | 11.968248 | 25.1333208 | C | Y |
| Etiketten | 1005.25 | C | Z | 10.720625 | 23.585375 | C | Z |
| Küvettentests | 4658.48 | A | X | 13.6959312 | 23.28308304 | C | X |
| Papier und Pappe | 3750.85 | B | Z | 21.379845 | 13.89689925 | C | Z |
| Kuverts | 1234.3 | B | X | 10.24469 | 6.6590485 | C | X |
| Waschmittel | 12.39 | C | Y | 3.8799285 | 6.59587845 | C | Y |
| Druckerpatronen | 329.62 | C | X | 1.08604882 | 4.88721969 | C | X |
| Absperrband | 20.47 | C | Y | 1.59666 | 3.11189034 | C | Y |
| Kerzen | 123.23 | C | X | 0.9722847 | 2.9168541 | C | X |
| Pellets | 1694.16 | B | X | 6581.033 | 0.77847039357 | C | X |
| Batterien | 333.66 | C | Z | 16.683 | 0.088820292 | C | Z |
| Mikrofasertücher | 147.3 | C | Z | 4.10967 | 0.02876769 | C | Z |

Table 9: Ferlach, Verbrauchsgüter, 2021

| Gut | Ausgaben (Euro) | ABC Cost | XYZ Cost | Menge (kg) | Kg CO2 Equiv | ABC CO2 | XYZ CO2 |
|---|---|---|---|---|---|---|---|
| Wasserzähler | 22416.39 | A | Y | 1631.71593314793 | 56228.9310562778 | A | Y |
| Gußeisen (Schachtabdeckung) | 9174.56 | A | Y | 1981.70496 | 1981.70496 | A | Y |
| Reifen | 168.9 | C | Y | 2.11125 | 1253.449125 | A | Y |
| Lampen | 570.07 | C | Z | 27.0327194 | 931.547510524 | A | Z |
| PVC-Artikel | 528.27 | C | Z | 143.27724 | 634.7181732 | A | Z |
| Schotter | 4275.33 | B | Y | 32885.83836 | 295.97254524 | B | Y |
| Hausanschlussschieber | 6155.76 | A | X | 153.894 | 200.0622 | B | X |
| Stiefel | 4578.73 | B | Y | 48.15994740397 | 139.663847471513 | B | Y |
| Einbaugarnitur | 2015.53 | B | Z | 46.35719 | 92.71438 | B | Z |
| Schilder | 12985.33 | A | Y | 68.822249 | 89.4689237 | B | Y |
| Bewegungsmelder | 350.9 | C | Z | 1.82468 | 62.8784728 | B | Z |
| Ordner und Hefter | 1242.11 | C | Y | 60.4015988 | 39.26103922 | C | Y |
| Klarsichthüllen | 169.19 | C | Y | 10.912755 | 21.82551 | C | Z |
| Bücher | 103.23 | C | Y | 19.648 | 19.648 | C | Y |
| Sperrschelle | 1380.47 | B | Z | 12 | 15.6 | C | Z |
| Verkehrsspiegel | 2063.15 | B | X | 10.934695 | 14.2151035 | C | X |
| Mähfaden | 113.12 | C | X | 3.156048 | 10.0993536 | C | X |
| Bohrer | 17.94 | C | Y | 3.3189 | 4.31457 | C | Y |
| Schlüssel | 255.24 | C | Y | 0.25524 | 0.331812 | C | Y |
| Jacken | 4636.96 | A | X | 22.3138498422184 | 0.156196948895529 | C | X |
| Akkus | 1942.88 | B | Y | 13.60016 | 0.07924813232 | C | Y |
| Arbeitshose | 474.24 | C | X | 2.47881503732928 | 0.017351705261305 | C | X |

Table 10: Ferlach, Gebrauchsgüter, 2021

The following six graphs (Figures 56-61) show the $CO_2$ equivalent emissions of the durable goods for the year 2021. The individual groups of the ABC analysis of $CO_2$ equivalent emissions are presented separately to enhance clarity. Additionally, for each group in the ABC analysis, there is a second graph that represents the results on a logarithmic scale to facilitate the identification of products with lower $CO_2$ equivalent emissions.

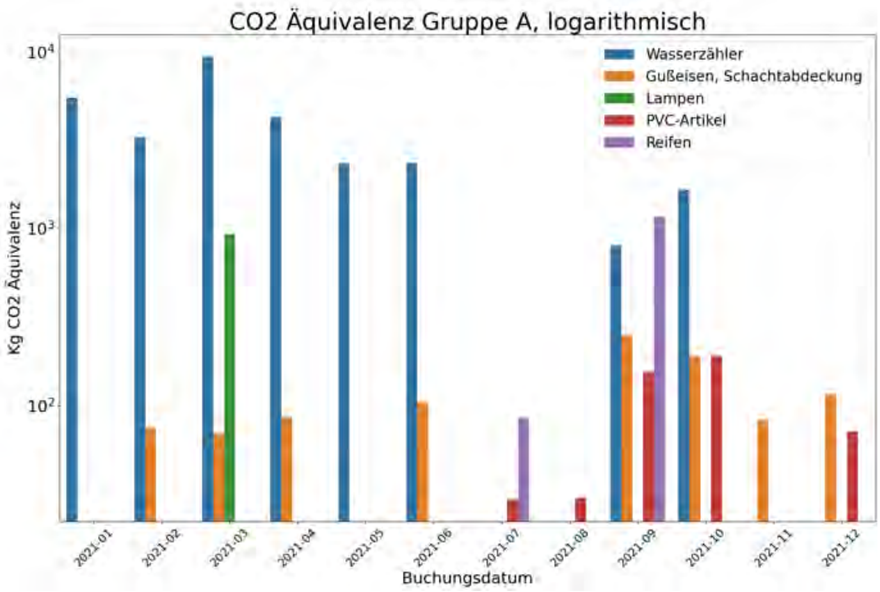


Figure 56: $CO_2$ Äquivalenz Gebrauchsgüter Gruppe A logarithmisch (2021)

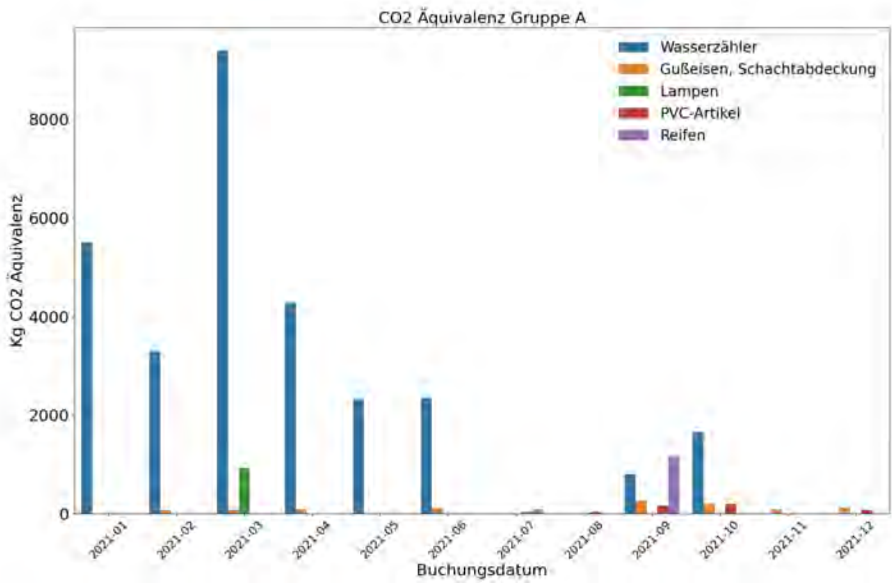


Figure 57: $CO_2$ Äquivalenz Gebrauchsgüter Gruppe A (2021)

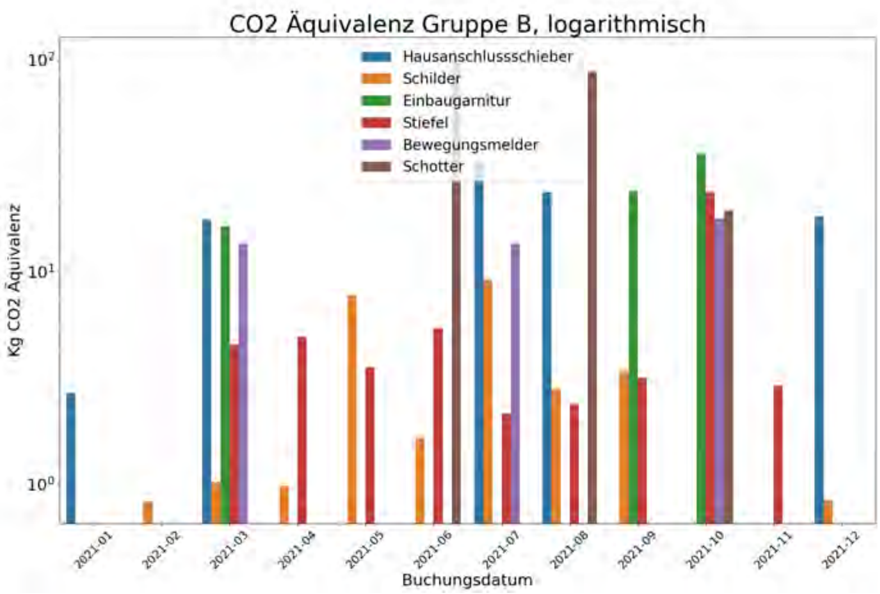


Figure 58: $CO_2$ Äquivalenz Gebrauchsgüter Gruppe B logarithmisch (2021)

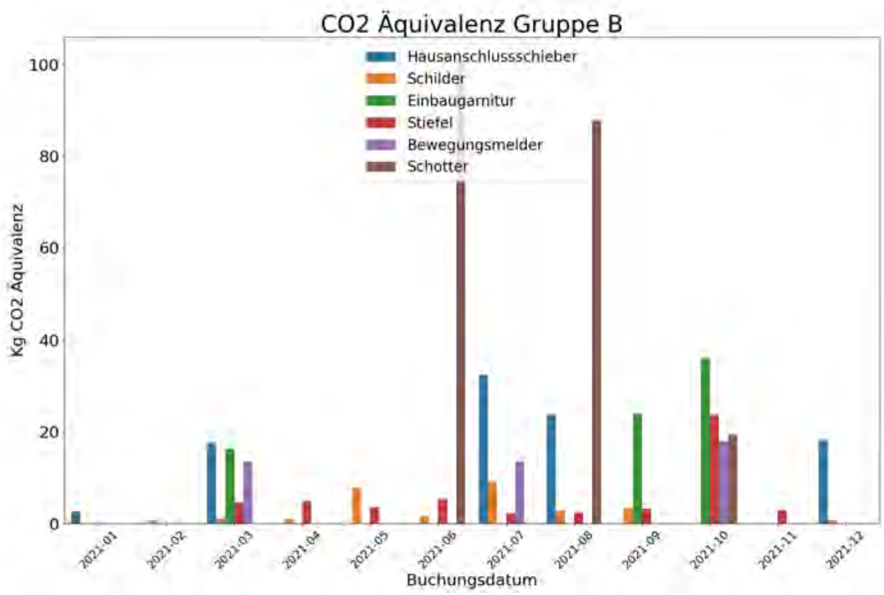


Figure 59: $CO_2$ Äquivalenz Gebrauchsgüter Gruppe B (2021)

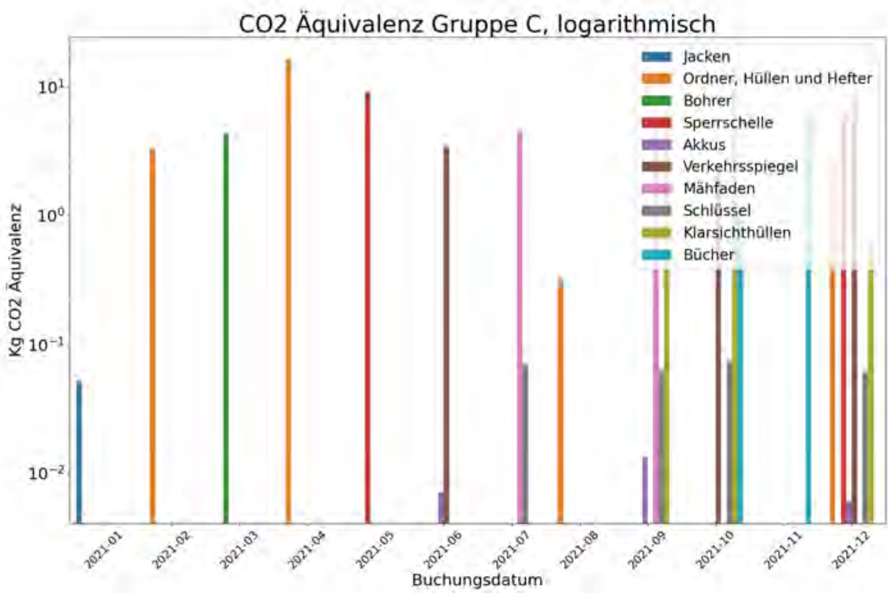


Figure 60: $CO_2$ Äquivalenz Gebrauchsgüter Gruppe C logarithmisch (2021)

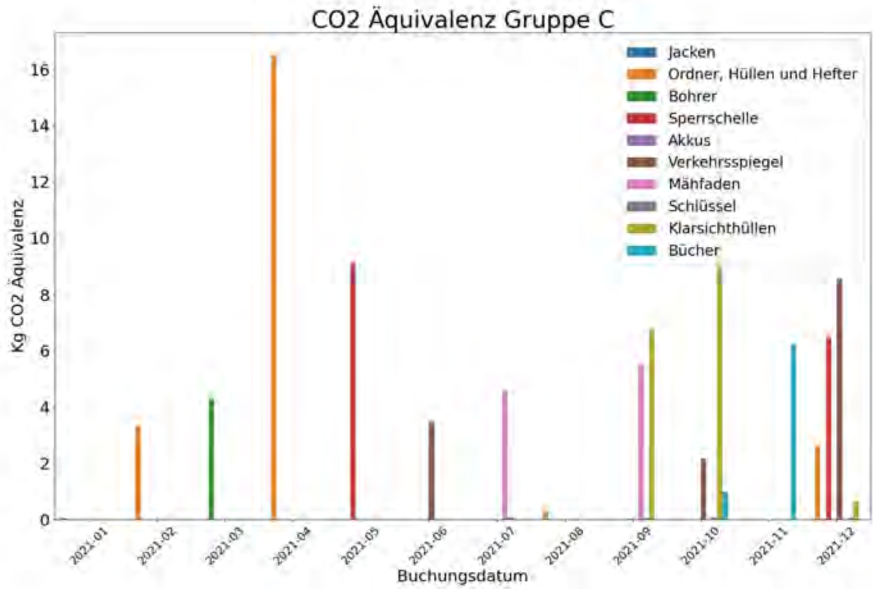


Figure 61: $CO_2$ Äquivalenz Gebrauchsgüter Gruppe C (2021)

In the following graphs, labeled 62-67, we present the $CO_2$ equivalent emissions of non-durable goods in the year 2021. These graphs provide a segmented representation of the distinct categories within the ABC analysis of $CO_2$ equivalent emissions, aiming to enhance clarity and comprehensibility. Additionally, for each category within the ABC analysis, a secondary graph is included, which employs a logarithmic scale to facilitate the identification of products with lower $CO_2$ equivalent emissions.

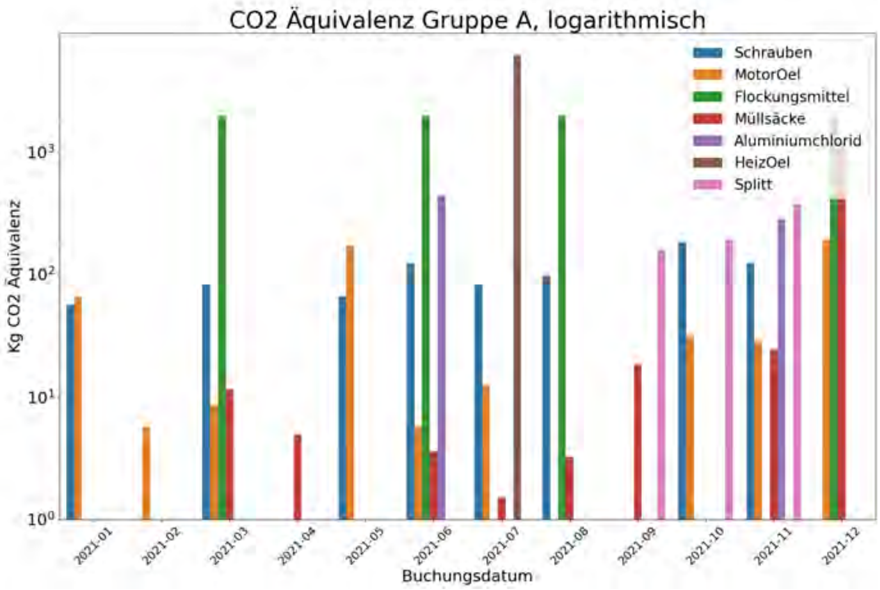


Figure 62: $CO_2$ Äquivalenz Verbrauchsgüter Gruppe A logarithmisch (2021)

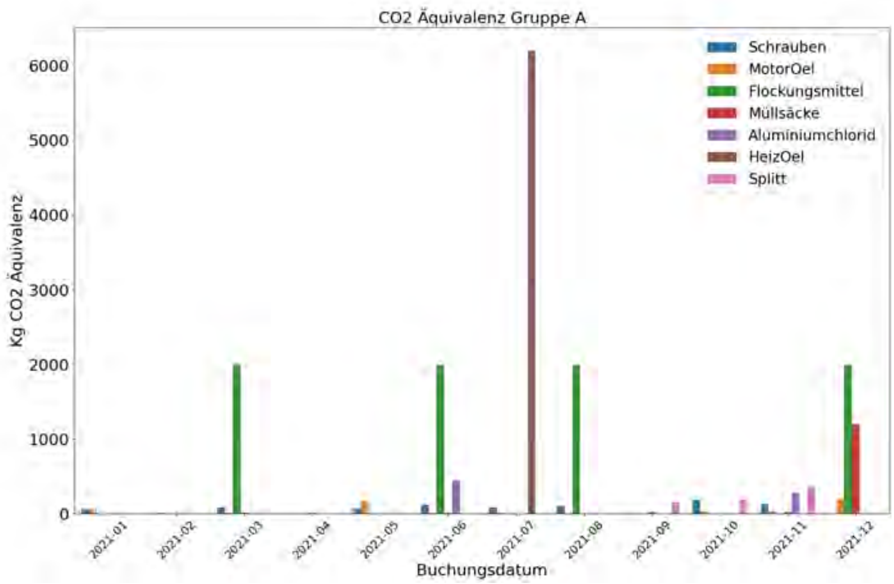


Figure 63: $CO_2$ Äquivalenz Verbrauchsgüter Gruppe A (2021)

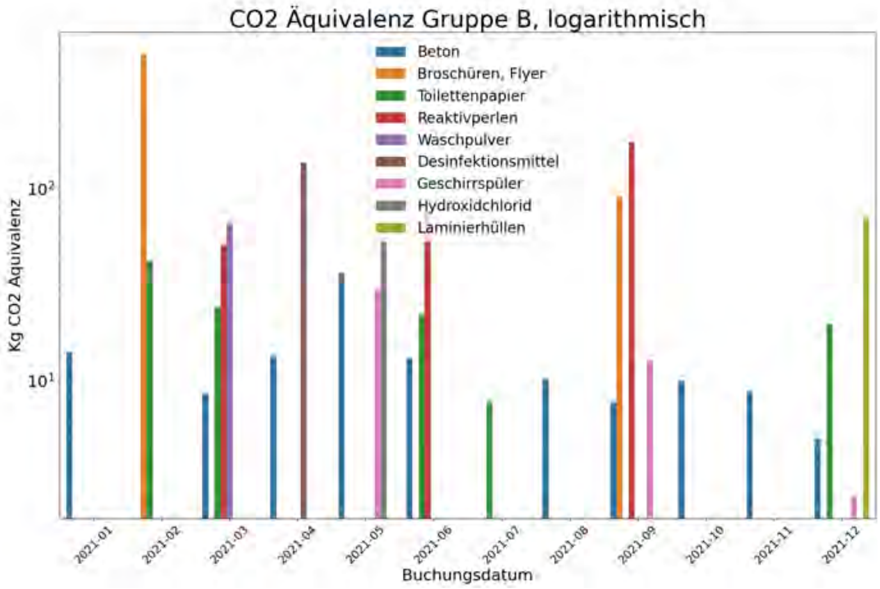


Figure 64: $CO_2$ Äquivalenz Verbrauchsgüter Gruppe B logarithmisch (2021)

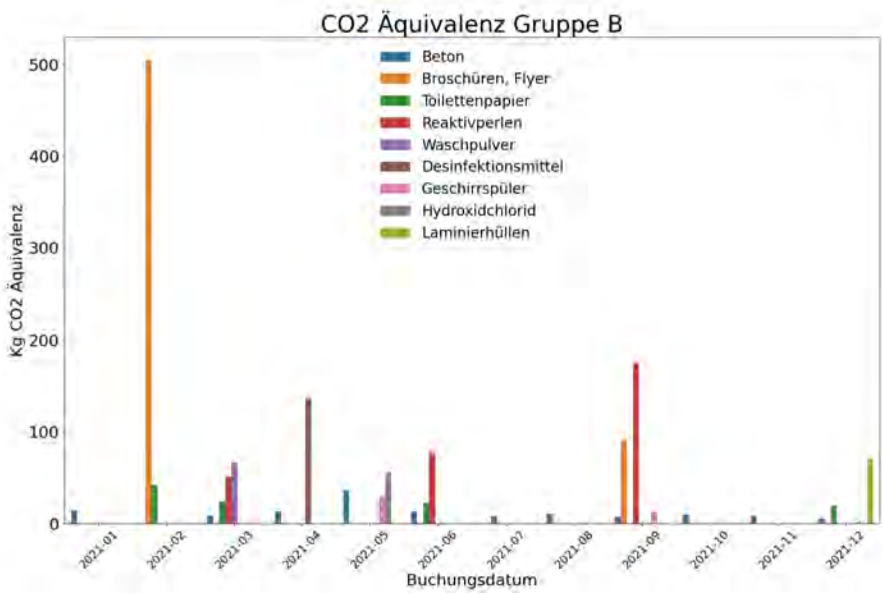


Figure 65: $CO_2$ Äquivalenz Verbrauchsgüter Gruppe B (2021)

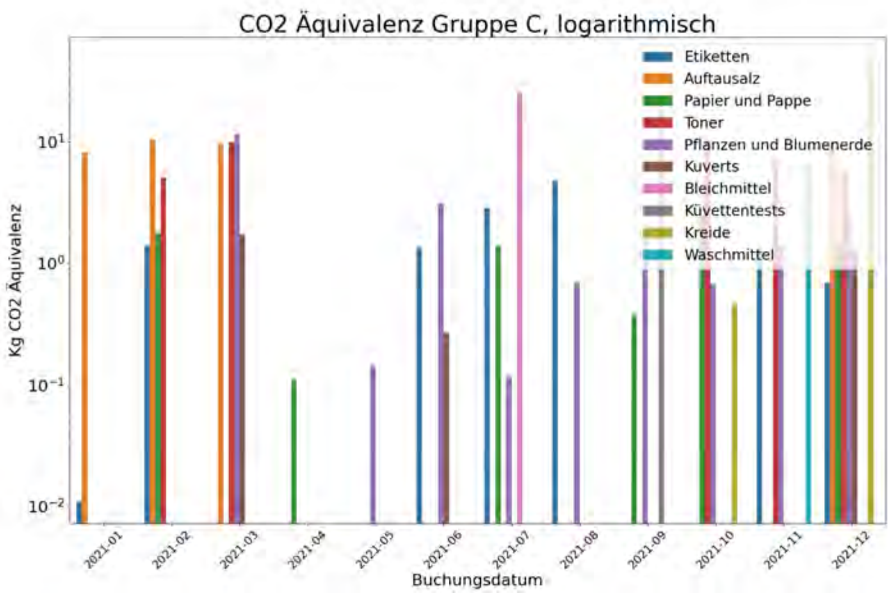


Figure 66: $CO_2$ Äquivalenz Verbrauchsgüter Gruppe C logarithmisch (2021)

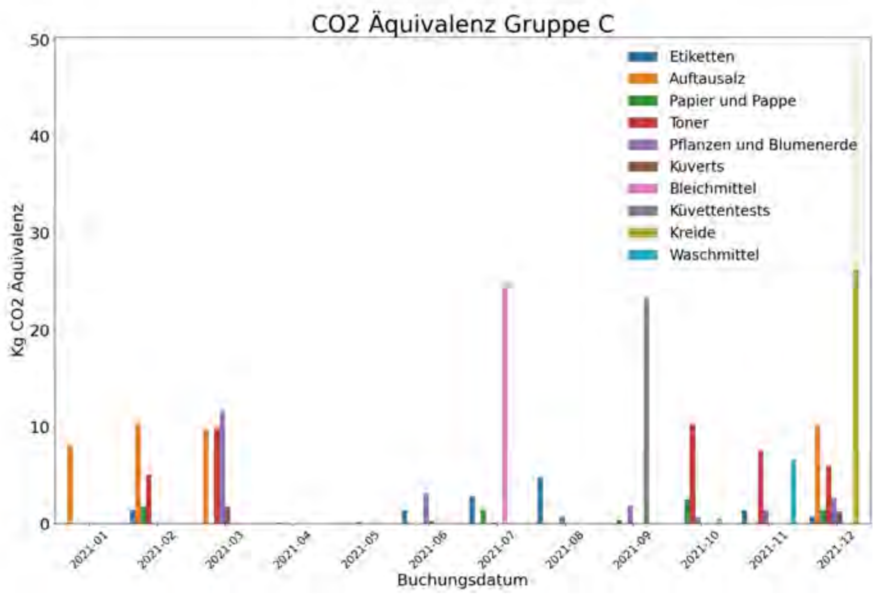


Figure 67: $CO_2$ Äquivalenz Verbrauchsgüter Gruppe C (2021)

## 2022

The following paragraph addresses the results of the analysis of the municipality Ferlachfor the year 2022.

The Tables 12 and 11 provide a summary of durable and non-durable goods from the year 2022.

| Gut | Ausgaben (Euro) | ABC Cost | ABC CO2 | Menge (kg) | Kg CO2 Equiv | XYZ Cost | XYZ CO2 |
|---|---|---|---|---|---|---|---|
| Wasserzähler | 26932.54 | A | A | 1960.45133061953 | 67557.1528531492 | X | X |
| Reifen | 601.21 | C | A | 12.72016 | 7551.958992 | Y | Y |
| LED Belichtung | 7042.21 | A | A | 55.5630369 | 1889.1432546 | X | X |
| Gußeisen (Schachtabdeckung) | 4322.82 | B | A | 933.72912 | 933.72912 | Z | Y |
| Einbaugarnitur | 14590.17 | A | A | 337.90057 | 675.80114 | Y | Z |
| Bücher | 1198.06 | C | B | 459.036 | 459.036 | X | X |
| Ordner und Hefter | 2175.67 | B | B | 363.871126 | 236.5162319 | Y | Y |
| PVC-Artikel | 329.91 | C | B | 50.2047105 | 222.406867515 | X | X |
| Stiefel | 5362.26 | A | B | 54.4619574163062 | 157.939676507288 | Z | Z |
| Lampen | 349.04 | C | B | 4 | 137.84 | Z | Z |
| Hausanschlussschieber | 3983.86 | B | B | 99.5965 | 129.47545 | Z | Z |
| Bewegungsmelder | 341.79 | C | C | 2.0760594 | 71.541006924 | Z | Z |
| Bohrer | 183.06 | C | C | 48.459 | 62.9967 | Y | Y |
| Schilder | 5916.09 | A | C | 32.5877502 | 42.36407526 | Y | Y |
| Sperrschelle | 1635.42 | B | C | 31.1055 | 40.43715 | Y | Y |
| Klarsichthüllen | 156.44 | C | C | 10.09038 | 20.18076 | X | X |
| Verkehrsspiegel | 445.98 | C | C | 2.363694 | 3.0728022 | Y | Y |
| Schlüssel | 204.25 | C | C | 0.20425 | 0.265525 | Y | Y |
| Jacken | 3901.44 | B | C | 18.7744009714176 | 0.131420806799923 | X | X |
| Akkus | 2085.08 | B | C | 14.50743 | 0.08453479461 | Z | Z |
| Arbeitshose | 306.48 | C | C | 1.60194676248456 | 0.011213627337392 | X | X |

Table 11: Ferlach, Gebrauchsgüter, 2022

| Gut | Ausgaben (Euro) | Menge (kg) | Kg CO2 Equiv | ABC Cost | ABC CO2 | XYZ Cost | XYZ CO2 |
|---|---|---|---|---|---|---|---|
| Flockungsmittel | 25012.99 | 35810 | 67967.38 | A | A | Z | Z |
| HeizOel | 6438.57 | 5009.20746 | 17532.22611 | A | A | Y | Y |
| Schrauben | 4683.72 | 7386.46505 | 9602.404565 | B | A | Z | Z |
| Müllsäcke | 5520.92 | 1312.30106 | 2624.60212 | B | A | X | X |
| Splitt | 3787.2 | 168000.058 | 1512.000522 | B | A | Y | Y |
| MotorOel | 1233.04 | 147.9648 | 517.8768 | B | A | Y | Y |
| Aluminiumchlorid | 5708.96 | 57.089 | 456.712 | B | A | Z | Z |
| Desinfektionsmittel | 431.13 | 43.97526 | 439.7526 | C | B | Y | Z |
| Reaktivperlen | 6297.6 | 600.79104 | 396.5220864 | A | B | Y | Y |
| Klebstoff | 277.4 | 73.723945 | 294.89578 | C | B | Z | Z |
| Toilettenpapier | 2005.4 | 356.9612 | 232.02478 | B | B | X | X |
| Waschmittel | 408.52 | 128.138845 | 217.8360365 | C | B | X | Y |
| Beton | 1882.91 | 99.0975533 | 178.37559594 | B | B | Z | Z |
| Broschüren und Flyer | 929.52 | 182.17836 | 118.415934 | B | B | Y | Y |
| Küvettentests | 11698.75 | 34.394325 | 58.4703525 | A | B | Z | Z |
| Auftausalz | 17418.42 | 452.35 | 45.235 | A | B | Z | Z |
| Toner | 762.57 | 4.9608228 | 39.6865824 | C | C | Z | Z |
| Pflanzen und Blumenerde | 9908.15 | 3963.26 | 35.66934 | A | C | Y | Y |
| Bleichmittel | 864.27 | 16.766838 | 35.2103598 | C | C | Z | Z |
| Absperrband | 335.83 | 16.949907484785 | 33.035369687846 | C | C | Y | Y |
| Etiketten | 858.4 | 8.395 | 18.469 | C | C | Y | Y |
| Papier und Pappe | 4468.45 | 25.453721 | 16.54491865 | B | C | Y | Y |
| Laminierhüllen | 71.29 | 6.62997 | 13.25994 | C | C | Y | Y |
| Pellets | 6761.16 | 25383.392 | 3.00260143968 | A | C | Y | Y |
| Kerzen | 37.62 | 0.2968218 | 0.8904654 | C | C | Y | Y |
| Kreide | 4.98 | 1.743 | 0.5229 | C | C | Z | Z |
| Kuverts | 61.86 | 0.513438 | 0.3337347 | C | C | Y | Y |
| Druckerpatronen | 32.57 | 0.04341581 | 0.195371145 | C | C | Y | Y |
| Mikrofasertücher | 405.09 | 11.302011 | 0.079114077 | C | C | X | X |
| AdBlue | 540.88 | 0.0566 | 0.058298 | C | C | Y | X |
| Batterien | 71.54 | 3.577 | 0.019043948 | C | C | Y | Y |

Table 12: Ferlach, Verbrauchsgüter, 2022

The following six graphs (Figures 68-73) show the $CO_2$ equivalent emissions of the durable goods for the year 2022. The individual groups of the ABC analysis of $CO_2$ equivalent emissions are presented separately to enhance clarity. Additionally, for each group in the ABC analysis, there is a second graph that represents the results on a logarithmic scale to facilitate the identification of products with lower $CO_2$ equivalent emissions.

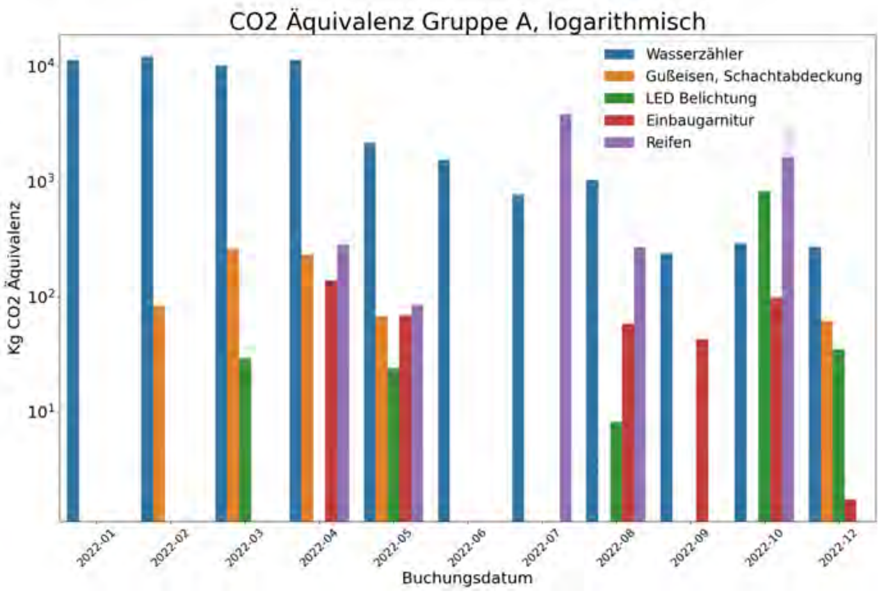


Figure 68: $CO_2$ Äquivalenz Gebrauchsgüter Gruppe A logarithmisch (2022)

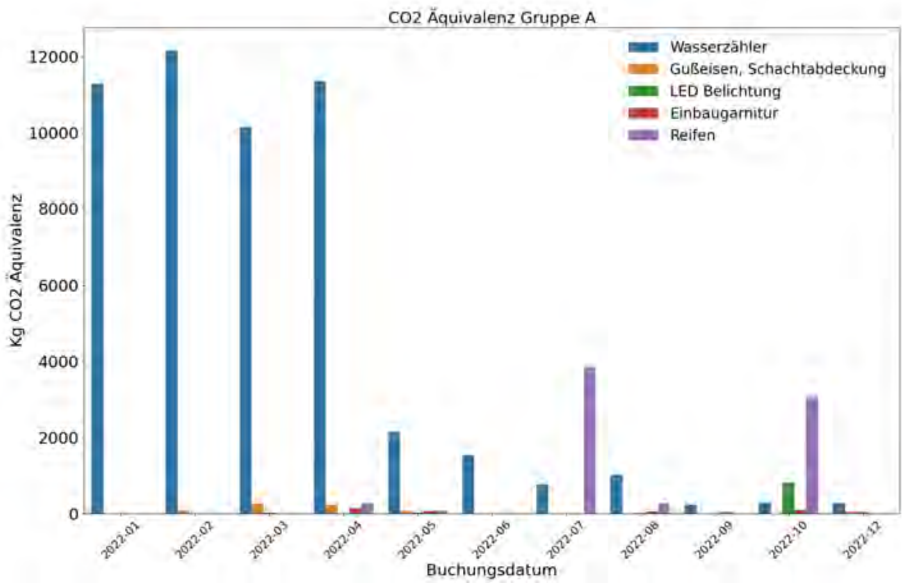


Figure 69: $CO_2$ Äquivalenz Gebrauchsgüter Gruppe A (2022)

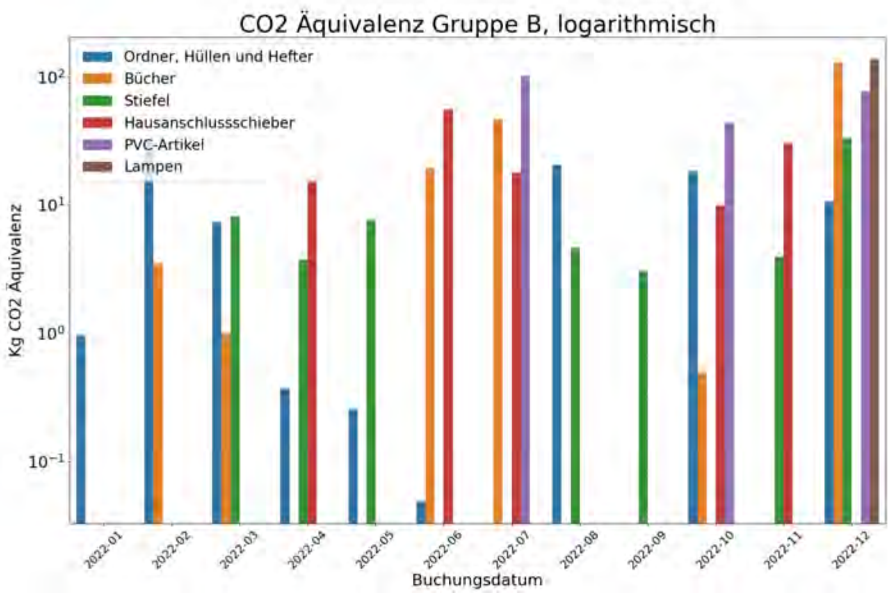


Figure 70: $CO_2$ Äquivalenz Gebrauchsgüter Gruppe B logarithmisch (2022)

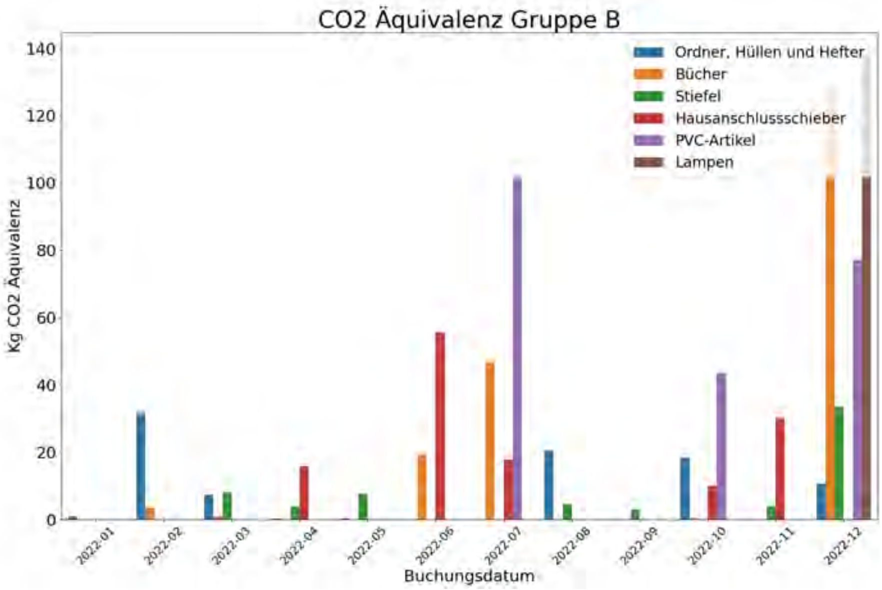


Figure 71: $CO_2$ Äquivalenz Gebrauchsgüter Gruppe B (2022)

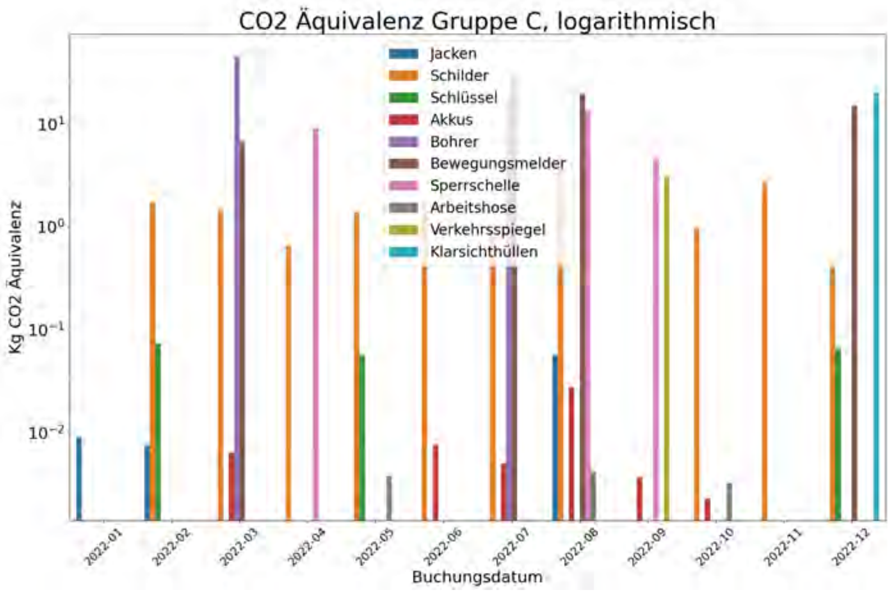


Figure 72: $CO_2$ Äquivalenz Gebrauchsgüter Gruppe C logarithmisch (2022)

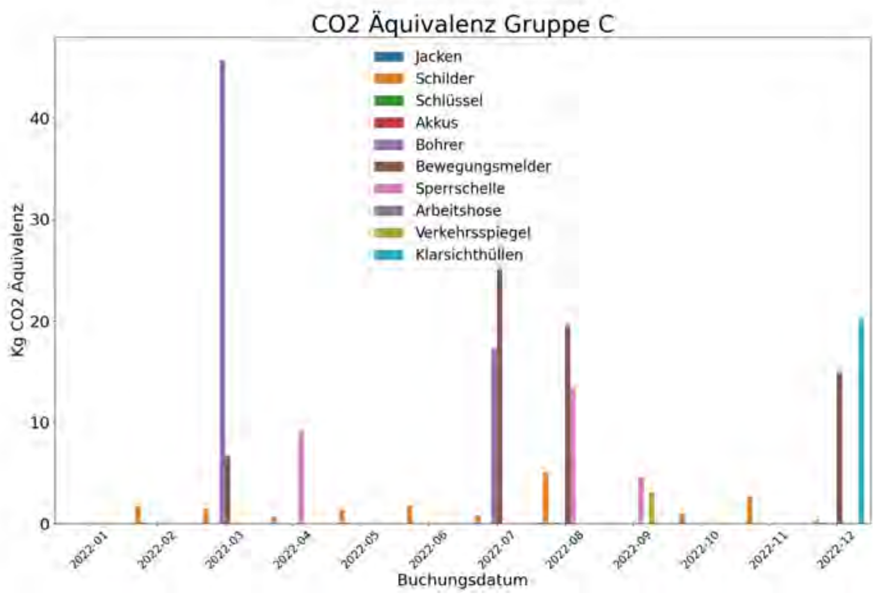


Figure 73: $CO_2$ Äquivalenz Gebrauchsgüter Gruppe C (2022)

In the following graphs, labeled 74-79, we present the $CO_2$ equivalent emissions of non-durable goods in the year 2022. These graphs provide a segmented representation of the distinct categories within the ABC analysis of $CO_2$ equivalent emissions, aiming to enhance clarity and comprehensibility. Additionally, for each category within the ABC analysis, a secondary graph is included, which employs a logarithmic scale to facilitate the identification of products with lower $CO_2$ equivalent emissions.

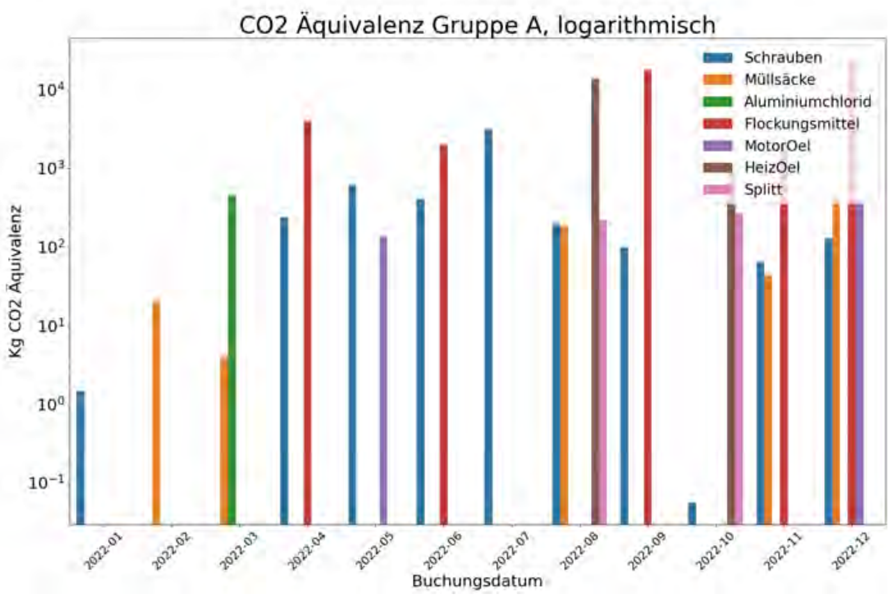


Figure 74: $CO_2$ Äquivalenz Verbrauchsgüter Gruppe A logarithmisch (2022)

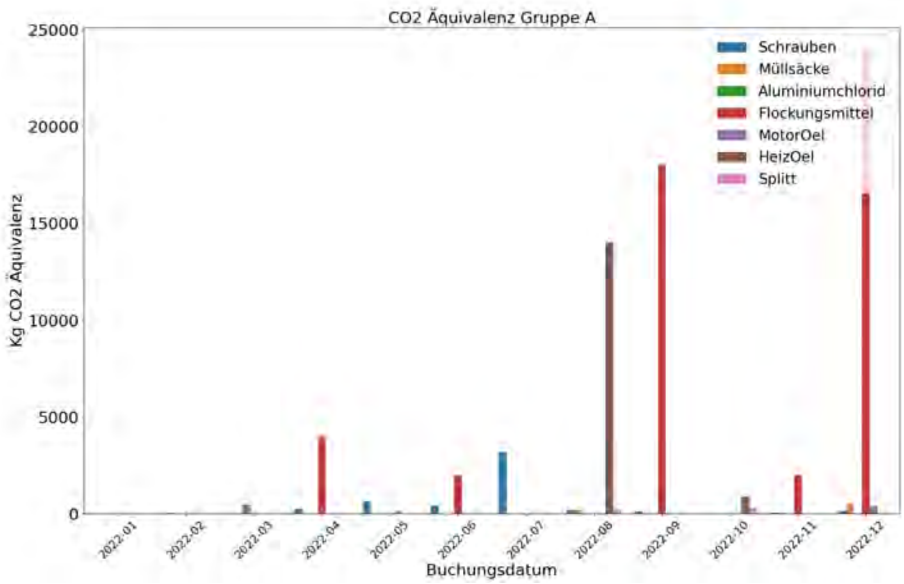


Figure 75: $CO_2$ Äquivalenz Verbrauchsgüter Gruppe A (2022)

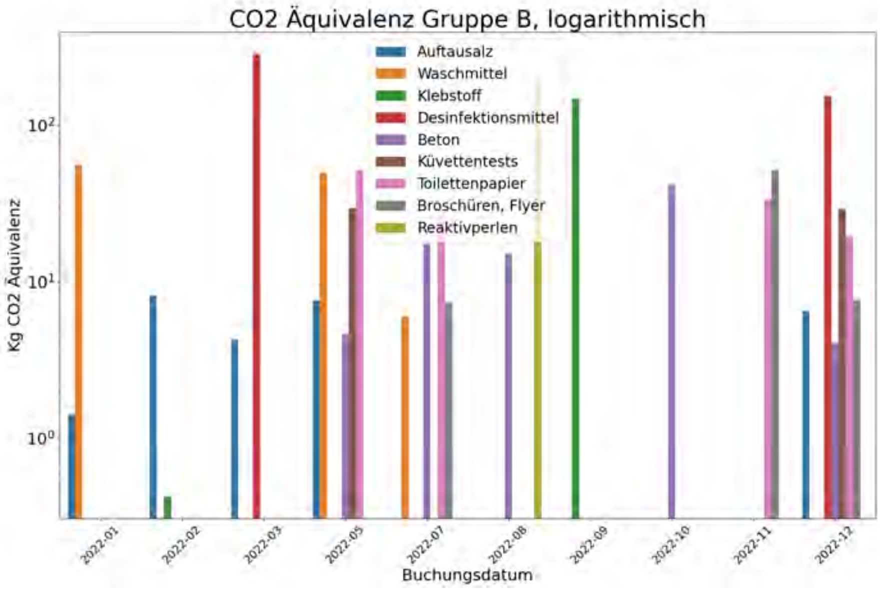


Figure 76: $CO_2$ Äquivalenz Verbrauchsgüter Gruppe B logarithmisch (2022)

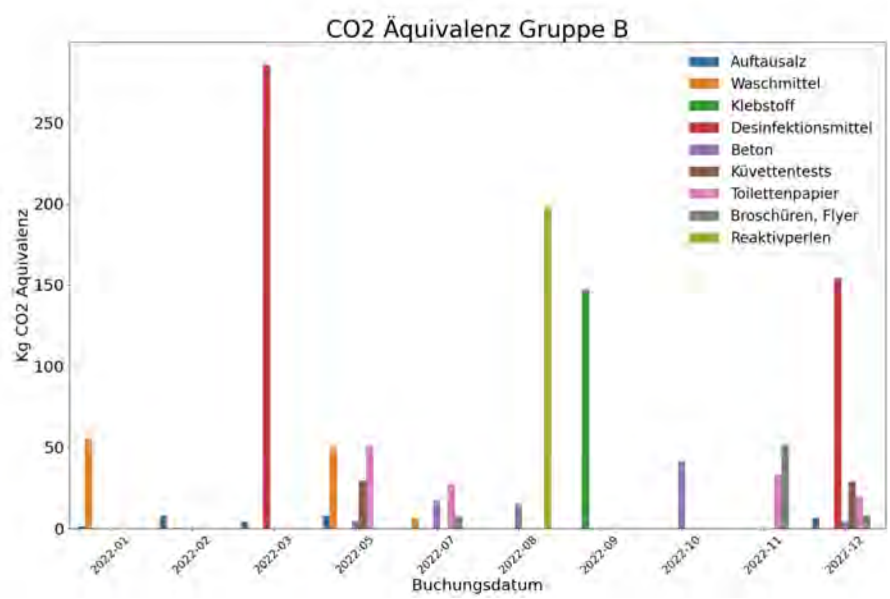


Figure 77: $CO_2$ Äquivalenz Verbrauchsgüter Gruppe B (2022)

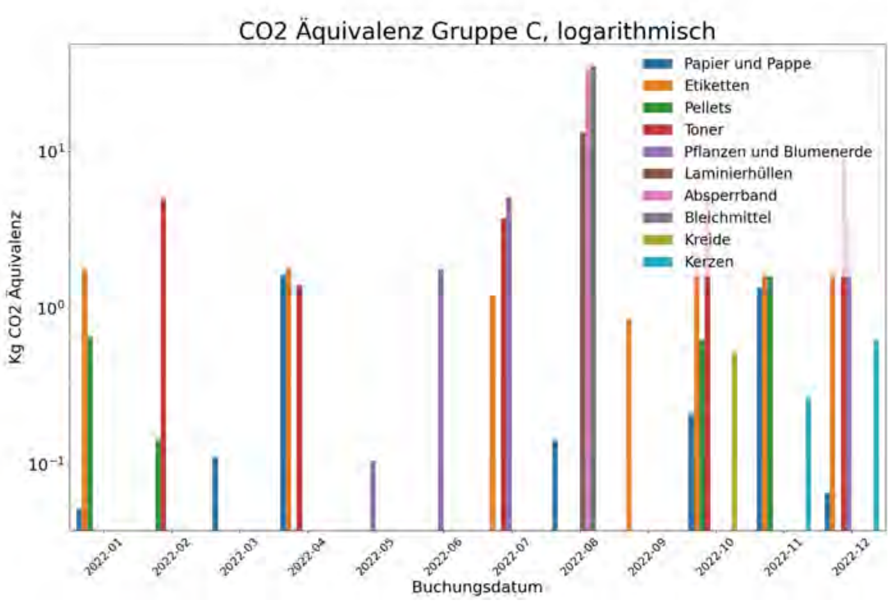


Figure 78: $CO_2$ Äquivalenz Verbrauchsgüter Gruppe C logarithmisch (2022)

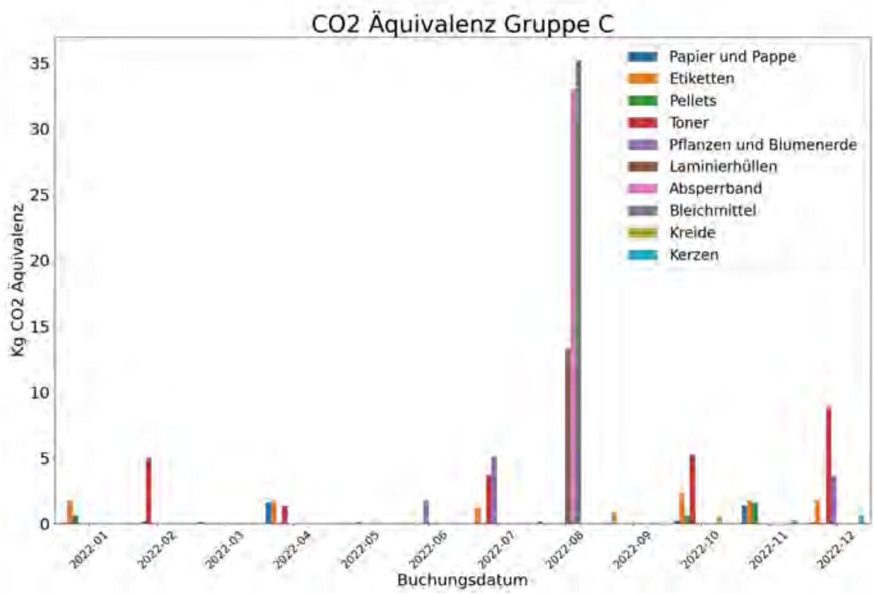


Figure 79: $CO_2$ Äquivalenz Verbrauchsgüter Gruppe C (2022)

## Köttmannsdorf

In the following chapter, the results for the municipality of Köttmannsdorfare presented graphically. Initially, the outcomes for the entire time span from 2018 to 2022 will be depicted, followed by the annual results.

## Entire timespan (2018 to 2022)

In figure 80 gives an overview of all expenses sorted by the amount from the year 2018 to 2022.

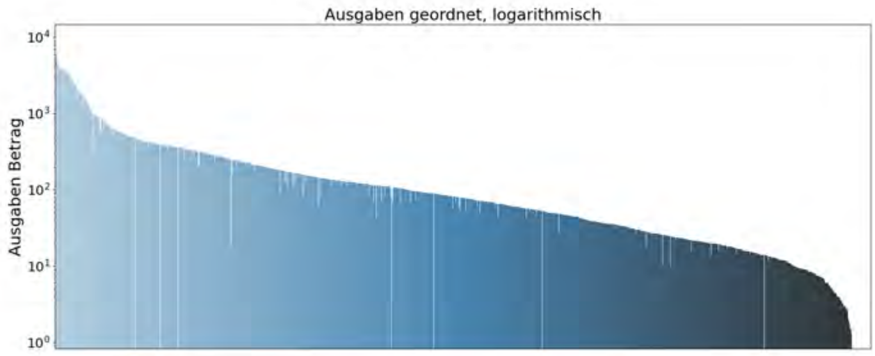


Figure 80: Übersicht aller Ausgaben, geordnet nach Betrag, 2018 bis 2022

The following Tables 13 and 14 provide a summary of durable and non-durable goods during the period from 2018 to 2022.

| Gut | Ausgaben (Euro) | ABC Cost | XYZ Cost | Menge (kg) | Kg CO2 Equiv | ABC CO2 | XYZ CO2 |
|---|---|---|---|---|---|---|---|
| Schneeketten | 16877.07 | A | Z | 1410.98 | 282196 | A | Z |
| Reifen | 5669.38 | B | X | 390 | 231543 | A | X |
| Wasserzähler | 27802.18 | A | X | 2582 | 88975.72 | A | X |
| Stromzähler | 1229.5 | C | X | 60 | 2067.6 | A | X |
| LED Belichtung | 4944.04 | C | X | 39.04 | 1327.36 | B | X |
| Schläuche | 2668.2 | C | Y | 316 | 632 | B | Y |
| Lampen | 1276.11 | C | Y | 12.9308 | 445.595368 | B | Z |
| Wickelrucksäcke | 6747.42 | B | Y | 105.45 | 275.488125 | B | Y |
| Stiefel | 5521.34 | B | X | 70.88 | 205.552 | C | Y |
| Schilder | 7244.42 | A | Y | 98.18916 | 127.645908 | C | Y |
| Verkehrsspiegel | 3458.9 | C | Y | 55 | 71.5 | C | Y |
| Ordner und Hefter | 1985.4 | C | X | 35.996 | 23.3974 | C | X |
| Bücher | 1246.73 | C | Y | 8.756 | 8.756 | C | Y |
| Jacken | 22965.64 | A | X | 43.74 | 0.30618 | C | X |
| Arbeitshose | 5446.98 | B | X | 15.21 | 0.10647 | C | X |
| Akkus | 838.95 | C | X | 3.93 | 0.02290011 | C | X |

Table 13: Köttmannsdorf, Gebrauchsgüter, 2018 bis 2022

| Gut | Ausgaben (Euro) | ABC Cost | XYZ Cost | Menge (kg) | kgCO2Equivalent | ABC CO2 | XYZ CO2 |
|---|---|---|---|---|---|---|---|
| Auftausalz | 47676.91 | A | Y | 323355 | 32335.5 | A | Y |
| Müllsäcke | 8998.24 | A | X | 14429.19 | 28858.38 | A | X |
| Splitt | 11841.6 | A | X | 409600 | 3686.4 | A | X |
| Papier und Pappe | 8665.52 | A | Z | 3700.252 | 2405.1638 | A | Z |
| Desinfektionsmittel | 418.13 | C | X | 234.39 | 2343.9 | B | X |
| MotorOel | 2062.6 | C | Y | 538.3375 | 1884.18125 | B | Z |
| AdBlue | 1246.26 | C | Y | 1447.52 | 1490.9456 | B | Y |
| Toilettenpapier | 2579.72 | B | Z | 675.828 | 439.2882 | B | Z |
| Broschüren und Flyer | 2686.51 | B | Y | 613.8 | 398.97 | C | Y |
| Toner | 2653.11 | B | X | 14.3 | 114.4 | C | X |
| Bleichmittel | 277.61 | C | X | 10 | 21 | C | X |
| Geschirrspüler | 158.52 | C | X | 26 | 11.7 | C | X |
| Druckerpatronen | 299.72 | C | Z | 0.39 | 1.755 | C | Z |
| Batterien | 4114.6 | B | X | 309.457 | 1.647549068 | C | X |
| Kreide | 558 | C | X | 4.16 | 1.248 | C | X |
| Schrauben | 51.04 | C | X | 0.4 | 0.52 | C | X |

Table 14: Köttmannsdorf, Verbrauchsgüter, 2018 bis 2022

In the following six graphs (Figures 81-86), the $CO_2$ equivalent emissions of the durable goods for the period 2018-2022 are depicted. The individual groups of the ABC analysis of $CO_2$ equivalent emissions are presented separately to enhance clarity. Additionally, for each group in the ABC analysis, there is a second graph that represents the results on a logarithmic scale to facilitate the identification of products with lower $CO_2$ equivalent emissions.

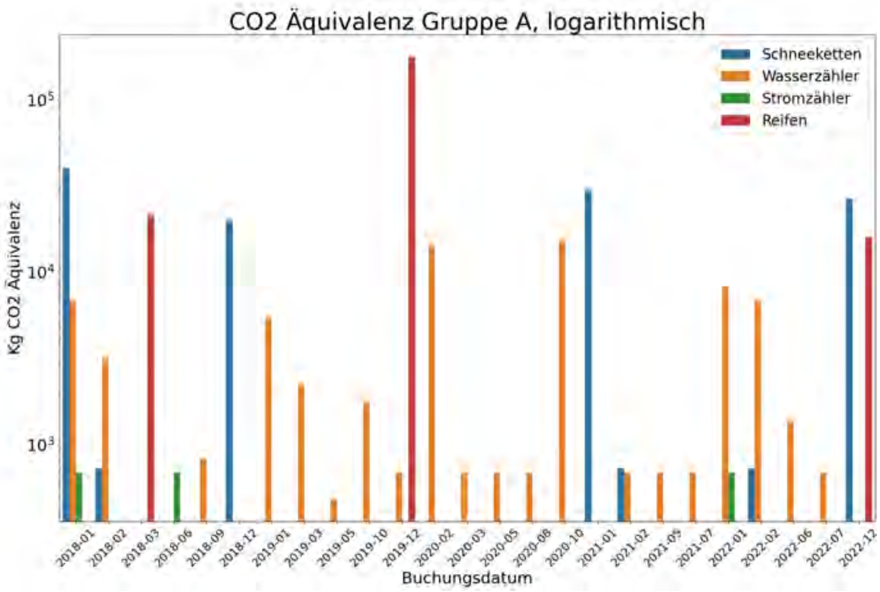


Figure 81: $CO_2$ Äquivalenz Gebrauchsgüter Gruppe A logarithmisch (2018-2022)

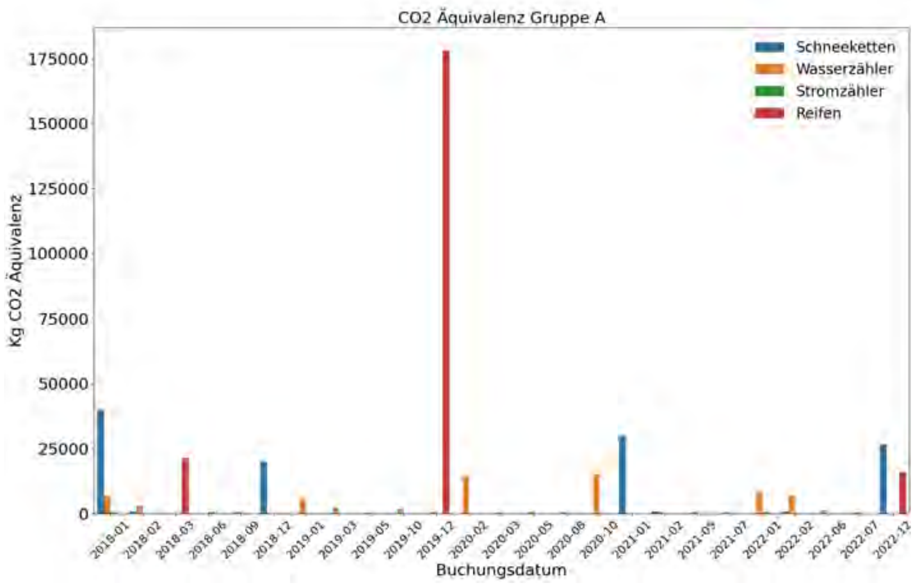


Figure 82: $CO_2$ Äquivalenz Gebrauchsgüter Gruppe A (2018-2022)

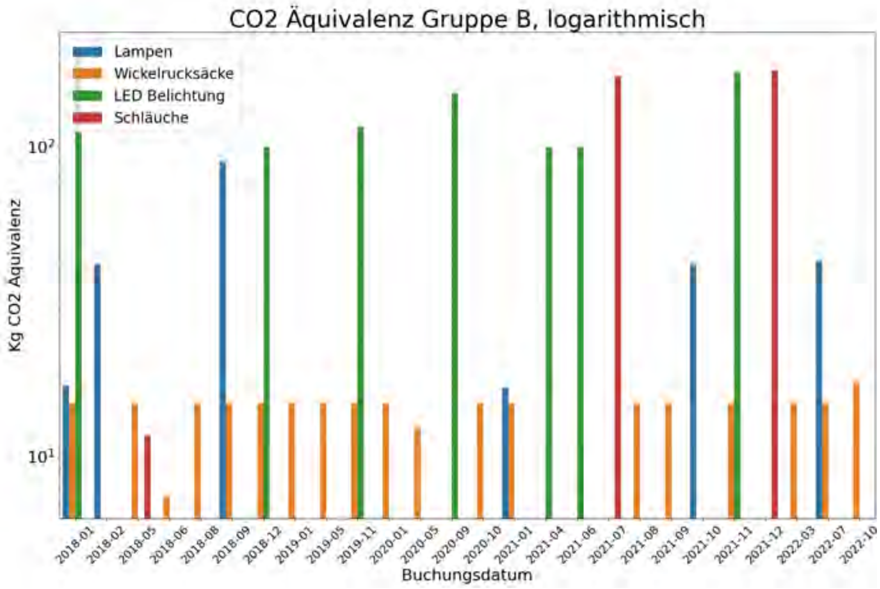


Figure 83: $CO_2$ Äquivalenz Gebrauchsgüter Gruppe B logarithmisch (2018-2022)

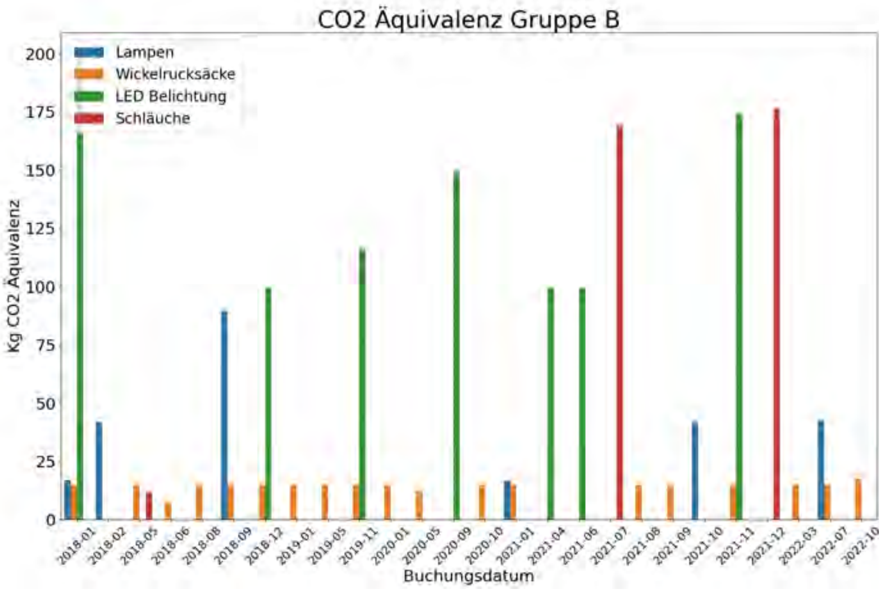


Figure 84: $CO_2$ Äquivalenz Gebrauchsgüter Gruppe B (2018-2022)

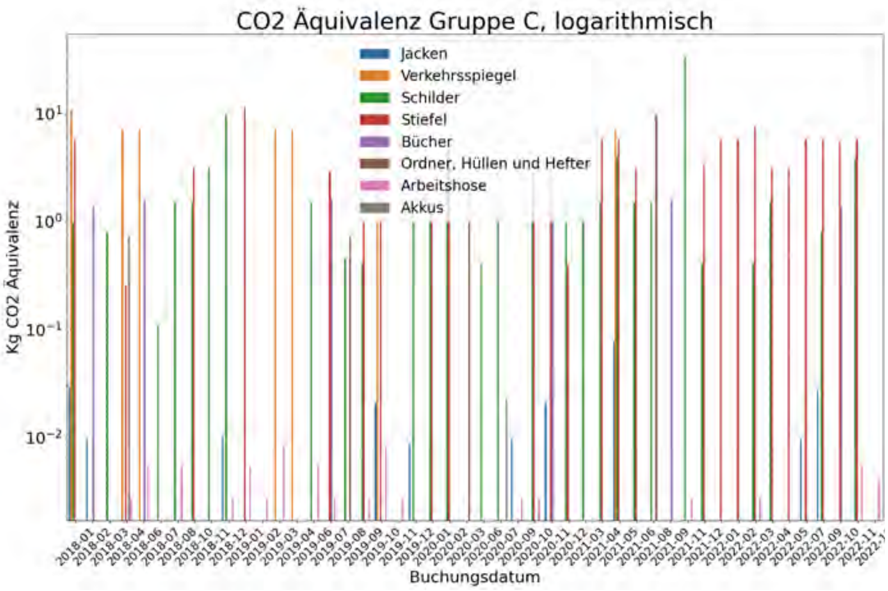


Figure 85: $CO_2$ Äquivalenz Gebrauchsgüter Gruppe C logarithmisch (2018-2022)

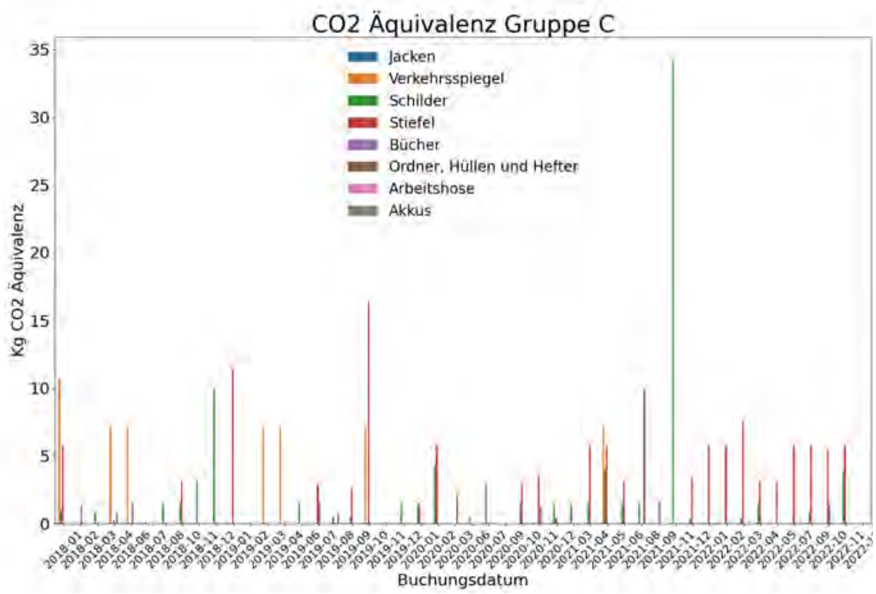


Figure 86: $CO_2$ Äquivalenz Gebrauchsgüter Gruppe C (2018-2022)

In the subsequent graphs, labeled 87-92, we present the $CO_2$ equivalent emissions of non-durable goods over the period from 2018 to 2022. These graphs provide a segmented representation of the distinct categories within the ABC analysis of $CO_2$ equivalent emissions, aiming to enhance clarity and comprehensibility. Additionally, for each category within the ABC analysis, a secondary graph is included, which employs a logarithmic scale to facilitate the identification of products with lower $CO_2$ equivalent emissions.

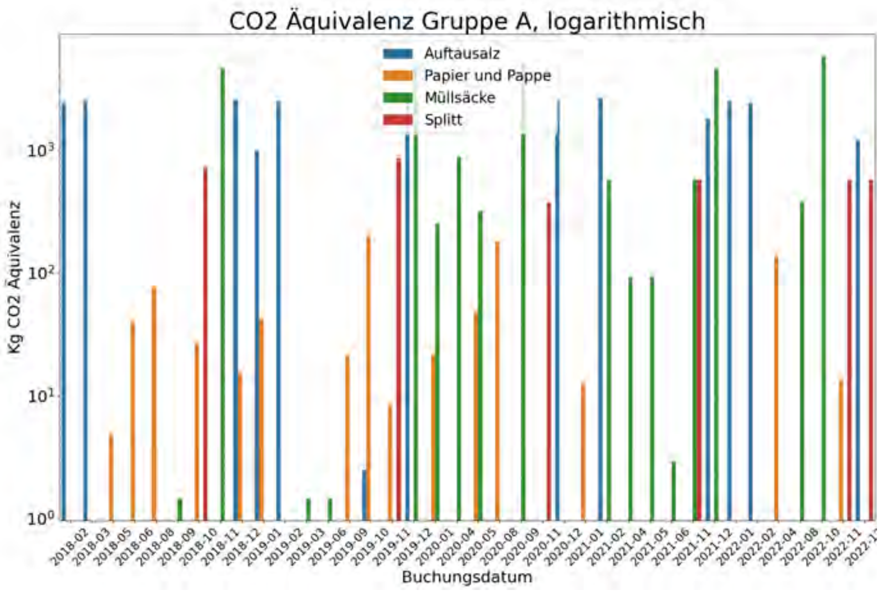


Figure 87: $CO_2$ Äquivalenz Verbrauchsgüter Gruppe A logarithmisch (2018-2022)

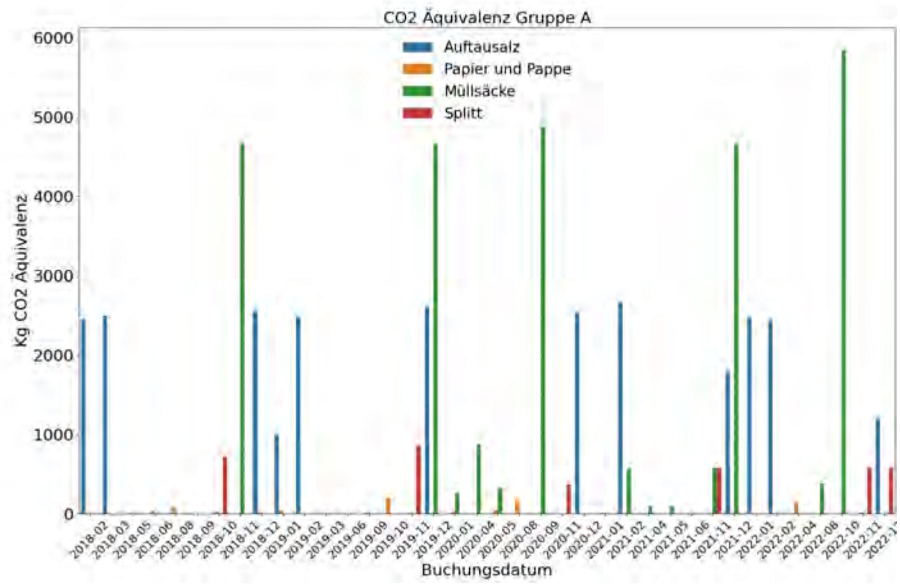


Figure 88: $CO_2$ Äquivalenz Verbrauchsgüter Gruppe A (2018-2022)

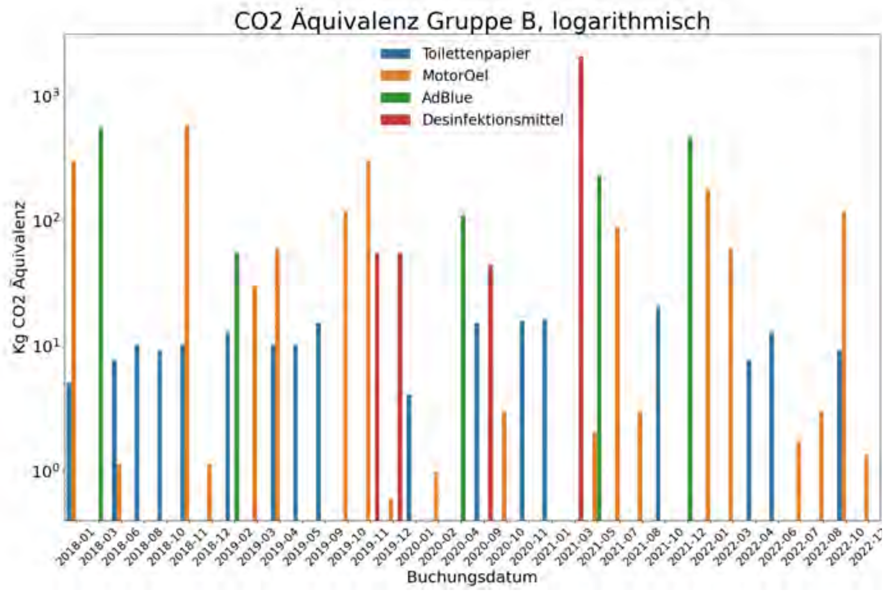


Figure 89: $CO_2$ Äquivalenz Verbrauchsgüter Gruppe B logarithmisch (2018-2022)

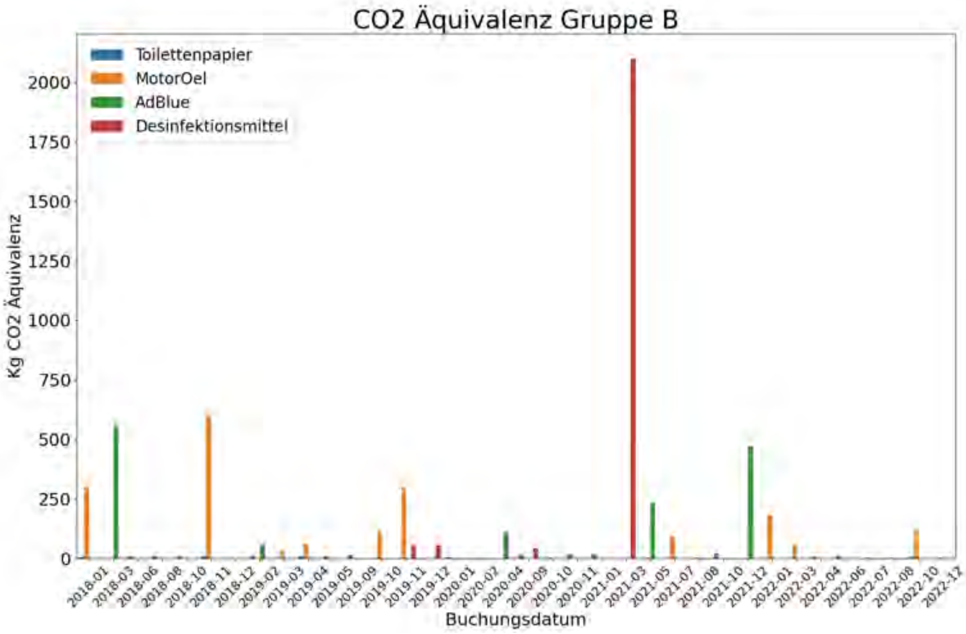


Figure 90: $CO_2$ Äquivalenz Verbrauchsgüter Gruppe B (2018-2022)

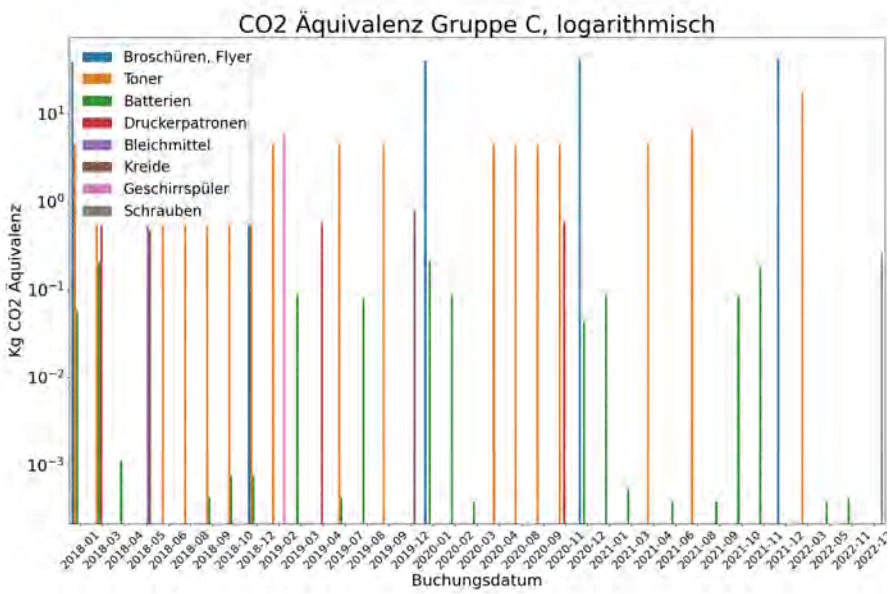


Figure 91: $CO_2$ Äquivalenz Verbrauchsgüter Gruppe C logarithmisch (2018-2022)

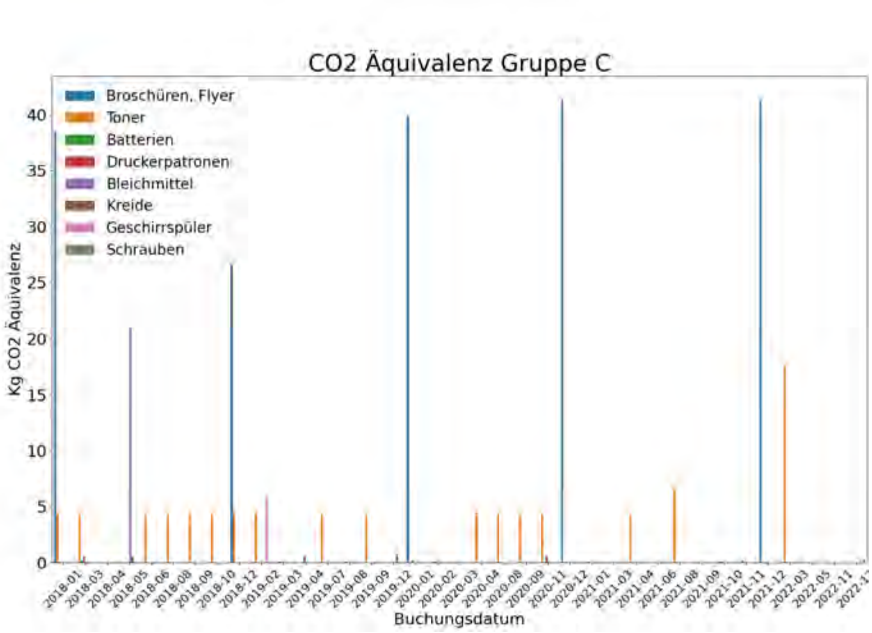


Figure 92: $CO_2$ Äquivalenz Verbrauchsgüter Gruppe C (2018-2022)

The following heatmaps depict the results of the ABC and XYZ analyses. The first two show the results from the analysis of the non-durable goods, the second two the results from the analysis of the durable goods

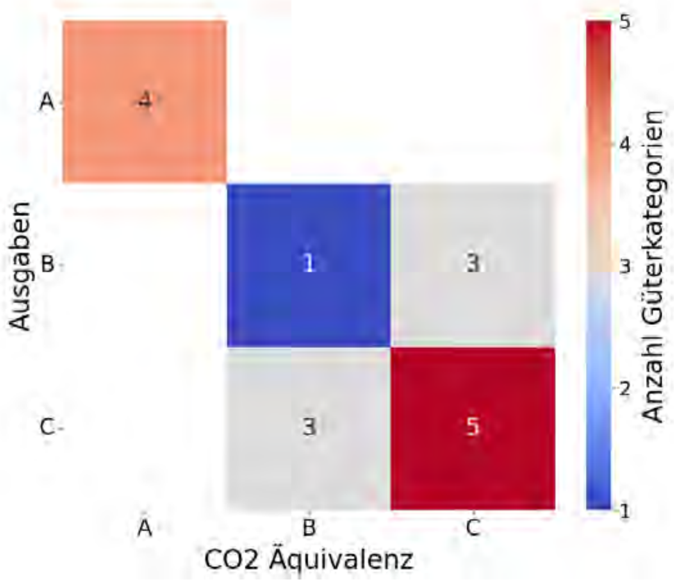


Figure 93: Heatmap ABC-Analyse Ausgaben und ABC-Analyse $CO_2$ Äquivalenzen der Verbrauchsgüter

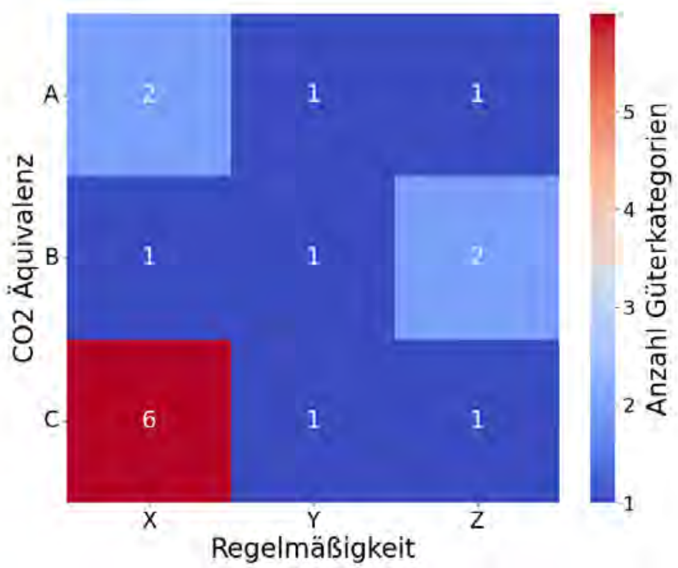


Figure 94: Heatmap ABC-Analyse $CO_2$ Äquivalenzen und XYZ-Analyse Regelmäßigkeit der Verbrauchsgüter

In Figure 93, the ABC analysis of expenditures is juxtaposed with the ABC analysis of $CO_2$ equivalences of the non-durable goods. The individual cells represent the number of product categories contained within these groups.
Figure 94 illustrates the results of the ABC analysis of $CO2_2$ equivalences and those of the XYZ analysis of regularity concerning them.

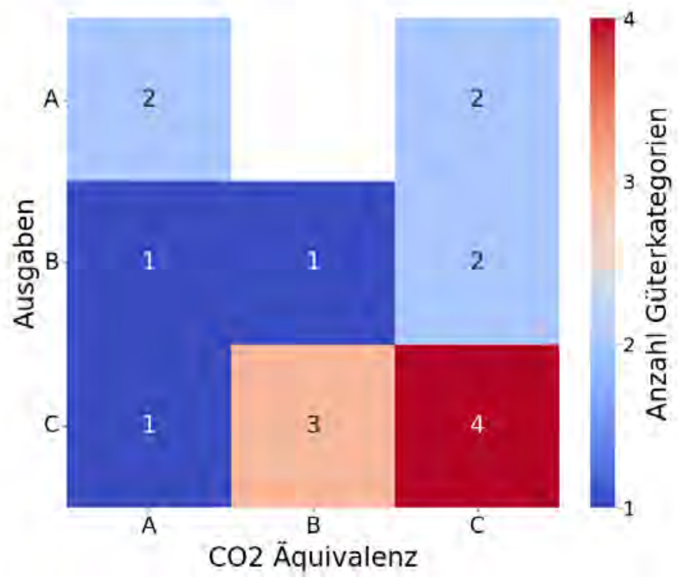


Figure 95: Heatmap ABC-Analyse Ausgaben und ABC-Analyse $CO_2$ Äquivalenzen der Gebrauchsgüter

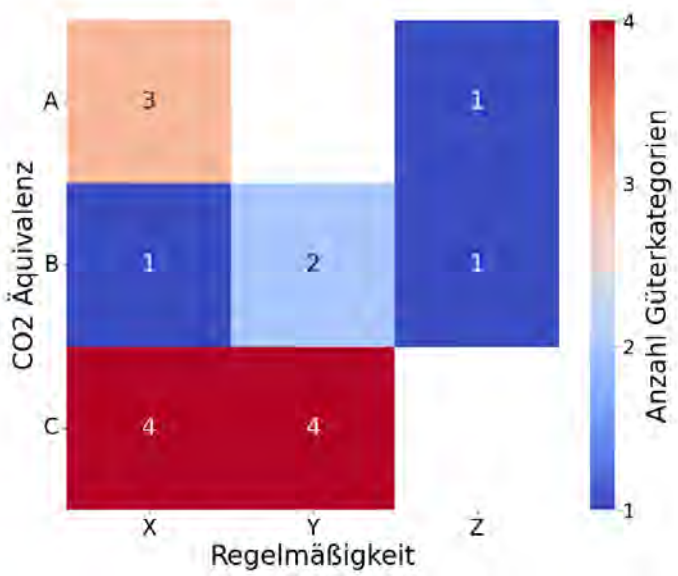


Figure 96: Heatmap ABC-Analyse $CO_2$ Äquivalenzen und XYZ-Analyse Regelmäßigkeit der Verbrauchsgüter

In Figure 95, we can observe a comparison between the ABC analysis of expenses and the ABC analysis of $CO_2$ emissions associated with durable goods. Each cell

within the figure indicates the quantity of product categories encompassed by these respective groups.
Figure 96, it provides a visual representation of the outcomes derived from the ABC analysis of $CO_2$ emissions and the XYZ analysis of their regularity.

## 2018

The following paragraph addresses the results of the analysis of the municipality Köttmannsdorf for the year 2018.

The Tables 15 and 16 provide a summary of durable and non-durable goods from the year 2018.

| Gut | Ausgaben (Euro) | ABC Cost | XYZ Cost | Menge (kg) | Kg CO2 Equiv | ABC CO2 | XYZ CO2 |
|---|---|---|---|---|---|---|---|
| Auftausalz | 9334.52 | A | Z | 75180 | 7518 | A | Z |
| Müllsäcke | 1415.56 | B | Y | 2336.73 | 4673.46 | A | Y |
| MotorOel | 853.12 | C | Y | 258.645 | 905.2575 | A | Y |
| Splitt | 2136 | A | Z | 80000 | 720 | B | Z |
| AdBlue | 94.08 | C | Y | 545 | 561.35 | B | Y |
| Papier und Pappe | 1551.34 | B | Z | 470 | 305.5 | B | Z |
| Toilettenpapier | 200.69 | C | Y | 91.9 | 59.735 | C | Y |
| Toner | 1305.04 | B | Z | 4.95 | 39.6 | C | Z |
| Bleichmittel | 277.61 | C | X | 10 | 21 | C | Y |
| Druckerpatronen | 89 | C | Z | 0.13 | 0.585 | C | Z |
| Kreide | 208.8 | C | X | 1.56 | 0.468 | C | X |
| Batterien | 1862.9 | A | X | 49.993 | 0.266162732 | C | X |

Table 15: Köttmannsdorf, Verbrauchsgüter, 2018

| Gut | Ausgaben (Euro) | ABC Cost | XYZ Cost | Menge (kg) | Kg CO2 Equiv | ABC CO2 | XYZ CO2 |
|---|---|---|---|---|---|---|---|
| Schneeketten | 5684.33 | A | Y | 403.66 | 80732 | A | X |
| Reifen | 525.98 | C | Y | 36 | 21373.2 | A | Y |
| Wasserzähler | 2951.5 | A | Z | 316 | 10889.36 | A | Y |
| Stromzähler | 809 | B | Y | 40 | 1378.4 | B | Y |
| Lampen | 264.85 | C | Y | 9.994 | 344.39324 | B | Y |
| LED Belichtung | 1104.9 | B | Z | 8.784 | 298.656 | B | Z |
| Schläuche | 789.6 | C | Z | 58.6 | 117.2 | B | Z |
| Wickelrucksäcke | 1951.92 | B | X | 31.35 | 81.901875 | B | Y |
| Verkehrsspiegel | 1625.68 | B | Z | 27.5 | 35.75 | C | Z |
| Schilder | 2065.9 | B | Y | 14.58086 | 18.955118 | C | Y |
| Stiefel | 200.7 | C | Y | 4.27 | 12.383 | C | Y |
| Bücher | 428 | C | Y | 2.985 | 2.985 | C | Y |
| Jacken | 3514.98 | A | Y | 7.06 | 0.04942 | C | Y |
| Arbeitshose | 338.94 | C | X | 2.34 | 0.01638 | C | X |

Table 16: Köttmannsdorf, Gebrauchsgüter, 2018

The following six graphs (Figures 97-102) show the $CO_2$ equivalent emissions of the durable goods for the year 2018. The individual groups of the ABC analysis of $CO_2$ equivalent emissions are presented separately to enhance clarity. Additionally, for each group in the ABC analysis, there is a second graph that represents the results on a logarithmic scale to facilitate the identification of products with lower $CO_2$ equivalent emissions.

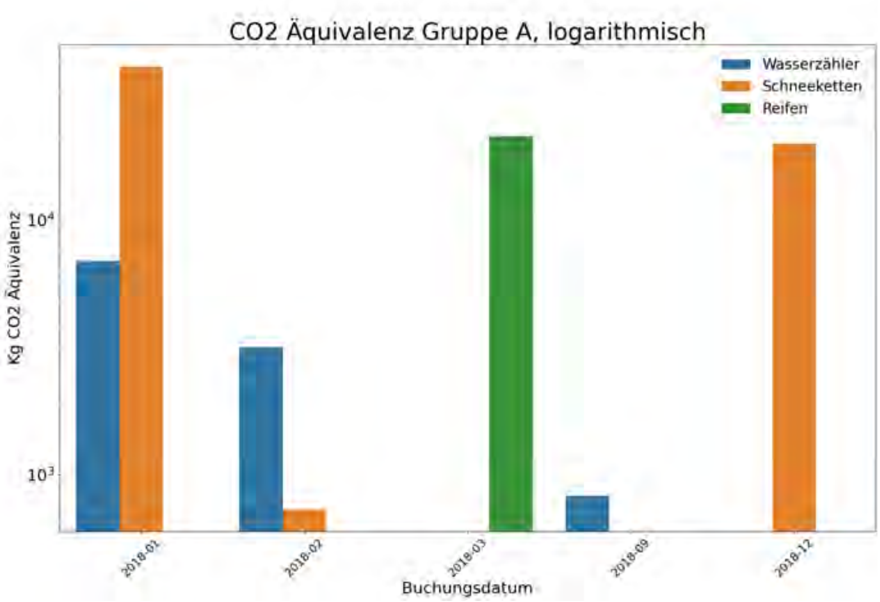


Figure 97: $CO_2$ Äquivalenz Gebrauchsgüter Gruppe A logarithmisch (2018)

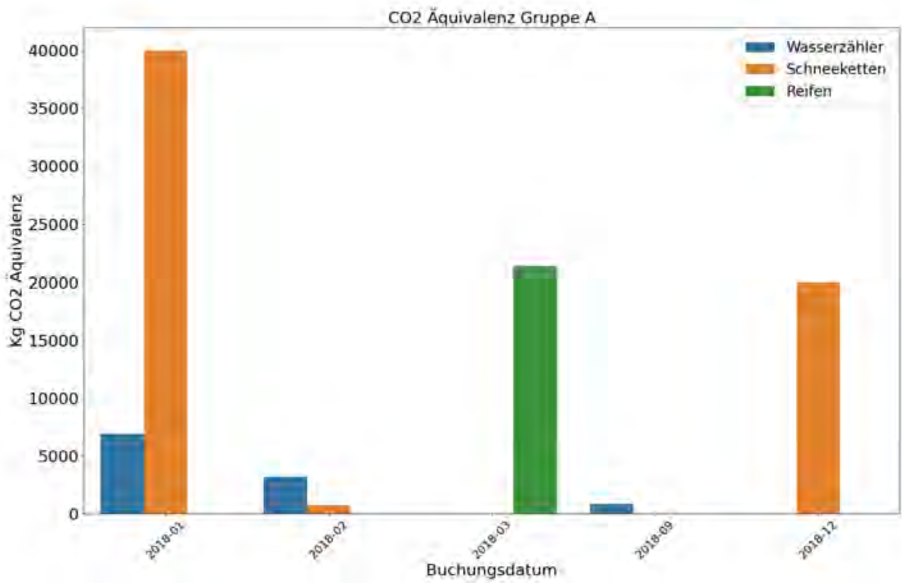


Figure 98: $CO_2$ Äquivalenz Gebrauchsgüter Gruppe A (2018)

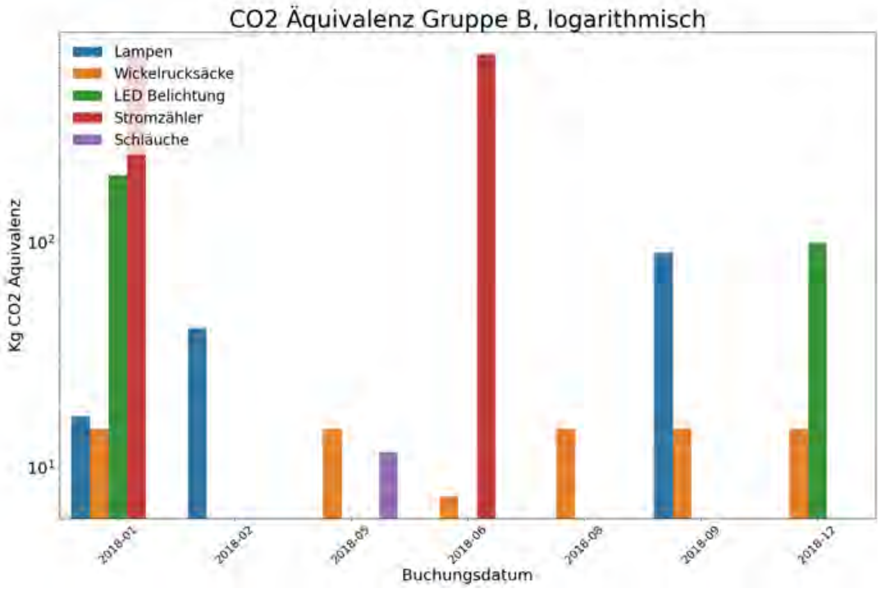


Figure 99: $CO_2$ Äquivalenz Gebrauchsgüter Gruppe B logarithmisch (2018)

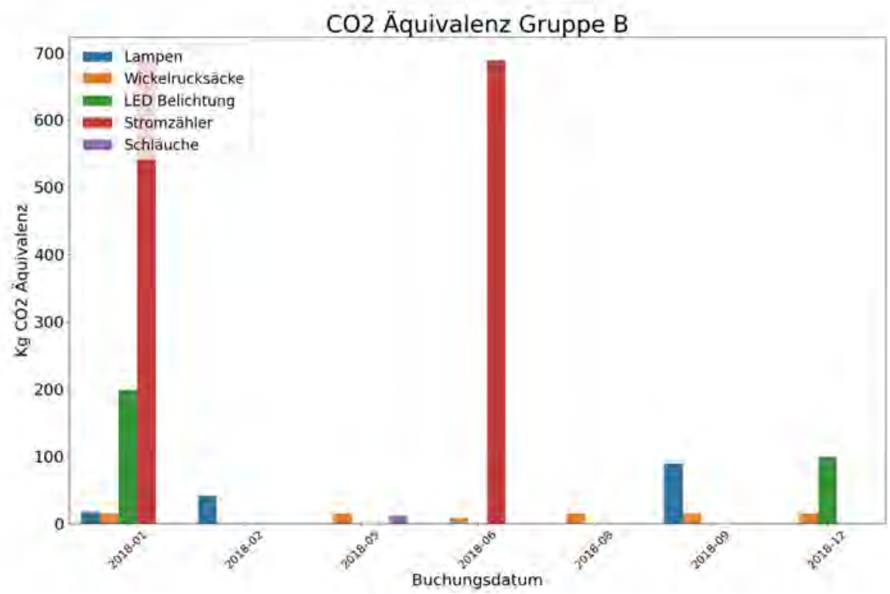


Figure 100: $CO_2$ Äquivalenz Gebrauchsgüter Gruppe B (2018)

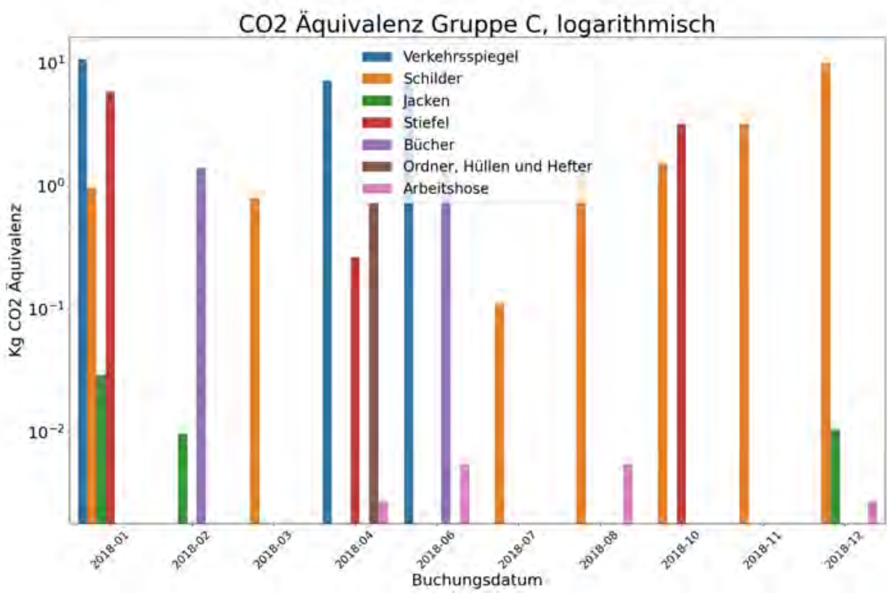


Figure 101: $CO_2$ Äquivalenz Gebrauchsgüter Gruppe C logarithmisch (2018)

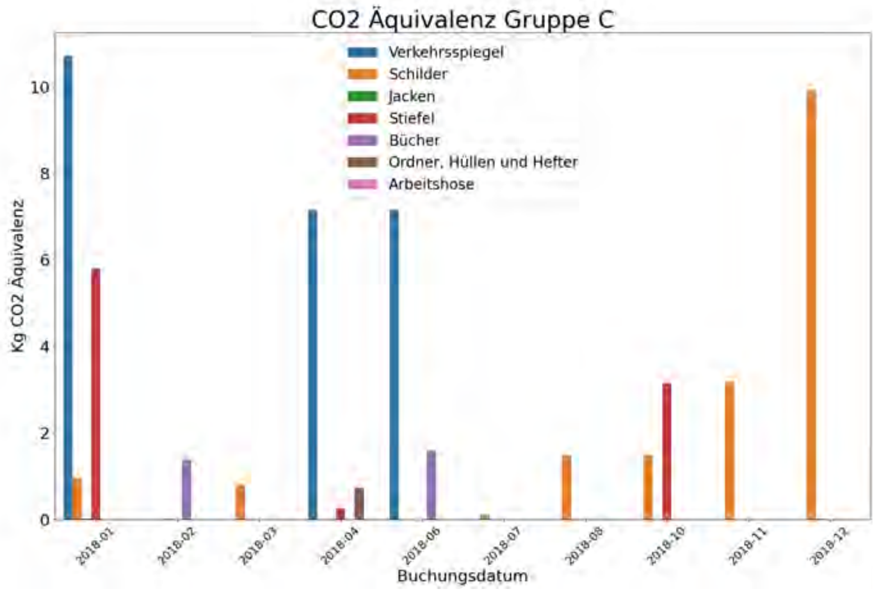


Figure 102: $CO_2$ Äquivalenz Gebrauchsgüter Gruppe C (2018)

In the following graphs, labeled 103-108, we present the $CO_2$ equivalent emissions of non-durable goods in the year 2018. These graphs provide a segmented representation of the distinct categories within the ABC analysis of $CO_2$ equivalent emissions, aiming to enhance clarity and comprehensibility. Additionally, for each category within the ABC analysis, a secondary graph is included, which employs a logarithmic scale to facilitate the identification of products with lower $CO_2$ equivalent emissions.

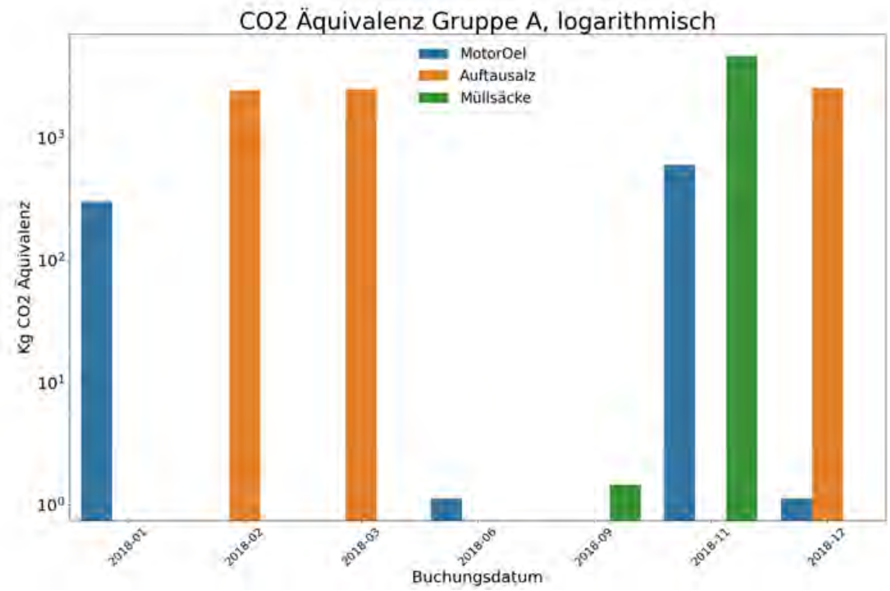


Figure 103: $CO_2$ Äquivalenz Verbrauchsgüter Gruppe A logarithmisch (2018)

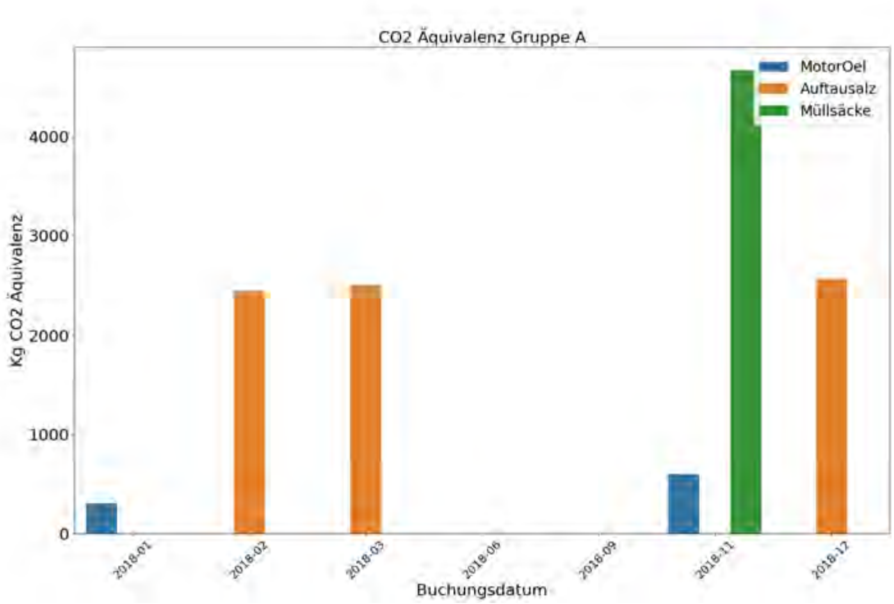


Figure 104: $CO_2$ Äquivalenz Verbrauchsgüter Gruppe A (2018)

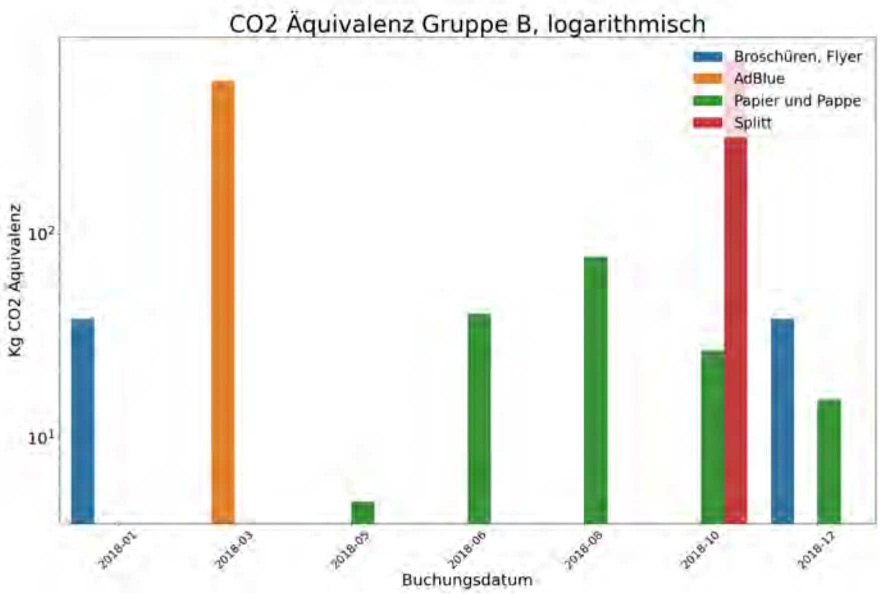


Figure 105: $CO_2$ Äquivalenz Verbrauchsgüter Gruppe B logarithmisch (2018)

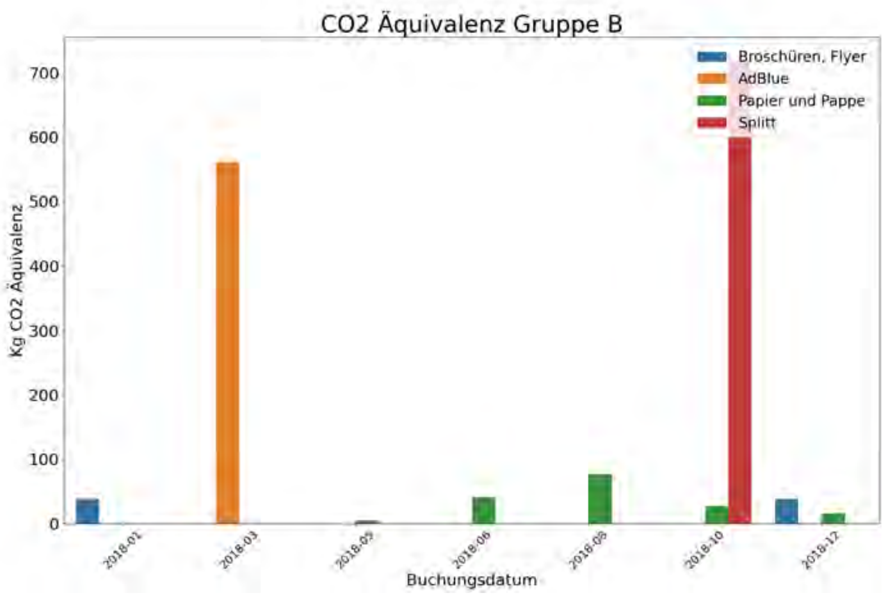


Figure 106: $CO_2$ Äquivalenz Verbrauchsgüter Gruppe B (2018)

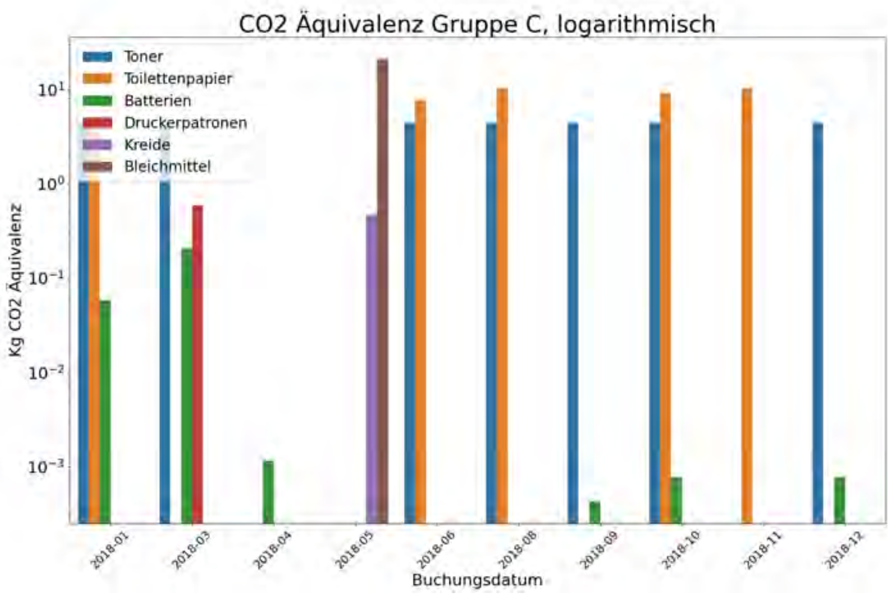


Figure 107: $CO_2$ Äquivalenz Verbrauchsgüter Gruppe C logarithmisch (2018)

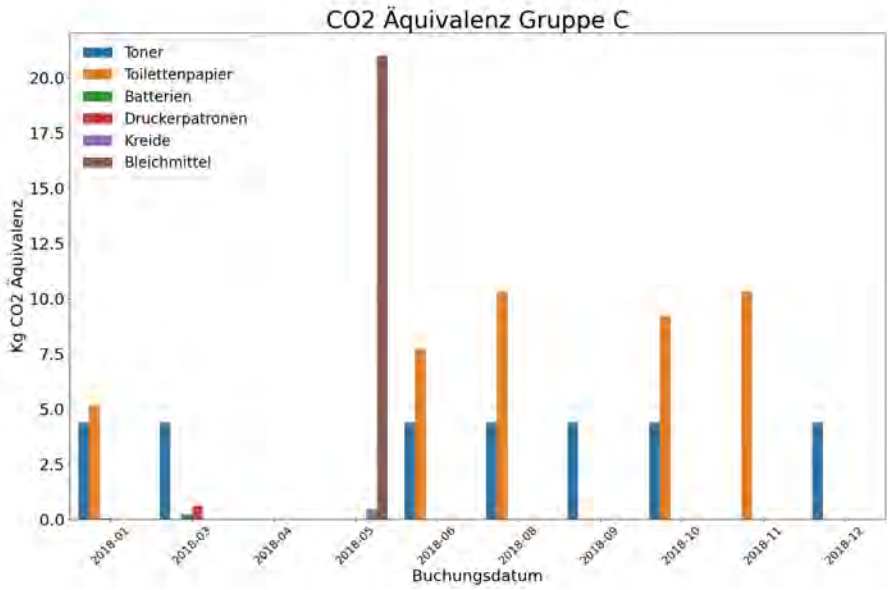


Figure 108: $CO_2$ Äquivalenz Verbrauchsgüter Gruppe C (2018)

## 2019

The following paragraph addresses the results of the analysis of the municipality Köttmannsdorf for the year 2019.

The Tables 17 and 18 provide a summary of durable and non-durable goods from the year 2019.

| Gut | Ausgaben (Euro) | ABC Cost | XYZ Cost | Menge (kg) | Kg CO2 Equiv | ABC CO2 | XYZ CO2 |
|---|---|---|---|---|---|---|---|
| Auftausalz | 9763.56 | A | Z | 61225 | 6122.5 | A | Z |
| Müllsäcke | 1456.72 | B | Y | 2337.46 | 4674.92 | A | Y |
| Splitt | 2649.6 | A | Y | 96000 | 864 | A | Y |
| Papier und Pappe | 2676.51 | A | Y | 1135.5 | 738.075 | B | Y |
| MotorOel | 454.99 | B | Z | 146.372 | 512.302 | B | Z |
| AdBlue | 155.82 | C | Z | 109 | 112.27 | B | Z |
| Desinfektionsmittel | 76.21 | C | Z | 11.16 | 111.6 | B | Z |
| Toilettenpapier | 261.6 | C | Y | 134.98 | 87.737 | C | Y |
| Toner | 498.69 | B | Z | 2.2 | 17.6 | C | Z |
| Geschirrspüler | 158.52 | C | Y | 26 | 11.7 | C | Z |
| Kreide | 349.2 | B | Z | 2.6 | 0.78 | C | Z |
| Druckerpatronen | 152.83 | C | X | 0.13 | 0.585 | C | X |
| Batterien | 176.43 | C | Y | 31.68 | 0.16866432 | C | Y |

Table 17: Köttmannsdorf, Verbrauchsgüter, 2019

| Gut | Ausgaben (Euro) | ABC Cost | XYZ Cost | Menge (kg) | Kg CO2 Equiv | ABC CO2 | XYZ CO2 |
|---|---|---|---|---|---|---|---|
| Reifen | 1500 | B | Y | 300 | 178110 | A | X |
| Wasserzähler | 5858.8 | A | Z | 552 | 19021.92 | A | Z |
| LED Belichtung | 847.48 | C | Y | 6.832 | 232.288 | A | Y |
| Stiefel | 1869.84 | B | Z | 24.68 | 71.572 | B | Z |
| Wickelrucksäcke | 1084.32 | C | Z | 17.1 | 44.67375 | B | Z |
| Verkehrsspiegel | 1466.98 | B | Z | 22 | 28.6 | B | Z |
| Schilder | 1005.86 | C | Y | 3.29873 | 4.288349 | C | X |
| Bücher | 226.3 | C | Y | 1.592 | 1.592 | C | Y |
| Ordner und Hefter | 157.2 | C | Y | 1.1245 | 0.730925 | C | Y |
| Jacken | 6786.38 | A | Y | 15.78 | 0.11046 | C | Y |
| Arbeitshose | 3697.85 | A | Y | 7.41 | 0.05187 | C | Y |

Table 18: Köttmannsdorf, Gebrauchsgüter, 2019

The following six graphs (Figures 109-114) show the $CO_2$ equivalent emissions of the durable goods for the year 2019. The individual groups of the ABC analysis of $CO_2$ equivalent emissions are presented separately to enhance clarity. Additionally, for each group in the ABC analysis, there is a second graph that represents the results on a logarithmic scale to facilitate the identification of products with lower $CO_2$ equivalent emissions.

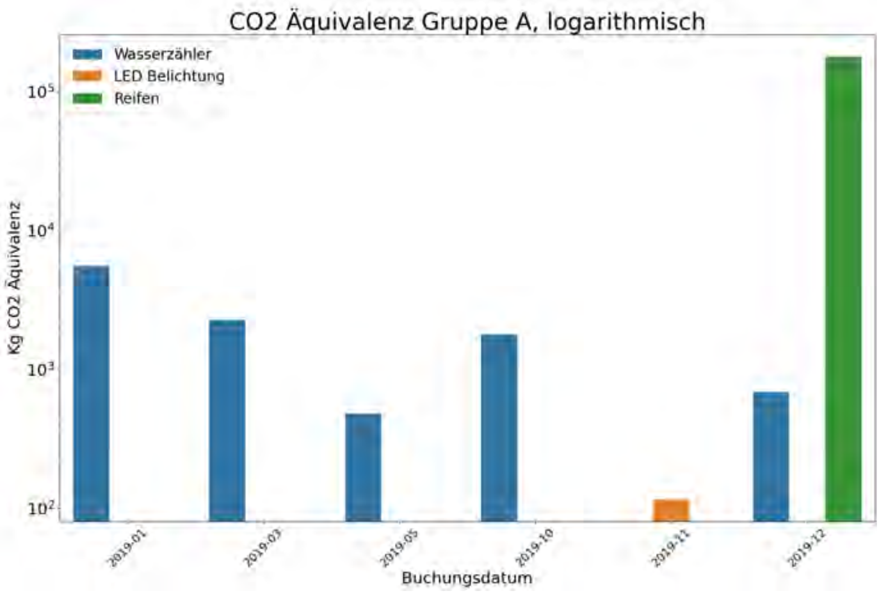


Figure 109: $CO_2$ Äquivalenz Gebrauchsgüter Gruppe A logarithmisch (2019)

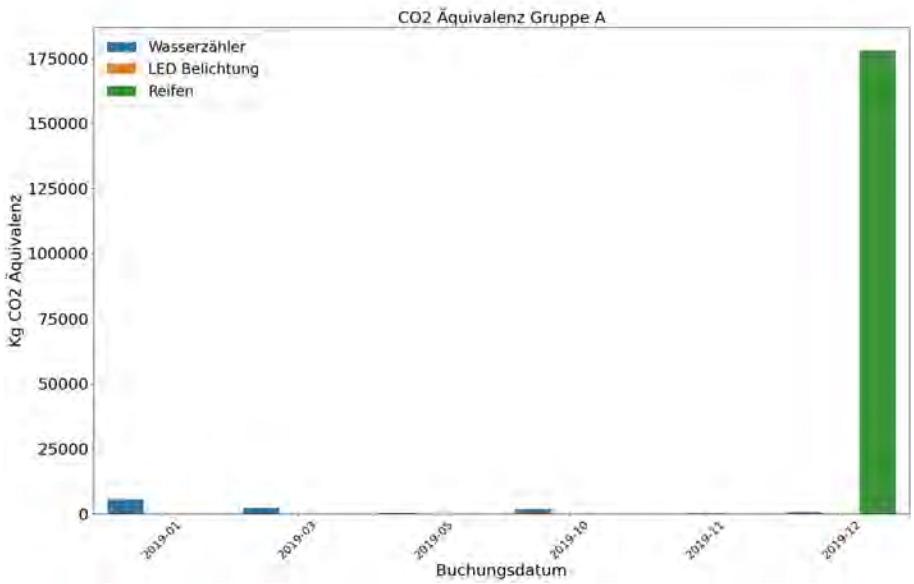


Figure 110: $CO_2$ Äquivalenz Gebrauchsgüter Gruppe A (2019)

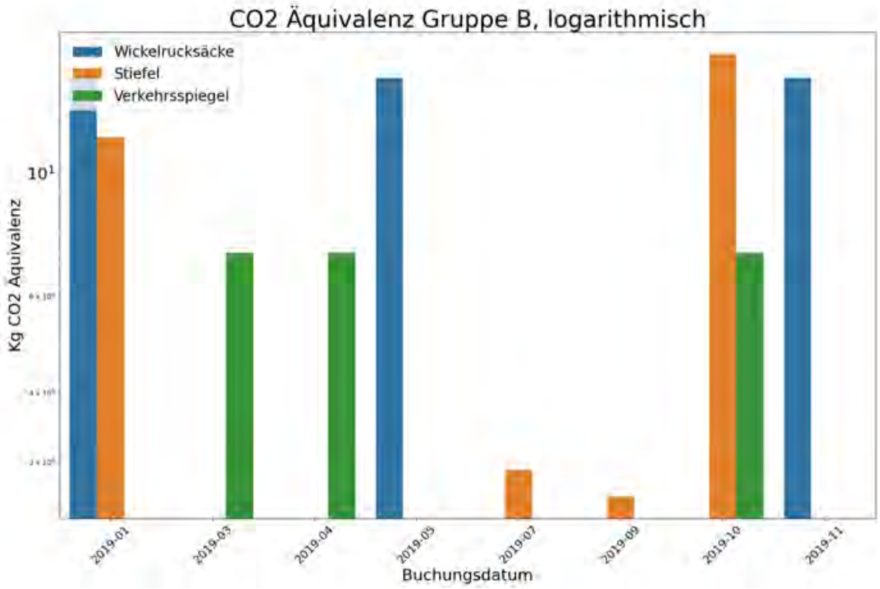


Figure 111: $CO_2$ Äquivalenz Gebrauchsgüter Gruppe B logarithmisch (2019)

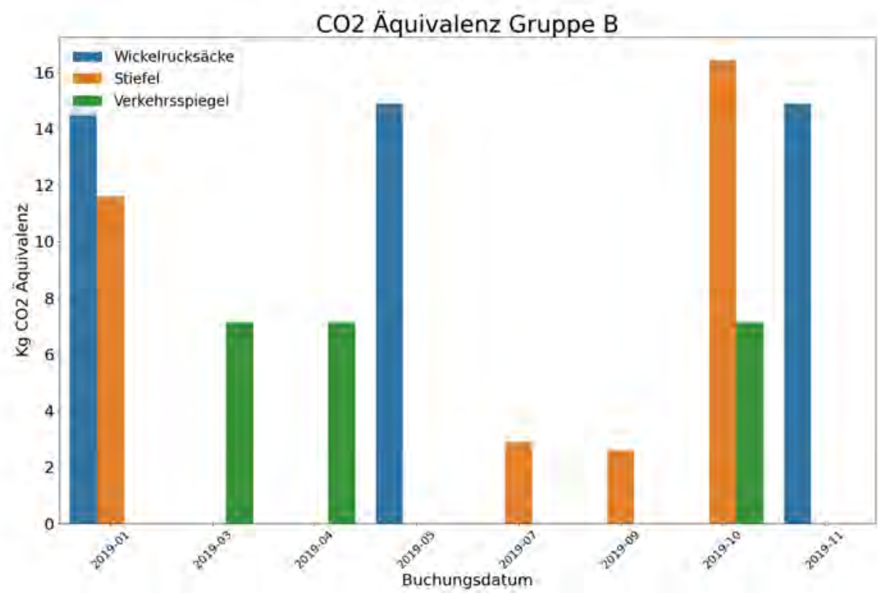


Figure 112: $CO_2$ Äquivalenz Gebrauchsgüter Gruppe B (2019)

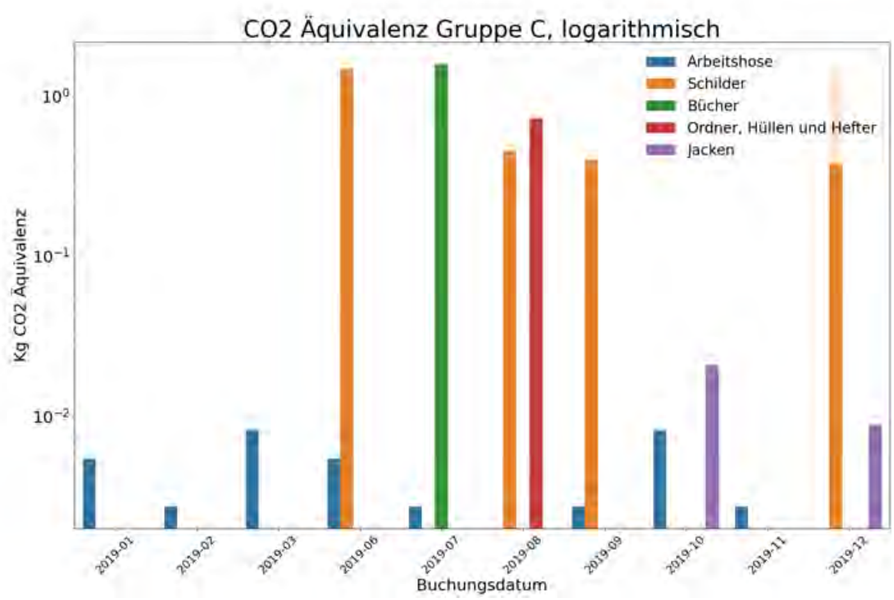


Figure 113: $CO_2$ Äquivalenz Gebrauchsgüter Gruppe C logarithmisch (2019)

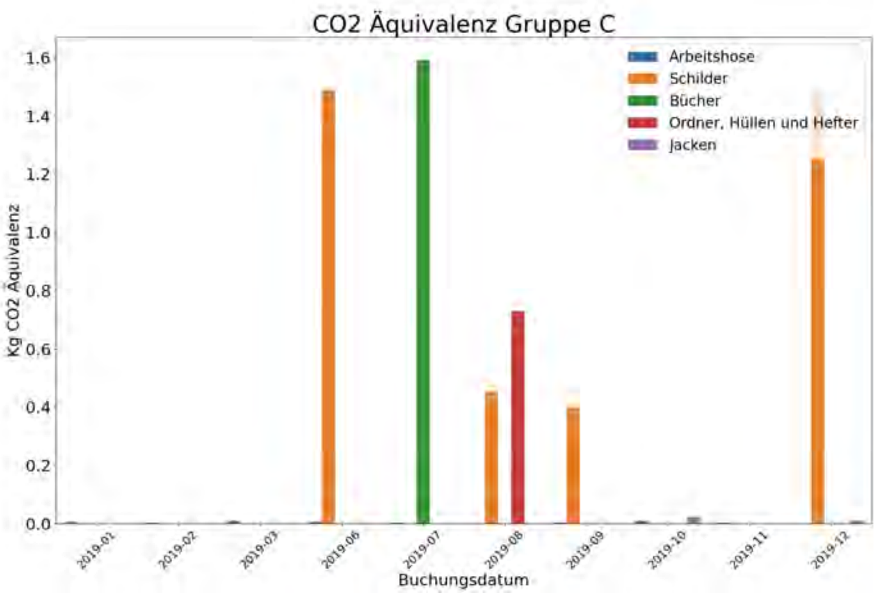


Figure 114: $CO_2$ Äquivalenz Gebrauchsgüter Gruppe C (2019)

In the following graphs, labeled 115-120, we present the $CO_2$ equivalent emissions of non-durable goods in the year 2019. These graphs provide a segmented representation of the distinct categories within the ABC analysis of $CO_2$ equivalent emissions, aiming to enhance clarity and comprehensibility. Additionally, for each category within the ABC analysis, a secondary graph is included, which employs a logarithmic scale to facilitate the identification of products with lower $CO_2$ equivalent emissions.

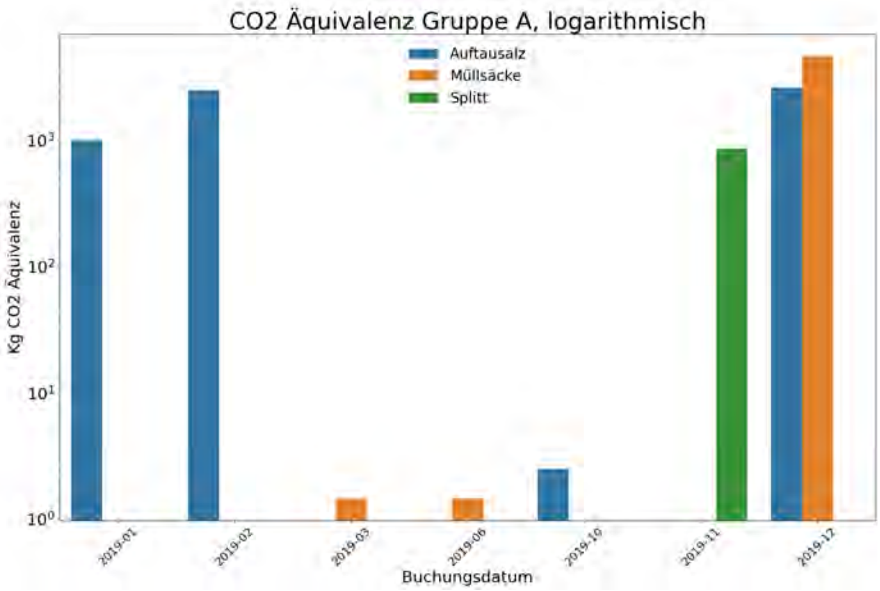


Figure 115: $CO_2$ Äquivalenz Verbrauchsgüter Gruppe A logarithmisch (2019)

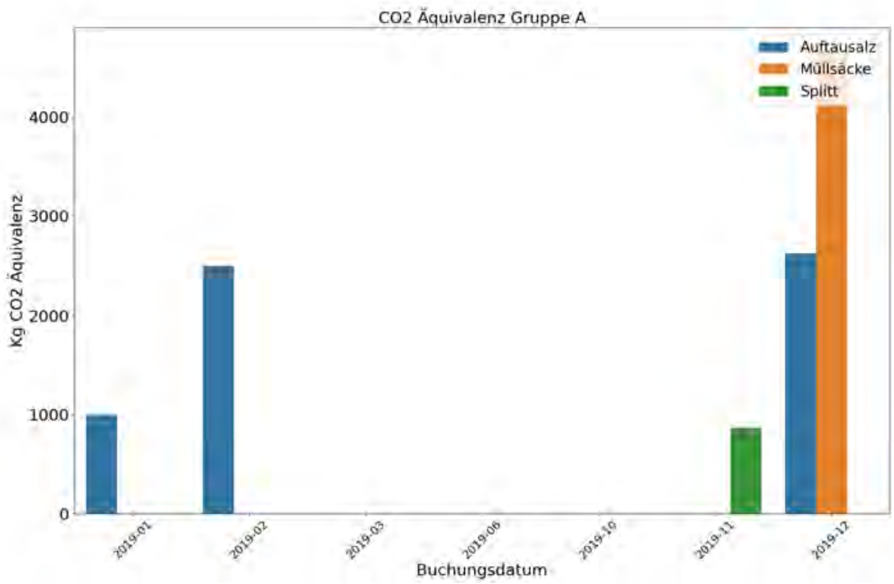


Figure 116: $CO_2$ Äquivalenz Verbrauchsgüter Gruppe A (2019)

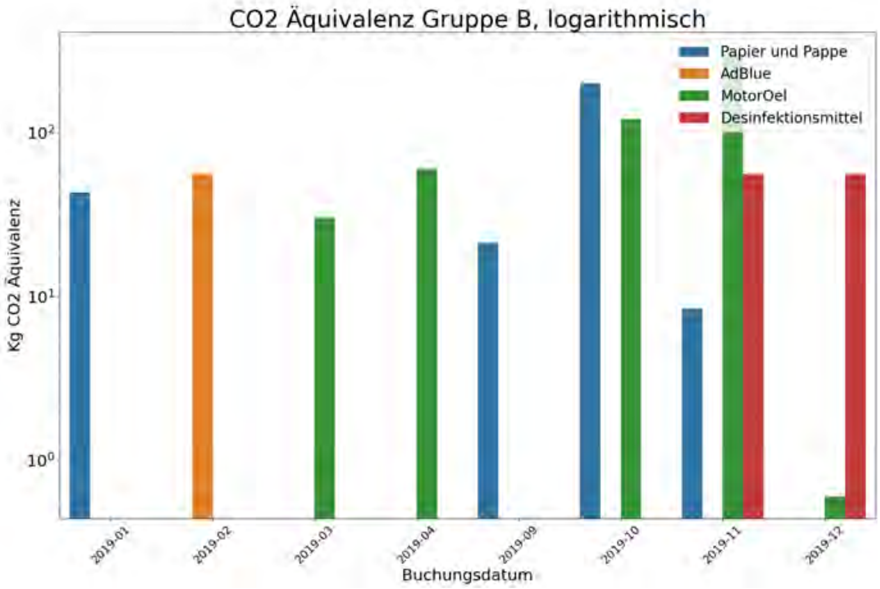


Figure 117: $CO_2$ Äquivalenz Verbrauchsgüter Gruppe B logarithmisch (2019)

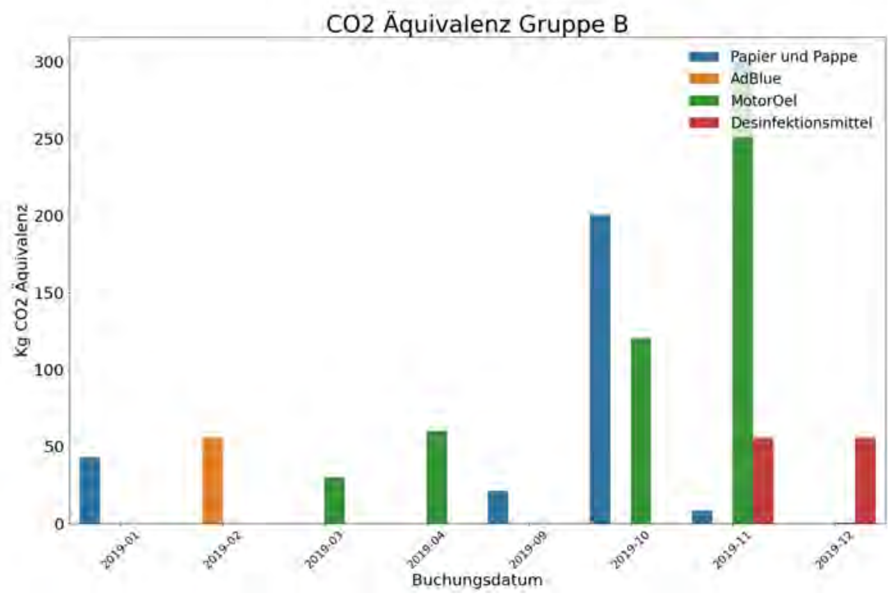


Figure 118: $CO_2$ Äquivalenz Verbrauchsgüter Gruppe B (2019)

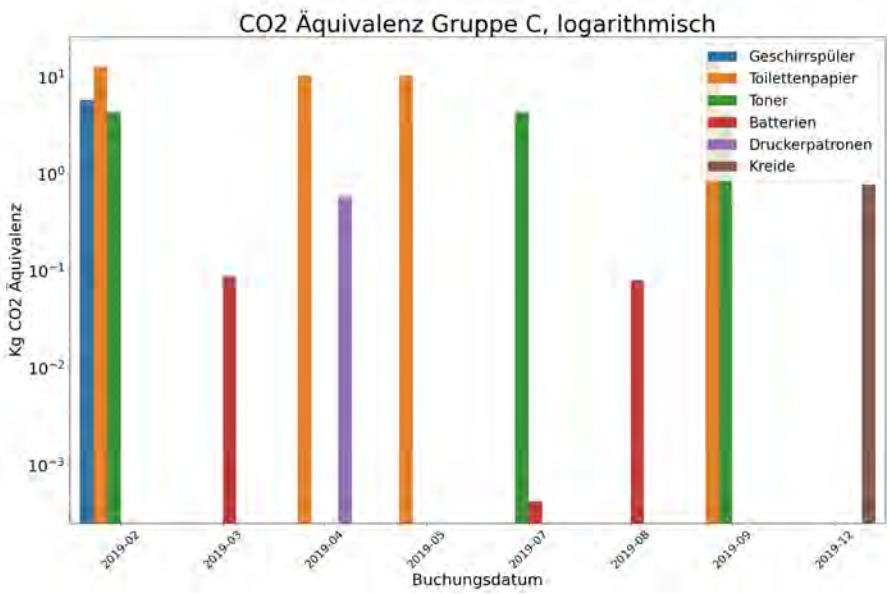


Figure 119: $CO_2$ Äquivalenz Verbrauchsgüter Gruppe C logarithmisch (2019)

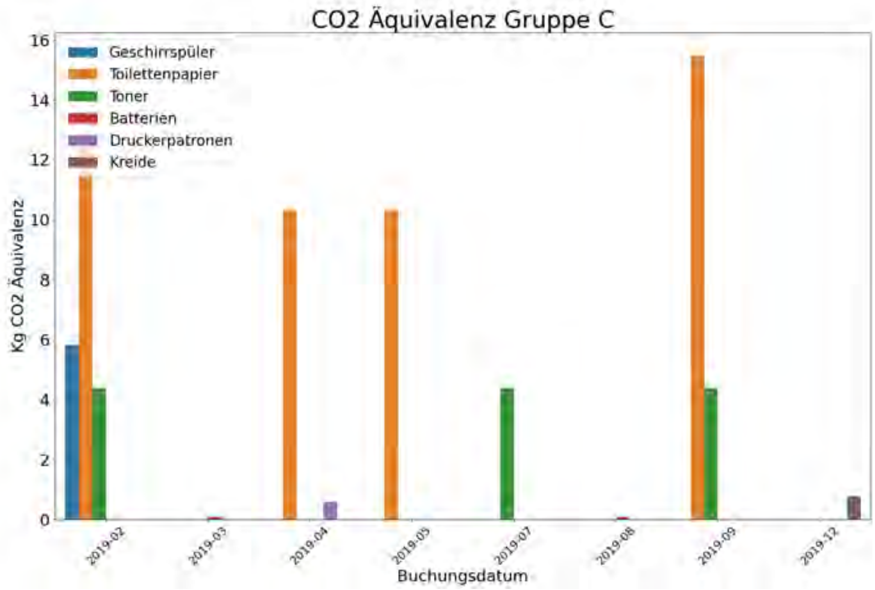


Figure 120: $CO_2$ Äquivalenz Verbrauchsgüter Gruppe C (2019)

## 2020

The following paragraph addresses the results of the analysis of the municipality Köttmannsdorf for the year 2020.

The Tables 19 and 20 provide a summary of durable and non-durable goods from the year 2020.

| Gut | Ausgaben (Euro) | ABC Cost | XYZ Cost | Menge (kg) | Kg CO2 Equiv | ABC CO2 | XYZ CO2 |
|---|---|---|---|---|---|---|---|
| Müllsäcke | 2071.56 | A | Z | 3351.3 | 6702.6 | A | Z |
| Auftausalz | 7496.96 | A | Z | 50900 | 5090 | A | Z |
| Papier und Pappe | 2041.57 | A | Y | 984.752 | 640.0888 | A | Y |
| Splitt | 1185.6 | B | Y | 41600 | 374.4 | B | Y |
| Desinfektionsmittel | 237.14 | C | Z | 13.23 | 132.3 | B | Z |
| AdBlue | 94.8 | C | Y | 109 | 112.27 | C | Y |
| Toilettenpapier | 196.65 | C | Y | 85.14 | 55.341 | C | Y |
| Toner | 519.16 | C | Y | 2.75 | 22 | C | Y |
| MotorOel | 21.47 | C | Z | 1.139 | 3.9865 | C | Z |
| Batterien | 782.94 | B | Y | 112.644 | 0.599716656 | C | Y |
| Druckerpatronen | 57.89 | C | X | 0.13 | 0.585 | C | X |

Table 19: Köttmannsdorf, Verbrauchsgüter, 2020

| Gut | Ausgaben (Euro) | ABC Cost | XYZ Cost | Menge (kg) | Kg CO2 Equiv | ABC CO2 | XYZ CO2 |
|---|---|---|---|---|---|---|---|
| Wasserzähler | 9663.18 | A | Z | 914 | 31496.44 | A | Z |
| LED Belichtung | 573.48 | C | Z | 4.392 | 149.328 | A | Y |
| Wickelrucksäcke | 1034.88 | B | Z | 16.15 | 42.191875 | B | Z |
| Stiefel | 911.44 | B | Y | 7.31 | 21.199 | B | Y |
| Schilder | 1499.44 | A | Z | 11.66943 | 15.170259 | B | Z |
| Ordner und Hefter | 471.6 | C | Z | 3.3735 | 2.192775 | C | Z |
| Bücher | 169.73 | C | X | 1.194 | 1.194 | C | X |
| Jacken | 526.76 | C | X | 4.39 | 0.03073 | C | X |
| Akkus | 838.95 | B | Y | 3.93 | 0.02290011 | C | Y |
| Arbeitshose | 308.59 | C | Y | 1.56 | 0.01092 | C | Y |

Table 20: Köttmannsdorf, Gebrauchsgüter, 2020

The following six graphs (Figures 121-126) show the $CO_2$ equivalent emissions of the durable goods for the year 2020. The individual groups of the ABC analysis of $CO_2$ equivalent emissions are presented separately to enhance clarity. Additionally, for each group in the ABC analysis, there is a second graph that represents the results on a logarithmic scale to facilitate the identification of products with lower $CO_2$ equivalent emissions.

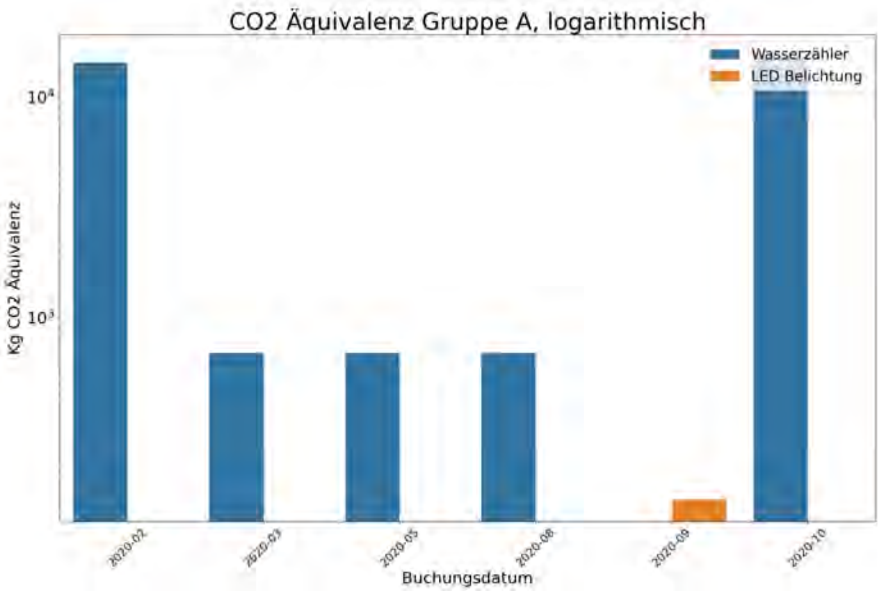


Figure 121: $CO_2$ Äquivalenz Gebrauchsgüter Gruppe A logarithmisch (2020)

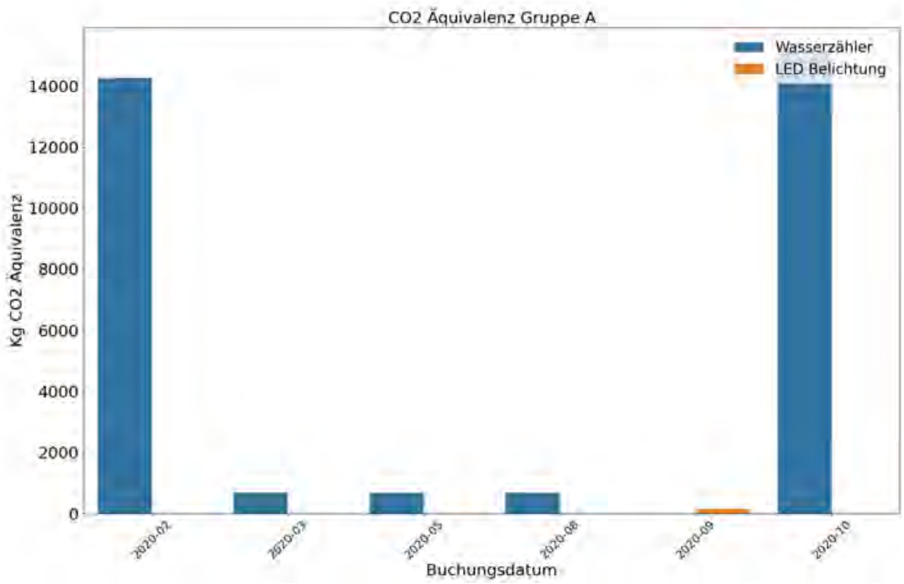


Figure 122: $CO_2$ Äquivalenz Gebrauchsgüter Gruppe A (2020)

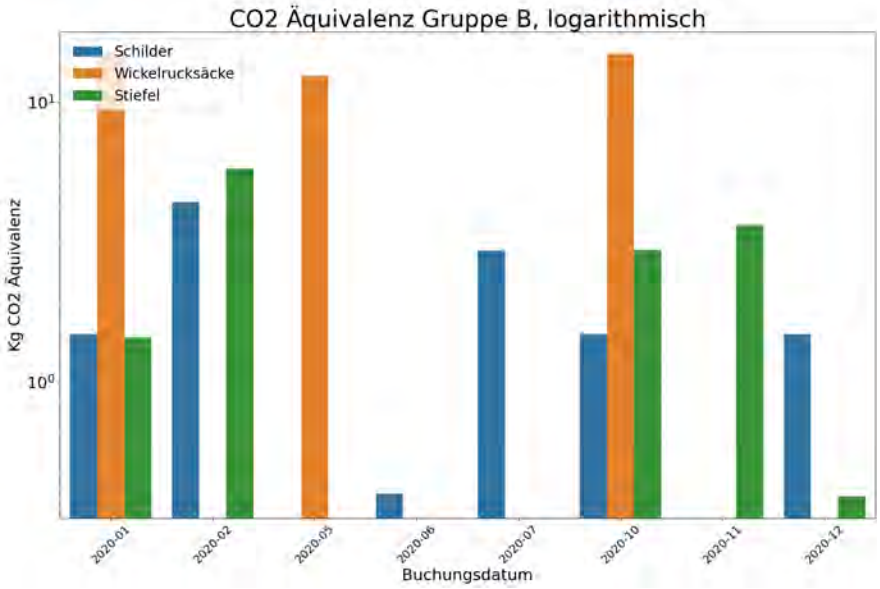


Figure 123: $CO_2$ Äquivalenz Gebrauchsgüter Gruppe B logarithmisch (2020)

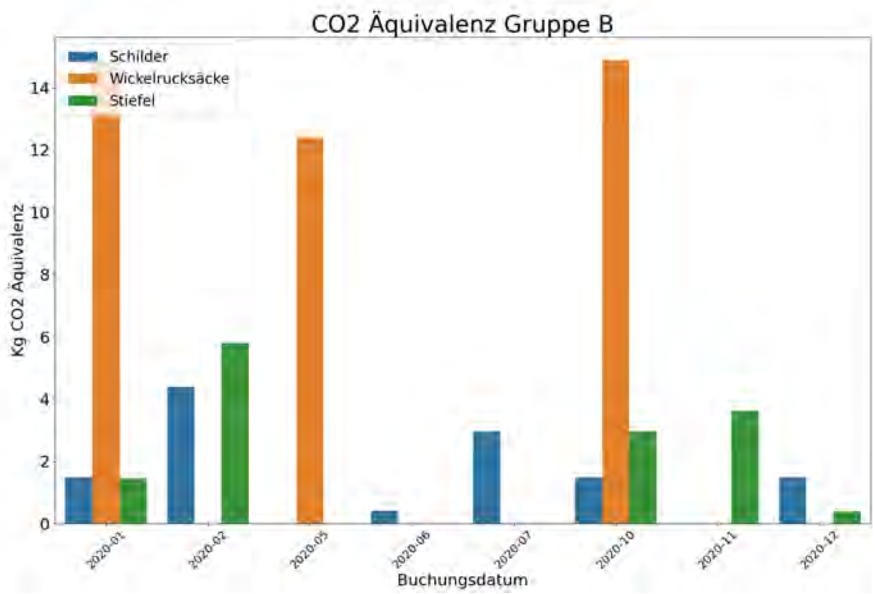


Figure 124: $CO_2$ Äquivalenz Gebrauchsgüter Gruppe B (2020)

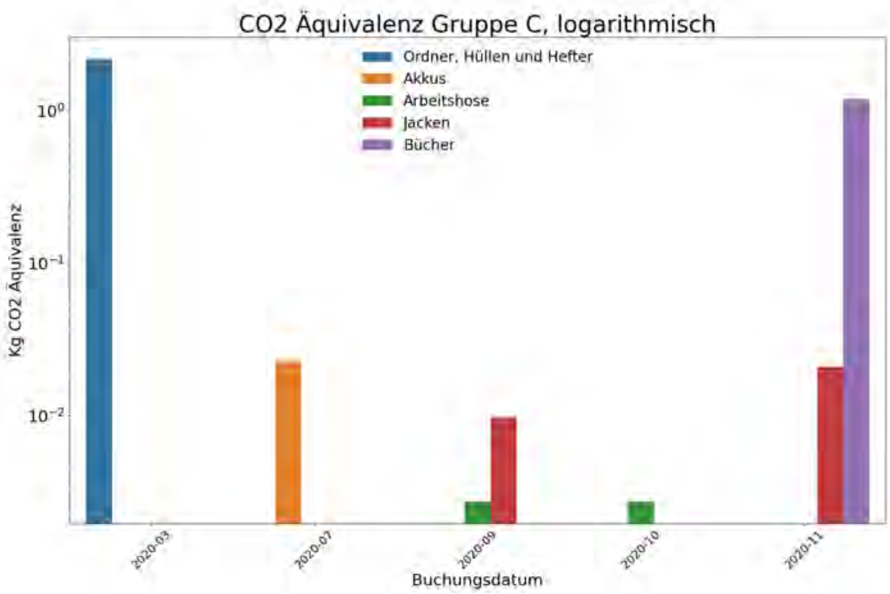


Figure 125: $CO_2$ Äquivalenz Gebrauchsgüter Gruppe C logarithmisch (2020)

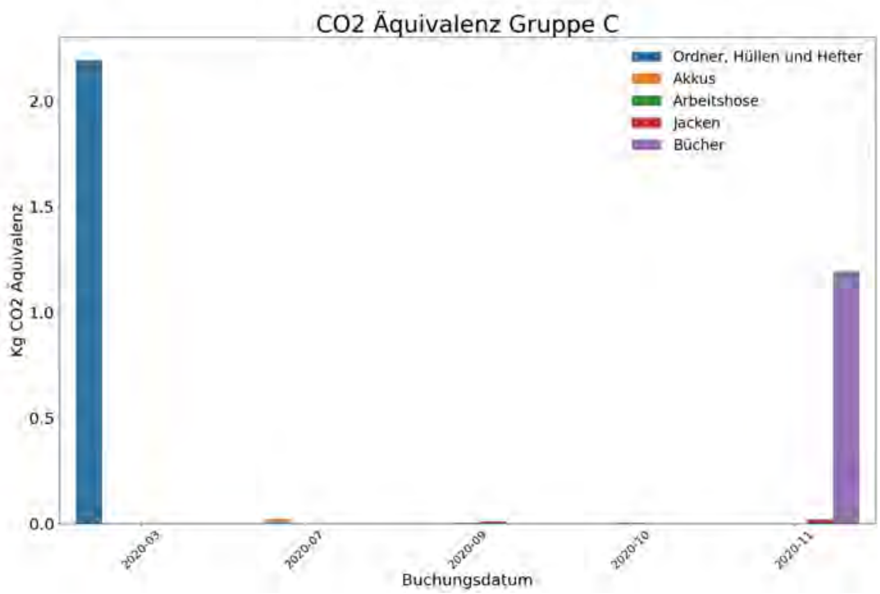


Figure 126: $CO_2$ Äquivalenz Gebrauchsgüter Gruppe C (2020)

In the following graphs, labeled 127-132, we present the $CO_2$ equivalent emissions of non-durable goods in the year 20120. These graphs provide a segmented representation of the distinct categories within the ABC analysis of $CO_2$ equivalent emissions, aiming to enhance clarity and comprehensibility. Additionally, for each category within the ABC analysis, a secondary graph is included, which employs a logarithmic scale to facilitate the identification of products with lower $CO_2$ equivalent emissions.

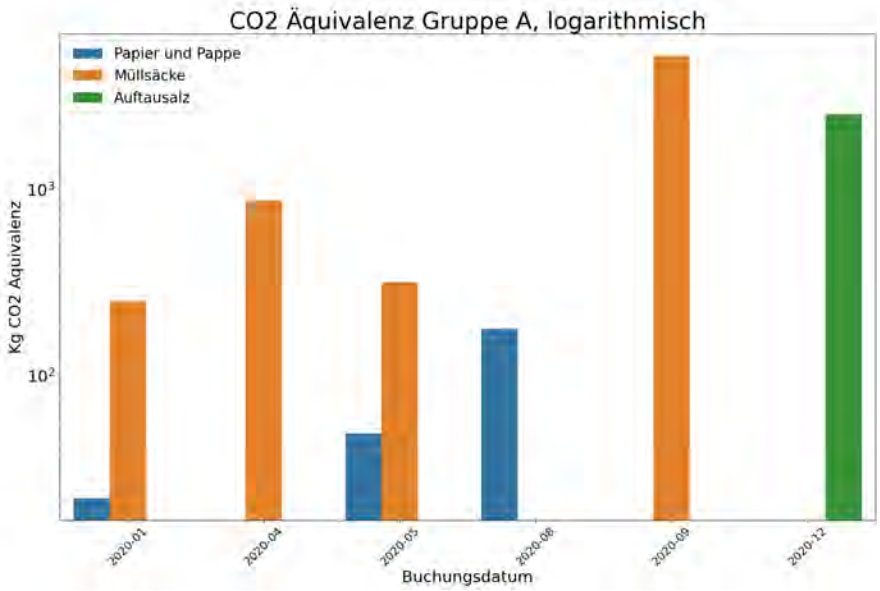


Figure 127: $CO_2$ Äquivalenz Verbrauchsgüter Gruppe A logarithmisch (2020)

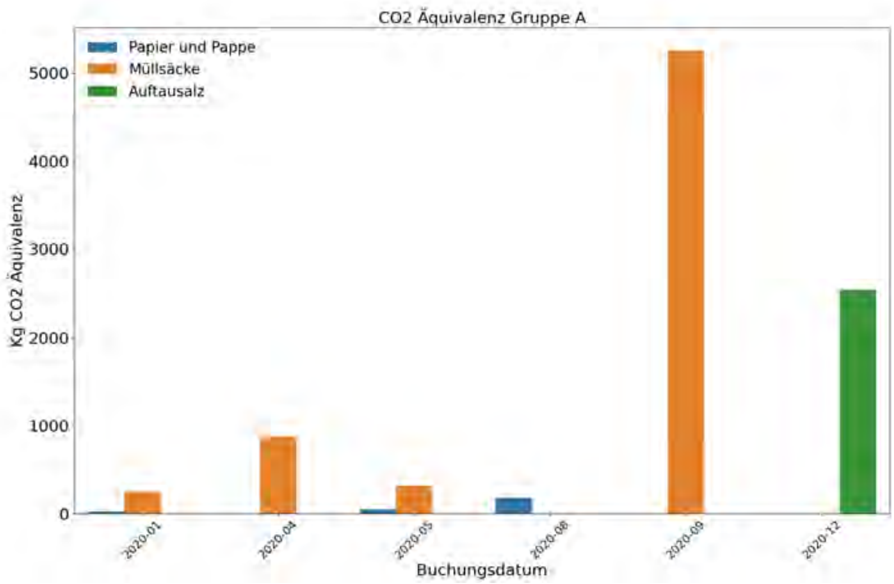


Figure 128: $CO_2$ Äquivalenz Verbrauchsgüter Gruppe A (2020)

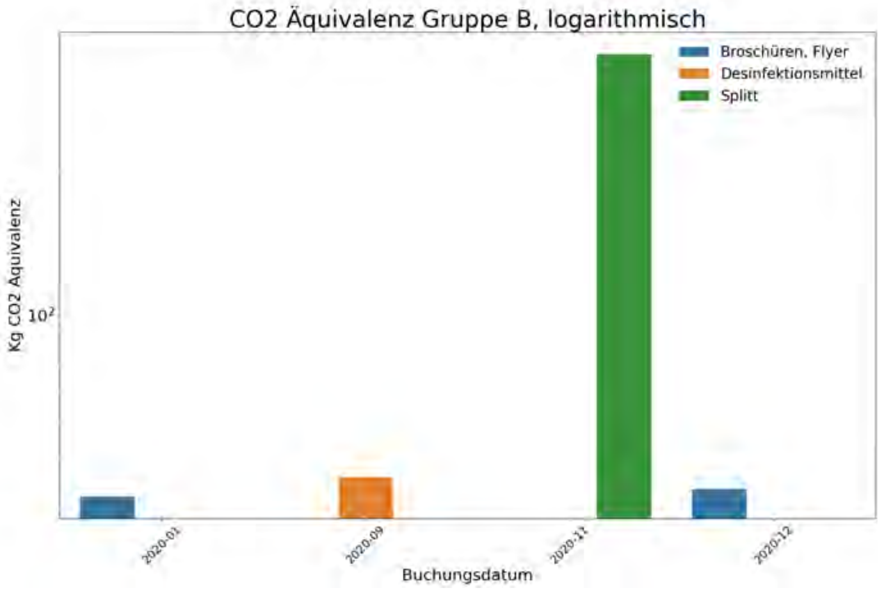


Figure 129: $CO_2$ Äquivalenz Verbrauchsgüter Gruppe B logarithmisch (2020)

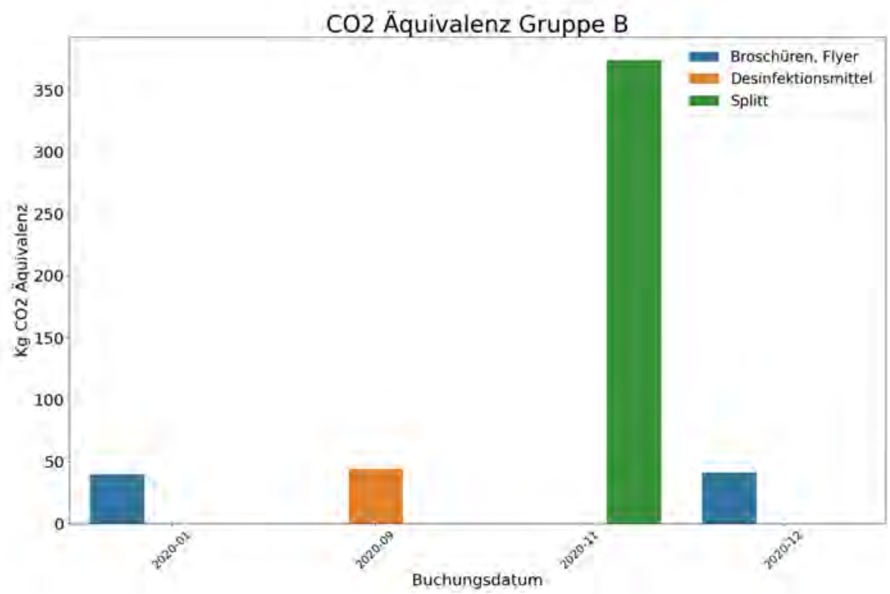


Figure 130: $CO_2$ Äquivalenz Verbrauchsgüter Gruppe B (2020)

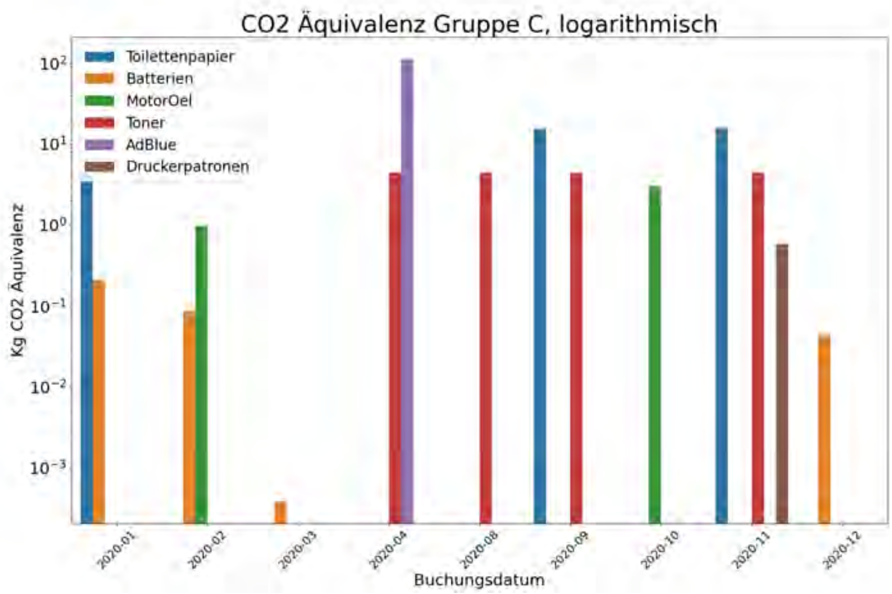


Figure 131: $CO_2$ Äquivalenz Verbrauchsgüter Gruppe C logarithmisch (2020)

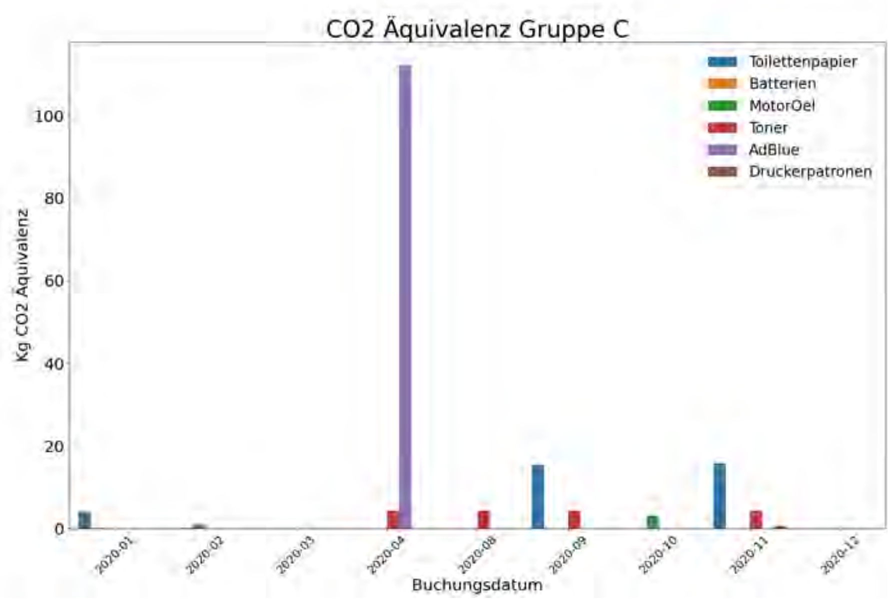


Figure 132: $CO_2$ Äquivalenz Verbrauchsgüter Gruppe C (2020)

## 2021

The following paragraph addresses the results of the analysis of the municipality Köttmannsdorf for the year 2021.

The Tables 21 and 22 provide a summary of durable and non-durable goods from the year 2021.

| Gut | Ausgaben (Euro) | Menge (kg) | Kg CO2 Equiv | ABC Cost | ABC CO2 | XYZ Cost | XYZ CO2 |
|---|---|---|---|---|---|---|---|
| Müllsäcke | 2023.4 | 3293.5 | 6587 | A | A | Y | Y |
| Auftausalz | 9976.74 | 62740 | 6274 | A | A | Y | Y |
| Desinfektionsmittel | 104.78 | 210 | 2100 | C | A | Y | Y |
| AdBlue | 901.56 | 684.52 | 705.0556 | B | B | Z | Z |
| Splitt | 1881.6 | 64000 | 576 | A | B | Z | Z |
| Toilettenpapier | 1415.9 | 191.328 | 124.3632 | B | B | Y | Z |
| MotorOel | 49.5 | 27.2405 | 95.34175 | C | C | Y | Y |
| Papier und Pappe | 190.1 | 39 | 25.35 | C | C | Z | Z |
| Toner | 205.26 | 2.2 | 17.6 | C | C | Y | Y |
| Batterien | 1271.36 | 114.988 | 0.612196112 | B | C | Y | Y |

Table 21: Köttmannsdorf, Verbrauchsgüter, 2021

| Gut | Ausgaben (Euro) | ABC Cost | XYZ Cost | Menge (kg) | Kg CO2 Equiv | ABC CO2 | XYZ CO2 |
|---|---|---|---|---|---|---|---|
| Schneeketten | 6203.06 | A | Z | 603.66 | 120732 | A | Z |
| Wasserzähler | 1249.2 | B | Z | 60 | 2067.6 | A | Z |
| LED Belichtung | 2418.18 | A | Z | 19.032 | 647.088 | A | Z |
| Schläuche | 1878.6 | B | Y | 257.4 | 514.8 | B | Y |
| Schilder | 2155.64 | B | Y | 63.68415 | 82.789395 | B | Y |
| Wickelrucksäcke | 1491.84 | B | Z | 22.8 | 59.565 | B | Z |
| Lampen | 84.86 | C | X | 1.6968 | 58.471728 | B | Z |
| Stiefel | 541.69 | C | Y | 7.44 | 21.576 | C | Y |
| Ordner und Hefter | 1221 | C | Z | 30.3735 | 19.742775 | C | Z |
| Verkehrsspiegel | 366.24 | C | Y | 5.5 | 7.15 | C | X |
| Bücher | 208.2 | C | Z | 1.592 | 1.592 | C | Z |
| Jacken | 9457.92 | A | Y | 11.12 | 0.07784 | C | Y |
| Arbeitshose | 354 | C | X | 0.39 | 0.00273 | C | X |

Table 22: Köttmannsdorf, Gebrauchsgüter, 2021

The following six graphs (Figures 133-138) show the $CO_2$ equivalent emissions of the durable goods for the year 2021. The individual groups of the ABC analysis of $CO_2$ equivalent emissions are presented separately to enhance clarity. Additionally, for each group in the ABC analysis, there is a second graph that represents the results on a logarithmic scale to facilitate the identification of products with lower $CO_2$ equivalent emissions.

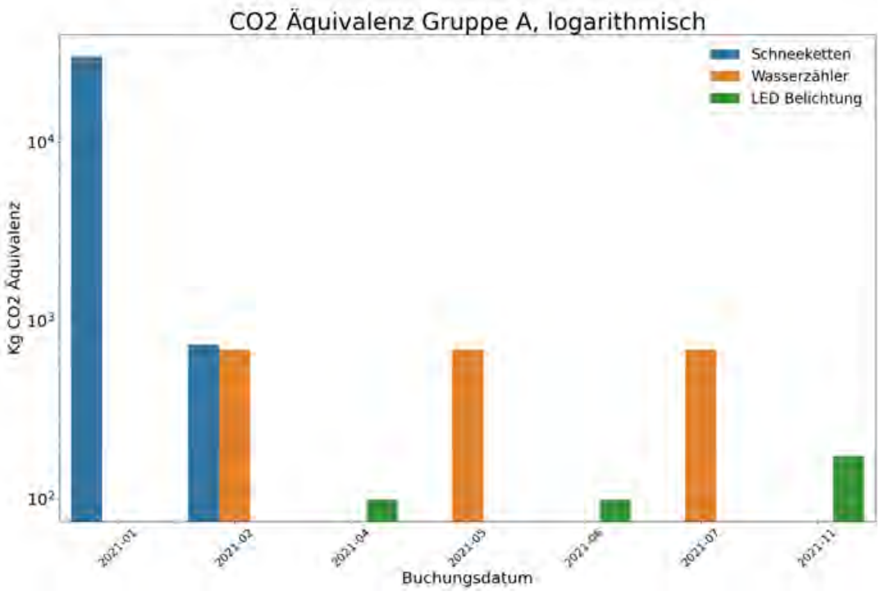


Figure 133: $CO_2$ Äquivalenz Gebrauchsgüter Gruppe A logarithmisch (2021)

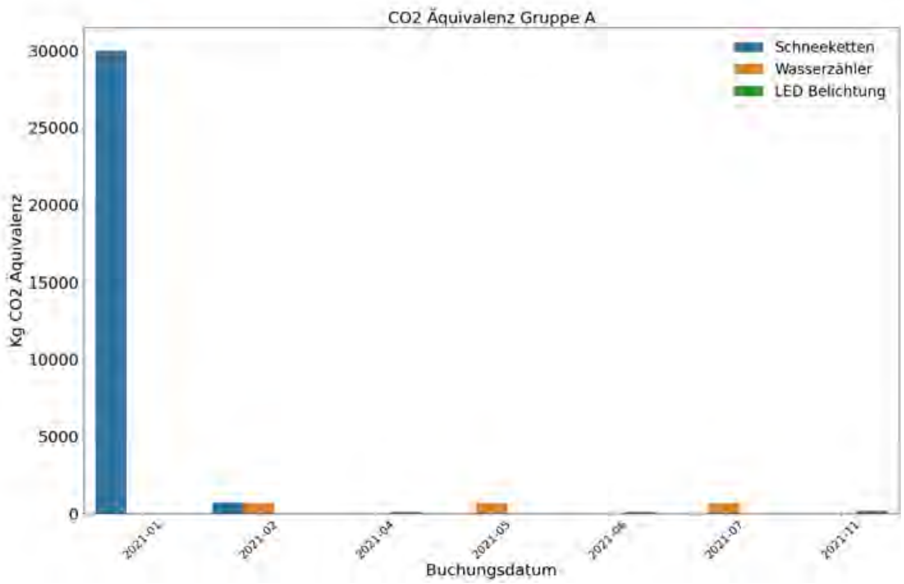


Figure 134: $CO_2$ Äquivalenz Gebrauchsgüter Gruppe A (2021)

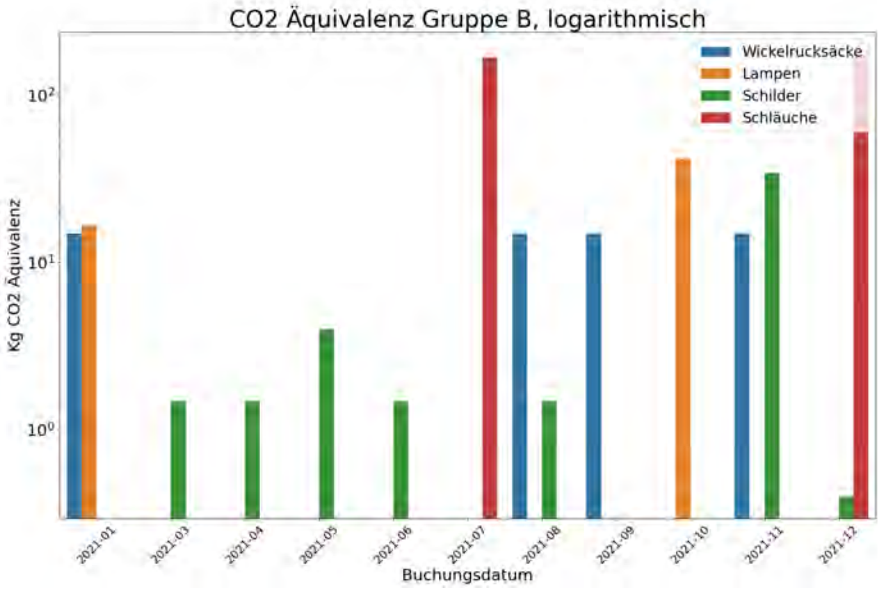


Figure 135: $CO_2$ Äquivalenz Gebrauchsgüter Gruppe B logarithmisch (2021)

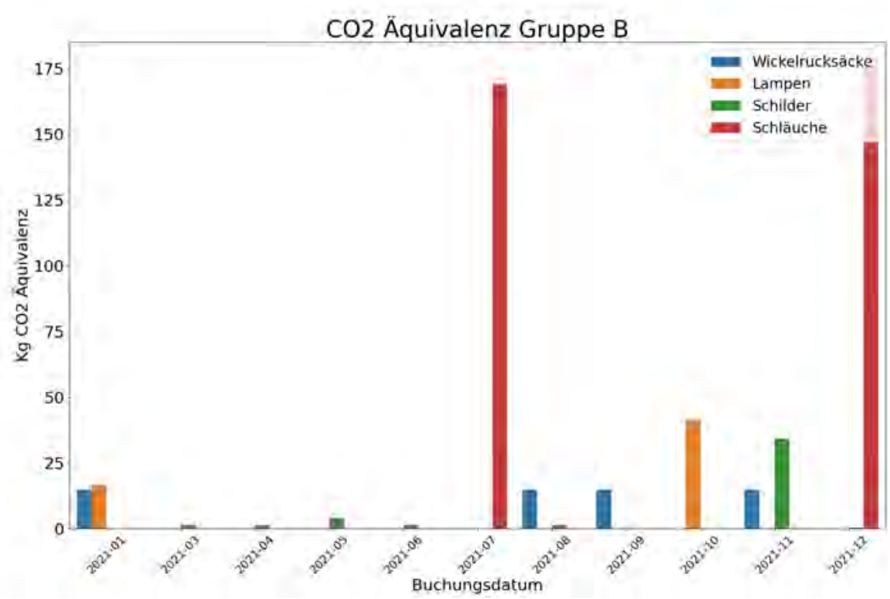


Figure 136: $CO_2$ Äquivalenz Gebrauchsgüter Gruppe B (2021)

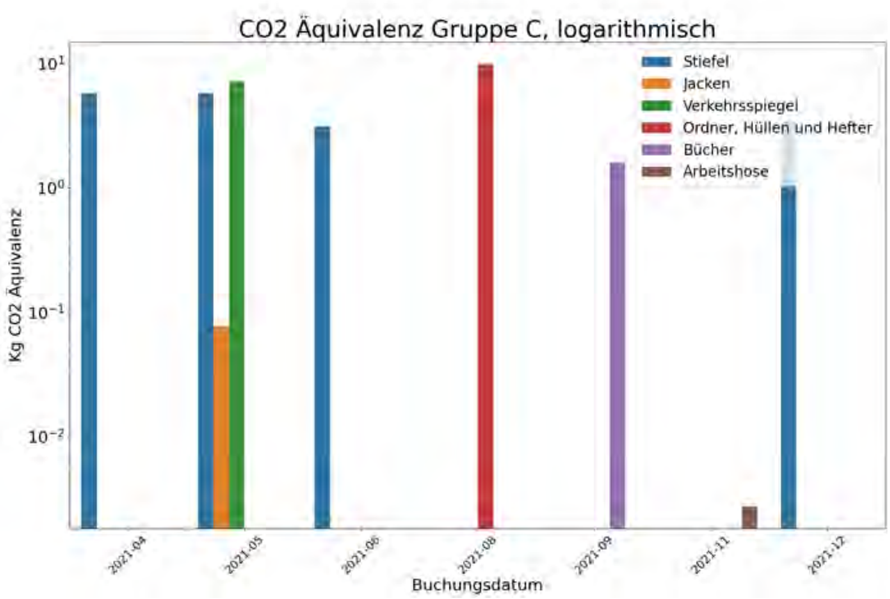


Figure 137: $CO_2$ Äquivalenz Gebrauchsgüter Gruppe C logarithmisch (2021)

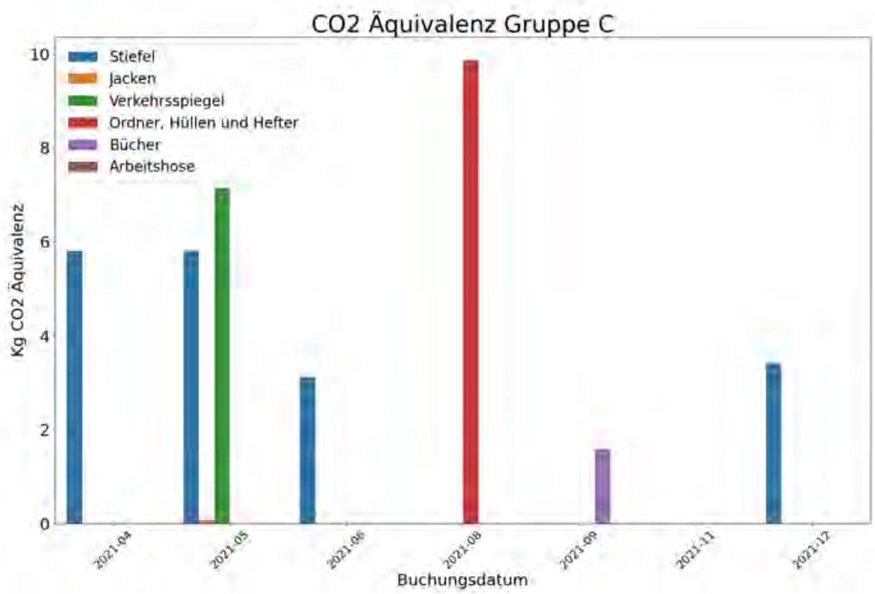


Figure 138: $CO_2$ Äquivalenz Gebrauchsgüter Gruppe C (2021)

In the following graphs, labeled 139-144, we present the $CO_2$ equivalent emissions of non-durable goods in the year 2021. These graphs provide a segmented representation of the distinct categories within the ABC analysis of $CO_2$ equivalent emissions, aiming to enhance clarity and comprehensibility. Additionally, for each category within the ABC analysis, a secondary graph is included, which employs a logarithmic scale to facilitate the identification of products with lower $CO_2$ equivalent emissions.

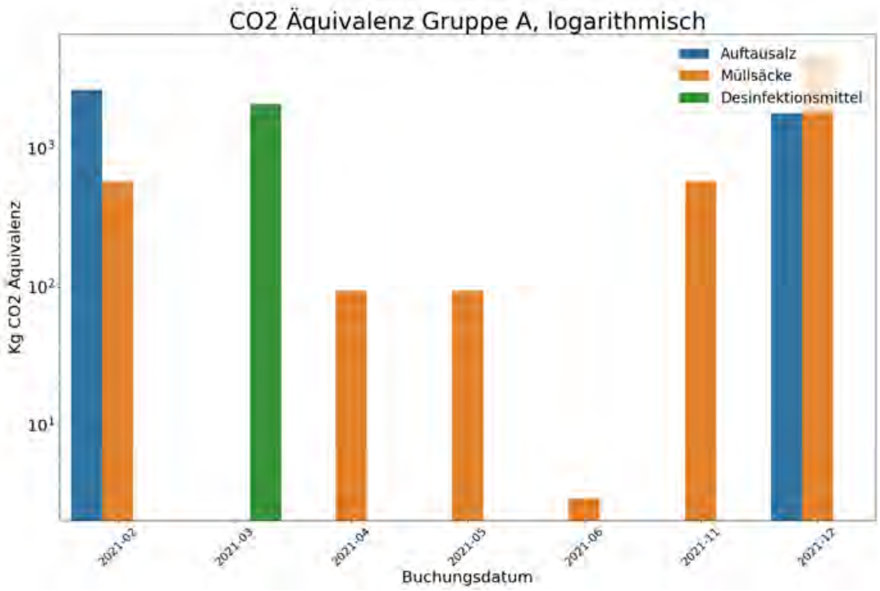


Figure 139: $CO_2$ Äquivalenz Verbrauchsgüter Gruppe A logarithmisch (2021)

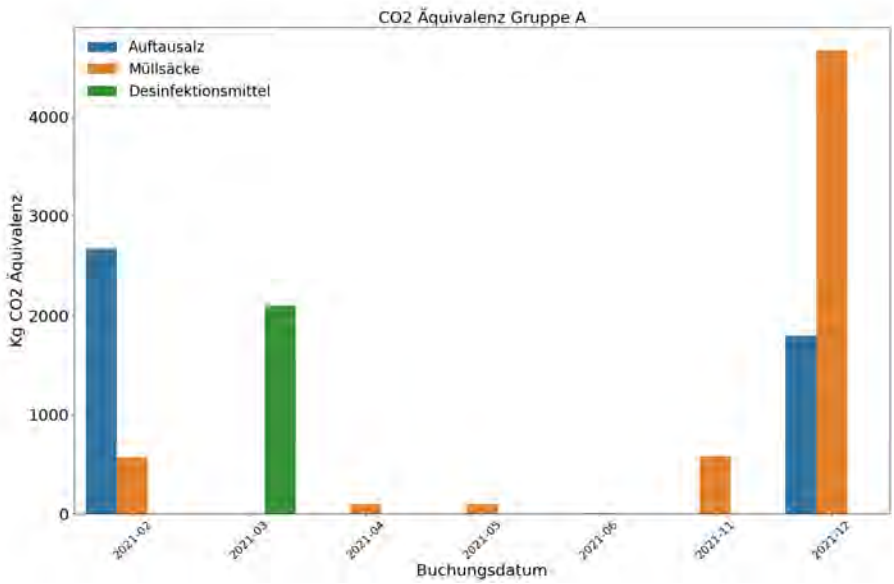


Figure 140: $CO_2$ Äquivalenz Verbrauchsgüter Gruppe A (2021)

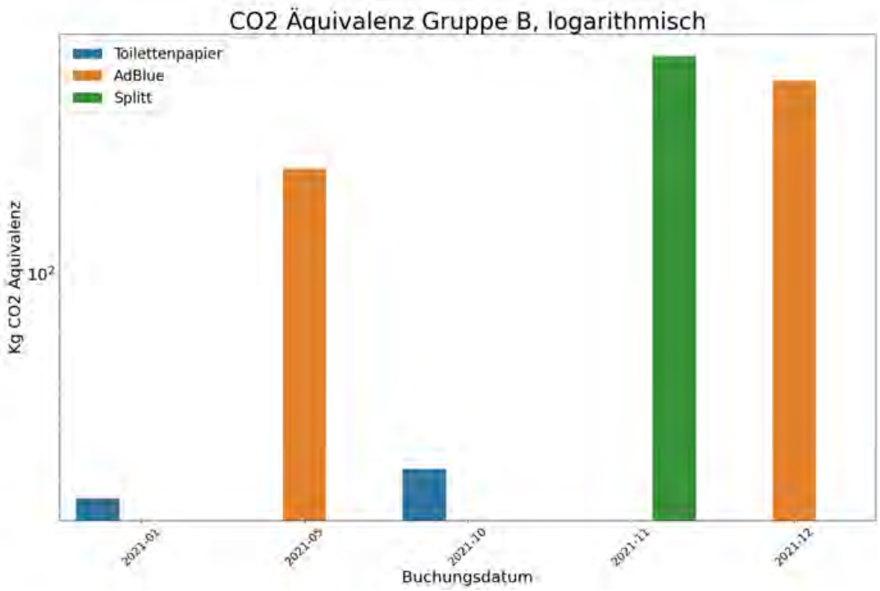


Figure 141: $CO_2$ Äquivalenz Verbrauchsgüter Gruppe B logarithmisch (2021)

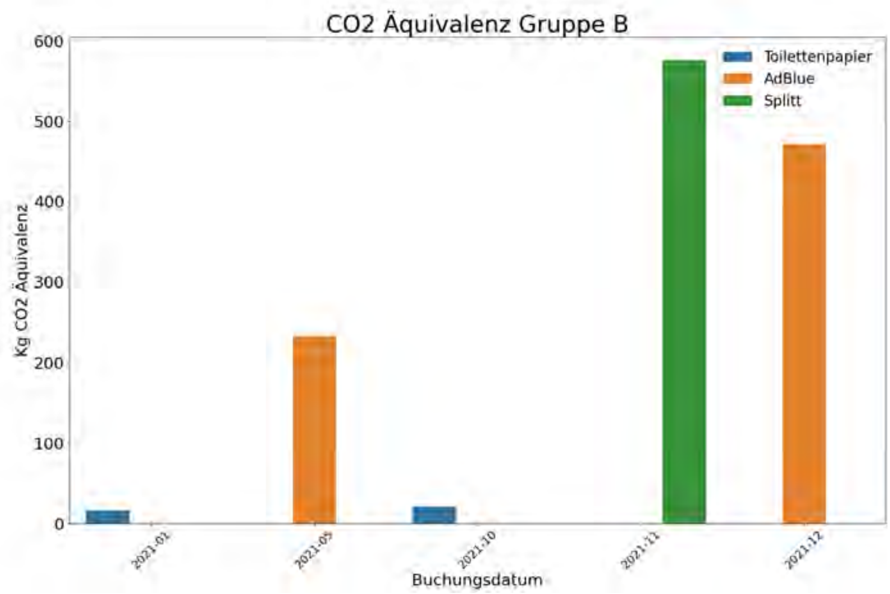


Figure 142: $CO_2$ Äquivalenz Verbrauchsgüter Gruppe B (2021)

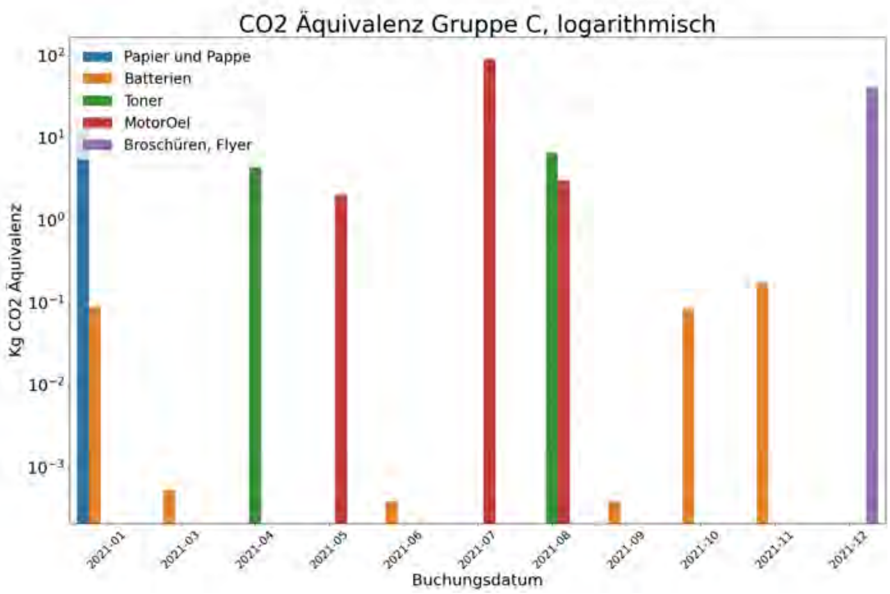


Figure 143: $CO_2$ Äquivalenz Verbrauchsgüter Gruppe C logarithmisch (2021)

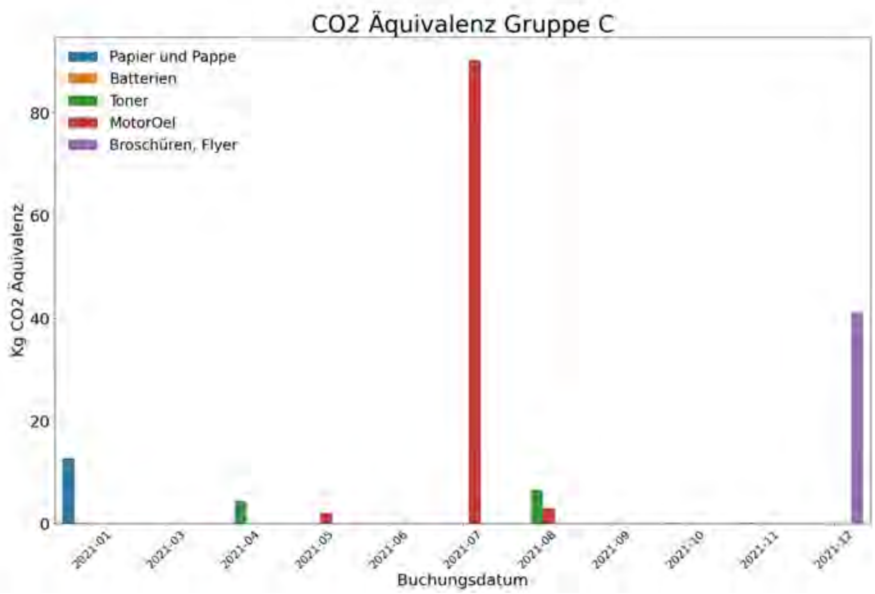


Figure 144: $CO_2$ Äquivalenz Verbrauchsgüter Gruppe C (2021)

## 2022

The following paragraph addresses the results of the analysis of the municipality Köttmannsdorf for the year 2022.

The Tables 23 and 24 provide a summary of durable and non-durable goods from the year 2022.

| Gut | Ausgaben (Euro) | ABC Cost | XYZ Cost | Menge (kg) | Kg CO2 Equiv | ABC CO2 | XYZ CO2 |
|---|---|---|---|---|---|---|---|
| Schneeketten | 4989.68 | A | Y | 403.66 | 80732 | A | Y |
| Reifen | 3643.4 | A | Z | 54 | 32059.8 | A | Z |
| Wasserzähler | 8079.5 | A | Y | 740 | 25500.4 | A | Y |
| Stromzähler | 420.5 | C | Z | 20 | 689.2 | B | Z |
| Stiefel | 1997.67 | B | Z | 27.18 | 78.822 | B | Z |
| Wickelrucksäcke | 1184.46 | B | Y | 18.05 | 47.155625 | B | Y |
| Lampen | 926.4 | C | Z | 1.24 | 42.7304 | C | Z |
| Schilder | 517.58 | C | X | 4.95599 | 6.442787 | C | X |
| Bücher | 214.5 | C | Z | 1.393 | 1.393 | C | Z |
| Jacken | 2679.6 | B | Y | 5.39 | 0.03773 | C | Y |
| Arbeitshose | 747.6 | C | Y | 3.51 | 0.02457 | C | Y |

Table 23: Köttmannsdorf, Gebrauchsgüter, 2022

| Gut | Ausgaben (Euro) | ABC Cost | XYZ Cost | Menge (kg) | Kg CO2 Equiv | ABC CO2 | XYZ CO2 |
|---|---|---|---|---|---|---|---|
| Auftausalz | 11105.13 | A | Y | 73310 | 7331 | A | Y |
| Müllsäcke | 2031 | B | Y | 3110.2 | 6220.4 | A | Y |
| Splitt | 3988.8 | A | Y | 128000 | 1152 | B | Y |
| Papier und Pappe | 2206 | B | Z | 1071 | 696.15 | B | Z |
| MotorOel | 683.52 | B | Z | 104.941 | 367.2935 | B | Z |
| Toilettenpapier | 504.88 | C | Z | 172.48 | 112.112 | C | Z |
| Toner | 124.96 | C | Y | 2.2 | 17.6 | C | Y |
| Schrauben | 51.04 | C | Y | 0.4 | 0.52 | C | Y |
| Batterien | 20.97 | C | Z | 0.152 | 0.000809248 | C | Z |

Table 24: Köttmannsdorf, Verbrauchsgüter, 2022

The following six graphs (Figures 145-150) show the $CO_2$ equivalent emissions of the durable goods for the year 2022. The individual groups of the ABC analysis of $CO_2$ equivalent emissions are presented separately to enhance clarity. Additionally, for each group in the ABC analysis, there is a second graph that represents the results on a logarithmic scale to facilitate the identification of products with lower $CO_2$ equivalent emissions.

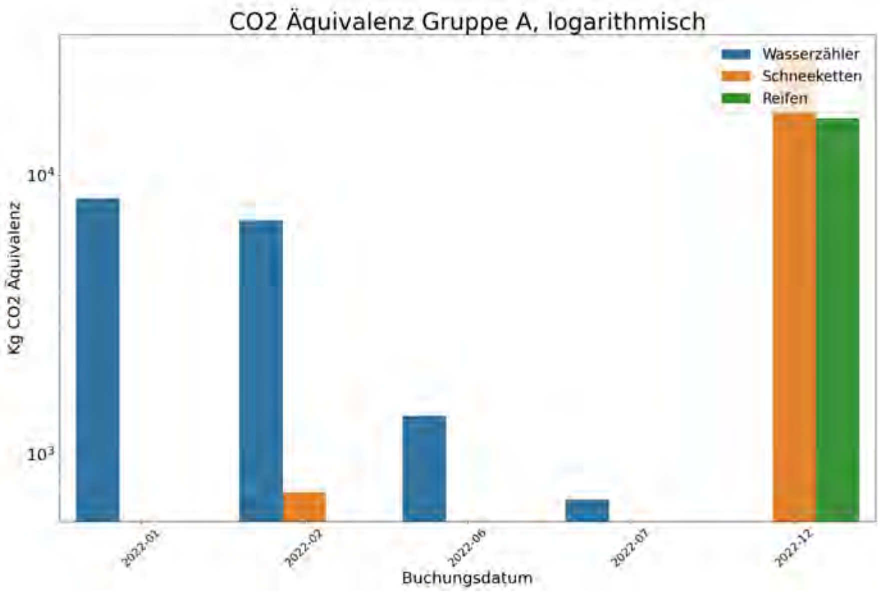


Figure 145: $CO_2$ Äquivalenz Gebrauchsgüter Gruppe A logarithmisch (2022)

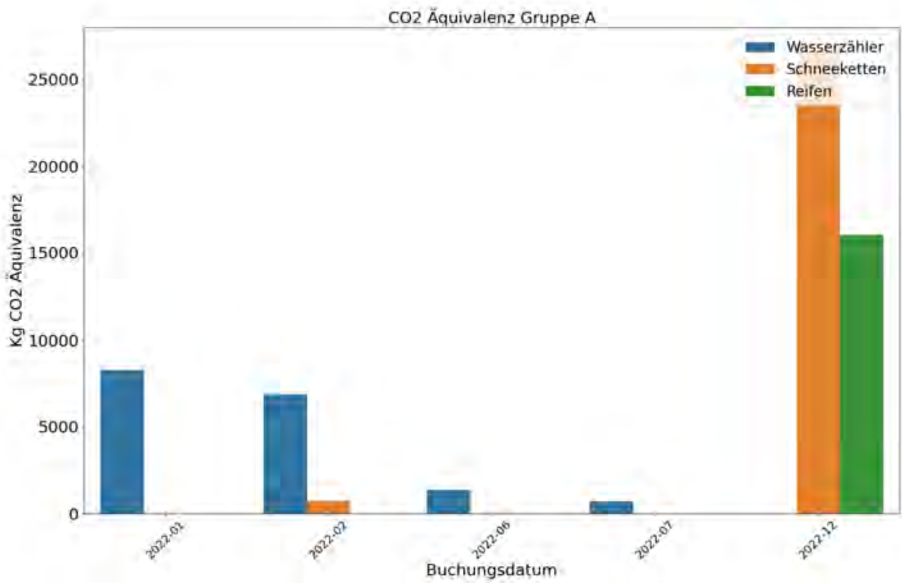


Figure 146: $CO_2$ Äquivalenz Gebrauchsgüter Gruppe A (2022)

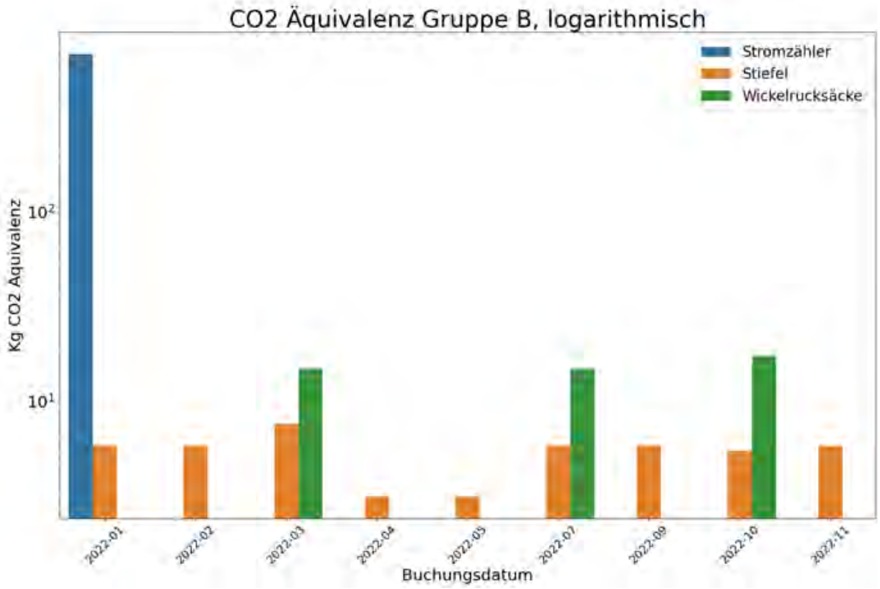


Figure 147: $CO_2$ Äquivalenz Gebrauchsgüter Gruppe B logarithmisch (2022)

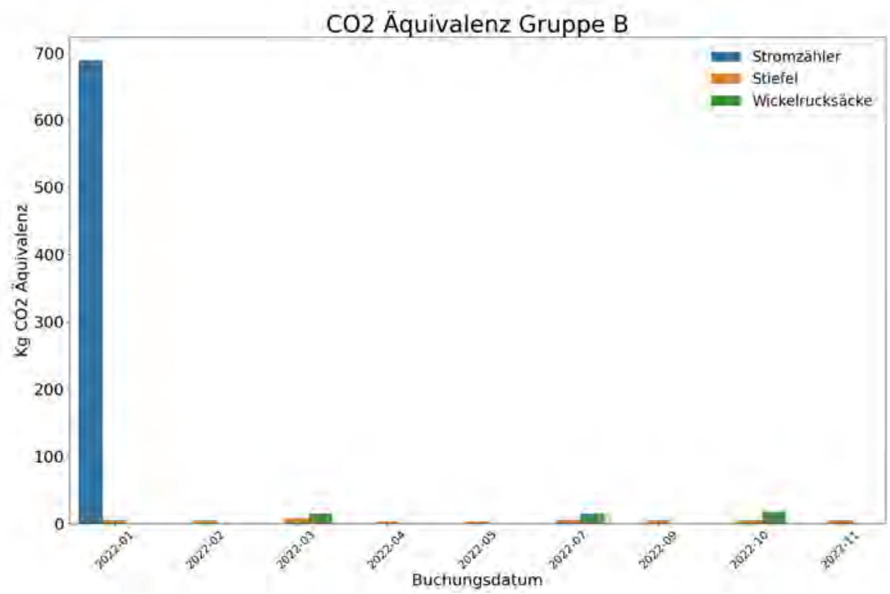


Figure 148: $CO_2$ Äquivalenz Gebrauchsgüter Gruppe B (2022)

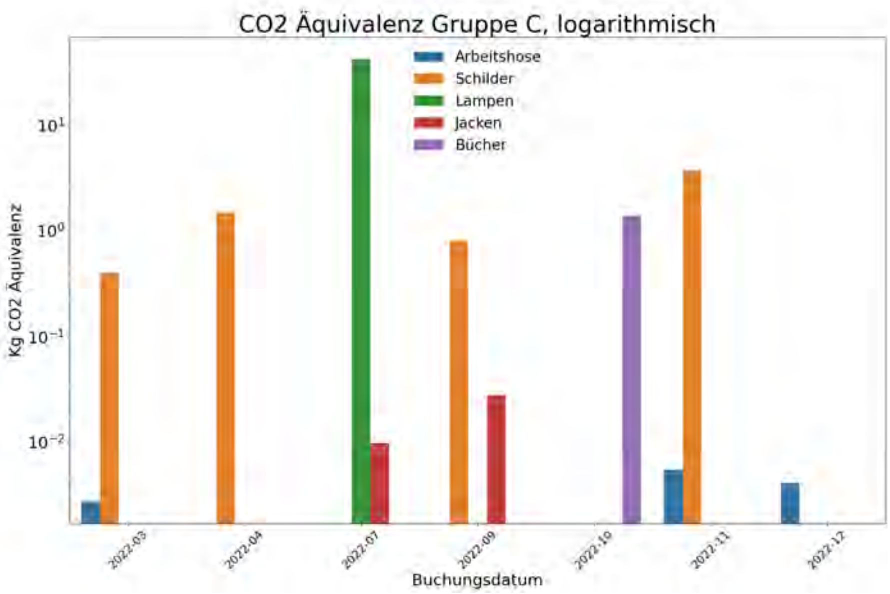


Figure 149: $CO_2$ Äquivalenz Gebrauchsgüter Gruppe C logarithmisch (2022)

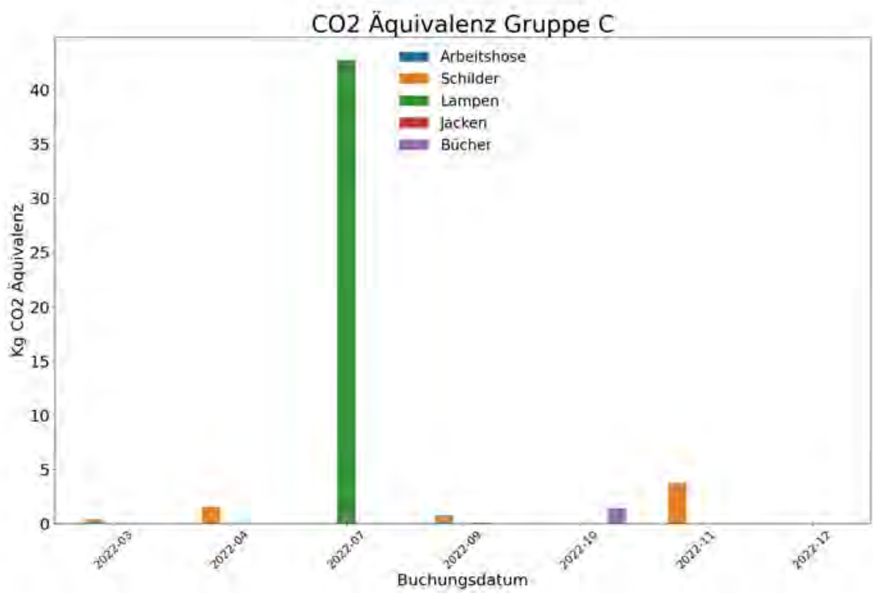


Figure 150: $CO_2$ Äquivalenz Gebrauchsgüter Gruppe C (2022)

In the following graphs, labeled 151-156, we present the $CO_2$ equivalent emissions of non-durable goods in the year 2022. These graphs provide a segmented representation of the distinct categories within the ABC analysis of $CO_2$ equivalent emissions, aiming to enhance clarity and comprehensibility. Additionally, for each category within the ABC analysis, a secondary graph is included, which employs a logarithmic scale to facilitate the identification of products with lower $CO_2$ equivalent emissions.

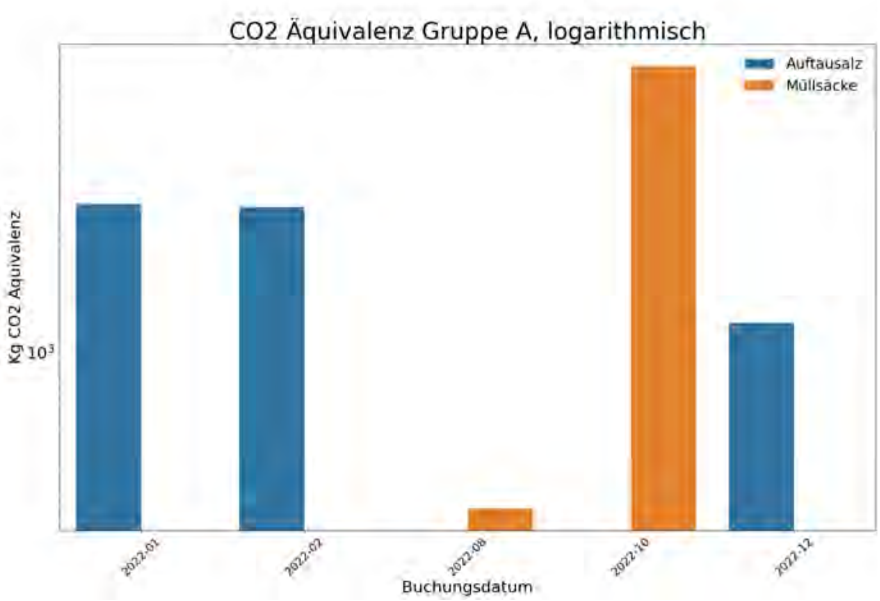


Figure 151: $CO_2$ Äquivalenz Verbrauchsgüter Gruppe A logarithmisch (2022)

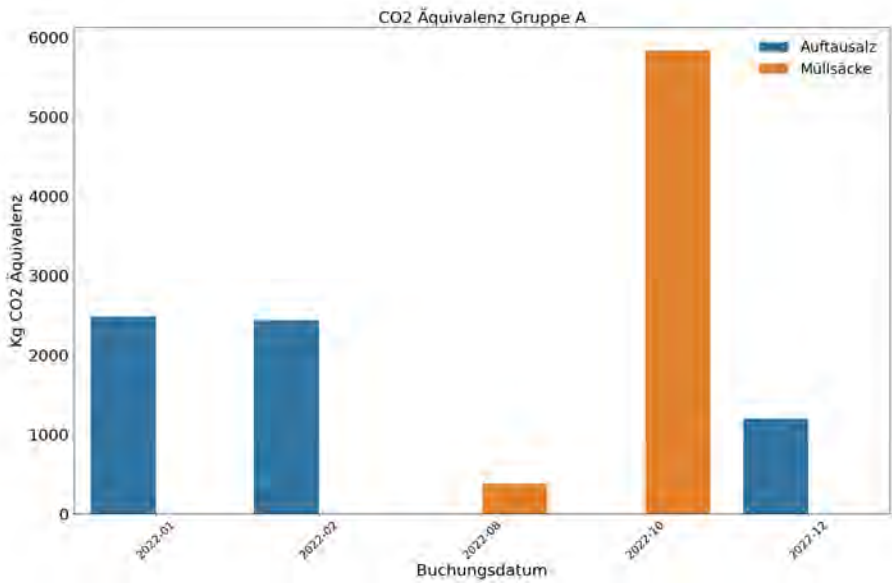


Figure 152: $CO_2$ Äquivalenz Verbrauchsgüter Gruppe A (2022)

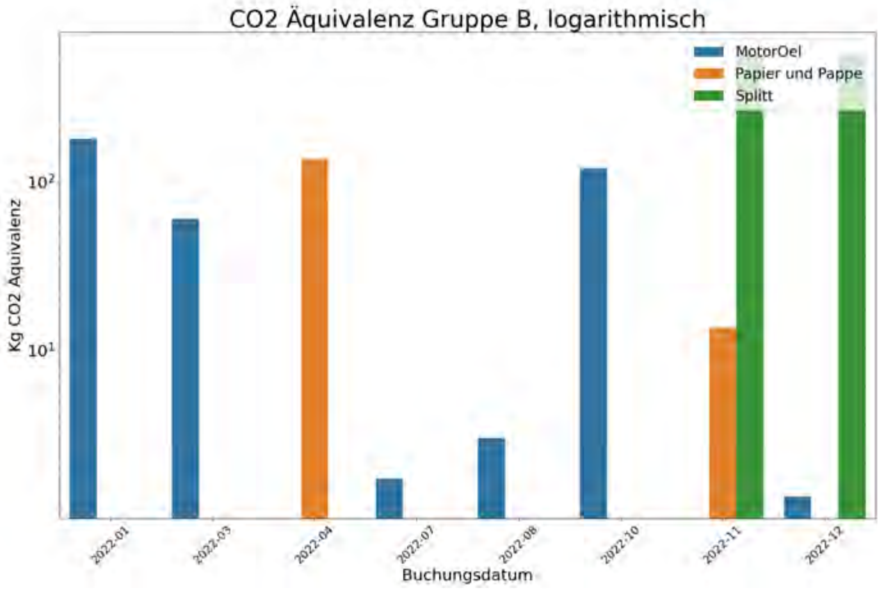


Figure 153: $CO_2$ Äquivalenz Verbrauchsgüter Gruppe B logarithmisch (2022)

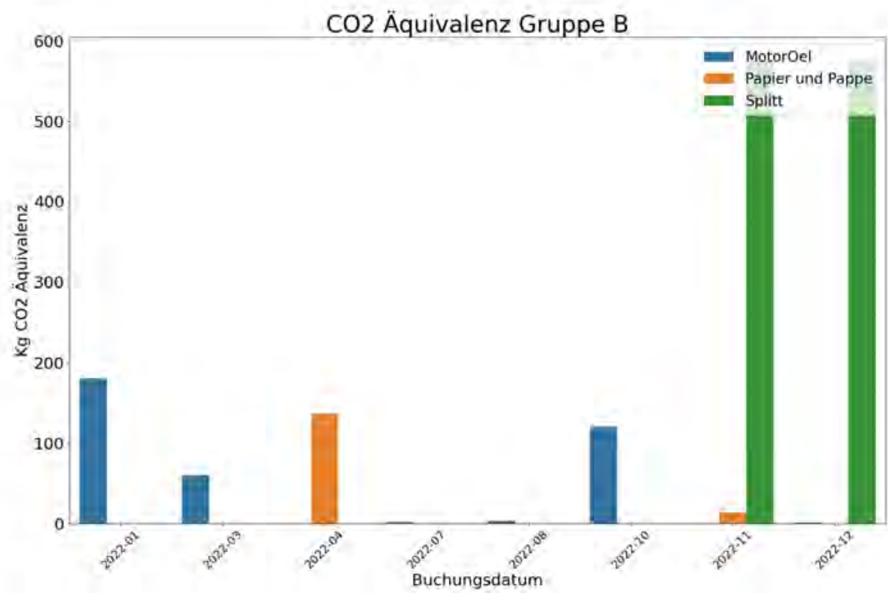


Figure 154: $CO_2$ Äquivalenz Verbrauchsgüter Gruppe B (2022)

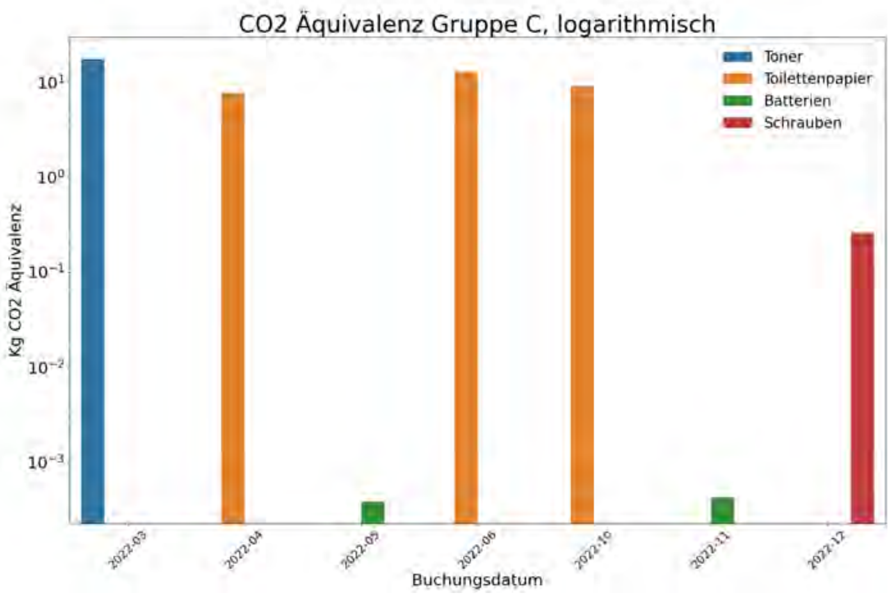


Figure 155: $CO_2$ Äquivalenz Verbrauchsgüter Gruppe C logarithmisch (2022

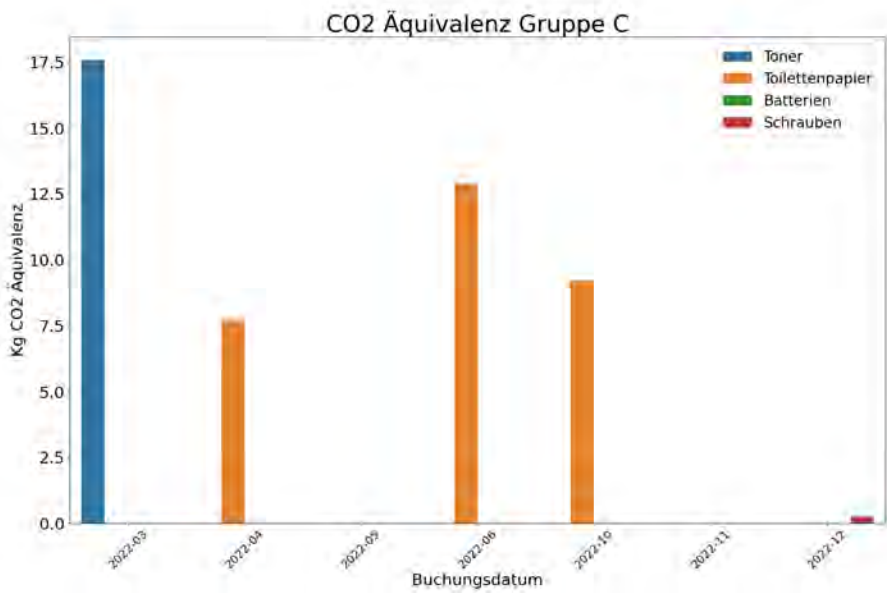


Figure 156: $CO_2$ Äquivalenz Verbrauchsgüter Gruppe C (2022)

**Estimating the $CO_2$ footprint of public procurement**
The analysis of assets in communities Ferlachand Köttmannsdorfhas provided valuable insights into the relationship between expenditures and $CO_2$ equivalent emissions. In Köttmannsdorf, the $CO_2$ value could be determined for approximately 69% of the total expenditures. This allowed for a precise identification of assets that had significant environmental impacts and laid the foundation for targeted measures to reduce these emissions.
In Ferlach, a $CO_2$ value could be determined for approximately 60% of the total expenditures. These results also facilitated a deeper understanding of the environmental aspects related to the procurement and utilization of assets. It paved the way for a focused and sustainable procurement strategy where environmental impacts are integrated into the decision-making process.

**ABC and XYZ analyzes as tools for developing sustainable procurement strategies**
Within the scope of our analysis, we have identified key levers for $CO_2$ reduction, as illuminated by the ABC and XYZ analyses:

- **High $CO_2$ Contribution (A):** Assets that make a significant contribution to CO2 emissions have been prioritized. Targeted measures to reduce the $CO_2$ footprint of these assets can yield substantial progress towards sustainability goals.
- **Frequent Procurement (X):** Assets that are regularly procured and concurrently exhibit significant $CO_2$ emissions present substantial potential for $CO_2$ reduction. Reviewing and optimizing the procurement frequency of these assets can significantly minimize environmental impacts.
- **Low Cost Proportion (C):** Assets with a low proportion of costs, yet still causing significant $CO_2$ emissions, should not be overlooked. Effective cost-saving strategies can be combined with the goal of reducing $CO_2$ emissions while simultaneously achieving economic benefits.

The identification of these levers provides communities with the municipalities to take specific actions to reduce their carbon footprint regarding economic aspects as well. This contributes to the development of sustainable and responsible procurement strategies that can have long-term positive effects on both the environment and finances.

# 5 Evaluation and Interpretation

In this section, we present specific results from our analysis of the provided Excel spreadsheets, with a primary focus on the CO2 equivalent emissions for the period 2018-2022 and the ABC and XYZ analyses.

**Municipality of Köttmannsdorf:**

- **Durable Goods:**
Figures 81 and 82 reveal that, despite infrequent procurement, tires constitute a significant portion of the CO2 equivalent emissions.
Figures 83 and 84 illustrate that frequent procurement of LED lighting contributes substantially to CO2 equivalent emissions.
In Figures 85 and 86, we observe eight product categories, which, though numerous, contribute minimally to CO2 equivalent emissions, rendering them of negligible impact.
Figure 95 highlights a product category of particular significance to our study. It is both cost-effective and leads to a high level of CO2 equivalent emissions. Table 13 indicates that this category pertains to electricity meters. Additionally, three product categories, namely LED lighting, hoses, and lamps, hold notable importance due to their relatively low expenditures and still relatively high CO2 equivalent emissions.
Figure 96 allows us to deduce that three pertinent product categories exhibit high CO2 equivalent emissions and regular procurement. Reference to Table 13 indicates that these categories are tires, water meters, and electricity meters.

- **Non-durable goods:**
Figures 87 and 88 depict that trash bags and de-icing salt contribute significantly to CO2 equivalent emissions.
Figures 89 and 90 indicate that the major share of CO2 equivalent emissions results from a single large procurement event of disinfectant.
Similar to capital goods, in Tables 91 and 92, we observe that most product categories have a minimal contribution to CO2 equivalent emissions.
In Figure 93, we find no product category that falls into both expenditure Group C and CO2 equivalence Group A. However, there are three product categories that fall into expenditure Group C while still producing a non-negligible share of CO2 emissions. Table 14 reveals that these categories include disinfectant, motor oil, and AdBlue.
Figure 94 reveals two highly significant product categories, which both contribute significantly to CO2 equivalent emissions and are procured on a regular basis. As per Table 14, these categories are trash bags and gravel.

**Municipality of Ferlach:**

- **Durable Goods:**
Figures 4 and 5indicate that the majority of CO2 equivalent emissions are

caused by procurements of water meters. Other major contributors are, similar to Köttmannsdorf, procured tires, as well as lights and lamps. Manhole covers, due to their manufacturing process, are another major factor of CO2 equivalent emissions.
Water meters in particular are one factor that needs to be looked into further, as it is unclear whether these data entries are done due to replacement of defective water meters, or due to replacements every few years even if they are still functional.

- **Non-durable goods:**
  Figures 11 and 10 show that flocculents are responsible for the majority of CO2 emissions, followed by trash bags and heating oil. Split, despite mostly consisting of rocks, still cause a very large amount of CO2 emissions, mainly due to transport. Disinfectants also play a major role, though the high volume may be explained due to the global pandemic in the examined years and thus the high volume for this product type should not be considered a permanent issue.

# 6 Discussion and Conclusion

The presented project has been instrumental in overcoming various challenges in assessing and analyzing data related to procurement practices. As expected, the project team encountered several challenges in assessing and analyzing the data, including inconsistent product nomenclature, missing quantity information, difficulties in identifying products based on their descriptions, instances of multiple products listed within a single entry, issues with tax categorization, as well as challenges in determining accurate CO2 values. Furthermore, rough estimations were required for certain products due to incomplete data, and the assessment was hindered by price fluctuations that made it challenging to evaluate the environmental impact of procurement effectively. These hurdles underscore the complexity of developing sustainable procurement strategies. Still, they also highlight the critical need for standardized data, improved data collection procedures, and practical tools and methodologies for better decision-making in pursuing climate-conscious procurement practices. Despite these challenges, the project represents a significant step towards enhancing the region's eco-friendly purchasing policies and showcases the commitment to addressing environmental concerns within the community.

Handling a substantial volume of data necessitated the extensive utilization of various tools, both existing ones such as CCaLC2 (a tool designed for calculating CO2 footprints within a production chain) and tools written in Python tailored explicitly for this project. These project-specific tools were employed to streamline the processing of procurement tables, consolidate products with slight variations in naming, assess products in groups, and enable the selection of specific time frames for analysis.

The reported expenditures for goods during the period of 2018-2022 exhibit a typical long-tail distribution. In the case of Ferlach, 89% of the roughly 7400 reported purchases fall within two orders of magnitude. Similarly, for Köttmannsdorf, the distribution is akin, with 88% of the approximately 2650 purchases residing within two orders of magnitude in terms of purchase costs.

Despite the substantial volume of data, it was possible to determine the CO2 equivalent value for 69% of the expenditures in the municipality of Köttmannsdorf and, correspondingly, for 60% of the expenses in the municipality of Ferlach. This still leaves a notable portion of primarily small and diverse goods without a comprehensive assessment. However, it is important to note that the explained expenditures encompass the majority of the spending, aligning with the project's objective of identifying the primary sources of CO2 emissions and, as such, providing insights into the strategies for reducing the municipalities' carbon footprint.

From the perspective of sustainability research, the transformation of procurement strategies within public institutions necessitates the establishment of uniform data foundations. Consistent and comparable data structures offer distinct advantages, particularly for smaller municipalities, which do not fall under the category of major cities. In the context of the KEM model region, the benefits are multifaceted. Firstly, collectively collecting data enables the aggregation of information, allowing for the pooling of CO2-related insights. Secondly, based on these aggregated data, collaborative strategies can be devised for engaging with suppliers and vendors. Thirdly, joint efforts in data collection and analysis serve to bolster the position of these communities in their interactions with the business sector, especially when it comes to fostering regional procurement and capitalizing on economies of scale, among other advantages.

What has become particularly evident in this project is the pivotal role of information technology in shaping and ensuring the uniformity of data structures. Without a homogenous data foundation, an effective and impactful shift towards a radical reduction in CO2 emissions associated with public procurement seems inconceivable. Therefore, to develop sustainable procurement strategies, it is strongly recommended that KEM regions collaborate with experts in the field to construct a robust and mutually workable data structure. This structure should encompass not only quantities and prices but also include information on CO2 emissions and product lifespans. Such an initiative will undoubtedly contribute to the advancement of environmentally responsible procurement practices and the broader goals of sustainability.

Follow-up work based on the project results could involve applying the developed tools and methods to new data, generating new knowledge from a comparison of a range of differently-sized municipalities in an area. Future research could further encompass a targeted search for alternative products within the identified domains and an assessment of the developmental potential for product groups.

# 7 Appendix: Final Presentation (4.7.2023)

The final presentation held at University of Klagenfurt on Tuesday, July 4, 2023, is included as a binary PowerPoint file with this report.

# 8 Appendix: Python Tool and Dataset

The Python tool developed for this project by Stefan Hohnwald and the configuration files and datasets are included as a binary attachment with this report. The code is released under a Creative Commons Public Domain license.