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Progress with the method for making early CO_2 emission estimates based on Eurostat monthly energy data

End of project report

Berlin, March 2019

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Table of Contents

List of Tables

List of Abbreviations

CO_2	Carbon dioxide
CRF	Common Reporting Format
EU	European Union
GCV	Gross calorific value
Gg	Gigagram = 10^9 g = 1 kt (kiloton) = 1000 tonnes
GHG	Greenhouse Gas
IPCC	Intergovernmental Panel on Climate Change
kt	Kiloton (1 kt = 1000 t)
MS	Member State
NCV	Net calorific value
NIR	National inventory report
QA/QC	Quality assurance and quality control
TJ	Tera joule
UNFCCC	United Nations Framework Convention on Climate Change

Summary

Early CO_2 emissions estimates from the energy sector for the EU and its Member States were made based on Eurostat monthly energy data. With this method, the CO_2 emissions from fossil fuels are calculated four to five months after the reference year, which is about one year earlier than final CO_2 emissions reported in national greenhouse gas (GHG) inventories submitted to the UNFCCC.

The method is based on the trend changes of the fuel consumption for aggregated fuel categories (liquid fuels, solid fuels and gaseous fuels) of Eurostat monthly energy data. This project has been used to perform a thorough examination of the suitability of the proposed method over a longer time period. Estimates for early CO_2 emissions have been calculated for the years 2015, 2016 and 2017. The application of the trend method to estimate early CO_2 emissions for all EU Member States represents a robust procedure that adjusts systematic errors of under- or over-reporting in monthly data.

Verifications of the CO_2 estimates for the years 2014, 2015 and 2016 were based on comparisons with the CO_2 emission data reported in the Member States' GHG inventory submissions to the UNFCCC (CRF Table 1.A.b Reference Approach), which become available approximately one year later. A verification of the 2017 CO_2 estimates could not be performed within this project, as GHG inventories will only became available in 2019.

An analysis of the quality of the Eurostat monthly energy data on fuel consumption used for calculating CO_2 emissions is carried out by comparing annual and monthly Eurostat energy data and energy data used in the Member States' GHG inventories for the years 2014–2016. In comparison to earlier years (2008-2013), the quality of the monthly data seems to have improved, which further contributes to the suitability of the trend change method. The improvements in the monthly reporting are a further step towards a harmonised method. However, data quality in some Member States is fluctuating and differences are high only in some years, which affect the trend changes and the results of the early CO_2 estimates. In order to apply a harmonised method to all EU Member States without correcting or updating any monthly data, a sufficient quality of monthly data is needed for all years.

1. Introduction and background

In order to improve the timeliness of the EU carbon dioxide emissions data, Eurostat initiated an action called “Early Estimates of CO_2 Emissions”. The aim is to provide estimates of CO_2 emissions from energy use (combustion of fossil fuels) only four to five months after the reference year (t+4), instead of the usual 16 months. These first estimates are based on a harmonised method and monthly energy statistics already available through the Energy Statistics Regulation. This information is particularly relevant because CO_2 emissions from fossil fuel combustion make up nearly 80% of the total greenhouse gas (GHG) emissions and, on average, around 80% of the annual change in EU GHG emissions.

The first objective was to test whether the trend method developed to estimate early CO_2 emissions continues to produce valuable results based on the use of monthly energy data. For this purpose, early CO_2 estimates at t+4 months were calculated in April of the years 2016, 2017 and 2018. In addition, the early CO_2 estimates calculated were verified by comparison with subsequent official CO_2 emission data reported in the GHG inventory submissions to the UNFCCC under CRF table 1.A (b)[1].

The second objective of this project was to analyse the quality level of monthly Eurostat energy data on fuel consumption compared to annual Eurostat data and to energy data used by Member States for the GHG inventory. Based on the comparison it was assessed whether the quality of these data improved and in which areas substantial deviations continue to occur.

This report includes a short description of the method used, a verification of the early CO_2 emission estimates for the year 2014, 2015 and 2016 and an analysis of the quality of the Eurostat monthly energy data on fuel consumption in comparison to Eurostat annual data and GHG inventory data for the years 2014, 2015 and 2016.

1.1. Method, timeline, data sources and quality checks

The following paragraphs summarise the method, timeline, data sources and quality checks used for the early CO_2 emissions estimates based on monthly energy data.

Method

Annualised monthly Eurostat energy data is used to make early CO_2 emissions estimates. The calculations take the annual change in fuel consumption and apply that change to reported CO_2 emissions from fuel combustion in the GHG inventory. The percentage change in consumption of solid, liquid, gaseous fossil fuels and peat are applied to the corresponding reported CO_2 emissions for the most recent available year. In other words, reported CO_2 emissions estimates are carried forward based on the change in associated fuel consumption.

Timeline and data sources

The timeline of data availability also underlines the reason why these calculations of early CO_2 emissions estimates are required. The GHG emissions published by the UNFCCC inventory report occur sixteen or more months in the past and are published in mid-April.

The monthly Eurostat energy statistics [the so-called M-2/M-3 data collections] are released at the middle of each month (e.g. mid of March/April 2018 data for the reference month December 2017). The date for additional releases of revisions is at the latest with the next monthly release. This in

[1] CRF (Common Reporting Format) table 1.A (b) SECTORAL BACKGROUND DATA FOR ENERGY: CO_2 from Fuel Combustion Activities - Reference Approach (IPCC Worksheet 1-1), Common Reporting Format - a set of standardised spread sheet data tables containing mainly numerical information and submitted electronically. These form one component of annual inventory submissions to the EU and the UNFCCC.

effect means that a calendar year of revised monthly data is available in March. The work to calculate early CO_2 emissions estimates for the previous year begins therefore end of March or beginning of April.

Quality checks

Quality checks are carried out in a number of ways. The monthly data sets are checked for internal consistency using tests that flag possible gaps and outliers. The annualised monthly Eurostat energy data is subsequently quality checked in three ways: against the annual energy data shown in the Member States' GHG inventories and against the annual Eurostat energy data. It is evident from the timelines that only the gap and outlier quality checks is able to be conducted on the up-to-date monthly Eurostat data. Within the duration of the project, the checks revealed that the quality of monthly Eurostat data in terms of gaps and outliers improved and no gap filling was applied. The comparisons against annual GHG inventory data and annual Eurostat data can only be performed when reviewing early CO_2 emissions estimates from previous years. Even so these checks are important and have shown that the reporting of monthly Eurostat data is fluctuating. Differences in comparison to Eurostat annual data and GHG inventory data are high only in some years, which affect the trend changes and the results of the early CO_2 estimates.

Uncertainties of early CO_2 estimates

The early CO_2 emissions estimates are verified by a a comparison against the corresponding CO_2 emissions in the Member States' GHG inventories in the following year.

Differences between early CO_2 estimates and final GHG inventory data due to methodological changes (changing emission factors, fraction of carbon stored/carbon excluded etc.) or revision of GHG inventory data on liquid, solid and natural gas consumption cannot be foreseen and are not related to the quality of Eurostat monthly energy data, but can result in uncertainties.

Besides data revision one main reason that increases the uncertainty of the early CO_2 estimates is the concept of carbon excluded/stored. According to the IPCC Guidelines, carbon that does not lead to emissions from fuel combustion is excluded in the calculation of CO_2 emissions from the energy sector.[2] This is called carbon excluded (or carbon stored; ESTAT calls it non-energy use). Either the excluded carbon is reported in other sectors (as emissions from industrial processes) or it is stored in a product manufactured from the fuel. Fuels that contain relevant quantities of excluded carbon include:

- Reductants for iron, steel and non-ferrous metals: coke (and petroleum coke),
- Non-energy fuel use: lubricants to be excluded (even if combusted in 2-stroke engines)
- Feedstocks: (Naphtha, LPG, refinery gas etc.): all deliveries to petrochemical feedstocks should be excluded, not subtracting products that are combusted in industry

Non-combusted fossil fuels are mentioned in Eurostat's annual questionnaire in specific tables as 'non-energy use'. E.g. natural gas can be used to produce fertilisers or for plastic production in the industry. Certain oil products are also used for plastic production as well as certain coal fractions. Carbon from coke oven coal has a dual use in blast furnaces: energy use to heat the ore, stabilising the process of melting the ore or as alloying agent in steel production (mac. C content in steel 2%).

[2] With the application of the 2006 IPCC guidelines since reporting year 2013 (submission year 2015), the quantity of carbon stored in certain products changed.

All these amounts of carbon from fossil fuels not being combusted can therefore be deducted before calculating CO_2 emissions from fuel combustion under the IPCC reference approach. As a consequence for certain countries (hosting the respective industries) one can expect that monthly data tend to be bigger than the respective annual data. This can cause differences between early CO_2 estimates and final GHG inventory data.

2. Main findings

2.1. Comparisons of early CO_2 estimates for 2014 to 2016 with inventory data

The overview provided in Table 2-1 shows the closeness of the results of the early CO_2 emission estimates based on Eurostat monthly energy data with final GHG inventory data (CRF table 1.A.(b)) submitted to the UNFCCC for the same reference year. The comparison is based on trend changes calculated for CO_2 emissions from fossil fuel combustion.

The verification of the early CO_2 estimates with final GHG inventory data shows further improvement of the early CO_2 estimates since the previous project (for the years 2011,2012,2013). Most Member States (MS) show very good results with deviations between the trend changes of early CO_2 estimates and final GHG inventory data below +/-2 %. Table 2-1 also shows that the differences at the level of EU-28 are very small.

Table 2-1: Closeness of early CO_2 emission estimates with final GHG inventory CO_2 emissions (CRF table 1A(b))

	2014	2015	2016
Number of MS with a difference to final inventory of ≤ ±2%	18 MS	16 MS	16 MS
Contribution of those MS' to total EU-28 emissions	66%	77%	61%
Number of MS with a difference to final inventory of ± >2 and ≤ 5%,	8 MS	10 MS	9 MS
Contribution of those MS' to total EU-28 emissions	33%	22%	32%
Number of MS with a difference to final inventory of > ± 5%	2 MS	2 MS	3 MS
Contribution of those MS' to total EU-28 emissions	1%	1%	8%
Closeness at EU-28 level	**1.1%**	**-0.2%**	**-0.3%**

Source: Authors' own compilation based on Eurostat early CO_2 estimates and MS' GHG inventory submissions to UNFCCC

The comparisons shown in Table 2-1 and Table 2-2 are based on the simple trend change method and do in most cases not contain any corrections of the original monthly energy data as provided by Member States. Some corrections were applied to the Eurostat monthly energy data in order to produce more reliable early CO_2 estimates. Systematic corrections for all years were made for hard coal and peat consumption data in Ireland[3] and for hard coal consumption in the Netherlands[4].

Table 2-1 and Table 2-2 show that the closeness of the early CO_2 emission estimates to the final inventory CO_2 emissions was within 2 % for most Member States (17 MS for 2014 and 16 for 2015 and 2016). For the three years, only 2 or 3 MS showed differences of more than 5 % between the early and final estimates.

Table 2-2 provides details on the closeness of the early CO_2 estimates to the final GHG inventory data on CO_2 emissions from fossil fuel combustion for EU aggregates which was quite good for the years in question. In comparisons of the estimates for these years only Estonia, Lithuania, Malta, Slovakia and Spain were outside the 5 % range. Estonia, Lithuania, Malta and Slovakia are relatively small Member States with low CO_2 emissions. In 2016 Spain contributed to 7 % of EU CO_2 emissions – the mismatch between the data reported to the UNFCCC and the monthly energy data was largely due to solid fuels. It can be also seen that in many Member States the differences

[3] Due to confidentially reasons hard coal and peat consumption data is not completely reported under monthly Eurostat data. Therefore hard coal and peat consumption data in Ireland is based on a share of deliveries to main activity power plants.
[4] Hard coal consumption is based on gross inland deliveries observed instead of gross inland consumption. Data improved in 2017.

between early CO_2 estimates and final GHG inventory CO_2 emission data change almost every year. This may indicate that the quality of the reporting of monthly energy data is not consistent over the years.

Table 2-2: Comparison of early CO_2 emission estimates from fossil fuels

Member States	Eurostat early CO_2 estimates	Inventory data (CRF table 1.A(b))[1]	Difference trend changes early - CRF	Eurostat early CO_2 estimates	Inventory data (CRF table 1.A(b))[2]	Difference trend changes early - CRF	Eurostat early CO_2 estimates	Inventory data (CRF table 1.A(b))[3]	Difference trend changes early - CRF
	Change 2014/2013 %			Change 2015/2014 %			Change 2016/2015 %		
Belgium	-1.0%	-5.9%	4.8%	4.7%	6.3%	-1.6%	-0.6%	-4.2%	3.6%
Bulgaria	7.1%	7.2%	-0.1%	4.6%	5.4%	-0.8%	-7.0%	-7.4%	0.4%
Czech Republic	-2.1%	-1.3%	-0.8%	0.0%	3.8%	-3.8%	-0.7%	1.3%	-2.0%
Denmark	-10.7%	-11.4%	0.7%	-9.9%	-7.6%	-2.2%	5.7%	3.1%	2.6%
Germany	-3.1%	-6.5%	3.4%	0.0%	0.3%	-0.3%	0.7%	1.3%	-0.7%
Estonia	-2.0%	-2.5%	0.4%	-16.0%	-13.6%	-2.4%	-1.0%	7.8%	-8.7%
Ireland	-1.0%	-1.8%	0.8%	3.9%	5.9%	-2.0%	1.1%	4.0%	-2.8%
Greece	-6.5%	-2.7%	-3.8%	-5.0%	-4.6%	-0.3%	-3.3%	-6.3%	3.0%
Spain	-2.1%	-1.9%	-0.1%	2.3%	6.9%	-4.6%	1.6%	-4.2%	5.8%
France	-8.2%	-9.2%	1.0%	1.7%	0.2%	1.4%	0.9%	0.1%	0.8%
Croatia	-6.3%	-5.4%	-0.9%	3.1%	2.7%	0.4%	4.3%	2.3%	2.0%
Italy	-6.9%	-6.5%	-0.5%	3.5%	2.1%	1.4%	-2.9%	0.9%	-3.8%
Cyprus	3.6%	3.2%	0.4%	1.0%	0.8%	0.3%	7.0%	6.6%	0.4%
Latvia	-1.3%	-1.1%	-0.2%	1.2%	-2.0%	3.2%	3.2%	1.6%	1.6%
Lithuania	2.2%	-3.7%	5.9%	-0.2%	-2.6%	2.4%	3.9%	3.1%	0.7%
Luxembourg	-6.2%	-5.3%	-0.8%	-3.9%	-5.4%	1.5%	-3.8%	-3.3%	-0.5%
Hungary	-2.4%	-2.5%	0.1%	6.7%	6.8%	0.0%	2.9%	3.4%	-0.5%
Malta	2.5%	-1.5%	4.0%	-26.9%	-20.4%	-6.5%	-18.2%	4.6%	-22.8%
Netherlands	-6.9%	-5.4%	-1.5%	2.1%	5.6%	-3.5%	0.4%	0.9%	-0.5%
Austria	-3.5%	-6.8%	3.4%	3.3%	3.2%	0.2%	2.7%	0.9%	1.8%
Poland	-5.3%	-6.0%	0.7%	1.6%	0.1%	1.5%	1.0%	5.1%	-4.1%
Portugal	-5.7%	-2.5%	-3.2%	8.6%	13.1%	-4.5%	-5.7%	-1.4%	-4.3%
Romania	-1.3%	-3.2%	1.8%	2.4%	5.6%	-3.3%	-1.4%	-2.9%	1.6%
Slovenia	-9.1%	-11.1%	1.9%	0.5%	1.5%	-1.0%	5.8%	6.3%	-0.5%
Slovakia	-14.1%	-8.0%	-6.1%	9.5%	-0.6%	10.1%	1.7%	2.0%	-0.3%
Finland	0.7%	-3.0%	3.7%	-7.4%	-10.5%	3.0%	8.5%	10.0%	-1.6%
Sweden	0.2%	-2.3%	2.5%	-12.8%	-12.5%	-0.3%	2.3%	2.1%	0.2%
United Kingdom	-8.7%	-9.5%	0.8%	-2.9%	-3.7%	0.8%	-4.8%	-5.4%	0.6%
EU 28	-5.0%	-6.1%	1.1%	0.6%	0.8%	-0.2%	-0.4%	-0.1%	-0.3%

Note: Green: difference ≤ ± 2%, Yellow: difference ± >2 and ≤ 5%, Red: difference > ± 5%
[1] based on GHG inventory data submission 2016
[2] based on GHG inventory data submission 2017
[3] based on GHG inventory data submission 2018
Source: Eurostat early CO2 estimates, MS GHG inventory submissions to UNFCCC

Table 2-2 shows that there is no Member State that reports large differences for all years but also only a few Member States like Bulgaria, France, Cyprus, Luxembourg, Hungary, Slovenia and the United Kingdom that show good results, with differences below 2 % for all years. However, on the level of CO_2 emissions from aggregated fuel categories of liquid, solid and gaseous fuels differences increase. Table 2-3 shows the differences in the trend changes between early CO_2 estimates and GHG inventory submission for all years at the level of the aggregated fuel categories liquid, solid and gaseous fuels. Different from Table 2-2 it can be seen that there are systematic differences for some Member States and some fuel categories. For CO_2 emissions from liquid fuels Estonia and Finland show differences for all years, while for CO_2 emissions from solid fuels systematic differences can be found for Austria and Sweden. Differences in trend changes from CO_2 emissions from natural gas are lower than for the other aggregated fuel categories and no Member State reports differences above 5 % for all three years. Best results can be found on

the level of the EU-28, where differences are mainly below +/-1 % for all years and all fuel categories.

Table 2-3: Differences in trend changes between early CO_2 estimates and GHG inventory submission for aggregated fuel categories

	Differences in trend changes between early estimates and GHG inventory submission for CO_2 emisions from ***liquid fuels***			Differences in trend changes between early estimates and GHG inventory submission for CO_2 emisions from ***solid fuels***			Differences in trend changes between early estimates and GHG inventory submission for CO_2 emisions from ***gaseous fuels***		
	2014	**2015**	**2016**	**2014**	**2015**	**2016**	**2014**	**2015**	**2016**
EU 28	**0.1%**	**-0.3%**	**-0.8%**	**2.2%**	**-0.6%**	**0.7%**	**1.1%**	**0.4%**	**-0.7%**
Belgium	2.7%	-3.0%	4.2%	23.7%	0.8%	32.2%	0.4%	0.0%	-1.6%
Bulgaria	-5.8%	-2.3%	0.1%	1.8%	-0.8%	0.6%	2.1%	2.9%	0.5%
Czech Republic	-2.2%	-6.7%	-9.1%	0.1%	-3.8%	-0.1%	0.4%	0.0%	-0.1%
Denmark	1.4%	-1.1%	1.9%	1.0%	-5.6%	6.3%	-1.5%	-0.2%	0.5%
Germany	1.9%	0.9%	-3.7%	5.3%	-0.4%	1.0%	2.1%	-2.0%	0.3%
Estonia	6.6%	20.3%	-38.4%	1.4%	-3.8%	-7.9%	-25.3%	0.8%	-3.6%
Ireland	0.8%	-1.4%	4.0%	2.1%	-0.3%	-19.4%	-0.3%	-4.7%	0.9%
Greece	-5.6%	0.3%	1.6%	-3.6%	-0.6%	6.1%	2.6%	-2.4%	-4.1%
Spain	-1.9%	-1.9%	3.7%	4.3%	-17.5%	17.3%	0.3%	-0.3%	0.1%
France	-0.3%	-2.3%	1.6%	-0.5%	1.3%	1.0%	4.6%	10.8%	-0.9%
Croatia	-4.7%	-2.3%	2.5%	0.0%	-1.8%	1.1%	6.8%	8.3%	1.4%
Italy	-1.6%	3.3%	-7.2%	0.1%	0.1%	-1.6%	0.3%	-0.5%	-0.8%
Cyprus	0.5%	0.3%	0.3%	NO	NO	NO	NO	NO	NO
Latvia	0.2%	6.1%	3.0%	-6.1%	-7.5%	-3.4%	0.3%	-0.1%	0.0%
Lithuania	4.6%	2.2%	0.5%	-1.8%	-5.0%	9.7%	11.2%	5.5%	-1.1%
Luxembourg	-0.7%	1.7%	-0.7%	-11.9%	9.7%	-1.3%	-0.1%	0.0%	0.3%
Hungary	-7.1%	2.9%	-0.9%	3.1%	-1.8%	-1.1%	3.9%	-1.8%	0.1%
Malta	4.1%	-6.5%	-21.8%	NO	NO	NO	NO	NO	NO
Netherlands	-1.3%	-9.7%	8.4%	-8.7%	1.6%	-0.7%	1.1%	-1.1%	-7.5%
Austria	2.1%	-1.1%	0.5%	17.4%	11.0%	16.6%	1.3%	-0.2%	0.7%
Poland	0.5%	0.8%	-5.2%	0.7%	2.0%	-4.4%	1.7%	-0.9%	-0.8%
Portugal	-4.8%	-4.4%	-9.3%	0.6%	0.0%	0.4%	-2.6%	-11.6%	3.5%
Romania	0.8%	-2.9%	2.9%	6.3%	-2.3%	1.6%	-1.6%	-4.5%	0.3%
Slovenia	3.2%	-0.2%	0.3%	0.5%	-2.4%	-2.4%	0.2%	-0.2%	2.0%
Slovakia	-2.1%	14.5%	-0.3%	2.8%	-2.7%	0.0%	-17.6%	20.9%	-0.6%
Finland	8.5%	6.7%	-9.2%	0.2%	-1.3%	6.5%	-1.2%	2.3%	4.0%
Sweden	5.3%	-3.6%	-1.3%	-13.0%	13.2%	10.8%	2.0%	0.5%	-1.4%
United Kingdom	0.7%	1.5%	1.0%	0.7%	1.3%	0.4%	0.9%	-0.2%	0.4%

Note: Green: difference ≤ ± 2%, Yellow: difference ± >2 and ≤ 5%, Red: difference > ± 5%
Source: Eurostat early CO_2 estimates, MS GHG inventory submissions to UNFCCC

2.2. Analysis of large differences at Member States level

This section provides additional explanations for the differences between early CO_2 emission estimates and Member State GHG inventory data for CO_2 emissions for the years 2014, 2015 and 2016 for those Member States for which the comparison with GHG inventory CO_2 emission data showed differences exceeding ± 4%.

Differences due to methodological changes (changing emission factors, fraction of carbon stored etc.) or revision of GHG inventory data on liquid, solid and natural gas consumption cannot be foreseen and are not related to the quality of Eurostat monthly energy data, but can result in large uncertainties. However, by comparing only the trend change of calculated CO_2 emissions compared to the previous year, most uncertainties due to methodological changes do not affect the

trend change[5]. Whereas differences, due to insufficient reporting of Eurostat monthly energy data, have an impact on the closeness of results of the early CO_2 estimates.

The trend changes based on monthly Eurostat data are calculated for total fuel consumption in kt in comparison to the GHG inventory submission data where trend changes are calculated based on CO_2 emissions from fuel consumption. There are different reasons that lead to differences between early CO_2 estimates and final GHG inventory data.

The results of the trend change method depend on the data quality of two consecutive years. Thus, the data quality of two years is relevant. Any changes in the data quality no matter if deterioration or improvement affects the trend change. In addition, a fluctuation in the data quality (overestimation in one year, underestimation in the second year) has effects on the trend change.

Another reason that explains the differences between early CO_2 estimates and GHG inventory data is the concept of carbon excluded (see chapter 1.1). For the calculation of the early CO_2 emission estimates the concept of carbon stored is not considered, due to data quality issues and missing data on monthly level. In Member States where the share of carbon stored is not changing over the years there is no influence on the trend change and the results of the early CO_2 estimates. However, in some Member States the share of carbon stored shows inter-annual changes, which leads to differences in the trend changes, which are not related to the quality of the reported monthly Eurostat data.

Further differences between trend changes of early CO_2 estimates and GHG inventory data are due to reporting issues for the GHG inventory and can mostly be explained by larger data revisions for the year t-3[6]. Table 2-4, Table 2-5 and Table 2-6 provide an explanation for Member States for which differences between early CO_2 estimates and GHG inventory CO_2 emission data identified in Table 2-3 exceed ± 4 % and where aggregated fuel categories have a share of above 10 % in total CO_2 emission of the Member States. The tables explain the differences found on the level of trend changes for liquid, solid and gaseous fuel consumption. Systematic differences in the reporting quality are not visible from the trend changes and therefore not explained in the tables. Differences on the level of reported fuel consumption in kilotons are described in chapter 2.3. Table 5-4 in the Annex includes data on apparent fuel consumption for liquid, solid and gaseous fuels from different data sources.

[5] The trend changes calculated for GHG inventory CO_2 emission data are based on the same submission (e.g. trend change 2016/2015 from inventory submission 2018).

[6] For the calculation of the early CO_2 estimates for the year 2016 the inventory data for the year 2015 (2017 submission) is used as a reference point. In 2018 the results of the early CO_2 estimates 2016 are verified by using the 2018 GHG inventory submission. Some Member States revised the data for the year 2015 to have a constistent time series. Thus the base year changes, which introduces a level of uncertainty for the comparison of the early CO_2 estimates.

Table 2-4: Analysis of differences that lead to differences of above +/-4 % between early CO_2 estimates and GHG inventory CO_2 emissions for liquid fuels

Member States	2014	2015	2016
Bulgaria Diff. CO_2 liquid fuels: 2014 -5,8%; 2015 -2,3%; 2016 0,1%	Deterioration of reporting of monthly Eurostat data in comparison to GHG inventory data -gas diesel oil in 2014.		
Czech Republic Diff. CO_2 liquid fuels: 2014 -2,2%; 2015 -6,7%; 2016 -9,1%		Changing share in carbon stored in GHG inventory submission (same submission, different years) - in 2014 CZ reports a share of 28 % of carbon stored and in 2015 24 %. Largest differences are related to the reporting of carbon stored from Naphtha in 2014 and 2015.	Changing share in carbon stored in GHG inventory submission (same submission, different years) - in 2015 CZ reports a share of 24 % of carbon stored and in 2016 16 %.
Estonia Diff. CO_2 liquid fuels: 2014 6,6%; 2015 20,3%; 2016 -38,4%	Changing share in carbon stored in GHG inventory submission (same submission, different years) - in 2013 EE reports a share of 20 % of carbon stored and in 2014 26 % of carbon stored.	Deterioration of reporting of monthly Eurostat data in comparison to GHG inventory data - increasing differences in 2015 as other oil is not reported under monthly Eurostat data and differences in the reporting for other fuels are decreasing and are not levelling out the non-reporting of other oil. Changing share in carbon stored in GHG inventory submission (same submission, different years) - in 2014 EE reports a share of 26 % of carbon stored and in 2015 30 %.	Changing share in carbon stored in GHG inventory submission (same submission, different years) - in 2015 EE reports a share of 30 % of carbon stored and in 2016 13 %. Due to increases in total liquid fuel consumption in 2016, the share of carbon stored from bitumen (100 % carbon stored) in total liquid fuel consumption is lower.
Greece Diff. CO_2 liquid fuels: 2014 -5,6%; 2015 0,3%; 2016 1,6%	Improved reporting of monthly Eurostat data - Improved reporting of gas/diesel oil and residual fuel oil in 2014.		
Italy			Deterioration of reporting of monthly Eurostat data in comparison to GHG

Diff. CO_2 liquid fuels 2014 2015 2016 -1,6% 3,3% -7,2%			inventory data - increasing differences for all liquid fuels, especially for refinery feedstocks and other oil in 2016. Changing share in carbon stored in GHG inventory submission (same submission, different years) - in 2015, IT reports a share of 15 % of carbon stored and in 2016 14 %.
Lithuania Diff. CO_2 liquid fuels 2014 2015 2016 4,6% 2,2% 0,5%	Changing share in carbon stored in GHG inventory submission (same submission, different years) - in 2013 LT reports a share of 8 % of carbon stored and in 2014 6 % of carbon stored.		
Hungary Diff. CO_2 liquid fuels 2014 2015 2016 -7,1% 2,9% -0,9%	Fluctuation in data quality of monthly Eurostat data - in 2013 HU overestimated liquid fuel consumption under monthly Eurostat data due to reporting of Orimulsion and international bunkers, while in 2014 HU underestimated liquid fuel consumption due to overestimation of gas/diesel oil imports.		
Malta Diff. CO_2 liquid fuels 2014 2015 2016 4,1% -6,5% -21,8%	Improved reporting of monthly Eurostat data - Reduction of differences due to improvements in the reporting of international bunkers from residual fuel oil in 2014.	Recalculation in GHG inventory submission (different submissions, same year) - in the GHG inventory 2017 submission the 2014 data for residual fuel oil was revised. This affects the trend changes for total liquid fuel consumption.	Recalculation in GHG inventory submission (different submissions, same year) - in the GHG inventory 2018 submission the 2015 data for gas/diesel oil and residual fuel oil was revised. This affects the trend changes for total liquid fuel consumption.
Netherlands Diff. CO_2 liquid fuels 2014 2015 2016 -1,3% -9,7% 8,4%		Deterioration of reporting of monthly Eurostat data in comparison to GHG inventory data - increasing differences in the reporting of NGL, LPG and Naphtha in 2015. Changing share in carbon stored in GHG inventory submission (same submission, different years) - in 2014 NL reports a share of	Improved reporting of monthly Eurostat data - improved reporting of NGL, LPG and Naphtha in 2016.

		41 % of carbon stored and in 2015 40 %.	
Poland Diff. CO_2 liquid fuels 2014: 0,5% / 2015: 0,8% / 2016: -5,2%			Changing share in carbon stored in GHG inventory submission (same submission, different years) - in 2015 PL reports a share of 15 % of carbon stored and in 2016 14 %. Recalculation in GHG inventory submission (different submissions, same year) - in the GHG inventory 2018 submission the 2015 data for crude oil was revised. This affects the trend changes for total liquid fuel consumption.
Portugal Diff. CO_2 liquid fuels 2014: -4,8% / 2015: -4,4% / 2016: -9,3%	Data quality of monthly Eurostat data - differences in the reporting of international bunkers from jet kerosene.	Data quality of monthly Eurostat data - differences in the reporting of international bunkers from jet kerosene. Changing share in carbon stored in GHG inventory submission (same submission, different years) - in 2014 PT reports a share of 17 % of carbon stored and in 2015 15 %.	Improved reporting of monthly Eurostat data - improved reporting of international bunkers from jet kerosene. Changing share in carbon stored in GHG inventory submission (same submission, different years) - in 2015 PT reports a share of 15 % of carbon stored and in 2016 13 %.
Slovakia Diff. CO_2 liquid fuels 2014: -2,1% / 2015: 14,5% / 2016: -0,3%		Fluctuation in data quality of monthly Eurostat data - in 2014 SK underestimates liquid fuel consumption under monthly Eurostat data due to differences in the reporting of residual fuel oil, while in 2015 SK overestimates liquid fuel consumption under monthly Eurostat data due to differences in the reporting of gas/diesel oil. Changing share in carbon stored in GHG inventory submission (same submission, different years) - in 2014 SK reports a share of 15 % of carbon stored and in 2015 21 %. Largest differences are related to the reporting of carbon stored from Naphtha and Bitumen in 2014 and 2015.	

Finland Diff. CO_2 liquid fuels 2014: 8,5% / 2015: 6,7% / 2016: -9,2%	Fluctuation in data quality of monthly Eurostat data - in 2013 FI underestimates liquid fuel consumption under monthly Eurostat data due to differences in the reporting of gas/diesel oil and other oil. In 2014, FI overestimates liquid fuel consumption due to differences in the reporting of gas/diesel oil and other oil, which results in low differences at the level of total liquid fuel consumption.	Deterioration of reporting of monthly Eurostat data in comparison to GHG inventory data - increasing differences in 2015 due to the reporting of gas/diesel oil and other oil.	Data quality of monthly Eurostat data - decreasing differences at the level of liquid fuel consumption as differences in the reporting of gas/diesel oil and other oil are levelled out. Changing share in carbon stored in GHG inventory submission (same submission, different years) - in 2015 FI reports a share of 15 % of carbon stored and in 2016 12 %.
Sweden Diff. CO_2 liquid fuels 2014: 5,3% / 2015: -3,6% / 2016: -1,3%	Data quality of monthly Eurostat data - differences in the reporting of many liquid fuels with higher differences at the level of total liquid fuel consumption in 2013 and lower differences in 2014 influence the trend change.		Fluctuation in data quality of monthly Eurostat data - in 2015 SE underestimates liquid fuel consumption under monthly Eurostat data due to differences in the reporting of gas/diesel oil and residual fuel oil, while in 2016 SE overestimates liquid fuel consumption due to differences in the reporting of gas/diesel oil. Differences in liquid fuel consumption are not shown on the level of trend changes for early CO_2 emissions as trend changes where corrected for the calculation of early CO_2 estimates 2016.

Source: Own presentation

Table 2-5: Analysis of differences that lead to differences of above +/-4 % between early CO_2 estimates and GHG inventory CO_2 emissions for solid fuels

Member States	2014	2015	2016
Belgium Diff. CO_2 solid fuels: 2014: 23,7%; 2015: 0,8%; 2016: 32,2%	Improved reporting of monthly Eurostat data - improved reporting of hard coal in 2014.		Changing share in carbon stored in GHG inventory submission (same submission, different years) - in 2015 BE reports a share of 63 % of carbon stored and in 2016 76 %. The share of carbon stored increased in 2016, as the share of carbon excluded from sub-bituminous coal and coke oven/gas coke increased. Recalculation in GHG inventory submission (different submissions, same year) - in 2017 BE reports for 2015 a share of carbon stored of 59%, in 2018 BE reports for 2015 a share of carbon stored of 63%.
Denmark Diff. CO_2 solid fuels: 2014: 1,0%; 2015: -5,6%; 2016: 6,3%		Fluctuation in data quality of monthly Eurostat data - in 2014 hard coal consumption in monthly Eurostat data was overestimated by 4% in comparison to inventory data, while in 2015 hard coal consumption under monthly Eurostat data was underestimated by 6% in comparison to inventory data.	Improved reporting of monthly Eurostat data - reporting of hard coal improved in 2016, trend changes are still affected by underestimation in 2015.
Germany Diff. CO_2 solid fuels: 2014: 5,3%; 2015: -0,4%; 2016: 1,0%	Data quality of monthly Eurostat data - differences in the reporting of hard coal. Changing share in carbon stored in GHG inventory submission (same submission, different years) - in 2013 DE reports a share of 4 % of carbon stored and in 2014 5 %.		

Estonia

Diff. CO_2 solid fuels		
2014	2015	2016
1,4%	-3,8%	-7,9%

Deterioration of reporting of monthly Eurostat data in comparison to GHG inventory data - increasing differences for reporting of oil shale in 2016.

Changing share in carbon stored in GHG inventory submission (same submission, different years) - in 2015 EE reports a share of 4 % of carbon stored and in 2016 2 %.

Ireland

Diff. CO_2 solid fuels		
2014	2015	2016
2,1%	-0,3%	-19,4%

Improved reporting of monthly Eurostat data - method used to calculate peat and hard coal consumption shows improved results for peat in 2016.

Greece

Diff. CO_2 solid fuels		
2014	2015	2016
-3,6%	-0,6%	6,1%

Improved reporting of monthly Eurostat data – reporting of lignite improved in 2016.

Spain

Diff. CO_2 solid fuels		
2014	2015	2016
4,3%	-17,5%	17,3%

Fluctuation in data quality of monthly Eurostat data - in 2013 hard coal consumption in monthly Eurostat data was underestimated by 1% in comparison to inventory data, while in 2014 hard coal consumption under monthly Eurostat data was overestimated by 2% in comparison to inventory data.

Deterioration of reporting of monthly Eurostat data in comparison to GHG inventory data - increasing differences in the reporting of hard coal in 2015 – total solid fuel consumption under monthly data was underestimated by 13% in comparison to inventory data.

Fluctuation in data quality of monthly Eurostat data - in 2015 solid fuel consumption in monthly Eurostat data was underestimated by 13% in comparison to inventory data, while in 2016 solid fuel consumption under monthly Eurostat data was overestimated by 5% in comparison to inventory data.

Netherlands

Diff. CO_2 solid fuels		
2014	2015	2016
-8,7%	1,6%	-0,7%

Data quality of monthly Eurostat data - differences in the reporting of hard coal and coke oven/Gas coke.

Austria

Diff. CO_2 solid fuels		
2014	2015	2016
17,4%	11,0%	16,6%

Improved reporting of monthly Eurostat data - improved reporting of hard coal in 2014.

Changing share in carbon stored in GHG

Changing share in carbon stored in GHG inventory submission (same submission, different years) - in 2014 AT reports a share of 68 % of carbon stored and in 2015 70 %.

Data quality of monthly Eurostat data - differences on the level of lignite, peat and coke oven/gas coke are not levelled out in 2016.

	inventory submission (same submission, different years) - in 2013 AT reports a share of 62 % of carbon stored and in 2014 67 %.	Recalculation in GHG inventory submission (different submissions, same year) - in 2016 AT reports for 2014 a share of carbon stored of 67%, in 2017 AT reports for 2014 a share of carbon stored of 68%.	Changing share in carbon stored in GHG inventory submission (same submission, different years) - in 2015 AT reports a share of 70% % of carbon stored and in 2016 73 %. The share of carbon excluded increased in 2016, due to a reduction of total solid fuel consumption in general. The absolute amount of carbon excluded remains almost constant.
Poland **Diff. CO_2 solid fuels** 2014: 0,7% / 2015: 2,0% / 2016: -4,4%			Differences because of calculation of trend changes in kt instead of TJ, due to changing shares of hard coal and lignite with different NCVs. Recalculation in GHG inventory submission (different submissions, same year) - differences due to recalculation of solid fuel consumption.
Romania **Diff. CO_2 solid fuels** 2014: 6,3% / 2015: -2,3% / 2016: 1,6%	Changing share in carbon stored in GHG inventory submission (same submission, different years) - in 2013 RO reports a share of 6 % of carbon stored and in 2014 4 %.		
Sweden **Diff. CO_2 solid fuels** 2014: -13,0% / 2015: 13,2% / 2016: 10,8%	Data quality of monthly Eurostat data - in 2013 solid fuel consumption in monthly Eurostat data was underestimated by 11 % in comparison to inventory data, while in 2014 solid fuel consumption under monthly Eurostat data was overestimated by 3 % in comparison to inventory data due to reporting of hard coal.	Data quality of monthly Eurostat data - in 2014 solid fuel consumption in monthly Eurostat data was overestimated by 3 % in comparison to inventory data, while in 2015 solid fuel consumption under monthly Eurostat data was underestimated by 21 % in comparison to inventory data due to reporting of hard coal. Changing share in carbon stored in GHG inventory submission (same submission, different years) - in 2014 SE reports a share of 34 % of carbon stored and in 2015 38 %.	Data quality of monthly Eurostat data - in 2015 solid fuel consumption in monthly Eurostat data was underestimated by 21 % and in 2016 by 18 % in comparison to inventory data, due to reporting of hard coal. Changing share in carbon stored in GHG inventory submission (same submission, different years) - in 2015 SE reports a share of 38 % of carbon stored and in 2016 35 %. Recalculation in GHG inventory submission (different submissions, same year) - in 2017 SE reports for 2015 a share of carbon stored

		Recalculation in GHG inventory submission (different submissions, same year) - in 2016 SE reports for 2014 a share of carbon stored of 1%, in 2017 SE reports for 2014 a share of carbon stored of 34%.	of 34 %, in 2018 SE reports for 2015 a share of carbon stored of 38 %.
Finland			Fluctuation in data quality of monthly Eurostat data - in 2015 solid fuel consumption in monthly Eurostat data was underestimated by 4 % in comparison to inventory data, while in 2016 solid fuel consumption under monthly Eurostat data was overestimated by 3 % in comparison to inventory data due to reporting of peat consumption.

Diff. CO_2 solid fuels		
2014	**2015**	**2016**
0,2%	-1,3%	6,5%

Source: Own presentation

Table 2-6: Analysis of differences that lead to differences of above +/-4 % between early CO_2 estimates and GHG inventory CO_2 emissions for gaseous fuels

Member States	2014	2015	2016
Estonia Diff. CO_2 gaseous fuels: 2014 -25,3%; 2015 0,8%; 2016 -3,6%	Changing share in carbon stored in GHG inventory submission (same submission, different years) - in 2013 EE reports a share of 25 % of carbon stored and in 2014 0 %, due to the close down of the ammonia production plant.		
Ireland Diff. CO_2 gaseous fuels: 2014 -0,3%; 2015 -4,7%; 2016 0,9%		Improved reporting of monthly Eurostat data - improved reporting of natural gas from 2015 onwards.	
Greece 2014 2,6%; 2015 -2,4%; 2016 -4,1%			Changing share in carbon stored in GHG inventory submission (same submission, different years) - in 2015 GR reports a share of 8 % of carbon stored and in 2016 6 %.
France Diff. CO_2 gaseous fuels: 2014 4,6%; 2015 10,8%; 2016 -0,9%	Improved reporting of monthly Eurostat data - in 2013 natural gas consumption in monthly Eurostat data was underestimated by 4% in comparison to inventory data, while in 2014 natural gas consumption under monthly Eurostat data was overestimated by 1% in comparison to inventory data.	Deterioration of reporting of monthly Eurostat data in comparison to GHG inventory data - deterioration of reporting of natural gas in 2015 again. Recalculation in GHG inventory submission (different submissions, same year) - recalculation of natural gas consumption for the year 2014.	
Croatia Diff. CO_2 gaseous fuels: 2014 6,8%; 2015 8,3%; 2016 1,4%	Data quality of monthly Eurostat data - differences in the reporting of natural gas in 2013 - 9 % in 2014 – 6 % between monthly Eurostat data and GHG inventory data.	Improved reporting of monthly Eurostat data - improved reporting of natural gas consumption in 2015.	

Lithuania **Diff. CO_2 gaseous fuels** **2014** 11,2% **2015** 5,5% **2016** -1,1%	Changing share in carbon stored in GHG inventory submission (same submission, different years) - in 2013 LT reports a share of 38% of carbon stored and in 2014 45 % (2016 submission).	Recalculation in GHG inventory submission (different submissions, same year) - in the 2016 submission, LT reports for 2014 a share of carbon stored of 45%, in the 2017 submission LT reports for 2014 a share of carbon stored of 42 %. Changing share in carbon stored in GHG inventory submission (same submission, different years) - in 2014 LT reports a share of 42 % of carbon stored and in 2015 46 % (2017 submission). In 2015 ammonia production increased by 7 % (LT NIR, 2017), which can explain the increase of carbon stored from natural gas consumption.	
Netherlands **Diff. CO_2 gaseous fuels** **2014** 1,1% **2015** -1,1% **2016** -7,5%			Deterioration of reporting of monthly Eurostat data in comparison to GHG inventory data - deterioration of reporting of natural gas in 2016.
Portugal **Diff. CO_2 gaseous fuels** **2014** -2,6% **2015** -11,6% **2016** 3,5%		Fluctuation in data quality of monthly Eurostat data - in 2014 natural gas consumption in monthly Eurostat data was overestimated by 2 % in comparison to inventory data, while in 2015 natural gas consumption under monthly Eurostat data was underestimated by 4 % in comparison to inventory data.	
Romania **Diff. CO_2 gaseous fuels** **2014** -1,6% **2015** -4,5% **2016** 0,3%		Changing share in carbon stored in GHG inventory submission (same submission, different years) - in 2014 RO reports a share of 20 % of carbon stored and in 2015 17 %. Recalculation in GHG inventory submission (different submissions, same year) - in	

		2016, RO reports for 2014 a share of carbon stored of 11 %, in 2017 RO reports for 2014 a share of carbon stored of 20 %.	
Slovakia **Diff. CO_2 gaseous fuels** **2014** / **2015** / **2016** -17,6% / 20,9% / -0,6%	Deterioration of reporting of monthly Eurostat data in comparison to GHG inventory data - Deterioration of reporting of natural gas in 2014.	Improved reporting of monthly Eurostat data - improved reporting of natural gas consumption in 2015.	
Finland **Diff. CO_2 gaseous fuels** **2014** / **2015** / **2016** -1,2% / 2,3% / 4,0%			Changing share in carbon stored in GHG inventory submission (same submission, different years) - in 2015 FI reports a share of 12 % of carbon stored and in 2016 15 %.

Source: Own presentation

2.3. Quality of monthly Eurostat fuel consumption data

This chapter presents the analysis of the quality level of monthly Eurostat energy data compared to annual Eurostat data and to energy data on fuel consumption used by Member States for the GHG inventory. Based on the comparison it is determined whether the quality of these data improved and in which areas substantial deviations continue to occur.

2.3.1. Comparison of monthly Eurostat energy data with annual data

This section provides comparisons of the differences between annual and cumulated monthly fuel consumption data of liquid, solid and gaseous fuel types for the years 2014-2016. The datasets for the 28 Member States of the EU were provided by Eurostat in the specific year and processed by Oeko-Institut.

2.3.1.1. Liquid fuels

In 2014, fifteen Member States showed differences of less than 2 % between Eurostat annual and cumulated monthly energy data on liquid fuel consumption. These fifteen Member States have a share of 84 % of the total EU-28 liquid fuel consumption. Differences greater than 5 % were identified for six Member States (see Table 2-7). These six Member States have a share of 9 % of EU-28 total liquid fuel consumption.

In 2016, the last reporting year for which Eurostat annual and cumulated monthly data are available, differences between annual and monthly data of less than 2 % were found for sixteen Member States. Liquid fuel consumption of these sixteen Member States amounts to 65 % of total EU-28 liquid fuel consumption. Five Member States were identified with differences of above 5 %. These five Member States have a share of 17 % in the total EU-28 liquid fuel consumption. While the number of Member States with differences in the reporting of liquid fuel consumption decreased, differences in the reporting increases for bigger Member States.

In most Member States, the consumption of liquid fuels constitutes a large share of the total CO_2 emissions from energy consumption. Cyprus and Malta use almost 100 % liquid fuels in their energy sector and in Luxembourg and Sweden the share of liquid fuels in total emissions from energy consumption is above 70 % (see Table 5-2 and Table 5-3). Thus, a high data quality for liquid fuels is required to provide good CO_2 estimates. On EU-28 level the differences in kt are quite small for total liquid fuels consumption, especially in 2016. Differences at Member States level are much higher and are levelled out at EU-28.

Table 2-7: Difference between Eurostat monthly and annual liquid fuel data, 2014-2016

Member States	Eurostat monthly vs. Annual Eurostat			Difference monhtly-annual Eurostat in kt		
Member States	**2014**	**2015**	**2016**	2014	2015	2016
Belgium	3%	2%	3%	675	559	732
Bulgaria	-5%	-6%	-2%	- 178	- 265	- 90
Czech Republic	0%	-1%	-1%	13	- 110	- 56
Denmark	7%	8%	10%	387	451	580
Germany	0%	0%	0%	- 450	237	- 46
Estonia	-23%	-45%	-38%	- 82	- 104	- 143
Ireland	1%	1%	3%	34	32	178
Greece	0%	-2%	1%	- 24	- 236	65
Spain	0%	-2%	1%	158	- 938	246
France	2%	1%	3%	1,312	552	1,752
Croatia	-2%	-5%	-2%	- 52	- 160	- 52
Italy	0%	-2%	-5%	- 211	- 1,317	- 2,718
Cyprus	-1%	0%	0%	- 13	- 9	- 3
Latvia	-7%	-8%	-4%	- 94	- 108	- 47
Lithuania	1%	-4%	0%	31	- 115	- 3
Luxembourg	-1%	0%	0%	- 23	8	- 1
Hungary	-3%	-2%	0%	- 178	- 117	18
Malta	-5%	-1%	-3%	- 39	- 6	- 15
Netherlands	-10%	-8%	0%	- 3,007	- 1,998	- 87
Austria	-1%	-1%	0%	- 69	- 78	- 39
Poland	0%	1%	1%	76	253	353
Portugal	10%	9%	-1%	923	835	- 110
Romania	2%	-1%	1%	192	- 113	111
Slovenia	-4%	-3%	-3%	- 87	- 67	- 59
Slovakia	2%	5%	6%	68	152	184
Finland	-5%	2%	0%	- 402	125	30
Sweden	1%	-1%	-6%	146	- 84	- 633
United Kingdom	-2%	0%	0%	- 869	- 186	- 115
EU 28	**0%**	**-1%**	**0%**	**- 1,763**	**- 2,807**	**32**
<+/- 2%	15 MS	15 MS	16 MS			
+/-2-5%	7 MS	6 MS	7 MS			
> +/- 5%	6 MS	7 MS	5 MS			

Note: Green: difference ≤ ± 2%, Yellow: difference ± >2 and ≤ 5%, Red: difference > ± 5%

Percentages calculated by dividing original cumulated monthly Eurostat by annual Eurostat data.
Annual Eurostat data = 100 %, a positive value indicates that monthly data is higher than annual data; a negative value indicates that monthly data is lower than annual data.

Source: Extraction from Eurostat database in the specific year

Table 2-7 shows that there is no overall systematic quality increase over the years. Some Member States improved the consistency of Eurostat monthly and annual energy data over the 2014-2016 period (Portugal due to the reporting of international bunker fuels under monthly Eurostat data, Latvia, Slovenia). The Czech Republic, Germany, Spain, Cyprus, Luxembourg, Austria, Poland and the United Kingdom provide good monthly data for liquid fuel consumption for all years. The share of these eight Member States in the EU-28 total liquid fuel consumption amounts to 50 % in 2016. Most other Member States show differences for one or two years in the time series.

Systematic differences above 5 % can be found for Denmark and Estonia. For Denmark, the large differences between monthly and annual Eurostat data are due to the inconsistent reporting of international bunkers in the monthly data. The reporting of international aviation bunkers is not mandatory under the Energy Statistics regulation for monthly data. Thus, Denmark only partly reports international bunkers in their monthly data. For the calculation of the fuel consumption based on the IPCC reference approach the reporting of international bunkers is relevant.

The largest differences in all years are observed for Estonia. These differences are due to the reporting of shale oil, which differs in the monthly reporting from the annual reporting. In addition, Estonia does not report Other Oil (Bitumen) under monthly Eurostat data. As the share of liquid fuels in total CO_2 emissions from energy consumption only amounts to 6 % of total CO_2 emissions in Estonia in 2016, these large differences do not strongly influence the results of the early CO_2 estimates.

2.3.1.2. Solid fuels

In 2014, thirteen Member States showed differences of less than 2 % between annual and cumulated monthly solid fuel consumption. These thirteen Member States have a share of 51 % of the total EU-28 solid fuel consumption. Differences greater than 5 % were identified for eight Member States (see Table 2-8). These eight Member States have a share of 18 % of EU-28 total solid fuel consumption.

In 2016, the last reporting year for which annual and cumulated monthly data are available, differences between annual and monthly data of less than 2 % were found for thirteen Member States. Solid fuel consumption of these thirteen Member States accounts for 52 % of the total EU-28 solid fuel consumption. The number of Member States that have differences of more than 5 % increased to nine Member States in 2016. These nine Member States have a share of 10 % of the total EU-28 solid fuel consumption.

Table 2-8: Difference between Eurostat monthly and annual solid fuel data, 2014-2016

Member States	Eurostat monthly vs. Annual Eurostat			Difference monhtly-annual Eurostat in kt		
Member States	**2014**	**2015**	**2016**	2014	2015	2016
Belgium	-4%	-1%	-1%	- 170	- 42	- 38
Bulgaria	0%	0%	1%	- 88	94	167
Czech Republic	0%	0%	-2%	224	- 117	- 793
Denmark	10%	-6%	0%	406	- 202	7
Germany	-3%	-5%	-4%	- 6,638	- 10,921	- 9,859
Estonia	-2%	-4%	-12%	- 350	- 671	- 2,206
Ireland	10%	12%	3%	563	727	148
Greece	-6%	-7%	-1%	- 2,952	- 3,176	- 354
Spain	2%	-13%	5%	484	- 3,121	993
France	7%	6%	7%	978	847	954
Croatia	0%	-1%	0%	- 4	- 13	- 3
Italy	0%	1%	0%	- 82	189	- 32
Cyprus	0%	0%	NA	-	-	1
Latvia	-5%	-15%	-14%	- 5	- 12	- 10
Lithuania	17%	14%	19%	61	40	55
Luxembourg	-13%	-6%	-7%	- 12	- 5	- 6
Hungary	0%	-1%	-1%	45	- 119	- 62
Malta	NO	NO	NO	-	-	-
Netherlands	-10%	-22%	0%	- 1,476	- 3,979	42
Austria	3%	4%	9%	122	196	401
Poland	0%	2%	-1%	- 454	1,939	- 1,562
Portugal	0%	1%	0%	- 7	72	9
Romania	-4%	-2%	-1%	- 1,139	- 538	- 295
Slovenia	-13%	-12%	-11%	- 454	- 419	- 413
Slovakia	0%	-1%	-2%	- 2	- 63	- 136
Finland	-1%	-3%	3%	- 94	- 290	287
Sweden	1%	-2%	9%	26	- 65	281
United Kingdom	0%	1%	0%	59	376	11
EU 28	**-2%**	**-3%**	**-2%**	**- 10,959**	**- 19,273**	**- 12,413**
<+/- 2%	13 MS	13 MS	13 MS			
+/-2-5%	6 MS	4 MS	4 MS			
> +/- 5%	8 MS	10 MS	9 MS			

Note: Green: difference ≤ ± 2%, Yellow: difference ± >2 and ≤ 5%, Red: difference > ± 5%; Percentages calculated by dividing original cumulated monthly Eurostat by annual Eurostat data.
NO is reported if there is no solid fuel consumption in the country. Cyprus did not report solid fuel consumption under annual Eurostat data in 2016
Annual Eurostat data = 100 %, a positive value indicates that monthly data is higher than annual data; a negative value indicates that monthly data is lower than annual data.
For IE the data for solid fuels has been corrected, as the reporting is confidential.

Source: Extraction from Eurostat database in the specific year

Member States with emissions from solid fuel consumption of above 50% of their total CO_2 emissions from energy consumption in 2016 are Bulgaria, the Czech Republic, Estonia and Poland (see Table 5-3).

Similar to liquid fuel consumption, Table 2-8 shows that in the period 2014-2016 there is no systematic quality increase over the years for solid fuels. There are eight Member States (Bulgaria,

the Czech Republic, Croatia, Italy, Hungary, Poland, Portugal and the United Kingdom) that provide good monthly data for solid fuel consumption for all reported years. The share of these eight Member States in total solid fuel consumption of the EU accounts for 39% in 2016. Improvements in the reporting can be found for Belgium, Denmark, Greece, Ireland, the Netherlands and Romania.

Systematic differences resulting in a constant over-reporting of monthly Eurostat data are found for France. This is due to differences in the reporting of hard coal imports and exports. Slovenia systematically underreports solid fuel consumption in monthly Eurostat data, due to inconsistencies in the reporting of brown coal consumption. In addition, Latvia, Lithuania and Luxembourg show systematic differences in the reporting of solid fuel consumption. However, the differences are below 100 kt, as solid fuel consumption is not a relevant energy source in these Member States.

Large differences can be found for Ireland for some years. Hard coal and peat consumption data for Ireland are incomplete in the Eurostat monthly database. This is due to confidentiality issues. For this reason for peat and hard coal consumption approximations were used based on reported deliveries to main activity producer power plants instead of the reported monthly hard coal and peat consumption data. This is done for all hard coal and peat consumption data for Ireland shown in this report and already reflected in Table 2-8.

Furthermore, tendencies of consistent underreporting of solid fuel consumption in monthly data are visible for Germany while for others it varies from under reporting to over reporting and vice versa. Some developments are very unfortunate – like the clear deterioration of data quality as is visible for Estonia, Spain, Austria and Sweden for the last year. It is the responsibility of Member States to carefully analyse the reasons for the differences indicated between their monthly and annual data for solid fuels.

The difference for total solid fuel consumption at the EU-28 level is about -2% in all years. Only in 2015 differences increased to 3 %.This amounts to an absolute difference of -19,273 kt and is due to large differences in solid fuel consumption in Germany (-10,921 kt), Greece (-3,176 kt), Spain (-3,121 kt) and the Netherlands (-3,979 kt).

2.3.1.3. Gaseous fuels

In 2014, nineteen Member States showed differences of below 2% between annual and cumulated monthly natural gas consumption. These nineteen Member States share 74 % of the total EU-28 gaseous fuel consumption. Differences of above 5% were identified for two Member States (see Table 2-9). These two Member States have a share of only 2% of the total EU-28 natural gas consumption.

In 2016, the last reporting year for which Eurostat annual and cumulated monthly energy data are available, differences between annual and monthly data below 2 % were found for eighteen Member States. These eighteen Member States account for 65 % of the total EU-28 natural gas consumption. The number of Member States that have differences of above 5 % increased to four Member States in 2016. These four Member States have a share of 29 % of the EU-28 total natural gas consumption.

Table 2-9: Difference between Eurostat monthly and annual natural gas data, 2014-2016

Member States	Eurostat monthly vs. Annual Eurostat			Difference monhtly-annual Eurostat in TJ NCV		
Member States	**2014**	**2015**	**2016**	2014	2015	2016
Belgium	-1%	-2%	-3%	- 6.768	- 13.240	- 17.563
Bulgaria	-3%	-3%	-3%	- 3.318	- 3.081	- 2.958
Czech Republic	0%	0%	0%	- 247	- 40	- 4
Denmark	-1%	-1%	0%	- 1.358	- 999	- 529
Germany	2%	4%	5%	56.216	95.900	156.901
Estonia	0%	0%	0%	-	-	-
Ireland	4%	0%	-1%	6.676	12	- 2.229
Greece	0%	0%	0%	- 230	- 196	- 401
Spain	0%	0%	0%	90	656	14
France	0%	1%	0%	52	10.600	575
Croatia	-6%	2%	7%	- 4.933	1.920	6.142
Italy	0%	0%	0%	5	40	- 34
Cyprus	NO	NO	NO	-	-	-
Latvia	0%	0%	3%	- 13	22	1.339
Lithuania	0%	0%	0%	- 280	- 25	3
Luxembourg	0%	0%	0%	-	- 1	-
Hungary	0%	0%	0%	- 150	- 1.486	105
Malta	NO	NO	NO	-	-	-
Netherlands	1%	-1%	-5%	10.371	- 6.928	- 67.360
Austria	-1%	-1%	0%	- 2.710	- 3.355	- 313
Poland	0%	-1%	0%	1.121	- 4.048	- 1.949
Portugal	3%	-2%	4%	4.478	- 4.072	7.259
Romania	3%	4%	6%	12.625	16.076	21.875
Slovenia	0%	0%	2%	31	- 25	534
Slovakia	-16%	-1%	1%	- 24.687	- 998	2.391
Finland	-1%	-2%	0%	- 1.137	- 1.414	- 181
Sweden	0%	0%	0%	-	- 17	- 36
United Kingdom	0%	0%	0%	8.712	1.418	- 6.832
EU 28	**0%**	**1%**	**1%**	**54.545**	**86.716**	**96.749**
<+/- 2%	19 MS	20 MS	18 MS			
+/-2-5%	5 MS	6 MS	4 MS			
> +/- 5%	2 MS	0 MS	4 MS			

Note: Green: difference ≤ ± 2%, Yellow: difference ± >2 and ≤ 5%, Red: difference > ± 5%; Percentages calculated by dividing original cumulated monthly Eurostat by annual Eurostat data.
NO is reported if there is no gaseous fuel consumption in the country
Annual Eurostat data = 100 %, a positive value indicates that monthly data is higher than annual data; a negative value indicates that monthly data is lower than annual data.

Source: Extraction from Eurostat database in the specific year

There is no country within the EU-28, for which the share of emissions from natural gas in the total energy CO_2 emissions is above 50 %. In Estonia, Greece and Sweden the share is even below 10 %. In Malta and Cyprus, natural gas is not consumed at all between 2014 and 2016. Of the three fuel consumption categories (liquid, solid and natural gas) Eurostat monthly data on natural gas consumption is the most consistent with the annual data. Sixteen Member States provide good data quality with differences below 2 % for all reported years. These sixteen Member States have a

share of 53 % of the total EU-28 natural gas consumption. Especially Ireland and Slovakia improved the reporting of natural gas since 2014.

In 2016, differences in the reporting increased and Germany, Croatia, the Netherlands and Romania showing differences above 5 % between monthly and Eurostat data for total natural gas consumption.

The difference for total natural gas consumption on EU-28 level is below 2 % in all years. In all years differences in the reporting of Germany influences the results on EU level most, followed by differences in the reporting in Romania.

2.3.2. Comparison of Eurostat monthly and annual energy data with GHG inventory data

This section provides comparisons of the annual and monthly Eurostat data with GHG inventory data from the reference approach table 1.A(b) from UNFCCC submissions for fuel consumption data of liquid, solid and gas fuel types for the years 2014-2016[7]. The comparison is based on physical units (kt) which are reported by Eurostat data and in the CRF table 1.A(b). As some Member States provide Table 1.A(b) only in TJ, energy consumption data from GHG inventory data for these Member States was converted to physical units for the comparison with Eurostat annual fuel consumption data using net calorific values from Member States' national inventory reports.

The following sub-chapters summarize large differences between annual and monthly Eurostat and GHG inventory data for aggregate fuel categories liquid, solid and gaseous fuels. Table 5-4 in the Annex provides a comparison of GHG inventory data and annual Eurostat data for the three aggregated fuel categories for all Member States.

The comparison of energy data on fuel consumption reported as annual and monthly data to Eurostat and the energy data used in the GHG inventory table 1.A(b) reveals that many Member States use different data sources for the inventory and for reporting to Eurostat as annual and monthly data. The following sub-chapters provide an overview of the differences for the reporting of liquid, solid and gaseous fuel consumption.

2.3.2.1. Liquid fuels

In 2014, twelve Member States showed differences of less than 2 % between monthly Eurostat data and GHG inventory data for liquid fuel consumption. These twelve Member States consume 45 % of total EU-28 liquid fuels. Differences above 5 % are identified for four Member States (see Table 2-10). These four Member States account for only 3 % of EU-28 total liquid fuel consumption.

In 2016, the last reporting year for which monthly Eurostat and GHG inventory data are available, the number of Member States with differences between monthly and GHG inventory data of less than 2 % stays constant. Liquid fuel consumption of the twelve Member States accounts for 59 % of the total EU-28 liquid fuel consumption. The number of Member States that have larger differences of above 5 % increased to six Member States in 2016, making up a share of 14 % of the EU-28 total liquid fuel consumption.

Only the Czech Republic, Greece, Cyprus, Luxembourg, Hungary and Poland show low differences for all years in the time series. For all other Member States reporting quality seems to

[7] http://unfccc.int/national_reports/annex_i_ghg_inventories/national_inventories_submissions/items/8108.php

fluctuate with improvements in Bulgaria, Germany, France, the Netherlands, Portugal, Romania and the United Kingdom. Systematic differences above 5 % are found for Denmark, Estonia and Lithuania.

Differences between annual Eurostat data and GHG inventory data are smaller than between monthly Eurostat data and GHG inventory data. In 2014, sixteen Member States showed differences below 2 % in the reporting of liquid fuel consumption between annual Eurostat data and GHG inventory data and in 2016 seventeen Member States showed only small differences. Differences of above 5 % are identified for five Member States in 2014 and for four Member States in 2016.

For twelve Member States, the differences along the time series are always below 2 %, while systematic differences above 5 % are found only for Latvia.

Table 2-10: Difference in liquid fuel consumption between GHG inventory data (table 1.A(b) and monthly and annual Eurostat data, 2014-2016

Member States	Eurostat monthly vs. GHG inventory				GHG inventory vs. Eurostat annual		
Member States	2014	2015	2016		2014	2015	2016
Belgium	0%	3%	4%		3%	0%	-1%
Bulgaria	-4%	-6%	-2%		0%	-1%	0%
Czech Republic	0%	-1%	-1%		0%	0%	0%
Denmark	8%	7%	9%		-1%	1%	1%
Germany	-1%	3%	1%		0%	-3%	-1%
Estonia	-23%	-45%	-39%		0%	0%	1%
Ireland	4%	2%	6%		-3%	-2%	-3%
Greece	0%	0%	1%		0%	-2%	0%
Spain	2%	0%	3%		-2%	-2%	-2%
France	-3%	-3%	-1%		5%	4%	4%
Croatia	-5%	-6%	-9%		3%	1%	8%
Italy	-4%	-3%	-10%		4%	1%	5%
Cyprus	-1%	-1%	-1%		1%	1%	0%
Latvia	-1%	-2%	4%		-6%	-6%	-7%
Lithuania	-6%	-6%	-7%		8%	1%	7%
Luxembourg	-1%	1%	0%		0%	0%	0%
Hungary	-2%	-1%	0%		-1%	0%	0%
Malta	-4%	-4%	-3%		-1%	1%	2%
Netherlands	1%	-9%	-2%		-11%	1%	2%
Austria	-2%	-2%	-2%		2%	2%	2%
Poland	-1%	0%	0%		1%	1%	2%
Portugal	9%	6%	-2%		1%	3%	0%
Romania	-1%	-3%	-1%		4%	1%	2%
Slovenia	-4%	-3%	-3%		0%	0%	0%
Slovakia	-4%	4%	5%		6%	1%	1%
Finland	1%	8%	3%		-6%	-6%	-2%
Sweden	-2%	-3%	3%		4%	3%	-8%
United Kingdom	-2%	0%	-1%		1%	0%	1%
EU 28	**-1%**	**-1%**	**-1%**		**1%**	**0%**	**1%**
<+/- 2%	12 MS	9 MS	12 MS		16 MS	22 MS	17 MS
+/-2-5%	12 MS	11 MS	10 MS		7 MS	4 MS	7 MS
> +/- 5%	4 MS	8 MS	6 MS		5 MS	2 MS	4 MS

Note: Green: difference ≤ ± 2%, Yellow: difference ± >2 and ≤ 5%, Red: difference > ± 5%; Annual Eurostat data is 100%, for comparison of monthly Eurostat data and GHG inventory data, GHG inventory data is 100%

Source: Extraction from Eurostat database and GHG inventory submission to UNFCCC in the specific year

2.3.2.2. Solid fuels

In 2014, seven Member States showed differences of less than 2 % between monthly Eurostat data and GHG inventory data for solid fuel consumption. These seven Member States are responsible for 40 % of total EU-28 solid fuel consumption.

Differences above 5 % could be identified for six Member States (see Table 2-11), which account for 12 % of the EU-28 total solid fuel consumption.

In 2016, the last reporting year for which monthly Eurostat and GHG inventory data are available, data differences between monthly Eurostat data and GHG inventory data of less than 2 % could be found for eight Member States. These eight Member States account for 35 % of the total EU-28 solid fuel consumption. Eight Member States show differences that are greater than 5 %. These eight Member State consume 8 % of EU-28 total solid fuels.

Differences between annual Eurostat data and GHG inventory data are smaller than between monthly Eurostat data and GHG inventory data. In 2014, nineteen Member States showed differences below 2 % in the reporting of solid fuel consumption between annual Eurostat data and GHG inventory data and in 2016, eighteen Member States showed only small differences. Differences of above 5 % are identified for four Member States in 2014 and in 2016.

Table 2-11: Difference in solid fuel consumption between GHG inventory (Table 1.A(b) and monthly and annual Eurostat data, 2014-2016

Member States	Eurostat monthly vs. GHG inventory				GHG inventory vs. Eurostat annual		
Member States	2014	2015	2016		2014	2015	2016
Belgium	-4%	-2%	-2%		0%	1%	1%
Bulgaria	0%	0%	1%		0%	0%	0%
Czech Republic	0%	-4%	-4%		0%	4%	2%
Denmark	4%	-6%	1%		6%	0%	0%
Germany	-2%	-4%	-4%		-1%	0%	-1%
Estonia	-2%	-4%	-12%		0%	0%	0%
Ireland	10%	10%	4%		0%	2%	-1%
Greece	-6%	-7%	-1%		0%	0%	0%
Spain	2%	-13%	5%		0%	0%	0%
France	-7%	-5%	-3%		15%	12%	11%
Croatia	0%	-1%	0%		0%	0%	0%
Italy	-2%	-3%	1%		2%	4%	-1%
Cyprus	-4%	0%	25%		4%	0%	NA
Latvia	2%	-15%	-8%		-7%	1%	-6%
Lithuania	-3%	-5%	-3%		21%	20%	23%
Luxembourg	-14%	-6%	-6%		1%	0%	-1%
Hungary	1%	-2%	-1%		0%	0%	0%
Malta	NO	NO	NO		NO	NO	4%
Netherlands	-14%	-25%	-4%		4%	3%	4%
Austria	3%	4%	9%		0%	0%	0%
Poland	-1%	0%	-1%		1%	1%	0%
Portugal	3%	3%	4%		-3%	-2%	-3%
Romania	-4%	-2%	2%		0%	0%	-4%
Slovenia	-13%	-11%	-11%		0%	0%	0%
Slovakia	3%	-1%	-2%		-3%	0%	0%
Finland	-3%	-4%	3%		2%	2%	-1%
Sweden	3%	21%	18%		-2%	-19%	-8%
United Kingdom	-2%	2%	2%		2%	-1%	-2%
EU 28	**-2%**	**-3%**	**-2%**		**0%**	**1%**	**0%**
<+/- 2%	7 MS	8 MS	8 MS		19 MS	20 MS	18 MS
+/-2-5%	14 MS	9 MS	11 MS		4 MS	4 MS	5 MS
> +/- 5%	6 MS	10 MS	8 MS		4 MS	3 MS	4 MS

Note: Green: difference ≤ ± 2%, Yellow: difference ± >2 and ≤ 5%, Red: difference > ± 5%; NA is used for Cyprus as under annual Eurostat data no solid fuel consumption is reported

NO is reported if there is no solid fuel consumption in the country.
Annual Eurostat data is 100%, for comparison of monthly Eurostat data and GHG inventory data, GHG inventory data is 100%

Source: Extraction from Eurostat database and GHG inventory submission to UNFCCC in the specific year

2.3.2.3. Gaseous fuels

In 2014, eighteen Member States showed differences of less than 2 % between monthly Eurostat and GHG inventory data for natural gas consumption. These eighteen Member States are responsible for 93 % of EU-28 total natural gas consumption. Differences greater than 5% were identified for two Member States (see Table 2-12), which consume only 2 % of EU-28 total natural gas.

In 2016, the last reporting year for which monthly Eurostat and GHG inventory data are available, differences between monthly Eurostat and GHG inventory data of less than 2% were found for seventeen Member States. The natural gas consumption of these seventeen Member States accounts for 65 % of total EU-28 natural gas consumption. Differences greater than 5% increased to four Member States (see Table 2-12), which consume 29 % of EU-28 total natural gas. Thus in comparison to 2014 reporting of natural gas deteriorated in 2016.

Differences between annual Eurostat data and GHG inventory data are smaller than between monthly Eurostat data and GHG inventory data. In 2014 and 2016, twenty-five Member States showed differences below 2 % in the reporting of natural gas consumption between annual Eurostat data and GHG inventory data. No Member State showed differences above 5 % in 2014 and in 2016. Thus, the consistency between annual Eurostat data and the energy data reported in the GHG inventory table 1.A(b) is very good for natural gas consumption data.

Table 2-12: Difference between natural gas consumption in GHG inventory (table 1.A(b) and monthly and annual Eurostat data, 2014-2016

Member States	Eurostat monthly vs. GHG inventory				GHG inventory vs. Eurostat annual		
Member States	2014	2015	2016		2014	2015	2016
Belgium	-1%	-2%	-3%		0%	0%	0%
Bulgaria	-3%	-3%	-3%		0%	0%	0%
Czech Republic	0%	0%	0%		0%	0%	0%
Denmark	-1%	-1%	0%		0%	0%	0%
Germany	2%	0%	2%		0%	3%	3%
Estonia	2%	3%	0%		-2%	-3%	0%
Ireland	4%	0%	-1%		0%	0%	0%
Greece	0%	0%	0%		0%	0%	0%
Spain	0%	0%	0%		0%	0%	0%
France	1%	3%	0%		-1%	-2%	0%
Croatia	-6%	2%	7%		0%	0%	0%
Italy	0%	0%	0%		0%	0%	0%
Cyprus	NO	NO	NO		NO	NO	NO
Latvia	0%	0%	2%		0%	0%	1%
Lithuania	0%	0%	-1%		0%	0%	1%
Luxembourg	0%	0%	0%		0%	0%	0%
Hungary	0%	0%	0%		0%	0%	0%
Malta	NO	NO	NO		NO	NO	NO
Netherlands	1%	-1%	-5%		0%	0%	0%
Austria	-1%	-1%	0%		0%	0%	0%
Poland	0%	-1%	0%		0%	0%	0%
Portugal	2%	-4%	3%		1%	1%	1%
Romania	3%	4%	6%		0%	0%	0%
Slovenia	0%	0%	2%		0%	0%	0%
Slovakia	-16%	0%	0%		0%	0%	1%
Finland	-1%	-2%	1%		0%	0%	-1%
Sweden	0%	-1%	-1%		0%	1%	1%
United Kingdom	0%	0%	0%		0%	0%	0%
EU 28	**0%**	**0%**	**0%**		**0%**	**0%**	**1%**
<+/- 2%	18 MS	18 MS	17 MS		25 MS	23 MS	25 MS
+/-2-5%	6 MS	8 MS	6 MS		1 MS	3 MS	1 MS
> +/- 5%	2 MS	0 MS	3 MS		0 MS	0 MS	0 MS

Note: Green: difference ≤ ± 2%, Yellow: difference ± >2 and ≤ 5%, Red: difference > ± 5%; NO is reported if there is no natural gas consumption in the country.

Annual Eurostat data is 100%, for comparison of monthly Eurostat data and GHG inventory data, GHG inventory data is 100%

Source: Extraction from Eurostat database and GHG inventory submission to UNFCCC in the specific year

3. Conclusion

The application of the trend method to estimate early CO_2 emissions for all EU Member States represents a robust procedure that adjusts systematic errors of under- or over-reporting in monthly data. The advantage of the method is the simplicity that ensures a fast and straightforward calculation for each Member State. By applying the trend change method, inconsistencies in the reporting of monthly energy data compared to annual or GHG inventory data can be levelled out, if these inconsistencies persist through the entire time series of Eurostat monthly energy data for the different fuel groups.

The use of a trend change method requires a consistent reporting over two consecutive years. Any changes in reporting including improvements, can affect the trend changes in a negative way leading to higher deviations between early CO_2 estimates and final GHG inventory data on CO_2 emissions from fuel combustion. As the quality of monthly Eurostat data improved considerably before the year 2014, no continuous improvement in reporting could be observed for the duration of the current project. Results of the early CO_2 estimates are mainly influenced by the fluctuations of the reporting and by inter-annual fluctuations in the share of carbon stored. However, results are robust enough to indicate the direction of change in CO_2 emissions for all Member States (except of 2-3 outliers). Especially on the level of EU-28, the method produces robust and reliable results that can be used as an early indication for the development of CO_2 emissions.

In general, the application of a harmonized method for all 28 EU Member States depends on the data quality, which continues to differ from year to year and from Member State to Member State. A further improvement of monthly data reported to Eurostat and a constant reporting quality over the years is needed for all Member States.

4. References

Eurostat data:

- Eurostat Monthly Oil and Gas Questionnaires (2013, 2014, 2015, 2016, 2017 submissions)
- Eurostat Monthly Coal Questionnaire (2013, 2014, 2015, 2016, 2017 submissions)
- Data from Eurostat database for monthly and annual fuel consumption for the years 2013 – 2016 normally extracted between mid and end April in the year after the reference year

Inventory data: Data as reported by Member States to the UNFCCC in CRF table 1.A.(b).Submissions 2016-2018 for the years 2014 -2016: https://unfccc.int/process/transparency-and-reporting/reporting-and-review-under-the-convention/greenhouse-gas-inventories-annex-i-parties/national-inventory-submissions-2018

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5. Annex

5.1. Comparison of early CO_2 emission estimates for liquid, solid and gaseous CO_2 emissions

Table 5-1: Comparison of changes in CO_2 emissions from liquid, solid and gaseous fuels in 2014

Member States	Eurostat early CO2 estimates	Member States GHG inventory emission data (CRF Table 1.A(b))	Difference	Share of liquid fuels in total CO2 emission of MS	Eurostat early CO2 estimates	Member States GHG inventory emission data (CRF Table 1.A(b))	Difference	Share of solid fuels in total CO2 emission of MS	Eurostat early CO2 estimates	Member States GHG inventory emission data (CRF Table 1.A(b))	Difference	Share of gaseous fuels in total CO2 emission of MS
	Liquid fuels				Solid fuels				Gaseous fuels			
	Change 2014/2013		%		Change 2014/2013		%		Change 2014/2013		%	
Belgium	2,2%	-0,5%	2,7%	56%	17,1%	-6,6%	23,7%	7%	-12,4%	-12,8%	0,4%	37%
Bulgaria	4,9%	10,7%	-5,8%	26%	9,4%	7,7%	1,8%	64%	-0,9%	-3,0%	2,1%	11%
Czech Republic	6,2%	8,4%	-2,2%	27%	-2,3%	-2,4%	0,1%	56%	-10,7%	-11,1%	0,4%	17%
Denmark	-2,4%	-3,8%	1,4%	51%	-18,9%	-19,9%	1,0%	30%	-16,4%	-14,9%	-1,5%	20%
Germany	-1,5%	-3,4%	1,9%	34%	-0,4%	-5,6%	5,3%	46%	-11,0%	-13,0%	2,1%	20%
Estonia	-13,2%	-19,8%	6,6%	5%	-0,3%	-1,6%	1,4%	89%	-21,5%	3,7%	-25,3%	6%
Ireland	-1,0%	-1,8%	0,8%	49%	1,6%	-0,6%	2,1%	25%	-3,4%	-3,1%	-0,3%	26%
Greece	-1,7%	3,9%	-5,6%	45%	-7,5%	-3,9%	-3,6%	48%	-23,3%	-25,9%	2,6%	7%
Spain	-1,8%	0,1%	-1,9%	56%	7,5%	3,2%	4,3%	19%	-9,3%	-9,6%	0,3%	25%
France	-1,3%	-1,0%	-0,3%	63%	-26,3%	-25,8%	-0,5%	12%	-13,1%	-17,7%	4,6%	24%
Croatia	-5,8%	-1,1%	-4,7%	59%	-4,1%	-4,1%	0,0%	17%	-8,7%	-15,5%	6,8%	23%
Italy	-4,1%	-2,5%	-1,6%	46%	-3,7%	-3,8%	0,1%	17%	-11,6%	-11,9%	0,3%	38%
Cyprus	3,6%	3,0%	0,5%	100%	-	-	-	-	-	-	-	-
Latvia	8,3%	8,1%	0,2%	57%	-24,0%	-17,9%	-6,1%	4%	-9,8%	-10,1%	0,3%	40%
Lithuania	8,7%	4,1%	4,6%	66%	-17,4%	-15,6%	-1,8%	9%	-4,9%	-16,0%	11,2%	25%
Luxembourg	-6,6%	-5,8%	-0,7%	76%	2,6%	14,5%	-11,9%	2%	-5,3%	-5,1%	-0,1%	22%
Hungary	4,5%	11,6%	-7,1%	37%	-0,1%	-3,2%	3,1%	23%	-8,8%	-12,7%	3,9%	40%
Malta	2,5%	-1,5%	4,1%	100%	-	-	-	-	-	-	-	-
Netherlands	-4,5%	-3,2%	-1,3%	34%	2,3%	11,0%	-8,7%	23%	-12,7%	-13,8%	1,1%	43%
Austria	-1,7%	-3,8%	2,1%	62%	0,1%	-17,3%	17,4%	9%	-8,1%	-9,4%	1,3%	29%
Poland	-1,9%	-2,3%	0,5%	19%	-6,6%	-7,3%	0,7%	71%	-2,1%	-3,8%	1,7%	10%
Portugal	-8,0%	-3,2%	-4,8%	57%	1,6%	1,0%	0,6%	25%	-7,6%	-4,9%	-2,6%	18%
Romania	1,6%	0,9%	0,8%	35%	0,3%	-6,0%	6,3%	32%	-6,1%	-4,5%	-1,6%	32%
Slovenia	1,2%	-2,1%	3,2%	53%	-21,8%	-22,3%	0,5%	35%	-9,4%	-9,6%	0,2%	12%
Slovakia	-4,0%	-1,9%	-2,1%	32%	-2,0%	-4,8%	2,8%	37%	-34,4%	-16,8%	-17,6%	31%
Finland	13,9%	5,4%	8,5%	49%	-9,3%	-9,6%	0,2%	39%	-12,2%	-10,9%	-1,2%	12%
Sweden	-0,8%	-6,1%	5,3%	75%	7,5%	20,5%	-13,0%	21%	-17,0%	-19,0%	2,0%	4%
United Kingdom	-0,1%	-0,8%	0,7%	40%	-20,1%	-20,8%	0,7%	25%	-8,6%	-9,4%	0,9%	35%

Source: Authors own estimate, based on monthly Eurostat data and GHG inventory data

Table 5-2: Comparison of changes in CO_2 emissions from liquid, solid and gaseous fuels in 2015

Member States	Eurostat early CO2 estimates	Member States GHG inventory emission data (CRF Table 1.A(b))	Difference	Share of liquid fuels in total CO2 emission of MS	Eurostat early CO2 estimates	Member States GHG inventory emission data (CRF Table 1.A(b))	Difference	Share of solid fuels in total CO2 emission of MS	Eurostat early CO2 estimates	Member States GHG inventory emission data (CRF Table 1.A(b))	Difference	Share of gaseous fuels in total CO2 emission of MS
	Liquid fuels				Solid fuels				Gaseous fuels			
	Change 2015/2014		%		Change 2015/2014		%		Change 2015/2014		%	
Belgium	2.1%	5.1%	-3.0%	55%	-1.3%	-2.1%	0.8%	7%	9.8%	9.8%	0.0%	38%
Bulgaria	6.4%	8.7%	-2.3%	26%	2.9%	3.7%	-0.8%	63%	10.4%	7.5%	2.9%	11%
Czech Republic	-2.2%	4.5%	-6.7%	21%	-0.4%	3.3%	-3.8%	63%	4.9%	4.9%	0.0%	16%
Denmark	-0.5%	0.6%	-1.1%	55%	-33.6%	-28.0%	-5.6%	23%	1.7%	1.9%	-0.2%	22%
Germany	1.0%	0.1%	0.9%	33%	-2.0%	-1.6%	-0.4%	46%	3.1%	5.2%	-2.0%	21%
Estonia	-14.9%	-35.2%	20.3%	4%	-16.5%	-12.6%	-3.8%	91%	-10.4%	-11.1%	0.8%	6%
Ireland	4.9%	6.3%	-1.4%	49%	9.4%	9.6%	-0.3%	26%	-3.3%	1.4%	-4.7%	25%
Greece	4.5%	4.3%	0.3%	49%	-15.9%	-15.3%	-0.6%	42%	7.8%	10.2%	-2.4%	8%
Spain	3.2%	5.1%	-1.9%	54%	-2.0%	15.5%	-17.5%	22%	3.7%	4.0%	-0.3%	24%
France	0.0%	2.3%	-2.3%	62%	-2.8%	-4.1%	1.3%	12%	8.3%	-2.6%	10.8%	26%
Croatia	2.7%	5.0%	-2.3%	60%	-8.3%	-6.5%	-1.8%	15%	11.9%	3.6%	8.3%	25%
Italy	1.7%	-1.6%	3.3%	44%	-4.3%	-4.4%	0.1%	15%	9.1%	9.6%	-0.5%	40%
Cyprus	1.0%	0.7%	0.3%	100%	-	-	-	0%	-	-	-	-
Latvia	2.9%	-3.2%	6.1%	58%	-29.4%	-21.9%	-7.5%	3%	1.6%	1.7%	-0.1%	40%
Lithuania	3.0%	0.8%	2.2%	68%	-25.1%	-20.2%	-5.0%	7%	0.4%	-5.0%	5.5%	25%
Luxembourg	-2.6%	-4.4%	1.7%	77%	1.3%	-8.4%	9.7%	2%	-8.8%	-8.8%	0.0%	21%
Hungary	8.9%	6.1%	2.9%	37%	3.1%	4.8%	-1.8%	23%	6.8%	8.6%	-1.8%	40%
Malta	-26.9%	-20.4%	-6.5%	100%	-	-	-	-	-	-	-	-
Netherlands	-8.9%	0.9%	-9.7%	31%	24.2%	22.6%	1.6%	27%	-1.1%	0.0%	-1.1%	41%
Austria	0.9%	2.0%	-1.1%	62%	9.9%	-1.1%	11.0%	8%	6.5%	6.8%	-0.2%	31%
Poland	7.3%	6.5%	0.8%	21%	0.0%	-2.0%	2.0%	70%	1.8%	2.8%	-0.9%	10%
Portugal	2.0%	6.4%	-4.4%	54%	21.7%	21.7%	0.0%	28%	11.1%	22.7%	-11.6%	18%
Romania	4.7%	7.6%	-2.9%	35%	5.9%	8.2%	-2.3%	35%	-3.7%	0.8%	-4.5%	30%
Slovenia	-1.2%	-1.0%	-0.2%	52%	1.5%	3.8%	-2.4%	36%	5.9%	6.1%	-0.2%	12%
Slovakia	12.3%	-2.2%	14.5%	31%	-2.6%	0.1%	-2.7%	38%	21.1%	0.2%	20.9%	31%
Finland	-4.4%	-11.1%	6.7%	49%	-10.1%	-8.7%	-1.3%	39%	-11.4%	-13.7%	2.3%	12%
Sweden	-15.6%	-12.0%	-3.6%	83%	-3.6%	-16.8%	13.2%	12%	-8.9%	-9.5%	0.5%	5%
United Kingdom	3.4%	2.0%	1.5%	42%	-20.0%	-21.3%	1.3%	20%	2.2%	2.4%	-0.2%	38%

Source: Authors' own estimates, based on monthly Eurostat data and GHG inventory data

Table 5-3: Comparison of changes in CO_2 emissions from liquid, solid and gaseous fuels in 2016

Member States	Eurostat early CO2 estimates	Member States GHG inventory emission data (CRF Table 1.A(b))	Difference	Share of liquid fuels in total CO2 emission of MS	Eurostat early CO2 estimates	Member States GHG inventory emission data (CRF Table 1.A(b))	Difference	Share of solid fuels in total CO2 emission of MS	Eurostat early CO2 estimates	Member States GHG inventory emission data (CRF Table 1.A(b))	Difference	Share of gaseous fuels in total CO2 emission of MS
	Liquid fuels				Solid fuels				Gaseous fuels			
	Change 2016/2015		%		Change 2016/2015		%		Change 2016/2015		%	
Belgium	-1.2%	-5.5%	4.2%	55%	-8.1%	-40.3%	32.2%	4%	1.7%	3.2%	-1.6%	42%
Bulgaria	3.5%	3.4%	0.1%	29%	-13.3%	-13.8%	0.6%	58%	3.8%	3.3%	0.5%	12%
Czech Republic	-7.3%	1.8%	-9.1%	22%	-0.7%	-0.6%	-0.1%	61%	8.2%	8.4%	-0.1%	17%
Denmark	3.4%	1.5%	1.9%	54%	15.4%	9.1%	6.3%	24%	1.3%	0.8%	0.5%	21%
Germany	-0.2%	3.6%	-3.7%	34%	-3.0%	-4.0%	1.0%	43%	9.8%	9.5%	0.3%	23%
Estonia	52.6%	91.1%	-38.4%	6%	-3.7%	4.2%	-7.9%	88%	9.7%	13.3%	-3.6%	6%
Ireland	8.4%	4.4%	4.0%	50%	-22.8%	-3.4%	-19.4%	24%	11.6%	10.7%	0.9%	27%
Greece	3.1%	1.6%	1.6%	53%	-17.3%	-23.5%	6.1%	35%	30.2%	34.4%	-4.1%	12%
Spain	5.1%	1.5%	3.7%	57%	-7.5%	-24.8%	17.3%	17%	2.0%	1.9%	0.1%	25%
France	-1.7%	-3.2%	1.6%	60%	-2.1%	-3.1%	1.0%	11%	8.5%	9.4%	-0.9%	28%
Croatia	1.3%	-1.2%	2.5%	58%	8.7%	7.6%	1.1%	16%	8.9%	7.5%	1.4%	26%
Italy	-7.1%	0.1%	-7.2%	44%	-11.8%	-10.1%	-1.6%	13%	5.0%	5.8%	-0.8%	43%
Cyprus	7.2%	6.9%	0.3%	100%	-	-	-	0%	-	-	-	-
Latvia	3.6%	0.6%	3.0%	57%	-8.6%	-5.2%	-3.4%	3%	3.6%	3.6%	0.0%	40%
Lithuania	8.6%	8.1%	0.5%	71%	11.5%	1.8%	9.7%	7%	-10.9%	-9.8%	-1.1%	22%
Luxembourg	-2.9%	-2.3%	-0.7%	78%	6.3%	7.6%	-1.3%	2%	-7.8%	-8.1%	0.3%	20%
Hungary	1.9%	2.8%	-0.9%	37%	-4.1%	-3.1%	-1.1%	21%	7.7%	7.6%	0.1%	42%
Malta	-18.2%	3.6%	-21.8%	99%	-	-	-	-	-	-	-	-
Netherlands	10.2%	1.8%	8.4%	31%	-8.0%	-7.3%	-0.7%	26%	-1.6%	6.0%	-7.5%	43%
Austria	2.0%	1.5%	0.5%	62%	-2.9%	-19.5%	16.6%	6%	5.6%	4.8%	0.7%	32%
Poland	10.8%	16.0%	-5.2%	23%	-2.8%	1.6%	-4.4%	67%	6.6%	7.5%	-0.8%	10%
Portugal	-8.2%	1.1%	-9.3%	56%	-12.3%	-12.7%	0.4%	25%	12.5%	9.0%	3.5%	19%
Romania	3.1%	0.2%	2.9%	36%	-9.0%	-10.7%	1.6%	31%	2.4%	2.1%	0.3%	32%
Slovenia	5.8%	5.5%	0.3%	52%	5.1%	7.6%	-2.4%	36%	8.1%	6.1%	2.0%	12%
Slovakia	7.2%	7.6%	-0.3%	34%	-3.6%	-3.6%	0.0%	35%	2.5%	3.1%	-0.6%	31%
Finland	7.9%	17.1%	-9.2%	53%	13.6%	7.1%	6.5%	38%	-6.7%	-10.8%	4.0%	9%
Sweden	0.8%	2.2%	-1.3%	82%	8.3%	-2.5%	10.8%	13%	13.0%	14.4%	-1.4%	5%
United Kingdom	1.8%	0.8%	1.0%	45%	-51.3%	-51.7%	0.4%	10%	12.9%	12.5%	0.4%	45%

Source: Authors' own estimates, based on monthly Eurostat data and GHG inventory data

5.2. Data tables

Table 5-4: Differences between monthly, annual Eurostat and GHG inventory data for fuel consumption

Fuel		Liquid fuels									Solid fuels									Natural gas								
Member States	Year	Cumulated Monthly Eurostat data	Annual Eurostat data	GHG inventory data	Difference Monthly Eurostat - Annual Eurostat data		Difference Monthly Eurostat - GHG inventory data		Differences GHG inventory - annual Eurostat data		Cumulated Monthly Eurostat data	Annual Eurostat data	GHG inventory data	Difference Monthly Eurostat - Annual Eurostat data		Difference Monthly Eurostat - GHG inventory data		Differences GHG inventory - annual Eurostat data		Cumulated Monthly Eurostat data	Annual Eurostat data	GHG inventory data	Difference Monthly Eurostat - Annual Eurostat data		Difference Monthly Eurostat - GHG inventory data		Differences GHG inventory - annual Eurostat data	
		kt			kt	%	kt	%	kt	%	kt			kt	%	kt	%	kt	%	TJ NCV			TJ NCV	%	TJ NCV	%	kt	%
Belgium	2013	21.984	21.497	21.965	487	2%	19	0%	468	2%	3.994	4.970	4.917	-976	-20%	-923	-19%	-53	-1%	594.578	602.704	602.704	-8.126	-1%	-8.126	-1%	0	0%
	2014	22.469	21.794	22.395	675	3%	74	0%	601	3%	4.678	4.848	4.849	-170	-4%	-171	-4%	1	0%	520.738	527.506	524.869	-6.768	-1%	-4.130	-1%	-2.638	0%
	2015	22.943	22.384	22.379	559	2%	564	3%	-5	0%	4.618	4.660	4.690	-42	-1%	-72	-2%	30	1%	571.535	584.775	584.775	-13.240	-2%	-13.240	-2%	0	0%
	2016	22.662	21.930	21.727	732	3%	935	4%	-203	-1%	4.246	4.284	4.314	-38	-1%	-68	-2%	30	1%	581.147	598.711	598.711	-17.563	-3%	-17.563	-3%	0	0%
Bulgaria	2013	3.509	3.481	3.473	28	1%	36	1%	-8	0%	30.409	30.585	30.585	-176	-1%	-176	-1%	0	0%	96.513	99.977	99.977	-3.464	-3%	-3.464	-3%	0	0%
	2014	3.680	3.858	3.847	-178	-5%	-167	-4%	-11	0%	33.281	33.369	33.370	-88	0%	-89	0%	1	0%	95.599	98.917	98.917	-3.318	-3%	-3.318	-3%	0	0%
	2015	3.914	4.179	4.148	-265	-6%	-234	-6%	-31	-1%	37.020	36.926	36.926	94	0%	94	0%	0	0%	105.557	108.637	108.637	-3.081	-3%	-3.081	-3%	0	0%
	2016	4.051	4.141	4.131	-90	-2%	-80	-2%	-10	0%	32.110	31.943	31.943	167	1%	167	1%	0	0%	109.521	112.479	112.479	-2.958	-3%	-2.958	-3%	0	0%
Czech Republic	2013	7.996	7.992	7.955	4	0%	41	1%	-37	0%	46.801	45.945	46.747	856	2%	54	0%	802	2%	289.558	290.832	291.435	-1.274	0%	-1.877	-1%	602	0%
	2014	8.490	8.477	8.455	13	0%	35	0%	-22	0%	45.718	45.494	45.697	224	0%	21	0%	203	0%	258.585	258.833	259.389	-247	0%	-804	0%	556	0%
	2015	8.305	8.415	8.376	-110	-1%	-71	-1%	-39	0%	45.516	45.633	47.309	-117	0%	-1.793	-4%	1.676	4%	271.380	271.420	272.007	-40	0%	-628	0%	587	0%
	2016	7.707	7.763	7.786	-56	-1%	-79	-1%	23	0%	45.189	45.982	47.006	-793	-2%	-1.817	-4%	1.024	2%	293.756	293.759	294.457	-4	0%	-701	0%	698	0%
Denmark	2013	6.303	5.950	5.930	353	6%	373	6%	-20	0%	5.485	5.364	5.479	121	2%	6	0%	115	2%	139.353	138.833	138.833	520	0%	520	0%	0	0%
	2014	6.152	5.765	5.686	387	7%	466	8%	-79	-1%	4.447	4.041	4.293	406	10%	154	4%	252	6%	116.431	117.789	117.790	-1.358	-1%	-1.358	-1%	0	0%
	2015	6.120	5.669	5.711	451	8%	409	7%	42	1%	2.952	3.154	3.154	-202	-6%	-202	-6%	0	0%	118.427	119.426	119.425	-999	-1%	-998	-1%	-1	0%
	2016	6.328	5.748	5.792	580	10%	536	9%	44	1%	3.406	3.399	3.387	7	0%	19	1%	-12	0%	119.971	120.500	120.499	-529	0%	-528	0%	-1	0%
Germany	2013	98.991	99.857	100.479	-866	-1%	-1.488	-1%	622	1%	237.599	247.279	246.447	-9.680	-4%	-8.848	-4%	-832	0%	3.075.491	3.051.546	3.178.642	23.944	1%	-103.151	-3%	127.096	4%
	2014	97.508	97.958	98.196	-450	0%	-688	-1%	238	0%	233.670	240.308	238.777	-6.638	-3%	-5.107	-2%	-1.531	-1%	2.738.165	2.681.949	2.688.044	56.216	2%	50.120	2%	6.095	0%
	2015	98.438	98.201	95.370	237	0%	3.068	3%	-2.831	-3%	228.927	239.848	239.333	-10.921	-5%	-10.406	-4%	-515	0%	2.823.782	2.727.882	2.811.535	95.900	4%	12.247	0%	83.653	3%
	2016	98.277	98.323	97.494	-46	0%	783	1%	-829	-1%	222.170	232.029	230.866	-9.859	-4%	-8.696	-4%	-1.163	-1%	3.101.490	2.944.589	3.035.561	156.901	5%	65.929	2%	90.972	3%
Estonia	2013	310	415	413	-105	-25%	-103	-25%	-2	0%	20.649	20.770	20.770	-121	-1%	-121	-1%	0	0%	23.233	23.233	23.083	0	0%	149	1%	-149	-1%
	2014	269	351	351	-82	-23%	-82	-23%	0	0%	20.556	20.906	20.906	-350	-2%	-350	-2%	0	0%	18.236	18.236	17.808	0	0%	428	2%	-428	-2%
	2015	125	229	229	-104	-45%	-104	-45%	0	0%	17.381	18.052	18.061	-671	-4%	-680	-4%	9	0%	16.348	16.348	15.826	0	0%	522	3%	-522	-3%
	2016	229	372	376	-143	-38%	-147	-39%	4	1%	16.774	18.980	18.982	-2.206	-12%	-2.208	-12%	2	0%	17.931	17.931	17.931	0	0%	0	0%	0	0%
Ireland	2013	5.792	5.946	5.762	-154	-3%	30	1%	-184	-3%	6.021	5.890	6.043	131	2%	-22	0%	153	3%	168.227	161.940	162.109	6.287	4%	6.118	4%	170	0%
	2014	5.733	5.699	5.536	34	1%	197	4%	-163	-3%	6.270	5.707	5.688	563	10%	582	10%	-19	0%	162.531	155.855	155.787	6.676	4%	6.744	4%	-68	0%
	2015	6.014	5.982	5.869	32	1%	145	2%	-113	-2%	6.567	5.840	5.981	727	12%	586	10%	141	2%	157.111	157.100	157.447	12	0%	-336	0%	348	0%
	2016	6.522	6.344	6.163	178	3%	359	6%	-181	-3%	5.936	5.788	5.725	148	3%	211	4%	-63	-1%	175.372	177.602	177.983	-2.229	-1%	-2.610	-1%	381	0%
Greece	2013	11.180	10.669	10.687	511	5%	493	5%	18	0%	53.193	54.688	54.688	-1.495	-3%	-1.495	-3%	0	0%	135.392	135.497	135.497	-104	0%	-104	0%	0	0%
	2014	10.993	11.017	11.014	-24	0%	-21	0%	-3	0%	49.200	52.152	52.152	-2.952	-6%	-2.952	-6%	0	0%	103.783	104.013	104.013	-230	0%	-230	0%	0	0%
	2015	11.493	11.729	11.502	-236	-2%	-9	0%	-227	-2%	41.372	44.548	44.548	-3.176	-7%	-3.176	-7%	0	0%	111.881	112.077	112.077	-196	0%	-196	0%	0	0%
	2016	11.853	11.788	11.771	65	1%	82	1%	-17	0%	34.209	34.563	34.563	-354	-1%	-354	-1%	0	0%	145.707	146.108	146.108	-401	0%	-400	0%	0	0%

Fuel		Liquid fuels									Solid fuels									Natural gas								
Member States	Year	Cumulated Monthly Eurostat data	Annual Eurostat data	GHG inventory data	Difference Monthly Eurostat - Annual Eurostat data		Difference Monthly Eurostat - GHG inventory data		Differences GHG inventory - annual Eurostat data		Cumulated Monthly Eurostat data	Annual Eurostat data	GHG inventory data	Difference Monthly Eurostat - Annual Eurostat data		Difference Monthly Eurostat - GHG inventory data		Differences GHG inventory - annual Eurostat data		Cumulated Monthly Eurostat data	Annual Eurostat data	GHG inventory data	Difference Monthly Eurostat - Annual Eurostat data		Difference Monthly Eurostat - GHG inventory data		Differences GHG inventory - annual Eurostat data	
		kt			kt	%	kt	%	kt	%	kt			kt	%	kt	%	kt	%	TJ NCV			TJ NCV	%	TJ NCV	%	kt	%
Spain	2013	46.235	46.305	45.467	-70	0%	768	2%	-838	-2%	20.420	20.633	20.633	-213	-1%	-213	-1%	0	0%	1.092.011	1.092.028	1.093.235	-16	0%	-1.223	0%	1.207	0%
	2014	45.406	45.248	44.507	158	0%	899	2%	-741	-2%	21.961	21.477	21.477	484	2%	484	2%	0	0%	990.950	990.860	991.961	90	0%	-1.011	0%	1.101	0%
	2015	46.844	47.782	47.024	-938	-2%	-180	0%	-758	-2%	21.520	24.641	24.653	-3.121	-13%	-3.133	-13%	12	0%	1.028.018	1.027.362	1.027.362	656	0%	656	0%	0	0%
	2016	49.251	49.005	48.008	246	1%	1.243	3%	-997	-2%	20.129	19.136	19.136	993	5%	993	5%	0	0%	1.048.379	1.048.364	1.050.694	14	0%	-2.315	0%	2.330	0%
France	2013	72.138	70.725	73.018	1.413	2%	-880	-1%	2.293	3%	20.052	18.824	21.317	1.228	7%	-1.265	-6%	2.493	13%	1.570.531	1.633.145	1.629.936	-62.614	-4%	-59.405	-4%	-3.209	0%
	2014	71.208	69.896	73.144	1.312	2%	-1.936	-3%	3.248	5%	14.774	13.796	15.879	978	7%	-1.105	-7%	2.083	15%	1.364.721	1.364.669	1.355.461	52	0%	9.260	1%	-9.208	-1%
	2015	71.180	70.628	73.722	552	1%	-2.542	-3%	3.094	4%	14.367	13.520	15.113	847	6%	-746	-5%	1.593	12%	1.477.662	1.467.062	1.434.662	10.600	1%	43.001	3%	-32.400	-2%
	2016	69.994	68.242	70.810	1.752	3%	-816	-1%	2.568	4%	14.064	13.110	14.558	954	7%	-494	-3%	1.448	11%	1.603.653	1.603.078	1.603.079	575	0%	575	0%	1	0%
Croatia	2013	3.083	3.014	3.073	69	2%	10	0%	59	2%	1.146	1.139	1.138	7	1%	8	1%	-1	0%	87.207	95.537	95.537	-8.330	-9%	-8.329	-9%	0	0%
	2014	2.903	2.955	3.044	-52	-2%	-141	-5%	89	3%	1.099	1.103	1.103	-4	0%	-4	0%	0	0%	79.616	84.549	84.620	-4.933	-6%	-5.005	-6%	72	0%
	2015	2.982	3.142	3.174	-160	-5%	-192	-6%	32	1%	1.008	1.021	1.020	-13	-1%	-12	-1%	-1	0%	89.085	87.165	87.164	1.920	2%	1.920	2%	-1	0%
	2016	3.022	3.074	3.324	-52	-2%	-302	-9%	250	8%	1.096	1.099	1.099	-3	0%	-3	0%	0	0%	97.018	90.877	90.877	6.142	7%	6.141	7%	0	0%
Italy	2013	53.495	53.455	55.913	40	0%	-2.418	-4%	2.458	5%	21.783	21.632	21.330	151	1%	453	2%	-302	-1%	2.402.257	2.402.667	2.402.951	-410	0%	-694	0%	284	0%
	2014	51.314	51.525	53.552	-211	0%	-2.238	-4%	2.027	4%	20.975	21.057	21.458	-82	0%	-483	-2%	401	2%	2.122.967	2.122.962	2.121.784	5	0%	1.183	0%	-1.178	0%
	2015	52.175	53.492	53.821	-1.317	-2%	-1.646	-3%	329	1%	20.083	19.894	20.735	189	1%	-652	-3%	841	4%	2.315.403	2.315.363	2.314.079	40	0%	1.324	0%	-1.284	0%
	2016	48.490	51.208	53.653	-2.718	-5%	-5.163	-10%	2.445	5%	17.723	17.755	17.541	-32	0%	182	1%	-214	-1%	2.431.642	2.431.676	2.431.965	-34	0%	-323	0%	289	0%
Cyprus	2013	1.816	1.826	1.830	-10	-1%	-14	-1%	4	0%	NA	1	13	-	-	-	-	12	-	NO	NO	NO	-	-	-	-	-	-
	2014	1.864	1.877	1.887	-13	-1%	-23	-1%	10	1%	4	4	4	0	0%	0	-4%	0	4%	NO	NO	NO	-	-	-	-	-	-
	2015	1.882	1.891	1.901	-9	0%	-19	-1%	10	1%	6	6	6	0	0%	0	0%	0	0%	NO	NO	NO	-	-	-	-	-	-
	2016	2.018	2.021	2.031	-3	0%	-13	-1%	10	0%	1	0	1	1	-	0	25%	1	-	NO	NO	NO	-	-	-	-	-	-
Latvia	2013	1.105	1.254	1.192	-149	-12%	-87	-7%	-62	-5%	132	131	131	1	1%	1	1%	0	0%	50.200	50.438	50.544	-238	0%	-344	-1%	106	0%
	2014	1.197	1.291	1.213	-94	-7%	-16	-1%	-78	-6%	100	105	98	-5	-5%	2	2%	-7	-7%	45.274	45.286	45.386	-13	0%	-112	0%	100	0%
	2015	1.232	1.340	1.254	-108	-8%	-22	-2%	-86	-6%	70	82	83	-12	-15%	-13	-15%	1	1%	46.009	45.987	46.096	22	0%	-87	0%	109	0%
	2016	1.276	1.323	1.230	-47	-4%	46	4%	-93	-7%	64	74	70	-10	-14%	-6	-8%	-4	-6%	47.678	46.338	46.935	1.339	3%	743	2%	597	1%
Lithuania	2013	2.193	2.189	2.372	4	0%	-179	-8%	183	8%	513	513	427	0	0%	86	20%	-86	-17%	90.554	90.624	90.608	-69	0%	-54	0%	-16	0%
	2014	2.384	2.353	2.542	31	1%	-158	-6%	189	8%	428	367	443	61	17%	-15	-3%	76	21%	86.157	86.437	86.450	-280	0%	-293	0%	13	0%
	2015	2.455	2.570	2.603	-115	-4%	-148	-6%	33	1%	328	288	346	40	14%	-18	-5%	58	20%	86.536	86.561	86.562	-25	0%	-26	0%	1	0%
	2016	2.667	2.670	2.858	-3	0%	-191	-7%	188	7%	347	292	358	55	19%	-11	-3%	66	23%	77.107	77.104	77.542	3	0%	-435	-1%	438	1%

Member States	Year	Liquid fuels: Cumulated Monthly Eurostat data	Annual Eurostat data	GHG inventory data	Difference Monthly Eurostat - Annual Eurostat data		Difference Monthly Eurostat - GHG inventory data		Differences GHG inventory - annual Eurostat data	
		kt	kt	kt	kt	%	kt	%	kt	%
Luxem-bourg	2013	2.365	2.372	2.363	-7	0%	2	0%	-9	0%
	2014	2.209	2.232	2.225	-23	-1%	-16	-1%	-7	0%
	2015	2.151	2.143	2.134	8	0%	17	1%	-9	0%
	2016	2.088	2.089	2.091	-1	0%	-3	0%	2	0%
Hungary	2013	5.784	5.524	5.662	260	5%	122	2%	138	2%
	2014	6.044	6.222	6.137	-178	-3%	-93	-2%	-85	-1%
	2015	6.583	6.700	6.669	-117	-2%	-86	-1%	-31	0%
	2016	6.711	6.693	6.693	18	0%	18	0%	0	0%
Malta	2013	712	733	773	-21	-3%	-61	-8%	40	5%
	2014	730	769	762	-39	-5%	-32	-4%	-7	-1%
	2015	527	533	548	-6	-1%	-21	-4%	15	3%
	2016	431	446	442	-15	-3%	-11	-3%	-4	-1%
Nether-lands	2013	27.926	28.178	28.739	-252	-1%	-813	-3%	561	2%
	2014	26.657	29.664	26.397	-3.007	-10%	260	1%	-3.267	-11%
	2015	24.297	26.295	26.569	-1.998	-8%	-2.272	-9%	274	1%
	2016	26.776	26.863	27.366	-87	0%	-590	-2%	503	2%
Austria	2013	12.032	11.448	11.680	584	5%	352	3%	232	2%
	2014	11.149	11.218	11.421	-69	-1%	-272	-2%	203	2%
	2015	11.252	11.330	11.523	-78	-1%	-271	-2%	193	2%
	2016	11.478	11.517	11.765	-39	0%	-287	-2%	248	2%
Poland	2013	21.781	21.538	21.593	243	1%	188	1%	55	0%
	2014	21.375	21.299	21.536	76	0%	-161	-1%	237	1%
	2015	22.927	22.674	22.979	253	1%	-52	0%	305	1%
	2016	25.410	25.057	25.488	353	1%	-78	0%	431	2%
Portugal	2013	10.569	9.214	9.341	1.355	15%	1.228	13%	127	1%
	2014	9.725	8.802	8.890	923	10%	835	9%	88	1%
	2015	9.918	9.083	9.322	835	9%	596	6%	239	3%
	2016	9.102	9.212	9.250	-110	-1%	-148	-2%	38	0%

Member States	Year	Solid fuels: Cumulated Monthly Eurostat data	Annual Eurostat data	GHG inventory data	Difference Monthly Eurostat - Annual Eurostat data		Difference Monthly Eurostat - GHG inventory data		Differences GHG inventory - annual Eurostat data	
		kt	kt	kt	kt	%	kt	%	kt	%
Luxem-bourg	2013	76	80	81	-4	-5%	-5	-6%	1	1%
	2014	78	90	91	-12	-13%	-13	-14%	1	1%
	2015	79	84	84	-5	-6%	-5	-6%	0	0%
	2016	84	90	89	-6	-7%	-5	-6%	-1	-1%
Hungary	2013	10.796	10.736	10.720	60	1%	76	1%	-16	0%
	2014	10.359	10.314	10.299	45	0%	60	1%	-15	0%
	2015	10.329	10.448	10.493	-119	-1%	-164	-2%	45	0%
	2016	10.140	10.202	10.202	-62	-1%	-62	-1%	0	0%
Malta	2013	NO	NO	NO	-	-	-	-	-	-
	2014	NO	NO	NO	-	-	-	-	-	-
	2015	NO	NO	NO	-	-	-	-	-	-
	2016	NO	NO	NO	-	-	-	-	-	-
Nether-lands	2013	12.890	13.056	13.668	-166	-1%	-778	-6%	612	5%
	2014	13.183	14.659	15.242	-1.476	-10%	-2.059	-14%	583	4%
	2015	14.005	17.984	18.602	-3.979	-22%	-4.597	-25%	618	3%
	2016	16.540	16.498	17.153	42	0%	-613	-4%	655	4%
Austria	2013	4.449	4.869	4.835	-420	-9%	-386	-8%	-34	-1%
	2014	4.563	4.441	4.441	122	3%	122	3%	0	0%
	2015	4.998	4.802	4.802	196	4%	196	4%	0	0%
	2016	4.868	4.467	4.468	401	9%	400	9%	1	0%
Poland	2013	137.563	137.871	137.827	-308	0%	-264	0%	-44	0%
	2014	129.964	130.418	131.324	-454	0%	-1.360	-1%	906	1%
	2015	129.973	128.034	129.398	1.939	2%	575	0%	1.364	1%
	2016	126.379	127.941	127.328	-1.562	-1%	-949	-1%	-613	0%
Portugal	2013	4.450	4.449	4.410	1	0%	40	1%	-39	-1%
	2014	4.519	4.526	4.377	-7	0%	142	3%	-149	-3%
	2015	5.499	5.427	5.326	72	1%	173	3%	-101	-2%
	2016	4.822	4.813	4.648	9	0%	174	4%	-165	-3%

Member States	Year	Natural gas: Cumulated Monthly Eurostat data	Annual Eurostat data	GHG inventory data	Difference Monthly Eurostat - Annual Eurostat data		Difference Monthly Eurostat - GHG inventory data		Differences GHG inventory - annual Eurostat data	
		TJ NCV	TJ NCV	TJ NCV	TJ NCV	%	TJ NCV	%	kt	%
Luxem-bourg	2013	37.259	37.258	37.258	1	0%	1	0%	0	0%
	2014	35.302	35.302	35.302	0	0%	0	0%	0	0%
	2015	32.193	32.194	32.194	-1	0%	-1	0%	0	0%
	2016	29.689	29.689	29.689	0	0%	0	0%	0	0%
Hungary	2013	320.365	322.601	322.601	-2.237	-1%	-2.237	-1%	0	0%
	2014	292.156	292.307	292.307	-150	0%	-150	0%	0	0%
	2015	312.136	313.622	313.622	-1.486	0%	-1.486	0%	0	0%
	2016	336.209	336.104	336.104	105	0%	105	0%	0	0%
Malta	2013	NO	NO	NO	-	-	-	-	-	-
	2014	NO	NO	NO	-	-	-	-	-	-
	2015	NO	NO	NO	-	-	-	-	-	-
	2016	NO	NO	NO	-	-	-	-	-	-
Nether-lands	2013	1.394.339	1.383.983	1.396.200	10.355	1%	-1.862	0%	12.217	1%
	2014	1.217.665	1.207.294	1.207.180	10.371	1%	10.485	1%	-114	0%
	2015	1.203.719	1.210.647	1.210.533	-6.928	-1%	-6.814	-1%	-114	0%
	2016	1.184.584	1.251.943	1.251.900	-67.360	-5%	-67.316	-5%	-43	0%
Austria	2013	290.772	293.567	293.566	-2.795	-1%	-2.794	-1%	-1	0%
	2014	267.122	269.832	269.832	-2.710	-1%	-2.710	-1%	1	0%
	2015	284.576	287.931	287.931	-3.355	-1%	-3.355	-1%	0	0%
	2016	300.378	300.691	300.691	-313	0%	-314	0%	0	0%
Poland	2013	574.372	574.674	574.674	-302	0%	-302	0%	0	0%
	2014	562.338	561.217	561.217	1.121	0%	1.121	0%	0	0%
	2015	572.716	576.764	576.764	-4.048	-1%	-4.048	-1%	0	0%
	2016	610.722	612.671	612.671	-1.949	0%	-1.949	0%	0	0%
Portugal	2013	162.206	157.251	157.799	4.955	3%	4.407	3%	549	0%
	2014	149.900	145.422	146.369	4.478	3%	3.531	2%	947	1%
	2015	166.504	170.575	172.791	-4.072	-2%	-6.287	-4%	2.216	1%
	2016	187.278	180.019	181.806	7.259	4%	5.472	3%	1.787	1%

Fuel		Liquid fuels									Solid fuels									Natural gas								
Member States	Year	Cumulated Monthly Eurostat data	Annual Eurostat data	GHG inventory data	Difference Monthly Eurostat - Annual Eurostat data		Difference Monthly Eurostat - GHG inventory data		Differences GHG inventory - annual Eurostat data		Cumulated Monthly Eurostat data	Annual Eurostat data	GHG inventory data	Difference Monthly Eurostat - Annual Eurostat data		Difference Monthly Eurostat - GHG inventory data		Differences GHG inventory - annual Eurostat data		Cumulated Monthly Eurostat data	Annual Eurostat data	GHG inventory data	Difference Monthly Eurostat - Annual Eurostat data		Difference Monthly Eurostat - GHG inventory data		Differences GHG inventory - annual Eurostat data	
		kt			kt	%	kt	%	kt	%	kt			kt	%	kt	%	kt	%	TJ NCV			TJ NCV	%	TJ NCV	%	kt	%
Romania	2013	8.095	7.987	8.139	108	1%	-44	-1%	152	2%	25.754	26.669	26.663	-915	-3%	-909	-3%	-6	0%	430.846	410.052	410.052	20.794	5%	20.794	5%	0	0%
	2014	8.227	8.035	8.325	192	2%	-98	-1%	290	4%	25.840	26.979	26.929	-1.139	-4%	-1.089	-4%	-50	0%	404.690	392.065	392.065	12.625	3%	12.625	3%	0	0%
	2015	8.617	8.730	8.859	-113	-1%	-242	-3%	129	1%	27.359	27.897	27.855	-538	-2%	-496	-2%	-42	0%	389.761	373.685	373.685	16.076	4%	16.076	4%	0	0%
	2016	8.888	8.777	8.956	111	1%	-68	-1%	179	2%	24.592	24.887	24.004	-295	-1%	588	2%	-883	-4%	399.032	377.157	377.157	21.875	6%	21.875	6%	0	0%
Slovenia	2013	2.163	2.332	2.330	-169	-7%	-167	-7%	-2	0%	4.045	4.487	4.487	-442	-10%	-442	-10%	0	0%	28.954	28.967	28.967	-13	0%	-13	0%	0	0%
	2014	2.188	2.275	2.273	-87	-4%	-85	-4%	-2	0%	3.163	3.617	3.617	-454	-13%	-454	-13%	0	0%	26.241	26.210	26.210	31	0%	31	0%	0	0%
	2015	2.161	2.228	2.228	-67	-3%	-67	-3%	0	0%	3.209	3.628	3.614	-419	-12%	-405	-11%	-14	0%	27.788	27.814	27.814	-25	0%	-26	0%	1	0%
	2016	2.286	2.345	2.345	-59	-3%	-59	-3%	0	0%	3.373	3.786	3.786	-413	-11%	-413	-11%	0	0%	30.053	29.519	29.519	534	2%	533	2%	0	0%
Slovakia	2013	3.042	3.105	3.134	-63	-2%	-92	-3%	29	1%	6.657	6.902	6.902	-245	-4%	-245	-4%	0	0%	203.223	201.571	201.628	1.651	1%	1.595	1%	57	0%
	2014	2.919	2.851	3.027	68	2%	-108	-4%	176	6%	6.522	6.524	6.305	-2	0%	217	3%	-219	-3%	133.253	157.940	157.818	-24.687	-16%	-24.565	-16%	-122	0%
	2015	3.278	3.126	3.156	152	5%	122	4%	30	1%	6.350	6.413	6.413	-63	-1%	-63	-1%	0	0%	161.427	162.425	162.154	-998	-1%	-728	0%	-270	0%
	2016	3.515	3.331	3.363	184	6%	152	5%	32	1%	6.124	6.260	6.260	-136	-2%	-136	-2%	0	0%	165.481	163.090	165.065	2.391	1%	416	0%	1.975	1%
Finland	2013	7.196	7.187	7.647	9	0%	-451	-6%	460	6%	11.337	11.507	11.719	-170	-1%	-382	-3%	212	2%	118.526	119.611	119.622	-1.085	-1%	-1.096	-1%	11	0%
	2014	8.196	8.598	8.117	-402	-5%	79	1%	-481	-6%	10.755	10.849	11.059	-94	-1%	-304	-3%	210	2%	104.086	105.223	105.243	-1.137	-1%	-1.157	-1%	20	0%
	2015	7.838	7.713	7.274	125	2%	564	8%	-439	-6%	9.712	10.002	10.154	-290	-3%	-442	-4%	152	2%	92.214	93.628	93.647	-1.414	-2%	-1.433	-2%	19	0%
	2016	8.461	8.431	8.240	30	0%	221	3%	-191	-2%	11.016	10.729	10.667	287	3%	349	3%	-62	-1%	86.014	86.195	85.029	-181	0%	985	1%	-1.166	-1%
Sweden	2013	11.558	11.404	12.178	154	1%	-620	-5%	774	7%	3.252	3.669	3.669	-417	-11%	-417	-11%	0	0%	40.068	39.996	39.996	72	0%	72	0%	0	0%
	2014	11.471	11.325	11.746	146	1%	-275	-2%	421	4%	3.398	3.372	3.308	26	1%	90	3%	-64	-2%	33.245	33.245	33.396	0	0%	-150	0%	150	0%
	2015	9.558	9.642	9.894	-84	-1%	-336	-3%	252	3%	3.259	3.324	2.686	-65	-2%	573	21%	-638	-19%	30.279	30.296	30.450	-17	0%	-171	-1%	154	1%
	2016	10.770	11.403	10.470	-633	-6%	300	3%	-933	-8%	3.526	3.245	2.989	281	9%	537	18%	-256	-8%	34.222	34.258	34.434	-36	0%	-212	-1%	176	1%
United Kingdom	2013	65.925	55.371	56.009	10.554	19%	9.916	18%	638	1%	61.027	60.778	61.270	249	0%	-244	0%	492	1%	2.747.482	2.750.037	2.756.655	-2.555	0%	-9.173	0%	6.618	0%
	2014	55.470	56.339	56.882	-869	-2%	-1.412	-2%	543	1%	48.781	48.722	49.559	59	0%	-778	-2%	837	2%	2.511.757	2.503.045	2.500.355	8.712	0%	11.402	0%	-2.690	0%
	2015	57.373	57.559	57.597	-186	0%	-224	0%	38	0%	39.005	38.629	38.066	376	1%	939	2%	-563	-1%	2.567.078	2.565.661	2.574.227	1.418	0%	-7.149	0%	8.566	0%
	2016	58.414	58.529	58.872	-115	0%	-458	-1%	343	1%	18.998	18.987	18.614	11	0%	384	2%	-373	-2%	2.899.030	2.905.862	2.904.152	-6.832	0%	-5.122	0%	-1.710	0%
EU 28	2013	515.278	500.968	509.118	14.310	3%	6.160	1%	8.150	2%	750.492	763.437	766.917	-12.945	-2%	-16.425	-2%	3.480	0%	16.163.517	16.188.567	16.334.109	-25.051	0%	-170.593	-1%	145.542	1%
	2014	497.930	499.693	503.107	-1.763	0%	-5.177	-1%	3.414	1%	718.286	729.245	732.747	-10.959	-2%	-14.461	-2%	3.502	0%	14.441.507	14.386.962	14.379.572	54.545	0%	61.935	0%	-7.390	0%
	2015	502.582	505.389	505.834	-2.807	-1%	-3.252	-1%	445	0%	695.512	714.785	719.449	-19.273	-3%	-23.937	-3%	4.664	1%	15.059.121	14.972.405	15.033.466	86.716	1%	25.655	0%	61.061	0%
	2016	508.677	508.645	512.496	32	0%	-3.819	-1%	3.851	1%	647.926	660.339	659.758	-12.413	-2%	-11.832	-2%	-581	0%	16.113.062	16.016.313	16.113.036	96.749	1%	26	0%	96.723	1%

Note: Green: difference ≤ ± 2%, Yellow: difference ± >2 and ≤ 5%, Red: difference > ± 5%

Differences for comparison of monthly and annual Eurostat data and annual Eurostat data and GHG inventory data: annual Eurostat data = 100 %, a positive value indicates that monthly data is higher than annual data; a negative value indicates that monthly data is lower than annual data. For comparison of monthly Eurostat data and GHG inventory data: GHG inventory data = 100%, a positive value indicates that monthly Eurostat data is higher than GHG inventory data; a negative value indicates that monthly Eurostat data is lower than GHG inventory data.

Source: Own compilation based on extraction from Eurostat database in the specific year, GHG inventory submission CRF table 1.A(b)