

Matching of power plants by fuel

For the EEA EU ETS dataviewer

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1 Introduction

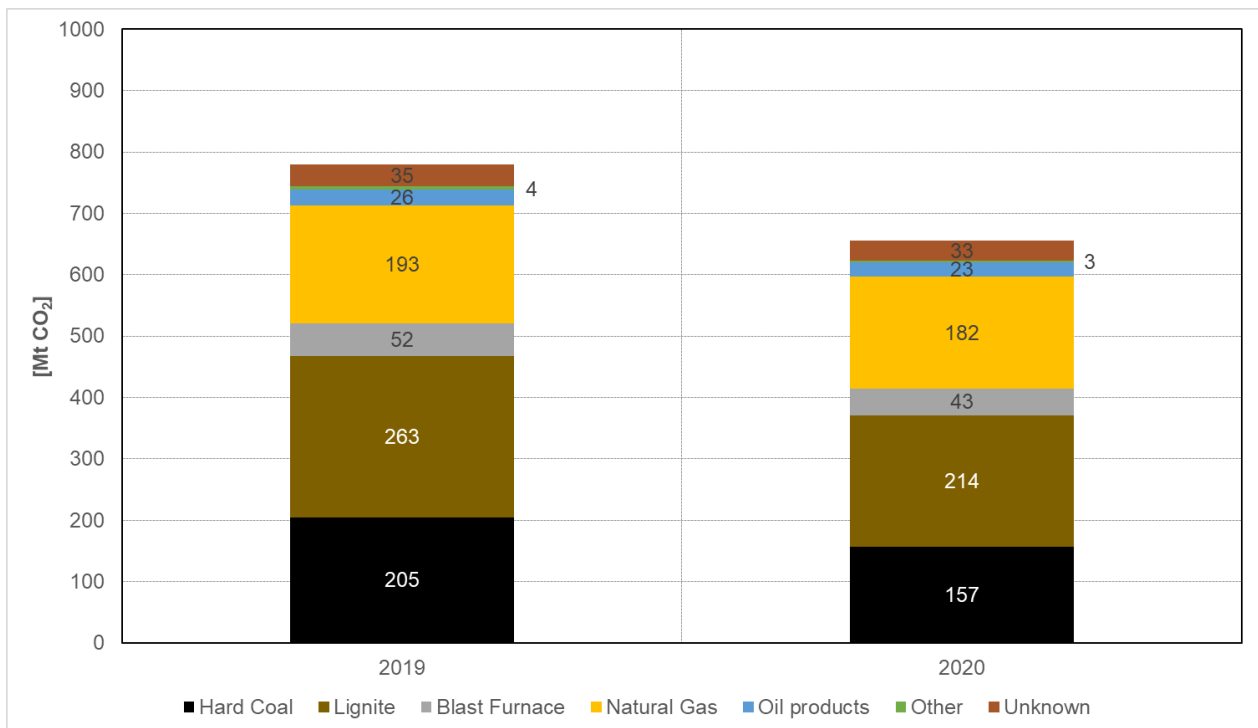
In the EU ETS emissions from power plants are reported under activity code 20 together with other combustion installations. A fuel is not reported in the EUTL. The aim of this project is to develop a dataset identifying power plants in Europe and their main fuel type. Since ETS data is one of the first official data sources to become available in the year, this methodology will help provide an early indication of changes in fuel composition in the European power sector. This, in turn, can help to shed a light on the reasons behind changes in emissions reported under the EU ETS.

This document provides information on the abovementioned methodology, for documentation and transparency purposes. The matching was consulted with member states and feedback was received from Denmark, Malta, Lithuania, and Slovenia. The feedback was very valuable and helped to improve the matching in these countries. The list of plants and their fuels is not static and further updates to the dataset might take place in light of new data provided by Member States or found in the public domain. Chapter 2 shows the emission trends for electricity generation resulting from the current status of the matching exercise. The following chapter 3 documents the methodological approach. In chapter 4, a check is made with other emission data sources to verify the quality of the method described.

2 Emission trends of the power sector

With ETS data as of 1st July 2021, total emissions of power plants sum up to 650 Mt CO₂ in 2020. In total this represent 45% of the emissions of all stationary installations in 2020. Figure 2-1 shows the emissions of the power plants matched to fuels for the whole EU-ETS for 2019 and 2020. Total abatement from 2019 to 2020 from power plants was 123 Mt CO₂. The majority of the abatement came from coal fired power plants. Both lignite and hard coal fired power plants contributed an abatement of about 50 Mt CO₂ from 2019 to 2020.

Figure 2-1 Emissions of power plants, matched to main fuel types



Source: Own matching of EUTL data.

Sorted by absolute emissions the following fuels contribute to emissions from power plants reporting in the EU ETS:

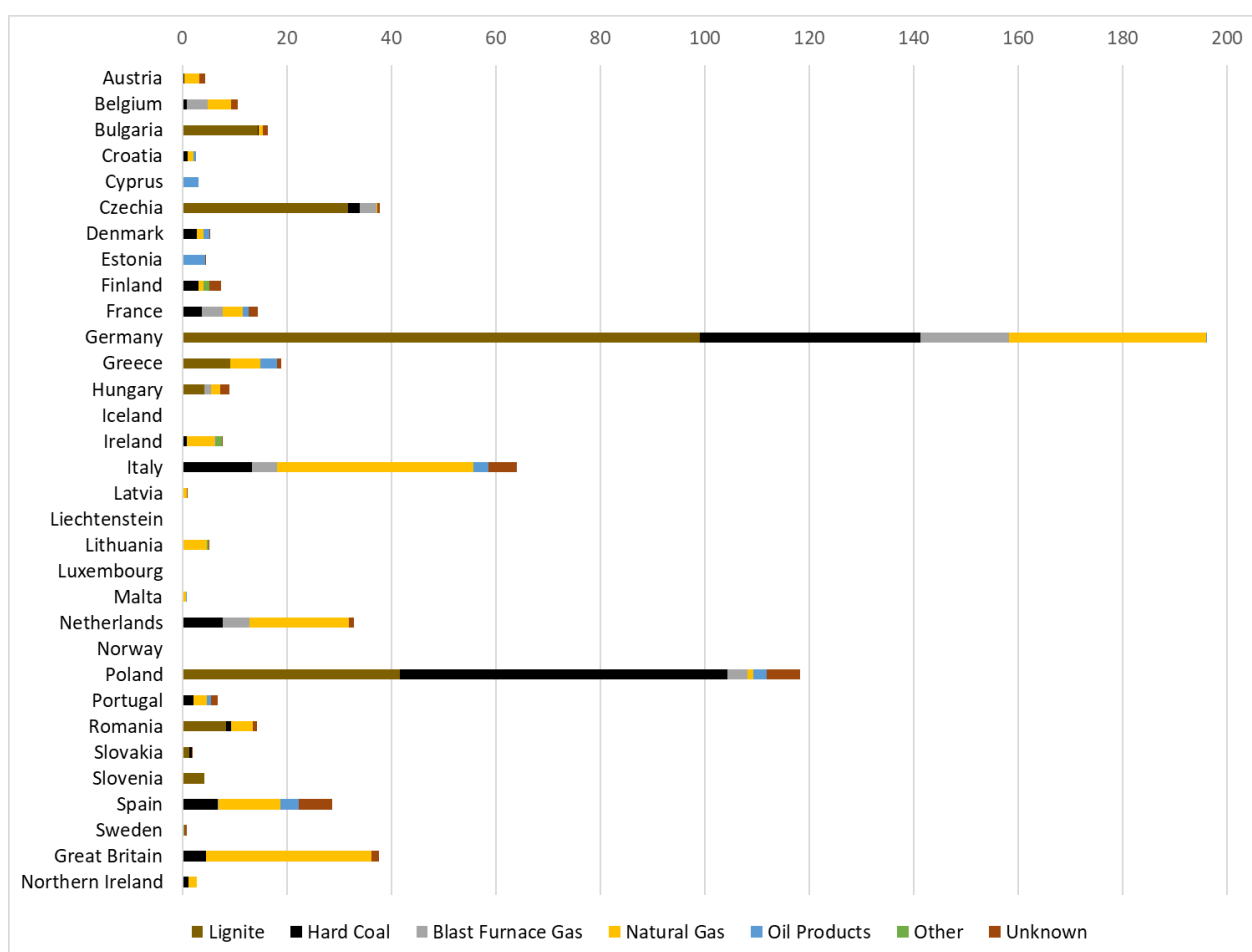
- Emissions from lignite power plants in 2020 were equal to 214 Mt of CO₂ (33% of all power plant emissions),
- Emissions from natural gas fired power plants in 2020 were 182 Mt of CO₂ (28% of all power plant emissions),
- Emissions from hard coal fired power plants in 2020 were 157 Mt of CO₂ (24% of all power plant emissions),
- Emissions from blast furnace power plants equal to 43 Mt of CO₂ in 2020 (7% of all power plant emissions).
- Emissions from the mapped oil power plants were equal to 20 Mt of CO₂ in 2020 (3% of all power plant emissions).
- Other power plants with special fuels (such as peat or waste) only make up 3 Mt CO₂ in 2020.
- Installations with emissions of 33 Mt CO₂ in 2020 have been identified as power plants (5% of all power plant emissions), but no fuel has been attributed (yet).

2.1 Emissions by fuel in ETS countries

Figure 2.2 shows the absolute ETS-Emissions of the identified power plants by fuel for each country in 2020:

- The countries with large amounts of emissions from lignite power plants are Germany, Poland and Czechia;
- Substantial emissions from hard coal power plants are reported for Germany and Poland;
- Large amounts of emissions from natural gas fired power plants are reported in Italy, Germany, UK and the Netherlands.

Figure 2.2 Emissions of power plants by fuel in Mt CO₂ in 2020



Note: including power plants with unknown fuel information.

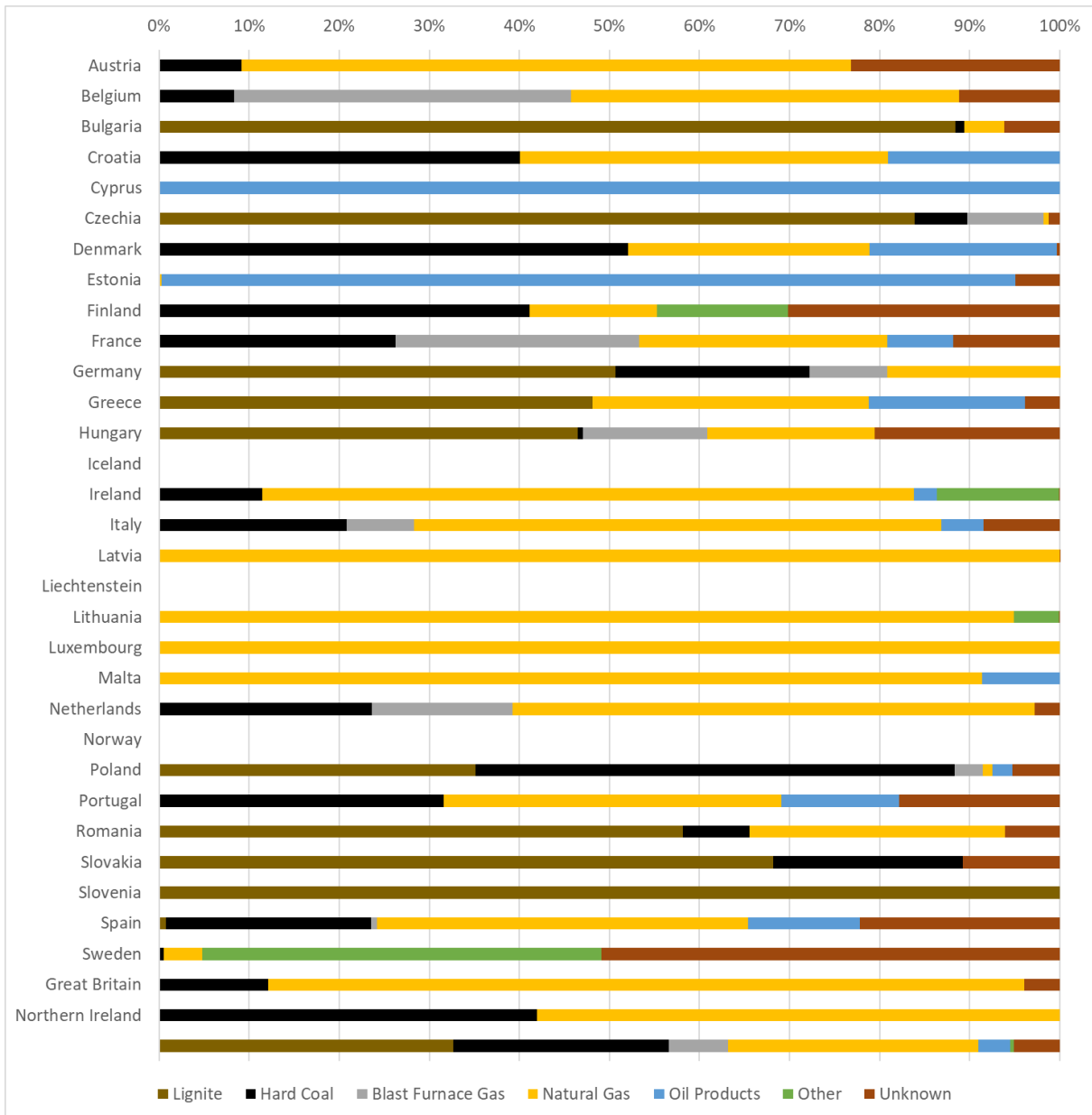
Iceland, Liechtenstein and Norway had no identified power plants in 2020 reporting emissions and thus are 0

Source: Own matching of EUTL data, based on ETS data as of 1st July 2021.

The relative fuel distribution for each EU-ETS country can be seen in Figure 2.3. It shows that lignite is responsible for large shares (>45%) of emissions in Bulgaria, Czech Republic, Germany, Greece, Hungary, Romania, Slovakia and Slovenia and in considerable amounts for Poland. In other countries hard coal or natural gas is the dominant fuel. Cyprus and Estonia have a high share of oil products in their electricity mix ⁽¹⁾. Please note, not that due to Brexit power plants from Great Britain will leave the EU ETS at the end of year 2020. Power plants from Northern Ireland will continue to be participate in the EU ETS. These power plants emitted 2.8 Mt CO₂ in 2020 (about 58% from natural gas and 42% from hard coal).

⁽¹⁾ It is interesting that natural gas replaced oil products as the main fuel in Malta in recent years.

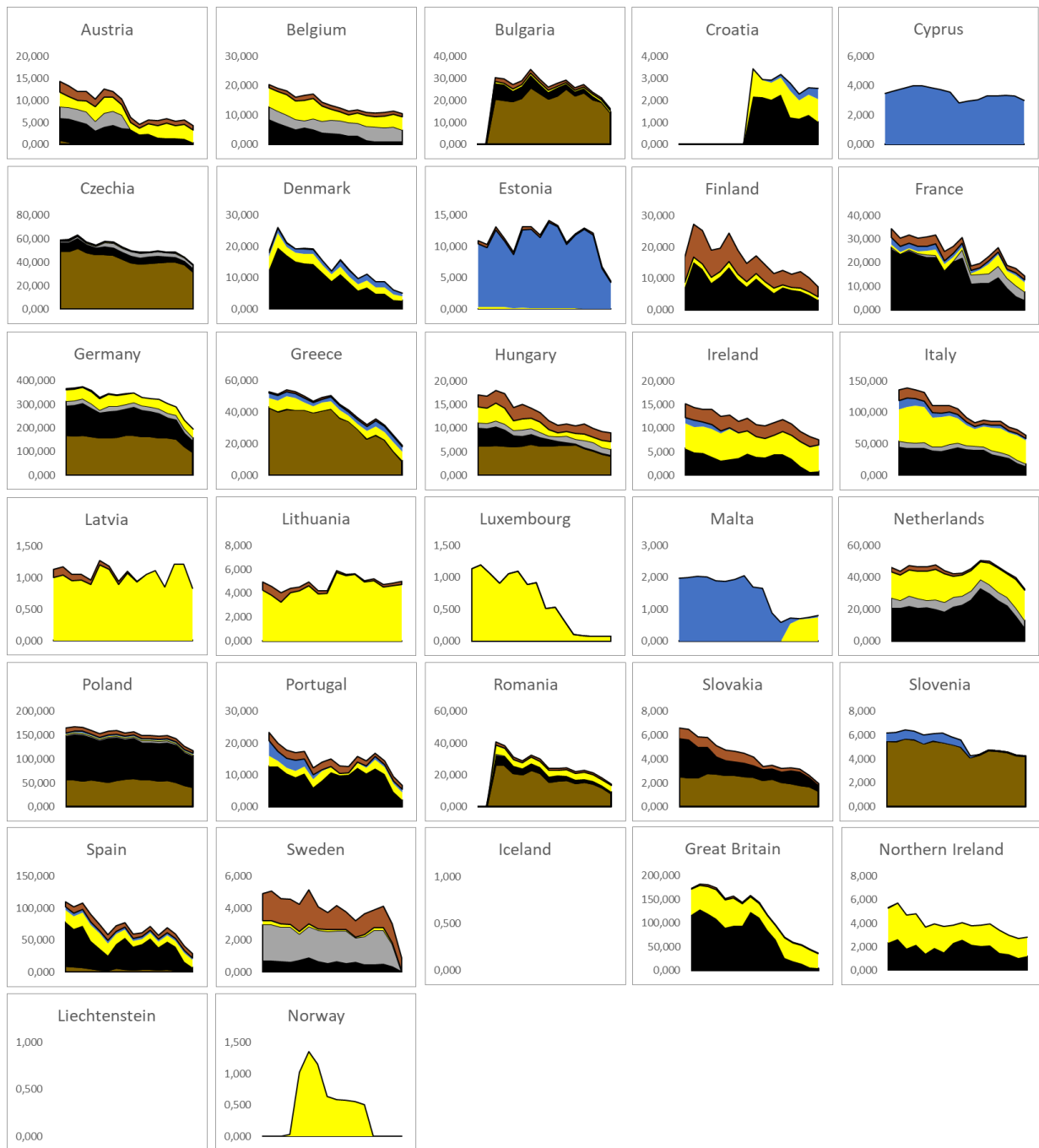
Figure 2.3 Fuel distribution by country in 2020



Note: Iceland, Liechtenstein and Norway had no identified power plants in 2020 reporting emissions and thus are 0
Source: Own matching of EUTL data, based on ETS data as of 1st July 2021

The following Figure 2-4 shows an overview how emissions by power plants have developed in the last 15 years from 2005 to 2020.

Figure 2-4 ETS emissions of power plants by fuels and by country from 2005-2020 [Mt CO₂]



Lignite
 Hard Coal
 Blast furnace gas
 Natural gas
 Oil products
 Other+Unknown

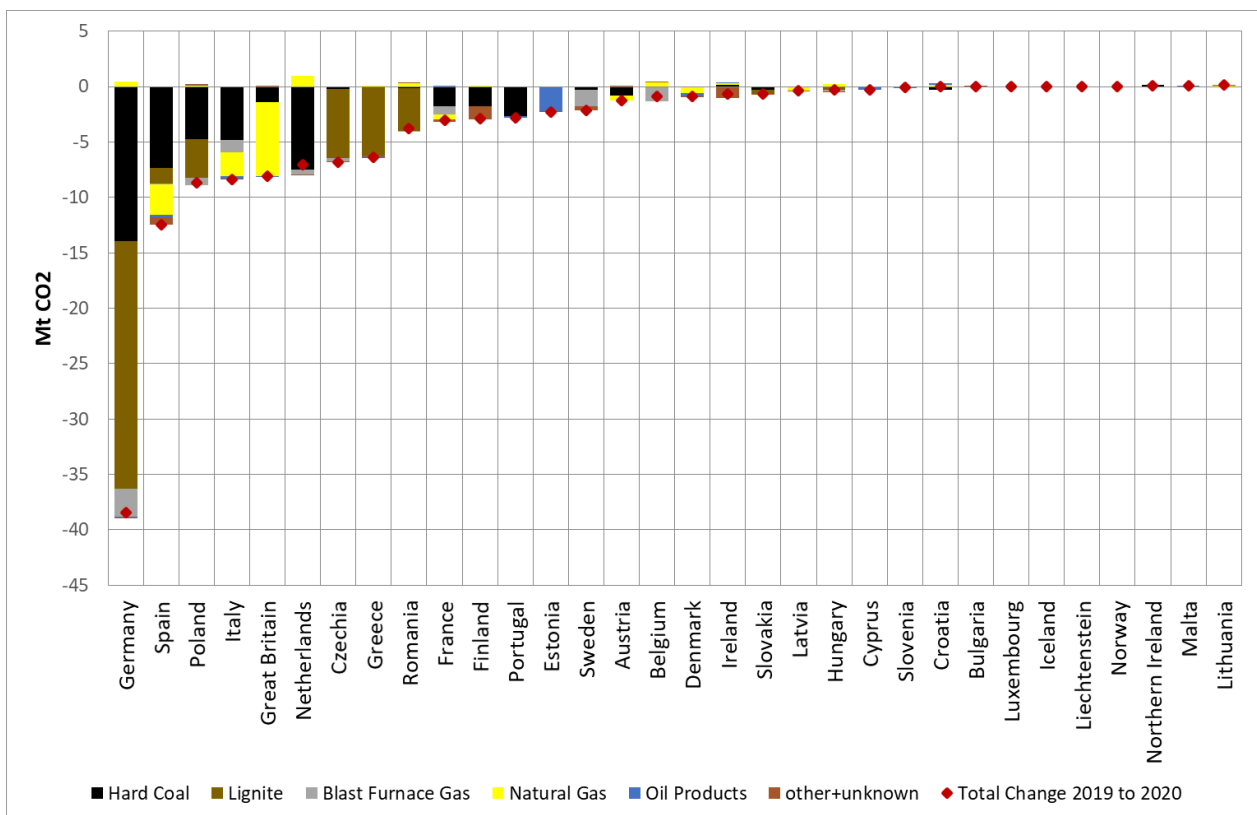
Source: Own matching of EUTL data with preliminary data as of 1st July 2021

2.2 Analysis of latest changes

In 2020 ETS emissions declined by 11,5% compared to the previous year ⁽²⁾. Total abatement was 176 Mt. CO₂. Power plants are responsible for the majority of this emission reduction (142 Mt. CO₂). Figure 2.5 analyses which countries contributed most to emission abatement in 2018 and 2019. The biggest contributions came from Germany (39 Mt of CO₂), Spain (12 Mt t CO₂) and Poland (9 Mt CO₂)

Furthermore, this graphic shows how high the respective proportions of the fuels are. This makes it possible to see which fuels are responsible for the reduction or whether they may have substituted other fossil fuels. Overall emissions from hard coal and lignite were reduced, at the same time this wasn't offset by higher emissions from natural gas.

Figure 2.5 Emission change of power plants 2019 to 2020 by fuel and country



Source: Own matching of EUTL data, based on ETS data of 1st July 2021

⁽²⁾ If the emission trend is calculated only for those installations which already reported VE 2020 and have also reported VE in 2019

3 Methodological Approach

As already outlined, emissions from power plants covered by the EU ETS are reported under activity code 20 together with other combustion installations. A fuel is not reported in the EUTL. Therefore, a matching exercise was carried out based on available public data. The following fuel categories were defined for this purpose:

- Lignite
- Hard coal
- Natural gas
- Blast furnace gas
- Oil products (fuel oil, oil shale, refinery gas)
- Other (peat, municipal and industrial waste, biomass)
- Unknown fuel

Different publicly available data sources have been used. This included the use of different search engines, company homepages, websites such as <http://globalenergyobservatory.org> and the Europe Beyond coal database. The following five steps were taken to carry out this matching:

- First power plants from activity code 20 have been identified, mainly from the company or the installation name.
- Then hard coal and lignite power plants have been identified ⁽³⁾.
- Power plants using blast furnace gas were identified due to their proximity to blast furnaces (reporting their emissions under activity code 24) and by the name of the power plants.
- The remaining power plants were sorted according to emissions. Plants with highest emissions were matched first. Most plants in this category were natural gas fired.
- Power plants using oil products were matched manually, taking country characteristics into consideration (e.g. the oil shale plants in Estonia and fuel oil plants on islands such as Crete, Cyprus and Malta).

A list of power plants which have been identified and sorted by Country and has been accompanied to this paper as an Excel file. Attached to each power plant one main fuel is listed.

3.1 Assumptions for the identification of power plants

Power plants were identified by first screening all plants with activity code 20 by plant and company name. The attribution was carried out over several years at Öko-Institut. This identification is continuously reviewed and updated.

3.2 Assumptions for the matching of power plants to fuel categories

Treatment of different fuel types in one installation

It is known, that in many power plants, several types of fuel are used, at least for the starting process. To facilitate the analysis, only the main fuel has been attributed to an installation, assuming that it is the relevant type of fuel which mainly decides upon the way of operation of a plant.

Installations with more than one block that use different fuels also have to be attributed to one main fuel. As cheaper fuels generally reach higher full load hours, cheaper fuels are generally chosen as the main fuel. The following assumptions have been made to reflect this approach:

⁽³⁾ based on the Europe Beyond coal database, where a complete matching of all hard coal and lignite power plants to EUTL installations was published <https://beyond-coal.eu/database/>

- For installations using hard coal and natural gas it is assumed that hard coal is the main fuel
- For installations using hard coal and fuel oil it is assumed that hard coal is the main fuel
- For installations using natural gas and fuel oil it is assumed that natural gas is the main fuel
- For installations using blast furnace gas and natural gas it is assumed that blast furnace gas is the main fuel.
- For installations using hard coal and blast furnace gas it is assumed that hard coal is the main fuel ⁽⁴⁾.

Treatment of biomass use

As emissions from biomass are generally counted as being CO₂-neutral in the EU ETS, it is not useful to have a biomass category, because no emissions would be recorded there. Therefore, these plants are included in the category “other”. Power plants using peat and biomass are also categorised in the category “other” ⁽⁵⁾. When the secondary fuel of biomass plant is known and is e.g. natural gas the plant is categorised in the category “natural gas”.

Treatment of changes over time

The attribution is based on the actual fuel. It can happen that the main fuel of an installation changes over time. In case of modernisation of plants, the change of the main fuel type can happen without that the EU ETS identification changes (e.g. if a power plant got a new boiler to use natural gas instead of coal). For past years the old fuel is not reflected in the attribution of fuels to power plants ⁽⁶⁾.

3.3 Result of the identification and mapping exercise

A matching of EU ETS emissions and fuels makes it possible to show the EU-ETS emissions of the power sector for each country and simultaneously allows an overview on how the importance of each fuel has developed in a country, as can be seen in Figure 2-4.

The following table shows that in total 2264 installations have been identified in the EU ETS to be power plants, which have reported emissions in at least one year since 2005. The fuel of 1440 power plants have been identified. Of this there are 124 lignite power plants, 284 hard coal power plants and 27 power plants using blast furnace gas. There are 57 power plants using oil products. The majority of the plants uses natural gas (858 plants). About 824 plants have not been matched to a fuel yet.

⁽⁴⁾ This is relevant for the installation ES 201 (Aboño 1). The plant uses blast furnace gas, but emissions seem to be dominated by hard coal. Therefore, the plant was classified with the main fuel “hard coal”.

⁽⁵⁾ This includes for example the installations FI 215 (Toppilan Power Plant) and IE 6 (Edenderry Power Plant)

⁽⁶⁾ This information might be considered for future analysis, especially when these switches become more relevant. Currently only few cases are known, in which such fuel switches took place without changes in installation IDs like DE1170 HKW Klingenberg in Berlin which switched from lignite to natural gas in 2017.

Table 3.1 Number of power plants by fuel

Country Code	Lignite	Hard Coal	Blast Furnace Gas	Natural Gas	Oil Products	Other	Unknown	Total
Austria	3	6	1	8	0	0	30	48
Belgium	0	6	2	9	0	0	21	38
Bulgaria	8	4	0	2	0	0	19	33
Croatia	0	2	0	4	1	0	0	7
Cyprus	0	0	0	0	3	0	0	3
Czechia	42	13	2	3	0	0	16	76
Denmark	0	10	0	152	70	0	15	247
Estonia	0	0	0	2	5	0	4	11
Finland	0	13	0	2	1	7	61	84
France	0	17	1	9	11	0	42	80
Germany	29	77	11	457	8	0	6	588
Greece	8	0	0	9	5	0	13	35
Hungary	1	5	1	4	0	0	42	53
Iceland	0	0	0	0	0	0	0	0
Ireland	0	1	0	14	1	3	5	24
Italy	0	13	2	51	10	0	102	178
Latvia	0	0	0	2	0	0	3	5
Liechtenstein	0	0	0	0	0	0	0	0
Lithuania	0	0	0	9	0	0	14	23
Luxembourg	0	0	0	5	0	0	0	5
Malta	0	0	0	2	2	0	0	4
Netherlands	0	9	2	19	0	0	42	72
Norway	0	0	0	2	0	0	0	2
Poland	8	56	2	2	1	0	109	178
Portugal	0	2	0	3	3	0	27	35
Romania	16	4	1	9	1	0	31	62
Slovakia	3	2	0	0	0	0	6	11
Slovenia	2	1	0	0	1	0	0	4
Spain	4	23	1	31	5	0	77	141
Sweden	0	1	1	1	1	5	51	60
Great Britain	0	18	0	45	2	1	87	153
Northern Ireland	0	1	0	2	0	0	1	4
Total	124	284	27	858	131	16	824	2.264

Note : All power plants including closed ones

Source: ETC/CME matching, based on data of 1st July, 2021

Table 3.2 shows the progress of the matching exercise by country in 2020. Overall, 95% of the emissions of all power plants have been matched to fuels. The extent to which the matching is completed differs by country. While for some countries all power plants have been matched to fuels, the rate is lowest in Finland, Sweden and Hungary. The installations in these countries with unknown fuels only have small amounts of verified emissions (of which < 0.4 Mt CO₂ in 2019 is the largest installation, and many of installations with < 0.01 Mt CO₂). It is assumed that most of the unknown fuels are in fact natural gas plants.

Table 3.2 Distribution of power plants by fuel in 2020

Country Code	Lignite	Hard Coal	Blast Furnace Gas	Natural Gas	Oil Products	Other	Unknown	VE 2020 [Mt CO ₂]
Austria		9%		68%			23%	4.3
Belgium		8%	37%	43%			11%	10.6
Bulgaria	88%	1%		4%			6%	16.4
Croatia		40%		41%	19%			2.6
Cyprus					100%			3.0
Czechia	84%	6%	8%	1%			1%	37.8
Denmark		52%		27%	21%		0%	5.2
Estonia				0%	95%		5%	4.5
Finland		41%		14%		15%	30%	7.4
France		26%	27%	27%	7%		12%	14.4
Germany	51%	22%	9%	19%	0%		0%	195.7
Greece	48%			31%	17%		4%	18.9
Hungary	47%	1%	14%	19%			21%	9.0
Iceland								0.0
Ireland		11%		72%	3%	14%	0%	7.5
Italy		21%	8%	59%	5%		9%	64.1
Latvia				100%			0%	0.8
Liechtenstein								0.0
Lithuania				95%		5%	0%	5.0
Luxembourg				100%				0.1
Malta				91%	9%			0.8
Netherlands		24%	16%	58%			3%	32.8
Norway								0.0
Poland	35%	53%	3%	1%	2%		5%	118.2
Portugal		32%		37%	13%		18%	6.7
Romania	58%	7%		28%			6%	14.3
Slovakia	68%	21%					11%	2.0
Slovenia	100%							4.2
Spain	1%	23%	1%	41%	12%		22%	28.6
Sweden		1%		4%		44%	51%	0.9
United Kingdom		12%		84%		0%	4%	37.6
Northern Ireland		42%		58%				2.8
Total	33%	24%	7%	28%	4%	0%	5%	655.9

Source: ETC/CME matching, based on data of 1st July 2021

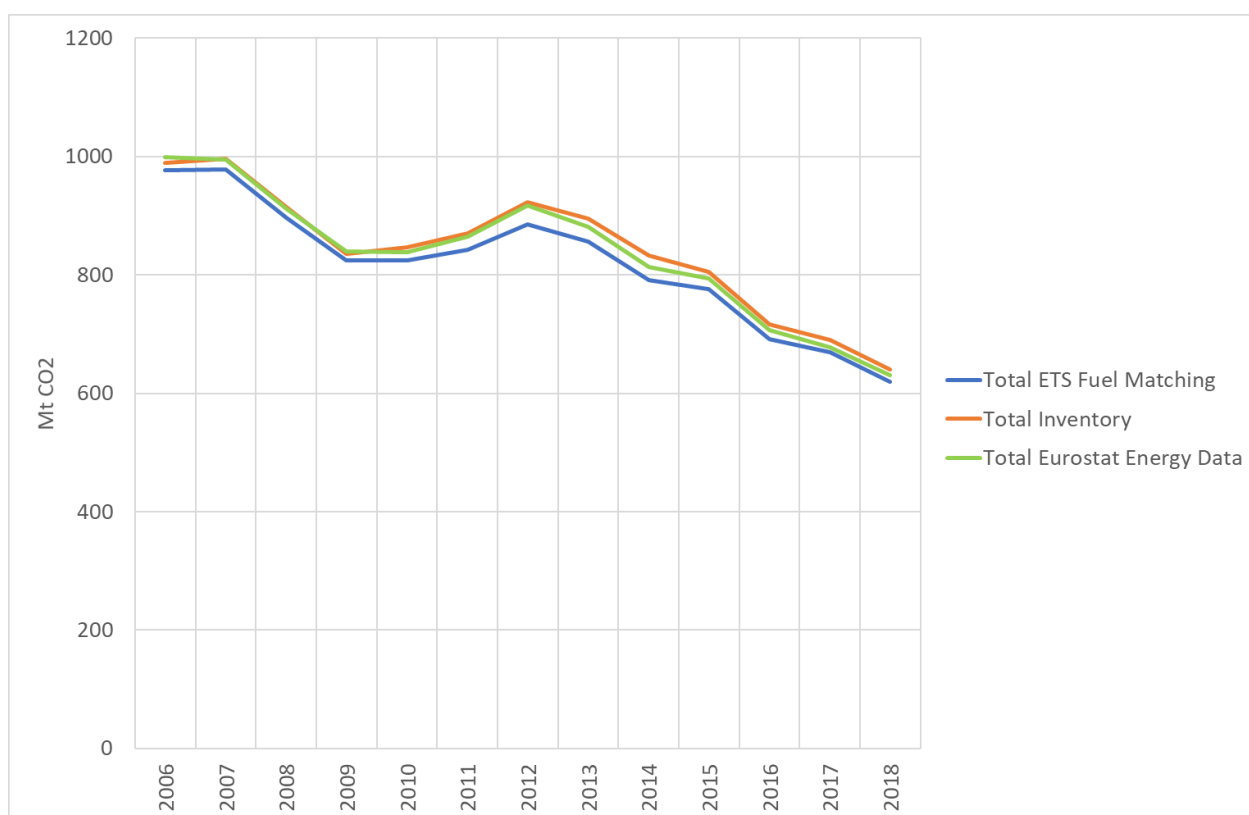
4 Comparison with data from Eurostat and GHG-Inventories

In order to verify the identification of power plants and their annual emissions, the results were compared with information from greenhouse gas inventories (1.A.1.a) and data from Eurostat (Main activity producer electricity only”, “Main activity producer CHP” and “Main activity producer heat only“).

For the inventory data, inventory information from emission source category 1.A.1.a on solid fuels was summed up for all countries. For Eurostat Energy data reported fuels were multiplied with the emission factors for hard coal (94.6 t CO₂/TJ) and lignite (112 t CO₂/TJ).

As can be seen in Figure 4.1 the results of the ETS fuel matching for solid fuels is comparable to the greenhouse gas inventory and Eurostat data.

Figure 4.1 Comparison of the different data bases for solid fuels*



Note: *Solid fuels: Hard coal and lignite
Source: Own matching of EUTL data, EEA (2020), Eurostat (2020)

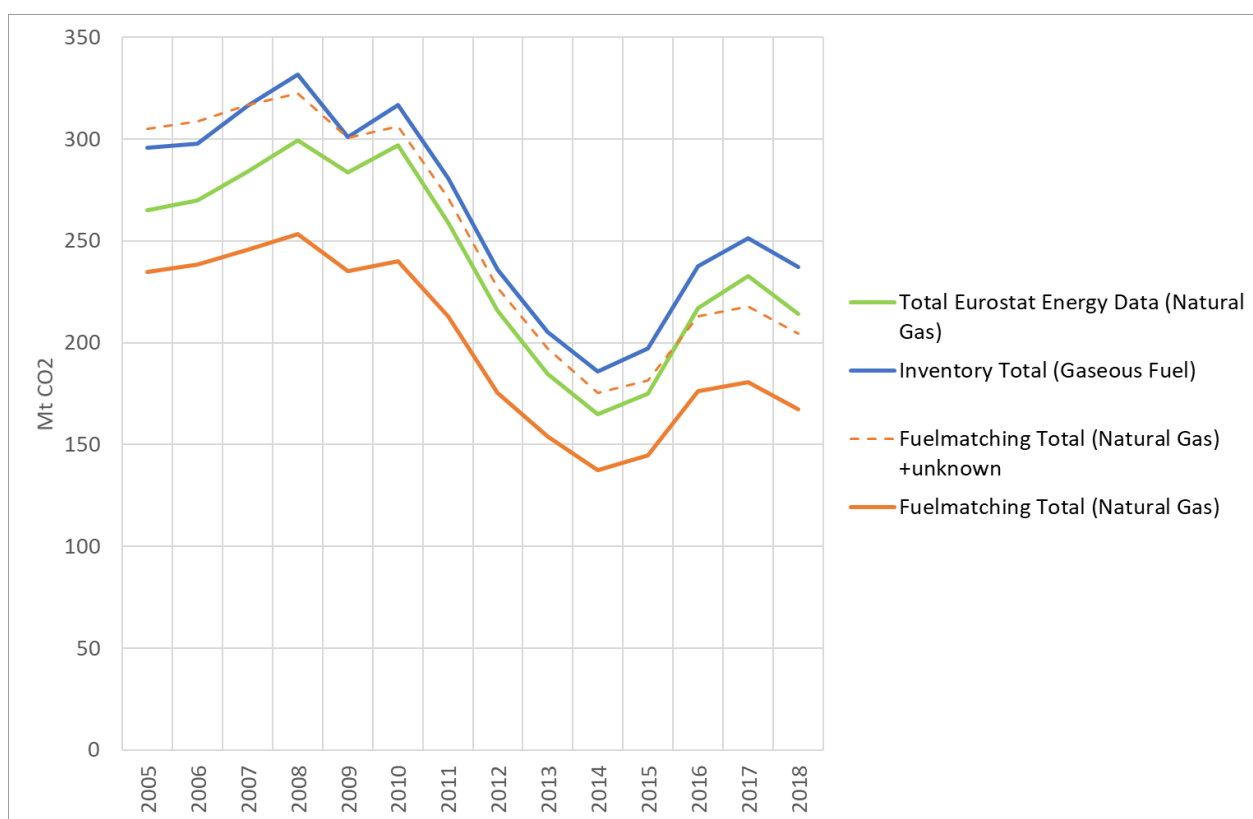
For the comparison of natural gas data, the same approach as for the solid fuels were chosen. The emissions factor for the Eurostat Energy data is 56.1 t CO₂/TJ.

Emissions from the identified natural gas power plants, are following the general trend of the inventory and Eurostat data but are at a considerably lower level. Different to solid fuels, there are considerably more power plants fuelled with natural gas which are not subject to the EU ETS, either because they are below the threshold of 20 MW or because they are used in excluded applications (e.g. in hospitals).

The difference between emissions from the identified natural gas power plants and inventory information increases from 2014 onwards. A reason for this might be the incentive to build smaller power or cogeneration plants either to avoid the inclusion under the EU ETS or to follow a strategy of decentralisation. In many countries a respective trend was observed with increasing Effort Sharing emissions in the energy sector. This trend is explained in ETC/CME reports on Effort Sharing emissions by sectors in (see ETC/ACM (2018) and ETC/CME (2021)). A second reason might be that new industrial natural gas plants are reporting in other activity codes than 20.

As most of unmatched power plants are estimated to be fuelled by natural gas, an additional line is included in Figure 4.2 which adds up these unmatched power plants to those which have been identified as natural gas power plants. Obviously, the sum of these emissions is very close to inventory information on gaseous fuels until 2013 with an increasing difference from 2013 onwards.

Figure 4.2 Comparison of the different data bases for Natural Gas/Gaseous Fuels



Source: Own matching of EUTL data, EEA (2020), Eurostat (2020)

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