

European Residual Mixes

Results of the calculation of Residual Mixes for the calendar year 2023

Version 1.0, 2024-05-30

1 Introduction

The purpose of a Guarantee of Origin (GO) system is to enable consumers to decide how the electricity they purchase is generated by selecting a supplier and a power product. GOs (RED II, Directive 2018/2001, Art. 19) provide a way to reliably track the origin of energy from production to consumption within the context of the international and complex power markets.

GOs are used (cancelled) by electricity suppliers¹, who must disclose the origin and environmental attributes of sold electricity (IEM Directive (EU) 2019/944, Annex 1 (5)). This process is called electricity disclosure.

A country's residual mix represents the shares of electricity generation attributes available for disclosure, after the use of explicit tracking systems, such as GO, have been accounted for.

Residual mix is a pre-requisite for reliable GOs

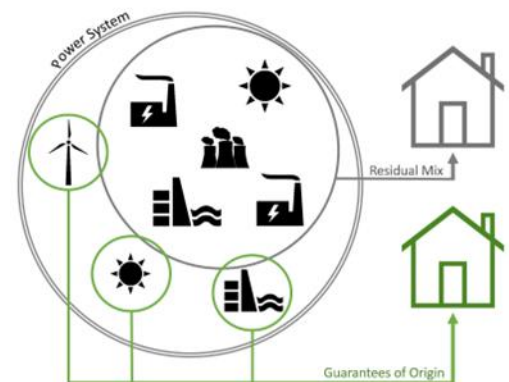
As long as not all consumption is tracked using GOs, a *residual mix* is needed to make the GO a reliable tracking instrument. The Residual Mix is the energy source mix excluding tracked energy generation attributes from the generation mix. A residual mix is a logical consequence of implementing energy attribute tracking as it ensures that the attributes represented by GOs are not double disclosed to other consumers through an implicit mix. In other words, without a residual mix, renewable electricity sold with GOs would be double counted because the same electricity would be disclosed to consumers buying "regular" electricity. The use of uncorrected generation statistics for purposes of disclosure should thus be avoided.

International harmonization of the residual mix calculation is needed

Due to the international nature of both the electricity markets and tracking systems, the volume of available generation attributes in the domestic residual mix differs from the volume of untracked consumption². Thus, the calculation of residual mixes needs to be centrally coordinated and a common pool for balancing generation attributes must be used. This is achieved via the European Attribute Mix (EAM), which replaces the deficit of energy origin caused by exported GOs (and/or imported electricity). EAM acts as an "equalising reservoir" for generation attributes for national residual mixes. After the attribute balancing via the EAM the volume of available generation attributes in the residual mix is equal to the untracked consumption in every country. This is a precondition for the GO to be a credible tracking instrument in the context of international trading.

Residual mix is not needed in countries with "full consumption disclosure"

Residual mix is needed when consumption is only partially explicitly tracked. In so-called "full consumption disclosure domains" residual mix is not needed because all consumption is covered by cancelled GOs. Austria and Switzerland have a full disclosure system in place and hence the residual mix is zero. Also the Netherlands have full disclosure



¹ In some cases and countries it might be done also directly by end-consumers (or service providers on their behalf) for own electricity use.

² Untracked consumption = Electricity consumption for which the energy source is not explicitly disclosed through tracking instruments such as Guarantees of Origin.

regulation but, due to implementation details and calculation rules, residual mixes can still be calculated and are included in the results.

AIB residual mixes are calculated with the issuance-based method

The AIB European Residual mixes are calculated using the so-called issuance-based method. For more information refer to methodology material on: <https://www.aib-net.org/facts/european-residual-mix>. AIB calculated national residual mixes are official when adopted by national disclosure authorities. A number of disclosure authorities calculate national residual mixes themselves. Most of those are calculated with the same issuing-based method utilizing EAM from this report, but some countries use different methodologies.

2 Description of the Document

The main results of this document are the **European Attribute Mix (EAM)** and **the residual mixes for all 34 countries** included in the calculation³. A wide variety of additional information and graphs is presented as supporting material. The EAM (Table 1) is the mix of energy sources and the corresponding CO₂ and radioactive waste that is collected from countries which have surpluses of energy attributes. The EAM is then used to fill up the national residual mixes in case of a deficit of disclosure attributes. The national surpluses and deficits to/from EAM are shown in Table 3 and Figure 3 and 4.

The **national residual mixes** for 34 European countries are shown in Figure 1 and 2 as well as Table 2. Note that the official residual mixes for each country are published by the respective national authorities. Also note that for countries without recorded explicit tracking, untracked consumption equals the total electricity consumption, and thus the residual mix is applicable for the disclosure of the entire electricity consumption.⁴

Energy sources in the residual mixes are divided in three main categories: renewable, nuclear and fossil, of which renewable and fossil are further divided into subcategories (Table 8). Selected subcategories are based on relevance in terms of volume and perceived consumer importance. The used categorization is also identical to all residual mix calculations since the 2013.

Figure 5 shows the direct greenhouse gas emissions as **direct CO₂ emissions per kWh** of produced electricity. Figure 6 shows the content of **highly active radioactive waste as mgRW/kWh**. Both environmental indicators are calculated for the European Attribute Mix (EAM), the production mix (PM), the residual mix (RM) and the total supplier mix (TSM) of European countries.

The total supplier mixes (TSMs) are presented in Table 4, Figure 7 and 8. The total supplier mix represents the total consumption mix of a country, i.e. it is the sum of attributes of 1) cancelled GOs as well as 2) the final residual mix. Thus, both explicitly tracked and available remaining electricity attributes are included in the TSM, which equals in physical volume with the country's total electricity consumption. For understanding, it might help to consider that without the international transferability of GOs and electricity, the TSM would equal the production mix of the country.

The production mixes of the countries are shown in Table 5. The evolution of attributes, on the European scale: how much renewables are in the Production mix, how much of those are left in the residual mix and lastly how much renewables are carried on to EAM is shown in the Figure 11 and Table 6.

The rest of the results are different kinds of comparisons between different mixes and different years, between the production and residual mixes as well as production and total supplier mixes of different countries. Finally Table 7 and Figure 16 show the difference between final residual mixes of 2021, 2022 and 2023.

Note: Any use of the data presented in this document should include a reference to AIB.

Note: The calculated country and energy source/technology emission factors forming the base for the National Residual Mix calculations may not be sold, distributed or processed as part of a derivative tool.

Disclaimer on data quality:

Because of the 12 months lifetime of GOs, the residual mixes were calculated based on all recorded GO transactions during the assumed time period (1.4.2023 – 31.3.2024) for disclosure of 2023 consumption, irrespective of the underlying production year of these GOs. This ensures that over the years all GO transactions are considered in the calculation.

Volumes which have been explicitly tracked without the use of transparent tracking instruments, e.g. by so-called contract based tracking, self-declarations etc., cannot be taken into account at all, if they are not reported by the competent authority.

³ Austria, Bosnia & Herzegovina, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Great Britain, Greece, Hungary, Iceland, Ireland (All-Island), Italy, Latvia, Lithuania, Luxembourg, Malta, Montenegro, Netherlands, Norway, Poland, Portugal, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland

⁴ Calculation of the Residual Mix obviously can only take the volumes of explicit tracking systems into account if the respective data is public or known by the authority and respectively being made available to the one who conducts the calculation. This means that explicit tracking systems, for which no statistical data is available to the competent authority and/or AIB, cannot be reflected in the residual mix and are therefore likely to lead to double counting.

Partners



3 Data sources and references

The main data source for the calculation is information collected from the national competent authorities through an information request specifically for the purpose of residual mix calculation. Most notably this includes information on any possible national tracking systems (certificate or non-certificate based) and electricity generation.

Where not reported by the competent authority, the generation data is based on Eurostat (electricity generation by fuel as well as supply, transformation and consumption of electricity). Power import/export data from/to countries outside of the calculation area are collected from ENTSO-E Transparency platform.

EECS GO statistics are collected centrally from the AIB statistics. The volume of ex-domain cancellations⁵ (including the target domains of these cancellations) is collected as part of data collection from competent authorities.

The base data for the direct CO₂-emissions is based on nationally reported information (where available) or the Ecoinvent database. The data for the radioactive waste has been compiled based on BDEW (2014), DECC (2014), the Platts World Database and IAEA PRIS. These indicators reflect the differences in waste rates produced by the types of nuclear power reactors used in the respective countries per kWh of electricity. Due to a lack of detailed data per reactor, the waste rates have been based on estimates of typical data for five major types of reactors used in Europe. However, where available, factors as reported by national authorities are used instead.

References

National Issuing Bodies and Disclosure Competent Bodies: Updates through the annual data collection

Generation data: Eurostat: [Product - Products Datasets - Eurostat \(europa.eu\)](#) and

[Product - Products Datasets - Eurostat \(europa.eu\)](#)

EECS Guarantee of Origin Statistics: Association of Issuing Bodies, [Statistics | AIB \(aib-net.org\)](#)

Sources for emission factors and radioactive waste:

Ecoinvent (2023): Ecoinvent database and bilaterally provided data.

BDEW (2014). Leitfaden "Stromkennzeichnung", Berlin, Oktober 2014

DECC (2014), Fuel Mix Disclosure Data Table, 2014

IAEA PRIS. The IAEA Power Reactor Information System (PRIS), 2015, <https://www.iaea.org/pris/>

Platts: The Platts World Database, 2014

⁵ A cancellation of a certificate for disclosure of electricity consumption in another country. Under AIB rules, ex-domain cancellations are not allowed between two countries connected to the AIB Hub.

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The need for a methodology to determine a cross-border central residual mix emerges when a country exports more GOs than physical energy, thus creating a deficit of generation attributes. In principle the deficit/surplus of attributes is always the net effect of import/export of electricity and export/import of GOs respectively (for details, please refer to the residual mix [methodology document](#)). Such a deficit of attributes in the disclosure of energy supplied without being backed by GO cancellation needs to be complemented with an excess of attributes from countries that are net importers of GOs.

The European Attribute Mix (Table 1) contains all surplus generation attributes from countries with an excess of attributes. It is used to fill the gap in the residual mix in countries with a deficit of attributes in their residual mix. The exchange with the European Attribute Mix is graphically presented in **Error! Reference source not found.**

Table 1: European Attribute Mix (EAM) 2023: Energy source distribution and environmental indicators

	RE total	RE unspecified	RE biomass	RE solar	RE geothermal	RE wind	RE hydro	Nuclear	FO total	FO unspecified	FO hard coal	FO lignite	FO oil	FO gas	CO2 (gCO2/kWh)	Rad waste (mg/kWh)
EAM	2,41 %	0,00 %	0,00 %	2,41 %	0,00 %	0,00 %	0,00 %	11,20 %	86,39 %	5,13 %	46,40 %	0,13 %	2,01 %	32,72 %	599,23	0,39

EAM = European Attribute Mix is used for balancing surpluses and deficits in national residual mixes caused by international trading of electricity and guarantees of origin.

The introduction of a GO system provides a way to supply energy with specified attributes, but also impacts the remaining attributes of energy supplied without a GO. According to preamble 13 of 2018/2001/EC: 'residual energy mix' means the total annual energy mix for a Member State, excluding the share covered by cancelled guarantees of origin. If uncorrected generation statistics were used for the purpose of disclosure of untracked electricity consumption, then the renewable energy origin represented by GOs would be double counted. Table 2 and Figure 2 and 3 present the residual mixes of 2023 for 34 European countries as calculated by AIB. Note that the official residual mixes for each country are in principle published by the respective national authorities. The residual mix is not applicable for Austria and Switzerland in which all power consumption is tracked with GOs.

Table 2: Residual Mixes 2023

Country code	RE total	RE unspecified	RE biomass	RE solar	RE geothermal	RE wind	RE hydro	Nuclear	FO total	FO unspecified	FO hard coal	FO lignite	FO oil	FO gas	Untracked %	CO2 (gCO2/kWh)	Rad waste (mg/kWh)
AT	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
BA	43,76 %	0,00 %	0,00 %	0,61 %	0,00 %	1,65 %	41,50 %	0,00 %	56,24 %	0,00 %	56,24 %	0,00 %	0,00 %	0,00 %	99,50 %	719,55	0,00
BE	0,00 %	0,00 %	0,00 %	0,00 %	0,00 %	0,00 %	0,00 %	61,93 %	38,07 %	1,55 %	2,86 %	0,00 %	0,01 %	33,65 %	66,79 %	167,49	1,67
BG	10,91 %	0,00 %	4,29 %	4,62 %	0,00 %	1,18 %	0,83 %	45,04 %	44,04 %	0,62 %	33,84 %	0,02 %	0,74 %	8,83 %	97,25 %	418,70	1,84
CH	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
CY	17,47 %	0,00 %	0,73 %	12,39 %	0,00 %	4,35 %	0,00 %	0,41 %	82,12 %	0,19 %	1,69 %	0,00 %	79,05 %	1,19 %	99,91 %	595,03	0,01
CZ	6,40 %	0,00 %	3,52 %	1,62 %	0,00 %	0,30 %	0,96 %	42,82 %	50,78 %	0,16 %	44,69 %	0,00 %	0,14 %	5,79 %	89,81 %	658,58	0,56
DE	0,00 %	0,00 %	0,00 %	0,00 %	0,00 %	0,00 %	0,00 %	3,21 %	96,79 %	7,12 %	55,76 %	0,00 %	1,68 %	32,23 %	13,35 %	719,90	0,09
DK	4,06 %	0,00 %	0,00 %	4,05 %	0,00 %	0,00 %	0,01 %	8,67 %	87,27 %	7,07 %	47,25 %	0,10 %	1,89 %	30,95 %	56,68 %	582,75	0,30
EE	6,16 %	0,00 %	0,07 %	5,77 %	0,00 %	0,16 %	0,16 %	6,71 %	87,13 %	37,69 %	27,82 %	0,13 %	1,20 %	20,29 %	79,71 %	711,66	0,23
ES	3,40 %	0,00 %	0,00 %	1,89 %	0,00 %	1,51 %	0,00 %	37,51 %	59,09 %	0,62 %	8,17 %	0,02 %	2,26 %	48,03 %	60,25 %	282,45	1,05
FI	5,61 %	0,00 %	2,76 %	2,85 %	0,00 %	0,00 %	0,00 %	13,85 %	80,55 %	6,18 %	45,77 %	0,10 %	2,04 %	26,45 %	35,93 %	565,31	0,45
FR	4,66 %	0,00 %	0,90 %	2,23 %	0,00 %	1,52 %	0,00 %	86,53 %	8,81 %	0,03 %	0,22 %	0,00 %	0,46 %	8,11 %	82,57 %	40,74	2,34
GB	13,25 %	0,00 %	1,83 %	0,68 %	0,00 %	10,74 %	0,00 %	18,57 %	68,18 %	3,20 %	14,36 %	0,04 %	1,47 %	49,12 %	80,82 %	388,40	1,34
GR	13,71 %	0,00 %	0,28 %	5,55 %	0,09 %	3,68 %	4,10 %	1,43 %	84,87 %	1,64 %	10,06 %	13,14 %	11,36 %	48,66 %	63,63 %	491,78	0,05

Country code	RE total	RE unspecified	RE biomass	RE solar	RE geothermal	RE wind	RE hydro	Nuclear	FO total	FO unspecified	FO hard coal	FO lignite	FO oil	FO gas	Untracked %	CO ₂ (gCO ₂ /kWh)	Rad waste (mg/kWh)
HR	9,34 %	0,00 %	1,07 %	3,26 %	0,10 %	0,52 %	4,39 %	6,29 %	84,38 %	2,88 %	34,79 %	0,07 %	1,49 %	45,14 %	77,32 %	550,15	0,22
HU	10,39 %	0,00 %	1,10 %	8,27 %	0,00 %	0,23 %	0,79 %	43,22 %	46,39 %	2,06 %	17,84 %	0,03 %	0,59 %	25,87 %	90,38 %	322,63	1,52
IE	17,49 %	0,00 %	0,00 %	1,58 %	0,00 %	15,92 %	0,00 %	0,00 %	82,51 %	2,17 %	13,92 %	3,17 %	0,12 %	63,13 %	10,13 %	445,50	0,00
IS	3,03 %	0,00 %	0,00 %	2,40 %	0,63 %	0,00 %	0,00 %	11,12 %	85,85 %	5,10 %	46,09 %	0,13 %	2,01 %	32,51 %	93,13 %	595,53	0,38
IT	7,28 %	0,00 %	0,63 %	6,21 %	0,00 %	0,43 %	0,00 %	4,40 %	88,32 %	3,57 %	22,72 %	0,05 %	3,76 %	58,22 %	86,13 %	500,57	0,15
LT	1,55 %	0,00 %	0,00 %	1,55 %	0,00 %	0,00 %	0,00 %	9,67 %	88,79 %	6,77 %	29,73 %	0,08 %	3,83 %	48,38 %	55,80 %	583,15	0,34
LU	46,64 %	0,00 %	0,00 %	24,71 %	0,00 %	7,85 %	14,08 %	4,08 %	49,28 %	18,48 %	16,90 %	0,05 %	0,73 %	13,12 %	5,62 %	357,90	0,14
LV	12,32 %	0,00 %	1,15 %	3,75 %	0,00 %	0,53 %	6,89 %	9,76 %	77,91 %	3,79 %	34,94 %	0,10 %	1,45 %	37,63 %	88,01 %	535,37	0,34
ME	25,17 %	0,00 %	0,00 %	1,48 %	0,00 %	8,82 %	14,86 %	3,32 %	71,51 %	1,52 %	13,78 %	45,90 %	0,60 %	9,72 %	99,96 %	747,73	0,11
MT	8,34 %	0,00 %	0,05 %	8,30 %	0,00 %	0,00 %	0,00 %	2,05 %	89,60 %	0,94 %	8,51 %	0,02 %	0,87 %	79,26 %	95,32 %	408,22	0,07
NL	38,17 %	0,00 %	4,44 %	33,63 %	0,00 %	0,00 %	0,11 %	0,30 %	61,53 %	0,25 %	26,10 %	0,00 %	3,63 %	31,55 %	12,19 %	379,89	0,01
NO	2,41 %	0,00 %	0,00 %	2,41 %	0,00 %	0,00 %	0,00 %	11,16 %	86,43 %	5,15 %	46,26 %	0,13 %	2,00 %	32,88 %	51,76 %	598,61	0,38
PL	14,58 %	0,00 %	2,00 %	6,51 %	0,00 %	5,58 %	0,50 %	0,43 %	84,99 %	1,05 %	70,35 %	0,00 %	0,07 %	13,51 %	86,17 %	788,24	0,01
PT	5,22 %	0,00 %	2,90 %	1,51 %	0,00 %	0,00 %	0,82 %	6,98 %	87,80 %	12,47 %	29,33 %	0,08 %	1,25 %	44,67 %	77,28 %	539,01	0,24
RO	52,24 %	0,00 %	0,32 %	3,17 %	0,00 %	14,17 %	34,57 %	20,21 %	27,55 %	0,00 %	12,62 %	0,00 %	0,07 %	14,86 %	98,08 %	212,54	3,84
RS	12,73 %	0,00 %	0,09 %	0,52 %	0,00 %	0,07 %	12,06 %	1,82 %	85,45 %	0,84 %	7,62 %	66,31 %	0,34 %	10,34 %	89,02 %	966,96	0,06
SE	51,60 %	0,00 %	10,26 %	17,38 %	0,00 %	8,20 %	15,75 %	35,53 %	12,88 %	9,63 %	0,63 %	0,00 %	1,06 %	1,57 %	12,39 %	68,23	0,96
SI	6,32 %	0,00 %	0,85 %	5,42 %	0,00 %	0,05 %	0,00 %	18,59 %	75,08 %	3,97 %	43,74 %	0,10 %	1,56 %	25,71 %	63,46 %	486,76	0,60
SK	4,69 %	0,05 %	2,76 %	1,86 %	0,00 %	0,03 %	0,00 %	46,70 %	48,60 %	3,92 %	18,86 %	2,82 %	1,94 %	21,05 %	85,13 %	357,56	1,82

Untracked Consumption = Electricity consumption not explicitly disclosed through tracking instruments such as Guarantees of Origin.

Note: CO₂ and radioactive waste figures reported are destined for purposes of electricity disclosure only (rf. page 2).

Data Sources: Information reported by national Competent Bodies; Association of Issuing Bodies (AIB); Eurostat

5 Graphs with detailed calculations results

5.1 Residual mixes 2023

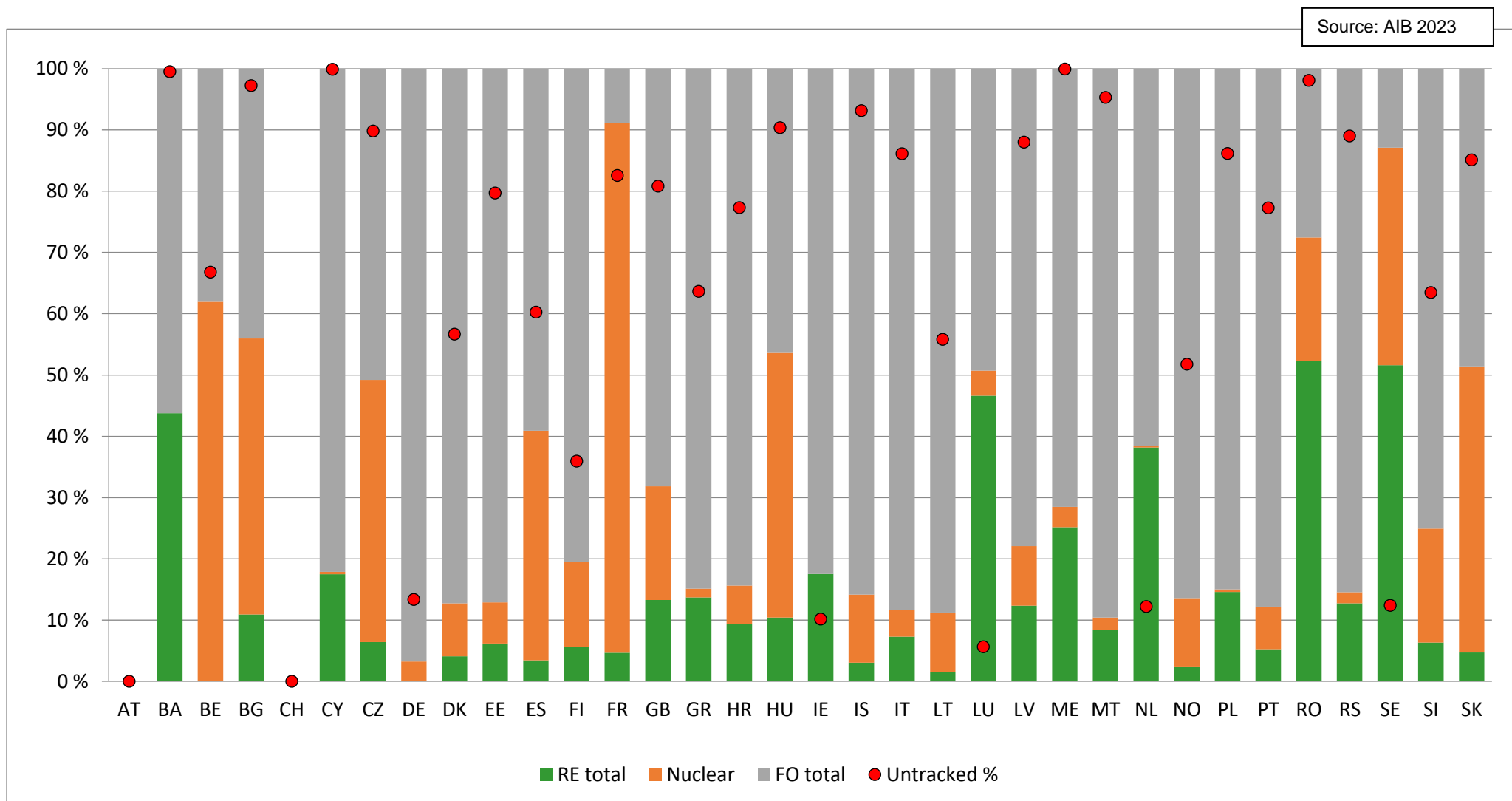


Figure 1 Residual Mixes 2023

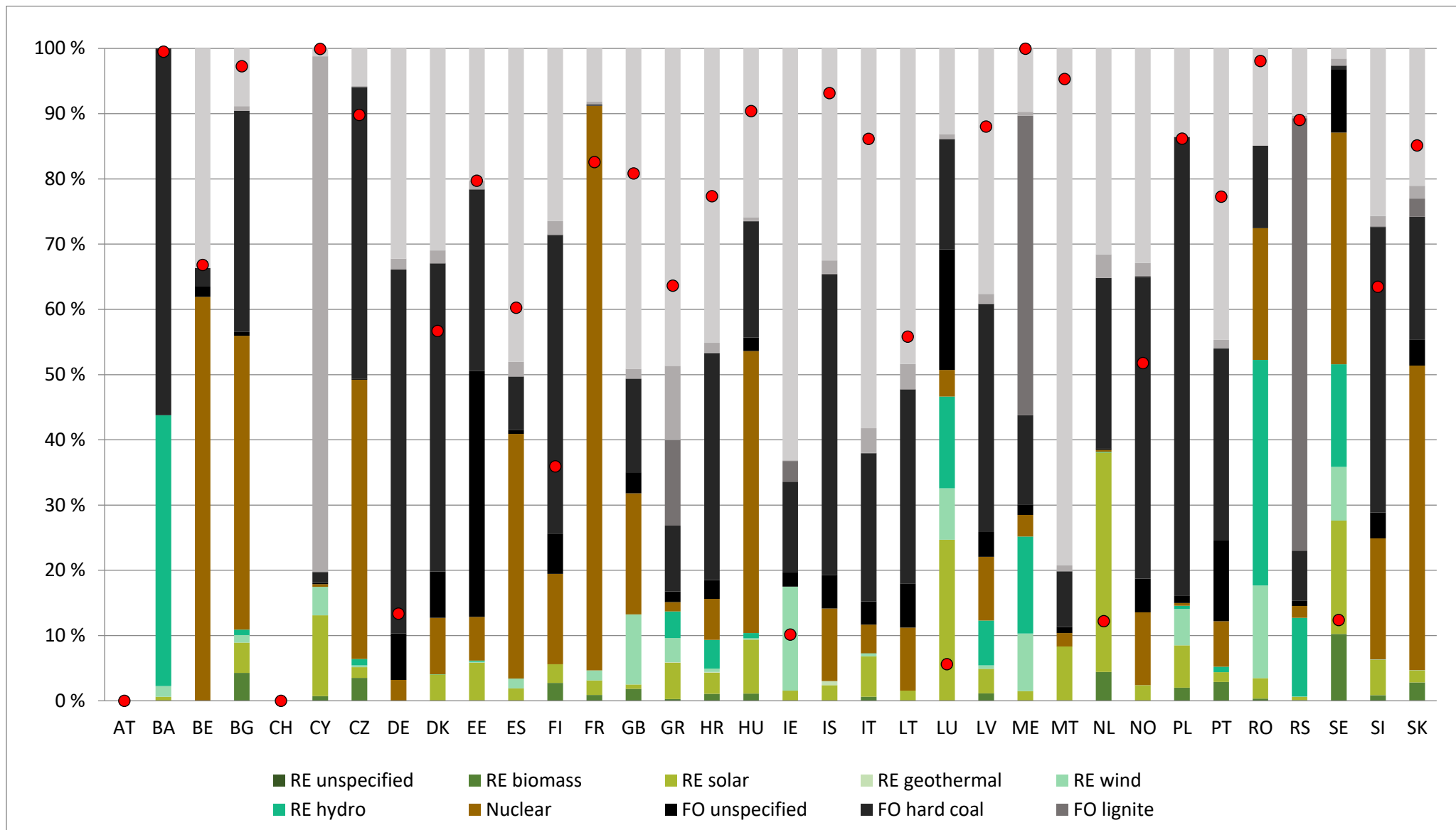


Figure 2 Residual Mixes 2023 (detailed fuel categories)

5.2 Attributes to/from the European Attribute Mix 2023

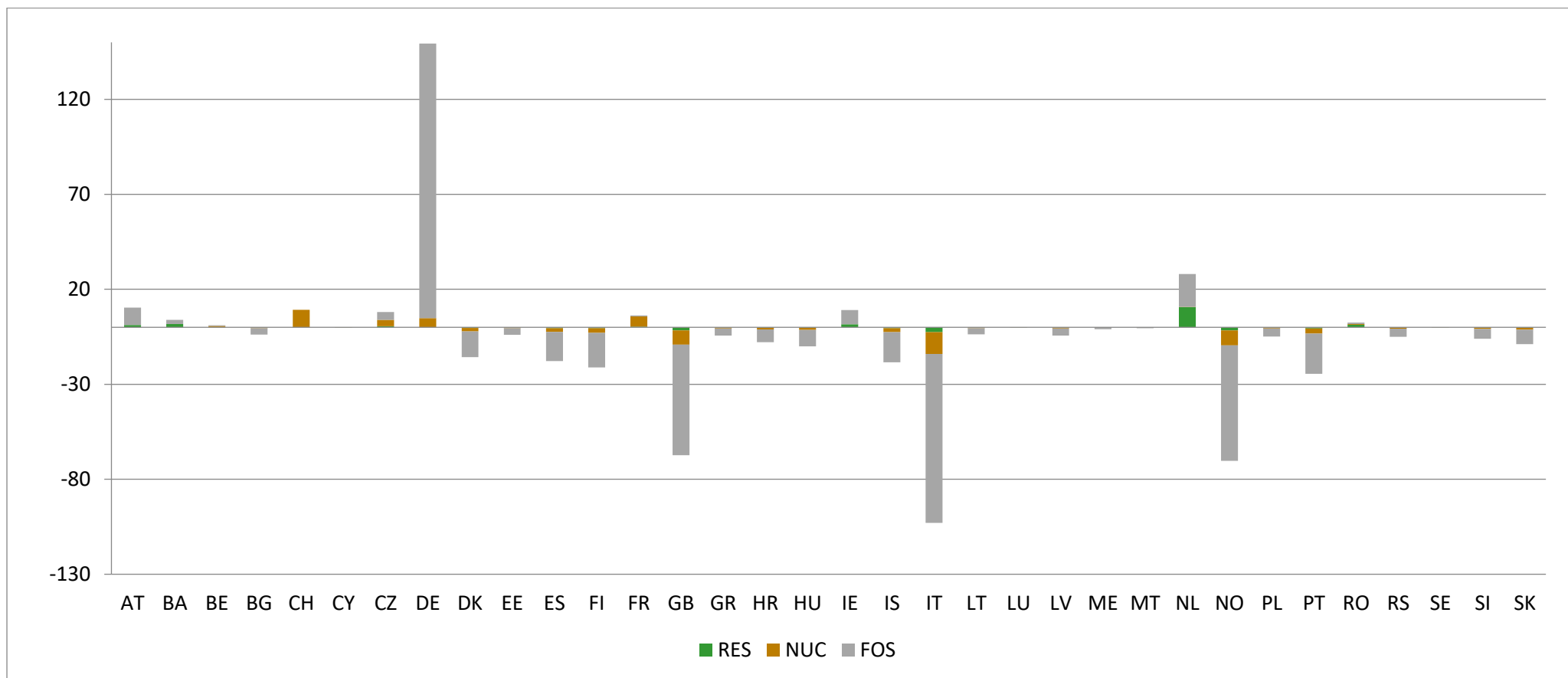


Figure 3: Attributes [TWh] to(positive)/from(negative) the European Attribute Mix 2023⁶

⁶ In this figure, the renewable energy added to the EAM does not equal the renewable energy taken out of it, which may seem peculiar. There are two reasons for it: 1) temporal attribute deficit caused by issuing volumes being higher than expiry and cancellation volumes, and 2) some countries have negative renewable energy balance in domestic residual mixes (caused by variation in disclosure periods and GO lifetimes overlapping two disclosure periods). This negativity is transferred into the EAM before considering the domestic residual mix attribute surpluses and deficits.

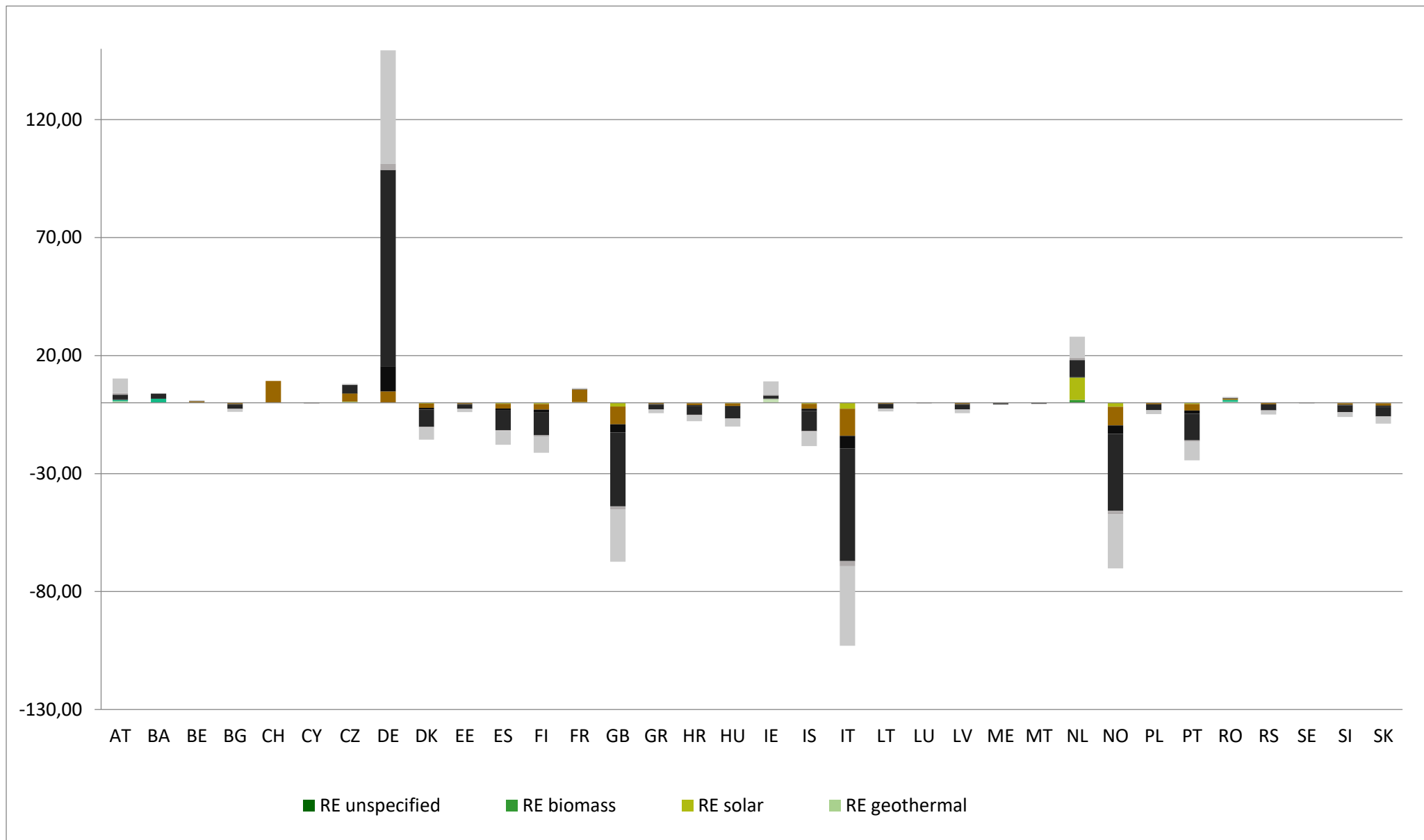


Figure 4 Attributes [TWh] to(positive)/from(negative) the European Attribute Mix 2023 (detailed fuel categories)

Table 3 Attributes [TWh] to/from the European Attribute Mix 2023⁷

	Volume (TWh)	RE unspecified	RE bio-mass	RE solar	RE geo-thermal	RE wind	RE hydro	Nuclear	FO un-specified	FO hard coal	FO lignite	FO oil	FO gas
AT	10,33	0,00	0,39	0,00	0,00	0,26	0,56	0,00	0,22	1,99	0,00	0,74	6,17
BA	3,90	0,00	0,00	0,02	0,00	0,06	1,62	0,00	0,00	2,19	0,00	0,00	0,00
BE	1,03	0,00	0,00	0,00	0,00	0,00	0,00	0,64	0,02	0,03	0,00	0,00	0,35
BG	-3,89	0,00	0,00	-0,09	0,00	0,00	0,00	-0,44	-0,20	-1,80	-0,01	-0,08	-1,27
CH	9,25	0,00	0,00	0,00	0,00	0,00	0,00	9,25	0,00	0,00	0,00	0,00	0,00
CY	-0,19	0,00	0,00	0,00	0,00	0,00	0,00	-0,02	-0,01	-0,09	0,00	0,00	-0,06
CZ	8,05	0,00	0,28	0,13	0,00	0,02	0,08	3,45	0,01	3,60	0,00	0,01	0,47
DE	149,32	0,00	0,00	0,00	0,00	0,00	0,00	4,79	10,63	83,27	0,00	2,51	48,12
DK	-15,65	0,00	0,00	-0,38	0,00	0,00	0,00	-1,75	-0,80	-7,26	-0,02	-0,31	-5,12
EE	-3,90	0,00	0,00	-0,09	0,00	0,00	0,00	-0,44	-0,20	-1,81	-0,01	-0,08	-1,28
ES	-17,78	0,00	0,00	-0,43	0,00	0,00	0,00	-1,99	-0,91	-8,25	-0,02	-0,36	-5,82
FI	-21,17	0,00	0,00	-0,51	0,00	0,00	0,00	-2,37	-1,09	-9,82	-0,03	-0,42	-6,93
FR	6,27	0,00	0,06	0,14	0,00	0,10	0,00	5,42	0,00	0,01	0,00	0,03	0,51
GB	-67,34	0,00	0,00	-1,63	0,00	0,00	0,00	-7,54	-3,46	-31,25	-0,09	-1,35	-22,04
GR	-4,38	0,00	0,00	-0,11	0,00	0,00	0,00	-0,49	-0,22	-2,03	-0,01	-0,09	-1,43
HR	-7,80	0,00	0,00	-0,19	0,00	0,00	0,00	-0,87	-0,40	-3,62	-0,01	-0,16	-2,55
HU	-10,06	0,00	0,00	-0,24	0,00	0,00	0,00	-1,13	-0,52	-4,67	-0,01	-0,20	-3,29
IE	9,02	0,00	0,00	0,14	0,00	1,44	0,00	0,00	0,20	1,26	0,29	0,01	5,69
IS	-18,37	0,00	0,00	-0,44	0,00	0,00	0,00	-2,06	-0,94	-8,52	-0,02	-0,37	-6,01

⁷ Same as in previous figure 3, the renewable energy added to the EAM does not equal the renewable energy taken out of it. For more information refer to footnote 4.

	Volume (TWh)	RE unspecified	RE bio-mass	RE solar	RE geo-thermal	RE wind	RE hydro	Nuclear	FO un-specified	FO hard coal	FO lignite	FO oil	FO gas
IT	-102,96	0,00	0,00	-2,49	0,00	0,00	0,00	-11,53	-5,28	-47,77	-0,14	-2,07	-33,69
LT	-3,67	0,00	0,00	-0,09	0,00	0,00	0,00	-0,41	-0,19	-1,70	0,00	-0,07	-1,20
LU	-0,10	0,00	0,00	0,00	0,00	0,00	0,00	-0,01	-0,01	-0,05	0,00	0,00	-0,03
LV	-4,38	0,00	0,00	-0,11	0,00	0,00	0,00	-0,49	-0,22	-2,03	-0,01	-0,09	-1,43
ME	-0,95	0,00	0,00	-0,02	0,00	0,00	0,00	-0,11	-0,05	-0,44	0,00	-0,02	-0,31
MT	-0,49	0,00	0,00	-0,01	0,00	0,00	0,00	-0,05	-0,03	-0,23	0,00	-0,01	-0,16
NL	28,00	0,00	1,24	9,42	0,00	0,00	0,03	0,08	0,07	7,31	0,00	1,02	8,84
NO	-70,24	0,00	0,00	-1,70	0,00	0,00	0,00	-7,86	-3,60	-32,59	-0,09	-1,41	-22,98
PL	-4,81	0,00	0,00	-0,12	0,00	0,00	0,00	-0,54	-0,25	-2,23	-0,01	-0,10	-1,57
PT	-24,44	0,00	0,00	-0,59	0,00	0,00	0,00	-2,74	-1,25	-11,34	-0,03	-0,49	-8,00
RO	2,44	0,00	0,01	0,08	0,00	0,35	0,84	0,49	0,00	0,31	0,00	0,00	0,36
RS	-4,95	0,00	0,00	-0,12	0,00	0,00	0,00	-0,55	-0,25	-2,30	-0,01	-0,10	-1,62
SE	-0,18	0,00	0,00	0,00	0,00	0,00	0,00	-0,02	-0,01	-0,08	0,00	0,00	-0,06
SI	-6,05	0,00	0,00	-0,15	0,00	0,00	0,00	-0,68	-0,31	-2,81	-0,01	-0,12	-1,98
SK	-8,86	0,00	0,00	-0,21	0,00	0,00	0,00	-0,99	-0,45	-4,11	-0,01	-0,18	-2,90

5.3 Environmental indicators 2023

According to directive 2019/944/EC, Annex 1(5), electricity suppliers shall (together with energy origin disclosure) disclose “information on the environmental impact, in at least terms of CO2 emissions and the radioactive waste resulting from the electricity produced by the overall energy mix of the supplier over the preceding year”. The calculation of the environmental indicators goes hand in hand with the calculation of energy source shares in the residual mix:

- The CO2 factor of the production mix is obtained by multiplying each energy in the production mix with the CO2 factor of that energy source for that country (nationally reported data or Ecoinvent database).
- The emissions of the Domestic Residual Mix are the emissions of the Production Mix adjusted with the Issued and Expired Attributes for each energy source respectfully,
- For surplus countries, CO2 factor in Final RM is equal to the CO2 factor in Domestic RM. For deficit countries, CO2 is added to the Domestic RM by multiplying the volume of deficit with the CO2 factor of the EAM.

The process is identical for radioactive waste, but the source data is as described in the introduction.

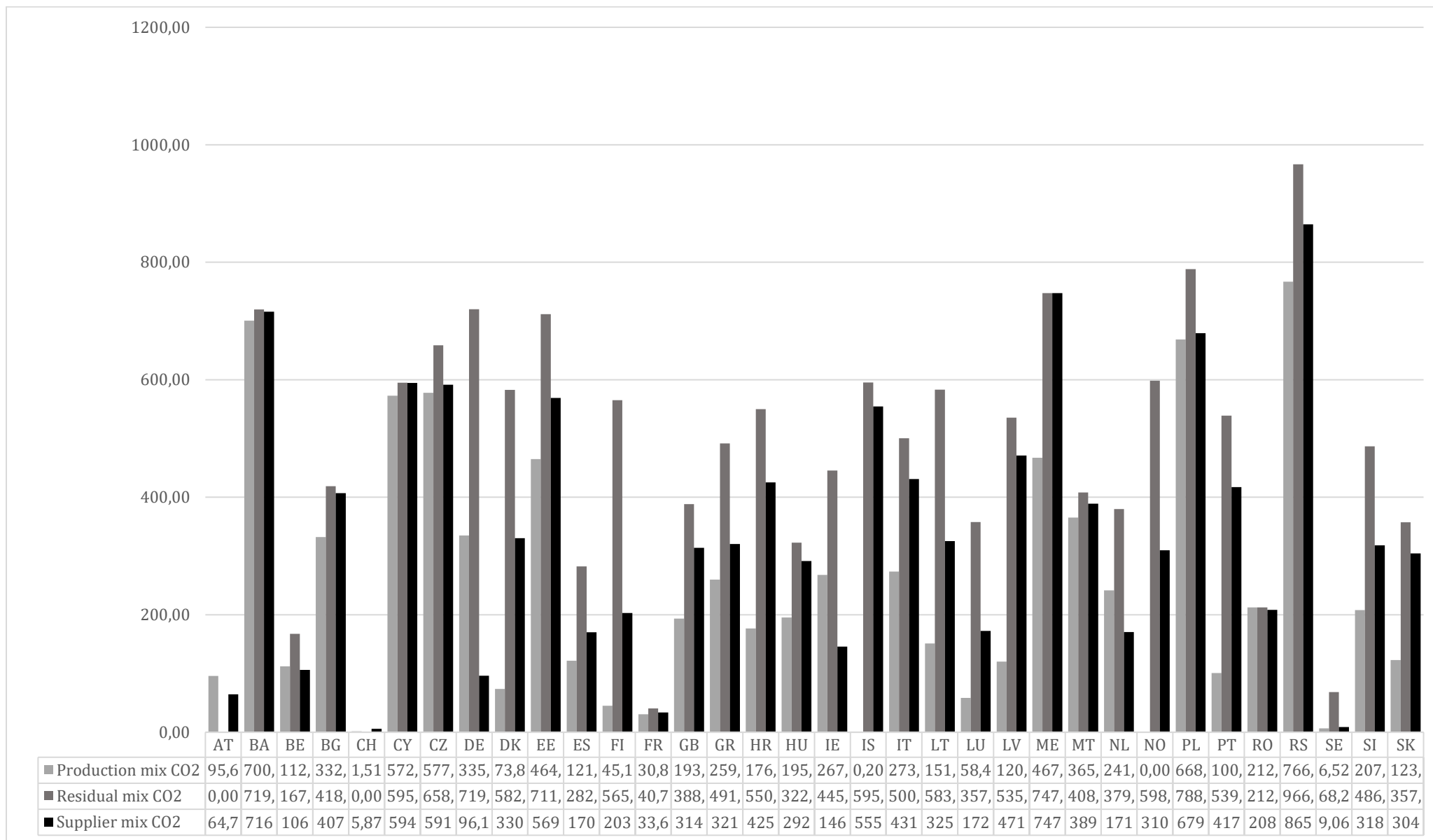


Figure 5 Direct CO2 content in Production, Residual and Total Supplier mix 2023 [gCO2/kWh]

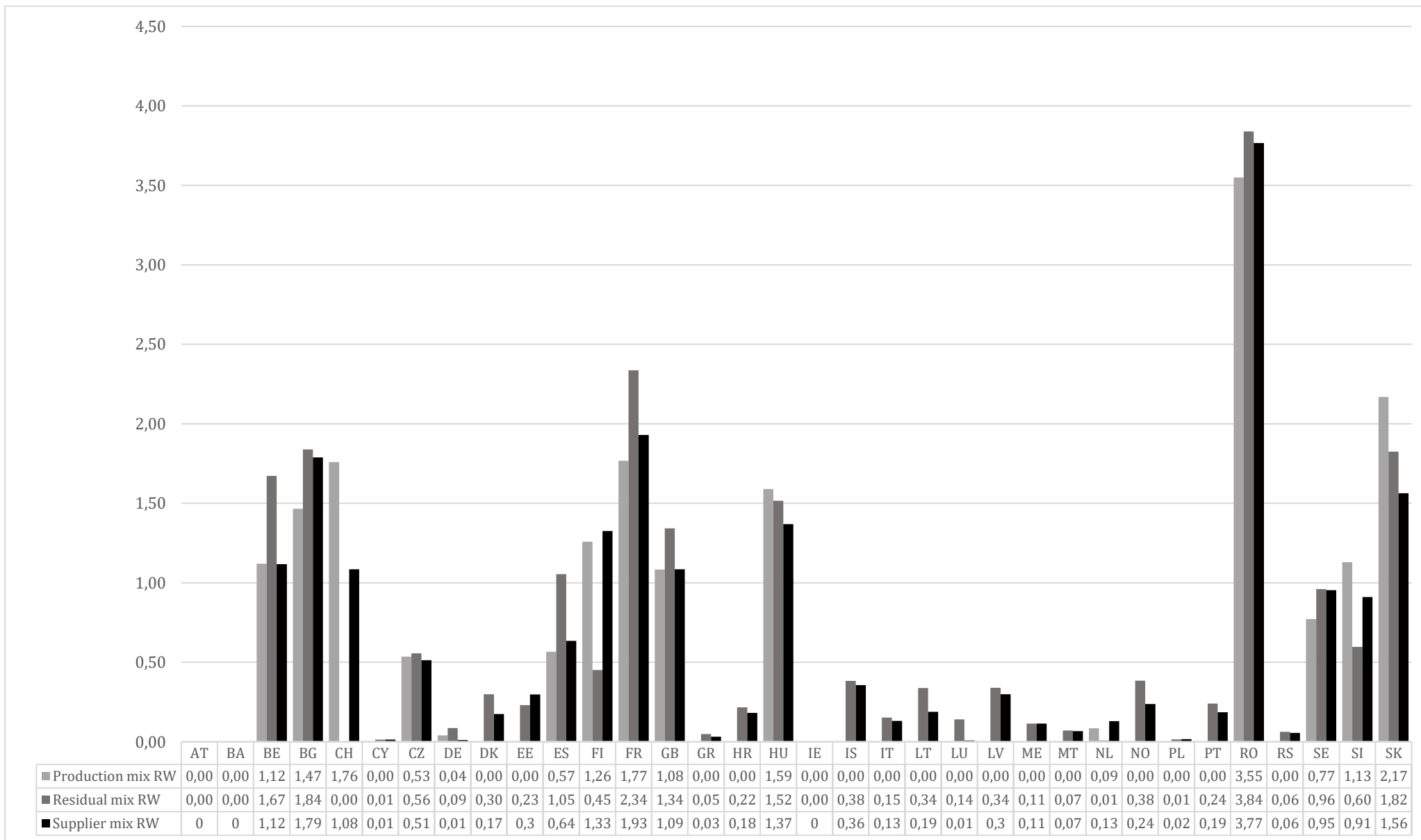


Figure 6 Highly active radioactive waste content in Production, Residual and Total Supplier Mix 2023 [mgRW/kWh]

5.4 Total supplier mixes 2023

The total supplier mix (Table 4, Figures 7 and 8) represents the total consumption mix of a country, i.e. it is the sum of attributes of 1) cancelled GOs as well as 2) the final residual mix. Thus, both explicitly tracked and available remaining electricity attributes are included in the TSM, which equals in physical volume with the country's total electricity consumption. For understanding, it might help to consider that without the international transferability of GOs and electricity, the TSM would equal the production mix of the country.

Table 4: Total Supplier Mix 2023

	Volume (TWh)	RE unspecified	RE biomass	RE solar	RE geothermal	RE wind	RE hydro	Nuclear	FO unspecified	FO hard coal	FO lignite	FO oil	FO gas	CO2 (gCO2/kWh)	Rad waste (mg/kWh)
AT	59,67	0,02 %	6,45 %	4,74 %	0,09 %	11,86 %	62,27 %	0,02 %	0,11 %	0,22 %	0,00 %	0,04 %	14,18 %	64,67	0,00
BA	11,12	0,00 %	0,00 %	1,03 %	0,00 %	1,64 %	41,37 %	0,00 %	0,00 %	55,96 %	0,00 %	0,00 %	0,00 %	715,96	0,00
BE	74,04	0,05 %	7,25 %	1,61 %	0,08 %	16,59 %	8,84 %	41,36 %	0,00 %	1,90 %	0,00 %	0,01 %	22,32 %	106,32	1,12
BG	33,27	0,00 %	4,18 %	5,42 %	0,00 %	1,91 %	1,85 %	43,81 %	0,60 %	32,91 %	0,02 %	0,72 %	8,59 %	407,20	1,79
CH	60,30	0,00 %	1,43 %	3,65 %	0,12 %	3,70 %	67,16 %	22,60 %	0,98 %	0,07 %	0,00 %	0,00 %	0,30 %	5,87	1,08
CY	5,13	0,00 %	0,73 %	12,38 %	0,00 %	4,44 %	0,00 %	0,41 %	0,19 %	1,69 %	0,00 %	78,98 %	1,19 %	594,49	0,01
CZ	59,37	0,00 %	5,90 %	2,90 %	0,20 %	2,10 %	3,86 %	39,45 %	0,15 %	40,14 %	0,00 %	0,12 %	5,20 %	591,48	0,51
DE	452,45	0,24 %	4,77 %	15,42 %	0,53 %	33,96 %	31,73 %	0,43 %	0,95 %	7,45 %	0,00 %	0,22 %	4,30 %	96,13	0,01
DK	35,68	0,00 %	2,57 %	8,80 %	0,00 %	28,80 %	5,28 %	5,08 %	4,01 %	26,78 %	0,06 %	1,07 %	17,54 %	330,29	0,17
EE	8,16	0,00 %	8,33 %	5,63 %	0,58 %	4,47 %	2,18 %	9,15 %	30,21 %	22,17 %	0,10 %	0,96 %	16,22 %	569,13	0,30
ES	245,13	0,00 %	1,83 %	9,85 %	0,03 %	21,82 %	8,26 %	22,60 %	0,37 %	4,92 %	0,01 %	1,36 %	28,94 %	170,19	0,64
FI	79,80	0,03 %	6,45 %	2,35 %	0,00 %	9,33 %	9,15 %	43,75 %	2,22 %	16,45 %	0,04 %	0,73 %	9,50 %	203,13	1,33
FR	440,60	0,01 %	1,36 %	3,42 %	0,01 %	6,62 %	9,87 %	71,45 %	0,02 %	0,18 %	0,00 %	0,38 %	6,69 %	33,64	1,93
GB	296,84	0,00 %	5,38 %	6,36 %	0,00 %	15,39 %	2,75 %	15,01 %	2,59 %	11,60 %	0,03 %	1,18 %	39,70 %	313,92	1,09
GR	54,05	0,00 %	1,41 %	11,47 %	0,09 %	20,85 %	8,97 %	0,91 %	1,05 %	6,40 %	8,36 %	7,23 %	33,26 %	320,55	0,03
HR	17,96	0,00 %	3,55 %	2,88 %	0,09 %	4,59 %	18,30 %	5,34 %	2,23 %	26,90 %	0,06 %	1,15 %	34,90 %	425,40	0,18
HU	44,32	0,36 %	1,96 %	8,50 %	0,10 %	2,16 %	5,93 %	39,06 %	1,86 %	16,12 %	0,03 %	0,53 %	23,39 %	291,60	1,37

	Volume (TWh)	RE unspecified	RE biomass	RE solar	RE geothermal	RE wind	RE hydro	Nuclear	FO unspecified	FO hard coal	FO lignite	FO oil	FO gas	CO2 (gCO2/kWh)	Rad waste (mg/kWh)
IE	40,97	0,63 %	5,42 %	6,62 %	0,00 %	44,92 %	10,60 %	0,00 %	0,22 %	1,41 %	0,32 %	0,01 %	29,85 %	145,80	0,00
IS	19,85	0,07 %	0,90 %	2,32 %	2,99 %	0,16 %	3,27 %	10,36 %	4,75 %	42,93 %	0,12 %	1,88 %	30,28 %	554,64	0,36
IT	303,91	0,01 %	2,73 %	7,51 %	0,34 %	4,26 %	5,29 %	3,79 %	3,07 %	19,57 %	0,04 %	3,24 %	50,15 %	431,14	0,13
LT	10,27	0,09 %	7,48 %	1,87 %	0,33 %	27,20 %	8,09 %	5,39 %	3,78 %	16,59 %	0,05 %	2,14 %	27,00 %	325,43	0,19
LU	4,96	0,34 %	3,40 %	6,79 %	0,77 %	9,03 %	57,06 %	0,23 %	18,99 %	0,95 %	0,00 %	0,04 %	2,38 %	172,50	0,01
LV	6,89	0,00 %	2,99 %	3,73 %	0,00 %	4,27 %	11,84 %	8,59 %	3,34 %	30,75 %	0,08 %	1,27 %	33,12 %	471,17	0,30
ME	3,21	0,00 %	0,00 %	1,48 %	0,00 %	8,85 %	14,87 %	3,32 %	1,52 %	13,77 %	45,88 %	0,60 %	9,71 %	747,42	0,11
MT	2,81	0,00 %	0,57 %	7,96 %	0,00 %	1,73 %	2,37 %	1,96 %	0,90 %	8,11 %	0,02 %	0,83 %	75,55 %	389,12	0,07
NL	114,09	0,04 %	3,46 %	11,25 %	0,01 %	40,70 %	3,04 %	4,79 %	2,18 %	3,93 %	0,00 %	0,44 %	30,16 %	170,52	0,13
NO	136,10	0,01 %	4,58 %	8,07 %	0,01 %	13,40 %	22,12 %	7,08 %	2,67 %	23,94 %	0,07 %	1,04 %	17,02 %	309,84	0,24
PL	153,10	0,00 %	4,93 %	6,68 %	0,00 %	12,60 %	2,05 %	0,50 %	0,91 %	60,62 %	0,00 %	0,06 %	11,64 %	679,25	0,02
PT	50,71	0,98 %	2,24 %	5,50 %	0,00 %	11,66 %	6,19 %	5,40 %	9,82 %	22,66 %	0,06 %	0,97 %	34,52 %	417,39	0,19
RO	49,19	0,00 %	0,32 %	3,48 %	0,00 %	14,68 %	34,68 %	19,82 %	0,00 %	12,38 %	0,00 %	0,07 %	14,57 %	208,45	3,77
RS	34,15	0,00 %	0,78 %	0,49 %	0,00 %	3,08 %	17,38 %	1,62 %	0,77 %	6,79 %	59,02 %	0,30 %	9,77 %	864,72	0,06
SE	134,82	0,08 %	8,65 %	3,08 %	0,01 %	14,75 %	36,42 %	35,29 %	1,32 %	0,08 %	0,00 %	0,13 %	0,19 %	9,06	0,95
SI	12,32	0,00 %	1,32 %	11,88 %	0,00 %	0,56 %	7,16 %	29,53 %	2,52 %	27,76 %	0,07 %	0,99 %	18,22 %	318,10	0,91
SK	27,88	0,06 %	2,91 %	3,11 %	0,00 %	1,07 %	11,41 %	40,06 %	3,34 %	16,06 %	2,40 %	1,66 %	17,92 %	304,38	1,56

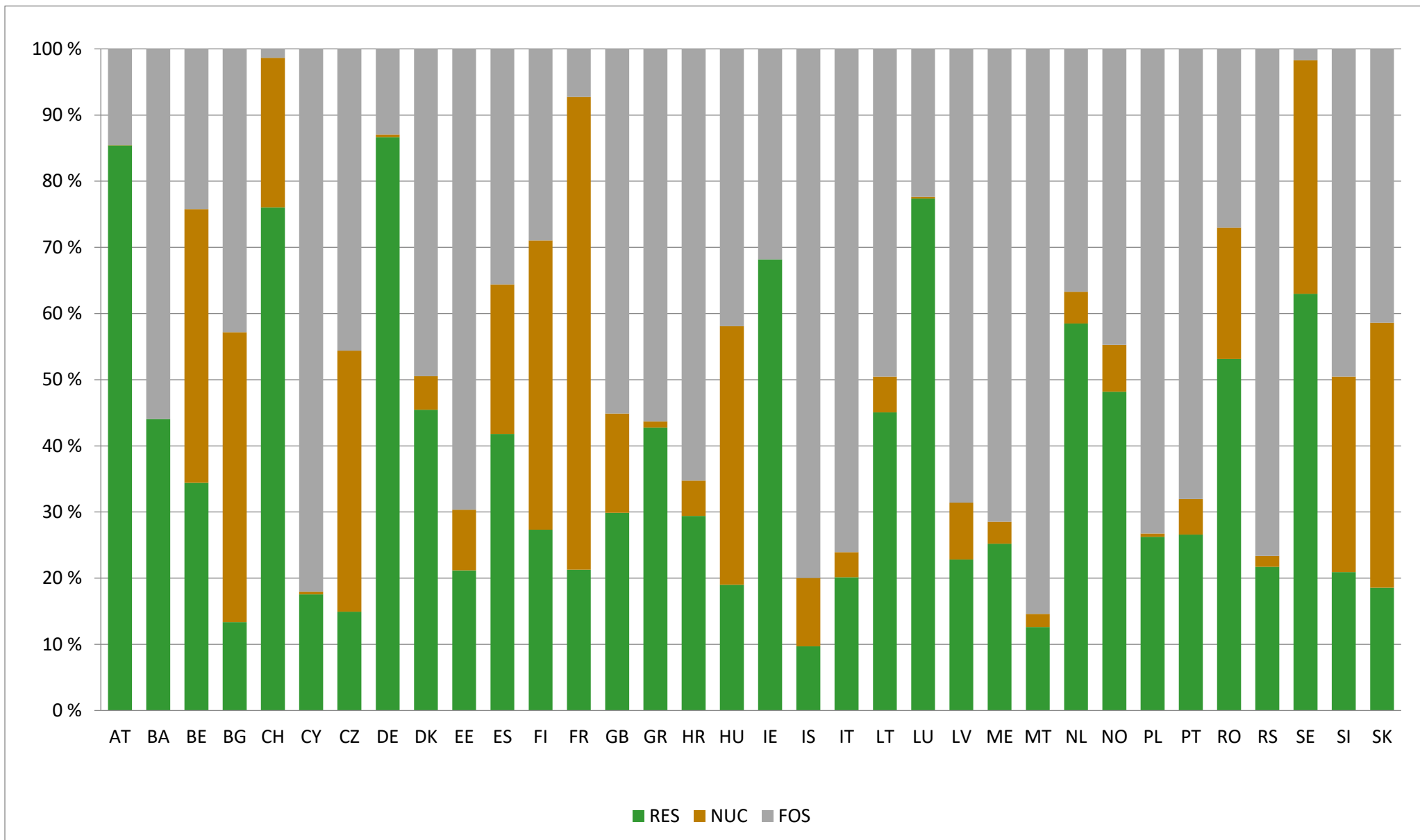


Figure 7 Total Supplier Mix 2023 (simple fuel categories)

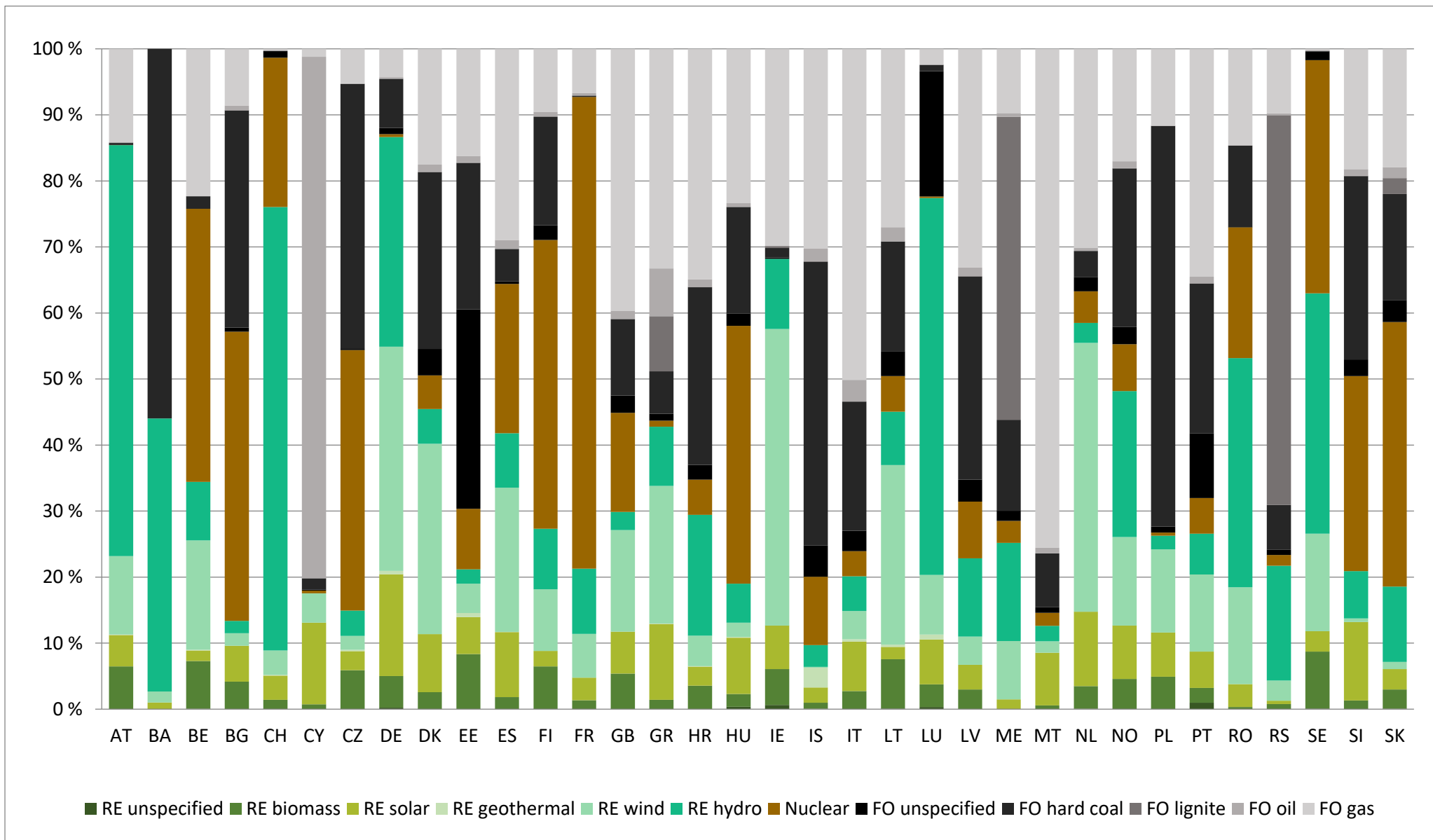


Figure 8 Total Supplier Mix 2023 (detailed fuel categories)

5.5 Production mixes 2023

Table 5: Production Mix 2023⁸

Country code	Volume (TWh)	RE unspecified	RE biomass	RE solar	RE geothermal	RE wind	RE hydro	Nuclear	FO unspecified	FO hard coal	FO lignite	FO oil	FO gas	CO2 (gCO2/kWh)	Rad waste (mg/kWh)
AT	65,24	0,00 %	4,61 %	0,00 %	0,00 %	14,03 %	63,91 %	0,00 %	1,06 %	3,13 %	0,00 %	1,17 %	12,08 %	95,68	0,00
BA	15,37	0,00 %	0,00 %	0,91 %	0,00 %	2,33 %	41,99 %	0,00 %	0,00 %	54,76 %	0,00 %	0,00 %	0,00 %	700,69	0,00
BE	75,38	0,00 %	3,76 %	9,63 %	0,00 %	19,27 %	0,39 %	41,48 %	1,04 %	1,91 %	0,00 %	0,01 %	22,52 %	112,11	1,12
BG	36,68	0,00 %	4,19 %	9,08 %	0,00 %	4,32 %	8,30 %	41,86 %	0,00 %	27,08 %	0,00 %	0,48 %	4,69 %	332,12	1,47
CH	63,69	0,00 %	1,65 %	4,96 %	0,00 %	0,27 %	56,13 %	36,66 %	0,02 %	0,00 %	0,00 %	0,00 %	0,31 %	1,51	1,76
CY	5,13	0,00 %	0,73 %	16,30 %	0,00 %	4,06 %	0,00 %	0,00 %	0,00 %	0,00 %	0,00 %	78,91 %	0,00 %	572,72	0,00
CZ	69,94	0,00 %	6,82 %	3,11 %	0,00 %	0,99 %	3,38 %	41,14 %	0,14 %	39,22 %	0,00 %	0,12 %	5,08 %	577,92	0,53
DE	450,60	0,00 %	3,85 %	13,75 %	0,04 %	32,15 %	3,66 %	1,49 %	3,31 %	25,96 %	0,00 %	0,78 %	15,00 %	335,09	0,04
DK	32,55	2,35 %	15,22 %	10,06 %	0,00 %	59,64 %	0,06 %	0,00 %	1,93 %	7,04 %	0,00 %	0,21 %	3,49 %	73,88	0,00
EE	4,93	0,00 %	24,42 %	14,05 %	0,00 %	14,36 %	0,50 %	0,00 %	45,63 %	0,00 %	0,06 %	0,00 %	0,97 %	464,96	0,00
ES	259,08	0,29 %	1,44 %	16,30 %	0,00 %	24,18 %	8,63 %	20,95 %	0,00 %	1,50 %	0,00 %	1,17 %	25,54 %	121,84	0,57
FI	78,04	0,00 %	13,28 %	0,83 %	0,00 %	18,53 %	19,25 %	41,95 %	0,88 %	4,23 %	0,00 %	0,21 %	0,84 %	45,17	1,26
FR	489,53	0,00 %	2,12 %	4,41 %	0,00 %	10,38 %	10,97 %	65,45 %	0,02 %	0,16 %	0,00 %	0,35 %	6,13 %	30,80	1,77
GB	273,18	0,00 %	10,90 %	5,06 %	0,00 %	30,01 %	1,89 %	13,55 %	1,54 %	1,17 %	0,00 %	0,79 %	35,08 %	193,39	1,08
GR	49,26	0,00 %	1,30 %	17,50 %	0,00 %	23,00 %	9,04 %	0,00 %	0,70 %	0,00 %	9,16 %	7,43 %	31,87 %	259,73	0,00
HR	16,79	0,00 %	5,45 %	1,81 %	0,10 %	15,07 %	47,90 %	0,00 %	0,00 %	7,23 %	0,00 %	0,30 %	22,14 %	176,71	0,00

⁸ The physical electricity imports and exports outside of the Residual mix calculation area are not included in these figures.

Country code	Volume (TWh)	RE unspecified	RE biomass	RE solar	RE geothermal	RE wind	RE hydro	Nuclear	FO unspecified	FO hard coal	FO lignite	FO oil	FO gas	CO2 (gCO2/kWh)	Rad waste (mg/kWh)
HU	33,23	0,00 %	3,87 %	19,48 %	0,02 %	1,86 %	0,65 %	45,42 %	0,90 %	6,58 %	0,00 %	0,10 %	21,12 %	195,56	1,59
IE	37,30	0,89 %	1,36 %	1,49 %	0,00 %	38,81 %	2,57 %	0,00 %	0,77 %	4,91 %	1,12 %	0,04 %	48,04 %	267,85	0,00
IS	20,24	0,00 %	0,00 %	0,00 %	29,67 %	0,03 %	70,28 %	0,00 %	0,00 %	0,00 %	0,00 %	0,02 %	0,00 %	0,20	0,00
IT	253,38	0,00 %	5,96 %	12,07 %	2,11 %	9,22 %	14,49 %	0,00 %	1,60 %	4,62 %	0,00 %	3,07 %	46,85 %	273,63	0,00
LT	4,07	0,00 %	3,25 %	1,97 %	0,00 %	61,57 %	10,56 %	0,00 %	3,49 %	0,00 %	0,00 %	3,59 %	15,57 %	151,16	0,00
LU	1,27	0,00 %	15,77 %	25,02 %	0,00 %	40,28 %	8,64 %	0,00 %	3,63 %	0,00 %	0,00 %	0,00 %	6,66 %	58,44	0,00
LV	6,08	0,00 %	8,97 %	2,11 %	0,00 %	4,41 %	62,12 %	0,00 %	0,00 %	0,00 %	0,00 %	0,00 %	22,40 %	120,23	0,00
ME	4,05	0,00 %	0,00 %	0,50 %	0,00 %	7,65 %	54,25 %	0,00 %	0,00 %	0,00 %	37,60 %	0,00 %	0,00 %	467,21	0,00
MT	2,19	0,00 %	0,06 %	9,62 %	0,00 %	0,00 %	0,00 %	0,00 %	0,00 %	0,00 %	0,00 %	0,61 %	89,71 %	365,34	0,00
NL	119,75	0,00 %	5,99 %	17,75 %	0,00 %	24,21 %	0,06 %	3,16 %	1,33 %	8,50 %	0,00 %	1,27 %	37,75 %	241,57	0,09
NO	148,77	0,00 %	0,08 %	0,00 %	0,00 %	9,36 %	90,56 %	0,00 %	0,00 %	0,00 %	0,00 %	0,00 %	0,00 %	0,00	0,00
PL	151,21	0,00 %	4,65 %	7,47 %	0,00 %	14,95 %	1,52 %	0,00 %	0,76 %	59,90 %	0,00 %	0,00 %	10,74 %	668,62	0,00
PT	44,92	4,24 %	2,85 %	8,04 %	0,00 %	28,79 %	32,59 %	0,00 %	5,85 %	0,00 %	0,00 %	0,00 %	17,64 %	92,18	0,00
RO	52,21	0,00 %	0,32 %	3,14 %	0,00 %	14,31 %	34,85 %	19,72 %	0,00 %	12,57 %	0,00 %	0,07 %	15,00 %	212,43	3,55
RS	36,34	0,00 %	0,70 %	0,13 %	0,00 %	2,90 %	33,11 %	0,00 %	0,00 %	0,00 %	58,26 %	0,00 %	4,90 %	766,82	0,00
SE	163,38	0,00 %	6,99 %	1,90 %	0,00 %	21,01 %	40,27 %	28,57 %	1,02 %	0,01 %	0,00 %	0,11 %	0,13 %	6,52	0,77
SI	14,23	0,00 %	1,56 %	4,21 %	0,00 %	0,04 %	34,48 %	37,64 %	0,05 %	19,52 %	0,00 %	0,01 %	2,48 %	207,78	1,13
SK	27,49	0,32 %	3,36 %	2,21 %	0,00 %	0,01 %	17,09 %	61,98 %	1,85 %	1,42 %	2,55 %	1,10 %	8,12 %	123,04	2,17

5.6 Various total mixes 2023

Table 6 European Total Production Mix, Total Attributes in Final Residual Mixes and European Attribute Mix 2023⁹

	Production mixes	Residual mixes	European attribute mix
Volume (TWh)	3105,48	1792,53	215,45
RE unspecified %	0,12 %	0,00 %	0,00 %
RE solar %	8,07 %	3,44 %	2,41 %
RE biomass %	4,47 %	1,18 %	0,00 %
RE wind %	18,64 %	2,99 %	0,00 %
RE geothermal %	0,37 %	0,01 %	0,00 %
RE hydro %	17,10 %	1,82 %	0,00 %
Nuclear %	20,87 %	31,52 %	11,20 %
FO unspecified %	1,19 %	2,55 %	5,13 %
FO lignite %	0,91 %	1,53 %	0,13 %
FO hard coal %	9,89 %	21,95 %	46,40 %
FO gas %	17,41 %	31,14 %	32,72 %
FO oil %	0,95 %	1,86 %	2,01 %

⁹ The EAM volume and percentages presented here do not exactly match numbers provided in Table 1. This is due to some countries having negative renewable energy balance in domestic residual mixes (caused by variation in disclosure periods and GO lifetimes overlapping two disclosure periods). This negativity is transferred into the EAM before considering the domestic residual mix attribute surpluses and deficits. This negativity correction is included in this Table 6 for statistics purposes. For any member state residual mix calculation the values from the Table 1 should be used.

6 Comparisons

The following graphs and tables are not really results of the calculation, but meant for background information. They compare different mixes of the same year or the evolution of mixes on an annual level.

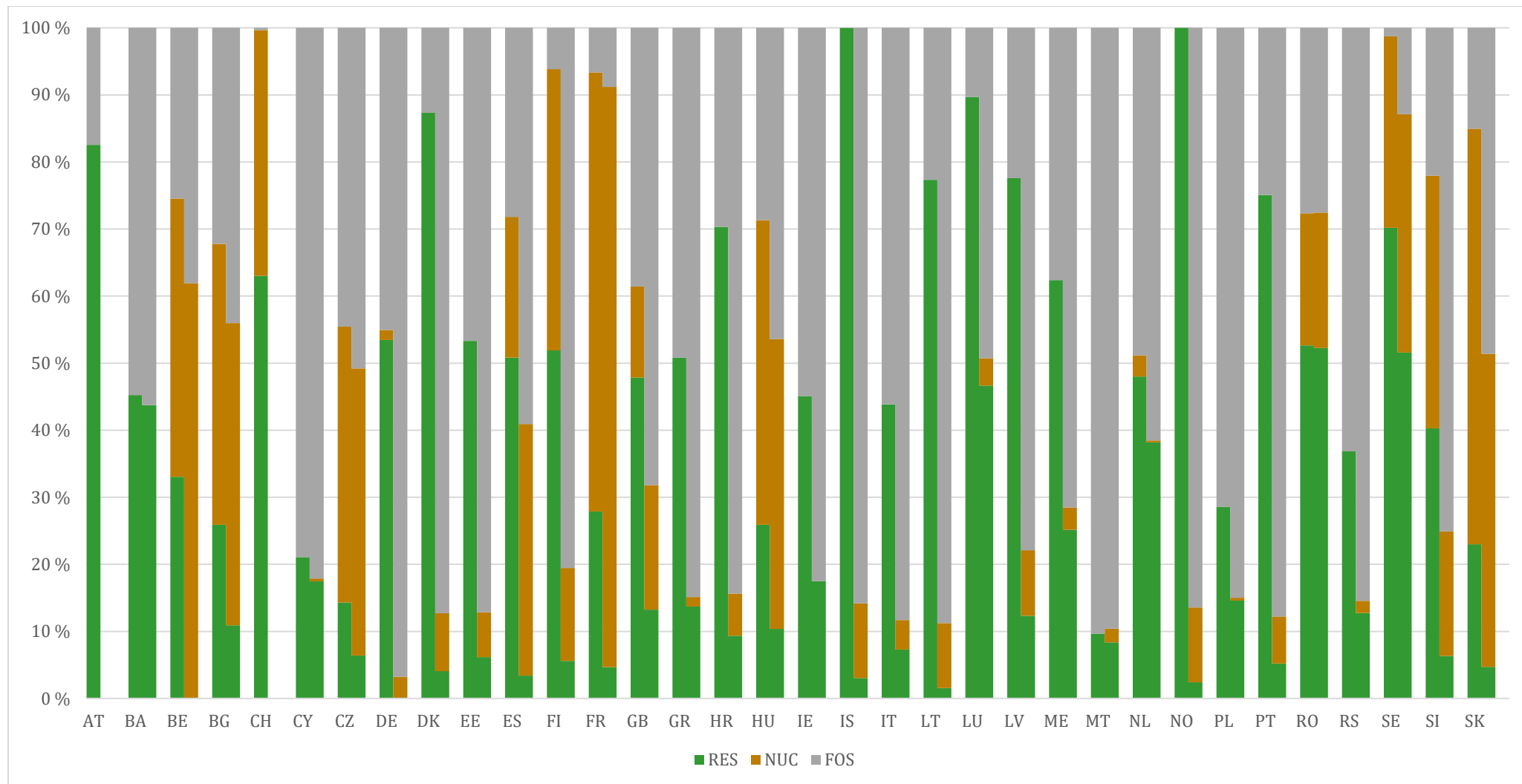


Figure 9 Production Mix (left) and Final Residual Mix (right) 2023 (simple fuel categories)

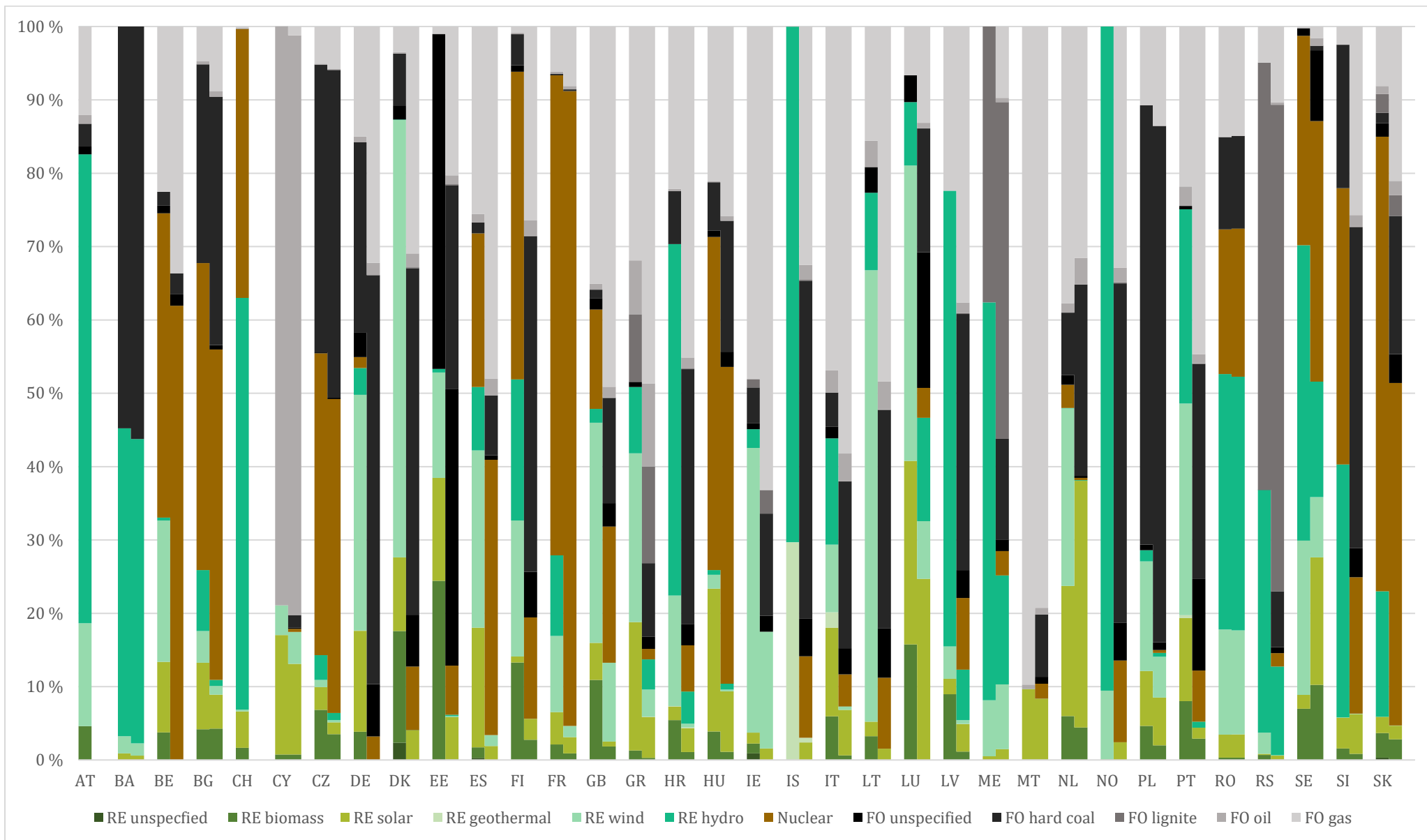


Figure 10 Production Mix (left) and Final Residual Mix (right) 2023 (detailed fuel categories)

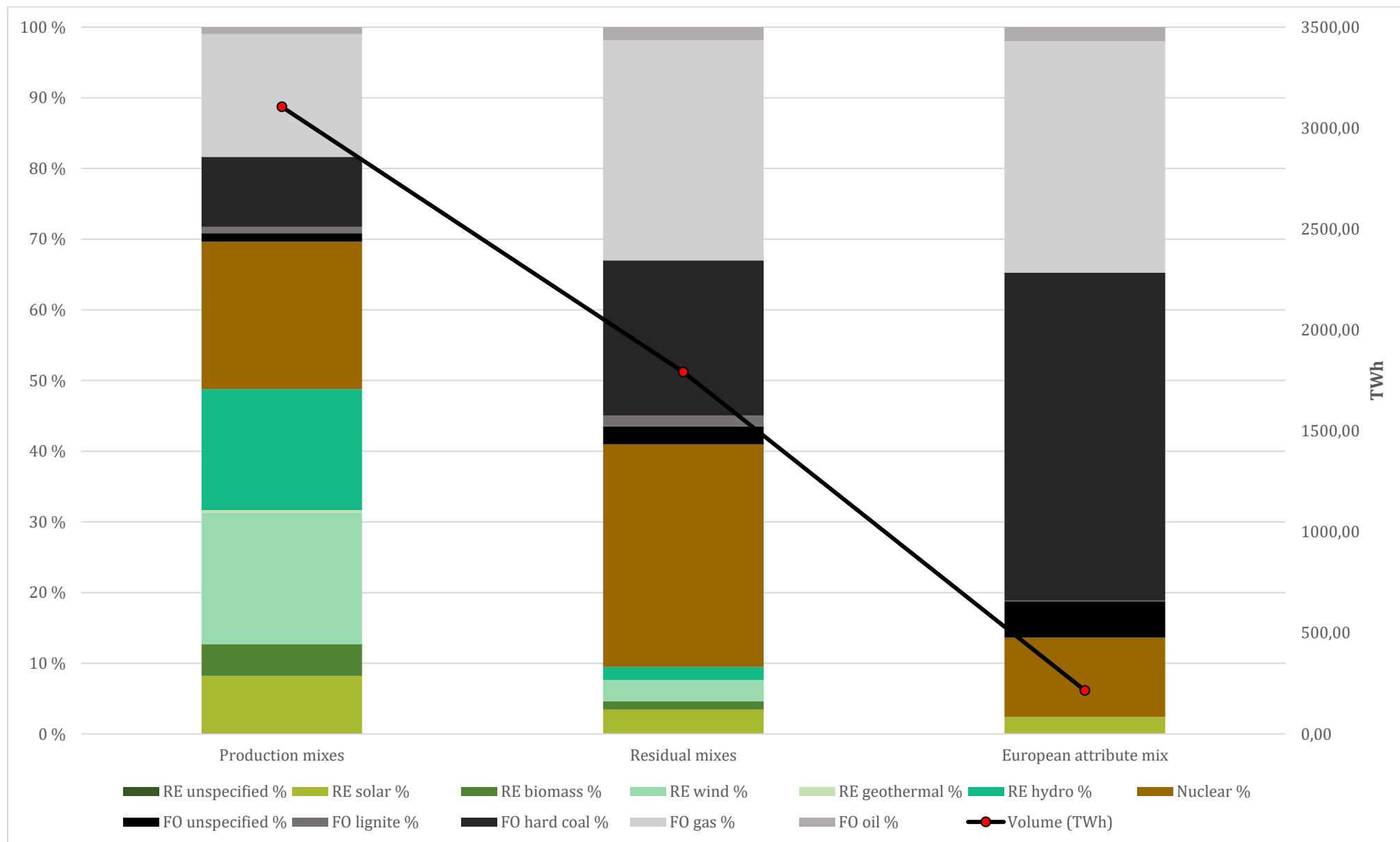


Figure 11 European Total Production Mix (left), Attributes in Final Residual Mixes (middle) and EAM (right) 2023

The following figures compare the production and total supplier mixes both in % and TWh. This provides an interesting viewpoint showing the difference of the production and consumption mix of countries. Countries with a “greener” consumption mix than their respective production mix are typically GO net importers and vice-versa.

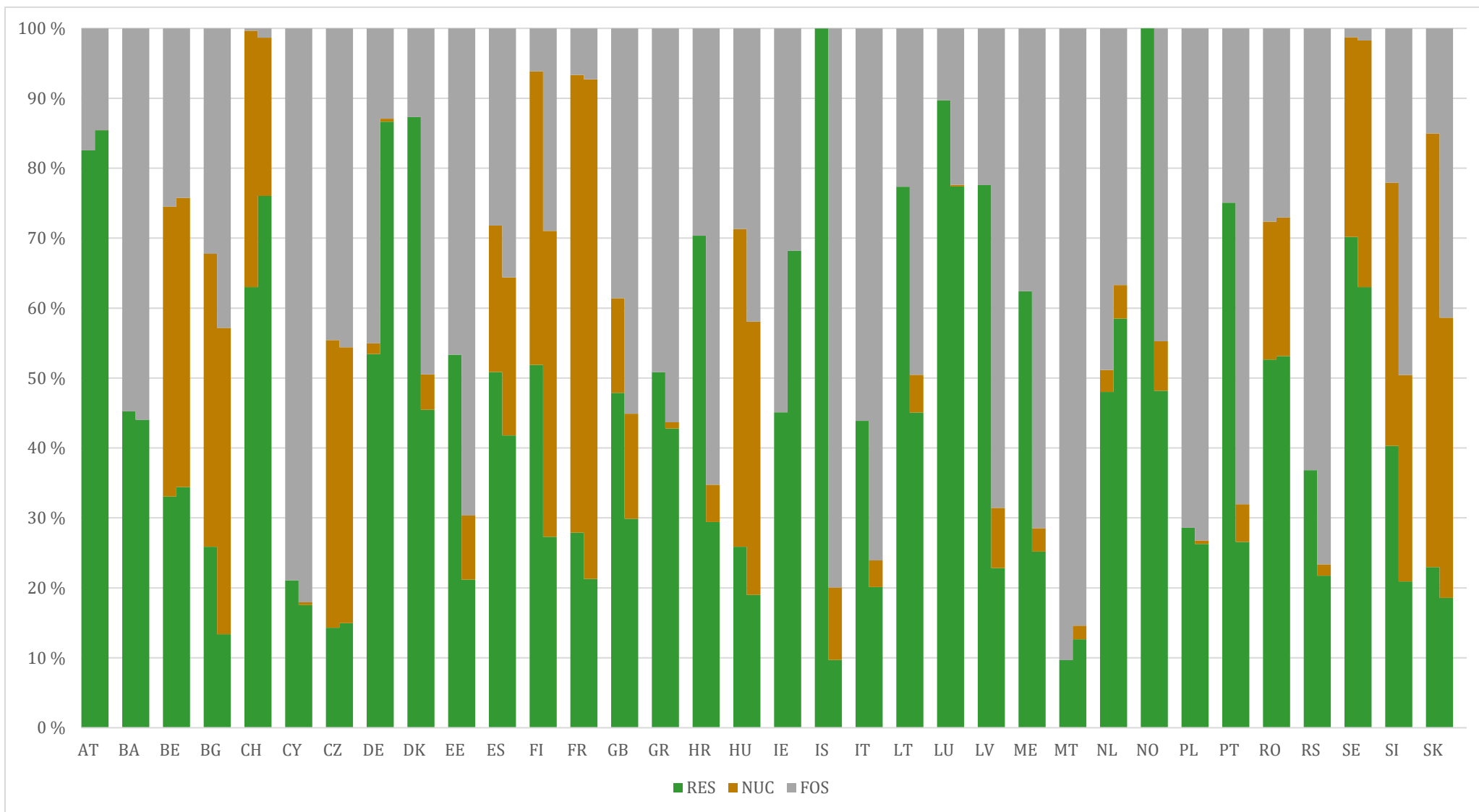
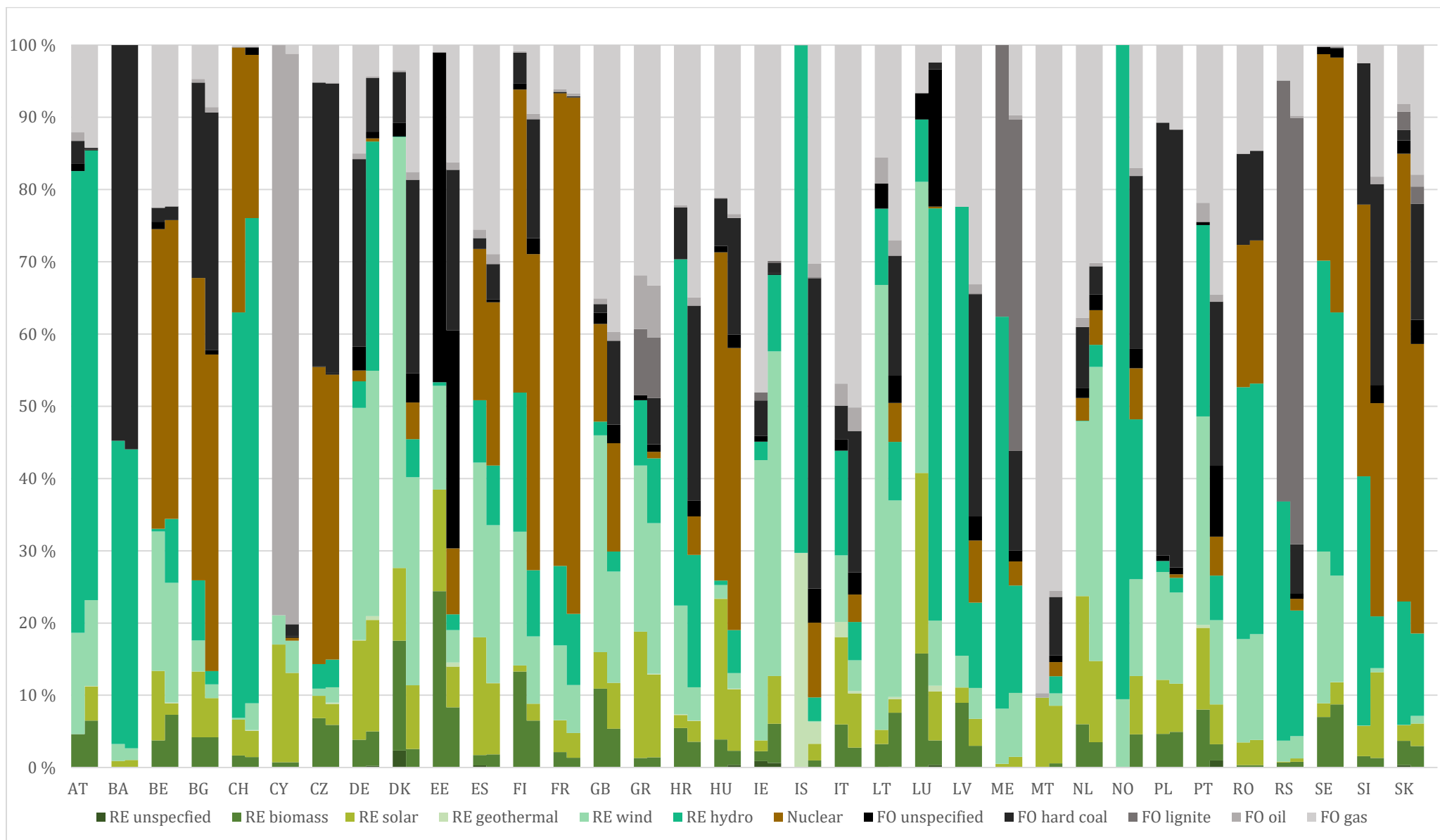


Figure 12 Production Mix (left) and Total Supplier Mix (right) 2023 % (simple fuel categories)



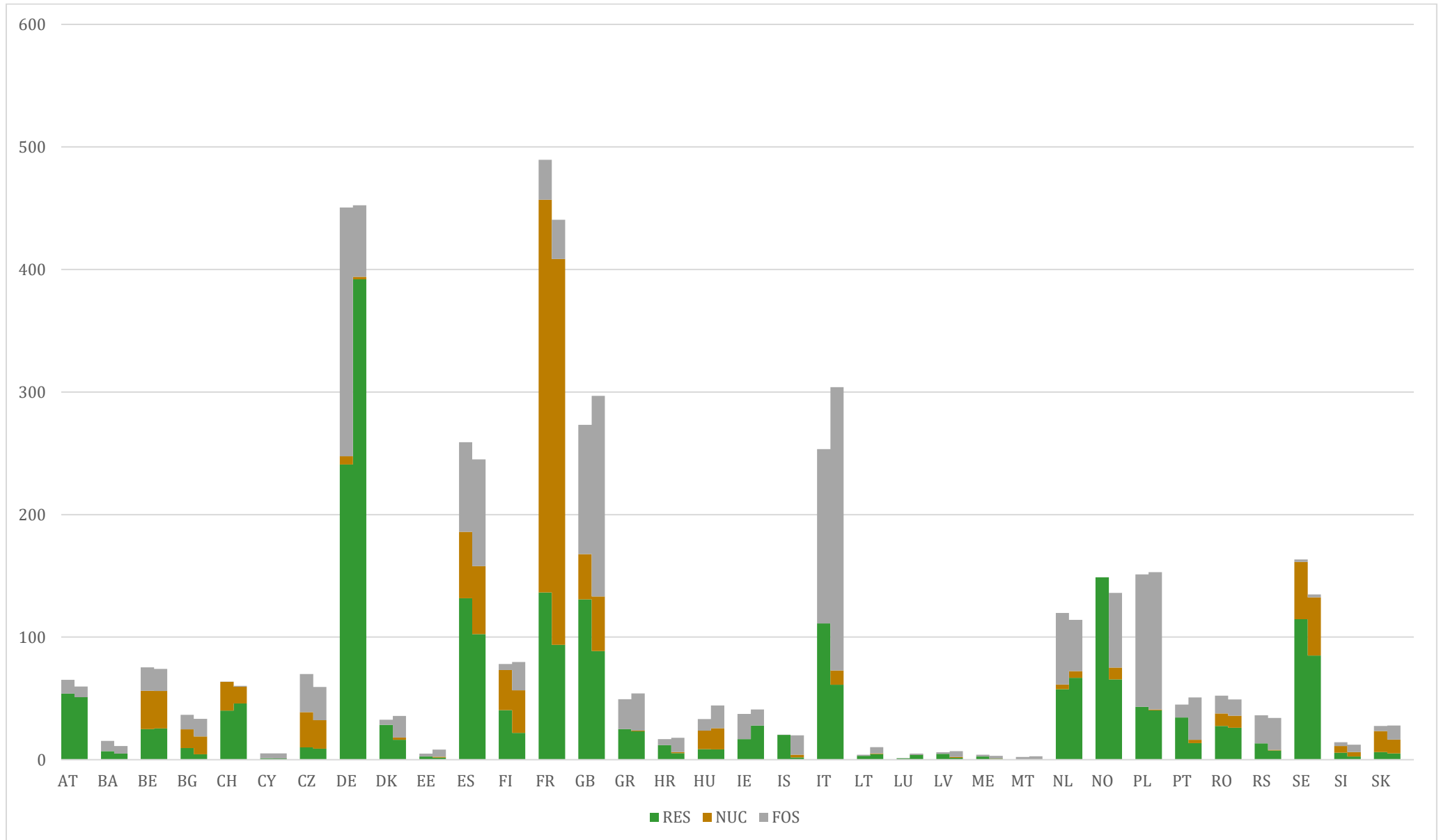


Figure 14 Production Mix (left) and Total Supplier Mix (right) TWh 2023 (simple fuel categories)

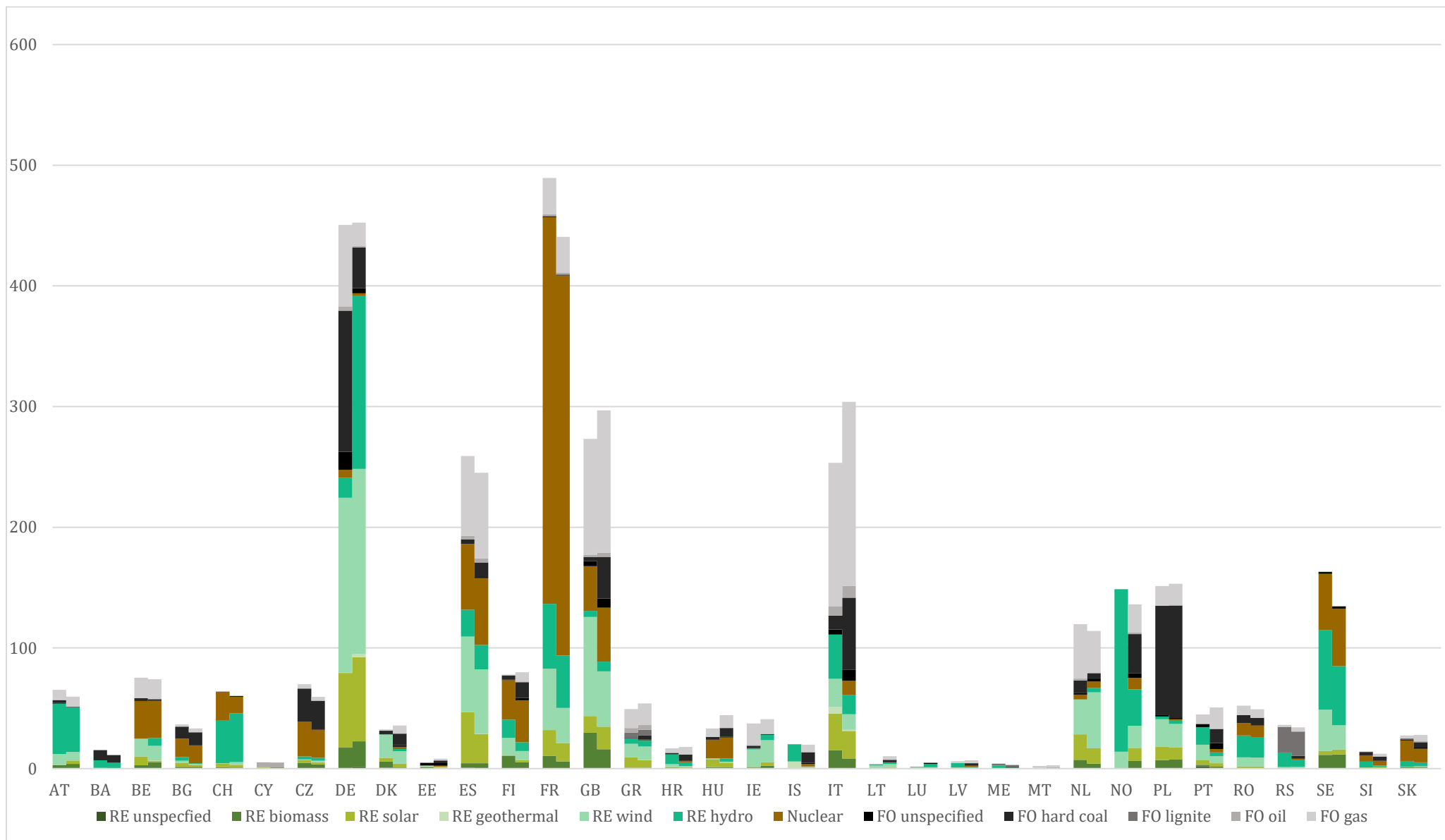


Figure 15 Production Mix (left) and Total Supplier Mix (right) TWh 2023 (detailed fuel categories)

Figure 16 and Table 7 compare the residual mixes of 2021, 2022 and 2023.

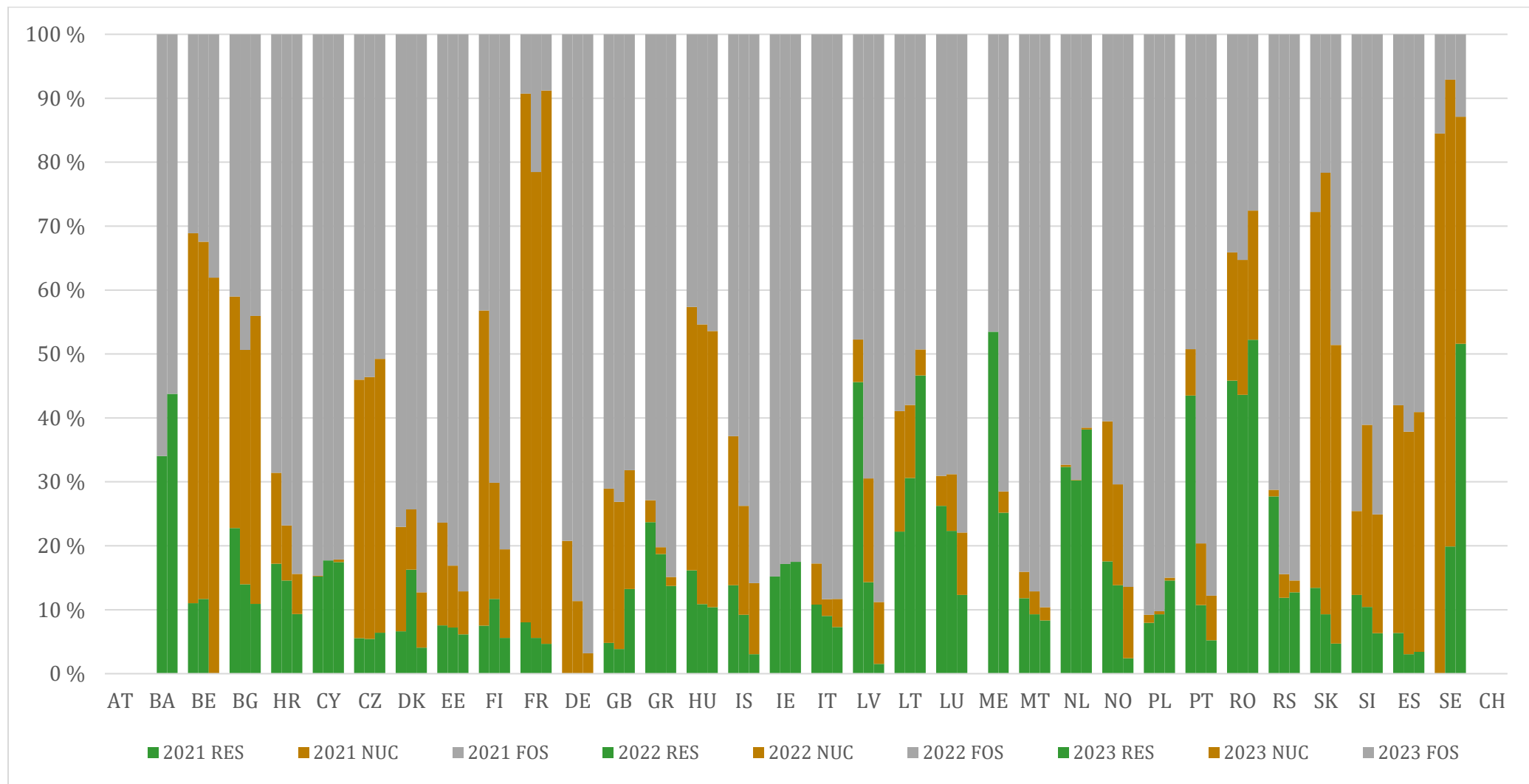


Figure 16 Residual Mixes 2021, 2022 and 2023

Table 7 Residual Mixes 2021, 2022 and 2023

		2021	2022	2023
AT	RES	0,0 %	0,0 %	0,00 %
	NUC	0,0 %	0,0 %	0,00 %
	FOS	0,0 %	0,0 %	0,00 %
BA	RES	0,0 %	34,0 %	43,76 %
	NUC	0,0 %	0,0 %	0,00 %
	FOS	0,0 %	66,0 %	56,24 %
BE	RES	11,0 %	11,7 %	0,00 %
	NUC	57,9 %	55,9 %	61,93 %
	FOS	31,1 %	32,4 %	38,07 %
BG	RES	22,8 %	14,0 %	10,91 %
	NUC	36,2 %	36,7 %	45,04 %
	FOS	41,0 %	49,4 %	44,04 %
HR	RES	17,2 %	14,6 %	9,34 %
	NUC	14,2 %	8,6 %	6,29 %
	FOS	68,6 %	76,8 %	84,38 %
CY	RES	15,2 %	17,7 %	17,47 %
	NUC	0,1 %	0,0 %	0,41 %
	FOS	84,7 %	82,3 %	82,12 %
CZ	RES	5,6 %	5,5 %	6,40 %
	NUC	40,4 %	40,9 %	42,82 %
	FOS	54,0 %	53,6 %	50,78 %
DK	RES	6,6 %	16,3 %	4,06 %
	NUC	16,3 %	9,4 %	8,67 %
	FOS	77,0 %	74,3 %	87,27 %
EE	RES	7,5 %	7,2 %	6,16 %
	NUC	16,1 %	9,7 %	6,71 %
	FOS	76,4 %	83,1 %	87,13 %
FI	RES	7,5 %	11,7 %	5,61 %
	NUC	49,3 %	18,2 %	13,85 %
	FOS	43,2 %	70,1 %	80,55 %
FR	RES	8,0 %	5,6 %	4,66 %
	NUC	82,7 %	72,9 %	86,53 %
	FOS	9,3 %	21,6 %	8,81 %

		2021	2022	2023
DE	RES	0,0 %	0,0 %	0,00 %
	NUC	20,8 %	11,4 %	3,21 %
	FOS	79,2 %	88,6 %	96,79 %
GB	RES	4,8 %	3,9 %	13,25 %
	NUC	24,2 %	23,0 %	18,57 %
	FOS	71,0 %	73,1 %	68,18 %
GR	RES	23,7 %	18,7 %	13,71 %
	NUC	3,4 %	1,1 %	1,43 %
	FOS	72,9 %	80,2 %	84,87 %
HU	RES	16,1 %	10,9 %	10,39 %
	NUC	41,2 %	43,7 %	43,22 %
	FOS	42,6 %	45,4 %	46,39 %
IS	RES	13,8 %	9,2 %	3,03 %
	NUC	23,3 %	17,0 %	11,12 %
	FOS	62,9 %	73,8 %	85,85 %
IE	RES	15,2 %	17,2 %	17,49 %
	NUC	0,0 %	0,0 %	0,00 %
	FOS	84,8 %	82,8 %	82,51 %
IT	RES	10,8 %	9,0 %	7,28 %
	NUC	6,4 %	2,6 %	4,40 %
	FOS	82,8 %	88,3 %	88,32 %
LU	RES	45,6 %	14,3 %	1,55 %
	NUC	6,6 %	16,2 %	9,67 %
	FOS	47,7 %	69,4 %	88,79 %
LV	RES	22,2 %	30,6 %	46,64 %
	NUC	18,9 %	11,4 %	4,08 %
	FOS	58,9 %	58,0 %	49,28 %
LT	RES	26,3 %	22,3 %	12,32 %
	NUC	4,7 %	8,9 %	9,76 %
	FOS	69,1 %	68,8 %	77,91 %
ME	RES	0,0 %	53,5 %	25,17 %
	NUC	0,0 %	0,0 %	3,32 %
	FOS	0,0 %	46,5 %	71,51 %
MT	RES	11,8 %	9,3 %	8,34 %
	NUC	4,1 %	3,6 %	2,05 %
	FOS	84,1 %	87,1 %	89,60 %

		2021	2022	2023
NL	RES	32,3 %	30,2 %	38,17 %
	NUC	0,3 %	0,1 %	0,30 %
	FOS	67,3 %	69,7 %	61,53 %
NO	RES	17,6 %	13,8 %	2,41 %
	NUC	21,9 %	15,8 %	11,16 %
	FOS	60,5 %	70,4 %	86,43 %
PL	RES	7,9 %	9,3 %	14,58 %
	NUC	1,3 %	0,5 %	0,43 %
	FOS	90,8 %	90,2 %	84,99 %
PT	RES	43,5 %	10,7 %	5,22 %
	NUC	7,2 %	9,7 %	6,98 %
	FOS	49,3 %	79,6 %	87,80 %
RO	RES	45,8 %	43,6 %	52,24 %
	NUC	20,1 %	21,1 %	20,21 %
	FOS	34,1 %	35,3 %	27,55 %
RS	RES	27,7 %	11,9 %	12,73 %
	NUC	1,0 %	3,7 %	1,82 %
	FOS	71,2 %	84,4 %	85,45 %
SK	RES	13,4 %	9,3 %	4,69 %
	NUC	58,8 %	69,1 %	46,70 %
	FOS	27,8 %	21,6 %	48,60 %
SI	RES	12,3 %	10,4 %	6,32 %
	NUC	13,1 %	28,5 %	18,59 %
	FOS	74,6 %	61,1 %	75,08 %
ES	RES	6,4 %	3,1 %	3,40 %
	NUC	35,6 %	34,8 %	37,51 %
	FOS	58,0 %	62,1 %	59,09 %
SE	RES	0,0 %	19,9 %	51,60 %
	NUC	84,5 %	73,0 %	35,53 %
	FOS	15,5 %	7,1 %	12,88 %
CH	RES	0,0 %	0,0 %	0,00 %
	NUC	0,0 %	0,0 %	0,00 %
	FOS	0,0 %	0,0 %	0,00 %

Annex 1: Fuel Categories

Table 8 Fuel category breakdown

Fact Sheet 5 compliance		Fuel code	Fuel description (including all subcategories)	Sub-table reference		
Renewable	Unspecified & Other	F01000000	Renewable - Unspecified			T1 Hard coal sub-categories
		F01040300	Renewable - Heat - Aerothermal			0 F0201010 Unspecified
		F01040400	Renewable - Heat - Hydrothermal			1 F0201010 Anthracite
		F01040501	Renewable - Heat - Process heat - Biogenic			2 F0201010 Bituminous coal
		F01050000	Renewable - Mechanical source or other - Unspecified			3 F0201010 Coking coal
	Solar	F01040100	Renewable - Heat - Solar			4 F0201010 Coke-oven coke
	Wind	F01050100	Renewable - Mechanical source or other - Wind			5 F0201010 Lignite coke
	Hydro & Marine	F01050200	Renewable - Mechanical source or other - Hydro & Marine			
	Geothermal	F01040200	Renewable - Heat - Geothermal			T2 Brown coal sub-categories
	Biomass	F01010000	Renewable - Solid			0 F0201020 Unspecified
F01020000		Renewable - Liquid			1 F0201020 Sub-bituminous coal	
F01030000		Renewable - Gaseous			2 F0201020 Lignite	
Nuclear	F03010100	Nuclear - Solid - Radioactive fuel			3 F0201020 Brown coal briquette	
		F02000000	Fossil - Unspecified			4 F0201020 Peat briquette
Fossil	Unspecified & Other	F02010000	Fossil - Solid - Unspecified			T3 Petroleum products sub-categories
		F02010400	Fossil - Solid - Municipal waste			0 F0202030 Unspecified
		F02010500	Fossil - Solid - Industrial and commercial waste			1 F0202030 Ethane
		F02020000	Fossil - Liquid - Unspecified			2 F0202030 Naphtha
		F02030000	Fossil - Gaseous	T4		3 F0202030 Aviation gasoline
		F02040000	Fossil - Heat			4 F0202030 Motor gasoline
	Hard Coal	F02010100	Fossil - Solid - Hard coal	T1		5 F0202030 Aviation turbine fuel
	Brown Coal / Lignite	F02010300	Fossil - Solid - Peat			6 F0202030 Other kerosene
		F02010200	Fossil - Solid - Brown coal	T2		7 F0202030 Gas and diesel oil
	Natural Gas	F02030100	Fossil - Gaseous - Natural Gas			8 F0202030 Fuel oil low-sulphur
		F02020200	Fossil - Liquid - Natural gas liquids			9 F0202030 Fuel oil high-sulphur
	Oil	F02020100	Fossil - Liquid - Crude oil			10 F0202030 Liquid petroleum gas
		F02020300	Fossil - Liquid - Petroleum products	T3		11 F0202030 Orimulsion
						12 F0202030 Bitumen
						13 F0202030 Lubricants
					14 F0202030 Petroleum coke	
					15 F0202030 Refinery feedstock	
					T4 Gaseous sub-categories	
					0 F0203000 Unspecified Unspecified	
					20 F0203020 Coal-derived gas Unspecified	
					21 F0203020 Coal-derived gas Blast furnace gas	
					22 F0203020 Coal-derived gas Coke-oven gas	
					30 F0203030 Petroleum products Unspecified	
					31 F0203030 Petroleum products Propane	
					32 F0203030 Petroleum products Butane	
					33 F0203030 Petroleum products Refinery gas	
					34 F0203030 Petroleum products Chemical waste gas	
					40 F0203040 Municipal gas plant Unspecified	
					50 F0203050 Process gas Unspecified	
					51 F0203050 Process gas Carbon monoxide	
					52 F0203050 Process gas Methane	
					53 F0203050 Process gas Hydrogen (fossil sourced)	
					54 F0203050 Process gas Phosphor gas	
					55 F0203050 Process gas Oxy gas	

Annex 2: Data Source Matrix

Table 9 Data Source Matrix

Country code	Production data	Consumption data	Exchange with third countries	Tracking data GOs	CO2 emissions	Radioactive waste
AT	a	b	-	d,h	i	k
BA	a	b	-	f	i	k
BE	a	b	-	d,e,h	i	k
BG	a	b	c	e,f,h	i	k
CH	Nationally provided information	Nationally provided information	-	f,h	i	k
CY	a	b	-	d,f,h	i,j	k
CZ	a	b	-	d,h	i	j
DE	a	b	-	d,f,h*	i	k
DK	Nationally provided information	Nationally provided information	-	d,h	i,j	k
EE	Nationally provided information	Nationally provided information	Nationally provided information	d,h	i	k
ES	Nationally provided information	Nationally provided information	Nationally provided information	d,f,h	i	k
FI	a	b	-	d,e,h	i	k
FR	Nationally provided information	Nationally provided information	-	d,e,h	i,j	k
GB	Nationally provided information	Nationally provided information	-	f,h	i	k
GR	Nationally provided information	Nationally provided information	c	d,e,f,h	i,j	k
HR	a	b	-	d,f,h	i	k
HU	a	b	c	d,h	i	k
IE	Nationally provided information	Nationally provided information	-	d,f,h	i	k
IS	Nationally provided information	Nationally provided information	-	d	i	k
IT	Nationally provided information, some attributes based on proportions from (a)	Nationally provided information	-	d,h	i	k

LT	a	b	c	d,f,h	i	k
LU	a	b	-	d,f,h	i	k
LV	Nationally provided information	Nationally provided information	Nationally provided information	d,h	i	k
ME	Nationally provided information	Nationally provided information	c	f	i	k
MT	Nationally provided information	Nationally provided information	-	h	i,j	k
NL	a	b	-	d,h	i	k
NO	Nationally provided information	Nationally provided information	-	d,e,h	i	k
PL	a	b	c	e,f,h	i	k
PT	Nationally provided information	Nationally provided information	Nationally provided information	e,f,h	i	k
RO	a	b	c	h	i	k
RS	Nationally provided information	Nationally provided information	c	d,f,h	i	k
SE	a	b	-	d,e,f,h	i	k
SI	a	b	-	d,f,h	i	j
SK	Nationally provided information	Nationally provided information	c	d,h	i	k

a https://ec.europa.eu/eurostat/web/products-datasets/-/nrg_cb_pem

b https://ec.europa.eu/eurostat/web/products-datasets/-/nrg_cb_em

c Entso-e Transparency Platform Cross-Border Flows: <https://transparency.entsoe.eu/transmission-domain/physicalFlow/show>

d EECS Activity statistics <https://www.aib-net.org/facts/market-information/statistics/activity-statistics-all-aib-members>

e EECS Ex-domain cancellations by country, by energy source, collected from DCBs

f DCB provided information on other reliable tracking means

h Ex-domain cancellations from other countries

i Ecoinvent

j Nationally provided factors

k http://reliable-disclosure.org/upload/250-D5.3_Direct_and_weighted_emissions.pdf

* <https://www.erneuerbare-energien.de/EE/Redaktion/DE/Downloads/eeg-in-zahlen-xls.html>

Appendix to “European Residual Mixes: Results of the calculation of Residual Mixes for the calendar year 2022”

Update of underlying emission factor for residual mix fuel categories
(2023-05-31)

Müller J.

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Terms

- **ecoinvent:** ecoinvent is an internationally active, mission-driven organization devoted to supporting high-quality, science-based environmental assessments. Its activities include publishing and maintaining the ecoinvent database, a comprehensive life cycle inventory database that provides reliable and transparent information on the environmental impacts of various products and services. It is used by companies, researchers, and policymakers to analyse the environmental impact of their operations, make informed decisions, and develop sustainable practices. www.ecoinvent.org
- **ecoinvent database:** Refers to the database published by ecoinvent. The ecoinvent database is a Life Cycle Inventory (LCI) database that supports the assessment of environmental impacts. More information: <https://ecoinvent.org/the-ecoinvent-database/>
- **ecoinvent datasets:** These datasets describe a specific activity producing a product and its associated environmental impacts. In this appendix the ecoinvent datasets will be referred to by their “activity name” and “geography” and are sourced from [v3.9.1](#) of the ecoinvent database using the [system model](#) “Allocation, cut-off”.
- **Fuel category emission factor:** Refers to the amount of direct carbon dioxide (CO₂) emitted for the production of 1 kWh of electricity for a country and fuel category as defined in Table 8 of AIB (2022).

Introduction

Up to the calculation of the residual mixes for the year 2021, published in AIB (2022), the calculation of the values for the “CO₂ (gCO₂/kWh)” column in Table 1, 2, 4, 5 for most countries were based on emission factors (EFs) from the RE-DISS project that ended in 2015. This set of EFs contained one EF for each country and used fuel category.

Due to rising demand for the representation of residual mixes in the ecoinvent database, AIB agreed to the publication and integration of the residual mixes in the ecoinvent database. This integration shed light on certain discrepancies in the underlying fuel category emission factors between the EFs from the RE-DISS project and the EFs in the ecoinvent database. It was decided in accordance with the competent disclosure bodies to aim for alignment of the two sources of EFs in order to publish consistent values for CO₂ emissions in the reporting of the residual mixes on the side of AIB and their implementation in the ecoinvent database.

This appendix explains how the new set of EFs for the fuel categories for the residual mixes were chosen, lists the EFs as well as their origin and gives an outlook of remaining discrepancies and further efforts of alignment.

Choice of emission factors

In accordance with AIB, the Competent Disclosure Bodies and ecoinvent, it was decided that from the AIB residual mix report 2022 onwards the underlying EFs for the fuel categories would be based on emission data from the ecoinvent database for all the countries where the Disclosure Competent Bodies do not report their own data.

Following this strategy, better alignment between the CO₂ values of the AIB residual mix report and the implementation of the residual mixes in the ecoinvent database is achieved. Additionally, more transparency, traceability and consistency is introduced in the set of EFs used for the calculation of the CO₂ values for the residual mixes. Furthermore, country-specific EFs are available for the electricity imported from countries outside the calculation area of the residual mixes.

For EFs maintained by Competent Disclosure Bodies, ecoinvent will aim to align the emissions in the ecoinvent database for further consistency.

List of emission factors

Table 1 shows the fuel category emission factors used for the calculation of the CO₂ values for the residual mixes. The column “Source” indicates the origin of the EF. In the case where the source is the ecoinvent database, the datasets from the ecoinvent database that were used to calculate the EF are listed subsequently. The datasets are listed in the format “<activity name> [<geography>]” and refer to the “Allocation, cut-off” system model in version 3.9.1 of the ecoinvent database. Entries with RE-DISS listed as their source take their value from the RE-DISS project. For those entries their value was retained due to insufficient information on the composition of the “FO unspecified” fuel category. As third option, values can be provided by the corresponding Competent Disclosure Bodies.

Table 1. List of emission factors (EF) used for the calculation of the residual mixes for the year 2022.

Country	Fuel Categories	Value (kgCO ₂ /kWh):	Source:
AT	FO unspecified	0.486	RE-DISS: Value retained from the RE-DISS project due to insufficient data for replacement.
AT	FO hard coal	0.862	Calculated value based on the following datasets from the ecoinvent database: - electricity production, hard coal [AT] - heat and power co-generation, hard coal [AT]
AT	FO gas	0.436	Calculated value based on the following datasets from the ecoinvent database: - electricity production, natural gas, combined cycle power plant [AT] - electricity production, natural gas, conventional power plant [AT] - heat and power co-generation, natural gas, combined cycle power plant, 400MW electrical [AT] - heat and power co-generation, natural gas, conventional power plant, 100MW electrical [AT]
AT	FO oil	0.926	Calculated value based on the following datasets from the ecoinvent database: - electricity production, oil [AT] - heat and power co-generation, oil [AT]

Appendix to “European Residual Mixes: Results of the calculation of Residual Mixes for the calendar year 2022”

Country	Fuel Categories	Value (kgCO2/kWh):	Source:
BA	FO lignite	1.279	Calculated value based on the following datasets from the ecoinvent database: - electricity production, lignite [BA] - heat and power co-generation, lignite [BA]
BA	FO oil	0.944	Calculated value based on the following datasets from the ecoinvent database: - electricity production, oil [BA]
BE	FO unspecified	0.461	RE-DISS: Value retained from the RE-DISS project due to insufficient data for replacement.
BE	FO gas	0.396	Calculated value based on the following datasets from the ecoinvent database: - electricity production, natural gas, combined cycle power plant [BE] - electricity production, natural gas, conventional power plant [BE] - heat and power co-generation, natural gas, combined cycle power plant, 400MW electrical [BE] - heat and power co-generation, natural gas, conventional power plant, 100MW electrical [BE]
BE	FO oil	0.767	Calculated value based on the following datasets from the ecoinvent database: - electricity production, oil [BE] - heat and power co-generation, oil [BE]
BG	FO lignite	1.105	Calculated value based on the following datasets from the ecoinvent database: - electricity production, lignite [BG] - heat and power co-generation, lignite [BG]
BG	FO hard coal	1.066	Calculated value based on the following datasets from the ecoinvent database: - electricity production, hard coal [BG] - heat and power co-generation, hard coal [BG]
BG	FO gas	0.786	Calculated value based on the following datasets from the ecoinvent database: - electricity production, natural gas, conventional power plant [BG] - heat and power co-generation, natural gas, combined cycle power plant, 400MW electrical [BG] - heat and power co-generation, natural gas, conventional power plant, 100MW electrical [BG]
BG	FO oil	1.383	Calculated value based on the following datasets from the ecoinvent database: - electricity production, oil [BG] - heat and power co-generation, oil [BG]
BY	FO lignite	1.135	Calculated value based on the following datasets from the ecoinvent database: - electricity production, peat [RoW]
BY	FO gas	0.513	Calculated value based on the following datasets from the ecoinvent database: - electricity production, natural gas, combined cycle power plant [RoW] - electricity production, natural gas, conventional power plant [RoW] - heat and power co-generation, natural gas, conventional power plant, 100MW electrical [RoW]
BY	FO oil	0.786	Calculated value based on the following datasets from the ecoinvent database: - electricity production, oil [RoW] - heat and power co-generation, oil [RoW]
BG	FO lignite	1.105	Calculated value based on the following datasets from the ecoinvent database: - electricity production, lignite [BG] - heat and power co-generation, lignite [BG]
BG	FO hard coal	1.066	Calculated value based on the following datasets from the ecoinvent database: - electricity production, hard coal [BG] - heat and power co-generation, hard coal [BG]
BG	FO gas	0.786	Calculated value based on the following datasets from the ecoinvent database: - electricity production, natural gas, conventional power plant [BG] - heat and power co-generation, natural gas, combined cycle power plant, 400MW electrical [BG] - heat and power co-generation, natural gas, conventional power plant, 100MW electrical [BG]
BG	FO oil	1.383	Calculated value based on the following datasets from the ecoinvent database: - electricity production, oil [BG] - heat and power co-generation, oil [BG]

Appendix to “European Residual Mixes: Results of the calculation of Residual Mixes for the calendar year 2022”

Country	Fuel Categories	Value (kgCO ₂ /kWh):	Source:
CH	FO unspecified	0.398	RE-DISS: Value retained from the RE-DISS project due to insufficient data for replacement.
CH	FO gas	0.460	Calculated value based on the following datasets from the ecoinvent database: - heat and power co-generation, natural gas, 500kW electrical, lean burn [CH]
CY	FO oil	0,738	Value provided by Competent Disclosure Body
CZ	FO unspecified	1.297	Calculated value based on the following datasets from the ecoinvent database: - treatment of blast furnace gas, in power plant [CZ] - treatment of coal gas, in power plant [CZ] - electricity, from municipal waste incineration to generic market for electricity, medium voltage [CZ]
CZ	FO lignite	1.528	Calculated value based on the following datasets from the ecoinvent database: - electricity production, lignite [CZ] - heat and power co-generation, lignite [CZ]
CZ	FO hard coal	1.388	Calculated value based on the following datasets from the ecoinvent database: - heat and power co-generation, hard coal [CZ]
CZ	FO gas	0.596	Calculated value based on the following datasets from the ecoinvent database: - electricity production, natural gas, combined cycle power plant [CZ] - electricity production, natural gas, conventional power plant [CZ] - heat and power co-generation, natural gas, conventional power plant, 100MW electrical [CZ]
CZ	FO oil	1.236	Calculated value based on the following datasets from the ecoinvent database: - electricity production, oil [CZ] - heat and power co-generation, oil [CZ]
DE	FO unspecified	0.922	RE-DISS: Value retained from the RE-DISS project due to insufficient data for replacement.
DE	FO lignite	1.176	Calculated value based on the following datasets from the ecoinvent database: - electricity production, lignite [DE] - heat and power co-generation, lignite [DE]
DE	FO hard coal	0.900	Calculated value based on the following datasets from the ecoinvent database: - electricity production, hard coal [DE] - heat and power co-generation, hard coal [DE]
DE	FO gas	0.436	Calculated value based on the following datasets from the ecoinvent database: - electricity production, natural gas, combined cycle power plant [DE] - electricity production, natural gas, conventional power plant [DE] - heat and power co-generation, natural gas, combined cycle power plant, 400MW electrical [DE] - heat and power co-generation, natural gas, conventional power plant, 100MW electrical [DE]
DE	FO oil	0.718	Calculated value based on the following datasets from the ecoinvent database: - electricity production, oil [DE] - heat and power co-generation, oil [DE]
DK	FO unspecified	0.939	RE-DISS: Value retained from the RE-DISS project due to insufficient data for replacement.
DK	FO hard coal	0.834	Calculated value based on the following datasets from the ecoinvent database: - heat and power co-generation, hard coal [DK]
DK	FO gas	0.463	Calculated value based on the following datasets from the ecoinvent database: - heat and power co-generation, natural gas, combined cycle power plant, 400MW electrical [DK] - heat and power co-generation, natural gas, conventional power plant, 100MW electrical [DK]
DK	FO oil	0.874	Calculated value based on the following datasets from the ecoinvent database: - electricity production, oil [DK] - heat and power co-generation, oil [DK]
EE	FO unspecified	1.007	Calculated value based on the following datasets from the ecoinvent database: - treatment of coal gas, in power plant [RoW]

Country	Fuel Categories	Value (kgCO ₂ /kWh):	Source:
			- electricity, from municipal waste incineration to generic market for electricity, medium voltage [RoW]
EE	FO lignite	1.260	Calculated value based on the following datasets from the ecoinvent database: - electricity production, peat [EE]
EE	FO gas	0.473	Calculated value based on the following datasets from the ecoinvent database: - heat and power co-generation, natural gas, conventional power plant, 100MW electrical [EE]
EE	FO oil	1.007	Calculated value based on the following datasets from the ecoinvent database: - electricity production, oil [EE] - heat and power co-generation, oil [EE]
ES	FO unspecified	0.433	RE-DISS: Value retained from the RE-DISS project due to insufficient data for replacement.
ES	FO lignite	1.030	Calculated value based on the following datasets from the ecoinvent database: - electricity production, lignite [ES]
ES	FO hard coal	0.982	Calculated value based on the following datasets from the ecoinvent database: - electricity production, hard coal [ES]
ES	FO gas	0.386	Calculated value based on the following datasets from the ecoinvent database: - electricity production, natural gas, combined cycle power plant [ES] - electricity production, natural gas, conventional power plant [ES]
ES	FO oil	0.740	Calculated value based on the following datasets from the ecoinvent database: - electricity production, oil [ES]
FI	FO unspecified	0.433	RE-DISS: Value retained from the RE-DISS project due to insufficient data for replacement.
FI	FO lignite	1.013	Calculated value based on the following datasets from the ecoinvent database: - electricity production, peat [FI]
FI	FO hard coal	0.866	Calculated value based on the following datasets from the ecoinvent database: - electricity production, hard coal [FI] - heat and power co-generation, hard coal [FI]
FI	FO gas	0.410	Calculated value based on the following datasets from the ecoinvent database: - electricity production, natural gas, combined cycle power plant [FI] - electricity production, natural gas, conventional power plant [FI] - heat and power co-generation, natural gas, combined cycle power plant, 400MW electrical [FI] - heat and power co-generation, natural gas, conventional power plant, 100MW electrical [FI]
FI	FO oil	0.594	Calculated value based on the following datasets from the ecoinvent database: - electricity production, oil [FI] - heat and power co-generation, oil [FI]
FR	FO unspecified	0,988	Value provided by Competent Disclosure Body
FR	FO hard coal	0,986	Value provided by Competent Disclosure Body
FR	FO gas	0,429	Value provided by Competent Disclosure Body
FR	FO oil	0,777	Value provided by Competent Disclosure Body
GB	FO unspecified	0.464	RE-DISS: Value retained from the RE-DISS project due to insufficient data for replacement.
GB	FO hard coal	0.895	Calculated value based on the following datasets from the ecoinvent database: - electricity production, hard coal [GB]
GB	FO gas	0.475	Calculated value based on the following datasets from the ecoinvent database: - electricity production, natural gas, conventional power plant [GB]
GB	FO oil	1.131	Calculated value based on the following datasets from the ecoinvent database: - electricity production, oil [GB]
GR	FO unspecified	1,255	Value from RE-DISS

Appendix to “European Residual Mixes: Results of the calculation of Residual Mixes for the calendar year 2022”

Country	Fuel Categories	Value (kgCO ₂ /kWh):	Source:
GR	FO lignite	1,477	Value provided by Competent Disclosure Body
GR	FO gas	0,354	Value provided by Competent Disclosure Body
GR	FO oil	0,779	Value provided by Competent Disclosure Body
HR	FO hard coal	0.940	Calculated value based on the following datasets from the ecoinvent database: - electricity production, hard coal [HR]
HR	FO gas	0.480	Calculated value based on the following datasets from the ecoinvent database: - electricity production, natural gas, combined cycle power plant [HR] - heat and power co-generation, natural gas, combined cycle power plant, 400MW electrical [HR] - heat and power co-generation, natural gas, conventional power plant, 100MW electrical [HR]
HR	FO oil	0.820	Calculated value based on the following datasets from the ecoinvent database: - electricity production, oil [HR]
HU	FO unspecified	0.474	Calculated value based on the following datasets from the ecoinvent database: - treatment of blast furnace gas, in power plant [HU] - treatment of coal gas, in power plant [HU] - electricity, from municipal waste incineration to generic market for electricity, medium voltage [HU]
HU	FO lignite	1.354	Calculated value based on the following datasets from the ecoinvent database: - electricity production, lignite [HU] - heat and power co-generation, lignite [HU]
HU	FO hard coal	1.354	#N/A
HU	FO gas	0.479	Calculated value based on the following datasets from the ecoinvent database: - electricity production, natural gas, combined cycle power plant [HU] - electricity production, natural gas, conventional power plant [HU] - heat and power co-generation, natural gas, combined cycle power plant, 400MW electrical [HU] - heat and power co-generation, natural gas, conventional power plant, 100MW electrical [HU]
HU	FO oil	0.958	Calculated value based on the following datasets from the ecoinvent database: - electricity production, oil [HU] - heat and power co-generation, oil [HU]
IE	FO lignite	0.990	Calculated value based on the following datasets from the ecoinvent database: - electricity production, peat [IE]
IE	FO hard coal	0.865	Calculated value based on the following datasets from the ecoinvent database: - electricity production, hard coal [IE]
IE	FO gas	0.429	Calculated value based on the following datasets from the ecoinvent database: - electricity production, natural gas, combined cycle power plant [IE] - electricity production, natural gas, conventional power plant [IE]
IE	FO oil	0.783	Calculated value based on the following datasets from the ecoinvent database: - electricity production, oil [IE]
IS	FO unspecified	0.486	RE-DISS: Value retained from the RE-DISS project due to insufficient data for replacement.
IS	FO oil	1.007	Calculated value based on the following datasets from the ecoinvent database: - electricity production, oil [IS]
IT	FO unspecified	0.461	RE-DISS: Value retained from the RE-DISS project due to insufficient data for replacement.
IT	FO hard coal	0.910	Calculated value based on the following datasets from the ecoinvent database: - electricity production, hard coal [IT] - heat and power co-generation, hard coal [IT]
IT	FO gas	0.427	Calculated value based on the following datasets from the ecoinvent database: - electricity production, natural gas, combined cycle power plant [IT] - electricity production, natural gas, conventional power plant [IT] - heat and power co-generation, natural gas, combined cycle power plant, 400MW electrical [IT]

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Country	Fuel Categories	Value (kgCO ₂ /kWh):	Source:
			- heat and power co-generation, natural gas, conventional power plant, 100MW electrical [IT]
IT	FO oil	0.794	Calculated value based on the following datasets from the ecoinvent database: - electricity production, oil [IT] - heat and power co-generation, oil [IT]
LT	FO unspecified	0.620	Calculated value based on the following datasets from the ecoinvent database: - electricity, from municipal waste incineration to generic market for electricity, medium voltage [RoW]
LT	FO gas	0.530	Calculated value based on the following datasets from the ecoinvent database: - heat and power co-generation, natural gas, combined cycle power plant, 400MW electrical [LT] - heat and power co-generation, natural gas, conventional power plant, 100MW electrical [LT]
LT	FO oil	1.309	Calculated value based on the following datasets from the ecoinvent database: - heat and power co-generation, oil [LT]
LU	FO unspecified	0,809	Value provided by Competent Disclosure Body
LU	FO lignite	1,430	Value provided by Competent Disclosure Body
LU	FO hard coal	1,080	Value provided by Competent Disclosure Body
LU	FO gas	0,436	Value provided by Competent Disclosure Body
LV	FO unspecified	0.620	RE-DISS: Value retained from the RE-DISS project due to insufficient data for replacement.
LV	FO lignite	1.135	Calculated value based on the following datasets from the ecoinvent database: - electricity production, peat [RoW]
LV	FO hard coal	1.001	Calculated value based on the following datasets from the ecoinvent database: - heat and power co-generation, hard coal [RoW]
LV	FO gas	0.537	Calculated value based on the following datasets from the ecoinvent database: - heat and power co-generation, natural gas, combined cycle power plant, 400MW electrical [LV] - heat and power co-generation, natural gas, conventional power plant, 100MW electrical [LV]
LV	FO oil	1.309	Calculated value based on the following datasets from the ecoinvent database: - heat and power co-generation, oil [LV]
ME	FO lignite	1.243	Calculated value based on the following datasets from the ecoinvent database: - electricity production, lignite [RoW]
MK	FO lignite	1.401	Calculated value based on the following datasets from the ecoinvent database: - electricity production, lignite [MK]
MK	FO gas	0.441	Calculated value based on the following datasets from the ecoinvent database: - heat and power co-generation, natural gas, combined cycle power plant, 400MW electrical [MK] - heat and power co-generation, natural gas, conventional power plant, 100MW electrical [MK]
MK	FO oil	0.869	Calculated value based on the following datasets from the ecoinvent database: - electricity production, oil [MK]
MT	FO gas	0,396	Value provided by Competent Disclosure Body
MT	FO oil	0,851	Value provided by Competent Disclosure Body
NL	FO unspecified	0.609	RE-DISS: Value retained from the RE-DISS project due to insufficient data for replacement.
NL	FO hard coal	0.841	Calculated value based on the following datasets from the ecoinvent database: - electricity production, hard coal [NL] - heat and power co-generation, hard coal [NL]
NL	FO gas	0.399	Calculated value based on the following datasets from the ecoinvent database: - electricity production, natural gas, combined cycle power plant [NL]

Appendix to “European Residual Mixes: Results of the calculation of Residual Mixes for the calendar year 2022”

Country	Fuel Categories	Value (kgCO2/kWh):	Source:
			- electricity production, natural gas, conventional power plant [NL] - heat and power co-generation, natural gas, combined cycle power plant, 400MW electrical [NL] - heat and power co-generation, natural gas, conventional power plant, 100MW electrical [NL]
NL	FO oil	0.915	Calculated value based on the following datasets from the ecoinvent database: - heat and power co-generation, oil [NL]
NO	FO unspecified	0.486	RE-DISS: Value retained from the RE-DISS project due to insufficient data for replacement.
NO	FO hard coal	1.175	Calculated value based on the following datasets from the ecoinvent database: - heat and power co-generation, hard coal [NO]
NO	FO gas	0.376	Calculated value based on the following datasets from the ecoinvent database: - electricity production, natural gas, combined cycle power plant [NO] - electricity production, natural gas, conventional power plant [NO]
NO	FO oil	0.430	Calculated value based on the following datasets from the ecoinvent database: - electricity production, oil [NO] - heat and power co-generation, oil [RoW]
PL	FO lignite	1.117	Calculated value based on the following datasets from the ecoinvent database: - electricity production, lignite [PL] - heat and power co-generation, lignite [PL]
PL	FO hard coal	0.995	Calculated value based on the following datasets from the ecoinvent database: - heat and power co-generation, hard coal [PL]
PL	FO gas	0.454	Calculated value based on the following datasets from the ecoinvent database: - heat and power co-generation, natural gas, combined cycle power plant, 400MW electrical [PL] - heat and power co-generation, natural gas, conventional power plant, 100MW electrical [PL]
PL	FO oil	0.754	Calculated value based on the following datasets from the ecoinvent database: - electricity production, oil [PL] - heat and power co-generation, oil [PL]
PT	FO unspecified	0.461	RE-DISS: Value retained from the RE-DISS project due to insufficient data for replacement.
PT	FO hard coal	0.910	Calculated value based on the following datasets from the ecoinvent database: - electricity production, hard coal [PT]
PT	FO gas	0.370	Calculated value based on the following datasets from the ecoinvent database: - electricity production, natural gas, combined cycle power plant [PT]
PT	FO oil	0.676	Calculated value based on the following datasets from the ecoinvent database: - electricity production, oil [PT] - heat and power co-generation, oil [PT]
RO	FO unspecified	1.103	RE-DISS: Value retained from the RE-DISS project due to insufficient data for replacement.
RO	FO lignite	1.118	Calculated value based on the following datasets from the ecoinvent database: - electricity production, lignite [RO] - heat and power co-generation, lignite [RO]
RO	FO hard coal	1.001	Calculated value based on the following datasets from the ecoinvent database: - heat and power co-generation, hard coal [RoW]
RO	FO gas	0.572	Calculated value based on the following datasets from the ecoinvent database: - electricity production, natural gas, conventional power plant [RO] - heat and power co-generation, natural gas, combined cycle power plant, 400MW electrical [RO] - heat and power co-generation, natural gas, conventional power plant, 100MW electrical [RO]
RO	FO oil	1.030	Calculated value based on the following datasets from the ecoinvent database: - electricity production, oil [RO] - heat and power co-generation, oil [RO]

Appendix to “European Residual Mixes: Results of the calculation of Residual Mixes for the calendar year 2022”

Country	Fuel Categories	Value (kgCO ₂ /kWh):	Source:
RS	FO lignite	1.259	Calculated value based on the following datasets from the ecoinvent database: - electricity production, lignite [RS] - heat and power co-generation, lignite [RS]
RS	FO gas	0.675	Calculated value based on the following datasets from the ecoinvent database: - heat and power co-generation, natural gas, conventional power plant, 100MW electrical [RS]
RU	FO lignite	1.660	Calculated value based on the following datasets from the ecoinvent database: - electricity production, peat [RU] - heat and power co-generation, lignite [RU]
RU	FO hard coal	1.551	Calculated value based on the following datasets from the ecoinvent database: - heat and power co-generation, hard coal [RU]
RU	FO gas	0.649	Calculated value based on the following datasets from the ecoinvent database: - heat and power co-generation, natural gas, combined cycle power plant, 400MW electrical [RU] - heat and power co-generation, natural gas, conventional power plant, 100MW electrical [RU]
RU	FO oil	0.985	Calculated value based on the following datasets from the ecoinvent database: - heat and power co-generation, oil [RU]
SE	FO unspecified	0.486	RE-DISS: Value retained from the RE-DISS project due to insufficient data for replacement.
SE	FO lignite	1.135	Calculated value based on the following datasets from the ecoinvent database: - electricity production, peat [SE]
SE	FO hard coal	1.079	Calculated value based on the following datasets from the ecoinvent database: - heat and power co-generation, hard coal [SE]
SE	FO gas	0.533	Calculated value based on the following datasets from the ecoinvent database: - heat and power co-generation, natural gas, conventional power plant, 100MW electrical [SE]
SE	FO oil	0.715	Calculated value based on the following datasets from the ecoinvent database: - electricity production, oil [SE] - heat and power co-generation, oil [SE]
SI	FO lignite	1.171	Calculated value based on the following datasets from the ecoinvent database: - electricity production, lignite [SI] - heat and power co-generation, lignite [SI]
SI	FO hard coal	1.001	Calculated value based on the following datasets from the ecoinvent database: - heat and power co-generation, hard coal [RoW]
SI	FO gas	0.482	Calculated value based on the following datasets from the ecoinvent database: - electricity production, natural gas, conventional power plant [SI] - heat and power co-generation, natural gas, conventional power plant, 100MW electrical [SI]
SI	FO oil	0.889	Calculated value based on the following datasets from the ecoinvent database: - electricity production, oil [SI] - heat and power co-generation, oil [SI]
SK	FO lignite	1.491	Calculated value based on the following datasets from the ecoinvent database: - heat and power co-generation, lignite [SK]
SK	FO hard coal	1.173	Calculated value based on the following datasets from the ecoinvent database: - heat and power co-generation, hard coal [SK]
SK	FO gas	0.482	Calculated value based on the following datasets from the ecoinvent database: - electricity production, natural gas, combined cycle power plant [SK] - electricity production, natural gas, conventional power plant [SK] - heat and power co-generation, natural gas, combined cycle power plant, 400MW electrical [SK] - heat and power co-generation, natural gas, conventional power plant, 100MW electrical [SK]
SK	FO oil	1.195	Calculated value based on the following datasets from the ecoinvent database: - heat and power co-generation, oil [SK]

Country	Fuel Categories	Value (kgCO ₂ /kWh):	Source:
TR	FO lignite	1.231	Calculated value based on the following datasets from the ecoinvent database: - electricity production, lignite [TR]
TR	FO hard coal	0.950	Calculated value based on the following datasets from the ecoinvent database: - electricity production, hard coal [TR]
TR	FO gas	0.393	Calculated value based on the following datasets from the ecoinvent database: - electricity production, natural gas, combined cycle power plant [TR] - electricity production, natural gas, conventional power plant [TR] - heat and power co-generation, natural gas, combined cycle power plant, 400MW electrical [TR] - heat and power co-generation, natural gas, conventional power plant, 100MW electrical [TR]
UA	FO hard coal	1.181	Calculated value based on the following datasets from the ecoinvent database: - electricity production, hard coal [UA] - heat and power co-generation, hard coal [UA]
UA	FO gas	0.788	Calculated value based on the following datasets from the ecoinvent database: - electricity production, natural gas, combined cycle power plant [UA] - electricity production, natural gas, conventional power plant [UA] - heat and power co-generation, natural gas, conventional power plant, 100MW electrical [UA]
UA	FO oil	1.057	Calculated value based on the following datasets from the ecoinvent database: - electricity production, oil [UA] - heat and power co-generation, oil [UA]
XK	FO lignite	1.243	Calculated value based on the following datasets from the ecoinvent database: - electricity production, lignite [RoW]
XK	FO oil	0.816	Calculated value based on the following datasets from the ecoinvent database: - electricity production, oil [RoW]

Outlook

Further efforts will be undertaken in order to align the resulting CO₂ values calculated for the residual mixes by AIB and those calculated by ecoinvent. ecoinvent is working on including EFs provided by Competent Disclosure Bodies where appropriate sources and background information is available. Furthermore, future calculations of residual mixes by AIB will benefit from updates of the ecoinvent database.

References

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