RE-DISS II
Reliable disclosure systems for Europe

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The Residual Mix and European Attribute Mix Calculation

Methodology Description of the RE-DISS II Project

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1 Glossary

(Electricity generation/production) Attribute – Attribute refers to a piece of information, which is tracked in order to disclose specific consumption. Most important attributes for disclosure are the energy source and the associated CO_2 emissions and radioactive waste. In the de-linked tracking system the information content of a GO represents all the relevant generation attributes of 1 MWh of electricity.

Available attributes – Attributes that are not explicitly tracked in order to disclose certain consumption. The pool of yearly available attributes in a country constitutes the domestic residual mix.

Competent Body – Body mandated to supervise reliability of electricity disclosure, typically the National Regulatory Authority.

Electricity Disclosure – The process in which electricity consumers are informed about the energy origin and environmental impact of sold/consumed electricity**.** Electricity disclosure is set forth by directive 2009/72/EC, Art.3(9).

European Attribute Mix (EAM) – The EAM is a calculatory pool of surplus available attributes in residual mixes and is needed for reliable coordination of residual mix calculation in Europe. EAM results from surpluses of available attributes compared to untracked consumption in surplus countries. The EAM is used to cover deficits of available attributes compared to untracked consumption in deficit countries.

Explicit disclosure – Electricity consumption disclosed with explicit electricity tracking instruments such as Guarantees of Origin.

Guarantee of Origin – An electricity tracking instrument, defined by Directive 2009/28/EC, Article 15, with the sole purpose of providing electricity disclosure information.

Implicit disclosure – Electricity consumption disclosed with a statistical mix of generation attributes, e.g. residual mix.

Reliable Tracking Systems (RTS) – RTSs are other explicit tracking systems besides EECS-GOs that are considered reliable and transparent. Typical example of certificate-based RTSs are national GO systems and examples of non-certificate-based RTSs are Feed-in tariffs when linked to disclosure or in some cases contract-based tracking.

Residual mix – The residual mix is a pool of available generation attributes, which are not explicitly tracked through EECS-GOs or RTSs. Residual mix is an implicit disclosure mechanism in which volumes and shares of energy sources and environmental impacts of untracked electricity consumption[1] are determined by the statistical mix of a country's yearly generation attributes, available after explicit tracking. It complements the disclosure done with explicit tracking instruments (EECS-GOs and RTSs) by determining the origin of the rest

[1] i.e. consumption, which has not been disclosed with explicit tracking instruments such as guarantees of origin or contract-based tracking.

of electricity consumption. Residual mix is defined on a country level[2] and calculated based on a calendar year.

Residual mix calculation – Residual mix calculation is an implicit tracking mechanism in which shares of energy sources and environmental impacts of untracked consumption are determined by the statistical mix of available attributes.

Total supplier mix (TSM) – TSM means the total attributes disclosed in a country; both explicitly tracked and those disclosed through the residual mix.

Untracked consumption – Untracked consumption refers to consumption that is not disclosed by using explicit tracking mechanisms, such as EECS-GOs. Untracked consumption is disclosed with the residual mix.

[2] Under unified power markets (e.g. the Nordic countries) a broader approach can be taken as long as all associated countries agree upon it.

2 Introduction

This paper aims primarily to describe how to calculate the Residual Mixes and the European Attribute Mix (EAM) following the RE-DISS methodology.

Chapters 2-3 introduce the key concepts and background knowledge necessary to understand the remainder of the document. They also explain why the residual mix and EAM are needed.

Chapter 4 describes the differences in national practices of residual mix calculation and implicit disclosure in order to justify choices made for the harmonized methodology for calculation of the EAM.

Chapter 5 presents the current residual mix and EAM calculation methodology as used by the RE-DISS II project and as suggested for the follow-up organization.

Chapter 6 depicts the Issuance-based method as a national alternative for residual mix calculation methodology and as a potential future methodology of the central calculation.

2.1 Electricity Disclosure

Klimscheffskij et al. (2015) summarize disclosure as:

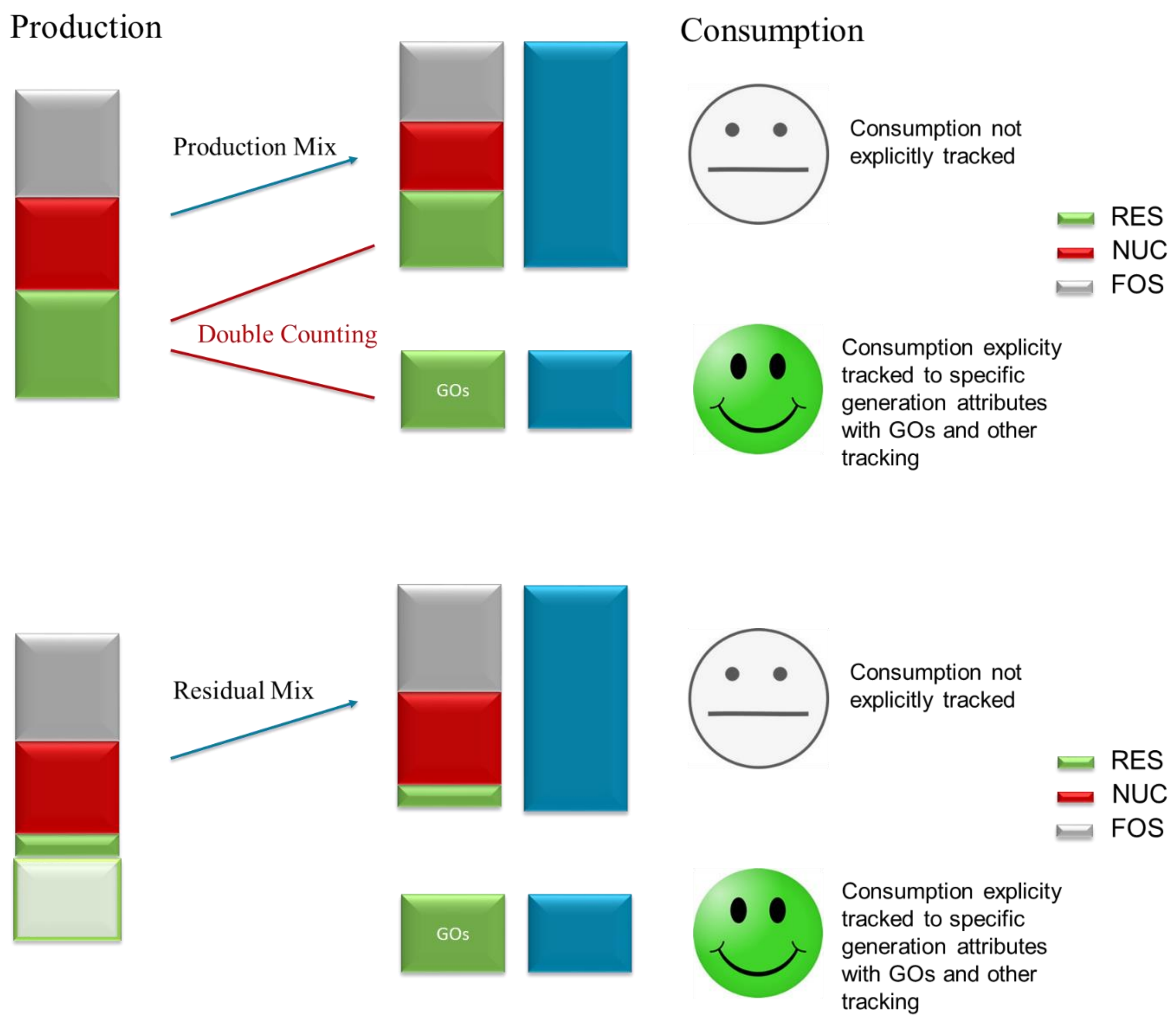
"Directive 2009/72/EC, Article 3(9), requires electricity suppliers to disclose in electricity bills and in promotional materials the energy origin of the electricity they are selling. This process is commonly referred to as electricity disclosure, which constitutes of both explicit tracking and implicit allocation of electricity generation attributes (Information about the characteristics of the power production which need to be tracked, most importantly the 'energy source and technology used for power production, the related CO2 emissions and radioactive waste produced' (Timpe & Seebach, 2011)) from production to consumption.

In the EU, guarantees of origin (GO) as defined by Article 15 of the Directive 2009/28/EC, are the main mechanism for explicit tracking of electricity generation attributes. As long as not all electricity consumption is explicitly tracked to certain generation attributes, explicit tracking mechanisms always require the support of an implicit disclosure system, a residual mix, in order to avoid double counting. This is important, because consumers expect the tracking system to be reliable and their willingness to purchase renewable power can be significantly reduced if the attributes are double counted (Jansen & Seebach, 2009)."

2.2 Residual Mix

The basic idea of residual mix calculation is fairly simple: it represents the production mix of a country corrected with generation attributes which are explicitly tracked (see also definition of residual mix). Residual mix is used to determine the energy origin of untracked consumption, i.e. consumption, which has not been disclosed with explicit tracking instruments such as GOs. So if all electricity consumption was explicitly tracked to specific generation attributes, residual mix would not be needed.

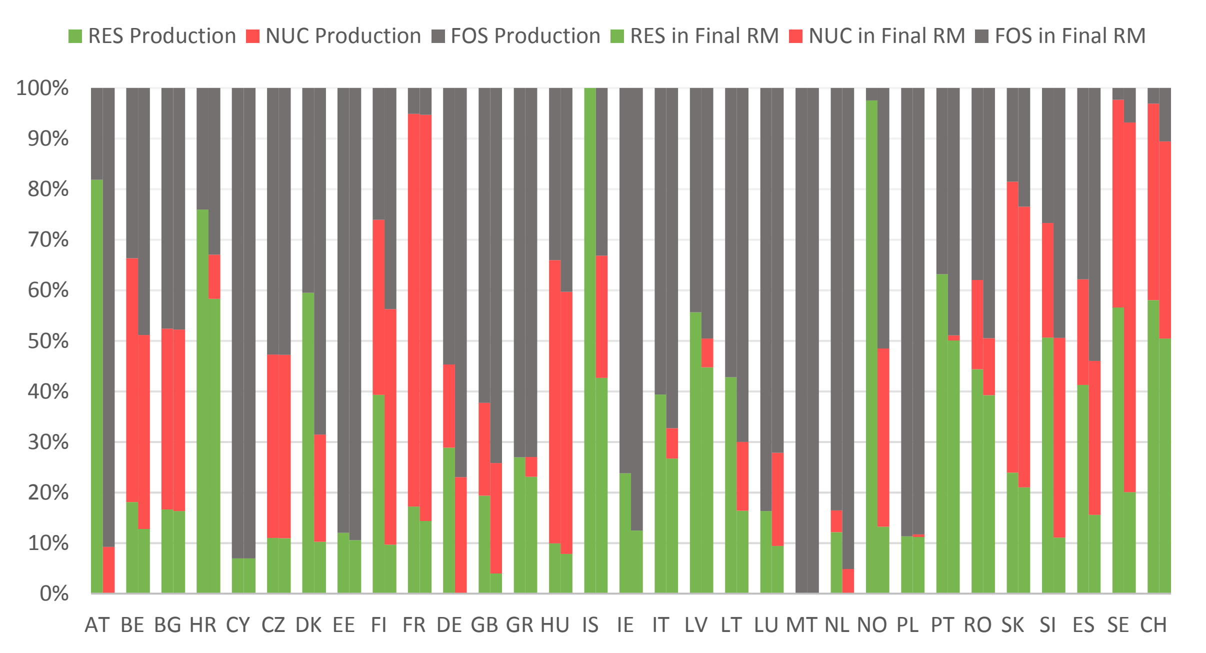
Figure 1 The idea of the residual mix



The residual mix should not be used for any electricity products which are differentiated with regard to the origin of electricity. This means that e.g. an electricity supplier should only use it “to bridge up the difference between the total electricity sales and the attributes from explicit tracking mechanisms where the supplier has not used explicit instruments for its entire sales.” (RE-DISS 2015a)

From the figure above it is visible that if untracked consumption were disclosed with the production mix (including attributes represented by issued GOs), as shown in the upper graph, it would mean that the renewable attributes which are explicitly tracked would be double counted in electricity disclosure. Figure 2 represents the differences in residual vs. production mixes of countries in 2014. The difference is notable amongst the front-runners of electricity tracking, whereas there is no clear difference in countries without an operating electricity tracking system. Results of residual mix calculations were published for years 2010-2014 by the RE-DISS project (RE-DISS 2015b).

Figure 2 Production mix (left) and Residual mix (right) of 2014



The need for residual mix calculation arises from the combined effect of Directives 2009/28/EC and 2009/72/EC, but interestingly enough, it is not mentioned in either of them and it is still a rarity among national legislations and regulations transposing those Directives. As long as not all electricity is not explicitly tracked, residual mix is needed and should be transposed by legislation.

As mentioned, using explicit tracking mechanisms, guarantees of origin, for the disclosure of a part of electricity consumption, requires that the explicitly tracked attributes are removed from the energy source mix of other consumption (untracked consumption), when complying with 2009/28/EC, Art.15(2) and with 2009/72/EC, Art. 3(9). Reliable and transparent residual mix calculation, enables this task, and is an accurate way to disclose untracked consumption to consumers and in the best case, to increase demand for green power.

3 European Attribute Mix

3.1 Why is European Attribute Mix Required?

"The process of residual mix calculation might seem simple, but the international exchange of both electricity and GOs necessitates that also the calculation is coordinated among countries, which adds complexity. In a closed system where no connection to the external world exists, the consumption energy mix of a country equals, in volume and energy sources used, its production mix. But in real life, electricity as well as generation attributes (through GOs) are transferred across borders, which can significantly alter this equilibrium in a country." (Klimscheffskij et al. 2015)

Box 1: Grasp the idea

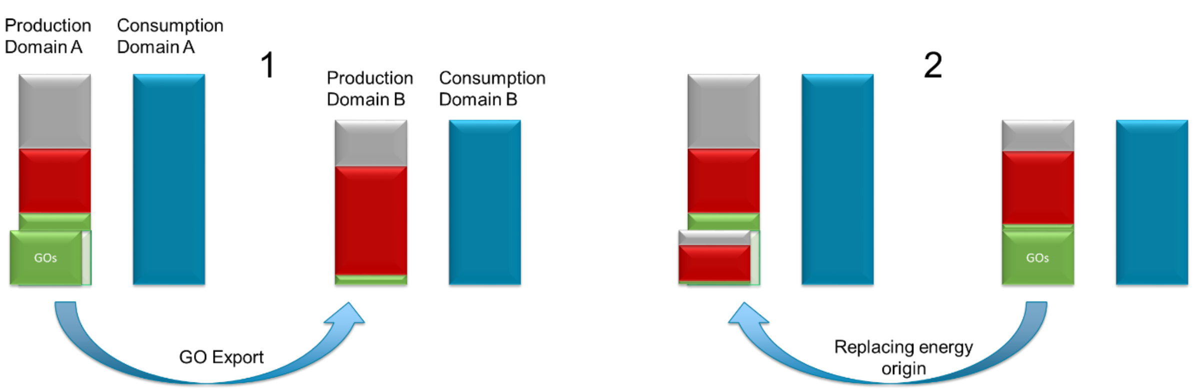
But what is the effect of international exchange of electricity and GOs? Imagine a small country with no domestic production. The energy origin of electricity consumed in that country would be the sum of energy mixes imported. Thus coordination is clearly needed to know the origin of imported electricity.

International exchange of electricity generation attributes (through GOs) has an even much greater effect. Hypothetically, if a country exports all of its attributes with GOs, we face the same question: what is the energy origin of electricity consumed in that country? It needs to be derived from the countries importing those GOs.

(Note: these examples seem far-fetched, but it needs to be noted that the GO market is highly international. It is not uncommon that a country exports a major part of its renewable generation attributes through GOs.)

In Figure 3, two countries with similar production mixes exchange energy origin. Country on the left exports GOs to the country on the right and gets in return the attributes that are now in excess due to imported GOs.

Figure 3 Exchange of energy origin between 2 countries



As described in Figure 3, "Ideally, each country should fill in the missing energy origin caused by net export of GOs with the residual mix of the country where the GOs were exported to, just as an importer of electricity would get the energy origin from the countries it is importing from. In practice, such bilateral balancing would be highly complicated considering the international nature of the guarantee of origin and electricity markets and might likely not even be possible, because of the hen and egg problem: The residual mix of country A depends on that of B, which depends on that of C, which in turn depends on that of A. This might sound manageable with 3 countries, but the calculation needs to be Europe-wide." (Klimscheffskij et al. 2015)

Hence, the bilateral balancing of Figure 3 is incorrect. A European wide approach for the harmonization of the calculation is needed: the European Attribute Mix.

3.2 How does the European Attribute Mix Work?

"The fundamental feature of the RE-DISS residual mix calculation methodology is the concept of a common attribute pool, generally known as the European Attribute Mix (EAM)[3]. Instead of different countries interacting with each other, they all interact with this common pool of attributes, which interconnects the domestic residual mixes the same way as the AIB Hub interconnects the explicit tracking of attributes (GOs). This means countries can themselves calculate the domestic residual mix, but have to coordinate to form the European Attribute Mix (EAM), which is needed in order to establish the final residual mix of each domain."(Klimscheffskij et al. 2015) This coordination was, from 2010 to 2014, carried out by the RE-DISS project.

Physically, electricity production and consumption in Europe equal each other in volume as long as electricity transfers to and from outside Europe are considered. International trading of GOs and electricity distort the equilibrium of generation attributes and electricity consumption on a national level, but on a European level the balance remains. The coordinated residual mix calculation, through EAM, returns this balance at the domestic level.

Plainly put the EAM works so that:

- Countries which have a surplus of generation attributes compared to their consumption (typically GO net importers and/or electricity net exporters) feed attributes to the EAM according to the shares of different energy sources and intensity of CO2 and radioactive waste in their domestic residual mix.
- The EAM is established as the total of surplus attributes.
- Countries which have a deficit of generation attributes compared to their consumption (typically GO net exporters and/or electricity net importers), receive these attributes from the EAM according to the shares of different energy sources and intensity of CO2 and radioactive waste in the EAM to fill in their domestic residual mix with the amount of the deficit.

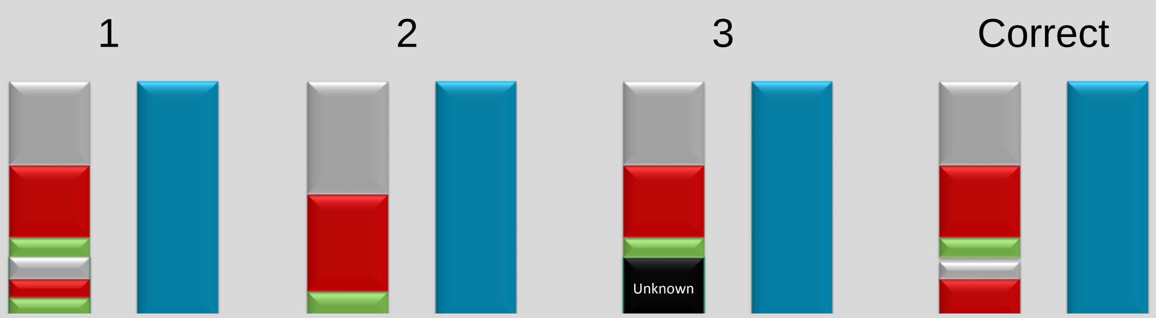
Because of the physical balance, the total surplus equals in volume with the total deficit. The coordinated residual mix calculation is a simple yet powerful tool to allow international trading of generation attributes whilst avoiding double counting.

[3] Which includes EU27, Norway, Iceland and Switzerland.

Box 2: What if there was no European Attribute Mix?

If no EAM would be calculated in Europe, deficit countries would have to "guess" the origin of the missing attributes, most commonly using their domestic production (1) or residual mix (2) (see Figure 4). In both cases the outcome would be wrong, often leading to double counting of renewables, because the content of renewables in the EAM is typically very low. One option would also be to mark a percentage of consumption originating from unknown energy sources (3), which could also hardly be considered as reliable disclosure.

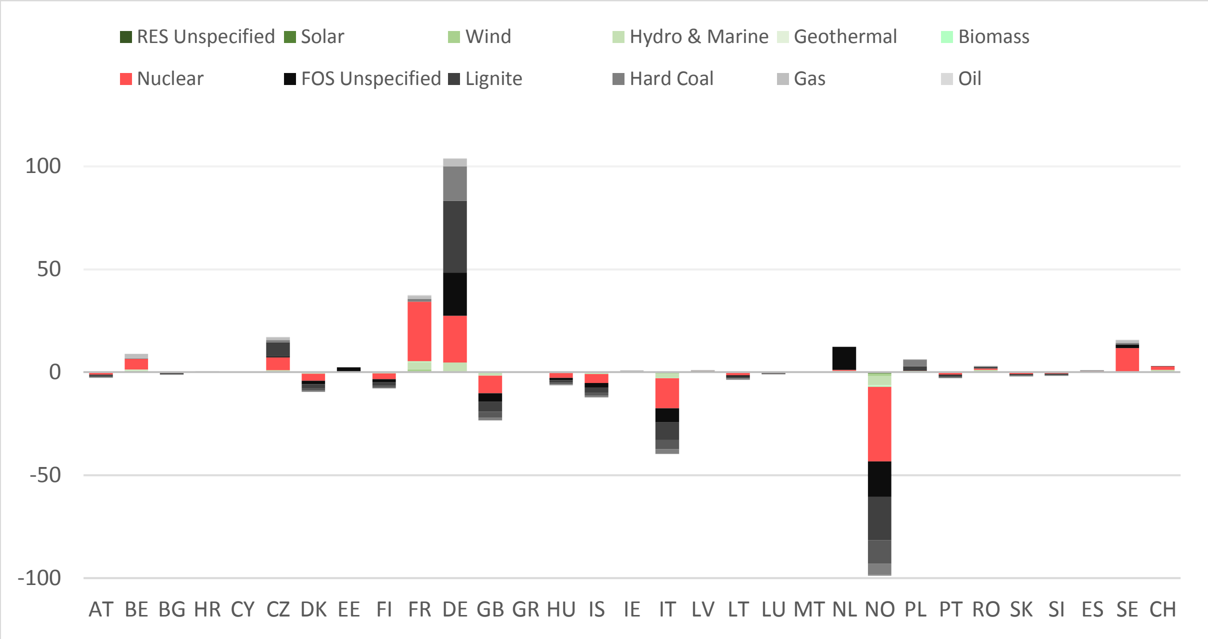
Figure 4 Without the EAM, countries in deficit of attributes would have to expand their production or residual mix or label part of electricity consumed in that country as unknown



3.3 Case Example: 2013 EAM

The physical balance of electricity production and consumption during a year can be observed from the example of countries' interaction with the EAM of year 2013. What is left over from surplus countries (+) is exactly the same as the total missing from deficit countries (-).

Figure 5 Attribute Balancing with the EAM in 2013



It is important to understand that Figure 5 actually portrays the combined effect of physical transfer of electricity and transfer of electricity generation attributes between countries. If GO trading is set aside, countries on the negative side would be the ones net importing physical electricity. On the other hand, net exporters of electricity, would have too many attributes to merely disclose the domestic consumption. This is why also countries that do not trade GOs internationally interact with the EAM.

When GO exporting and importing is added to the picture, large exporters of GOs, such as Norway, lose generation attributes. Even though the difference between production and consumption in Norway is not great, the large export of GOs causes there to be significantly more untracked consumption than available attributes in the domestic residual mix. The counter-effect of Norway can be seen mainly in Belgium, Germany and the Netherlands. Also there the production and consumption are quite equal, but Norwegian attributes as well as the domestic ones are used for disclosure, which explains the surplus. This means that information disclosed to Norwegian customers on electricity origin contains a major share of residual mixes of Belgium, Germany and the Netherlands, which ensures that double counting is avoided.

4 Current Residual Mix Calculation Practices of Countries

RE-DISS I project set out to develop a common methodology for residual mix calculation in Europe. However, during RE-DISS II, it became clear that too significant differences reside in the disclosure practices of European countries for a common methodology to be feasible. The following lists some of the fundamental reasons why:

1. Concept of the residual mix is different

While the residual mix successfully eliminates double counting of explicitly tracked attributes by removing them from any default generation mix, some countries have taken an even more conservative approach. They have established a residual mix which consists of only fossil and nuclear attributes according to the production mix of the country (or possibly taking into account tracking of fossil and nuclear attributes). The result of this calculation is naturally different from an actual residual mix calculation, as it assumes that all renewable attributes are explicitly tracked and in some cases that no explicit tracking of fossil or nuclear attributes occurs.

Thus for some countries, the concept of the residual mix is a mix which removes all possibilities of double counting of renewable attributes, but does not necessarily yield an altogether reliable disclosure scheme.

2. Timing of disclosure is not harmonized

Many countries have established a deadline for cancellation of GOs relating to electricity disclosure of a certain year. According to RE-DISS Best Practices, cancellation of GOs relating to disclosure of year X should be made the latest by March 31st of the following year. Only after this deadline, the residual mix for the previous year can be calculated.

While the deadline of March 31st is a common practice, there are exceptions that extend as far as the end October of the following year or in some cases the deadline might be non-existent. Logically if different timeframes are used to calculate the residual mix of different countries, the data will be incompatible and the balance between generation attributes and consumption is lost.

3. Different outlook on whether GO's eligibility for electricity disclosure is bound to its generation year

Perhaps one of the most fundamental difference in the perspective different countries have on GOs is whether a GO is to be used for disclosure of electricity consumption of the same year during which the related electricity was produced. This sounds logical, since electricity consumed in a given year is effectively derived from the energy sources used for electricity production during that year. However, the interpretation of the 12 month lifetime of GOs has created 2 schools of thought (For more accurate description of the problems of 12 months lifetime, please see Appendix X):

- GOs are eligible for electricity disclosure of only the year the respective production took place. This means that electricity disclosure should always only include attributes of power production of the corresponding year and that any residual GOs of the production year which reside after the disclosure deadline, become worthless in that country. Therefore also the residual mix needs to account for tracking of attributes of only the corresponding production year. This is most reliably done by deducting issued GOs from the production mix.

- The time of cancellation of the GO defines to which year's electricity disclosure it shall be counted for. The production year of the GO is not a limitation, but the only constraint is the GO's lifetime, which means GOs relating to production in year x can still be used after the deadline, for disclosure of year x+1 electricity consumption. In such case the residual mix needs to account for all the GOs used during a year and their net import/export.
  - Subset of the second school of thought: Cancellation of GOs can be allocated to electricity disclosure of any year during which it has/will not be expired. The difference is that the time of cancellation does not define the disclosure period, which can be freely allocated within the lifetime of the GO. For example a production year 2015 GO cancelled in March 2015, may be allocated to electricity disclosure of year 2016 or 2015.

All of the above are national interpretations of the directives and it is clear that more specific legislation is needed from EU level. Until such time, the various approaches can be seen to persevere.

As a result of diversified national rules in electricity disclosure, different residual mix calculation methodologies are used. Therefore a single methodology can never deliver compatible results with all national calculations, which means some countries' results will differ from the results of the centralized calculation. The EAM needs to cope with the various implementations and ensure no double counting appears on a European level.

5 How to Calculate the EAM in a Non-harmonized Environment

5.1 Why is a single methodology needed?

As explained in Chapter 3.2, the idea of the EAM is to compile surpluses from national calculations to be used for fulfilling deficits established in these national calculations. Due to the physical balance of power production and consumption, the deficits match in volume with the surpluses (see chapter 3.2).

However, as discussed in Chapter 4, countries use different methods to establish their national residual mixes. If such national calculations are used as a basis for the EAM, surpluses will not match deficits in the current environment, because e.g.:

- Countries that deduct all renewables from the domestic residual mix would typically cause attributes to disappear
- Countries using different cancellation deadlines would accumulate GO transaction data of differing periods, causing a mismatch between GOs imported and exported.
- Countries that link production year of the GO to the year of disclosure, would typically base the calculation on GOs issued during the year. Whereas countries not enforcing this link would base it on GOs cancelled and internationally transferred regardless of the production time of the GO. Also the allocation of cancellations might differ depending on whether the cancellation timing unequivocally determines the disclosure period. On a longer time span and assuming correct implementation, all these options would yield same results, but they differ significantly on a yearly level.

Clearly, if the calculation of the EAM is done following different national approaches, the data is not consistent and the balance of production and consumption is lost. However this balance is critical for the reliability of the EAM, because without it, there is no European wide harmonization that electricity from renewable (and other) energy sources is produced an equal amount as it is disclosed to consumers. The whole concept of the European wide residual mix calculation could lose its relevance and countries might return to the "dark-ages"; marking missing energy origin as unknown or expanding their domestic residual mixes (see Figure 4).

Hence, a single methodology for the calculation of the EAM is needed even in an unharmonized environment. This methodology should 1) cope with national differences, 2) be as precise as possible and most importantly 3) prevent chances for double counting.

5.2 Choice between Issuance-based and Shifted Transaction-based calculation

The central residual mix calculation (and the calculation of the EAM) can be done reliably following 2 different general-level methodologies: Issuance-based methodology (IB) and the Shifted Transaction-based (STB) methodology. During RE-DISS I and II, countries have usually selected one of the alternative methodologies, but to ensure reliability, as explained above, the EAM calculation needs to follow only one. This choice has been an active question in RE-DISS II.

An important precondition for any calculation methodology is that double counting of attributes must be avoided, which can be achieved with both of the alternatives. This is more straightforward in a pure transaction-based methodology as all transactions are always accounted for (once) without need for consideration of production time. In IB, a special provision to consider GO issuings for year X production after 31.3.X+1 in year X+1 calculation has to be added to address the avoidance of double counting in the rare case where not all GOs for year X production are issued by this time. Table 1 compiles pros and cons of the two methodologies.

Table 1 Pros and Cons of STB and IB methodologies

	STB	IB

Cons	• Does not portray fully correct production year attributes (an estimated 70 % of transactions are of production year X GOs)
	  ○ Possibility for negative renewable energy share in RM (>20 TWh of negativity balanced through EAM in 2014 calculation)
	  ○ Renewable shares in RM fluctuate yearly to a great extent, which is difficult to understand
	  ○ Greater chance for RM to be greener than production mix than with Issuance-based calculation
	• Statistics of international transfers are sometimes inaccurate
		• Difference between Cancellations vs. Issuing minus Expiry leads to difference between overall surplus and overall deficit, which requires expansion/shrinking of the European Attribute Mix. This is balanced over years.
		• Late issuings (issuing of GOs for year X production after 31.3.X+1) have to be deducted from year X+1 residual mix, which causes small discrepancy between production years. More importantly, this information is difficult to obtain.

Pros	• Robust without special measures, because considers only transaction time • Overall surplus = Overall deficit as long as physical electricity data is correct	• Residual mix portrays the correct production year as accurately as possible (expiries and late issuings still cause discrepancy) • Arguably a more logical methodology • Residual mixes remain more stable throughout years and variate only as result of increased tracking • Slightly more Issuing Bodies use this methodology for internal calculations • More accurate handling of environmental indicators in residual mix calculation. Currently some estimations are needed for STB due to lack of international country-by-country transfer data, which is needed for environmental indicator calculations.

Significant minus of the IB method is that total surplus to the EAM does not always equal total deficit. For example, an “excess surplus” in year X calculation occurs if the quantity of unused GOs from production year X at 31.3.X+1 is greater than the same quantity of GOs from production year X+1 on 31.3.X+2. This is then balanced by an “excess deficit” in X+1 calculation. So in other words, on year X calculation this amount evaporates from EAM (EAM shrinks) and in year X+1 calculation the EAM is expanded by this amount. On a several year average the expanding equals shrinking, in volume (although differences are possible in attribute shares depending on the EAM of the specific year).

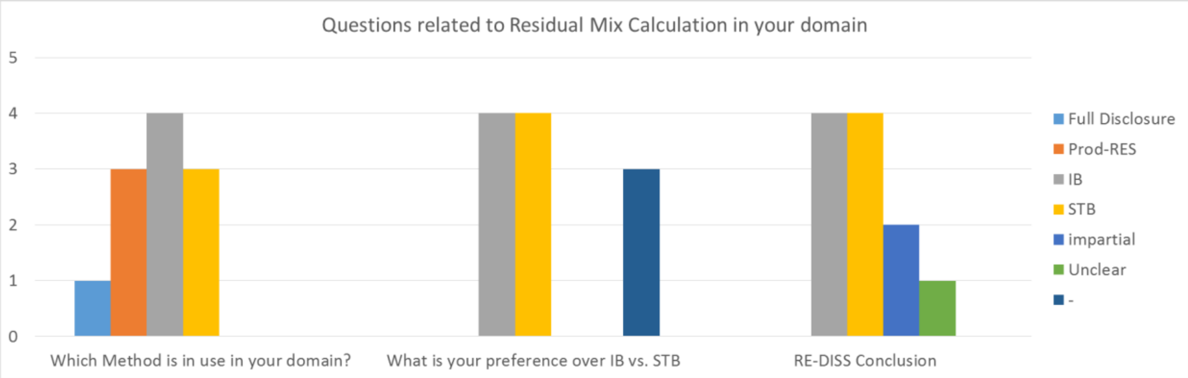
Another deficiency of the IB method is that in some cases (especially thermal plants) issuing of GOs for production of year X has not concluded by 31.3.X+1. This means, that in order to avoid double counting of these “late issuings” they need to be deducted from the residual mix of year X+1. Late issuing data is typically difficult to obtain, although for EECS data it is available.

The most important downside of the STB is that using GOs from previous production years may create more exports and cancellations than there are generation attributes in a specific country. According to the methodology, the share of that energy source should then become negative. This is a very regular problem and as long as the overall RES category remains positive deductions can always be made from unspecified renewables and other RES fuel categories. A rarer, but existing problem is when whole RES turns negative as was the case in 2011 and again in 2014. The total negativity (more than 20 TWh in 2014!) was transferred to EAM, which stayed barely positive. Had also the EAM gone negative, the remaining negativity would have to have been transferred to 2015 EAM to avoid double counting.

It is important to note that mathematically the IB and STB are the same in the long run as explained in Chapter 6.1, but they only differ on a yearly level.

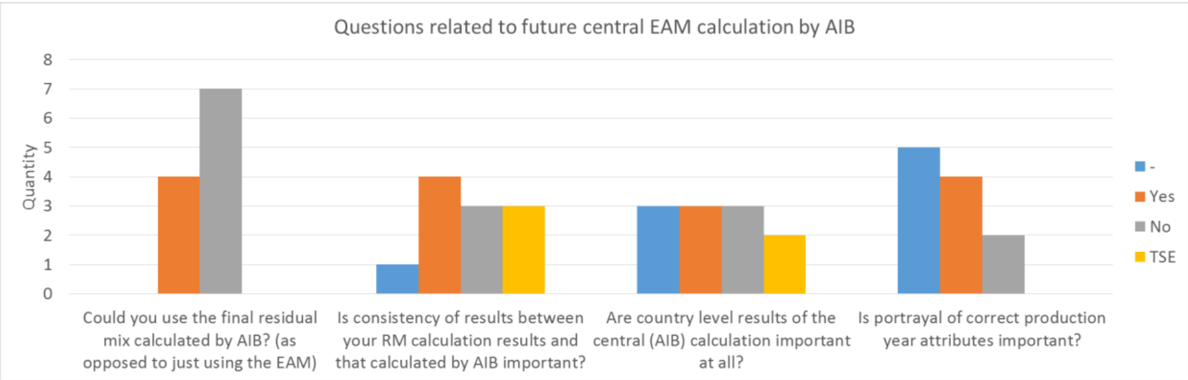
To resolve the question on which methodology to pass on, RE-DISS II project sent out a survey to competent bodies. 11 domains replied and key results of the survey are elaborated in Figure 6 and Figure 7.

Figure 6 Questions related to Residual Mix Calculation in your country



- Prod-RES: Approach where residual mix is total production minus all RES (in some cases also tracked NUC and FOS attributes might be reflected)
- IB: Issuance-based methodology
- STB: Shifted transaction-based methodology

Figure 7 Questions related to future central EAM calculation by AIB



- TSE: To some extent

The conclusion from the survey was that since there is no strong will among competent bodies to change the calculation methodology for EAM and centrally calculated country residual mixes, the calculation should be continued following the Shifted Transaction-based methodology. The considerations for Issuance-based methodology should, however, not be lost, but the decision may be revisited if seen necessary by competent bodies (referring to Table 1, IB has many upsides compared to STB). The recommendation from RE-DISS is to continue the calculations for 2015 and 2016 following STB methodology after which revisit the issue if needed. Individual countries may follow the IB methodology already now and the methodology will be described in Chapter 6.

In STB, the central calculation should be made by selecting a unified timeframe for transactions and for the time being focusing solely on the transaction times of GOs. This will be the basis of the methodology presented in this chapter. This timeframe is selected as 1.4.X – 31.3.X+1 for year X residual mix calculation. This is due to the wide acceptance of the cancellation deadline of March 31st, which means most of year X disclosure can be assumed to occur during this period.

5.3 Data Collection

5.3.1 Energy Source breakdown

Data collection and calculation should be performed following the energy source categories listed below. If only data at the level of RES/NUC/FOS is available, the unspecified categories of RES and FOS should be used.

Table 2 Energy Source Breakdown

Renewable Unspecified	Nuclear	Fossil Unspecified
Solar		Lignite
Wind		Hard Coal
Hydro&Marine		Gas
Geothermal		Oil
Biomass		

5.3.2 Production data

- **Country's nett electricity production during year X**
  - All own consumption (production auxiliaries) of power production is excluded. For hydro plants this means that only electricity production relating to natural inflow should be considered
    - By default, energy ***losses*** related to hydro pumping (and other energy storage) should be considered as consumption and not deducted from production. However this practice is subject to national regulation, which might require otherwise.
- **Country's electricity consumption during year X**
  - Grid losses are included as well as losses from pumped hydro (subject to national deviation).
- **Net electricity export to and import from external countries**[4]
  - The country should determine the net exchange of electricity with all relevant external countries.
    - In case the country has net import from a specific external country, the net imported volume should be specified by energy source according to the production mix of the external country (or if available, residual mix). Sources for external countries' production mixes are Entso-e (2015) and International Energy Agency (2015).

[4] Currently the list of external countries contains all countries outside EU27. As exceptions, Iceland, Norway and Switzerland are not external countries. The list of internal countries is: Austria, Belgium, Bulgaria, Croatia, Cyprus, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Great Britain, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden and Switzerland

      - In case the country has net export to a specific external country, the net exported volume is collected as a single value to be used in the calculation.
    - *Important: note that information on electricity transfers between the country and other internal countries **should not be** collected.*
- **GHG emissions from fossil-based electricity production in gCO_2 per kWh**
    - Relates to direct and life-cycle emissions from electricity production both in CO_2 and CO_2eq (4 different values for each fuel, see Table 3).
- **Highly active ~~R~~radioactive waste from nuclear electricity production in mg of radioactive waste per kWh**

Table 3 Each energy source has 5 different environmental indicator values

	Res Uns	Solar	Wind	Hydro	Geo	Bio	Nuc	FOS Uns	Lig	Coal	Gas	Oil
CO2 Onsite	**Nn**	**Nn**	**Nn**	**Nn**	**Nn**	**Nn**	**Nn**	**Nn**	**Nn**	**Nn**	**Nn**	**Nn**
CO2eq Onsite	**Nn**	**Nn**	**Nn**	**Nn**	**Nn**	**Nn**	**Nn**	**Nn**	**Nn**	**Nn**	**Nn**	**Nn**
CO2 LCA	**Nn**	**Nn**	**Nn**	**Nn**	**Nn**	**Nn**	**Nn**	**Nn**	**Nn**	**Nn**	**Nn**	**Nn**
CO2eq LCA	**Nn**	**Nn**	**Nn**	**Nn**	**Nn**	**Nn**	**Nn**	**Nn**	**Nn**	**Nn**	**Nn**	**Nn**
RW	**Nn**	**Nn**	**Nn**	**Nn**	**Nn**	**Nn**	**Nn**	**Nn**	**Nn**	**Nn**	**Nn**	**Nn**

5.3.3 Explicit Electricity Tracking Information

- EECS certificates and certificate-based RTSs[5]:
    - Volume of imports, exports and cancellations of tracking certificates in the country during 1.4.year X – 31.3.year X+1[6] per energy source.
      - Note that this relates to transactions of all certificates that occur during this time period (not only production year X)[7].
      - Ex-domain cancellations from the country, for the benefit of other countries, should be considered as exports.
      - Ex-domain cancellations for the benefit of the country, from other countries, should be considered as both imports and cancellations.

[5] Certificate-based RTSs can be for example national GO systems or other tracking certificate systems

[6] According to RE-DISS BPR [32] “The deadline for cancelling GO for purposes of disclosure in a given year X should be 31 March of year X+1”. This means that cancellations which relate to disclosure of year X occur during 1.4.X – 31.3.X+1. Imports and exports are collected for the same time period (relevant for the transaction-based method).

[7] Considering only production year X GO transactions would lead to cancellations, exports and imports of GOs from production year X-1 after 31.3.X not to be accounted for in any residual mix calculation.

- Non certificate-based RTSs:
    - Explicit tracking per energy source in the country for calendar year X disclosure (e.g. Contract-based tracking, feed-in tariff linked to disclosure)
        - Explicit tracking by non-certificate-based RTSs should be considered as cancellations.
        - In case of non-certificate-based RTSs between countries, it should be considered as ex-domain cancellations.

5.4 Calculation of the Domestic Residual Mix

5.4.1 Step 1: Determining Available Attributes

After the necessary data has been collected, the first step of the calculation is to determine the yearly available generation attributes of the country (available after explicit tracking). This pool of available attributes is called the domestic residual mix and is calculated as follows:

Formula 1 Determining the volume of Energy Source X in the domestic residual mix

$$Generation_{EnergySource_X} + Imported\ Attributes_{EnergySource_X} - Exported\ Attributes_{EnergySource_X} - Cancelled\ Attributes_{EnergySource_X} = Domestic\ Residual\ Mix_{Energy\ Source\ X}$$

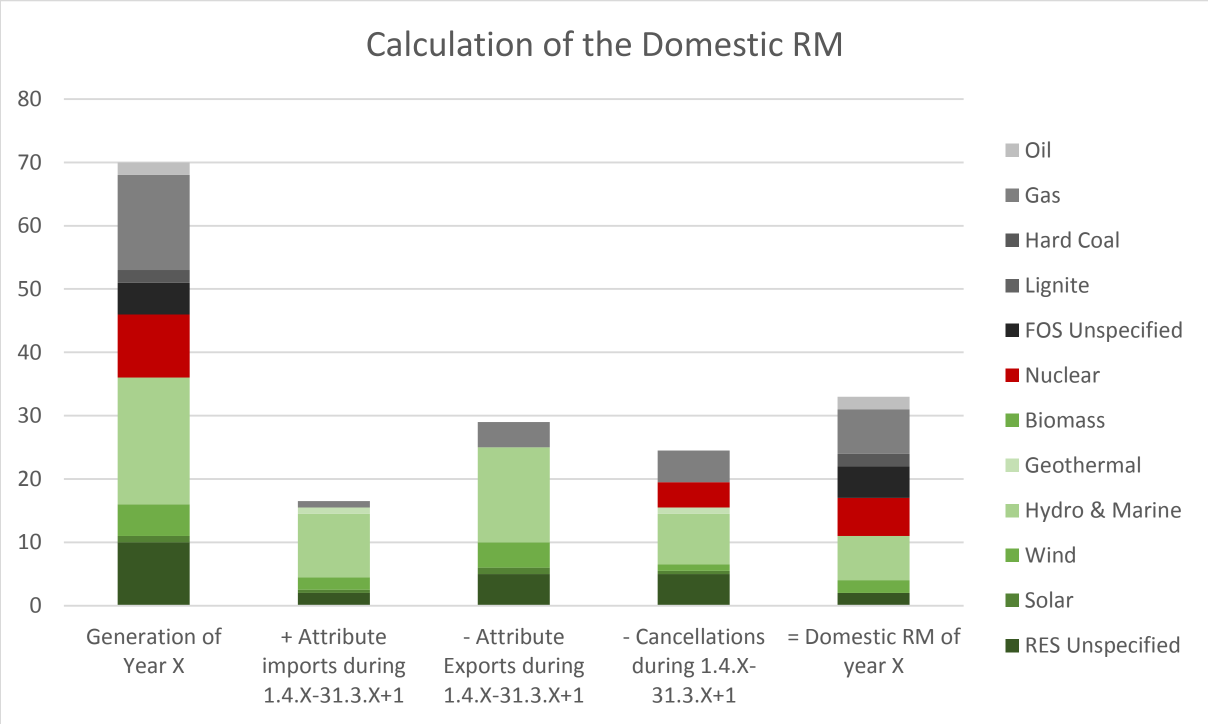
Note: Please see the data collection chapter for information on how ex-domain cancellations and non-certificate based RTSs should be considered in the above formula.

The total volume of the domestic residual mix is calculated as the sum of volumes of different energy sources in the domestic residual mix.

Formula 2 Determining the volume of the domestic residual mix

$$\sum_{Energy\ Source}^{1\rightarrow x} Domestic\ Residual\ Mix_{Energy\ Source\ X} = Domestic\ Residual\ Mix$$

Figure 8 Determining the domestic residual mix



The share of a specific energy source in the domestic residual mix is calculated by dividing the volume of that energy source in the domestic residual mix with the total volume of the domestic residual mix.

Formula 3 Determining the share of Energy Source X in the domestic residual mix

$$\%\ in\ the\ Domestic\ RM_{Energy\ Source\ X} = \frac{Domestic\ Residual\ Mix_{Energy\ Source\ X}}{Domestic\ Residual\ Mix}$$

Please note: if the country has exchange of physical electricity with external countries, this is not the final domestic residual mix. Please apply measures of Chapter 5.4.2 to determine the final domestic RM.

5.4.2 Considering Electricity Imports/Exports with External Countries

The effect of physical electricity import from or export to external countries on residual mix calculation is elaborated separately in this Chapter, because it only concerns a small number of countries. If the country has no exchange of electricity with external countries, this chapter is not relevant.

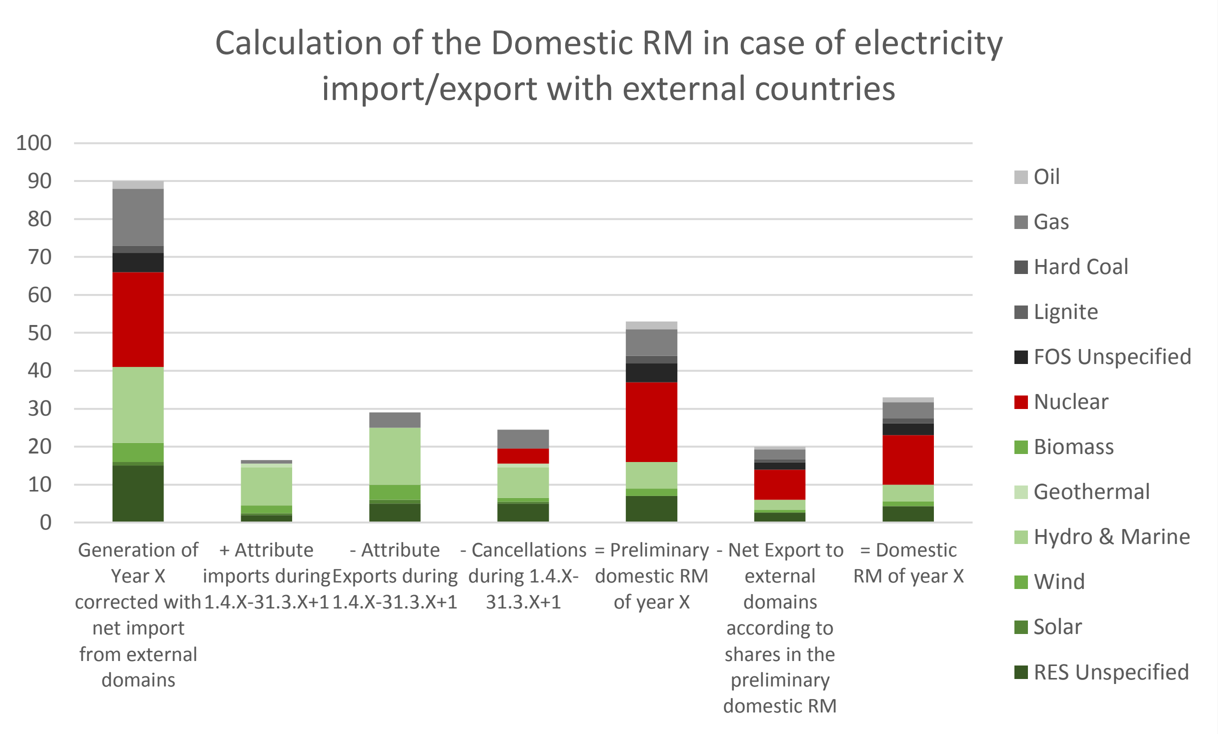
- Exchange with external countries is always considered country by country, so it is possible for an internal country to have both physical electricity net import from external country A and physical electricity net export to external country B.
- Net electricity import during year X from external country A is added to the production data of the importing (internal) country according to the shares of different energy

sources in the production mix (or if available, residual mix) of the exporting external country A.

- Net electricity export during year X from an internal country to an external country B is deducted from the available attributes of the exporting (internal) country according to the shares of different energy sources in the domestic residual mix of the exporting (internal) country.

Note: Physical electricity import from external countries should also be reflected in the CO_2 and radioactive waste factors of the country.

Figure 9 Determining the domestic residual mix in case the country has electricity exchange with an external country



Formula 4 Determining available attributes in the domestic residual mix in case of electricity exchange with external countries

$$\begin{aligned}&Generation_{EnergySource_X}(corrected\ with\ physical\ net\ import) + Imported\ Attributes_{EnergySource_X}\\&\quad - Exported\ Attributes_{EnergySource_X} - Cancelled\ Attributes_{EnergySource_X}\\&\quad - physical\ export\ (according\ to\ shares\ of\ the\ preliminary\ domestic\ RM)\\&\quad = Domestic\ Residual\ Mix_{Energy\ Source_X}\end{aligned}$$

After this, the process is as defined in chapter 5.4.1.

If country had physical net electricity import from an external country, the attributes (including environmental indicators) would have been added to the domestic mix according to the production mix (or if available residual mix) of the external country. Exchanges with external countries are always netted each external country individually.

5.4.3 Step 2: Establishing Surplus/Deficit

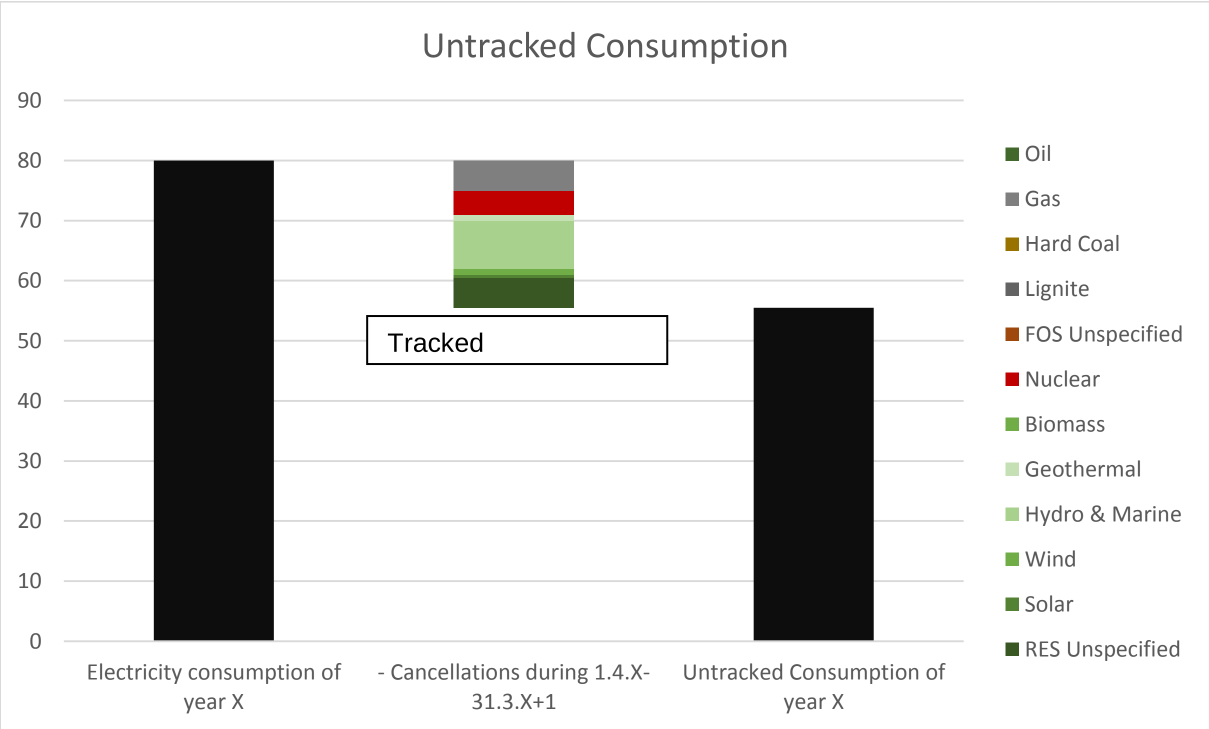
In the second phase of the calculation, the domestic residual mix is compared to the volume of untracked consumption in the country.

Untracked consumption is such consumption, which has not been disclosed with explicit tracking instruments. Therefore it can be obtained simply by deducting all cancellations (as collected based on Chapter 5.3.3) from the country's yearly electricity consumption.

Formula 5 Determining untracked consumption of a country

$$Electricity\ Consumption - \sum_{Energy\ Souce}^{1 \to x} Cancelled\ Attributes_{energy\ source\ x} = Untracked\ Consumption$$

Figure 10 Determining untracked consumption out of the total electricity consumption of the country



The difference between the volumes of the domestic residual mix and untracked consumption shows the deficit or surplus of attributes in the country. In case the country has an attribute surplus, the surplus is collected to the European Attribute Mix. In case the country has an attribute deficit, the deficit needs to be fulfilled with attributes from the European Attribute Mix (Figure 11). This will be explained in chapters 5.5.1 and 5.5.3, respectively.

Formula 6 Determining surplus or deficit of attributes of a country

$$If\ Domestic\ RM > Untracked\ consumption \to Surplus$$

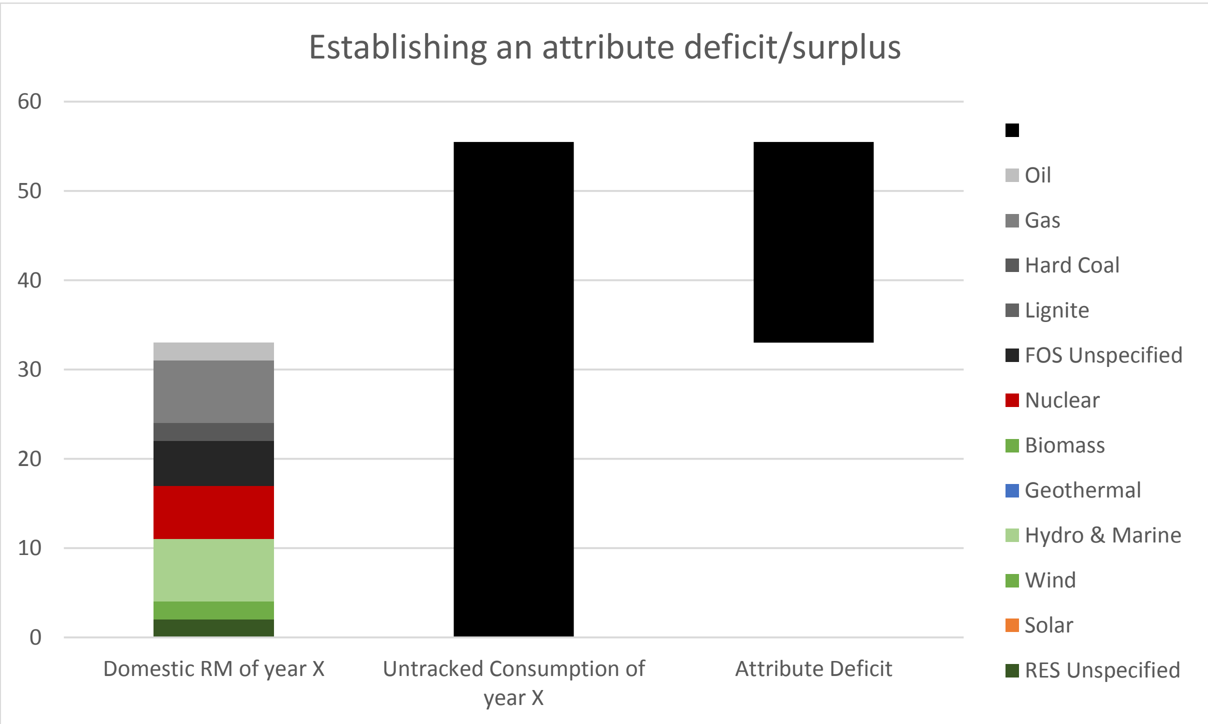
$$Surplus = Domestic\ RM - Untracked\ consumption$$

$$If\ Domestic\ RM < Untracked\ consumption \rightarrow Deficit$$

$$Deficit = Untracked\ consumption - Domestic\ RM$$

In our example case, domestic electricity consumption amounted to 80 TWh (Figure 10) whereas production was 70 TWh (Figure 8). That meant that the country was importing 10 TWh of electricity from internal countries and therefore had an attribute deficit of 10 TWh because of exchange of physical electricity. GO trading further increased the imbalance as attribute exports yielded to 29 TWh and imports only to 16,5 TWh. Altogether the international exchange of electricity and generation attributes caused the example country an attribute deficit of 22,5 TWh (10+29-16,5), which needs to be fulfilled with the European Attribute Mix. (Note that these example figures don't take into account chapter 5.4.2 on electricity exchange with external countries as this is only relevant for a small number of countries. If electricity exchange with external countries takes place, domestic residual mix needs to be corrected as instructed in chapter 5.4.2 before establishing an attribute surplus/deficit).

Figure 11 Determining attribute deficit/surplus as the difference between the residual mix and untracked consumption



5.4.4 Environmental Indicators

The following description is given for CO2 onsite emissions, but the same process is to be applied with the ground values for CO2 LCA, GHG onsite, GHG LCA and Radioactive Waste in similar manner.

First, the CO2 factor of the production mix corrected with physical import and export with physical countries (if relevant) needs to be obtained by multiplying each energy source (after considering physical import/export) in the production mix with the CO2 factor of that energy source for that country.

Second, CO2 represented by exported GOs are compiled into a “CO2 export pool” which is the average of exported GOs’ CO2 of all countries of each respective energy source.

Third, CO2 represented by imported GOs is derived from the “CO2 export pool” average for that respective energy source. The “CO2 export pool” figure can only be calculated by the central calculation body (in charge of EAM calculation) and therefore domains using the STB method should communicate with the body for this information or as second best solution, use domestic values for CO2 content of that energy source. For the Issuance-based method (see Chapter 6) this information is not required.

Fourth, CO2 represented by cancelled GOs is derived from the combined effect of imported GOs and the country’s own factor so that imported GOs are assumed to be cancelled first, unless more accurate data is available. This is also done for each energy source separately.

CO2 in domestic residual mix is calculated by deducting CO2 exported (according to the factors of the country), adding CO2 imported (according to the factors of the “CO2 export pool”) and deducting CO2 cancelled (first according to the factors of the “CO2 export pool” and then by country’s factor if necessary). It is important to note that this must be done for each energy source separately.

The same process should be applied to other environmental factors: GHG onsite, CO2 LCA, GHG LCA and radioactive waste.

Formula 7 CO2 in domestic residual mix

$$
\begin{aligned}
& Generation_{EnergySource_X}(corrected\ with\ physical\ net\ import) * CO2Factor_{EnergySource_X Country_N} \\
& - Exported\ Attributes_{EnergySource_X} * CO2Factor_{EnergySource_X Country_N} \\
& + Imported\ Attributes_{EnergySource_X} * CO2Factor_{energysource_X, CO2Exporttopool} \\
& - (IF(Cancelled\ Attributes_{EnergySource_X} \leq Imported\ Attributes_{EnergySource_X}, \\
& \rightarrow YES\ \left(Cancelled\ Attributes_{EnergySource_X} * CO2Factor_{energysource_X, CO2Exporttopool,}\right) \\
& \rightarrow NO\ \ (Imported\ Attributes_{EnergySource_X} * CO2Factor_{energysource_X, CO2Exporttopool} \\
& + \left(Cancelled\ Attributes_{EnergySource_X} - \ Imported\ Attributes_{EnergySource_X}\right) \\
& * CO2Factor_{EnergySource_X Country_N})) \\
& = CO2inDomestic\ Residual\ Mix_{Energy\ Sourcex}
\end{aligned}
$$

$$
, Where\ COFactor_{energysource_X, CO2Exporttopool,} = \frac{\sum_{Domain}^{1\rightarrow N}(Export_{EnergySource_X Country_N} * COFactor_{EnergySource_X Country_N})}{\sum_{Domain}^{1\rightarrow N}(Export_{EnergySource_X Country_N})}
$$

$$
\sum_{Energy\ Source}^{1\rightarrow x} CO2inDomestic\ Residual\ Mix_{Energy\ Source\ X} = CO2inDomesticResidualMix
$$

$$
CO2factorinDomesticResidualMix = \frac{CO2inDomesticResidual\ Mix}{DomesticResidualMix}
$$

5.4.5 Negative Balances

It is possible that the volume of a specific energy source in the domestic residual mix goes negative. Negative balance may occur primarily, because GOs of production year X-1 are cancelled or exported after 1.4.X, which means they will be deducted from the residual mix of year X. If a specific category in year X calculation is already close to zero because of transactions of year X attributes, the leftover from previous year likely turns the balance into negative.

Less likely, it is also possible that negative balances appear, because of inaccuracies or errors in the input data:

- The generation statistics are not accurate enough or other discrepancy between generation and GO statistics, e.g. wind generation is considered as other renewable in the generation statistics.
- Errors in the GO transfer statistics.

In case of negative balance, the negativity should primarily be compensated by other categories. As a case example, if wind energy source in the domestic residual mix is negative, the below describes the measures to be taken and in which order until the negativity has been compensated:

1. The renewable unspecified category should compensate. If there are more exports and cancellations of wind attributes than generated and imported wind attributes, the renewable unspecified category should be deducted with the respective negative amount.
2. If the renewable unspecified category is not enough to compensate the whole negativity the remaining negativity should be deducted from other renewable categories. This should be done in proportion of the shares of these categories in the domestic residual mix.
3. If all other renewable categories of the domestic RM together are not enough, meaning that no more renewables reside in the domestic residual mix of that country, the remaining negativity should be applied into the unspecified renewable category of the EAM.
4. If the renewable unspecified category of the EAM is not enough to compensate the whole negativity, the remaining negativity should be deducted from other renewable categories. This should be done in proportion of the shares of these categories in the EAM.
5. If all other renewable categories of the EAM are not enough, meaning that no more renewables reside in the EAM, the remaining negativity should be transferred to the EAM of the following year (considered in the next residual mix calculation).

In the calculation of 2011 steps 1, 2 and 3 and in 2014 steps 1, 2, 3 and 4 had to be taken. Steps 1 and 2 commonly occur every year.

Same applies for fossils and in theory nuclear. If the negative category is a fossil one, compensation should be made from the fossil unspecified category, then from other fossil categories and thenon from the unspecified fossil category of the EAM.

However note that a negative renewable category should never be compensated by a fossil category or vice versa.

5.5 Determination of the European Attribute Mix

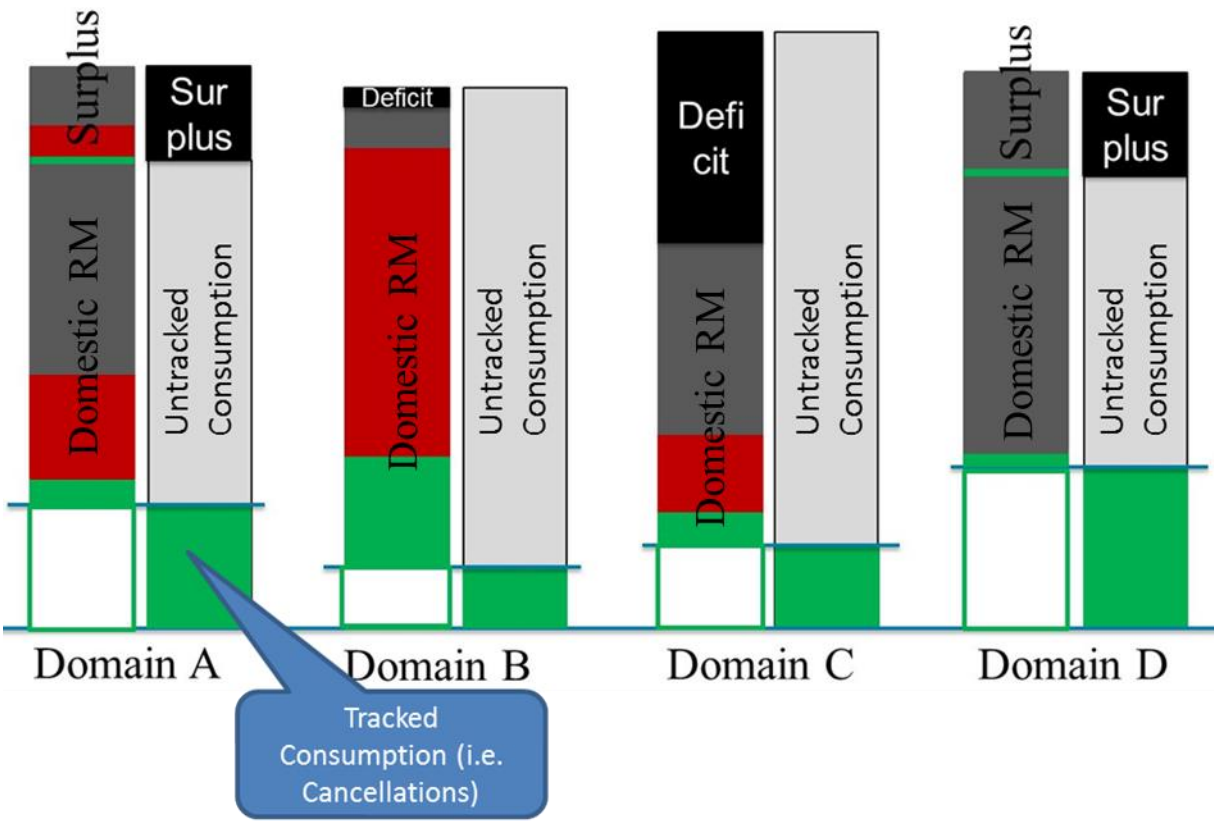
5.5.1 Surplus Countries

Countries with attribute surplus feed attributes to the EAM according to the shares of energy sources in their domestic residual mix and for the volume of the surplus. Figure 12 shows the example. For the sake of clarity, only 3 fuel categories are used: RES, NUC and FOS.

Formula 8 Determining the contribution of Surplus Country N for Energy Source X into the EAM

$$Surplus_{Country\ N} * \%\ in\ the\ Domestic\ RM_{Energy\ source\ X, Country\ N} = Contribution\ to\ the\ EAM_{Energy\ source\ X, Country\ N}$$

Figure 12 Determining surplus



For surplus countries, the final residual mix equals the domestic one in shares of different energy sources. In physical volume it is the amount of available attributes in the domestic residual mix subtracted with the surplus transferred to the EAM. Because the shares of different energy sources in the surplus are equal to their shares in the domestic residual mix, the shares of energy sources remain unchanged when moving from domestic to final residual mix in surplus countries.

Formula 9 Determining the Content of Energy Source X in the final residual mix of Surplus Country N

$$Domestic\ Residual\ Mix_{Energy\ Source\ X, Country\ N} - Contribution\ to\ the\ EAM_{Energy\ source\ X, Country\ N} = Final\ Residual\ Mix_{Energy\ Source\ X, Country\ N}$$

Formula 10 Determining the volume of the final residual mix of surplus country N

$$\sum_{Energy\ Source}^{1\rightarrow x} Final\ Residual\ Mix_{Energy\ Source\ X,Country\ N} = Final\ Residual\ Mix_{Country\ N}$$

Formula 11 Determining the share of Energy Source X in the final residual mix of surplus country N

$$\%\ in\ the\ Final\ RM_{Energy\ Source\ X,Country\ N} = \frac{Final\ Residual\ Mix_{Energy\ Source\ X,Country\ N}}{Final\ Residual\ Mix_{Country\ N}}$$

5.5.2 European Attribute Mix

All surpluses are collected into a virtual pool of attributes, the European Attribute Mix. The volume of each energy source in the EAM is the total of all contributions from all Surplus countries (Formula 12). The volume of the whole EAM is hence the total contribution of all energy sources (Formula 13, Figure 13) from all countries and the share of an energy source in the EAM is the content of that energy source in the EAM divided with the total volume of the EAM (Formula 14).

Formula 12 Determining the content of Energy Source X in the EAM

$$EAM_{Energy\ Source\ x} = \sum_{Domain}^{1\rightarrow N} Contribution\ to\ the\ EAM_{Energy\ source\ X,Country\ N}$$

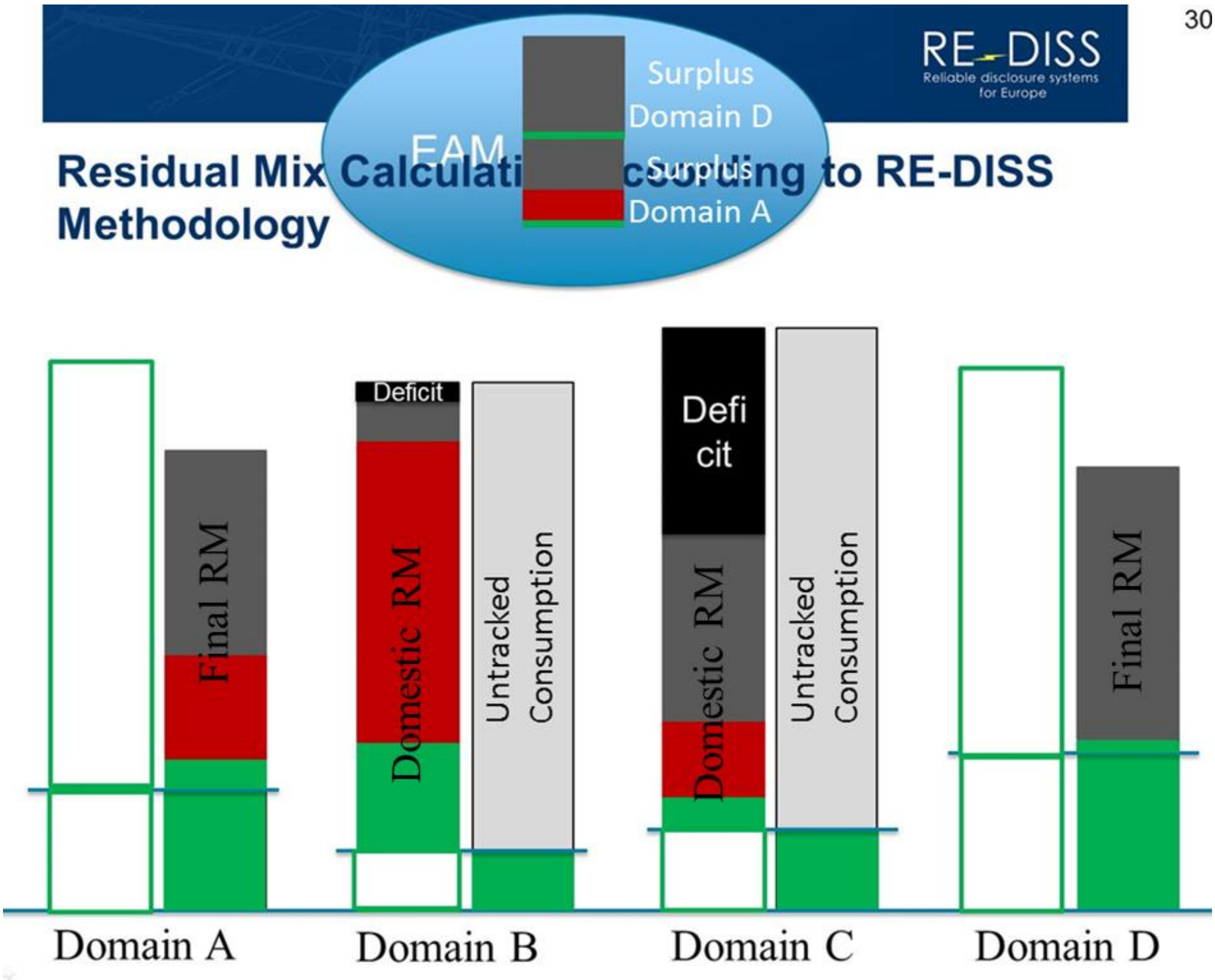
Formula 13 Determining the volume of the EAM

$$EAM = \sum_{Energy\ Source}^{1\rightarrow X} EAM_{Energy\ Source\ X}$$

Formula 14 Determining the share of Energy Source X in the EAM

$$\%\ in\ the\ EAM_{Energy\ Source\ X} = \frac{EAM_{Energy\ Source\ X}}{EAM}$$

Figure 13 Collecting surpluses to the EAM



5.5.3 Deficit Countries

Once the EAM is established, it can be used to fill in deficits in deficit countries. Deficit countries take in the volume of deficit from the EAM according to the share of different energy sources in the EAM (Formula 15, Figure 14). These are added to the domestic residual mix to constitute the final residual mix of the deficit country (Formula 16, Figure 15).

Formula 15 Determining the intake of Deficit Country M for Energy Source X from the EAM

$$Deficit_{Country\ M} * \%\ in\ the\ EAM_{Energy\ source\ X} = Intake\ from\ the\ EAM_{Energy\ source\ X, Country\ M}$$

Formula 16 Determining the Content of Energy Source X in the final residual mix of Deficit Country M

$$Domestic\ Residual\ Mix_{Energy\ Source\ X, Country\ M} + Intake\ from\ the\ EAM_{Energy\ source\ X, Country\ M} = Final\ Residual\ Mix_{Energy\ Source\ X, Country\ M}$$

Formula 17 Determining the volume of the final residual mix of deficit country M

$$\sum_{Energy\ Source}^{1 \to x} Final\ Residual\ Mix_{Energy\ Source\ X,Domain\ M} = Final\ Residual\ Mix_{Country\ M}$$

Formula 18 Determining the share of Energy Source X in the final residual mix of deficit country M

$$\%\ in\ the\ Final\ RM_{Energy\ Source\ X,Country\ M} = \frac{Final\ Residual\ Mix_{Energy\ Source\ X,Country\ M}}{Final\ Residual\ Mix_{Country\ M}}$$

Figure 14 Fulfilling deficits

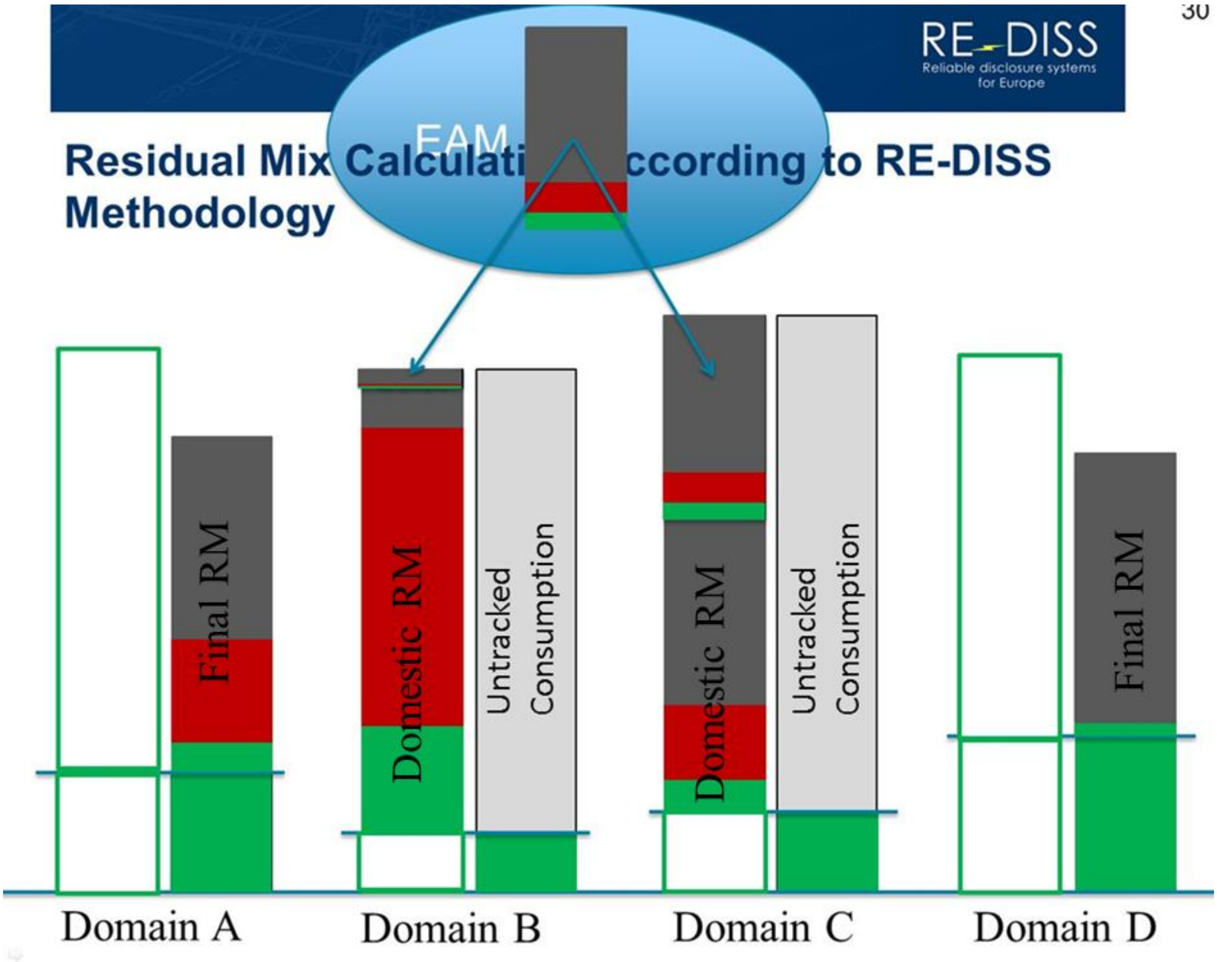
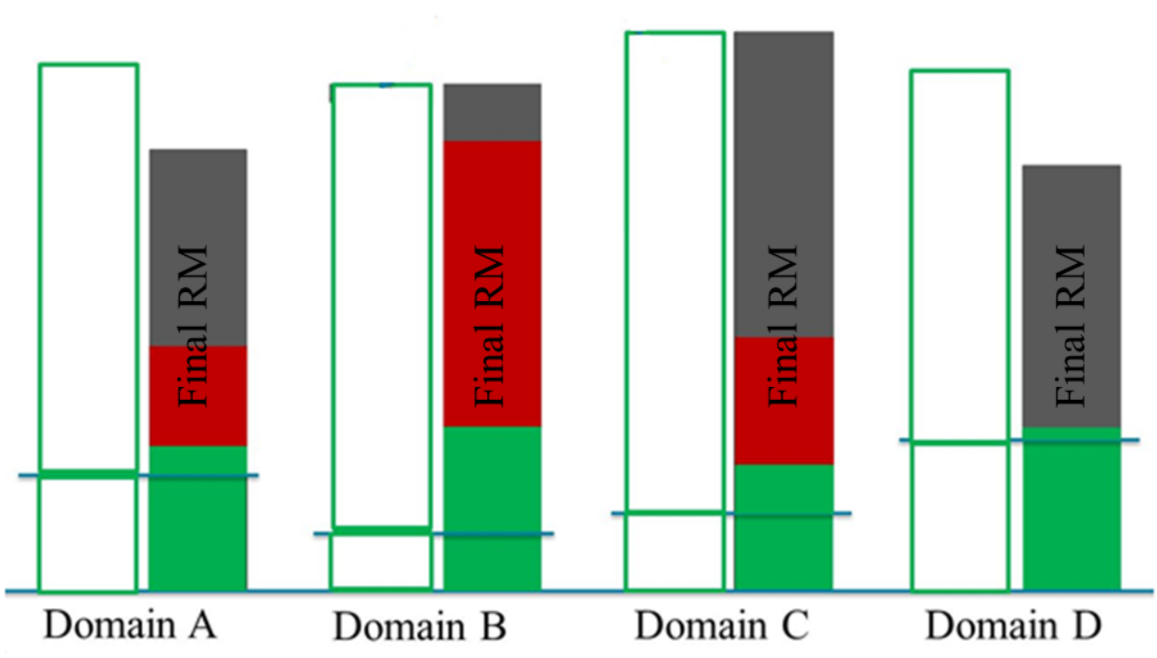


Figure 15 Disclosing untracked consumption with the final residual mixes



5.5.4 Environmental Indicators

After deriving the CO2 of the domestic residual mix (see chapter 5.4.4) the surplus CO2 is fed into the EAM by multiplying the CO2 factor of the domestic residual mix with the surplus. This needn't to be done for each energy source separately.

CO2 factor of the EAM is derived by dividing the fed in CO2 with the total surplus. This factor constitutes the CO2 factor which is used to fill up deficits in deficit countries by multiplying it with the deficit of each respective country.

The quantity of CO2 in final RM for each country is the quantity of CO2 in domestic RM deducted/added with CO2 fed to / taken from EAM.

Formula 19 CO2 in EAM

$$\sum_{Country}^{1\rightarrow N} CO2factorinDomesticResidualMix_{Country\ N} * Contribution\ to\ the\ EAM_{Country\ N} = CO2inEAM$$

Formula 20 CO2 factor of EAM

$$CO2factorofEAM = \frac{CO2inEAM}{EAM}$$

Formula 21 CO2 for deficit countries

$$CO2factorinRM_{CountryM} = \frac{CO2factorofEAM * Deficit_{CountryM} + CO2inDomesticResidualMix_{CountryM}}{FinalResidualMix_{CountryM}}$$

For surplus countries CO2 factor in final RM is equal to the CO2 factor in domestic RM, because CO2 is fed into the EAM according to the CO2 intensity of the domestic RM.

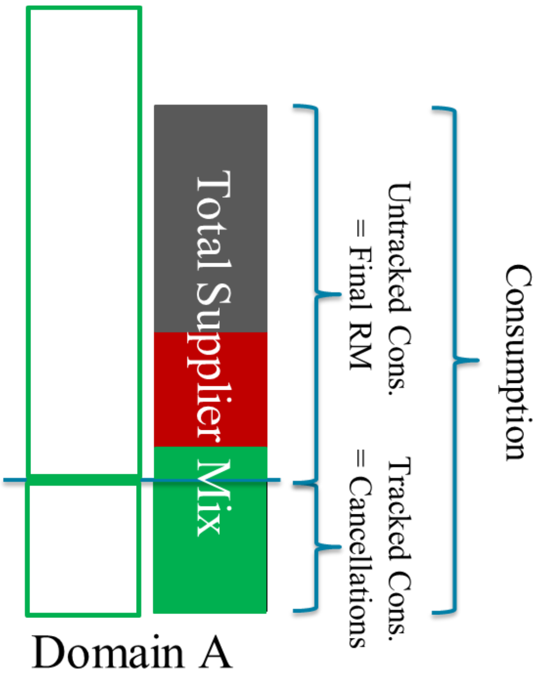
The same process should be done for environmental indicators relating to GHG onsite, CO2 LCA, GHG LCA and radioactive waste.

5.6 Total Supplier Mix

Total supplier mix means the total volume of attributes disclosed in a country, both explicitly tracked and those disclosed through the residual mix. It is obtained by summing the volume of cancellations per attribute with the final residual mix. In physical size it equals the total electricity consumption in the country. (Because untracked consumption = consumption – cancellations).

Environmental indicators of the total supplier mix are calculated by adding e.g. onsite CO_2 content of the final residual mix with the CO_2 content of tracked consumption. Regarding tracked consumption, it should be assumed that imported attributes are first use, if better data is not available. This sum is divided by the volume of electricity consumption in the country to obtain the onsite CO_2 per kWh of average consumption.

Figure 16 Determining total supplier mix



Formula 22 Determining the volume of EnergySource X in Total Supplier Mix:

$$\begin{aligned}
&Total\ Supplier\ Mix_{Energy\ Source\ X, Country\ M} \\
&\quad = Final\ Residual\ Mix_{Energy\ Source\ X, Country\ M} \\
&\quad + Cancelled\ Attributes_{EnergySource_X Country_M}
\end{aligned}$$

Formula 23 Determining the share of Energy Source X in the total supplier mix of Country M

$$\%\ in\ the\ Total\ Supplier\ Mix_{Energy\ Source\ X,Country\ M} = \frac{Total\ Supplier\ Mix_{Energy\ Source\ X,Country\ M}}{Consumption_{Country\ M}}$$

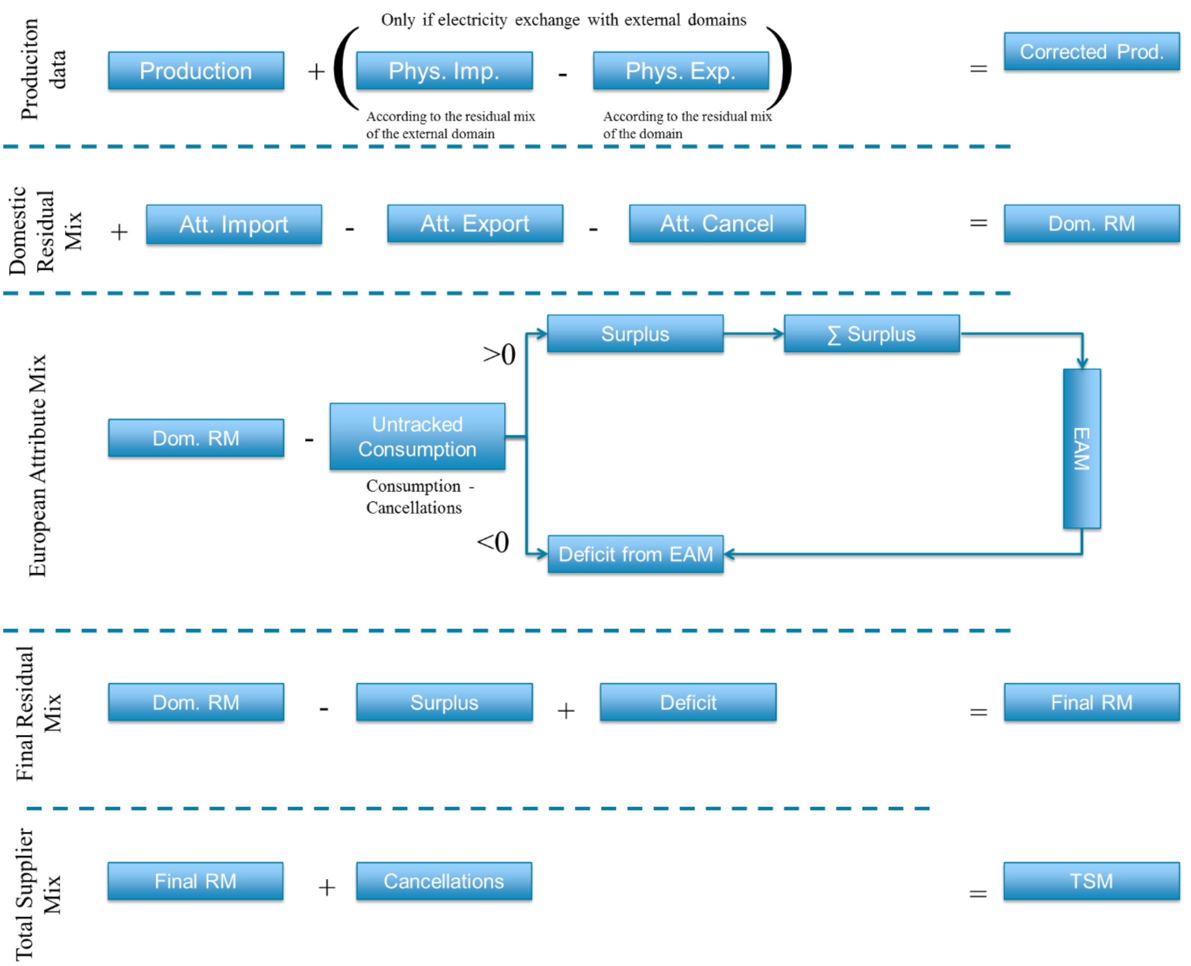
Formula 24 CO2 in total supplier mix

$$\sum_{Energy\ Source}^{1\rightarrow x} IF(Cancelled\ Attributes_{EnergySource_X,CountryM} \leq Imported\ Attributes_{EnergySource_X CountryM},$$
$$\rightarrow YES\ (Cancelled\ Attributes_{EnergySource_X Country_M} * CO2Factor_{ExportPool})$$
$$+\ CO2inResidualMix = CO2inTotalSupplierMix$$
$$\rightarrow NO(Imported\ Attributes_{EnergySource_X Country_M} * CO2Factor_{ExportPool}$$
$$+ \big(Cancelled\ Attributes_{EnergySource_X Country_M}$$
$$- Imported\ Attributes_{EnergySource_X Country_M}\big) * CO2Factor_{EnergySource_X Country_M}$$
$$+\ CO2inResidualMix = CO2inTotalSupplierMix$$

$$CO2factorinTotalSupplierMix_{CountryM} = \frac{CO2inTotalSupplierMix}{Consumption}$$

5.7 Process Description

Figure 17 Residual mix calculation process



6 How to Calculate the EAM and Residual Mixes in a Future Harmonized Environment

6.1 Underlying Theory

Since the residual mix is calculated based on the generation of a specific year, restricting the accuracy of tracking information into the mere transaction time (instead of combination of transaction and production time) will always lead to some discrepancies in the data. This can be observed e.g. through the possibility of negative balances within a fuel category (see Chapter 5.4.5), which may come about if the leftover of previous production year GOs is significant.

Still, at a national level, especially countries that have ruled that GOs relating to production during year X may only be used for electricity disclosure of year X consumption have understandably applied a more accurate methodology. This methodology, bases the calculation of the domestic residual mix on the amount of GOs, which are issued and expired instead of GOs, which are net imported/exported and cancelled.

The issuance-based methodology has a number of benefits including:

- Easier data collection: it has been observed that it is easier to collect data on issuances rather than imports and exports of GOs
- Negative balances do not occur: it is impossible to issue more e.g. renewable GOs than the production of renewables during that year
- An altogether better link between the production time of the GO and the year when it is accounted for in the residual mix.
- So-called “CO2 export pools” (see Chapter 5.4.4) are not needed for residual mixes.

However, at a European level, the scheme is not ready for this change, primarily due to the differences in national disclosure rules (see Chapter 4) as well as because of the potential late issuings and expansion of the EAM.

It is crucial to note that allowing a more sophisticated methodology in the front-running countries (e.g. having implanted a link between production and disclosure year), does not cause double counting even though the European Attribute Mix is calculated based on a simple, transaction-based methodology. This is because these two methodologies are essentially the same in the long run. If we consider the entire lifetime of GOs relating to production year X for example, the input of certificates to a country has to equal the use of certificate in the country, i.e:

Formula 25 The inflow of GOs vs. the outflow

$$Issue + Import = Cancellation + Export + Expiries$$

By rearranging the above Formula, we can illustrate that:

Formula 26 Issuance-based methodology vs. transaction based methodology

$$-Issue + Expiry = -Cancellation - Export + Import$$

However, they differ in the sense of how attributes of unused GOs are returned to the residual mix. The transaction-based method (Chapter 5) returns attributes of all GOs of production year X, which are unused at 31.3.X+1 to the residual mix of year X, but then removes them from residual mix of year X+1 in case the GOs are used after 31.3.X+1. Whereas the issuance-based method (Chapter 6) removes attributes of all issued GOs of production year X (used or unused at 31.3.X+1) from the residual mix of year X, but returns those which remain unused (expire) to the residual mix of X+1[8]. It is more common that these GOs are used after 31.3.X+1 than that they expire after it and therefore the IB method can be considered more accurate also in this respect.

6.2 Calculation

The residual mix calculation following the issuance-based method differs from the methodology presented in Chapter 5, only in the respect of how the domestic residual mix is calculated and which data is needed for it. For all other parts, please refer to Chapter 5.

6.2.1 Explicit Electricity Tracking Information

- EECS certificates and certificate-based RTSs[5]:
    - Volume of issuance of tracking certificates for year X electricity production per energy source
        - A possible addition to the issuing volume is issuing of year X-1 electricity production per energy source which was not considered in year X-1 residual mix calculation due to delays.
    - In case of early expiry[9]:
        - volumes of cancellations relating to certificates of production year X before 31.3.X+1.
        - Volumes of expiries relating to certificates of production year X that are expired or unused by 31.3.X+1.
    - In case of no early expiry:
        - Volume of cancellations in the country during 1.4.year X – 31.3.year X+1 per energy source.
        - Volume of expiries in the country during 1.4.year X – 31.3.year X+1 per energy source.
    - Ex-domain cancellations:
        - from the country, for the benefit of other countries, should not be considered.
        - for the benefit of the country, from other countries should be considered as cancellations.
- Non-certificate-based RTSs:
    - Explicit tracking per energy source in the country for calendar year X disclosure. (E.g. Contract-based tracking, feed-in tariff linked to disclosure).
        - Explicit tracking by non-certificate-based RTSs should be considered as both issuance and cancellation.

[8] Or into the year X residual mix in case the GO from production year X expires before 31.3.X+1.

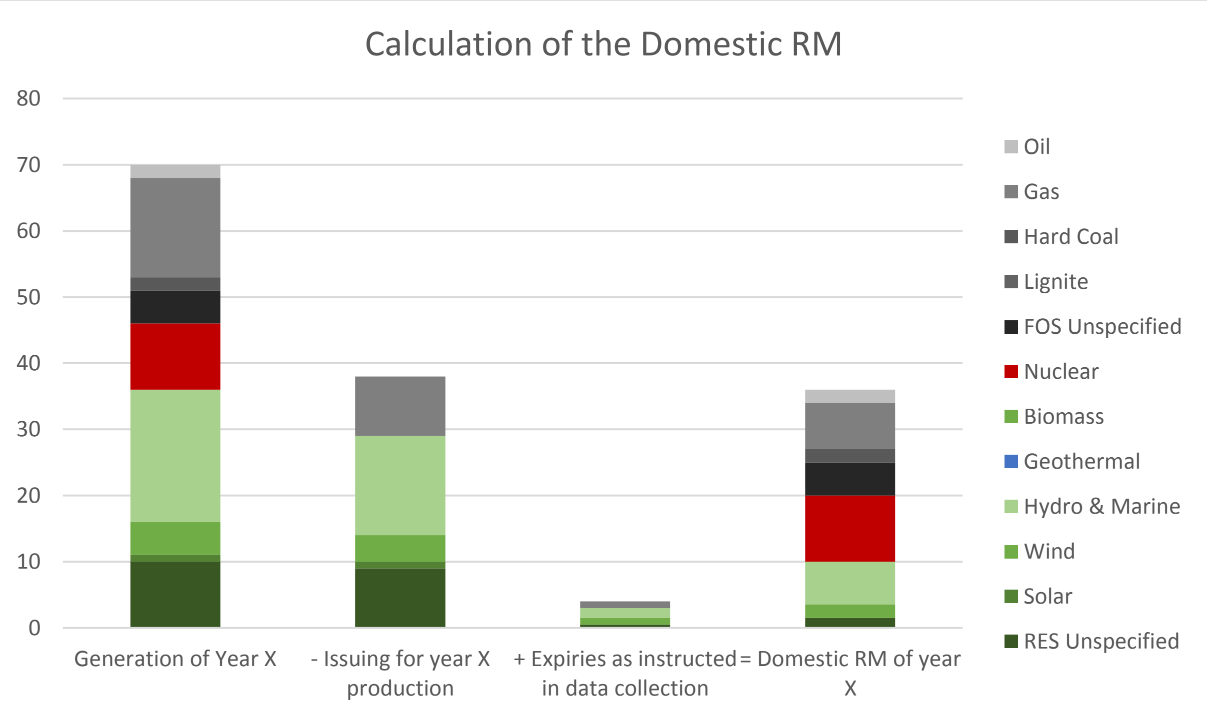
[9] In Early Expiry, unused certificates relating to production year X that reside in the registry on March 31st of year X+1 are expired.

6.2.2 Domestic Residual Mix

In the issuance-based method, the issuing for generation attributes is considered. Issuing volume (as collected in Chapter 6.2.1) is subtracted from the production mix and unused certificates (expiries) are added to it.

- Please see the data collection chapter on information how ex-domain cancellations and non-certificate based RTSs should be considered.

Figure 18 Determining the domestic residual mix in the issuance-based method



Formula 27 Determining the volume of Energy Source X in the domestic residual mix according to Issuance-based methodology

$$Generation_{EnergySource_X} - Issued\ Attributes_{EnergySource_X} + Expired\ Attributes_{EnergySource_X} = Domestic\ Residual\ Mix_{Energy\ Source\ X}$$

Besides the calculation of the domestic RM, the issuance-based method follows the logic as presented in Chapter 5, but with data as collected in Chapter 6.2.1. In case exchange of physical electricity with external countries is relevant, please see Chapter 5.4.2.

6.2.3 Environmental Indicators

Environmental indicator calculation follows the same logic as with Shifted Transaction-based method, but removing CO2 corresponding to issued certificates instead of export/import/cancel from the residual mix. This makes the procedure simpler as a separate export CO2 pool is not needed for residual mix (see Chapter 5.4.4). Note however, that calculation of CO2 (and other environmental indicators) in Total Supplier Mix requires the export CO2 pool value and thus follows the formula as presented in Chapter 5.6.

Formula 28 CO2 in domestic residual mix according to the Issuance-based methodology

$$Generation_{EnergySource_X}(corrected\ with\ physical\ net\ import) * CO2Factor_{EnergySource_X Country_N} - Issued\ Attributes_{EnergySource_X} * CO2Factor_{EnergySource_X Country_N} + Expired\ Attributes_{EnergySource_X} * CO2Factor_{energysource_X, CO2Exporttopool} = CO2inDomestic\ Residual\ Mix_{Energy\ Sourcex}$$

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