Residual Mix methodology for I-REC issuing countries

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I-REC issuing countries, taken from: https://www.irecstandard.org/world-map/

Summary

The International REC Standard Foundation (I-REC Standard) is a non-profit organization that provides a standard for developing attribute tracking systems. The I-REC Standard ensures the highest quality systems and adherence to best practices designed to avoid double counting, double certificate issuance, and double attribute claims.

An I-REC certificate for renewable electricity, I-REC(E) or I-REC, represents the environmental attributes of the generation of one-megawatt hour (MWh) of energy produced by renewable sources, and can be used to make end-user claims for energy/electricity consumption. According to the GHG Protocol a Residual Mix should be used by end-users for any electricity consumption not tied to an I-REC or other recognized tracking system that meets the Scope 2 Quality Criteria. The emissions from all untracked and unclaimed energy comprise a Residual Mix emission factor. Hence, the Residual Mix is an integral element in preventing double counting of renewable energy attributes in any energy tracking system. However, country specific Residual Mix emission factors are not frequently available for consumer Scope 2 calculations. Through this report, the I-REC Standard Foundation expects to contribute to enhance transparency and robust energy attribute markets globally.

This report recommends implementing a modified Issuance Based (IB) method for calculating Residual Mixes to be used for I-REC issuing countries, valid for national tracking markets that are not legislatively linked in the same way as European markets are. It is further recommended that the national Residual Mixes are published within one year after the generation year, which means January in year X+2 for generation at any point in year X. However, redemption (or cancelation) data for attribute tracking certificates might still not be definitive at the date of publication.

The modified method calculates the Residual Mix by withdrawing the issued volume from the generated volume in the respective year. It is therefore based on two assumptions: (1) potential unclaimed issued I-RECs at the moment of publication are assumed to be redeemed over time, and (2) the Residual Mix volume is assumed to correspond to the volume of Untracked Electricity Consumption in the respective country. Hence, the occurrence of a potential surplus/deficit of attributes is not considered. Two checkpoint assumption tests are recommended to verify the potential impact of both assumptions for the Residual Mix calculation.

The report also presents two different ways for calculating the direct CO_2 emission factor for the Residual Mix, depending on the availability of data.

Finally, it is recommended that I-REC Standard regularly reviews these methodologies and assumptions to ensure continued applicability.

I-REC should regularly review annual calculated Residual Mixes and underlying assumptions to ensure the continued validity of the method. If, for example, surpluses and deficits of attribute certificates in markets are considered substantial or consistently increasing, or if unredeemed certificate rates tend to increase, the I-REC Foundation should reevaluate these methodologies and/or propose modifications such as implementing an expiry date for I-RECs (like in the European GO system).

Contents

1 Introduction

The International REC Standard Foundation (I-REC Standard) is a non-profit organization that provides a standard for developing attribute tracking systems. The I-REC Standard ensures the highest quality systems and adherence to best practices designed to avoid double counting, double certificate issuance, and double attribute claims.

The I-REC Standard is acknowledged by major reporting frameworks such as the Greenhouse Gas Protocol (GHGP)[1], Carbon Disclosure Project (CDP)[2], the Science Based Targets Initiative (SBTi)[3] and RE100[4] as a reliable backbone for credible and auditable tracking instruments. Through the International Attribute Tracking Standard, the I-REC Standard outlines a set of requirements to ensure the quality of accredited attribute tracking systems in order to meet the expectations of stakeholders, market parties, and end-users.

An attribute tracking system for renewable electricity certificates such as I-REC(E) provides a digital platform to register basic information about each MWh of renewable electricity being generated and tracked up to the point of consumption. This makes it possible for I-REC(E) to be purchased by end-users that want to claim the attributes of the underlying renewable energy generation that the certificate represents. Since grids transmit power from a mix of renewable and non-renewable sources, end-users that have not purchased certificates for renewable energy they consume cannot make a claim to its underlying attributes. Instead, they must use a Residual Mix calculation, described in this document, that excludes the attributes claimed by certificate holders.

NORSUS is supporting the I-REC Standard with this work area. This report presents the a recommended method for Residual Mix calculation for I-REC(E) issuing countries.

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[1] See GHG Protocol Scope 2 Guidance available at https://ghgprotocol.org/scope-2-guidance
[2] https://www.cdp.net/en
[3] https://sciencebasedtargets.org/
[4] https://www.there100.org/

2 Relationship of I-REC(E) certificates and Residual Mix

I-REC(E) can be used to certify end-user claims on their electricity consumption. For any electricity consumed but not accompanied by I-REC(E) or other recognized tracking instruments, end-users obtain the attributes (e.g., technology type, associated carbon emission, other environmental and societal benefits) of the electricity system's remaining, or residual, mix. Therefore, the electricity disclosed or shown to these end-users will represent a mix of electricity generated from different untracked and unclaimed energy sources in the respective country or region (Raadal, 2013). End-users who do not claim I-REC(E), or another recognized tracking system, must claim the Residual Mix – an integral part of energy tracking systems for preventing double counting in energy source disclosure (Kuronen, Lethovaara, & Jakobssen, 2020). A Residual Mix emission factor is needed when a nontrivial share of the renewable production sources is removed from the grid emissions average. The removal of these attributes, as defined below, can be done at the point of I-REC(E) issuance or at the point of I-REC(E) redemption.
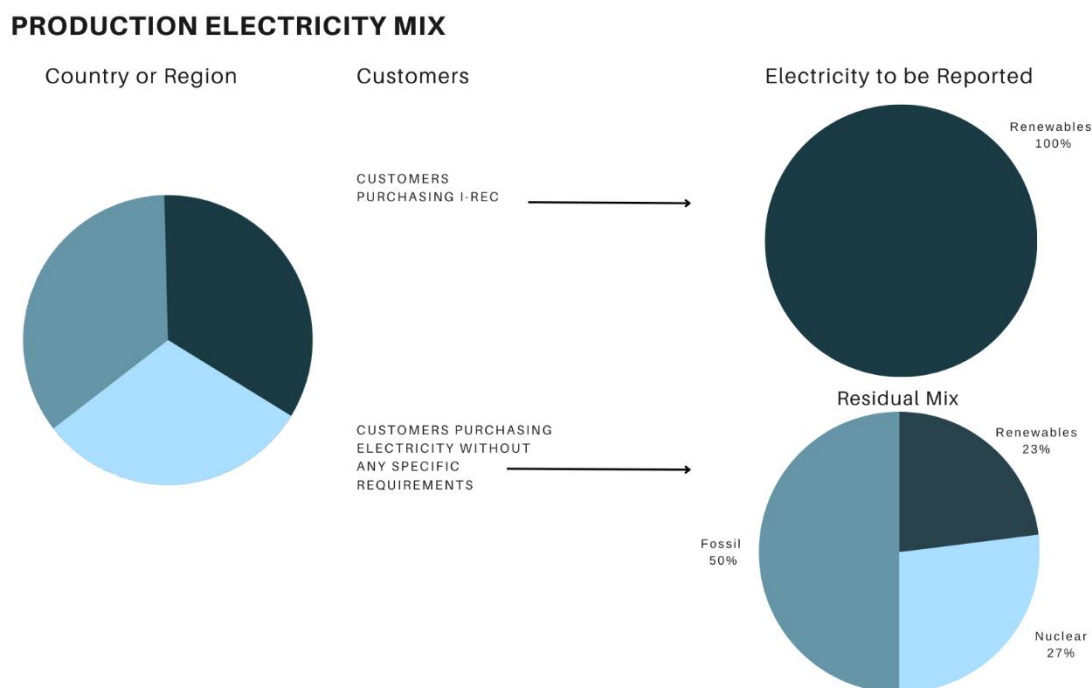

Figure 1 The principle of separating a production mix into a specific electricity mix (claimed by I-RECs) and a Residual Mix (based on Raadal (2013)).

As seen in Figure 1, the more I-REC(E) that are removed, the less of these attributes will be in the Residual Mix. In general, this results in a residual grid mix with a higher carbon emissions factor and lower portions of renewable electricity. In a full-disclosure environment where all generation assets – both fossil and renewable – receive a certificate, a residual grid mix is not required.

In Europe, where Guarantees of Origin (GOs) are internationally traded and recognized, a centralized calculation of the Residual Mix which covers all the participating countries is needed. Centralized Residual Mixes have been calculated, based on the methodology developed during the EU funded projects E-Track II, RE-DISS and RE-DISS II. The Association of Issuing Bodies (AIB) took over the calculation in 2015 and renewed the calculation methodology in 2020. The first explicit requirements to calculate and use Residual Mix were introduced in directive (EU) 2018/2001, the so called RED II (Kuronen et al., 2020).

3 Residual Mix method used by the European GO system

As mentioned above, the AIB is responsible for calculating Residual Mixes for all countries in the European Guarantees of Origin (GO) system. This is based on the system for GOs and Electricity Disclosure as described in the EU Directives (European Commission, 2018) (European Commision, 2009). The Residual Mix calculation method used by the AIB was introduced through the E-Track and RE-DISS projects.

Through these projects, two ways for calculating the Residual Mix were identified: the Issuance Based Method (IB) and the Transaction Based Method (TB) (Kuronen et al., 2020). From 2019, the AIB changed its method for Residual Mix calculations from TB to IB (https://www.aib-net.org/facts/european-residual-mix/2019). The major reason for this was the challenges related to the increased trading activity between national registries within the EU. The IB Method, as used by the AIB, is presented in the following chapters.

3.1 Determining volume of Domestic Residual Mix

The IB Method is based on issued and, in the case of the EU, expired GO volumes, to determine available attributes in the Residual Mix, as shown in Figure 2.
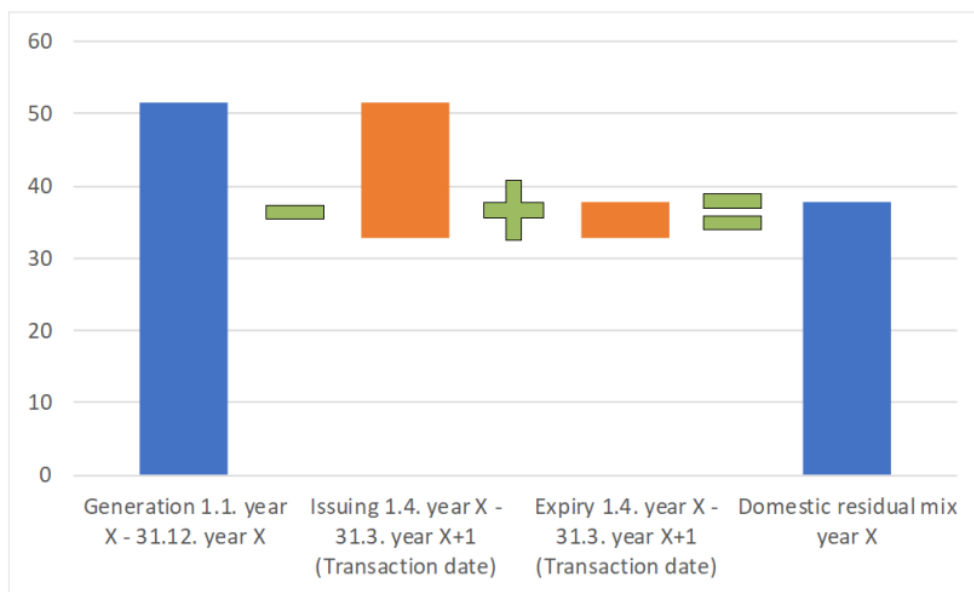

Figure 2 Principle for the Issuance Based method for determining the volume of Domestic Residual Mix for a country (Figure 11 in Kuronen et al. (2020)).

As seen in the figure above, the Residual Mix within a national (domestic) market is calculated by subtracting the issued volume from the total generated volume in year X, then adding the expired volume (issued attributes not redeemed by their expiry date). This is expressed by Equation 1.

Equation 1 The volume (MWh) of Domestic Residual Mix for year X

$Domestic\ RM_{year\ X} = Generation_{year\ X} - Issued\ attributes_{April\ year\ X - March,\ year\ X+1} + Expired\ attributes_{April,\ year\ X - March,\ year\ X+1}$

As seen from Equation 1, overall generation in calendar year X is considered alongside the volume of issued and expired attribute certificates during the period April year X – March year X+1.

3.2 Determining the CO_2 emission factor for the National Residual Mix

The CO_2 emissions of the Domestic Residual Mix are calculated by subtracting the emissions associated with the issued and expired attributes from the emissions of the overall Production Mix. The overall CO_2 emissions are calculated by multiplying each energy source in the Domestic Residual Mix by its respective CO_2 emissions factor (g CO_2/kWh) and volume. Finally, the CO_2 emission factor for the Residual Mix is calculated by dividing the overall CO_2 emissions by the overall volume of the Domestic Residual Mix. This is shown in Equation 2.

Equation 2. Direct CO_2 emission factor for the Domestic Residual Mix

CO_2 emission factor [g CO_2/kWh] = total CO_2 emissions Domestic Residual Mix [g CO_2]/volume of Domestic Residual Mix [kWh]

The CO_2 emission factors for different energy sources should be obtained from official or recognized sources, e.g., from Annex 3 in AIB's report "European Residual Mixes. Results of the calculation of Residual Mixes for the calendar year 2022" (AIB (Association of Issuing Bodies), 2023).

3.3 Determining surplus/deficit of attributes

The "Untracked Consumption" represents the electricity consumption which has not been claimed by end-consumers with explicit tracking instruments (like GOs or other recognized tracking mechanisms). Since the European market is considered a unified and single market, and since there is significant cross-border trade in physical electricity and attributes (GOs), it is necessary to determine whether there is a surplus or deficit of attributes for the "Untracked Consumption" in each country. The IB method calculates the Untracked Consumption by subtracting all redemptions from total consumption (see details in chapter 4.2.2). The attributes related to the Untracked Consumption is given by the Residual Mix, and represent the consumption mix for all end-users who do not claim GOs in the respective country. However, if the volume of the Residual Mix does not correspond to the volume of Untracked Electricity Consumption in the respective country a surplus or deficit of attributes for the Untracked Consumption occurs. This volume is calculated, as shown in Equation 3.

Equation 3 Determining surplus or deficit of attributes in a country.

If: Domestic Residual Mix > Untracked Consumption -> Surplus

   Surplus = Domestic Residual Mix - Untracked Consumption

If: Domestic Residual Mix < Untracked Consumption -> Deficit

   Deficit = Untracked Consumption - Domestic Residual Mix

The Residual Mix methodology in the European tracking system also includes a European Attribute Mix which balances all surpluses and deficits in the participating countries. Countries with a surplus of attributes <u>provide</u> the European Attribute Mix with attributes while deficit countries <u>are provided</u> with attributes from European Attribute Mix. Details on how the Domestic Residual Mixes are adjusted with the European Attribute Mix to calculate Final Residual Mixes is described in Kuronen et al. (2020).

4 Suggested method for Residual Mix calculation for I-REC issuing countries

A major challenge for Residual Mix calculations is timing. It is recommended that the national Residual Mixes are published within one year after the generation year, which means January in year X+2 for generation at any point in year X. However, redemption (or cancelation) data of attribute tracking certificates might still not be definitive at the date of publication. The I-REC code does not have any date of expiry for issued I-RECs, but it operates with two issuance deadlines for electricity generated in year X (Everson, 2022): May 31 in year X+1 (for production periods between January and June in year X), and September 30 in year X+1 (for production periods between July and December in year X), respectively. Hence, the proposed methodology needs to consider the fact that a portion of I-RECs issued might not yet have been redeemed at the time of the Residual Mix publication.

The suggested Residual Mix calculation method for I-REC issuing countries is a modified version of the AIB European Residual Mix calculation, valid for national tracking markets that are not legislatively linked in the same way as European markets are (RE100 et al., 2022). The method only takes the issued volume into account and does not consider unclaimed certificates. It is therefore based on the following assumptions:

1. Potential unclaimed issued I-RECs at the moment of publication are redeemed over time. While a temporary mismatch between issuance and redeemed volumes may exist at the time of publication of the Residual Mix and given there is some flexibility on vintage requirements by major reporting standards, this unbalance is assumed to become smaller over time.
2. Cross-border trading is negligible. The Residual Mix volume is assumed to correspond to the volume of Untracked Electricity Consumption in the respective country. The major reporting standards that recommend claims from the use of renewable electricity are based on renewable generation attributes coming from the same geographic region that defines a market (i.e., individual countries are considered distinct markets for renewable electricity). Exceptions are the US and the EU regional markets which have their own EAC tracking systems reflecting a common regulatory framework that allows cross-border trading (RECs between the US and Canada, and GOs between different EU countries).

Both assumptions imply that the volume of the national Residual Mix equals the volume of Untracked Electricity Consumption. Hence, no surplus/deficit of attributes is taken into consideration, which means there is no need for adjusting the national Residual Mixes with a calculated "I-REC Attribute Mix" (reflecting the "European Attribute Mix"). Additionally, potential import and export of physical electricity are not accounted for in the national Residual Mix.

Two checkpoint assumption tests are recommended to verify the potential impact of both the above-mentioned assumptions for the Residual Mix calculation. The recommended procedures for these checkpoints are given in sections 4.2.1 and 4.2.2 . Finally, two different ways for calculating the direct CO2 emission factor for the Residual Mix, depending on the availability of data, are presented in section 4.3.

4.1 Calculating the volume of the Residual Mix

As described above, the suggested Residual Mix calculation method is based on a modified version of the Issuance-based (IB) AIB European Residual mix calculation methodology. As shown in Figure 2 above, the IB approach is calculated by withdrawing the issued volume from the generated volume in year X and then

adding the expired volume. The I-REC code does not have any date of expiry for issued I-RECs, but it operates with two issuance deadlines for electricity generated in year X (Everson, 2022): May 31 in year X+1 (for production periods between January and June in year X), and September 30 in year X+1 (for production periods between July and December in year X), respectively.

The principle for the suggested modified Residual Mix calculation method for I-REC issuing countries is shown in Figure 3 and Equation 4 below.
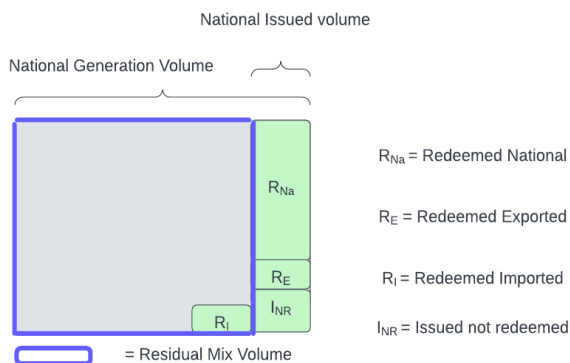

Figure 3 Principle for calculating the volume of the national Residual Mix.

As seen in Figure 3, the adapted equation for determining the volume (MWh) of a national Residual Mix in year X for a country is calculated by withdrawing the national issued I-REC volume from the national generation volume. This is presented in Equation 4.

Equation 4: Volume (MWh) of national Residual Mix for year X

National RM$_{year X}$ = National Generation$_{year X}$ − National Issued attributes (vintage X)$_{January year X – September year X+1}$

Information about national electricity generation can be found in IEA (or similar) annual reports. Other national reports, if available, can be used if noted in the Residual Mix report. For countries which have other national recognized tracking mechanisms, the issued volume from these should also be subtracted from the overall generation volume in Equation 4. However, the availability of both issued and redemption data for these mechanisms will determine in which way these data can be included in the calculations. The I-REC secretariat, together with national authorities, will define potential other recognized tracking mechanisms.

4.2 Additional assumption tests

4.2.1 Checkpoint 1: The volume of unredeemed I-RECs

As described above, Residual Mixes should be published within one year after end of the generation year. Hence, I-RECs issued by September 30 in year X+1 have a maximum three months to be redeemed to be correctly included in the Residual Mix calculation. The volume of issued but still unredeemed I-RECs (vintage X) in country A by end of year X+1 is expressed by Equation 5 (see also Figure 3). It should be noted that potential other tracking mechanisms beyond I-RECs should be included in these checkpoint calculations if official redemption (or cancelation) data exists.

Equation 5 The volume (MWh) of issued, unredeemed I-RECs (vintage year X) in country A by end of year X+1.

Issued unredeemed I-REC$_X$ = National Issued Volume$_{X+1}$ − R$_{Na, X+1}$ - R$_{E, X+1}$

Where:

National Issued Volume $_{X+1}$ =   Total issued I-RECs for electricity generated in country A in year X by the end of year X+1 (MWh)

$R_{Na,\,X+1}$: Redeemed National$_{X+1}$ =   Total redeemed I-RECs for electricity generated in year X by the end of year X+1, issued and redeemed in country A (MWh)

$R_{E,\,X+1}$: Redeemed exported$_{X+1}$ =   Total redeemed I-RECs for electricity generated in year X by the end of year X+1, issued in country A and redeemed in another country (MWh)

Since the Residual Mix calculation withdraws all issued I-RECs, there is a probability that there still exists a certain number of unredeemed I-RECs at the publication date of the Residual Mix. Hence, the Residual Mix might contain fewer renewable attributes than what is the actual situation. However, as I-RECs being issued in year X still can be redeemed after the date of publication, the "actual" Residual Mix will most likely move towards the calculated one.

The difference between issued and unredeemed I-RECs should be compared to the total issued certificate volume, the total generation volume and the Residual Mix volume for the country in question to determine the potential impact on the Residual Mix.

4.2.2 Checkpoint 2: Surplus/deficit of available attributes at publication date

In order to calculate whether there is a surplus or deficit of available attributes for the Untracked Electricity Consumption, the volume of the national Residual Mix (Equation 4) needs to be compared with the volume of Untracked Consumption in the respective country.

The Untracked Electricity Consumption is obtained by withdrawing redeemed I-RECs (both national and imported) from the country's annual electricity consumption volume. The principle for calculating the Untracked Electricity Consumption is shown in Figure 4 below. For simplification, it is assumed that the national generation volume equals the national consumption volume in the country.
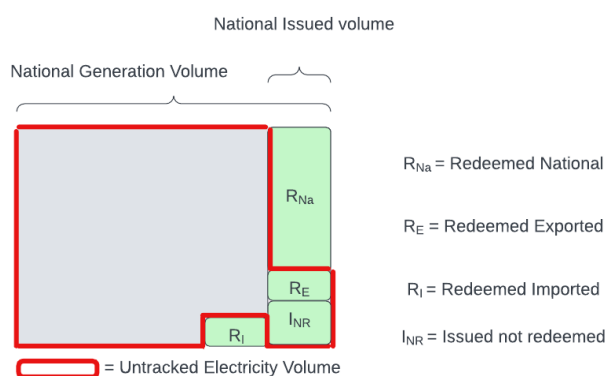

Figure 4 Principle for calculating of the volume of the Untracked Electricity Consumption.

As described earlier, the publication date for the Residual Mixes should be maximum 1 year after end of the generation year. Hence, I-RECs issued by September 30 in year X+1 have a maximum of three months to be redeemed to be correctly included in the Residual Mix calculation. The volume of Untracked Electricity in country A by end of year X+1 is expressed by Equation 6 (see also Figure 4).

It should be noted that potential other tracking mechanisms beyond I-RECs should be included in these checkpoint calculations if official redemption data exists.

Equation 6 The volume (MWh) of Untracked Electricity Consumption in country A for year X

Untracked Electricity Consumption$_X$ = National Generation Volume$_X$ – R$_{Na, X+1}$ - R$_{I, X+1}$

Where:

National Generation Volume$_X$ =   Generated electricity in year X in country A (MWh)

R$_{Na, X+1}$: Redeemed National $_{X+1}$ =   Total redeemed I-RECs for electricity generated in year X by the end of year X+1, issued and redeemed in country A (MWh)

R$_{I, X+1}$: Redeemed imported $_{X+1}$ =   Total redeemed I-RECs for electricity generated in year X by the end of year X+1, issued in another country and redeemed in country A (MWh)

By adapting Equation 3 above, the potential surplus/deficit of attributes can be calculated from Equation 7:

Equation 7 Calculation of potential surplus or deficit of attributes.

Surplus/deficit of attributes = National Residual Mix$_{yearX}$ - Untracked Consumption$_{yearX}$

If the calculated volume of attributes results in a negative number, the country has a deficit of attributes, while a surplus of attributes is the situation if the calculation ends up with a positive number.

From Figure 3 and Figure 4 it can be seen that Equation 4 can be rewritten as follows when replacing National Issued attributes (vintage X) with R$_{Na}$ + R$_E$ + I$_{NR}$:

Rewritten Equation 4 Volume (MWh) of national Residual Mix for year X.

National RM$_{year X}$ = National Generation$_{year X}$ – National Issued attributes (vintage X)$_{1.1 \, year \, X – 30.9 \, year \, X+1}$

= National Generation$_{year X}$ – (R$_{Na}$ + R$_E$ + I$_{NR}$)

By substituting into Equation 7, the National Residual Mix calculation from the rewritten Equation 4 and then the Untracked Consumption calculation from Equation 6, we obtain Equation 8.

Equation 8 Calculation of potential surplus or deficit of attributes

Surplus/deficit of attributes = R$_{I, X+1}$ - R$_{E, X+1}$ - I$_{NR}$

From Equation 8 the potential surplus or deficit of attributes depends on the difference between imported and exported I-RECs, as well as the number of not-redeemed I-RECs. If import equals export, only the not-redeemed I-RECs define the deficit of attributes. As mentioned above, as I-RECs being issued in year X still can be redeemed after the date of publication of the Residual Mix, it is reasonable to assume no surplus/deficit of attributes is taken into consideration over time. This means there is no need for adjusting the national Residual Mixes with a calculated "I-REC Attribute Mix" (reflecting the "European Attribute Mix").

The calculated surplus/deficit of attributes should be compared to the Untracked Consumption volume (vintage year X) for the country in question to assess the potential impact on the Residual Mix.

4.3   Direct CO_2 emission factor for the Residual Mix

The direct CO_2 emission factor for the Residual Mix (EF_{RM}) can be calculated in two different ways, depending on the availability of data. These are explained below. If the country in question has other national tracking mechanisms, the total issued volume for both I-RECs and the other mechanisms should be included when calculating the Residual Mix, and, as such, in calculating the Residual Mix emission factor.

1.   Based on the national emission factor (EF_{Na})

If there exists an official figure for the national emission factor (EF_{Na}) for electricity generation, the Residual Mix emission factor (EF_{RM}) should be calculated as shown in Equation 9.

Equation 9 Residual Mix emission factor (EF_{RM}) based on national emission factor (EF_{Na}).

EF_{RM} = EF_{Na} * Volume Total generation [TWh]/Volume Residual Mix [TWh]

2.   Based on specific emission factors for each energy source in the Residual Mix

If an official number for national emission factor (EF_{Na}) for electricity generation does not exist, the Residual Mix emission factor (EF_{RM}) can be calculated as shown in Equation 10.

Equation 10 Residual Mix emission factor (EF_{RM}) based on specific emission factors per energy source

$$EF_{RM} = \frac{\sum_{k=1}^{n} kg\ CO2\ per\ kWh_{energy\ source\ k} * kWh_{energy\ source\ k}}{\text{Volume Residual Mix [kWh]}}$$

where k is the number of energy sources in the Residual Mix.

As described in chapter 3.2, the direct CO_2 emission factors per kWh for electricity generated by different energy sources can be provided by different sources. An example is given in Annex 3 in AIB's report "*European Residual Mixes. Results of the calculation of Residual Mixes for the calendar year 2022*" (AIB (Association of Issuing Bodies), 2023).

5   Recommendations

This report recommends implementing a modified Issuance Based (IB) method for calculating Residual Mixes to be used for I-REC issuing countries, valid for national tracking markets that are not legislatively linked in the same way as European markets are. It is further recommended that the national Residual Mixes are published within one year after the generation year, which means January in year X+2 for generation at any point in year X. However, a major challenge for Residual Mix calculations is timing and redemption (or cancelation) data for attribute tracking certificates might still not be definitive at the date of publication.

Hence, the occurrence of a potential surplus/deficit of attributes is not considered, which means that the proposed methodology is based on two assumptions: (1) potential unclaimed issued I-RECs at the moment of publication are assumed to be redeemed over time, and (2) the Residual Mix volume is assumed to correspond to the volume of Untracked Electricity Consumption in the respective country. Two checkpoint assumption tests are recommended to verify the potential impact of the assumptions for the Residual Mix calculation.

The report also presents two different ways for calculating the direct CO_2 emission factor for the Residual Mix, depending on the availability of data.

I-REC should regularly review annual calculated Residual Mixes and underlying assumptions to ensure the continued validity of the method. If, for example, surpluses and deficits of attribute certificates in markets are considered substantial or consistently increasing, or if unredeemed certificate rates tend to increase, the I-REC Foundation should reevaluate these methodologies and/or propose modifications such as implementing an expiry date for I-RECs (like in the European GO system).

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