Technical support for RES policy development and implementation.

Establishing technical requirements & facilitating the standardisation process for guarantees of origin on the basis of Dir (EU) 2018/2001

Task 4

The development of systems for EU based market supervision statistics

Task 4.2

Methodologies for an updated residual mix calculation method

FaStGO
Facilitating Standards for Guarantees of Origin

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1 Framework

1.1 FaStGO

The FaStGO project has the objective of providing expert advice to the European Commission DG ENER, based on the terms of Reference N° ENER/C1/2019-517: "Technical support for RES policy development & implementation. Establishing technical requirements and facilitating the standardisation process for guarantees of origin on basis of Dir (EU) 2018/2001."

1.2 What and why

Taking into account the legislative frameworks, the operational experiences of the current system, and the additional requirements based on a revised EN 16325, FaStGO task 4 works on development of systems for EU based market supervision statistics for GOs.

Task 4.2 considers how the residual mix can be upgraded in order to establish a reliable claim of the origin of consumed energy that is not covered with cancelled guarantees of origin.

1.3 Methodology for the 2 different tasks of 4.2

The FaStGO project enabled 2 upgrades to the concept of the residual mix:

1) FaStGO enabled the consultation of an **updated residual mix methodology for electricity** as developed in AIB in the autumn of 2019, with a wider audience, and thus establish higher trust.
2) With regards to completing the GO system with a residual mix for **non-electrical energy carriers**, this document proposes a reasoning and elaborates options for future further development when 1) volumes of renewable and cross-border transferred energy increase and 2) non-electrical energy carrier related energy origin disclosure regime is more established. Also, energy carrier specific needs are being mapped.

1.4 Glossary

EAM	European Attribute Mix, the mix of surplus energy origin attributes from countries where (mainly renewable) energy attributes were imported through guarantees of origin, used to fill in the deficit in nett attribute exporting countries.
GO	A guarantee of origin in the meaning of article 19 of REDII
H/C	Heating and/or Cooling
REDII	The Renewable Energy Directive 2018/2001/EU
RES	Renewable energy sources
RM	Residual Mix

2 Executive Summary

For the purpose of this document, the residual mix is considered to be the mix of energy sources and their attributes for energy supply which is not proven with the cancellation of guarantees of origin or possible other means of explicit tracking.

2.1 Updating the residual mix methodology for electricity

FaStGO enabled the consultation of an **updated residual mix methodology for electricity** with a wider audience, and thus established increased trust. This resulted in the confirmation of the methodology update, which AIB consulted at the end of 2019 in a smaller circle of involved organisations. The Issuance-Based method for the calculation of the residual mix for electricity, with some modifications to the original concept from the RE-DISS project, was accepted to replace the former Transaction-Based calculation method.

2.2 General principles for a residual mix calculation for any energy carrier

With regards to completing the GO system with a residual mix for **non-electrical energy carriers**, the following reasoning is proposed, to facilitate further developments in the legal framework (figure 1):

1. **A legislative disclosure system is essential for reliable energy origin disclosure.**

   It does not make sense to calculate a residual mix just for the sake of having one. If a mandatory disclosure system is not in place for the given energy carrier, then it is doubtful whether a residual mix would be reliable in its calculation and use. Without the surrounding disclosure legislation a residual mix provides little value.

2. **For a reliable residual mix calculation, it is necessary to (be able to) monitor all energy that is being sold or consumed as "originating from renewable sources".**

   This is essential in order to ensure that these renewable energy claims are excluded from the residual mix. Untransparent tracking can happen if (e.g.) renewable energy contracts are not centrally monitored, or do not include measures to avoid double claims for energy for which GOs are issued. This needs to be eliminated before a residual mix can be reliably calculated and implemented.

3. **The perimeter of the area in which the residual mix counts should be the same as the perimeter of the area in which consumption and production of energy are taken into account.**

4. **For energy carrier conversion, GOs can only be issued for the output if GOs for the input energy have been cancelled.**

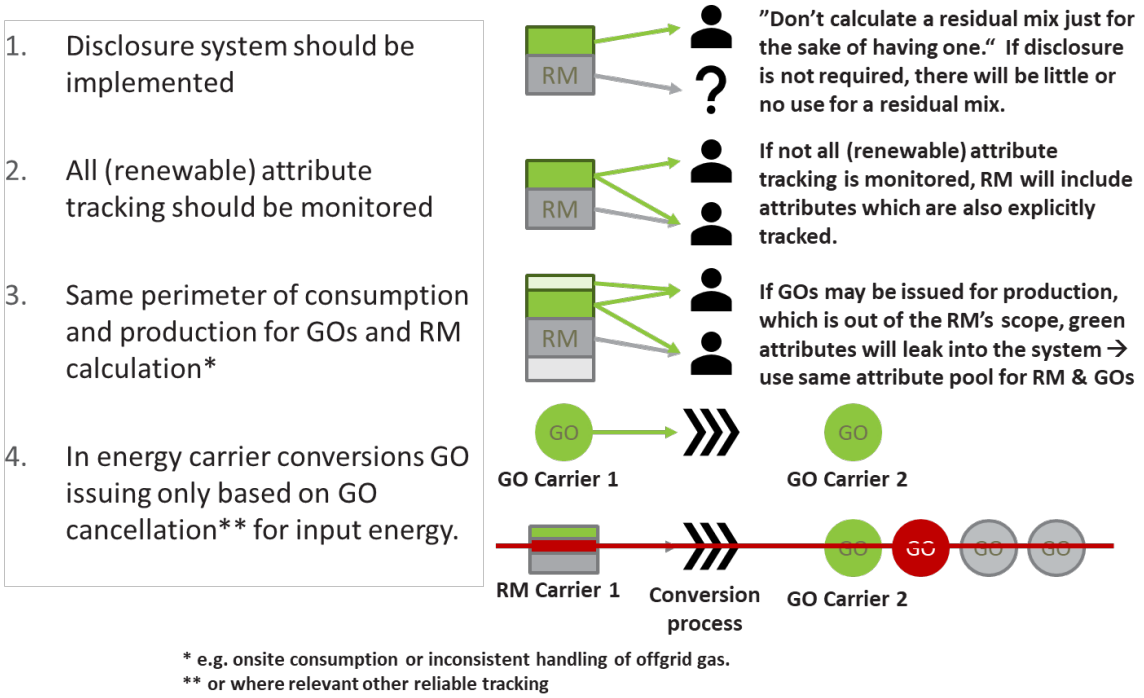


Figure 1 General principles and requirements for residual mix calculation

2.3 Moving towards an energy carrier specific residual mix with an interim solution

As an interim solution, this document proposes that the residual mix for gas, hydrogen, and heating and cooling consist of fossil energy sources. For gas and hydrogen this can immediately be further detailed down to natural gas. As an interim solution, the dummy fossil-only residual mix may contain attributes of expired GOs where it can be guaranteed that those have not been used for disclosure.

A properly-calculated residual mix may only be implemented for the non-electrical energy carriers, similar to the residual mix for electricity, when the four general principles from section 2.2 for a residual mix have been fulfilled and a detailed residual mix (in contrast with a dummy fossil-only residual mix) is seen to add customer value.

For credibility reasons, the residual mix should be calculated at a country-level. Once large numbers of international transfers leave a deficit in the remaining available origin attributes in a nett GO exporting country, a pan-European harmonised approach becomes relevant. To account for imports and exports beyond the borders of a country, the residual mix should be balanced internationally through the European Attribute Mix (EAM) separately for each energy carrier. A reliable residual mix requires all countries to apply the same calculation methodology.

2.4 Characteristics to consider per energy carrier

2.4.1 Heating and cooling

For Heating and Cooling (H/C), grid-specific (rather than country-specific) residual mixes might be relevant, depending on the national disclosure framework. However, this could create excessive complexity, especially if H/C grids should become international.

2.4.2 Hydrocarbon gas

The relevance of having a residual mix for hydrocarbon gas should be carefully assessed. Considering all untracked gas simply as natural gas (with the option of adding attributes of expired GOs) is a very lucrative and simple approach for the hydrocarbon gas residual mix. Given that the end result could be very close to natural gas only, setting up a detailed residual mix calculation system may not pay off while: (1) renewable gas represents a relatively small part of the input to and consumption from the gas grid; and (2) is mostly covered with GOs.

2.4.3 Pure Hydrogen

Similar to heating, cooling and gas, the mix of hydrogen supplied without the cancellation of guarantees of origin will remain more than 95% natural gas based, the rest being electrolytic H2 produced without GOs. Therefore, it would be unjustified to set up a system allowing an exact residual mix to be calculated. The residual mix for hydrogen can simply be qualified as being "Natural Gas based".

When moving towards more detail in the residual mix for hydrogen, regulation-related challenges come up. Unlike electricity and network-distributed gas, and heating and cooling (to a certain extent), the hydrogen sector is not regulated. For this reason, composing accurate (annual) production and consumption figures for the full European hydrogen system perimeter is a bigger challenge for hydrogen than for the other energy carriers.

2.4.4 Blending hydrogen in gas networks

With energy policy strategies orienting towards increased shares of hydrogen into the gas networks, cross-energy carrier dynamics also play a role here: with massive injection of renewable hydrogen into the gas grid, it will be necessary to account for this, while keeping the hydrogen residual mix and the gas residual mix separate.

1. The option of having one mix for both carriers (hydrogen and hydrocarbon gas) could affect the credibility of the disclosure system towards consumers. It creates an extensive monitoring challenge in order to include all production and consumption of the full system perimeter in one mix.
2. Alternatively, establishing separate residual mixes for hydrogen and network-gas requires tracking of the blending of hydrogen into the gas grid. This could be done by putting an earmark "blended in gas distribution or transmission system" on the hydrogen GO relating to hydrogen that is injected into a gas network. Another way of implementing tracking of blending can be either the cancellation of a hydrogen GO and issuing of a corresponding hydrocarbon gas GO, or direct issuing of a hydrocarbon gas GO (without prior issuing of a hydrogen GO).

3 Background: Disclosure and need for residual mix

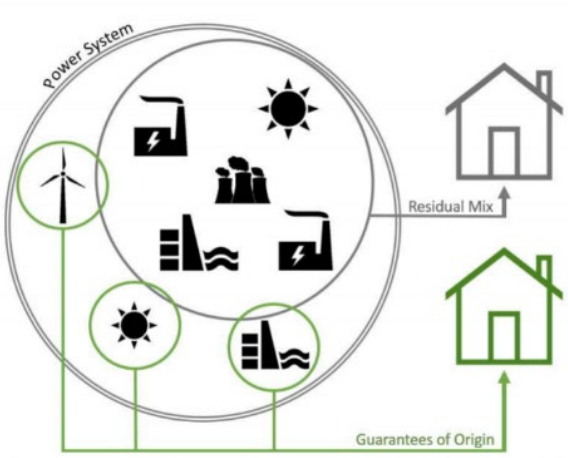
3.1 What is Disclosure?

The concept of 'Disclosure' used in this document refers to the provision of information regarding the origin of energy supplied to the final consumer of that energy.

For electricity, this has an even more specific meaning, given the rules from the Internal Energy Market Directive. Such European rules are in place since 2003 (2003/54/EC), and have gradually been refined over the European legislative framework.

Currently, each electricity supplier is obliged to disclose on its invoices to its customers the energy origin of all electricity sold (2018/2001(EU), Article 19.8; 2019/944(EU), Annex 1.5). In most countries, this information is typically only partly-based on cancelled guarantees of origin. The need for a residual mix stems from the fact that electricity disclosure is mandatory for all electricity sold, but GOs are typically issued and cancelled only for a part of the volume.

The introduction of a GO system provides a way to supply energy with specified attributes, but also impacts the remaining attributes of energy supplied without a GO. According to preamble 13 of 2018/2001/EC: 'residual energy mix' means the total annual energy mix for a Member State, excluding the share covered by cancelled guarantees of origin. If uncorrected generation statistics were used for the purpose of disclosure of untracked electricity consumption, then the renewable energy origin represented by GOs would be double counted.



With the extension of the GO system to non-electrical energy carriers, an according extension of the disclosure system for these energy carriers is needed, in order to assure the credibility of the GO in terms of avoidance of double counting of energy origin attributes.

3.2 Residual mix is the origin of energy supply which is not backed with cancellation of GOs

As elaborated, the introduction of a GO system provides a way to supply energy with specified attributes to any consumer within the domain. However, a purely logical consequence is that this also impacts the qualification of any supply of energy without a GO within the domain: that supply of energy must logically be described as having the average characteristics of the energy supplied without cancellation of GOs, called the residual mix.

In particular, this means that energy which has been consumed close to a renewable energy production plant, but supplied without cancelling GOs, must be considered to be part of the residual mix.

This only applies to energy consumption within the perimeter of the GO scheme, i.e. the GO domain. Outside of that domain, claims on the origin of energy supplied could still be based on physical considerations: e.g. all consumers of gas downstream of the

injection point of renewable gas in a gas system could claim consumption of this renewable gas **in the absence of a GO system**. However, when a GO system including that gas consumption is introduced, such claims may no longer logically be made without cancelling GOs.

3.3 How full disclosure would exclude the need for a residual mix

Once GOs are issued for all energy carriers and all energy sources, and all energy supply is to be backed with cancellation of GOs, there is no longer a need for a residual mix. However, the current legislative framework does not yet cater for such obligatory GO issuance and cancellation of GOs for all energy carriers and from all energy sources. Hence the means of disclosing the origin of energy supply which is not backed with GOs must be considered.

3.4 Lessons learned on electricity disclosure over 2 decades

There are now almost two decades of experience with the continuous further development of a reliable energy origin disclosure system for electricity.

GOs are to be seen as the beginning of the process, of which the end is disclosure to an end-consumer (figure 2). However, issuing and registration of GOs is not always governed by the same organisation, which supervises energy suppliers and their origin claims. This division of responsibilities, which stems from a similar separation of responsibilities in the originating European legislation, has been a challenge for the GO system. Indeed, in some countries, this challenge could risk losing consumer credibility through misunderstandings in the management of the GO versus the disclosure system management.

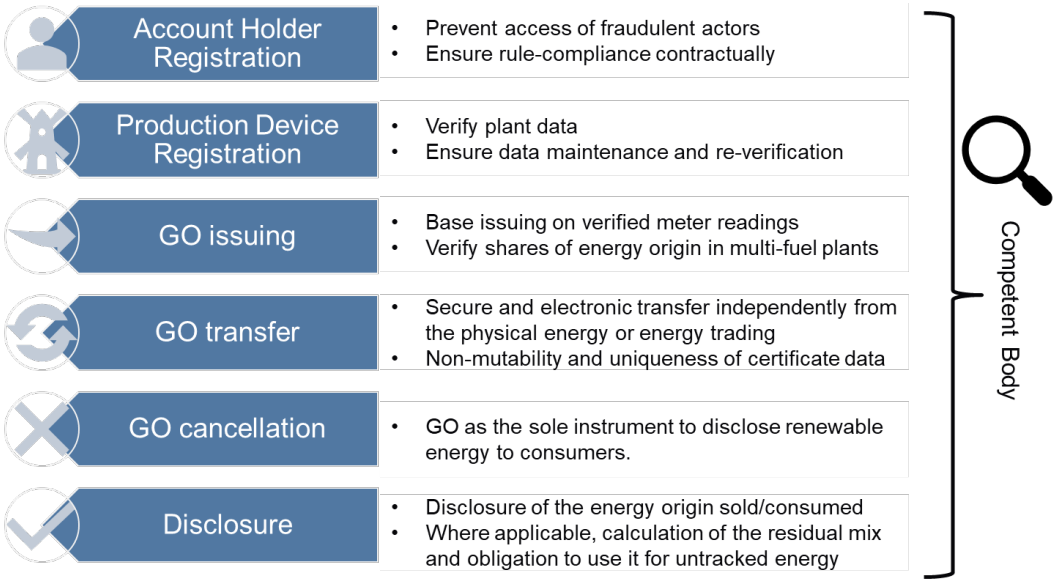


Figure 2 GO and disclosure process ending with the ultimate purpose of GOs being disclosure

The EECS Rules, a standard jointly created by European issuing bodies, have the "Uniqueness" of certificates as their core principle. This implies that an EECS GO will only be issued to energy that has not yet been (or will not be) otherwise disclosed, and also that the cancellation of EECS GOs shall be the only proof of the qualities of the associated energy (EECS Rules section A2.1.2.). The GO systems of AIB members are being regularly audited against these core principles.

The RE-DISS[1] project aimed to overcome the challenges in the framework of electricity disclosure by producing Best Practice Recommendations for reliable disclosure, in absence of a legislative framework that harmonised the disclosure methodology. These Best Practice Recommendations addressed e.g. lifetime, uniqueness, recognition, timing of disclosure, how to establish supplier-level disclosure figures and residual mix calculation. Many European countries followed these Best Practice Recommendations in their national disclosure legislation or regulation. See www.reliable-disclosure.org.

3.5 How cross border transfer of renewable attributes induces the need for a harmonised residual mix calculation

The need for a methodology to determine a cross-border central residual mix emerges when a country exports more GOs than physical energy, thus creating a deficit of generation attributes. Such a deficit of attributes in the disclosure of energy supplied without being backed by GO cancellation needs to be complemented with an excess of attributes from countries that are net importers of GOs.

This system has been proven to work for the electricity sector, through pan-European cooperation, even though further harmonisation of practices can still be made. The challenge was resolved by maintaining the concept of a national residual mix, while adding the concept of the European Attribute Mix, which balances attributes centrally without the need for complex country-by-country balancing of attributes.

The European Attribute Mix contains all surplus generation attributes from countries with an excess of attributes. It is used to fill the gap in the residual mix in countries with a deficit of attributes in their residual mix. If some countries calculate their residual mix in a different way, especially for attribute-deficit countries, there is a risk of double counting of the same attributes, which should at all times be avoided in a reliable disclosure system.

[1] *http://www.reliable-disclosure.org*

4 The role of the system perimeter in a reliable origin disclosure system

A reliable disclosure system based on a book-and-claim certification mechanism needs to carefully set its system boundaries. It also needs to establish that, within these system boundaries, the generation attributes relating to a unit of produced energy can be consumed solely by cancelling the associated GO. This is necessary to avoid double counting.

Equal amounts of **Electricity** are always produced and consumed within a certain time period, and therefore the total attribute excess is equivalent to the total deficit. For electricity distributed over the public Distribution or Transmission system, grid equilibrium of injection and consumption in the grid is carefully balanced, and such figures are made publicly available by the regulated system operator. Where countries also incorporate production and consumption from other (private) grids, a reliable determination of the residual mix requires the same principle of equilibrium to be applied to the overall system, and including any private grids.

When the system perimeter includes **energy carriers that are transported by vehicle**, the overall communication of tracking all production and consumption quantities over this full perimeter becomes more challenging. Once these volumes develop, their variety and cross-border transfer will increase and a more complex residual mix calculation will become relevant, requiring monitoring of the total quantity of production and consumption along the full system perimeter.

4.1 Defining GO scheme boundaries

Reliable disclosure in a book-and-claim system can only take place within carefully regulated system boundaries. There are different ways of defining the boundaries of the GO scheme depending on the energy carrier in scope, and specific questions are raised by each case, such as:

- First of all: geographic boundaries, (all production/inputs inside listed countries under a joint legal disclosure framework);
- Subsequently, the area in which a specific methodology of origin disclosure can be imposed for all stakeholders. Here, the legal framework plays a role. Elements of relevance when setting system boundaries include:
    - For electricity: is self-production (onsite consumption) within the boundaries of the GO scheme?
    - For gas: is off-grid gas (CNG and LNG) included in the same origin disclosure system as grid-supplied gas?
    - For hydrogen: are volumes that are not sold to another party to be considered within the origin disclosure system boundaries, such as volumes produced and consumed on the site of a plant, as in an ammonia plant or within refinery processes? Such off-market volumes currently exceed traded volumes of hydrogen.

As a general rule: the system perimeter for GO issuing should be the same as the boundaries of the system for which origin disclosure rules apply for the energy consumption, and for which the residual mix is being calculated.

Separate residual mixes per type of grid (or per other physical energy dissemination method, like vehicle transport) only make sense if there are corresponding rules in relation to origin claims, stating that the cancellation of GOs is only allowed in relation

to the type of grid on which the consumption takes place (i.e. cross-usage of GOs between different dissemination methods would not be allowed).

For GOs relating to an energy carrier which can only be used for energy consumption via a physically specified system, the residual mix needs to be determined considering energy supplied within that system only (e.g. GOs issued for biomethane production, being the energy carrier Hydrocarbon gas can be used for claiming the origin of consumption of hydrocarbon gas). Thereby, the same system perimeter is needed for GOs and the residual mix.

5 Update of the Residual mix Calculation Methodology for electricity

5.1 Consultation confirmed the issuance-based RM calculation methodology

The residual mix calculation methodology for electricity was developed in the Reliable Disclosure Systems for Europe (RE-DISS) projects 1 and 2 during 2010-2015. The RE-DISS projects were funded by the Intelligent Energy Europe programme. The RE-DISS methodology was refined in 2019 with a transition to a so-called Issuing-Based Method (instead of the Transaction Based Method used earlier). This transition was already recommended in the final report of the RE-DISS project when the GO system and its statistical reporting had evolved to a suitable maturity.

An updated residual mix calculation methodology adds value and efficiency, on condition that it is widely endorsed by disclosure Competent Bodies across Europe. This methodology focuses on electricity, as it is currently the only energy carrier for which there is an EU regulated energy origin disclosure system. The current residual mix calculation methodology for electricity may be found here.

The main difference between the Issuance-Based and Transaction-Based Methods is that the former bases the number of attributes in the residual mix on issued and expired GOs, whereas the latter basis them on net exports/imports and cancellations. The former is easier to understand and avoids some of the shortcomings of the Transaction-Based Method such as occasional "negative RES balances" and the interference of international trading. Generally speaking, however, the two methodologies are remarkably similar. The updated residual mix calculation methodology and the arguments for using it, are available in this document.

AIB members, competent authorities for electricity disclosure, as well as other relevant stakeholder have been invited to comment the new methodology in two occasions. First in an AIB internal commenting round in December 2019, and secondly in a wider FaStGO consultation. This FaStGO consultation consisted of publication and sharing by e-mail with relevant stakeholders, and a webinar (on 10th March 2020) organised by the FaStGO project team, which was open for a wider audience. Competent bodies responsible for electricity disclosure supervision were specifically targeted, and they comprised a significant share of the webinar audience.

These consultations supported the amendment of the residual mix calculation to move to the issuance-based methodology. The consultation also led to the adjustment of the residual mix delivery deadline of the initial draft update for the methodology. As a result of this confirmation of the updated RM methodology, it was immediately applied for the calculations in spring 2020 and applied to the calculation of the 2019 residual mix for electricity.

5.2 Electricity system perimeter discussions in the development of the GO standard

For electricity production that is consumed on the site of production and not transferred further, it becomes relevant to reflect the dissemination level of the physical electricity. This enables confirmation that the perimeter of GO issuance is the same as that of the area for which production and consumption figures are used to calculate the residual mix. For the reason elaborated in section 0 above, it is important to monitor the perimeter for which GOs are being issued in a Domain.

6 Extension of the GO and energy origin disclosure systems to gas, hydrogen, and heating and cooling

6.1 Surrounding legislative disclosure framework for non-electrical energy carriers

The Renewable Energy Directive (2018/2001) stipulates that Member States must arrange for issuing of GOs for energy production from renewable energy sources for electricity, gas (including hydrogen) as well as heating and cooling. Member States must also recognise GOs issued in other Member States regardless of the transfer of the physical energy. The sole purpose of GOs is the disclosure of the energy origin of sold or consumed energy.

Although the system for issuing guarantees of origin is set similarly for electricity, gas, hydrogen and heating and cooling, there are important differences concerning how energy origin disclosure is addressed for different energy carriers, which affects the usability of the residual mix and the possibility to calculate it reliably for such energy carriers. The following weaknesses need to be addressed.

6.1.1 Disclosure is not mandatory for gas, hydrogen

No requirement exists for disclosure of the energy origin of gas or hydrogen. This means that a supplier does not have to inform its customer of the origin of the supplied energy, which results in the consumer not caring or having to guess the energy origin, and thereby it misses an opportunity to incentivise the supplier to provide energy of a more environmentally friendly origin.

For heating and cooling, disclosure is (at least vaguely) set forth by Directive 2018/2001 (EU) Art. 24 (1), which requires information on the energy performance and share of renewable energy in district heating and cooling systems to be provided to final consumers.

It is important to underline that **without a mandatory disclosure, the residual mix would not hold much value**, because the origin of untracked energy would not need to be disclosed (unless specifically asked for by the customer). Therefore, it does not make sense to introduce a residual mix just for the sake of having one, i.e. if the surrounding system for disclosure is not in place to enforce the usage of that residual mix.

It is assumed that that a disclosure system will emerge at member state level for non-electrical energy carriers as well. This is especially needed as, when tracking of non-electrical energy carriers increases, this will affect the origin and also the accuracy of carbon accounting of untracked energy.

6.1.2 GOs are not the only tracking instruments for the energy origin of gas, and heating and cooling

The main cornerstone of reliable residual mix calculation is the availability of statistical data on energy attribute tracking through GOs and possible other reliable tracking systems. An important precondition for a reliable residual mix calculation is that all (renewable) energy origin tracking is monitored, and thereby can be accounted for in the residual mix. For tracking with GOs, this is always true. However, if other less transparent ways of tracking (renewable) energy, such as contracts, are also allowed, then a reliable residual mix calculation might not be possible - at least, if information concerning such tracking is not centrally collected.

Since Directive 2018/2001/EC clearly sets GOs as the sole instrument for such tracking of renewable electricity, the collection of tracked attribute volumes is well coordinated for the electricity energy carrier. However, for gas as well as heating and cooling, the Directive does not stipulate GOs as the sole instrument of renewable energy attribute tracking.

To overcome this lack of enforcement of the role of GO, it could hence follow as a general advice to the European legislator that future European legislation should provide at least the following minimum requirement for energy suppliers[2]: that **the origin of electricity, gas or heating and cooling from RES can only be claimed by GOs (and other possible legislative and centrally monitored tracking schemes** which avoid the same attributes from being disclosed more than once). Also, it should be acknowledged that allowing other tracking instruments (even if centrally reported and monitored) than GOs complicates the supervision process for reliable disclosure and the calculation of the residual mix.

In the absence of European harmonised legislation, such a rule could emerge at member state, but not necessarily Europe-wide, level. The fact that other tracking instruments for renewable gases, as well as heating and cooling, might exist alongside GOs must be taken into account in the residual mix calculation methodology for gas as well as heating and cooling.[3] This can be done by, for example, considering the residual mix simply as fossil energy (e.g. natural gas in case of gas, and the fossil energy production mix in case of heating) until it is guaranteed that all (renewable) energy is centrally monitored for the given energy carrier.

6.2 Hydrocarbon gas residual mix

As explained above, the need for a residual mix stems from the requirement to disclose the origin of all supplied or consumed energy. The assumption in this paper is that some sort of voluntary need or mandatory requirement for the disclosure of the origin of gas will emerge at least at a national level, which will necessitate disclosure of information on the energy origin of untracked gas.

6.2.1 Specific consideration on potential multiple explicit tracking instruments

On the "explicit tracking" side, the interplay of GOs and sustainability certificates (Directive 2018/2001(EU), Art. 25-31) in disclosure needs to be clear, so that the same energy origin cannot be disclosed through two separate instruments (see more here in the report of FaStGO task 1.3 "Mapping of GO system management challenges", under topic 8). The same goes for other possible tracking, such as contract-based tracking. Each MWh of renewable energy production needs to be tracked once for the purposes of energy origin disclosure.

[2] *Article 19.8 also only limits itself to claims by electricity suppliers, this would better be expanded to claims by consumers as well.*

[3] *Until 2018, other tracking mechanisms were also in theory allowed for RES in electricity GOs. However, in practice the existence of clear disclosure regime as well as rules for avoidance of double counting effectively limited the use of such mechanisms. For gas as well as heating and cooling for which disclosure is less stringent, it is also less clear which mechanisms besides GOs, if any, are usable for disclosure.*

6.2.2 Reasons for deviating the gas residual mix from the electricity method

As explained, the lack of enforcement of disclosure and GOs as the sole tracking instrument causes challenges for calculating the residual mix, which is the primary reason for changing the methodology for gas into a simple natural gas residual mix. However, there are also other reasons for adopting a simplified approach for the time being.

The technical justification for residual mix calculation might be higher for electricity than gas because the carbon emission of power generation depends widely on the energy source, and the energy sources used depend widely on the country. In many countries, the origin of electricity is disclosed at the categorisation detail level, being categories renewable, nuclear, and fossil.

For gas (hydrocarbon gases), the energy that is introduced into the system without issuing GOs is mostly natural gas; so the residual mix is basically average natural gas – i.e. "fossil gas", which reduces the need for a residual mix calculation[4].

A similar "non-renewable residual mix" approach is taken in some countries on the electricity disclosure side, where the "residual mix" is simply determined as the country's production mix, stripping renewables from it. This solution is administratively quite simple and ensures the avoidance of implicit double counting of the renewable energy origin. It does not require information from other possible tracking mechanisms for the reliable calculation of a residual mix. There is also no similar problem in such approach potentially leading to double counting of the zero-carbon (nuclear) energy source as is the case in electricity.

Furthermore, fossil gas (natural gas) is largely imported in most countries. Thus, the calculation of domestic residual mixes based on domestic production would be quite artificial and rather similar across countries. The residual mix would consist of only a small number of attributes of biogas production without corresponding GO issuing and expired GOs and would hence be **dominated by imported natural gas**[5]. Hence the residual mix easily falls to natural gas even if done as for electricity. Only when the volume of low carbon/renewable gas production becomes substantial, and when there would be such gases left over for which the origin is not yet claimed, might a complex residual mix calculation make sense and the need for it need to be reassessed.

These reasons tend to further confirm that, instead of calculating a residual mix, it would be a straightforward first step to **consider all non-tracked gas as fossil natural gas, at least until the GO (or other legislative and centrally monitored tracking schemes) becomes the only method for tracking renewable gas.**

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[4] *Only once significant volumes of hydrogen are injected into the natural gas grid, and which are not covered with issuance of GOs, then the "natural gas" origin of the residual mix may have to be complemented with the energy sources for which such hydrogen is produced in the specific country. When, however, GOs are issued for the hydrogen that is injected into the gas grid, this hydrogen should not be included in the residual mix unless these corresponding GOs have expired.*

[5] *According to the RM calculation methodology (for electricity), gas imported from outside the EU needs to be added to the attribute mix of the importing country and the surplus/deficit is then balanced through the EAM. For imports from an EU country, the attributes are included in the attribute mix of the producing country, and the surplus/deficit is balanced through the EAM.*

6.2.3 Dealing with off-grid gas

A further aspect to consider is the distinction between gas which is injected into the grid (grid-supplied gas) and gas which is produced and/or consumed off-grid (gas not injected to a TSO/DSO grid, but transported from production to consumption through other means such as by a vehicle or a local grid). It might be argued that there is a need to calculate a country's residual mix separately for grid-supplied gas and off-grid gas, the logic being that grid-supplied gas is largely imported natural gas, whereas off-grid gas is often domestically produced biogas. **However, since the GO is by characteristic indifferent of the transfer of the physical energy, the national production should be taken as the basis of the residual mix without differentiating grid injected volumes with off-grid volumes. Hence the system perimeter of the GO scheme should be followed in the residual mix calculation.**

6.2.4 Displaying the geographical origin of the natural gas in the residual mix

The relevance of certain geographical origin might be higher for gas than electricity consumers. For example, natural gas from within the internal energy market might be valued differently than natural gas imported to Europe. However, it is not advisable to mix the geographic origin of gas with the calculation of the residual mix. **Instead GOs should be used to prove all relevant generation attributes (including location of production or extraction) of consumed gas.** Section 7.2 elaborates where the geographic origin of the natural gas becomes relevant for determining the carbon emissions, and a high level principle for how to come to those.

6.2.5 Options for a detailed calculation of the gas residual mix once disclosure rules are established

Figure 3 sets out theoretical high-level options for how a residual mix for gas could be framed. At first stage, options **1** or **2** could be implemented, with the possibility to move to option **3** in the future if 1) previously presented preconditions for a reliable disclosure regime are met, and 2) it would add value for the consumer. Option **4** is only recommended if separation of the grid and off-grid residual mix adds value, and such separation is compatible with the concept of physical detachment of GOs from the underlying energy.

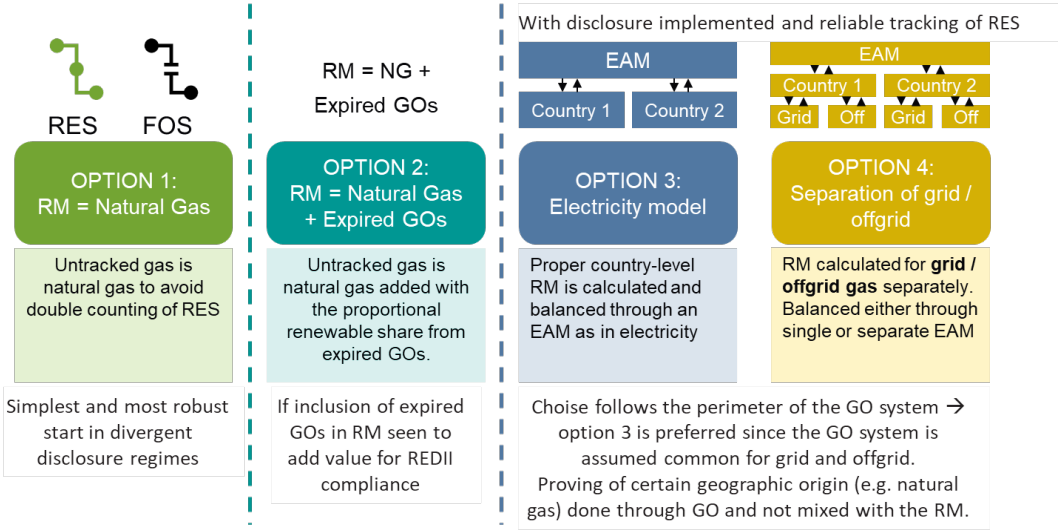

Figure 3 High-level options for hydrocarbon gas residual mix calculation

6.2.6 Recommendations for a gas residual mix

Based on the abovementioned reasoning, the following recommendations are proposed for developing a reliable residual mix for gas:

1. GOs (where relevant, together with possible other legislative tracking instruments that avoid double claims and are included in a supervised disclosure system) should become the sole instrument for tracking renewable energy origin of gas, in order to avoid double disclosure of the same amount of renewable gas;
2. Until there is a supervised origin tracking and disclosure system that avoids double claims of the same origin of energy, the residual mix can be simplified to consist of natural gas, which effectively avoids double counting of tracked renewable gases;
3. One further advanced step from such a "simplified residual mix" could also include attributes of expired gas GOs in the residual mix for gas, if seen to add value and if the number of expired gas GOs would be significant. This increases the complexity of residual mix implementation to some extent from the simple "natural gas residual mix". However, it would allow to adhere more precisely with the requirement of REDII on adding expired GOs to the residual mix;
4. Once renewable gas volumes become significant, a detailed residual mix method can be determined, after careful consideration of the needs of the market of GOs and of gas supply, collection systems for statistics on gas production and consumption, and of consumer behaviour; and
5. Since the GO system is common for grid-injected and off-grid gas, the residual mix should also be calculated by country and not separated between grid and off-grid gas.

6.3 The interplay of a gas and hydrogen residual mix

As renewable hydrogen is expected to be injected into the natural gas network in increasing quantities, in order to raise the share of renewable energy in gas consumption, the interplay between the residual mix for both energy carriers is a relevant concept to consider at the time of GO system design.

Injection of hydrogen into the gas grid, in view of allowing gas consumers to claim the renewable origin of the corresponding renewable energy, can be reflected in different ways. These will impact the way in which the hydrogen GOs are processed, as well as the handling of the residual mix. Two options are elaborated here below, as illustrated in figure 4.

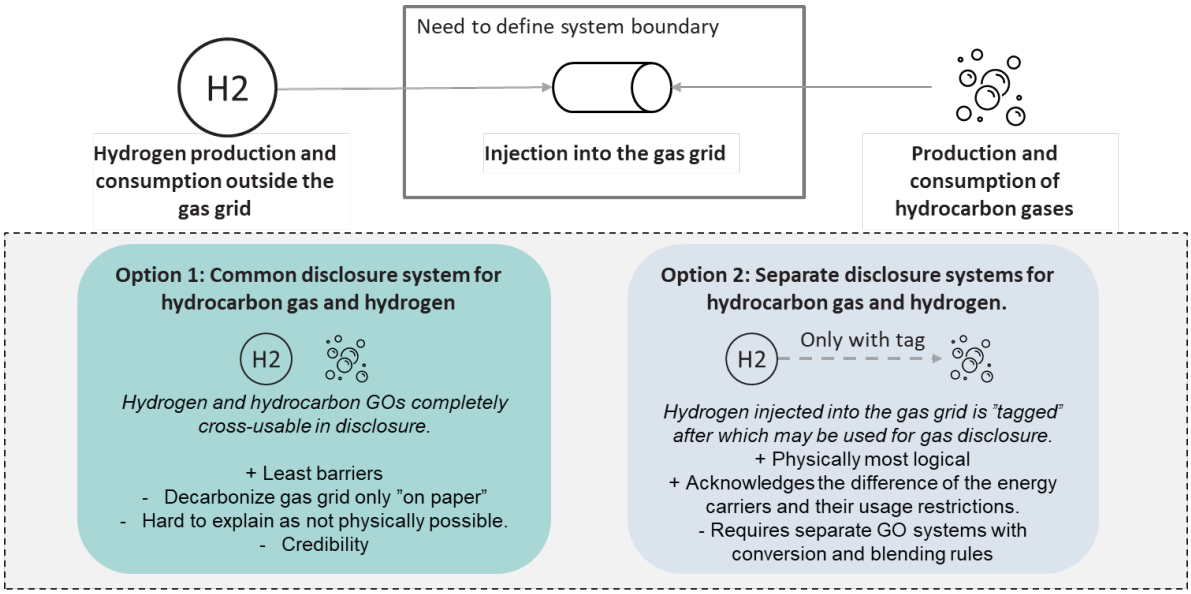

Figure 4 The interplay of hydrocarbon gas and hydrogen disclosure

6.3.1 Option 1: One mix for gas and hydrogen

This option consists in considering a single system boundary including consumers both of pure hydrogen and of gas.

As a consequence, in this option it is assumed that disclosure rules allow that:

- Any hydrogen GOs may be used for claiming the supply of renewable gas to a gas consumer;
- Conversely, biomethane GOs can be used to claim the supply of renewable hydrogen to a hydrogen consumer; and
- There is a single residual mix reflecting the properties of non-certified energy supplied either in the form of gas or hydrogen within the system boundary.

This approach raises issues of confusion, trust, and market acceptance:

- Supply of gas having the environmental attributes of renewable hydrogen can be claimed without that hydrogen having been injected into the gas network. This implies that more hydrogen can be claimed to be consumed from the gas network than the total amount actually injected into it;
- As a result, a gas supplier can claim the supply of tracked renewable energy, without making the effort of physically introducing renewable energy into the gas supply system, and eliminating any incentive on gas suppliers to actually carry out an essential step for reducing GHG emissions from consumption of gas; and
- Since there is a different carbon footprint from the consumption of hydrogen than from the consumption of methane, the cross-usage of GOs issued for one such energy carrier for consumption of the other carrier, complicates the carbon footprint calculation along the value chain.

6.3.2 Option 2: A residual mix for gas and a separate residual mix for hydrogen

This option considers that the hydrogen supply system and the gas supply system are two distinct systems with an interface at point of hydrogen injection into the gas network. Any GO is designated for use exclusively within one of the two systems related to the physical shape of the energy carrier (i.e. a GO designated for use within the gas system cannot be used to make a claim on pure hydrogen consumption, and conversely). As explained in section 4, these separate system perimeters entail defining distinct residual mixes for hydrogen and gas, respectively.

There are multiple ways of maintaining the separate system perimeters at the point of blending of hydrogen into a gas network:

- Direct issuing of gas GOs for hydrogen injected into the gas grid (rather than issuing first hydrogen GOs, the use of which is restricted under this option to making a claim on consumption of pure hydrogen, unless one of the measures listed below is taken); and
- If Hydrogen GOs were already issued for the hydrogen prior to its injection into the gas grid:
    - Cancel these hydrogen GOs upon injection, and issue gas GOs that gas consumers can (by definition) use to claim consumption of renewable gas;
    - Arrange for direct conversion of the hydrogen GO into a gas GO, with the same results as above, through a simplified procedure (compared to sequential execution of the cancellation procedure and the issuing procedure);
    - Earmark the hydrogen GO for exclusive application to physical consumption of gas (knowing that, in the context of option 2, non-earmarked "pure" hydrogen GOs can exclusively be applied to physical consumption of pure hydrogen).

To be noted:

- The last two methods above would require the application of a correction factor to account for the fact that the energy unit for hydrogen refers to the lower heating value, whereas the energy unit for gas refers to the higher heating value.
- Applying the last option (Hydrogen GO earmarking) while preserving the GO immutability principle, could consist in simply adding the information "Injected into the gas grid" without changing any other field.

Thereby the questionable consequences of Option 1 can be eliminated using any of the ways presented above for implementation of Option 2.

6.3.3 Recommended approach for claiming the attributes of renewable hydrogen to gas consumers

In order to avoid potential market acceptance issues, the recommended approach is option 2. This provides means for claiming the supply of energy having the attributes of renewable hydrogen to gas consumers. It requires GO system design to ensure that such a claim can only be made in relation to hydrogen that is actually injected into the gas grid. Different ways to achieve this are listed under Option 2 (see above).

6.3.4 Why harmonise?

The risk of not harmonising the approach for either option 1 or option 2 above over the full European GO system perimeter, is that GOs from one country are not considered credible in another country. That brings along import barriers, market valuation and GO differentiation based on system design criteria rather than the more desirable differentiation on attributes on the GO. An overall pan-European approach would overcome this challenge. In consideration of the potential acceptability issues of Option 1 presented above, this report assumes option 2 to be selected as a harmonised approach.

6.4 Hydrogen

6.4.1 Natural gas as the main energy source of hydrogen

For **hydrogen**, almost all production in Europe is from natural gas, so the residual mix is basically hydrogen from natural gas, which will likely remain the case in the future for nearly all hydrogen for which a GO is not issued (attributes constituting the residual mix). Next to that, there is small share of hydrogen (<1%[6]) produced from electricity as a by-product in chlor-alkali plants, however this does not change the overall picture.

Consequently, the residual mix in Europe can be characterised as "natural gas-based hydrogen" and setting up a system for a (labour intensive) detailed calculation of the residual mix therefore does not appear justified in the current situation.

6.4.2 Moving on to cover the energy sources of all hydrogen more accurately

The hydrogen residual mix will consist mainly of:

- hydrogen produced by steam methane reforming from natural gas;
- hydrogen co-produced in chlor-alkali plants from electricity; and
- hydrogen produced by water electrolysis from electricity.

Electricity used in hydrogen production is assumed the energy origin of the electricity residual mix of that country, unless electricity GOs are cancelled for the electricity used in hydrogen production.

As this approach may be a rather extensive exercise within the current "mostly natural gas based hydrogen", and would require a national monitoring and supervisory authority, it is proposed to start for now with the approach for determining the natural gas-residual mix as mentioned in 6.4.1 above.

6.5 Heating and Cooling

Preamble 59 of 2018/2001 (EU), rules that: *Guarantees of origin which are currently in place for renewable electricity should be extended to cover renewable gas*, which does not explicitly require extension to heating and cooling. However, from Article 19, it can be deduced that the extension should cover heating and cooling as well. The following specificities have to be considered when developing a method for the residual mix determination for heating and cooling.

[6] *Less than 1% of hydrogen is produced from other energy carriers than natural gas (based on figures in IEAs 2019 Future of Hydrogen report: less than 0.5 Mt out of 70 Mt).*

6.5.1 Only the renewable share is required to be included for disclosure without link to GOs

A preliminary sort of disclosure obligation is set on district heating and cooling providers, although it is far less stringent than that for electricity suppliers: *Member States shall ensure that information on the energy performance and the share of renewable energy in their district heating and cooling systems is provided to final consumers in an easily accessible manner, such as on the suppliers' websites, on annual bills or upon request.* (2018/2001 (EU), Art. 24(1)).

As such this disclosure information is not linked to GOs, but from preamble 55 of 2018/2001 (EU)[7], it can be understood that GOs may be used for the above-mentioned purpose, taking into account that other means of tracking might exist alongside as in the case of gas.

One important difference from the electricity disclosure obligation (in 2019/944 (EU) Annex 1.5) is the requirement to only disclose the share of renewable energy (and energy performance), but not the remaining shares of non-renewable energy origin. This is however often the part of disclosure where residual mix would be most needed. As tracking of renewables is done by GOs or other explicit tracking instruments, an implicit tracking mechanism (residual mix) would not be, by default needed to fulfil the above requirement for disclosure in the existing European legislative framework.

6.5.2 Heating and cooling grids are not interconnected

A key characteristic of district heating and cooling networks in Europe is that they are not interconnected - even within a country. This calls for attention on how credible a European-wide GO system would be for heating and cooling since the energy is produced and consumed very locally. Although GOs are by nature independently transferrable from the physical energy to which they relate, it is unclear whether countries may impose stricter rules for their disclosure regimes (e.g. requiring that heating and cooling energy must be produced in the same network for the GO to be usable, see topic 17 here for examples). However, since the very nature of GOs is their transferability, regardless of the transfer of the physical energy, this report assumes that GOs may be traded and thus used for disclosure across heating and cooling grids and across national borders.

6.5.3 Heating and cooling grids have diverging energy source mixes

Another aspect to consider is that a single country might include several H/C grids with quite different energy source mixes. Having a country-level residual mix might not be seen "fair" by energy companies operating in H/C grid with renewable share much higher than the country average.

- Thus, it could make sense to add an extra layer in the residual mix calculation compared to electricity: first constituting a grid-specific residual mix, which is then balanced nationally and only in a final step with the European Attribute Mix (EAM).
- Another alternative would be to consider each individual H/C-grid as its own domain, which would balance directly to a central European Attribute Mix.

[7] *Guarantees of origin issued for the purposes of this Directive have the sole function of showing to a final customer that a given share or quantity of energy was produced from renewable sources.*

- However, since such procedures could be administratively too complex, a domestic residual mix (as opposed to grid-specific) is at this point seen most sensible. However, the situation might develop as the H/C GO market evolves.

Although a country-level residual mix might seem unfair for energy companies operating in high RES-share H/C-grids, it must be reminded that these companies have the possibility of not selling the GOs issued for them and in this manner deviating from the national residual mix. Hence, the national approach is likely to be sufficient also in the long run as the basis of the heating and cooling residual mix as opposed to grid-specific residual mixes.

6.5.4 Isolated heating systems

Another question for heating and cooling is separate heating (heating not connected to district heating networks). Heat is produced from renewable and fossil energy sources in individual buildings. Since Directive 2018/2001 (EU) does not explicitly state that the issuance of GOs should be limited for heat injected into a district heating network, energy production in separate heating has *in theory* an equal right to apply for freely transferrable GOs. Hence a system boundary for heating and cooling GOs is needed (comparable to off-grid gas production), and raises the question of whether the disclosure system and residual mix should be separate for: a) district heating; and b) for separate heating systems.

It is not advisable to include separate heating into the heating and cooling GO system, mostly because the heat is always consumed locally (the energy is not traded). Separate heating is likely to be below the minimum capacity limit which Member States are free to set for production devices eligible to receive GOs. Although in theory separate heating is eligible for GOs, in practice the energy should be physically tracked from production to consumption and it is recommended that this should not be included in the GO system. Furthermore the, albeit loose, disclosure framework for heating and cooling is only set for district heating.

6.5.5 Options for a residual mix for heating and cooling

Figure 5 sets out different high-level options on how theoretically a residual mix for heating and cooling could be framed. At first stage options 1 or 2 could be implemented depending on whether the disclosure should extend to RES only or all energy origin. With regard to options 3, it should be emphasised that a grid internal residual mix is only possible to determine reliably, if GOs are not transferrable across heating grids.

When a reliable disclosure rule system is in place and all (renewable) tracking is monitored, a proper residual mix may be implemented (options 4-6).

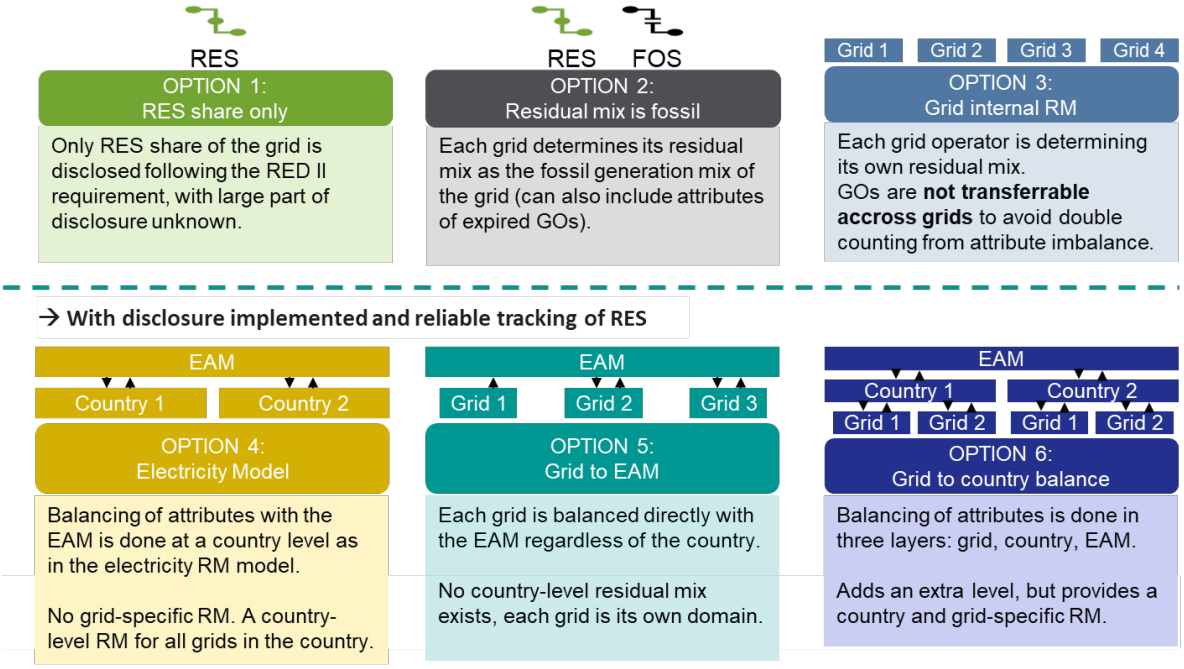

Figure 5 High-level options for heating and cooling residual mix calculation

6.5.6 Recommendations:

It is recommended that:

- The renewable share of disclosure is corroborated solely by GOs;
- When trading of H/C GOs across heating grid and national borders begins, the residual mixes of individual countries (or grids) need to accommodate this. Balancing attributes bilaterally between grids and countries quickly becomes too complex. As a simple first option to proper residual mix calculation, the national residual mix could constitute from all fossil-based generation to secure avoidance of double counting of renewables;
- If a) disclosure regime extends to necessitate disclosure of all sold/consumed heating and cooling, and b) disclosure of renewable energy origin is only possible with GOs, a detailed residual mix calculation may be seen to add value. Such a residual mix should correspond to the country-level + EAM balancing residual mix calculation methodology currently used for electricity. Feasibility and added value of more complex "grid-specific" residual mixes would have to be carefully assessed, with consumer acceptance risks to be taken into account; and
- Residual mix calculation should be completely separated for district heating versus for district cooling to acknowledge the difference of the energy carrier and generation technologies.

7 Reflections on carbon intensity of the residual mix

7.1 Relation between residual mix and carbon emission information

7.1.1 Electricity – legislative framework

Under the Internal Energy Market Directive (2019/944/EC, Annex 1), disclosure of CO2 emissions of sold electricity is mandatory for electricity suppliers in Europe. To support this obligation, calculating the CO2 and radioactive waste intensity of the residual mix has been an integral part of the residual mix calculation along with determining composition of different energy sources. There is also use for the CO2 values, as reported in the residual mix calculation report, directly by end-consumers as especially corporations often base their market-based Scope 2 emissions on such values.

7.1.2 Generic principles for carbon intensity of untracked energy from all energy carriers

That being said, the aim of the residual mix calculation is to **allocate untracked generation attributes** (including CO2) to consumption considering international transfer of energy as well as energy tracking. The focus and scope of the residual mix calculation is therefore **not** in determining (new figures for) the CO2 intensity of different fuels and generation methods, but rather in using existing figures for such intensities as input data for the calculation and to allocate such figures to consumption. The input values for CO2 intensity of different generation methods should be derived from national inventories and databanks to be deployed in the residual mix calculation.

7.2 Impact of geographic origin of natural gas on the carbon intensity of the gas residual mix

The geographic origin of natural gas will be different depending on the location of natural gas consumption. Hence, there may be distinct carbon emission figures related with gas from different geographic origin. National figures could be used as input data for the residual mix calculation to determine the CO2 intensity of the national natural gas grid mix.

7.3 Hydrogen specific risk: becoming greener through the Residual Mix

For hydrogen, as a preliminary, re-source saving and pragmatic approach, the residual mix is proposed to consist out of natural gas-based hydrogen. The specific concern on utilising this method is that in some cases electricity-based hydrogen is more CO2 intensive than hydrogen produced from natural gas. This may lead to the CO2 emission figures from this (natural gas based) residual mix undermining such higher CO2 intensity.

7.3.1 Higher accuracy of the residual mix

This concern could be addressed by determining the CO2 intensity of the hydrogen residual mix in a domain partly based on the electricity residual mix, pro rata the share of hydrogen production from electricity in that domain. This part of the residual mix should be combined with the amount of natural gas-based hydrogen to form a single residual mix for hydrogen produced from both electricity and gas in each country.

7.3.2 Accountability of hydrogen producers concerning their carbon emissions

In presence of a GO system, accountability of producers for the greenhouse gas intensity of non-certified product is lost: hydrogen supplied without a GO is described as hydrogen from the Residual Mix, rather than hydrogen with a GHG intensity corresponding to the production pathway actually used by the producer. This is a point of particular relevance for hydrogen, because the GHG intensity of hydrogen production by electrolysis from carbon intensive electricity could be up to 4.8 times higher than hydrogen production by steam methane reforming, the production pathway identifying the Residual mix since it is the one used for over 95% of hydrogen production in Europe.

The main concern might be lifted by setting the disclosure system perimeter in such a way that the hydrogen residual mix is only for declaring the energy source for hydrogen that is not consumed on the site of the production (and for which no GOs have been cancelled). The carbon-intensive hydrogen producer who consumes his hydrogen onsite, then is held accountable for the carbon-intensity of his own consumption. (avoid swapping carbon intensive hydrogen by renewable hydrogen through GO cancellation)

The carbon-intensive hydrogen producer could, in addition, be incentivised and held responsible for its emissions through other regulatory means.

8 Recommendations

8.1 Recommendations for EN16325

8.1.1 Basic principles on residual mix

From this analysis, while in draft stage, several aspects were integrated in the draft document for the revised EN16325. This resulted in dedicated text in the FASTGO text proposal for a revised EN16325 that was published on 8th July as the FASTGO Task 2 Part 2 version 2 report. See also the Task 2 Part 3 report, published on the same day.

8.1.2 Ensure the residual mix perimeter to be the same as the GO issuance parameter

After the FaStGO text proposals for a revised EN16325, the discussions in CEN developed with regards to the concept of 'onsite consumption': they did not adopt the FaStGO text proposals of a) introducing the concept of a "Tradeable GO" to be issued in accordance with "tradeable energy", nor b) the immediate cancellation upon issuance for GOs that were issued for energy consumed on the site of the production device.

Instead it was opted to add an identifier on the GO that indicates the physical dissemination level of the energy for which the GO was issued. Therefore, the following recommendation is not yet incorporated in the FaStGO text proposal for a revised EN16325.

In addition to a differentiator on the GO of the physical dissemination level of the energy for which a GO is issued, a double disclosure prevention measure is to be retained. This can be done through ensuring it is included in European legislation, or in the EN16325 standard in 4.5.3 or in 4.5.4.1, through the following addition:

> *"As a condition for issuing GOs, National GO Schemes shall provide that either:*
>
> *a) the quantity of both production and consumption in the distribution system in which the physical energy for which the GO is issued, is disseminated, shall be taken into account in the residual mix calculations, and that consumption on this distribution system is subject to a legal Disclosure requirement, backed with either*
>
> *a. cancelling GOs for consumption of electricity with specific Attributes or*
>
> *b. Residual Mix."*
>
> *or*
>
> *b) GOs are immediately cancelled after issuing without being transferred to another Account."*

8.2 Recommendations for European legislation

It is recommended that provisions be introduced into European legislation to:

1) Install a mandatory disclosure obligation for suppliers of gas, hydrogen and heating and cooling. This includes the installation of supervision on this obligation;
2) Ensure the uniqueness of the tracking instruments: where a GO is issued, it should be the sole instrument for claiming the corresponding attributes of energy. Where other Reliable Tracking Systems exist alongside the GO system, their compatibility should be ensured;

3) If the abovementioned recommendation for EN16325 is not adopted in the standard EN16325, then it should be established in legislation;
4) Set a system perimeter for the interplay between hydrogen and network-gas, and harmonise one of the two implementation options; and
5) Educate consumers on origin tracking and/or finetune rules on disclosure: Where consumers tend to look for physical tracking, this is often not feasible and also not what the essentials of the current legislative (book-and-claim) GO system facilitate. Explaining consumers about the disclosure rules and the functioning of origin tracking mechanisms can help to avoid confusion with consumers on the origin of their energy.

   With energy carriers that are usually transported by vehicle, there remain challenges on the interplay between the physical supply chain and the book-and-claim system of GOs. In order to avoid double claims of the same origin of vehicle transported energy, educational efforts will be needed to de-couple origin claims related to physical supply from the GO, unless a physical relation will be established between the GO and physical supply.

8.3 Recommendations for further finetuning disclosure and the residual mix

RE-DISS developed Best Practice Recommendations for electricity disclosure in an existing framework for legal disclosure obligation and while volumes of issued and cancelled GOs were already substantial. This report elaborates an interim solution where neither of these is the case for the non-electric energy carriers.

It is recommended that the details be reconsidered for the disclosure practices, through a similar exercise done under RE-DISS[8] I and II, for disclosure and residual mix for all energy carriers; and at least into the following areas:

- Basic disclosure implementer rule-set;
- Best Practice Recommendations for disclosure both at national and supplier level
  - Consisting of e.g. how to compile supplier and product-level information in order to avoid double counting at supplier level, how to supervise disclosure, how to implement disclosure periods and timings, how to facilitate the coexistence of possible other tracking instruments;
- Further consideration of sector integration and energy carrier conversions;
- Finetuned RM methodology per energy carrier;
- Overview of disclosure framework: legislation, supplier practice and supervision
- Harmonising for each energy carrier the boundaries of the system perimeter for disclosure of the energy source
- Harmonised methodology for carbon intensity and other environmental indicators;
- Educational strategies establishing trust with consumers and consumer representatives (e.g. explaining them how the origin tracking system works, call for avoidance of double tracking with physical tracking separately from GOs issued for the same energy, …).

[8] *http://www.reliable-disclosure.org/documents/*

8.4 Conclusion

In conclusion, this document highlights possible future areas of work for developing a more consistent disclosure framework for hydrocarbon gas, hydrogen, and heating and cooling, which are essential in the preparation of a detailed residual mix of sources of untracked energy supply. It sets out general principles for further elaboration and integration in the regulatory framework. This report proposes an intermediary approach until such further work is established in order to facilitate energy source claims for energy consumption that is not covered with cancelled guarantees of origin or other reliable tracking mechanisms.