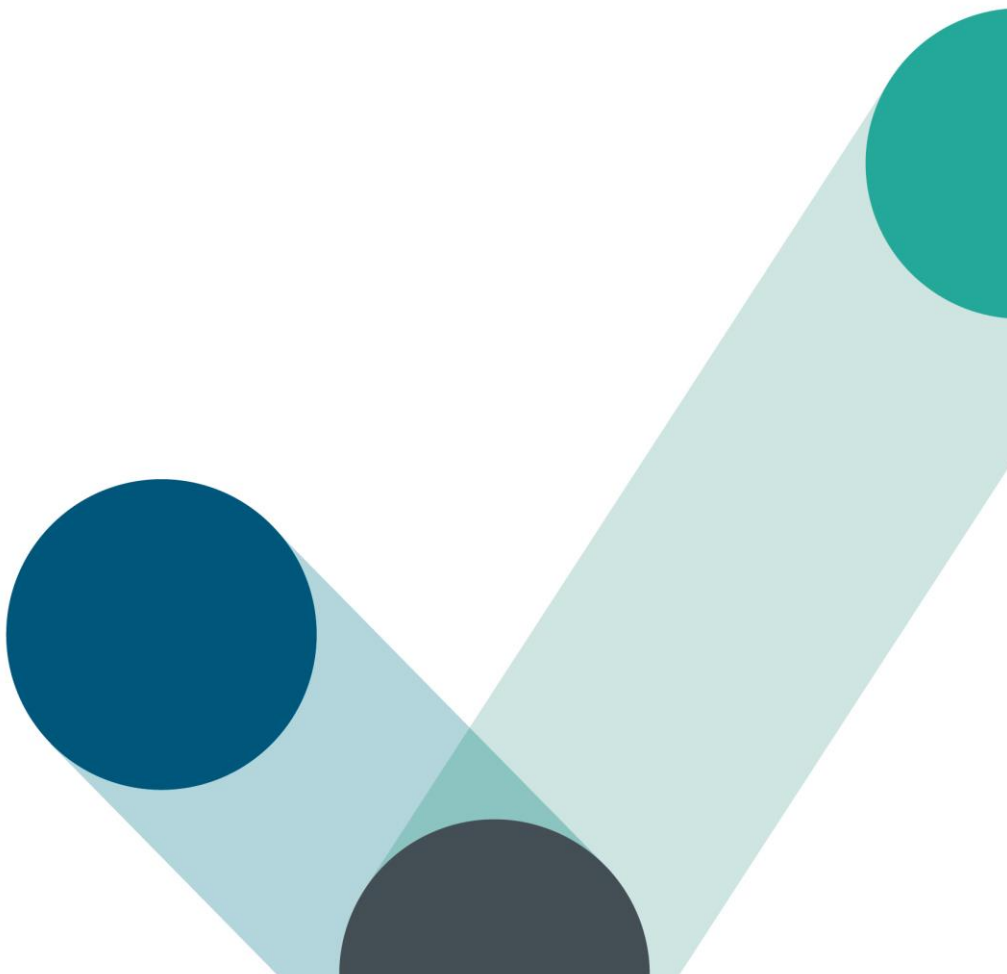
ENERGY TRACK AND TRACE | September 2022

Locational Matching of Granular Certificates

Version 1.0



Content

Introduction

Energy Track and Trace (ETT) is an international cooperation between 4 European TSOs, providing a highly accurate and trustworthy electricity tracking system to consumers[1]. ETT uses the concept of Granular Certificates (GCs), standardized through the EnergyTag industry standard. GCs are time-stamped (hourly or quarter-hourly) digital documents that hold information on produced and consumed energy volumes that serve as the basis for granular energy tracking. In order to avoid any form of double counting, GCs integrate with the existing European Guarantee of Origin (GO) scheme. ETT further introduces ambitious matching requirements for GCs that ensure the trustworthiness of the information given to energy consumers: 1. temporal matching, 2. locational matching (subject of this paper) and 3. matching through energy storage.

By designing and implementing a prototype for a European Granular Certification system, the ETT cooperation aims at fulfilling the need of corporate consumers (and their energy suppliers) to prove their decarbonization efforts more accurately and build trust around green electricity tracking. However, ETT is not only a disclosure instrument with enhanced transparency. The introduction of Granular Certification does also provide stronger incentives for RES investments and brings value to the energy system as a whole. Further information can be found in our paper **System Benefits of Granular Certification[2].**

Locational matching is a mechanism that reflects the “transportability” of the electricity and is one of the key aspects of the international ETT cooperation. It requires common standards and an IT architecture that allows for interoperability between registries (for further information see our paper **Architectural concepts and insights[3]**).

Locational matching further requires a set of rules that determine the conditions under which GCs can be exchanged across bidding zone borders. This paper describes and assesses the locational matching rules under consideration and draws conclusions for the ETT prototype system, when it comes to testing the different possible rules and which rule eventually proves to be best suited representation of the “transportability” of the electricity.

[1] At a later stage of the project, also other energy types (such as gaseous energy carriers) will be covered.

[2] https://energytrackandtrace.com/wp-content/uploads/2022/08/ETT_System-benefits-paper_1_0.pdf

[3] https://energytrackandtrace.com/wp-content/uploads/2022/05/ETT-Architectural-Specification.pdf

Background information

The Concept of Granular Certificates

ETT uses the concept of Granular Certificates (GCs). A GC is digital document that holds time-stamped information about produced or consumed energy as well as additional attributes. The concept of GCs is standardized by the EnergyTag industry standard[4] and forms the trustworthy foundation of the ETT tracking and matching system.

In comparison to the established Guarantees of Origin (GOs), defined in the European Directive 2018/2001 (REDII), GCs are designed to represent the power markets more realistically and thereby provide more accurate information to energy consumers. They enable new use cases in energy tracking:

- **temporal matching** reflects the intermittent aspect of renewable generation: it ensures that the green electricity has been produced (or discharged from storage) and consumed in the same market time unit.
- **locational matching** reflects the "transportability" of the electricity. Although this can only be approximated, locational matching brings the certification scheme closer to the physics of the grid and is key to ensure the trustworthiness of the tracking system, send adequate investments signals and exclude unrealistic situations that are detrimental to the credibility of the tracking system, i.e. the transfer of certificates between zones that are loosely or even not interconnected.
- **Inclusion of storage** is another key aspect of Granular Certification. GCs allow tracking the in- and outflux of batteries and other storage technologies in a trustworthy manner. Thereby, storage units can be used to increase temporal generation matching and new value streams for storage operators are created.

These use-cases highlight the purpose of the ETT system. We want to provide consumers with more accurate information about the energy they are using. This also includes better information about the energy-related emissions and new ways of ESG reporting.

Technical implementation of locational matching

The ETT system is designed as a distributed, federated network. In contrast to a single centralized system, a federated network allows to flexibly define a set of rules (a topology), based on agreed-up standards and policies while also allowing each node in the network to enforce local specificities and regulations. In the ETT network, each local granular registry is a node and thus a trusted party in the network. This model enables interoperability and transparency between organizations and provides a consistent user experience for clients engaged across multiple organizations, while still supporting autonomy for organizations in the network. It also allows organizations to join and leave the network at any time, resulting in a faster time-to-market overall for the ETT participants and allows for wider and easier adoption across Europe. Further information can be found in our paper **Architectural concepts and insights.**

[4] See https://www.energytag.org/

The topology is an essential part of the ETT network. It defines the mechanisms and rules by which production and consumption certificates can be matched (or "cancelled"). One mechanism that has already been widely discussed (i.e. in the EnergyTag initiative) is temporal matching: The ETT system design ensures that generated electricity can only be matched with consumption volumes, when both occurred in the same time-frame (thus, when certificates have the same time-stamp). Otherwise, the registries automatically reject the transaction request – a match is not allowed by the topology.

A similar process is used for locational matching. Locational matching is a set of rules that is applied to the transactions of GCs between two registries. Only when certain locational conditions (such as the availability of physical capacity in the grid) are met, the registries accept the requested transactions.

The open question that we are tackling in this paper is:

What is the optimal locational matching mechanism for the ETT system that meets our customer expectations, creates beneficial impact in the energy system and is well-understandable to end consumers?

Long-term evolution of the ETT system

Granular energy tracking is still in early stage. Some corporate consumers and their energy suppliers have voiced their ambition to use renewable electricity at every hour of the year. Their need to prove these ambitions to the public and use their marketing potential is materialized in the EnergyTag industry standard.

Today, GOs are the only legally binding tool for energy disclosure, defined in the European Directive 2018/2001 (REDII). Though, the REDII directive is currently under revision as part of the Fit for 55 package. Adding further time- and locational granularity to GO certificates is one of the topics addressed in the revision. Nevertheless, we are not expecting major changes of the (European) GO system in the near future.

Having said that, **ETT is designed as a voluntary tracking system without legal definition**. Energy suppliers, traders and energy consumers may voluntarily decide to use ETT in order to get better information about their energy. This highlights the need to coordinate ETT with the existing GO scheme in order to avoid any forms of double counting.

Given the further adoption of voluntary granular certification schemes in Europe, we expect legislative attention in the long-term.

Accordingly, we distinguish four phases in the evolution of the ETT tracking system:

- **2022: Architecture design and prototype development.** In this phase, ETT aligns on common architectural principles and the setup of the federated network. First network nodes (granular registries) are being developed as prototypes.
- **2023: Testing phase.** In this phase, the first granular registries expose APIs for testing operations (with limited liabilities and the exclusion of service fees). This phase is also intended to create further insights and understanding of the impact of the ETT system and allows us to re-define the network topology. Other European TSOs (or other organizations) are expected to join the initiative and in order to extend the prototype network by establishing further network nodes. The data gathered in this phase will be used to re-define the topology rules before the go-live, best suited to give our customers the desired documentation of their electricity consumption.
- **2024: Go-live as voluntary system**. ETT establishes clearly defined topology rules in the network and ensures trustworthiness of the tracking system. Further network nodes can be accepted by the network

only if they meet the ETT acceptance criteria. In this phase, the established and legally defined GO system still remains the only binding disclosure instrument. ETT coordinates with GO Issuing Bodies (IBs) in order to avoid double counting.

- **2027+: Legally defined granular energy tracking.** Given a wide adoption of granular tracking systems across Europe, we expect a legal definition of GCs and associated concepts in EU and national law on the long-term.

Evaluation criteria for locational matching rules

As stated above, ETT is a voluntary system, designed and developed by TSOs - in cooperation with a group of partners and customers. Locational matching rules are an approximation of what happens in the actual power system and ensure that the tracked electricity can be regarded as “physically delivered” which is an important quality criteria for our customers. ETT is willing to design the system to be best suited to our customers as well as to create a positive impact in the energy system.

In order to identify the optimal set of rules, we are taking the following evaluation criteria into account (see also Figure 1)

- **Credibility:** We provide a realistic tracking system that is understandable to “the people on the street” and that provides value adding information to the end-consumers.
- **Energy system benefits:** We provide a tracking system that creates a positive impact on the energy system as a whole (e.g. through additional investments in RES and flexibility or improved dispatch behavior).
- **Feasibility & Adoption:** Since ETT is designed as a voluntary system, we keep the entry barriers low and ensure that a critical mass of customers is able to engage in the solution.

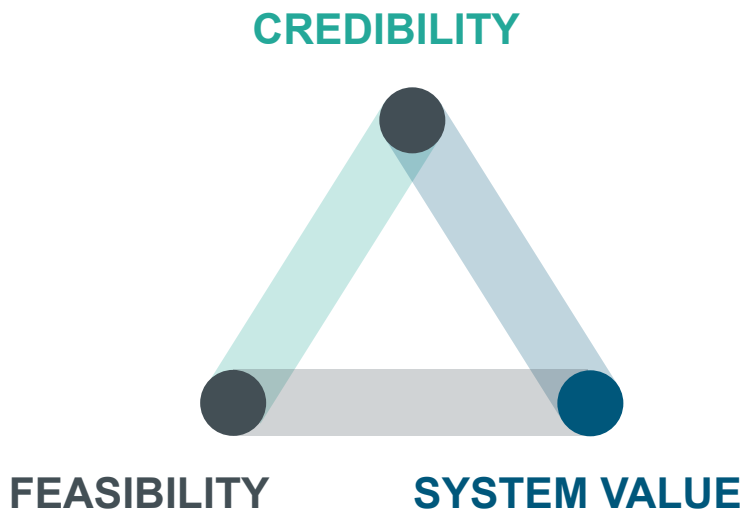


Figure 1: The evaluation criteria of the different locational matching rules form a triangle

Locational matching mechanisms

Spatial resolution

Locational matching is an approximation of the physical reality. If we were to follow the physics in their purest form, electricity consumers wouldn't have a choice about the electricity they are getting, since the Kirchhoff laws fully determine the power flows in the grid. To give an example: A consumer that is located directly next to a coal-fired power plant is likely to only receive power flows from that plant. The only choice that this consumer has, is moving their factory or home to another region, where there is more renewable generation, or build new RES capacity in proximity.

An alternative to this physical approach is achieved by so called Energy Attribute Certificates (EACs). EACs are exchanged independently from the physical power flows and by choosing the certificates of their liking, a consumer (or their energy supplier) actively "labels" their energy. In comparison to the above-mentioned physical approach, Europe's EAC system (the GOs) is on the other end of the scale: there is no consideration of any physics at all. This obviously results in unrealistic scenarios, such as unlimited electricity imports from Norway to Germany which is not satisfactory for conscious consumers.

ETT aims at finding the best compromise between these two extremes. We want to provide consumers with more accurate and realistic information about their energy consumption, while still giving them the choice.

To start with, we therefore defined areas in which generation and consumption is well connected and we assume that the power is always delivered. Following the rules of the electricity market itself, these areas are the so-called bidding zones. In electricity markets, bidding zone are the largest geographical area within which market participants are able to exchange energy without further capacity allocation. Within each bidding zones, local congestions in the grid are not reflected by the electricity markets, but are handled by the grid operators, depending on the market results.

ETT applies the same logic: Within a bidding zones, GCs can be exchanged without limitations – following the logic of the electricity markets.

Different locational matching rules under consideration

As stated above, we allow that GCs can be exchanged without limitations within a bidding zone of electricity. The remaining question is how to approximate the physical exchange of power between these bidding zones. We have identified and assessed three different options that are elaborated in this section:

- Option 1: Locational matching rules based on physical interconnector capacities.
- Option 2: Locational matching rules based on actual power flows.
- Option 3: Locational matching rules based on prices correlations.

Option 1: Locational matching rules based on physical interconnector capacities

Description:

In this option, the cross-border capacities (the capacities of the interconnectors) serve as a limitation for the transactions of GCs between bidding zones. In other words, the total amount of GCs that is allowed to be exchanged between bidding zones is equal or less than the available capacity. These cross-border capacities are calculated by the TSOs and are publicly available information.

The available capacities can be allocated in different ways to the allowed transactions of certificates:

- The simplest way is a “first come first serve” mechanism. Whenever a transaction between two (neighboring) registries is performed, the respective value is deducted from the total capacity. This is done, until all the capacity (for each hourly time-frame) is booked. After this moment, no more transactions are allowed and these would be rejected by the registries.
- Ex-ante booking or ex-ante auctions of available capacity are more sophisticated solutions that allow participant to actively reserve capacity. While this introduces further complexity to the system, it also increases the plannability and reduces risks of rejected transactions.

The described mechanism is fairly simple for a transfer of GCs between neighboring bidding zones, where the available transfer capacities are easily calculated. A more complex situation arises from transfers across multiple bidding zones (i.e. a request to transfer a GC from Denmark to Belgium). In this case, the respective volume must be deducted from all capacities along the route (“first come first serve”) or reserved accordingly.

Generally, it should be noted that rejections of transfers in the ETT system (due to lacking capacity) are only likely to occur, once a critical mass of customers are using the ETT tracking. With a limited amount of participants, it’s unlikely to reach any transfer limitations.

Pros:

- A strong argument for this option is its credibility. While still leaving enough room for active choice, this option guarantees that only energy is tracked that could be physically transported through the grid. It’s furthermore a rather simple-to-understand mechanism for any layperson.
- As we show in our paper **System Benefits of Granular Certification**, long-distance temporal matching does not necessarily improve the energy system behavior, even worse – in certain situations this may even destroy economic value. By limiting transactions to physical capacities, this behavior can be mitigated, and the positive system impact of GCs can be guaranteed.
- Entso-e suggests this option as well as as part of a step-wise-approach towards a target model of implicit allocation (ENTSO-E, 2022).

Cons:

- It should be noted that this is only an approximation to the physical reality. The availability of cross-border capacity is not guaranteeing that power is flowing in the real world. This may result in reduced credibility.
- The limitation of transactions based on interconnector capacities clearly mitigates the damaging effect of long-distance temporal matching (see above). However it cannot be fully avoided. The available capacity can still be used for non-desirable dispatching, since the mere limitation does not create a better optimization signal for the market.

Option 2: Locational matching rules based on actual power flows

Description:

Limiting GC transactions to the interconnector capacities (Option 1) is not guaranteeing that power is actually flowing in the real world. In order to further increase the accuracy of the ETT tracking system, one could instead use resulting power flows from the Day-Ahead (DA) electricity markets or even the measured power flows at the borders as an alternative framework.

In the European Union, flow-based market coupling (of electricity markets) is the target model to compute correct trading capacities between markets (bidding zones), while approximating physical grid constraints (David Schönheit, 2021). Based on these trading capacities, the mechanism finds an optimized overall market result and thus yields theoretical power flows between bidding zones. Nevertheless, these are just theoretical values that can still deviate from the actual power flows that can be measured on the interconnectors.

In this option, the resulting power flows serve as a limitation for the transactions of GCs between bidding zones. In other words, the total amount of GCs that is allowed to be exchanged between bidding zones is equal or less than the resulting power flows.

Since the results of the flow-based market coupling are not predictable, they can only be allocated ex-post and the “first-come-first-serve” allocation (described above) is the only viable option.

Pros:

- Even though the results of the DA markets are just theoretical, this option reflects the reality much closer than Option 1. The end-consumer is thereby equipped with more accurate information about their energy consumption.
- Since this option is also more restrictive than Option 1 (with less available transfer), also a better mitigation of long-distance temporal matching (see Option 1) can be expected.

Cons:

- A major drawback of Option 2 is the limited plannability. Since the results cannot be predicted, a long-term planning or reservation of capacities (thus guaranteed GC transfers) is not possible. Furthermore, it’s more restrictive than Option 1 with limited choice and liquidity. Both aspects are expected to have a negative impact on the “feasibility” and may compromise the success of a voluntary solution.
- Even though the damaging effect of long-distance matching is further mitigated, also this Option does not create a better optimization signal for the market.

Option 3: Locational matching rules based on price correlations

Description:

This option emerged from the discussions around the Commission's delegated act on Renewable Fuels of Non-Biological Origin (RFNBO). The delegated act defines the rules for the production of renewable hydrogen, including the case that electricity is sourced from the grid. Even though this is currently only applicable to the transport sector, these rules are expected to be applied in other sectors (or other regulated green products) in the future as well.

The current proposal foresees rules for locational matching. Based on the delegated act, electricity from a neighboring bidding zone can only be used for the production of green hydrogen if *"[…] electricity prices in the relevant time period on the day-ahead market […] in the neighboring bidding zone is equal or higher than in the bidding zone where hydrogen is produced."*

Since the verification of hydrogen production is a regulated use-case of the ETT tracking system, we are taking this option into account. However, it should be noted that the original purpose of this approach deviates from Option 1 and 2. The first options are intended to provide a realistic tracking system to customers. In contrast, Option 3 is an approach that focuses on system optimization. It is merely intended to create the right temporal and locational incentives for the production of hydrogen, but not as an information tool for end consumers.

Pros:

- While Option 1 and 2 are mainly created in order to meet our customer expectations (in terms of credible energy tracking), this option would instead be compliant with a legally defined use-case, thus ETT would simply implement the given EU rules.
- Since this option is designed to ensure a beneficial behavior of electrolyzes in the energy system, it can be assumed that it creates the highest energy system benefits of GCs if largely adopted. It also reduces the risk of long-distant temporal matching by allowing transfer between neighboring bidding zones only.

Cons:

- The major drawback of Option 3 is its deviation from the purpose of ETT. ETT is designed as a tool for consumers that want more credible information about their energy consumption. The purpose of Option 3 is however only a systemic optimization of electrolyzes. There is no relationship between price correlations (determining the limitation of transfers) and actual power flows in the grid.
- Another drawback is the lack of plannability in this option. Price correlations can hardly be predicted on the long-term and thus, long-term reservations or guaranteed GC transfers are not possible.
- In addition, the delegated act is still under discussion with uncertain outcome. Thus, it's too early to actively consider this option in ETT system.

Conclusions and next steps

Locational matching is a key aspect of the ETT tracking system. It provides consumers with more realistic information about their energy consumption and ensures that Granular Certificates create benefits for the energy system as a whole. As mentioned in section *Long-term evolution of the ETT system*, we are willing to provide a clear set of rules as soon as ETT is a fully operational product on the market (Go-live phase in 2024). This well-defined topology will guarantee the quality and credibility of each of the claims that our customers (i.e. energy suppliers) are making based on ETT.

While this paper already provides a first assessment of the different options for locational matching, further data acquisition is necessary in order to choose the optimal solution for ETT. The up-coming testing phase (2023), with already large numbers of customers connected to ETT, will generate the necessary data that allows us to re-define the topology and identify the optimal locational matching mechanism – together with our customers.

During the testing phase, we **refrain from setting explicit rules for locational matching.** Instead, we are willing to enable our customers to choose the locational matching method of their liking. During the testing phase, we enable different locational matching mechanisms (as optional features) and process the response of our customers. The first voluntary option that we want to provide during the testing phase is Option 1 (“Locational matching rules based on physical interconnector capacities”). This option is prioritized by most of our customers, is seen as credible and feasible. Depending on the rules of the emerging delegated act and the evolving needs of our customers, also Option 2 and 3 will be further developed.

The data gathered during the testing phase will be thoroughly analyzed and serves as the basis for choosing the appropriate option for the ETT system.

Literature

David Schönheit, M. K. (2021). Toward a fundamental understanding of flow-based market coupling for cross-border electricity trading,. *Advances in Applied Energy,*.

ENTSO-E. (2022). *Views on a Future-Proof Market Design for Guarantees of Origin.*

Contact information

Estonia

Elering

Kadri-Liis Rehtla | P +372 5348 2948 | Kadri-Liis.Rehtla@elering.ee

Belgium and Germany

Elia Group

Michaël Piron | P +32 2 546 76 68 | Michael.Piron@elia.be

Denmark

Energinet

Morten Houborg Andersen | P +45 20 36 53 34 | MHU@energinet.dk