REGATRACE

Renewable Gas Trade Centre in Europe

D2.6 Report on design study and technical specification for dashboard and trading platform

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1.1 REGATRACE in a Nutshell

REGATRACE (REnewable GAs TRAde Centre in Europe) aims to create an efficient trade system based on issuing and trading biomethane/renewable gases certificates/Guarantees of Origin (GO) with exclusion of double sale.

This objective will be achieved through the following founding pillars:

- European biomethane/renewable gases GO system
- Set-up of national GO issuing bodies
- Integration of GO from different renewable gas technologies with electric and hydrogen GO systems
- Integrated assessment and sustainable feedstock mobilisation strategies and technology synergies
- Support for biomethane market uptake
- Transferability of results beyond the project's countries

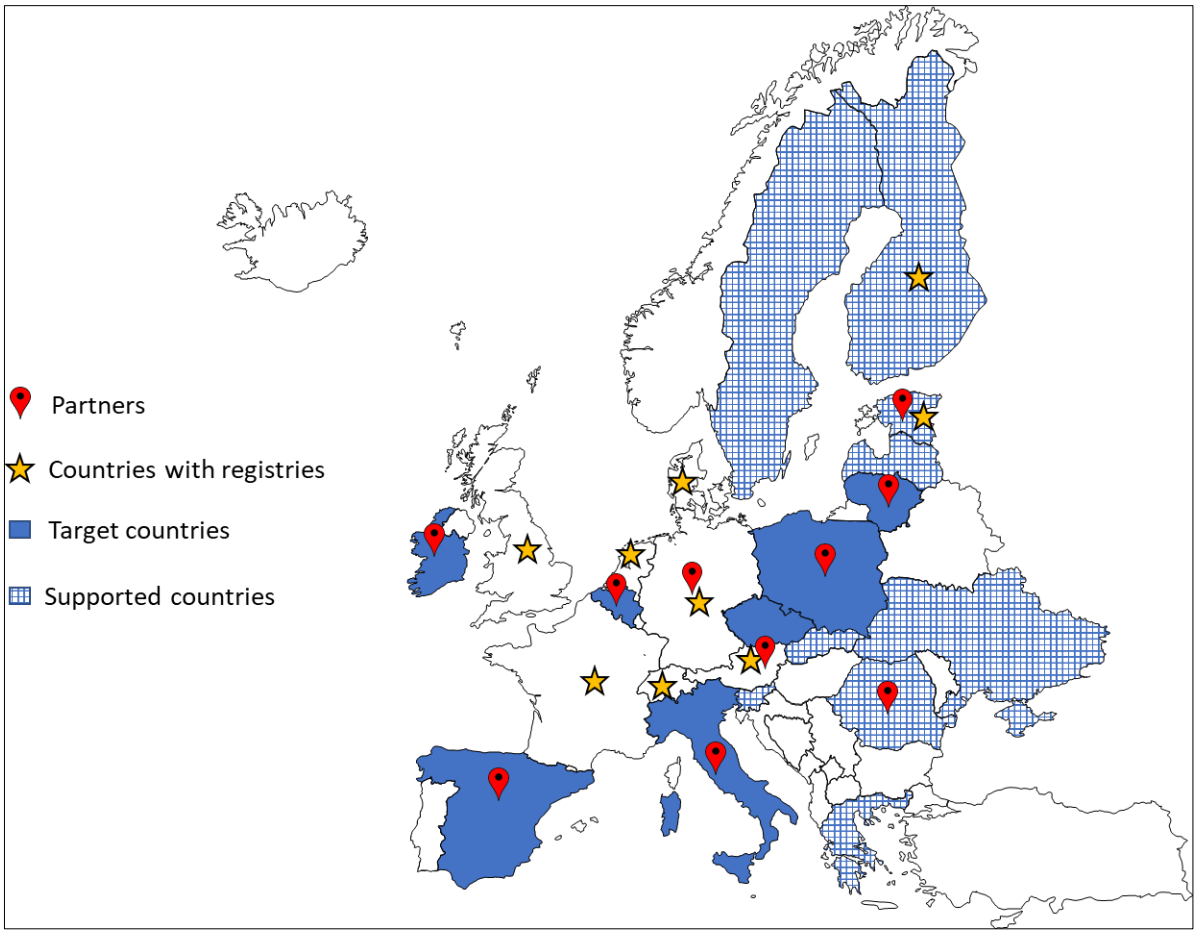

Figure 1: REGATRACE countries and partners

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1.2 Target of REGATRACE D2.6

The project title highlights the project goal namely, to establish a REnewable GAs TRAde Centre in Europe (REGATRACE) by preparing the framework for an efficient trade system based on issuing and trading renewable gas certificates with exclusion of double counting and fraud. Trade refers to the exchange of renewable gas certificates with specific attributes defining the quality and quantity, including a change in ownership ("title transfer") of the respective certificate.

A state-of-the-art Dashboard system and Trading Platform shall enable producers, consumers, and traders of renewable gas to simplify exchange of renewable gas certificates in Europe. The target of a **Dashboard** is to **publish market participants' request** on buying and selling of renewable gas certificates, however **no ownership transfer** is foreseen. A **Trading Platform** shall be designed as a trade centre to **enable ownership transfer amongst registered trading entities** and must thus have interfaces to the IT-infrastructure of databases holding the renewable gas certificates.

A renewable gas certificate must be assigned to an owner at any point in time, while the operator of the Dashboard and Trading Platform neither acts as owner at any point, nor takes any influence on setting the price. The functionalities to operate the necessary IT-infrastructure must be highly secure, reliable, and automated. The IT-infrastructure must comply with state-of-the-art requirements on IT-solutions, including the software solution and the operation of reliable and powerful hardware to run the trading software according to defined availability times. IT-services shall always be operated based on a suitable balance of efficiency, highest possible quality, and cost-effectiveness. Additionally, the solution must be user-friendly to support the interplay of market participants with the IT-service.

Based on BIOSURF EU-project Deliverable 3.6 *Proposal for the establishment of national and European biomethane certificate trading platforms*[1], the consortium partners will envisage the trade centre as a technical system with direct connection to the IT-infrastructure (national registries / Issuing Bodies, European Hubs / Platforms / Databases) which documents the ownership of renewable gas certificates.

REGATRACE project, and especially the present report, address the European Commission and organisations involved in integrating renewable gas into the European energy market and establishing and operating a Europe-wide IT-infrastructure for trading of the renewable (and sustainable) value of renewable gases.

Different technical solutions have been analysed in this report. Due to limited market development, no concrete system specification was developed but a broad analysis of requirements was performed. The focus was made on the description of different technical and business-relevant options from implementation perspective, neglecting detailed analysis on costs and timeframe for development and implementation since no decision on a final solution for development of a trade centre can be taken in this report. To gather insights and feedback from market participants/stakeholders who intend to use the respective system in the future, interviews with experts of trading organisations and interest groups, particularly in the gas sector, were held: ENTSO-G and Edig@s, Energyweb/EWS, EEX, EXXETA, Green Navigation, Green Power Hub, Landwärme, Prisma, Transparenzplattform.at, Vertogas. The vast experiences by the Association of Issuing Bodies (AIB aisbl) have been taken into account.

Three related project tasks (2.5, 2.6 and 2.7) result into a joint documentation package with guidelines to enable an organisation to conduct a tender for the IT-services needed to establish active trade on

[1] BIOSURF D3.6: Proposal for the establishment of national and European biomethane certificate trading platforms; http://www.biosurf.eu/wordpress/wp-content/uploads/2015/07/BIOSURF-D3.6.pdf

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the European renewable gas market. While the report D2.5 *Guidelines for tender process of IT-services*[2] (published in November 2020) describes the organisational and technical aspects of the tender process for IT-services, the present report (D2.6) follows up with detailed technical specifications of the necessary IT-services. This report also comprises a design study and details options on technical specification mainly performed by AGCS subcontractor, i.e., smart technologies Management-Beratungs- u BeteiligungsgesmbH.

Chapter 0 describes the pillars for a European renewable gas certificate and trading system by describing the framework consisting of National Organisations (Issuing Bodies and National Biomethane/Renewable Gas Registries), a European Transfer Platform / Hub enabling cross-border ownership transfers, a Dashboard, and a Trading Platform.

Chapter 3 provides details on the Dashboard concept, focusing on organisational aspects such as business processes and fees regulation. Different technical solutions and a demand analysis for established National Organisations are also included.

The European Trading Platform is illuminated in chapter 4 from different perspectives, including a design study developed by smart technologies management- beratungs- und beteiligungsgesellschaft m.b.h. Functional and non-functional IT requirements, module user stories and a proposed system design build the technical specification and design study for the European Trading Platform. Practical recommendations on the implementation and a specification of interfaces round off the chapter.

Chapter 5 was developed as a service for readers who are not yet experts in energy trading / energy certificate trading as it provides insights on the different options for trade of renewable gas certificates.

To connect this knowledge with practical information, chapter 6 presents an introduction and comparison of established systems for trading of energy certificates: EEX, Green Power Hub, Herkunftsnachweise.at, Biomethanmarkt.de, Tender 365. It includes information based on interviews and contributions provided by market experts.

Chapter 7 comprises a glossary of commonly used terms of the energy / gas market.

The aim of the present report is to provide a broad overview and deep insights into the technical setup and specifications of a European Dashboard and European Trading Platform for renewable gases, serving all European market parties and stakeholders. It does not cover legal or taxation issues in any way. The technical specification bases on the trading of commodities.

Following a market analysis and interviews with stakeholders and IT-experts, different options are described and may be used for a future tendering process of a Trading Platform together with REGATRACE D2.5 *Guidelines for tender process of IT-services*[3]. The experience of the project team and authors and the results of conducted interviews with energy market experts and IT-experts are incorporated in a neutral manner.

[2] https://www.regatrace.eu/wp-content/uploads/2020/11/REGATRACE-D2.5.pdf
[3] https://www.regatrace.eu/wp-content/uploads/2020/11/REGATRACE-D2.5.pdf

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1.3 Executive Summary

The idea to develop a design study and technical specification stemmed from the lack of a holistic, Europe-wide renewable gas market with all its functions. The present report, together with D2.5 *Guidelines for tender process of IT-services*, shall build a documentation package which allows the tendering of IT-services for a European Dashboard and Trading Platform for renewable gas in the future. This supports reaching the project goal as mentioned in the project title, namely describing the steps for establishing a REnewable GAs TRAde Centre in Europe.

The renewable gas market is currently scattered within Europe, and it requires tremendous efforts for establishment of harmonised systems and legislation, which for some areas lies in the responsibility of Member States. It is recommended that the European Commission facilitates progress on the implementation of Europe-wide renewable gas trade (ownership transfer of certificates).

The foundation on which the European trade of renewable gas certificates is based on, is represented by National Organisations (referring to Issuing Bodies and biomethane/renewable gas registries) who manage national schemes and registry IT-systems to document the production of renewable gas and issuance, transfer, and cancellation of certificates. These National Organisations shall be connected via a European Transfer Platform / Hub (for details see REGATRACE D2.4) which should serve as a coordinated entity, acting as intermediary to provide (future) interfaces to all National Organisations and a European Trading Platform. Harmonised attribute lists, standardised certificates and established National Organisations are considered the foundation for an integrated European renewable gas market. Since this report focusses on technical and IT aspects, not covering legal or taxation issues, it is based on the hypothesis that this foundation does already exist.

However, in practice, developments on establishment of National Organisations and harmonisation efforts are still ongoing and progressing slowly. This does not allow for exact requirement definition and specification for the implementation of necessary IT-systems. Due to widely separated and inconsistent national implementation pathways and lack of European harmonisation, concrete measures cannot be reliably predicted to choose the final most viable strategy/solution. Therefore, this report includes a broad spectrum of definitions, options on business processes, covering organisational and technical levels for implementation of different solutions for Dashboard and Trade Platform functions. Nevertheless, the report comprises a technical design study, which includes functional and non-functional requirements for a robust and state-of-the-art software solution required to fulfil the major challenges of the Dashboard and Trade Platform.

There are different options of ownership transfers possible, involving National Organisations and one or multiple European Transfer Platforms / Hubs. The final chosen solutions shall consider different types of trades such as ex-post (production lies in the past), spot and forward (production lies in the future). Also, the decision on one or multiple European Transfer Platforms / Hubs will be influential but shall not become a game stopper/hurdle for the development of a Trading Platform. This is why a central interface solution is recommended, which allows the connection of one or more IT-systems and simplifies the market design significantly from Trading Platform perspective. The interaction between entities such as the Trading Platform with the European Transfer Platform / Hub is illuminated in detail.

Several chapters are dedicated to introducing data formats and structure because they play an immense role in the connection of different IT-systems. Technical standards in the European energy market, and in particular the gas market (Edig@s), have been analysed and compared for practical implementation.

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In order to determine the best possible products for a highly liquid market of a future trade centre, different trading options were analysed, e.g., OTC (Over the Counter) or auction-based trading. Their application is described such as linkage between the physical product and the renewable value (= certificate). The knowledge of the author team with the support of ERGaR, AIB and energy and IT experts beyond the REGATRACE project consortium led to the provision of a comprehensive list of those options.

Deliverable 2.4 of the REGATRACE project provided concrete input by defining the most viable IT-options acting as intermediary for the connection of national registries / Issuing Bodies via a European Transfer Platform / Hub. The present report (D2.6) bases business processes and technical requirements for Dashboard and Trading Platform functions on using such a European Transfer Platform / Hub for market communication and technical interface description. Whereby the connection to each National Organisation (registry / IB) and its IT-system would require exhaustive efforts for developing a trade centre, the application of a single interface to connect the National Organisations, as also recommended in Deliverable 2.4, was anticipated to be used in the future European renewable gas market. The automation level influences the connection and processes of the trade centre (Dashboard and Trading Platform), but this seems a rather technical detail compared to the scattered implementation of National Organisations in Europe up to now.

In the report, five different trading solutions for energy products in Europe were analysed, amongst them the biggest European energy exchange EEX. Market research and expert interviews were conducted, and the results used to determine the different trading options and provide neutral information on pros and cons. The platforms are compared transparently via standardised criteria. Two of the analysed platforms dealt with renewable gas certificates specifically. They were developed on the private sector and mainly focussed on a national market. Both platforms were closed within the project lifetime since the liquidity was too low for the systems to be further maintained. This confirms the author's approach to offer a broad, but in-depth requirement analysis and provide a wide range of options to implement a Trading Platform in the future, whereby the final choice on the most suitable option is not yet in sight.

The authors conclude that an implemented and fully operational Trading Platform for ownership transfer and a Dashboard to connect potential buyers and sellers without ownership transfer will support the renewable gas market integration and will increase the value of National Organisations beyond the sole documentation function for the fulfilment of legal requirements.

1.4 Recommendations

1.4.1.1 Certificate Harmonisation

As described in previous REGATRACE reports (D2.1, D2.2, D3.1, D4.2), the certificate serves to provide information on quantity and quality of the renewable gas product. The core part of the certificate is the list of attributes which hold the essential information; on the one hand information about the quality of renewable gas, its sources, auditor statement and on the other hand information about the production installation. From technical and organisational point of view, attributes are considered data fields within an IT-database of the registry.

For producers to promote/offer their renewable gas product or for potential buyers to post a request on their desired gas product, these certificate attributes are essential. Usually, a limited list of the certificate attributes suffices to post a bid/ask request and raise interest by a potential business partner.

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It is recommended that the harmonisation of attributes and standardisation of certificates is facilitated by the European Commission, Member States, authorised organisations, and renewable gas stakeholders.

1.4.1.2 Settlement of Ownership Transfer

The settlement of trades in the certificate market can most likely be conducted using different options of certificate ownership transfer (for description see chapter 5.9) based on interface specifications between National Organisations and a subsequent European Transfer Platform / Hub.

To select the most appropriate option, the product definition is of relevance. All presented options facilitate ex-post trading, while only options 4 and 5 are suitable for trading of future products.

Where physical volumes are transferred in parallel with the certificates, the physical fulfilment is accomplished through European market processes for physical gas delivery, so called Schedules (to exchange natural gas).

The selection of the most appropriate option influences the specification of interfaces and the communication between the market participants.

1.4.1.3 Data Formats

The content definition for data and file exchanges for a specific business process is an enormous task which requires technical and market experts to define the relevant attributes for each communication.

Since .XML format is widely used, this type of content aggregation offers a clear definition and implementation guide and is recommended for the communication of the Trading Platform and the European Transfer Platform / Hub, respectively, and for other market participants directly communicating with the Trading Platform.

Examples on such a harmonisation in the gas market sector has been described using Edig@s format. It is recommended to use already defined file formats in the gas or trading market, such as Edig@s, which is similar to European electricity transmission system operators (ENTSO-E) documentation.

1.4.1.4 Market Types

The Trading Platform shall support one or more market types, such as

- Bilateral trades (OTC over-the -counter)
- Auction: Bids are collected and matched at a specified time
- Continuous Trading: bids are collected within a period and matched continuously.

which are subject to future definition of products and Trading Platform operator.

1.4.1.5 Registration Options for a Dashboard

The Dashboard should be designed to be available to a high number of market participants. The total number of users is influenced by the applied criteria/requirements on registration and eligibility to be owner of a renewable gas certificate. The balance between quality of registration and quality of market participants must be determined and maintained by the Dashboard provider/operator and will be also influenced by financing needs (the more participants, the higher the income from application fees may be acquired).

1.4.1.6 Technical Options for a Dashboard

From cost perspective, a central solution seems to be practical and the most economical solution, as the integration on the side of the registry is reduced to zero or minimum efforts. Any developments

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within the registry may lead to significant aggregated costs for the Dashboard function. Still, the development of a Dashboard may have great interest for each domestic registry, which in turn allows to consider higher implementation costs (not necessarily the cheapest solution envisaged).

Also, the operational costs are significantly lower in a central solution approach, as only one IT-solution has to be operated, maintained and updated, whereby in all other options also registries must provide specific technical requirements to operate the Dashboard communication and their functions.

1.4.1.7 Provision of a European Dashboard

The national registries and GO Issuing Bodies are not required by European legislation to implement a Dashboard. Such an implementation could only be considered if all registries were willing to invest or a private investor takes up the project. In the latter case, only the central interface option (see chapter 3.4.4) seems reasonable, where no connection to national registries exists and those costs do not appear. Only recently, have there been several initiatives to connect biomethane registries and gas GO Issuing Bodies with each other to establish a Europe-wide renewable gas market.

It is recommended that the European Commission not only requests the acceptance of certificates from other EU Member States, as mentioned in Art 19 RED II. In the best case, the European Commission should trigger the connection of national markets into a European market by requesting National Organisations to provide a link to a European Dashboard function.

REGATRACE D2.5 and 2.6 provide a documentation package which allows the future tendering of an IT-system for a European Dashboard for renewable gas.

1.4.1.8 Interface Specification

From the perspective of the Trading Platform, the communication via a single interface is preferred in order to handle all transactions and queries with one entity instead of multiple national systems. This approach is supported by deliverable D2.4 of the REGATRACE project which recommends the connection of national registries / Issuing Bodies via a central interface. Such a European Transfer Platform / Hub would suit the Trading Platform processes and communicate with a single entity taking up the linkage with national registries / Issuing Bodies.

1.4.1.9 Functional Requirements of a Trading Platform

The functional requirements of a Trading Platform are determined by the trading products (certificates) and their attributes. Whereby no concrete option has been defined within this report, the functional requirements have been analysed and described to be fit for different market types and products and still provide for an automated, secure, and reliable solution to conduct trading processes and particularly related use cases such as bid submission, financial and technical clearing.

1.4.1.10 Non-functional Requirements of a Trading Platform

For a state-of-the-art Trading Platform, non-functional requirements must be defined allowing for secure and reliable operation, continuous improvement, and future development. These major challenges have been incorporated to pursue automated, secure, reliable, and scalable operation of a future Trading Platform. The operation of the hardware is a key aspect for the setup of a trade centre and is influenced by the operator of the Trading Platform or Dashboard and the knowledge and infrastructure of the organisation.

1.4.1.11 System Design and Implementation of a Trading Platform

Recommendations on system design and implementation strategy are included to provide an outlook for a future-oriented IT-solution covering Dashboard and Trade Platform functions. One example is the

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usage of a service-oriented architecture allowing individual management of software modules within the overall solution.

1.4.1.12 Physical Linkage

In order to document the exchange between parties on renewable gases, a link to the physical component of the transfer may be requested. This approach, called mass balancing, is different to the sole intrinsic (renewable value) transfer using certificates. The physical linkage should be added depending on the definition of the auction product and its final application, for example as renewable transport fuel. The report provides proposals on how to define the physical linkage and its interpretation possibilities.

1.4.1.13 Trade Product Definition

Product definition is of importance for the liquidity of a future renewable gas market. The trade of certificates can be executed in different forms, such as ex-post or future. For ex-post trades, certificates must be already created and thus used to transfer within different trade options, such as exchange or OTC platforms. Another option would be to trade volumes not produced yet, so called spot or future products. The current certificate market is mostly built on the first approach, where only already produced certificates with providing evidence on the quality and quantity are traded.

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2 Pillars for a European Renewable Gas certificate and Trading System

2.1 Introduction

In a developing European renewable gas market, the need to balance increasing production and demand is growing. Current gas supply majorly depends on imports. Imported gas via pipeline and LNG represents more than 80% according to the European gas market report Q2 2021[4]. Gas production in the EU is limited to a minority of companies. The vast potentials for renewable gas production in Europe are not yet harvested. The integration of renewable gases into the European energy market is considered a prerequisite to the establishment of necessary layers of a renewable gas market (see Figure 2). According to European and national legislation, the establishment of a certification system is a national competency, comprising the issuance, auditing, and cancellation of renewable gas certificates. In ten countries, Biomethane Registries have been established and in eight countries Issuing Bodies have been appointed (as of August 2021). Those National Organisations (registries and issuing bodies) active today have already set up their individual attribute structures and IT-infrastructure without international coordination and therefore represent individual domestic solutions. There are several initiatives ongoing for the harmonisation of the attribute structure, based on bilateral agreements between registries, the adaptation to European Schemes (e.g., EECS Rules by AIB or the ERGaR Certificate of Origin Scheme), as well as overreaching initiatives, such as the REGATRACE Network. The EU CEN 16325 Standard on Guarantees of Origin for Energy is being adapted following Art 19 RED II. The revised Standard is expected to provide Europe-wide harmonisation on the attributes of renewable energy carrier certificates referring to electricity, gas, hydrogen, heating, and cooling.

Another element of a harmonised European, renewable gas market (besides standardisation of attributes) is to enable structured and secure communication and data exchange between such National Organisations. The IT-infrastructure for European cross-border ownership transfers of the certificates has to be set up via a European Transfer Hub / Platform. Europe-wide harmonisation allows individual agreements to be consolidated and the burden of negotiating and establishing individual interfaces between National Organisations is removed.

These elements represent the foundation on which the European trade of renewable gas certificates within the European energy market is based. A European Trading Platform relies on harmonised information and data (certificate attributes) provided by National Organisations and European Schemes and, as such, is the top layer of Europe-wide market for renewable gas certificates. The REGATRACE project covers all necessary layers and provides specified guidelines. Figure 2 illustrates these layers in the form of a pyramid with the enabling of trade which is positioned at the top.

[4] https://ec.europa.eu/energy/data-analysis/market-analysis_en

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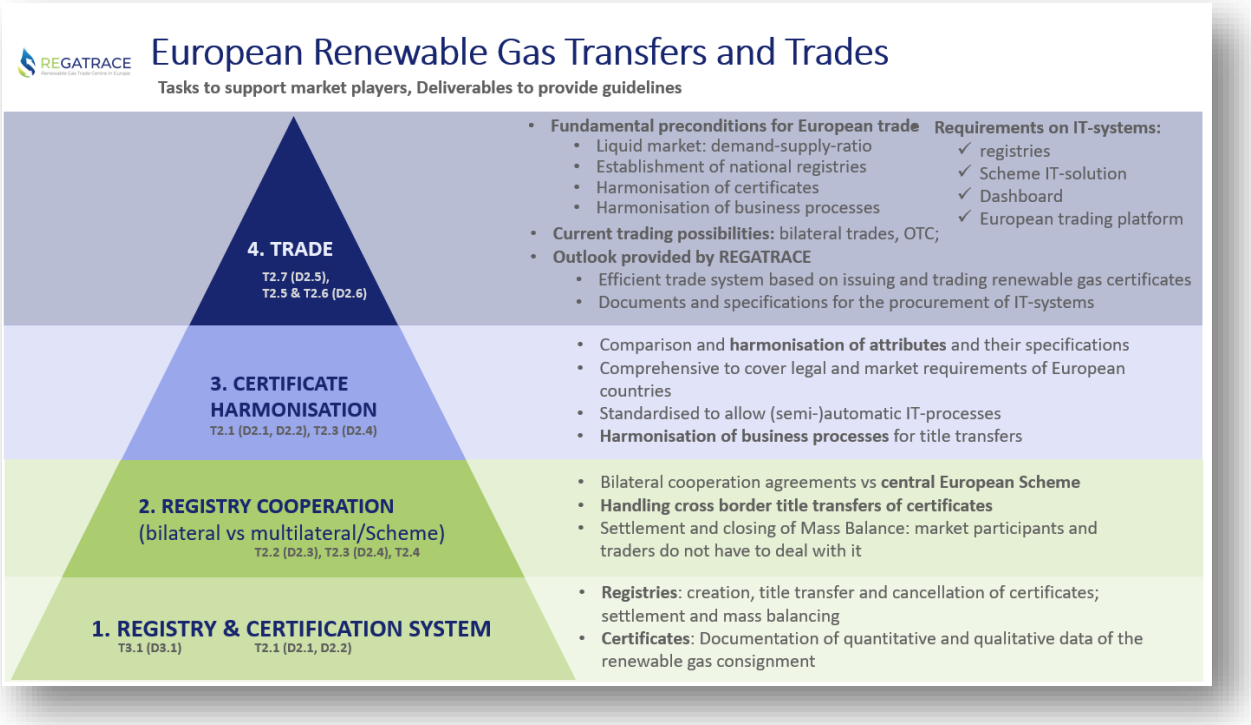

Figure 2: Steps to reach harmonised European renewable gas market

Understanding that trading activities represent the top of the pyramid, it becomes evident that all elements of the bottom layers significantly influence the design of a European trading platform. Influencing factors are particularly:

- IT-setup of registries,
- Certificate creation principles, including attributes,
- Setup of registry cooperation,
- Processes for interchange of certificates between registries,
- Data format for registry cooperation for cross-border exchange of certificates,
- Security during data delivery and transfer particularly IT-security and avoidance of multiple counting,
- Tracking Claim: book & claim or mass balancing,
- Market Participants definition (producers, traders, supplier, and others).

Although several countries have set up the framework for certificate transfer - which is yet to be harmonised - renewable gas developments are still scattered. Many countries do not yet have any legal framework and are still lacking on each layer of the pyramid. REGATRACE also provides insights into the status and progress of national framework developments, see task 3.2 and report D6.1[5]. The smooth functioning of the European renewable gas trade requires standardised certificate attributes, otherwise the system will not be able to perform in a correct and reliable way. Clear and simple guidelines on implementation are necessary to be able to span the renewable gas market over Europe as soon as possible.

[5] REGATRACE D6.1 Mapping the state of play of renewable gases in Europe https://www.regatrace.eu/wp-content/uploads/2020/04/REGATRACE-D6.1.pdf

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In the following chapters, these necessary layers as illustrated in the pyramid above, are described in more detail:

- Chapter 2.2 National Organisations: Biomethane/Renewable Gas Registries and Issuing Bodies
- Chapter 2.3 European Hub or Transfer Platform
- Chapter 2.4 European Dashboard
- Chapter 2.5 European Trading Platform

2.2 National Organisations: Biomethane/Renewable Gas Registries and Issuing Bodies

According to European and national legislation, the establishment of a certification system is a national competency. A national registry is established either by government mandate or through the voluntary cooperation of market participants and is operated on the domestic market.

Since there are many different application purposes for renewable gases – consumer disclosure, target compliance with transport target or Union target, self-commitment, national subsidy documentation, and marketing purposes - more than one registry can exist per one country or region. In this regard a well-functioning exchange of information is required in order to avoid double counting and double sale of the renewable (and sustainable) value of renewable gases.

A registry is an administration system which documents the full chain of custody of biomethane/renewable gas from production to the distribution to the final consumers. The major task is to provide harmonised and transparent documentation of production for off-grid and on-grid volumes (or injected volumes in case of on-grid volumes) of renewable gas including the properties and attributes it acquires during production and processing. The registry provides a platform for market actors to generate, exchange and cancel certificates documenting different kinds of renewable gas applications.

The functions and performed tasks by a national biomethane/renewable gas registry depend on the domestic regulatory and business environment and may differ from country to country. Generally, the key functions of the registries are as follows:

- Apply transparent framework and rules,
- Verification of data during registration of market participants: renewable gas producers, renewable gas consumers/traders and auditors,
- Administering master data of registered market participants,
- Operating an electronic, account-based database for the administration and documentation of the renewable (and sustainable) characteristics of renewable gases,
- Issuing of renewable gas certificates,
- Providing a documentation system for market participants to perform ownership transfers of renewable gas certificates,
- Documenting the final consumption of renewable gases via the function of cancellation and by providing cancellation statements,
- Establishing an interface to a European scheme to enable cross-border title transfers,
- Provide reporting functions for internal, external and transparency purposes.

REGATRACE D3.1 *Guidelines for establishing national biomethane registries* provides more detailed insights into the tasks and operations of such a National Organisation.

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The Renewable Gas Registries established today have already set up their individual attribute list, their master data structure and individual IT-infrastructure for the national certification system. These individual solutions may be well adapted, efficient and fulfil the national regulations of the domestic market. However, the IT and attribute structure were set up without international coordination and represent therefore individual domestic solutions. Proposals for standardised attribute structures are provided in REGATRACE D2.1 *Updated Guidelines for creating the European Biomethane GoO*[6] and D2.2 *Report on content and attributes of GoO*[7].

2.3 European Transfer Platform or European Hub

Besides overseeing national markets, the task of National Organisations such as Renewable Gas Registries and Issuing Bodies shall be to pursue a European market by being connected to a European IT-option, underpinned by a European Scheme. REGATRACE D2.4 *Investigative study of IT system options for harmonized European cross border title-transfer of biomethane/renewable gas certificates*[8] investigated different IT-options for cross-border transactions and title transfers:

1) Standardised data exchange without dedicated database;
2) Standardised data exchange with simplified database;
3) Bolt-on module;
4) **Platform for information exchange;**
5) **Centralised communication hub;**
6) Central IT-solution for all services.

Based on the fact that legislation requests the handling of certification systems to be at the national level and that there are not yet operating systems in each region/Member State, the project team concluded that a decentralised solution based on already existing IT-infrastructure (IT solutions 1-3) is a suitable short-term solution. In the mid-term, however, more automated business processes will be required. Hence, IT-options 4 and 5 seem suitable when advanced national IT-systems and know-how of Scheme Participants are available.

The project team further describes steps for establishing a European renewable gas market to be based on IT-option 4) Platform for information exchange and IT-option 5) Centralised communication hub; further called European Transfer Platform and European Hub, respectively.

Such IT-solutions provide for harmonised and efficient integration of registry systems and if a large number of participants are engaged in the system, they can share the organisational and financial burdens involved.

The organisational aspect of connecting National Organisations is performed by them joining a European Scheme that provides the IT-solution for the exchange of renewable gas certificates. The connection between the respective IT-systems can be established via different interface options as described in REGATRACE D2.4. The transfer process shall be conducted in a way that at its end, the certificate has been transferred from one Economic Operator (Account Holder in the sending national IT-system) to another (Account Holder in the receiving national IT-system) and the transaction is

[6] D2.1 Updated Guidelines for creating the European Biomethane GoO: https://www.regatrace.eu/wp-content/uploads/2019/11/REGATRACE-D2.1.pdf

[7] D2.2. Report on content and attributes of GoO https://www.regatrace.eu/wp-content/uploads/2020/03/REGATRACE-D2.2-new-version.pdf

[8] D2.4 Investigative study of IT system options for harmonized European cross border title-transfer of biomethane/renewable gas certificates https://www.regatrace.eu/wp-content/uploads/2020/10/REGATRACE-D2.4.pdf

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confirmed by all involved entities, particularly the Scheme Participants. The European Scheme reproduces these business processes continuously, securely, and efficiently.

2.4 European Dashboard

Although the application purposes are diverse (renewable power generation, application as transportation fuel, consumer disclosure, etc.), renewable gas producers and potential investors need reliable framework conditions for their business cases and to enter long-term contracts. Trades are mostly conducted by established trading organisations with deep market knowledge. Producers or consumers who are small companies or individuals (e.g., farmers producing biomethane) are either often not aware of those market players or do not have time and resources to pursue business with international stakeholders. They prefer simpler ways to conduct trades, finding a counterparty for sales or buys in a quick and easy way.

A Dashboard function may help solve these problems and supports the uptake of renewable gas trade by facilitating the introduction of potential sellers and buyers in a simple way, without the need for personal contact or previous communication. This concept is founded on the understanding that collaboration between both traditional and emerging partners in green gas trade creates opportunities for innovation, efficiency, and growth.

Within the present report, a Dashboard is defined as a communication tool of the renewable gas market. The Dashboard - may also be called bulletin board, blackboard, white board, notice board - is considered a technical platform for market participants to place simple offer requests (either buying or selling) without direct ownership transfer. Such offers may include individual information of the product, the offering party such as contact details and volume/price specifics. Those offers are available to registered market participants using a standardised interface, for example a European Transfer Platform or European Hub. The number of participants to view or announce offers can be increased if the criteria for their registration at National Organisation level (national registry / issuing body) are kept simple (e.g., soft application only for Dashboard function). The users of the Dashboard may be limited to a certain type and number of market participants of renewable gas registries which are interlinked with the European Transfer Platform and European Hub. If the user group shall be extended also to none-registry participants, special registration procedures may be applied directly at the Dashboard or at registry level with reduced access rights and participation rules. A technical Dashboard solution within a registry has the advantage that an additional registration is not necessary with the registry compared to stand-alone platforms or especially exchanges which have a complex and time-consuming registration process. The set-up depends on the organisational position the Dashboard shall have within the market.

The functions of a Dashboard can be compared to a commercial online platform: for example, auction platforms for private good or dating apps with standardised profiles for each user. The big difference to a Trading Platform is however, that the Dashboard strives to be a contact platform between buyer and seller and does not settle a trade whether financially or physically. It means that no ownership transfer is foreseen within a Dashboard function.

A Dashboard provides many advantages for non-mature markets because it offers full flexibility for sellers and buyers to agree on product details, settlement rules and other individual requirements such as internal company policies. This flexibility can be analysed and over a specific time frame conclusions drawn for market participants, which may lead to a harmonisation of specific product attributes, settlement procedures or other important aspects to conduct trades. This could in turn be used to develop a Trading Platform with respective tradable products with high liquidity to support trading

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integration and provide price signals for producers and potential buyers; very important aspects for market development.

The technical solution of a Dashboard should be designed and organised in a way to enable a wide range of market participants to view those requests entered (sell or buy) on the Dashboard. The information on the Dashboard shall serve as bid or offer requests providing specific information. Market participants will enter a request with specific information which is published either to all or only to specific Dashboard participants. Such a request should at least include the following information which may be interlinked with certificate attributes documented in the national registry:

- Type of offer (Buy or Sell),
- Product (type of renewable gas),
- Type of certificate (application purpose),
- Issuance date (production period) of the renewable gas consignment,
- Energy amount (kWh or MWh),
- Country of production,
- Mode of delivery (or also referred to as “tracking claim” considering book and claim or mass balance),
- Price (at least optional),
- Offered/requested renewable and sustainably characteristics (PoS available, GHG footprint),
- Contact Information, and
- Individual text.

In case the request is of interest to another Dashboard participant, the interested party contacts the creator using the entered contact information. Only in case of interest on a Dashboard entry by a market participant, further communication will be conducted. The major obstacle when arranging a trade is the time-consuming bilateral negotiation between buyer and seller due to limited number of standardised processes. Any negotiation on details (legal issues, financial settlement, delivery point etc.) is handled based on individual agreements beyond the Dashboard system boundaries. Another option can be to offer a function of the Dashboard, e.g., interface to a Trading Platform or chat functions to enable direct communication between market participants. EFET (European Federation of Energy Traders) does offer standard and template contracts[9] which could be referenced as basis for such trade agreements.

In general, the legal documentation of renewable gas volumes is subject to European Directives, most prominent of which is the Renewable Energy Directive. Therefore, the requirement on establishing an active exchange between participants of registries for communication purpose could be requested by European legislation, which could make an implementation mandatory also for Member States and their national registries or where already implemented on Union-wide databases. By equipping all existing and future registries with such a function (via a dedicated interface to the Dashboard), the information could be spread to a high number of market participants even across borders. Whereby the technical linking of registries could be offered via the European Transfer Hub / Platform, the Dashboard may be also developed as a stand-alone IT-system within the European Transfer Platform / Hub. Different technical options exist, which are discussed in the chapter 3. The request to buy or sell biomethane can be provided on a dedicated Dashboard platform, but of course also directly in the registry if the registry IT-system does offer such a functionality, e.g., the Biomethane Registry Austria offers a Dashboard function, but with current restriction to Austrian market participants only. A

[9] https://efet.org/home/documents#

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technical solution within a registry has the advantage of providing first contacts with interested trading participants without additional efforts such as registration in other systems. Considering the current status and constantly changing market developments, the prominent factor is to provide a simple and secure system for market participants.

Based on the analysis of needs of market participants and stakeholders, this report provides a specification for a European Renewable Gas Dashboard. The detailed chapters on the Dashboard will provide different solution concepts. Those could be used by different market participants and legal (private and public) institutions for development of a renewable gas Dashboard. Hence, the principle can be extended to other non-mature markets or energy carriers not having a liquid market yet, but decentralised market structure.

2.5 European Trading Platform

While the renewable gas Dashboard performs as a communication platform to publish requests on potential bids and offers, the European Trading Platform shall provide the function to settle deals on an administrative and financial level. Actual (cross-border) ownership transfers may be settled via the Trading Platform by accessing certificates stored on the accounts at national registries/IB. The certificate availability marks another important distinction. Since ownership transfers may be settled via the Trading Platform, it reflects that only trades on already existing certificates may be dealt on the trading platform. Another option is to trade forward products (volumes not yet produced) and trigger transfer of ownership as soon as these certificates are created in the account of the seller. Chapter 5.9 is dedicated to describing five options on settling ownership transfers in detail. The connection of the Trading Platform to national registries represents a task which is challenging but still an important basis for establishing trading opportunities.

The Trading Platform should not be mistaken as being a stand-alone registry, rather it represents the top layer of the pyramid (see Figure 2) for a European renewable gas market. It relies on the information provided by national registries/IB and by the European Transfer Platform/Hub. Especially, the data on the renewable gas product – the certificate attributes – have to be provided to the Trading Platform by registries but the Trading Platform must be capable of handling/processing such data. The core functions of creation/issuance, auditing and cancellation of renewable gas certificates remains with the National Organisation (issuing body/renewable gas registry).

The European Trading Platform enables ownership transfer between (national or international) market participants, based on an agreement between two market participants/traders or with the Trading Platform (central counter party) depending on the setup of the ownership settlement process (five options described in chapter 5.9). The ownership transfer is initiated in the trading platform, but as the certificates are documented in the national registries/IB exclusively, the ownership transfer and the documentation are finalised only when available in the receiving registry. The Trading Platform must document transfers of certificates properly to ensure that a certificate must not be counted or used multiple times within the same transaction.

Based on BIOSURF EU-project Deliverable 3.6 *Proposal for the establishment of national and European biomethane certificate trading platforms*[10], the project partners envisage the Trading Platform as a stand-alone IT-system with direct connection (interface) to the European Transfer Platform / Hub and through that European Transfer Platform / Hub a connection to the National Organisations (registries/issuing bodies).

[10] http://www.biosurf.eu/wordpress/wp-content/uploads/2015/07/BIOSURF-D3.6.pdf

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This report will shed light on options for operating a European Trading Platform (operated and financed by the private or public sector), the different trading options available now (see chapters 5 and 6) and possibilities for the future. Prerequisites for a functioning European Trading Platform are harmonised certificate attributes to provide the renewable value as a tradable, standardised product and the technical requirements for the functional and non-functional elements of the Trading Platform. Chapter 4 is dedicated to the definition and design study for a European Trading Platform of renewable gases.

The present report primarily discusses the technical requirements for the functional and non-functional determination of a Trading Platform whereby the existence of national registries and a harmonised renewable gas documentation alongside all registries is taken as a basis. These prerequisites must be defined and solved upfront in order to allow the Trading Platform to minimise complexity and offer market participants simple and automated support to transfer certificates. As the Trading Platform shall build up its functions on “certificates” of national registries (not created by the trading platform), it requires a clear and easy to handle interface between the Trading Platform and the national registry.

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2.6 Data Structure and Data Flow

The previous chapters described the four IT-systems necessary to enable European trade of the renewable (and sustainable) value of renewable gases. As explained, the harmonised set of attributes and standardised certificate are considered prerequisites for the establishment of a European renewable gas market. Thus, the IT-systems must be able to handle standardised input and output data, as listed in Table 1. Such standardised data are used in different business processes and by different market participants. Table 2 provides insights into who and how standardised dataset are handled.

Table 1: Dataflow using Input and Output data based on the entities Registry, Transfer Hub/Platform, Dashboard, Trading platform

Dataflow at IT-system type	Input	Output
Registry	Meter Data, Audit Report	Certificates
Transfer Hub / Platform	Certificates	Certificates
Trading Platform	Certificates, Bids, Collaterals	Certificates, Results, Reporting, Accounting, Transparency
Dashboard	free text	free text

Table 2: Type of data and business process of the IT-systems of Registry/IB, Transfer Hub/Platform, Dashboard, Trading platform

	Registry/Issuing Body	Transfer Hub / Platform	Dashboard	Trading Platform
Market Participants	• Renewable Gas Producers • Renewable Gas Consumers/ Traders • Auditors • Registry Operator	• Registry Operators	• Renewable Gas Producers • Renewable Gas Consumers/Traders • Registry Operators • Dashboard Operator	• Renewable Gas Producers • Renewable Gas Consumers/Traders • Registry Operators • Trading Platform Operator

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	Registry/Issuing Body	Transfer Hub / Platform	Dashboard	Trading Platform
Master data	• Data specific to the production installation • Data identifying companies: name, address, VAT number, etc. • Data identifying persons: name, mail address, phone number, related company, etc.	• Data specific to the Scheme Participant (= registry operator): name, address, VAT number, etc. • Data specific to their contact persons: name, mail address, phone number, etc.	• Data identifying the producers and traders as companies	• Data identifying the producers and traders as companies • Certificate attributes • Registries
Certificates and attributes	• Certificates are created by the registry. • Certificates are audited by auditors who insert their information into the certificate within the registry system. • Registry provides its individual list of attributes. • Registry provides a list of attributes harmonised with the European Transfer Hub/Platform. • Registry operator does not own certificates at any point.	• Hub/Platform is able to read the harmonised list of attributes (specifications defined). • Certificates are created by the registry. • Registry provides a list of attributes harmonised with the European Transfer Hub/Platform. • Operator does not own certificates at any point.	• Dashboard provides a (limited) list of attributes in harmonisation with registry. • Market participants fill in data according to the certificates on their registry accounts. • Information additional to harmonised attributes: contact information, Individual text. • Operator does not own certificates at any point.	• Trading Platform provides a (limited) list of attributes in harmonisation with registry. • Provision of Certificate information for trading purposes before and after trading (dependent on system design). • Information additional to harmonised attributes: contact information, Individual text. • Operator does not own certificates at any point.

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	Registry/Issuing Body	Transfer Hub / Platform	Dashboard	Trading Platform
Business processes	Organisational aspects ● Development, update, and maintenance of market rules (terms and conditions, rule book, etc) provided by registry operator. Registration ● Market participants undergo registration process. ● Registry operator finalises registration and creates accounts for market participants. ● Registry operator maintains master data. Daily business ● Registry operator issues/creates certificates. ● Auditors add data to specific certificates. Settlement processes	Organisational aspects ● Development, update, and maintenance of scheme rules. ● Responsibility for development and maintenance of IT-infrastructure, with support of an IT-provider via a Service Level Agreement. Registration ● Registry operators undergo registration process. ● Hub operator finalises registration and creates accounts for registry operators. Daily Business ● Registry operators perform cross-border transactions by using the IT-infrastructure. Settlement processes	Organisational aspects ● Provision of standardised procedures (terms and conditions, rule book, etc) provided by dashboard operator. Registration ● Market participants undergo registration process. ● Dashboard operator finalises registration and creates accounts for market participants. ● Registries are no participants of the Dashboard. Daily Business ● Market participants enter bid/ask requests on the Dashboard. Settlement processes ● No ownership transfers are foreseen.	Organisational aspects ● Provision of standardised procedures (terms and conditions, rule book, etc) provided by Trading Platform operator. Registration ● Market participants undergo registration process. ● Registry operators undergo registration process. ● Trading Platform operator finalises registration and creates accounts for market participants. Daily business ● Bid Submission ● Auction Process ● Clearing (certificate exchange) ● Publication of trade information

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	Registry/Issuing Body	Transfer Hub / Platform	Dashboard	Trading Platform
	• Market participants (producers, trades) may split, initiate transfer, accept/reject transfer, cancel certificates. • Market participants initiate cross-border transactions by requests. • Registry operator performs cross-border transaction, including cancellation of exported certificates to withdraw them from the registry database.	• Ownership transfers are performed between accounts of different national registries but are not performed by the operator itself.		<u>Settlement processes</u> • Settlement: financial settlement and settlement of ownership transfer. • Management of collaterals.
Ownership	• The certificates are allocated towards the account of market participants (producers, traders) and are in the account holder's ownership. • Registry operator does not own certificates at any point.	• The certificates are allocated towards the account of market participants (producers, traders) of national registries and are in the account holder's ownership. • Hub/platform operator does not own certificates at any point.	• The certificates are allocated towards the account of market participants (producers, traders) of national registries and are in the account holder's ownership. • Certificates are never stored on accounts of the Dashboard.	• The certificates are allocated towards the account of market participants (producers, traders) of national registries and are in the account holder's ownership. • Trading Platform controls ownership transfer of certificates after trade confirmation (dependent on system design).

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	Registry/Issuing Body	Transfer Hub / Platform	Dashboard	Trading Platform
			• Dashboard operator does not own certificates at any point.	• Trading Platform operator does not own certificates at any point.
Ownership transfer	• Ownership transfer is performed between accounts (account holders) of the national registries.	• Ownership transfer is performed cross-border between accounts (account holders) of two different national registries.	• No ownership transfer is performed.	• Ownership transfer is performed either i) between accounts (account holders) of the national registries or ii) cross-border between accounts (account holders) of two different national registries.
Interface (see also input/output)	• Interfaces between national organisations responsible for the documentation of renewable gases (issuing bodies, biomethane registries, biofuel registries) shall establish interfaces and cooperation agreements to ensure the prevention of multiple counting.	• The European transfer hub/platform provides a centralised IT-platform to which the national organisations shall establish interfaces to enable cross-border transactions.	• The market participants allowed to use the dashboard enter offers (dependent on user groups). • The entering is based on the system design. (either in a national organisation registry system or directly in the Dashboard).	• The Trading Platform provides a stand-alone IT-platform which shall be connected either i) to national registries or ii) to the transfer hub/platform to allow (cross-border) ownership transfers of certificates between market participants.

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	Registry/Issuing Body	Transfer Hub / Platform	Dashboard	Trading Platform
	● The national organisation shall establish an interface to the European transfer hub/platform to enable cross-border transactions.		● The Dashboard is interlinked via the European Transfer Platform/Hub with the national organisations or theoretically directly with the national organisation IT-system bypassing the European Transfer Platform/Hub.	

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3 Dashboard

3.1 Introduction

Compared to the fossil gas industry, the renewable gas sector has many small production facilities by different operators. Renewable gas production facilities are established/operated primarily by farmers and smaller production companies. Most of them are not fully integrated into the European natural gas market and its requirements such as balancing production and consumption, trading, supply volumes to final customers or balancing their forecast with actual production. Those fundamental processes of the European energy market have so far been widely implemented only for the product natural gas.

To offer future renewable gas production to the already established natural gas market participants, a harmonised and integrated approach must be ensured. By offering a Dashboard function, hurdles could be reduced. The main function of such a Dashboard is to offer production facilities and potential buyers a platform, where they can exchange offers without direct personal contact and without ownership transfer. A European wide Dashboard could offer small production facilities a large audience to provide their production capacities. On the other hand, natural gas suppliers would have much easier access to those small entities and their renewable gas volumes which are not fully integrated and connected via existing European gas market processes.

The Dashboard could be offered as one central web-based platform with one web appearance via a dedicated URL. Based on the chosen technical solution, this platform could offer individual information on the registration, administration, connection to registries, transaction fees and support contacts.

Practically speaking, renewable gas producers who want to inject into the natural gas grid, could ask via the Dashboard if somebody is interested in buying their product. By entering additional information such as certificate issuing time/renewable gas production period, volume/energy amount, quality, expected price, contact information and delivery point, etc., potential buyers could get in touch with the offering party. The information exchanged via the Dashboard shall serve to post bid or offer requests including specific information in a pre-standardised format. Further communication is only conducted if potential business partners are requesting such additional information. Exchange may be individually organised beyond the Dashboard or supported by other functions of the Dashboard or national registries, e.g., interface to a Trading Platform or chats functions to enable direct communication between market participants. Currently, without standardised business processes, the major obstacle when arranging a trade is the time-consuming bilateral negotiation between buyer and seller. The Dashboard will reduce this burden. The main obstacle can be resolved via a Dashboard, namely the selling of renewable gas for producers, and receiving access to those volumes by natural gas consumers. After an agreement is achieved, which is expected to happen beyond the Dashboard system boundaries, the final execution will be handled through the mutual agreements - beyond the system boundaries of the Dashboard. However, because of individual settlement processes on a Dashboard - compared to a Trading Platform - there are higher efforts needed by business partners/counterparties for contract design and negotiation and potentially also for settlement of ownership transfer. The Dashboard will empower market participants to find each other, get into communication and exchange information which consequently will ease the possibilities for trade and will empower the market development.

Some national registries provide such a function, similar to the Dashboard concept described in this report, to their national market participants. However, on national level, the number of market

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participants is still low in some countries and if market participants personally know each other, such functions often will not be widely used. However, the complexity to establish business relations is even higher on an expanded, Europe-wide market. Factors such as time restrictions and language barriers are common hurdles. A European Dashboard will ease the complexity and administrative burden for market participants to enter a European market and will provide a way of kick-starting trading activities cross border and facilitating European integration of biomethane/renewable gas in established markets.

The current practice is that biomethane producers sell the physical gas via gas market processes to a known gas suppliers which also handle the physical imbalance of the gas injection. The renewable value is purely documented via certificates, which are traded separately to the physical gas and also timely detached from selling the physical gas. This principle may change in the future towards a product representing both elements – physical and renewable values. The gas market processes already support this approach and in the electricity sector such product has been already established. To provide a practical example, it is a tradable spot product in the electricity market on the Austrian Energy Exchange EXAA which allows to trade physical production timely bound to certificates.

3.2 Business Processes of a European Dashboard

3.2.1 Definition of Business Processes

To supply the dashboard for the renewable gas market in a well-functioning manner for all entities involved, several business processes are of importance. Those processes are directly interlinked with the setup and administration of the Dashboard operator. The business processes described in the following sub-chapters have been identified within a Dashboard for supporting communication of interested selling and buying entities. Also, their consequences on implementation within a renewable gas Dashboard are considered.

The principle of this Dashboard could be extended to other energy carriers, markets and products surrounding the renewable gas market such as a Dashboard for farmers and production facility suppliers.

3.2.2 Registration

3.2.2.1 Prerequisites for Dashboard Registration

The Dashboard should be designed to be available to a high number of market participants. The total number of users is influenced by the applied criteria/requirements on registration and eligibility to be owner of a renewable gas certificate. These are in turn influenced by the requested level of security and quality background checks which must be performed by the operator. The minimum requirement, which might lead to the highest number of market participants, is simple registration with username and password without any further validation but also provides less quality assurance in the administration of accounts and the offers entered or the communication towards other market participants. The lowest number of market participants might be achieved if only market participants registered at national registries are allowed to access the Dashboard. Several levels of security and registration requirements in between those two options are feasible, for example users may come to the dashboard as “visitors” who simply register with username and password but still have the option to use limited features of the Dashboard. The balance between quality of registration and quality of market participants must be determined and maintained by the Dashboard provider/operator and will be also influenced by financing needs (the more participants, the more application fees may be acquired). The following different registration options are imaginable:

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3.2.2.2 Options to register Dashboard Users

1) Option: registry participants equal dashboard participants

All market participants registered at the national renewable gas registries are automatically accepted as registered users of the Dashboard. In such a case, all registries need to collect and maintain at least similar participant information in their master databases to together provide a harmonised Dashboard master database. Examples for necessary data:

- Company name
- Company ID

2) Option: dedicated Dashboard registration via national registries

The Dashboard requires a dedicated registration process on registry level to become Dashboard user. This can be an own document to be signed by parties or simply via a web formular within the registry system.

The implementation of different user groups is imaginable to provide specific set of rights to different market participants. There may be different fee regulations applied to reflect the extent of the rights available for the specific user group. In case the use of the Dashboard is connected to financial fees, a clear list specifying rights per user group may help to structure the fee regulation; for example, placing offers is for free but display costs are X €.

Additionally, the registration may be combined with information for the dashboard use such as:

- Allowance of specific users (persons) assigned to the company
- Application only for placing sell offers
- Application only for placing buy offers
- Application for display of other offers
- Display of offers only with special attributes within the buy or sell offer such as
    - Energy medium
    - Country
    - Technology
    - Substrates/input materials

3) Option: Central Registration via Dashboard

The Dashboard operator handles the registration of Dashboard users on its own. To background check the applying market participants, the Dashboard operator could cross-check the applicants with the master databases of national registries. However, a central registration would most likely be completely disconnected/separated from the master databases of national registries, which will increase the administrative burden for market participants (who have to register more than once, but most probably with same personal data) and also for operators of registries and Dashboard who could otherwise pool their resources. A stand-alone registration on the Dashboard bears a higher risk of fraud by not well-known market parties.

In options 1 and 2, the question arises if market participants non-registered at national registries can be considered acceptable Dashboard users. If yes, which registration requirements and fee regulation would apply to such parties. The evident advantage is that commodity traders often act as

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intermediary between producer and consumer. They are often not registered at national registries (avoiding national fee regulations) while still holding large knowledge on the renewable gas market and being heavily involved in national markets. Commodity traders see the need for and the value of a Dashboard. With an established Europe-wide Dashboard they will most probably connect with market participants directly via the Dashboard. This might decrease the need of commodity traders to find value in opening accounts in national registries themselves. On the other hand, well-connected commodity traders may fear the Dashboard as a threat to their own, established network with market participants. The higher the number of market participants on the European market (Dashboard and Trading Platform), the higher transparency can be reached, and the easier market barriers may be overcome.

Allowing non-registered market participants at national registries to enter the market/to become users of the Dashboard, such as briefly mentioned in option 3, bears risk of security and fraud. An important question has to be raised: Will it be necessary for such parties to proof that they actually hold ownership of the respective certificates which they offer on the Dashboard? The background-check of such parties (at point of registration, and potentially also at point of closing trades) will be increased for the Dashboard operator. This additional administrative burden may be covered with income from a specific registration fee.

3.2.2.3 Market Participant Administration

The Dashboard market participants may be divided into different user groups with specific sets of rights. The requested level of anonymity will influence the decision on two user groups.

- First, market participants which are allowed to enter buying and selling offers.
- Secondly, market participants with reading rights only.

Market participants of the first group are allowed to use the offer function (bid/ask) to post their request and find a suitable business partner. It could be the case that only specific users may be restricted to view specific offers only, best matches only or even specific attributes only, e.g., related to energy medium, country, production technology, etc. Implementing a chat function in the Dashboard would allow interested parties to get in contact and request further information directly.

In the second case, only the display and communication based on existing offers is possible. This option could be applicable for those market participants, who are interested in screening the Dashboard offers and communicate only based on those. The administrator of the Dashboard can configure the rights of the market participants and the market participant itself can change the user group under certain requirements.

3.2.3 Administration of Offers (Bids/Asks)

The registered market participants shall have the possibility to enter offers (bids/asks), update and delete them. By adding several standardised attributes with mandatory and optional information, the quality of Dashboard offers can be changed.

The Dashboard should provide several filter requirements to optimally display only relevant offers for market participants, e.g., only valid offers (not deleted and not executed) should be displayed first. A history of entries and the respective changes (updates) of entries would increase the transparency towards the market participants. Based on the user rights assigned by the Dashboard operator, the display of entries shall change accordingly, allowing only registered users with respective assigned rights to perform specific actions such as the entering of offers. The anonymity of offers should be

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possible as well allowing market participants to provide their contact and business information only when getting in direct contact with one of the Dashboard parties.

3.2.4 Communication Tool

In general, communication between counterparties may be managed beyond the Dashboard once they have had been able to exchange their contact information.

However, a chat function would enable interested parties to ask questions or simply agree on specific conditions to find an agreement on a trade. Such communication may be executed privately or publicly.

Private communication refers to the communication between the requesting party and the offering party only. The differentiation between anonymous and non-anonymous communication might be useful.

If the posed questions have relevance for all market participants – e.g., questions on the quality or on specific attributes – the communication could also be executed publicly, meaning to openly publish a note related to a specific offer.

In order to continue communication personally, the option to add contact data (mail address, phone number) should also be provided.

3.2.5 Reporting

The Dashboard shall offer reporting functions for the Dashboard administrator and the market participants to provide standardised reports on the offers and their attributes. Similar, to an exchange or trading platforms, which publish their trade volumes and prices, the Dashboard could anonymously publish the number of registered market participants, the number of buy and sell offers, and the aggregated volume of those offers for defined periods. Market participants may receive reports on their own offers in a structured form, as well as invoices for fees and registered persons for market participants.

3.2.6 No Ownership Transfer

No ownership transfer is foreseen on or via the Dashboard. There may be a link to a Trading Platform to perform transfers previously agreed on the Dashboard in a subsequent system. As described in the design study (see chapter 4.2), it is recommended that the Dashboard and Trading Platform are based on similar IT-infrastructure to ensure interoperability. It is even imaginable that both IT systems represent a combined solution developed/maintained by the same IT provider.

3.3 Fees Regulation

Depending on the financing of the Dashboard, costs may be covered via a fee regulation to be determined by the Dashboard operator. There are different options such as the simple registration fee for the use of the Dashboard function as a whole or only when providing offers respectively when using the communication method for specific offers. Whereby the latter may be difficult to administrate, a simple registration fee to allow for all Dashboard functions seems reasonable and simple to handle. The registration fee could be defined also for specific user groups separately. Whereby the display of offers may be free for all, the entering of orders and communication may be related to costs. Still, this approach allows to contact providers of offers if they insert their contact information.

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Details on options for fee regulations of registries, which are partly also applicable for a Dashboard, are provided in REGATRACE D3.1[11] *Guidelines for establishing national biomethane registries* (chapter 6.5.10 Payment accounting/billing) and REGATRACE task 2.4.

A simple registration fee seems easy to administrate, but if only registration fees apply, these may have to be set quite high to finance the Dashboard and may be a hurdle for small participants. If a fee is set proportionally to the level of activity, it may be easier to lower the entry barrier supporting the usage-based fee regulation. Summarised, several cost structures are possible:

- Pay or see nothing - access to Dashboard only via a subscription
- Freemium - participants can see parts of the market, volumes offered, etc., but cannot perform any actions unless they register and pay a fee
- Pay per service - pay X €/MWh posted; pay per number of users; pay per number of transactions (e.g., 500 Euro for a year for <20,000 MWh).

The authors may not provide a best suitable approach since the evaluation of information on Dashboard implementation and maintenance costs, market participant number, offered volumes and integration efforts for stakeholders such as registries or European Transfer Platforms / Hubs is beyond the present report which focuses on technical specification and a design study.

3.4 Different Technical Options for a Dashboard

3.4.1 Introduction

The Dashboard must be simple to integrate into the market structure and established market roles and easy to use by a high number of market participants, considering their different backgrounds (producers, consumers, small/large companies, different native languages). Technically, the Dashboard shall be an independent system function, which can be used by all national registries or even integrated into national registries IT-landscape. Therefore, several technical options are possible, as described in the following sub-chapters.

[11] D3.1 Guidelines for establishing national biomethane registries: https://www.regatrace.eu/wp-content/uploads/2019/11/REGATRACE-D3.1.pdf

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3.4.2 Client Solution

The Dashboard provides a client for each national registry to integrate into its IT landscape, whereby a central Dashboard system administrates, stores, and makes available all offers to each client transparently. In this case (see Figure 3), the client could be also independently used by none-registry users or other organisations such as brokers, trading platforms, etc.

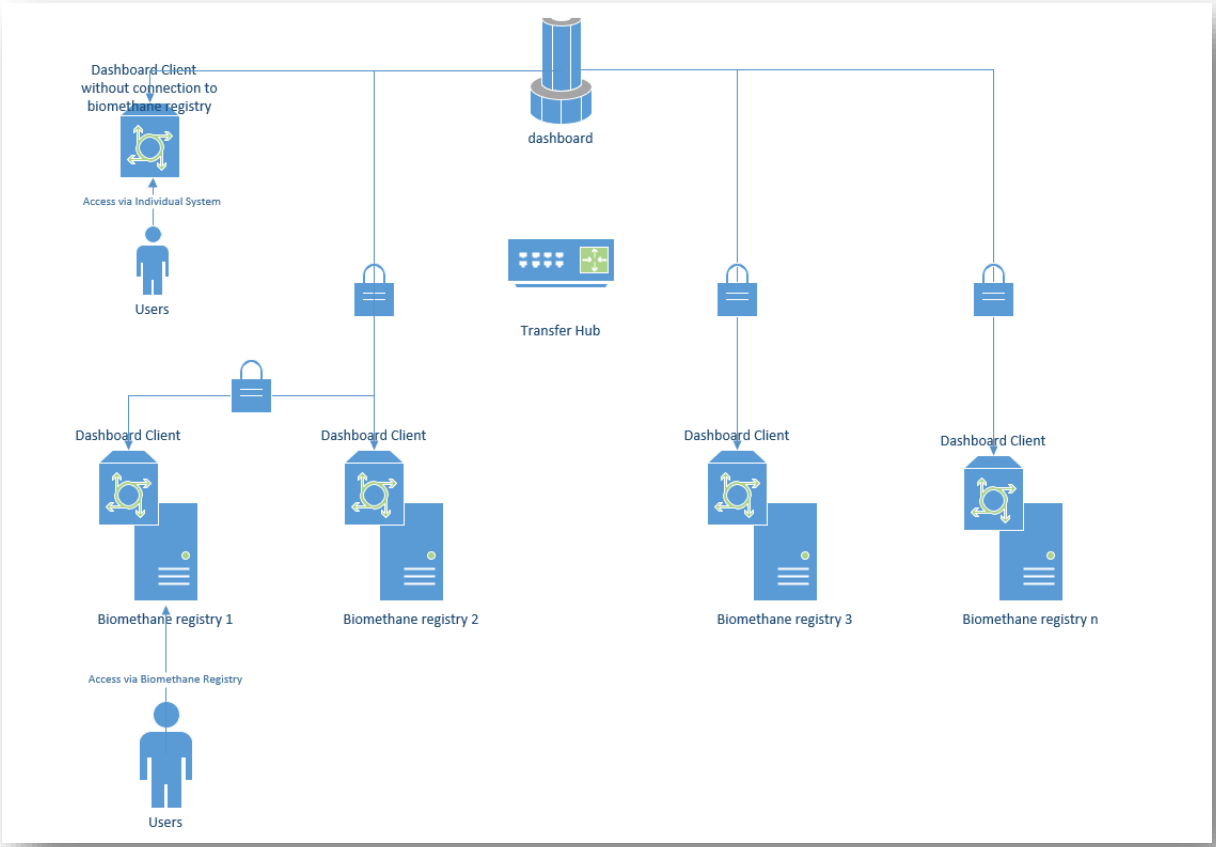

Figure 3: Dashboard system option - client solution

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3.4.3 Single Interface

The Dashboard offers a single interface to the European Transfer Platform / Hub (see Figure 4), where offers (bids/asks) can be exchanged. Orders may be entered in the registry systems and sent to the Dashboard in a structured data format via a standardised interface. The Dashboard places the offer on its central platform and makes it available to all interested parties via one interface with the European Transfer Platform / Hub.

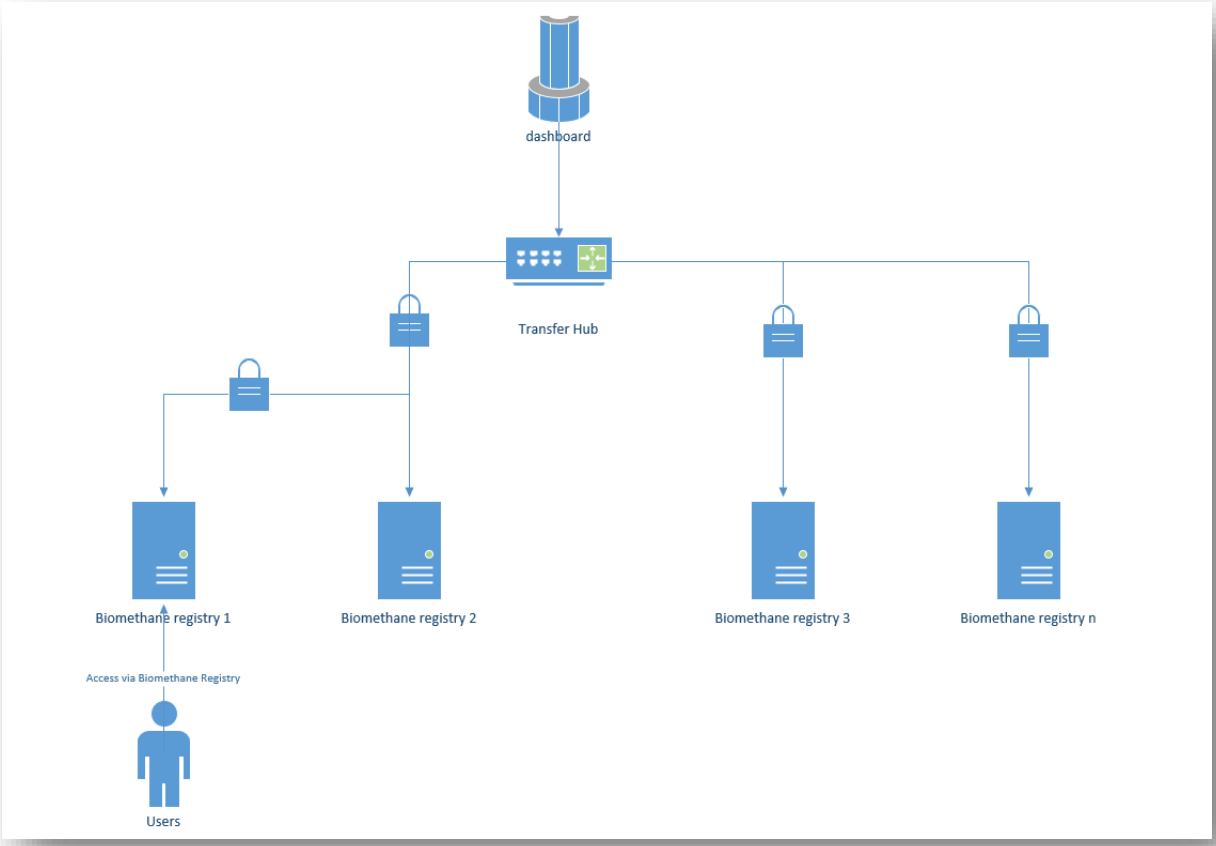

Figure 4: Dashboard system option - single interface

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3.4.4 Central Interface

The Dashboard could be independent of existing registries and the European Transfer Platform / Hub. This option provides for central registration at the Dashboard but limits the registration requirements as the comparison with master databases of registries will be administratively demanding (see Figure 5).

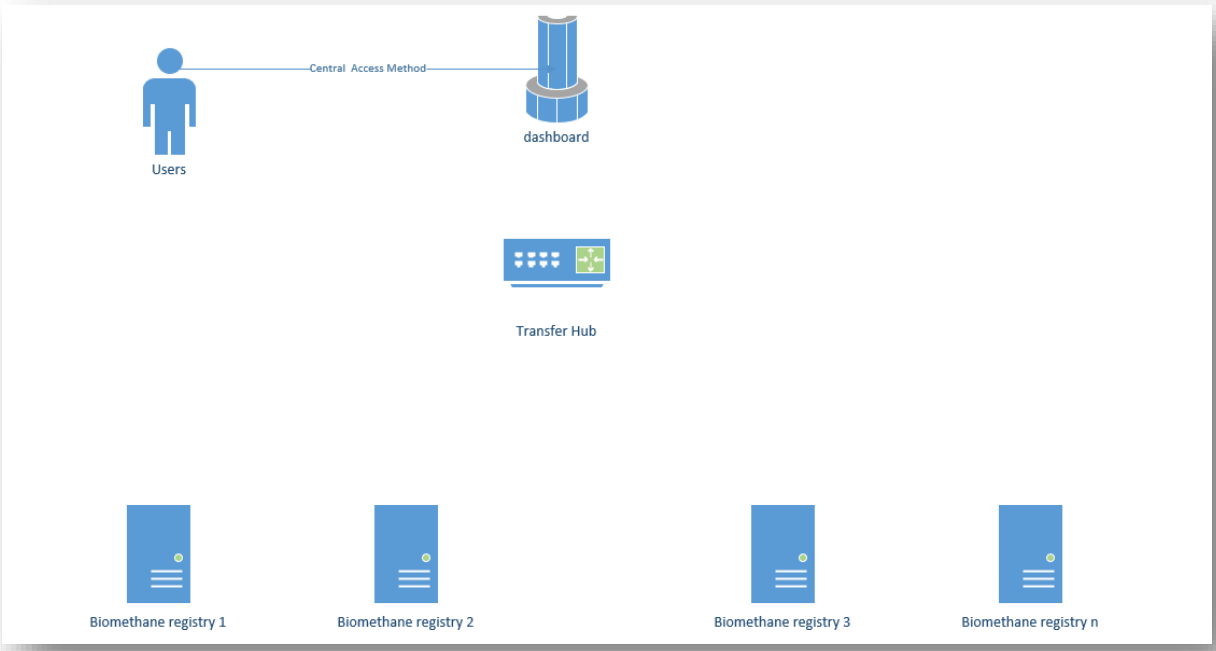

Figure 5: Dashboard system option – central interface

3.4.5 Hybrid Solution

Theoretically, the Dashboard can be a combination of all three abovementioned options, whereby this approach is the most technically demanding one but offers great flexibility for market participants and registries. The client solution may be used by registries with limited IT-services. This approach offers a simplified integration of the Dashboard function than through a more sophisticated IT-interface provided by the single interface option. Large registries with an advanced IT-system may want to integrate the dashboard through an individual development in their own IT-system as a service for market participants. For such cases the single interface would be necessary, whereby structured information is translated into the own IT-system landscape. The central interface would offer a central solution for entities not registered at any national registry to execute their Dashboard processes. Whereby the application requirements may be different than in the first two options, the central approach provides none or very little effort for registries. Combining all options or only two of three may lead to a higher number of market participants and less hurdles to use the Dashboard function.

3.4.6 Conclusion on Technical Options for a Dashboard

From cost perspective, a central solution seems to be practical and the most economical solution, as the integration on the side of the registry is reduced to zero or a minimum. Any developments within the registry, whether for option 1, 2 or hybrid solution may lead to significant aggregated costs for the Dashboard function. Still, the development of a Dashboard may have great interest for each domestic

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registry, which in turn allows to consider higher implementation costs (not necessarily the cheapest solution envisaged).

Also, the operational costs are much less in a central solution approach, as only one IT-solution has to be operated, maintained and updated, whereby in all other options also registries must provide specific technical requirements to operate the Dashboard communication and their functions.

Using a blockchain technology may be an approach due to the decentralisation of offer gathering particularly in option 1 and 2, reducing the requirements of the intermediary, in this case the Dashboard. But due to the missing of ownership transfer and the main function of communication between market participants based on entered offers, the blockchain technology seems to be inappropriate to look deeper into implementation of this option. Also, it requires massive know-how by each registry to operate a blockchain, which may increase costs of implementation because there is yet none or very little experience with such a technical solution on side of the national registries. It would still make sense to use harmonised identifiers so called “Decentralized Identifiers” (DIDs) supported by blockchain technology in the dashboard as a result of registration, which then would talk to the Trading Platform and be used by participants there.

3.5 Demand Analyses at established National Organisations

The national registries and GO Issuing Bodies are not required by European legislation to implement a Dashboard. Such an implementation could only be considered if all registries were willing to invest or a private investor takes up the project. In the latter case, only the central interface option (see chapter 3.4.4) seems reasonable, where no connection to national registries exists and those costs do not appear. National Organisations have not yet come up with such an idea because the “market has solved” such problems up to now through the work of commodity traders, specific companies specialised in matching production and consumption demand on the renewable gas market. Examples for such companies are introduced in chapter 6. Additionally, the renewable gas market so far has been scattered over national markets, never having been interconnected. Only recently, have there been several initiatives to connect biomethane registries and GO Issuing Bodies with each other to establish a Europe-wide renewable gas market.

Currently, the renewable gas market is fragmented and non-mature which hinders the harvesting of its growing potential. The connection of production and demand side is one of the corner stones for a well-functioning market, whereby the production and demand may not be influenced majorly by registries as this shall be triggered by legislation, market actors and merely consumers. Supporting the market development does not necessarily require a Dashboard function but National Organisations are interested in offering the best possible quality to their market participants.

Registries may want to separate this service clearly from their daily operation, but still may offer their know-how and technical capabilities to integrate the Dashboard function in the selected technical solution. In case National Organisations decide not to or are otherwise unable to implement a Dashboard function, an independent organisation (neutrally from the registries) could offer this service through a central interface approach. This initiative could offer this service for a high number of participants, not only restricted to market participants registered at National Organisations. When financing such a platform privately, the higher the number of participants, the more financially viable the project will be. Still, such a Dashboard must be accessible in all countries and enable broader usage supported also by different language selection.

The standardisation of attributes (data fields) plays again an essential role in the harmonisation of the European renewable gas market. In practical terms, the Dashboard must agree with the National

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Organisations on a minimum list of certificate attributes to be incorporated into a bid/ask request. Coordination and harmonisation between all National Organisations are necessary to implement this agreed attribute list and allow an interface to the European Dashboard.

Similar to OTC platforms, where buyers and sellers agree on a transaction, which is executed in most cases beyond the OTC platform, where a match between registered persons leads to a communication beyond, an agreed transaction via the Dashboard could be executed in a registry or even financially via a connected Trading Platform.

In any case, a close coordination on technical and organisational issues with National Organisations is of utmost importance, independent of the chosen technical design. The approach has to comprise several coordination and implementation steps as listed in Figure 6.

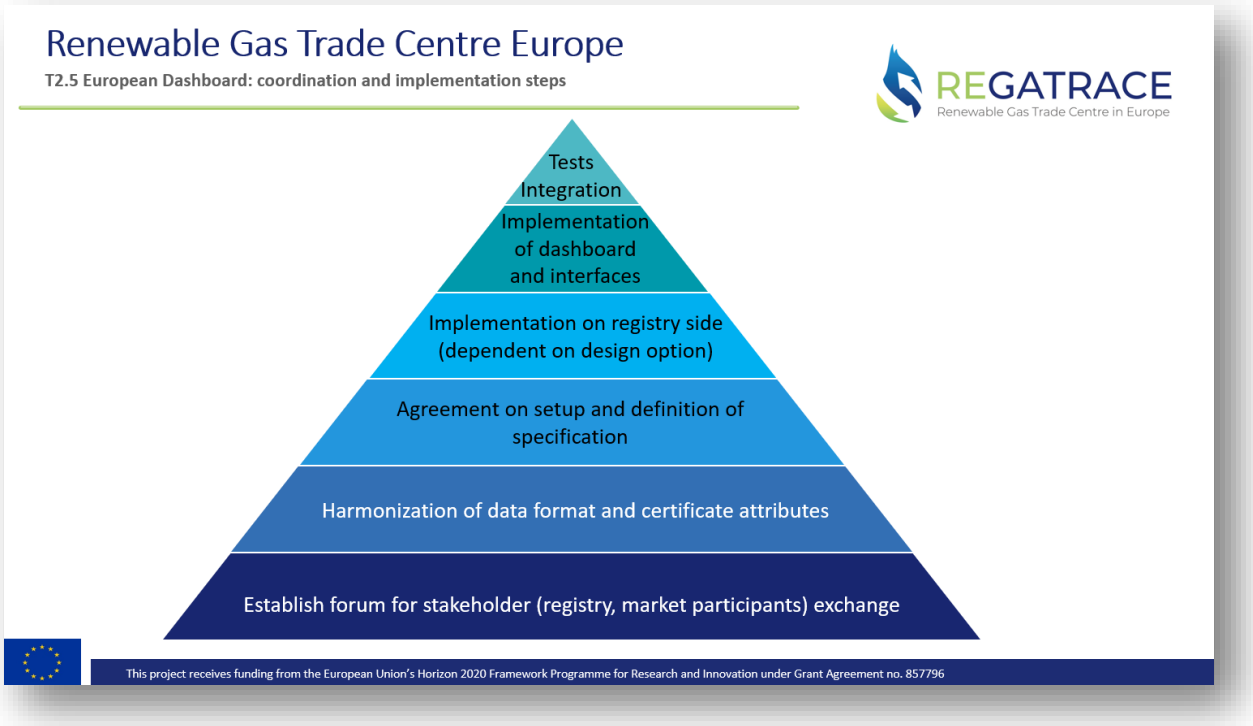

Figure 6: European Dashboard: coordination and implementation steps

4 Trading Platform & Design Study for a European Trading Platform for Renewable Gas

4.1 Introduction

4.1.1 Definition of a Trading Platform for Renewable Gas

The design study and technical specification has been provided with significant input from smart technologies Management- Beratungs- u BeteiligungsgesmbH.

An integrated European energy market must support harmonised, secure, and automated trading including ownership transfer of the renewable value of renewable gas (= certificates). The Trading Platform shall be based on established certificate and registry systems which are responsible for the documentation of the renewable value, particularly the inclusion of attributes defining the renewable gas product. The trading platform allows for ownership transfer, which defines that only existing certificates / GO determined as ex-post trades (for definition see chapter 5.5) can be conducted via the trading platform – in comparison to the Dashboard. Once the business process for the mode of ownership transfer, respectively the source of the seller, is clear the Trading Platform should offer to its users a powerful and future-oriented system to perform transactions in a simple, secure, and trustworthy environment. Buyers should be able to view sell offers, enter buying positions or simply confirm sell offers they want to buy. Needed functional and non-functional requirements must be efficiently designed, implemented, and maintained on different levels, but most importantly on legal, organisational, and technical levels.

The organisational setup of a trading platform includes the founding of a legal entity and the legal definition of participation requirements (registration) and accounting rules. Other legal elements are subject to a more comprehensive analysis for the start-up and operation of a trading platform. Publicly available trading platforms, such as power exchanges for example EPEX (EEX), EXAA, Nordpool, GME, provide detailed registration information for market participants on their websites to become a participant.

The present report primarily discusses the functional and non-functional e.g., quality measures requirements for a trading platform whereby the existence of National Organisations in each European Member State and a Europe-wide harmonised renewable gas documentation alongside all National Organisations is considered as basis. The Trading Platform shall build up its functions on “certificates” of other entities (registries, not created by the Trading Platform). Thus, it requires an interface between the Trading Platform and the National Organisations which is provided by the European Transfer Hub/Platform. The Trading Platform shall be able to support different system setups of European Transfer Platforms / Hubs with subsequent registry connections. This is the most complex setup for the connection of all National Organisations with the Trading Platform but should still be possible if all participating entities agree on the concept from the very beginning and subsequently implement the same requirements (see Figure 7).

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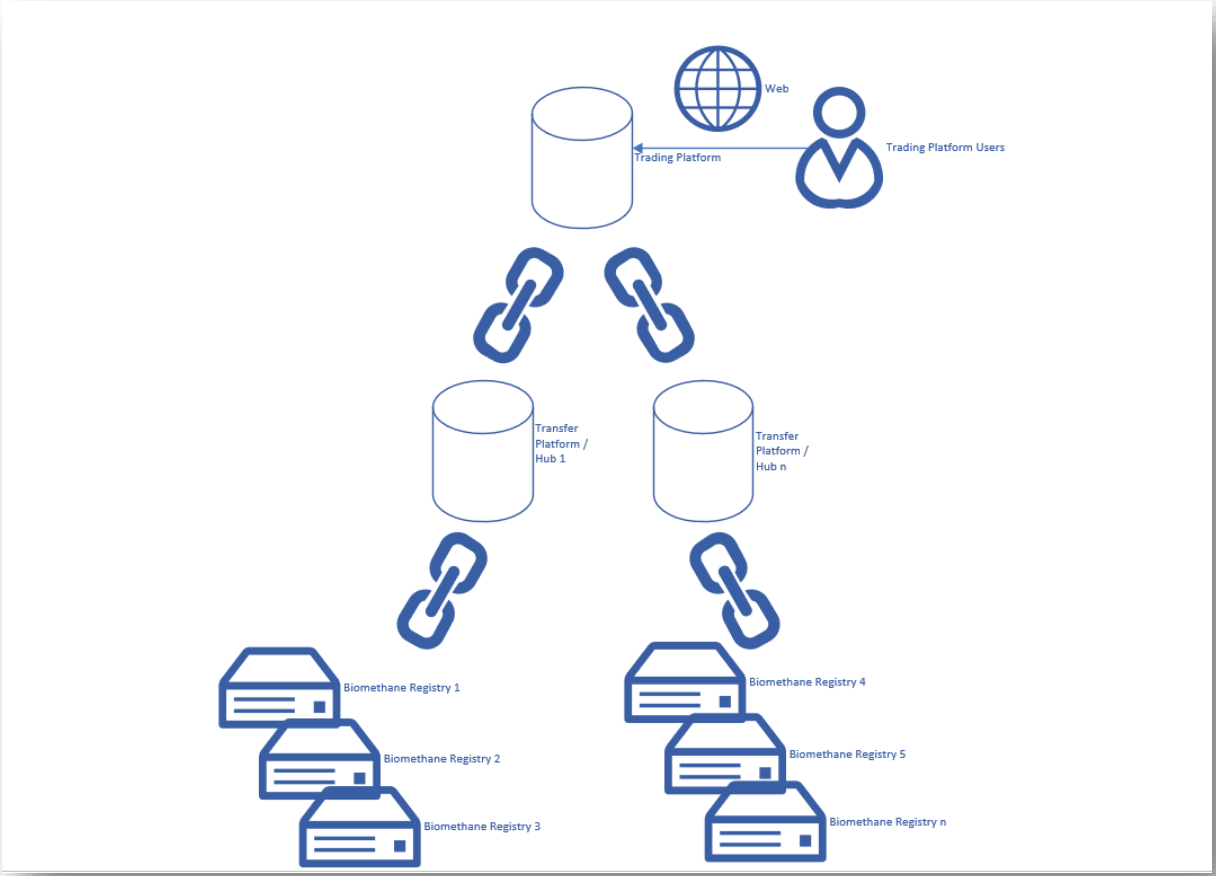

Figure 7: System setup connecting the Trading Platform with one or several European Transfer Platforms/Hubs and furthermore with National Organisations (registries/IB)

Hence, several trading options exist in the electricity market for GO, for which those platforms have special accounts in one of the national Issuing Bodies to document the GO transfer after trading has taken place. As illustrated in Figure 8, the trading facility has its own account in one of the Issuing Bodies. This account is owned by the trading facility and is operated on its behalf. Therefore, all transactions of GO are conducted through this trading facility account, even if the transactions are handled cross-border.

A common transaction of certificates / GO is executed as follows, as depicted in Figure 8: Account 1 from Registry 1 transfers certificates to the account of the trading facility. This transaction may involve a different registry using the European Transfer Hub / Platform as an intermediary to transfer toward the account of the trading facility. The new intermediary owner will be the trading facility. After the completion of the transaction, the trading facility transfers the certificate to the final buyer, which can have its account in the same registry as the trading facility or any other registry connected through the European Transfer Hub/Platform.

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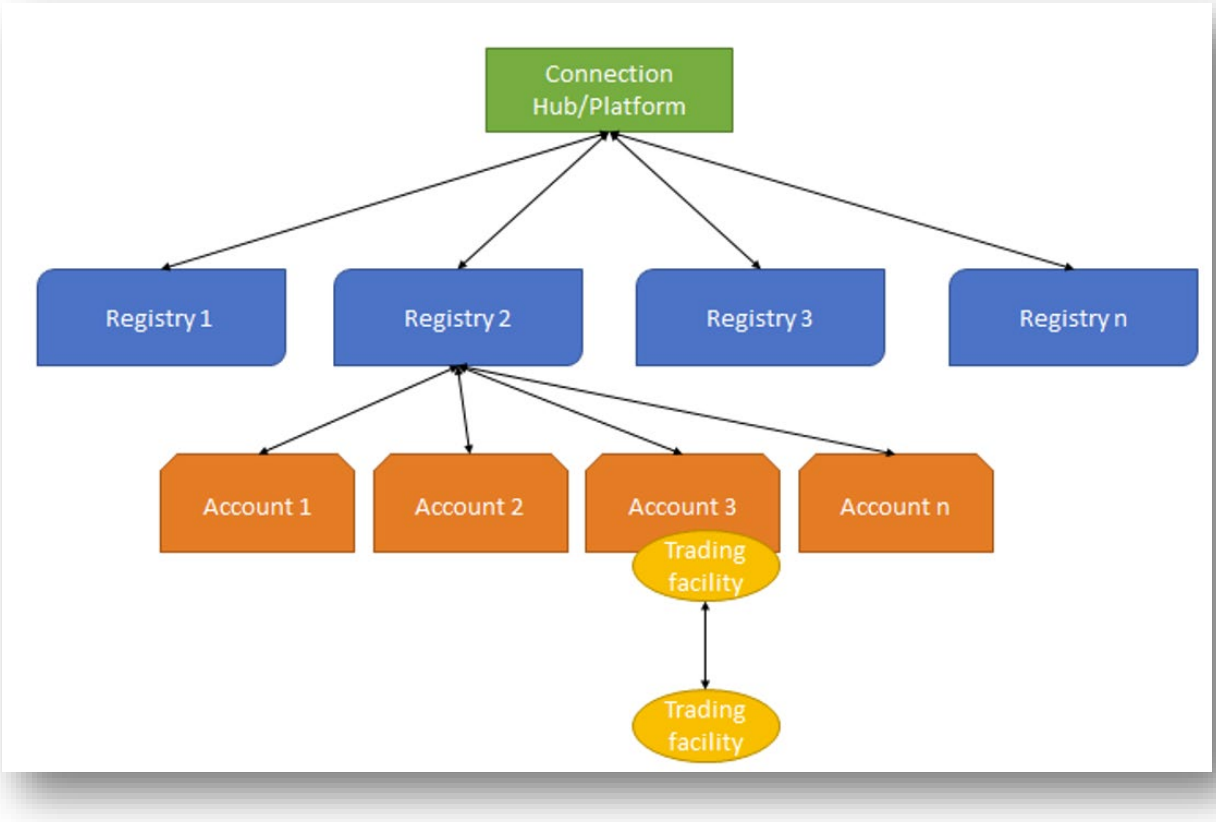

Figure 8: Approach for renewable power GO trading options

4.1.2 Scope of Trading Platform in the REGATRACE framework

According to the REGATRACE Grant Agreement (project plan), the European biomethane/renewable gas Trading Platform should be established as individual IT-system enabling the ownership transfer of certificates (incl. GO) between market participants of National Organisations (renewable gas registries/issuing bodies) via a connection to a European Transfer Platform/Hub via a dedicated interface.

Regarding the Trading Platform, different technical solutions have been analysed and compared. The technical specification and a design study for the hardware and software was mainly performed by smart technologies Management- Beratungs- u BeteiligungsgesmbH, an Austrian IT-company providing services to the energy sector in Austria and in Europe. smart technologies Management-Beratungs- u BeteiligungsgesmbH is involved into the REGATRACE project as subcontractor to the task leader AGCS Gas Clearing and Settlement AG. The present report together with REGATRACE D2.5[12] provides the guidelines to procure the necessary IT-services resulting in a Renewable Gas Trade Centre for Europe (project acronym REGATRACE).

REGATRACE D2.4 [13] has elaborated the different technical solutions for a European Transfer Platform/Hub based on several different aspects such as costs, security, automated procedures,

[12] D2.5 Guidelines for tender process of IT-services: https://www.regatrace.eu/wp-content/uploads/2020/11/REGATRACE-D2.5.pdf
[13] D2.4 Investigative study of IT system options for harmonized European cross border title-transfer of biomethane/renewable gas certificates: https://www.regatrace.eu/wp-content/uploads/2020/10/REGATRACE-D2.4.pdf

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including an analysis of the application of blockchain technology. Considering the example of a fully automated Trading Platform with highly automated interfaces may become overwhelming to a European Transfer Platform/Hub based on a basic documentation scheme such as Microsoft Excel with highly manual interactions. Therefore, the basic design of the Trading Platform majorly needs to be aligned with the European Transfer Platform/Hub to efficiently communicate and process data in an automated and secure manner. The project partners have concluded IT-options 4 Transfer Platform and 5 Transfer Hub to be most suitable for the current market situation where advanced national IT-systems and know-how of Scheme Participants are available in most of the Member States. This report bases its description of technical solutions for a European Trading Platform on the hypothesis of established IT-options 4 *Transfer Platform* and 5 *Transfer Hub*.

4.2 Design Study Purpose and Scope

4.2.1 Introduction

The following chapters contain the design study and technical specification for an IT-solution for a renewable gas Trading Platform and potential connection of the dashboard functionality or total integration.

The experience of the authors and the results of conducted interviews with energy market experts and IT-experts have been incorporated in a neutral manner. The design study was mainly specified by smart technologies Management- Beratungs- u BeteiligungsgesmbH, a software company with more than two decades of experience in energy market related software solutions and their maintenance.

In scope of this design study are functional and non-functional requirements including the interface to the European Transfer Platform / Hub for the required exchange of renewable gas certificates / Guarantees of Origin (GO). The national registries and their established synchronised communication via a European Transfer Platform / Hub are considered prerequisites such as the technical and business relevant exchange of certificates / GO between them.

4.2.2 Definitions

A requirement with “must” is meant critical. The word “shall” denotes a desirable item. “may” is considered optional.

Functional Requirements - Functional Requirements define the functions that a system, product or data set must provide for the customer of the system for example the bid submission via a Graphical User Interface.

Non-functional Requirements - Non-functional Requirements define the functions of a system which are necessary to comply with the requested quality of the system for example the maximum number of system users.

4.2.3 Related documents

The following documents have been used to determine the content and considered as reference for defining the scope of this report:

- EU-funded project BIOSURF Deliverable 3.3[14] “Guidelines for creating the European Biomethane Guarantees of Origin”

[14] BIOSURF D3.3: Guidelines for creating the European Biomethane Guarantees of Origin http://www.biosurf.eu/wordpress/wp-content/uploads/2015/07/BIOSURF-D3.3.pdf

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- EU-funded project BIOSURF Deliverable 3.6[15] "Proposal for the establishment of national and European biomethane certificate trading platforms"
- EU-funded project REGATRACE Deliverable 2.4[16] "Investigative study of IT system options for harmonized European cross border title-transfer of biomethane/renewable gas certificates"
- EU-funded project REGATRACE Deliverable 3.1 [17] "Guidelines for establishing national biomethane registries"

4.3 Concepts

4.3.1 Actors & Stakeholders

Several major stakeholders and actors concerning a renewable gas Trading Platform were identified:

- Trading Operator - control the trading business process
- System Administrator - control the functioning of the trading system
- Computing Centre Operator - provides environment for hosting the trading system
- Trading Party - legal entity, a company, that is responsible for trading and may trade own items – including producers, suppliers, and consumers.
- Trader - a person that acts on behalf of a trading party
- Registry - issue, transfer & maintain certificates and GOs
- Transfer Platform / Hub - serves as an intermediary between registries and the Trading Platform for the purpose of GO transfer processes.
- Banking service provider - financial settlement of trades, collaterals
- Clearing House - financial clearing of trades
- EU Commission - support an efficient and transparent market & set legal constraints

4.3.2 Product Ownership

4.3.2.1 Certificate

The ownership of a certificate is originally maintained by the issuing registry. A valid trade may relocate a certificate between registries and corresponding account holders in registries. A trade operation implies a temporary exclusive transitional period.

There are several possibilities for ownership transfer which are described in chapter 5.9 to achieve mutual exclusion for concurrent certificate operation processes e.g., transfer or cancellation.

smart technologies Management- Beratungs- u BeteiligungsgesmbH recommends implementing the second ownership transfer option described in chapter 5.9 on locking the certificates on registry level, whereby the locking shall be delegated to the European Transfer Platform / Hub for efficiency. Hence, the locking must be forwarded, controlled, and processed by the European Transfer Platform / Hub with its connected national registries / Issuing Bodies consequently as they are the holders of the certificates / GO accounts. This concept provides security for the market through implementation of automatic processes on the transfer platform/ hub and subsequently registry side. Locking during the

[15] BIOSURF D3.6: Proposal for the establishment of national and European biomethane certificate trading platforms http://www.biosurf.eu/wordpress/wp-content/uploads/2015/07/BIOSURF-D3.6.pdf
[16] REGATRACE D2.4: Investigative study of IT system options for harmonized European cross border title-transfer of biomethane/renewable gas certificates https://www.regatrace.eu/wp-content/uploads/2020/10/REGATRACE-D2.4.pdf
17 REGATRACE D3.1: Guidelines for establishing national biomethane registries: https://www.regatrace.eu/wp-content/uploads/2019/11/REGATRACE-D3.1.pdf

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trade transaction and release after trade offers transparent integration of certificates in trading purpose.

4.3.2.2 Other Products

If trading is to be extended to other products (i.e., physical gas, derivatives) which may not be secured by the seller through the product itself, it needs a different approach to determine ownership. In that case smart technologies Management- Beratungs- u BeteiligungsgesmbH recommends applying a mechanism to have trade volumes to be covered by financial collaterals. Compared to the certificate market, the financial security requirements can be neglected where confirmation of the seller can be achieved through certificate validity check prior to trading.

4.3.3 Trading Platform

The main purpose of the renewable gas Trading Platform is to provide a trading environment for its users, e.g., trading parties or economic operators to exchange certificates, including GOs. The main principles of trading are described in chapter 765 and are taken as basis for the subsequent functional and non-functional requirements, whereby the solution is designed and described as openly as possible allowing for different approaches related to trading options and product definition.

4.3.4 Dashboard

A renewable gas Dashboard with required processes have been described in this report, see chapter 3.2. The functional and non-functional requirements defined in the following sub-chapters offer the connection or combination of the Trading Platform with the Dashboard and to the last extent may include both functionalities if requested by the involved stakeholders.

A potential interface of “Dashboard matching” which leads to a trade (ownership transfer) on any platform, may be subject to the concept of a “OTC trade” which is possible to include in the Trading Platform and is addressed in this design study.

4.4 Execution of Trades

Different options to execute trades are described in chapter 5. For definitions on commonly used trading terms (e.g., ex-post, sport, future, etc.), see chapter 5.5.

The trading of commodities and products can be organised differently in the energy and climate markets. This applies also for certificates, e.g., Guarantees of Origin or CO_2-certificates. The content (attributes) of these certificates needs to be standardised. These certificates are documented in respective databases.

Currently, there is no Trading Platform with direct connection to such databases and fully integrated business and settlement processes. Chapter 6 introduces and compares currently available trading platforms. In all described cases, a dedicated Trading Platform account is opened in one of the registry databases. On these accounts all transactions with market participants are conducted and documented typically manually by the operations team. Automated processes for the transactions with registries have not been widely applied yet.

In the currently known trading setups, the certificate transfers are typically ex-post processes. In such situations, the energy amounts have been already produced, certificates have been issued for these energy amounts, and serve as an input for trading. Such a detachment from the physical product is applicable for special trading products, such as Guarantees of Origin.

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This principle is different from other energy trading markets such as physical gas or electricity. The market participants on trading platforms such as power exchanges can conduct trades without prior transfer of goods or products. The "ownership transfer" will be conducted through another mechanism, so called "Schedules" or "Technical Schedules". These Schedules include a delivery or purchase of a commodity (gas or electricity) in the future and are the result of a trade. Hence, the product has not been produced in the moment of trade, but the trade consequently obliges the parties to produce or consume the traded amount at the agreed time. Any deviations from the traded amount are handled through the settling of imbalance energy of each national market. This process compares the Scheduled (forecasted) amount with the physical measurements (meter readings) at the end of the balancing period, which is typically performed on monthly level (or in some cases daily).

Due to the detachment of the renewable value from the physical renewable gas because of the certificate creation process (typically after meter readings have been made available), the execution of a certificate ownership transfer is conducted later than trade of the physical product. In case the transaction would be organised as future product (production of quantity physically and certificate / GO at the point of trading not available yet) and would not be executed correctly, or the seller would not own corresponding certificates, the Trading Platform rules had to include respective measures, how potential disputes would be solved e.g., through other equivalent products, penalties, etc.

The settlement of trades in the certificate market can most likely be conducted using different options of certificate ownership transfer (for description see chapter 5.9) based on interface specifications between National Organisations and a subsequent European Transfer Platform / Hub.

This deliverable bases its further descriptions on ex-post trades of already created and most likely validated certificates, which have already been previously issued by registries. Hence, this principle may lead to the following restrictions during operation:

- No trading of future products as certificates have not been created yet,
- Mandatory fulfilment of trades limits the use to "digital assets" (certificates and certificate attributes without physical fulfilment or at least detached from physical production),
- High burden for ex-post control of physical delivery: when supplying physical gas as a result of certificate trade transaction, the physical transaction would be timely detached from physical injection of the renewable gas product. This fact is based on certificates being created ex-post through verification requirements not allowing to transfer physical gas volumes in the same process as the certificate.
- Energy amounts must be already produced which can hinder price determination and orientation - less price signals when always traded in the past.

4.5 Technical Approach for a Trading Platform

Trading Platforms are typically IT-services which undergo a continuous evolution process. System requirements defined by security, product definition, automation by trading participants or process optimisation within the platform are subject to changes independent whether they are triggered by technology or customers' request. Therefore, the design of a Trading Platform shall cope with such changes. On the other hand, the system shall be scalable to provide high quality services independent of the number of user actions and overall transactions. The quality of the performance highly depends on the hardware concept and software design.

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Different hardware options have been already discussed in deliverable D2.5[18], whereby the hosting partner is of importance. Depending on the infrastructure of the tendering organisation, it may provide its own infrastructure for the IT-services of a trading platform. The present report cannot predict the infrastructure. The authors assume that no infrastructure will be available at the point in time when the IT-services will be tendered. Such a neutral view allows the tendering organisation to procure the hardware independent from the software elements in the future.

Software elements should be designed to be flexible and scalable to cope with future changes. Standard software products may be useful to kick-start the development by providers but may not fit precisely to the requirements of a Trading Platform for renewable gases. The tendering process should provide a balance between very flexible software developed from scratch only for the given IT-service and standard products which may be configured and customised with additional efforts to fulfil the requirements by the tendering organisation. The latter may provide synergies within the provider's organisation leading to a better financial offer.

A modern software architecture must ensure the adaptation of functionalities without changing the overall structure of the IT-service. Therefore, a service-oriented architecture may be used. It shall include a granularity to isolate specific functionalities, meaning the whole system is useable even in situations where specific services are not operated. Functions would be implemented in different and independent services which are communicating equally with each other through standardised interfaces. One example of such a service would be the bidding module of a Trading Platform, which is responsible for the receipt, validation, saving and reporting of bids submitted by market participants and supervised by the trading platform.

Another approach is the use of micro service architecture. This concept includes even higher granularity. The biggest difference to SOA (service-oriented architecture) is the usage of micro services independent of the overall system. Micro services can be exchanged in a production environment without influencing the overall system which provides much higher flexibility and offers higher availability of the overall solutions. For example, the system can continue to calculate reports or invoices and in between the bidding service or bidding services are updated in parallel. Micro services can be developed for single processes, functions, or modules.

If the requirement in the specification included the availability of the overall IT-service even in case single modules are updated or exchanged, it would require a software architecture very close to the micro service architecture.

4.6 Trading Platform using Blockchain Approach

Blockchain technology is a highly secure, interoperable, scalable, and modern technology to offer reliable, verifiable, and secure documentation of data, while potentially reducing the need for an intermediary. Such documentation offers several advantages when performing ownership transfer due to the multiple confirmation principle. Decentralised and blockchain technologies offer a good solution for trading high-volume products in an environment with numerous stakeholders who exchange data. The market of green gas certificates would be suitable to apply blockchain technology according to Energy Web Foundation.

Technically, all participants within a blockchain need to confirm the transactions and store these data within their "system" for security and verification purposes. Such a local system may be called a wallet

[18] D2.5 Guidelines for tender process of IT-services: https://www.regatrace.eu/wp-content/uploads/2020/11/REGATRACE-D2.5.pdf

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or node. This concept ensures that certificates are only traded once, and each transaction is documented in several different wallets which highly supports fraud-resistance. All participating entities can perform a transaction in case the registration requirements may be kept simple. When using such a technology, the most important aspect is how and who is allowed to register certificates in the blockchain and how and who performs the export from the blockchain. This must be very clear already at point in time of designing the blockchain.

In general, open-source blockchain technology can provide a stable, interoperable and credible digital infrastructure for green gas and associated certificates which is supported by similar industrial projects, such as a decentralised exchange for Renewable Energy Certificates (RECs) operated by a US ISO or a Trading Platform for renewable electricity certificates in Turkey: https://fotonplatform.com/. Generators and buyers can register on the platform and engage in trading activities.

As for the trading of renewable gas certificates, a concept based on blockchain technology could be beneficial if the European Transfer Platform / Hub operated also on blockchain technology, as it could be a simple add-on to the ownership transfer between national registries. But as the trading and documentation should be strictly separated to guarantee neutrality and enable the trading part for organisations which have knowledge to do so, this report only considers the blockchain technology strictly for the Trading Platform.

Whereby national registry/IB operators are typically competent in performing documentation and verification of renewable gas, they are usually not experienced in providing trading facilities. Operators of trading facilities are on the other hand highly experienced with organisation of trade, documentation, verification, and settlement. The provision of a Trading Platform based on blockchain technology is not necessarily more efficient than a centralised approach because there is still a need for an intermediary. However, blockchain technology can also be applied on level of National Organisations to document every energy unit (where and how it was produced), when it changes hands, and if it should move cross-border. From a technical perspective there may be pros and cons depending on the registry's organisational and technical setup which need to be considered when tendering a trading platform.

There is a technical potential to use the blockchain technology for a decentralised ownership administration (contractual ownership transfer and maintenance), especially as it offers credible shared digital infrastructure for numerous stakeholders across different countries (who do not have inherent trust with each other) to transact. However, the Trading Platform shall be designed as a central service for the renewable gas market. Data might still be spread over different infrastructure elements for technical purposes. Following aspects shall be considered because they contrast with applying blockchain technology:

- Registries and other market participants are not yet prepared for the implementation and application of this technology.
- The Trading Platform shall serve as a central organisation for specific business processes and thus being more efficient when performed with central services.
- If ownership registration is decentralised on an anonymous service, then it will be difficult to validate the existence, quality, and quantity of certificates.
- Data may be held in different infrastructure leading to higher overall costs of the solution.
- Difficult processes to modify entries within blockchain if an error occurred.

From a technical perspective, the introduction of blockchain technology does not seem recommendable at this time due to limited usage of this technology over the past years particularly in

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energy trading market areas in Europe. Further details on the application of the blockchain technology for the European renewable gas certificates market have been discussed in REGATRACE D2.4[19] (chapter 5.2 Blockchain technology).

4.7 Functional Requirements of a Trading Platform

4.7.1 Background Information on Functional Requirements

4.7.1.1 Introduction

The Trading Platform shall be designed as a software solution that implements trading functionality operated by a licensed party. Trading is executed by representatives of the trading parties, which are stipulated in general terms and conditions and subject to a defined registration process.

4.7.1.2 Trading System Access

A system user representing a person must have a trusted method to access the system in a public internet environment. For system-to-system communication, specific system access must be granted in order to allow for automated authentication and system interaction between system of trading party and trading platform.

4.7.1.2.1 Trading System Account

Each actor in the system must be represented by a trading system account.

A trading system account is a profile of a system user. It keeps basic data of that person and links to the roles and privileges in respect to the system and one or more trading companies. If email communication is used, then an email certificate shall be linked to this account.

An account must be linked to an authentication provider.

An account may have relations to several trading companies but must not have different roles for the same company.

4.7.1.3 System Login

The login to the system must be implemented in a secure manner using two-factor-authentication such as username/password and a second method, e.g., text message token code. The second authentication method may involve utilisation of biometric attributes such as fingerprint or facial recognition known from mobile devices. Upon login, the user may select one of its user roles which are bound to a company account.

The system must provide a secure option to reset the user's password without involving the operator. The system must provide a secure authentication method for system users not representing natural persons such as data users pushing and pulling data to and from the Trading Platform for automated data processing.

4.7.1.4 Currency Units

In general, all trades shall be done in a common currency that shall default to EUR. Currency units must be part of all applicable data entities. If mixed currencies are involved, a mechanism to deal with

[19] D2.4 Investigative study of IT system options for harmonized European cross border title-transfer of biomethane/renewable gas certificates: https://www.regatrace.eu/wp-content/uploads/2020/10/REGATRACE-D2.4.pdf

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exchange rates must be provided. In such a case, user interfaces shall reflect the currency selected by the user.

4.7.1.5 Time Zones

In general, all datetime data items must be represented and executed in respect to a time zone selected by the application administrator. The solution shall support different time zone dependent UI (User Interface) visualisations such as timely related deadlines and selection of reporting periods, selected by the user.

4.7.1.6 Communication Services

The system shall provide one or more communication services. That may be

- Email supporting secure methods (signatures, encryption)
- Web services
- Repository of artefacts for trade party only download
- Repository of artefacts for public download
- Optionally: chat service for Dashboard support

4.7.2 System Administration

4.7.2.1 Definition

The system administrator controls the operation of the IT system. It may be a dedicated entity who is responsible of the operation of the Trading Platform and who may be supervised by the owner of the Trading Platform. The definition of the organisational setup is independent of the content of this paper but in practice influences the share of work and responsibilities.

4.7.2.2 System Operation

4.7.2.2.1 System Run Status

The system must startup and shutdown in regular manner. The system shall be self-aware of its operational status. The system shall allow business user access only if applicable to the operational status.

4.7.2.2.2 Process Control

Each individual service within the Trading Platform shall be controllable

- Start/stop
- Set process resource characteristic online, if applicable
- Update the used implementation version (select from available versions).

4.7.2.2.3 User Controls

The administrator shall be able to

- Monitor historical user actions
- Log out connected users for emergency reasons
- Prohibit individual users or groups of users from logging in

4.7.2.3 Monitoring

The administrator shall be able to monitor

- Overview users' activity (logins, roles) from administrative perspective (security, resource usage)
- Processes (Services) overview: run status, runtime statistics, error conditions

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- Resources Overview: total available, used, warning thresholds, error conditions
- System plausibility
- Security Dashboard.

4.7.2.4 Miscellaneous

4.7.2.4.1 General Job Scheduler

Repetitive standard tasks shall be executable by a general job scheduler, which is configurable to perform actions in a continuous timely manner such as every day at a specific time or each full calendar hour. It shall be configurable by system users and may be started, stopped, or blocked by system users.

4.7.3 Application Administration

The application administrator controls the execution of the business processes.

4.7.3.1 Account management

The application administrator must be able to

- Maintain user accounts (create, (de)activate, (logical) delete)
- Reset passwords respective authorisation methods bindings
- Assign application roles to accounts
- Monitor users access (last login & logout) and activity in business processes
- Log out connected users
- Prohibit individual users or groups of users from logging in.

4.7.3.2 Accreditations

It shall be possible to accredit entities (trade companies, optionally traders) for specific market segments (auction type, product).

4.7.3.3 Messaging

The application administrator must be able to send messages to accounts. The message content shall be ad-hoc or text module assisted. If multi-language support is activated, accounts shall receive messages in their selected default language.

The application administrator shall be able to post messages to a system bulletin board. The message content shall be ad-hoc or text module assisted. If multi language support is activated, accounts shall read messages in their selected default language.

4.7.3.4 Master Data Management

The application administrator must be able to maintain all system or application master data by a System User Interface (UI).

4.7.3.5 Business Process Monitors

Each relevant business process shall be subject to monitoring. That may involve process attributes such as:

- Process health
- Process status (eventual workflow status)
- Statistical data

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4.7.4 Data

4.7.4.1 Data - introduction

The system needs to access at least data on following entities, as described in the following subchapters.

4.7.4.2 System Master Data

4.7.4.2.1 User Role

A user role is a set of system privileges. System privileges are predefined by the system vendor.

4.7.4.2.2 User Account

A user account describes attributes of an individual or virtual user. Data includes particularly:

- Personal attributes
- Authorisation methods
- Contact attributes
- User roles assignment

4.7.4.3 Application Master Data

4.7.4.3.1 Trading Party

A trading party is a legal entity to participate in trades. Data includes particularly:

- General party (company) attributes
- Trading constraints
- Bindings to one or more European transfer platforms / hubs (subsequent Issuing Bodies and national renewable gas registries), including an authorisation method
- Optional: Collaterals
- Optional: banking connection.

4.7.4.3.2 European Transfer Platform / Hub

A European Transfer Platform / Hub is an intermediary between the renewable gas Trading Platform and national registries / Issuing Bodies. Data includes particularly:

- Registry profile of the European transfer platform / hub
- Data exchange connectors configuration
- Data formats used for data transfer purposes.

4.7.4.3.3 Product Data

Products must include attributes determined by standardised certificates (GO) and may be extendible to other products such as:

- Physical energy amounts, and/or,
- Futures.

The attributes for exchange of certificate (GO) are subject to national registries / Issuing Bodies harmonisation processes influenced by the agreement between the connected parties of European Transfer Platform / Hub and other regulatory requirements such as the CEN 16325 standard development.

4.7.4.4 Dynamic System Data

Dynamic System Data with high probability of new data entries respectively of continuous updates may include:

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- System access history log
- Audit trail data
- System performance data.

4.7.4.5 Dynamic Application Data

Dynamic Application Data with high probability of new data entries respectively of continuous updates may include:

- Market instances
- Market log
- Bids (Buy and Sell Offers)
- Trade (results of auction algorithm calculation) & Auction results
- Operation log.

4.7.5 Trading Platform

4.7.5.1 Market Types

The Trading Platform shall support one or more market types such as:

- Bilateral trades (OTC over-the -counter)
- Auction: Bids are collected and matched at a specified time
- Continuous Trading: bids are collected within a period and matched continuously.

4.7.5.2 Trade Algorithm

To implement the selected market types, pluggable implementations for trade algorithms shall be designed. Each algorithm shall provide a description of:

- Minimal and optional bid attributes that can be provisioned by a general bid framework
- Trade result attributes
- Trade constraints
- Trade parameters
- Trade execution data (runtime)

and respective handler methods.

The algorithms shall be workflow based and report on their volatile and persistent states.

4.7.5.3 Bidding

Each registered active trader is eligible to put bids within their implicit (influenced by trading party registration and other requirements such as collaterals deposit) or explicit (globally determined by the general terms and conditions of tradeable products by the trading platform) bids constraints.

Depending on the market and product type, constraints may be:

- Owned trade product amounts (i.e., GOs, as guaranteed by a European Transfer Platform / Hub and subsequent national registry / Issuing Bodies account)
- Total bid value specified in MWh or other energy volume limited by company or trader attributes
- General auction bid constraints such as maximum and minimum price in EUR for a product.

To put a bid the trade party shall be able to choose between:

- Data entry via web Graphical User Interface (GUI)

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- Data entry via Web Service.

For emergency purposes, a so called OBOT (On Behalf of Trader) function may be integrated into the Trading Platform, which allows the System Administrator to enter bids on behalf of a specific trading party. This might be useful in case of connection problems by trading parties. The request for bid change towards the Trading Platform must be recorded properly by the Trading Platform administrator for legal purposes. And technically, the bid submission or change of existing bids should be possible through the web GUI by the System Administrator and properly recorded for the monitoring purposes.

4.7.5.4 Results Communication

Any trade results must be visible for the affected parties via the trade platform GUI (graphical user interface).

The Trading Platform must send a result report to successful trading parties using one of the selected communication channels. For backup, a printed report for ordinary mail dispatch shall be available.

Anonymous trade results for publication purpose such as on websites or trading newspapers must be made available through defined interfaces and formats based on time triggers.

Additional publication tasks may be derived from EU transparency requirements. Those are not analysed within this design study. In case it is required then automatically an interface must be supplied with the relevant data.

4.7.6 Dashboard

4.7.6.1 Definition

From technical perspective a Dashboard accompanies a bilateral trade market to endorse trades. To trade any offers agreed on the Dashboard by market participants acting on the Dashboard, it must support the products bilaterally traded on the Trading Platform. Consequently, the Dashboard may be extended to products of other markets (that lack a Dashboard) or do not (yet) have an organised market. As described in more detail in chapters 2.4 and 3, a Dashboard provides information on buy or sell interest of eligible traders. The following chapters focus on the requirements of a Trading Platform, but do also apply to the Dashboard functions, particularly non-functional requirements and those functional requirements, which may be combined in a future trade centre covering both services, Dashboard and Trade Platform.

4.7.6.2 Offer: Place Buy or Sell Interest

The trader must enter a non-binding offer to sell or buy a product. An offer may contain additional product characteristics or trade constraints. It may be enriched by contact information on affected trader's decision.

An offer may be automatically invalidated (deleted) if there is no reaction until a definable deadline.

4.7.6.3 Offer List

The system must present an overview for registered trading parties / market participants on offers for selected periods and may be further filtered by product characteristics or trade constraints trough simple WEB GUI functions. The offer list must be visible to all eligible traders equally.

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4.7.6.4 Respond to Offer

A trader may respond to an offer by declaring their interest within the Dashboard using communication tools provided by the IT-System or outside of the IT-System using standard communication interfaces such as phone, e-mail, or web-based chat function tools.

4.7.6.5 Optional: Transmit to OTC Trade Module

In an integrated IT-system covering Dashboard and trade functionality (or at least with a direct link between those two systems), the offering and responding parties may transmit the agreed trade data into a bilateral trade session. Within this session the standard procedure as for trade execution within the Trading Platform may be executed.

4.7.6.6 Response List

The response list shows those entries where the affected company is either offering or responding.

4.7.6.7 Online communication

Optionally, an online chat functionality may be provided. This chat text will be exchanged between the offer party and the responding party in a non-transparent manner. Additionally, the message may be automatically translated into another languages.

4.7.7 Clearing with European Transfer Platform / Hub

The clearing is the process to perform the actual ownership transfer based on a trade result. It involves data exchange between the Trading Platform and the European Transfer Platform / Hub (single or multiple ones).

The clearing is workflow-based and must comply with specific requirements dependent on the defined business process and workflow to achieve the ownership transfer of certificates / GOs, at least:

- Logically lock tradeable items (volumes and characteristic of products) of a trade party at the Transfer Platform / Hub and subsequently at the national registries / Issuing Bodies supervised by the Transfer Platform / Hub. The lock info is passed as a secure token towards the different entities.
- Transfer the ownership of a certificate from a trade party to the Trading Platform or directly to the receiving trade party. In case of multiple European Transfer Platforms/Hubs, the trade party not necessarily needs to be the same Transfer Platform / Hub where it originated.
- Logically unlock tradeable items at the Transfer Platform / Hub.

Following constraint applies:

- A locked tradeable item at the Transfer Platform / Hub must not be modified or change ownership except by request of the Trading Platform that requested the lock.

Supporting functions that must be provided by Transfer Platform / Hub and Trading Platform are:

- Register and maintain a trade relation between a trade party and a Transfer Platform / Hub
- Query the Transfer Platform / Hub for existing trade relations
- Check the validity of the tradable items and the locking information.
- Query the Transfer Platform / Hub for tradeable items (volumes and characteristic of products) authorised by a trade relation.

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4.7.8 Settlement

The system may provide an interface to an external settlement system, that accepts data on resulting payments or refunds. In this case, each transfer and its technical / business transfer results must be logged.

Optionally, the workflow of actual ownership transfer may involve successful transfer or booking to a settlement system or successful effective payment.

4.7.9 Risk Management

If products are introduced, that are not guaranteed by a registry or Transfer Platform / Hub, then methods for risk management shall be applied. This may include to register collaterals that backup trade costs. The calculation on risk volume called collaterals may be determined through a specific algorithm leading to required financial volume of trading parties to execute trades.

4.7.10 Reporting

4.7.10.1 Introduction to Reporting Options

Two methods of reports usually are implemented in IT-Systems for trading purposes. There are standard reports which are available through simple and standardised processing. Such reports are typically available on the WEB GUI of the Trading Platform for different user groups.

The second method represents customisable reports which require individual data aggregation in specific formats. Those reports are usually more sophisticated and must be filled with specific reporting parameter determining the extend of the required report.

4.7.10.2 Standard Reports

The system shall provide a standard reporting functionality to export list data items (as visible on GUIs) in a plain text-based format.

4.7.10.3 Customisable reports

There shall be provided a data scheme for Trading Platform related data that is optimised for reporting purposes.

Data from the operational database shall be organised in a separate persisted representation (e.g., dedicated reporting database) that conforms to the required reporting data scheme. An extraction and transformation process shall populate the reporting database in a configured cycle. That data is read only for reporting purposes.

Customisable reporting shall be done in a separate module, that distinguishes between a report data query definitions and report layout definitions. It shall allow online modifications of both definition categories. Report creation is performed then by using the query definition by a report database connector and format it according to the layout definition.

4.8 Non-Functional Requirements

4.8.1 Availability

Definition

Degree to which a system, product or component is operational and accessible to its users when requested to use.

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Relevance

The Trading platform shall be operational 24/7, but for practical reasons there shall be a period during trading times for example from 8:00 – 17:00 CET where there shall be high availability of 99,6% (that comes up to a maximum outage 9 hours in critical period in a year). System maintenance consequently is done in the non-critical periods outside of trading times. The availability 24/7 is therefore meant in a way that the service shall be accessible anytime, but outside trading times a lower availability than a very high availability may be acceptable by the System Administrator. For efficiency purposes a good balance between costs and availability must be defined.

4.8.2 Backup

Definition

A data backup is a complete and consistent snapshot of persisted data at a time.

Relevance

There must be a procedure to create a reliable backup of the system and its data. That method shall not significantly impact on availability. In the case of a severe failure (disaster)not more than 1 hour of data shall be lost.

There must be a procedure to restore a backup into the system. If there are high availability periods during the day, the time to restore shall be less than the duration of the low availability period until the next day. Or else it shall not take longer than 8 hours.

4.8.3 Archiving

Definition

Archiving is understood here as saving and removing consistent parts of data when it is not operationally needed any more.

Relevance

Archiving data helps reducing the load on the operational database and preserve performance.

There shall be a procedure to export static and master data to an external media.

There shall be a procedure to import and merge master data into the system, or a functionally equivalent system (i.e., test system).

There shall be a procedure to export and remove dynamic data of a specified period and save it to an external media.

There shall be a procedure to import archived dynamic data of a period into the system, or a functionally equivalent system (i.e., test system).

4.8.4 Compliance

Definition

In general, **compliance** means conforming to a rule, such as a specification, policy, standard or law.

Relevance

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The system must comply to the European *General Data Protection Regulation*. That applies on data on traders and their activities.

4.8.5 Data Integrity

Definition

Data integrity is the maintenance of, and the assurance of, data accuracy and consistency over its entire life cycle.

Relevance

The system design shall take measures to prevent unintentional changes to information. Important sub-scenarios involve:

- Concurrent modifying access
- References between data items when deleting data.
- Acts of malicious intent.

4.8.6 Deployment

Definition

Software deployment refers to all activities that make a software system available for use.

Relevance

There shall be a (partially automated) process to transfer new or updated versions of separately deployable software modules from the software provider into the running system.

4.8.7 Disaster Recovery

Definition

Disaster Recovery involves a set of policies, tools, and procedures to enable the recovery or continuation of vital technology infrastructure and systems following a natural or human induced disaster. Disaster recovery focuses on the IT or technology systems supporting critical business functions, as opposed to business continuity, that involves keeping all essential aspects of a business functioning despite significant disruptive events. Disaster recovery can therefore be considered a subset of business continuity. Disaster Recovery assumes that the primary site is not recoverable (at least for some time) and represents a process of restoring data and services to a secondary survived site, which is opposite to the process of restoring back to its original place.

Relevance

There shall be a detailed procedure to describe the necessary conditions, actions, and time effort to perform a full disaster recovery on a different location.

4.8.8 Extensibility

Definition

Extensibility is a software engineering and systems design principle that provides for future growth. Extensibility is a measure of the ability to extend a system and the level of effort required to implement the extension. Extensions can be through the addition of new functionality or through modification of existing functionality. The principle provides for enhancements without impairing existing system functions.

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Relevance

There shall be described

- which modules likely shall be added later (i.e., to extends tradeable products or trading algorithms) and,
- where general mechanisms are prepared for not foreseen extensions (i.e., restful web service interfaces).

4.8.9 Internationalisation and Localisation

Definition

In computing, internationalisation, and localisation, often abbreviated i18n and L10n, are means of adapting computer software to different languages, regional peculiarities and technical requirements of a target locale.

Relevance

The system shall provide a default setup of i18n items that applies when the user does not override it.

4.8.9.1 Multi Language Support

The System shall support visualisation of GUI items in selected languages. The user can select a default language and switch between languages.

4.8.9.2 Time Zones

The System shall support visualisation of time zone dependent data according to the preference of the user.

4.8.9.3 Character Sets

Multi-language support imposes availability of character sets, that do not limit correct spelling including special characters.

4.8.9.4 Number Formatting

The system shall support visualisation of number data in country specific number formatting.

4.8.9.5 Date Formatting

The system shall support visualisation of calendar date and time in country specific formatting.

4.8.10 Maintainability

Definition

Maintainability is the ease with which a product can be maintained.

Relevance

It is up to the software provider which measures are applied. The measures shall be described. The use of standard / state of the art methods is recommended. This applies to

- Development environment
- Deployment environment
- Programming languages
- Programming guides.

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4.8.11 Performance

Definition

The performance of a software solution is meant here as a set of measurable criteria to describe runtime aspects of useful work being performed. Under same other condition aspects may be for example:

- Response times or absolute times to complete
- Throughput of some type
- Amount of resource needed to do a task.

This way the performance can be used to:

- Compare a solution relative to other systems or the same system before/after changes
- Describe contractual obligations.

Relevance

All long running processes shall be identified, and a typical runtime measure (duration) provided. That allows comparing runtime configurations and assessing effectiveness of eventual scaling and provided resources.

In processes of direct user interaction to the system a GUI response shall happen within 3 seconds. If synchronous processes take longer to finish, then a life signal shall be shown. If it takes longer than 10 seconds, a progress indicator shall hint the expected end.

The system shall log performance data to a performance log for later analysis.

4.8.12 Scalability

Definition

Scalability is the property of a system to handle a growing amount of work by adding resources to the system.

Relevance

The system provider shall describe if the offered solution provides built-in scaling measures. That may include

- Adding memory or file space in general
- Adding caches (or size)
- Adding processors or processor threads.

4.8.13 Security

Definition

Computer security, cybersecurity, or **information technology security (IT security)** is the protection of computer systems and networks from information disclosure, theft of or damage to their hardware, software, or electronic data as from the disruption or misdirection of the services they provide.

Relevance

Security is a mission critical aspect of a system that deals with sensible data and monetary implications. Details are provided in the following sub chapters.

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4.8.13.1 Vulnerabilities

4.8.13.1.1 Backdoor

Definition

A backdoor in a computer system, a cryptosystem, or an algorithm, is any secret method of bypassing normal authentication or security controls.

Relevance

The software provider must declare and implement in a way that backdoors do not exist.

4.8.13.1.2 Denial-of-service attack

Definition

Denial of service attacks (DoS) are designed to make a machine or network resource unavailable to its intended users.

Relevance

Communication channels shall accept messages from known/authorised senders only. Rejections must be applied at the earliest possible processing stage and omit significant resource footprint.

4.8.13.1.3 Direct-access attacks

Definition

An unauthorised user gaining physical access to a computer is most likely able to directly copy data from it. They may also compromise security by making operating system modifications, installing software worms, keyloggers, covert listening devices or using wireless microphone.

Relevance

The solution shall be hosted in a data centre with elevated access control.

4.8.13.1.4 Eavesdropping

Definition

Eavesdropping is the act of surreptitiously listening to a private computer "conversation" (communication), typically between hosts on a network.

Relevance

All internal and external communication must use encryption methods (SSL).

4.8.13.1.5 Phishing & Social Engineering

Definition

Phishing is the attempt of acquiring sensitive information such as usernames, passwords, and credit card details directly from users by deceiving the users.

Social engineering, in the context of computer security, aims to convince a user to disclose secrets such as passwords, card numbers, etc. or grant physical access by, for example, impersonating a senior executive, bank, a contractor, or a customer.

Relevance

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For authorisation (login) and commercial relevant actions (endorse/confirm trade), always two-factor-authorisation (2FA) shall be applied. Certificates shall be accepted only from registered European Transfer Platforms / Hubs and cannot be created locally (not for test as well).

4.8.13.1.6 Privilege Escalation

Definition

Privilege escalation describes a situation where an attacker with some level of restricted access is able to, without authorisation, elevate their privileges or access level.

Relevance

On operating system level typical activities are regularly scan all components for vulnerabilities and check if the specified permission setup is still in place.

On application level the integrity of the role setup shall be a regular automatic task.

4.8.13.1.7 Reverse Engineering

Definition

Reverse engineering is the process by which a man-made object is deconstructed to reveal its designs, code, architecture, or to extract knowledge from the object.

Relevance

Security must not rely on the (hidden) knowledge of the algorithms.

4.8.13.1.8 Tampering

Definition

Tampering describes a malicious modification or alteration of data.

Relevance

Tampering is a general threat. In web-based applications data tampering can affect cookies, HTML form fields, URL Query strings and HTPP Header. General countermeasures involve:

- Data signing, digital signatures
- Strong authorisation
- Secure communication on all levels, message protocols that provide message integrity
- Firewalls, complex passwords, IP address blocking

4.8.13.1.9 Malware

Definition

Malicious software (malware) installed on a computer can leak personal information, can give control of the system to the attacker, and can delete data permanently.

Relevance

Type and characteristics of malware is constantly changing and beyond description within this report. smart technologies Management- Beratungs- u BeteiligungsgesmbH recommends outsourcing the operation and maintenance of the needed IT services to a certified professional company.

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4.8.13.2 Security Principles

4.8.13.2.1 Security by Design

Definition

Security by design, means that the software has been designed from the ground up to be secure. In this case, security is considered as a main feature, although listed here as non-functional requirement.

Relevance

Consequently, vulnerability patterns need to be counteracted from the start instead of searching and fixing leaks afterwards.

4.8.13.3 Least Privilege

Definition

The principle of least privilege implies to permit any actor or software function only the bare minimum of privileges that are needed to perform a function.

Relevance

Privileges shall be fine grained enough to guard a specific context. User roles shall clearly cover only a limited set of functions.

4.8.13.3.1 Secure Defaulting

Definition

Defaulting is applied when an explicit permission is missing.

Relevance

On any access, unless a security subject is given explicit access to an object, such access shall be denied.

4.8.13.3.2 Open Design

Relevance

Security shall not rely on the secrecy of the respective design.

4.8.13.3.3 Complete Mediation

Relevance

Every access to every object must be checked for authority.

4.8.13.3.4 Security Measures

A state of computer “security” is the conceptual ideal, attained by the use of the three processes: threat prevention, detection, and response. These processes are based on various policies and system components.

4.8.13.3.5 Prevention

Authentication: security objects need to provide enough information to prove their identity. The use of two independent factors for registration shall be mandated. Where passwords are used, the system must provide a functionality to configure password complexity and password aging policy.

Authorisation: the access rights of security subjects to objects must be specified.

Privilege: specific access right must be defined; they shall not be exposed to others than the system administrator.

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Roles: A set of privileges to perform related parts of business process shall be defined. Those are used for authorisation on application level.

Information minimality: Error messages to the application users shall contain only minimum information that help users independently or together with application support personnel resolve the issue.

4.8.13.3.6 Detection

System Log: that log shall record activities on system level. The verbosity shall be changeable online.

Operation Log: that log shall record activity on application level. The detail level shall be changeable online.

Audit trail: that shall record any security relevant access or activity. The detail level shall be changeable online.

Event forwarding: system shall forward log messages that match a specific pattern to a security responsible person or monitoring system.

4.8.13.3.7 Response

There shall be mechanisms to

- Automatic lock of accounts after several failed login attempts
- Exclude users online from further operations (forced log off)
- Shut down or pause individual services or the complete application.

4.8.14 Testability

Definition

Software testability is the degree to which a software artifact (i.e., a software system, software module, requirements- or design document) supports testing in each test context.

Relevance

It is left to the software provider to manage testability on unit and module level. For the system operator it is relevant to be able to test the application on system level before putting to production.

The system shall support:

- Exporting selected operational data and all master data to a test system (see also archiving)
- Simulating external systems (i.e., a European Transfer Platform / Hub response)
- Simulating environment (i.e., current time).

4.8.15 Usability

Definition

Usability is the degree to which a software can be used by specified consumers to achieve quantified objectives with effectiveness, efficiency, and satisfaction in a quantified context of use.

Relevance

The software provider shall provide guidelines (under a non-disclosure agreement):

- UI Style Guide

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- UI Behaviour Guide

to determine the user experience for the system users when using the Graphical User Interface of the trading platform.

4.9 Design Considerations

4.9.1 Introduction on Design Considerations

Regarding the renewable gas trading platform, different technical requirements have been discussed in the previous chapters.

The renewable gas Trading Platform requires a standardised and secure interface to the European Transfer Platform / Hub. The chapter 5.9 considers different transfer options of certificates and chapter 4.14 addresses on the specifications of interfaces to interconnect other systems.

4.9.2 Certificate Treatment on Transfer Platform / Hub in Transactions

For the purpose of trade, several options are possible:

- Transfer the certificate /all certificates of a party completely to the trade platform before a trade starts
- Lock the certificate via the Transfer Platform / Hub when actual bidding is intended
- Ex-post transfer of the certificates without direct involvement of the trading platform.

The variant to lock certificates has preference, because it allows Transfer Platform / Hub (single or multiple) to be the coordinator and involve certificates in other processes independent of the trading platform.

4.9.3 Alternative Trade Algorithms

Although the trade platform is focusing on certificates / GO in the first place it can be a framework to integrate other products which require different trade algorithms dependent on the defined products and its constraints.

4.10 Module User Stories

4.10.1 Definition of Module User Stories

A user story is a rather informal, high-level description of a system feature from end user perspective. As part of this design study, it shall highlight what can be expected as main system behavior.

4.10.2 Core

4.10.2.1 System Access - Login to System

As a trader in the beginning, I want to get access to the system. Using the GUI, I provide my security credentials and take a role in the system.

4.10.2.2 Own Data Inspection

As a trader, I want to see my own master data and trade activity.

4.11 System Administration

4.11.1 System and Service Control

As a system administrator, I want to:

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- See and control the status of the system, perform runup and shutdown. Available and used resources are displayed and notifications on critical limits are received.
- See and control the status and performance of each service, eventually change its configuration, resources, or software implementation.

4.11.2 Security Monitoring

As a system administrator, I want to

- See, who is logged-in, and inspect activity.
- Execute various check to ensure integrity of the system.

4.11.3 Trading Platform

4.11.3.1 General

4.11.3.1.1 Trade Preparation

As trader, I can see:

- My tradable products, based on valid linked certificate / GO account provided through a Transfer Platform / Hub and its connected national registries / Issuing Bodies.
- Open market segments, including characteristics and constraints of i.e., auctions
- Trade interest on Dashboards.

Based on the available information and own trading goals, I decide my trade strategy and bid actions offline.

4.11.4 Trading

As trader, I can enter, change, verify and delete bids for my registered products during trading times, see submitted bids by other system users of the same trading account and receive information on historical bid submissions.

4.11.4.1 Awarding

As trader, I receive a notification on the bid result.

4.11.4.2 Clearing

As trader, I receive a notification when the trade has been cleared and the ownership transfer has been performed.

4.11.4.3 OTC

4.11.4.3.1 OTC Monitoring

As operator, I monitor market participant activity and take care that no outdated trading requests remain active in the system.

4.11.4.3.2 Bidding OTC

As trader I can use the Dashboard optionally to find a trade partner. Once I know a potential trade partner, I can put an OTC bid to the platform.

Subsequently, I can see

- The status of the OTC function
- Other valid bids of registered OTC users
- All my active bids and their eventual status

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- All historic own bids.

4.11.4.4 Auction

4.11.4.4.1 Auction Setup

As operator, I create auctions for specific periods, in compliance to a market Schedule.

4.11.4.4.2 Auction Control

As operator, I can monitor the process behavior of auctions. Processing of the workflow is done automatically by business triggers or Schedules. I can manually intervene to achieve the goals of each processing step.

4.11.4.5 Bidding on Auction

As trader, I can put an auction bid to the trade platform. After a bid is submitted, I receive a system acknowledgement.

Subsequently, I can see:

- The status of the auction
- All my active bids and their eventual status
- All historic own bids.

4.11.5 Dashboard

4.11.5.1 Offers

As trader, I can see Dashboard entries from other trader, those can be responded to get in contact or initiate a trade through an optional interface to the Trading Platform (OTC function).

As trader, I can put an offer to the Dashboard, to get a trade partner.

Subsequently, I can see:

- All my active offers or responses and their eventual status
- All valid offers by registered Dashboard participants
- All historic own offers.

4.11.5.2 Get in Contact

As trader, I can enter a chat-based communication subsystem within the Dashboard to exchange further information required to finally come to a deal via the OTC trade function.

Optionally, as trader, I can declare preferred languages for the chat/talks.

Optionally, such chat offers possibility to automatically translate text between languages (compare: Google translate), if set then to the preferred language.

As trader, I can submit a reference to other communication means (i.e., a telephone number, email address).

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4.12 Proposed System Design

4.12.1 System architecture

4.12.1.1 Web Tier

Web front end service(es) connect to the internet and care for respective routing, load balancing, external security measures. It must be protected by firewalls (Demilitarised Zone).

4.12.1.2 Application Tier

The application consists of several services that interact on module level to perform the business processes.

4.12.1.3 Service Tier

Each service may implement a set of related / interacting functions. They may be further decomposed to elementary independent process parts. Software libraries may provide standard functions.

4.12.1.4 Database Tier

Database Service(s) provide data persistency only. No business logic must be executed inside the database. Data is accessed by the services. If possible, database objects shall not be shared between services to reduce eventual access contention.

4.12.1.5 Interfaces

An interface connects to external system processes, complying to the respective protocols. They may be implemented as services. It is recommended to use existing interfaces and protocols on the European Energy Market such as standards in the electricity market (ENTSOE library) and gas market (EDIGAS).

4.12.2 Modules

As a recommendation functional module separation may be done at least for:

- Trade Platform Core
- Dashboard (whether integrated into the Trading Platform or Interface to external Dashboard)
- Bid Management
- Auction execution (Workflow)
- Auction algorithm (Awarding, Pricing, Ordering)
- Results management
- Document server (formats parsing & writing)
- Risk Management/Monitoring (optional)
- Settlement
- Reporting

4.12.3 Integrations

Depending on the actual scope several integrations/Interface will be necessary:

- Mail System
- Interfaces:
  - Transfer Hub
  - Web service connector (optional) bids, results
  - Reports database export

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- Optional: Dashboard
- Optional: Publication Platforms such as REMIT [20] (The Regulation on Wholesale Energy Market Integrity and Transparency)

4.13 Implementation Recommendations

4.13.1 Application Hosting

The trade platform needs a physical or virtual execution environment for its services. Different alternatives are described in the following.

The technical specification and design for the hardware and software of the Trading Platform has to be determined within the project based on a concrete requirement specification and the performance requirements.

Following options are available and described:

On site own Hardware:

There are multiple challenges on continuous operation, security, maintenance, and costs. It is not recommended to perform this on own site, because that is not the typical core competence of a trade platform organisation.

Dedicated hardware in computing center:

Dedicated hardware imposes maintenance and availability challenges. It is not recommended.

Virtual hardware in computing center:

This is a feasible setup. All hosts need to be operated in clusters for failover.

Cloud based service provision:

Depending on the concrete software architecture of the software provider, that can be a feasible setup. It must be distinguished between public and private cloud approaches. For public cloud services the same considerations as for the private cloud should apply such as data protection regulation and scalability whereby the public cloud service may have restricted influence of fulfillment of individual requirements not within the standard scope of public cloud services (for example Amazon Web Service “AWS” or Microsoft Azure cloud computing platform).

4.13.2 Standard Software

It is recommended to use latest Long-Term-Support release of well-known frameworks and programming languages to get vendor support and available skilled developers. For those tools there shall be a long-term development and support plan.

The provider must declare:

- the major frameworks for user interface development
- programming languages for backend operations
- Supported Operating system environments
- Supported providers of data persistence services (database).

[20] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32011R1227

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4.13.3 Service Environment

For some general IT-Services a shared service infrastructure may be used:

- Depending on the host Operating System: domain server (Active Directory, Windows)
- Domain name service (DNS): at least caching of DNS entries
- Mail Server (in, out), provide mailbox and basic mail security measures
- File Transfer Protocol (FTP, SFTP, FTPS) Server
- Reporting Service (3rd party report creation system, accessing the reporting database scheme)

4.14 Interface Specification

4.14.1 Introduction and general Interface Requirements

The Trading Platform will require a standardised and secure interface to the national registries (supported by the European Transfer Platform/Hub) which will enable the transfer of certificates either prior to trading or after the final settlement. There may also be additional information, such as master data for verification of trading entities, accounts, or certificates that will be transferred via such an interface.

Information and experiences of developing and using these types of interfaces have been collected from a broad range of experts and organisations including AIB, who has extensive experience in connecting national Issuing Bodies via a standardised interface for the purpose of GO transfer, and ERGaR, who has know-how on the implementation of a standardised interfaces for certificate transfers between national biomethane registries via ERGaR's ExtraVert Platform. Outside the REGATRACE consortium, insights were gathered from third party technical and gas experts, for example those involved with the Edig@s format used for data exchange within the European gas market. The information collected from these stakeholders has been incorporated in a neutral manner.

The transfer interface of the Trading Platform may have a range of functionalities, but its primary goal is the settlement of certificate trades conducted ex-post, i.e., certificate already issued. All described options of ownership transfer are subject to certificates already created (ex-post). In case the tradeable product shall be a future product, for energy amounts not yet produced, only a subset of the options can be used, or additional options may be introduced. Those options for future product trading may relate to physical gas trade execution, which is more suitable and logical for future products compared to ex-post certificate trades, where physical volumes have been already produced and injected into the natural gas grid. Chapter 5.9 describes the different options for ensuring that the traded certificates are available and have been restricted from other transfers or cancellation while the trading process takes place (these are set out again the follow section 4.14.2. The focus on ex-post trading must be explicit during the development of the interface and the collaboration of the national registries, the European Transfer Platform / Hub and developers of the Trading Platform.

As far as possible the interface should operate using automated procedures which will enable highest number of transactions with the least resources. Such an automated interface must be defined on three levels, which are further detailed in the following subchapters:

1) business process level (see chapter 4.14.2)
2) technical exchange level (e-mail, FTP, web-service etc.) (see chapter 4.14.3)
3) content level (file or database format) (see chapter 4.14.4)

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4.14.2 Business process level

Business processes provide definitions to all stakeholders to create a common understanding of how the operation of the interface and the roles of each acting party.

The interaction of these stakeholders is essential to the proper functioning of the Transfer Platform and processes must be agreed between the national registries, the European Transfer Platform / Hub, and the Trading Platform.

It is envisaged that the Trading Platform interface with national registries is channelled through a European and therefore business processes between the national registries and the Transfer Platform / Hub must be consistent with the processes developed by the Trading Platform. Still, this chapter is primarily based on the Trading Platform being connected to all national registries via one dedicated interface, which can be used by one or multiple Transfer Platforms / Hubs.

The most important business process is the exchange of certificates for the purpose of trading. Different options are possible as described in chapter 5.9:

1) Trading Platform has dedicated account in each registry and certificates must be transferred to these accounts prior to trading.
2) Trading Platform blocks certificates on the registry accounts through a defined mechanism.
3) Trading Platform requests national registries if accomplished trades are executable (are certificates available for transfer).
4) Selling parties must arrange the certificate transfer themselves, using a specific Trading Platform account and the Trading Platform must transfer the received certificates from the selling party to the account of the buyer.
5) Selling parties must arrange the certificate transfer themselves after the trade execution under the monitoring supervision of the Trading Platform.

For the Trading Platform, the connection via a single interface is more favourable, e.g., via a central interface compared to a connection to each registry individually. In the first scenario, the national registry systems are connected to the European Transfer Platform / Hub which acts as central system - a central transfer facility - providing one single interface to the Trading Platform. The processes might seem more complex because of a third entity involved in the transfer (Transfer Platform/Hub). However, it is simpler for the Trading Platform because it communicates only with one entity whereby the Trading Platform must provide an interface for each national registry system individually in the second scenario. From technical point of view, this option may be more sophisticated for the Transfer Platform/Hub because it needs to connect all national registry systems. In current practice, the basic certificate transfer process is an essential result of the connection between the national registries using the Transfer Platform / Hub. Therefore, adding of processes to connect with a Trading Platform can be interpreted as an add-on with limited efforts. Summarised, from the view of the trading platform the communication via a single interface is preferred in order to handle all transactions and queries with one entity instead of multiple national registry systems. Figure 9 illustrates provides an example on the required business processes for such kind of certificate transfer.

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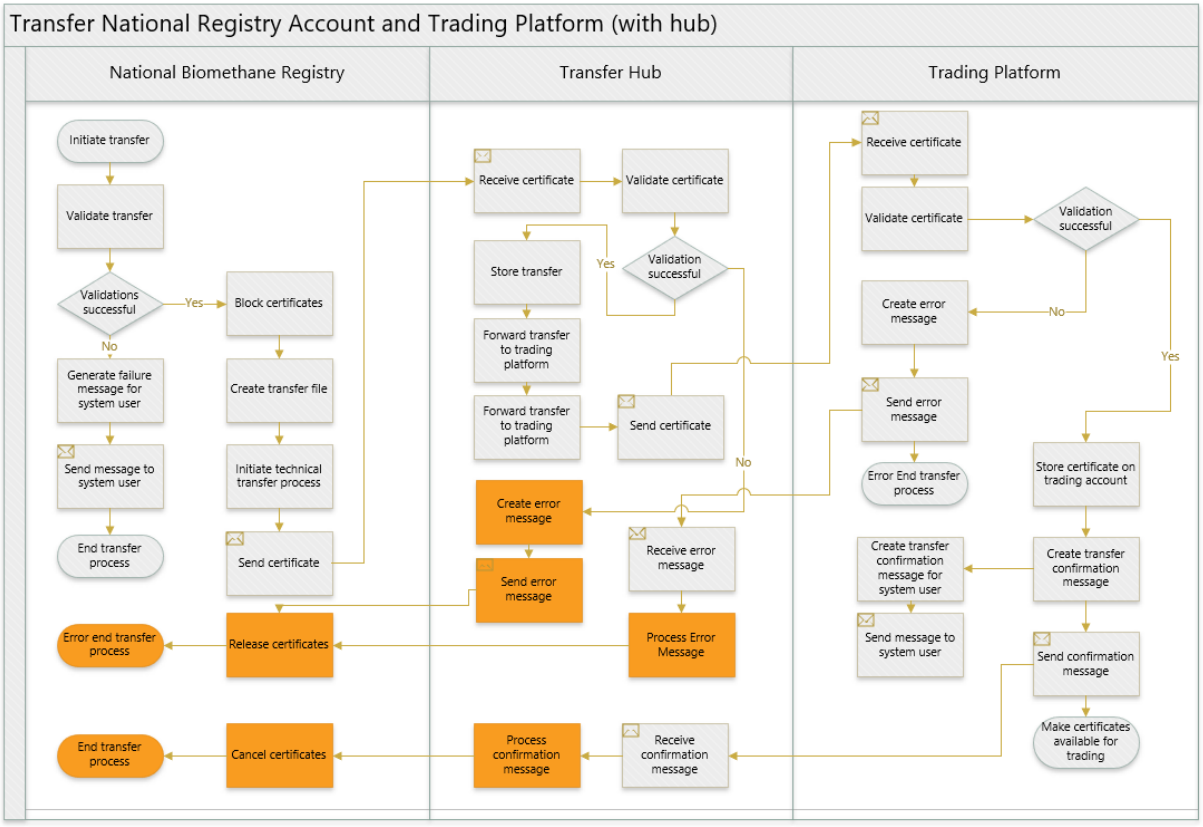

Figure 9: Single interface between Trading Platform and European Transfer Platform / Hub as central transfer facility

The example of a transfer process based on typical operations of the Tranfer Platform / Hub operating in this sector shown in Figure 9 shows the importance of harmonised business processes and their definition, when establishing a Trading Platform for the European renewable gas market.

4.14.3 Technical exchange level

Although there are many different options for data transfers and communication between IT-systems, an important precondition is to implement a highly secure and automated solution.

As mentioned above, it is envisaged that the Transfer Platform / Hub will be as automated as possible and based on existing communication technologies the following options may be considered:

- E-mail (with or without signing and encrypting methods)
- FTP / SFTP /FTPS
- Web-service
  - ♦ SOAP (Simple Object Access Protocol)
  - ♦ REST (Representational State Transfer)
  - ♦ AS4 (Applicability Statement 4)
- File-share
  - ♦ file server
  - ♦ public cloud
  - ♦ private cloud

From the above-mentioned options those that use a web service (e.g., SOAP, REST, AS4) machine-to-machine communication are considered state of the art. AS4 web service protocol is used widely by

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the Gas Market TSOs and other market actors such as capacity platforms. The final agreed method will depend on negotiations between the stakeholders.

Regardless of the choice made, the system should incorporate the potential for manual operation of exchanges so that testing, back-ups, and emergency procedures can be carried out when the automated processes are not available.

4.14.4 Content and Data level

4.14.4.1 Relevant data to specify the interface

Independent of the interface setup, the included content and data must be properly defined with structured information. Thus, it is described in accordance with the data structure and data flow described in chapter 2.6. The chapter will provide information from data structure level down to the smallest element definition must be very detailed and even comprise details on the lowest level including header information, content structure, attributes, validations, and limitations.

Registries must be able to provide all the necessary information to enable trade and ownership transfer. The contents and their formats/specifications must be harmonised at all national registry systems to allow the use of a single Transfer Platform / Hub and consequently the Trading Platform. It shall not be the task of the Trading Platform to change, adapt or generate certificates. The content definition is one of the most important requirements to provide a liquid market where products can be traded in a transparent and synchronised way. Only if an acquired certificate can be read, processed, and used in the same way by seller and buyer, it will lead to transactions of various certificates of different countries.

Other contents which may be exchanged between the national registries and the Trading Platform comprise master data, which are required to map trading market participants and companies registered at national registries.

Technically the harmonisation is supported by a data definition which has to be done in accordance with the national registries and their available certificate attributes. This pre-requisite is the sole task of national registry systems in order to facilitate trade on a central Trading Platform. Typically, a set of fields is defined which can either be mandatory, conditionally mandatory, or optional.

- Ad) mandatory: this field must not be empty.
- Ad) conditionally mandatory: In case a prior field is filled with a specific content, another field must be filled with data as well. For example, if a renewable gas certificate is audited by a voluntary scheme, any fields related to information on sustainability criteria must be filled as well. This may be irrelevant for audits which are conducted by national auditors not leaving information on sustainability.
- Ad) optional: This field may be kept empty as it provides only optional information for example contact data of the transfer entity.

It is recommended that optional fields are avoided as they increase the potential for problems (unclarity, inconsistency) in data processing. If a field is not relevant for the actual process, it may be deleted from the set of harmonised attributes. Particularly during the starting phase, the harmonisation of attributes might not be as advanced and individual registries might request specific optional fields, e.g., to fulfil national market requirements.

The content should be exchanged using standardised and actual data streams. This could be either realised via data streams such as .JSON or specific files such as Microsoft CSV or .XML format. The latter

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is practically in use for several European energy market communication within Transmission System Operators, Distribution System Operators, Power Exchanges, and other market institutions. For this reason, the given interface description builds up on the .XML format.

For the communication between the Trading Platform and the European Transfer Platform / Hub (and subsequently between the national registries and the European Transfer Platform / Hub), this file format should be introduced. The specific business processes require such a .XML format for each communication which must be subject to a technical specification. Several .XML files with different content might be exchanged, but most important is the standardisation of the content for each of the files.

For better understanding, an example for the exchange of such an .XML file is illustrated in Figure 10. In this example, called the "Transfer_MarketDocument", it would be envisaged to exchange certificate information between the European Transfer Platform / Hub and the Trading Platform. The content of the .XML file shall contain all relevant information to process the file automatically and conduct corresponding business processes.

TradingPlatformXML.xml

```
<?xml version="1.0" encoding="utf-8"?>
<Transfer_MarketDocument xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance">
    <FileID>TradingPlatformTransfer-20-10-01</mRID>
    <revisionNumber>1</revisionNumber>
    <type>TransferFile</type>
    <process.processType>SendCertificate</process.processType>
    <process.classificationType>S1</process.classificationType>
    <sender_MarketParticipantID
          codingScheme="A01">REGISTRY1</sender_MarketParticipant.mRID>
    <sender_MarketParticipant.marketRole.type>REGISTRX</sender_MarketParticipant.marketRole.type>
    <Transfer_MarketParticipantID
          codingScheme="A01">TRANSFERPLATFORM1</Transfer_MarketParticipant.mRID>
    <Transfer_MarketParticipant.marketRole.type>TRANSFERPLATFORM</Transfer_MarketParticipant.marketRole.type>
    <receiver_MarketParticipant.ID
          codingScheme="A01">TRADINGPLATFORMID</receiver_MarketParticipant.mRID>
    <receiver_MarketParticipant.marketRole.type>TradingPlatform</receiver_MarketParticipant.marketRole.type>
    <createdDateTime>2020-09-29T21:00:00Z</createdDateTime>
    <CerificateID>
        <FROMCertificateID>ID-COUNTRY-REGISTRY-YEAR-Code</start>
        <TOCertificateID>ID-COUNTRY-REGISTRY-YEAR-Code</end>
    <CertificateInformation>
        <Owner>TradingEntity1</Owner>
        <Volume>11</Volume>
        <CertificateAttribute1>XXXXX</CertificateAttribute1>
        <CertificateAttribute2>XXXX</CertificateAttribute2>
        <CertificateAttribute3>XXX</CertificateAttribute3>
        <CertificateAttributen>XX</CertificateAttributen>
    </CerificateInformation>
</Transfer_MarketDocument>
```

Figure 10: Example .XML file called "Transfer_MarketDocument"

The above example on the exchange includes general information on the communication, entities involved in the transfer and certificate information in form of attributes as listed below. A detailed description and explanation of certificate attributes is provided in REGATRACE D2.1 and D2.2.

- File ID: unique identification of the file – naming convention to be agreed between all parties
- Revision Number: version of the document – in case of update of file, the version number must be increased
- Type: content type of the .XML file which varies depending on the business process
- Process Type: Process for which the .XML file shall be used. One type of .XML file can be used for multiple process types.
- Process Classification Type: short name of the process type
- Sender Market Participant ID: unique identification of the actual sender – in this example the national registry

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- Transfer Market Participant ID: unique identification of the actual transferring party – in this example the European Transfer Platform / Hub
- Receiver Market Participant ID: unique identification of the actual receiver – in this example the trading platform
- Created Date Time: time the file has been created
- Certificate ID: Unique identification of the certificate most probably defined by the national registries – for GoO relevant certificates a FROM and TO attribute must be provided
- Certificate Information: detailed information on the attributes of the certificate. It must be defined based on the tradable products and the business processes particularly for the exchange of certificates. The number of certificate attributes can be numerous and therefore must be chosen wisely and future-oriented (which attributes are of importance for the certificate transfer).

This principle of file definition must be executed for all communication files which are necessary to conduct the agreed business processes. They must be implemented by all entities and tested during the integration phase of the Trading Platform to secure a stable and automated communication. Only by having a clear "language" which determines the content of each attribute, problems or errors during the connection can be minimised. By defining the detailed conditions and validations of each attribute, any unexpected behaviour of IT-Systems involved in the communication can be avoided from the beginning.

Apart from the certificate transfer message, standard messages for the confirmation and rejection of messages shall be introduced. There may be numerous messages with different defined codes, such as for errors based on executed validations. One example would be the definition of a validation "Does the file have an .xml ending?". In case it is not an .XML file, the error message is defined using a reason code such as "A02" which states for the reason text "File format not supported." The reason code not necessarily needs to be transferred, because it is globally defined that the reason code stands for the error message. Other warnings or errors during file processing can be for example:

- Error in file format
- Error during encryption
- Error due to data format (mentioning the corresponding line of error e.g., wrong date format)
- Missing entity
- Not valid entity
- Transfer ID already used
- Certificate data invalid e.g., wrong substrate type
- General error for not defined error messages

Information on such errors will be transferred in separate messages between the involved entities. It is recommended to use already defined file formats in the gas or trading market, such as Edig@s, which is similar to European electricity transmission system operators (ENTSO-E) documentation particularly for exchange of data between market participants and electricity Transmission System Operators.

EASEE-gas/Edig@s workgroup has initiated the standardisation of data exchange processes in the European gas market. For this purpose, Edig@s has been developed and is freely available in the public web. The Edig@s specifications make use of internationally recognised information interchange standards such as UN/EDIFACT. Depending on the area of business, the standard provides very detailed business processes and data exchange formats including a standardised communication method using AS4 format.

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The “European Association for the Streamlining of Energy Exchange - gas” has defined a role model based on requirements drawn from European legislation and required business processes. Different stakeholders such as ENTSOG and other market actors have developed these definitions in a continuous manner. By having a harmonised role description, clear notations of communication interactions between the involved parties within the business process are transparently available. The role model defines the actors involved in each process and describes at each process step their potential actions, other involved parties, and technical communication requirements.

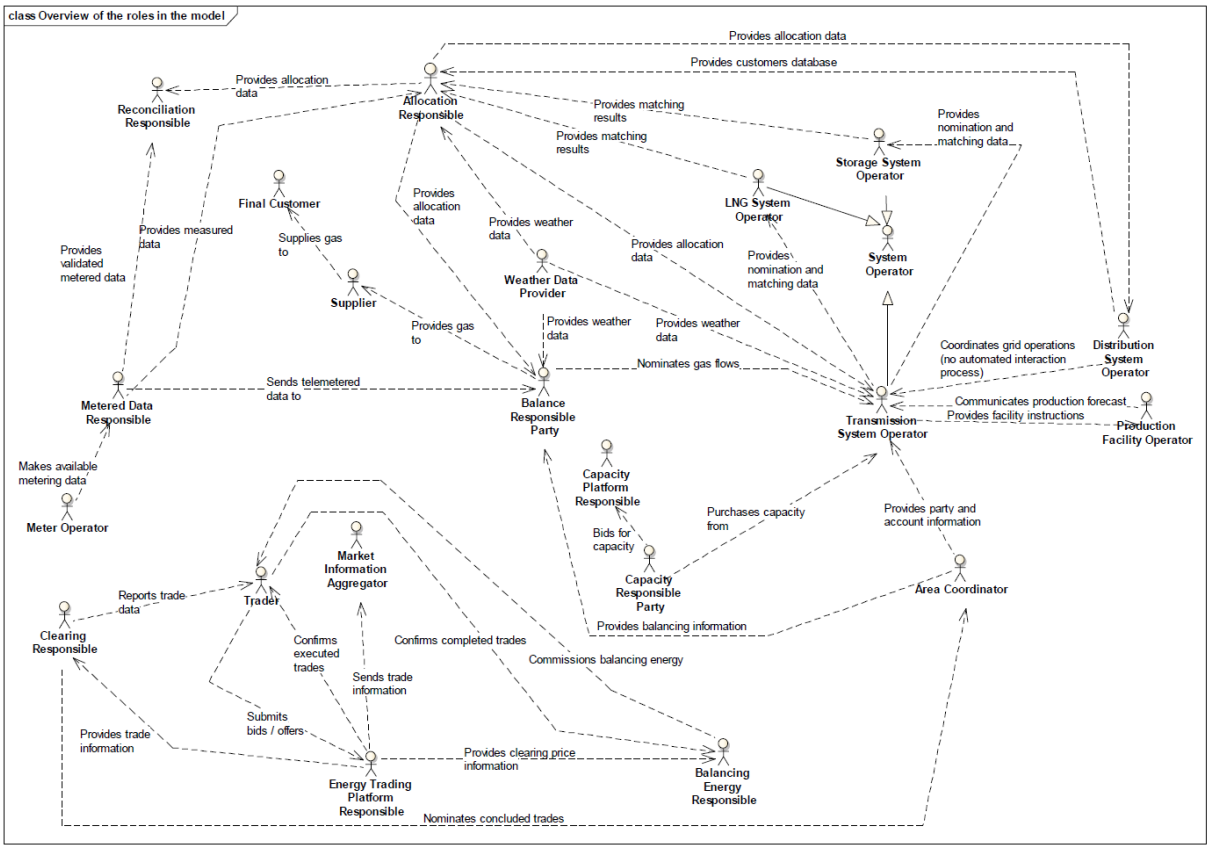

Figure 11: European Gas Market Role Model

Based on the gas market processes, different roles are involved in the data exchange. Each process defines the potential exchanges between the parties. This information is available in a dedicated business process description supported by Figure 12 on the example of the Edig@s “Exchange Gas Trading Process”.

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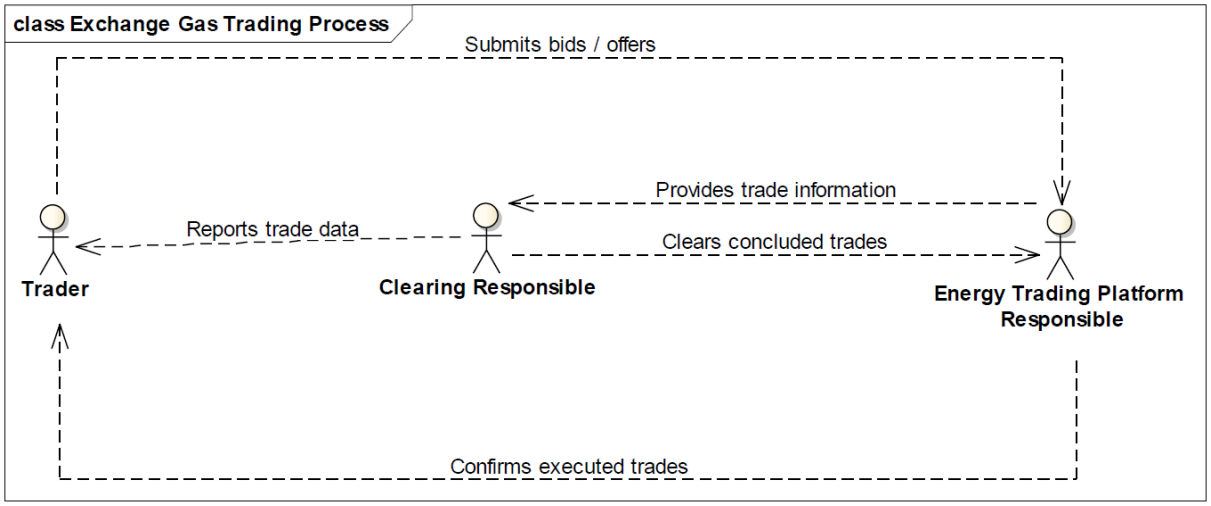

Figure 12: EDIGAS Gas Trading Process

4.14.4.2 Communication Method AS4

Applicability Statement 4, shortly „AS4“, is a business-to-business interface to exchange data. The content for the exchange can be freely chosen. The European gas market TSOs and other entities selected this secure, robust, and continuously updated standard for data exchange between the stakeholders. By using web service technology, the exchange protocol provides for automated processes and integration into different IT-systems.

COMMISSION REGULATION (EU) 2015/703 of 30 April 2015 establishing a network code on interoperability and data exchange rules published on 30 April 2015 by the European Commission (EC) specifies that “The following common data exchange solutions shall be used [for the communication] protocol: AS4” [CR2015/703] for document-based exchanges. Further details on the specification[21] can be found online.

4.14.4.3 Versioning of EDIGAS

EDIGAS has developed different versions of business processes and data exchange information. Through the update of Edigas Version 4, the use of XML electronic documents has been supported.

Version 5 is currently under review and will be updated with version 6 in due time. Version 5 of Edigas covers particularly the following gas market related exchange processes:

- General Guidelines (0. General Messages guidelines)
- Trade Process (1. Capacity Trading Process and 2. Gas Trading Process)
- Transport Process (3. Nomination and Matching Process)
- Settlement Process (4. Settlement Process)
- Balancing Process (5. Balancing Process)
- Transparency Process (6. Transparency Process)
- Facility setting Process (7. Facility setting Process)
- General Service Processes (8. General Service Processes)

[21] https://www.entsog.eu/sites/default/files/2019-05/INT0488-161115%20AS4%20Usage%20Profile_Rev_3.6_clean_final.pdf

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4.14.4.4 Interoperability

The absence of harmonisation among Gas TSOs regarding capacity trading is in contradiction with the European Network Code on interoperability. Since capacity trading affects gas availability and gas prices, several stakeholders are of the opinion that harmonisation via a document-based solution using Edig@s format is significant. Different national implemented processes have been tried to reach harmonisation within a common data exchange solution as viewable in the provided Figure 13.

In the future all capacity auction platforms are likely to use EDIGAS format and subsequent data exchange protocol AS4 at least between TSOs and capacity platforms.

Process Area Value	BRS	Document Chapter	Document Line Number	Information Flow	From Party Role Value	To Party Role Value	Confidentiality Level	Common Data Exchange Solution	Date of Publication	Optional Data Exchange Solution
Capacity Trading Processes	CAP0554_160726_BRS_CAM+CMP_V19.docx	3.3.1.2	509	Network User Registration	Network User	Transmission System Operator	Private			Recommendation - Interactive
		3.3.1.3	515	Network User Registration to Auction Office	Network User	Auction Office	Private			Recommendation - Interactive
		3.3.1.4	522	Approved Network Users	Auction Office	Registered Network User	Private			Recommendation - Interactive
		3.3.1.5	531	Surrender Capacity Rights	Registered Network User	Auction Office	Private	Interactive	1/11/2016	Document Based
		3.3.1.6	551	Offered Capacity	Auction Office	Registered Network User	Public	Interactive	1/11/2016	Document Based
		3.3.1.8	572	Capacity Bid	Registered Network User	Auction Office	Private	Interactive	1/11/2016	Document Based
		3.3.1.9	578	Allocated Capacity	Auction Office	Registered Network User	Private	Interactive	1/11/2016	Document Based
		3.3.1.11	590	Aggregated Auction Results	Auction Office	All	Public	Interactive	1/11/2016	Document Based
		3.3.1.12	601	Surrendered Capacity Sold	Transmission System Operator	Registered Network User	Private	Document Based	1/11/2016	Interactive
		3.3.1.14	614	Reverse Auction Bid	Registered Network User	Auction Office	Private	Interactive	1/11/2016	Document Based
		3.3.1.15	626	Allocate Reverse Auction Results	Auction Office	Registered Network User	Private	Interactive	1/11/2016	Document Based
		3.3.2	643	Secondary Market Sales	Registered Network User	Transmission System Operator	Private	Interactive	1/11/2016	Document Based
		3.3.2	651	Secondary Market Sales	Transmission System Operator	Registered Network User	Private	Interactive	1/11/2016	Document Based
Nomination and Matching Processes	BAL0453_160822_BRS on nominations_V17.docx	3.3.3.3	282	Nomination Authorisation	Registered Network User	Transmission System Operator	Private			Recommendation - Document Based
		3.4.1	338	Nomination	Registered Network User	(Initiating) Transmission System Operator	Private	Document Based	1/11/2016	Interactive
		3.4.1	338	Nomination	Registered Network User	(Matching)Transmission System Operator	Private	Document Based	1/11/2016	Interactive
		3.4.1	347	Forward single sided nomination	(Active) Transmission System Operator	(Passive) Transmission System Operator	Private	Document Based	1/11/2016	Interactive
		3.4.1	354	Processed Quantities	(Initiating) Transmission System Operator	(Matching)Transmission System Operator	Private	Document Based	1/11/2016	Interactive
		3.4.1	362	Matching Results	(Matching)Transmission System Operator	(Initiating) Transmission System Operator	Private	Document Based	1/11/2016	Interactive
		3.4.1	367	Confirmation Notice	(Initiating) Transmission System Operator	Registered Network User	Private	Document Based	1/11/2016	Interactive
		3.4.1	367	Confirmation Notice	(Matching)Transmission System Operator	Registered Network User	Private	Document Based	1/11/2016	Interactive
		3.4.1	375	Interruption Notice	(Initiating) Transmission System Operator	Registered Network User	Private	Document Based	1/11/2016	Interactive
		3.4.1	375	Interruption Notice	(Matching)Transmission System Operator	Registered Network User	Private	Document Based	1/11/2016	Interactive

Figure 13: Common Data Exchange Solution

Summarised, the content definition for data and file exchanges for a specific business process is an enormous task which requires technical and market experts to define the relevant attributes for each communication in a way that all market actors are aware of their implementation tasks and do understand the processes surrounding the communication. Examples on such a harmonisation in the gas market sector has been described using Edig@s format.

Different file formats, communication channels and business processes are available for communication between market participants not involving the Trading Platform such as national registries with the European Transfer Platform / Hub. Since .XML format is widely used, this type of content aggregation offers a clear definition and implementation guide and is recommended for the communication of the Trading Platform and the European transfer platform / hub, respectively, and for other market participants directly communicating with the trading platform.

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5 Trading Options of Renewable Gas Certificates

5.1 Introduction

In the past years, the intention for developing a renewable gas certificate market has been based on market participants' wish to meet voluntary renewable energy targets of distributors and consumers in a cost-effective way using competitive market forces. RED II implements Guarantees of Origin for consumer disclosure (Art 19) and green certificates for target compliance (Art 3 and Art 25-31) for all energy carriers (power, gas, hydrogen, heating/cooling) and encourages Member States to accept each other's certificate systems facilitating Europe-wide trading possibilities. The request to implement RED II into national legislation represents an important turning point ushering in a new era for renewable gas certificate markets with the goal to reach a harmonised Europe-wide integrated market area.

The following sub-chapters provide insights into the different trading principles and possibilities.

5.2 Principles

Preconditions for competitive and transparent markets - as known from general economic literature - are:

- Sufficient supply and demand to ensure market liquidity and to ensure that a single market participant cannot influence market prices,
- Market transparency and equal access to relevant information for all market participants,
- No or low entry barriers and negligible transaction cost.

Due to the inflexible demand and supply in the past, the price of biomethane/renewable gas certificates has varied, and the certificate market has high price volatility. Each transaction is executed via the relationship of a buyer and a seller. In case there are more buyers for a specific product, the price will trend up based on the immutable laws of supply and demand. If there are more sellers than buyers, the price will trend down and vice versa. Preventing price volatility is possible by

- Improving flexibility in renewable gas production and delivery to match market demands; this means ramping up production at times of high certificate prices and the other way around,
- Improving flexibility on the demand side via reliable mid-term and long-term planning.

The quality of certificates - reflected by the number of attributes and therein provided data of a certificate - determines their prices. Whereby production volumes from input material based on residues and waste may raise significant interest of buying parties thanks to their high value of ecological and sustainable attributes and thus the quality of the renewable gas, renewable gas consignments based on not-publicly-acknowledged or not-legislatively-supported input materials with very few attributes might not raise market demand. The availability of volumes and the harmonisation of attributes among different Member States (countries or regions) are the most important prerequisite for reaching a liquid market and facilitating standardised trading activities via trading platforms.

The economic target of a platform is to provide a liquid marketplace, where a high number of market participants can conduct transactions/trades. The trading is done based on defined products (standardised certificates) or bilateral agreements between parties, which have agreed on specific products. The more standardised products with the same product definition are available, the more liquid the market will be. This is the case for the physical electricity or gas sectors where the product definition is the same among all European countries. But for renewable certificates based on different

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input materials with different public and legislative recognition, the situation is different. The more different products are available, liquidity decreases, or several smaller and less liquid markets exist in parallel. The attributes of the certificates hold information which may include GHG footprint, financial support provided for the product, and location of the production plant, etc. This wide range of information complicates the definition of a standardised product, which contradicts with the aim of providing a liquid market.

Harmonisation of attribute lists and quality criteria for certificates have been addressed in the REGATRACE project, e.g., in Deliverables D2.1 and D2.2. Consequently, the present report will not further detail attributes but is based on the hypothesis that standardised certificates with harmonised attribute lists are in place, available and tradable via a European Dashboard and Trading Platform.

5.3 Trading of Physical Gas

For natural gas trading (trading of the physical product), several standardised options for buyers and sellers to settle trades are available. The trades of the physical gas can be combined (mass balance) with or decoupled from (book and claim) the renewable gas certificate.

Examples for gas exchange platforms - for trading the physical natural gas - are the German exchange EEX (European Energy Exchange AG), Austrian exchange CEGH (Central European Gas Hub AG) or the intercontinental exchange ICE (Intercontinental Exchange, Inc.) launched in 2000.

In addition, several platforms without an exchange license (OTC, Over the Counter platforms) have been established which can be used for biomethane trading as well if prerequisites stated above are fulfilled. Platforms and exchanges offer various products whether they are differentiated by category (natural gas, LPG, etc.), period or delivery (physical or virtual).

5.4 Bids/Offers/Requests: Buy versus Sell

A bid is defined as a binding offer, as soon as it is submitted by a registered market participant and recorded in the order book. This is secured with a unique identification and timestamp. One market participant may have different trading accounts in the renewable gas Trading Platform to offer more flexibility for traders and departments. Through an account-based role concept, users can be assigned to one or several accounts of the same company, whereby a clear separation of bids and user rights is possible. Offers can be updated as long as trading is open. This includes change, deletion and re-entering of offers.

Market participants publish their offers/requests to other market participants to find a suitable counter party for their desired trade. The market terms used to represent the supply or demand offer are “buy” and “sell”.

The buy offer represents the demand side of the market. The buy offer is the highest proposed purchase price a market participant is willing to pay for a product. A market participant offers to buy a desired product by publishing a respective “buy” offer.

A sell offer represents the supply side of the market. The sell offer is the lowest proposed selling price a market participant is willing to receive for a product. A market participant offers their product by publishing a respective “sell” offer.

In case of a match between an existing buy and an existing sell, a trade will be executed. The transaction is performed either when the potential buyer accepts the sell price, or a potential seller accepts the buy price.

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The difference between the buy and the sell prices is called “spread”. The more liquidity, the narrower the price spread and the larger the size of offers (buy and sell offers).

The different options for potential sellers and buyers to make their sell and buy offers available to other market participants and the options for settling the trades are described in the following chapters.

The aggregated list of all buy and sell offers is called an order book. It includes all submitted offers which are placed for a specific trading product and may change over time because of new offers, cancelled offers, conducted transactions or the ending of the trading period for a specific auction product. The market participants see only their sell and buy offers in their own order book. Administrators of the Trading Platform may see all available buy and sell offers of registered market participants.

The question remains whether the definition of a trading product can be done in a way that as many buy and sell offers can be placed in one order book, which results in high liquidity. A separation of trading products reduces liquidity and should only be done when requested by the market. Hence, there may be a tradeable product for physical gas and one for the renewable value (with specific attributes) but when separating the renewable value based on certificate attributes, a high number of trading products will arise, and this consequently will split one order book into several different once, reducing liquidity. Different types of attributes (quality criteria) may lead to different levels of willingness to pay for the respective certificate.

A renewable gas Trading Platform shall serve different products. These products can be limited to the green value of the produced gas and may include the physical volume. By trading the physical volume, additional requirements are to be fulfilled for trade. Whereby pure certificate trading may be conducted by companies not necessarily gas suppliers, the trading of physical volumes sets higher requirements on market parties allowed to execute trades. Physical gas trading is only possible if companies are registered at central marketplace, such as Transmission System Operators or Clearing Organisations to cope with physical gas exchange. The setup of a tradable product influences the number of potential companies to be registered at a renewable gas Trading Platform.

A hybrid solution could be introduced, which enables both, a physical trading of green gases (combination of physical gas trading and certificate trading) or just certificate trading. One order book including bid and ask for green gas is separated from the certificate order book but is opened and closed at the same time for order entry. The orders which cannot be fulfilled within the green gas auction, could be reduced only to “certificate” offers. This provides flexibility on order execution procedures and increased liquidity. In theory, this approach could be offered vice versa, whereby a natural gas offer is entered (only physical natural gas) and a premium added for “additional certificates”. In such cases sell offers which do match a buy offer including physical natural gas and a renewable gas certificate will be auctioned prior to “only natural gas volumes”. Such a combination of order books may seem complex, but practical examples exist in Europe by trading organisations. In principle, each offer is considered in multiple iterations of an auction algorithm: If offer X is not considered in auction run 1 (whereby 1 is certificate and physical gas), re-run auction with step 2 (whereby 2 can be only physical gas trading) will be performed. Such options can be added when placing an offer on the gas Trading Platform and settled based on the requirements of each product defined prior to the auction.

After the auction has been finalised, which includes the calculation of auction results and potential risk management validations such as the availability of certificates or financial securities, the trading results

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are determined. Those trading results are detailed information on awarded buy and sell offers. Particularly the volume and price of each awarded bid and the aggregated results are visible for trading companies per account. The prices and the total volume for each product shall be separated to enable proper tracing of actions. In the above-mentioned hybrid solution one bid can be awarded in one or multiple products which must be understandable and transparently displayed to the customers of the renewable gas trading platform. This increased trust in the platform, the products, and the trade execution leads to higher quality and acceptance.

After the trading results are determined, relevant information shall be automatically packed into structured information packages and forwarded to market participants via defined interfaces. Automatic processing of data such as trading results and invoices increases the automation on trading companies' side and reduces their costs. Still, manual downloading of data should be possible, beside the display of structured information on the renewable gas Trading Platform itself, but only for registered and assigned persons (accounts).

For the separation of products (natural gas and certificates), the renewable gas Trading Platform may need different physical balance groups and certificate accounts in the national registries or European Transfer Platform / Hub.

Certificate selling companies must provide evidence on the availability of the renewable gas certificates, provide financial securities or, depending on the auction product, the ability to produce the volumes during the auction product period. Such validations and checks should be performed prior to the auction to secure the physical execution of trade transactions. For example, this can be ensured by companies signing terms and conditions that legally oblige them to deliver sold products plus provide evidence on historic production data. Consequently, there must be clear rules on the business process to transfer future certificates and penalties if transactions are not fulfilled. By having such a clear definition, the risk of nonfulfillment is reduced.

Only believing in the trust of companies, that they will supply certificates without having proof before the trade execution, may reduce the overall quality and such processes contradict with a central counterparty approach, in which the renewable gas trading platform is the contracting party for buying and selling companies.

5.5 Ex-Post, Spot and Forward trades

The spot (short-term) and forward (long-term) markets cover different time periods to procure products on marketplaces. While the spot market is a marketplace delivered at short notice in the future (day-ahead market), the longer-term supply can be procured on the futures market with trades executed several months up to several years in advance of the actual product delivery. There is also the option of intraday trading (very close to real time), but this requires massive liquidity and is operated only for physical markets such as gas or electricity.

For renewable gas certificates, the ex-post market is relevant as well, because certificates may have been already produced and include a specified validity period (at least for GO according to Art 19 RED II), which allow for ex-post trading. Whereby the term "ex-post" refers to the production period of the respective renewable gas volume being in the past. On the ex-post market, consumers or distribution companies will trade certificates that have been issued in the past.

On the spot and forward market, market participants negotiate future contracts i.e., trading with certificates that will be produced/issued in the future. In case of spot and forward markets, the issuance of certificates lies in the future. Consequently, the execution of settlement processes and the

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surveillance of certificate ownership transfers is much more complex on spot and forward markets compared to the ex-post market. The future market may be operated only on financial basis (without certificate transfer) to hedge for price risks, therefore securing investments into renewable gas projects. For this, a liquid market product must exist, based on which the financial product can rely on.

5.6 Over the counter (OTC) versus Exchanges

5.6.1 Introduction

There are key differences between the transaction mediums of over-the-counter trades and trades executed on exchanges.

Over-the-Counter (OTC) or off-exchange trading is executed between two market participants without supervision of a gas exchange. Buyer and seller do "meet" each other, being in a direct contact (parties know each other). In an OTC trade, the price is not necessarily published for the public. The OTC market does not have the strict limitation on standardisation. Market participants may agree on specified criteria which may be unusual to the mainstream of market participants. In an OTC market, contracts are bilateral (i.e., contract between only two parties), each party could have credit risk concerns with respect to the other party.

On an exchange, every party is exposed to offers by every other counterparty, which may not be the case in OTC trading. A gas exchange has the benefit of facilitating liquidity, mitigating all credit risk concerning the default of one party in the transaction, providing transparency, and maintaining the current market price. Products traded on an exchange must be well standardised, meeting specific requirements on quantity, quality, and identity as defined by the exchange. Products offered on an exchange are identical within all transactions of that product. Since exchanges act as intermediary, they do take the risk for transactions as central counterparty. The transaction is always conducted with the exchange as counterparty, and it covers the responsibility for fulfilling the transaction (buy or sell).

5.6.2 Over the counter (OTC) trades

"Over-the-Counter" trade execution, so called OTC, provides the option for fast and transparent trade execution. OTC can be described as a board with multiple buy- and sell-offers by market participants. These can be individually selected (buy or sell) which results in a trade execution. Market participants who are correctly registered and fulfil all respective prerequisites to participate in an OTC market, can place buy or sell offers or select a buy or sell order previously entered by other market participants. The display of bids is usually in an anonymous form. Only when a trade is settled (a buyer selects a sell offer he wants to buy from, or a seller selects a buy offer he wants to sell to) the parties are informed about each other. Theoretically, the OTC platform provider can also handle the transaction as an intermediary, but this is an additional service.

A mandatory requirement of OTC trading is the product definition for market participants. Typically, the OTC function provides a user-friendly interface ("board" graphical user interface) for the display of buying and selling offers whereby it contains only volume and price, but the product itself is defined transparently for all market participants and apply to all displayed offers. There can still be multiple products, but the better aggregated, the higher liquidity (number of buy and sell offers) can be achieved.

The OTC trading option is equivalent to a continuous trading where buying and selling offers remain available for trade transactions until they are either deleted or finally traded. The trading will be

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stopped for products which get invalid, e.g., the trading day ends, or the validity period of a certificate attributes are out of product definition.

The flexibility on products and agreements do allow for different fee regulation enabling also smaller companies to participate in trades. Due to less restricted legal obligation compared to an exchange, individual tariffs for the usage of an OTC platform can be defined and support integration of smaller market participants and their limited trade volumes.

5.6.3 Exchanges

An exchange provides a platform where trading can be easily conducted by matching buyers and sellers of predefined products. Those products may be financial products such as equities, bonds, or stocks or commodities. In the case of a renewable gas market, the commodity trades are performed through exchanging renewable gas certificates.

The trading option via an exchange provides several advantages. It provides a central place with clear and defined rules for all market participants. Anonymity, harmonised regulatory framework, central counter party risk mitigation and liquidity are most important advantages of an exchange. The buyer and the seller do not “know” each other. Liquidity is increased with the number of buyers and sellers as well as with the number of offers (buy and sell). The exchange enables efficiently processed trades because clearly standardised trading products and clearly defined trading times are set and offer security and continuousness for their trading members. The market participations of an exchange have to register based on given rules and forms. All participants are treated equally which puts more trust into trading partners as they can rely on the defined rules and regulation each member of the exchange has to follow.

The operation of an exchange incurs ongoing costs which are usually covered by the income, generated by income defined via the fee regulation – e.g., annual, or monthly fees, registration fees, or trading fees for each. With such high standards from registration to trade execution, the costs for usage might have a level, which is too high for small market participants. Therefore, the setup of a Trading Platform must consider the target group and their financial capabilities to keep up with the continuous fees for the exchange.

5.7 Auction (similar to exchange)

The closed auction option of the Trading Platform provides its market participants with two major advantages fully aggregated: anonymity, and liquidity. The bids are submitted for a defined product. This product definition is transparently available to the market participants. Further rules are published prior to this auction such as opening time of the auction, closing time of the auction, product details, bid details, for example maximum volume per bid or matching rules (auction algorithm). The defined rules for an auction provide a secure environment for all market participants in a way that all participants have to undergo the same registration, confirmed the rules and other related legal requirements.

The closed auction allows to place bids offers (Buy and Sell) offers without immediate matching of already entered bids. Each bid is binding as soon as it is submitted and recorded in the order book (as well as in the database with time stamp and identification number). However, as long as trading is open, bids can be changed, deleted and re-entered. Bid offers of market participants are entered until a defined closing time. Those bids are typically including following attributes:

- name of the company (not viewable to others) - automatically added by the system or in case of multiple options a unique key assigned to each company,

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- volume in MWh (or MW per product period),
- price in EUR (or other defined currency).

The execution of a closed auction enables market participants to place their bids in a respective timeframe, after the gate open time and before the auction gate close time. During this period, the market participants can enter new bids, change bids, or delete bids.

At the time of the gate close, all bids submitted are taken as firm and forwarded to an auction algorithm which calculates based on defined auction algorithm parameters the respective results. The determination of an auction algorithm typically includes a target function with clear rules such as the maximisation of transaction volume or the highest social welfare (price oriented). The auction algorithm will determine based on the product information, buy and sell offers, the results including a list of matched buy and sell offers and an auction price per product.

An auction must include a defined auction algorithm on which basis the buy and sell offers are matched.

Dependent on the algorithm definition (e.g., social welfare), prize determination can vary significantly. In case of different target functions within an auction algorithm, the results of price determination and matched volumes can differ.

After the auction, the trading results are made available on the platform to the respective participants. The prices and the total volume for the auctioned product will be visible to all participants for information purposes. The individual quantities awarded to individual participants will be visible only to the respective participant. The confirmations of the auction results will be sent to all participants who have been awarded with the auctioned product. All participants have the possibility to download these data in the trading system. In case of physical products, additional information on the physical delivery must be exchanged with respective stakeholders such as shippers. The financial settlement will also be handled by the exchange to secure that all buyers pay their trades and sellers get their financial payments.

As there is only a limited number of closed auctions, preferable as few as possible, the number of bids on buying and selling side are aggregated at maximum level. If more products are allocated within one auction, the liquidity defined as number of bids in total, can even be higher than in cases where each product is differently auctioned. This option allows a marketplace such as a Trading Platform to offer its market participants high value. In the electricity market one day-ahead-auction exists for Central Europe electricity market. Further information is publicly available on the ENTSO-E website[22]. This single auction per day combines all buying and selling offers at midday for a set of defined products over many different countries. Such an auction has enormous liquidity and is operated anonymously as well.

If this principle is allocated to the renewable gas certificate market, it would make sense to define a set of products which may include a large number of certificates (for example product definition: all certificates produced in one calendar year, independent of production country, any kind of renewable gas attributes with the requirement that it must be either produced from renewable electricity only, from biomass, food waste, residues or agricultural products). This would lead to a liquid auction because many certificates can be traded. This would be different to the case where one auction

[22] https://www.entsoe.eu/network_codes/cacm/implementation/sdac/

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includes only the product definition of one calendar month production, of one country and produced from food waste only.

5.8 Continuous trading (similar to exchange)

Beside the closed auction, where at a specific point in time an auction is conducted to concentrate liquidity, in other words buy and sell offers, there is an option of a continuous trading. This is very similar to an OTC Trading Platform with the main difference, that the bid results of each market participant are anonymous. Similar to the closed auction, any transaction will be conducted with the gas exchange for each market participant. The gas exchange will handle the transaction with the buying and the selling party and will take the risk of failure, e.g., in case one market participant cannot fulfil its obligations related to his trading activity.

5.9 Different Options of Ownership Transfer of Certificates

5.9.1 Introduction to Options for Ownership Transfer

The certificate transfer process must be organised in the best possible manner meaning it must be reliable, secure, and automated. It involves different entities, in particular certificate sellers (producers or commodity traders), national registries, European Transfer Platform / Hub, Trading Platform and the certificate buyer. There are different options to transfer certificates meaning the renewable value of the gas, while whereby the physical gas treatment is out of scope. Each ownership transfer option is defined by time, technical and organisational aspects. The present report provides a comprehensive description of the different options to be selected when implementing the Trading Platform, but this report will not define one particular option as this decision is up to market participant agreements. The following options for certificate transfer are applicable considering current transfer options of biomethane certificates, power GOs and CO_2-certificates. Each option is considered based on comparable information, structured to cover the following points in individual sub-chapters:

- Description: general description on the transfer process
- Actors: involved actors in the actual transfer process of certificates
- Certificate availability: Point in time when the certificate must be available to the respective market participants during the transfer process
- Timeline: Information on the timing of the certificate transfer process
- Owner: Information on the ownership during (each step of) the transfer process
- Fraud Resistance: Fraud Resistance of the transfer process
- Pro: Positive aspects of the transfer process
- Contra: negative aspects of the transfer process
- Costs: Categories LOW, MEDIUM, and HIGH determined by the author's experience.
- Automation Category: grade of automatisation HIGH (very low manual administrative tasks), MEDIUM and LOW (high number of manual tasks) determined based on the author's experiences.

5.9.2 Transfer option 1) Trading Platform has dedicated account in each registry and certificates must be transferred to these accounts prior to trading

5.9.2.1 Description

The Trading Platform has an account in each participating registry and market participants, who want to trade (sell) certificates, must transfer them to the Trading Platform account prior to its trading. The ownership transfer should be organised by the selling entities and the Trading Platform must take care

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of those certificates transferred, meaning the owner of the Trading Platform account in the national registry must forward/store this information in the actual Trading Platform in order to allow selling parties to enter respective offers. This administrative process of the Trading Platform to connect to the national registry account information with the Trading Platform is of importance and involves also specific processes to be implemented. One process of particular importance is the transfer of the information from the national registry to the Trading Platform. Where possible, automated processes should be established to keep information on accounts up to date with the Trading Platform. The involvement of the European Transfer Platform / Hub may only be relevant when transferring certificates after trade, but not prior to the trading. After the execution of a trade, the Trading Platform needs to initiate the ownership transfer of the respective certificate on the Trading Platform and or respectively via the Trading Platform account in the national registry.

When selling parties want to regain their certificates which have not been sold, a specific process needs to be implemented to allow selling parties to receive their certificates back on their national registry account.

5.9.2.2 Actors

- Selling certificate party,
- National Organisation (registry/IB),
- European Transfer Platform / Hub, Trading Platform,
- buying certificate party.

5.9.2.3 Certificate availability

- Certificates must be available prior to the trading.
- Ex-Post trading of certificates (volumes already produced and certificates created).

5.9.2.4 Timeline

Ownership transfer of certificates for trading purpose must take place before trading any time. This requires additional effort by the selling party and the Trading Platform to provide such information before execution of a trade.

The ownership transfer after the trade needs to be conducted by the Trading Platform potentially as soon as possible.

5.9.2.5 Owner

This option theoretically leads to a situation where the Trading Platform does own the certificates at least for the time period while the selling party has transferred their certificates to prepare for selling purposes. The selling party is not able to use the certificates for other purposes as the certificates are not further available on the selling party's national registry account.

5.9.2.6 Fraud resistance

The certificates are only traded once. A clearly defined and documented chain of ownership is available reducing fraud to a minimum.

5.9.2.7 Pro

This option is very secure and guarantees that only available and "blocked" certificates (due to prior transfer to the Trading Platform account on the national registry) can be traded at the trading platform. The ownership transfer is executed solely by the Trading Platform supporting anonymity and trust into the market.

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5.9.2.8 Contra

The approach of prior transfer of certificates reduces fast and automated handling because several processes must be executed in order to start entering sell offers on the Trading Platform. This extra effort may lead to additional administrative tasks and costs during implementation and operations.

Requiring ex-post certificates in advance is a constraint - in some power GO registries, producers have to pay an issuance fee for receiving certificates. Many producers try not to issue certificates until they have found a confirmed customer. If there is a requirement to deposit certificates before the trade, then producers will run into risks of not being able to sell their certificates and will be posed with unnecessary issuance costs.

5.9.2.9 Costs

MEDIUM

When also considering the administrative processes by the selling party and Trading Platform to synchronise those ownership transfers with Trading Platform accounts, the cost category is HIGH.

5.9.2.10 Automation category

MEDIUM

5.9.3 Transfer option 2) Trading Platform blocks certificates on the registry accounts via a defined mechanism

5.9.3.1 Description

A process will be established to enable the Trading Platform to block certificates which are subject to trade on the national registry account of the seller. Any selling party entering data to sell a specific product must determine the respective certificate. The Trading Platform will immediately execute a process with the corresponding account of the national registry to block those certificates for other processes. Only such blocked certificates can be traded on the trading platform. In the event, that the selling party accomplishes to close a trade on the trading platform, the Trading Platform will notify the national registry to execute a transaction for the blocked certificate. Whether this transaction for ownership transfer will be executed directly with the buying party or first via an intermediary (Trading Platform or other account) is subject to detailed definition.

The block-and-release-process of certificates must be an automated process and requires a well-functioning interface between the Trading Platform and the national registries involving also the European Transfer Platform / Hub. Hence, the Trading Platform must store detailed master data of the national registry accounts particularly for those market participants who are registered as selling parties. The blocking process can be also repeated, meaning it could be executed a second time (first time when entering a bid) when a bid would be finally traded in order to ultimately secure that the certificate is still blocked for the purpose of trading.

5.9.3.2 Actors

- Selling Party,
- National Organisation (registry/IB),
- European Transfer Platform / Hub,
- Trading Platform,
- Buying Party.

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5.9.3.3 Certificate availability

- Certificates must be available at the moment of entering selling offers onto the trading platform.
- Ex-Post Trading of Certificates (volumes already produced and certificates created).

5.9.3.4 Timeline

The business process of blocking certificates for trading purpose must take place shortly before the trade entering. The check on the availability of certificates owned by the selling party must be as automated as possible. This will ensure a short lead time, meaning the time between the order entering and the confirmation that the order is valid (certificates available) is reduced to a minimum. In the best case, such a process can be executed within seconds and not within hours or even days because of the involvement of manual processes. This requirement significantly increases the automation between the Trading Platform and the national registries respectively the European Transfer Platform / Hub.

5.9.3.5 Owner

The selling party stays the owner of the certificate as long as no trade has been finally executed. The blocking of certificates represents only an intermediate step / status which does not influence the ownership (no effect on change of ownership). After trade execution, the transfer to the buying party can be executed via different options, but not necessarily influence the ownership principle (whether directly transferred to the buying party or through the usage of an intermediary).

5.9.3.6 Fraud resistance

The certificates are only traded once. A clearly defined and documented chain of ownership allows reducing fraud to a minimum.

5.9.3.7 Pro

This option allows that certificates stay in the ownership of market participants (selling and buying party) only without involvement of any intermediary party. The blocking of certificates has a much shorter lead time compared to the transfer of certificates to a dedicated account prior to trade execution. The check on blocked certificates will be done only when a bid is placed by the selling party.

5.9.3.8 Contra

Blocking certificates in this option requires enormous technical integration into each national registry, the European Transfer Platform / Hub and the trading platform. These technical efforts might be too exhaustive for actual implementation; particularly the high availability of this process for all registries during trading times is enormous. The Trading Platform must store master data of all market participants and synchronise the information continuously between national registries and the trading platform. This requires additional data to be exchanged with all registries at least with those where selling parties are registered.

5.9.3.9 Costs

HIGH

5.9.3.10 Automation category

HIGH

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5.9.4 Transfer option 3) Trading Platform requests national registries if accomplished trades are executable (check of certificate availability for ownership transfer)

5.9.4.1 Description

This certificate ownership transfer option is very similar to the blocking of certificates during the bid submission. But in this option the verification whether the selling party owns the respective certificates in its account, is executed only when a match between a selling and buying bid is observed. In such a situation, the Trading Platform must request to the national registry account of the selling party if the product and its dedicated volume is available for such a transaction of ownership transfer. In the positive case, the matching of sell and buy offer is executed and the transfer of certificates is initiated by the Trading Platform with the buying party or first via an intermediary (Trading Platform or other account). In the negative case, the trade is cancelled, and no further transaction processes initiated.

5.9.4.2 Actors

- Selling Party,
- National Organisation (registry/IB),
- European Transfer Platform / Hub,
- Trading Platform,
- Buying Party.

5.9.4.3 Certificate availability

- Certificates must be available at the moment of trade execution in the trading platform.
- Ex-post trading of certificates (volumes already produced and certificates created).

5.9.4.4 Timeline

Validation on existing certificates for selling purpose takes place at the moment of matching. The check on availability of selling party certificates must be as automated as possible to reduce the matching time of orders to a minimum. This requirement significantly increases the automation between the Trading Platform and the national registries, respectively the European Transfer Platform / Hub.

5.9.4.5 Owner

The selling GoO party stays the owner of the certificate until the trade has been finally executed. After trade execution, the transfer to the buying party can be executed via different options, which do not necessarily influence the principle of ownership transfer (whether directly transferred to buying party or using an intermediary).

5.9.4.6 Fraud resistance

The certificates are only traded once. The Trading Platform only executes transactions if the certificates are available for transaction in the respective national registry account of the selling party. A clearly defined and documented chain of ownership is available reducing fraud to a minimum.

5.9.4.7 Pro

This option allows that certificates stay in the ownership of market participants (selling and buying party) only without involvement of any intermediary party. The validation on the availability of certificates has the least lead time before a transaction and such a check is only performed in case of matching sell and buy order. This reduces the processes for validation to the least extent as only potential matches are validated with the national registry accounts.

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5.9.4.8 Contra

As for other options requesting the national registries on the availability of certificates, this option requires enormous technical integration into each national registry, the European Transfer Platform / Hub and the trading platform. These efforts might be too exhaustive for actual implementation; particularly the high availability of this process for all registries during trading times is enormous. The Trading Platform must store master data of all market participants and synchronise the information continuously between national registries and the trading platform. This requires additional data to be exchanged with all registries at least those where selling parties are registered.

5.9.4.9 Costs

HIGH

5.9.4.10 Automation category

HIGH

5.9.5 Transfer option 4) Selling parties must arrange the certificate transfer after trade execution

5.9.5.1 Description

Within this option the selling party must take care of the transfer of certificates after the trade execution. Selling parties must themselves track the sold volumes and shall only execute trades for products and volumes, which they have available in their portfolio / on their national registry account. The validation of the existence of those certificates is subject to trust between the market participants. A final check on the quality of certificates can only be executed after the trade execution. In this case, the Trading Platform offers a legal and administrative framework, whereby the certificate transfer is supported by a Trading Platform certificate account in one national registry or all registries to keep the anonymity of the selling party. Practically, the selling party transfers the respective certificates to the established Trading Platform account after trade execution and consequently, the Trading Platform transfers the certificates to the buying party after respective validations. By doing so, the anonymity of the selling party is kept.

This option requires only limited automated processes and primarily builds up on the trust that all selling parties placing offers are capable to provide the respective certificates after trade execution. Automatic checks on the existence of certificates or prior certificate transfer processes before the offer placement respectively order execution is not necessary in this ownership transfer option which reduces administrative processes for all market actors to a minimum.

5.9.5.2 Actors

- Selling Party,
- National Organisation (registry/IB),
- European Transfer Platform / Hub,
- Trading Platform,
- Buying Party.

5.9.5.3 Certificate availability

- Certificates must be available after trade execution.
- Ex-post trading of certificates (volumes already produced and certificates created).

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5.9.5.4 Timeline

Validation on existing certificates for selling purpose takes place ex-post. The Trading Platform receives the certificates on its account after trade execution from the selling party and must transfer the certificates to the buying GoO party using national registry transfer functions.

5.9.5.5 Owner

The selling party stays the owner of the certificate until the trade has been finally executed. After trade execution, the transfer to the buying party can be executed via different options, but in this case, it is envisaged to be executed via an intermediary (trading platform) to keep the anonymity of the trading parties.

5.9.5.6 Fraud resistance

This option is based on trust in the market and its market participants because no check is performed prior to the trade execution, if the certificates are available. The Trading Platform can only verify ex-post the accomplishment of the certificate transfer, which requires administrative processes. In case the transaction is not completed correctly, respective measurements need to be in place to secure the transaction, or in the worst case, provide a refund / penalty to the involved parties.

5.9.5.7 Pro

The ex-post transfer is simple, easy to operate in case of limited transactions and requires minimal automated processes. It can be implemented very fast and relies primarily on the administrative work of selling parties and reduces the Trading Platform activities to ex-post control, validation checks and transfers from its account to final buying party.

5.9.5.8 Contra

Offering a solution, which is not highly secure and guarantees the trade execution, may be not welcome by market participants. Still, it all depends on the acting of the selling parties to only place offers and execute the transfer of certificates after trade execution. The behaviour can be controlled by the Trading Platform through the implementation of respective measures or processes, but still the Trading Platform highly relies on the willingness and correctness of market participants. To guarantee this, detailed legal and administrative framework must be established with connected consequences in case of problems, errors, or delays of such processes. Considering a fully integrated solution, this option may not be fully capable of providing all those functions. Decentralised technologies such as blockchain technology might provide a remedy.

The certificate transfer to the final buyer must be manually executed by the trading platform. For this, the Trading Platform team most likely requiring access and know-how on national registries.

5.9.5.9 Costs

LOW

When considering the administrative task of Trading Platform operations team to control and execute the transfer process, the cost category rises to MEDIUM.

In case of high number of trades, the costs will even be shifted to HIGH.

5.9.5.10 Automation category

LOW

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5.9.6 Transfer option 5) Selling parties must arrange the certificate transfer after the trade execution which is communicated by the Trading Platform

5.9.6.1 Description

The principle of this option is very similar to the option before because market participants have to arrange the ownership transfer themselves, whereby in option 5 the ownership transfer of certificates stays in the sole responsibility of the selling party. The main difference to the option before is, that in this case the ownership transfer of certificates after a trade execution is conducted between the selling and buying party directly. There is no anonymity because no intermediary party is involved. This option is very much favourable for OTC trades, where selling and buying party may be directly linked for reasons of administrative and financial settlement (in case the Trading Platform just provides a marketplace to agree on a transaction but without additional processes).

The Trading Platform must provide product data information on the buyer to the selling party. Therefore, detailed information on the buying party must be made available to conduct the final transfer of certificates after trade execution.

For ex-post verification purposes, if the transaction was finally accomplished, the Trading Platform must have secured secure the option to control these processes, but most likely only offline (request confirmation from buyer party) because access to national registry accounts for verification purpose may not be granted widely to the Trading Platform operator.

5.9.6.2 Actors

- Selling Party,
- National Organisation (registry/IB),
- European Transfer Platform / Hub,
- Trading Platform,
- Buying Party.

5.9.6.3 Certificate availability

- Certificates must be available after trade execution.
- Ex-post trading of certificates (volumes already produced and certificates created).

5.9.6.4 Timeline

Validation on existing certificates for selling purpose takes place ex-post. Most likely this is an administrative process to check whether all buying parties have received the corresponding certificates on their accounts within a specific time period (to be defined) after order execution.

5.9.6.5 Owner

The selling party stays the owner of the certificate until the trade has been finally executed. After trade execution, the transfer to the buying party is directly executed with additional information provided by the trading platform. The Trading Platform itself is not actively involved in the transfer process.

5.9.6.6 Fraud resistance

This option is highly based on trust into the market and the market participants because no validation/check will be performed prior to the trade execution, if respective certificates are available. The Trading Platform can only verify the accomplishment of the certificate transfer ex-post, which requires administrative processes. The risk of market manipulation where buy and sell offers are made without intention to execute remains and is heightened if there are limited way to monitor. In case the

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transaction is not completed correctly, respective measurements need to be in place to secure the transaction, or in the worst case, provide a refund / penalty to the involved parties.

5.9.6.7 Pro

This certificate transfer process requires the lowest effort for the Trading Platform as almost the full process is handled between the selling and buying party directly, only requiring validation and control processes on Trading Platform side, and potentially only in events the buying party is not provided with the certificates by the selling party in sufficient time and quality. The necessary process for ownership transfer on the side of the Trading Platform can be established faster than in other options and relies primarily on the administrative work of selling parties.

5.9.6.8 Contra

Offering a solution, which is not highly secure and guarantees the trade execution, may not be welcomed by market participants. High responsibility of and dependency on the selling party to only place offers of certificates which are actually in their portfolio / on their national account. The selling party is also responsible for the final execution of the agreed trade. The behaviour of selling parties can only be controlled to a limited extend. To guarantee this, a detailed legal and administrative framework must be established which also describes consequences in case of problems, errors or delays of such processes. Considering a fully integrated solution, this option may not be fully capable of providing all those functions.

The anonymity of market participants is not given in this process, which may not be welcomed by market participants.

5.9.6.9 Costs

LOW

5.9.6.10 Automation category

MEDIUM

5.9.7 Conclusions of Ownership Transfer Options

The above-mentioned list and the selection of the most appropriate option influences the specification of interfaces described in chapter 4.14 and the communication between the market participants and implementation efforts significantly. The national registries, Transfer Platform / Hub and trade platform operator must mutually agree on an option considering all different aspects.

Trading of future products, referring to energy consignments to be generated in the future, have a huge impact on the execution of the ownership transfer of certificates. In such cases, the trading happens before the actual generation of the renewable gas volume and subsequent certificate creation process. Different methods for the certificate transfer need to be considered when trading in the future, whereby the transfer of certificates is a rather administrative process to be executed after the creation of those. This can take up to several weeks or even longer depending on the timeline of certificate creation.

Where physical volumes are transferred in parallel with the certificates, the physical fulfilment is accomplished through European market processes for physical gas delivery, so called Schedules (to exchange natural gas). Detailed information on the physical linkage during the certificate transfer or trading process are described in chapter 5.10. In general, the documentation of delivery and supply of green gas may be provided with additional technical accounts for example green gas balance groups usable for production, trade, and consumption.

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5.10 Physical linkage

5.10.1 Modes of delivery

The characteristics of the green value of a renewable gas consignment are documented on its respective certificate which is created/issued after production. From that point onwards, its relationship to the physical product varies according to the applied modes of delivery, which may be either the "mass balance" or "book and claim" methodology.

Separating the renewable and physical value, meaning separating the certificate from the physical commodity, allows for two separate transactions, one certificate ownership transfer and one physical gas transaction. The renewable gas producer receives higher flexibility to choose suitable buyers, may expand the user base, and determine a market price on the European level.

These methodologies place different technical and organisational requirements on the electronic document (certificate), the organisational structure of European exchange processes (Scheme Rules) and the IT-infrastructure, in relation to:

- types of certificates that are being exchanged,
- the information documented on the certificate (attributes),
- validity periods of the certificates,
- collection and recording of evidence on withdrawal of renewable gas from the grid.

The book and claim methodology allows the physical product to be separated from the green value (= certificate). Simple certificate trading without connection to the ownership transfer of the physical product itself is thus possible.

The mass balancing methodology strictly combines the physical product with its green value (= certificate). Any ownership transfer of the green value is only eligible if the ownership transfer of the respective connected physical product has been conducted as well.

These two different concepts influence the trading possibilities as well.

5.10.2 Certificate trade following the Book & Claim concept

Under a book and claim system there may be no connection at all between the physical product and the certificate (= green value) beyond the point of issuing. The certificate may be used to record the consumption of renewable gas at any location, regardless of there being transportation of any gas (independent of fossil or renewable origin) between the two locations of injection and withdrawals.

The current GO system for the electricity sector has been operating based on the book and claim methodology for more than two decades.

5.10.3 Physical and certificate trade following the Mass Balancing concept

Mass balancing is described in detail in Article 18 of the Renewable Energy Directive I (2009/28/EC) and in Articles 25-31 the Renewable Energy Directive recast (2018/2001/EC), which define a specific set of technical and organisation requirements.

The physical transport of the renewable gas between injection and withdrawal must be shown to have taken place within a system "where consignments would normally be in contact, such as in a container, processing or logistical facility or site (defined as a geographical location with precise boundaries within which products can be mixed)", (RED I, 2010).

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Another requirement is that the "physical product and sustainability information are coupled when they are traded between parties. There cannot be trade in sustainability information between parties without trading physical products between the same two parties (as is possible in a book and claim system)." (Ecofys, 2013[23]).

The Trading Platform must therefore ensure its market participants the tools to provide evidence of the connection between the physical product and green value (certificate type = proof of sustainability, PoS). Another requirement is that the cancellation of the certificate at the point of consumption is restricted to locations which may be shown being part of the same logistical facility into which the renewable gas consignment was injected. This is likely to be done by collecting information such as meter readings and potentially auditing reports stating the energy amount (of renewable gas volume) and location of the renewable gas withdrawn from the grid.

5.10.4 Time restrictions

Time restrictions must be accounted for in the certificate information and scheme structure because they will define requirements on the ownership transfer and the trading platform.

Under RED II, Guarantees of Origin will have a validity period of twelve calendar months to their trading and cancellation.

The validity of a certificate including sustainability information will face further restrictions, as mass balancing must be performed within a maximum of a three-months-period.

These time restrictions highly influence the trading possibilities including the financial settlement as well as the ownership transfer of the certificate in case of book and claim or ownership transfer of the certificate combined with the physical product in case of mass balancing.

5.10.5 Interpretations of MB on different levels

5.10.5.1 Interpretations and their background

Mass balance refers to specific system boundaries, such as containers, storages, or the whole gas grid. Europe lacks a mass balancing concept for renewable gas along the interconnected, European gas grid. The delegated acts referring to Art 25-31 RED II are being awaited with high interest. Currently different interpretations are followed to find a workaround for the lacking concept.

5.10.5.2 Match of production and consumption

Matching the energy amounts and their related green value on production side as well as on consumption side is related to double checking metering values of the producing and consuming market participants. This requirement may be documented on subsequent levels:

[23] Ecofys, 2012. Analysis of the operation of the mass balance system and alternatives. https://bit.ly/3hpLMEF

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- Country level: validate if total national renewable gas production including imports on the exchange borders is within national gas consumption minus exports for a specified time period. Example: Ireland validates if all renewable gas consumption and imports documented by certificates is within the total gas consumption minus exports for a specific calendar year. In such cases only cancelled certificates (cancelled referring to consumed) are used to document the mass balance. The documentation on country level mass balance can be done by a national registry with respective certificate information and registered companies' data within the registry plus publicly available country data.
- Market Area level: validate if total renewable gas production including imports of a Market Area on the exchange borders from Market Areas is within gas consumption of a Market Area minus exports to other Market Areas for a specified time period. Example: Market Area East in Austria validates if all renewable gas consumption and imports documented by certificates to the Market Area is within the total gas consumption minus exports from this Market Area for a specific calendar year. In such cases only cancelled certificates (cancelled referring to consumed) are used to document the mass balance. The documentation on Market Area level mass balance can be done by a national registry with respective certificate information and registered companies' data within the registry plus publicly available Market Area data.
- Balance Group / Supplier level: validate if total renewable gas certificates cancelled by a specific balance group / Supplier is within the total physical gas consumption of this Balance Group / Supplier for a specified time period. Example: Supplier X in Germany is validated if all cancelled certificates is within its aggregated gas consumption for a specific calendar year. In such cases only cancelled certificates (cancelled referring to consumed) are used to document the mass balance. This check of Balance Group / Supplier data requires detailed information on the trading and consumption of specific market participants and their balance groups. Such data are available at national or market area clearing organisation. This data is very sensitive, and its receipt must be defined mutually between the corresponding market actors (clearing agency, DSOs and national registries).

Considering the low amounts of renewable gases in whole Europe, the matching of gas consumption versus renewable gas consumption is negligible.

5.10.5.3 Physical tracking (on molecular level)

By tracking the chain of custody of the physical product, it is meant to follow the exact pathway of renewable gas molecules. The execution is impossible in practice as natural gas and renewable gas molecules blend upon mixture and cannot be differentiated in a practical way. It has to be mentioned that sustainable biofuels – the sector which is legally obliged to execute the mass balancing concept – are also not tracked on molecular level, but the chain of custody is technically tracked (comparable to option 3).

5.10.5.4 Technical tracking (on Schedule level)

Liberalised energy markets are based on a balancing group model which is designed to balance physical injection into and withdrawals from the energy grids. Producers and consumers are obliged to provide forecasts in the form of technical Schedules. The actual energy provision/injection and consumption/withdrawals, based on meter readings, is matched with the Schedules by the settlement agencies, which can be entities such as transmission system operators or balancing group coordinators. Based on the differences between Schedules and meter readings, imbalance energy is calculated and settled.

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The balancing group model may provide a suitable system to document the fulfilment of the mass balance because both production, interchange and consumption are tracked within the balancing group model. Firstly, it provides the concept for settlement in the fossil gas sector, and it would be an appropriate measure to integrate renewable gases and use this concept for the settlement of renewable gases as well. Secondly, the balancing group model has been implemented in each European Member State and thus provides good prerequisites to perform harmonisation. The clearing and settlement processes may be executed by different organisations, either by grid operators (most often TSOs) or by dedicated, third-party imbalance clearing agencies (balancing group coordinators) such as in Austria, Belgium, Croatia, and the Czech Republic.

In general, the documentation of delivery and supply of green gas may be provided with additional technical accounts for example green gas balance groups usable for production, trade, and consumption. For such purposes, the organisation of the balancing model in Europe could be extended to only renewable balance groups in parallel to natural gas (fossil energy consignments). Whereby it seems obvious to document renewable gas volumes and transactions only between the respective technical components (balance groups), the physical supply is always a mixture of natural and renewable gases. This approach has not been introduced anywhere in Europe yet and is also not subject to international transactions within the interconnected grid. In the ultimate development, all renewable gases would need to be documented technically detached from the fossil gas volumes which would require enormous administration efforts, new pieces of legislation and IT-service upgrades. Consequently, the current principle on documentation of energy consignments from gas along the natural gas grid are still to be used but should be considered to adapted to cope with specialities of renewable gases, instead of developing a separate methodology for renewable consignments only.

If the mass balancing concept is a prerequisite for trading of renewable gas certificates on a Trading Platform, technical Schedules provide the necessary basis to proof the ownership transfer of the physical product additional to the ownership transfer of the certificate. Both market participants (seller and buyer) have to provide their technical Schedules as proof to the balancing group coordinator.

In case of an OTC-trade, both seller and buyer have to provide their technical Schedules as proof:

1) Schedule from seller to buyer has to be provided to the balancing group coordinator by the seller.
2) Schedule from seller to buyer has to be provided to the balancing group coordinator by the buyer.

In case of a trade executed via an exchange, the ownership transfer is executed in an anonymous way with the exchange being a party interacting in between of the seller and the buyer. In this case, technical Schedules have to be provided by all three involved parties: by the seller, the exchange and the buyer. This also means that the exchange needs to have an account available for interim certificate storage. The exchange could have accounts in each national registry where the buyer and seller are registered.

1) Schedule from seller to exchange provided to the balancing group coordinator by the exchange.
2) Schedule from exchange to buyer provided to the balancing group coordinator by the exchange.
3) Schedule from seller to exchange provided to the balancing group coordinator by the seller.
4) Schedule from exchange to buyer provided to the balancing group coordinator by the buyer.

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The ownership transfer and thus the trade may only be finalised if all technical Schedules are provided and have been proven to be correct. If that is not the case, no trade is executed and imbalanced energy has to be settled.

1) Example: trade in the same market area
2) Example: trade is executed as cross-border transaction, proof by border capacity bookings.

Although the balancing group model may provide a suitable system to fulfil the mass balance methodology, the definition of system boundaries along the chain of custody leaves room for interpretation:

1) National gas grids and/or market areas are considered as separate mass balancing units that are connected via interconnection points. For each interconnection point between the point of injection and the point of withdrawal, capacities must be booked (and gas flows have to be nominated).
2) A gas flow into the national gas grid and/or market area of the point of withdrawal needs to be demonstrated via capacity booking at the interconnection point.
3) The interconnected European natural gas network is considered as one single logistical facility (mass balancing unit) and injection and withdrawal of renewable gases are balanced with each other. This concept is supported by ERGaR RED MB Scheme and is intended by the upcoming Union Database on transport fuels.

6 Existing Trading Systems

6.1 Introduction

Different existing technical solutions for trade transaction in the energy and certificate sector have been researched and the most important platforms from the author's perspective analysed and compared also including the biggest energy exchange in Europe. To gather insights and feedback from market participants/stakeholders who intend to use the respective system in the future, interviews with energy experts of trading organisations and interest groups, particularly in the gas sector, were held.

The following chapters provide insights and comparisons on existing systems for certificate trading. Each platform (and organisation) is briefly introduced. The last subchapter provides a table with structured presentation of each system.

6.2 European Energy Exchange EEX

"EEX Group (European Energy Exchange) has been providing services to the electricity industry, such as algorithmic trading softwares for balancing and market coupling services, auction platforms and registry services. The European Energy Exchange (EEX) merged Powernext activities into EEX on 1 January 2020. EEX provides customers with access to European natural gas products on a Trading Platform powered by Trayport® Global Vision ETS (Exchange Trading System) and Deutsche Börse's T7 technologies, which are the industrial standards in the energy trading community." (Powernext Website[24]).

[24] Powernext website (accessed 29/09/2021) https://www.powernext.com/

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6.3 Green Power Hub (by ISN AS)

"The Green Power Hub is a complete bilateral trading network for Power Guarantees of Origin (GOs) and Elcerts. More than 200 companies from 25 countries across Europe have registered to do their green deals on the platform. Green Power Hub is strictly speaking an interest-sharing platform that facilitates trades between members who settle deals bilaterally. The hub does not require and does not have an exchange license. Green Power Hub is aiming to become a worldwide solution for renewable energy trading.

The company behind the Green Power Hub is ISN AS. ISN was founded on a dream of digitalising the green power business. ISN is a privately held company founded in January 2019. ISN is based in Bergen, Norway with offices in Oslo." (GHP Website[25]).

6.4 Herkunftsnachweise.at (by Transparent Marktplatz Handels GmbH)

„Transparent Marktplatz Handels GmbH is a joint venture of Alpenenergie - Gesellschaft für Energievermarktung mbH (http://www.alpenenergie.at) and K. u. F. Drack Gesellschaft m.b.H. & Co. KG (www.kfd.at). The companies involved have been active in electricity supply, electricity marketing and electricity generation for many years and are exclusively family-owned. The shareholders of Transparent Marktplatz Handels GmbH and affiliated companies will also trade on this portal.

The aim of our marketplace for guarantees of origin is to offer all market participants, both nationally and internationally, simple, and transparent market access to trading in guarantees of origin. To trade guarantees of origin on www.herkunftsnachweise.at means to save a lot of time compared to other options for buying or selling guarantees of origin. To deal on our marketplace is as easy as buying a book online.

We want to provide all market participants with simple and legally secure market access to trading in guarantees of origin. We offer full market transparency to registered users who have an interest in making trading in guarantees of origin more transparent together with us.

The target group for our platform are all small and medium size energy suppliers who have no own 24/7 trading floor with own access to an energy exchange.

However, the protection of our users' data is also important to us. As long as no concrete purchase contract is concluded between two users, we do not disclose our users' data. The data is not passed on to third parties." (herkuntsnachweise.at 19/10/2021).

6.5 Biomethanmarkt.de (by Green Navigation GmbH)

"The Green Navigation GmbH (formerly known as Arcanum Energy Solutions GmbH) is a service provider, consultant, and partner for energy supply companies, local authorities, and industries. From our head office in Unna (North Rhine-Westphalia, Germany) our team, consisting of eight employees with different job specialisations, operates nationwide. With services focused to the topic of sustainability, we are actively committed to the success of tackling climate change. Our innovative and digital solutions enable our customers to establish sustainability in operational practice in an ecologically sensible and economically optimal way.

One of our key aspects of activity is the development and operation of digital trading and verification systems for sustainable energy products. Green Navigation (formerly Arcanum Energy Solutions) has been successfully operating a biomethane verification / mass balance system certified according to

[25] GHP Website (accessed 29/09/2021) https://www.greenpowerhub.com/

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German legislation EEG, EEWärmeG and EWärmeG for years. Furthermore, we create concepts for municipal and industrial climate protection, for carbon footprinting projects, and thus navigate our business partners into a more sustainable future. We are also an experienced service provider and pioneer in the field of energy efficiency and climate protection networks. Our digital gr-EEN platform already forms today the optimal basis for successful network in many energy efficiency networks.

We have been successfully active in the market for over 12 years: initially integrated into the Arcanum Energy group company as Arcanum Energy Solutions GmbH. Since October 2020 we have been operating independently under the company name Green Navigation GmbH." (Green Navigation 09/09/2021).

6.6 Tender 365 (by EXXETA)

„Tender365 was founded in 2018 by EXXETA and GasVersorgung Süddeutschland. Since 2017, both companies were working together on Tender365 as a software development project. The idea behind was to bring the electricity and gas economic together for building an own trading OTC Platform.

Since EXXETA AG was founded in 2005, we have reached important milestones and have grown successfully. ECG Erdgas-Consult GmbH is now operating as EXXETA GmbH in Leipzig, effective since July 1st, 2016, and was merged into EXXETA AG at the end of 2020.

The company has been working on European projects for leading companies in the energy supply industry since the year 2000 and has established itself as a specialist provider of software, consulting, and process services. The portfolio offers solutions for all market roles in the European gas markets. This includes transport, trading, and storage systems as well as gas and capacity trading and cooperation platforms. Currently EXXETA has more than 850 employees in different markets e.g., Automotive, Banking and Retail.

We closed the Tende365 platform because of less liquidity on the marketplace. After three years we had 75 customers but the most of them were on Tender365 without any interest in trading commodity on it. Also, there is another platform, called enmacc. They were on the market two years earlier as Tender365 and they had more budget and larger companies on their platform. At the end it was not possible to find a business case next to enmacc and after two years the stakeholder started to leave the Tender365 Company." (EXXETA 29/09/2021).

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6.7 Comparison

The following matrix (see Table 3) provides a structured overview of the previously introduced systems for energy certificate trading. The information was gathered from interviews held with representatives of these system providers. The information provided in this matrix has been approved by the respective system providers.

Table 3: Comparison of systems for trading of certificates

Categories	EEX (former Powernext)	Green Power Hub by ISN AS	herkunftsnachweise. at by Transparent Marktplatz Handels GmbH	Tender365 by EXXETA	Biomethanmarkt.de by Green Navigation
Introduction					
Operator	EEX	ISN AS	Transparent Marktplatz Handels GmbH	EXXETA	Green Navigation GmbH
Geographical scope	Europe	Europe	Main scope is Austria and Germany, Swiss market participants	Germany	Germany
Functions Type (Dashboard / Trading Platform)	Trading Platform	Dashboard	Dashboard without ownership transfer	Trading Platform	Trading Platform without ownership transfer
Date / Timeframe of Expert interview	January 2021	March 2020 & Sept/Oct 2021	July-October 2021	January 2021	March 2020 & September 2021
Generic					
Title	EEX auction for French electricity GOs	Green Power Hub	www.herkunftsnachweise. at	Tender365	Biomethan-markt.de
Weblink	https://www.eex.com/en/services/registry-services/french-	https://www.greenpowerhub.com/	https://www.herkunftsnachweise.at/	https://www.tender365.energy/ (not further maintained)	https://biomethan-markt.de/ (not further maintained)

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Categories	EEX (former Powernext)	Green Power Hub by ISN AS	herkunftsnachweise.at by Transparent Marktplatz Handels GmbH	Tender365 by EXXETA	Biomethanmarkt.de by Green Navigation
	auctions-for-guarantees-of-origin				
Sector of activity (power, gas, both)	Power GO	Power GO	Power GO	Both	Physical Gas (and biomethane certificates). Also, power GO are available but beyond the scope of this report and thus excluded from description.
Operator	EEX	ISN AS	Transparent Marktplatz Handels GmbH	EXXETA	Green Navigation
IT-provider	EEX	ISN AS	Kitschmedia	EXXETA	Green Navigation
Operational	Since end 2018	Yes	Platform operation started in February 2020	Started operation on 1st August 2018 stopped operation on May 31st 2021	05 /2013 – 06 /2018
Participation					
Registration procedure and requirements	GO account holder Member of ECC	Registered companies	Registration including check of VAT number and know-your-customer process	Easy registration with name, E-Mail, Phone Number, Company name and address. The person who did the registration first was the company administrator. After registration you´ve got an	Registered companies of German Biogas Registry (operated by dena) and German BiMaS System

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Categories	EEX (former Powernext)	Green Power Hub by ISN AS	herkunftsnachweise. at by Transparent Marktplatz Handels GmbH	Tender365 by EXXETA	Biomethanmarkt.de by Green Navigation
				e-mail with the information that the registration was successful, and that Tender need some time (48h) for checking the information. It´s necessary because we didn´t want, that to much service provider and unknown companies where on Tender365. The verification of the registration disclosures was a safety aspect for us. After the review the registered person/company received a personal e-mail from us with log in information and some information for the first steps on the platform.	
Fees regulation	Membership fee + transaction fee	Membership fee	Transaction Fee only	Registration fee + transaction fee	Membership fee, Registration fee + Transaction fee

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Categories	EEX (former Powernext)	Green Power Hub by ISN AS	herkunftsnachweise. at by Transparent Marktplatz Handels GmbH	Tender365 by EXXETA	Biomethanmarkt.de by Green Navigation
Registration fees (once, monthly, annual)	Annual	Members may choose monthly or annual payment	None	Monthly or annual. The participants could decide which kind of fee they would pay. we	Once and annual
Transaction fees	Yes	No	3.5% fee charges of transaction volume	Yes	Yes
Connections to European Scheme Operators	Yes, AIB	No	Yes, AIB. Transparent Marktplatz is registered with an international account at AIB	No	No
Connections to Registries	Yes, French Registry	No	Yes, Austrian and German Power GO Issuing Bodies	No	German Biogas Registry (dena), German BiMaS System
Trading partners (contact to all users vs. selected trading partners)	Central auction entity	Registered companies	Registered Companies	Registered Companies	Registered companies
Communication between trading partners (e.g., chat function)	No	Yes	Yes, after the users have made a deal.	Easy registration with name, E-Mail, Phone Number, Company name and address. The person who did the registration first was the company administrator. After registration you´ve got an	Yes

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Categories	EEX (former Powernext)	Green Power Hub by ISN AS	herkunftsnachweise. at by Transparent Marktplatz Handels GmbH	Tender365 by EXXETA	Biomethanmarkt.de by Green Navigation
				e-mail with the information that the registration was successful, and that Tender need some time (48h) for checking the information. It´s necessary because we didn´t want, that too many service provider and unknown companies where on Tender365. The verification of the registration disclosures was a safety aspect for us. After the review the registered person/company received a personal e-mail from us with log in information and some information for the first steps on the platform.	
Trading: business processes					

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Categories	EEX (former Powernext)	Green Power Hub by ISN AS	herkunftsnachweise.at by Transparent Marktplatz Handels GmbH	Tender365 by EXXETA	Biomethanmarkt.de by Green Navigation
Info on placing buy offers	Bids consist of price, volume, type of bids (simple or complex) and type of products (all technologies, all regions, specific technology, specific region, specific power plant)	Flexible creation of buy offers with visibility of offers after publication	Flexible creation of buy offers with visibility of offers after publication	Flexible creation of buy offers with visibility of offers after publication	Flexible creation of buy offers with visibility of offers after publication
Info on placing sell offers	Only for one participant (French Authority)	Flexible creation of sell offers with visibility of offers after publication	Flexible creation of sell offers with visibility of offers after publication	Flexible creation of sell offers with visibility of offers after publication	Flexible creation of sell offers with visibility of offers after publication
Info on "receiving a match"	Through general auction results	Active selection of offers	Active selection of offers. No auction. No match system. The system has a search agenda. When an offer/demand appears that meets my requirements, I get an automatic message. First come, first served. Trade: Market participants actively accept; thus a legally	Auction Results or direct communication between buyer and seller depending on trade process	Active selection of offers

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Categories	EEX (former Powernext)	Green Power Hub by ISN AS	herkunftsnachweise.at by Transparent Marktplatz Handels GmbH	Tender365 by EXXETA	Biomethanmarkt.de by Green Navigation
			binding contract is established.		
Unit	Megawatt hours	Megawatt hours	Megawatt hours	Megawatt hours	Kilowatt hours
Currency, currencies	Euro	EUR, NOK, SEK, DKK, GBP, CHF	Euro	Euro	Euro
Partial bid execution (possibility to purchase partial amounts of offered bids)	Yes	Yes	Yes, with options of hidden and not hidden quantities.	Yes	Yes
Info on transparency	https://www.eex.com/en/services/registry-services/french-auctions-for-guarantees-of-origin	No publicly available trade information	Publicly available information on website: https://www.herkunftsnachweise.at/herkunftsnachweise-ganz-einfach-handeln	No publicly available trade information	
Info on trading history	Yes	Yes	Yes	Yes	Yes
Risk management	Yes, via ECC	No	No (Not necessary, the users will be checked when they register. If one user does not fulfil a contract we will exclude this user from	No	No

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Categories	EEX (former Powernext)	Green Power Hub by ISN AS	herkunftsnachweise. at by Transparent Marktplatz Handels GmbH	Tender365 by EXXETA	Biomethanmarkt.de by Green Navigation
			further trading activities. Non-registered users can see the most recent daily bids/asks on the website in reduced view, but cannot log in.		
Settlement: business processes					
Coverage of title transfers	Yes	No	Optionally possible, but base case without title transfer	No	No
Coverage of contractual framework	Yes, GO Auction General Terms and Conditions and adhere to the corresponding Access Agreement	Yes, Terms and Conditions of Green Power Hub	Yes, own framework conditions of Transparent Marktplatz Handels GmbH. Transaction fee: automatic invoice by direct debit. Users are sent a trading contract containing all the details of the offer/demand, but financial settlement and ownership	Yes, own framework conditions of Tender365 platform	Yes, Terms and Conditions of Green Navigation

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Categories	EEX (former Powernext)	Green Power Hub by ISN AS	herkunftsnachweise.at by Transparent Marktplatz Handels GmbH	Tender365 by EXXETA	Biomethanmarkt.de by Green Navigation
			transfer is executed beyond platform.		
Coverage of financial settlement	Yes, via ECC	No	No	No financial settlement.	No
Certificate attributes					
Energy carrier	Electricity	Electricity	Electricity	Electricity and Gas	Gas / Biomethane
Technology	Wind, hydraulic, Solar, and Thermal	Wind, Hydro, Solar, and Others	Wind, Hydro, Solar, and Others (All technologies, renewable and non-renewable)	Wind, Hydro, Solar, Biogas, and Others. Had certificates for Hydro and Biogas in combination with commodity.	Biogas production (Anaerobic Digestion)
RED II appliance	Yes, Art 19	Yes, Art 19	RED I conformity because certificates of Austrian Power IB. RED II ready, dependent on Austrian GO system.	Optionally possible for Art 19 but not mandatory	Optionally possible for Sustainability Art 25-31 but not mandatory
Trading modes					
Mode of delivery (book & claim vs mass balancing)	Book & Claim	Book & Claim	Book & Claim	Book & Claim and Mass Balancing	Book & Claim and Mass Balancing
Option for physical delivery (only applicable for gas)	No	No	No	Yes	Yes

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Categories	EEX (former Powernext)	Green Power Hub by ISN AS	herkunftsnachweise.at by Transparent Marktplatz Handels GmbH	Tender365 by EXXETA	Biomethanmarkt.de by Green Navigation
Direct sales, Auctions or Both	Auctions	Direct sales	Direct sales, and optionally with anonymity clause. Upon request, the operator takes over the settlement and charges a transaction fee of 1 ct/MWh.	Both	Direct sales
Past, Spot, Future markets, or All	Spot	Standard, Spot or Special	Previous year, current year and next 3 years Quarterly and annual can be offered.	Spot and Future	All
Price determination	Pay as bid	Pay as Bid	Pay as Bid	Marginal price and Pay as Bid	Pay as Bid

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7 Glossary

ACCOUNT HOLDER

Person or organisation in respect of whom a transferable account or a cancellation account is maintained on a registration database (for the issuance of certificates).

ADDITIONALITY (ELECTRICITY)

The additionality criteria ensures that additional demand for renewable electricity is met by additional supply. And that the demand for renewable fuels of non-biological origin for the transport sector does not interfere with the electricity production that is reserved for other sectors (adapted from Global Alliance Powerfuels, 2020).

ASSOCIATION OF ISSUING BODIES (AIB)

AIB is an international non-profit organisation established under Belgian law registered in Belgium as aisbl. The Association of Issuing Bodies (AIB) operates the European Energy Certificate System (EECS®), a multipurpose and multi-energy carrier certificate system facilitating standardised cross border transfer of energy certificates. This system was in 2019 complemented with the EECS® Gas Scheme. Early 2020 AIB reorganised to facilitate independent decision making by respectively electricity and gas issuing bodies for all topics that relate to either electricity or gas specifically. Guarantees of Origin under REDII art.19 can be issued under the EECS® Gas Scheme, as can other type of gas certificates, either or not under independent criteria schemes.

ATTRIBUTE

Data specifying the characteristics of energy produced by a renewable gas producing installation in terms of the input(s) used and/or the details of that production installation and production process.

Information field within the electronic document, comprising different types of information related to the installation (BPI), quantity and quality of the renewable gas product.

Attributes are essential to the overall value of the renewable gas as different marketing pathways require different characteristics/specifications of the renewable gas product according to the legislative framework and consequently lead to different monetary values for renewable gas producers. Attributes shall be harmonised from organisational (audited attributes) and technical (content option of field) point of view to enable Europe-wide harmonisation. Biomethane Certificates are shaped by their specific attributes which have to be designed in a holistic and flexible way to fulfil all requirements of the respective marketing pathway and underlying legislative framework. At the same time, Biomethane Certificates have to be harmonised to allow a transfer between IT-systems of different competent bodies.

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AUTHORISED ISSUING BODY

A body operated under governmental mandate, responsible for the issuing of GO according to Art 19 RED II and the respective national implementation.

BALANCING GROUP MODEL

A balancing group summarises suppliers and customers into a virtual group within which a balance is struck between the generation of energy (procurement Schedules, feed-ins) and the delivery of energy (delivery Schedules, feed-outs). Every system user connected to the gas grid (who feeds in or withdraws) must belong to a balance group. The balancing group model is applied in whole Europe and represents the concept of grouping all stakeholders along the gas grid into one system which allows the balancing of input (injection / feed-in) and output (withdrawal / supply).

BOOK & CLAIM

A term to indicate that the certificate can be transferred, independently of the transfer of energy to which it is related, from one holder to another, i.e. trade of the physical product is decoupled from the transfer of the certificates. Consumption of the physical energy can only be attributed to the source and other attributes mentioned on the "Book and claim" certificate, if the corresponding certificate is cancelled.

CERTIFICATE (RENEWABLE GAS CERTIFICATE)

An electronic document that records or guarantees information in relation to attributes of the input consumed in a production installation and the production method and amount of a specific energy carrier that is yielded by this production installation.

CERTIFHY

CertifHy is a project, funded by the Fuel Cells and Hydrogen Joint Undertaking (FCH JU) of the European Commission. It is dedicated to developing a European framework for Guarantees of Origin for hydrogen.

CHAIN OF CUSTODY

Refers to the process of tracing the origin and ownership of products throughout the value chain.

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COMPETENT BODY

Body duly authorised under the laws and regulations of any state to exercise or discharge any legislative, governmental, regulatory or administrative function associated with the administration of a national GO scheme designated by the government in accordance with Article 19 of the RED II.

DISCLOSURE

Provision of information to a final customer about the attributes and quantity or share of energy that has been supplied.

DOUBLE/MULTIPLE COUNTING

Renewable energy consignments are eligible to be applied for different market pathways, renewable gases may especially be consumed for heating and cooling (consumer disclosure), sustainable biofuels, national subsidy schemes and other relevant market pathways. Double/multiple counting refers to fact that each renewable energy consignment may only be consumed and allocated to one specific applications. If a renewable energy consignment has been counted towards meeting one application, then the respective renewable energy consignment is not eligible for a second/multiple allocation to other applications.

EECS®-CERTIFICATE

A unique electronic certificate specifying and representing the quality and method of production of a specific quantity of Output, which is maintained on an EECS® Registration Database and Issued in accordance with the provisions of the EECS® Rules.

EECS® GO

The EECS® Rules define an EECS® GO as “an EECS® Certificate corresponding to a type of Guarantee of Origin”.

The EECS® Rules define a Guarantee of Origin as “a certificate issued by (a) a Competent Authority, or (b) by an AIB Member acting as the duly authorised agent on behalf of a Competent Authority, under the laws of a State as a guarantee of the nature and origin of energy for the purpose of providing proof to the final consumer of energy that a given share or quantity of energy, as the case may be:

Was produced from the energy source to which the guarantee relates, and/or

Was produced by the specified technology type to which the guarantee relates, and/or

Has, or the Production Device(s) which produced it has (or have) other attributes to which the guarantee relates.

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ERGaR aisbl

ERGaR (European Renewable Gas Registry) aisbl is an international non-profit organisation established under Belgian law. ERGaR was founded in September 2016 as a cooperation between national renewable gas registries and other major energy organisations interested in supporting the development of ERGaR's vision to enable cross border transfer of renewable gas certificates in Europe. The association currently counts 28 members from 15 European countries comprising established biomethane/renewable gas registries, gas distribution and transmission system operators, biogas associations and other major stakeholders of the European biomethane market.

ERGaR Certificate of Origin (CoO)

An electronic document that corresponds to renewable gas certificates that were issued and transferred to the ERGaR CoO scheme by an ERGAR Scheme Participant with the purpose of transferring it to another ERGaR Scheme Participant. ERGaR CoO provides proofed qualitative and quantitative information about a biomethane consignment injected into the Natural Gas Network. CoO are primarily designed to meet the demand of consumers for a method of disclosing their use of renewable gas which, depending on the countries and the reporting methodology, can have various benefits. These benefits are largely related to corporate emissions reporting and statutory uses.

ERGaR CoO Scheme

The ERGaR Certificate of Origin scheme (ERGaR CoO scheme) is organised and operated by the European Renewable Gas Registry (ERGaR) aisbl. The Scheme allows the Europe-wide cross-border title transfer of Certifcate of Origin (CoO) between participating national biomethane registries, who create such documents in respect of biomethane that has been injected into the natural gas network in their country of operation.

European Scheme

Connecting the National Organisations via a European Scheme is the preferred solution compared to several bilateral or multilateral agreements to prevent the risks of double/multiple counting. A robust and harmonised scheme, governed by a central organisation, allows a structured administration of cross-border transfers and the respective energy amounts and quality criteria. The technical and financial efforts and costs for a single interface to a central organisation will be significantly lower.

The Scheme is defined by its Scheme Rules and governed by the Scheme Operator. National Organisations may become Scheme Participants upon joining the European Scheme.

Energy Carrier Conversion

The production of an energy carrier from one or more inputs including at least one other energy carrier

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EXTERNAL AUDIT/INSPECTION

External audits/inspections are carried out by independent, third-party professionals who perform an impartial audit/inspection of the renewable gas production installation and the renewable gas produced within a dedicated time period.

FUNCTIONAL REQUIREMENTS

Functional Requirements define the functions that a system, product or data set must provide for the customer of the system for example the bid submission via a Graphical User Interface.

GUARANTEE OF ORIGIN (GOO)

The RED II[2] defines the purpose of Guarantees of Origin as follows (recital 55):

"*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.*"

Specifically, according to Article 19 RED II, a **Guarantee of Origin (BGO)** is an electronic document certificate, containing the purpose of the GO, issued by:

(a) a Designated Competent Bodies; or

(b) by a Member acting as the duly authorised agent on behalf of a Competent Authority, under the laws of a State

as a guarantee of the nature and origin of energy for the purpose of providing proof to the final consumer of energy that a given share or quantity of energy, as the case may be:

(i) was produced from the energy source to which the guarantee relates; and/or

(ii) was produced by the specified technology type to which the guarantee relates; and/or

(iii) has, or the Production Device(s) which produced it has (or have), other attributes to which the guarantee relates;

GUI

Graphical User Interface

HYDROCARBON GAS

An energy carrier consisting of chemical compounds composed mainly of the elements of carbon and hydrogen, which are in gaseous state when they are at 20°C and atmospheric pressure. (FastGO)

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IMBALANCE ENERGY

The imbalancing energy represents the difference of energy values between technical Schedules and metering values. It has a specific price and is settled by the balancing group coordinator/settlement agency.

MASS BALANCING

In relation to RED II, mass balancing is an approach to document compliance with RED sustainability criteria and greenhouse gas emissions savings thresholds in relation to the production and supply of liquid and gaseous energy carriers. (Other definitions and interpretations of mass balancing exist.)

NATIONAL BIOMETHANE/RENEWABLE GAS REGISTRY

An organisation that operates an account-base administration system which documents the chain of custody of injected biomethane/renewable gas from the moment of injection until the moment of withdrawal from the domestic natural gas network. A National Biomethane Registry may be established either through government mandate or by voluntary cooperation of market participants and is operated on a domestic market.

NATIONAL ORGANISATION

The term “National Organisation” is used in this report, referring to the operator or a renewable gas registry, Authorised Issuing Body, Biofuel Registry/Database and similar. They may fulfil one, several or all of the following purposes on national levels:

- Track the green value of renewable gases,
- Track the energy amounts of renewable gases injected into the national gas grid,
- Track the energy amounts and sustainability criteria of sustainable bio-fuel consignment for the allocation to the national biofuel quota according to FQD,
- Issue GOs according to Art 19 RED II.

National organisations become Scheme Participants upon joining a European Scheme.

NON-FUNCTIONAL REQUIREMENTS

Non-functional Requirements define the functions of a system which are necessary to comply with the requested quality of the system for example the maximum number of system users.

OVER THE COUNTER (OTC) TRADES

“Over-the-Counter” trade execution, so called OTC, provides the option for fast and transparent trade execution. OTC can be described as a board with multiple buy- and sell-offers by market participants.

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PROOF OF SUSTAINABILITY (POS)

A document detailing the verification of sustainability claims relating to biofuel consignments that comply with sustainability and greenhouse gas emissions saving criteria in accordance with RED2 Art. 25- 30)). PoS are issued by conformity assessment bodies (certification bodies) associated with a voluntary scheme recognised by the European Commission under the RED.

PURPOSE (OF A CERTIFICATE)

The original intended use for which a certificate is issued, whether this is disclosure, support, target counting, demonstrating compliance with a label or a combination of these.

RENEWABLE ENERGY DIRECTIVE (RECAST) – RED II

Directive (EU) 2018/2001 of the European Parliament and of the Council of 11 December 2018 on the promotion of the use of energy from renewable sources (recast).

SCHEME CONTRACT/AGREEMENT

A contract between the Scheme Operator and Scheme Participants refers to the Scheme Rules and give the signatories a legal basis for collaboration. It refrains from a detailed explanation of the procedures of the scheme because they may be updated/adapted and might change from time to time. The Scheme Contract/Agreement shall refer to the Scheme Rules and shall state that all rules and procedures are defined in the Scheme Rules and all signatories will adhere to which.

SCHEDULE OR TECHNICAL SCHEDULE

The term technical Schedule is used in the balancing system. It is the document that specifies the energy amount which is injected or withdrawn into/from the grid, respectively, as a forecast average energy value within a constant measurement period at certain grid points. For the settlement, the energy values of the technical Schedule are put against the actual metering values collected afterwards.

The difference of energy values between technical Schedules and metering values is called “imbalancing energy” which has a specific energy price and is settled by the balancing group coordinator/settlement agency.

SCHEME OPERATOR

The Scheme Operator is a central organisation responsible for the administering and governing a European Scheme. The Scheme Operator shall be unbiased and independent. The Scheme Operator is responsible for providing the respective documentation for the Scheme (Scheme Rules, Participation

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Contract, contact list of Scheme Participants, registration forms, standardised exchange format, activation guidelines). The central IT-solution shall be within the responsibility of the Scheme Operator themselves or a respective IT-provider. Scheme Participants enter a contract (Participation Contract) with the Scheme Operator under harmonised and standardised conditions.

SCHEME PARTICIPANT

A National Organisation admitted to a European Scheme by decision of the Scheme Operator and in accordance with the respective Scheme Rules.

The National Organisation is responsible for several business processes on national level, including the registration of production plants and economic operators who will become account holders in the IT-system of the National Organisation. To allow European cross-border title transfers, the Scheme Participant joins a European Scheme.

The Scheme Participant has to comply with the organisational, legal and technical requirements set out in the Scheme Rules. All Scheme Participants are equally treated by the Scheme Operator and the Scheme Rules. The Scheme Participant is the connection of Economic Operators with a European Scheme and the Scheme Operator.

TEMPORAL CORRELATION

Temporal correlation refers to the temporal link between the production of the energy carrier input and energy carrier output. The aim is to avoid issuing certificates for hydrogen based on electricity, which was generated after the hydrogen (adapted from Global Alliance Powerfuels, 2020).

TRADER

The term “trader” refers to a market participant who performs an exchange (title transfer) of a respective Certificate, not consuming it directly, but transferring it to another market participant. In this document, the term “trader” is used in a generic way. In practice, a trader may be of different: end consumer, a supplier or a commodity trader.

UI

User Interface

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