D2.4 Investigative study of IT system options for harmonized European cross border title-transfer of biomethane/renewable gas certificates

Deliverable:	D2.4 Investigative study of IT system options for harmonized European cross border title-transfer of biomethane/renewable gas
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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
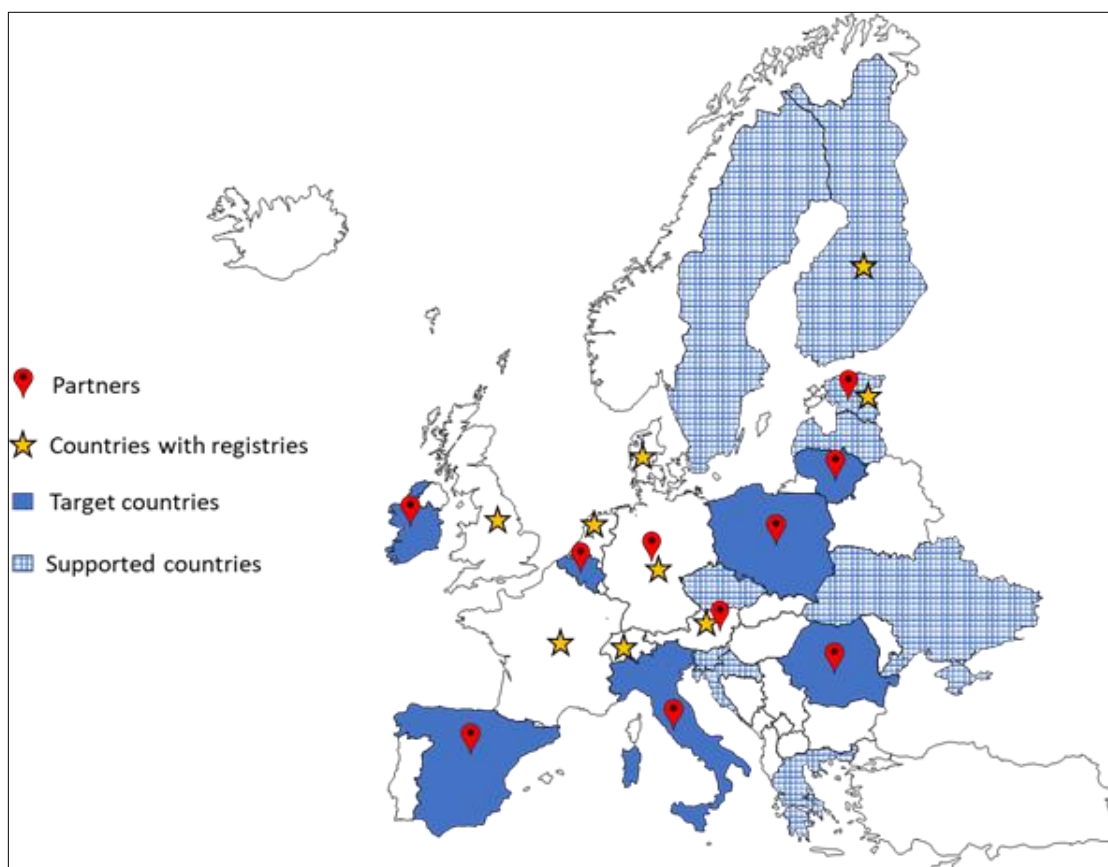- Transferability of results beyond the project's countries

Figure 1: REGATRACE countries and partners

The network of issuing bodies will be established by including existing national biomethane registries (Austria, Denmark, Estonia, Finland, France, Germany, The Netherlands, Switzerland and UK) and by creating issuing bodies in the Target countries of the project (Belgium, Ireland, Italy, Lithuania, Poland, Romania and Spain).

Moreover, REGATRACE will prepare the ground for setting-up national biomethane registries in other 7 Supported countries (Croatia, Czech Republic, Greece, Latvia, Slovenia, Sweden and Ukraine).

Using a participatory process involving several stakeholders, REGATRACE will develop strategic visions and national roadmaps to boost the biomethane market.

1.2   Executive summary

Fundamental basics for Europe-wide title transfers are the IT-systems of National Organisations (national biomethane registries, issuing bodies and biofuels registries/databases) which shall be designed to not only oversee the national markets, but also to pursue a European market by being connected to a European IT-option, underpinned by a European Scheme. This report evaluates six IT-options to interconnect such National Organisations to enable efficient and trustworthy cross-border title transfer of renewable gas certificates:

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.

Additionally, a hybrid solution, combining national IT-systems in some Member States and the direct use of a Central IT-solution by other Member States, was investigated. Performing transactions via blockchain technology has also been evaluated in view of applying a blockchain for peer-to-peer solutions and in centralised IT-options.

The evaluations of the IT-options are performed from point of view of National Organisations, considering the status of the European renewable gas market. The results contain i) an in-depth analysis of all six IT-solutions, based on a SWOT analysis and a rough cost benefit analysis (see chapter 4 and 5), and ii) a comparative analysis based on a score table (see chapter 6).

The number of Scheme Participants and, even more importantly, the number of transactions (or market volume) highly influence the budget available in the Scheme. The European renewable gas market presents an uneven picture, while several countries are well advanced with a high number of production plants/injection sites and a lively market, in other countries neither production nor any framework conditions have been established. The IT-solution interconnecting these countries has to be able to bridge such gaps. The following recommendations for an IT-solution regarding European cross-border trade of renewable gas certificates were drawn.

Short-term IT-solution for a European Scheme

IT solutions 1-3 which are based on already existing IT-infrastructure could provide a short-term, temporary approach because they pose low requirements on the IT-systems of Scheme Participants and the handling of business processes is rather simple. However, a high number of transactions and Scheme

Participants will require more automated business processes. Hence, IT-options 4 and 5 seem suitable when advanced national IT-systems and know-how of Scheme Participants are available.

Medium term IT-solution for a European Scheme

For some Member States that are in the early development of a renewable gas market, a Central IT-solution could be beneficial to start with. In order to address the different situations in Member States, a Hybrid IT solution could be suitable combining well advanced and tailormade national IT-systems with a Central IT-solution. However, without standardisation across Europe country-specific circumstances will be prevalent, decreasing the efficiency of the Central IT-option. It might pose high costs for development and maintenance and is mainly suitable for markets with a high number of participants and transactions.

Long-term IT-solution for a European Scheme

A Central IT-solution (option 6) for all services in Europe might be a suitable long-term solution from IT-perspective since it pushes harmonisation and standardisation across Europe and simultaneously avoids duplication of organisational efforts. The level of centralisation is open for investigation, several business processes might still be performed on national level, e.g., the registration of production plants. However, the development phase of such an IT-solution is highly complex. Especially during a transition phase, the synchronisation of the Central IT-solution with IT-systems of National Organisations, where already established, will pose complexity and possibly additional costs. Experiences with a similar IT-solution in the EU ETS sector has shown that development might take years or up to decades. For countries with no system and market established yet, the connection to a Central IT-solution will provide guidance and support, overcoming the challenge of developing a tailor-made national IT-solution. The implementation of a Central IT-solution may need legislative support (national and/or European).

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2 Background & introduction

2.1 Objective of REGATRACE Deliverable 2.4

Fundamental basics for Europe-wide title transfers are the IT-systems of National Organisations (national biomethane registries, issuing bodies and biofuels registries/databases, for definition see chapter 8 Glossary) which shall be designed to not only oversee the national markets but also to pursue a European market by being connected to a European IT-option, underpinned by a European Scheme. This report focuses on the analysis of IT-options to interconnect such National Organisations via a standardised interface to enable efficient and trustworthy cross-border title transfer of renewable gas certificates.

According to the Grant Agreement of the REGATRACE Project, Task 2.3 of the REGATRACE project will investigate and evaluate the requirements and options for establishing the IT-systems for secure, reliable and transparent cross-border title transfers of biomethane/renewable gas certificates. The FaStGO project (Facilitating the Standardisation of GO) focuses on "*Technical support for RES policy development & implementation. Establishing technical requirements & facilitating the standardisation process for guarantees of origin on basis of Dir (EU) 2018/2001*". The FaStGO project includes the task „Developing IT Systems Specification", which will include a report on a vision for a future IT infrastructure, a data transfer protocol for multi-energy carrier and multipurpose certificates and a high level IT-system requirements specification. The parallel developments, both in terms of time and partly in terms of scope, called for explicit dialogue between the authors of both reports of the FaStGO and REGATRACE projects. The explicit differences in starting points of the reports show that FaStGO builds on how the existing system for standardised and automated multivolume cross-border transfer of electricity certificates can develop to a next stage while incorporating certificates for gaseous and thermal energy carriers, whereas REGATRACE focuses on evaluating different IT-options for title transfer of renewable gas certificates.

The following chapters of the present report investigate and evaluate different IT-options which enable the European cross-border title transfer. Six IT-options in a broad range of advancement and complexity are described:

- Standardised data exchange without dedicated database;
- Standardised data exchange with simplified database;
- Bolt-on module;
- Platform for information exchange;
- Centralised communication hub;
- Central IT-solution for all services.

These options are investigated based on a SWOT and rough cost-benefit-analysis and evaluated from the point of view of National Organisations. In particular, the processual, administrative, technical, and organisational requirements will be determined, which may be applicable for all participating national issuing bodies/registries. Finally, a comparative analysis, providing an outlook on the most viable IT-option for cross-border title transfers for biomethane/renewable gas certificates is performed.

REGATRACE, and especially this present report, addresses countries and organisations engaged in establishing a national renewable gas market and connecting to the European market. European exchanges of power GoOs have been performed for almost two decades and the experiences gained by AIB and its members shall support the kick-start of the European certificate exchange of renewable gas consignments. However, REGATRACE takes into account the current status of the renewable gas market

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that is yet to evolve and presents several particularities and differences to the electricity sector. For detailed information on the renewable gas market, please see REGATRACE report number D6.1 *Mapping on the state of play of renewable gases market in Europe* (https://www.regatrace.eu/wp-content/uploads/2020/04/REGATRACE-D6.1.pdf). There are 19 biomethane-producing countries in Europe. In ten countries, Biomethane Registries have been established and in eight countries Issuing Bodies have been appointed. REGATRACE works with eight target countries on establishing their national market including registries/Issuing Bodies. The authors perform the evaluations from the point of view of these National Organisations who represent the audience for the present report. The present report provides necessary insights into the IT architecture, infrastructure, and framework to connect a National Organisation to an IT-solution for European cross-border title transfer of renewable gas certificates.

At a later stage within the REGTRACE project, a techno-economic analysis will be conducted based on the most promising IT-option in Deliverable 2.8 "Techno-economic feasibility study on a harmonized system for cross border title-transfer of the renewable character of gas in Europe".

2.2 Application purposes for renewable gases

Renewable gases are flexible energy carriers, which can be used for different application purposes. In relation to the renewable characteristics of the gas, the producer of renewable gas may decide to sell this renewable value in a broad set of purposes. However, any double/multiple applications of the renewable value shall not be possible. The tracking and documentation of the production, title transfer and consumption of the renewable value of such renewable gases is performed via certificates. Different purposes require specific characteristics regarding the certification of the whole chain of custody. Some purposes directly derive from European and national framework conditions, while others are market driven:

- Article 19 of the RED II which extends the system of Guarantees of Origin (GO) for consumer disclosure to cover renewable gases.
- The Articles 25-30 of the RED II which extend sustainability criteria for renewable energy use in several sectors (transport sector, heating sector, etc) in combination with target compliance.
- The Fuel Quality Directive which refers to sustainable biofuels for the transportation sector, setting specific national and European quotas.
- Consumption of renewable gases for marketing purposes e.g. in chemistry and other applications.
- Self-commitment of consumers and industry to use a certain share of energy from renewable resources or to reduce greenhouse gas emissions.

The afore-mentioned application purposes of renewable gases and newly evolving purposes in the future, require secure, trustworthy, and transparent Europe-wide tracking systems. Such different purposes require renewable gases to be documented via different certificate types and there is a broad range of organisations operating on national and European level fulfilling the related tasks for the documentation. To prevent double/multiple counting and track renewable gas in a secure, trustworthy, and transparent manner, a European system for cross-border transfer is required and solutions are necessary as soon as possible.

Currently, several different organisations are operating with the responsibility for tracking and documenting renewable gas for specific purposes on national level:

- According to Article 19 of the RED II, with the purpose of consumer disclosure: presently, the transposition of the RED II into the Member States' national legislation is ongoing and the governments' decisions on designating bodies for issuance of renewable gas GOs are pending in most Member States. Decisions have already been taken in AT, BE (Flanders & Wallonia), DK, EE, FR, IT, LT, NL.
- According to the Fuel Quality Directive, which refers to sustainable biofuels for the transportation sector, setting specific national and European quotas. To track the chain of custody of sustainable biofuels and to allocate the used energy amounts towards the national biofuels quotas, several Member States have established a dedicated database or registry system, among them AT, DE, EE, NL, SK, UK.
- Biomethane registries have been operating in several countries to track biomethane/renewable gases. They are operated for different purposes, e.g. to provide certificates as proof for national subsidy schemes (different forms possible: investment/production/consumption subsidies) or on market initiatives to fulfil the purpose of self-commitment and/or marketing. Such registries are established in AT, CH, DE, DK, EE, FI, FR, LT, NL, UK.

In some countries, National Organisations are responsible for one specific purpose, while in some others, organisations are appointed to take responsibility for several purposes. In the case of different responsible National Organisations being entrusted with the documentation of renewable gases for different purposes, cooperation agreements and IT/communication interfaces may be implemented to prevent any possible double/multiple counting. Such cooperation agreements shall be of the goal to facilitate information exchange on the respective energy amounts and quality of the energy carrier.

Some National Organisations responsible for the documentation of injection and title transfer of renewable gas via biomethane certificates, referred to as Biomethane Registries, are already connected by means of several bilateral agreements that support cross-border title transfer:

- Bilateral agreements between the biomethane registry operators for biomethane certificates: AT <-> DE, DE <-> DK, DE <-> UK;

- Bilateral agreements between the biofuel registries operators for sustainable biofuel consignments: AT <-> DE.

A more sophisticated way to connect National Organisations and enable cross-border title-transfers is within the framework of European Schemes. More details on the design and functions of European Schemes from organisational point of view will be provided in REGATRACE task 2.4. The following chapters present and investigate different IT-options which support the establishment and consequent operation of such common European Schemes.

2.3 Scope, structure, and IT-solutions for title-transfer

2.3.1 A European Scheme for cross-border title transfers
European legislation encourages Member States to facilitate the Europe-wide cross-border title transfer of renewable gas consignments, specifically the exchange of GOs according to Art 19 of RED II and the exchange of sustainable, gaseous biofuel consignments. In order to track the movement of the green value of renewable gases in a secure, trustworthy and transparent manner, the market requires a European tracking system for cross-border transfer and exchange of renewable gas certificates now. Stakeholders, such as the European Renewable Gas Registry (ERGaR aisbl) and its members, some of which are national biomethane registries and designated Issuing Bodies for gas GOs by governmental

mandate, and the Association of Issuing Bodies (AIB) and its members which are all designated Issuing Bodies for electricity GOs by governmental mandate, and several are issuing body for gas GOs, either by governmental mandate or under a voluntary scheme, have set themselves the target to provide solutions as soon as possible.

RED II specifically empowers Member States to take decisions on their national renewable gas market design. Thus, National Organisations shall take up designated roles to overlook the markets while a European connection of these National Organisations will be necessary to enable cross-border title transfers. All possible application purposes require a Europe-wide tracking system in order to support an integrated European energy market. Such a tracking system has two main pillars, comprising the (IT-)technical and organisational structure, as illustrated in Figure 2.

The organisational structure is usually governed by a European Scheme, either developed on market initiative or based on national or European legislation. Task 2.4 will describe the organisational structure of such a European Scheme, providing insights on the purpose of a European Scheme as well as guidelines on the steps and documentation necessary for National Organisations to connect to a European Scheme.

Such Scheme Rules are usually underpinning the operation of the necessary (IT-)technical infrastructure, for which REGATRACE *Task 2.3 "Prepare for the IT systems to facilitate reliant and efficient cross border title transfer of European biomethane/renewable gas certificates"* will provide insights in this present report.
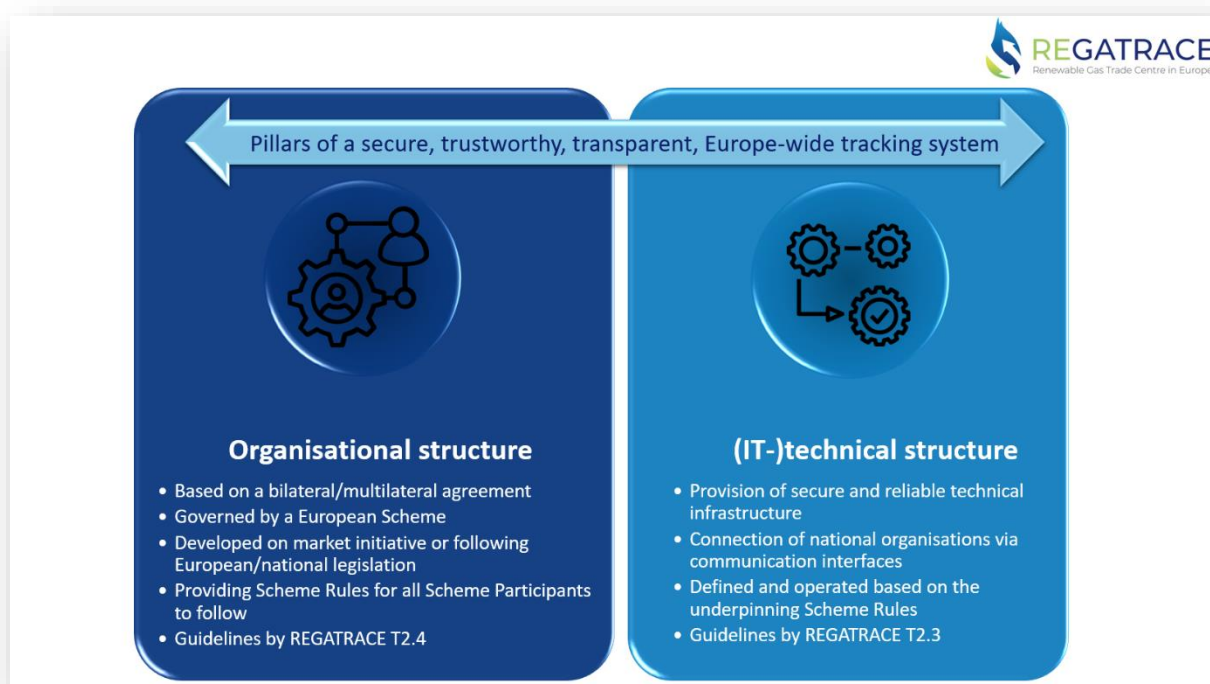
Figure 2: Pillars of a secure, trustworthy, transparent, Europe-wide tracking system

2.3.2 Organisational structure of a European Scheme

Since renewable gases may be applied to different purposes (quota obligation, tax exemption, consumer disclosure, etc.), a broad range of organisations may be operating on national and European level fulfilling

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the related tasks of documentation. Amongst others, the organisational structure for a European Scheme is shaped by the scope, legal basis, and the purpose of the title-transfer.

To allow cross-border exchanges of renewable gas consignments, the respective, responsible National Organisations may be connected in different ways: i) as is currently (Q3 2020) the case in the renewable gas sector, bi- or multilateral agreements are possible, while ii) connecting the National Organisations via a European Scheme by becoming "Scheme Participants" is considered a more efficient solution. A central Scheme per application purpose provides several advantages, as it prevents the risks of double/multiple counting, allows the establishment of harmonised and transparent processes for all Scheme Participants, and reduces overall system costs. A robust and harmonised scheme, governed by a central organisation (the Scheme Operator), allows a structured administration of cross-border transfers and the respective energy amounts and quality criteria.

The related contractual relations of the two described options are depicted in Figure 3. One of the main targets of the REGATRACE project is to support its target and supported countries in establishing the necessary framework and tools for their domestic renewable gas market. When establishing national Issuing Bodies and National Biomethane Registries, the documentation provided by the Scheme will pay off immensely in simplifying all necessary steps and reducing the related investment and operational costs.
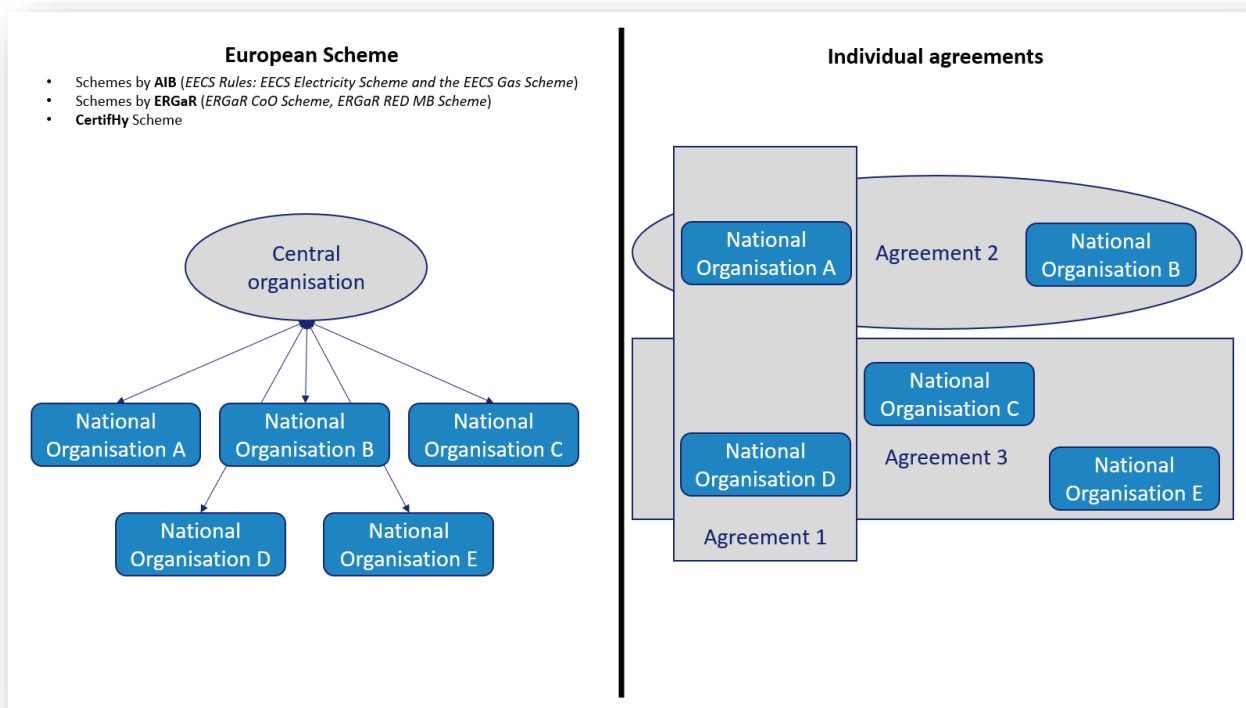

Figure 3: Schematic presentation of a common European Scheme (left) vs. individual agreements (right)

2.3.3 IT-options for a European Scheme

Respective IT-services are required in addition to the organisational structures to connect National Organisations beyond national borders.

The established National Organisations have already developed national IT-systems supporting their national requirements, including technical interfaces for automated information exchange between those systems. Most of these systems have been developed as bespoke inhouse products (UK, DE, AT, NL), but the use of common platforms such as Grexel (DK, FL, FR) is also possible. The Grexel IT-system (www.grexel.com) is applied in the power and gas sectors to provide registry systems.

These IT-systems are typically account-based web applications accessible via a public browser. Since many of these systems have been developed recently, they rely on individually designed databases and software modules. The blockchain technology has been explored in the Netherlands by Vertogas, the operator of the Dutch renewable gas registry and Issuing Body.

In order to connect the national IT-systems with each other, a future-proof IT-solution is required. Such a system shall include a variety of requirements to overcome technical difficulties in connecting differently designed national IT-systems. This particularly shall reflect functions, such as data exchange, using different channels, data formats and business processes to conduct an exchange of the renewable gas certificates.

The output of this REGATRACE task will be an investigation and evaluation of the options for IT-systems that connect National Organisations, when becoming Scheme Participants, and to enable cross-border title transfers of renewable gas certificates. Based on qualitative analyses (e.g.: potentials/limitation analysis, SWOT analysis), the different IT-systems are described and compared. The present report provides insights for the consideration of existing and future National Organisations, such as Issuing Bodies, Biofuel Registries/Databases, Biofuel/Renewable Gas Registries and other organisations responsible for exchange of renewable gas certificates and track of the green value of renewable gases. There may be different European Schemes for different purposes and energy carriers (e.g., GOs for renewable gases vs PoS for liquid and/or gaseous biofuels) which this present report will also address in relation to the connection of the IT-systems of these Schemes.

2.4 European cross-border title transfers

2.4.1 IT-system: possible setup design

To execute a secure and reliable cross-border transfer, the active involvement of at least two counterparties is necessary, one exporting and one importing. Three main architectural IT-options exist for such transactions: centralised, decentralised and a hybrid of the two.

When connecting existing, national IT-solutions, such as the IT-systems of renewable gas registries and Issuing Bodies, the key requirement is the interoperability of the connecting infrastructure with the national IT-solutions. The fundamental aspects of the IT-solution which have to be standardised within the European Scheme are:

- Design of IT-system;
- Standard exchange process including harmonised requirements for the exporting/sending and importing/receiving party;
- Standardised exchange format.

Decentralised, National Organisations maintain a domestic registry system with functions such as to document renewable gas consignments and especially their renewable characteristics. Following, those national systems have to be interlinked with each other. The organisational aspect of connecting National Organisations is performed by them to become Scheme Participants (for definition see chapter 8 Glossary) by 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 described in this report (see chapter 4 Investigation and evaluation of IT-options). 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 confirmed by all involved entities particularly the Scheme Participants. This is fundamental to reproduce the related business processes continuously, securely and with the least efforts.

The second option is to establish one **centralised IT-solution** for all European countries/EU Member States which fulfils standardised requirements and is the single system to be used for documenting national production volumes, as well as transfers between market participants including cross-border transactions (see chapter 4.7 Central IT-solution for all services). Such a solution is highly efficient from an IT-technical point of view. All processes, data structure, graphical user interfaces and user access, regardless of the country of application, are harmonised, respectively standardised. Still, national specifics can be considered, but only to a limited extent, as the system is mainly designed to function equally for all its participants. The Union registry to document emission titles for the Kyoto protocol poses an example (further information under https://ec.europa.eu/clima/policies/ets_en). Each country has a dedicated login into a single platform which reduces the need to maintain national systems. Of importance is the standardisation of the datasets and processes executed. By defining clear and precise compliance targets, a standardised product, which can be more easily operated in a centralised manner, is indirectly defined.

A **hybrid IT-solution** combines both, a centralised IT-solution that documents and issues certificates for national production devices and interfaces to national systems for the cross-border transfer of certificates between Scheme Participants.

Blockchain takes up a specific role, as it may be applied as peer-to-peer solution for National Organisations to communicate directly or also as the communication technology by a centralised organisation to which all Scheme Participants are connected.

2.4.2 Standardised data exchange

Due to blending of fossil and renewable gas molecules, the issuance and administration of certificates provide a simple and robust solution to differentiate between the renewable and fossil origin of the gases. The certificates reflect the special value of "green" gases, as compared to the fossil equivalents. This special value is amongst others related to being renewable and environmental-friendly to support climate protection and circular economy.

The characteristics of renewable gases, their origin, type of input material (substrates), production process and period, details on grid injection and particularly their green, intrinsic value are documented on a renewable gas certificate (see Figure 4). The centrepiece of a renewable gas certificate is the list of attributes which hold the relevant information. Attributes are essential to the overall value of the renewable gas, as different characteristics may generate different monetary values for renewable gas producers.

Definitions of renewable gas certificates and Guarantees of Origin are provided in chapter 8 Glossary. Content of a certificate and list of necessary attributes are explained in previous reports published by the REGATRACE consortium:

- Deliverable 2.1 Updated Guidelines for creating the European Biomethane GoO: https://www.regatrace.eu/wp-content/uploads/2019/11/REGATRACE-D2.1.pdf
- Deliverable 2.2. Report on content and attributes of GoO: https://www.regatrace.eu/wp-content/uploads/2020/03/REGATRACE-D2.2-new-version.pdf
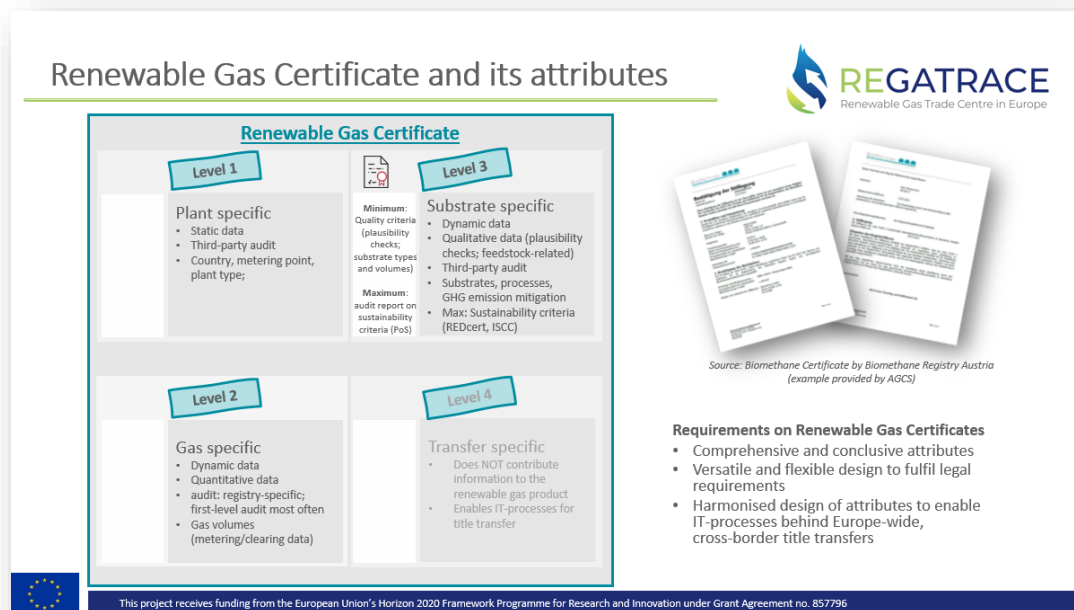
Figure 4: Illustration of the four attribute levels of a Biomethane Certificate; comprises the relevant information for a Renewable Gas Certificate

Scheme Participants are responsible for delivering data according to the standardised exchange format and they commit themselves to accept only data provided in the same standardised exchange format. The data format could be a simple table or excel file which is easy to be filled-in and handled manually by sending and receiving Scheme Participants, or it could be a more sophisticated data format which requires programming efforts to fully automate transactions including exports and imports of certificates. The data exchange format comprises the attributes of the certificate (attribute levels 1-3, see Figure 4) and, additionally, the transfer-specific data (attribute level 4, see Figure 4) which allow for the (semi-)automatic transfer IT-process. An example data exchange format is given in Figure 5. Information provided has been blurred for reasons of data protection, however the structure of a data exchange format becomes clear. The data exchange format may comprise transfer-specific data such as:

- ID-number of the certificate,
- ID-number of transferred data package,
- Unique identification of sending market participant,
- Unique identification of receiving market participant,
- Unique identification of sending Scheme Participant,
- Unique identification of receiving Scheme Participant,
- Transaction date.

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Figure 5: Illustration of an example data exchange format (blurred due to data protection)

In order to allow a harmonised transfer of specific data, the exchange processes have to be clearly defined in the European Scheme. Each process step has a dedicated underlying function, whose design is dependent on the dedicated IT-option. Different IT-options are described and investigated in detail in chapter 3.5. The sum of processes and actions are part of a workflow, which needs to be agreed and executed by each Scheme Participant to fulfil an exchange process.

A simple solution could be E-Mail exchange via a provided list of E-Mail addresses for each Scheme Participant. In a more sophisticated and state-of-the-art IT-option, a password protected access may be provided to each Scheme Participant to access a web-based IT-solution. In the latter case, a Scheme Operator is responsible for operation and maintenance of the IT-solution, but the operation can also be handled by a contracted IT-provider.

2.4.3 Business processes

It has to be understood that the IT-solution is only a means to the end, i.e. it is a tool, underpinning the Scheme itself. To describe the required specifications of the IT-solution, the business processes and the framework, in which the IT-solution is embedded, have to be defined. The organisational framework for the set-up of a European Scheme comprises actions on processual, administrative, organisational, technical, and financial levels. The Scheme Operator and the Scheme Participants will have to perform certain actions on these levels for the go-live of a European Scheme.

A set of actions are listed in Table 1. REGATRACE is especially considering its target countries who first face the challenge of establishing a National Organisation, before being able to connect to a European Scheme to allow cross-border title transfers of renewable gas consignments. Although the actions will vary in each National Organisation when becoming a Scheme Participant, REGATRACE Task 2.4 provides a broad set of guidelines for National Organisations.

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Table 1: Overview of requirements on processual, administrative, organisational, technical, and financial level (for more information see REGATRACE T2.4)

PROCESSUAL	ADMINISTRATIVE	ORGANISATIONAL	TECHNICAL	FINANCIAL
Scheme Operator Level				
Development of specific set of business processes for the exchange processes between Scheme Participants	Definition of rules for registration of National Organisations to become Scheme Participants	Development of Scheme Rules	Definition of standardised processes, exchange format, including provision of technical guidelines and specifications	Definition of financial rules (registration fee, annual participation fee, transaction fee, etc.)
Provision of reporting and monitoring processes during the operation	Definition of audit requirements for Scheme Participants to proof that they are able to adhere to the necessary business processes	Development of contractual framework (Participation Agreement as contract between Scheme Operator and Scheme Participant)	Definition of standardised communication channel, including provision of technical guidelines and specifications	
		Development of sanction system in case of non-compliance	Definition of a standardised data storage and processing including monitoring	
Scheme Participant Level				
Development of specific set of business processes within the system of the Scheme Participant	Registration at the common Scheme, including the proof of adherence to the Scheme Rules on organisational, processual, administrative,	Provision of auditing reports	Implementation of processes and functions to accept the standardised exchange format for imports and exports	Proof that financial means for joining the European Scheme will be fulfilled

PROCESSUAL	ADMINISTRATIVE	ORGANISATIONAL	TECHNICAL	FINANCIAL
	technical, and financial levels			
Provision of relevant information to market participants: handbook explaining functions and processes for market participants	Provision of relevant information to market participants: present information on European Scheme on website	Legal aspects: preparation of the contractual framework: information on the operation according to the European Scheme shall be integrated in the rule book (e.g. terms and conditions) of the National Organisation	Implementation of processes and functions to apply the standardised communication channel	Adjustment of fee regulation
	Implementation of new business processes into internal documentation (quality management)			

The operation and maintenance of a National Organisation is based on a broad range of business processes. Depending on the national IT-system and the chosen IT-option for cross-border title transfers, business processes may be performed manually or (semi-)automatic. Chapter 6.8 of REGATRACE report *D3.1 Guidelines for establishing national biomethane registries* (https://www.regatrace.eu/wp-content/uploads/2019/11/REGATRACE-D3.1.pdf) describes the main processes to be maintained at a National Organisation. Even if the National Organisations differ in their set up and may comprise differing scopes, there are core processes and functions, which are prerequisites for the operation of a related IT-system. Such business processes could comprise:

- Registration of market participants
- Provision of contractual framework
- Maintenance of master data
- Generation of certificates, including data provision for the four levels of attributes (see Figure 4) from different sources (metering values, auditing information, etc)
- Operative tasks, including first-level support
- Publication of information and statistics, providing transparency while protecting personal data of market participants
- Depending on the scope of the National Organisation, these actions must be performed for the respective application purposes which lie in the responsibility of the operator.

In order to establish an interface from an existing National Organisation (renewable gas registry/issuing body) to a European Scheme and the respective IT-infrastructure, National Organisations need to perform adaptations at different levels, including legal, technical, processual and administrational level. Further details on the necessary steps to establish an IT/communication interface and the related business processes for its maintenance are elaborated within REGATRACE Task 2.4 *Establish communication interfaces between the hub and the participating national registries/issuing bodies*. Business processes specific to Europe-wide cross border exchanges of renewable gas certificates comprise:

- Handling of registration processes for international stakeholders
- Handling the business processes for the IT/communication interface

  ♦ Handling of processes for import of certificates
  ♦ Handling of processes for export of certificates
  ♦ Handling of Cancellation/Withdrawal Certificates
  ♦ Monitoring of exchange processes
  ♦ Change, deletion, or inclusion of data (attributes) from the exchange process
  ♦ Handling of errors and corrections of certificates

- First-level support to stakeholders
- Communication with Scheme Operator
- Support Case with operator's IT-solution
- Communication with other Scheme Participants
- Validation of auditing reports (production plants and certificates)
- Maintain statistics and data on European exchanges (import/export level)
- Release process for new software version of operator's IT-solution

Business processes solely performed by the Scheme Operator to maintain the European IT-solution of the underpinning European Scheme are:

- Development, publication, and regular update of Scheme Rules
- Development, publication, and regular update of the template of Participation Agreements
- Handling of registration processes for National Organisations, when becoming Scheme Participants National Organisations, when becoming Scheme Participants
- Communication with and first-level-support for Scheme Participants
- Responsibility for the operation, maintenance, and security of the IT-solution, which the Scheme Operator may perform itself or may commission another party (possibly an IT-provider under a Service Level Agreement) for
- Handling exchanges of European certificates between Scheme Participants
- Responsibility for closing the mass balance for application purposes, where mass balance is a pre-requisite, e.g. sustainable biofuels
- Handling of Cancellation Certificates
- Maintenance of respective database and statistics
- Changing certificates in emergency situations (correction and emergency processes)
- Execution of audits, if applicable
- Release process for new software version of Scheme Participant

2.5 Modes of delivery

2.5.1 Introduction

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

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,
- validity periods of the certificates,
- collection and recording of evidence on withdrawal of renewable gas from the grid.

2.5.2 Concept of Book & Claim

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

European Schemes are concerned with title transfer between points of production and consumption within Europe, as defined geographically or by membership of institutions and frameworks, e.g., EU, ETFA, EEC. This introduces an element of restriction, but looking at examples such as the mutual recognition between Members States required by RED II for GO, these are types of book and claim systems, where no proof of the link to the physical product is required at the point of withdrawal and certificate cancellation.

Other restrictions that must be accounted for in the Certificate information, scheme structure and IT-infrastructure are that GO under RED II will also have a time restriction to their trading and cancellation.

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

2.5.3 Concept of Mass Balancing

Mass balancing is described in detail in Article 18 of the Renewable Energy Directive I (2009/28/EC), which creates 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).

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, https://bit.ly/3hpLMEF).

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Any Scheme must therefore ensure it gives its users (Scheme Participants, economic operators/market participants) the tools to provide evidence of the connection between the physical product and proof of sustainability. 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 gas volume) and location of the renewable gas withdrawn from the grid.

The validity of a certificate will face further restrictions, as mass balancing must be performed within a maximum of a three-months-period, so Schemes will need to meet any requirements this creates for rapid issuing, transfer and cancellation of certificates.

2.6 Status quo / current systems

Europe-wide systems, comprising the necessary organisational and IT-structure, have been in operation or are currently under development for different energy carriers and different application purposes. Different schemes and respective IT-solutions enable cross-border title transfers which are operated following the related Scheme. Figure 6 illustrates the existing schemes and IT-systems. The organisations responsible for their development are stated including some basic information on the systems. This report focuses on IT-options to connect National Organisations handling renewable gas certificates but also creates awareness to the possible future need to interlink the IT-solutions of existing Schemes. From a business point of view, this may result in a single and standardised interface to the National Organisations for each Scheme Operator, and on the other hand provide a single interface between Schemes to enable proper automatisation and standardisation even between different European Schemes.
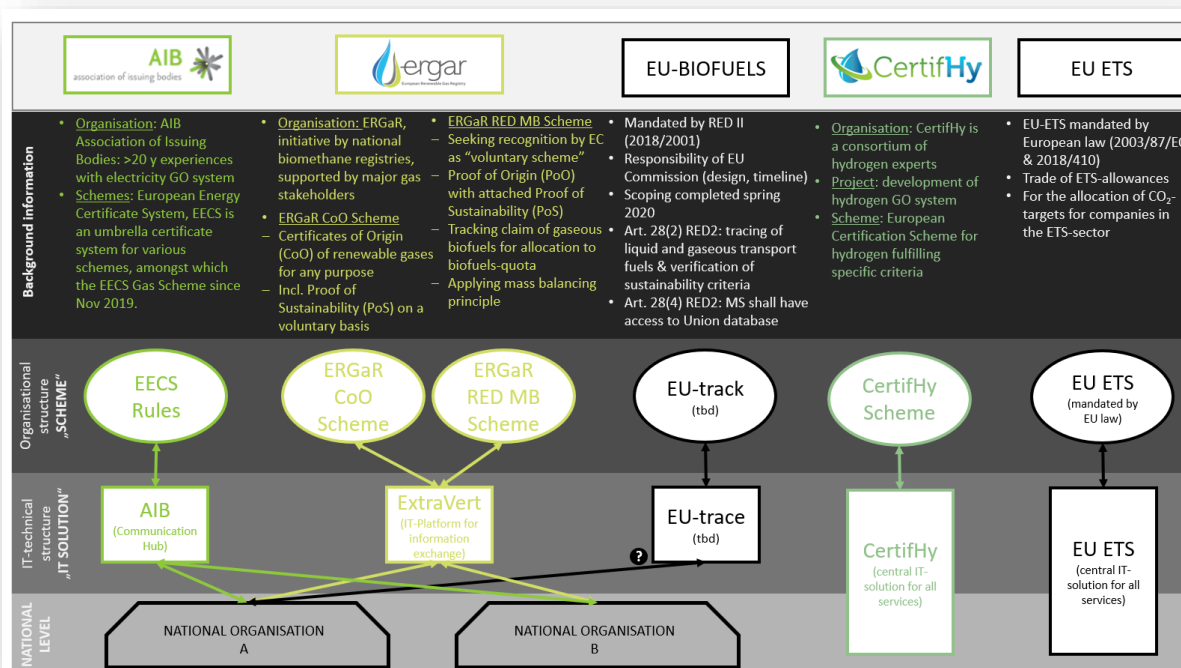
Figure 6: Graph on existing Schemes and related IT-solutions

Figure 6 presents the complexity of the future renewable gas market when considering at least four different organisations are ready to operate Schemes. All Schemes provide for the same renewable gas consignments (energy amounts and gas volume, respectively), while different rules and requirements exist. This even increases the risk of multiple counting. Therefore, any cooperation between the Schemes should be as efficient as possible, considering the requirements and obligations also National Organisations have to prevent double/multiple counting. REGATRACE tries to tackle this challenge in its task 2.2, which aims at creating the REGATRACE Network, a platform for information exchange, communication, and collaboration of responsible organisations.

The states in each country vary significantly based on the development of the national market and the integration of European legislation into national acts and regulation. The set-up does have a high impact on the time, costs, and efforts to connect to European Schemes.

3   Methods

3.1   Sources and expertise

The authors of this report have comprehensive experience in the implementation and administration of IT-solutions for the exchange of data with other parties and IT-solutions. AIB has used resources and expertise from its EECS Gas Scheme Group and ERGaR involved its experts from its Technical Working Group. Additionally, in Q1-2 of 2020, interviews were held with experts of the sector (commodity traders, operators of National Organisations, operators of comparable national and European IT-systems, market participants) to identify potential IT-options that shall be further described and analysed and gain deep insights into their requirements. The results of those interviews will be fed into several REGATRACE reports.

3.2   Research scope

This report provides an overview, investigation and evaluation of IT-options for harmonised European cross-border title-transfer of biomethane/renewable gas certificates. The identified IT-options will be evaluated from the point of view of National Organisations seeking to become Scheme Participants. Consequently, a comparative analysis, providing an outlook on the most viable IT-option for cross-border title transfers for biomethane/renewable gas certificates, will be performed.

3.3   Identification of IT-options

In chapter 2.4 *European cross-border title transfers*, particularly chapter 2.4.1 *IT-system: possible setup design*, the authors briefly introduced options of title transfers, either i) via connecting National Organisations to a European Scheme and respective IT-structure, ii) via a centralised IT-solution without stand-alone system on national level, or iii) in a peer-to-peer solution, such as the blockchain technology. The respective chosen IT-solutions are listed in Table 3.

3.4   Performance of evaluation and analyses

In the second step, the IT-options are fully described, requirements are identified in terms of processual, administrative, technical, and organisational aspects. For each of the described IT-options, these requirements were listed and described from the point of view of the National Organisations (national issuing bodies or registries), anticipating becoming Scheme Participants. A SWOT analysis was conducted, evaluating the four aspects of Strengths, Weaknesses, Opportunities, and Threats of each IT-option. Furthermore, the costs and benefits were assessed. The costs of the IT-solution for a European tracking system comprise two main parts: (1) development (CAPEX) and (2) operational costs (OPEX). The former is composed of the development and implementation of the IT-option, including system specifications, software development, specifications of the interfaces to the National Organisations, live-tests, and go-live actions. The latter arise throughout the lifetime of the system itself. Usually, an annual hourly pool is decided upon covering first and second level support. Operational costs may rise, depending on the actual need for support considering the implemented procedures and the extent of the system being used. Finally, activation guidelines were elaborated which consider the integration of the respective IT-option into the European (renewable) gas market. The results of the described evaluations and analyses are presented in chapter 3.5 Performance of comparative analysis.

3.5 Performance of comparative analysis

In the last step, a comparative analysis was conducted (see chapter 0) based on all presented IT-options, in order to identify the most viable one. The selection criteria (see Table 2) were assessed by the authors of this report, who are experienced in implementation and operation of IT-projects.

Table 2: Criteria catalogue for choosing the most viable IT-option for establishing the IT-systems for secure, reliable and transparent cross-border title-transfers of biomethane/renewable gas certificates

1. Criteria on **implementation phase** of IT-system and underpinning Scheme	
1.1 Implementation costs (CAPEX)	The costs for the start-up of the respective IT-option include (but not limited to) the following activities: 1. scope definition of the chosen IT-solution 2. development of the system specifications and flow diagrams, 3. tendering process to choose the software provider, 4. creation of a specification sheet for the implementation of the specific system requirements by the IT provider, 5. preparation of a template of the standardised exchange format, 6. programming work, 7. testing and implementation. In case of high costs during the start-up phase, these costs will be fully or partially charged by the Scheme Operator on the Scheme Participants via registration and/or transaction fees.
1.2 Complexity	IT-requirements from the perspective of necessary software and hardware define the complexity and level of advancement of the respective IT-option. In case of simple IT-options, the available software and hardware may be used (computers, Microsoft Suite or Open Source Programmes, E-Mail accounts, internet connection, IT-security) for the operation. Web-based IT-options may provide the advantages of centralisation, advanced IT-solutions while requesting a low level of additional software from Scheme Participants.
1.3 Time scale/efforts	The complexity of the respective IT-option highly influences the necessary time efforts before the start-up of the IT-system for the Scheme as well as the time efforts from each individual National Organisation to become a Scheme Participant.
2. Criteria on **operation phase** of IT-system and underpinning Scheme	
2.1 Maintenance costs (OPEX)	The costs during operation of the respective IT-option comprise the handling of business processes of the IT-provider and the regular maintenance of the IT-system, particularly concerning the work on change requests. The services and related costs are defined in the Service Level Agreement between the Scheme Operator and the IT-provider.

2.2 System operation	The operation of a system refers to its manageability, security, reliability, and robustness. High complexity and processes of manual character lead to challenges when it comes to the handling of the system, while automated processes ensure easy and secure handling.
	Liability issues have to be clearly defined within the Scheme Rules. If the Scheme Participants are in direct contact, liability issues have to be clarified between the respective parties directly. In case a centralised IT-option is chosen, the liability has to be clarified in a Service Level Agreement between the Scheme Operator and the respective IT-provider because all Scheme Participants have to trust on the operation of the system. Also, the possible fails over conditions in case of downtime should be robust and clear.
2.3 Complexity and robustness of business processes	Business processes shall be robust and reliable because they have to be repeated continuously. All Scheme Participants must be able to trust on the same level of quality in the performance of business processes. Scheme Participants may have different approaches to certain business processes, e.g. depending on the manual/automatic character. However, the level of quality and robustness as well as time periods of each business process have to be defined in the Scheme Rules.
	Data security and protection during transfer process and data storage shall be ensured at any time. It is also of importance that a harmonised level of security is ensured between all Scheme Participants. Technical and legal requirements set by national and EU-legislation, including General Data Protection Regulation (GDPR), have to be respected.
2.4 Democratic control of IT-system	The democratic control of IT-system describes the governance structure which can range from hierarchical (Scheme Operator has the power/is in control) to collaborative (Participating Schemes share power among one another).
	Scheme Participants may perform the Scheme governance in accordance with each other and the role and power of a Scheme Operator is diminished. Such a system seems only suitable for a low number of Scheme Participants who are in close collaboration.
	A high number of Scheme Participants will make the joint Scheme governance very complex and difficult. In that case, a neutral, central Scheme Operator shall take up the role of Scheme governance. The Scheme Participants shall still have the power and right to be part of the Scheme governance.
2.5 Usability	Usability refers to the degree of ease with which the system can be used. Moreover, usability describes the capacity of the respective IT-option to perform the defined business processes and fulfil the specified requirements in a user-friendly, efficient, and reliable way. All

	Scheme Participants must be able to trust on even quality levels in performance and ease of use to execute the Scheme Rules.
3. Outlook	
3.1 Future-proof system	On the one hand, the start-up of the IT-solution shall be quick and simple for the Scheme Operator and the Scheme Participants, on the other hand, it is of high importance to provide a future-proof IT-solution.
	The IT-solution shall apply state-of-the-art technology but shall also provide a system flexible enough to be equipped for an increasing number of Scheme Participants and easy implementation of further requirements (e.g. additional attributes or advancement of field types of the respective attributes). The scalability of the IT-option is part of providing a future-proof system.
3.2 Compatibility with national and EU policy framework	The IT-option shall be compatible with the European and national framework. All business processes must respect relevant policies and data security. The IT-option shall be acceptable to national policy makers and satisfy the needs of the involved market participants.

During the decision process, the authors of this report provided their evaluations by voting on each IT-option considering the mentioned selection criteria. The assigned scores ranged from 1 (very poor) to 5 (excellent). A conversation was held in a respective forum (in form of telephone conference due to COVID-19 security measurements) and substantial deviations (e.g., higher than 2 points per category) and peculiarities were discussed.

As the last step of this process, a joint statement was provided, supported by a score table (Table 25).

4 Investigation and evaluation of IT-options

4.1 Introduction

In a joint conversation of all authors, six IT-options on how to connect National Organisations to allow a European data exchange were chosen. An overview of these IT-options is provided in Table 3, which includes descriptions of each selected IT-option to allow for simple comparison.

Table 3: IT-options to be investigated and evaluated in REGATRACE Task 2.3

#	IT-options	Description
1	Standardised data exchange without dedicated database	This IT-option refers to a peer-to-peer solution in which National Organisations are communicating directly. There is no dedicated database in which transfers are registered or from which statistics are extracted. A centralised organisation (Scheme Operator) may or may not be available to support overseeing transactions and to develop harmonised rules on the exchange of information and format.
2	Standardised data exchange with simplified database	Scheme Participants submit information and data on the performed transactions to the Scheme Operator who documents all transfers and respective data sets in one sole, centralised database. The Scheme Operator bears sole responsibility over the database as a service to all participating countries. The database is considered as a transaction log enabling transfers analyses and statistics; however, it does not necessarily actively facilitate transfers. Such a simplified IT-option could be handled, based on an MS Excel or MS Access database. While the IT-technical and financial efforts are little, the manual processes might become exhaustive and difficult to keep in harmonisation.
3	Bolt-on module	A bolt-on module for automated processing of transactions may be integrated in the existing IT-system of a National Organisation who acts as IT-provider for this centralised module to which all Scheme Participants receive access to. The added functionality may work as a communication module between all National Organisations. The operator of the engaged National Organisation must take responsibility for servicing this module and providing additional services in form of customer support and single point of contact for the other Scheme Participants.
4	Platform for information exchange	A stand-alone transfer Platform providing secure (password-protected) electronic accounts for each National Organisation, where Scheme Participants transfer certificates based on upload and download of electronic documents in pre-defined, standardised format.
5	Centralised communication hub	An automated, stand-alone IT-solution to automatically exchange information/data packages between Scheme Participants based on standardised data formats and exchange protocols. Such a solution is required for fully automated and numerous data exchanges 24/7.

#	IT-options	Description
6	Central IT-solution for all services	One centralised IT-solution that handles all processes from registration of market participants to creation, transfer, and cancellation of renewable gas certificates. National IT-solutions might not be necessary anymore. A single European registry may be built based on straight forward rules and processes which are harmonised between all European, participating countries. All connected countries would have access to one centralised IT-solution, delivering all needed tools and requirements.

4.2 Standardised data exchange without dedicated database

4.2.1 Introduction: Definition of a "standardised data exchange without database"

This IT-option refers to a peer-to-peer solution in which National Organisations are communicating directly. There is no dedicated database in which transfers are registered or from which statistics are extracted.

A centralised organisation (Scheme Operator) may or may not be available to support overseeing the market. In case such a centralised organisation is implemented, its task is to provide a template for a pre-defined, standardised data exchange format, which was developed in agreement with participating National Organisations. For the purpose of reporting and creating statistics, National Organisations could submit their annual statistics to a responsible party or Scheme Operator who summarises all statistics. An annual report could be prepared even without having a dedicated database implemented.

Scheme Participants are responsible for delivering data according to the standardised format and they commit to accept only data provided in the standardised format. The data format could be a simple table or excel file which is easy to be filled-in and handled manually by sending and receiving Scheme Participants. In case of an agreement of a more advanced data format, which could be any specified IT-format (e.g.: Microsoft CSV, XML, flatfile, etc), the manual handling becomes more complex and prone to manual mistakes or typos and would thus require a more advanced IT-system to allow for a secure and reliable system.

Within the Scheme, also a standardised communication channel shall be agreed on. Via this channel, all exchange files and all communication shall be performed. No Scheme Participant should perform or accept any transactions via a different communication channel. As communication channel, simple E-mail exchange could be chosen. In this case, the Scheme Operator should maintain a list of specific E-mail addresses, assigned to each Scheme Participant. Another option would be the provision of a cloud or FTP/SFTP server where users may have access to and upload/download documents in dedicated folders.

4.2.2 Requirements: "standardised data exchange without database"

Table 4: List of processual, administrative, technical, and organisational requirements of "standardised data exchange without database"

PROCESSUAL	ADMINISTRATIVE	TECHNICAL	ORGANISATIONAL
Present business processes have to be expanded for European transfers.	Scheme Participants have to provide suitable information to national economic operators and market participants.	Low IT-requirements in hardware and software (Computer, internet connection, Mail Software, Excel from Microsoft, or Open Sources Software).	Low organisational requirements for training of present staff
Processes will be of manual character. Efforts by staff members have to be enhanced.	Validation of processes will be of manual character. Efforts by staff members have to be enhanced.	Little IT-efforts thanks to simple and quick system development and operation.	Little organisational efforts because no additional (technical) equipment necessary
		Little IT-efforts in adherence to standardised exchange format.	

4.2.3 Analyses and evaluations

Table 5: SWOT-analysis of "standardised data exchange without database"

STRENGTHS	WEAKNESSES
• Simple creation of exchange format • Simple transferring of exchange format • Low IT-requirements in hardware and software • No long and complicated harmonisation of IT-resources necessary • Low skill set for manual processes needed (no additional training) • Easy introduction to new or changing staff members	• Manual processes: prone to errors and typos or non-harmonised data sets • Low or non-harmonised data security (each Scheme Participant uses its own IT-resources) • Scalability is limited • Increasing activity demands more human resources • Further investments necessary for system upgrades • No monitoring/reporting control by a central database • Requires high coordination efforts of all Scheme Participants individually. • 24/7 operation usually not possible • No personalised transaction log

OPPORTUNITIES	THREATS
- Simple and quick set-up and implementation - Short preparation period for go-live - Low IT-requirements make low financial resources necessary - Simplicity of the IT-option allows for simple test runs to get to know the necessary functions of a European Scheme - Might be easily updated or exchanged with a more sophisticated system - Useful for kick-off phases	- Low or non-harmonised data security - Technology not up to date to current IT-standards in other sectors - No sophisticated IT-option; does not seem modern; trend goes towards highly advanced and secure systems; this might lead to low acceptance of Scheme Participants and Market Participants; - Non-sustainable systems considering that policies might request higher security - No "active" Scheme government by a Scheme Operator: lack of central governance in case of high number of Scheme Participants - Longer processing time in case of high number of certificate transfers

Table 6: Cost Benefit Analysis of technology "standardised data exchange without database"

COSTS (economic aspects)	BENEFITS
Lowest costs compared to other IT-options	Simple and quick implementation into existing system of a National Organisation
Low investments and operation costs for Scheme Participant	Low technical requirements for Scheme Participants
Low investments and operation costs for Scheme Operator which means only little or maybe even no costs forwarded to Scheme Participants	
High HR cost when amount of transfers increase	
Additional HR cost of Error rectification following manual handling	

4.2.4 Activation guidelines: Integration of "standardised data exchange without database" into the (renewable) gas market

Only low investment and operational costs arise for the Scheme Operator which means that only little costs will be forwarded to Scheme Participants. If only little or even no costs arise at all for the operation of schemes, registration fees and transaction fees might be reduced to a minimum. Still, the coordination efforts remain for harmonising the attributes and generate the simple exchange file.

Scheme Participants are confronted with little IT-requirements in hardware and software; the available IT-equipment comprising computers, internet connection, e. g. E-Mail software, Excel from Microsoft or Open Sources Software are necessary. Also test runs will be performed with limited time resources. This allows an easy and quick implementation on technical level.

The lack of a centralised IT-solution may lead to issues in security and liability. The described IT-option is very basic and probably not future-proof particularly related to the automatisation of processes. There are restrictions to scalability and the limitation of the system might be reached already with a low number of Scheme Participants and medium number of transactions because of significant manual processes requiring human staff.

Such an IT-option is mostly used in case of bilateral and multilateral agreements for cross-border transfer but most likely this IT-option will not be chosen by an established European Scheme. Since the Scheme Participants are in direct communication, only little power remains with the Scheme Operator who might not have an active, central role in governance or data collection. The current bilateral agreements between the operators of existing Biomethane Registries have implemented the procedures for their exchanges based on "standardised data exchange without database". This IT-option is applicable for the kick-off of a European market with a very limited number of Scheme Participants and transactions. The switch to a more sophisticated IT-option does not pose a lot of financial risks as the financial costs and the IT-technical efforts of this IT-option are generally low.

4.3 Standardised data exchange with simplified database

4.3.1 Introduction: Definition of a "Standardised data exchange with simplified database"

This IT-option may allow transfers as peer-to-peer solutions, such as IT-option 1, or the Scheme Operator could take up an active role. Data exchange files may be transferred from the sending Scheme Participant to the Scheme Operator as central party who forwards them to the receiving Scheme Participant. This way, the Scheme Operator is enabled to take notice of each transaction in real time and may document respective data in a central, simplified database. The Scheme Operator documents all transfers and respective data sets in one sole, centralised database. IT-option 2 implements a centralised, dedicated database and hence provides a higher level of harmonisation which represents the difference to IT-option 1. The Scheme Operator bears sole responsibility of the database as a service to all Scheme Participants.

This central database may be a very simple IT-solution, documenting all transactions. It may be operated with little technical efforts and little costs; however, the manual character of all processes is prone to errors and the efforts for personnel to maintain data and extract reports might be more intense. Such a simplified IT-option could be handled, based on an MS Excel or MS Access database. The database can be considered as a transaction log that allows to analyse the transfers; however, it does not necessarily facilitate transfer by itself.

4.3.2 Requirements: "Standardised data exchange with simplified database"

Table 7: List of processual, administrative, technical, and organisational requirements of a "Standardised data exchange with simplified database"

PROCESSUAL	ADMINISTRATIVE	TECHNICAL	ORGANISATIONAL
Present business processes have to be expanded for European transfers.	Scheme Participants have to provide information to national economic operators	Low IT-requirements in hardware and software (computer, internet connection, mail	Low organisational requirements for training of present staff

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and market participants.	software, Microsoft or Open Source software)	
Processes will be of manual character. Efforts by staff members have to be enhanced.	Validation of processes will be of manual character. Efforts by staff members have to be enhanced.	Little IT-efforts thanks to simple and quick system development and operation
		Little IT-efforts in adherence to standardised exchange format

4.3.3 Analyses and evaluations

Table 8: SWOT-analysis of "Standardised data exchange with simplified database"

STRENGTHS	WEAKNESSES
- Template for exchange format provided - Guidelines for data transfer provided - Low IT-requirements in hardware and software - No long and complicated harmonisation of IT-resources necessary - Low skill set for manual processes needed - Easy introduction to new or changing staff members - Data control by a central database (allows detection of errors)	- Manual processes: prone to errors and typos or non-harmonised data sets - Low or non-harmonised data security (each Scheme Participant uses its own IT-resources) - Higher efforts in communication with operator of database compared to other IT-options - In case of MS Excel or MS Access databases, individuality in data fields (attributes) is limited - Further investments necessary for system upgrades - No personalised transaction log;
OPPORTUNITIES	THREATS
- Simple and quick set-up and implementation - Short preparation period for go-live - Low IT-requirements mean low financial resources necessary - Simplicity of the IT-option allows for simple test runs to get to know the necessary functions of a European Scheme - Might be easily updated or exchanged with a more sophisticated system	- Based on manual processes: slower, prone to errors and higher internal labour costs - Lower data security compared to other IT-options - Technology not state-of-the-art compared to current IT-standards in other sectors

	This less sophisticated IT-option is not considered to be modern; the trend goes towards highly complex and secure systems; risk of low acceptance from operators of Scheme Participants
• Useful for kick-off phases	• This less sophisticated IT-option is not considered to be modern; the trend goes towards highly complex and secure systems; risk of low acceptance from operators of Scheme Participants
	• Non-sustainable systems considering that policies might request higher security
	• Scalability is limited

Table 9: Cost Benefit Analysis of "Standardised data exchange with simplified database"

COSTS (economic aspects)	BENEFITS
In the range of all described IT-options, low cost solution	Simple and quick implementation into existing system of a National Organisation
Low investments and operation costs for Scheme Participant	Low technical requirements for Scheme Participants
Low investments and operation costs for Scheme Operator which means only little costs forwarded to Scheme Participants	Centralised database: fosters standardisation, easy reporting, and development of statistics

4.3.4 Activation guidelines: Integration of a "Standardised data exchange with simplified database" into the (renewable) gas market

Only low investment and operational costs arise for the Scheme Operator, which means that only little costs will be forwarded to Scheme Participants. If only little or even no costs arise at all for the operation of schemes, registration fees and transaction fees might be reduced to a minimum. Still, the coordination efforts remain for harmonising the attributes, generating the standardised exchange file and maintenance of the centralised database.

Scheme Participants are confronted with little IT-requirements in hardware and software. Also test runs will be performed with limited time resources. This allows an easy and quick implementation on technical level.

The simple solution of a quickly developed database would enable fast exchanges and quick business processes. The setup of a central database and connection to each registry via clear and easy access can be done very fast with very low development time. The security and usability are higher in a centralised solution but clearly more expensive due to the administration of an additional tool by an entity. Operation of this IT-option should be taken over by the central Scheme Operator to make sure there will not be any liability and data security issues.

The described IT-option is very basic and probably not future-proof. There are restrictions to scalability and its limitation might be reached soon with a low number of Scheme Participants. This IT-option is rather applicable for the kick-off of a market and for a very limited number of Scheme Participants, however the switch to a more sophisticated IT-option does not pose a lot of risks as the financial costs and the IT-technical efforts are generally low. This approach should be envisaged only as an interim solution towards a more robust and automated IT-option which centralises tasks and processes.

4.4 Bolt-on module

4.4.1 Introduction: Definition of a "bolt-on module"

A bolt-on module for automated processing of transactions might be integrated into the existing IT-system of one National Organisation which acts as Scheme Operator and/or IT-provider. It may work as a communication module between the respective National Organisations of each country. The service operator of the IT-solution of the National Organisation is responsible for servicing this module and providing additional services in form of customer support and single point of contact for the other Scheme Participants.

4.4.2 Requirements: "bolt-on module"

Table 10: List of processual, administrative, technical, and organisational requirements of a "bolt-on module"

PROCESSUAL	ADMINISTRATIVE	TECHNICAL	ORGANISATIONAL
Changes in processes must be communicated in a timely and effective way so that every country has sufficient time for preparation and adaptation.	Administrative burden on one single Scheme Participants.	Higher technical efforts to reach compatibility with the existing National Organisation who will act as IT-provider (Scheme Operator).	One Scheme Participant takes up organisational responsibilities of operating the Scheme.
Each National Organisation needs to administrate an additional account in another registry with corresponding underlying business process	Administrative efforts by the Scheme Operator to process all applications and activation procedures.	Higher technical efforts during implementation and operation phases.	Existing staff members may take up additional responsibilities for scheme operation.

4.4.3 Analyses and evaluations

Table 11: SWOT-analysis of technology a "bolt-on module"

STRENGTHS	WEAKNESSES
- Build on knowledge and IT-system of established National Organisation. - The close collaboration among Scheme Participants for the implementation of this IT-option may lead to strong and long-lasting collaboration. - Manageable costs due to use of existing IT-system and current staff of National Organisation.	Conflict of interest: neutrality not fully given due to the operation of the centralised transfer solution by one of the Scheme Participants. In this case one Scheme Participant acts as the Scheme Operator and may be equipped with indirect power. One Scheme Participant bears all administrational, technical, and organisational costs.

- Relying on well-experienced staff and already established processes speeds up implementation phase.
- Medium usability standards, since each Scheme Participant may integrate functions individually.

- Risk of long and complicated upgrade to centralised and neutral solution.
- After evaluation of the existing IT-solutions of National Organisations, there might remain only be limited software solutions which would enable such a module.
- High dependency on single IT provider.
- IT-updates might not be easily implemented due to given limitation of IT-solutions of National Organisations.

OPPORTUNITIES	THREATS

- Build on knowledge and IT-system of established National Organisations.
- Lower initial investment costs compared to a stand-alone solution.
- Well-experienced staff and already established processes may allow quick integration of bolt-on module.
- Different level of velocity in the establishment of the bolt-on module is not of importance for the commissioning of the scheme. A small group of Scheme Participants may perform kick-off.

- High efforts for the registration and connection of new Scheme Participants because they have to be done on an individual basis. This may lead to high complexity and slow down the efforts of new markets/countries willing to connect.
- Useful only if a small group of Scheme Participants work together: this solution is not sustainable for a large group (Europe-wide) of Scheme Participants.
- Scheme Participants are highly dependent on Scheme Operator's IT-provider for the integration of the bolt-on solution. If the bolt-on module has a different user interface compared to the National Organisation's platform, then this may lead to a duplication of existing features and functions.
- Potential dependency and restrictions due to national (technical and legal) requirements.
- Scalability is limited: Seems suitable only for a limited number of Scheme Participants, as efforts increase significantly with each new Scheme Participant
- No "active" Scheme government by a Scheme Operator.
- At a later stage, the migration of data to a more proprietary solution could be challenging

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Table 12: Cost Benefit Analysis of a "bolt-on module"

COSTS (economic aspects)	BENEFITS
Initial investment costs are reduced compared to stand-alone solution.	An already proven system can be used as basis.
Investment costs of enhancement of existing/own IT-infrastructure are higher compared to a simplified solution.	Operational staff experienced with the processing of the IT-system as most probably will be done by experts of the National Organisation.
Update of the transfer system can require all underlying registries to correspondingly update their processes including IT, which decreases the flexibility of this IT-option.	

4.4.4 Activation guidelines: Integration of a "bolt-on module" into the (renewable) gas market

The implementation of this IT-option requires a bolt-on module to be installed at one of the existing IT-systems of the National Organisations taking part in the Scheme. It may only require a minor enhancement of the existing functionality of a given IT-system of a National Organisation.

First, the existing IT-solutions of National Organisations need to be evaluated to identify the one with the most sufficient capacity for a European Scheme. Furthermore, there might only be limited software solutions available which might be compatible with the current national IT-solution. During the preparatory phase, a close collaboration might be necessary between National Organisations to develop the suitable, standardised exchange format and processes.

In comparison to option 1 and 2, this IT-option provides a web-based and more user-friendly solution for National Organisations when transferring certificate cross-border. It is in the interest of the Scheme Operator to serve the Scheme Participants with simple and workable functions to execute the transfer processes. In case of such an IT-option, very little responsibility remains with the Scheme Participants, while the Scheme Operator must engage in high efforts for maintenance, communication, and services. Since one of the Scheme Participants takes up the role of IT-provider for the IT-solution and maybe even additionally as Scheme Operator there are high risks on conflict of interest. Furthermore, there is the risk that national and/or organisational circumstances for the operation and maintenance of the IT-solution change or stop against the Scheme Participant's interest.

The respective Scheme Participant will always have advanced knowledge of organisational and IT-requirements. The Scheme Rules and the organisational structure is of high importance to ensure an even, democratic control of all Scheme Participants within the Scheme.

4.5 Platform for information exchange

4.5.1 Introduction: Definition of a "platform for information exchange"

This IT-option refers to a stand-alone transfer Platform providing secure (password-protected) electronic accounts for each National Organisation, similar to a cloud system, where Scheme Participants upload

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and download the electronic document in pre-defined, standardised formats which allows them to transfer certificates.

The Scheme Operator provides the standardised exchange format to which all Scheme Participants must adhere to. The uploaded exchange file will be securely stored on the Platform until its download by the receiving Scheme Participant. The range of functions of such a Platform shall be defined by the Scheme Operator under agreement with Scheme Participants. The Platform may provide technical validation functions for the examination of uploaded exchange files. After positive or negative validation, the Platform may accept or reject the upload of an exchange file. Further, advanced functions may comprise a transaction log, automated communication, and reminder messages to Scheme Participants when transactions happen on a respective account, upload of additional files in other formats (e.g.: auditing reports in PDF-format), etc.

The Scheme Operator bears responsibility for the neutral operation, maintenance, and security of the Platform, which the Scheme Operator may perform itself or may commission another party (possibly an IT-provider) for. Contrary to IT-options 1 and 2, the Scheme Participant does not hold any direct responsibility for the operation of this IT-option. Each Scheme Participant receives at least one personalised account with the registration at the Scheme. To provide a connection to the Platform, Scheme Participants either receive a personalised login to manually access the system or receive activation guidelines in the form of an interface description to interact with the system. Such an IT-option may be used for a limited number of transactions and consequently primarily manual business processes will be applied. The accessibility of the Platform will be 24/7, but due to the manual character of business processes, the execution period depends on the individual Scheme Participants. Thus, there is no need for 24/7 availability of the IT-provider of the Platform.

The Scheme Participant is responsible for providing the renewable gas certificate in the pre-defined standardised exchange format. The Scheme Participant bears responsibility for all business processes on national level. It is up to the operator of the national IT-system to decide if internal processes should be performed on a manual basis or should be designed as (semi-)automatic processes.

4.5.2 Requirements

Table 13: List of processual, administrative, technical, and organisational requirements of a "platform for information exchange"

PROCESSUAL	ADMINISTRATIVE	TECHNICAL	ORGANISATIONAL
Higher efforts in development of, adaption to and operation of more advanced business processes.	Higher efforts in development and implementation phase. A tender procedure shall be performed to assure a neutral process.	More advanced and sophisticated IT-requirements than in simplified IT-options.	Organisational efforts for training of staff.
Higher efforts in managing a dedicated	Higher efforts in development and maintenance of	Higher technical efforts to reach compatibleness of	Higher organisational requirements due to the possible need of

account in the reporting centralised IT-platform.	individual interface design with centralised IT-platform.	additional (technical) equipment (depending on the design of the interface).
	Higher technical efforts during activation phase for the testing phase of business processes.	

4.5.3 Analyses and evaluations

Table 14: SWOT-analysis of a "Platform for information exchange"

STRENGTHS	WEAKNESSES
• Stand-alone, independent system • Harmonised conditions for all Scheme Participants • High data security provided by a centralised Platform (password protected, personalised access) • Consistent conditions for all Scheme Participants: templates and guidelines provided • Flexibility for the Scheme Participant in the set-up design of the communication interface • Possibility to upgrade to fully automated solution (bottom up) • Operation independently from National Organisations possible means less administrical burden on National Organisations • Individual solutions for interfaces to Scheme Participants are possible considering national phase of market integration/traffic	• Establishment of interface and go-live more demanding compared to simpler systems • Coordination efforts of all participants required • High initial costs which might have to be shared between all Scheme Participants • Potential technical dependency and restrictions due to national (technical and legal) requirements • Complexity for very small registries to connect to the Scheme Operator • Restricted number of fully automated processes and transactions • No direct/immediate information on the destination/purpose of the certificate from the receiving entity (e.g. information on fulfilling mass balance) • Transaction periods dependent on manual processes, thus no 24/7 availability of IT-provider necessary
OPPORTUNITIES	THREATS
• High flexibility considering different national (legal and technical) requirements • High flexibility considering new/updates in European legislation and requests on security • Potentials in scalability: suitable for a low and high number of Scheme Participants	• Technical and organisational complexity to provide interface with central Scheme Operator • All Scheme Participants are highly dependent on the IT-provider/Scheme Operator during the operation phase

- Scalability: suitable for a low and high number of Scheme Participants
- Evolvement and future-orientation of technology
- To become a Scheme Participant, the set-up of one single interface to the central Platform is possible while enabling the connection to all other Scheme Participants (with one interface, a broad market may be reached)
- Level of sophistication of the communication interface to be decided by the Scheme Participants themselves

Table 15: Cost Benefit Analysis of a "platform for information exchange"

COSTS (economic aspects)	BENEFITS
In the range of described IT-options, this "platform for information exchange" ranges in the middle.	Level of advancement at National Organisation to be decided individually; National Organisations do not influence each other's progress.
Higher costs for development and implementation of this IT-option compared to simplified IT-options.	Centralised Platform: fosters standardisation, easy reporting, and development of statistics.
Significantly lower costs than "centralised IT-solution" and implementation of "block chain technology" for all market participants Europe-wide.	Good usability standards, since each Scheme Participant may integrate functions individually.
Higher update and maintenance costs for the IT-solution which the Scheme Operator will divide between all Scheme Participants.	The stand-alone IT-solution offers neutrality to all Scheme Participants.
Higher staff costs due to operation of a centralised IT-solution by the Scheme Operator.	Scheme Operator shall serve as a knowledge centre for future Scheme Participants.

4.5.4 Activation guidelines: Integration of a "platform for information exchange" into the (renewable) gas market

A centralised Platform for information exchange requires low efforts for each Scheme Participant as only one interface (to the Platform) is required for the National Organisation, while it provides standardised exchange formats and activation guidelines for Scheme Participants.

From financial point of view, this IT-option requires higher resources as investments for the European Platform which have to be covered by all Scheme Participants and additionally investments in the IT-systems of the National Organisations are necessary. The initial costs are potentially higher than in simpler IT-options. The level of advancement at National Organisations is to be decided individually. The Scheme

Participant may start with manual business processes when joining the European Scheme. Over the course of time, the manual business processes could be exchanged with (semi-)automatic processes to allow more secure and more efficient operation. Scheme Participants do not influence each other's progress.

The Scheme Operator takes up a central role in governing the Scheme and taking responsibility for the centralised Platform and consequently takes up significant power compared to an IT-option which enables Scheme Participants to communicate directly.

A centralised Platform for information exchange based on a stand-alone web-based system seems to be a very suitable concept to kick-off the Europe-wide market taking into account security, reliability and performance measures.

4.6 Centralised communication hub

4.6.1 Introduction: Definition of a "central communication hub"

A centralised communication hub is referring to a central IT-solution to which Scheme Participants are directly connected to via a dedicated IT-interface. Its design is focussed on mass data processing and 24/7 availability.

If an international exchange is initiated within the IT-system of a Scheme Participant, the communication will run via the communication hub and will be automatically finalised by being transferred to the receiving party's account at the registry system of the receiving Scheme Participant. The related business processes are performed fully automatically, independent of the day (workdays/weekends) or time (within/beyond working hours).

Although this IT-option is also based on the communication of National Organisations, the IT-systems behind are highly complex and more sophisticated than in previously described IT-options. Because of the high level of automatisation, the specifications of the communication hub are highly complex. Each National Organisation, anticipating becoming a Scheme Participant, will have to perform detailed integration testing in which the full automatisation can be proven to be able to connect to the communication hub.

The system shall be able to handle hundreds of different market participants which exchange data packages (holding the renewable gas certificates) using one single interface. The central communication hub receives, validates and forwards encrypted information. The administration of all Scheme Participants is possible via a graphical user interface which shall guarantee user-friendliness.

The hub shall be able to handle a significant number of transfers per day (assumption: up to 100,000 transfers based on estimation of 1,000 parallel users with 100 daily transactions) and operation availability of at least 99.9% between Monday and Sunday. Respective service level agreements with the IT-provider and the provider of the data centre must be in place. This availability of the central hub should also be fulfilled by the Scheme Participants to guarantee a back-to-back automatic transfer process.

The relevant services requested by IT-providers will pose high maintenance costs which have to be divided between all Scheme Participants.

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4.6.2 Requirements: "central communication hub"

Table 16: List of processual, administrative, technical, and organisational requirements of a "central communication hub"

PROCESSUAL	ADMINISTRATIVE	TECHNICAL	ORGANISATIONAL
More complex and automatic business processes require higher level of sophistication in development and operation.	Scheme Participants have to provide information to national economic operators and market participants.	Highly complex IT-requirements for hardware and software (secure and robust data centre necessary).	Higher organisational efforts for training of staff.
	Higher efforts in development and implementation phase. A tender procedure shall be performed to assure a neutral process.	More complex and automatic business processes require higher level of system security and system availability.	Higher organisational efforts due to the need of additional (technical) equipment (depending on the design of the interface).
	Higher efforts in development and maintenance of reporting requirements.	Higher technical efforts during implementation phase due to more complex and longer process.	Higher organisational efforts for Scheme Operator to provide detailed test cases for activation procedure.
		Higher technical requirements to reach compatibility with central communication hub.	

4.6.3 Analyses and evaluations

Table 17: SWOT-analysis of a "central communication hub"

STRENGTHS	WEAKNESSES
- Automatisation provides high level of efficiency and security provides high level of efficiency and security - High level of harmonisation of business procedures, IT-processes, data security, IT-services, customer services - Highest level of transparency in the range of all described IT-options - High level of usability possible	- Longer and more complex preparation phase to find harmonisation between all National Organisations/market players and requirements - Overall scheme development is subject to all participants. Front-runners difficult to move ahead.

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• Equal treatment of each Scheme Participant in highest automated way • 24/7 operation and availability	• More complex system needs higher skill set from staff members. Might be a hurdle for newly establishing national market/Scheme Participants. • No direct/immediate information on the destination/purpose of the certificate from the receiving entity (e.g. information on fulfilling mass balance) • High dependency on IT-providers of national systems and central communication hub • High dependency on compatibility of IT-systems of National Organisation and communication hub
OPPORTUNITIES	**THREATS**
• Modern concept, state-of-the-art IT-concept • High level of data security and trustworthiness of data transactions of data transactions • Easily expandable related to scale	• Very high set-up costs; high financial risks during implementation especially when only low number of Scheme Participants involved • Long development and implementation phases • Risk of losing a Scheme Participant behind if they cannot fulfil technical requirements • Complex set-up for new countries to get into the renewable gas market

Table 18: Cost Benefit Analysis of technology a "central communication hub"

COSTS (economic aspects)	BENEFITS
In the range of described IT-options, this "central communication hub" ranges in the middle. Higher costs for development and implementation of this IT-option compared to simplified IT-options. Higher costs for development and implementation than "Platform for information exchange". Lower costs than "centralised IT-solution" and implementation of "block chain technology" for all market participants Europe-wide.	Centralised Platform: fosters standardisation, easy reporting, and development of statistics
Operational costs significantly higher than of simplified IT-options and "Platform for information exchange" due to level of automatisation, mass data processing and data centre.	Pursue automatisation of data processing

Higher update and maintenance costs for the IT-solution which the Scheme Operator will divide between all Scheme Participants.	Highly secure
	Maximum of equal treatment while keeping the possibility to handle individual national requirements in the national IT-system

4.6.4 Activation guidelines: Integration of a "central communication hub" into the (renewable) gas market

The design of a central communication hub, being focused on 24/7 availability, brings several advantages such as mass data processing, full automatisation of business processes, high level of security and reliability, clear reporting, and high transparency for Scheme Participants.

The IT-requirements and specifications are very complex and might pose a risk for countries who are newly establishing their renewable gas market of not being able to comply. The implementation phase for the communication hub is more complex and longer. Also, the establishment of automatic interfaces at National Organisations to connect to the hub are extensive. The high availability might lead to high maintenance costs, also for national IT-systems.

The central communication hub may represent a suitable system for the operation of the renewable gas market. Even if an IT-option such as the Communication hub is based on automated processes, the IT-system of the Scheme Participant does not necessarily have to work on a comparably high level of automatisation in the beginning. An interface may be developed which allows to send data packages manually. However, it is questionable if countries working on the establishment of a market and framework (their National Organisations and respective IT-systems) are able to reach this high level of automatisation already at the point of time of market kick-off. A long-term goal of such an IT-option is however to connect Scheme Participants to automatically communicate with each other, thus the IT-systems of National Organisations shall be able to handle the same level of automatisation as the communication hub in a long-term solution.

4.7 Central IT-solution for all services

4.7.1 Introduction: Definition of a "central IT-solution of all services"

One centralised IT-solution for all services would replace existing national IT-solutions because it can handle all processes from registration of market participants to creating, handling, transferring, and cancelling of renewable gas certificates. It will also replace the Scheme in its common understanding, since there are no National Organisations involved, using their own national systems. The administrational burden for registration, establishment of interfaces and test runs is increased.

The common Scheme is replaced by a single European registry system, which may be designed as a stand-alone web-based system for national representatives to have their own online access. A single European registry may be built based on straight forward rules and processes which are harmonised between all European, participating countries.

All connected countries would have access to one centralised IT-solution, delivering all needed tools and requirements. This approach has been applied in the EU ETS sector:

https://ec.europa.eu/clima/policies/ets/registry_en

4.7.2 Requirements: "central IT-solution of all services"

Table 19: List of processual, administrative, technical, and organisational requirements of a "central IT-solution of all services"

PROCESSUAL	ADMINISTRATIVE	TECHNICAL	ORGANISATIONAL
Highest efforts on harmonisation of business processes between all Scheme Participants.	Low efforts in operation of IT-solution thanks to high-level of harmonisation.	Most complex development and harmonisation of IT-requirements and specifications.	High organisational efforts to reach harmonisation during decision processes, especially in case a Member State intends to integrate individual, national requirements.
Most complicated system in case one Member State intends to integrate individual, national requirements.	Technical administration most effective thanks to monitoring of one single system.	High efforts in case of necessary adaptations due to complexity.	Highest organisational efforts for coordination of centralised communication hub.
			High organisational hurdles since the system is not supported by European legislation.

4.7.3 Analyses and evaluations

Table 20: SWOT-analysis of a "central IT-solution of all services"

STRENGTHS	WEAKNESSES
- Centralised IT-solution for all connected countries - Centralised and harmonised IT-services for all Scheme/Market Participants - Centralised and harmonised customer services for all Scheme/Market Participants via single point of contact (One Stop Shop) - Data control by a central database allows detection of errors and provides harmonised criteria and requirements throughout Europe	- Longer and more complex preparation phase to find harmonisation between all National Organisations/market players and requirements. - Overall scheme development is subject to all participants. Front-runners difficult to move ahead - Minimum of individual treatment while the renewable energy sector is significantly based on national legislation and requirements

- Modern/state-of-the-art IT-concept
- Simplified set-up for new countries to get into the renewable gas market
- Maximum transparency
- High level of harmonisation on business procedures, IT-processes, data security, IT-services, customer services.
- Highest level of transparency in the range of all described IT-options
- Overall low operational costs as they are divided between all Scheme Participants and no costs for operation of national IT-systems necessary.

- More complex system needs higher skill set from staff members. Might be a hurdle for newly establishing national market/Scheme Participants.
- Scalability: down-scaling not applicable; this IT-option is most suitable for a high number of market participants and numerous automated transactions
- Different organisational setup of Member States related to documentation of renewable gas tracking may provide difficulties in using the centralised IT-solution (complex role concept necessary).
- Member States still might be interested in having their own databases for related purposes.
- National characteristics very difficult to cover.

OPPORTUNITIES	THREATS
- Very modern and future-looking IT-option - Developments accessible and applicable for all Scheme Participants - No risk of losing a Scheme Participant behind - Highest level of transparency - Blueprint for European integration	- Very high set-up costs: high financial risks during implementation especially when only low number of Scheme Participants involved - Long development and implementation phases - No decision making in case of missing "democracy" rules such as majority voting - Not supported/requested by national and European legislations - National governments and market players might express high reservations against a centrally governed IT-solution and Scheme because of limited influence - Little changes in functionality could result in large programming efforts.

Table 21: Cost Benefit Analysis of a "central IT-solution of all services"

COSTS (economic aspects)	BENEFITS
Very high implementation costs.	Highest level of harmonisation
Operational costs: potentially high but in practice reduced because no additional operational costs for national systems arise.	Future proof

Complexity and extra costs for updating IT-solutions	Reduced administration compared to national (fragmented) operation
Reduced administrative costs because no national IT-solutions to be operated	Easy to add new Scheme Participants and all Scheme Participants are treated equally unless weighting is introduced
Continuous security and monitoring required due to single point of failure and risk	Not leaving a Scheme Participant behind (updates are for all members equally)
Higher update and maintenance costs for the IT-solution which the Scheme Operator will divide between all Scheme Participants.	Cost sharing principle

4.7.4 Activation guidelines: Integration of a "central IT-solution of all services" into the (renewable) gas market

A centralised IT-solution providing all services seems to be a future-oriented approach to pursue European integration and harmonisation. It provides several advantages, such as high level of transparency and a level playing field for all Member States/involved countries. Moreover, the administrational burden and operational costs for the operation of a national IT-solution is ceased when considering the avoidance of national IT-system costs.

Although this is a future-looking IT-option, it is higher sophisticated than current state-of-the-art systems. Due to lack of National Organisations/actors in each Member State and missing Europe-wide regulations and rules, such a Scheme and related IT-option would overrun markets/countries which are in their infancy. The necessary organisational structure is neither encouraged by European, nor by national legislation. The underlying Scheme should be based on a single set of rules stated by European institutions. A centralised set of rules is not envisaged in RED II, because several implementations are to be decided on Member-State-level.

The necessary IT-infrastructure does not yet exist and would pose high start-up costs and complexity on existing National Organisations and newly established ones. It would also create a big organisational barrier due to lack of missing national support and respective knowledge.

REGATRACE is aware that its Target Countries face the challenge of first establishing the national market and respective structure, before being able to connect to a European Scheme for cross-border title transfers of renewable gas consignments. Such an advanced and complex IT-option would slow down the development of a common European market into the future while pushing already advanced countries further. This is contra-productive in the point of view of REGATRACE partners, as one of the main project targets is to support the uptake of a Europe-wide biomethane/renewable gas market particularly in countries and regions which have not developed markets.

A centralised platform should still be envisaged as the European long-term vision because it pushes harmonisation and standardisation with all its members, but simultaneously reduces costs and organisational efforts. Such kind of systems are usually developed over years or even decades, considering the harmonisation of underlying processes, data, and information over all its participants.

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5 Alternative solutions

5.1 Introduction to alternative solutions

The following chapter provides alternative solutions for establishing a harmonised cross-border title transfer of renewable gas certificates in Europe. But due to the current limited extent of knowledge and available solutions on the market in addition to greater complexity, they have not been considered within the evaluation process. Still, these options should be elaborated more deeply in the future in case of their implementation for comparable solutions.

5.2 Blockchain technology

5.2.1 Contributions by Energy Web Foundation

Energy Web Foundation (EWF, https://www.energyweb.org/), is a Swiss non-profit building open-source decentralised digital solutions for the energy sector. The publicly available solution, EW Origin (https://www.energyweb.org/technology/toolkits/ew-origin/), operates an electricity certificate exchange system based on blockchain technology and is exploring other renewable energy use cases for EW Origin beyond electricity.

- EW Origin is a suite of open-source software tools that help energy market participants build their own blockchain-based platforms for easy and efficient energy traceability in alignment with existing standards and regulations.
- To-date, EW Origin has been leveraged for building decentralised marketplaces for green electricity attribute certificates (EACs).
- Examples of such new digital platforms include PTT in Thailand and wider ASEAN, PJM EIS in the U.S., Foton in Turkey, AES Tiete and Fohat in Brazil, Mercados Eléctricos in Central America, where the aim of these platforms is to increase market transparency, reduce costs, and enable anyone (including multinational corporations, small/medium enterprises, cities, electric vehicle fleets, households, etc.) to easily and directly procure verified renewable power.

Energy Web Foundation offered their insights during an interview and by contributing to the chapter on blockchain technology for the renewable gas market.

5.2.2 Introduction: Definition of "blockchain technology"

To provide a detailed explanation on the blockchain technology itself and on the diverse technical and organisational aspects of its implementation and operation is beyond the scope of the REGATRACE project. However, to understand the possible application in the renewable gas sector, a few basics on the concept shall be provided.

Blockchain is commonly defined as a distributed, decentralised, public ledger. A ledger is understood as a book, storing specific information. Blockchains may hold digital pieces of information, the information being stored on a "block" while several information blocks might be stored in a "chain". A digital wallet can be considered as a national account on the specific "renewable gas blockchain". This technology in principle holds the "data" in different storages allocated to a high number of participants. This storage is called "wallet". The update of those "data" can only be done if all different holders of a wallet confirm the transaction. When using the blockchain technology in the given scenario, the "data" are renewable gas certificates including information about the characteristics of the renewable gas consignment such as

volume, owner, production facility and substrate. While each participant holds a copy of the blockchain, the technology is also referred to as a distributed, decentralised, public ledger.

The data are encrypted and can only be readable or changeable by defined entities. Any changes made are being recorded in all the ledgers in the system which together represent "the blockchain". The holders of a wallet can be biomethane registries, issuing bodies, producers, traders, consumers etc. The data can only be changed by specific actions which are defined when designing the block chain. For example, only Scheme Participants may be allowed to create new "data packages" (renewable gas certificates) and only a specific entity such as consumers may be able to change the status of a data package to "withdrawn". A variety of functionalities exist which can serve the needs of renewable gas certificates.

Since each Scheme Participant holds a copy of the blockchain, the technology comprises various aspects compared to traditional centralised software including:

- After the data sources are established and connected, blockchain guarantees access to trustworthy data while also preserving necessary privacy and security. Credible data is crucial for accurate accounting of environmental attributes such as renewable gas certificates, as well as establishing trust among different parties such as generators, traders, buyers, and regulators.
- Blockchain is fit for markets with various stakeholders. Not only blockchain facilitates access to trustworthy data, it also enables multiparty access to these data. Therefore, blockchain may offer a common, European platform for green attribute tracking and trading.
- As blockchain makes any transaction financially viable, it provides a strong and cost-efficient capability to handle an ever-increasing number of production devices and renewable energy products with high granularity level and accuracy. Such scalability, in turn, lowers market barriers for participants on a market which is still in its infancy.
- Blockchain facilitates interoperability. Blockchain-based National Organisations and marketplaces, once set for a specific market or country, are scalable and able to integrate with other use cases. For example, initially a blockchain-based marketplace for renewable gas certificates can be extended to biofuels, green and blue hydrogen, sustainable aviation fuels, carbon credits, and other low-carbon energy products.

Blockchains can be operated as public or private systems depending on the market and regulatory requirements and the solution design. While private blockchains can be more efficient, faster, and provide greater control of the system participants, public blockchains offer higher security, lower risks of data tampering, multiparty data access, and avoidance of technology lock-in. A public system is designed to incorporate an ever-increasing number of participants and would be appropriate if the system were intended to be used by producers and traders for example. A private system is designed to be used by a limited number of participants who are similar in scope which fits more closely with the requirements of a Scheme for exchanging renewable gas certificates across border between National Organisations only. In the future, there may be potential for a public blockchain providing a dual function of transferring and the issuing and cancellation of certificates at national level. This report does not specify the type of blockchain used which would require a separate cost-benefit analysis based on the solution requirements and design. But it is evident that a blockchain solution would fit the requirements of the envisaged IT-solution.

In the case of renewable gas markets, blockchain can serve as digital infrastructure for national or European registries and/or for creating a cross-border marketplace, where Scheme Participants exchange data packages (renewable gas certificate) without a central intermediary. Given that there are already established National Organisations in some Member States, there is potential for building a blockchain-

based renewable gas certificate platform on the EU-level that would integrate with the existing national systems. Such integration between the national systems and a decentralised EU-wide blockchain-based platform could be done using a secure and automated API (Application Programming Interface), which defines interactions between multiple software intermediaries. One approach can be building a centralised API that helps each Scheme Participant to propagate their data to the blockchain. Another approach can be that each Scheme Participant on the blockchain pushes transactions directly on their servers. The design of such blockchain-based platform can be highly customisable depending on the final requirements. The certificates will be stored on the Scheme Participant's own blockchain account and from there further transferred to the other Scheme Participant's blockchain account. From that point onwards, the receiving Scheme Participant holds certificates in its blockchain account. The risk of double-counting of certificates within the blockchain is zero, as there is no way for a single party to destroy, copy or manipulate it.

Another application of blockchain to renewable gas certificates could be leveraging the technology for operating National Organisations in order to take full advantage of the blockchain benefits. Each National Organisation would hold individual data of its market participants, while required certificate data would be on the shared blockchain-based platform. That way, there would be a single source of truth and full synchronisation across borders. On top of that, a marketplace can be built either accessible by issuers and generators or by all eligible users. However, this option requires political will and coordination of numerous parties, which can pose issues in the solution's implementation.

The information on the renewable gas certificates within the blockchain can be separated into dynamic and static information. Static information, such as plant-specific information or information related to the Scheme Participant - specified by REGATRACE as level 1 attribute information (see Figure 4) - only needs to be registered once and can be used along the certificate lifecycle (requests for creation, transfer, cancellation) or even further markets (e.g. wholesale gas markets). The dynamic part includes information such as volume or production period - specified by REGATRACE as level 2 attribute information (see Figure 4), which are created individually for each transfer process.

Blockchain technology provides several functions to pursue absolute anonymity which is important considering data protection. On the other hand, for example in private blockchains, full anonymity might not be required. In that case, the account details may also be shared between Scheme Participants. A midway option could be for the Scheme Operator to maintain a list of account details without making it public to all Scheme Participants.

Another feature of data management on blockchain is classifying which data need to be on the blockchain and which data can be kept out. A general rule of thumb is to keep only required data on blockchain, such as renewable gas certificate volume (energy amount), issuance (where, when, by whom and to whom), and final ownership details.

That information should be kept as simple and straight forward as possible to minimise storage and increase performance. On the other hand, there may be information to be stored on a centralised server or even the national IT-systems, e.g. further details about the renewable gas producer, generation evidence reports, information exchanges beyond the main renewable gas certificate transfer process. Such division serves the process of keeping the blockchain-based platform efficient and compliant with privacy regulations. To simplify and familiarise the user experience, the user will not see whether the action is done on or off blockchain, the solution would look like any other web-based application. The user will be informed about the outcome of the respective action irrespectively where it was done.

Running a blockchain-based solution for renewable gas certificate markets can be possible with limited technical requirements (e.g. managing an on-premise server or employing cloud services). This platform can be run on existing servers that would further decrease technical complexity and significantly lower the costs. Therefore, depending on the concept and the need for a central server, the operational costs can be reduced to a minimum. Transaction costs could be close to zero.

On the other hand, while the strength of a blockchain is the exclusion of a central supervisory authority, the fact that the gas certification schemes are also driven by legislative frameworks on national and European level and may appoint a legally mandated supervisor, undermines the main business case for blockchain for certificates that implement such legislative framework. Still, the technology may also offer to serve supervisory functionalities. Further questions may raise on the flexibility of such blockchain systems to adapt to changing circumstances of legislative frameworks or markets.

For emergency reasons, it may be of value to define governance within the blockchain to include a so-called "Master user". It may have ultimate access in case extraordinary steps are required such as the update of certificate attributes or the full cancellation of a certificate. This might be necessary in case a certificate transaction has not been confirmed by one of the Scheme Participants or in case manual errors occurred.

5.2.3 Requirements: "blockchain technology"

Table 22: List of processual, administrative, technical, and organisational requirements of "blockchain technology"

PROCESSUAL	ADMINISTRATIVE	TECHNICAL	ORGANISATIONAL
Information on regulatory frameworks and market participants need to be collected and assessed to define solution requirements, user roles and a business model.	High efforts by Scheme Operator to develop knowledge and documentation for management of blockchain-based platform and creation of reports for Scheme Participants.	There needs to be a cost-benefit analysis to evaluate private and public blockchains, as well as options of developing a new blockchain as opposed to leveraging existing solutions.	Development of new contractual clauses (e.g., registry and marketplace users) and Scheme Rules that account for the unique nature of blockchain technology. No existing European Scheme is yet applying this technology.
Business processes for secure and accurate data exchange on and off blockchain have to be developed.	Permissions and functionalities for users such as admin (and super admin) need to be carefully designed to efficiently manage emergency situations.	Gathering business requirements, there needs to be a technical assessment to understand system requirements, solution options, design, and interlinkage with the national IT-systems.	Design of a structure that accounts for the increased responsibility of the Scheme Participants in operating the IT.
Higher efforts on development of data	High efforts to develop comprehensive	Handling of processes and data on and off	Significant effort to build knowledge about

protection and data privacy issues.	administrative guidelines and training materials to help Scheme Participants understand unfamiliar technology.	blockchain (e.g. on central server).	blockchain technology with the Scheme Participants who will be hosting the ledgers.
Significant effort to build knowledge about blockchain technology at level of Scheme Participants, regulators, and end-users.		Definition of privacy features and their implementation.	

Further hardware requirements were provided by Energy Web and may be found online (https://energyweb.atlassian.net/wiki/spaces/EWF/pages/716898335/Value+Proposition+of+Hosting+a +Validator+Node).

5.2.4 Analyses and evaluations

Table 23: SWOT-analysis of "blockchain technology"

STRENGTHS	WEAKNESSES
- Future-oriented: Will not be leapfrogged if blockchain becomes the base level IT-solution within the sector. - High level of security and immutability - Perception as "innovative" - Decentralised control: High efficiency due to avoidance of intermediary (Scheme Operator) but based on self-organisation by Scheme Participants - Very low technical operation costs expected - Supports multiparty access to trusted data to stakeholders of any size while also preserving necessary privacy, which makes blockchain a suitable and efficient solution for European renewable gas certificate platform that would be shared by many different actors. - Versatility and high level of customisation.	- Lack of flexibility to make corrections to the ledger - Lack of experience of developing and operating blockchain products – with limited pool of IT-providers able to do the development work - Costs for implementation can be defined after technical assessment and requirements definition - Scepticism by Scheme Participants due to lack of knowledge and experience - Requirement for highly trained staff within Scheme Participants - Duration of implementation phase can be defined along with the solution requirements and assuming National Organisations share their implementation details. This should lead to faster implementation time for all national registries that are coming after the first few.

OPPORTUNITIES	THREATS
• Perception as innovative and high interest by development companies to set up a suitable system (preliminary information available) • Technical feasibility of blockchain solutions has been proven in various energy use cases, which can provide guidance to renewable gas certificate markets. (For example, Energy Web Foundation's publicly available tools enable blockchain-based solutions for the renewable electricity certificates and can be leveraged for the renewable gas markets. Similarly, experience by Energinet and Vertogas may also offer lessons in blockchain applicability.) • An opportunity to build a first-mover reference implementation with blockchain and offer that service to other entities and markets. • Minimum operational costs • Good scalability from organisational point of view: blockchain-based platforms can be scaled from one country to the entire EU territory • Interoperability with other energy markets: For example, initially a blockchain-based marketplace for renewable gas certificates can be extended to biofuels, green and blue hydrogen, sustainable aviation fuels, carbon credits, and other low-carbon energy products. • Blockchain can nudge standardisation across markets and geographies that are largely separated and inconsistent today. • With the help of smart contracts, blockchain can integrate market processes and reduce manual processes in a secure way. While traditional software solutions can provide similar automatisation benefits, they are normally controlled by a central party that can tamper with the data or creates costs to other parties besides that central party.	• Limited trust and/or knowledge/experience by Scheme Participants in technology • Slowness of energy sector to adapt to blockchain based technology • Limited operational experience by the market (market participants) in technology • Insecurities about implementation costs due to uncertain developments including interface of national system to blockchain and blockchain as such • Strong interlinkage with national IT-systems necessary, despite low levels of experience • Unnecessary data storage • More advanced than state-of-the-art: neither IT-infrastructure and systems nor necessary legal framework currently available, hence extensive regulatory feedback will be necessary for the development of a regulatory compliant solution • High energy consumption of the blockchain technology may undermine the environmental benefits claimed to establish with the renewable gas certification system

Due to lack of practical knowledge and information on the costs of a blockchain for the renewable energy sector and comparable implementation projects, the information on costs for the Cost-Benefit-Analysis can only be based on the assumptions and experience of the authors.

Table 24: Cost Benefit Analysis of "blockchain technology"

COSTS (economic aspects)	BENEFITS
Development and operational costs of the blockchain are uncertain due to lack of experience and comparable projects in the renewable gas sector.	Potential to earn revenue by offering services to National Organisations for certificate issuing, transfer, and cancellation and to other sectors seeking similar IT solutions. Blockchain solutions also remove market entrance barriers by reducing transaction costs and democratising market entrance.
The expectation is that the development costs for the blockchain are high due to limited experience on specification and development. The high costs are less related to the need of extensive software and hardware but rather to the intensified need of human resources and potentially also travel costs for exchanges, workshops, trainings, etc.	Existing projects provide proof of the feasibility and workability of blockchain as an additional societal value, especially for renewable electricity certificate markets. Potentially, the new renewable gas certificate platform can be also scalable to other countries and interoperable with other energy markets (e.g., renewable electricity, green hydrogen).
Any gaining of knowledge by Scheme Participant is connected to additional staff costs or requires trainings.	Operational costs are expected to be minimal, especially if the solution is built on one of the existing blockchain and using publicly available technology stack that is constantly improved and matured by the development and energy community.
The costs for interface establishment from the national IT-system of Scheme Participant to the blockchain-based platform is highly uncertain but potentially expensive due to limited experience of development companies. This interface will be required for all Scheme Participants and lead to undefined extra costs outside the implementation of the sole blockchain.	Blockchain-based solutions provide highly secure system/technology for the market which can be enhanced in the future (e.g. public blockchain).

5.2.5 Activation guidelines: Integration of "blockchain technology" into the (renewable) gas market

To build a European blockchain-based platform for renewable gas certificate tracking and trading processes and technical functions will be required which cannot be defined in detail within the scope of this report. Further elaboration by dedicated technology experts would be needed. This specific conversion functionality from the national IT-system into the blockchain requires additional implementation by all Scheme Participants. In addition, staff at the Scheme Participants must be trained to develop expertise on the use of blockchain and in conducting cross-border transactions. It is

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understood that none of the relevant stakeholders in Europe do yet have the dedicated experience to the necessary extent. This will potentially increase costs and length of the development period and might unnecessarily delay the kick-off of a European renewable gas market.

Through its distributed concept of data storage and conformity of data, blockchain may provide additional measures on security, efficiency, cost savings and interoperability, compared to the other described IT-options. This does not necessarily mean that existing technologies or IT-systems are less secure or even bear the risk of data loss. Blockchain is a new IT-concept which would require each Scheme Participant to develop their knowledge and potentially trust only a minority of partners in taking the lead to develop the system or may operate their own systems on a blockchain. Therefore, blockchain technology may make sense from a technical perspective but several uncertainties remain due to the lack of detailed solution design. Comparable solutions on the energy and IT-sector require much more detailed analyses which goes beyond this present report. Such advanced efforts contradict the immediate necessity of the energy market to develop a solution for cross-border title transfer of renewable gas consignments.

Blockchain-based solutions can simplify the registration process of National Organisations, generation devices and market participants, as well as streamline the creation and cancellation of the certificates. Each entity would have a unique digital identity and a certificate account (wallet) that should allow harmonised and simple trading and accounting of certificates. The Scheme Participants may limit the accessibility to the blockchain through different rules and definitions, but the blockchain can include this functionality reducing the effort for Scheme Participants.

The IT-systems and business processes at established National Organisations differ significantly. The blockchain technology could streamline those processes and provide for a fast integration on European level. The "blockchain module" that a registry may add to its existing procedures, consists of processes, contracts, etc. and would not intervene with existing processes. In addition to the registry model, a blockchain-based marketplace can be added as a layer on top to scale cross-border trade.

The development of the renewable gas market on blockchain basis might most properly take longer and cost more than comparable adaptations of existing IT-solutions, though eventually this solution might bring significant advantages. Considering the time to deliver a cross-border transfer solution for renewable gases, the decision on a technical solution should balance fast, efficient, and secure developments.

At the same time, experience of Energy Web Foundation, a non-profit developing publicly available blockchain solutions for the energy sector, demonstrates that blockchain can be efficiently leveraged for building a production-grade marketplace for renewable electricity certificates in line with the International Renewable Electricity Standard (I-REC Standard). This experience could be directly translated to renewable gas certificate markets.

The investigation of the blockchain technology in the Netherlands by Vertogas, the operator of the Dutch renewable gas registry and Issuing Body, and results by RECS International (report see: https://www.recs.org/news/recs-publishes-opinion-paper-on-blockchain) have shown that blockchain is not appropriate for the establishment and implementation in the renewable gas market.

5.3 Hybrid solutions

5.3.1 Introduction

A Hybrid option refers to an IT-option based on a combination of a Central IT-option (e.g. IT-option 6, see chapter 4.7 Central IT-solution for all services) with a central title-transfer exchange platform (e.g. IT-options 3-5). It allows to submit data twofold: following the original idea of a Hybrid solution, data may be entered directly into the Central IT-option, for the cases when a National Organisation established in a Member State chooses to use a centralised established IT-solution. Another possibility is for National Organisations to submit data through their own established IT-solution to the Central IT-option via a dedicated interface, for the case that National Organisations keep the authority over business processes that should be performed on national level. The design of the Central IT-option could be facilitating different levels of centralised services, some by the National Organisation and some at level of the Central IT-option. Based on this solution, it is up to the National Organisation if they want to use their own national IT-system and connect it through the central IT-solution to other registries or they can use the central IT-solution equivalent to a national IT-system and perform transactions with other registries directly through the central IT-solution. In chapter 2.4.3, Business processes to be performed on national and European level are compared. A hybrid solution would allow a Scheme Participant to participate in one or more of the following levels:

- Centralised bookkeeping of individual account holders (market participants such as producers, traders, and consumers),
- Centralised documentation of renewable gas certificates for a particular Member State facilitating national and international transactions,
- Centralised collection of statistics on creation, transfer, and cancellation,
- Centralised transfer facilitation,
- Centralised calculation of the residual mix (only applicable when the proportion of renewable gases and their cross-border transfer become substantial),
- Centralised certificate cancellation reporting,
- Centralised recording of issued certificates (and withdrawn and expired certificates),
- Centralised production device registration and meter data processing.

5.3.2 Analyses and evaluation

Whereas countries in a new-built situation might choose to perform various processes centralised in order to reduce national IT-system investments, for countries and National Organisations who have already made - in some cases substantial - investments in their national IT-system, a limited level of centralisation might be preferred at the time of European harmonisation of international transactions.

The use of centralised services and processes is economically viable only if several National Organisations choose to do so. This would share investment costs and reduce the effort for national implementations significantly. Still, there might be national requirements which need to be implemented in the centralised IT-solution (for further details see chapter 4.7 Central IT-solution for all services). In addition to the centralised IT-solution, national IT-systems will still exist which need to be connected through a central exchange solution. This central exchange solution needs to be connected/attached/integrated to the central IT-solution. This requires additional investments which need to be considered and shared between its users.

Political support on European level is envisaged due to the usage of centralised services but may be differently interpreted on Member State level, where national requirements might not be treated the same way as within the establishment of a national IT-system connected through a standardised interface to an exchange platform only to handle international transactions. An optional hybrid solution could still entail that a cross-national centralised IT-solution communicates certificate transfers with existing national registries through a standardised data protocol.

Acknowledging that the different IT architectural options facilitate National Organisations at different stages of maturity of their certificate transfer system, and considering the differing policies of Member States, a hybrid solution might be suitable to overcome non-technical obstacles originating from these differences.

6   Comparative analysis

The six described IT-options were evaluated in a comparative analysis applying selection criteria of Table 2. Since the support of REGATRACE target and supported countries is a major project goal, the comparative analysis was performed from the point of view of National Organisations preparing to connect to a European Scheme. The result of the joint evaluation, including the scores of each selection criterion for each IT-option, is provided in Table 25.

The number of Scheme Participants and, even more importantly, the number of cross-border transactions (or market volume) highly influence the available budget of the Scheme and will have a significant impact on the velocity of market expansion. An increased number of Scheme Participants does not necessarily lead to a significantly higher market volume, which is mainly dependent on the number and size of biomethane producing plants and the national framework conditions. Additionally, Member States have to implement rules accepting imported certificates in order to establish a Europe-wide, liquid market. These unclear factors leave it difficult to predict the market growth over the next decades:

- A small market volume, handled by a low number of Scheme Participants, will provide only a low budget for the Scheme, and will ask for simplified business processes, which might most probably be performed on manual or (semi-)automated basis.
- A medium market volume, handled by a low number of Scheme Participants, might allow a medium budget for the Scheme. However, it could easily lead to high number of transactions, which would require a more sophisticated and higher secure IT-option on European level.

Considering the costs for implementation and maintenance of a European IT-solution and considering the number of transactions and the time for the establishment of an IT-solutions, less complex IT-options are deemed suitable to kick-off cross-border title transfers. Maintenance costs are difficult to estimate because different perspectives need to be considered. This is the reason why no scores are provided for some IT-options; the sign "*" is included in Table 25 to raise awareness to possible different views. The decisive factor is if there are already operational IT-systems at National Organisations. In absence of such, their establishment might profit significantly from detailed guidelines, specifications, and IT-requirement lists. Developed and operational national systems may raise more reluctance to IT-adaptations due to the additional efforts triggered by implementation and maintenance costs due to complex integration processes.

Also, the selection criterion 2.4 "democratic control of the IT-system" is deemed controversial and hence labelled with the sign "x" in Table 25 in some cases. To ensure democratic control during implementation and maintenance of a respective IT-option, the Scheme Rules and organisational aspects might weigh even higher than the IT-requirements per se.

The described options 1, Standardised data exchange without dedicated database, and 2, Standardised data exchange with simplified database, will pose less complex requirements on the IT-systems of Scheme Participants, facilitating the connection of National Organisations which are at the very beginning of establishing documentation schemes.

IT-option 3, Bolt-on module, poses high risks for conflict of interest, since one of the Scheme Participants also acts as IT-provider for the IT-solution and maybe even additionally as Scheme Operator. The Scheme Participant appointed as IT-provider will always have an advantage on the knowledge of organisational and IT-requirements. The maintenance and long-term operation of the Bolt-on module are posed to the risk that the national situation and framework conditions could change.

IT-option 4, Platform for information exchange, does not pose specific requirements on the national IT-system of the Scheme Participant. While the Platform enables standardised data exchange, the business processes are of manual character because each Scheme Participant receives a log-in to access the Platform. In comparison, IT-option 5, Centralised communication hub, has a more automated character and thus more advanced and more specified national IT-systems are necessary to connect. The goal of this IT-option is to reach the same level of automatisation between all Scheme Participants and the communication hub.

For countries with no IT-system and market established yet, the connection to a Central IT-solution (option 6) will provide guidance and support. It will support overcoming the challenge of developing a tailor-made national IT-solution and eases organisational efforts by sharing them between a high number of Scheme Participants. For countries with well-established systems, the integration into a Central IT-solution might become a challenge. The costs are again difficult to estimate, depending if national systems are already in place, different perspectives have to be considered.

In chapter 5, Alternative solutions are described. Since an exhaustive evaluation of these alternative solutions goes beyond this report, they are not part of the comparative analysis in Table 25. The option of performing transactions via blockchain technology was investigated in chapter 5.2 and showed that it can be applied for peer-to-peer solutions and also in centralised IT-options. A Hybrid solution, combining national IT-systems in some Member States and the direct use of a Central IT-solution by other Member States, may be a viable option to overcome some of the challenges of option 4 and 5.

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Table 25: Score table: result of the comparative analysis

Selection criteria	1.1 Implementation costs	1.2 Complexity	1.3 Timescale	2.1 Maintenance costs	2.2 System Operation	2.3 Business processes (complexity, robustness)	2.4 Democratic control of IT-System	2.5 Usability	3.1 Future Proof	3.2 Compatibility with national & EU policies
IT-Options	Implementation phase			Operation phase					Outlook	
1 Standardised data exchange without database	4-5	5	4-5	3-4	2	2	2	1-2	1	1
2 Standardised data exchange with database	4-5	4-5	4-5	3-4	2	2	2-3	2-3	1	1
3 Bolt-on module	3	2-3	3	*	3-4	3-4	x	3	2	2
4 Platform for information exchange	3	3	3	3	3-4	4	4-5	4	3-4	5
5 Centralised communication hub	2	2-3	1-2	3	5	4-5	4-5	4-5	3-4	5
6 Central IT-solution for all services	1-2	1-2	1-2	*	5	4-5	x	4	4-5	1-2

7 Conclusions

The European renewable gas market presents an uneven playing field. While several countries are well advanced, with a high number of production plants/injection sites and a lively market, in other countries neither production nor market tools (certification/documentation systems for renewable gas injections and their transfer possibility between market participants, statistical analyses, national support systems, etc) have been established. One of the main goals of the REGATRACE project is to support its target and supported countries in establishing the necessary framework for their domestic renewable gas market. The authors perform the evaluations from the point of view of these National Organisations who build the audience for the present report. Hence, the current situation must be considered as starting point for implementing a European IT-solution.

Currently, only a low number of National Organisations are engaged in the development and/or operation of national systems. The technical potential for biomethane production throughout Europe has been estimated in numerous scientific studies as significantly higher than the current production. As described in the introduction of this report, there are 19 biomethane-producing countries in Europe, ten of them have established Biomethane Registries and eight have appointed Issuing Bodies (status Q3 2020). Amongst these different organisations, there is an integral interest to establish transfer of renewable gas certificates across borders by connecting National Organisations via standardised processes and secure IT-solutions. The transition from the currently scattered and individually acting national systems to a common European renewable gas market with (one or several) European Scheme(s) shall be the main goal.

Deeming less complex requirements necessary for the market harmonisation, IT-solutions 1 and 2 could address a situation of transition. A few established Scheme Participants are participating, with a low number of transactions taking place, while more sophisticated IT-solutions are still being developed. With an increasing number of transactions and Scheme Participants, the cost of operation will increase and justify the development of more automated and consequently costly IT-solutions. The less automated the IT-solutions and the underlying business processes are, the more important the Scheme Rules and the possibilities of enforcing them will become.

In a situation with a high number of transactions and Scheme Participants, dedicated IT-solutions with more automated business processes are considered appropriate. Option 3 Bolt-on module, option 4 Platform for information exchange, and option 5 Centralised communication hub, seem suitable to cope with a high number of Scheme Participants. However, well-functioning and advanced national IT-systems and know-how of Scheme Participants will be pre-requisites to successfully implement these IT-options in the European renewable gas market.

For countries that face the situation of a low number of production facilities in combination with a low budget for the development of a documentation scheme, connecting to IT-options 4 and 5 might become challenging. Rather they could benefit from a Central IT-solution (option 6) that facilitates cross-border transfers and documents all domestic production and transfers within one single system. Providing a vision for Europe, option 6 Central IT-solution for all services should be considered as the European long-term vision because it pushes harmonisation and standardisation across Europe. However, this IT-solution is not recommended to kick-off the market, considering that the renewable gas market is currently still in its infancy, the development phase of such a Central IT-solution might last for years. Further, legislative and/or financial support from European authorities would be

required on the one hand, and political acceptance from the Member States on the other. Experiences with a similar IT-solution in the EU ETS sector should be considered. After some years of operation, it was decided to switch responsibilities and migrate data from National Organisations to a Central IT-solution. The transition phase comprised several years before the implementation was completed. Recently, Member States have established national databases again in parallel to the Central IT-solution to satisfy their own requirements and expectations.

Even a Hybrid solution requires standardisation across Europe, otherwise country-specific circumstances will be prevalent, decreasing the efficiency of the Central IT-option. A Hybrid solution will still require interfaces for National Organisations operating their own national IT-system and a suitable communication tool, such as e.g. a central communication hub. Combining such sophisticated systems seems to become one of the most expensive IT-solutions described and is rather meaningful for very mature markets with a high number of participants and transactions or markets which are likely to grow very quickly.

Despite some performed studies, none of the currently established National Organisations have yet applied a blockchain for the operation of performing transactions of renewable gas certificates in their domain. The implementation phase seems too demanding and time-consuming to recommend the implementation of the blockchain technology into the renewable gas market at current stage.

Interconnecting National Organisations to establish international exchanges is key for a liquid market. Beside the establishment of a Scheme with harmonised rules, technical processes and solutions are of importance. Different parameters must be considered defining the most-viable IT-option, such as the number of National Organisations and their IT-systems or IT-budgets. For the current fragmentation of national renewable gas documentation systems, a central Scheme and an IT-solution to exchange renewable gas volumes/characteristics seems suitable. This would allow keeping the national IT-systems for fulfilling national requirements particularly for handling national support schemes, but still provide space for international exchanges for specific purposes such as transport fuel obligations or Guarantees of Origin. Other application purposes will develop in the future which will require further integration on national and European level particularly related to exchange across national borders. Energy carrier conversion becomes another design criterion in coordinated approaches for the certificate systems for different energy carriers and will demand harmonised rules that are currently established in different schemes. REGATRACE Work Package 4 will propose such harmonised conversion rules and develop a design study on the technical requirements of a coordinated conversion process.

When designing a system from scratch, from IT-perspective it would be wise to establish a centralised certification system, or at least documentation system, for all renewable gas volumes independent of the respective application purposes. This would require a Central IT-solution already, such as available for the EU ETS sector and currently under development for transport fuels. If the EU is pushing into this direction, a centralised IT-solution, or a hybrid solution with focus on centralised processes and services will be a favourable concept. But such a system is currently neither supported by European nor by national policies and would require fundamental adjustments of EU legislation. As data registration is often embedded in other national data registration systems, national politics may prefer maintaining IT-system management at national level. Therefore, if a Central IT-solution would be chosen, a top-down decision embedded in the European legislative framework might be the only means to establish it.

To harmonise the current uneven market, the most viable option in the short to medium term seems to be interconnecting IT-systems of National Organisations via European Schemes and IT-solutions for

cross-border title transfers of renewable gas certificates. If, in the future, Member States conclude that an interconnected network of registries has shortcomings which cannot be overcome to their satisfaction, and that a Central IT-solution would provide a more beneficial solution, then such a Central IT-solution could be implemented and the respective data be migrated into it.

The evaluations performed and insights gained in this report shall be further developed within the REGATRACE project. In accordance with the respective market status, a "Techno-economic feasibility study on a harmonized system for cross border title-transfer of the renewable character of gas in Europe" will be performed in Deliverable 2.8.

REGATRACE
Renewable Gas Trade Centre in Europe

D2.4 Investigative study of IT system options for harmonized European cross border title-transfer of biomethane/renewable gas certificates

8   Glossary

Attribute

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.

Association of Issuing Bodies (AIB)

AIB is an international non-profit organisation established under Belgian law registered in Belgium as aisbl with office in Koning Albert II-laan 20 bus 19 B-1000 Brussels. 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.

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.

Certificate (Renewable Gas Certificate)

An electronic document that records (quantitative and qualitative) information about a renewable gas consignment, injected into the Natural Gas Network. A Certificate may be used by a renewable gas producer to market the green value of their related renewable gas consignment. A Certificate may be used by a gas consumer to demonstrate their use of a renewable gas consignment, in that this consignment described in the Certificate can be set against an amount of gas that the consumer has withdrawn from the Natural Gas Network. Certificates follow the approach detailed in Article 15 of Directive 2009/28/EC on the promotion of the use of energy from renewable sources, including amendments as per Directive (EU) 2015/1513 (also referred to as "RED I") and Article 19 of Directive 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) – also referred to as "RED II".

CertifHy

CertfiHy 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 the generation of guarantees of origin for green hydrogen.

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.

EBA aisbl

EBA (European Biogas Association) aisbl is an international non-profit organisation established under Belgian law with its registered seat in Rue d'Arlon 63-65, 1040 Brussels. EBA is the voice of renewable gas in Europe. Founded in February 2009, the association is committed to the active promotion of the deployment of sustainable biogas and biomethane production and use throughout the continent. EBA counts today on a well-established network of over 100 National Organisations, scientific institutes and companies from Europe and beyond.

EECS

European Energy Certificate System is the AIB's formal statement of its principles and rules of operation. Each EECS® certificate is uniquely identifiable, transferable and therefore tradable, and contains standard information on the source of the energy, and its method of production.

The Principles and Rules of Operation of the European Energy Certificate System (the EECS® Rules) defines a certificate as an electronic document which identifies the source and method of production of a unit of energy, and relates to a specific purpose – such as energy source disclosure or compliance with an obligation. It also prohibits certificate holders from separately claiming or conferring rights or title to any element of this benefit, and for this purpose.

Certificates are created, change owners and are eventually made untransferable under a carefully developed and managed control infrastructure, the EECS® Rules, as interpreted by each country or region according to its "Domain Protocol". The adequacy of this interpretation is assured by the other AIB members as a condition of membership.

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ERGaR aisbl

ERGaR (European Renewable Gas Registry) aisbl is an international non-profit organisation established under Belgian law with its registered seat in Rue d'Arlon 63-65, 1040 Brussels. ERGaR was founded in September 2016 as a cooperation between national renewable gas registries in Europe to enable cross border transfer of renewable gas certificates among the member registries. The association currently counts 26 members from 14 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.

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.

Fuel Quality Directive (FQD)

Directive 2009/30/EC of the European Parliament and of the Council of 23 April 2009 amending Directive 98/70/EC as regards the specification of petrol, diesel and gas-oil and introducing a mechanism to monitor and reduce greenhouse gas emissions and amending Council Directive 1999/32/EC as regards the specification of fuel used by inland waterway vessels and repealing Directive 93/12/EEC (Text with EEA relevance). The FQD introduces sustainability criteria for applied biofuels and requires a reduction of the greenhouse gas intensity of transport fuels by a minimum of 6% by 2020.

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;

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.

Proof of Sustainability (PoS)

A document detailing the verification of sustainability claims relating to biomethane consignments designated for use as biofuel, in accordance with the relevant EU documents (RED, FQD and Communication 2010/C 160/01). PoS are issued by conformity assessment bodies (certification bodies) associated with a voluntary scheme recognised by the European Commission under the RED.

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.

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 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.

Scheme Rules

Scheme Rules shall provide a common understanding for its participants particularly the Scheme Operator and Scheme Participants and other stakeholders (e.g. economic actors and government regulators) of the functions of the Scheme and how the Scheme operates. Scheme Rules shall be set out in a dedicated document or a bundle of documents which the Scheme Operator shall make publicly available. It includes provisions particularly for the registration to join the scheme, its operation, the control of it and how the rules can be updated on a regular basis.

Source Trader

The market participant initiating the transfer of the biomethane consignment. The source trader can have different nature: end consumer, a supplier or a commodity trader.

Target Trader

The market participant receiving the biomethane consignment. The target trader can have different nature: end consumer, a supplier or a commodity trader.

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.