Technical support for RES policy development and implementation.

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

Task 3

Developing IT Systems Specification

Task 3.3

High-level Requirements Specification

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Executive summary

This report provides a high-level technical specification for the main developments in the IT infrastructure envisioned in the FaStGO task 3.1 report. Requirements are provided for extending an existing certificate registry interconnector hub with facilities for *automated residual mix calculation*, *centralised cancellation,* and potentially *centralised recording of all transactions*. While this document can be used to develop these features using an agile development approach, it is not detailed enough to be used as a requirements specification in a public tendering procedure. This is intentional, as prior to the development of such detail, it would be advisable to further refine the visions of the various issuing bodies and authorities.

Automated residual mix calculation facilitates the calculation exercise for all energy carriers. The feature would enable collection of data that is not yet stored in the hub, but is needed for the residual mix calculation, and enable the residual mix to be calculated automatically. The automated calculation of the residual mix is evaluated to potentially save time needed for the calculation and to enable better quality via faster sensitivity to raw data analysis. On the other hand, the methodology is quite complex and not fully structured, giving rise to a number of issues to be solved and agreed before it makes sense to automate it.

Centralised cancellation provides the registries with a centralised facility to cancel certificates both for use domestically, and ex-domain (for use in other domains). The centralised facility would enable account holders in any domain to cancel guarantees of origin for use in any (other) domain, provide standard and on-line cancellation statements, and manage domain-specific rules and restrictions. It can also be a useful tool for facilitating the cancellation of GOs for the purpose of energy carrier conversion. Centralised cancellation is evaluated to offer clear and numerous benefits, but it might be difficult to agree, because it would mean national authorities conceding some control over cancellations to a central supervisory body and system.

The requirements of the abovementioned features are described in the form of an initial product backlog and high-level data structures. Also, short evaluations of the described concepts are provided. This format of the requirements is suitable for developing the features using *agile development* methods.

In addition to specifying the requirements for the extensions, this report studies and evaluates the technical concept for transforming an interconnector hub into a multi-domain registry. A multi-domain registry would be an evolution of the current IT infrastructure towards a centralised registry or a hybrid model as described in the FaStGO task 3.1 report. Extending an existing interconnector hub into a combined multi-domain registry and hub would probably not be technically viable. Rather, it would make more sense to build a multi-domain registry, which could co-exist with an existing interconnector hub and national registries.

Finally, as an alternative to a multi-domain registry, a concept of **central recording of all transactions** is explored in brief. It would be technically feasible to enhance an existing hub so that it would collect all transaction information from separate registries as well as perform real-time analysis and validation of even intra-registry transaction. In addition to the hub enhancement, also registries would need to be amended to that they would also route internal transfers via a hub.

However, for this to succeed, it would be necessary to conduct a close and intensive dialogue between the involved issuing bodies, and to agree a framework for aligning rules and practices. This can be achieved without additional legislation, provided the appropriate contractual agreements are established to support it. Further, a stepwise approach is advised in which the relevant parties agree how to: mitigate such

challenges as the linkage with other national certificate systems, maximise return on investment for existing national registries, and migrate data.

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1. Framework

1.1 FaStGO

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

1.2 What and why

Taking into account the legislative frameworks, the operational experiences of the current system, and the additional requirements based on a revised CEN standard EN 16325, FaStGO task 3 develops the design requirements for an IT systems infrastructure that enables reliable and efficient for cross-border exchange of GOs.

For enhancing efficient and reliable cross border-trade of guarantees of origin, IT systems have proven to play a central role. The FaStGO task 3.1 report provided a vision for the future information system architecture for guarantees of origin. The recommendation of the task 3.1 report was to gradually increase the level of centralisation based on a currently existing interconnector hub as illustrated in Figure 1 below.

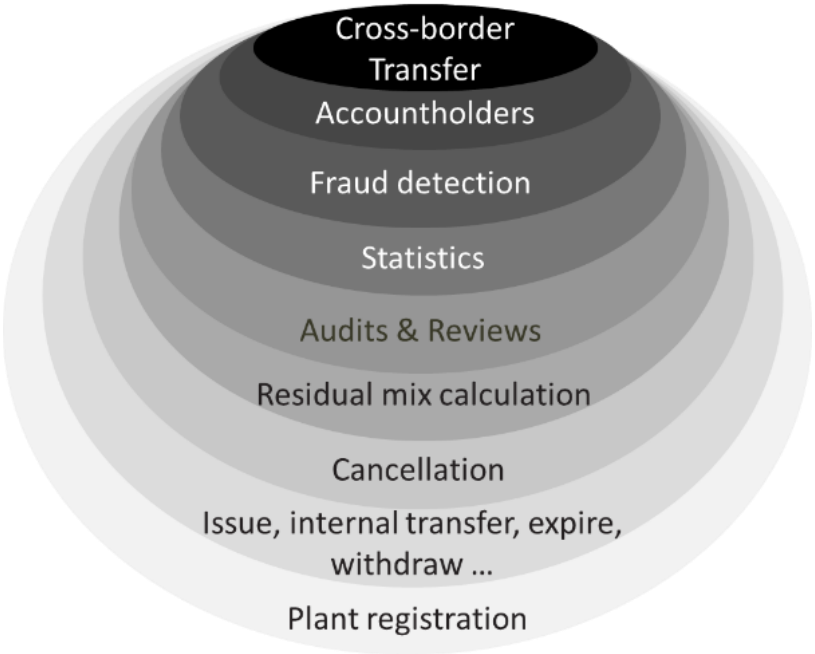

Figure 1. Extensions to an interconnector hub envisioned in FaStGO Task 3.1 report

This FaStGO task 3.3 continues the work done in task 3.1 by providing high-level technical requirements for the future infrastructural changes seen as the most appropriate in the task 3.1 report.

1.3 Scope

The requirements presented in this report are based on a "black box" interconnector hub and propose extensions to it. Assumptions made about the functions and data which are handled in an existing interconnector hub are listed, but their detailed specifications are not elaborated, given that these can vary over time and are subject to intellectual property rights.

There is an existing hub that centralises: the management of cross-border transfers, identification of account holders, monitoring mechanisms to enhance fraud detection, collection of statistical data and technical audits of connected registries. Therefore, with reference to figure 1, this report starts with a specification relating to the layer "*Residual Mix Calculation*" and works further towards the outer layers shown in this figure.

The level of detail of the requirements presented in this document has been intentionally set low. The requirements can be used as an initial product backlog[1] when developing the extension using an *agile development* approach. However, the level of detail is not high enough for competitive tendering for such extensions. For public tendering, the level of detail should be increased while the scope should be narrowed, and the existing hub described at a detailed level. In addition, non-functional requirements such as security, availability, and capacity should be added.

[1] *For definition or Product Backlog, see for example: https://www.agilealliance.org/glossary/backlog*

2. Glossary

Agile (Software Development)	An approach to software development emphasising changing requirements and dealing with uncertainty, often as opposed to so-called waterfall approach. See more about agile at e.g. https://www.agilealliance.org/agile101/;
AIB	Association of Issuing Bodies, the AIB is a Brussels-based non-profit-making international association with enterprise number BE0864.645.330;
API	Application Programming Interface, a way to access computer software without user interface, https://en.wikipedia.org/wiki/API;
Attribute	Data specifying the characteristics of energy produced by an energy production device in terms of the input(s) used and/or the details of that production device and production process;
Cancellation Agreement	An agreement between two or more issuing bodies regulating the cancellation of certificates in a registry managed by one issuing body to the benefit of consumption in another issuing body's domain, including the provision of statistical information concerning cancelled certificates and the items of information held on any related cancellation statement;
Class Diagram	A standard UML diagram that describes system structure, for example structure of data elements and their relationships. See for example https://en.wikipedia.org/wiki/Class_diagram;
Competent Body	An organisation authorised under the laws and regulations of the state or region to exercise or discharge a function, such as issuance or market supervision, related to Guarantees of Origin;
(Issuing) Domain	A geographic area containing production devices with respect to which an issuing Body is responsible for issuing GOs for the relevant energy carrier;
Disclosure Domain	A geographic area where a supplier provides to its customers information about energy that has been supplied to them by means of a specific energy carrier and for which a residual mix is calculated;
Disclosure Period	A time period of energy consumption for which energy suppliers must provide to their customers information about energy that has been supplied to them and for which a residual mix is calculated, for example, a calendar year;

EECS	European Energy Certificate System®, as conceived, elaborated, maintained, and implemented by the AIB;
Environmental Indicator	Information in addition to energy source distribution, which energy suppliers must provide to their customers about energy that has been supplied to them during a disclosure period, for example CO2 emissions and radioactive waste produced;
Epic	Feature, a collection of user stories. See for example: https://www.agilealliance.org/glossary/epic/#q=~(infinite~false~filters~(postType~(~'page~'post~'aa_book~'aa_event_session~'aa_experience_report~'aa_glossary~'aa_research_paper~'aa_video)~tags~(~'epic))~searchTerm~'~sort~false~sortDirection~'asc~page~1);
European Attribute Mix (EAM)	Following differences between import and export of guarantees of origin and physical energy, some countries have a deficit of energy sources (and other energy origin attributes) to cover the origin claims for all national energy consumption; while others have a surplus of them. The EAM is a calculated pool of surplus available attributes in national domestic residual mixes of countries with such a surplus. It is needed for reliable coordination of residual mix calculation in Europe that balances out the international transfers. The EAM results from surpluses of available attributes compared to untracked consumption in surplus countries. The EAM is used to cover deficits of available attributes compared to untracked consumption in deficit countries;
Ex-Domain Cancellation	Cancellation of guarantee of origin in one domain for the benefit of consumption in another domain;
External Physical Exchange	Exchange of physical energy between countries inside and outside of a residual mix Area;
External Tracking System, Reliable Tracking System (RTS)	Explicit tracking systems other than GOs that are considered reliable and transparent. Typical example of certificate-based RTSs are national GO systems; while examples of non-certificate-based RTSs are feed-in tariffs when linked to disclosure or, in some cases, contract-based tracking. A Reliable Tracking System guarantees that the attribute of an amount of energy has no more than once been claimed for consumption;
GO	A guarantee of origin, as defined by article 19 of REDII;
Grooming	Gradual refinement of software requirements as part of an agile development method. See for

	example: https://www.agilealliance.org/glossary/backlog-grooming/#q=~(infinite~false~filters~(postType~(~'page~'post~'aa_book~'aa_event_session~'aa_glossary~'aa_organizations~'aa_research_paper~'aa_video)~tags~(~'backlog*20refinement))~searchTerm~'~sort~false~sortDirection~'asc~page~1);
(Interconnector) Hub	An electronic service facilitating the export and import of Guarantees of Origin between electronic registries managed by different issuing bodies in different domains;
Product Backlog	Inventory of requirements comprising User Stories and Epics and constituting requirements for a piece of software or feature;
Purpose	The originally intended use for which a certificate is issued, for example disclosing an energy attribute to final consumers, allocating government support, or target accounting;
RED II	The Renewable Energy Directive 2018/2001(EU);
Residual Mix (RM)	The residual mix is a pool of available generation attributes which are not explicitly tracked through GOs or RTSs. A residual mix is an implicit element of a disclosure mechanism in which volumes and shares of energy sources and environmental impacts of untracked electricity consumption are determined by the statistical mix of a country's yearly generation attributes, available after deducting the volumes involved in explicit tracking. It complements the disclosure done with explicit tracking instruments (GOs and RTSs), by determining the origin of the rest of the energy consumption. The residual mix, in line with art.2(13) of the Renewable Energy Directive 2018/2001/EU, is defined at member state level and calculated based on a calendar year, as follows: • Domestic residual mix – intermediary residual mix at national level, before balancing of attributes using a common attribute pool of the other countries participating in the residual mix Area. See chapter 3.2 "*Calculation of the Domestic Residual Mix*". • Final residual mix – results from the residual mix calculation, with correction for cross-border transfer of attributes. This is the value that is referenced when talking about residual mixes, without specifying anything else. Note that the official residual mixes of member states are published by national authorities, and the AIB

	calculated residual mixes are official only when they have been nationally adopted;
Residual Mix Area	The residual mix is calculated centrally for a certain area, typically a group of disclosure domains (i.e. usually a group of countries in which a similar quality level of disclosure rules is implemented, like EEA). Exports and imports of both physical energy and tracking instruments are treated differently in the calculation, depending on whether they take place inside or across the border of the residual mix area. The residual mix Area is another term for the system perimeter as elaborated in section 4 of the FaStGO Task 4.2 report;
RESTful API	a standard way of implementing an API, see for example: https://searchapparchitecture.techtarget.com/definition/RESTful-API;
Unified Modelling Language, (UML)	A standard modelling language developed for visualising software design. See for example: https://en.wikipedia.org/wiki/Unified_Modeling_Language;
User Story	Single functionality from a user's perspective. See for example: https://www.agilealliance.org/glossary/user-stories/#q=~(infinite~false~filters~(postType~(~'page~'post~'aa_book~'aa_event_session~'aa_experience_report~'aa_glossary~'aa_research_paper~'aa_video)~tags~(~'user*20stories))~searchTerm~'~sort~false~sortDirection~'asc~page~1).

3. Introduction

The future evolution of an interconnector hub between energy certificate registries is presented at two levels.

First, the requirements for enhancing the most appropriate extensions are described as epics, user stories and entity level data diagrams in section 4. This is done for an automated residual mix calculation facility and for a centralised cancellation facility. Second, the technical concept of extending a hub into a multi-domain registry is studied at the level of general description, epics, and evaluation of the concept.

The data structures are described as UML class diagrams but limited to entities and their relationships. For the centralised cancellation Facility, key data attributes are also provided to help in understanding the user stories.

Certain functions and data elements are assumed to be already provided by the underlying interconnector hub software. For this report, it is assumed that the features and data listed below have already been collected and are both available and reliable.

- Features
  - Secure two-way registry connection
  - Transaction handling
  - User access and Security
  - Management of issuing bodies, domains, and registries
  - A public site and basic information publishing
- Data entities
  - Certificate transaction data structure
  - Transaction volumes on a monthly basis per energy source, Technology, and domain: number of guarantees of origin that are:
    - Issued, corrected by amount that is withdrawn
    - Imported/exported
    - Expired
    - Cancelled
  - GO domains including linkage to relevant issuing bodies and Registries
  - GO energy sources and Technologies
  - Users linked to issuing bodies and residual mix calculation roles
  - Account holders

4. Enhancing an interconnector hub

4.1 Automated residual mix calculation

4.1.1 General description of feature

Currently the residual mix calculation involves mostly manual work, using an Excel tool developed by Grexel for the AIB. The calculation process includes data collection from various sources, including national data from competent bodies. The rationale for further automation of the residual mix calculation, and doing this in the hub, is that the hub already stores a large part of the information that is needed for the residual mix calculation. Even after implementing the automation as described further in this chapter, there would still be manual work in several process steps, especially related to:

- Data collection,
- Data validation and quality checking (apart from technical validation done by the system),
- Reporting, and
- Communication.

When it comes to data collection and reporting, the level of automation is left open, and is subject to the level of ambition of an implementation project and the availability and stability of data sources. For example, were ENTSO-E[2] to make production and consumption statistics available via an open API, it would be simple to get the data directly from there. Also, the level of reporting of outputs may vary from simply providing the needed data for an administrative user, to full management of the publishing process and making the results available on a website and an open API.

The Residual mix methodology and actual calculation is not explained in this document. For the current calculation method, please refer to AIB website at: https://www.aib-net.org/sites/default/files/assets/facts/residual-mix/2019/RM%20EAM%20IB%20Calculation%20Methodology%20V1_1.pdf. This document describes the required system functionalities as user stories, and the high-level data structure.

The primary requirement is for all functionalities is that they shall be available via a RESTful API to enable integration and automation in the future. In addition to the APIs, there should be a user interface that can be accessed via a standard browser.

4.1.2 Initial product backlog

The functional requirements are described from users' perspective in the form of Epics and User Stories[3]. Epics and User Stories constitute an initial product backlog. A product backlog can be consumed as such by an agile development team. The development team Grooms the user stories together with a Product Owner, as the development progresses. The main Epics and User Stories are the following:

Epic A Data relevant to the residual mix calculation can be stored so that, together with the transaction data which already exists in the hub, residual mixes for different energy carriers can be calculated.

[2] https://www.entsoe.eu/

[3] For definition of Product Backlog, Epic and User Story, see the Glossary

The data not already available in the hub, such as national overall consumption figures and energy production / grid injection figures, must be collected and stored in a meaningful data structure. All such data must be time-stamped, and there should be the possibility to leave notes on individual data elements or sets of data. These notes could, for example, contain information on the origin of the data, and whether the data deviates from official sources or is based on the data collector's own estimates. All data shall be technically validated for errors as it is fed in. The validation should check data against e.g. plausible lower and upper limits and credible deviation from previous years' figures.

User Story 01 *As a residual mix data collector, I can feed in External Tracking System transaction volumes and data source by domain(s), transaction type, energy source, energy carrier, and disclosure period via an API or a user interface, so that it completes GO data for explicit tracking and so enables residual mix calculation.*

User Story 02 *As a residual mix data collector, I can feed in production data and data source via an API or a user interface by domain(s), energy source, energy carrier, and disclosure period, so that it completes GO data for explicit tracking and so enables residual mix calculation.*

User Story 03 *As a residual mix data collector, I can feed in consumption data and data source via an API or a user interface by domain(s), energy source, energy carrier, and disclosure period, so that it completes GO data for explicit tracking and so enables residual mix calculation.*

User Story 04 *As a residual mix data collector, I can feed in environmental indicator data and data source via an API or a user interface by domain(s), energy source, energy carrier, and disclosure period, so that it completes GO data for explicit tracking and so enables residual mix calculation.*

User Story 05 *As a residual mix data collector, I can feed in external physical exchange data and data source via an API or a user interface by domain(s), energy source, energy carrier, and disclosure period, so that it completes GO data for explicit tracking and so enables residual mix calculation.*

User Story 06 *As a residual mix data collector, I can update production, environmental indicator, external physical exchange, external tracking system transaction and consumption data and data sources, so that values can be corrected, that I can leave a note and that a timestamp of my edit is stored.*

Epic B The system shall calculate the European attribute mix, the domestic and final residual mixes of all participating domains and other agreed results according to the prevailing calculation methodology. The results are used by the competent bodies to calculate and publish their own national residual mixes.

The results should be available for a user with sufficient privileges as soon as all required data for the disclosure period and energy carrier are present. The

system should make the calculations real-time, always based on current base data. All results shall be presented by disclosure period, energy carrier, and domain, where relevant.

User Story 07 *As a residual mix calculator, I can view and download, by consuming an API, the final residual mixes per domain, based on the current data stored in the system, so that I can evaluate and publish the results.*

User Story 08 *As a residual mix calculator, I can view and download, by consuming an API, European attribute mix based on the data currently stored in the system, so that I can evaluate and publish the results.*

User Story 09 *As a residual mix calculator, I can view and download, by consuming an API, the total supplier mixes per domain based on the data currently stored in the system, so that I can evaluate and publish the results.*

User Story 10 *As a residual mix calculator, I can view and download, by consuming an API, the final environmental indicators in the residual mix, European attribute mix and total supplier mix per domain based on the data currently stored in the system, so that I can evaluate and publish the results.*

User Story 11 *As a residual mix calculator, I can view and download, by consuming an API, the raw and corrected production mix per domain based on the data currently stored in the system, so that I can evaluate and publish the results.*

User Story 12 *As a residual mix calculator, I can view and download, by consuming an API, the attributes exchange between domains and the European attribute mix per domain based on the data currently stored in the system, so that I can evaluate and publish the results.*

User Story 13 *As a residual mix calculator, I can view and download, by consuming an API, the current raw data used for the calculation including timestamps and notes, so that I can analyse the calculation results and detect possible problems.*

User Story 14 *As a residual mix calculator, I can view and download by consuming an API what data is still missing and preventing showing of the results, so that I can see what data is still missing.*

User Story 15 *As a residual mix calculator, I can view and download the results of User Stories 07-12 in comparison with last year, so that I can swiftly detect huge differences in the results.*

Epic C The system shall facilitate Master Data management so that administrative users can set up prerequisite data for residual mix calculation.

Administrative users must be able to manage master data on a disclosure period basis. This enables changes in master data between disclosure

periods. As mentioned before, part of the relevant master data is assumed to be already managed in an existing hub. The master data management in an existing hub may need some enrichment, but this is outside of the scope of this document. The most relevant master data categories managed in the extended hub as described in this document are:

- A **disclosure domain** may consist of one or several GO Scheme Issuing domains configured in an existing hub. For example, Belgian regions are separate domains in terms of GO Schemes, but the residual mix is calculated for Belgium as a whole. Disclosure domains are considered per energy carrier and per disclosure period. This way a residual mix balances domain attribute surpluses and deficits via the European attribute mix[4].
- A **disclosure period** is a period of energy consumption for which a residual mix is calculated, being normally a calendar year, but it might be set differently. However, this does not mean that the data used for calculating residual mix for a certain disclosure period concern the same exact time period. See residual mix calculation methodology for more information.
- An **energy carrier** is either electricity, gas, heating and cooling, or hydrogen. Separate residual mixes shall be calculated per energy carrier, in line with the considerations on the system perimeter, as elaborated in the report of FaStGO task 4.2.
- A **residual mix energy source category** may consist of one or a combination of several energy sources managed in a current hub for certificates. A residual mix is calculated using residual mix energy source categories, not the full list of all possible certificate energy sources.

4.1.3 Data model for automated residual mix calculation

As explained in the framing and introduction sections of the document, the data model presented here is based on numerous assumptions regarding, for example, data already handled in an existing hub.

The data model below represents main data classes (entities) and their relationship with each other. The data is assumed to be already available in an existing hub is in a separate package ("a hub"), but the relationship between the data classes are not included. Data attributes are not included here, nor physical data structures, like link tables.

[4] *See https://www.aib-net.org/sites/default/files/assets/facts/residual-mix/2019/RM%20EAM%20IB%20Calculation%20Methodology%20V1_1.pdf for detailed description of the calculation methodology*

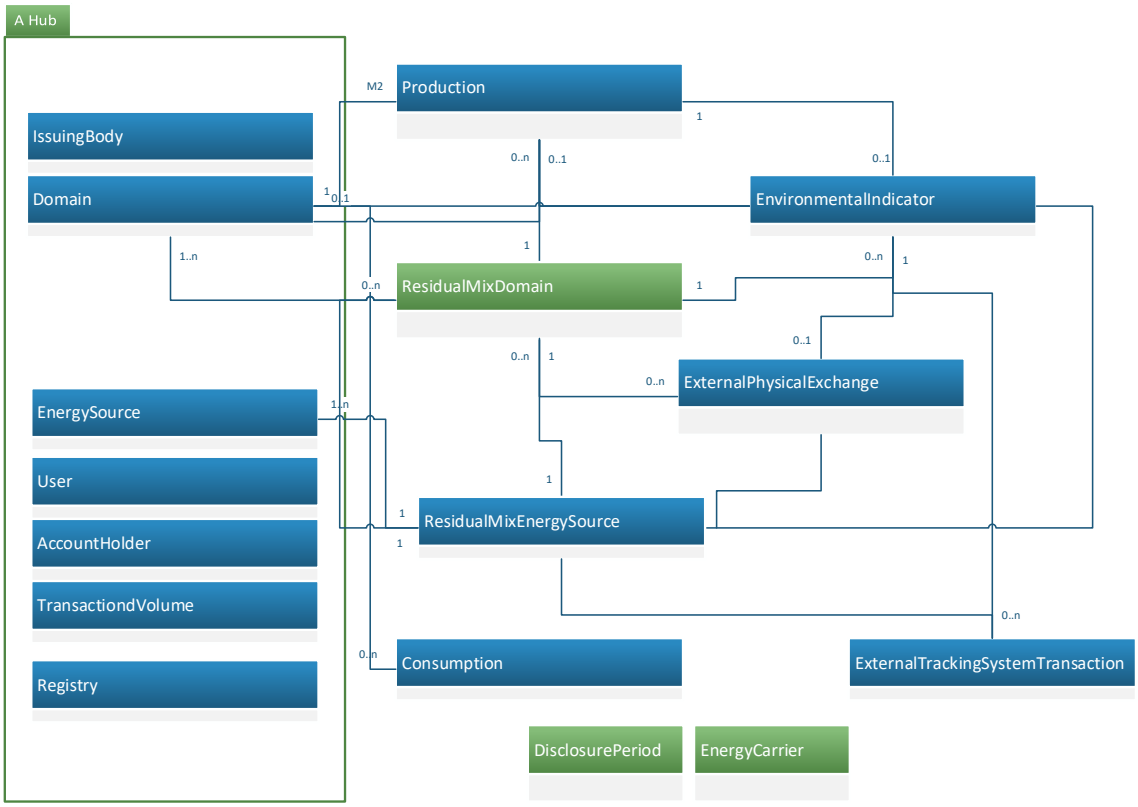

Figure 2. Automated residual mix calculation data structure[5]

4.1.4 Evaluation of the automated residual mix calculation facility

This section evaluates the general feasibility of an automated residual mix calculation feature; along with whether it makes sense to build one. According to the assumptions made in the introduction section, an interconnector hub already stores the most recent and "official" version of certificate transaction data; so the collection features would need to be added to feed in data relating to production, physical energy flows across the residual mix area, consumption, and data from other reliable tracking systems. In addition, the actual calculation and data publishing features would need to be added as a facility on a hub.

Automated calculation would save working time which is normally used for manual calculation. The savings would be even larger if residual mixes were, in the future, to be calculated for different energy carriers. Automation should also increase the quality of calculations by eliminating manual steps which may be prone to error; by enabling faster calculation rounds; and by enabling faster sensitivity analyses to changes to the raw data.

There are, however, some open questions and concerns worth considering before proceeding with any automation initiative. The most important ones are listed below:

[5] *Please note that connections between (DisclosurePeriod and EnergyCarrier) and other classes are not shown in the figure because they relate to most other data classes. Hence, showing them in the figure would have made it very messy. The multiplicity of the connection between them and other elements is 1 to 0...n meaning that for all data elements there is one DisclosurePeriod and EnergyCarrier and that for one DisclosurePeriod or EnergyCarrier there are zero to many other data elements*

- **Flexibility** is one of the key advantages of the current Excel-based tool. Should there be changes to the calculation methodology, or if different energy carriers have different calculation rules, then these are rather easy to implement in the Excel model. When changing the calculation method, program code and algorithms would require possible restructuring of the code, and a lot of testing. On the other hand, the calculation method should not change often.
- The **complexity** of the calculation itself is not addressed in this document. There are many intermediate results, balancing operations and checks to be performed. Implementing and testing the calculation model as code might be a considerable effort and investment.
- The **savings** would materialise via elimination of manual work. However, much of the work done using the current routine and tools is related to data collection from competent bodies, data quality checks, and reporting. The productivity of the calculation work can be improved by creating a user-friendly and versatile user interface, but these tend to be expensive to implement, so a balance must be struck between the investment and future productivity.
- **Data versioning** is not addressed in the above requirements because it would cause major added complexity. In the Excel model, data versioning is easy, and it is widely used as part of the calculation. In the automated process featuring real-time calculation the outcome of the calculation would be changed whenever any raw data is updated. Hence, the process and publishing would need further consideration regarding for example when to call the outcome "official", how to deal with late data updates, etc.
- **Data quality evaluation** would probably be easier in the Excel-based calculation model, because it is easy to see the big picture of the data as well as different intermediary calculation products, such as inflow and outflow of attributes and negative balances. This is however only valid for as long as human expertise for this is maintained.
- The above requirements assume that a **disclosure domain** is either the same as a GO Scheme Issuing domain, or else it consists of several domains. However, the relationship between these may be more complex. For example, the disclosure domain of Ireland consists of the Republic of Ireland (having its own GO Scheme) and Northern Ireland (the latter belonging to the UK GO Scheme domain).

Elegant and careful design of the feature would probably solve most of the problems addressed above. For example, if the feature is carefully parametrised, it might provide even more flexibility. It would also be possible to automate part of the data collection from competent bodies by providing them with a user interface or an API as well as timely reminders and instructions.

One option to be considered would be to phase the implementation of the feature so that the first set of features would only provide the collection and storing of data, as well as providing the data for those performing the calculation in a structural form via an API or a downloadable file. The calculation and the versioning of base data would still be handled outside the hub in an Excel model. The next step, if deemed economically viable, would be actual calculation and publishing in the hub or in an external service.

4.2 Centralised cancellation

4.2.1 Arguments for centralised cancellation

A Centralised cancellation facility for GOs would allow more central control over the usage of GOs.

For account holders, it would enable cancellation from one account for the benefit of consumption in several countries. That would mean that multinational corporations which manage their energy origin centrally would no longer need to open accounts in each of the domains where they have consumption to certify. As such parties currently tend to perform normal cancellations without informing the issuing body that it is for usage in another country, this causes a gap in the correctness of the GO statistics, residual mix, and overall origin disclosure to consumers. Centralised cancellation would relieve issuing bodies and disclosure competent authorities from this lack of transparency that currently undermines a clear overview of overall origin disclosure.

A centralised cancellation facility would also enable uniform and publicly available cancellation statements. This would make it more difficult to counterfeit cancellation; and would also increase the credibility of the system in the eyes of consumers.

Moreover, it would facilitate limitations, whether these are common or national, so that the limitations would be checked "on the fly". The clearance would strongly indicate the legitimacy of the cancellation for the cancelling account holder.

Also, fraud and double counting prevention would become easier, as the destination of all GOs would be centrally managed and monitored.

4.2.2 General description of the feature

Validating cancellations on the hub

In practice, when installing centralised cancellation, actors in registries would no longer cancel (all) certificates within the registry. Instead, they would need to request the cancellation from the hub. The hub then receives the full cancellation details in a similar way as transfers between domains. It subsequently validates the cancellation, and answers with either an approval or a rejection accompanied by an error code. An approval would return a cancellation ID and a link to a publicly available cancellation statement if that is requested. Such public links should include a long enough random string, so they would be practically impossible to guess, even if an automated brute force attack were to be used.

The validation should consider common and domain-specific cancellation rules and established cancellation agreements between domains. These validation rules could include, for example, criteria relating to permitted production domains, energy carriers, production time, certificate expiry time, etc. The cancellation Rules should support all parameters required to adjust the feature, so that the domains retain the agreed level of control over GOs being cancelled to them.

Impact on the fee structure and need for reporting facility

The central cancellation Facility should feature adequate reports for domains, or an organisation providing the system, such as the AIB, to carry out invoicing of cancellation and membership fees. The system and the governing common agreements should facilitate the collection of these fees from account holders across domain borders without the collecting issuing body carrying the credit risk related to the cancelling account holder in another domain.

This work assumes that the format and approval of limitations would be coordinated by an industry agreement, such as the AIB's EECS®, or a new EU level regulation. The data transport layer, protocol, and data protocol would be similar to those used for inter-registry transactions.

4.2.3 Initial product backlog

The main Epics and User Stories constituting an initial product backlog are the following:

Epic D Registries shall be able to upload initiated cancellation transactions, so it is available for central administration. The initiating Registry shall receive an answer in a reasonable time to be able to confirm the transaction to the account holder. In case of positive answer, the initiating Registry shall also receive a cancellation ID and cancellation Statement issued by the hub.

User Story 16 *As a registry, I can send initiated cancellation transaction to the hub, so that the hub can validate, approve, and register the transaction. Along with the cancellation transaction information is conveyed on the type of cancellation (for own consumption, for supply to customers, for energy carrier conversion, for conversion losses).*

User Story 17 *As a registry, I can receive approval or rejection of the cancellation transaction with an error code, and, in case of approval, a cancellation ID issued by the hub and a link to a cancellation statement issued by the hub, so that this information can be provided with the account holder initiating the cancellation.*

Epic E Cancellation data and statistics can be viewed and downloaded from the hub by relevant parties.

User Story 18 *As a hub operator, I can view and download full cancellation data for the calculation of fees and creating statistics.*

User Story 19 *As an issuing body, I can view and download full cancellation data regarding cancellations where the beneficiary is in my domain and where the cancelling account holder is in my domain, so that I can supervise the GOs in my domain over their lifetime, the market and invoice market participants for the services provided to them.*

User Story 20 *As a disclosure authority, I can view and download full cancellation data regarding cancellations where the beneficiary is in my domain and where the cancelling account holder is in my domain, so that I can supervise the disclosure reporting in my domain.*

Epic F If required by the cancelling account holder and permitted by the issuing body of the cancelling registry, the hub must create cancellation statement, which is optionally publicly available. The cancellation statement must be located behind the hub web address but include a long enough random string

so to make it practically impossible to guess the whole link by either human or computer.

User Story 21 *As an account holder I can download cancellation statements in relation to my cancellations or where I am beneficiary, issued by the hub. It shall be publicly available if I have opted for a public cancellation statement so that I have a credible proof of the cancellation for my customers and interest groups. A cancellation statement shall always display its unique ID, to ensure it cannot be double used.*

Epic G The system shall facilitate Master Data management so that administrative users can set up necessary base data for the feature.

User Story 22 *As an administrator I can manage information on ex-domain cancellation agreements so that the system can validate whether cancellation from a specific domain to another is allowed, the default being yes for same energy carrier domains and no between different energy carrier domains.*

User Story 23 *As an administrator I can manage domain specific cancellation rules so that the system can validate what kind of GOs can be cancelled for the benefit of a domain, for example with regard to the age, origin, energy source, Product[6], and energy carrier of the GOs.*

4.2.4 Data model for the centralised cancellation facility

As explained in the introduction, the data model presented here is based on numerous assumptions regarding, for example, the data already handled in a current hub. It is also assumed that the hub features a data model for the storing of full information on certificates and transactions. Further, it is assumed that the publishing of information and adequate security, including management of users and rights, is provided by the hub.

The data model below represents main data classes (entities) and their relationship with each other as well as the main data attributes related to cancellation and cancellation rules. The data that is assumed to be already available in an existing hub is in a separate package "a hub", but the relationships between the data classes are not presented. Physical data structures, like link database tables and detailed attributes, such as IDs, names, time stamps, etc. are not presented.

[6] *Product here refers to differentiation between electricity GOs issued for energy source and for technology of the originating production device*

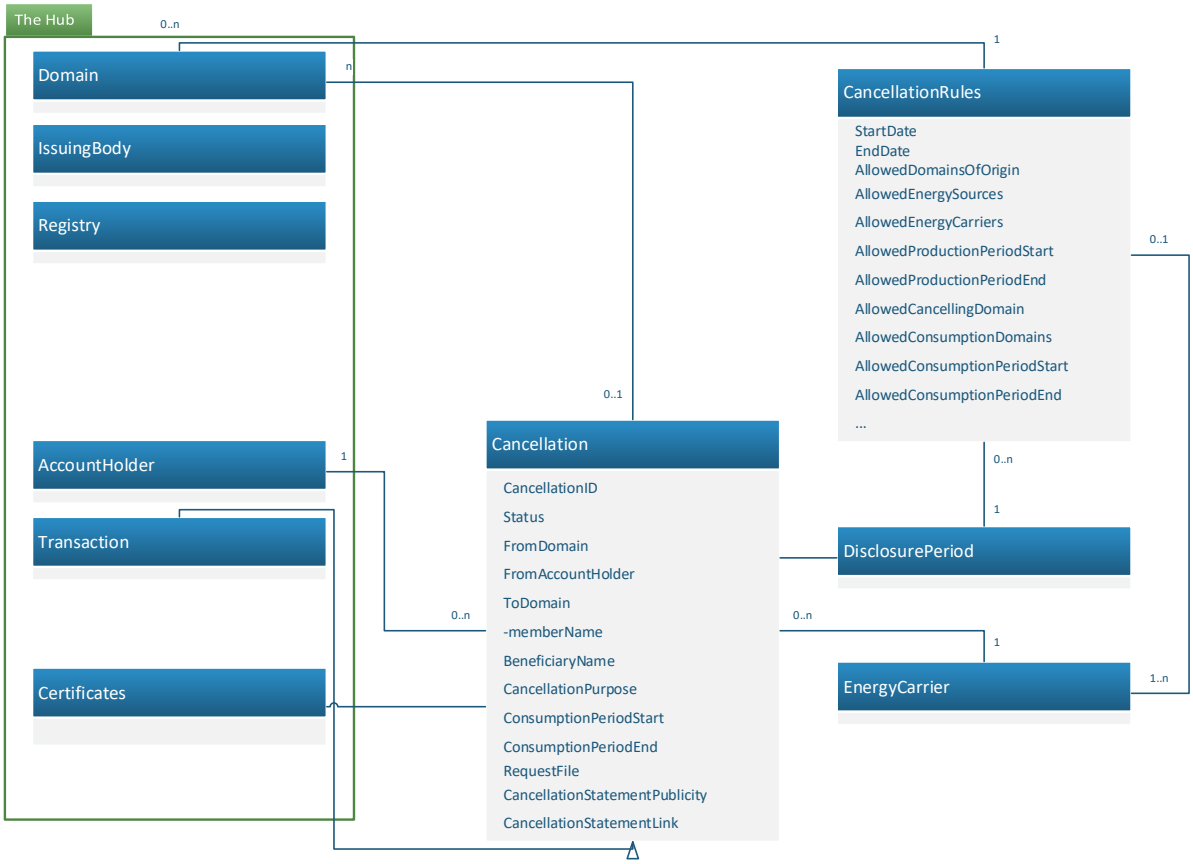

Figure 3. High-level data model for centralised cancellation facility

4.2.5 Evaluation of the centralised cancellation facility

A logical next step

When studying the overall IT infrastructure from the perspective of gradually increasing centralisation, the centralised cancellation utility is one of the most obvious and most logical additions to an interconnector hub[7]. It would bring many benefits, as discussed in the general description of the feature above. The requirements, including the data model, do not seem overly difficult or expensive. In fact, many of the structures and functions already in use for handling the transfer of certificates across domains can be recycled for the cancellation function. Indeed, it looks like a feature that can be built with a reasonable budget and it would clearly benefit the market. Where a market party wishes to be active in several domains, the requirement to open an account in each registry has been widely criticised by the market parties, which risks undeclared ex domain cancellations to undermine transparent origin disclosure overviews.

Facilitating energy carrier conversion

A centralised cancellation facility would be a useful tool for facilitating energy carrier conversion. Energy carrier conversion is the transfer of energy from one carrier to another, for example burning biomethane in a combustion device to generate

[7] *See FaStGO task 3.1*

electricity; or using electricity to produce hydrogen in an electrolyser[8]. In order to issue a GO for the output of conversion, where the input energy is carried by electricity, gas, or heat, then the GOs associated with the input energy carrier must be cancelled, and must reflect any losses incurred in the conversion process. Many properties of the GOs for the input energy carrier, such as energy source and support information, must be inherited by the output energy carrier GOs. Also, as it is likely that GOs for different energy carriers are issued in different domains, the cancellation of GOs for energy carrier conversion may in many cases be an ex-domain cancellation. The centralised cancellation facility with online standard cancellation statements, APIs and centrally issued cancellation IDs, would be a useful tool to improve quality and to reduce administrative burden.

Challenges

There are, however, a few issues to be addressed before centralised cancellation can become a reality.

- **Sovereignty of domains** would be reduced regarding cancellations to their domains. This would even be the case if the central utility were to provide versatile tools to configure domain specific rules including restrictions regarding cancellation. domains would still lose the "final word" compared with the situation where GOs are required to be cancelled in a registry managed by themselves.
- The content and design of **cancellation statements** would be harmonised, preventing domains from having deviations nationally from any international norm. It might be, however, permissible for registries to create their own cancellation statements, as long as they contain certain mandatory information and a linkage to universal statements. For registries, this would be easy in cooperation with the proposed feature, as all of the data would be made available by the hub via an API. In this case it has to be avoided that for the same cancellation there are two cancellation statements issued.
- **Overlapping domains and administrative territories** may obscure who has the authority to define cancellation rules for the disclosure domain. In many countries, energy source disclosure is the responsibility of a different authority to GO issuance. For centralised cancellation utility to be a useful tool, the latter would need to agree on rules and procedures. A clear framework for cooperation needs to be set up with the supervisory authority for energy origin disclosure towards consumers, in each involved domain, and also a cooperation between disclosure authorities cross-domains is likely to be beneficial.

Even after considering the identified challenges, centralised cancellation seems a sensible addition to an interconnector hub. The feature seems technically very feasible and rather straightforward. The challenges lie on the regulatory and administrative side of the equation.

[8] *See FaStGO task 2.3 report for more information of the energy carrier conversion problematics*

5. From a hub to a multi-domain registry

5.1 General description of the feature

This chapter studies a concept of enhancing an interconnector hub into a multi-domain registry. The (black box) assumptions regarding the underlying interconnector hub are the same as those used in the previous chapter for the automated residual mix and centralised cancellation facility.

The multi-domain registry would manage internal domains so that they are separated from administrative functions, the hub functionality, and each other. Each internal domain would be a logically isolated, like a separate registry from an issuing body's point of view. The issuing body of a domain would have administrative access to the data relating to its own domain and manage data objects which belong to that domain with a limited visibility and no edit access to data objects managed centrally or belonging to other domains. Data objects belonging solely to a domain include issuing body users, account holders and their users, production devices, Meter Readings, and Transactions within the domain. Data relating to transactions between domains would be shared with the counterparty domain.

Numerous domain parameters would be needed to enable deviations to adequately accommodate for national peculiarities. These include, for example, policies regarding GO expiry, production device registration, cancellation, Issuing, Meter Readings, additional data elements recorded on the GO etc. Localisation shall provide support for national languages as well as date and number formats.

All information recorded and actions taking place within a multi-domain registry must be available primarily via RESTful APIs, and secondly via a user interface. The availability of the APIs is especially important for account holder, production device, and Meter Reading management; because these activities are most likely to interface with national and issuing body internal IT infrastructure. An issuing body might, for example, need a national production device registrations system or a national account application management on their own website, and post only the outcome of the internal process to the central system via the AIB. Also, measurement values are typically handled in an imbalance settlement system or national data hub, which can rather easily be integrated to the central registry if a well-documented and public API exists.

5.2 Scope

The level of details specified in this document for the multi-domain registry is lower than in the previous chapter. The goal is to explore the concept of evolving from an interconnector hub towards a central registry, from a technical point of view. Unlike for the hub extensions elaborated in the previous chapter, mere *epics*[9] are provided for the Multi-domain Registry.

Even though the securing of a multi-domain registry is more complex than is the case for a mere interconnector hub, description of additional security measures is out of the scope of this report.

[9] *For definition of epic, see for example https://www.atlassian.com/agile/project-management/epics*

5.3 Specification

5.3.1 Epics

Epic H The multi-domain registry must be able to manage the concept of internal domains so that, from an issuing body's perspective, they constitute a separate registry connected to other registries and the hub.

Epic I The multi-domain registry must be able to manage issuing bodies, so that they are the administrators of internal domains. One issuing body can cover one domain and one or several energy carriers, certificate types and Purposes.

Epic J Issuing bodies must be able to manage account holders of their own domain. Account holder management includes registration and Know-Your-Customer -process, editing, user management, locking, and deleting. One account holder may, subject to governing issuing body and domain of Residence, handle one or several energy carriers, certificate types and Purposes.

Epic K Issuing bodies and, if allowed by domain parameters, account holders, subject to issuing body Approval, must be able to manage production devices. A production device must have one responsible account holder (registrant), but it can have several owners. A production device can have several meters from which the qualified output is calculated. Production device management must support versioning of production devices so that, in case of changes, the issued certificates use production device data standing at the time of production. Production devices must feature several licenses which regulate what kind of certificates can be issued for which production periods.

Epic L Issuing bodies, production registrars, and, if allowed by domain parameters, account holders and measurement bodies, subject to issuing body Approval, must be able submit measurement values. Measurement values are allocated to specific meter and production device by a meter ID which is unique in the domain.

Epic M Issuing bodies, production registrars and, if allowed by domain parameters, account holders and measurement bodies, subject to issuing body Approval, must be able submit production and consumption declarations. Declaration can include contribution shares of energy sources, auxiliary energy consumption, own consumption, High-efficiency cogeneration data, or other additional information regarding production during a certain period. Declarations relate to production device and Time Period.

Epic N Issuing bodies must be able to Issue certificates for a specific time period and production device. Issuing features must enable reasonable configurability by the issuing body to support national practices, including automatic issuance, issuing frequencies, backward issuing limits, and use of issuing requests. Comprehensive reports must be available for the issuing body and relevant account holders to monitor the issuance of certificates, with at least filters on issued certificates per account holder, per production device, per time period, per energy source or group of energy sources. Depending on the registration of the production device, issued certificates might be aggregated to another account holder in the same domain to

enable service providers to handle certificates on behalf of the owners and registrants.

Epic O Issuing bodies must be able to withdraw certificates which are held in their domain. Withdrawal is a transaction that removes extraordinary or erroneous certificates from circulation by marking them as withdrawn and preventing any subsequent transaction on the same certificates. With a withdrawal, the withdrawing issuing body must provide the reason for withdrawal, for example, error in issuing or in transactions.

Epic P The registry must enable creation and management of accounts held by account holders. By default, a newly established account holder has one single account per domain, to which certificates are issued and incoming transactions point to, for all the different energy carriers and purposes for which the issuing body, at which the account holder is registered, is entitled to issue certificates. Issuing bodies can adjust settings to have separate accounts for different energy carriers and purposes. Issuing bodies can customise setting to link accounts from the same account holder in different domains, upon existence of an agreement to do so with the issuing bodies of the other domains involved. account holders must be able to create and inactivate additional accounts for their company-internal organisation of their certificates. Issuing bodies must be able to freeze accounts and immobilise certificates in order to prevent account holders from moving certificates away from an account in case of for example insolvency or litigation.

Epic Q The registry must facilitate certificate accounts between the accounts within an account holder, between accounts from different account holders in a domain, and between account holders in different domains. Transfers must be subject to global and domain-specific rules. For example, it might not be possible to transfer GOs of fossil origin to certain domains. Transaction data, including the full certificates participating the transaction, must be stored separately from the actual certificates, to provide a full audit trail.

Epic R The registry facilitates certificate transfers with a specified hub that interconnects external registries, in line with the transfer protocol of that hub.

Epic S The registry must facilitate the cancellation of certificates to the benefit of the consumer of the associated physical energy. Cancellation must be initiated by an account holder and, if so configured, approved by the issuing body of the domain. When initiating a cancellation, the account holder must give all relevant data that is required from a cancellation, including the consumption period, the beneficiary of the cancellation, the geographic area of the corresponding energy consumption and cancellation purpose. cancellations are automatically validated by the registry against cancellation Rules.

Epic T The registry must ensure that certificates expire in accordance with expiry rules valid in the respective domain. Expired certificates can no longer be transferred nor cancelled. Issuing bodies can retrieve reports of expired certificates. The issuing Body can install a reminder message to the account holder informing him about the certificates that are about to expire within a time interval of which the length is to be specified by the issuing body. The

issuing Body can also adjust the setting so that the account holder sets the reminder time interval before expiry.

Epic U The registry must provide the issuing bodies and account holders with adequate and clear private reports. These reports provide information on transactions, user activities, meter readings, production devices, etc.

Epic V The registry must provide Public Reports as required by the regulation and governing certification scheme to increase market transparency.

Epic W The central administrator and, to certain extent, the relevant issuing body, must be able to manage master data and domain parameters per domain. Domain parameters control the policies and practices in use in the domain. They are the main vehicle to facilitate for national differences and deviations.

Epic X The central administrator must be able to carry out central master data management. Central master data includes for example adjusting the list of facilitated energy carriers, Purposes, Technologies, and energy sources. Some master data shall be specific to a time period, so that different master data would be used for a different point of time. Time might relate to 'now', production time, cancellation time, expiry time, or disclosure period, in order to provide a smooth transition when, for example, regulation or the governing certification scheme changes.

5.4 Evaluation of the multi-domain registry concept

In practice, the enhancement of a currently existing hub software into a full central registry is probably not a viable approach, because of the original limiting assumptions and design choices of the software. If a central registry is to be built, then a more viable product would be achieved by designing and implementing it from scratch as a central registry system. In the real world, this does not mean that such a central registry would immediately replace the existing interconnector hubs and national registries. Rather, a more practical approach would be to let the existing hubs remain as connectors between the currently existing national registries and the multi-domain registry elaborated here. In this way, the interconnector hub and a new multi-domain registry together would become artefacts of the "hybrid solution" as described and evaluated in the FaStGO task 3.1. This IT infrastructure might gradually over time, or rapidly due to a new regulation, evolve into a single central registry.

6. Central recording of all transactions?

Building a full Multi-domain registry would be a major step from the current situation (of distributed registries connected through an interconnecting hub) and would require a major development effort. Nevertheless, the FaStGO task 5 report on fraud prevention raises the issues caused by not having all transaction information available in one place. Because of that, it is not possible to efficiently detect fraud cases in scenarios involving several domains, such as MTIC (Missing Trader Intra-Community) fraud.

This problem could be mitigated by collecting all transaction information into one place for analysis in real-time. A lighter solution than a completely centralised registry architecture would be to collect the intra-domain transaction information into an interconnector hub, in addition to the inter-domain transaction information. Intra-registry transaction data combined with the already existing inter-domain transaction data would constitute a complete transaction log that could be used for automatic real-time fraud prevention analysis, and even the prevention of suspicious transactions. Such data could also be used for such matters as retrospective data analysis and market statistics.

What technical changes would be needed for an interconnector hub to be able to collect all transaction information? Two technical approaches are discussed briefly below:

Option 1) Making use of existing import/export features

The easiest way of collecting all transaction information would be to use the same data protocols, logic, and structures which are already used for the inter-registry transactions. The only difference between intra- and inter-registry transactions would be that, for intra-registry transfers, they would be confirmed to the transferring registry, rather than forwarded to another registry. Figure 4 (below) illustrates the differences between the relative flows of events for each of the two transaction types.

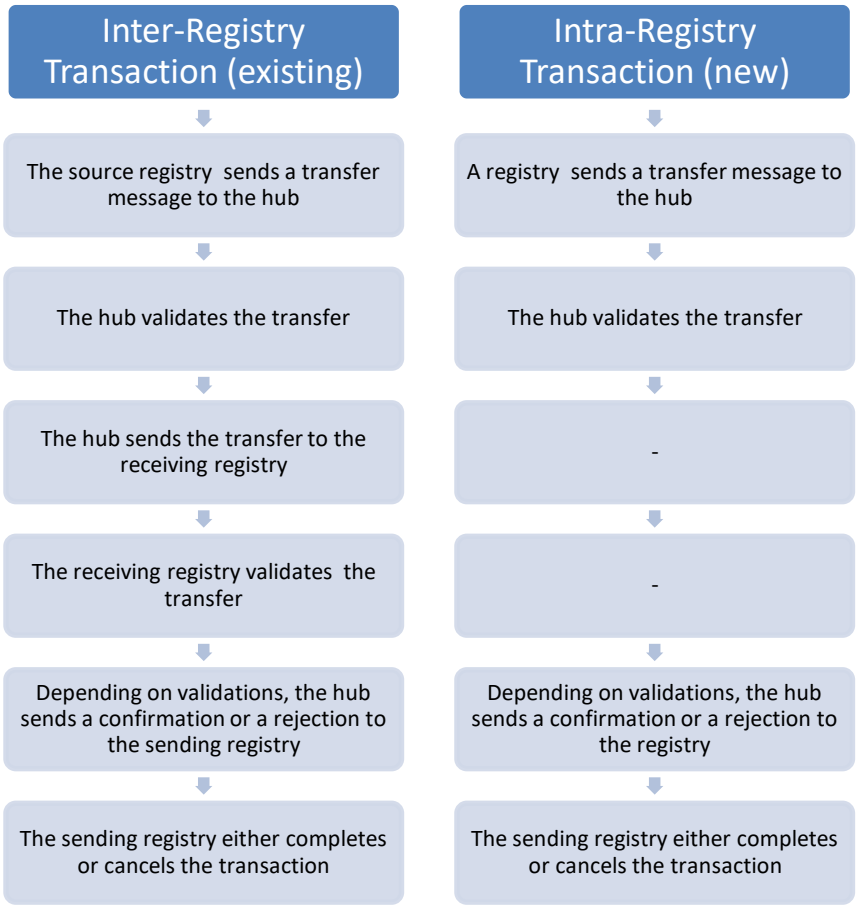

Figure 4. The difference between inter- and intra-registry transfers when both are passing through the hub

As can be seen in Figure 4 (above), the technical implementation of the collection of intra-registry transfers within the hub would be based on existing functionality and simply mean omitting the communication with the receiving registry. This means that the changes to an existing hub would not require major restructuring of the code.

The changes that would need to be implemented by each registry depend on the design of the registries' software. A registry would need to be changed so that it would handle intra-registry transactions in the same way as it handles imports and exports. In essence, an internal transfer requires the registry to amend the contents of the accounts in which the certificates are held and create a transaction data object to maintain the audit trail. That process would need to be divided into initiation and completion, in the same way as for an export/import transaction. In other words, the registry would no longer facilitate internal transfers as a whole, but as the two parts of the transaction: debiting and crediting the account. Technically the debit and credit functions would be the same as existing export and import functions.

It would be technically viable to implement transaction log functionality using the existing hub-centric infrastructure. In addition, it would probably be possible to implement this, both in the hub and in the registries, without major revision of the software. New registries would need less development effort because they would be able to rely on the hub and develop only one type of transaction covering both internal (intra-registry) and inter-registry transactions.

However, several open questions and issues still need to be addressed:

a) Who would 'own' the full transaction data, and who would have access to it?

b) The quantity of transactions and the data volumes in the hub would grow perhaps 200%, potentially causing performance and capacity issues.

c) Transfers within registries would become dependent on the hub, putting more pressure on hub performance and reliability.

d) Transfers within registries would no longer take place immediately but would be delayed by the same amount of time as international transfers, so account holders would have to check separately if and when their transfers have been successful or not.

e) In addition to the above process, which facilitates collection of the data, a sophisticated analysis and alert system is needed if the transaction log is to become a useful tool.

f) The main driver for this functionality is fraud prevention. However, issuing bodies are not mandated for explicit expenditure on fraud prevention, so funding the change and maintenance of the related software is likely to be an issue.

Option 2) Separate collection of intra-registry transactions

If member states prefer national governance of transaction validation and delivery, they may wish to consider simplified information collection.

Here, a registry would not change its current handling of internal transactions, but after the completion of an intra-registry transaction, the registry would send information about the transaction to the hub; which would then store this information in order to facilitate central analysis.

However, this does not resolve issues a), b), e) and f) of the central transaction management option (Option 1 above – "*Making use of existing import/export features*"). Furthermore, it would be challenging to guarantee that all transactions are properly logged within the hub.

Consequently, while it would be relatively straight-forward to specify the detail of a central collection system for transaction data using either of the above options, it would be advisable to further explore the concerns and needs of issuing bodies and authorities before doing so.

7. Concluding remark

This report elaborates the high-level requirement specification for a first step towards the evolutionary model as described in the FaStGO task 3.1 report, with a vision of a future IT infrastructure for guarantees of origin. The report shows that implementation of the proposed model is feasible.

For this to succeed, it will be necessary to hold a close and intensive dialogue between the relevant issuing bodies, including confirmation of a joint vision and a framework for aligning rules and practices. This can be achieved without additional legislation by establishing appropriate contractual agreements. It is advisable that a stepwise approach be adopted in which the relevant parties agree how to: mitigate such challenges as the linkage with other national certificate systems, maximise return on investment for existing national registries, and migrate data.