Interim Report Renewable Fuels Traceability

Dutch Blockchain Coalition

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An overview and recommendations for the Renewable Fuels Traceability initiative as of November 2023

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Interim Report Renewable Fuels Traceability Dutch Blockchain Coalition

End of the Design Phase

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Date

21 November 2023

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EXECUTIVE SUMMARY

Anticipating a surge in green energy, challenges in data exchange for renewable fuels arise due to traceability issues and non-interoperable databases under new Fit-For-55 regulations. This may hinder the renewable fuels' market growth. To address this, exploring new digital infrastructures is recommended for a more efficient and transparent information exchange system. Technology advancements, such as blockchain technology, can facilitate this innovation.

This report provides an overview and recommendations for the Renewable Fuels Traceability project, which aims to answer the following research questions: *"How to mitigate the risk in the supply chain's information exchange for renewable fuels*?" and "*how to - under further growth of renewable fuels volumes - keep the administration of sustainability and CO2 emissions reduction information and the monitoring on the sector manageable and cost-effective while serving the (end-) users with sustainability information?"*

The initiative advanced from Q4 2021 to Q1 2023, mapping out a preferred future process flow and the corresponding functional prerequisites for creating a Minimum Viable Product (MVP).
This included considerations such as business rules, transaction initiations, adjustments and cancellations, administrative functions, authentication, authorization levels, external interfaces, and reporting requirements.

The project concluded on the importance of collaboration and transparency in the renewable fuels industry, grounded in the principle of *privacy-by-design*. Multipe recommendations for future developments were provided, including the need for a common long-term vision for the future, the importance of establishing a strong mandate, and the focus on building a trust framework. The report also suggests potential scenarios for new partnerships/consortia, such as community building and the development of an interoperable digital product passport standard.

INTRODUCTION

Decentralized technologies such as blockchain and cryptography offer unprecedented opportunities for innovation for our society and business. Decentralized cryptography can ensure data integrity and contribute to secure data accessibility and exchange. This allows citizens, the business community and the government to benefit from the possibilities and opportunities that decentralized technology offers us.

One sector in particular benefiting from data integrity and secure data exchange is the renewable fuels market, which is encountering new challenges due to upcoming regulations to mitigate climate change. This document aims to provide insights into the renewable fuels traceability initiative's background and the lessons learned, catering to those seeking a better understanding of the subject.

Problem Statement

A substantial influx of green molecules or green energy carriers is expected in the upcoming years, necessitating rigorous registration and verification processes. Owners of the volumes are responsible for the data quality and storing and transferring this data down the supply chain appropriately. However, the current practices encounter challenges concerning the traceability of renewable fuels and the assurance of sustainable energy, complicating valid, trustworthy information exchange. With the introduction of new and forthcoming regulations following the Fit-For-55 package, multiple non-interoperable central databases have emerged, leading to potential issues such as 'double spending' claims and increased efforts and costs to provide sustainability information. This situation may hinder the market value and growth of renewable fuels.

To improve the information exchange system, new digital infrastructures should be explored to overcome challenges resulting from the current paper based, non-interoperable systems. Technological advancements, such as blockchain technology, can facilitate this shift.

Global/Europe

Amid the need for mitigating climate change, renewable fuels have become increasingly vital. The current energy supply system heavily relies on fossil resources, causing environmental and socio-economic impacts and contributing to GHG emissions. Renewable fuels have a significantly lower carbon footprint compared to traditional fossil fuels and therefore the shift to renewables is crucial. In various scenarios for 2050, the IEA estimates a need to nearly triple current biofuel production to achieve sustainable development goals (figure 1). This includes ethanol, biodiesel, renewable diesel and biojet, but also options such as biomethanol or biomethane.

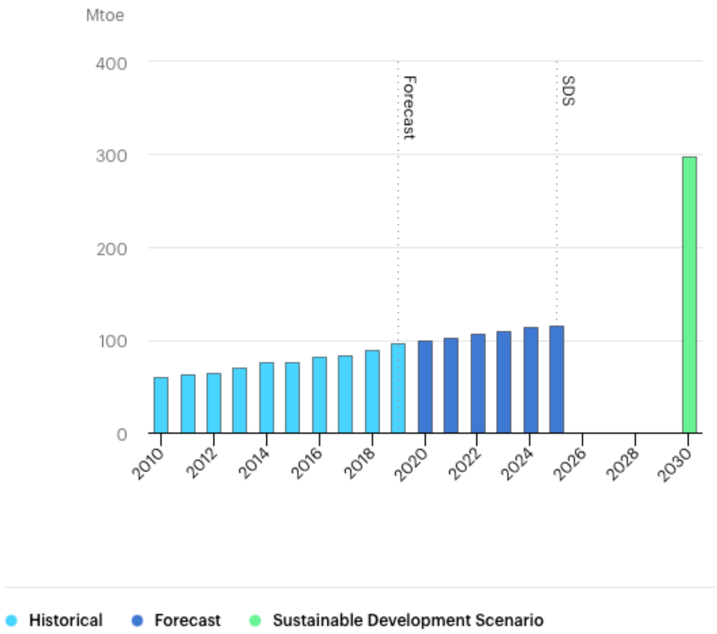

Figure 1. Global biofuels production 2010-2025 compared to consumption in the Sustainable Development Scenario (IEA, 2021).

Other green carbons and electrons in the mix (e.g., renewable liquid fuels /feedstock, renewable gaseous fuels/feedstock, green hydrogen and hydrogen derivatives including green ammonia) will also need to increase over time, see figure 2.

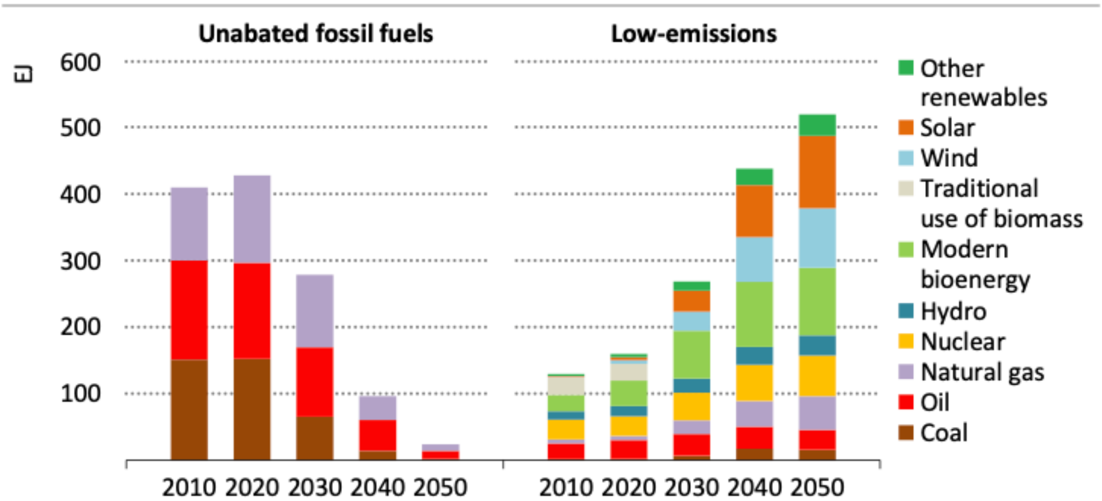

Figure 2. Total energy supply of unabated fossil fuels and low-emissions energy sources in the NZE (IEA, 2021).

The growing volumes of renewable fuels however present new challenges with regards to demonstrating sustainability (e.g., proof of origin and sustainable sourcing) and CO_2-emission reductions. Upcoming regulations in various sectors propose new registration requirements following the EC fit-for-55 package (table 1), posing administrative burdens for both sector parties and the oversight body as a result of the current information exchange system.

1. Existing reporting in fuel supply chains	**2. Sustainable aviation fuels**	**3. Marine fuels (FuelEU Maritime)**	**4. Scope 3 reporting End-users**	**5. Carbon dioxide Removal**
RED- certification and verification requirements (also RFNBO's (e.g., green hydrogen or e-methanol)	EC Parliament proposes European book and claim system for SAF	GHG marine fuel certification	GHG accounting (GHG protocol) Used to meet Science Based targets	Certification rules for permanent storage in ETS (by 2026)
Union Database, a central register for Biofuels, Recycled Carbon Fuels, Green Hydrogen	ISCC-certification scheme offers for SAF-users credit transfer systems. Market parties such as Sabena and Shell offer own system	Fuel EU monitoring/ reporting/ verification systems	Allocating GHG-reduction to customers	Carbon farming and carbon storage in products in LULUCF-regulation (by 2025)
National registers (Nabysi, Nea)	P.M: carbon credits voluntary markets can be used in ETS/ aviation allowances			Credits can be used in the biomass value chain or outside the value chain

Table 1. Overview of new registration requirements in regulation following the EC fit-for-55 package.

The Netherlands

Companies that deliver fuels in the Netherlands are subject to requirements based on the law and ordinance governing Energy for Transportation, which include an annual obligation and a reduction obligation. To date, the annual obligation requires a rising percentage of renewable energy in fuel delivery, increasing from 17.9% in 2022 to 28.0% in 2030. Additionally, companies must reduce carbon emissions in their fuel supply by at least 6% compared to the 2010 baseline. To comply, companies are required to annually register their duty-paid fuel deliveries in the Energy for Transport Registry (REV) of the Dutch Emissions Authority (NEa) by means of providing their Proof of Sustainability (PoS) documents in order to calculate the yearly obligations. The level of the obligations is expressed in Renewable Energy Units (HBEs[1]). Companies can trade HBEs, which occurs without involvement of the NEa and outside the REV.

The current information exchange system has presented some challenges which are summarized below.

Risks in proving sustainability

In last years, several fraud cases have been revealed where some parties have committed fraud to receive double counting premium for non double counting feedstocks.

To fully grasp the risks in the current system, first a basic understanding of the actors and supervision bodies in the supply chain is required. As visualized in figure 3, oversight occurs at every stage of the supply chain and is supervised by private schemes. These private parties such as DEKRA, Control Union and Quality Services Inspection (QSI) make use of voluntary schemes, e.g., based on the ISCC. They also verify double counting and verify registrations in The Netherlands. The public oversight body (NEa) in the end has the capacity to periodically check on registrations alongside the registration verifiers. Incorrect registrations can be officially corrected by the NEa up to 5 years after the calendar year to which the registration relates. The international, complex nature of the renewable fuels supply chains that make use of differing methodologies to review sustainability of fuels in jurisdictions and the gap between physical streams and paper streams because of mass balancing are factors that make this chain susceptible to fraud. Fraud affects the public credibility of renewable fuels and should be tackled strongly for that reason. In terms of administrative burdens, supervisory measures must be absorbable by the sector to not unnecessarily hinder the desired growth of renewable energy and biofuels. One of the solutions to reduce the risk of fraud is to increase transparency in the supply chain. These developments are important within the renewable fuels supply chain to develop a better information position with regards to the correct application of mass balances. By increasing transparency in the supply chain, this can also strengthen the position of private supervision.

[1] "Multiplication of the mandatory shares and the energy content of the deliveries for final consumption yields an energy value. This is subsequently used to express the annual obligation in a number of Renewable Energy Units (HBEs), with one HBE required for each gigajoule (GJ) calculated. One HBE is awarded for each gigajoule (GJ) of renewable energy delivered to the Dutch market or transport market that is registered in the REV. As a result of the sub target for advanced biofuels and the limits on conventional biofuels and fuels from used fats and oils, the annual obligation is expressed using the four types of Renewable Energy Units – HBE Advanced, HBE Conventional, HBE Annex IX-B and HBE Other. The feedstock of the biofuels and the type of renewable energy registered determine the type of HBE that is created." (NEa, 2022). "The feedstock also determines whether the biofuel is eligible for double-counting" (NEa, 2022)

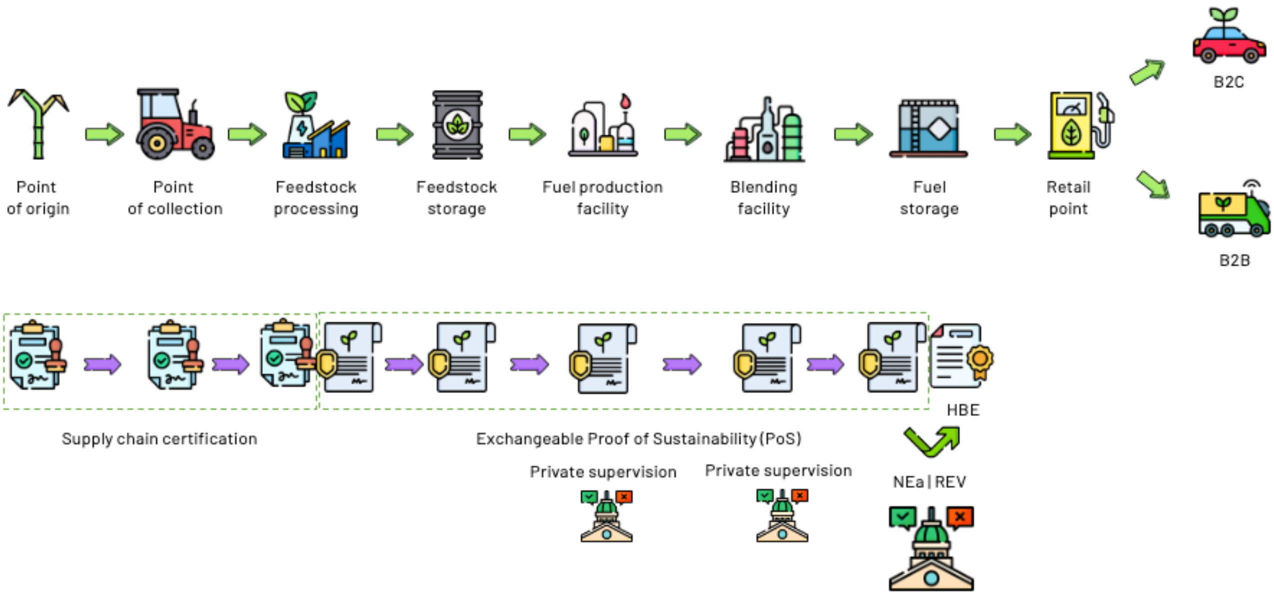

Figure 3. Renewable fuels supervision and HBE-creation.

Weak information stream to end users

Specifically in the Dutch context, the growing demand from end users for information on the sustainability of purchased renewable fuels presents challenges. Some end users want to prove that their activities are based on renewable fuels, may it be for branding, granting concessions in public transport or when tendering for large infrastructure projects. The increasing demand for information about purchased renewable fuels is especially expected from road transport, inland shipping and maritime transport operators, and among tenders (infrastructural projects) and concessions (public transport). Consumers also have a growing interest in the origin and sustainability of products. Currently, there are no legal obligations to deliver (sustainability) information to end users (figure 4), which makes this information transfer to the end user not regulated.

With a lack of transparency, it can happen that sustainability information is duplicated and and provided to multiple end users, called 'double spends'. Also, the use of differing frameworks for calculating the carbon footprint complicates comparison. Additionally, end users may inquire about other aspects, such as biodiversity and ILUC, to determine fuel compliance with the RED. However, extracting this information directly from the PoS is challenging, particularly due to the complexity of depots mixing various supply chains from various feedstocks and blend them with fossil fuels.

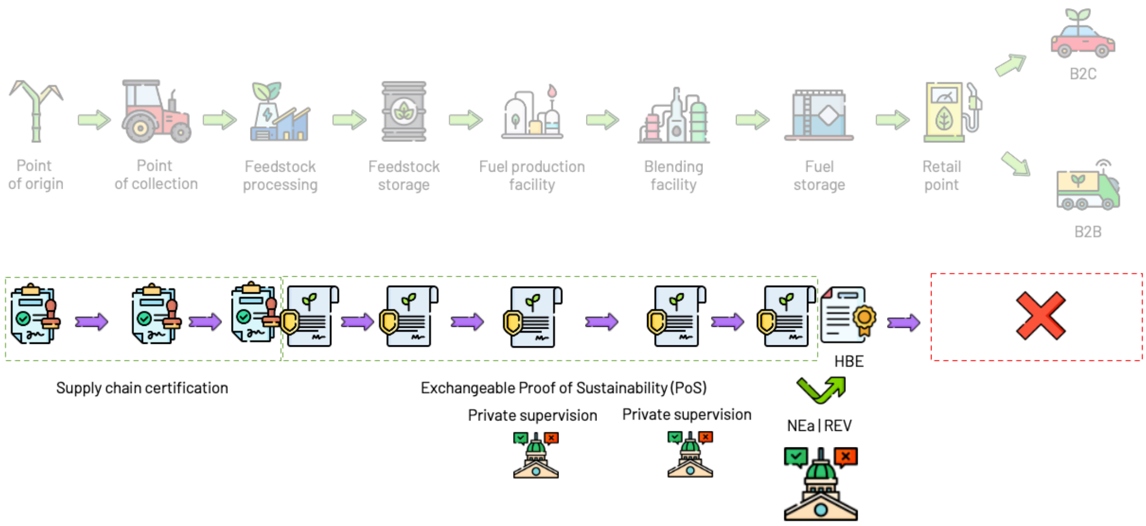

Figure 4. Dutch sustainability information transfer system.

Additionality not available

Another problem in current practices is the fact that end users who use biofuels to achieve sustainability goals can only do so under the annual obligation. This means that using biofuels in their practices does not stimulate additional renewable fuels above the obligations set for the market. The concept of additionality, meaning supplying renewable fuels to the market that are not registered for the annual obligation, is currently not made possible for any of the fuel suppliers in the Dutch market. Ways to pursue additionality is to buy biofuels with a PoS but without an HBE (and drop the PoS). This way, biofuels would then be added to the market on top of what the law mandates. End users basically claim using part of the volumes that have been supplied to the Dutch market.

Research question

The question that initiated this project was: *"How to mitigate the risk in the supply chain's information exchange for renewable fuels?* Later on, the subquestion *"how to - under further growth of renewable fuels volumes - keep the administration of sustainability and CO_2 emissions reduction information and the monitoring on the sector manageable and cost-effective while serving the (end-) users with sustainability information?"* was added.

PROJECT PHASES

The Renewable Fuels Traceability Initiative commenced in Q4 2021 and continued to make progress as of Q1 2023. The subsequent section will delineate the past two years into two distinct phases: the exploration phase and the design phase. Resulting from the chronological order of presenting the deliverables of each phase, some information may be repetitive or differing with/from the introduction.

Phase 1: Exploration

The first phase consisted of two parts: the problem-solution analysis and the validation. The following section will describe both subphases and key deliverables.

Problem-solution analysis

In Q4 2021, the Dutch Blockchain Coalition initiated the establishment of the "Blockchain and Energy Working Group," focusing on the traceability of renewable fuels as its inaugural use-case. Collaborating with Shell, the Dutch Emission Authority (NEa), Platform Renewable Fuels (PHB), and the Energy Web Foundation (EWF), the working group conducted in-depth explorations to identify current pain points related to information sharing within the renewable fuels supply chain. Here, the working group scoped on biodiesel (FAME – B7) and renewable diesel (HVO- RD20, RD30, RD100) made from Used Cooking Oil (UCO) due to their relative high volumes in the Dutch market. Three issues in the current biofuels supply chain processes were found:

1. Inefficient processes with high risk
    a. High manual efforts required for both the regulatory bodies as well as the industry players to stay compliant.
    b. Paperwork is lagging, thus real time proof of sustainability is not possible, causing high risks for supply chain partners
    c. Potential fraudulent actions by one bad actor can cause high financial and reputational exposure for all supply chain partners
2. Cumbersome to prove sustainable performance
    a. Especially for downstream players it is cumbersome to claim and prove sustainable performance of products towards end customers. This leaves room for 'double spending' claims.
    b. Delivering sustainability information requires additional efforts and costs, while market value is presumably lacking

3. Lack of transparency
    a. Inability for end customers to verify the sustainable nature and provenance of renewable fuels
    b. The need to improve the confidence in the industry to be able to grow demand for renewable fuel products
    c. Fraud possibilities potentially jeopardize the product value

Based on these findings, the working group brainstormed potential solution directions for enhancing the traceability of biofuels and ensuring transparency in sustainability attributes. Subsequently, a design sprint was conducted under the guidance of Kryha to further develop and refine the proposed solutions. The goal of this design sprint was to set the initial goals and vision for the solution, map out the current and to-be process which resulted in a clickable demo of the potential solution elements, and to validate conceptual considerations with external stakeholders.

Goals and vision for the solution

The goals of the initial solution can be summed up as following:

- Make sure to capture accurate product attribute data in the beginning of the value chain and prevent the 'garbage in, garbage out' problem.
- Minimize manual input of data as much as possible.
- Passing through the information on the correct level of transparency for every stakeholder, respecting market dynamics and the confidential nature of commercial information.
- Creation of the sustainability documents based the right information
- Create digital representation of the physical product to create trust and confidence.
- Ensure the integrity of the data with respect to transparency and (dis)ability to change.
- Account for the conversion of the material within a site by means of mass balance.
- Verification at the value chain steps to secure the correctness of the transfer of information.

Following the defined goals, Decentralized Ledger Technology's (DLT) potential in supply chains was recognized, owing to its inherent attributes of immutability, transparency, and decentralization. These features ensure secure and tamper-resistant recording and tracking of transactions and data throughout the supply chain, fostering increased trust and operational efficiency among all stakeholders. Furthermore, blockchain's capacity to establish a unified, auditable source of truth simplifies the management of intricate supply chain networks, lessening administrative complexities, and addressing challenges associated with data discrepancies and fraudulent activities. However, during this phase, the working group decided that while technology played a pivotal role in achieving the solution goals, it should not be the primary focus. As such, the solution direction primarily emphasized the envisioned results over the specific technology utilized.

Clickable demo for potential solution elements

In this first phase, the focus lied on biodiesel (FAME – B7) and renewable diesel (HVO- RD20, RD30, RD100) made from Used Cooking Oil (UCO), which can be blended with diesel fuel[2]. Notably, FAME volumes dominate the Dutch biofuel market, whereas HVO volumes are lower but witnessing growth. However, the HVO delivery to The Netherlands is heavily reliant on a few major players in the sector, and uncertainty surrounded their willingness to participate in the traceability initiative. To maintain adaptability, the working group chose to remain flexible regarding the specific supply chain used as input for the first clickable demo. Nonetheless, the primary objective remained to develop an open and transparent digital system efficiently tracking biofuels and sustainability information from origin to end-customer. Such a solution aims to bolster industry confidence, foster overall market growth, and increase volumes of sustainable biofuels.

Using Figma, a web-based design tool used for creating, prototyping, and sharing user interfaces and designs, a clickable demo was made by Kryha. The demo was a combination of a desktop and mobile application to enable the collection, aggregation, and visualization of information along the value chain of a biofuel, see figure 5.

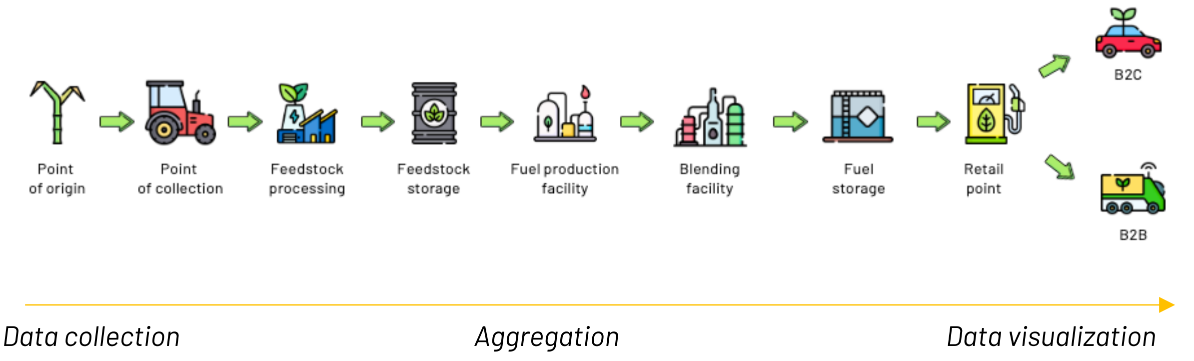

Figure 5. Supply chain covered in the clickable demo.

[2] Renewable diesel has the same chemical composition as fossil diesel and so is fully compatible with existing diesel engines. Biodiesel has a different chemical composition to fossil diesel and so blending is limited. Europe, for example, limits blends to 7% (IEA, 2021).

The demo consisted of 6 key solution elements:

1. Register material
    a. Register material by its attributes at the point of origin by means of a mobile application.
2. Handshake
    a. A digital handshake between every two sites to transfer product (attribute) information.
3. Mass Balance
    a. The mass balance module connects input to output at every site.
    b. Either based on FiFo, manual allocation, or other mass balancing approach.
4. Sustainability documents
    a. Automatically create sustainability documents based on collected data and mass balance allocation.
5. Proof of Sustainability (PoS) derivatives
    a. Extending and sharing sustainability information to downstream players and end-customers by creating 'PoS derivatives' to give insight into the sustainable performance of (to be) sold/procured renewable fuel, which can be used for alternative sources of income such as carbon credits.
6. Stakeholder Dashboards
    a. Dashboarding with aggregated data and insights suitable for every stakeholder.

The clickable demo (figure 6) represented the initial attempt to conceptualize the solution goals, resulting from collaborative brainstorming sessions with experts from the organizations in the working group. Through multiple iterations, the group achieved alignment on the solution direction. However, these iterations also gave rise to additional research questions that the present organizations lacked the expertise to address. Due to the extensive nature of the biofuels supply chain, input from multiple actors from upstream, midstream, and downstream was required to address these questions. The research questions were documented and served as valuable input for phase 2, which was expected to involve a broader range of organizations.

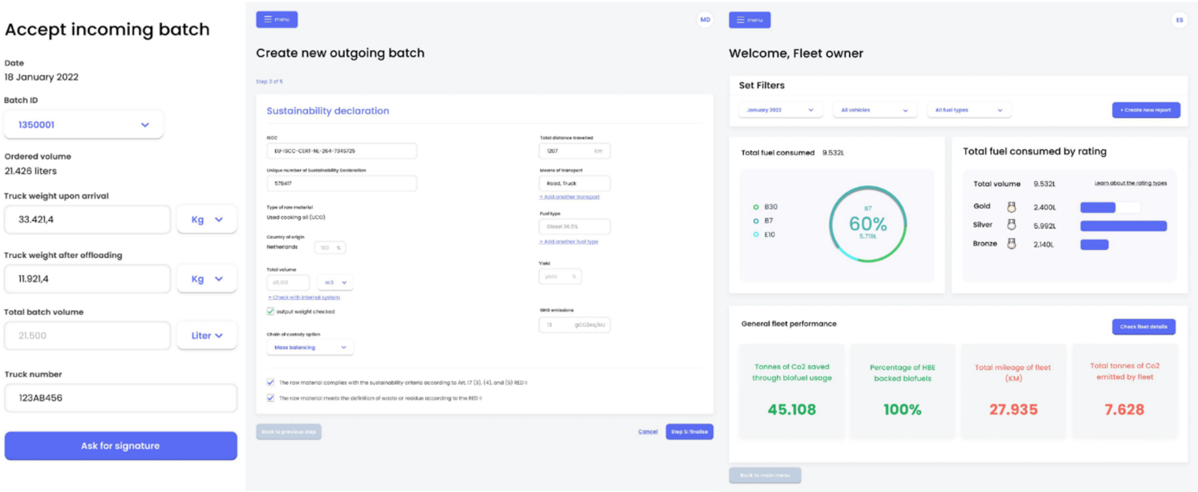

Figure 6. Screens from clickable demo.

The research questions established were categorized as follows:

1. Business value
    a. How to deliver to end-users and what information (data)?
    b. How to reduce administrative burden?
    c. How to secure interoperability (with data systems)?
    d. How to enable exchange and trade in the network?
    e. How to establish IP and licensing?
    f. How to organize trust in different contexts: mandated versus additional volumes?
2. Technical: scoping and functionality of MVP
    a. Data, methodologies, markets
        i. What is the scoping in terms of markets: Maritime/ Road? -We need to understand if it matters for the data transfer for MVP
        ii. What is the data? -datapoints on PoS, and all info on PoS? Contracts? Do we have data gaps? How do we exchange data? (see attached slide example PoS)
        iii. What are the methodologies? E.g GHG-calculation, PoS uses GHG calculation RED – applicable for EU market
        iv. Do we follow data on basis of Book and Claim or do we follow mass balance?
    b. Digital solution
        i. Who operates the platform?
        ii. What is the architecture/technical design of the solution?
        iii. Who are the users and what type of users?
        iv. What functionality is expected?
3. Governance
    a. Cooperation agreement to secure results?

b. Boundary of the solution
c. Principles of the platform: not for profit, open source?
d. Boundaries of the solution?
e. Who owes this platform?
f. Who operates the platform?
g. Who are the users of the platform (roles, rights and obligations)?
h. How to organize IP?
i. Licencing of commercial modules, solutions on top of the basic open source application

Validation

The validation of the problem-solution analysis was twofold: the first round was held by Kryha during the design sprint (Q1 2022) and second round was held by the working group after the design sprint (Q2-Q3 2022).

The first validation round by Kryha tried to determine whether the envisioned concept and solution as proposed was desired by the industry. One-hour virtual interviews were held with supply chain actors from biofuel production facilitates, fuel blenders and AGPs[3] / retail points. Some interesting outcomes from the industry are summed up below:

- Supply chain partners are already sharing product attribute information but with a major risk-producing delay in the process.
- This risk is substantiated by the amount of misinformation in the value chain, making it hard for organizations to prove compliance.
- A reduction of the information delay will result in a reduction of the exposure to risk in the market.
- Supply chain partners are hesitant to become more transparent due to the confidential nature of the information. One actor stated: "The market is not necessarily interested in transparency, only end-customers and politicians are". So far, variables like trade routes, price information and yield calculations are considered as confidential.
- End-customers currently lack visibility in sustainable performance of the fuels they procured (e.g., origin, feedstock used and GHG emissions).
- There is a willingness to pay a premium for more sustainable fuels among end-customers.
- At this moment in time, it is difficult to prove the actual GHG performance to end-customers because organizations use benchmark data.

[3] Accijnsgoederenplaats, translated as excise goods place.

Thus, the system should aim to minimize risk exposure by efficiently sharing accurate product attribute data among value chain partners, while prioritizing confidentiality. Additionally, it should effectively utilize the captured sustainability data to empower end-customers in making informed decisions about fuel procurement and consumption and to support claims regarding sustainable performance.

The second validation round was held by the working group after the design sprint. This validation round consisted of several formal presentations and conversations with actors from all over the industry. The interviewed actors can be categorized as renewable fuel producers / blenders / suppliers / traders, AGPs, verification and validation bodies, standards bodies and regulators. The working group presented the identified challenges in the renewable fuels supply chain and the identified solution. All actors agreed on the identified challenges and were interested to learn more, however, also made critical remarks about the (high) level of transparency the first solution design presented. It became clear that in order to identify and act upon all the pain points these differing actors were facing, the working needed to be extended with a number of additional partners that would work together on building a new digital infrastructure, tackling a broad range of complexities. The actors agreed on this collaborative approach and decided to join the expanded "Renewable Fuels Working Group" in September 2022.

Phase 2: Design

The second phase consisted of two parts: working group expansion and defining the functional requirements. The following section will describe both subphases and key deliverables.

The working group

During this subphase, the working group expanded and the new "Renewable Fuels Working Group" (from now: the working group) established. The working group comprised of active members who actively participated in bi-weekly steering committees, played a significant role in making scoping decisions, and provided financial backing for the project. There were additional stakeholders involved in the project, but they chose not to make a financial investment during this phase. Among the financially supportive organizations, the working group had representatives from various points in the supply chain, including Van Kessel, Shell, GoodFuels, Koole, VARO, GateTerminal, and Vopak. The NEa, PHB, and EWF remained project partners and extended their support through in-kind contributions.

Furthermore, there were non-financially contributing parties involved, such as ACT Commodities, ISCC, Dekra, Connekt, Volvo, TLN, SkyNRG, Vertogas, and Neste.

Requirements Definition

During the Requirements Definition subphase, the working group established the functional requirements essential for the development of the Minimum Viable Product (MVP). To achieve this objective, the working group enlisted the assistance of technical party Kryha, tasked with capturing the existing and future (desired) process flow. As a result of this collaboration, an initial list of functional requirements was compiled, encompassing various aspects such as business rules, transaction initiations, adjustments and cancellations, administrative functions, authentication, authorization levels, external interfaces, and reporting requirements.

The key challenges that Kryha aimed to tackle consisted of two main areas: innovating the status quo and pioneering the unknown, see table 2.

Challenge	Innovating the status quo	Pioneering the unknown
Main question	How do we keep the administration of sustainability performance data manageable and cost-effective for the sector?	How do we ensure that the sustainability performance data reaches the end-customer in an accessible and and trustworthy manner?
Focus on	1. Efficiency of the current processes 2. Unified ways of working across the industry 3. Building confidence in "the system" that we will need down the line	1. Greenfield innovation of the information flow towards the end-customer 2. Creating additionality in the market 3. Building confidence and trust in the information supplied to them
Target group	Renewable fuels value chain players, including certification bodies, standards bodies, and regulators.	Renewable fuel end-customers and the clients they are providing a service to.

Table 2. Overview challenges drafted by Kryha for the Requirements Definition phase.

The working group's discussions during this phase emphasized crucial principles that served as the basis for shaping the desired future process flow. These principles included decentralization, independency, interoperability, and open source, all of which played a pivotal role in guiding the development of the project.

Between November 2022 and February 2023, Kryha conducted several contextualization interviews with key process players and held group sessions involving selected stakeholder experts. These interactions provided valuable insights and inputs to the functional requirements for the MVP.

Results Requirements Definition phase

Kryha used an iterative approach to further develop the desired future process flow, utilizing findings from their previous work in phase one. New outcomes from this phase, in addition to the outcomes of the previous design sprint, included:

1. Defined additional boundary conditions for the system.
2. Redesigned the incoming data and acceptance flow.
3. Worked out the dashboarding, mass balance and data output flow.
4. Designed the information flow up until the end-customer utilizing the fuels.

The designed desired process flow consisted of 5 modules: data input & acceptance, dashboard, mass balance & data output, end-customer and fuel consumption, see figure 7.

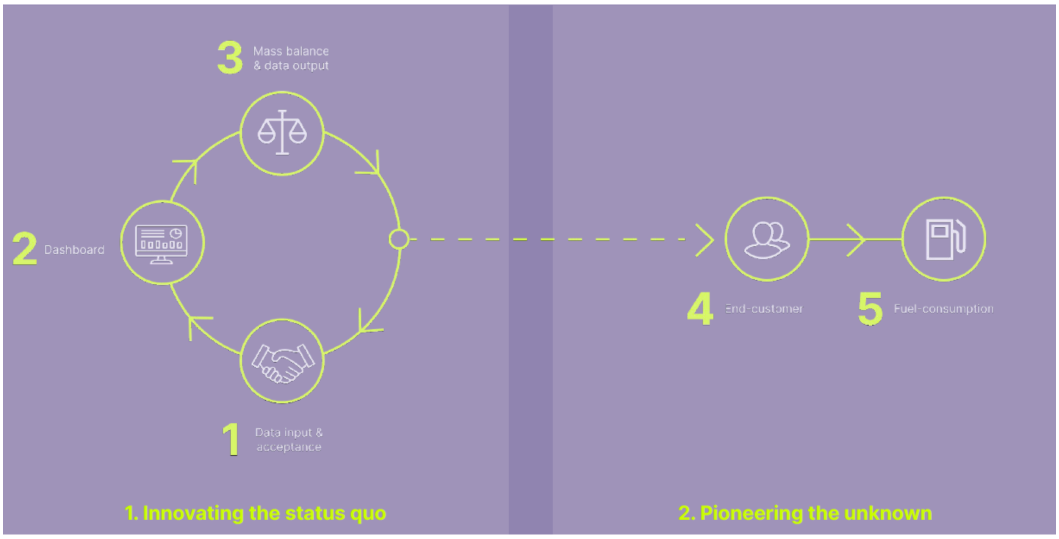

Figure 7. Modules of the future process flow as drafted by Kryha.

Main deliverables per module are summed up below:

1. Data input & acceptance: A digital input and verification flow between every two sites to transfer the sustainability performance data of renewable fuels.
    a. Purpose: To reduce the administrative workload of managing sustainability information across different systems and to expedite the transfer of PoS and to ensure integrity of data entering the system.
    b. Main outcomes: Four different input & acceptance flows, from fully automated to fully manual. This is a loosely coupled PoS flow with the physical flow, focusing on reliable tracking of sustainability data and taking a step back from physical traceability.
2. Dashboard: A dashboard displaying a comprehensive view of both incoming and outgoing Poss, complete with accompanying data and related documentation
    a. Purpose: To provide a clear overview of aggregated incoming and outgoing PoSs.

    b. Main outcomes: Envisioned the main user overviews.
        i. Incoming list of pending and accepted PoSs
        ii. Outgoing list of pending and accepted PoSs
        iii. Aggregated mass balance overview
3. Mass balance & data output: A module to actively manage the organization's mass balance and mandate(s).
    a. Purpose: To ensure precise allocation of incoming to outgoing PoSs and prevent double counting.
    b. Main outcomes:
        i. Flow for the initiation of an outgoing PoS through a transaction by the trader, optionally pre-populating data field for the PoS.
        ii. Mapped the various calculation methods for an organization that contributes to the total Carbon Intensity (CI) value.
        iii. Identified how volumes can be correctly allocated to (end)customers, "digitally trust-marked" by the regulator and marked as additional.
4. End-customer: A mechanism that facilitates the reliable transfer of sustainability performance data of fuels to end-customers.
    a. Purpose: To provide trustworthy sustainability data to end-customers on the fuels they buy & to offer a user-friendly mechanism to help utilize the data for their own purposes (e.g., compliance, reporting, marketing etc.)
    b. Main outcomes:
        i. The conversion of PoS to a Sustainability Performance Document (SPD), containing the same data.
        ii. A dashboard that displays overviews of SPDs, including related sustainability information.
        iii. Filter options to compare fuel types and suppliers on the aggregated and individual Carbon Intensity parameters.
        iv. Process to filter and set parameters to download a dataset.
5. Fuel consumption: A module that enhances the utilization of sustainability data when made available to the client of the fuel end-customer.
    a. Purpose: To create additional market demand that drives the adoption and usage of renewable fuels
    b. Main outcomes:
        i. Ideas on tokenizing the value of renewable fuels, locking in value for a specific purpose.
        ii. Demonstrate the validity of SPDs and the sustainability claims using Zero Knowledge Proof (ZKP) mechanisms.

The desired process flow was delivered as a Miro-board, and the functional requirements were delivered in an Excel-sheet. Kryha's analysis emphasized concepts in cryptography, including ZKP. It is important to note that the highlighting of these concepts does not necessarily imply the adoption of specific technological decisions. However, in the context of the analysis, Kryha did put forward certain recommendations, such as the utilization of DLT and tokenization.

After these deliverables by Kryha, the working group brainstormed on the future course of action based on the obtained results. The working group reached a consensus to continue its collaboration and initiate the development of a Minimum Viable Product (MVP). The precise scope of the MVP was yet to be determined, but it was evident that it should be kept relatively small, focusing, for instance, on (a part of) a single supply chain. This approach aimed to demonstrate the added benefits of the proposed new digital infrastructure. The intention for the industry was to replicate the successful outcomes of the MVP and increase adoption of the solution through a 'follow by example' strategy. However, organizing a joint assignment to develop an MVP and associated program management also implied new financial support. The working group was unable to secure the required new funding, leading to the working group's decision to disband. Nonetheless, the Dutch Blockchain Coalition, in collaboration with PHB, demonstrated their commitment to the project and embarked on meetings with potential new working group members to gather new funding. As of July 2023, the working group has officially dissolved. However, the valuable insights gained throughout the project's duration are expected to lay the foundation for a promising comeback in the near future.

DISCUSSION

This section will first describe the challenges encountered during phase 1 and 2, as well as the lessons learned from this.

Business Value

The business value proposition for the renewable fuels digital infrastructure evolved throughout the project's course. Initially, the primary focus lay on physically tracing biofuels back to their feedstock origin. However, as the project progressed, it became evident that enabling efficient and accurate exchange of sustainability information during transactions was equally crucial. Consequently, the second phase's objective shifted towards passing on immutable sustainability information of renewable fuels, adopting a privacy-by-design approach. This strategic pivot was influenced by insights gained on upcoming regulations and technical possibilities (see chapters below). However, it was also made clear that this business value is not in every supply chain member's interest. Some crucial players seem to benefit from information asymmetries and have an interest in maintaining the status quo. This is a risk to the future development of the project. It is therefore questionable whether a solely market-driven initiative is going to get optimal societal benefits, or whether it is expected to be viable in the first place.

Upcoming regulations

While the project's outset targeted the FAME and HVO segments, the scope expanded over time as the entire renewable fuel market faced similar challenges. The European Commission's fit-for-55 package introduced new registration requirements for renewable fuels across all supply chains. The complexities arose from the need to register sustainability information in multiple, unrelated central databases that lacked any interconnection and unified ways of working. Among these, the Union Database posed particular challenges, remaining a "black box" with limited communication and unclear distinctions from the envisioned new digital infrastructure, therefore creating the fear of doing double work. For working group members, compliance with this mandatory registry posed additional ambiguities, given the requisite time and efforts alongside working on the proposed solution. Nevertheless, the working group also recognized the possibility that the Union Database might not imply double work, but that the proposed solution would actually provide a way to have an automated and safe data exchange *with* the Union Database.

Through the creation of a market driven traceability system, the concept of a 'single source of truth' gained prominence. The notion implied that all compliance-related information, regardless of the database served, should be based on a unified and reliable source. This immutable record could serve as an input for the Union Database to account for the sustainability claims, but also other databases. This way, the renewable fuel organizations could organize their own compliance to e.g., the Union Database through designing the data exchanges with it from a market-accepted method that protects the companies from publishing sensitive information. Since the Union Database is still being designed, it is a possibility to take an active role in further specifying the interactions with the Union Database, allowing these kinds of market-driven platforms for data supply to be interoperable with it.

Technical possibilities

Recognizing the array of upcoming registration databases, the concept of a 'single source of truth' became a fundamental part of the vision of the proposed solution. To enable a single source of truth, DLT seemed fitting. Employing DLT assures secure data exchange and precluded double spending, strengthening the business case for the working group's proposed decentralized digital infrastructure. This broader perspective highlighted the role of DLT in enhancing (an appropriate level of) transparency and trust within the supply chain, thus contributing to the overall sustainability efforts of the renewable fuels market. Concepts such as tokenization and ZKPs were also explored, and new business opportunities were identified, especially at the side of the end-users where demand could be tokenized. Thereby, it would become possible to lock-in values of renewable fuels and GHG savings, possibly creating whole new market dynamics. However, whereas the technological fit to the problem area seems obvious to DBC and some of the collaboration partners, the technical discussion that came up in the conversations between collaboration partners has rarely helped the project move forward. Misinformation regarding blockchain technology, or the concept of an 'open source' solution have clouded a beneficial discussion. Also, there seems to be a general mistrust towards the technology as well as a resistance to taking the perspective of a technology focused solution design in this stage of the project. If you come with a hammer, everything looks like a nail. Considering that blockchain is only one of the many required technologies, it is the question whether the involvement of the DBC in its current role is helping the project further.

Organizational

During the exploration of potential solution directions and scopes, certain organizational issues were identified, including participant uncertainty about entry points into the system, the need to determine ultimate costs, potential free riders benefiting from the network, assessing the likelihood of achieving a critical mass of participants/volumes, and the requirement for a sufficient number of parties to ensure the system's value. Another issues was the lack of a shared problem definition for the entire supply chain. At the beginning of the chain, parties repeatedly expressed their reluctance to provide more transparency and implement a new system, as it would only result in additional costs and time without any (short-term) financial gains. These parties were content with the status quo and compliance with current regulations. While they were willing to change if regulators mandated it, incurring additional costs for the public good without any financial concessions was not appealing to them. In the middle of the supply chain, actors were primarily concerned with risk reduction and efficiency gains for their HBE tickets. Parties at the end of the chain were mainly concerned with procuring renewable fuels without impeccable proof of their sustainability. On top of this, they also saw a business opportunity of selling the tokenised GHG savings. This individualistic way of thinking has been one of the reasons why it has been challenging to come up with a first scoping of the MVP.

The required investment in the MVP seemed to cause commitment issues to the project. During the project, rough estimations have been made for the creation of a full functioning blockchain application for a supply chain, however, involved parties have been unable to secure financial resources within their respective companies for such a large-scale project encompassing the entire sector. While narrowing down the scope of the MVP would naturally reduce investment costs, it would also mean overlooking use cases that are relevant to all parties in the supply chain. Besides that, risks were identified in the unforeseeable maintenance of having two systems (thus, the new and the current) during the 'transition phase'. Although subsidies have been explored, no concrete options have emerged throughout the duration of the project. Nevertheless, multiple discussions have emphasized the crucial role of subsidies, as all private entities involved have struggled to obtain the necessary financial resources for this undertaking.

Lastly, an recurring issue was the knowledge disbalance between working group members. Some parties seemed to struggle with the possible technological interpretations of the desired solution, resulting in recurring discussions about DLT. While certain aspects of the proposed solution would not be feasible without utilizing these technological advancements, they should not have been the primary focus of attention or concern. The concept of DLT has been present since the start of this initiative as it has been guided by the DBC. This led working group members to believe that this was primarily a technological initiative, whereas it became apparent along the way that the problem was more related to the lack of collaborative system building rather than the technology used. The involvement of the DBC in its current role may not have been beneficial for this initiative, given the technological bias it unfortunately presented. Therefore, as previously stated, it remains uncertain whether the DBC's involvement is helping the project progress.

All these factors play a pivotal role in the successful implementation of sustainable DLT-solutions, emphasizing the importance of effective planning and governance.

Government

Difficulties arose while discussing the role the government (should) play(s) in this initiative. Some parties expressed interest in joining the working group solely due to the involvement of the NEa in the initiative. Parties situated at the beginning and middle of the supply chain face strict checks by the NEa and are seeking ways to mitigate risks, such as for their HBE ticket creation. During phase 2, parties sought greater assurance from the NEa that the newly designed proposed system would be accepted to justify their potential investments. However, the NEa stated that they were unable to provide such assurance, as they solely serve as supervisors for the Ministry of Infrastructure and Water and naturally EU regulation, which did not mandate the implementation of a new system. Regardless, "it's not feasible to provide guarantees in advance without knowing what we will receive as regulators", the NEa stated. During the project, there was insufficient clarity about the reliability of the new system, which means the NEa cannot discard the old systems until they are certain about the added value of new ones. Moreover, it remained unclear how many parties would participate in this initiative and how advantageous approving this new method would be. As a government entity, they face constraints in terms of time and resources, making it impractical to thoroughly explore multiple new initiatives and subject them all to an approval process. However, the absence of a guarantee from the NEa regarding the acceptance of the new system led parties to perceive the investment risk as too high. Additionally, parties believed that the government should play a role in investing in a new system, as it is the responsibility of the authorities to ensure product safety and reliability for citizens. This situation raises a "chicken and egg" dilemma.

RECOMMENDATIONS

This next section covers recommendations by the Dutch Blockchain Coalition, based on the obtained experiences and lessons learned, that would be crucial for the next steps.

Establishing a Common Long-Term Vision for the Future

The need for a solution as proposed increases with the growth of the renewable fuels market. Although all parties seem to be aware of the need to do things differently, the true urgency is not felt yet. It requires a perspective for and by the sector on what common future we are designing for.

Strong mandate

The creation of a strong mandate by a consortium of supply chain partners that have a joint interest in solving the problems that this project is associated with, is vital for the further development of this project. It needs to be clear which business value can be derived and where certain actors might experience perverse incentives, for which control measures need to be designed to align those incentives. This mandate can also come from the government, pushing the market to continue innovating on information exchange system.

Focus on building a Trust Framework

Following an established long-term vision, it is recommended to prioritize the development of a Trust Framework. A Renewable Fuels Traceability Trust Framework can provide trust services based upon efforts such as:

- Established funding model
- Standards / taxonomy
- Goverance
- Collaboration and data sharing agreements

The Trust Framework will enable effective collaboration with other businesses, consumers and interaction with public parties through a framework that supply chain partners can trust in their benefit, without compromising their businesses. It is important to emphasize that technology serves merely as a facilitating layer within the Trust Framework

Platform Renewable Fuels to Assume Lead Role in Project

Due to the DBC's prominent position in the current stage, there have been counterproductive technical debates and a silent resistance towards embracing this solution. Consequently, it is recommended that moving forward, the project no longer positions the DBC as the leading and initiating entity. Instead, it is suggested that the supply chain takes the responsibility of organizing itself under the guidance of an organization that represents the sector. Therefore, it is advisable to continue with PHB as the project's leading organization, which can facilitate future collaboration within the sector. The DBC can still remain involved in an advisory capacity, albeit with a more background role.

Government demand for regulatory compliance with fit-for-55

Whereas the fit-for-55 package from the EU is the main regulatory driver that creates a need for the solution proposed by the collaborating parties, it is up to the Dutch government to demand the sector to come up with solutions that can support compliance. The current incentives prevent the market to feel this urgency and several organizations have mentioned to only come in action with a clear message from the NEa that this is accepted and necessary to participate in, although the NEa claims not to have that liberty. Another way of government support or urgency needs to be found. An obvious governmental department is the Ministry of Infrastructure and Water. In the current state of art, it is very complex to prove the green nature of products, which encourages fraud. Fraud should be tackled which is a responsibility of the government.

Apply the solution to a small scope use case with a limited group of actors

Whereas the current group of stakeholders contains a large number of different parties, it creates the situation where parties cannot commit if the value to them on the short term is not absolutely clear. Committing to an MVP at this point has no certainty that there will be tangible results to one's company in the subsequent phase. To address this issue, it is recommended to design a use-case that focuses on a single step in the supply chain process. By selecting a specific use case, parties can more easily commit and articulate the value to their respective organizations. Although this approach may result in a smaller community in the short term, it facilitates easier financial backing for the next phase. It is recommended to focus on securing correct sustainability information first instead of focusing on tokenization, as these tokens will be created based on the sustainability information. Sustainability information first, tokenization second.

POTENTIAL SCENARIOS FOR THE FUTURE

This section outlines potential scenarios recognized by the Dutch Blockchain Coalition that may serve as viable routes to further explore this research topic and the proposed solution.

Community building by Platform Renewable Fuels

Due to that the potential collaborating partners are not yet united, whether in a common vision, governance or designed solution that fits all required business values, it is highly advisable to focus on community building in the short run. This community building will need to establish the insight that the potential collaboration partners will benefit from a joint approach and that they are willing to put the lack of gains in the short term aside. The party responsible for creating the communal perspective is Platform Renewable Fuels, due to their unique position in the sector, the trust they have with the partners and the in-depth knowledge of the field that they have.

Interoperable Digital Product Passport Standard Development by DBC

Although the technical implementation of a full solution is dependent on fitting governance, there is a possibility to separately develop structural elements of the technical solution. For example, the concept of product passports is an upcoming one that seems to suit this solution. A product passport for a renewable fuel is a data set that summarizes information about the chemical composition/substances and other relevant information such as its production process and its environmental and sustainability characteristics. Considering the global character of the renewable fuels market, interoperability is crucial. Hence, interoperability standards should be investigated. The DBC has been active in the product passport space, as well as the interoperability spaces with the initiative DIIP (Decentralized Identity Interop Profile). This could significantly help to set up a parallel development path that does not have to take into account the content-specific discussion and the governance of the community. As soon as those are realized, the DBC's standardization work can be adopted as part of the technical design of the eventual solution.

Bring focus through a clear scoping of a use case

It is expected that partners come on board more easily if the use case is well defined and they understand their role. It is therefore advisable to select a limited scope of a single step in the supply chain to deploy the solution. This can be, for example, the entry on the European market or a production facility. Potential use cases that were explored involve the international shipment of ethanol from Brazil to the port of Rotterdam where it is converted to 'green hydrogen', and the transformation of used cooking oil in biofuel. Selecting a fitting use case will help to bring relevant stakeholders on board, make the potential results more concrete and allows for a more rapid development of the technologyEstablishing interoperability with on-site IT systems is crucial to enable the seamless onboarding of data on production or transport. To ensure a trustworthy implementation of the system, it is necessary to adopt privacy-enhancing technologies alongside several other technologies. These measures are essential to safeguard data privacy and integrity while facilitating the secure exchange of information within the system.

Conclusion

These scenarios are possibilities, and the list is not exhaustive. This report has tried to provide numerous insights for the project's benefit and the future enhancement of efficient collaborations in the renewable fuels market. Please reach out to nina.huijberts@dutchblockchaincoalition.org if you have any remarks or questions.