



Trust Trail / CAST

An Auditing Platform for Carbon Capture Supply Chains



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Smart Environment

Trust Trail / CAST: An Auditing Platform for Carbon Capture Supply Chains

With the contribution of:

DIH involved:

Faubourg Numérique



SMEs or slightly bigger companies involved:

- JadenX GmbH
- iExec Blockchain Tech
- <u>4C-Chem</u>
- Warren Brandeis (formerly WBNoDE)
- Lab Automation Networks
- <u>act4carbon e.V.</u> (Associated Partner)

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Challenge & Context

The biggest challenge is the complexity of the supply chain involved in the production of solidified carbon. Different actors and organisations are involved in the various stages, such as biomass collection, transportation, chemical transformation, and distribution. Ensuring transparency and integrity throughout this multi-participant process can be difficult, and breaches of integrity can occur. This complex process involves multiple participants, from biomass providers to energy providers, logistics companies, and pyrolysis plants. Each









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step in the supply chain requires verification and assurance to ensure that the process is carried out correctly and that the resulting assets are genuine.

Regulation authorities also face challenges in verifying the correct execution of these processes. With multiple steps and numerous participants, monitoring the entire supply chain and ensuring compliance with regulations can be a daunting task.

Furthermore, the implementation of carbon capture technologies requires significant investment and infrastructure development. Setting up facilities for carbon storage and confinement requires careful planning and coordination.

The Trust Trail Platform (CAST) operates within the context of carbon capture supply chains and the need for reliable monitoring and verification. Carbon capture is a crucial aspect of mitigating climate change by capturing and storing carbon emissions from industrial processes. It addresses several challenges in the monitoring and verification of carbon capture supply chains. These challenges arise due to the complexity and vulnerability of these supply chains, as well as the need for trust, transparency, and auditability. Trust Trail utilises shared audit trails and blockchain technology to provide a comprehensive solution.

In conclusion, it is an innovative solution that addresses the monitoring and verification challenges in carbon capture supply chains. By using shared audit trails and blockchain technology, Trust Trail (CAST) ensures asset integrity and transparency. Lastly, it is adaptable to different industries and contributes to mitigating climate change and helping to ensure the success of the New Green Deal.

Solution

In the pursuit of sustainable and environmentally friendly practices, the need for accurate tracking and certification of biomass materials has become increasingly important. To address this, the CAST experiment introduces a comprehensive framework that leverages blockchain technology and smart data models to ensure transparency and reliability in the biomass supply chain. The CAST experiment encompasses various stakeholders, including biomass providers, biochar plants, independent labs and sequesters. Each participant plays a significant role in the process flow, all facilitated through the use of interconnected systems and advanced technologies.



Let's delve into the details of the example flow within the CAST project:

1. Biomass Provider and Data Provider Role:

A biomass provider, facilitated here by <u>Lab Automation Network</u>, declares the quantity of biomass produced and its origins. The biomasses' information is stored in a biomass object, a smart data model, within the context broker of the biomass producer. Authentication is conducted via iSHARE using DIH <u>Faubourg</u> <u>Numerique</u>'s Keyrock and Kong components.

2. Biomass Provider and Blockchain Integration:

The biomass provider creates a new instance of the biomass in the context broker. Simultaneously, a checksum is generated and written to the blockchain. The blockchain integration ensures the immutability and transparency of the biomass data.

3. Biochar Plant and Process Data:

The biochar plant, represented by <u>4C-Chem</u> in this project, executes the pyrolysis process to convert biomass into biochar. It retrieves information regarding the biomass from its own context broker, allowing verification of data integrity through the blockchain. The biochar is then linked to a digital twin called "biochar" and published using the pyrolysis plant's context broker, that is again secured by a checksum on the blockchain.

4. Independent Lab Analysis:

To validate the claims made by the pyrolysis executor, an independent lab conducts an analysis. The lab's results are published using its Context Broker, and the associated data hash is stored on the blockchain. In the experiment, the lab analysis is simulated by <u>act4carbon</u> to evaluate the process and provide an artificial attestation.

5. Biochar Handover to Sequester:

The produced biochar is then handed over to a sequester, represented by <u>Warren Brandeis (formerly WBNoDE)</u> in the project. The sequester's role is to store the biochar in a sink, ensuring its long-term storage. The sequester generates data regarding the storage location, method, and duration, which is ingested through its context broker.

6. Emission Certificate and NFT Creation:

Finally, the sequester creates an emission certificate linked to the digital twin of the sequestered biochar. This certificate is represented as a non-fungible token (NFT) on the blockchain. The NFT later allows for the trade and traceability of emission certificates.

This concludes the flow of the experiment.

<u>The CAST experiment</u> consists of multiple participants with different roles and expertise. <u>JadenX GmbH</u> is the technology provider and facilitator of the experiment, responsible for integrating the iSHARE scheme and FIWARE into the tracking system. They also manage the project and explore commercialization opportunities. <u>iExec</u> Blockchain Tech implements the iExec framework for

decentralised cloud computing and works with JadenX to deploy and maintain the smart contract related to the experiment. <u>4C-Chem</u> is a development service provider specialising in chemical-technical projects and processes. They will focus on developing and operating a pyrolysis installation as part of the carbonnegative techniques. <u>Warren Brandeis (formerly WBNODE)</u> is a network of technology and strategy consultants that will design the economic concept of the carbon certification market. <u>act4carbon</u> e.V. provides neutral consulting, selects accredited labs for analytical inputs, and disseminates project results. <u>Lab Automation Network</u> sources and provides biomass for the pyrolysis process. <u>DIH Faubourg Numérique</u> offers technical support, infrastructure, and virtual immersive environments to prototype and implement data models and support integration. All these participants contribute their expertise and services to ensure the success of the CAST experiment.

How it works

The Trust Trail Platform (CAST) is an auditing platform designed to monitor carbon capture supply chains. It utilises Shared Audit Trails and blockchain technology to ensure the integrity and security of the carbon capture process.

FIWARE is utilised in the Trust Trail Platform (CAST) to manage and store the data related to the carbon capture process. The FIWARE context broker is used to store the information about each asset, including its name, description, and other attributes. This allows auditors to retrieve the asset information from the context broker and compare it with the information stored in the blockchain, ensuring the authenticity and integrity of the assets.

iSHARE is used in Trust Trail (CAST) to facilitate secure data exchange between different participants in the carbon capture supply chain, ensuring that only authorised parties have access to the relevant information.



In this diagram, the flow of creating an AgriProductType by the Biomass Provider is shown. The AgriProductType is created in the Biomass Provider's Context Broker and then synchronised to the Context Brokers in other participants' environments, including the Pyrolysis Plant, the Analysis Lab, and the Sequester. This synchronisation ensures availability in participant environments.

The process begins with the ERP Application creating an AgriProductType in the Biomass Provider's Context Broker. The SVC Blockchain Middleware is subscribed to this Context Broker and receives a notification about the new AgriProductType. The middleware computes a checksum hash of the AgriProductType and writes it to the Ethereum Blockchain using an Infura RPC node. The transaction receipt, which contains the transaction hash, is then received by the SVC Blockchain Middleware. This transaction hash is used to update the transactionHash attribute field of the AgriProductType in the Context Broker.

At this point, the side-car/authzforce component becomes active and triggers the synchronisation flow. It forwards the notification of the Create request of the

AgriProductType to the PEP-Proxy/PDP in the Kong instance, along with the iShare JWT M2M Token. The PEP-Proxy/PDP connects to the Identity Provider/Token Provider in the Keyrock instance to validate the token and access. The Identity Provider/Token Provider checks the trusted access in the iShare satellite, and if successful, the token is considered valid. The PEP-Proxy/PDP then validates the access rights for the notification.

If the access rights are satisfied, the PEP-Proxy/PDP forwards the Create AgriProductType notification to the Apollo component of the Pyrolysis Plant, Analysis Lab, and Sequester. Each Apollo component creates the AgriProductType in their respective Context Brokers. Now, the AgriProductType is available in all Context Brokers.

For example, if the Pyrolysis Plant's ERP Application Backend queries its Context Broker, it will find the newly created AgriProductType and can perform pyrolysis based on it. The same process applies to other participants as well. Once the pyrolysis is performed, the Pyrolysis Plant creates a ManufacturedProductType, which is again synchronised to all participants. The Analysis Lab then creates a VerifiableAttestation based on the ManufacturedProductType, and the Sequester creates a CarbonRemovalCredit based on the VerifiableAttestation, which concludes the flow.

Benefits & Impact

<u>Trust Trail</u> (CAST) introduces a solution that establishes a shared audit trail among all participants involved in producing and sequestering stable solid carbon from carbon-rich waste biomass. This value chain includes biomass producers, transformation plants, carbon storage sites, transportation providers, and a market platform for carbon certificates. It holds immense potential in terms of its user base. With the number of biomass producers, transformation plants, carbon storage sites, and transportation providers encompassed within the value chain, a significant number of users can be anticipated. Moreover, as the importance of sustainable practices gains traction and environmental concerns become a priority, the future holds even greater prospects for the adoption of this technology, with a surge in expected users. In addition, considering the evolving focus on carbon reduction and the increasing demand for carbon credits, the number of customers availing the services provided by the market platform for carbon certificates will undoubtedly witness exponential growth. Ultimately, with the implementation of this technology, a vast number of new potential clients can be identified in various sectors, ranging from waste management to carbon offsetting enterprises.

The technology addresses the challenge of carbon emissions and climate change by efficiently converting carbon-rich waste biomass into stable solid carbon, actively contributing to reducing greenhouse gas emissions. The shared audit trail ensures transparency and traceability throughout the value chain, fostering trust among participants. This transparency is crucial for accurate carbon accounting and certification in the carbon market.

For biomass producers, the technology offers new revenue opportunities by enabling the utilisation of carbon-rich waste biomass and participating in the carbon market through the sale of carbon certificates. Transformation plants benefit from enhanced operational efficiency and resource optimization, while carbon storage sites ensure secure and monitored storage of stable solid carbon.

Transportation providers benefit from improved logistics and supply chain visibility, reducing costs and enhancing operational efficiency.

Furthermore, the Trust Trail (CAST) Software offers several advantages that directly contribute to revenue growth for all participants in the value chain. Biomass producers can tap into a previously untapped revenue stream by using carbon-rich solid waste biomass, leading to increased production of biochar and hydrochar that can be sold in the carbon market. Transformation plants benefit from improved operational efficiency and resource optimization, while carbon storage sites generate revenue through secure storage of stable solid carbon. Transportation providers benefit from enhanced logistics and supply chain optimization, and a market platform for carbon certificates serves as a central hub for trading, driving revenue growth for all involved. Overall, the technology provides a minimum 30% revenue increase for all participants in the value chain by maximising biomass utilisation, improving operational efficiency, carbon credit trading, and optimising supply chains.

Overall, the technology delivers significant business value by addressing environmental sustainability goals, creating revenue streams, optimising operations, ensuring carbon storage integrity, and facilitating carbon trading through a reliable market platform.

Added value through i4Trust

During our software implementation process, we were fortunate to receive exceptional support from the technical mentors provided by i4Trust. Specifically, the assistance from the technical iShare and FIWARE mentors and architects proved invaluable. Their expertise and guidance helped us seamlessly incorporate software functionalities and ensure its effectiveness. With their help, we were able to navigate any technical challenges efficiently, streamlining our development process.

On the business side of our project, we had equally positive experiences. Our business mentors at i4Trust played a crucial role in assisting us in creating a robust business plan. Through engaging workshops and one-on-one sessions, we were able to leverage their expertise and insights to develop a comprehensive plan. Their guidance ensured that our business strategy aligned with market demands and customer needs, setting us up for success in the long run.

i4Trust, with its integration of the FIWARE and iShare technology stack, proved to be the perfect solution for our requirements. At the core of our solution lies the need for inter-organizational data exchange. The i4Trust components are designed specifically for this use case, providing us with precise functionality tailored to our needs. By leveraging these existing, production-grade components, we were able to save significant development time and resources. Moreover, this allowed us to deliver a higher value proposition to our customers, as the components were already tested and proven in real-world scenarios. The most recent addition is that AWS is adding a managed AWS service for the FIWARE Context Broker and we are in the process of utilising that service and appreciate the possibility to hand over responsibilities to AWS.

Next steps (if applicable)

We have been engaged in fruitful discussions with forestry sequesters in Germany who have displayed a strong interest in utilising our solution. This feedback has prompted us to broaden the application of our solution, making it adaptable for use in diverse domains. One industry we are actively targeting is the car industry, where we aim to deliver valuable applications of our solution that can address specific challenges and requirements.

On a technical level, our focus is on enhancing the product's features to improve user experience. We are developing a user-friendly frontend interface that will streamline interaction with our solution. Additionally, we are implementing alternative login methods through other Identity Providers, enabling users to access our solution through various authentication channels. This approach not only enhances usability but also provides a seamless experience for our users. Another key aspect of our extended functionality is the incorporation of H2M (Human-to-Machine) communication. By offering a second means of accessing our solution through H2M communication, we ensure that users have flexibility and multiple options for interacting with our system using different methods and technologies.

References

• https://www.trusttrail.io

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Categories

User(s):

Carbon Certifiers, Forestry industry, Carbon Capture Industry

Key words:

New Green Deal, Interoperability

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Founding Partners









i4Trust has received funding from the European Union's Horizon 2020 research and innovation programme under the Grant Agreement no 951975.





