ESTAINIUM Association

Design of an “Holistic Emission-to-Sink Approach” to Decarbonize the Industrial Supply Chain

December 2022

The ESTAINIUM Association

Design of an "Holistic Emission-to-Sink Approach" to Decarbonize the Industrial Supply Chain

ESTAINIUM was founded in 2022 to establish a direct link between economic activity and its climate-damaging impacts. Our focus is on calculating, exchanging, reducing, and offsetting carbon footprints along the supply chain through decentralized trust technology and self-sovereign data management. This solution is characterized by lowering costs for operating infrastructure, maintaining data sovereignty of all participants, and enabling of a fast scale up. The ESTAINIUM members (see all on estainium.eco) represent diverse roles in the future ecosystem of a circular carbon economy: there are representatives from industry and research, certifying institutions, carbon sink operators and software providers. This unique constellation enables us to develop practical solutions to identify and overcome current and future challenges – for all stakeholders. In addition to the work in three technical working groups illustrated in text below, common use cases and pilot projects are defined to learn and share the experience with the members of the association. All activities pay into the association's vision, which maps the path from carbon emission to carbon sink along multi-stage, complex production networks.

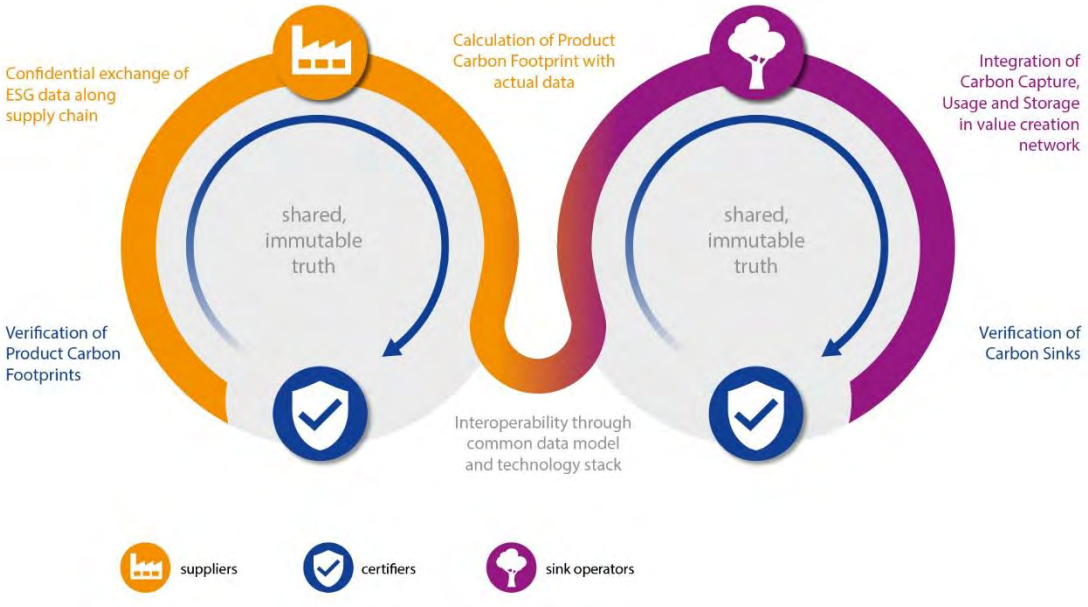


Figure 1 Roles and Targets of the ESTAINIUM Association

The general goals of the association are shown in Figure 1. The first is to enable the exchange of product-specific information, such as the product carbon footprint (PCF), along complex value chains. Confidential data, such as a company's lists of suppliers, must remain protected. Furthermore, it must be ensured that the shared data is correct and trustworthy. To this end, trustable third parties are integrated into the ecosystem to verify the exchanged information. Since not all participants in a value chain will use the same software solutions for calculating and sending data, another important goal of the association is to ensure interoperability. The association's three technical working groups (WG) are working on these challenges:

WG 1 – Technology and Infrastructure: Besides interoperability, requirements such as data sovereignty and confidentiality must be identified and implemented. This is the aim of the first working group, which is selecting and developing the basic technical infrastructure for the exchange of product carbon footprints and other ESG data. The members of the association will co-design this technology stack, which is an open-source solution and allows every software provider to connect their solution to the ESTAINIUM network. The technology is based on the approach of self-sovereign identities of IDunion.

WG 2 – Standards and Norms Compatibility: One of the most important prerequisites for fulfilling the vision of an ecologically transparent supply chain is the existence of generally recognised data exchange formats. The second working group aims to identify differences between existing standards and methodologies to contribute to their harmonisation. Therefore, the members work together with different other initiatives which are working in the field of Life Cycle Assessment and Product Carbon Footprints. The goal is to establish consistent methodologies to ensure interoperability and to enable meaningful and aligned integration of new fields like the carbon sink domain.

WG 3 – Carbon Capture, Use, Storage & Compensation: Offsetting unavoidable emissions by investing in carbon removal projects is part of many transformation strategies. This leads to a very dynamic development in voluntary carbon markets. The third working group aims to create transparency in this topic area and to develop technical solutions for the integration of trustworthy projects into value-creation networks. Aspects focused on are to create comparability of different carbon sinks and the establishment of a verifiable chain of custody. In addition to long-term storage, the integration of carbon as a raw material for new products is being discussed to encourage manufacturers to substitute carbon intensive feedstock with low carbon (biogenic-sourced) ones.

All in all, the ESTAINIUM association strives for a holistic approach to the elimination of industrial carbon emissions, which is illustrated in Figure 2.

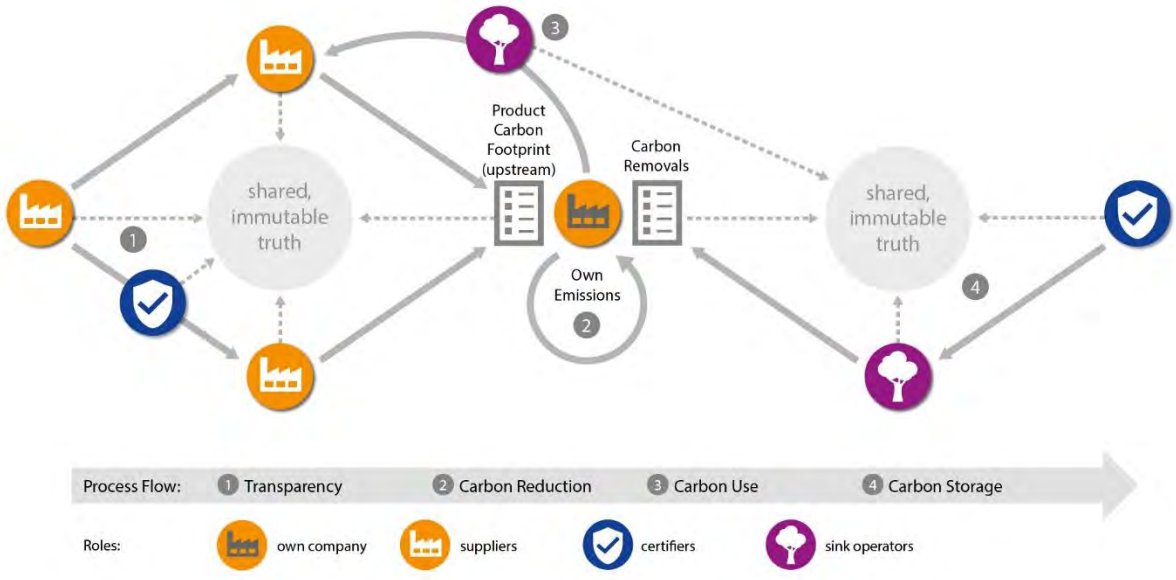


Figure 2: Holistic Emission-to-Sink Approach to Decarbonize the Industrial Supply Chain

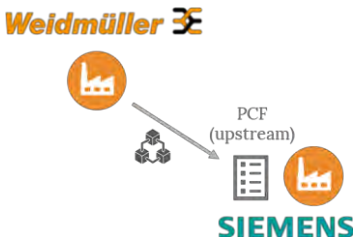
As shown in the picture, the ideal emission-to-sink process starts with the creation of transparency (1). Product carbon footprints should be calculated using real data from suppliers' production facilities and only taken from databases (containing averages) where not otherwise possible. The values sent should be checked and verified by an independent, trustworthy third party. The exchange of data along the value chain takes place based on a decentralized approach using common

data formats and methods, considering requirements such as data protection and security. In the second step (2), the determined PCF must be reduced as far as possible. This can be done both by taking measures to reduce emissions in one's own production environment and by engaging suppliers to reduce their emissions. Only when it is no longer possible to implement measures to reduce the PCF, the remaining emissions should be compensated by investing in CCUS projects. For this purpose, it currently is recommended to give preference to projects that remove CO_2 from the atmosphere and transform it into products that are as durable as possible (e.g., construction materials), as this enables the decarbonization of other value chains (3). In the fourth and final step, unavoidable emissions can be compensated by investing in long-term stable carbon reservoirs (e.g., deep sea or geological injection). In both the third and fourth step, it is important that the carbon sinks are audited and verified by independent, trustworthy third-party institutions and that the information about which product is linked to which sink is stored in a safe and trustworthy environment.
Since the founding of the association various use cases and pilot projects have already been initiated by ESTAINIUM's members, each addressing individual aspects of the vision. The following overview represents an excerpt of current activities and will be updated regularly:

Transparency

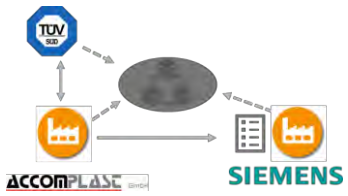
Carbon Footprint Management (status: implemented)

In this proof of concept, Weidmüller and Siemens demonstrated the exchange of Product Carbon Footprints using the SiGREEN software of Siemens. The PCF of a component was requested by Siemens from the supplier Weidmüller. There the PCF was calculated with actual data from production and shared with Siemens. The calculation took place in accordance with ISO 14067 (PCF) and the product category rules of EN50693 and PEP-Ecopassport. SiGREEN is based on peer-to-peer communication whose trustworthiness is secured using cryptographic keys.



Verified Product Carbon Footprints (status: implemented)

Using SiGREEN, Siemens requested a PCF for a specific part at ACCOMPLAST GmbH, a supplier for plastic injection molding parts. ACCOMPLAST calculated the product carbon footprint according to ISO14067. To get a higher level of reliability ACCOMPLAST sent the calculated PCF with metadata to TÜV SÜD Product Service GmbH. TÜV Süd verified it regarding the applied methods and background information and then issued a verifiable credential to ACCOMPLAST via SiGREEN. Now ACCOMPLAST shared their 3rd party verified PCF with the customer Siemens. Siemens finally received a primary data-based PCF for calculating their products' carbon footprint.

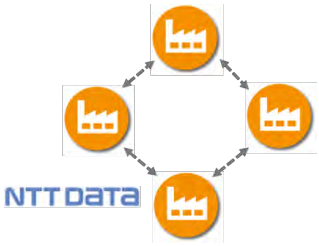


Live calculated Product Carbon Footprint (status: implemented)

ATS Automation Tooling Systems GmbH is an industry-leading automation solution provider. On the automation lines, live calculation of PCF was realized by measuring the energy consumption, especially electrical energy and compressed air. The values are displayed and can be used for different evaluations like the trend of PCF over time or the amount of carbon emissions caused by scrap parts.

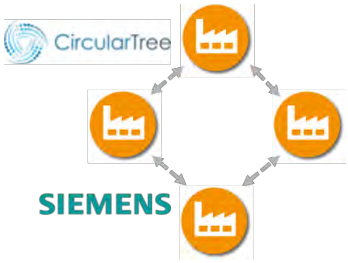
PCF Data Exchange Across Supply Chain (status: initiated)

The Green x Digital Consortium, which NTT DATA is part of, has created a carbon visualization framework and technical specifications for data exchange for the Japanese industry while facilitating communication with the WBCSD Partnership for Carbon transparency (PACT). Solution providers and user companies participate in a proof-of-concept experiment. These 35 participants check that emissions data calculated with the same methods by companies from diverse industries can be exchanged among different solutions to gauge supply chain emissions accurately and effectively.



Cross-solution PCF data exchange (status: implemented)

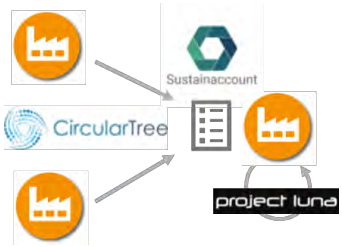
Within the PACT (Partnership for Carbon Transparency) framework of WBCSD, the ESTAINIUM members Siemens and CircularTree demonstrated how product-specific carbon emissions can be transferred between different technological solutions. The developed specifications were tested in a pilot for a liquid laundry detergent value chain.



Carbon Reduction

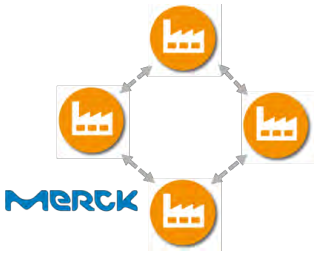
Reducing Product Carbon Footprints (status: initiated)

The solution provider CircluarTree and experts on Life Cycle Assessment from Sustainaccount work with pilot customer project luna on calculating product carbon footprints using a combination of primary and secondary data. The goal is to demonstrate the positive impact of measurements for reducing the product carbon footprints, e. g. by using electricity from solar power generation or the use of waste for heating. After solving the challenge of gathering consistent and holistic LCA data for all scopes, the design of a robust and transparent accounting methodology for carbon sinks is planned ensure comparability of declarations.



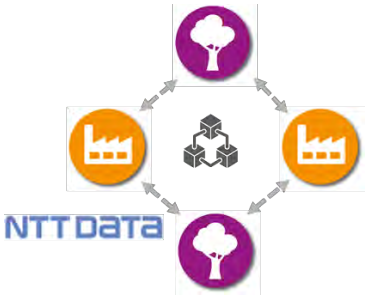
Circular Economy Measures (status: initiated)

Merck is working to reduce its own greenhouse gas emissions by introducing circular economy measures. For example, an ammonium phosphate nutrient solution is offered on a digital platform based on funding project "DigInForm". This platform takes up the guiding idea of data spaces and aims to provide an ecosystem for the secure, verifiable and cross-organizational exchange of data in the network of manufacturing companies and their waste management service providers. The product offered can either be purchased as a technical grade product from other companies or, in case of no request, recycled by waste management companies.



MeetZero (status: implemented)

MeetZero, which NTT DATA is part of, is a blockchain platform that supports the creation of a carbon market, from project database to the carbon trading, including monitoring, reporting and verification procedures. The platform was established to help public administrations and/or private cooperations to create carbon markets according to article 6 of the Paris Agreement. In this way, regional carbon markets in developed countries can be created and the needs of corporations demanding local carbon credits can be satisfied.



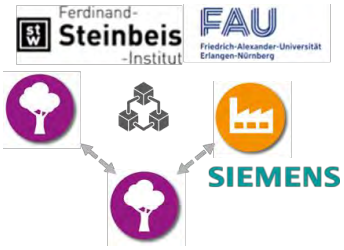
Carbon Use & Store

Real-time connection between Emission and Sink (status: implemented)

The electrical energy consumption of a laser etching machine at Siemens in Amberg was measured and multiplied by an emission factor to calculate the live CO_2 emissions associated with the machine's operation. To demonstrate real-time compensation for the affected emissions, an algal carbon capture system at the University of Technology Sydney removes carbon from the atmosphere by photosynthesis. The amount of CO_2 removed is measured, and data is matched using an IoT platform to link emissions to the sink in real-time.

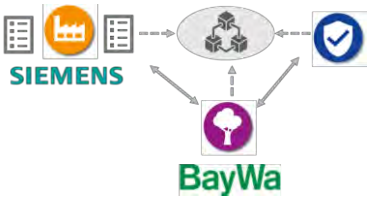
Tokens for carbon credits (status: initiated)

Solutions for transparent and trustworthy data exchange are needed to prevent carbon credits from being duplicated or otherwise misused. Facing this challenge, the Friedrich-Alexander University, Steinbeis Institute and Siemens are working on a cryptographic token to track compensation spending through a public blockchain network.



Linking PCFs to regional and international compensation projects (status: initiated)

BayWa and Siemens cooperate on linking the calculation and management of Product Carbon Footprints to the investment in high quality regional and internationally validated projects to compensate in a combined way remaining carbon emissions, which are ideally left over, after several carbon emission avoidance and reduction projects. Therefore, a connection between Siemens SiGREEN Software and the BayWa platform Combayn will be established in a first Proof-of-Concept to gain experiences regarding required data interfaces and methodologies. Future cooperations will focus on securing the exchanged data by verifiable credentials.



CO2Sink - Offsetting with high-quality forest carbon credits (status: initiated)

NTT DATA has developed a solution for accurately accounting, monitoring, and tracking carbon credits in forestry sequestration projects and is issuing a marketplace based on blockchain technology. The carbon accounting and monitoring methods are based on inventory and on-field flux measurements combined with remote sensed data. NTT DATA has requested for integration of the methods – if not yet included - in the currently adopted methodologies of the main standards (Gold Standard and Verified Carbon Standard).

Overview of all activities

Use Case	Status	Step in Process Flow	Participating ESTAINIUM members
Carbon Footprint Management	*implemented*	1	Weidmüller Siemens
Verified Product Carbon Footprints	*implemented*	1	TÜV Süd Siemens
Live calculated Product Carbon Footprint	*implemented*	1	ATS
PCF Data Exchange Across Supply Chain	*initiated*	1	NTT Data
Cross-solution PCF data exchange	*implemented*	1	Siemens CircularTree
Reducing Product Carbon Footprints	*initiated*	2	CircularTree Sustainaccount
Circular Economy Measures	*initiated*	2	Merck KGaA
MeetZero	*implemented*	2	NTT Data
Real-time connection between Emission and Sink	*implemented*	3 4	UTS Siemens
Tokens for carbon credits	*initiated*	3 4	Ferdinand Steinbeis Institute FAU, Siemens
Linking PCFs to regional and international compensation projects	*initiated*	4	BayWa Siemens
Offsetting with high-quality forest carbon credits	*initiated*	4	NTT Data

The ESTAINIUM Association is the official partner of the World Economic Forum's Initiative "Industry Net Zero Accelerator".

If you are interested in joining the Association on the journey towards a decarbonized industry, please contact us at info@estainium.eco .

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