Theory and Practice of Science and Technology
2025, VOL. 6, NO. 6, 131-136
DOI: 10.47297/taposatWSP2633-456926.20250606

Research on the Establishment of Carbon Footprint Accounts of Chinese Enterprises Based on Blockchain Technology : It Is Mainly Based on the Analysis of Catl

Zhuoyao Yang

Business college, Macau University of Science and Technology, Taipa, Macao, 999078, China

ABSTRACT
In response to the mandatory requirements of the EU Carbon Tariff and the New Battery Law for the full life cycle carbon management of Chinese battery enterprises, this paper takes CATL as a case to explore the construction path of a carbon footprint account driven by blockchain technology. Based on CATL's "Times Carbon Chain" platform, a three-layer technical architecture was constructed by adopting distributed ledger, perspective life cycle assessment and smart contract technologies: data layer, accounting layer and application layer. By comparing the full life cycle carbon footprint of the 1kwh lithium iron phosphate battery of BYD's subsidiary FinDreams Battery, the research found that the carbon emissions in the transportation link of CATL were significantly higher than those of the benchmark enterprises. Based on this, a multimodal transportation optimization plan was proposed. This work provides a reusable carbon management technology paradigm for Chinese enterprises to deal with international carbon barriers, which has practical value for promoting the implementation of China's carbon neutrality goal.

KEYWORDS
Carbon footprint account; CATL; Power battery; LCA

1 Introduction

The proposal of China's goals of peaking carbon emissions before 2030 and achieving carbon neutrality before 2060, along with the mandatory declaration requirements of the EU carbon border adjustment mechanism for carbon emission data throughout the product life cycle, have jointly restructured the global trade rules. This has forced Chinese enterprises to upgrade the establishment of carbon footprint accounts from a core tool to a core strategy to deal with international trade barriers. Blockchain technology, with its distributed ledger, immutability and smart contract features, provides a technical foundation for data penetration, real-time verification and asset securitization for carbon footprint accounts, becoming a key path to break through the bottleneck of carbon data governance. Current research has been fully carried out on how blockchain technology can make carbon footprints traceable, but there is still a gap in the complete construction of carbon footprint accounts using blockchain technology. This paper takes CATL, a leading global power battery enterprise, as the research object. By deconstructing its independently developed "Times Carbon Chain" platform, the main purpose of the experiment reported here is to construct a carbon footprint account framework empowered by blockchain and propose an efficiency optimization path for CATL's carbon account in transportation.

2 SWOT analysis of CATL under carbon footprint

2.1 Strengths

To comprehensively trace and record all aspects of product production and supply chain management, CATL has established a supply chain compliance traceability system, covering both internal traceability, including raw material procurement, production and manufacturing, packaging, and internal logistics and external traceability, such as the source of raw materials for products, the compliance of suppliers, and the traceability of the entire supply chain.

2.2 Weaknesses

Although CATL has reduced its emission intensity through green electricity substitution and energy-saving technological transformation, the expansion of production capacity has still led to a significant increase in total carbon emissions. The core contradiction lies in the difficulty of balancing business growth with carbon reduction targets, especially against the backdrop of the EU's "New Battery Act" which requires the disclosure of the entire life cycle carbon footprint, the pressure to control the total carbon emissions in huge.

2.3 Opportunities

CATL plans to achieve carbon neutrality in its core operations by 2025 and throughout its entire value chain by 2035. This requires extensive carbon asset management, including the application of green electricity and the purchase of carbon sinks. By establishing Times Carbon Asset Management Co., LTD., CATL can not only optimize its own carbon asset allocation but also share its experience with upstream and downstream enterprises, and even clients from other industries, creating new sources of income.

2.4 Threats

ACC, a joint venture established by Stellantis, TotalEnergies and Mercedes-Benz, plans to build factories in France, Germany and Italy, with a total production capacity of 120GWh by 2030. It aims to launch high energy density lithium iron phosphate batteries in 2025, directly targeting the core market of CATL.

3 How does CATL build a carbon footprint account

"Times Carbon Chain" is a carbon management platform independently developed by CATL, based on a carbon footprint account but with more powerful features. It not only includes the core functions of a carbon footprint account, recording carbon emission data, but also adds advanced features such as data analysis and supply chain collaboration. Its core positioning is to solve the carbon data governance challenges in the lithium battery industry chain. The following is the three-layer technical architecture for establishing the carbon footprint account.

3.1 Data layer

CATL has developed a technical system based on blockchain distributed ledgers for carbon footprint accounts, achieving full-process, penetrating data management at the data layer.

(1) Data collection: Through IoT devices directly connecting to all levels of the supply chain (mineral extraction → material processing → battery manufacturing), 6,500+ sensors are deployed to collect energy consumption, raw material sources, with updates every 5 seconds. Based on the "Tier N" penetration mechanism of the supply chain, it penetrates to the upstream mineral level, such as the cobalt mine in Congo, covering over 40 material categories and 130+ suppliers, with the data coverage rate of positive and negative electrode suppliers reaching 100%.

(2) Data storage: Data is stored using a distributed ledger. The main chain is based on the Hyperledger Fabric consortium chain that supports synchronous verification by multiple nodes, storing core carbon asset certificates such as battery passports and green electricity certificates. The side chain adopts sharding technology to increase throughput (the amount of data successfully transmitted or processed by the system within a unit of time), storing real-time data during the production process. The remaining is the storage of private data, using homomorphic encryption technology to protect the privacy of commercial data such as mineral purchase prices and supplier cost details.

(3) Data verification: Machine learning algorithm LOF outlier detection is deployed to identify abnormal carbon emission data and dynamically adjust the carbon sink baseline.

3.2 Accounting layer

CATL's Perspective LCA achieves precise calculation of the carbon footprint throughout the product's entire life cycle and optimization of carbon reduction paths through dynamic modeling, real-time data calibration, and AI prediction.

(1) Early R&D design: By integrating a digital twin factory, it realizes product full life cycle management, production process optimization, and precise quality control through the deep integration of virtual and reality, simulates process optimization effects, and supports the selection of low-carbon materials.

(2) Dynamic data: Automatically updates emission factors based on the proportion of green electricity at the production site to avoid the lag of traditional LCA models, links key data to blockchain for digital certificate storage to prevent data tampering, and enhances the credibility of the data.

(3) AI prediction: Built-in intelligent algorithms compare the carbon reduction benefits of difficult carbon reduction schemes and predict the environmental impact of new battery technologies throughout the entire cycle, and optimize the design in advance.

3.3 Application layer

CATL has utilized smart contract technology to upgrade carbon assets from a passive management tool to an active value creation platform. Internally, it has achieved precise control over zero-carbon factories and carbon neutrality in the value chain. Externally, it has expanded carbon asset management services such as green electricity trading platforms.

(1) Carbon asset registration and traceability: Smart contracts automatically trigger carbon footprint accounting. For instance, the battery passport information required to be disclosed under the new battery law in the EU, such as the source of raw materials and ESG evaluations, can be updated and verified dynamically through smart contracts. Additionally, smart contracts automatically generate an immutable carbon asset ledger.

(2) Green electricity trading and carbon credits: The green electricity quota is automatically matched with the

electricity demand of the CATL production base through smart contracts, and carbon emission reduction amounts are settled in real time. Monitoring data for forestry carbon sink projects, such as the carbon sequestration capacity of forests, are automatically verified by satellite remote sensing through smart contracts and generate tradable CCERs (China Certified Emission Reductions). After theCCER is restarted in 2024, CATL can quickly convert green electricity projects into carbon credit assets.

(3) Supply chain collaboration and incentives: The CREDIT tool (CATL's Supply Chain Sustainable Development Audit System) based on smart contracts automatically assesses the emission reduction progress of suppliers and triggers reward and punishment mechanisms such as adjusting order priority and providing green financial credit. At the same time, CATL uses smart contracts to pledge carbon quotas to financial institutions to release the liquidity of carbon assets.

4 Based on ICA, a comparison between CATL and BYD (findreams battery)

CATL and BYD have both demonstrated industry-leading systematic approaches in establishing carbon footprint accounts. CATL sets hard standards through full-chain data transparency and zero-carbon factory certification, while BYD highlights soft integration through industrial collaborative carbon trading and closed-loop supply chain carbon reduction. Both have reached international cutting-edge levels. At the same time, CATL is more precise in the granularity of carbon footprint traceability, and BYD is more innovative in the path of carbon asset monetization. As the two global power battery leaders, they collectively occupy more than half of the global market share. Their carbon footprint models directly affect the emission reduction paths of China's new energy vehicle industry chain. Moreover, FFinDreams Battery and CATL have highly overlapping main businesses, both focusing on power batteries and energy storage systems as their core businesses. Comparing with CATL is instructive. Reducing carbon emissions and establishing carbon footprint accounts are interdependent and mutually reinforcing. Carbon footprint accounts, as the core tool for quantifying and managing carbon emissions, provide a data foundation, incentive mechanism, and decision-making basis for emission reduction actions, and the realization of emission reduction targets relies on the precise accounting and dynamic tracking of carbon footprint accounts. Therefore, the purpose of this experiment is to analyze, in comparison with FinDreams, which part of CATL's carbon emissions has the greatest impact on the total carbon emissions, identify this part and propose suggestions for reducing carbon emissions, thereby better optimizing the carbon footprint calculation results.

Table 1 LCA METHOD VS SIMPLIFIED METHOD

Dimensionality	Two methods	
	LCA method	Simplified method (Such as the emission factor method)
coverage area	Full life cycle (Scope1-3)	Usually only covers direct emissions (Scope 1-2)
data accuracy	High	Low (Relying on the industry average)
International recognition	Compliant with ISO/PAS standards	Applicable only in certain scenarios
Emission reduction guidance value	Precisely identify the high-carbon processes	It is difficult to assess the energy consumption of supply chain stability

a. LCA method strictly follows the ISO 14040/14044 and PAS 2050:2022 international standards, covering the "cradle-to-grave" (Scope 1-3) entire life cycle carbon emissions. The emission factor method by relying on industry average emission factors (such as those from the IPCC or the default values of the State Grid), which cannot quantify indirect emissions in the supply chain (Scope 3) and has limitations in regional applicability. Date source: Chapter 2 of the WRI Greenhouse Gas Accounting System (GHG Protocol)

Total carbon emissions of the product=$\sum_{i=1}^{n}\left(inputi \times carbonemissionfactori\right)$

4.1 Data sources

Ecoinvent website, ESG report, National Battery Power White Paper

· Sheet 1

· CATL

· FinDreams Battery

Input	Unit	Quantity	Data entry
Lithium phosphate	kg	0.24	Lithium carbonate {CN}| lithium carbonate production, from spodumene | Cut-off, S
Phosphoric acid	kg	0.37	Phosphoric acid, industrial grade, without water, in 85% solution state {GLO}| market for | Cut-off, S
Ferrous phosphate	kg	0.44	Iron sulfate {CN-QC}| production | Cut-off, S
Electric power	kwh	3.5	Electricity, high voltage {CN}| market group for | Cut-off, S
Steam	kg	0.9	Steam, in chemical industry {RoW}| market for steam, in chemical industry | Cut-off, S
Water	kg	5	Water, deionised {RoW}| market for water, deionised | Cut-off, S
Glucose	kg	0.05	Glucose {GLO}| market for glucose | Cut-off, S

Figure 1 Preparation of lithium iron phosphate

Input	Unit	Quantity	Data entry
Lithium iron phosphate	kg	3.4	sheet1
Graphite	kg	1.9	Graphite, battery grade {GLO}| market for | Cut-off, S
Aluminum	kg	1.1	Aluminium, cast alloy {GLO}| market for | Cut-off, S
Copper	kg	2.1	Copper-rich materials {GLO}| market for copper-rich materials | Cut-off, S
Lithium hexafluorophosphate	kg	1.4	Lithium hexafluorophosphate {GLO}| production | Cut-off, S
PE	kg	0.5	Polyethylene, low density, granulate {GLO}| market for | Cut-off, S
Negative electrode binder	kg	0.9	Carboxymethyl cellulose, powder {GLO}| market for | Cut-off, S
Positive electrode binder	kg	0.9	Polyvinylidene chloride {GLO}| market for | Cut-off, S
Electricity consumption	kwh	12	Electricity, high voltage {CN-FJ}| electricity, high voltage, production mix | Cut-off, S
Recycled electricity consumption	kwh	0.8	Electricity, high voltage {CN-FJ}| electricity, high voltage, production mix | Cut-off, S
Land transportation	tkm	19	Transport, truck 10-20t, EURO4, 100%LF, default {GLO} Economic, S
Sea transportation	tkm	260	Transport, barge ship, bulk, 350t, 80%LF, default {GLO} Economic, S

Figure 2 The input list of CATL

Input	Unit	Quantity	Data entry
Lithium iron phosphate	kg	3.7	sheet1
Graphite	kg	2.3	Graphite, battery grade {CN}| market for | Cut−off, S
Aluminum	kg	2.25	Aluminium, cast alloy {CN}| market for | Cut−off, S
Copper	kg	1.4	Copper−rich materials {CN}| market for copper−rich materials | Cut−off, S
Lithium hexafluorophosphate	kg	1.6	Lithium hexafluorophosphate {GLO}| production | Cut−off, S
PE	kg	0.7	Polyethylene, low density, granulate {CN}| market for | Cut−off, S
Negative electrode binder	kg	0.99	Carboxymethyl cellulose, powder {CN}| market for | Cut−off, S
Positive electrode binder	kg	0.99	Polyvinylidene chloride {GLO}| market for | Cut−off, S
Electricity consumption	kwh	18	Electricity, high voltage {CN−FJ}| electricity, high voltage, production mix | Cut−off, S
Recycled electricity consumption	kwh	1.5	Electricity, high voltage {CN−FJ}| electricity, high voltage, production mix | Cut−off, S
Land transportation	tkm	13	Transport, truck 10−20t, EURO4, 100%LF, default {GLO} Economic, S
Sea transportation	tkm	100	Transport, barge ship, bulk, 350t, 80%LF, default {GLO} Economic, S

Figure 3 The input list of FinDreams Battery

4.2 Counting process

4.2.1 Simapro software

Fig. 4 to 6 illustrate the standardized process of the entire analysis, which involves data input → model construction → method selection → result calculation, all accomplished through the Simapro software. The selection of the IPCC 2021 GWP100 is not only due to its authority and scientific rigor, but also because it has updated the greenhouse gas emission factors and optimized the carbon absorption model, enabling it to precisely quantify the differences in the contributions to climate change made by the two enterprises in various production stages such as material differences, transportation distances, and the use of green electricity, providing a reliable basis for the selection of a low-carbon battery technology route.

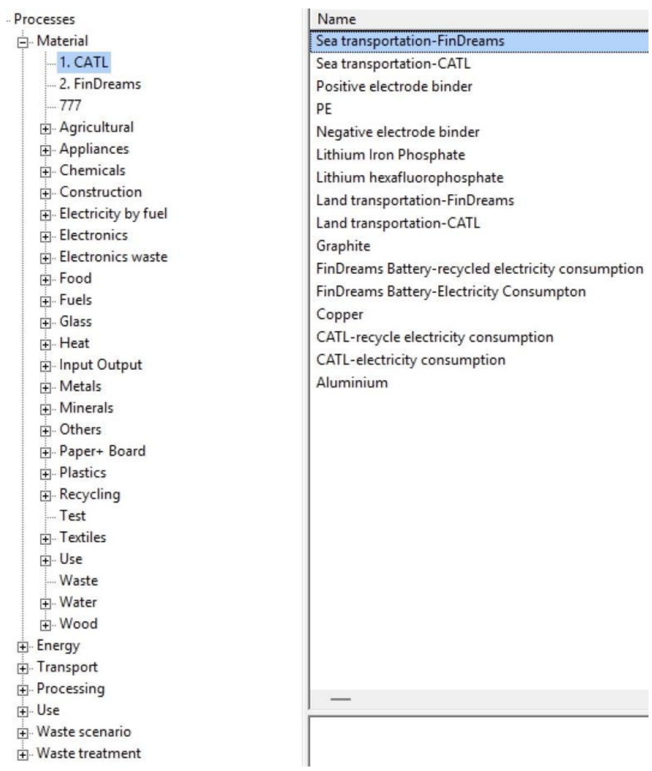

Figure 4 Input data

The IPCC 2021 GWP100 is a global warming potential indicator defined by the Intergovernmental Panel on Climate Change (IPCC) in its Sixth Assessment Report, with carbon dioxide as the reference (GWP = 1), and it is used to quantify the cumulative radiative forcing effect of a unit mass of greenhouse gas relative to carbon dioxide over a 100-year time horizon.

Name	Status	Comment	
1. CATL LFP	None		
Materials/Assemblies	**Amount**	**Unit**	**Distribution**
Lithium Iron Phosphate	3.4	kg	Undefined
Graphite	1.9	kg	Undefined
Aluminium	1.1	kg	Undefined
Copper	2.1	kg	Undefined
Lithium hexafluorophosphate	1.4	kg	Undefined
PE	0.5	kg	Undefined
Negative electrode binder	0.9	kg	Undefined
Positive electrode binder	0.9	kg	Undefined
CATL-electricity consumption	12	kWh	Undefined
CATL-recycle electricity consumption	0.8	kWh	Undefined
Land transportation-CATL	19	tkm	Undefined
Sea transportation-CATL	260	tkm	Undefined

Name	Status	Comment	
2. FinDreams-LFP	None		
Materials/Assemblies	**Amount**	**Unit**	**Distribution**
Lithium Iron Phosphate	3.7	kg	Undefined
Graphite	2.3	kg	Undefined
Aluminium	2.25	kg	Undefined
Copper	1.4	kg	Undefined
Lithium hexafluorophosphate	1.6	kg	Undefined
PE	0.7	kg	Undefined
Negative electrode binder	0.99	kg	Undefined
Positive electrode binder	0.99	kg	Undefined
FinDreams Battery-Electricity Consumpton	18	kg	Undefined
FinDreams Battery-recycled electricity consumption	1.5	kg	Undefined
Land transportation-FinDreams	13	tkm	Undefined
Sea transportation-FinDreams	100	tkm	Undefined

Name	Status	Comment	
1. CATL LFP battery-Without transportation	None		
Materials/Assemblies	**Amount**	**Unit**	**Distribution**
Lithium Iron Phosphate	3.4	kg	Undefined
Graphite	1.9	kg	Undefined
Aluminium	1.1	kg	Undefined
Copper	2.1	kg	Undefined
Lithium hexafluorophosphate	1.4	kg	Undefined
PE	0.5	kg	Undefined
Negative electrode binder	0.9	kg	Undefined
Positive electrode binder	0.9	kg	Undefined
CATL-electricity consumption	12	kWh	Undefined
CATL-recycle electricity consumption	0.8	kWh	Undefined

Name	Status	Comment	
2. FinDreams LFP-Without transportation	None		
Materials/Assemblies	**Amount**	**Unit**	**Distribution**
Lithium Iron Phosphate	3.7	kg	Undefined
Graphite	2.3	kg	Undefined
Aluminium	2.25	kg	Undefined
Copper	1.4	kg	Undefined
Lithium hexafluorophosphate	1.6	kg	Undefined
PE	0.7	kg	Undefined
Negative electrode binder	0.99	kg	Undefined
Positive electrode binder	0.99	kg	Undefined
FinDreams Battery-Electricity Consumpton	18	kg	Undefined
FinDreams Battery-recycled electricity consumption	1.5	kg	Undefined

Figure 5 Modeling (defining input parameters)

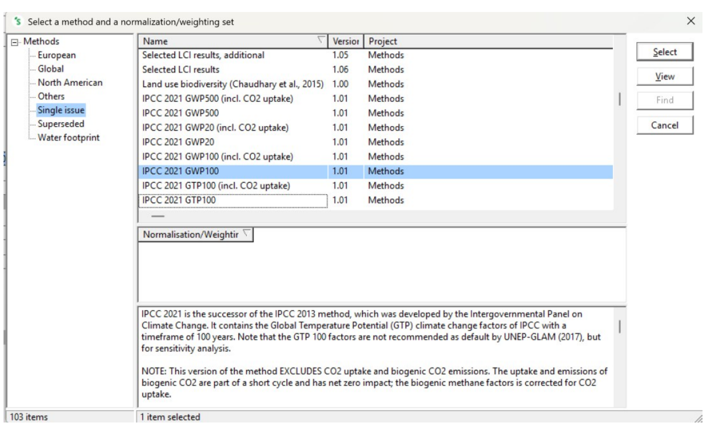

Figure 6 Determine the analytical method for calculating carbon emission factors: IPCC 2021 GWP100

4.2.2 Results

From the results in Fig. 7 and 8, the total carbon emissions of CATL are slightly higher than those of FinDreams Battery, mainly due to the impact of carbon emissions during transportation.

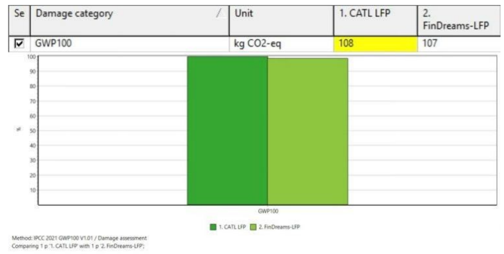

Figure 7 The carbon emissions of CATL and FinDreams Battery

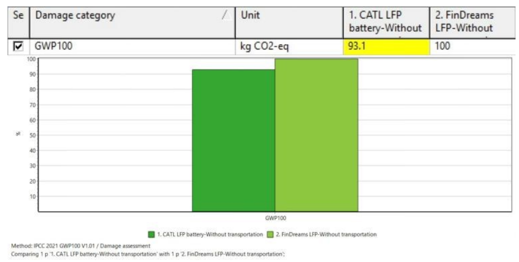

Figure 8 The carbon emissions of CATL and FinDreams Battery without transportation

4.3 Suggests

The carbon intensity of transportation methods can be stratified, and the granularity of transportation methods can be refined in the existing accounts. The unit value carbon emission factors for air transport, sea transport, railway transport, and electric heavy trucks can be distinguished. The emission coefficients can be dynamically adjusted based on real-time loading rates such as the empty running rate. For example, a label "Air Transport - High Carbon Emission" can be added for the "European Emergency Order" scenario, automatically triggering account alerts and generating alternative solution reports. The "Times Carbon Chain" platform has achieved partial automatic collection of transportation data, but it has not involved multi-modal data fusion such as the impact of weather on fuel consumption. Real-time collection of vehicle energy consumption and load data through IoT sensors can be linked with the account system to update carbon emissions.

5 Discussion

This research is based on blockchain technology and takes CATL as a case to construct a three-layer technical framework for enabling enterprises' carbon footprint accounts. It provides a reusable carbon management technology paradigm for addressing international carbon barriers. Additionally, the system compared the carbon emissions differences between CATL and FinDreams during the entire life cycle of battery power and found that CATL had higher carbon emissions in the transportation. Based on this, a further optimization plan was proposed. The main limitation of this research is that the case focuses on a single industry leader, and the advanced nature and resource investment of its technical platform "Times Carbon Chain" may not be fully replicable by small and medium-sized enterprises. Future research can explore modular and lightweight blockchain solutions to lower the application threshold. Moreover, how to drive supply chain collaborative emission reduction at a deeper level through smart contracts will be an important direction for further research. The promotion of this technical framework has significant practical value for Chinese enterprises to respond to international carbon tariffs and help the country achieve its "carbon neutrality" goals.

About the Author

* Corresponding Author: Zhuoyao Yang, 2750428505@qq.com

References

[1] da Cruz, A. M. R., Santos, F., Mendes, P., & Cruz, E. F. (2020, May). Blockchain-based Traceability of Carbon Footprint: A Solidity Smart Contract for Ethereum. In ICEIS (2) (pp. 258-268).

[2] Iansiti, M., & Lakhani, K. R. (2017). The truth about blockchain. Harvard business review, 95(1), 118-127.

[3] Ju, C., Shen, Z., Bao, F., Weng, P., Xu, Y., & Xu, C. (2022). A novel credible carbon footprint traceability system for low carbon economy using blockchain technology. International journal of environmental research and public health, 19(16), 10316.

[4] Lin, X., Li, X., Kulkarni, S., & Zhao, F. (2021). The application of blockchain-based life cycle assessment on an industrial supply chain. Sustainability, 13(23), 13332.

[5] Marcatto, A. C. C. Modelling the Carbon Footprint of Blockchains.

[6] Nechetnyy, N., Balassem, Z. A., Goyal, W., Singh, M. P., Mittal, V., Sobti, S., ... & Nagaraju, K. C. (2024). Analysis of Carbon Footprint Reduction in Supply chains using Blockchains. In E3S Web of Conferences (Vol. 581, p. 01017). EDP Sciences.