

Web3 for Better

Whitepaper 3.0

MARCH 2023

Table of Contents

01	Vechain's Journey		Appendix
02	Our Aspiration		Glossary of Terms
03	How We Identify Sustainability Needs		Table of Figures
04	Building the Blockchain Biosphere for Sustainability		Works Cited
05	What Does an Ecosystem Look Like?		Credits
06	Engaging the Individual and Building Communities		
07	Vechain Technology Landscape and Roadmap		
08	Vechain Governance		
09	What's Next for vechain?		
10	Conclusion		

01

Vechain's Journey

We established Vechain when it was still rare to see major business applications running on public blockchains and before public enthusiasm for blockchain's potential was on the rise. We wanted to change that by providing enterprises with a trusted, distributed platform that could enable transparent flow of information, efficient collaboration, and high-speed value transfers.

We released Whitepaper 1.0 in June 2017 to present this vision and our aspiration to become the platform of choice for blockchain-based business applications offering concrete economic, environmental, and societal value.

As is the case with many technologies, we understood VechainThor blockchain would go through several sequential stages of development:

1. Overcoming technical barriers
2. Removing business obstacles to drive enterprise adoption
3. Reaching scale
4. Subdividing into new breakthroughs in specific fields
5. Starting a new technology cycle

In Whitepaper 1.0, we argued we had entered the early phase of the second stage. Our VechainThor blockchain incorporated all the basic requirements for enterprise adoption of blockchain technology, including:



A proper governance model with the transparency and operational efficiency necessary to enable continual and rapid innovation



A sustainable economic model (two-token model: VET and VTHO) designed to prevent transaction fees from being directly exposed to the volatility that afflicts most single-token economic models



A flexible blockchain developed to comply with changing regulation and to be easily integrated with a variety of complementary technologies such as IoT¹, RFID², 5G, AI³/ML⁴, big data, etc.

1. Internet of Things, 2. Radio-frequency identification, 3. Artificial Intelligence, 4. Machine Learning Machine Learning



Subsequently, we published Whitepaper 2.0 in December 2019. In that whitepaper, we expanded upon our commitment to enable mass blockchain adoption by established businesses, with the long-term goal of creating value and solving real world economic problems. With this in mind, we pinpointed the three major phases of blockchain evolution which would form the foundation of our strategy to become the world's first choice for blockchain: Technical Consensus, Business Consensus, and Governance consensus.

We had already moved past the Technical Consensus stage, which is typically driven by developers and focused on building up the initial technology infrastructure, and were building features that could improve business use cases and activities, including:

Proof of Authenticity consensus algorithm (PoA 2.0), which provides safety guarantees on blocks and transactions at a faster speed than the previous algorithm.

Meta transaction features, such as Transaction Lifecycle Control, which grants users control over when a transaction is executed or abandoned, even when the blockchain is running at high capacity. This is critical for business applications.

Transaction fee delegation, which allows users to interact with decentralized applications (dApps) and make payments directly, without having to purchase cryptocurrencies.

With the adoption of the VechainThor platform by major enterprises and assurance companies, we were entering the Business Consensus phase, a critical process in which businesses shape the evolution of blockchain applications towards features that fulfil their specific needs. We began to focus on identifying companies and solutions capable of bridging the digital space with the physical one (e.g., IoT and tagging companies), while maintaining a particular focus on business use cases. Additionally, many developer tools such as Connex.js and Sync were released to simplify the development process and improve the accessibility of the VechainThor blockchain ecosystem, further accelerating the adoption of our technology.

The final step to widespread enterprise adoption (development stage 2) was achieving Governance Consensus. In this phase, legal authorities around the world join corporations in driving the regulatory development of blockchain. Specifically, regulatory requirements must be merged with advanced blockchain features.

In our Whitepaper 2.0, we envisioned a comprehensive governance consensus for the blockchain protocol, attempting to find an efficient balance between centralised and decentralised governance models and technologies. As our infrastructure matured, we continued to embrace decentralisation, gradually tipping the scales in its favour. We designed the Vechain Governance Principles and Charters with a focus on transparency, fairness, and operational efficiency to enable continuous future iterations and rapid progression in developing solutions.

Our governance must allow individuals to be stakeholders, alongside corporations, governments agencies, and other institutions, empowering people as owners and creators rather than just users. As we will see in **Chapter 7**, we are still progressing through this phase. We are constantly improving our governance to achieve the goal of operating a decentralised public blockchain with the capacity to scale and meet the needs of large enterprises that create concrete value. At the same time, we are turning regulatory compliance into a valuable transition; provided regulations evolve as rapidly as the blockchain industry itself, we can leverage our resources to facilitate the cooperation of institutions, enterprises and people within this constantly evolving framework.

Throughout this journey, we've created relationships with supportive individuals and organisations who share both our passion for blockchain technology and our vision of creating a more transparent way to collaborate. We have built differentiated underlying technologies and formed strong strategic partnerships focused on lowering the barrier to entry for enterprises, while leveraging blockchain technology to create value and solve tangible economic problems.

Differentiating underlying technologies:

VechainThor is a constantly evolving public blockchain committed to helping global enterprises and governments achieve Sustainable Development Goals (SDGs) efficiently, quickly, and at low cost. VechainThor's unique Proof-of-Authority consensus mechanism allows for fast and secure transaction processing while also enabling secure governance of the platform by a group of trusted nodes. Additionally, VechainThor is designed to handle many transactions per second, making it suitable for use by solutions that demand scalability and high-volume processing of transactions.

Two-token Design embedded within VechainThor platform includes vechain token (VET) and veThor (VTHO). VET serves as a value-transfer medium (utility token), whereas VTHO represents the underlying cost of using VechainThor (Energy). The unique, two-token design significantly helps to separate the cost of using blockchain from market speculation, a fundamental requirement for enterprise use of a platform.

PoA 2.0 "Proof of Authority 2.0" is designed to guarantee data integrity while also providing high-throughput and scalability capabilities to meet the evolving needs of businesses. PoA 2.0 is meant to combine the strengths of Nakamoto and Byzantine Fault Tolerance (BFT) architectures while eliminating their individual weaknesses, solving one of the great trade-offs in blockchain design – scalability versus data finality.

Our enterprise partnerships include widely recognised consulting firms, retail and wholesale businesses, and luxury goods companies. Our strategic partnerships have fostered an array of real-world applications. Some examples of applications developed with our partners include:

- My StoryTM,⁵ a blockchain-powered digital assurance solution that enables brands to share the true and authentic story behind every product directly with consumers.
- Walmart China Blockchain Traceability Platform, which allows supermarket users to scan 30+ product categories (e.g., fresh meat, rice) and acquire detailed information, including the product's source and geographic location, logistics processes, and product inspection reports.
- A solution for tracking the origin of plastics recovered during clean-up activities.

Fundamentally, throughout our years of research, study of pain points in numerous industries around the globe, modelling of industries and initiatives connected by and collaborating through blockchain, and our cooperation with industry experts, we have always focused on solving tangible problems for enterprises. Recently, we have seen an urgent desire across industries to tackle growing sustainability challenges. We believe our blockchain solution can support a viable system of sustainability that will serve our planet for generations to come.

In this whitepaper, we will articulate our aspirations for a future where sustainable living and conduct of business is the norm and not the exception.

5. Trademark owned by DNV (Det Norske Veritas)



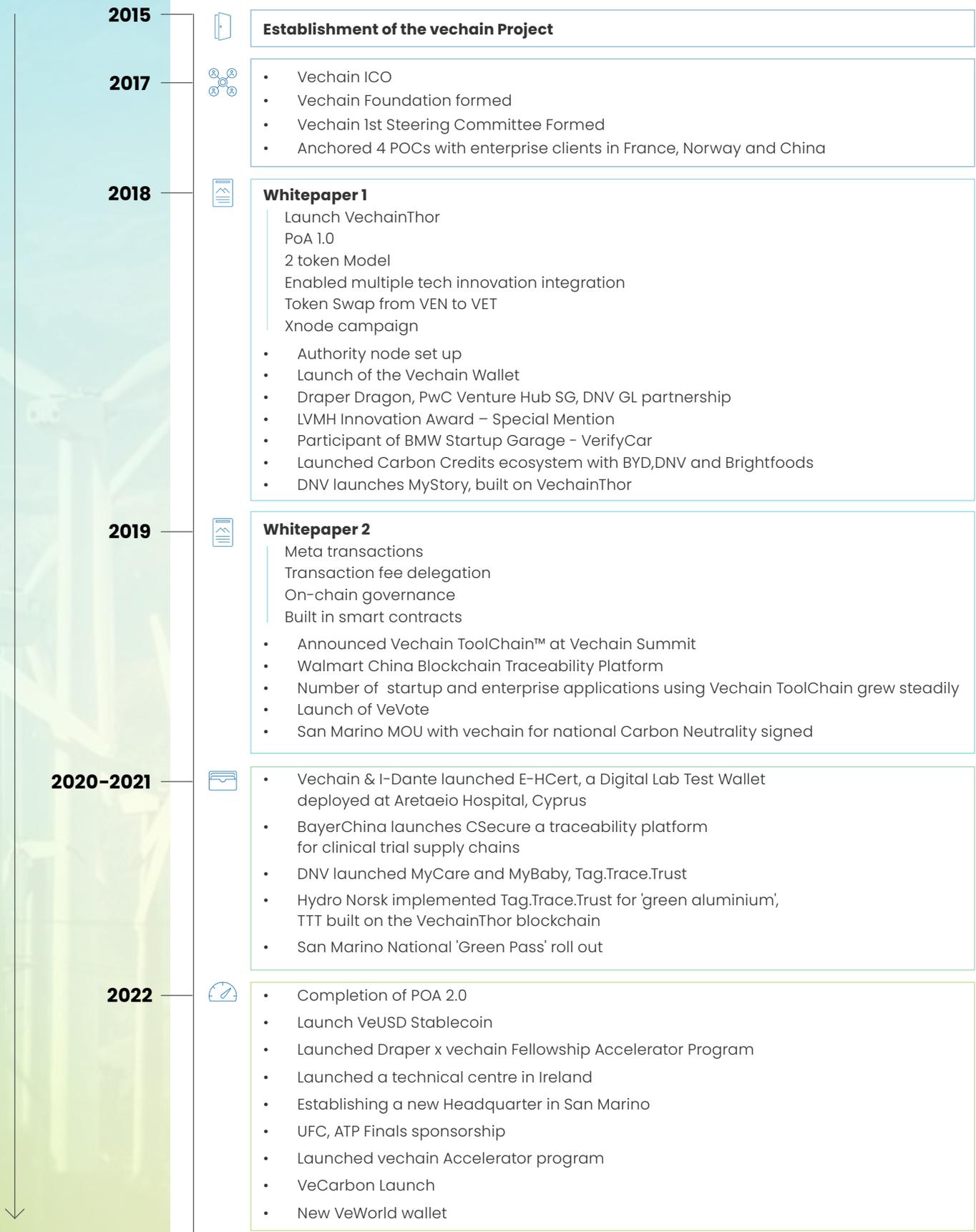
Figure 1 - Timeline of the vechain Project Journey

Traceability · Enterprise Applications · Sustainability

TRACEABILITY

ENTERPRISE APPLICATIONS

SUSTAINABILITY



A woman is seen from behind, holding a young child. They are standing in a field with several wind turbines in the background. The sun is low on the horizon, creating a warm, golden glow and lens flare effects. The child has their arms raised, pointing towards the sun. The woman has her arms around the child's shoulders.

02

Our Aspiration

Anyone who wants to change the world for the better knows humanity's greatest challenges will only be overcome by a collective global movement. We all must work together in ways previously unimagined to successfully combat climate change, address threats to the environment, bring equity to our societies and ensure companies act in the best interests of all stakeholders.

Taking on our world's greatest sustainability challenges requires collaborative action. And so, our aspiration is clear: We seek to **multiply individual impact to unleash our collective potential for sustainability.**

Empowered by blockchain and other technologies, we are building partnerships that will catalyse and support the coming sustainability transition. Previously, individuals had limited power to address the critical challenges of our time. As we enter the Web3 era, we will build platforms to put sustainability within reach.

Small individual efforts, things like reducing personal food waste, will be multiplied across the community. For instance, our blockchain solutions will be integrated with municipal initiatives to help people donate food that is about to expire. We can then track the reduction in food waste at scale. And this is but one, small example.

Our overall goal is to enable people to engage with sustainability every day. We will do this by putting more power in their hands to make impactful, informed decisions that influence the fundamental environmental and societal factors underpinning our existence as humans, such as access to healthy food, clean water, and fresh air. With ever-evolving technologies like blockchain, we will help people develop real, meaningful partnerships with organisations, governments, and enterprises. These partnerships will help create a more sustainable society and economy.

Blockchain for our better world

Blockchain is ushering in a new era. It is a technology with the potential to unite people around a common sustainability goal and combine their impact so that the sum is greater than the parts.

We must leverage technology and digital innovation for the good of all humanity – not only for the benefit of the few – and also provide a system of trust and transparency, if we want to meaningfully address the sustainability issues facing us today. Consequently, we propose a new paradigm, one that will allow us to quantify the impact of discrete actions, ensure individuals maintain ownership of their personal data and control its use, and provide secure, trustworthy, and transparent transfer of information and services, as well as distributed ownership, among individuals, enterprises, and governments.

This is the promise of Web3.

Figure 2 – Core ideas for vechain today



OWNABILITY

We have the vision and cutting edge technology to **silently shape society in ways yet not imagined**

It takes a conductor in these moments of transition to be successful



DESTINATION

We imagine a future where our systems are interwoven in a way that creates trust, efficiency, and optimal decision making

The interwoven society will flourish for generations



IMPACT

Saving our planet is the most pressing challenge of our time, and it will take **radical new ways of approaching sustainability solutions**

And we must bring this vision to the world for it to have an impact

We believe technology can foster the trust between people, organisations and governments required to bring about this new paradigm. By facilitating transparency and accountability, Web3 provides people with a basis to trust that enterprises and institutions will uphold their sustainability commitments; that corporate and governmental reports and communications on sustainability initiatives are substantiated; and that technology companies are tracking and selling user data properly.

We aspire to surpass Web 1.0 and Web 2.0 and their outmoded philosophy wherein a select few owned and controlled most data and access. Because Web3 systems are built atop decentralised networks, people have control over their personal data and identities. As a practical matter, this translates to greater security and privacy compared to the incumbent centralised setup and creates a generation of owners and co-creators – rather than users or customers – who can hold each other accountable in pursuing similar passions and achieving similar goals.

However, Web3's impact extends beyond information exchange. Web3 is an enabler of value exchange, too. Moreover, this value is not only economic but also environmental and societal. Indeed, a key driver of the sustainability transition will be a fundamental redefinition of "value" as a concept. Web3 technologies enable us to understand, qualify, quantify, and share the value of an action, including its societal, environmental, and economic factors.

Figure 3 – Journey from Web 1.0 to Web 3.0

WEB 1.0

1990–2005

Introduction of the Web

Users **read content** on static sites

Publishers collect revenue

WEB 2.0

2005–2020

Rise of the Platform

Users both **read and create content**

Networks and platforms control creators' revenue streams in a centralized manner

WEB 3.0

2020+

Emergence of the Semantic Web

Users **read, create, and own their content and exchange value**

Users transact their data across decentralized, blockchain-based networks without using third parties

In the future, everyday life will be defined by a merger between the physical and digital worlds. Web3 is a phygital environment powered by blockchain, IoT and other technologies. Collectively, these Web3 technologies help create sustainable value chains and achieve sustainability missions shared by a variety of different parties. Individuals will participate equally with other partners in collaborative missions, whether acting as part of a platform, a corporation, an association, a government body, or even on their own. The priority of every initiative will become consensus identification and collaboration to execute actions. This will multiply individual actions so that everyone has the chance to make a perceptible difference in how the world will look in the decades to come.

Society faces a critical need for new business models, which must encompass activities related to the physical value chains where sustainability issues are most pressing (e.g., manufacturing, transporting, and purchasing goods). These business models must enable collaboration with other parties and provide governance that facilitates interactions and transactions. Web3 will be the basis of these new ways of doing business, and blockchain technology like VeChainThor – alongside smart contracts, fungible tokens, non-fungible tokens (NFTs⁶), and decentralised autonomous organisations (DAOs) – is evolving every day to support these collaborative missions. These Web3 features are the ideal engine for meeting the world's sustainability needs and transforming the way we understand and unlock value.

What does it mean to be “Phygital”?

“Phygital,” a combination of the words “physical” and “digital,” is a term describing the blending of digital experiences with physical ones. As communication channels between organisations and users grow, the role of VeChain is to build a trusted bridge between the digital and physical. Through blockchain and other technologies we can acquire data from the physical world for use in the digital space, where we can create new concepts of value and new ways of collaborating.

6. See chapter 4 for details on smart contracts, fungible tokens, NFTs and DAOs.

At vechain, we are building an interconnected platform where individuals will play an active role in making sustainability aspirations real. This could mean engaging in small actions, such as riding a commuter train instead of driving a car and then receiving rewards for doing so, or building trailblazing solutions to critical climate challenges. We envision a world where everyone – individuals, enterprises, and governments – is accountable to the new value systems we collaboratively establish to promote healthier communities, protect the environment, ensure humane working conditions, and provide easy access to clean drinking water.

Our personal actions, big and small, are the basis of this transition. Web3 makes every action count. Blockchain-enabled technology will help everyone make informed decisions that engender a greener, more mindful, more responsible global community. Together, our impact will be multiplied across a network of networks, connecting people, governments, and entire industries to sustainable outcomes that will benefit us all. In these trusted ecosystems, individuals and institutions will link their efforts to ensure the full value of every action is recognised and rewarded.

At vechain, we believe in the power of blockchain to transform individual action into collective steps that incentivise cooperation and improve how we perceive value. In such a world, one plus one no longer equals two, but three, or four, or five. With these new models of interaction, we can all participate in defining, creating, scaling, and sustaining new value systems that will protect our shared world and unleash our collective potential.

Figure 4 – Our Journey of Inspiration

2017 “ To build a trust-free and distributed business ecosystem platform to enable transparent information flow, efficient collaboration, and high-speed value transfers ”

2019 “ ...lowering the barrier and enabling established business with blockchain technology to create value and solve real world economic problems... ”

2023 “ **Multiply individual impact to unleash our collective potential for sustainability.** ”

03

How We Identify Sustainability Needs



The previous sections detailed how Web3 can be used to promote a more sustainable future. Now, we will examine what sustainability really means in this context.

Sustainability is often instinctively associated with environmental consciousness and broad actions such as reducing emissions, reusing goods, and recycling waste. However, the concept of sustainability is much broader. Indeed, sustainability encompasses the total functioning of our global society. Sustainability entails granting access to essential goods and services to all people, protecting vulnerable individuals and communities, providing humane working conditions to employees, ensuring that consumer products and services are healthy and safe, and enabling the regeneration of natural resources.

Building a global culture of sustainability requires a common definition. In the business community, sustainability is typically discussed under the rubric of Environment, Social, Governance (ESG). We go a step further and break down this universe of sustainability-related topics into five primary dimensions and 24 sustainability needs.⁷

Environment: greenhouse gas emissions (e.g., CO₂, methane, nitrous oxide) and air quality; energy management; water and wastewater management; waste management circularity; natural resource use; biodiversity protection

Social conditions: human rights and community relations; customer privacy and data security; customer welfare; selling practices and accessibility

Labour conditions: human rights and community relations; customer privacy and data security; customer welfare; selling practices and accessibility

Leadership and governance: business ethics and competitive behaviour; management of the legal and regulatory environment; risk management

Business model and innovation: supply chain and responsible sourcing; business resilience

7. The five dimensions and 24 sustainability needs are based on the Sustainability Accounting Standards Board's (SASB) taxonomy. See appendix 1 for further details. Source of the sidebar: "Why do we need to protect biodiversity?", European Commission

Protecting biodiversity: a key challenge for the future

“Biodiversity” refers to the variety of life on Earth (species, genera within a single species, ecosystems). Every living being, including human beings, is involved in complex networks of interdependent relationships, which are called ecosystems. Many such ecosystems are currently endangered. For example, the global animal population has declined 68% since 1970, highlighting an urgent need to act.

Healthy ecosystems provide us with food, clean our water and air, regulate the climate, provide resources for medicines and other benefits. For this reason, biodiversity must be protected and, where needed, restored.

When we apply the five dimensions of sustainability to different industries, the most pressing issues vary considerably. A carmaker might be more concerned about emissions, while a clothing manufacturer or distributor might pay more attention to labour conditions in factories.

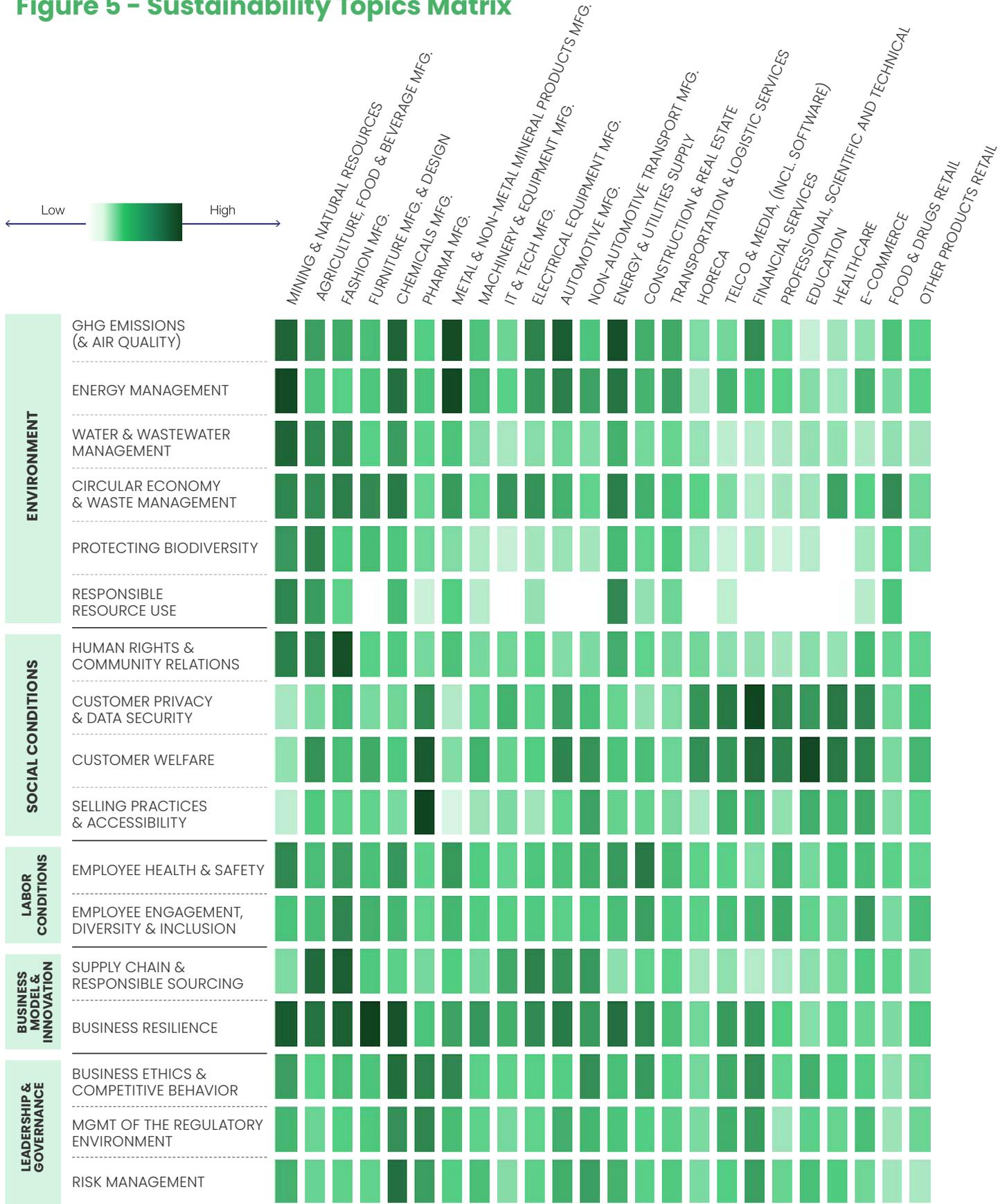
To account for this variability, we have built a **Sustainability Topics Matrix**⁸ which highlights the most important sustainability needs in different industries. The Sustainability Topics Matrix was developed using the Materiality Maps published by hundreds of companies in each sector as part of their most recent sustainability reports (2019–2021) **(see appendix 3 for the methodology of the Sustainability Topics Matrix)**.⁹

The Matrix helps us identify the most pressing issues for each sector today. It can be updated to take account for how those needs evolve over time.

8. See appendix 3 for the methodology, 9. Maps used by firms to disclose the sustainability needs they consider most relevant (see appendix 2 for further details)



Figure 5 - Sustainability Topics Matrix



The Sustainability Topics Matrix is the tool we developed to identify and show the relevance of sustainability needs across industries



Specific trends in materiality of sustainability needs

Environmental needs are particularly important to heavy industry and sectors that use natural resources. Those needs include addressing emissions in industries with carbon-intensive production processes, like oil and gas, and improving waste management in industries where hazardous waste is produced, such as chemical manufacturing.

Social and Labour conditions are more significant in sectors that are customer centric or labour-intensive. Needs related to social conditions range from ensuring safety and quality in pharmaceuticals and healthcare to protecting customer privacy and data security in e-commerce and financial services. Employee health and safety is particularly relevant for sectors where production sites present a risk of safety incidents.

Leadership, governance and business model innovation needs apply to all industries that are subject to sudden changes stemming from, among other causes, energy transition, new regulations, disruptive technologies, or consumer innovation.

The complexity of sustainability derives both from the broad environmental and societal scope it encompasses and from an inherent need for collaborative action. A wide variety of actors must work together to move the needle on sustainability, even at the local level.

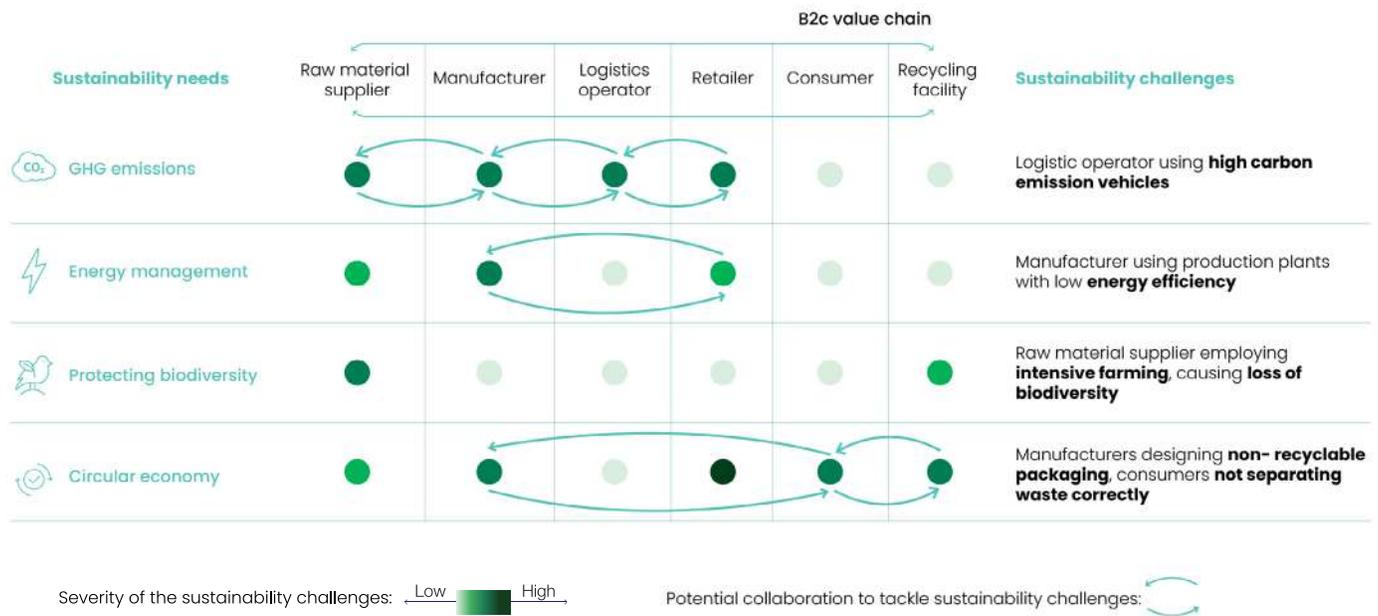
Consider the everyone involved in the life cycle of a simple chocolate bar: Farms provide the raw materials and the energy and labor to cultivate them; power companies supply the electricity used during the production process by the manufacturer; logistics companies manage transportation; and wholesalers and retailers handle distribution. Finally, consumers buy and consume it, leaving municipalities to dispose of or recycle the waste generated by wrappers and shipping materials. And then the process begins again.

If citizens wish to consume a product without causing an excessive environmental impact, they must be sure that the raw materials have been obtained in a manner that protects biodiversity, that the manufacturer uses renewable energy to run its plants and has employed an efficient and low-polluting production process, that the greenest possible forms of shipping are used, and that retailers have been careful to manage orders in such a way as to avoid waste. The citizen must then make a personal commitment to properly dispose of packaging and food waste, ultimately relying on the municipality to recycle them.



Figure 6 – Collaboration systems

Example of each actor's contribution to sustainability needs



All these actors should have an interest in making their actions sustainable. Moreover, since they are interconnected, they can multiply the impact of their individual sustainability actions and unleash their collective potential by collaborating and acting in a coordinated, synergistic manner.

More often than not, the greatest sustainability challenge is getting every player on board and coordinated with the others. This requires inspiring, facilitating, and managing long-term cooperation and collective action. However, several obstacles may prevent the creation of effective collaborative ecosystems:



Need for trust and Proof of Authenticity

Lack of **visibility into the sustainability of suppliers' operations** (e.g., difficulties for retailers in identifying the amount of emissions generated by their suppliers when manufacturing a specific product)

No traceability and brand liability regarding the usage and end-of-life of products (e.g., no opportunities for municipalities to verify whether end consumers dispose of products correctly)

Inadequate or absent proof of authenticity or definitive product identification (e.g., difficulties in identifying whether second-hand luxury products are authentic)

Absence of traditional trust mechanisms among specific actors in a digitized and hyper-connected world (e.g., lack of trust among players who have never met one another in person when interacting in an online marketplace)

Data ownership & privacy challenges

Poor **digital maturity and tools for data collection** and sharing (E.g., when refugees flee war zones without proper documentation, there is no unified platform where their home country and NGOs or host countries can collect and share information needed to identify them.)

Concerns about the **sharing and protection of sensitive data** (E.g., companies may be reluctant to join ecosystems that require them to share data with competitors.)

Incomplete or incorrect **tracking of customer information** (E.g., despite loyalty programs companies do not know how consumers interact with their products after point of sale, if they use them, waste them, recycle the packaging, etc.)

A lack of trust and proof of authenticity can prevent different players from cooperating and addressing sustainability needs. Everyone must trust each other and possess sufficient visibility into each other's work. They must know that the information they receive from their counterparts is trustworthy in order to collaborate productively. Similarly, customers must be sure the products they are buying are authentic and sustainably manufactured, which means they need insight into how the goods were produced and distributed. Without this assurance, consumers will be reluctant to recognise the full value of these goods. For example, if retailers and end consumers cannot trust information on emissions or wastewater generated through manufacturing and transportation of products, they cannot base their purchasing behaviour on environmental impacts. If consumers do not account for environmental impacts when choosing products, then manufacturers will not be incentivised to improve their environmental policies.

Another obstacle to collaboration is a lack of data ownership and privacy. People and organisations with a common sustainability goal must be able to safely store data and make it accessible to each other in a secure fashion. If they are reluctant to share sensitive information due to privacy concerns, this will reduce visibility into each other's sustainability actions. Conversely, more data sharing and greater visibility will make collaboration easier and more successful. Indeed, the lack of innovative and fast ways to safely share data may slow down necessary activities (e.g., if the sale of medical products requires individuals to provide a medical prescription on paper).

Furthermore, people and organisations can only effectively collaborate if the **externalities** generated by their actions are **valued correctly**. If someone's actions produce positive effects for others, but go unrecognised, they will be less inclined to repeat the behaviour. Conversely, if someone's harmful actions go unnoticed and are not penalised, they may be more inclined to replicate the conduct, either because they are unaware of the harm created or because they lack incentives to improve. For instance, consumers who choose environmentally conscious options, such as food packaged in compostable or reusable materials, often do not receive a reward for their choice, leading to lower consumer demand and minimal investment from companies in compostable packaging; if there is no demand from consumers, firms are not motivated to go the extra mile

Need for attribution of value to externalities

Absence of **ways to monetize positive externalities** or incentives to reduce negative ones (E.g., there are no incentives for consumers to bring their clothes back to manufacturers to allow for the recycling of fabric.)

Lack of **penalisation for generation of negative externalities** (E.g., No effective measures are in place to penalise firms that outsource their operations to foreign countries that employ child labour.)

Figure 7 – Obstacles to Collective Sustainability Action



Need for trust and Proof of Authenticity

- Lack of visibility on sustainability of suppliers' operations
- No traceability and brand liability on the usage and end-of-life of products
- Inadequate or absent proof of authenticity and definitive product identification
- Absence of traditional trust mechanisms among specific actors



Data ownership & privacy

- Poor digital maturity and tools for data collection and sharing
- Concerns about the protection of sensitive data shared
- Incomplete or incorrect tracking of customer information



Need for attribution of value to externalities

- Absence of ways to monetize positive externalities or incentives to reduce negative ones
- Lack of penalization for generation of negative externalities

The obstacles detailed above obstruct lasting, collective, positive action. Indeed, when the impact on society caused by certain actions fails to be fully captured, or there is lack of trust and privacy in data exchange, actors in the value chain are more reluctant to pursue virtuous behaviours.

On the other hand, well-structured compensation mechanisms can encourage people and organisations to join forces and collaborate. When individuals act in an environment that recognises and values actions beneficial to the community (on a social, financial, or legal level, for instance), it generates a virtuous circle of positive improvements. If the system encourages choices that create more sustainable value for society, then we can count on a rising number of people, enterprises, and organisations addressing sustainability needs collectively, while also reaping a personal benefit: a true win-win situation.

Examples of positive or negative compensation mechanisms

Adding a charge for shopping bags in supermarkets creates an incentive for customers to re-use bags they already have.

Congestion charge zones discourage citizens from using private vehicles, thereby reducing emissions (e.g., congestion charge zone in London).

Emissions trading systems incentivise companies to finance carbon-removal projects in exchange for a monetary reward.

Today, most sustainability focused regulations, enforcement regimes, taxation policies, and even the SDG infrastructure itself, are centred on the actions and initiatives of governments and enterprises. As a result, individuals are rarely directly involved in sustainability efforts, and their actions and contributions are not fully captured nor credited. This also reduces the effectiveness of initiatives undertaken by governments and companies.

Presently, companies can design their products so that their components are recyclable, but if consumers are not encouraged to dispose of them properly, or if their municipalities tax them equally regardless of whether they recycle or not, such efforts will be in vain. It is crucial to identify methods for measuring, evaluating, and recognising individual contributions.

This is a substantial opportunity.

Consequently, we chain partners with enterprises that serve as facilitators and advocates of collaborative systems aimed at engaging institutions, local governments, and – most importantly – citizens themselves.





Building the Blockchain Biosphere for Sustainability

Blockchain Biosphere for Sustainability Framework

In the previous chapter we discussed the Sustainability Topic Matrix and areas where there is an acute sustainability need. We also outlined several challenges that prevent collaboration to address those sustainability needs. In this chapter, we propose a new conceptual solution to these challenges by developing a framework for how innovative Web3 technologies can thrive in a collaborative model.

Borrowing from the concept of Earth's biosphere, we aim to enable and support the **Blockchain Biosphere for Sustainability**. This will eventually consist of many ecosystems dedicated to solving specific needs, everything from monitoring logistics to get food from point A to point B safely to reducing emissions by shortening a supply chain.

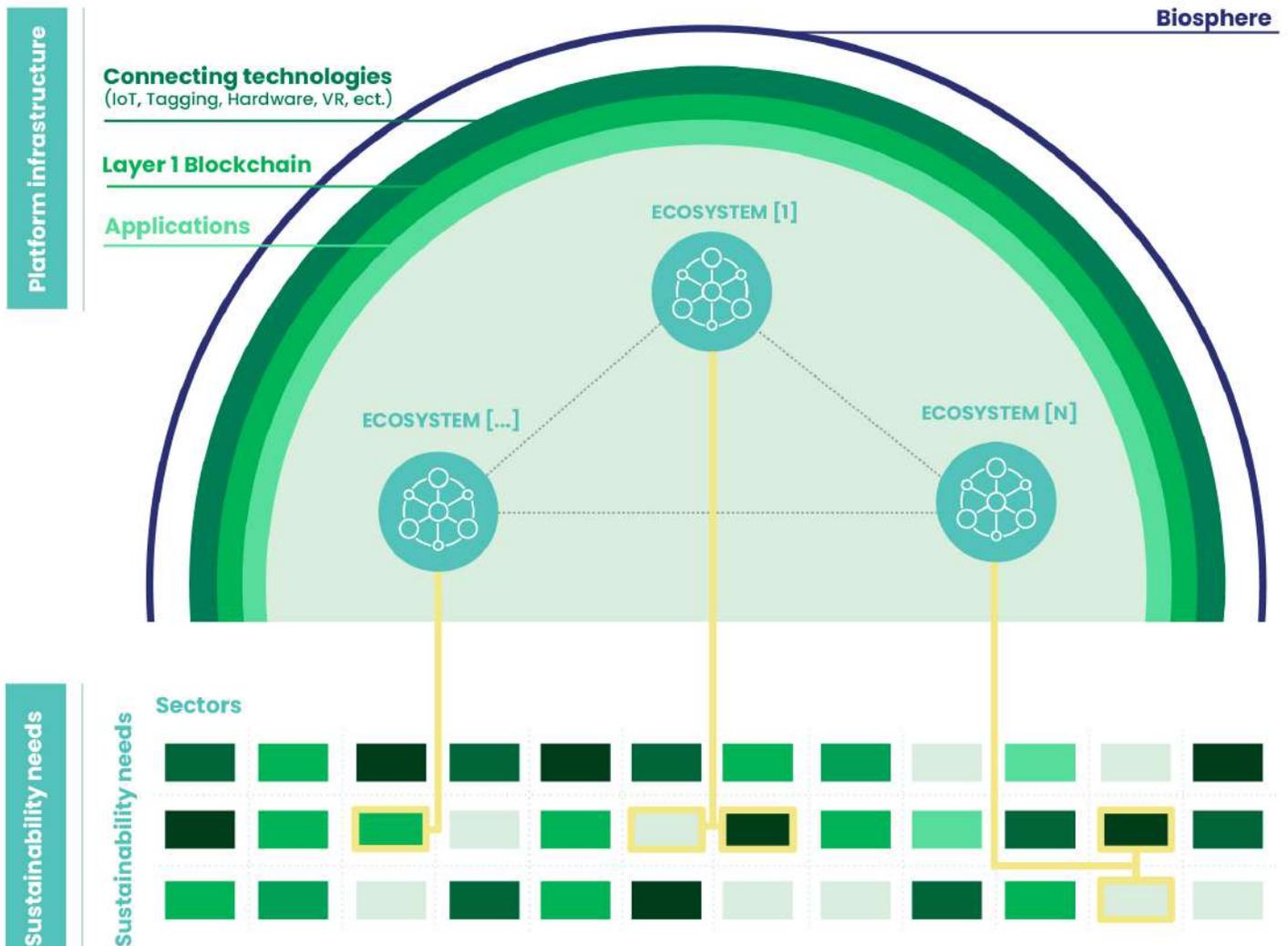
The Biosphere represents a framework within which we can develop blockchain powered solutions for sustainability challenges around the globe. These solutions, connected with Web3 technology, will galvanise the collective action required to overcome the challenges we see today.

The Biosphere will provide a platform for developing **ecosystems** to solve different sustainability needs, such as by establishing a circular economy for the fashion sector or mitigating emissions in the energy industry. Through an **interconnected network**, individuals will be able to seamlessly explore and participate in the full spectrum of ecosystems and build or grow their own ecosystems as well.

Two critical components make up the Blockchain Biosphere for Sustainability: the **platform infrastructure** and disparate but interconnected **ecosystems**.

Figure 8 - The Blockchain Biosphere for Sustainability

The Blockchain Biosphere for Sustainability



As discussed in Chapter 3, mapping sustainability needs by industry sector helps us identify the materiality of the needs and specific industries where there is high demand for a solution.

Sustainability needs might be industry-specific, like a circular economy in the fashion sector, or they might span multiple industries, like mitigating emissions across the mining, automotive, and energy sectors.

Platform infrastructure comprises the technical components of the connected technologies, the layer 1 blockchain, and the applications that power and connect all ecosystems.

We aim to expand our current enterprise partnerships and technical and operational capabilities throughout the Biosphere. VeChain's operational capabilities complete the support functions of the platform infrastructure.

The platform infrastructure connects and supports all individual ecosystems similar to how a power grid connects a community. One can build a house and connect it to the grid for full access to the electricity the grid supplies, plus integration with the wider network. Similarly, the platform infrastructure enables the functionality of all ecosystems to deliver value in the broadest sense of the word.



Naturally, for the ecosystems to be sustainable, the infrastructure itself must also be sustainable. VechainThor, vechain's layer 1 blockchain, is built with this vision in mind, and it offers an energy efficient, user friendly, open platform for collaboration.¹⁰

VechainThor's base infrastructure is necessary to connect ecosystems to each other and provide the entire Biosphere with the decentralised trust and transparency that only a public blockchain can offer. Furthermore, VechainThor will enable the potential implementation of DAOs – uniting sustainability communities – while non-fungible tokens (NFTs) and fungible tokens (FTs) may drive the trade of assets for sustainable applications. Meanwhile, smart contracts will power sustainability reporting, monitoring, and transaction facilitation.

In this new Biosphere, a seller can receive a token for selling a second-hand coat in a sustainable fashion ecosystem and then spend that token at a charging station in the electric vehicle (EV) ecosystem.

While blockchain will anchor the Biosphere, next generation technologies such as AR, VR, AI, IoT, and 5G, will contribute to the Web3 environment and will be key components of the platform infrastructure required to meet sustainability needs.

10. Please refer to Chapter 7 for further details on our platform's sustainability.

What is a DAO?

A Decentralised Autonomous Organisation (DAO) is an **institution operating under member control** that is transparent and not influenced by a central governance. The members of a DAO vote to determine their internal regulations and make shared decisions. The number of tokens owned determines voting power.

For example, people living in a neighbourhood may join together in a DAO to set goals for the community and assign specific prizes (fungible tokens) to citizens who contribute to reaching those goals.

What is a Token?

Tokens are a **unit of value**, that enable different actors to:

- Interact with each other
- Carry out transactions
- Transfer value

There are 2 types of tokens:

Fungible tokens are equivalent to one another and can be interchanged. Examples include cryptocurrencies, carbon credits, rewards, etc.

Non-fungible tokens represent unique assets, which are not interchangeable. NFTs are unique. Examples include product passports and digital art.

We are already seeing these technology combinations at work in supply chains that use a secure blockchain record paired with IoT and GPS to track food, raw materials, and other critical products. This is an early step in creating a full-fledged sustainability solution. Similarly, a crypto token-driven circular economy can leverage AI and big data analytics to incentivise reuse and recycling, while cloud computing helps enable digital wallets. The integration of these technologies into ecosystems will require both hardware and software solutions, plus a tech platform that connects these functionalities within the Biosphere infrastructure.

What is a smart contract?

A smart contract is a decentralised application built on top of the blockchain which will **automatically enforce contract parameters** when a condition occurs.

A company can use a smart contract to associate an immediate and certain reward with a specific positive action by a community member, such as the return of empty glass bottles to the supermarket in exchange for some form of value.



Collaboration Is Key

The alliances vechain has already formed with founding partners will enhance the ability of ecosystems to leverage existing markets and expertise. We aim to expand our current enterprise partnerships while adding strategic, technical, and operational partners and collaborators, including governments, NGOs, and sustainability experts, throughout the Biosphere.

While vechain currently has the capability to integrate many advanced IoT offerings into the blockchain Biosphere, with the help of developer partners we plan to explore the creation of even more technologies to enable a mature Web3 environment and better support users. We are currently seeking formal, dedicated partners who want to be involved in an ecosystem as owners, not just participant. These partners will contribute to the design of ecosystems, build dedicated solutions, attract additional users, and communicate the ecosystems' value to the community, all while generating additional value for themselves. With this in mind, we are committed to enhancing collaboration between start-ups, academia, financing partners, and developer communities through grants, accelerator programs and other similar initiatives (see Chapter 7).

The vechain Environment

Vechain's operational capabilities will complete the support functions of the platform infrastructure. We will not only provide the infrastructure, but also ensure the availability of helpful tools, services, and educational resources to seamlessly adopt our blockchain for all relevant applications. Through these efforts, we hope to engage and encourage all builders to grow their ecosystems within vechain's favourable environment. We act as the custodian of the blockchain platform infrastructure that connects the Biosphere and enables partnerships that support and connect ecosystems. By hosting native features designed to facilitate the construction and execution of specific sustainability-related solutions,¹¹ vechain's layer 1 blockchain is uniquely qualified to enable the sustainability biosphere.

11. See chapter 7 for a technology roadmap which provides an overview of the technology features that will be developed for VechainThor.

Ecosystems are distinct communities devoted to solving specific sustainability challenges. Each ecosystem is designed with its own unique business model, stakeholders, incentives, value flows, and technology requirements, so as to maintain its long-term viability.

The **modular environment** we envision provides an agile development environment where stakeholders can create their own ecosystems independently, similar to the development of apps for a mobile phone, and incorporate them into the Biosphere. The resulting scalability allows for tailored ecosystems to achieve their own specific goals while still enabling connectivity with the other ecosystems of the Biosphere. Thus, anyone who builds an ecosystem will have unlimited access to the myriad possibilities provided by other ecosystems in the Biosphere.

Each ecosystem can include a number of **key roles**, filled by individuals or enterprises who share an interest in achieving the ecosystem's common mission, such as waste reduction or fashion recycling.

The main roles one might find in an ecosystem are:

- **The sponsor** who funds development and go-to-market strategy or invests in a growing ecosystem by financing events, conferences, and hackathons.
- **The adopter** who demands a solution to a sustainability need and consumes the offering, while adjusting behaviour based on incentives set up by the ecosystem.
- **The promoter** who attracts enterprises and individuals to the ecosystem by communicating the value of the solution and encouraging existing users to understand and leverage the full range of the offering.
- **The developer** who builds applications and technical solutions to meet specific needs of the ecosystem, addressing pain points relevant to adopters and unlocking the platform's capabilities.
- **The partner** who offers unique tech and operating capabilities that plug-in to the platform, thereby helping to create the sustainability use-case offerings and providing additional technology and auditing capabilities when required.
- **The enabler** who acts as the "glue" of the whole ecosystem, filling in interoperability gaps to fulfil customer and developer needs and bridging business development shortfalls.
- **The platform provider** who supports developers with tools and resources such as SDKs and APIs and creates the structures and incentives for the whole ecosystem.



Why are there different ecosystem roles?

Each role serves a distinct purpose within an ecosystem, ensuring its long-term success through the following actions:

Incentivizing participation in an ecosystem as a sponsor through activities such as financing events

Serving the ecosystem as an adopter who actively participates or a promoter who helps attract participants

Creating the ecosystem's design and implementation as a developer, platform provider, enabler, or other partner type

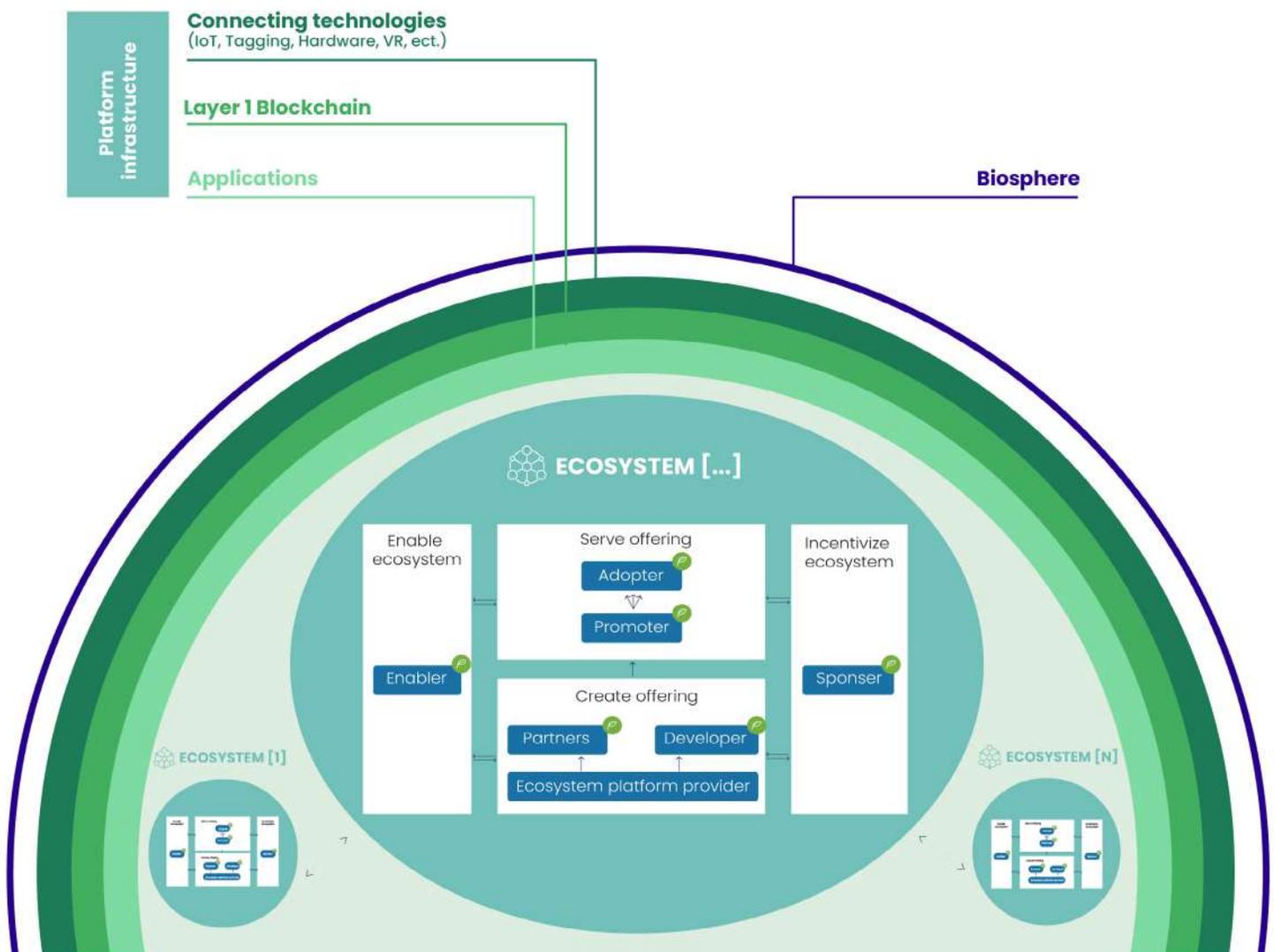
Depending on the needs of a given ecosystem, the same actor can play multiple roles, or multiple actors can play the same role. For instance, a start-up software company primarily playing the developer role within an ecosystem may also serve as the promoter by proactively marketing the ecosystem in its commercial channels. In that same ecosystem, the start-up may also partner with other start-ups or with independent developers to create and maintain dApps for the ecosystem, resulting in multiple actors fulfilling the developer role.

Not only does each actor bring a different skillset to the ecosystem, but each one also receives different benefits in return. For example, developers bring with them expertise and knowledge of programming languages and know-how about complex smart contract creation. In return, the community might incentivise developers to contribute to the ecosystem through financial rewards or recognition.

Corporations may provide resources or infrastructure to support the development and growth of the ecosystem. Their benefit will be the ability to extract tangible value from what used to be intangible; for example, blockchain powered traceability of a product’s origin can enable a company to ask for a premium price. Users can create value for the ecosystem by adopting and using the offering (paying for it monetarily or otherwise), increasing the circulation and value of tokens. In return, those same consumers can participate in the decision-making process for improvements.

All these players are vital for the success and evolution of the ecosystem and the validation of its business model.

Figure 9 – Purposes and Roles in an Ecosystem



An ecosystem's business model must make good economic sense and provide the right incentives to all actors in the ecosystem. If it fails to do this adequately, people and organisations won't see a compelling reason to join or maintain membership in an ecosystem. Indeed, companies and individuals have a long history of defaulting to a concept of value dictated by fiat currency and cash flows. For new ecosystems to take hold, we must translate this new, broader concept of value that incorporates societal impacts into a system that rewards and promotes pro-societal and eco-friendly behaviours.

We believe that a self-sufficient, well-planned ecosystem will benefit all stakeholders and provide positive incentives for everyone to participate and contribute. Everyone should benefit from their participation in ecosystem. Furthermore, the ecosystems that make up the Biosphere will not only interconnect and provide individually functioning business models but will also be able to constantly evolve and improve sustainability outcomes and value delivery for everyone involved. Web3 technology is integral to instilling transparency, ownership, and stakeholder agency among participants, so that the business models and incentives of an ecosystem are equitable and trusted.

The Role of Web3 within the Biosphere

These modular ecosystems will have specific technological needs which must be addressed for them to operate seamlessly. Integrating innovative technology tools and capabilities is critical. As discussed in Chapter 3, we must overcome three primary challenges to facilitate an environment of collaboration:

- The necessity of trust and proof of authenticity
- The challenges related to data ownership & privacy
- The need for attribution of value to externalities

We must ensure that individuals have the right incentives to participate in an ecosystem, that trust is fostered and guaranteed between actors, and that ownership is distributed equitably using Web3 technology. The environment created with Web3 technology is uniquely positioned to provide tools and innovative behaviours to overcome the obstacles experienced in Web2.

Trust forms the backbone of all transactions in Web3 and depends on the certainty that the terms of an agreement will be fulfilled. Because blockchain is a decentralised, distributed ledger and uses trusted oracles to facilitate and manage the off-chain to on-chain data connections, records are tamper-proof and can be notarised at any time. Thus, blockchain enables secure and trustworthy storage of data for any transaction.

However, beyond just data, Web3 also facilitates transactions through smart contracts, which empower parties to enter into transaction agreements without requiring significant due diligence on the trustworthiness of other parties. Once the terms laid out in a smart contract are fulfilled, an unalterable, pre-determined outcome is triggered.



Network effects for social media

Social media platforms rely on network effects, where the value of the service increases proportionally with an increase in the number of users. As more users join the platform, the service becomes more valuable, which in turn attracts even more users. This creates a self-reinforcing cycle that benefits the platform by increasing its user base and making it more valuable to advertisers, content creators, and other stakeholders.

In the current Web2 world, individuals do not fully control of their data. The rewards for their work are distributed among middlemen and, in many instances, the original creators may only see a small return on their investments. Web3 promises to usher in a wave of distributed ownership where the creators are the ones who reap the benefits of their creations.

This reorganisation of ownership is possible because of two key features in a blockchain-enabled ecosystem: tokens, which act as both a stake and proof of ownership, and DAOs, which are engines for a collaborative community.

Web3 and blockchain allow for the tokenization of positive externalities that are created through an individual's actions. Today, societal, environmental, and economic dimensions are often not considered in totality when evaluating the full value of an action. Consequently, such value is not stored and exchanged among its creators and consumers. However, positive externalities which go beyond mere monetary value can be digitized via fungible tokens and awarded to different ecosystem participants.

The tokenization of value in an ecosystem gives participants a stake in its success. Token holders are motivated to contribute to and build on the ecosystems they participate in, thus growing the value of their own holdings. Furthermore, for ecosystems with a DAO element, token holders can use tokens to vote on proposals, initiatives, or other DAO-related activities. In simple terms, these Web3 elements distribute ownership and decision-making among all ecosystem stakeholders, incentivising participation and allowing them to collectively chart a more sustainable course.

Redefining the Concept of Value

Value is the foundation of any business activity: It drives business investment decisions and incentivises key players in any ecosystem to improve their contributions. However, the concept of value has traditionally been confined to economic value, which mainly considers cash flow projections without accounting for other potential sources of value.

The concept of value has been evolving for several years now. For example, the economic valuation of internet-based platform companies is not only tied to their cash flow but also to how many users they can harness. This is the result of the network effect, where users derive more value and benefits from a product or service the more users there are.

Similarly, the value in the **Blockchain Biosphere for Sustainability** contains not just the benefits enjoyed by shareholders in a given company, but also the collective benefits for society at large. This new concept of value encompasses economic, environmental, and societal impacts. This concept also prices positive and negative externalities, similar to how carbon taxes try to price the negative externality of carbon emissions.





Consumers are beginning to change their behaviour to reflect their personal preferences and a broader definition of value beyond just the monetary. Indeed, many people are increasingly incorporating societal and environmental elements into their own personal definitions of value and are using their purchasing power to select products and services from companies that have demonstrated commitment to similar values beyond profit. For instance, a recent Boston Consulting Group¹² survey of approximately 19,000 consumers worldwide found that 16% of them said sustainability was one of the top-three drivers in their most recent purchase and a significantly larger share said they can be persuaded to make sustainable choices if the products or services deliver other related needs. (Case in point, 43% of consumers seek beverages that are “healthy, high quality, guilt free, and socially responsible”).

Figure 10 – A new concept of value



Economic value



Societal value



Environmental value

In other words, social and environmental consciousness matters; these externalities have value, and traditional forms of worth assessment fail to take those factors into account. It is through this lens that we challenge the traditional thinking on valuing goods, services, and actions in search of a more complete, holistic concept of value as it relates to sustainability.

Web3 with blockchain provides the mechanisms to expand our perspective beyond traditional value conceptions. A more comprehensive view of value includes consideration of a company's commitment to sustainability initiatives and its willingness to cooperate and collaborate with users or other companies to fulfil those initiatives.

12. “Consumers Are the Key to Taking Green Mainstream”, by Kanika Sanghi, Aparna Bharadwaj, Lauren Taylor, Léa Turquier, and Indira Zaveri, September 2022 – <https://www.bcg.com/publications/2022/consumers-are-the-key-to-taking-sustainable-products-mainstream>

In the Blockchain Biosphere for Sustainability, we unlock significant sustainability values from the following key sources:

Blockchain Biosphere for Sustainability: Sources of sustainability value

Source	Definition
1. Enabling multi-stakeholder collaboration towards a common objective	Creating partnerships among individuals, developers, organisations, and institutions, so they can share resources and expertise
2. Creating communities of impact to spark network effects for sustainability	Bringing people together to work toward a common goal with the belief that the combined efforts of a group can lead to a greater impact than individual efforts alone
3. Establishing a decentralised governance and ownership mechanism to empower all stakeholders and maximize sustainability impacts	Giving individuals the opportunity to be active participants in the decision-making and ownership of a project or initiative, rather than being passive recipients of services
4. Establishing clear rules of participation with distributed benefits for all contributors	Ensuring different individuals and organisations share benefits; creating mechanisms to coordinate and encourage cooperative efforts
5. Incorporating and giving transparency on the full value of assets, supply chains, and behaviours	Allowing all players to have visibility on the full range of consequences and externalities – positive and negative – of actions and choices made by other players and valuing them correctly
8. Using a platform with more energy-efficient infrastructure and operation	Building an infrastructure that is designed to be sustainable over the long-term, taking into account environmental impacts of operations
7. Providing a platform facilitating sustainability-focused projects	Creating an open platform that gives space for grass-roots innovation to anybody who has a vision and/or project ideas on sustainability

Addressing key sustainability issues will require cooperative and collective actions among all players in an ecosystem coupled with a commitment to identifying and capturing value that traditional finance overlooks. To that end, we can employ crypto tokenomics design in an array of ecosystems, which we will discuss further in this white paper.

Tokenomics – including the tokenomics of VET, VTHO, and potentially newly created tokens designed for specific ecosystems – will become the next wave of not only a more holistic definition of value but also act as a foundation for more inclusive governance in the Web3 era. By embodying digital representations of ownership and value, tokens enable the creation of new models for doing business.

By rectifying flaws in traditional valuation methodology, this new paradigm will incorporate traditional economic value as well as more comprehensive environmental and societal value for all stakeholders. At the same time, tokens can be used to facilitate governance of ecosystems and communities by giving members the ability to vote on important decisions, with the tokens acting as a form of digital equity. And the incentivisation of positive contributions to ecosystems is made easier by rewarding those who participate in sustainable activities, create content, or take on leadership roles in communities. Overall, tokenomics empowers a decentralised, transparent, and secure way for communities to govern themselves.

Educating markets and users on this new concept of value and developing new standards, mechanisms, and metrics will be critical to successfully account for sustainable actions alongside profits.

05



What Does an Ecosystem Look Like?

Considerations When Designing an Ecosystem

Successful ecosystems will disrupt current value chains and generate monetary, environmental, and societal value, without necessarily needing large investments.

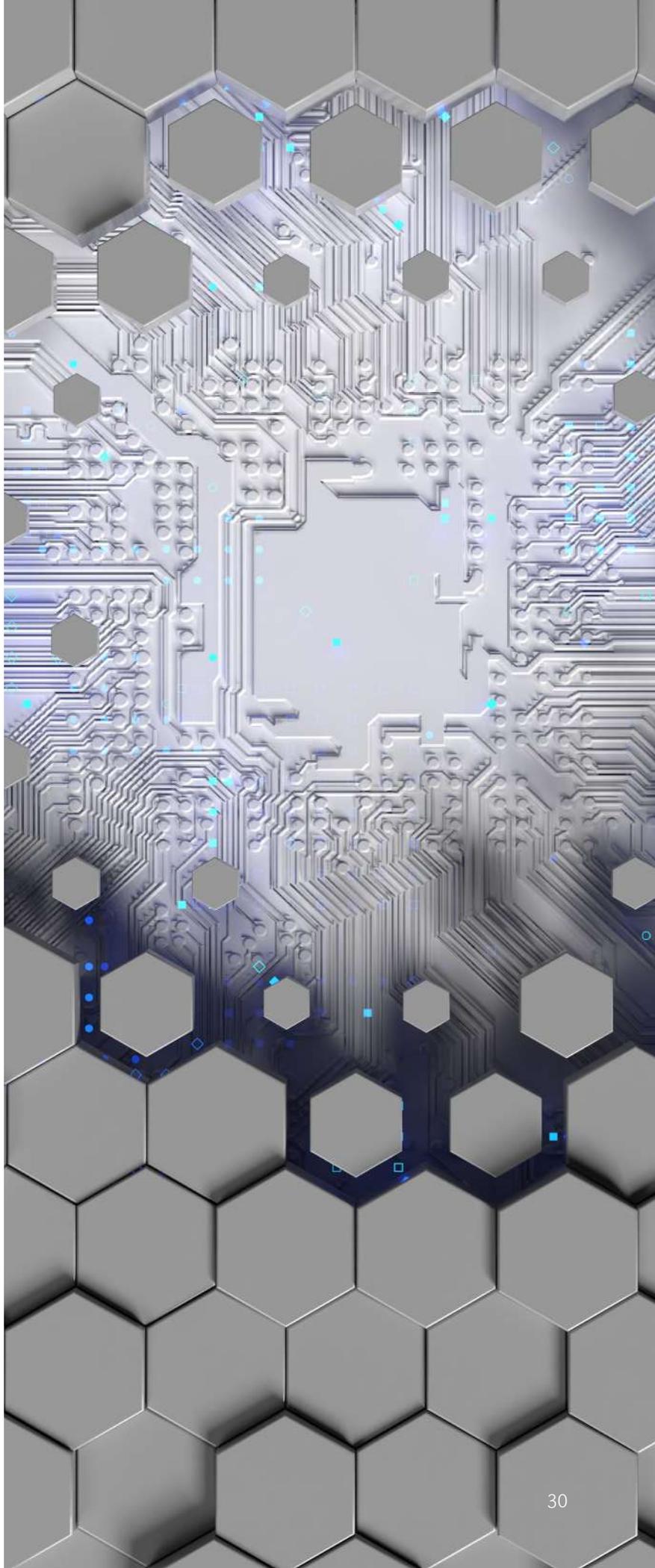
When designing an ecosystem, we must first evaluate current pain points (sustainability challenges and obstacles to actors' collaboration) within the traditional value chains we are seeking to change. The solutions created by an ecosystem generate the additional value necessary to attract and retain new developers, actors, and investors.

Leveraging BCG's broad experience in sustainability issues and pressure testing our ideas with a wide array of industry experts, we have constructed a number of blockchain-enabled example ecosystems related to food & beverage, fashion, pharma, automotive and energy sectors. We have included case studies for the three examples that demonstrate the most promise in the near term:

1. Second-hand market for fashion: bridging the physical and the digital part of a product (through a tagging process) and creating a digital passport (based on an NFT) for fashion and luxury items, so as to provide an authenticity guarantee on second-hand markets and thus incentivise resale and reuse, extending the life of the product and thereby reducing waste.
2. EV battery management: using blockchain to enable battery passports (based on an NFT) to provide for traceability of EV batteries (tagging), streamlining the recall process and easing the recycling process.
3. Supply Chain at the Edge: harnessing blockchain to enable real time 3D printing of spare parts close to end users, thereby decreasing emissions from logistic processes, increasing efficiency, and guaranteeing the immutability of the design for certified original spare parts.

Each of these example ecosystems identifies specific sustainability and societal needs, all of which will generate additional value for ecosystem participants and society at large once addressed. For each of the three proposed ecosystems, we have conducted an in-depth examination of how the existing process operates today to identify its unique pain points. We then explore how blockchain adoption can help address these pain points while also creating functional communities to maintain these ecosystems for the long haul. We propose these ecosystems as examples of what can be built using vechain's technology platform. While they will not be developed and built by vechain directly, we aim to provide the technology tools to developers and a collaboration environment that will make such endeavours possible.

The diversity of the ecosystems we present reflects the wide-ranging applications of vechain's blockchain solution as a catalyst for change. And new applications can be developed quickly to tackle a diverse set of problems across industries. Due to the modular nature of the Blockchain Biosphere for Sustainability, the ideation and design process for new ecosystems can be done independently of other pre-existing ecosystems.





Ecosystem Concept 01

Second-hand market for fashion

The first example ecosystem reflects the need for a second-hand marketplace dedicated to promoting sustainable fashion. **The objective of this proposed ecosystem is to promote the second life of used clothes and reduce the environmental impact of the fashion industry, while giving ecosystem participants control over the authentication process of their sales and purchases.**

The current secondary marketplace model for fashion has three primary pain points:

1. Expense of verifying brand authenticity in the second-hand market
2. Information asymmetry for buyers regarding second-hand product information
3. Low fashion resale rates, which result in greater waste and lead to environmental and social harm as a result

The first pain point — authenticity — is most applicable in marketplaces selling luxury goods and other valuable items at a high risk of counterfeiting. The marketplace counters this risk by providing additional authentication services to shield buyers from fake goods. However, these authentication costs are passed on to buyers and sellers as additional fees. Unfortunately, manual authentication not only creates additional friction in an already complex process but also results in added emissions because of the need to ship items to authenticators prior to selling them on the secondary market.

The second pain point — information asymmetry — encompasses two points of asymmetry for buyers. First, buyers must rely on the marketplace's reputation and its assurances that a product is authentic. Buyers lack substantial insight into the authentication process, and thus cannot make their own judgements about the accuracy of the authentication. Second, buyers lack access to product history for items sold on the marketplace, which further deepens the gap in transparency.

Counterfeits: An expensive problem

According to the Organisation for Economic Co-operation and Development (OECD), the volume of international trade in counterfeit and pirated products in 2019 amounted to \$464 billion (2.5% of world trade).

Footwear, clothing, and leather goods/handbags combined make up over 50% of global customs seizures.

Importance of 2nd hand markets

As a society, we are buying more and using less. Our average textile consumption has doubled in the last 15 years as fast fashion has become the trend. As the amount of clothing we buy increases, the number of times that we wear garments decreases — by 36% globally in the last 15 years according to the Ellen MacArthur Foundation. This leads to a situation where the fashion industry churns out more items than we can wear. And when we no longer wear clothes and instead buy new ones, the items often get landfilled rather than resold.

Low buy-in for second-hand markets

According to the BBC, only 15% of resalable luxury goods are sent to second-hand stores annually. This level of waste amounts to an environmental and sustainability problem. Discarded clothes take decades to break down. Meanwhile, the fashion industry tries to meet the demand of the primary market and the opportunity to recycle and reuse clothing goes by.

Tagging enables brand and customer connection

Tagging articles of clothing is something that the fashion industry has already been testing to connect with consumers:

- **Adidas** uses tags to activate a mobile experience for customers.¹
- **Burberry** enhances customer experiences by using a tag to connect media content specific to an item.²
- **Nike** embeds tags in the soles of shoes to enable broadcasting of data.³

We can harness this innovative method of engagement to help brands and customers interact with each other after the initial purchase of an item.

The last pain point — low resale rates in the second-hand market — leads to environmental and social harm: If the initial buyers no longer want an item and cannot sell it in a second-hand marketplace, they will most likely discard it in a landfill. The blockchain-powered ecosystem adds an element of digital identity, enabling a network effect that boosts the number of users and goods that are traded rather than trashed.

Given these pain points, a new ecosystem powered by Web3 technologies can offer some solutions that benefit all participants. It all starts with companies embedding clothing or accessory items with tags containing unique ID codes at the time of manufacturing. Each unique ID code will be digitized onto the blockchain through the creation of an associated NFT and item profile. The item profile will capture manufacturing information related to sustainability (e.g., emissions generated) as well as product details like colour, make and model, and year of production.

The tag will remain embedded throughout the lifespan of the item. Each time the item is repaired or maintained, the action will be recorded onto the NFT as a new, immutable data point. Thus, the NFT becomes a complete history of the item. To participate and receive an authentication guarantee, buyers will only need to use their smartphone to unlock the benefits provided by the ecosystem during each stage of the transaction. This further helps reduce emissions because items no longer need to be shipped for authentication.

Alongside tagging technology, blockchain will play a fundamental role in the design and operation of this ecosystem. It enables a high degree of data transparency, making buyers, sellers, and the marketplace responsible for their actions. Because of its transparency and immutability, blockchain disintermediates the ecosystem by removing the third-party authenticator role. By incorporating Web3 elements into the ecosystem, participants will have greater control over the second life of their clothes, marketplace operations, and the distribution of the ecosystem's financial benefits.

The benefits of the ecosystem extend beyond simply solving the pain points in the traditional business model. The ecosystem also generates additional value. For example, first and second-hand buyers could benefit from increased communication with brands via the NFTs, receiving brand updates, access to discounts, curated content, and unique loyalty rewards such as special releases. The increased direct interaction between brands and buyers ideally fosters brand loyalty as buyers feel more connected with the brand.



Under the new model, brands will gain insights into the second-hand marketplace. This improved understanding of second-hand sales will in turn help them curate product offerings to serve future consumer demand.

In conclusion, the ecosystem provides an opportunity for individuals to extend the life of their clothing and accessories. Surveys show that consumers are already highly motivated to consider sustainability when making purchasing decisions.



Web3 capabilities to drive customer engagement & loyalty

Institutions are starting to lean on Web3 and more creative and open ways to engage customers. Recent examples in 2022 include Tiffany's NFTiff, which offers exclusive rights to jewellery pieces resembling the CryptoPunks NFTs to their owners, and Starbucks Odyssey, which provides the ability to earn and buy NFTs and unlock coffee experiences and benefits.

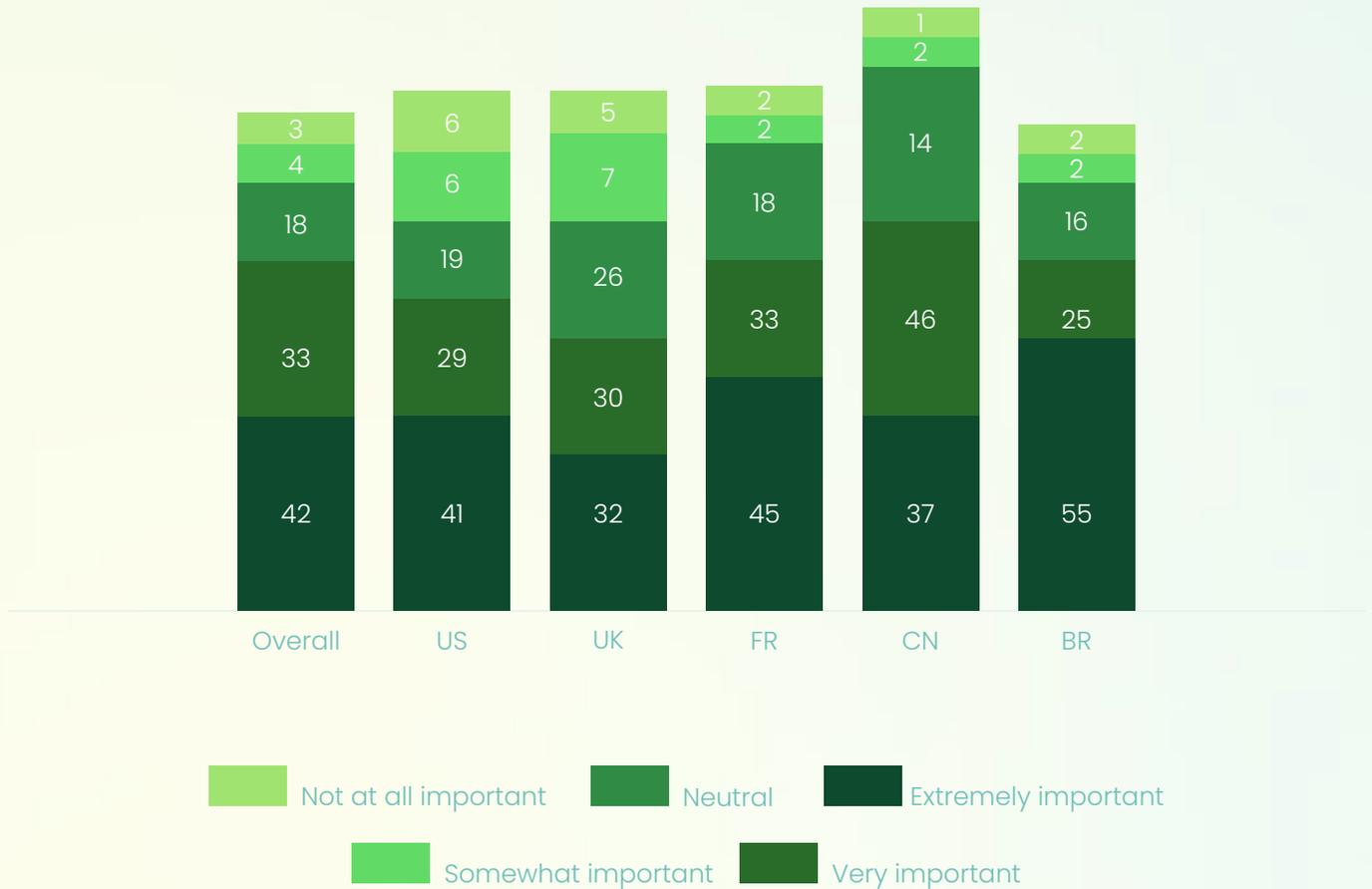
With the emergence of capabilities such as **on-chain fungible tokens, NFTs, smart contracts, and DAOs**, Web3 can help drive greater customer engagement and stickiness within the ecosystem. Beyond employing digital assets, elements of Web3 can be used to roll out features that incentivise participation and promote loyalty.

- **Fungible and non-fungible tokens** (e.g., spendable loyalty currencies, NFTs) can be used to gamify interactions, track engagements with sellers, and reward loyalty with real-world perks and benefits.
- **Utility or "Phygital" NFTs**, can be issued to reward activity in the ecosystem by unlocking early access, discounts, and unique experiences.
- Employing blockchain-based tokens opens creative avenues to plug-in external partners and merchants more easily. With immediate transaction settlement and interoperability rules programmed in, **Smart Contracts** can automate a lot of the manual overhead that typically goes into managing such collaborations.
- **Token gating** is gaining popularity as open and connected ecosystems become an alternative to traditionally closed ecosystems, enabling smoother collaboration between parties to engage and reward users.
- Brands can also use **DAO-like** structures to easily enable voting on brand decisions, such as which product to launch or partnership to bring onboard next. Governance can be configured through the DAO to give certain token holders' votes more weight depending on loyalty status, history of engagement, participation in key challenges, and so on.

Figure 11 – Consumer Sentiment

75% say sustainability is “extremely” or “very” important when purchasing fashion

How important is sustainability to you when purchasing fashion products?



Consumers are already displaying a strong preference for sustainability when making purchasing decisions

(Source: BCG Pulse of the fashion industry report 2019)

Thanks to favourable consumer sentiments about sustainability and the monetary savings provided by the elimination of third-party authentication, the ecosystem will replace the old model of only sporadically reselling clothing and accessories with a new model where resale becomes the norm. This ecosystem – built on blockchain and Web3 technologies – will power a broad and all-inclusive marketplace where individuals and enterprises participate collectively to extend the life of clothing.

Traditional fashion resale

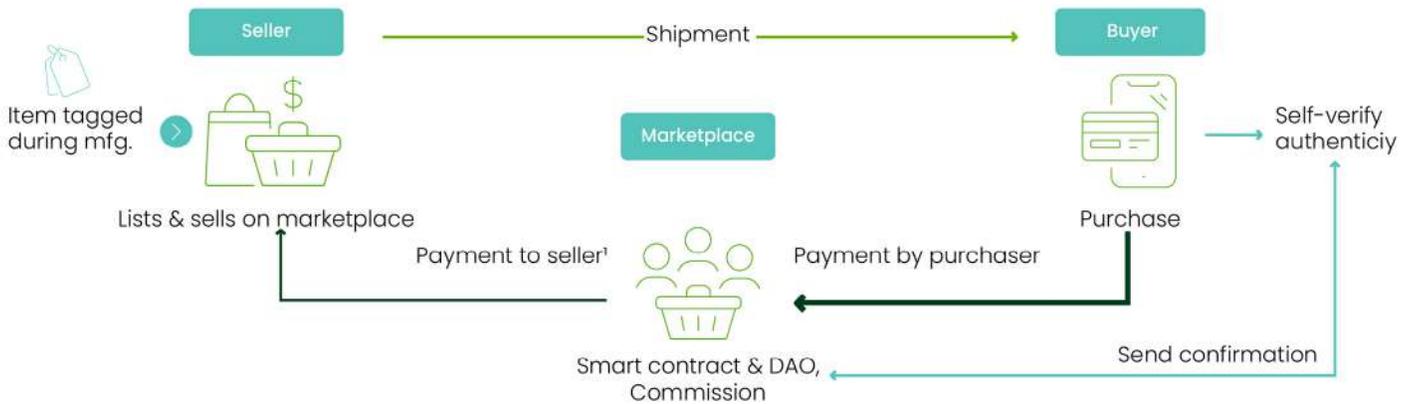


1. Lower than payment made by purchaser, due to commissions paid to marketplace

In the traditional resale market, sellers list goods on the marketplace. Higher value goods require authentication at physical locations, in exchange for a commission. Once purchased, the goods are shipped to the buyer, who relies on the credibility of the marketplace for authentication. Payment flows from the buyer, through the marketplace, to the seller.



Secondhand market for fashion



1. Lower than payment made by purchaser, due to commissions paid to marketplace

In the second-hand market for fashion ecosystem, the seller lists goods on the marketplace. However, instead of the seller shipping the goods to an authentication site, the goods are sent straight to the buyer. The buyer can scan the tag to verify the authenticity of the goods. Payments are executed by smart contracts.



Ecosystem Concept 02

EV Battery Management

Our second ecosystem case study reflects the demand for a more sustainable electric vehicle (EV) batteries. The objective of this ecosystem is to use blockchain to create battery passports to enable traceability of the EV battery, ease the recycling process, and promote the reuse of critical materials.

EVs are estimated to make up half of all automobiles sold in the US by 2030, according to Bloomberg. However, that rapid growth means we must examine the challenges facing the sector as it continues to evolve and scale. We have identified three significant pain points for EVs and their batteries:

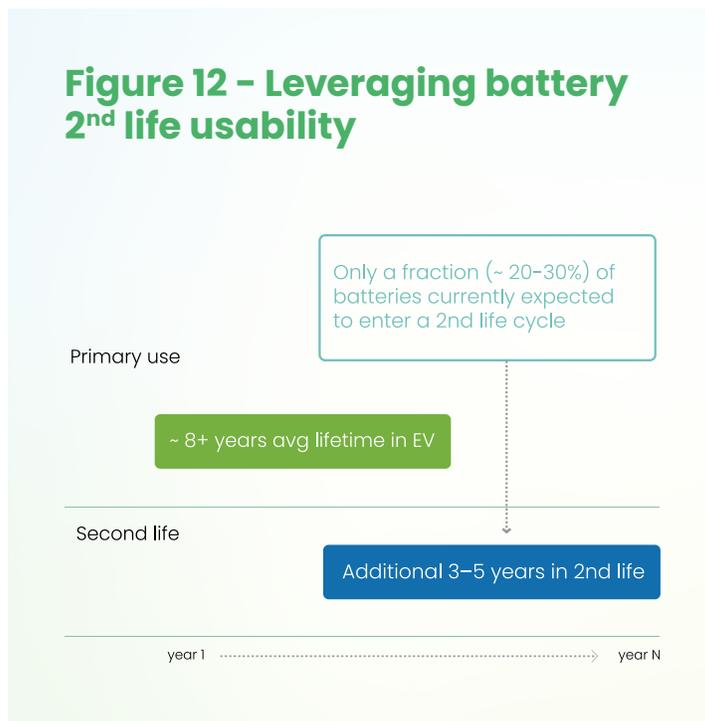
1. High initial carbon footprint for manufacturing EVs
2. Low recycling and second life usage of EV batteries
3. Lack of engagement after initial EV sale

The first pain point – the high carbon footprint of EV manufacturing compared to traditional internal combustion engine vehicles – is the result of resource-heavy production methods. EVs only begin to have a lower carbon footprint when compared to their internal combustion counterparts if they are driven for more than 21,700¹³ kilometres (13,500 miles).

The second pain point derives from a lack of sufficient recycling options for EV batteries. To maximise the sustainability benefits of EVs, batteries need to be used for as long as possible, a major challenge given the batteries' short lifespans for EV use. Current projections indicate **less than a third of EV batteries will enter a second life** when no longer suited for EV use.

Additionally, data from the International Institute for Sustainable Development indicates that less than 5% of lithium batteries are recycled. The combination of the two trends leads to significant resource waste, since battery components are not integrated back into the supply chain. A solution for these problems is made all the more necessary due to a predicted shortage of the precious metals used to construct new EV batteries.

Figure 12 – Leveraging battery 2nd life usability



13. Argonne National Laboratory estimates the breakeven point of a Tesla Model 3 and a Toyota Corolla to be 13,500 miles, considering thousands of parameters from the type of metal in the battery to the amount of plastic in the car itself.



Regarding the third pain point, when an EV is sold on a first- or second-hand market, the communication between the buyer and the manufacturer or seller may be limited or non-existent after the purchase. This is a missed opportunity for information sharing. The EV owner may not fully understand the charging infrastructure available to them or miss important announcements from the manufacturer. Furthermore, there is additional post-purchase support or education that the owners could benefit from, and clear, ongoing communication would improve the overall EV ownership experience.

Governments around the globe are applying regulatory pressure to the original equipment manufacturers (OEMs) of EV batteries and are requiring them to increase the recycled content of batteries. For example, the European Union's battery mandate requires that a certain percentage of a lithium-ion battery's content come from recycled sources. Additionally, governments are providing significant monetary incentives to build-out the EV battery supply chain and set up recycling systems. These trends, taken together, further incentivise the adoption of new solutions.

New regulations around the globe are fuelling an EV surge:

EUROPEAN UNION

The EU will use €127B to develop the battery value chain in Europe, with investment of €382B expected by 2030.¹

1. Source: "Questions and Answers: The European Battery Alliance: progress made and the way forward", European Commission

UNITED STATES

The Inflation Reduction Act (2022) will provide approximately \$370B of energy-related spending, including up to \$20 billion in loans and \$2 billion in grants for new and existing EV facilities.²

2. Source: "The Inflation Reduction Act deal could benefit clean energy, EVs", iShares

CHINA

China's 14th 5-year plan will focus on electric transport and building a complete battery recycling system by 2025.³

3. Source: "China's 14th Five-Year Plan (2021-2025): Spotlight on New Energy Vehicles (NEVs)", Global Policy Watch

To address these challenges and establish a more sustainable and transparent EV market, we propose creating an EV battery management ecosystem. This ecosystem would use blockchain to establish an NFT battery passport to store information about the EV battery, including manufacturing information related to sustainability (e.g., emissions generated), battery specifications, and ownership. The battery passport will be attached to the EV and transferred to the new EV owner if the vehicle is ever sold on the secondary market.

The NFT passport enables verification along multiple stages of an EV battery's lifecycle. Manufacturers can use the NFT passport to track recycled content of batteries to meet regulations, while second-hand buyers can leverage the passport to obtain information about the battery for both second-hand usage of the EV or second life applications for the EV battery itself.

By leveraging Web3 elements such as NFTs and blockchain technology in the EV battery ecosystem to create an NFT passport, we can increase trust and transparency around sustainability in the supply chain and secondary market and promote recycling and reuse of EV batteries to reduce waste and emissions.

NFTs are a critical enabler of information dissemination and interaction in this ecosystem. Through the battery passports, OEMs and EV sellers can communicate with first and second-hand buyers throughout the lifespan of the vehicle.

The volume and complexity of transactions needed to trace the composition and use of EV batteries over their lifespan is substantial. This makes processing performance critical to the success of any EV battery tracing ecosystem. Blockchain plays a foundational role in enabling this type of complex data tracking in a transparent and trustworthy manner. Blockchain will also facilitate interoperability between the multiple actors in the ecosystem through data consolidation and integration of disparate data systems. Lastly, given the increased regulatory oversight of EV battery supply chains, the data security that blockchain can provide is critical for companies seeking to reduce their compliance risk with government mandates.

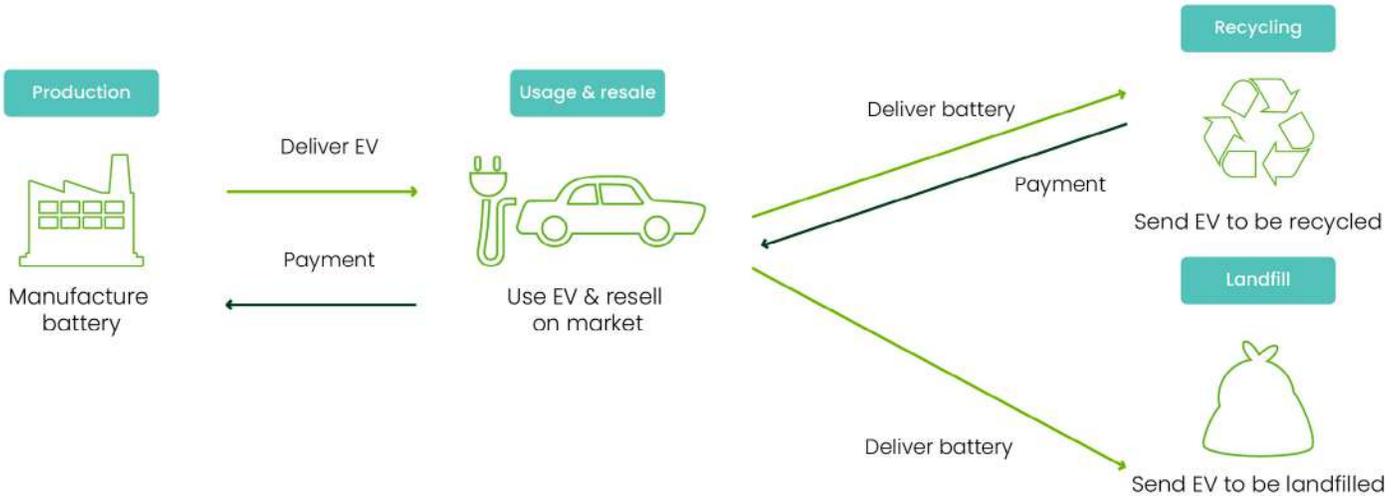
Second life applications for EV batteries

Second life repurposing of EV batteries in pilot stage:

- Storage of solar or wind power
- Backup for smaller power grids or single-family homes
- Power source for smaller vehicles such as forklifts
- Increased power stability and capability by providing power during energy usage peaks



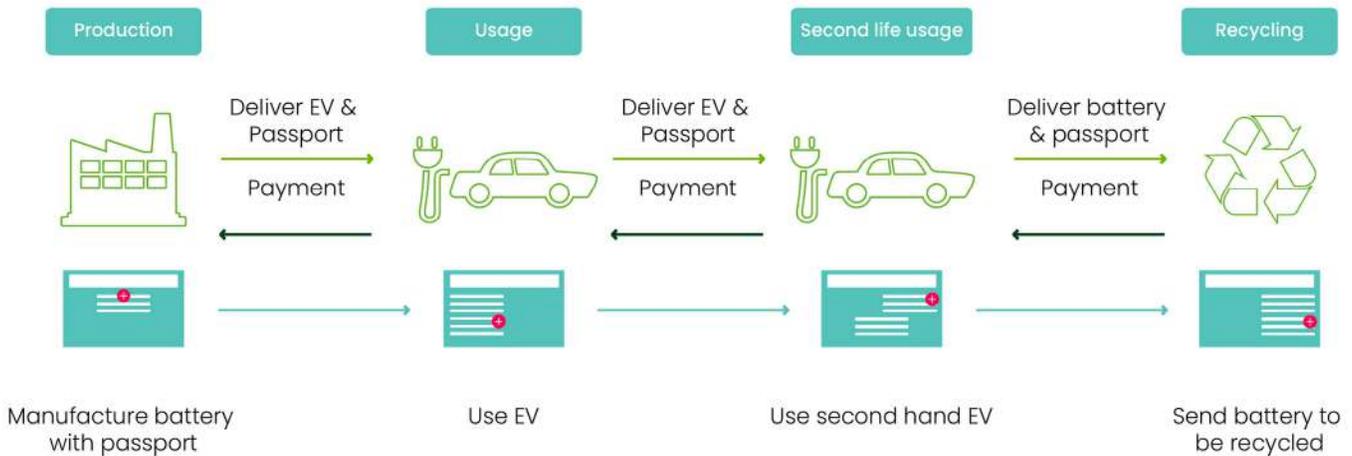
Traditional EV battery lifecycle



In the traditional EV battery lifecycle, there is a lack of credibility regarding sustainability throughout the supply chain. Consumers have little insight into the manufacturing of EVs, including the batteries. Additionally, there is a lack of traceability of the battery after the initial sale of the associated EV, as batteries are then often brought to landfills or recycled.



Improved battery lifecycle management and recycling



Every new action is documented on a Digital Product Passport

In the EV Battery Ecosystem, a battery passport becomes an enabler of sustainability behaviour. The passport collects information throughout the manufacturing process. Second-hand customers, and eventually recycling facilities, can access the EV battery passports to retrieve battery information.



Ecosystem Concept 03

Supply Chain at the Edge (SC@E)

Ultimately, we want enterprises to join vechain in reimagining the world's manufacturing supply chain and logistics industry. **By harnessing the power of 3D printing and combining it with blockchain technology, we can create innovative solutions to address the sustainability and economic needs of the logistics industry.**

To illustrate the potential of this ecosystem, we will focus on the supply chain and logistics industry for automobile spare parts. While this is a well-established industry, there are three significant pain points which cause friction among the different actors:

1. Supply chains as significant contributors to emissions
2. Expensive and lengthy transportation of spare parts from original equipment manufacturers (OEMs) to end users
3. Unused stock leading to waste and working capital losses by the OEMs

The current global supply chain accounts for 8% of global emissions, according to the International Energy Agency. And the magnitude of supply chain and logistics emissions is only projected to grow in the coming decades. The International Transport Forum has predicted that global demand for freight will triple by 2050, driven by economic growth in Africa, Latin America, and Asia. This increase in demand is expected to double emissions from the supply chain sector.

Logistics industry & its pain points

As the logistics industry grows, the existing pain points will only grow more profound across industries.

In the **automotive sector**, there is high demand for repair and maintenance services coupled with unpredictable needs for spare parts.

The **aerospace sector** must grapple with multi-year product development and long lead times for products, rising fuel costs driving up the cost of aeroplane ownership, and low volumes of production.

The **medical sector's** pain points include the need for speedy turnaround times for parts and a requirement of patient-specific components in many therapies



Examples of 3D printing

Legacy companies and institutions are already using industrial 3D printing to reinvent and decarbonize their supply chains. Aboard the amphibious assault ship USS Essex, the U.S. Navy is testing the use of a liquid metal 3D printer to fabricate metal parts – from hand wheels to spanner wrenches – at sea. Volkswagen became the first major automaker to implement 3D printing in their production process when the German carmaker installed a binder jetting machine at their production plant in Wolfsburg in 2021.

In addition to the emissions generated by transporting materials and parts around the globe, transportation also involves an expensive and lengthy logistics process. Many suppliers manufacture goods overseas at facilities which are often thousands of miles away from their final destination. For already manufactured parts, end users must often endure significant wait times when ordering new spare parts due to long-distance shipping and all its potential delays. If inventory levels are low and new parts must be manufactured, buyers may have to wait weeks or months for orders to arrive.

Rather than endure unexpected delays and long delivery times, many OEMs instead stock up on spare parts inventory. However, this is an inefficient and costly solution which leads to a suboptimal use of resources and can result in working capital losses, since OEMs must maintain an overstock. And if parts never sell, they end up as waste.

These pain points make the overall supply chain and logistics industry for spare parts inefficient and environmentally damaging. However, we have devised a solution called Supply Chain at the Edge (SC@E) to address these pain points and reimagine how supply chains will work across the globe.

SC@E functions by replacing traditional manufacturing with blockchain-enhanced 3D printing. A customer will initiate the process by placing a request for a spare part. The request will be sent to the owner of the spare part's intellectual property who will relay a digital blueprint of the part to a 3D printing facility close to the customer. The 3D printing facility will use the digital blueprint to print the part and ship it only a short distance to the customer.

To make the switch to a new logistics process possible, VechainThor will securely facilitate data transfer and intellectual property management. Automobile OEMs can send blueprint files to service bureaus anywhere in the world, and those service bureaus will then print the needed part, all while keeping proprietary data safe and secure.

The SC@E ecosystem will generate three sources of value and yield savings and incentives for participants while also directly addressing the three pain points identified with the traditional ecosystem:

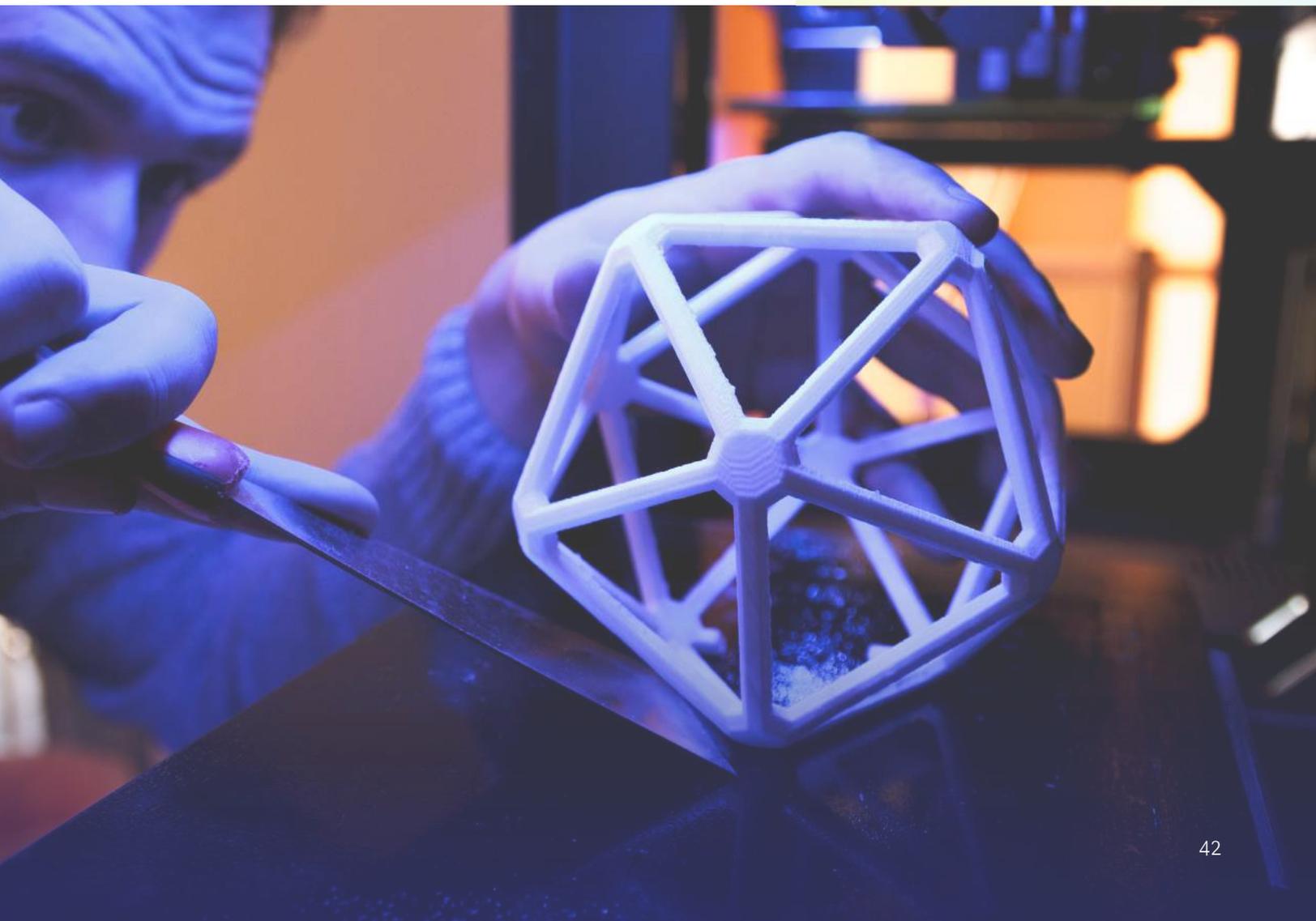
- The first source of value is the emissions savings that results from using blockchain-enabled 3D printing to manufacture physical goods and parts closer to the end customer, rather than shipping parts thousands of miles.
- The second source of value derives from delivery time savings due to the drastically sped up supply chain process in SC@E. 3D printing a part in a local facility takes only 12–24 hours, followed by a quick delivery time, compared to manufacturing overseas and transporting a part for days or weeks to a final customer located in a different country or continent.
- The third source of value stems from additional economic opportunities enabled by faster supply chains. A faster supply chain allows OEMs to reduce their inventory stockpiles since they can rely on just-in-time and on-demand 3D printing to cover any short-term spare parts needs. This reduces OEMs' working capital costs and lets OEMs scale down their inventory warehouses.

Furthermore, a faster supply chain also allows end customers (car dealerships or repair shops in the spare auto parts industry example) to avoid over-purchasing parts to meet potential future demand. Customers can rely on spare parts being delivered quickly to cover any maintenance issues.

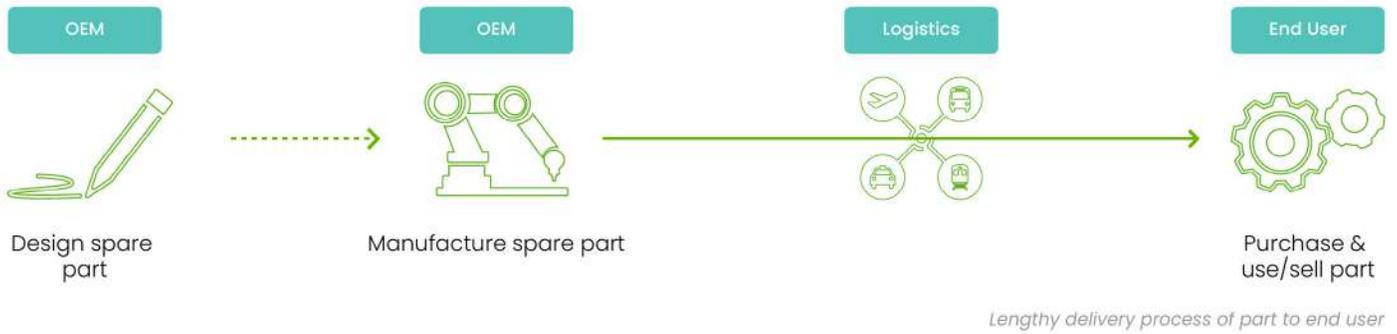
These sources of value will incentivise individuals and firms to participate in the ecosystem. However, the differentiating elements of blockchain are key to facilitating this ecosystem. The complex exchange of highly sensitive blueprints makes blockchain's security features critical to protect intellectual property (IP) rights and maintain transaction integrity. By establishing clear ownership rights and transparent tracking, blockchain enables OEMs to maintain clear control over their IP to prevent fraud and maintain visibility into how the blueprints are being used and by whom. With the technology innovations enabled by Web3, an ecosystem that reimagines how the world's supply chains function could create a new norm for manufacturing in the near future.

Ecosystem economic benefits summary

- **Faster manufacturing of parts** with 3D printing over traditional manufacturing
- **Faster delivery times** for parts, since they are 3D printed close to the location of the end-user
- **Reduced need for spare parts inventory** due to on-demand manufacturing, reducing working capital costs
- **Elimination of tooling costs** associated with subtractive manufacturing such as CNC tools
- Agility to address **unforeseen industrial challenges** that affect physical supply chains



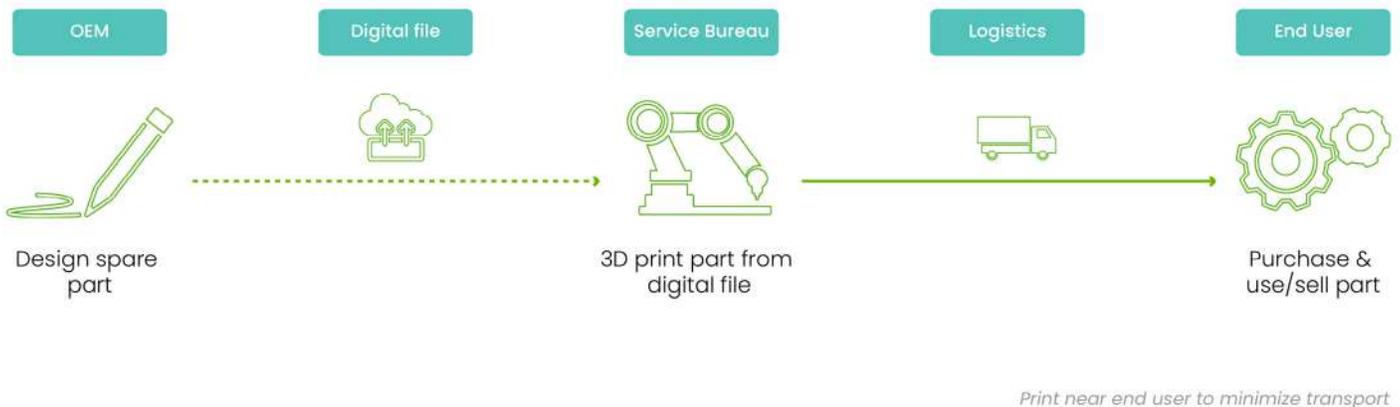
Traditional supply chain



In the current supply chain and logistics industry, OEMs manufacture a spare part far away from the end user. This part may be transported hundreds or thousands of miles to the end user through a variety of transportation methods, generating significant emissions. The whole process can take days or weeks, leading to long lead times in the case of supply chain shocks.



Supply Chain at the Edge



Supply Chain at the Edge is a more versatile and streamlined process in which the OEM is only responsible for designing the parts. When an end user has a request for a part, that part will be printed close to them after the digital file has been sent to a 3D printer via blockchain. The lead time for parts shrinks drastically, as does the emissions related to the product's manufacturing and delivery.

A person with a backpack stands on a grassy bank, looking across a calm lake. The lake reflects the surrounding forested hills and a misty sky. Large green leaves are visible in the foreground, framing the scene. The overall atmosphere is serene and natural.

Ecosystems reflections

In this chapter we examined three examples of how Web3 tools can be used to build ecosystems and how, through collective action, participants can achieve their sustainability objectives and solve pain points. The ecosystems demonstrate that communities can come together and contribute to building solutions to address waste in the fashion industry, enable the recycling and reuse of critical materials in EV batteries and reimagine the world's supply chains. By detailing potential ecosystems, we hope to inspire people, companies, and communities to participate in and build their own ecosystems. As we move towards a more decentralised and inclusive Web3, the power of the individual to shape the world around them and unlock new flows of value will continue to grow.



Engaging the Individual and Building Communities

The power of individuals should never be underestimated. The belief that power should be distributed among the many and not concentrated within a few has been at the core of blockchain's history and development. We believe that every person's efforts count, and every voice matters in the Web3 world. This is especially true when it comes to solving sustainability challenges, and it makes Web3 a conducive environment in which to tackle these issues. Small changes, such as choosing to recycle or resell something rather than throw it away, can have an enormous positive impact when multiplied across an entire population.

Vechain is investing heavily in building an engaged and inviting community that will eventually help solve sustainability and other global challenges. In our early years, we focused on building a solid technological community. We will now extend our efforts to also foster large-scale involvement by enterprises and sustainability-minded individuals. Such virtual communities grow from shared interests and goals across the globe, and we want to extend that bond beyond the screen.

We aim to create spaces for passionate minds to connect, exchange, and ultimately build. Through several international events, we have witnessed the impact of bringing our virtual connections to the field. For instance, our regular events in partnership with UFC¹⁴ (the world's premier mixed martial arts organisation) provide a conducive space to build real life bonds within our existing community. On the sidelines, projects are brainstormed, argued, and built.

In 2022, we attended Nitto ATP Finals¹⁵ (the thrilling final instalment of the ATP tennis tour) with inspiring professionals across industries. This shared experience naturally sparked stimulating exchanges that inspired ideas and collaboration. These interactions build momentum and make projects come to life. We create and foster communities from screens to arenas to connect individuals and ultimately unleash our collective potential. Through these strength-building efforts, we hope to inspire each member of our community to actively imagine, create, and grow the ecosystems they believe in.

For the fair and successful deployment of these ecosystem, we take inspiration from DAOs, which remove barriers to entry and guarantee all members have an equal opportunity to propose improvements and influence decisions. The DAO model allows individuality to shine and efforts to collide.

Beyond democratising the decision-making process and giving power to community members, we believe that DAOs can be powerful tools to connect individuals across the globe, regardless of professional background, age, race, or education level. They can unite people with common values and goals via borderless collaboration and community building and foster a sense of belonging and inclusivity.

14. Ultimate Fighting Championship; trademark owned by Zuffa, LLCs,

15. Season-ending championship of the ATP (Association of Tennis Professionals) Tour; trademark owned by ATP

We envision a community where everyone can participate and make meaningful contributions to initiatives they believe in. By forming DAOs, our community members become active and empowered contributors and owners of their ecosystems and are able to multiply their individual impacts to advance the chosen initiative.

DAOs remain a relatively new concept, yet we believe they could revolutionise human organisations. We are therefore actively exploring their potential to create an inclusive decision-making system. Starting from research and practical applications, vechain aims to study and experiment with this in internal governance (see chap. 8) and broader organisational contexts.

A community brought together in a DAO could set out to achieve multiple goals. For instance, in the second-hand market for fashion ecosystem presented in Chapter 5, participants may gradually shift to focus on a more philanthropic aim: Members can choose which community-focused projects to support, which environmentally and ethically conscious brands to promote, and whom to endorse as social justice advocates. For a member participating in the ecosystem as a seller or buyer, fungible tokens could empower them to vote and propose new plans of action. Establishing

a DAO grants flexibility as the community and their goals mature.

That being said, DAOs may not yet be suitable for every ecosystem due to variations in their size, culture, governance structures, and sustainability needs. DAOs may gradually be considered and established depending on each ecosystem’s overarching goals and governance needs.

To motivate participation, provide a more interactive platform, and enhance community engagement beyond DAOs, we intend to implement incentive mechanisms to reward individuals and developers who are active members of ecosystems. Furthermore, adding more action-based activities can make the ecosystems more interactive, socially engaging, and approachable.

For instance, these activities could include granting active participants access to special events and curated experiences with brand partners, creating new customisation features for community developers, setting up bounty programs to foster a sense of achievement and progression for blockchain users, and awarding prizes to the winners of hackathons hosted by vechain.

Examples of reward mechanisms in the sustainable second life for fashion & luxury ecosystem

DESIRED INDIVIDUAL ENGAGEMENT

Join the second-hand marketplace to promote the circular economy and sustainability in luxury and the fashion industry.

Make frequent purchases in the second-hand marketplace and leave quality reviews on purchased items

Promote frequent interactions among buyers and sellers on the second-hand marketplace, including sharing product stories and answering questions.

REWARD / INCENTIVE RECEIVED

- **Sense of accomplishment:** instant digital NFT badges issued for “Your first listing,” “Your first review,” “Your first sold item,” etc.
- **Sense of ownership:** Rewarding tokens with DAO governance voting rights to repeat buyers who give fashion/luxury items a second life
- **Pleasant surprises:** A mystery box with a discount code for a virtual store in the metaverse sent to buyers who make recurring purchases or submit detailed reviews with pictures
- **Process of co-creation:** Empowerment as an essential marketplace builder through contributions that make the marketplace more reliable and honest

Examples of reward mechanisms in the sustainable second life for fashion & luxury ecosystem (cont.)

DESIRED INDIVIDUAL ENGAGEMENT

Encourage self-authentication of second-hand luxury items by buyers and sellers to promote marketplace credibility and anti-counterfeiting.

Invite others to join and educate them about the meaningful impact of sustainable fashion.

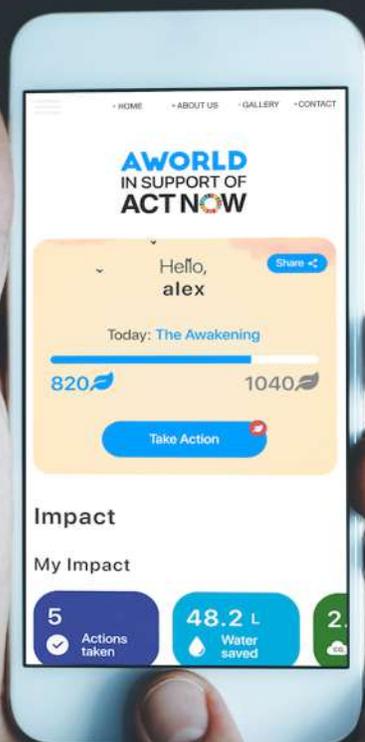
REWARD / INCENTIVE RECEIVED

- **Sense of ownership:** Rewarding tokens with DAO governance voting rights to repeat buyers who give fashion/luxury items a second life
- **Social influence and sense of belonging:** Participation in community channels and access to new connections with those who share a common mission of sustainability and waste reduction
- **Access to invite-only events:** Access to closed-list events (e.g., SDG TED Talk, Web3 conferences), fashion made of recycled material, and other customised options

We plan to further engage with the community, leveraging gamification design and Web3 capabilities (e.g., fungible / non-fungible tokens, or phygital NFTs) to incentivise engagement and enhance user experience.

In a gamified environment, incentives act as a form of behavioural feedback to motivate participation. People are at the centre of game design, as their motivations and needs will shape how the incentives are designed in the game.

For ecosystem enablers/developers, gamification can enhance community engagement, generate deeper insights into consumer behaviour, increase retention, and more. For participants, gamification can promote feelings of belonging, accomplishment, and ownership. Tactics tied to these drivers can effectively alter an individual's behaviour.



What is gamification?

Gamification is the process of incorporating game style mechanics into everyday or non-game activities to drive specific behaviors emphasizing human motivation and increasing actors' engagement. Game design leverages as points, rewards, leader boards, and social gifting, etc. to incentivise specific behavior based on customised needs from different participants.

Tech integration use cases for sustainability and community engagement

Enabled by maturing Web3 technology, we are building a future of true individual ownership and collective accountability. We live in an exciting time where many fast-evolving technologies like IoT, Big Data, and 5G have already begun to scale and allow for phygital integration, with many successful use cases and applications already on the books:

- The State of California has allowed its residents to choose blockchain-based delivery of vital records, including birth certificates and marriage licenses, allowing for faster, cheaper, and more efficient record services.
- The city of Raleigh, North Carolina, uses machine learning and AI-powered video analytics to improve mobility and urban planning. The city has transitioned from employing personnel to manually count cars to analysing traffic patterns in real time through machine-learning software, thus providing policy makers with more accurate traffic data.
- Disney has leveraged IoT and RFID technologies in their Disney MagicBand to allow park visitors to digitally consolidate park tickets, credit cards, and room keys, while also providing for a more personalized guest experience.

Sources:

"New Law Allows Californians to Store Vital Records on Blockchain." Pymnts.com

"Raleigh, North Carolina Taps NVIDIA and Esri for Traffic Management Machine Learning Project." State Scoop

"Disney's Internet of Things MagicBand." IEEE Innovation at Work

"Disney's MagicBand: The Secret Tech Behind the Happiest Place on Earth." Wired, Conde Nast

For example, a journey can be created to increase second-hand buyer engagement with brands, leveraging NFT and token-gated access. The digital product passport (tokenomics design as an NFT) can transfer ownership of a product from seller to buyer in a secure and immutable way, providing additional emotional assurance and an engaging experience for the buyer, to further enhance the sense of ownership. As the buyer collects more product digital passports, they can monitor their status along the journey and be motivated to earn the extra tokens rewarded when a milestone is reached (e.g., their tenth purchase). Token-gating can expand the aperture of gamification across multiple brands, enabling more nuanced hurdles created with a combination of different brands (e.g., partnering brands) to achieve a higher level status. We plan to further explore which incentives best drive engagement for our community members.

Vechain is determined to support and encourage people striving for a better future, and gamification is one tool we can use to drive engagement and participation. We will do this, in part, by adding more engaging features and incentives to our tech platform. The vechain platform and the Blockchain Biosphere for Sustainability will act as a conduit for socially responsible individuals to contribute to and collaborate on far-reaching sustainability goals while enjoying the rewards of their contribution to society.





Vechain Technology Landscape and Roadmap

Update on VechainThor blockchain

Since the inception of vechain in 2015, we have had the pleasure of working with amazing people and organisations who share our passion for blockchain technology and our vision for the future. Our business partners have been incredibly supportive and have demonstrated a serious belief in the potential of our VechainThor blockchain. We have always been committed to supporting ecosystem participants who are striving to solve real world economic problems by enabling the creation of new business models and value chains. Today, we want to go one step further by promoting economic gains alongside sustainable value. Through its energy efficiency, new Proof of Authority mechanism, accessibility, and openness, VechainThor has become the ideal platform to jumpstart sustainability initiatives. Additionally, enterprises and people without cryptocurrencies may also seamlessly use the platform in pursuit of these initiatives through fee delegation and multi-task transactions.

To briefly recap, in Whitepaper 1.0, we discussed the key features for the next generation of public blockchain to enable continual and rapid innovation and onboard businesses and companies. At the time, the focus was on “translating” real-world

products, participants, and business activities onto the blockchain, facilitating opportunities to drive holistic growth and maximize economic benefits.

Then, in vechain Whitepaper 2.0, we outlined our strategy based on the phases we envisioned for blockchain technology. Having already achieved the first stage of technical development, we were preparing to move from a blockchain driven by business needs to a more holistic direction that also considered governing entities and regulators.

This was the first time we introduced our concept of a new and improved Proof-of-Authority (PoA). Generally, PoA is a consensus algorithm that requires nodes to be authorised before they can participate in the blockchain. Once authorised, all nodes have an equal opportunity to create new blocks and earn rewards, without the need to spend vast resources competing against each other. This ensures that richer nodes do not have an unfair advantage over other nodes in the system. Additionally, PoA is efficient in terms of network bandwidth usage, as it quickly selects block producers, allowing more time for transmitting transaction data.

Despite its many advantages over other consensus mechanisms, such as increased security and efficiency, the PoA 1.0 consensus algorithm has some limitations. For instance, it lacks an algorithm-based method to deter a node from manipulating the system. Although PoA ensures that any traced misbehaviour can be used as evidence against the node later, it still doesn't have a mechanism to prevent the misbehaviour from occurring in the first place. Another limitation is that, like other Nakamoto consensus algorithms, PoA only provides probabilistic assurance to the safety of transactions. This means that there is a small probability that an attacker may be able to disrupt the network, and this probability increases in situations such as large-scale network partitioning. This may not be sufficient to maintain system consistency in extremely asynchronous situations where a high level of security is required.

To address the data security ([finality](#)), high throughput, and scalability challenges discussed above, the vechain blockchain development team, in collaboration with researchers and partners within our vechain community, invested significant resources in the design and implementation of PoA 2.0, a protocol-level upgrade to introduce finality as well as additional security mechanisms into VechainThor.

Instead of replacing the PoA consensus with a completely new one, we have chosen to design and implement a finality instrument, named the Finality with One Bit (FOB), which should allow us to run dual modes of consensus, namely, the Nakamoto and BFT consensus, at the same time.



VechainThor provides a sustainable and inclusive infrastructure

VechainThor is one of the most energy efficient blockchains, using just 0.000216 kWh of electricity per transaction (0.04% of other comparable blockchains). The 2022 carbon footprint of vechain's core network of 101 authorities' nodes was calculated to be 4.46 t of CO2 emissions per year. The calculation methodology, developed in collaboration with DNV, is based on Life Cycle Assessment as described in ISO 14040 and ISO 14044.

The unique **Proof of Authority 2.0 mechanism** provides data integrity alongside high scalability. VechainThor relies on just 101 authority nodes to validate and sign blocks on the blockchain, processing transactions and validating blocks in a fraction of the time and with much lower processing power and energy consumption requirements than other blockchains.

Being a public blockchain, VechainThor is highly **accessible** by nature and provides an **open platform** for individuals, developers, companies, and other actors to interact and collaborate. Open-source tools, blockchain-as-a-service, and turnkey solutions are readily available for builders and developers who want to work together hand-in-hand to build the next viral dApp for sustainability. Imagine citizens seamlessly accruing carbon credits through their eco-friendly actions, which they are then able to spend on goods and services in an inclusive economy. VechainThor's unique fee delegation technology empowers these citizens to participate without directly owning or managing crypto, widening the universe of potential users in a sustainability ecosystem.

The PoA 2.0 consensus algorithm has been theorised around two key components as outlined in proposals VIP-214 and VIP-220: a VRF-based source of randomness, and a passive block finality confirmation process. The combination of these two components offers several advantages for the blockchain compared to the previous iteration. First, it guarantees block finality, ensuring that once a block is added to the blockchain, it cannot be modified or reversed. Second, it maintains the usability and robustness of the system by decoupling finality from the PoA process, allowing the blockchain to grow even in adverse environments. Third, it helps reduce the complexity of the current PoA-based system, minimising the potential risks caused by unknown design deficiencies and implementation bugs. Lastly, it adds minimal extra information – just one bit per block – for network communication, so as not to sacrifice system performance to achieve block finality **(for more technical details on VIP-214 & VIP-220, please visit our website vechain.org)**.

The PoA 2.0 consensus mechanism is one of the first in the world to combine the strengths of the two main consensus types, Byzantine Fault Tolerance (BFT) and Nakamoto Consensus, while eliminating the weaknesses of each, solving one of the great trade-offs in blockchain design – scalability or data finality. This upgrade makes blockchain more robust and secure, while maintaining sufficient scalability from PoA 1.0, meeting strict regulatory data-protection standards and answering the call for from real-world clientele for a scalable and secure platform for the digital-sustainability revolution.

Note that this blockchain update is especially crucial to prepare vechain to address global sustainability challenges, as it reaches an optimum balance between speed and security. We will continue to develop more features customised for the Blockchain Biosphere for Sustainability, and we envision vechain becoming the best blockchain for sustainability applications.

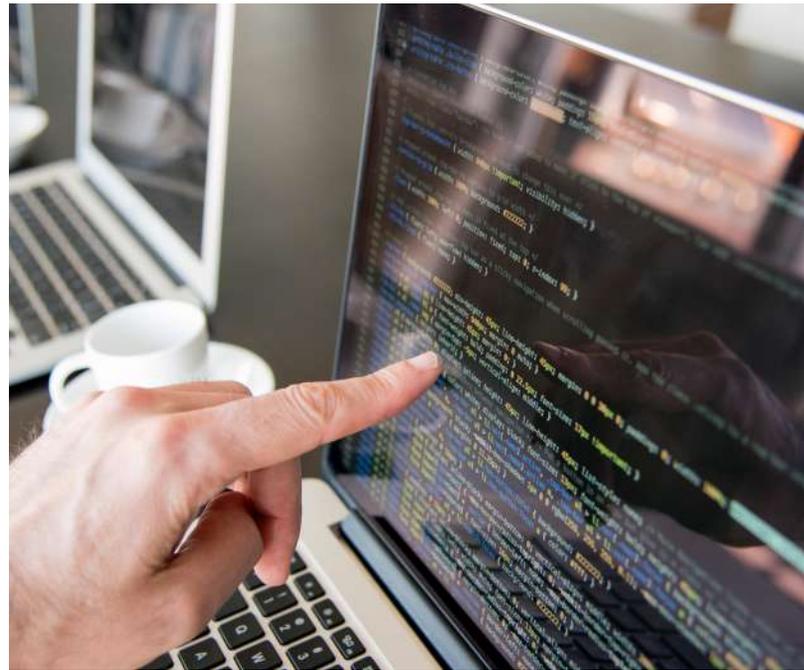


How We Are Building Thriving Collaborations

Vechain aims to address today's sustainability needs by using the untapped potential of communities. Consequently, we are committed to enhancing engagement and collaboration between start-ups, academia, financing partners, and developer communities.

With these goals in mind, we have been building momentum to:

- Engage developers, system integrators, and strategic partners through forums and co-development opportunities
- Promote research & innovation through university partnerships, research grants, and accelerator programs for start-ups



Engaging Developers, System Integrators, and Strategic Partners

At vechain, we recognise that independent developers are the lifeblood of our platform and our future ecosystems. Without them, we wouldn't have the diversity of perspectives and talent required to become the blockchain solution of choice for so many enterprise applications.

Developers who build in the vechain universe have ready access to a variety of resources for coding, testing, and implementation. Whether they are using the official Telegram channel for developers or accessing FAQs and tutorials or sample code, creators enjoy an array of support materials in their journey to improve existing applications or launch new ones.

Among the tools that developers can use to create, test, and release dApps within the vechain community are a Connex library, a Web3 adaptor, standard openZeppelin smart contract libraries, Web3-as-services, a dApp interface, various wallets and mobile SDKs, and a testnet.

The Web3 universe already supports upwards of 100 dApps, including NFTs, DeFi projects and games. And vechain will continue to incentivise developers and groups to build in the community through hackathons, bug bounties, grants, and accelerator programs.

Our investments in people and technology reflect our commitment to developers. We have also worked with VechainStats to improve the functionality of the blockchain explorer and user experience during exploration of blockchain data. Additionally, we developed Connex so that developers could easily use vechain's core unique features. The Web3 adaptor enables developers familiar with Web3 libraries to build their dApps on VechainThor. The vechain community has built additional tools, such as an Ethereum NFT bridge via xp.network as well as several NFT marketplaces, and wallets. Moreover, Vechain.energy is building a fee delegation service. We will continue working with the community to enhance our tech offerings.

And these developments and innovations are just the beginning.

This year, we are on track to hire even more developers dedicated to improving the VechainThor platform. Some imminent plans include:

- Our Web3-as-a-service portal VORJ
- A smart contract development frameworks integration
- Vechain managed and sponsored DEX/Defi protocols
- An Ethereum token bridge
- DID implementation
- A DNS naming system for vechain
- A DAO development framework.



VORJ to attract new developers

VORJ, our Web3-as-a-service offering, will democratise the Internet and give ownership back to users through sustainable technologies. We envision VORJ as a Web2-based portal to cater to the most demanding Web3 needs. Here, users can create, mint, and manage VechainThor-based fungible and non-fungible tokens all in one place. They can also access smart contract templates as well as a smart contract wizard and deployer to quickly implement and deploy smart contracts. We anticipate a free, rate-limited version of VORJ will be available to vechain community members by mid-2023. We are already providing an API-only version for enterprises and community projects.

We also plan to introduce a carbon footprint explorer on VechainStats, launch a community driven, vechain managed and sponsored NFT marketplace for sustainability, and release a wallet (browser extension and mobile) for ecosystems.

Currently, we are dedicating significant resources to improving developer tools and interconnectivity. To make development easier, we are working hard to establish contract development framework integration, a contract development IDE, and a smart contract library, such as OpenZeppelin. Furthermore, we plan to develop oracles to link with real-world data and bridges to link with other leading blockchains.

In addition to building a platform and tools to empower builders, vechain further connects blockchain technologies and the real world by co-developing applications with enterprise partners and other tech partners.

We have a strong track record with established enterprises, including big box retailers, premier automotive companies and more, allowing us to

leverage vechain's technology across multiple industries. A wide variety of applications have already been enabled by VechainThor (one example is an automotive company's platform for keeping vehicles free from forgery). These applications have demonstrated the business value of vechain's technology.

Vechain has also built strategic alliances with major tech partners and consulting firms. These partnerships extend the platform across various use cases, test modularity, and supercharge adoption. For instance, AirTrace has built an innovative, low-code digital service platform integrated with vechain solutions, which their clients can use to implement traceability in industrial processes and to ensure secure and reliable data and automated reporting. Our long-term partnerships have yielded a wide range of applications across consumer products healthcare, sustainability, and more. A recent partnership with a smart fingerprint technology company will generate solutions that integrate blockchain with scanning technologies.



Typically, we join forces with enterprises and businesses who invest in research and development of blockchain technologies. Together, we drive quick blockchain and Web3 adoption in the business world by closing the gap between business needs and technological offerings and progressively testing and learning through real world use cases.

Promoting Research & Innovation

At vechain, we understand the significance of continued research and innovation efforts for collectively enabling Web3 advancement.

Through our global grant, veResearch, we aim to support academic research on blockchain-related advancements. Since its launch, veResearch has been a major driving force behind blockchain-related progress, collaborating with leading global research bodies and co-developing new technologies with a specific focus on sustainability.

Vechain and the Mathematical Institute at the University of Oxford have been working together as close partners. Recently, we jointly wrote a technical paper on blockchain consensus protocols. The paper was accepted and published by the Association for Computing Machinery (ACM) in 2021. Ongoing research activities focus on building mathematical models for tokenomics and incentivisation, with the purpose of making ecosystem compensation more balanced and sustainable. Broadly speaking, each contributor in an ecosystem brings a different skillset to the ecosystem, yet they also receive different benefits in return. Such compensations may impact the scale and quality of actors who participate to our ecosystem, and ultimately to its scale of impact. Studying the dynamics and nuances of these incentives or compensations is instrumental in the successful growth of ecosystems and therefore of our contribution to sustainability goals.

Likewise, vechain has a partnership with the National University of Singapore. Our latest discussion with the Department of Mechanical and Energy Engineering at NUS focused on potential use cases and collaborations with blockchain protocols for Smart Materials. The research focuses on the development of innovative intelligent materials for a cleaner, sustainable future. It aims to mitigate the challenges of sustainable energy through the creation and application of functional intelligent materials. Such materials will potentially provide alternatives in extracting additional energy from the environment, revolutionising energy production and control processes, battery technology, catalysis processes, machine-human interfaces, artificial organs and tissues, and smart membranes, among other applications.

Finally, vechain's partnership with the Crypto-Fintech Lab at the Hong Kong University of Science and Technology (HKUST) has also advanced thinking on Web3 and blockchain technologies. This work has helped to improve education about the subjects. It has also incubated innovative student projects for vechain's ecosystem and has helped them to identify and conduct research on technologies that support Web3.



How we build technology to support our sustainability mission: an example

NFT-related technologies will be developed incrementally – enabling different features along the way – to target specific sustainability needs. Firstly, we aim to leverage this technology to create digital product passports, linking an NFT to a single physical product to showcase different product characteristics (for instance, proof of the emissions generated by manufacturing it). The NFT will also link the product to carbon credits purchased to offset the previously mentioned emissions. Then, we will go a step further by transforming physical products into phygital ones, enabling the showcasing of product features in digital environments (e.g., in the metaverse).

Across the board, the research led and supported by vechain has helped unlock the potential of Web3 and accelerate enterprise adoption by speeding up the development of technological enablers, including blockchain consensus, token economics, cryptocurrency market predictions, smart contract security, blockchain-based ecosystem design and more. We see a direct line between advances in research and innovation and new, practical uses of Web3 and blockchain technologies in the pursuit of a more sustainable society.

Technology Roadmap

Our technology development serves a central mission: becoming the platform of choice for sustainability. The way we choose which technological features to develop and how to customise and prioritise them over time is based on this mission.

In Q1 2023, we are laser focused on improving support for developers. We are adding libraries, developers' frameworks, Web3 connectors, Web3-as-a-service infrastructure, and a browser extension wallet. These tools will make it easier for developers to work with our technology platform and build exciting new ecosystem solutions on top of it.

Our goal is to empower developers and make their jobs easier. We believe this precious community can deliver more and more robust and feature-rich applications, which are crucial for future growth. By providing developers with the right tools and resources, we can foster innovation and creativity. The developers working on our platform today are building the future; the more developers who participate, the greater the sustainability impact we can make.

Our second phase, in Q2 2023, will focus on improving engagement and the experience for end users. We will be releasing a mobile version of our new wallet and standing up a user portal. This portal will be a resource for both businesses and the broader community, enabling them to interact with vechain's offerings and applications.

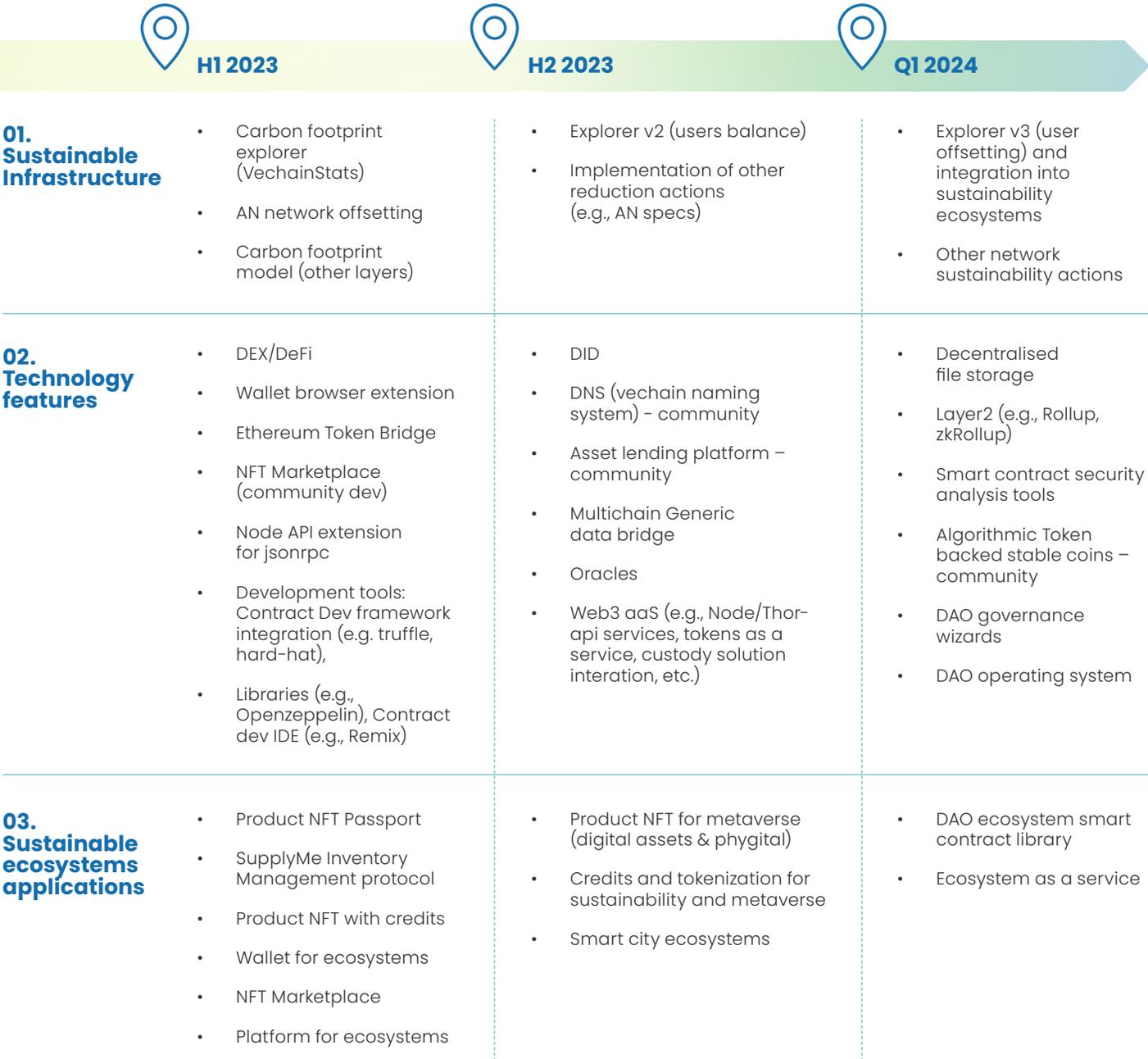
The third phase will encompass both Q3 and Q4 of 2023. This phase will focus on the interoperability of VechainThor with other blockchains as well as the addition of foundation backed DeFi protocols and NFT marketplaces. These advances will enhance the experience for developers and create more opportunities for users.

Finally, in 2024 we will continue to make further interoperability enhancements and also focus on integration with Web2 systems. We will provide frameworks and wizards to help the community build DAOs focused on sustainability.

Overall, this technology roadmap will help us achieve our goal of becoming the platform of choice for sustainability ecosystems and encouraging mass adoption. Additionally, by continuously gathering feedback from users and considering their needs, the infrastructure tools can be refined and adapted to meet the changing demands of the market. This approach ensures that the development process remains dynamic and responsive, leading to continued growth and success.

In Figure 12, we have outlined a technology roadmap of the tools and capabilities we will focus on in the upcoming phases of our journey.

Figure 13 – Vechain tech roadmap 2023



08



Vechain Governance

It is our belief that the scalability issues associated with blockchain adoption are not only related to technical limitations, but also to governance-related consensus concerns. Vechain plans to improve its governance model to enable rapid innovation and development while also complying with regulators, meeting the needs of our users, community, and fast-growing enterprises, and serving sustainability needs.

Unconventional governance models, including DAOs and the experimental voting mechanisms their structures enable, are already being adopted in various fields and are constantly updated as part of a natural evolution of the technology. By implementing DAO principles, our goal is to progressively decentralise platforms, reducing the need for intermediation and making ecosystems more efficient.

In whitepaper 2.0 we argued that for blockchain solutions to reach mass adoption, the governance model must be efficient, cost-effective, transparent, and also balance the views of all blockchain stakeholders. Vechain is more than just a blockchain platform, and the governance structure of our organisation is being carefully designed to be adaptable and efficient, with oversight provided by the Steering Committee, which is elected publicly by nodeholders.

Most importantly, our approach is based on nonstop improvement and iteration as technology advances and ecosystems mature. We will continue to evolve our governance model to better align with our sustainability and Web3 aspirations, including exploring new governance guidelines such as a DAO infrastructure. We will share progress updates on an ongoing basis.

Here at vechain, we want to not just talk the talk, but also walk the walk, which is why our final focus will be on governance and operations best practices to support and enable our partners, sponsors, developers, and users. We believe that having a well-defined, efficient, and effective internal governance and decision-making process at vechain will set an example for the DAOs and governance structures that will arise in ecosystems within the Biosphere. Indeed, by meeting the expected standards and performance guidelines we have set for ourselves, we will help demonstrate to the world just how dedicated we are to the Biosphere and its long-term viability.

Vechain is not just building a sustainable platform, but also a public blockchain that is actively developing and implementing applications that promote sustainability and generate tangible economic value. As we continue to work on the various projects, tools, and technologies in the developmental pipeline, we aim to bridge the gap between Web3 and the real economy.

The Steering Committee's election process helps to promote member diversity, enabling us to benefit from their varied perspectives and expertise. The most recent election was carried out in February 2023; all nodeholders were granted voting rights and were encouraged to actively participate and help shape the future of our organisation. The establishment of a Steering Committee constitutes the first step towards decentralisation. Moving forward, the decision-making process will devolve from the committee to become ever more distributed between Biosphere participants.



The ongoing changes are not limited to the Steering Committee. Since the publication of whitepaper 2.0, vechain has been enhancing its team and driving collaboration with our partners and the community at large. With the objective to evolve as a sustainable organisation, we focus on four key areas:

- 1. Tech development:** We have expanded our teams to support the blockchain upgrade (e.g., the PoA 2.0 update) and build platform infrastructure (e.g., implementing the tech roadmap). Our technology roadmap aims at transforming vechain into the best layer 1 option for sustainability, through the development of specific features that simplify enterprise and user adoption. We select and prioritise our initiatives with the goal of inspiring more developers to build infrastructure tools and services with us. As a result, our tech development is continuously shaped by our community's input.
- 2. Business development:** We built up dedicated teams to closely monitor sustainability trends and the evolution of new technologies. These teams support sustainability transitions and the development of new sustainability initiatives by enterprises and developers and help us steadily upgrade our strategy and support our mission. Additionally, we regularly engage with advisors, consultants and system integrators to illustrate how vechain's infrastructure (VechainThor) and governance can inspire and support them in building solutions to address their clients' sustainability needs.

- 3. Community engagement:** The vechain community has always been a crucial part of our development, and we are expanding the engagement team to build new communities centred around sustainability. In our understanding of Web3's potential, every individual counts and becomes a builder. Over the years, we have witnessed the power of the community through the infrastructure and tools we provide, and we plan on continuing to build momentum for and with our supportive community.
- 4. Internal governance:** Our People, Finance and Legal functions have also been expanded to better support the growing team in vechain. We continue to be one of the most open and transparent public blockchains, and we release our financial report quarterly. We also continue to closely monitor the development of blockchain policies and other relevant regulations, such as data protection codes, and make sure that vechain is fully compliant with them. Staying true to our ambitions in the field of sustainability, we will take the necessary measures to carry out sustainable practices and uphold our values internally. Evolving towards sustainable governance is imperative to our mission.

Moving forward, the organisation will continue to evolve to serve a nascent global sustainability community; we will take inspiration from the best practices of DAOs to build organisational structures customised specifically for vechain. More details will follow soon.



09

What's Next for vechain?

We set on our journey in 2015 with a mission to pioneer real-world blockchain applications across the globe. In our first years, we strengthened our nascent technological offering with the aid of an ever-growing community of developers and partners. We soon turned our attention to the widespread obstacles – such as difficulty in sharing information safely or a lack of trust and auditability in transactions – which hindered collaboration and value creation potential across several industries.

Indeed, even in an era of increasing consumer engagement, we still saw a struggle on the part of both enterprises and organisations to catalyse the potential power of communities. Over the years, we engaged major companies and public organisations in a discussion on how Web3 solutions could help resolve these collaboration pain points and foster value creation. As discussed at length already in this document, in the year 2023 no Web3 system would be complete without accounting for a broader meaning of value and what people working together in complex ecosystems can accomplish for society, humanity, and our planet.

This embrace of Web3 enabled sustainability is not a reinvention of vechain, but rather the natural next step in our journey. We've been building up to this moment for a long time, improving our governance model, developing and refining infrastructure, tools, use cases, and applications, and demonstrating our ongoing efforts to leverage vechain's technologies for good. We know the vision of a more sustainable world, collaboratively built by communities and enabled by Web3 and blockchain is a grand one. It's not something that can be achieved overnight. Yet, vechain has concrete plans to reach critical scale, power breakthrough achievements, and making this future real.

Creating a successful ecosystem won't happen without an active push and deep investment in terms of time, energy, and resources. First and foremost, we will need more **strategic technology partners to build out the Biosphere's platform infrastructure**. In the past we have connected with innovation leaders in complementary technologies to, for example, co-create blockchain-guaranteed tagging and tracing solutions for consumer or luxury items. Going forward, it is critical that we leverage the great work of our developers to add features to a blockchain that must have the inherent capability to interoperate with technologies such as IoT, 5G, 6G, edge computing or AI/ML.

We are actively seeking out technology partners who will combine their capabilities with ours for varied sustainability missions, such as: tracking the lifecycle of an EV battery via NFT, tagging biogas and green hydrogen to certify their origin, and sharing a person's biometric information on a secure blockchain to create a globally recognised humanitarian passport. All of these sustainability-minded use cases have Web3 technology in common, but they also require very different data collection and tagging technologies. Ensuring the flexibility of VechainThor, our layer 1 blockchain, and the collaboration of the correct partners is crucial for each ecosystem.

Tech partners and developers are clearly not the only collaborators we need to strengthen our Biosphere technological layer. Ultimately, our vision will be confirmed by real world applications and successes. To put this vision into action, we'll need key opinion leaders – users and enterprises who attract attention for their sustainability efforts – and key strategic partners to all come together as enthusiastic supporters and promoters. We have been growing our network of partners since vechain's early days, but now we must put even more focus on it. We must secure **lighthouse enterprise partnerships** to quickly generate awareness and build recognition, requirements for the mainstream adoption of our vision so far.

The primary benefits of these lighthouse enterprise partnerships are:

- Giving valuable feedback on the platform infrastructure or how an ecosystem is set up and operated
- Providing strategic collaborations which can help vechain grow and scale the Biosphere or a specific ecosystem
- Serving as influential testimonials for the Blockchain Biosphere for Sustainability or its ecosystems

Launching and establishing the first ecosystems and progressively building **the Blockchain Biosphere for Sustainability must be a priority** in the near future. We will require engagement and participation from all players in the ecosystems to support the **development of the minimum viable product and pilot project**. We've already been the platform provider helping companies create pilot applications for blockchain in the real world. Now, conceptualising the Biosphere, we want to coordinate and enable something even grander. We must identify players who can fit into the roles required for each sustainability ecosystem to operate and understand the correct incentives for all stakeholders to participate. Our differentiated underlying technologies and a portfolio of real-world applications (co-developed through enterprise partnerships) will springboard vechain to become an enabler of Web3 and empower people and communities to drive positive change.

Attracting companies, investors, governments, and the general public into the Biosphere will require a **focus on educating the market** about our enhanced concept of value which incorporates environmental and societal value. From the very beginning, our vision has incorporated an element of outreach to our audience, including tech partners, enterprises, and regulators. We are used to opening paths in unexplored fields, and we understand that with awareness of the use of Web3 to support sustainability still low, we have yet another uphill climb. But with the right combination of marketing and communications – such as case studies, webinars, blog posts, social media campaigns, marketing partnerships, or even additional whitepapers – we can galvanise the first wave of Web3 owners who understand that blockchain-enabled protocols are crucial to empowering collective action to solve sustainability issues.

Our goal is to both introduce a new definition of the concept of value and demonstrate that blockchain can enable and support many sustainability opportunities and ecosystems.

We are eager to embark with our partners on the next phase of creating the premier destination for Web3 sustainability solutions.





10

Conclusion

Web3 technology can provide the critical infrastructure needed to multiply individual impacts and unleash our collective sustainable potential. With Web3, we can collaborate to solve some of the biggest sustainability issues of our time – from climate change and emissions to food insecurity and unethical labour practices.

Vechain proposes the development of a Biosphere of interconnected ecosystems that will allow individuals, enterprises, and governments to all play an active and collaborative role in overcoming specific obstacles, whether that's allowing consumers to resell unwanted articles of clothing or fashion accessories rather than throwing them away or developing systems to promote recycling of EV batteries.

Those ecosystems will provide the foundation for developing collaborative systems of action that incentivise communities of people to commit to and achieve key sustainability goals. This interconnected network, powered by blockchain, will give individuals the tools to seamlessly participate in any ecosystem – or even grow their own.

The promise of Web3 technology is its ability to distribute power among the many instead of concentrating it among the few. With ecosystem governance under the direction of the community – enabled by DAOs – inclusive decision-making will become the global norm instead of the occasional exception.

Through our promotion of continuous research and innovation, in partnership with academic institutions, developers, and strategic partners, vechain will work to advance Web3 and blockchain technology to power practical and efficient solutions for real-world challenges. With new governance and economic models that will allow for smooth and scalable adoption of blockchain and its integration with other key technologies such as IoT and AI, we envision mainstream embrace of our Biosphere model. This will lead to a new era of building communities of action globally and establishing accountability for individuals, governments, and enterprises as they seek to build a more sustainable world.

A sustainable future for all is just ahead, and vechain aims to leverage blockchain for our better world.

Appendix

Appendix 1: Sustainability needs according to SASB

The five dimensions identified are based on the Sustainability Accounting Standards Board's (SASB) taxonomy:



Environment: impacts on the environment, either through the use of non-renewable, natural resources as inputs to the factors of production (e.g., water, minerals, ecosystems, and biodiversity) or through harmful releases into the environment (such as air, land, and water), which may negatively affect natural resources.



Social conditions: the perceived role of business in society, or the expectation that a business will contribute to society in return for a social license to operate. This addresses the management of relationships with key outside parties, such as customers, local communities, the public, and the government. It includes issues related to human rights, protection of vulnerable groups, local economic development, access to and quality of products and services, affordability, responsible business practices in marketing, and customer privacy.



Labour conditions: the management of a company's human resources (employees and individual contractors). It includes issues such as employee engagement, diversity, and incentives and compensation, as well as the attraction and retention of employees in highly competitive or constrained markets for specific talent, skills, or education. It also addresses working conditions and the management of labour relations in industries that rely on economies of scale and compete on the price of products and services, and in industries with legacy pension liabilities. Finally, it includes the management of the health and safety of employees and the ability to create a culture of safety in companies operating in dangerous working environments.



Business model and innovation: the integration of environmental, human, and social issues in a company's value-creation process, including resource recovery and other innovations in the production process, as well as in product innovation, including efficiency and responsibility in the design, use phase, and disposal of products. It also includes management of environmental and social impacts on tangible and financial assets – either a company's own or those that it manages as the fiduciary for others.



Leadership and governance: the management of issues that are inherent to the business model or common practice in one industry and that are in potential conflict with the interests of broader stakeholder groups (e.g., government, community, customers, and employees). This includes regulatory compliance, and regulatory and political influence. It also includes risk management, safety management, conflicts of interest, anti-competitive behaviour, and corruption and bribery.

Appendix 2:

What is a materiality map?

Firms use Materiality Maps to disclose the sustainability needs they consider most relevant based on two dimensions:

- 1. Relevance of the need to long-term business success
- 2. Importance of the need to stakeholders like investors, governments, and consumers

Figure 14 – Materiality Maps



Appendix 3: How was the sustainability Topic Matrix built?

We built the Sustainability Topic Matrix through the following process:

1. A comparable group of relevant companies was selected for each sector.
2. The material sustainability needs were identified for each company, based on firms' Materiality Maps, and then aligned terminology to our taxonomy based on SASB definitions.
3. A consolidated Materiality Map was built for each sector as an average of materiality maps from individual firms within a sector.
4. The consolidated Materiality Maps from all sectors were integrated into an overall Sustainability Topics Matrix showing one sector per line and one sustainability need per column.

The matrix also reflects interviews with multiple industry and Climate & Sustainability experts, which helped us consider the future evolution of sustainability needs to ensure comparability across different industry sectors.



Glossary

Glossary of Terms

3DP – 3D printing OR 3D printer

Agile – A philosophy of software development characterised by early and continuous iteration and delivery of software.

AI – Artificial intelligence – the ability of a computer or machine to conduct tasks that typically require human intelligence, like learning, problem solving, decision-making, and language comprehension

API – Application programming interface – a set of rules and protocols that lay out how two software systems should interact and communicate with each other

AR – Augmented reality – the enhancement of the real world with digital information and data, such as visual and audio content.

EV – Electric Vehicle

Big Data – The management of extremely large datasets that are often difficult to process using traditional software and database technology.

Bridge – A software that allows users to exchange digital assets from one blockchain to another without using a centralised exchange.

Carbon footprint – A measure of the total greenhouse gas (GHG) emissions caused by a person, company, organisation, event, good, or service.

CNC – Computer numerical control – a technology that uses computers to control the operation of 3D printers.

DAO – Decentralised autonomous organisation – a type of organisation that is controlled by members, transparent, and not influenced by a central government.

dApps – Decentralised application – decentralised applications built on top of blockchain using smart contracts.

DeFi – Decentralised finance – a type of financial system that is built atop decentralised networks such as blockchain and is designed to be open and accessible to anyone.

Ecosystem – A structure enabling a set of partners to actively cooperate by pursuing a common objective and creating common value using tokens to exchange value across participants.

Externality – An economics term for a consequence of a transaction that is experienced by a third party and not reflected in the market price of the good or service being exchanged.

Fiat – Currency issued by a government, backed by the faith and credit of the government, and not by a commodity such as gold or silver.

GHG – Greenhouse gas – a type of gas that traps heat in the Earth's atmosphere and contributes to the greenhouse effect and climate change.

IDE – Integrated development environment – a software application that provides a range of tools and features to help developers write, edit, and debug code.

Information asymmetry – A situation where one party in a transaction has more information or better information than the other party, leading to imbalances of power and market inefficiencies.

IoT – Internet of Things – the interconnected network of physical devices and objects that are equipped with sensors, software, and network connectivity, allowing them to collect and exchange data.

Layer 1 blockchain – The base infrastructure of blockchain.

Materiality – The high demand and significance for a sustainability solution

ML – Machine learning – a class of artificial intelligence that allows computers to learn and improve their performance without being explicitly programmed.

NFT – Non-fungible token – an asset or commodity which is not interchangeable; NFTs are designed to be special or unique.

NGO – Non-governmental organisation – an organisation that is formed and operates independently of any government and whose objective is typically to address a social or political issue.

OEM – Original equipment manufacturer.

Phygital – The integration of the physical and the digital world, referring to how technology is used to blur the line between the physical and digital and creating hybrid experiences.

Platform infrastructure – The foundation of the Biosphere encompassing the technology platform as well as the operating and support capabilities layers.

PoA – Proof of Authority – a consensus model with a small number of pre-approved verifiers. It consumes very little energy.

PoW – Proof of work – a consensus model, used by blockchains such as Bitcoin, designed to solve the problem of “double spending” and ensure that all transactions are valid. Mining computers randomly guess numbers to solve a cryptographic puzzle, where the winner receives a significant block reward. In Bitcoin, it takes an average of 10 minutes for miners to find the winning answer.

SASB – Sustainability Accounting Standards Board – a non-profit organisation that develops and maintains financial reporting sustainability standards for publicly listed enterprises in the United States.

SC@E – Supply Chain at the Edge.

SDGs – Sustainable development goals – a set of 17 global goals adopted by the United Nations in 2015 as part of the 2030 Agenda for Sustainable Development, which involve a universal call to action to end poverty, protect the environment, and ensure people have the opportunity to live peaceful, healthy, and prosperous lives.

SDK – Software development kit – a set of tools and resources that allow developers to create software applications for a specific platform.

Service bureau – Business that owns and operates 3D printers and 3D prints parts.

Smart contract – A decentralised application built on top of blockchain, which will automatically enforce contract parameters: If event A happens, then transaction B is executed.

Sustainability topics matrix – A matrix that maps materiality for sustainability topics across various industry sectors to organise and prioritise sustainability needs.

Testing centre – A business that validates 3D printed parts for quality assurance; could be same as service bureau.

Token – A unit of value of a blockchain-based ecosystem that enables different actors to interact with one other, carry-out transactions, or transfer value; each fungible token, or fraction of a token, is equivalent to the next.

Tokenomics – The application of economic principles and game theory to design the tokens on a blockchain to ensure desired incentives and behaviours from users and that tokens are effective and efficient.

VechainStats – Blockchain network analytics for the VechainThor blockchain.

VechainThor – Vechain Foundation's blockchain technology.

VET – Native vechain token.

VIP – Vechain Improvement Proposal. It is a design document providing information or describing a new feature. VIPs contain ideas from developers and communities to improve the VechainThor blockchain.

VR – Virtual reality – the computer-created simulation of a 3D environment that can be interacted with in a seemingly real way by a user with specialized equipment.

VTHO – Native vechain token used to pay for transaction gas fees.

Wallet – A software application that allows users to send and receive digital currencies and assets by storing private and public keys and interacting with various blockchains.



Figures

Table of Figures

Figure 01 - Vechain timeline	6
Figure 02 - Core ideas for vechain today	8
Figure 03 - Journey from Web 1.0 to Web 3.0	9
Figure 04 - Vechain aspiration journey	10
Figure 05 - Sustainability Topics Matrix	13
Figure 06 - Collaboration systems	15
Figure 07 - Obstacles to Collective Sustainability Action	17
Figure 08 - The Blockchain Biosphere for sustainability	20
Figure 09 - Purposes and Roles in an Ecosystem	24
Figure 10 - A new concept of value	27
Figure 11 - Consumer Sentiment	34
Figure 12 - Leveraging battery 2nd life usability	36
Figure 13 - Vechain tech roadmap 2023	56
Figure 14 - Materiality Maps	63

Works

Works Cited



1. "AM4 Speedfactory." BlueBite <https://www.bluebite.com/case-studies/am4-speedfactory>.
2. "Analysis: When Do Electric Vehicles Become Cleaner Than Gasoline Cars?" Reuters, https://environment.ec.europa.eu/topics/waste-and-recycling/batteries_en.
3. "Batteries" European Commission, https://environment.ec.europa.eu/topics/waste-and-recycling/batteries_en.
4. "Battery Reuse & Recycling Expand to Scale in China," Electrive, <https://www.electrive.com/2020/11/24/battery-reuse-recycling-expand-to-scale-in-china/>.
5. "Burberry puts digital interaction into clothes." Digiday, <https://digiday.com/marketing/burberry-puts-digital-interaction-into-clothes/>.
6. Ashwin Kaja, Sean Stein. "China's 14th Five-Year Plan (2021-2025): Spotlight on New Energy Vehicles (Nevs)." Global Policy Watch, <https://www.globalpolicywatch.com/2021/06/chinas-14th-five-year-plan-2021-2025-spotlight-on-new-energy-vehicles-nevs/>.
7. "Conceptual Framework." SASB, www.sasb.org/standards/conceptual-framework/.
8. "Disney's Internet of Things MagicBand." IEEE Innovation at Work, <https://innovationatwork.ieee.org/disney-internet-of-things-magicband/>.
9. "Disney's MagicBand: The Secret Tech Behind the Happiest Place on Earth." Wired, Conde Nast, www.wired.com/2015/03/disney-magicband/.
10. "Draper University Partners with vechain to Train Web 3 Founders." CoinDesk, <https://www.coindesk.com/business/2022/03/22/draper-university-partners-with-vechain-to-train-web-3-founders/>.
11. "Electric and hybrid vehicles: the future of the car industry?" European Parliament Research Service, [https://www.europarl.europa.eu/RegData/etudes/ATAG/2022/729285/EPRS_ATA\(2022\)729285_EN.pdf](https://www.europarl.europa.eu/RegData/etudes/ATAG/2022/729285/EPRS_ATA(2022)729285_EN.pdf).
12. "European Commission. "Biodiversity" European Commission, European Union, https://ec.europa.eu/environment/nature/biodiversity/intro/index_en.htm.
13. "Introducing the vechain Accelerator Program." Medium, <https://vechainofficial.medium.com/introducing-the-vechain-accelerator-program-f2013a2c2ce5>
14. "Merger Cases: NACE All." European Commission, https://ec.europa.eu/competition/mergers/cases/index/nace_all.html.
15. "More Than Half of U.S. Car Sales Will Be Electric by 2030." Bloomberg, www.bloomberg.com/news/articles/2022-09-20/more-than-half-of-us-car-sales-will-be-electric-by-2030?leadSource=verify%20wall.
16. "New Law Allows Californians to Store Vital Records on Blockchain." Pymnts.com, <https://www.pymnts.com/blockchain/2022/new-law-allows-californians-to-store-vital-records-on-blockchain/>.
17. "Nike Smart Shoes Communicate via Bluetooth." Fierce Electronics, <https://www.fierceelectronics.com/embedded/nike-smart-shoes-communicate-via-bluetooth>.
18. OECD/EUIPO. Global Trade in Fakes: A Worrying Threat. Illicit Trade, OECD Publishing, Paris, 2021. <https://doi.org/10.1787/74c81154-en>.
19. "Questions and Answers: The European Battery Alliance: progress made and the way forward", European Commission, <https://>

ec.europa.eu/commission/presscorner/detail/en/QANDA_22_1257

20. "Raleigh, North Carolina Taps NVIDIA and Esri for Traffic Management Machine Learning Project." State Scoop, <https://statescoop.com/raleigh-north-carolina-esri-nvidia-traffic-machine-learning/>
21. "Sustainability and Second Life: The case for cobalt and lithium recycling." International Institute for Sustainable Development, <https://www.iisd.org/publications/report/sustainability-and-second-life-case-cobalt-and-lithium-recycling>.
22. "Taking VechainThor to the next Level with Upgraded Developer Tools and Documentation - Devpost." Vechain Hackathon - Building Fundamentals for the Future, <https://vechain.devpost.com/rules>.
23. "The Inflation Reduction Act deal could benefit clean energy, EVs", iShares, <https://www.ishares.com/us/insights/the-inflation-reduction-act-deal-could-benefit-clean-energy-evs>
24. "Transport," International Energy Agency, <https://www.iea.org/topics/transport>
25. "Transport demand to triple: sector faces potential disruptions," International Transport Forum, <https://www.itf-oecd.org/transport-demand-set-triple-sector-faces-potential-disruptions>
26. "U.S. Navy Equips USS Essex Warship with 3D Printing Technology," 3D Printing Industry, <https://3dprintingindustry.com/news/u-s-navy-equips-uss-essex-warship-with-3d-printing-technology-212073/>
27. "Volkswagen Using Advanced 3D Printing Process to Make Parts," WardsAuto, <https://www.wardsauto.com/industry-news/volkswagen-using-advanced-3d-printing-process-make-parts>



Credits

Vechain



Marina Fortunato
Project Manager



Jay Zhang
CFO



Sunny Lu
Founder



Peter Zhou
Chief Scientist



Antonio Senatore
CTO

DNV contributors



Federica Guelfi
*Circular Economy
Project Manager*



Gabriele Manno
*Head of Digital
Assurance Platforms*

Friendly contributors - Luca Crisciotti, Renato Grottola

Boston Consulting Group



Lamberto Biscarini
*Senior Managing
Director & Partner*



Edwardo L. Sackey
*Managing Director
& Partner*



Guy Gilliland
*Senior Managing
Director & Partner*



Federico Colombara
Partner & Associate Director



Marco Tonegutti
*Senior Managing
Director & Partner*



Qingyuan Lin
Principal



Thomas Baker
*Managing Director
& Partner*



Antonio Sangiovanni
Project Leader

The authors thank BCG colleagues Gaia Dell'Eugenio, Anne Deng, Giulia Gargiulo, Jonathan Greene, Jan Joho, Liana Lei, Mimi Li, Laura Morano and Elisabetta Sagretti for their contributions to this whitepaper.

Furthermore, we would like to express our gratitude to all the enterprises and individuals who have collaborated with us and participated in the discussions that have inspired the drafting of this whitepaper.

For any information on this Whitepaper or vechain, please write to info@vechain.org

Disclaimer

The Boston Consulting Group (BCG) was engaged and paid by Vechain Foundation San Marino S.r.l. (vechain) to undertake an extensive analysis of vechain's global business and to make recommendations to vechain on a sustainability strategy and communication plan as part of a Strategic Partnership. The Whitepaper to which this Disclaimer is attached is the product of that extensive analysis by BCG. The Whitepaper was prepared by BCG for the purpose of publication, and the content included herein stems from vechain's engagement of and payments to BCG to help prepare and write the Whitepaper.

BCG helped prepare and wrote the Whitepaper in good faith based on information and materials available before its initial publication. BCG did not independently verify any of the information or materials that was provided by vechain or any third parties and reproduced in the Whitepaper. Changes in the underlying data or operating assumptions will clearly impact the analyses and conclusions of the Whitepaper. BCG does not guarantee or make any representation or warranty with respect to the accuracy, reliability or completeness of the third-party information and materials underlying BCG's analyses in the Whitepaper or with respect to the Whitepaper's usefulness in achieving any purpose. Readers of the Whitepaper are responsible for assessing the relevance and accuracy of its content. BCG included in the Whitepaper data from various sources and assumptions provided to BCG from other sources. BCG has not independently verified the data and assumptions from those third-party sources. Changes in the underlying data or operating assumptions in the Whitepaper will clearly impact its analyses and conclusions.

BCG and vechain disclaim any liability for any loss, damage, cost, or expense incurred or arising by reason of any person using or relying on the information in the Whitepaper. To the fullest extent permitted by law, neither BCG nor vechain shall have any liability whatsoever to any person in connection with the Whitepaper, and any person using the Whitepaper hereby waives any rights and claims it may have at any time against BCG and vechain with regard to the Whitepaper. To the fullest extent permitted by law, receipt and review of the Whitepaper including this Disclaimer shall be deemed agreement with and consideration for this Disclaimer.

The Whitepaper is based primary on qualitative and quantitative research executed by BCG. Neither BCG nor vechain provides legal, accounting, or tax advice. Readers of the Whitepaper are responsible for obtaining independent advice concerning those matters. That advice may affect the guidance in the Whitepaper. Further, neither BCG nor vechain has attempted to update the Whitepaper after its initial publication, notwithstanding that such information in the Whitepaper has or might become outdated or inaccurate. Neither BCG nor vechain provides fairness opinions or valuations of market transactions, and the Whitepaper must not be relied on or construed as such. Further, any evaluations, projected market information, and conclusions contained in this document are based upon standard valuation methodologies, are not definitive forecasts, and are not guaranteed for any purpose by BCG or vechain.

The Whitepaper does not purport to represent the views of the third-party companies mentioned in it. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by BCG or vechain.

The Whitepaper may not be used or distributed for any purpose without the written consent of vechain.

The V, vechain, VechainThor, VTHO, and VET trademarks are owned or licensed by Vechain Foundation San Marino S.r.l.

Thank you

 vechain + 