Sustainability and Web3: Can Web3 become a sustainable social infrastructure?

Introduction

We are entering a new era of decentralized internet—Web3—driven by advancements such as blockchain-based payment networks and tokenized ecosystems. While this era can feel exciting and full of promise, it also raises key concerns: can the next phase of decentralized internet become a sustainable part of our social infrastructure?

Over the course of this article, the evolving nature of our social infrastructure will be examined in the Japanese context. This will then be followed by environmental concerns of Web3, a critical analysis of the tradeoffs of PoW to PoS transition, and challenges of regulation in this evolving landscape.

Evolving social infrastructure- Why is Web3 involved?

Technology is advancing at a rapid pace, but it remains important to ground innovation in its original purpose—to improve our lives.

Japan has already recognised the need to re-envision the relationship between technology and society for some time. The concept of "Society 5.0," introduced in the 5th Science and Technology Basic Plan (Cabinet decision of January 22, 2016), sets out a vision of <u>a human-centered society in which economic development and the resolution of social issues are compatible with each other through a highly integrated system of cyberspace and physical space.</u>

Web3 fits into this narrative and is already being included in conceptions of this idea. This is due to the global, borderless infrastructure, particularly its blockchain-based architecture, which could play a significant role in this shift by enabling freer and more secure movement of data. Importantly, Japan is also one of the first governments to begin formally recognizing Web3, with initiatives from METI and the FSA to explore regulatory frameworks and business use cases. This shows that Japan is not only theorizing about a new way to apply technology in society, but is also experimenting with how Web3 itself can be integrated into that future.

Almost 10 years later, this stance of wanting to foster innovation in Japan while still maintaining a safe regulatory environment continues, with the Japanese government's policy of advancing the social implementation of digital technologies according to the <u>Digital Agency of Japan in June 2025.</u>

Environmental Concerns of Web3

Web3 [1] is founded on blockchain technology- a decentralized ledger that avoids central servers. This has proven effective against hacking, an issue that is becoming increasingly grave in an era of AI and other advanced technologies, which can be used to develop harmful programs that hijack centralized systems. One of the earliest consensus mechanisms, Proof of Work (PoW), comes with a heavy environmental cost. To validate transactions, miners must solve complex computational problems, often requiring massive amounts of non-renewable energy resources.

Bitcoin, for example, consumes not only electricity but also enormous amounts of water to cool the computers used in mining. According to <u>Alex De Vries in Bitcoin's Growing Water Footprint (Cell Reports Sustainability, 2024)</u>, Bitcoin's water footprint increased by 166% from 2020 to 2021, rising from 591.2 to 1,573.7 gigaliters (GL). The water footprint per transaction in those years jumped from 5,231 liters to 16,279 liters, and by 2023 the annual total may have reached 2,237 GL.

To put this into perspective, this is approximately the amount of water used to fill a standard backyard pool for a single bitcoin transaction.

This footprint highlights that blockchain technology has environmental costs that have compounding effects beyond electricity use, straining other vital resources like water.

When thinking about the integration of society, climate, and technology, considering the knock-on effects and the interconnected nature of our coexistence on the planet is essential.

Critical analysis of the transition from PoW to PoS

A significant environmental improvement came with Ethereum's transition from PoW to Proof of Stake (PoS) in September 2022 ("The Merge"), which cut its estimated electricity

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[1] web3's <u>central ideas are as follows:</u>
- Decentralization enables user ownership of data and content.
- Transparency is a core principle, reducing the chances of manipulation.
- Blockchain technology allows for secure and verifiable transactions.
- User governance models can foster community-driven decision-making.
- Interoperability between platforms enhances user experience.

consumption by ~99.95% (De Vries, 2023; Kapengut & Mizrach, 2023).

In PoS, validators stake cryptocurrency as collateral to secure the network, replacing energy-intensive mining. Misbehavior can result in loss of the stake ("slashing"), aligning incentives with honest participation.

However, PoS is not without criticism:

● Validator monopoly risk — Wealth concentration can lead to large stakeholders dominating validation rights.

Essentially, the problem is that if you are rich, you can "stake" more cryptocurrency than someone who has less money. The more you stake, the higher the possibility that you are selected to validate new blocks and thus earn more rewards in the long run. This creates a harsh wealth divide, where the rich become richer and also more powerful, creating potential for an oligopolistic or monopolistic market of staking to evolve. This undermines the idea that Web3 could become a fairer extension of our social infrastructure.

● Censorship and cartelization — Staking pools could collude to exclude competitors or censor transactions.

On a similar note to the potential of an oligopolistic/ monopolistic market of staking, it could be conceivable that a group of (presumably wealthy) validators could band together to manipulate blockchain networks to their advantage. This could result in validators censoring transactions and increasing fees to gain profit.

While PoS drastically improves energy efficiency, these governance risks mean sustainability must be measured not only in carbon savings but also in resilience against centralization.

If there is insufficient governance and protection in place, PoS cannot be a sustainable choice. To be truly sustainable, a system must be supportive of the natural environment (this is the case with PoS), but also the social environment. This is iterated in Japan's Society 5.0 idea, as well.

If wealth concentration and inequity continue to extrapolate into the Web3 world, there could be dire effects as this technology becomes part of the fabric of our daily life.

<u>Regulation Challenges</u>

With Web3 being based on the idea of decentralization, it can be challenging for centralized authorities to regulate. Without a central entity to oversee or enforce compliance, it becomes difficult to apply traditional law directly. Questions such as determining the responsibility of actors on a decentralized network or tracking to confirm adherence to laws and best practices

in anonymous environments are a problem. Additionally, it remains a challenge on the part of regulators to apply existing regulations, in their current form to Web3.

Japan is a case study of how governments are attempting to bridge the gap between decentralized technology and the need for crisis-proof regulations, but understanding how this links to sustainability is still a challenge.

Conclusion

The intersection of Web3 and sustainability creates both new challenges and opportunities. While the decentralized internet will likely put a strain on our limited environmental resources, it also offers tools that could revolutionize climate accountability.

For Web3 to form part of Society 5.0's human-centered vision, it must evolve not only through energy-efficient consensus but also through governance models and legal frameworks.

To this end, legal professionals will continue to be at the forefront of pushing positive changes to guide innovation towards responsible growth.

Contributor Article – So & Sato Legal Assistant Perspective

This article was authored by a Legal Assistant at So & Sato Law Offices.

The content reflects an individual exploration of emerging legal and social issues, and does not constitute legal advice or represent the official position of the firm.

Disclaimer: This article is for informational purposes only and does not constitute legal advice. For legal questions related to blockchain, sustainability, or regulatory frameworks, please consult a qualified professional.

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