Hedera

THE HBAR FOUNDATION

Hedera and The HBAR Foundation's Response to the White House Office of Science and Technology Policy RFP on the role of Distributed Ledger Technology in tackling climate change and the transition to a clean and reliable electricity grid

Thank you for the opportunity to provide the White House Office of Science and Technology Policy (OSTP) our expertise in advancing efforts to tackle climate change and the transition to a clean and reliable electricity grid.

We strongly believe that distributed ledger technology (DLT) is uniquely poised to catalyze strong growth in climate innovation that will enable our country to achieve the President's goals of cutting U.S. greenhouse gas pollution by 50-52% by 2030, advancing environmental justice, and having a net-zero emissions economy by 2050. As a leader in the Hedera DLT ecosystem, the HBAR Foundation has created a $100M+ USD Sustainable Impact Fund [1] devoted to promoting data standardization, interoperability of auditable climate assets and reporting infrastructure with projects built on Hedera's carbon-negative network and open-source algorithm. In addition, we thank University College of London (UCL) for their paper titled 'The Energy Footprint of Blockchain Consensus Mechanisms Beyond Proof-of-Work' [2, Attachment A] available to the White House OSTP as well.

We believe trust and transparency are particularly vital in empowering governmental oversight to effectively, equitably, and efficiently direct financing of "green" technologies that are dynamically informed by rigorous scientific data collected from the "ground up." For a sustainable economy to be built, current challenges of insufficient data and opaque climate assets need to be urgently improved with standardized open data, trusted environmental markets, and transparent carbon accounting measurements. Artificial Intelligence (AI) and Internet of Things (IOT) advancements are already racing to reduce costs and improve prediction quality and monitoring. Combatting the climate crisis urgently requires cogent cross-country collaboration between commerce, governments, and people – DLT readily affords this for and with trust.

Our responses below reflect the discussions of top experts in distributed ledger technology and sustainability around two major themes: (1) use of DLT as a tool to build trusted sustainability markets and (2) the energy footprint of various DLT technologies.

Sincerely,

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1. Protocols

The world's first "cryptocurrency," Bitcoin [3], resorted to Nakamoto consensus, a mechanism to achieve agreement which has PoW at its core. A network maintained by many participants can be easily attacked because it is costless to create new digital identities to influence the network (this is called a Sybil attack [4]), hence Bitcoin's consensus mechanism attaches a digital identity's ability to influence the network to a scarce resource: energy.

PoW is thus energy-intensive by design. This does not mean that it necessarily has a large negative impact on the climate, there being several factors influencing this (including size of the blocks, token price, consumption of stranded energy, and ability to facilitate flexible load demand and utilize renewable energy as a supply for proofs. In addition, creating circular economies to minimize energy consumption is also something that would benefit the decarbonization of consensus protocols. However, the climate impact of PoW *can* be high.

Other consensus mechanisms, such as PoS, are more energy efficient than PoW because no mining is involved. Hedera, for instance, uses the *hashgraph*, [5] a low-energy alternative which uses PoS. PoS also attaches the ability to influence consensus to a scarce resource which is the stake of an individual's digital asset tokens used to validate transactions as opposed to energy. This means that nodes in the network commit their own token holdings towards validating transactions, receiving proportionate rewards if they fulfill this role adequately (and sometimes punishments if not). Most of a proof of work system's energy consumption comes from the energy-intensive mining process, which alternatives to proof of work exclude altogether, hence reducing energy consumption by several orders of magnitude.

Hashgraph consensus, particularly, is low-energy even within the PoS family [6] because its "gossip about gossip" and "virtual voting" technology enable consensus with minimal message-passing. This technology represents an improvement upon some of the drawbacks of Nakamoto consensus, not only because it has much lower energy consumption, but also because no efforts are wasted (as most mining efforts are) and a fair transaction process is achieved.

2. Hardware

Almost the entirety of the climate impact for the physical components used to run digital assets protocols emerges from mining. Mining activity is executed with specialized hardware generally known as "mining rigs." However, non-PoW systems that do not use mining have no need for this hardware, reducing their climate impact to the carbon emissions from the energy used to power the network's nodes. This impact is negligible. Hedera, for example, requires no specialized mining equipment, with mitigating measures not being necessary. Ultimately, a POS system requires minimal hardware with negligible impact on the environment. Hedera requires no specialized mining equipment. In addition, some of the nodes on Hedera run in fully renewable data centers and / or cloud-based data centers which have adopted new technologies to be carbon neutral (liquid immersion cooling, grid-interactive UPS / batteries, cleans fuels for the power backup, etc.)

3. Resources

The overwhelming majority of the electricity required to power a digital assets protocol is spent on PoW mining. Although there are questions of how large this impact is now (considering consumption of stranded energy and renewable energy-friendliness), this is simply not an issue under non-PoW systems which require no mining. Low energy intensity (and, therefore, lower carbon) blockchains will not contribute to climate change and is orders of magnitude lower than Bitcoin.

The climate change that may be disproportionately borne by historically disadvantaged communities results from emissions from fossil fuel plants in those areas - plants that are kept open to service large local energy consumers and the aggregate local load from residential and commercial consumers. Due to the findings that show POS [Platt [7] where carbon emissions that are lower by orders of magnitude lower than POW, the effects of PoS digital asset networks on climate change globally - or in historically disadvantaged communities - will be de minimis.

The academic paper *The Energy Footprint of Blockchain Consensus Mechanisms Beyond Proof-of-Work* [8] quantified the energy consumption of many of the most important Proof of Stake networks. The findings show that PoS networks are not only orders of magnitude below Bitcoin's energy consumption but can also be even more efficient than non-blockchain networks such as Visa's. For comparison, whereas Bitcoin's energy consumption per transaction can power a house for a month, a Hedera's energy consumption per transaction could only provide such power for a fraction of a second. [9]

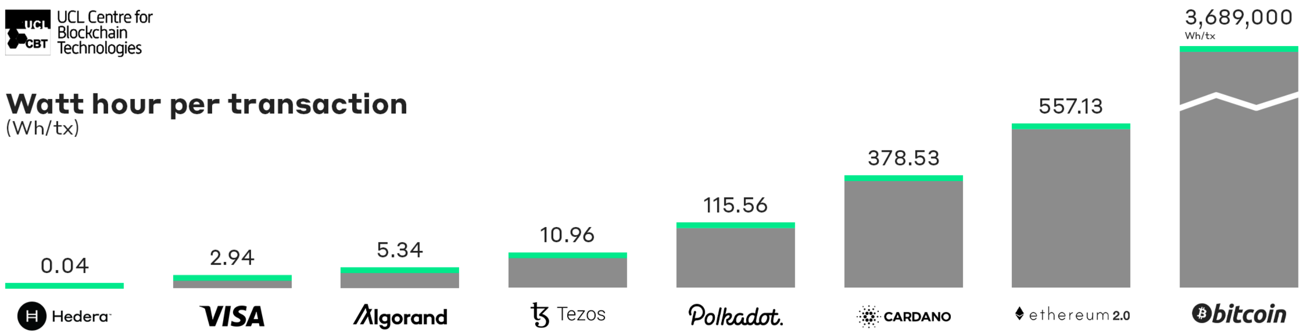

Table 2- Watt Hours per Transaction (Source: UCL Centre For Blockchain Technologies)

4. Economics

Because proof-of-work mining is incentivized by mining rewards, which are expressed in cryptocurrency, the higher the price of the cryptocurrency, the more mining construction and operation activity will be undertaken, with the consequent increase in energy consumption. For this reason, the question of whether cryptocurrency miners can facilitate renewable energy penetration instead of adding to the non-renewable energy load is an important one.

DLTs with no mining do not have the specific issues of incentivizing constructing mining farms and their associated environmental, infrastructure, and grid impacts. Fluctuations in the pricing of HBAR, the native digital asset to the Hedera network, will not incentivize mining or excess energy behaviors. Once Hedera becomes fully permissionless, the addition of more validators would mean more energy consumption, but that amount would be negligible as well. Therefore, in the case of Hedera, fluctuations in HBAR price will not incentivize mining, simply because there is no such activity.

5. Past or Ongoing Mitigation Attempts

Within the proof of work niche, there are several initiatives to mitigate mining's climate impact, which deserve attention. Nevertheless, there are also very important initiatives outside of this niche, developing ESG goals even further.

First, the industry is demonstrating how some NGOs that champion climate change goals could self-regulate DLT decarbonization. For instance, Hedera not only resorts to a low-energy consensus mechanism but has furthermore ensured its carbon negative status by purchasing carbon credits for 23 metric tons of CO_2, which exceed the total CO_2 emissions of the network [10].

ESG goals outside of proof-of-work must go further and beyond simply being carbon negative. It is important to focus on the creation of circular tokenized economies on Hedera such as mining and battery reclamation. There are various DLT and digital asset organizations championing decarbonization as well.

6. Potential Energy or Climate Benefits

Digital assets on **public ledgers** are critical as a tool in the effort to improve **auditability** and **transparency** in environmental, nature-based, biodiversity, water rights, and comparable platforms for tokenized assets. Like other emerging technologies digital assets have different use cases. One of the most promising use cases is monitoring and mitigating climate impacts for systems that today have many roles and permissioned systems across different organizations involved in accounting for a single outcome such as a metric tonne of Greenhouse Gas (GHG) emissions or the capture of a metric tonne of Co_2 or its equivalent (mtCo_2e). As there are often complexities of siloed systems (including a lack of granular information and an inability or agility to scale) public distributed ledger technologies are a good tool in combating double counting of

GHG inventories and doing so in a publicly visible manner with all parties represented and involved in signing for their part in the process.

"This process, by having all parties involved in the creation of the assets, enables those stakeholders who do the work to improve the state of our climate to be paid equitably."

To do this across many emissions sources or carbon sinks there are a large variety of methodologies for accounting today. Each methodology has corresponding roles, actors who fulfill those roles within the methodologies, and the data generated for both energy and climate impact in the form of GHG emissions generated or mtCo2e captured.

Tools such as Carbon Emissions Tokens and audit trails that describe the credentials of each participant in accounting for these assets have enormous potential to provide insights that leads to a full picture of the source and types of emissions, where they originate from, and what organization (or even what devices) are involved in attesting to the accuracy along with information about projects tied to the asset itself.

Today there is a small yet relatively difficult to enter industry for carbon emissions measurement or environmental project validation and verification that is heavily fragmented. Standards for most projects rely on estimates-based reporting from auditors which allows for inaccuracy as well as siloed reporting which leads to possible double counting issues. Using a scalable DLT and tokenized assets with audit trails linked to those assets, allows information to be reported granularly for the first time with full attestations from each party in a publicly auditable way down to the device level and gives authorities auditability to the sub metric tonne for both emissions and offsetting, mitigations, removals, or the like in adjacent industries like water.

Public DLT's provide transparency for each participant to build these auditable reputations over time, and capabilities such as Decentralized Identifiers, Verifiable Credentials, and Verifiable Presentations have strong potential to give credibility to the accounting done by Validation and Verification Bodies (VVBs) and their associated registries, along with the public reporting and disclosures which would lead to better outcomes across naturally decentralized processes that involve multiple roles, actors, and devices required to sign off on truthfulness of information [Attachment B] as well as enable complete transparency to avoid double counting. <u>This can be done while maintaining privacy for individuals, devices, and organizations in this model through selective and progressive disclosure of information</u>.

Today in the climate focused (and comparable) markets there is a dearth of these auditors and an extreme bottleneck in project auditing with very little access to the reported data at a granular level and how it's transformed, which leads to opacity. For example, the leading voluntary carbon registry, Verra, which services most credits today, has less than 30 "Active" VVBs globally with a large concentration of them based in China and only two additional verifiers under accreditation [11].

By using DLT it would allow for scaling of standards approval by allowing registration and grassroots creation of new methodologies, upskilling new VVBs for those processes (based on the reputations they build) in the regions they're serving, and improving data transparency by auditing organizations for the results as they would be publicly visible with reputations built based on their effectiveness. This also applies to emissions measurement where GHG Protocol, EPA Standards, amongst other process based environmental reporting can be scaled by organizations based on verifiable criteria and outcomes with reputations built over time.

7. Likely Future Developments or Industry Trajectories

Comparing the energy consumption of different distributed ledgers is not a straightforward enterprise, as they do not all currently handle the same number of transactions per second but controlling for this variable is essential to meaningfully contrast the efficiency of different technologies. The academic paper The Energy Footprint of Blockchain Consensus Mechanisms Beyond Proof-of-Work [12] estimated trajectories of energy consumption per transaction for different throughput scenarios, resulting in the following figure:

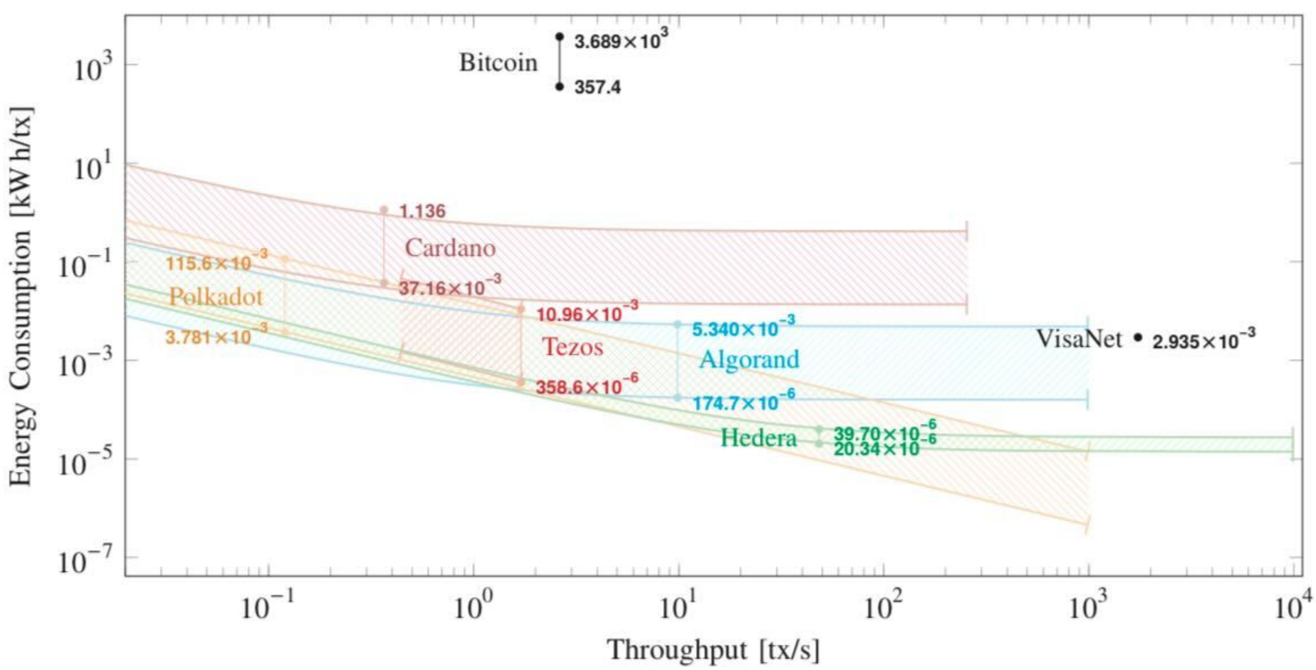

Table 3- The Energy Footprint of Blockchain Consensus Mechanisms Beyond Proof-of-Work (Source: IEEE)

Alt Text: Estimated Trajectory of DLT Consensus Networks: consumption on the y axis in kilowatt hour per transaction, and the throughput or transactions per second on the x axis, with Bitcoin, Polkadot, Cardano, Tezos, Algorand, Hedera, and VisNet measured on the graph in different locations. The locations show Bitcoin with a high energy consumption and average throughput, while Polkadot has a medium energy consumption with a very low throughput, while VisaNet has a medium energy consumption with a very high throughput, and Hedera in between with an average throughput, but less energy consumption than either Bitcoin, Polkadot, or VisaNet.

As it shows, proof-of-stake networks not only display energy consumption levels many orders of magnitude lower than their proof-of-work counterparts but may even represent substantial improvements upon incumbent systems such as VisaNet (Hedera).

8. Implications for U.S. Policy

In order to achieve positive climate impacts, we must channel the U.S. "Spirit of Innovation" and think of Distributed Ledger Technology as a tool to improve our climate accounting and transparency. Every country, the US included, has a Nationally Determined Contribution for a transition to net-zero, and we need to think of how the US can effectively account for our emissions and what we're doing to achieve reductions, mitigations, and ultimately increase the inventories of our domestic carbon sinks.

If DLT is thought of as a tool it can be used and channeled in both voluntary and compliance carbon markets, in addition to enhanced transparency in emissions measurement. Through improved accounting processes we can better assess the true US carbon footprint and what we're doing to achieve net zero emissions at organizational levels rolled up through localities, states, and ultimately the national inventory [13].

What is unique about this is only a DLT can bring transparency to show the net balances in a systematic way that is fully publicly auditable for all actors involved down to the unique signature in a cryptographically secure manner. When tested at scale this may ultimately lead to other opportunities, such previous feasibility studies by the United States Military Academy (USMA) [14] as it relates to managing grid assets using technologies such as hashgraph.

This type of transparency and proposed toolsets enables further trust in our institutions and public disclosures in what is otherwise likely to be an opaque process in emissions reporting or GHG accounting to investors, stakeholders, and authorities.[15]

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- Brett McDowell, Chair, Hedera Council, Hedera Hashgraph

Copies of References Attached

Attachment A: M. Platt, J. Sedlmeir, D. Platt, J. Xu, P. Tasca, N. Vadgama, and J.I. Ibañez: 'The Energy Footprint of Blockchain Consensus Mechanisms Beyond Proof-of-Work,' *IEEE 21st International Conference on Software Quality, Reliability and Security Companion (QRS-C)*, 2021. The IEEE has granted permission for reuse of this paper as material for the Request for Information (RFI) on the Energy and Climate Implications on Digital Assets. The paper is used with permission from the IEEE, any other use would require additional permission and the IEEE copyright line is included in the citation to the paper.

Attachment B: W. Geisenberger 'Building Processes Using Decentralized Identifiers', January 1, 2022

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[15] Platt et al.