MATTEREUM

Green Blockchain – Transcript

Mattereum Event

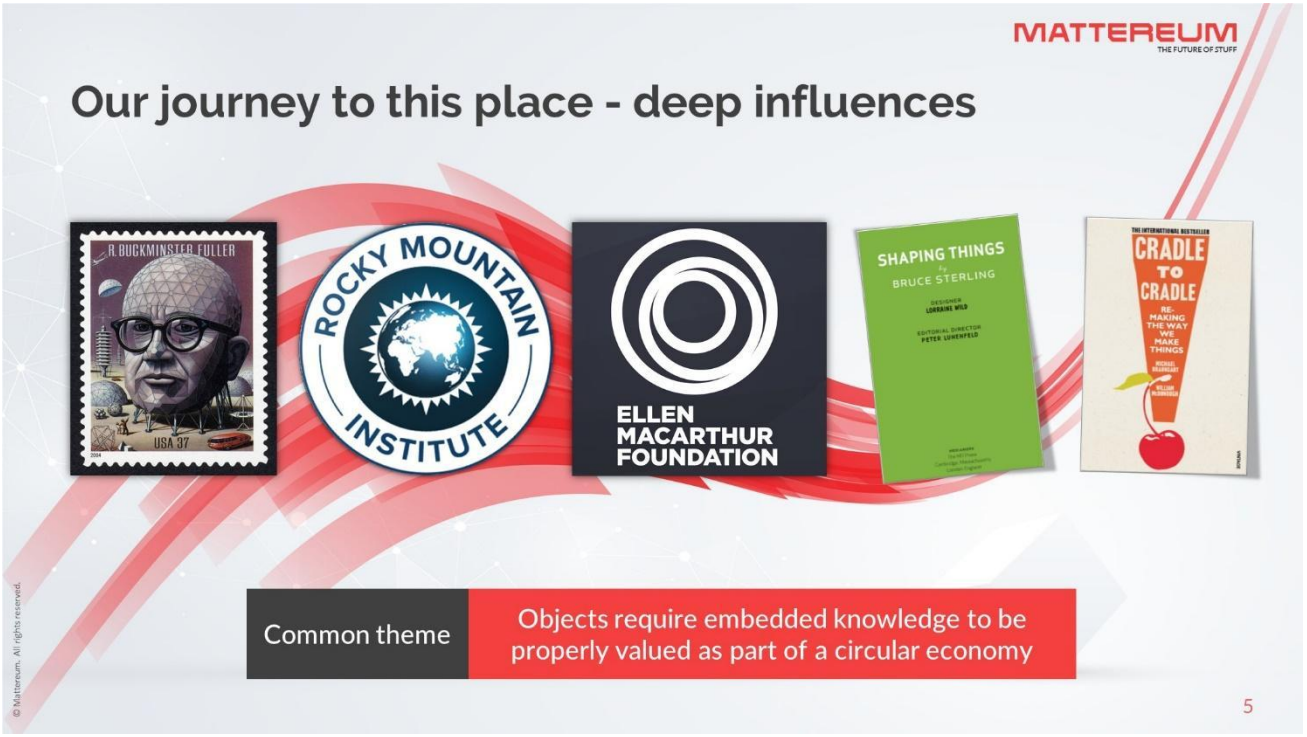
10th of November 2021

Anton: Dear friends, thank you so much for joining us at this event, at this beautiful venue. Mattereum is very proud to be working with Hub Culture, to bring you these series of events. This is our last event at COP26, with the title “Green Blockchain, Green Economy.” We are aiming for a zero-Covid transmission policy at our event, so if I may ask everybody to wear a mask. You’ve been provided with these wonderful N95 masks, which protect the wearer as well as those around them, they have really great data showing zero transmission for folks who wear them.

I will introduce our panellists as they come up, as they speak. First we’re going to hear from my colleague and my friend Vinay Gupta, Founder and CEO of Mattereum. Vinay has a very long professional history of working to address emergency situations, including some of the worse outcomes of climate change, he has been working on these issues for several decades. Today Vinay is going to share with us the importance of carbon-neutral blockchains to companies like Mattereum. A week ago we witnessed the historic announcement that the Avalanche blockchain has gone carbon-neutral, and Vinay will now present Mattereum’s view on that in that context. [applause]

Vinay: Hi everyone. This is going to be a wee bit of a journey. We've presented this set of slides three times, and each time there's a slightly different angle. This is going to be brutally more technical than the previous talks, because this is the one that actually really addresses the blockchain technology underlying, and how we're using the blockchain. And we are doing some very, very radical, new stuff which has not been done using blockchains before, not in the blockchain layer itself but in the layers above the blockchain, the applications which we're writing which run on top of it. So, let's get cracking!

My background is basically noodling around with technology in the 1990s, mostly 3D graphics, a couple of worlds-firsts. Then after 9/11 I spent 12 years in defence, security and resilience, including working directly for the chief information officer at the Department of Defense, and the former UK Secretary of Defence, and then I had enough of that, said, "Sod this for a game of soldiers," and went off and joined the Ethereum team. There I project-managed the launch of Ethereum, and then moved on to start Mattereum, specifically as a company to integrate what we call Ricardian contracts, which are smart contracts which are recognisable in a court as a legal contract: when you move something on the chain, a court of law will recognise that you've done that, and will correspondingly enforce the contract. My colleague Anton has done years' work with the UK government to get their understanding of this, up to the point where they're willing to change regulation to support that model, and we succeeded in that this year, with some very, very dramatic expansions of what you can do with the blockchain as a result.

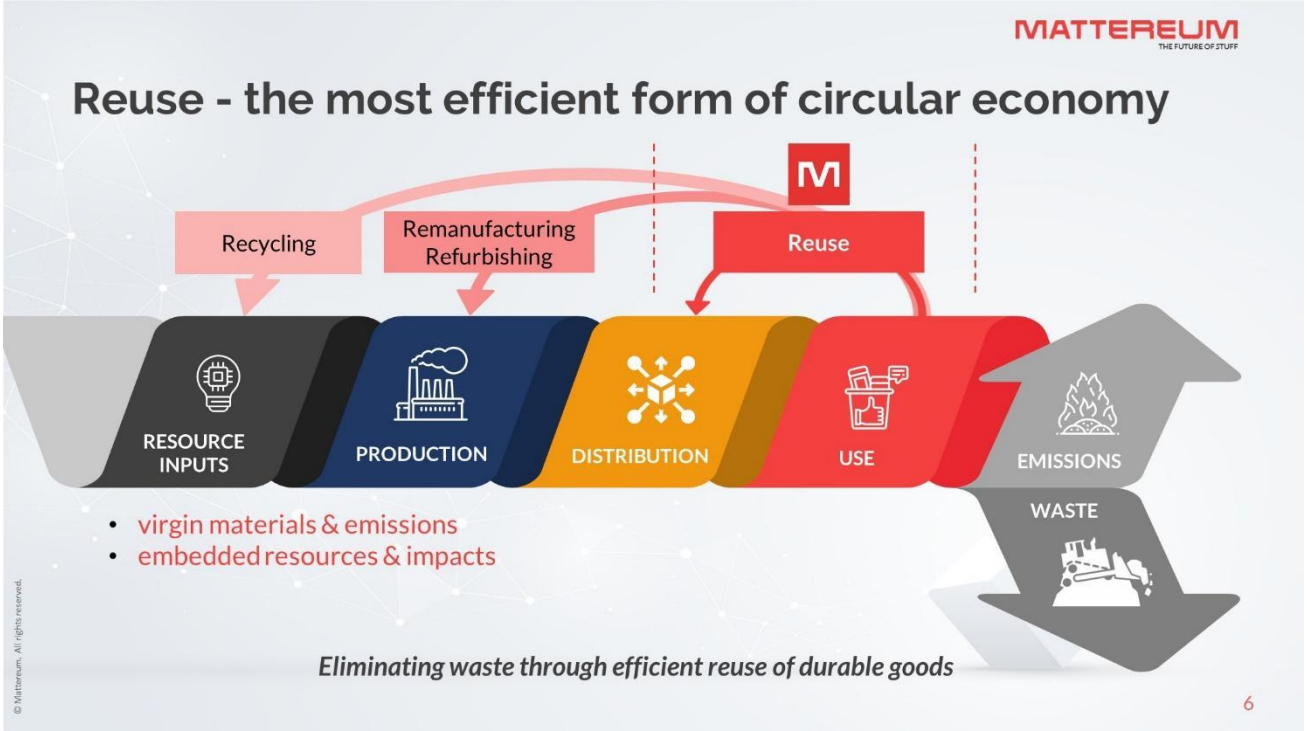


The other side of this background is the Buckminster Fuller thread. I'm very much a disciple of Fuller's, I redesigned the geodesic dome so you could manufacture it using nothing but a table saw and a bunch of 4x8 by getting all of the trigonometry out, and we did that by changing the mathematical basis of the geodesic dome from spherical trigonometry to convex tiling. If you think about what shapes can I make with straight cuts across a 4x8, and then how can I make those shapes curved, what you get is a different class of structures which still approximate domes, but can be made on building sites by people without any specialised skills, and that design has gone massively viral. They build tens of thousands of these things a year for Burning Man, they're being used as a second-generation system in refugee camps, it actually works. My saying about this has been that if the hippies had had these, they would have won.

That thread then goes through Rocky Mountain Institute, which is where I worked for a good while, edited a couple of their books, and then through into the era of Bruce Sterling's *Shaping Things* [1], another massive intellectual influence who now works with us, and then finally the cradle-to-cradle stuff, circular economy... We're sharing this facility right now with the McDonough team, including the man himself, and we're greatly indebted to all of these people in terms of the intellectual milieu from which this works.

This is not the normal intellectual heritage of the blockchain folks. The blockchain folks normally draw this diagram, and it goes basically straight back to Ayn Rand, and if you're lucky it will go back to the Scottish Enlightenment economists, Adam Smith and those guys. So, it's the blockchain, but it's the blockchain seen through a

completely different intellectual lens, building from a completely different intellectual base. This is why we have so much more traction than the regular blockchain folks.



The goal state is to run the world within the resource limits we have, and the radical way of thinking about this is we take the sustainable yield of the Earth and we divide it by eight billion. If you do that for carbon, carbon intensity for average spending is about 250 grams per dollar of GDP. If you look at your consumer spending, on average for every dollar you spend 250 grams, this means that you can spend ideally $8,000 a year, and that's everything, including things like rent. That's kind of sort of what sustainability looks like.

By the way, to get that to be sustainable, you have to move to that standard of living 20 years ago; today we've already overshot what is acceptable, and we are well into the process where we have to do active reduction of the amount of atmospheric carbon. We can't just live sustainably; we have to live regeneratively, which means getting the carbon out of the atmosphere. Most of the folks talking environmental stuff don't really make this model quite so damn clear, because when you do make it that damn clear your audience tends to freak out. And they tend to freak out for very good reasons, because this is a terrifying contingency, this is a really, really hard outcome.

So, what we do to get us there is we build on the circular economy model, but what we say is rather than having a circular economy where we take the steel or the aluminium and we melt it back and we turn it into products and we go around that long loop, what if we have a circular economy which is based on the idea of reuse? As long as *this* phone is bought in perfect condition, and has a replaceable battery so the battery that's in it is in great condition when I buy it, I have very little reason to

care whether I'm the first owner or the second owner or the fifth owner; the specification of the phone is unchanged by the number of previous owners.

If you imagine a hotel in let's say Japan, they could have a stock of phones that are already set up on the Japanese phone networks, they already have a SIM in them, I arrive, I buy a phone at the front desk, I use it for three weeks while I'm in Japan, I drop it back off at the front desk and the hotel buys it back from me, and then they sell it to the next guest in line. Those kind of services are displacing production. Rather than me buying a phone – and it's my second phone, and I put a local SIM in it, and then I leave it sitting in my suitcase the rest of the year – the phone which does the service in Japan is constantly in use in Japan, and I don't have a second phone, because any hotel that I go to I just buy the second phone when I need it, use it, and then drop it off at the desk on the way out.

That sort of circularity applies to everything: clothing, furniture, consumer electronics, transport vehicles... All of these things, in theory, could just go round and round and round and round again, and the reason that they don't is economic transactional friction. So, the rest of this is going to be about getting down into the roots of why blockchain technology is the answer to reducing the economic transactional friction in second-hand markets, to the point where the circular economy begins to actually work.

So, the platform... I'm just going to skip over the amount of waste in the world, because the numbers are gigantic – they're so big you can't even conceive of them!

Nothing made to be thrown away. The critical part of nothing made to be thrown away is that everything that you buy you buy with the intention of selling again. If you only take one thing away from this, imagine a world where everything you buy you buy with the intention of selling again: this gives you total clarity about how the future has to look. You can't buy things with the intention of throwing them into landfill, you can't buy things with the intention of just dumping them in some charity shop; you have to buy it with the intention of selling it, and getting the best-possible price. This changes

your behaviour in two ways: the first thing is you buy things which are high quality so that they will last, and the second is you preserve accurate information about the condition of things, so that when you are selling them again you're selling them with complete information about what the object is, so that the next buyer doesn't lower the price because they can't get clarity about what they're buying. Those two behavioural changes then go back up the process, and begin to change what it is that people are actually buying and selling, and just how all of those processes work.

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THE FUTURE OF STUFF

Commodities achieve high liquidity

- Almost as old as human civilization (~4000BCE)
- Centralized, highly liquid marketplaces for professional traders
- Derivatives ensure price-discovery and spreading of risk among market participants
- Prices may fluctuate wildly but the *specification* of the commodity is never in question

KEY TO LIQUIDITY

All market participants have a standard specification
Doesn't work for real-world goods, because each is unique

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THE FUTURE OF STUFF

Much of the world's *manufactured* goods are "stranded"

True value of a material asset

The "Doubt Discount"

- ✗ Provenance
- ✗ Authenticity
- ✗ History
- ✗ Condition
- ✗ Compatibility
- ✗ Future price curve

Uncertain value depresses tradability and liquidity

Knowledge and transaction certainty restores value

- ✓ Inventory
- ✓ Parametric search
- ✓ Asset passport captures uniqueness
- ✓ Warranties
- ✓ Legally enforceable
- ✓ Suitable for automation

Mattereum

The circular economy depends on precision around specification and legal enforceability
precise specification → agreement on value + enforceability → willingness to transact

I'm going to skip the commodities slide, and come right to this concept of the doubt discount. This thing that we call the doubt discount is specifically that uncertainty reflected directly in the way that these systems operate. If you have an object, and you're trying to buy it and you don't know how much it's worth – you don't know what condition it's in, you don't trust the available data that you have on it – what you're going to do is you're going to discount the price, you're going to say, "Actually, that's kind of expensive, I'm not really sure if it's real or not," and this causes a tear between the buyer and the seller in their valuation of the object.

If I'm selling an object, and I know that it's worth $1,000 and I know exactly what condition it's in, then it's $1,000. If you're buying the object, and you say, "Well, I can't really see this thing before I buy it, it's being shipped to me in the post... I've seen some pictures, they're not taken in great light, I just wonder how much wear and tear there is... What if there's a scratch I can't see?" then you say, "Maybe I'm going to offer $800," because you're dropping the price of the object to reflect the uncertainty about the condition, you can't get good data so you drop the price. This means there's now a $200 difference between what I know the object to be worth and what you're willing to pay, because your information is imperfect. This means that we have a collapse of liquidity in second-hand markets, because if we can't agree on the price we can't make the transaction happen. That $200 gap means that I'm only going to accept the $800 bid if I'm desperate, and you're going to only give me $1,000 if you're desperate, and the result is that you just don't get effective second-hand trade.

I mean, if you think about this, how much easier is it for you to buy something than to sell something? How many clicks does it take for you to buy something off Amazon? Maybe three clicks? Four? You can say to your Amazon Alexa thing, "Alexa, buy me two pounds of coffee," and it will turn up on your doorstep the next day. If I want to resell those two pounds of coffee because it turns out that I don't need them anymore, how hard is it? That asymmetry between the ease of buying and the ease of selling is why the average Western consumer has something like 300,000 objects in their house. Stuff just piles up: you get a bunch of cables to plug things into other things, you no longer need those cables, the thing that you originally plugged them into is gone, you have no way of reselling the cables, you don't want to throw them away, you might need them someday, somebody worked hard to make that cable, and now you have a cable monster. And anybody that works in technology has a cable monster in their house – nobody will deny this. And if you're a photographer, it's the same thing with old lenses. If you're a chef, it's whatever weird piece of equipment you have: you just wind up with a whole bunch of old stuff.

So, all of that kind of accumulation of nonsense, it's clogging up the arteries of civilisation in a really severe way, and all of it implies massive amounts of new production which isn't helping anybody; it's literally destroying the climate, for no human gain. And that is, I think we can all agree, kind of a bad outcome.

So, we get rid of this doubt discount with having perfect information, and that creates enormous amounts of liquidity in the second-hand markets.

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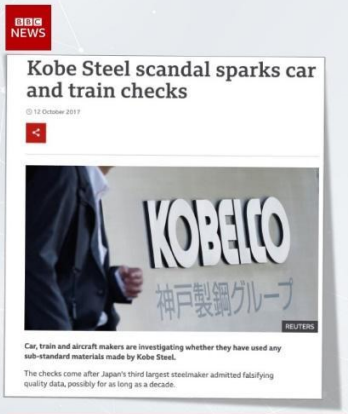
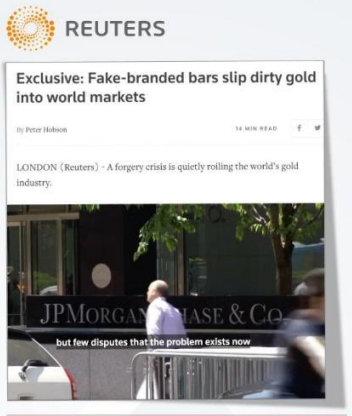
Value uncertainty is measured in trillions of dollars annually



"On 13 October 2017, Kobe Steel admitted to misleading more than 500 companies including Ford, Toyota, Nissan, General Motors, Hitachi, Boeing and Mitsubishi Heavy Industries with potential safety implications for their vehicles."

"The total value of fake wine according to Maureen Downey, one of the foremost experts on fake wine who was leading the wine authentication classes, is around $3 billion."



"Bars worth at least $50 million stamped with Swiss refinery logos, but not actually produced by those facilities, have been identified by all four of Switzerland's leading gold refiners and found in the vaults of JPMorgan Chase & Co., one of the major banks at the heart of the market in bullion."

This value uncertainty thing, much as it hits individuals hard, you ought to see how hard it hits industry. If I'm buying high-specification bolts for an aeroplane, and I'm paying say $75 a bolt, if I only need 24 bolts but the box comes as 144, trying to get those bolts sold in a way that preserves their value of $75/bolt is practically impossible, because moving the certification along with the bolt is hard. And those kind of asymmetries are value-destroying, and they often mean that it's easier to buy a new box of bolts than it is to get the remaining bolts sold. And those problems litter the economy.

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THE FUTURE OF STUFF

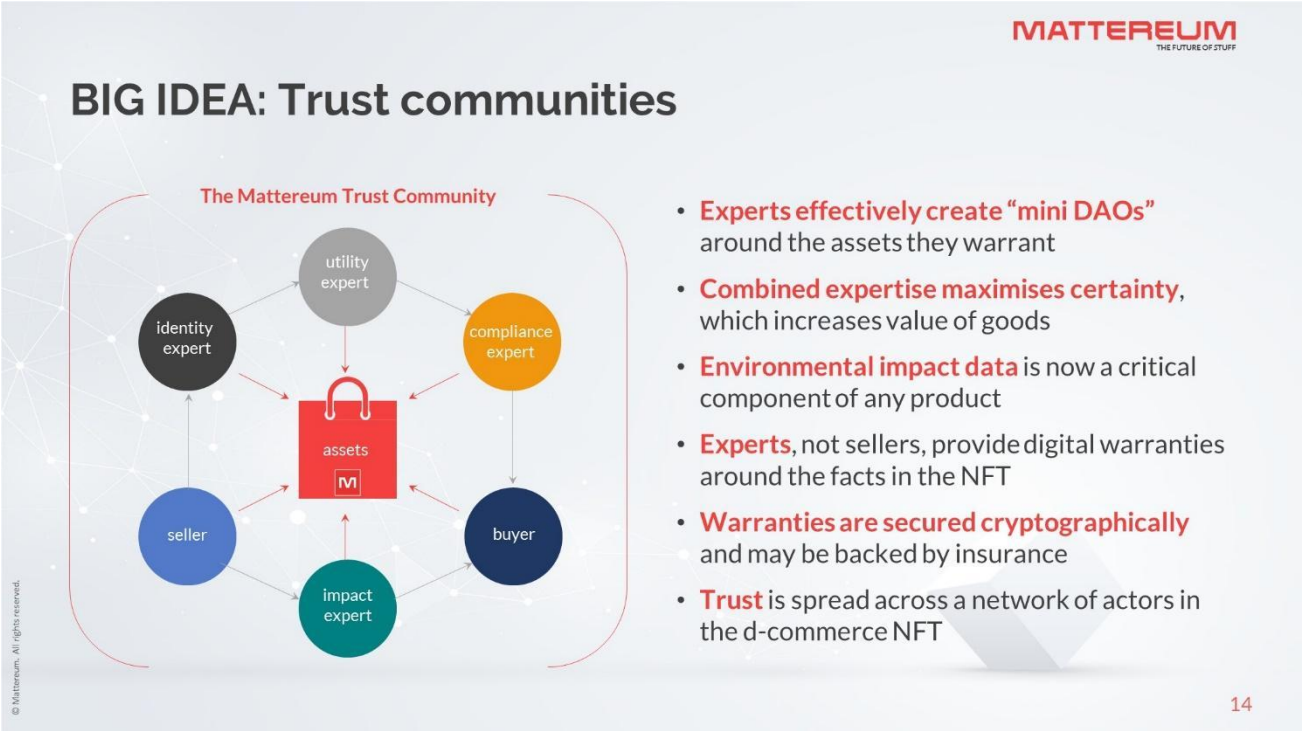
C2C e-commerce today: expensive, poorly incentivised

- No parametric search: you can't find it
- Items explicitly listed for sale
- Poor specification/verification
- Expensive listing fees
- Fraud / error prone → low trust
- Manufacturers do not participate

Today's mainstream commerce incentivises the first sale only, then disposal

We briefly discussed this consumer-to-consumer ecommerce: it's much harder to sell than to buy. As a result, trade between consumers has never really taken off. eBay does a little bit of it, but it's nothing like an efficient clearing rail, because if it was, would you have all of this stuff in your house that no longer serves your purposes? What we're looking for here is a kind of marriage between high technology and Marie Kondo, so that we can live minimally but we always have what we need, and when we no longer need it we sell it on for 95% of what we paid for it. It becomes like respiration: you buy, you sell, you buy, you sell, you buy, you sell. You never have more than you need, but you have a constant flow of novelty, because, frankly, humans get bored with having the same stuff all the time. You want a new jacket, you get a new jacket, your old jacket goes out, the new jacket isn't actually new, you're the fifth person to wear it, you don't care, you wear it for a season, you're bored with it, you sell it on, you buy another new jacket, and that one is also fifth-hand.

So, you can have a constant churn of stuff in your life, without creating more environmental damage as a result of that churn. And I think that that potentially is a consumer society that we're much happier with, because we've got constant access to goods and services at really low prices, particularly goods, but it also provides us with a churn which doesn't damage the environment every time we go around that loop. It's a much better way for the world to run, and we have the technology to implement it.



Here's where the crypto stuff begins. The mechanism that we use to implement this is called a trust community, and a trust community is a special case of a thing called a DAO, a decentralised autonomous organisation. For the most part, a DAO is basically a pool of tokens and some decision-making procedures that are all set up on a

blockchain. Those kind of DAOs have a bunch of astonishingly unfortunate legal hangovers, because courts don't really understand that structure, and as a result they often think of the DAOs as being collective investment vehicles or other things, which have a bunch of very problematic legal outcomes.

The way that we think of a DAO, in our specific instance, is a little different, we call them kind of mini DAOs: you take the object, in this case we're going to use my phone, and what we have is a bunch of independent third parties that have all had a look at this. I show it to Thomas, Thomas says, "Yeah, it's in pretty good condition, you kept it in a case, it's nice," you look at it and say, "Yeah, I've just factory-reset the software as requested, and I'm going to guarantee the software has been factory-reset," you look at it and you say, "I checked the battery capacity on my machine, it's all legit," Anton looks at it and says, "That is indeed the iPhone 11/12/9/14/21/whatever."

That process, we've got independent information coming from multiple parties, but the thing is identified as the union of all of that information. If you think of something like a balloon that's being tethered to the ground by four or five different ropes, the value in the object is attached to multiple different people, and every time another person joins that collective and adds an additional piece of information to it, it increases the value of every other piece of information in the system.

When we think of a large purchase, let's say a 100-million-dollar office building, you might have 30 or 50 different entities, each certifying a different part of the building's story: *this* person has inspected all of the windows for corrosion, *this* person has looked at the structural engineering reports, and certifies that they're current and up-to-date, *this* person has gone down and done seismic analysis of the area, and has come to the conclusion that the building is still up to code, somebody else has gone through and energy-tested it to figure out how fast it leaks energy. Every single one of these pieces of information makes the building more valuable because it reduces buyer uncertainty. Same thing for the legal status of the building: 12 different teams of lawyers go through and make sure that there are not two mortgages on it, they make sure that there are no liens, there's no pending litigation, there are no other legal problems, snags, problems with title – all of that has been sorted out, it's perfect.

The thing about that arrangement is that every additional person that provides more information makes the existing information worth more. If I only have a report on *this* that says the battery capacity is 85% of what it was when it was new, that one piece of information is not enough to sell this phone. Similarly, if I've got all of the other reports but I don't have the battery information, that also is not enough to sell this phone; you need complete information. So, what happens is that the other three reports suddenly become dramatically more valuable when the fourth report comes in, because now we know the phone, we know the software, we know the condition, and we also know the battery. It's kind of a technical example, but I really want to stress that what makes these things like DAOs is that all of the different people who

are adding value to that pool are also benefitting directly from it, but it doesn't have the enormous legal complexity that comes with tokenisation per se.

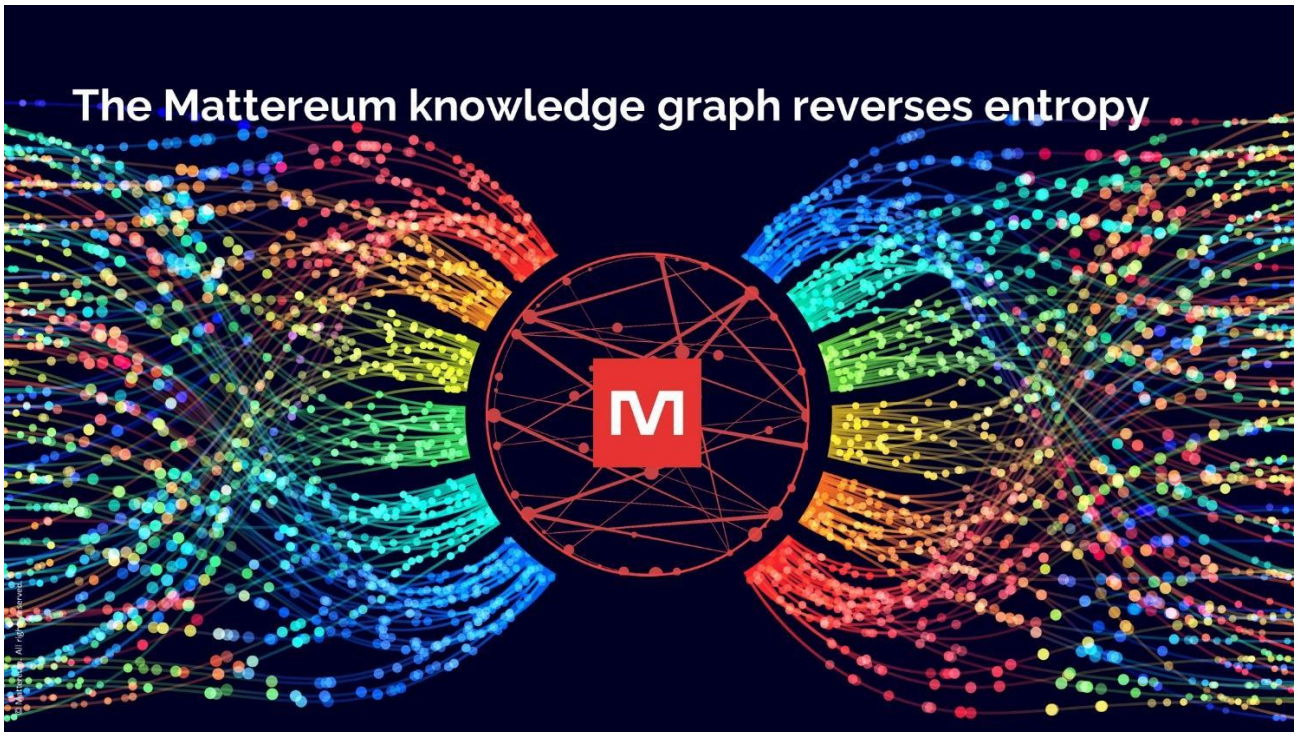
So, that structure in the middle of the slide, the thing which says "assets", that's an NFT: absolutely bog-standard ERC-721 NFT, currently trading on OpenSea, Polygon... What's the other one?

Thomas: OpenSea on Mattereum mainnet, and we also have some things on Venly Market with Polygon, and probably Avalanche coming quite soon.

Vinay: I'll talk about the Avalanche thing in a second. So anything that's EVM-compatible, Ethereum-compatible we can do that stuff very, very quickly now, semi-quickly, quickly-ish.

So, that notion that we take an NFT, we couple it with a DAO-like structure which is multiple independent threads of liability, those liabilities are represented as legal contracts, and those legal contracts are enforceable because they're structured as Ricardian contracts, and they run against the UK arbitration rules, which we spent years kind of having discussions with the relevant regulators, until they made a change to the way that that stuff works.

So, that stack is a very, very deep stack: it goes right the way down to law, and it travels all the way from this deep legal layer, layer by layer by layer, until it's connected to bang-up-to-date, brand new blockchain technology, like for example the Avalanche chain which is now net-zero, which was the announcement we made earlier this week.



What we talk about in terms of the knowledge graph is the combined total of all of the information that we have about these objects. That's the thing that really generates the value in this scenario, is our ability to say, "We understand everything about these objects in depth, and we also understand their relationships to each other." So, will *this* phone connect to this other piece of equipment... I mean, I had two hours of entertainment this afternoon, trying to figure out how to get files between this phone and an SSD drive that we had kicking around, and there were probably four or five different components that were in the loop before we made that work. That's not really work that human beings should be doing. I ought to have an index of all of the stuff that I have in the bag, and I ought to be able to tell a computer "I want *this* and *this* to work together," and it ought to go there and figure it out for me.

Now, to get that done, what's required is some way of representing the knowledge about what these objects are like and how they work together. We don't have slides for this bit, because basically this is the first time we're really talking about this in public, but the way that we're getting that done is we are going and we are reviving the ghost of the semantic Web. Does anybody remember the semantic Web? Yeah, you can see people are already going pale in fear! The semantic Web is a kind of late '90s, early 2000s attempt to organise all of the world's documents and all of the world's data using a single common representation, and that common representation was called XML. On top of that, there were then a bunch of layers that were indexing layers, like WSGI.

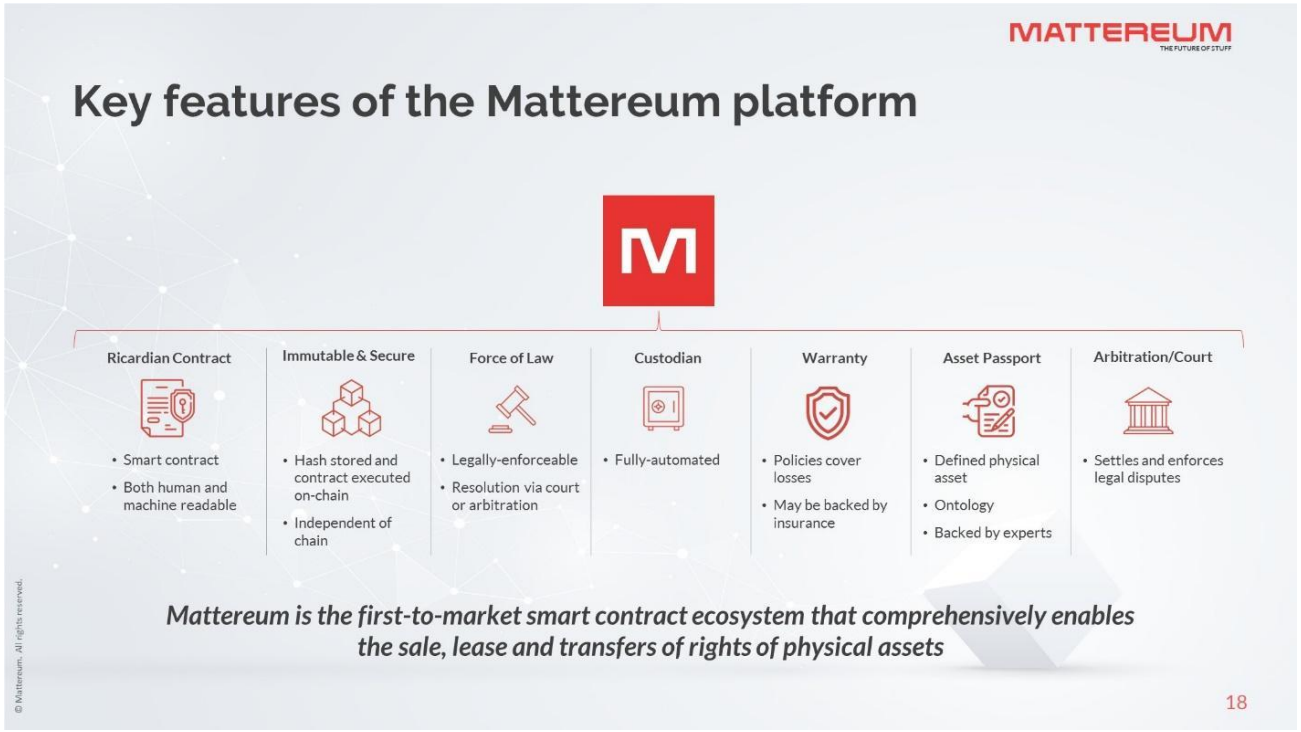
The sort of idea was that you could retrieve information about how services operated, like search engines, you could then send them formatted queries that would be able to access the deep knowledge inside of those search engines, and you could map your way around the Internet with intelligent agents that would be able to talk to each other to figure out what the other agent did. So instead of your Web browser just throwing you webpages, your Web browser could have structured conversations with other people's data services. "Hey, you're an airline, right? – Yeah, I'm an airline. – Hey, here's my calendar. Could you tell me when I would be able to fly to Seattle reasonably cheaply in the next three months? And it should be on a date when I've got at least two friends who are available in Seattle to go and see. – Okay, we can figure that out."

That ability, to have everything talk to anything and behave in intelligent ways, all of the technology was there 20 years ago; what wasn't there was enough of a business model to push up the complexity hill to get to the other side where those services became real. This is where our friend the blockchain comes in. Because if you can figure out a direct monetisation strategy for information as a service, you can then take that monetisation strategy, refold it into all of this XML stuff and all of the rest of the semantic Web concepts, because you can now get paid for providing accurate information, which is correctly formatted using these XML standards.

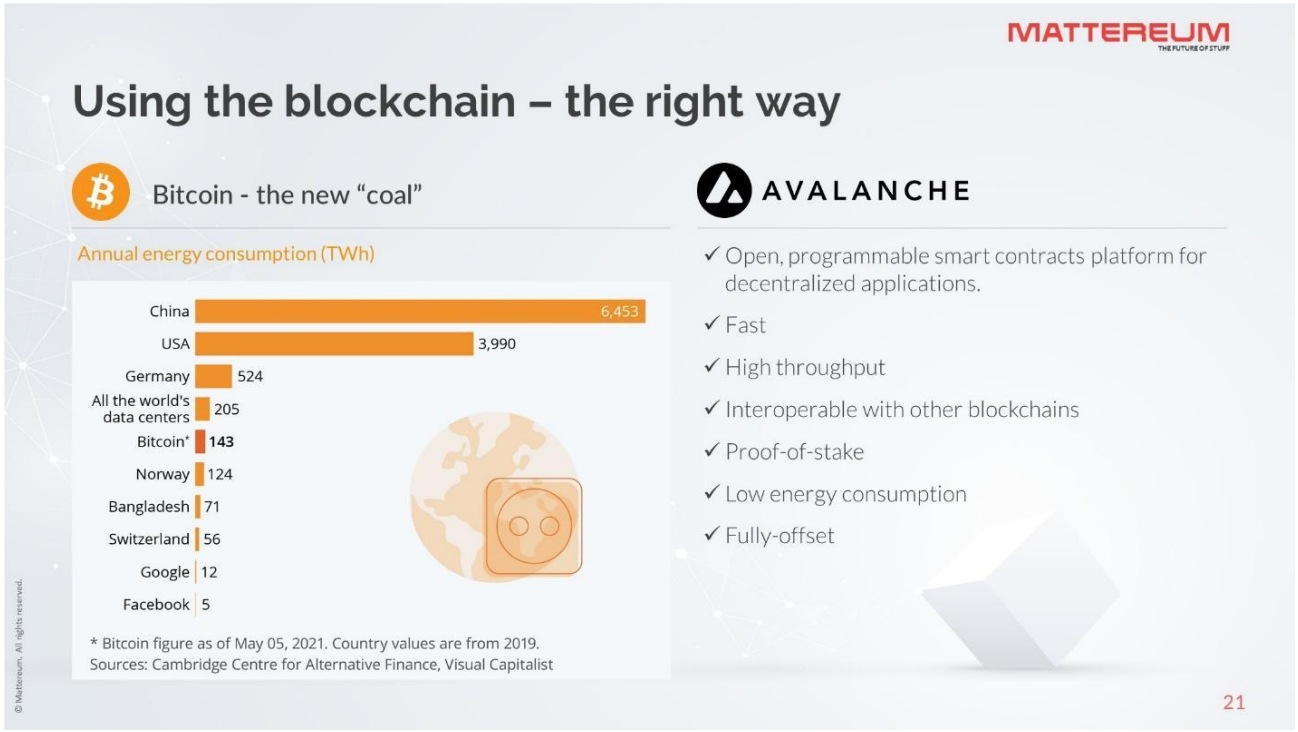
And that ability to get correctly-formatted information that is accurate about physical things, this is how we solve the cabling problem. I want to connect this phone to an SSD, every single cable in my bag has an XML file that describes what's on each end of it, and the drive, it describes its power requirements, the hub tells us whether it moves the power through the hub, all of the little converter doohickies tell us whether they do power or whether they only do data, and if they do power how much power they do, and those interconnected pieces, you can use a computer to figure out whether they join together to make a complete data pathway from one device to another, or whether you're one connector short, and if you're a connector short, it can figure out where you can buy one and it can sell it to you.

That kind of problem-solving capability is everywhere around us, it's anything technical: computers trying to connect to printers, car repairs, moving into a new house and trying to figure out whether your couch will make it through the door... Say that you're somebody that cares about clothes: do these two colours go together? Can I have these shoes in green? Will this fabric survive dry cleaning? All of that stuff, that's all data representation questions, and if we have that data, you wind up in a position where when you throw a bunch of clothes into a bag and send it to your dry cleaner, they automatically detect if something in there will be destroyed by dry cleaning.

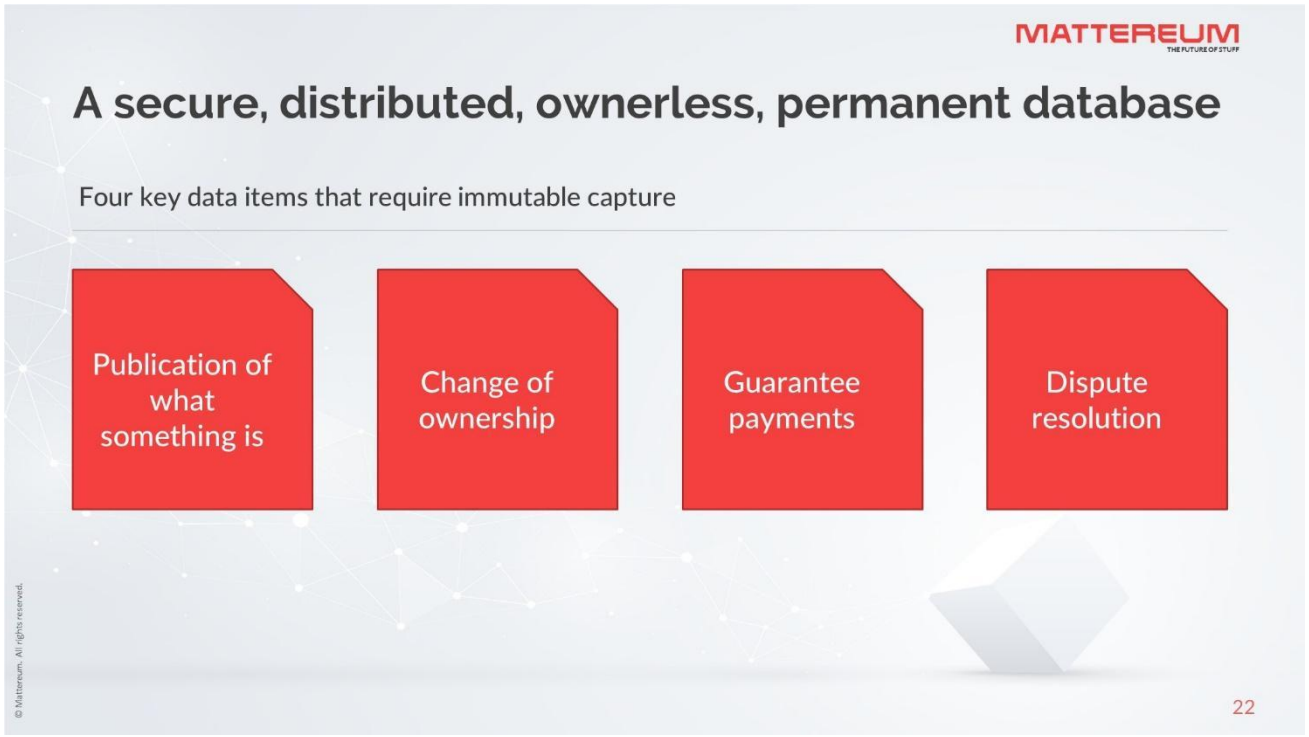
It's a way of having computers begin to soak up the complexity of the world that we have made with computers, because almost anything in this room that you're looking at, apart from the plants, originally existed as a computer model and was manufactured using CAD/CAM; even the timber that was used to make these tables, that stuff was cut using a robot. We have computers for generating complexity, but we don't have computers for soaking it back up and making meaning, and this is the problem that's solved with the semantic Web.



So, in this we have a whole set of different structures: Ricardian contracts, immutable storage, force of law, warranties, asset passports, and so on. All of the stuff that we're talking about fits into these asset passports. That is the place where the data is stored, and that's where all this XML stuff goes, that's where the semantic Web is going to be revived. It's going to be revived in the context of describing, using data, the precise condition of an object, which is then being insured with a legal contract. You have the XML file, you have the legal contract that gives it force, if the file is wrong or the data is wrong or the thing is misdescribed or the information is incomplete, if somebody makes a decision using that data, they can litigate and they can recover their money. And that is how we get the semantic Web back.

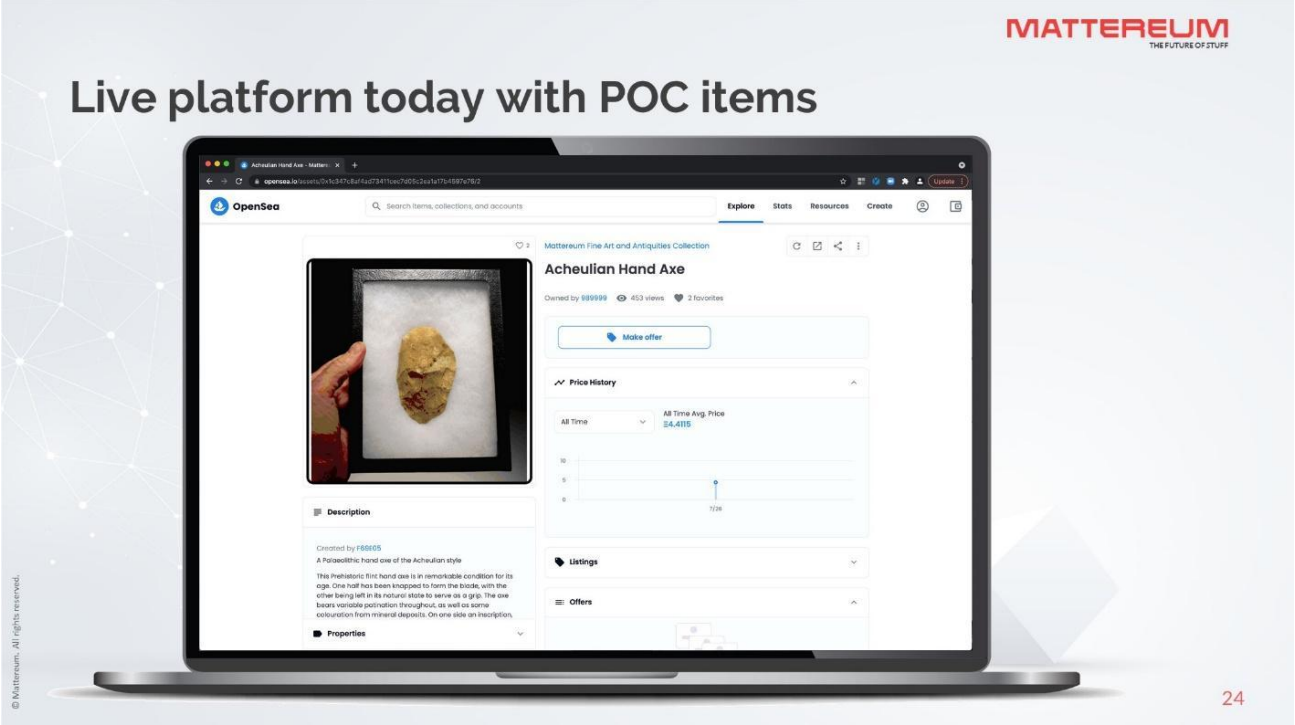


Avalanche is the blockchain of choice for this kind of work, it's that way because it is now net-zero, they have taken it carbon-neutral, it's incredibly fast and incredibly efficient, and we're very, very proud to be working with them.



Publication of what something is, we've just discussed that. Change of ownership records, you get that from NFTs: very simple, very direct, we all know how NFTs work, mostly. Guaranteed payments: because we've got all these legally-binding contracts

around, if I'm buying a warranty I make a payment on the blockchain. As a result, I've got proof that I've made the payment, which means my insurance cover starts automatically – this is absolutely critical. And then dispute resolution, we've got all of this court machinery in place so we can enforce at the nation state level. Because you know that we can enforce at the nation state level, it means that we can then also provide alternatives to litigation, where we say, "You know, if we have to enforce this contract the hard way we can, but wouldn't you rather we did this the easy way?" and we've got the machinery for doing that as well.



The system that I've described is live right now: ERC-721s on OpenSea, being bought, being sold – *That* is a half-a-million-year-old hand axe – asset passports containing structured data about objects in these legally-binding containers, including numbered gold bars. And all of this stuff is up and running today, it's all legally enforceable in 161 countries, the assets are in vaults, you buy the NFT and it gives you the right to take the asset out of the vault. In the next phase, we'll start doing all of these services for assets which are not in a vault, and at that point we are right out in the real world.

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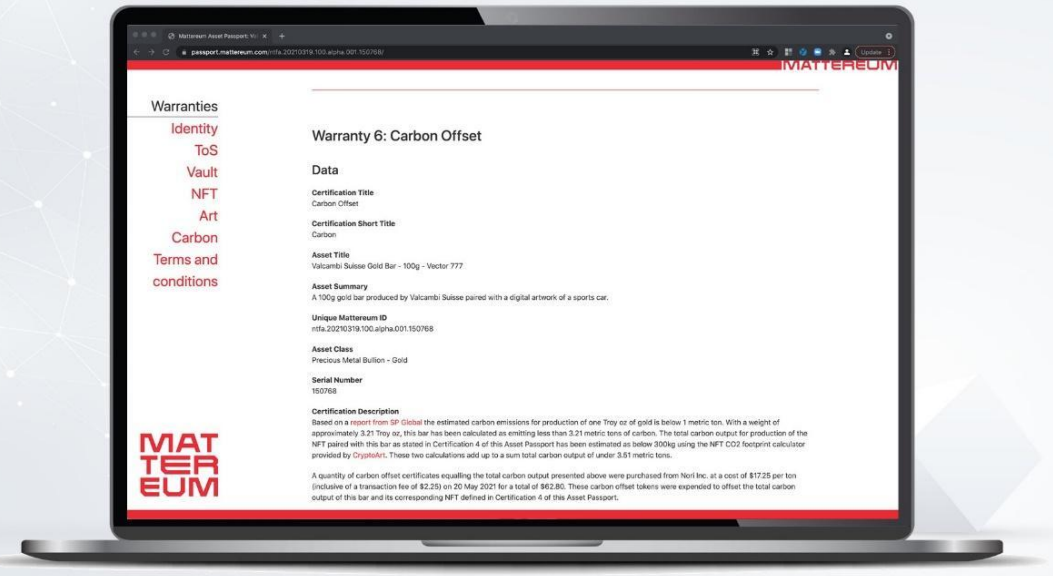
Carbon offset capture



Carbon offsetting for this kind of material: the gold bars that we're selling have carbon offsets, not only for the issuing of the NFTs but also for the original mining of the gold. If we go back to our friend the phone, the previous owner bought 23 tonnes of carbon to offset the emissions of the phone, they also bought some water offsets, and maybe soaking up of toxic chemicals in disposal offsets, and when I buy the phone I inherit all of those offsets.

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So, the goal is to reboot the circular economy, to basically say, “Right, we’ve got a new set of technology that wasn’t available to the people implementing circular economy 20 years ago. We’re going to plug this stuff right into the circular economy concepts,” hopefully partnering with a lot of the existing actors in circular economy, and the result of that will be that we can begin to build a circular economy which works for consumer electronics. A world in which phones are literally used until they break, a world in which clothes are worn until they fall apart, a world in which furniture goes through a whole bunch of nice homes who take good care of it, and then when it’s finally mangled by kids, it goes straight into student accommodations and lives there for the next 50 years. All of these kinds of models... The data layer is there, the physical objects are there, zipping the data layer and the physical objects together is a mechanical process that we know how to do in a relatively affordable way, and the more of it we do the cheaper it gets.

So this is not a sort of talk about a far-off futuristic model of the world; this is we’re already doing this for gold bars and fine art and comic books and, you know, William Shatner’s personal collection of memorabilia, we’re already doing it for all of that stuff. Now that we have the carbon-neutral chain, we can stop doing it just for things which are rapidly-appreciating assets which were individually carbon-offsetting; we can now do this for mass-manufactured goods, using a chain that doesn’t require us to do the offsets because the chain itself is offset. And it moves the whole process of carbon offsetting from action by action by action, to simply the infrastructure is carbon-neutral and we can do anything we like on it.

And that’s it, that’s where I will stop – thank you very much! [applause]

Anton: Thank you, Vinay. Now we have a pre-recorded conversation which Vinay had with John Nahas of Avalanche, where they discuss in detail how the Avalanche blockchain went carbon-neutral. Could we play the video, please?

Vinay: Hi John, it’s good to see you today!

John: Good to see you too!

Vinay: So, I guess we should start at the very beginning: tell us who you are, and tell us something about Avalanche.

John: Sure. I’m John Nahas, I’m Vice President of Business Development for Ava Labs. Ava Labs is the firm that created and spun out the Avalanche blockchain, which is a new layer-1 blockchain. Ava Labs serves as the license service provider to the Avalanche Foundation, to support the growth of the Avalanche ecosystem.

Vinay: And Avalanche is... It’s been around for a year now since the chain went live, a little more?

John: Avalanche went live on the 21st of September in 2020, so it’s been about 14 months.

Vinay: So well-established, an enormous user base, it's certainly one of the top 10 chains in the world, probably top 5, just depending on your metrics, ~block users coming on~ very quickly... Tell us a little more about where it fits into the blockchain ecosystem as a whole, like relative to the things that people are more familiar with. What is it like, what is it unlike? Where does it fit into the blockchain ecosystem?

John: Sure. In order to do so, let's start at the very beginning. Avalanche spun out of Cornell University, it was a work of our Founder Emin Gün Sirer, who is a notable computer science and distributed systems professor, he has been in this space for many years. And the real breakthrough of Avalanche is the Avalanche consensus, and I'll take you through a quick history of consensus.

There's only been three consensus protocols in the history of consensus or distributed systems, the first being classical consensus, that is what most people are familiar with, those are the networks that are used by the likes of Visa and MasterCard. They're usually closed systems, they're scalable, they're efficient, and they're fast and they're cheap, but they're closed, meaning participants, validators are selected and allowed entry, and others are not.

The paradigm shift in 2008-2009 with the advent of the Bitcoin whitepaper is the Nakamoto consensus. What the Bitcoin whitepaper brought to bear is decentralised ledger technology, or blockchains per se, a distributed ledger that is trustless, that is decentralised, but with that, and the advent of Bitcoin, you had these blockchains that have been created that utilise proof-of-work. Bitcoin, Ethereum utilise proof of work: if you're familiar with the hash power or computing power, they solve difficult algorithms in order to validate ~their network~. Anybody can be a participant, it's open, it's decentralised, but it's energy-intensive, it's expensive, and it doesn't scale.

Avalanche is only the third ever novel consensus protocol. Avalanche as a network utilises proof-of-stake, and proof-of-stake does not require expensive, heavy computing power; it just requires a somewhat basic computer or network participation. Anybody can participate, and you need a minimum amount of tokens to do so; if you do not possess the minimum amount, you can delegate your tokens to a node and run on their validator node. So the network is truly decentralised, with over 1,100 validators in less than 14 months running the network, and that number is continually growing.

We are very fast, so we see about 4,500 transactions per second, equal to Visa, and we have near-instant finality, meaning that transaction settles in less than a second. Whereas Bitcoin takes up to an hour to settle a transaction, Ethereum takes 16 minutes to settle a transaction, we settle transactions within a second, if not less than a second, and handle larger volumes. The consensus algorithm behind Avalanche allows for this to be done in a fast, cheap and sustainable way, due to the lower carbon requirements necessary, and utilisation of proof-of-stake. But even within

proof-of-stake compared to proof-of-work, which is much, much less energy intensive, Avalanche is at the top as well.

Vinay: Yeah. I mean, this is a tricky point for people that aren't computer scientists. I remember probably a year and a half ago, in the very early stage of the pandemic, we did about a three-hour session and really went through the thing end-to-end, and about two-thirds of the way through the penny just dropped, like "Oh... Oh, this is new. This really changes things." Because I have a distributed systems background going back to the late-'80s, when I was a teenager in high school ~I got ahold of a library where I have~ I basically read everything there was about distributed systems, because Edinburgh had the Edinburgh Parallel Computing Centre, and they were up to their eyeballs in transputers and concurrent sequential processes, and I kind of soaked all of that stuff ~up and off I went~.

~So, the Avalanche system~ was the first really fundamental thing that I'd seen that was new really since the Bitcoin whitepaper. There was just this moment of like "Wait, that works, you could explain that in three minutes!" It's like everybody talks to their neighbours, you randomly shuffle the neighbours, you do this a number of rounds... And what I want to stress for the audience is that in computer science, simple equals accurate equals fast. You know, if you can describe it in non-technical language relatively easily, it probably means that it's fundamentally correct in a deep way, and when you then build systems that way... You know, Bitcoin is simple to explain: you race a bunch of computers, you hand out prizes. So, it's a really big deal to have a new consensus algorithm.

Tell me a bit more about the kind of parameters of the project. So, it's in the sort of top 10 chains of the world, top 5 by some metrics... Give me a sense of how many developers are working either on Avalanche, or building products on top of Avalanche... Give me a sense of the ecosystem shape.

John: Absolutely. So, the beauty of Avalanche as a platform or a primary network is that it's very broad, in the sense that it allows for a lot of development to occur. Certain chains that exist currently have their own niches: I like to always say there's your NFT blockchains, there's your supply chain blockchains, your payment blockchains, your DeFi or decentralised finance blockchains... Everybody somewhat has a niche, and that's great, a niche is easy to kind of stay in that lane. But ultimately, for the promise of blockchain technology and for distributed ledgers to really take over as a new technology that can encompass a lot of things, you need to have a really strong footing in a lot of different verticals.

The Avalanche network itself has three chains currently on the primary network, one of those chains being the C-chain, that is a smart contracts chain, that's equivalent to Ethereum. It's like Ethereum, but before Ethereum 2.0, which is intended to come out sometime in the future but it keeps getting postponed, we've actually been able to achieve Ethereum but on a proof-of-stake network, which is Avalanche. So ~it's the same as~ Ethereum Virtual Machine, but faster and cheaper, and on that one chain

alone since launching we have about $10 billion in total value locked, being transacted on the network, we have had 335 projects launch on us since inception, with another 280 in the pipeline currently that are intending to deploy in the next 4/8/12 weeks.

Any development cycle, as you may know, is about 8-12 weeks. We started a real boom in the incentive structure of rewarding and investing in projects and in teams that build on us, so we've seen exponential growth. Our daily active users, daily active wallets, new wallets, daily transactions have all been growing on hockey stick growth. I couldn't give you the actual numbers, because what they were yesterday are different than they are today, because they've been significantly growing so fast.

Vinay: I think this is what's so significant about you having taken the entire chain to net-zero, because it now means that those 335 projects are now all net-zero. All of the capital which is locked is now stored in net-zero form, all the new projects which are building and all new users that are coming on, they're coming into an environment where their actions are no longer generating carbon which is being just dumped into the atmosphere. And the comparison here is that... the numbers for Ethereum are like... We do transactions for Mattereum which are 130/150/250 kilograms of carbon per transaction, versus on Avalanche where it's just flat-out zero, it was cheaper to actually take the chain net-zero than it was to calculate how much was being used per transaction – you know, the programmer time cost more than just offsetting the entire chain! And that's a dramatic development, that's like... For an industry that has a reputation for having a gigantic carbon footprint... Blockchain got a very bad reputation because of how much Bitcoin and Ethereum were burning, and you're now in a position where you can say... There are some chains that have very small carbon footprints, and there are other chains which have no footprint... That's a whole new era of blockchain!

John: I want to take a step back. Because I know everyone has a very keen understanding of how energy-inefficient Bitcoin is, but let's also think in relative terms. Bitcoin as a distributed network uses a lot of energy, it uses the equivalent of the city of Las Vegas for the entire year, as much as some small countries. But if you compare it to some banks or Fortune 500 companies that have physical, brick-and-mortar branches and locations and headquarters, and the hotels and the flights and all of the carbon that those corporations emit... No-one has done that study, so I'm curious to see where that is.

Having said that, Bitcoin is very hot, and eventually I think it could reach some kind of lower emissions or offsets, if it uses renewables, nuclear energy... Right now processing goes where power is cheapest: it might be West Texas, it might be anywhere else where it is, and it's always going to find the cheapest electricity, because that's just the way it is. As electricity and carbon get cheaper or greener, it'll benefit, and I think, to their credit, the Bitcoin community is actively engaging in better ways. Having said that, it's orders of magnitude more than what currently exists in these new-generation blockchains.

I like to think of Bitcoin as a first-generation blockchain: it's the first iteration, it's the first creation. Then you have your second-generation blockchain, which is maybe Ethereum. So Bitcoin is generation-one, you can send and receive value without an intermediary. Generation-two, Ethereum comes, still on proof-of-work: you're able to compute value, there is smart contracts, the ability to program how value transfers, when it transfers, why it transfers, *if X then Y*, if I do *this* then I get paid *that*, this can all be coded. There are implications for insurance, for legal aspects, for contracts, for payments, for a myriad of use cases. And since Ethereum, you've seen a lot of chains kind of come up and use some combination of classical consensus or Nakamoto consensus, with a couple of tweaks to make them faster and cheaper, but nothing has really achieved that necessity.

What you see now with Avalanche and some others that are coming up in the third generation of blockchains I like to say is a shift towards proof-of-stake. Within that third generation though, Avalanche, because of its consensus mechanism, unlike the others in the third generation, that are fast and cheap, and might be decentralised, they are not as green, because they still utilise some older aspect of consensus in order to achieve finality and to close out those transactions. Avalanche, by using a gossip network, is much greener, is much more efficient, and utilises much lower standards of hardware: you could run it in your house, on your desktop, if you so chose.

So, there's this progression, right? As we know, with any kind of technology, there's a progression to being more efficient, more capital-efficient, more computing power, etc. – Moore's Law, we can get into so many things – that blockchains, like any other technology, by definition, should evolve, should improve, and that's what you see with Avalanche currently.

Vinay: Yeah, I think this is a really good way of thinking about it. I mean, the power gap between Bitcoin and Ethereum is about a factor of 20, so in that six-seven-year gap between Bitcoin is launched and Ethereum is launched, a whole bunch of optimisation is done, the whole thing comes down, we've got another round of technology now and it's slashed again... I mean, the numbers that I saw for Bitcoin were something like 23 million tonnes, and the number for the gold mining industry is just a little under 100 million tonnes. So the sort of comparison, if you think of gold as being the great granddaddy of all these things, and it's by far the dirtiest, then this tendency for each generation to get clearer and clearer and leaner and leaner...

I mean, I think that we are at the point where the blockchain's reputation for being a very dirty technology and a very dirty industry is becoming rapidly outmoded. I think that five years from now you will have seen the Bitcoin folks move almost entirely to renewables, maybe, that seems to be the way they're solving the problem, they're not so much for offsetting... Ethereum I'm sure will eventually figure out how to do proof-of-stake, they'll clean their acts up... I sort of feel like we need to almost draw a line under it, and say, "Okay, we've proven that you can have a chain be

carbon-neutral, net-zero, it's done," I expect most of third-generation chains will eventually figure out that they should be doing that too, and then that will be the line that's drawn underneath it, and it's just like the blockchain is no longer a dirty industry, you can now use it guiltlessly, and you could just get on with fixing the world using it.

John: To give you an analogy, I think you could look at Bitcoin as kind of your basic gasoline car, and then where we are now is kind of the tilt between a hybrid that uses both but closer to the electrical side, and I think eventually, in a couple of years, you'll look at blockchains like the way you look at electric cars. There's still some offset, there's still some carbon use... I think these third-generation blockchains, in particular Avalanche, are where the electric cars are today, but I still think you hear about how much cars emit. Even though they've gotten more efficient over the years and over the decades, they're still very dirty relative to where this third-generation is or where electric cars are.

To your point, Bitcoin uses as much electricity as the entire city of Las Vegas or small countries, Ethereum uses maybe a third of that or a little bit less.... In comparison, based on recent studies and metrics that we have, and some reports that we have coming out from credible sources in the sustainability movement, from top-tier universities, the entirety of the Avalanche ecosystem, the entirety of the whole network and every one of the 1,100 validators running this network is equal to that of 12 US households in one year, that's it. Or, 10 business-class flights from Munich to San Francisco and back, that's it. Which is a testament to not just the low requirements of the hardware that's needed, but also to the consensus mechanism that allows for consensus to be achieved quickly, cheaply and efficiently.

Vinay: Yeah, it's a beautiful thing. Because it's very clear that at those levels of energy consumption you're not burning power to secure the network. The network is being secured with smart rather than with brute force, and the result is fast, elegant and clean, and I really think... I think there's an excellent chance that it's going to be the platform on which the future is built. If I had to look at all of the chains out there and just point at something and say, "It's that..." The underlying computer science is incredibly impressive.

Tell me a little bit about the sort of future plans. You're 14 months from launch now, go for another 14 months: what do you think the big changes will be from where you are now to then, in terms of the community, in terms of the technology... What is your next step going to look like?

John: So, I think what you see now is when the network first launched, there was a focus on one of our three chains, which is called the X-chain. That's a DAG, that's optimised for speed and throughput, that's where our native token AVAX lies, that's initially what we started with. Then you've seen a shift now to the C-chain, which is our smart contracts chain, that's the Ethereum virtual machine on Avalanche, where you see a kind of Cambrian explosion of DeFi or decentralised finance applications, NFTs, so the same standard as Ethereum. But think about it: it cost $80-100 to mint an NFT on

Ethereum, and the amount of carbon is equal to that of like a six-hour car ride; it costs cents on Avalanche, and by an order of magnitude of 20 or 30 less carbon – it's not even comparable. So, you've seen that growth there, in terms of smart contract adoption, application adoption, NFTs, we've been working with enterprises.

The real thing I think in a year from now that you'll see a huge growth – which I think is the sleeping giant, more so for Avalanche than anything else – is the utilisation of the P-chain, where validation and delegation occur, that's kind of the administrator of the network. But the real thing there is under the P-chain if you run a node, with 2,000 AVAX tokens, you can create a subnet or a subnetwork. A subnet is your own chain, either permissioned, meaning closed, or permissionless, meaning open. So anybody can launch their own network on the Avalanche primary network, and have it be interoperable. Think of it in terms of an Internet of blockchains, where different blockchains are all running on the Avalanche network, that are interoperable and work with each other.

So you can have a public chain running, that connects with the C-chain and utilises the smart contracts there for stablecoins, for payment perhaps. If you're an enterprise, or a financial services company, a bank a supply chain, a logistics company in supply chains, or whatever it may be, you might want to create a chain, but you're hesitant. Because you've heard about Ethereum, but Ethereum is a public chain, you don't want your transactions broadcasted on a public network, even if the addresses are pseudo-anonymous. But at the same time, you want control over that. So, on Avalanche you can drop a subnetwork, or create your own permission subnetwork, choose who's a validator, choose your fee structure, choose what kind of control mechanisms you may want. Meaning if you're a US-based company, you can geo-restrict that subnet to US users only, or US IPs; if it's a financial services application, that it's only available to accredited investors, you can have an accredited investor kind of barrier; or you can have a KYC/AML barrier, to whitelist addresses that are tied to people that have passed KYC/AML; or you might have GDPR considerations for European clients that have to be adhered to within your blockchain.

So, no longer does it exist where you can either choose to be on a closed chain – like a Quorum or a Hyperledger, that is closed and not open to the people – or be on a fully-public chain like an Ethereum. Think of Avalanche as a public good or a public utility: you can launch your own private blockchain or public chain on the larger chain, and run your own transactions. I think with that you'll start to see the true promise of what blockchain was invented to do: to disintermediate intermediaries, to open up decentralised ledger technology for a myriad of options and opportunities, whether it's financial services, logistics, payments, remittances, anything and everything, but with rulesets that still follow current laws, current statutes, current regulations, current things, to make sure that good actors are using this technology for good uses.

Vinay: Fantastic. Thank you very much for taking the time to talk to us, and we'll let you know how it goes tomorrow!

John: Thanks Vinay!

Vinay: Amazing! And yeah, congratulations again: the world's first major chain on carbon-neutral, net-zero – I hope it sets the trend for everything that follows!

John: Absolutely, we appreciate that! [applause]

Anton: The world's first net-zero blockchain – truly a historic moment. As our friend and colleague Barbara once said, we are living in the future. Next up we have Professor John Moriarty. He is one of my oldest friends, we went to university together, and I'm very happy that he's been able to join us. He is the Smart Energy Lead at the Alan Turing Institute, and a Professor of Mathematics at Queen Mary University of London. John is going to talk about ESG blockchain today.

John: Thanks so much, Anton. And wasn't it fantastic to hear about Mattereum and the circular economy and the carbon-neutral Avalanche blockchain?

I'm John Moriarty, Lead on Smart Energy at the Alan Turing Institute, and there we do exciting stuff, like digital twins of the UK energy system, working together with UK government. If you know anything about reinforcement learning, we have a project called Wrangle, which is a competition platform for problems in smart energy, largely a long-term investment problems. And I'm also a mathematician at the Queen Mary University of London, so essentially I specialise in randomness, hopefully in a good way. Randomness is important for example in electricity systems, because solar and wind power depend on the weather, which, particularly in this country, is somewhat random, and I've been studying those matters for about the past 10 years. Randomness is of course also important in financial markets, and some of my professional experience relates to that also.

About 20 years ago, I also briefly worked as an investments consultant for a company called ~Mesa~, and one of my first tasks was to work on something that we were calling ESG. We could call this an evaluation of a firm's collective consciousness for social and environmental action, and of course ESG stands for Environmental, Social and Governance. Why would you care about ESG? Well, you might want to have a double bottom line to your resources, to your finances, and care about both financial returns, and also environmental and social benefit from the capital which you control. But also, there is research that shows that ESG considerations are actually an intangible asset for companies, which comprise an increasing percentage of their future enterprise value.

The story of ESG is that it largely began as an initiative of the United Nations about 20 years ago, and in that time it's grown to be... I think we can call it a phenomenon. There's now $30 trillion of assets under management globally in ESG investments, and the idea of for example cryptocurrency ESG, blockchain ESG is also starting to gain traction in an investment sense. So, I would just like to throw out the question: in

the next 20 years, could ESG investment considerations be driving blockchain, in the same way that it's driven conventional investment over the past 20 years?

I can remember very precisely when I first got interested in investment: I was seven years old, I was standing in the post office, and I had my National Savings logbook, and we updated it for the first time. When I was born I was given the sum of £20, and I saw – we had some high-ish interest rates in my early years – and I saw that added to my £20 was £26 in interest, and this blew my mind and I thought "This stuff is powerful!"

Earlier this year my mind was blown again: I was having a chat with Anton and with Vinay, and previously I have thought that cryptocurrency equals Bitcoin equals dirty, and that I didn't need to engage with it. And I heard that there's this thing proof-of-stake, like Avalanche – first there's proof-of-work, like Bitcoin – in which, I think you can reasonably say, you use mathematics instead of coal. So you use the guarantees that come from a mathematical understanding of randomness to secure the protocol, instead of using a huge amount of energy, it's been compared of course to the carbon emissions of a small country. And that conversation blew my mind, and I thought "I need to engage with this stuff!"

When we look at the story ESG investment, it tells us very clearly that people want to do good with their money. Morgan Stanley for example found in 2017 that 75% of people surveyed said they were interested in ESG investment, in 2018 that was 85%, and I feel sure that in the same way people want to do good with their digital money, and will want to do so in the coming years. To give an idea of the size of that potential investment opportunity... When it comes to conventional investments, worldwide there's $150 trillion invested, $30 trillion in ESG, that's expected to grow to $50 trillion by 2025. And so it strikes me that when it comes to blockchain, if we can enable consumers to make good choices of the blockchain protocol that they use, then that consumer power will have massive economic potential, both environmentally and also more broadly.

Let's just reflect on what do ESG criteria look like for blockchain, what are some of examples. Of course environmentally the big story is indeed energy: demand creates emissions, and we need to both reduce demand and decarbonise. I think it's important to make the point that it is challenging to build enough renewable generation: building wind farms takes a long time, as well as a lot of capital, and so efficiency really is important from that perspective. It's also actually a real challenge to operate an electricity system that has that amount of randomness feeding it. So, while renewables are certainly a big part of the answer, they're hard and they're challenging to run, because they're variable and they're intermittent.

What about social considerations? Let's try to, where we can, use blockchains that have potential to positively influence people and communities. We've heard about Mattereum, that's a great example, with their work on the circular economy. Let's try to use blockchains that offer to decentralise bodies and processes which are currently

centralised, if that leads to positive effects for people and communities. Let's try to use blockchains which offer to bring let's say permissionless, decentralised financial goods and services to the many people in the world who are undocumented and unbanked. And in terms of governance, let's try to work with blockchains that are governed themselves in a sustainable, for example democratic way. Let's try to encourage blockchains which have a built-in capacity for further innovation, for example through voting on network upgrades, etc.

So, what can each of us do? Well, of course if and when we use blockchains, we can try to make good choices in respect to ESG considerations. In the coming years, as the financial institutions which we use – our pension funds, our insurance companies – if and when they adopt blockchain, let's use our consumer power to choose between them on the basis of their ESG policy. Let's ask questions of our pension funds, of our insurance companies, of the charities which we support, just in the same way as we do now for conventional ESG considerations. I think pensions are a particularly apt area to think about ESG investing, because of course we're thinking about our retirement. What sort of world do we want to retire into? One with dirty or clean air and water, one with weak or strong societies, one which is badly governed, or one which is well-governed? What do we want to tell our grandchildren about how we invested in cryptocurrency for example?

There's a chap called Chris McNett who works for ~Auspring Investments~, and he makes a nice analogy with insurance. If we were to take a poll in this room, what do we think are the chances that there will be a climate disaster in the future? How do we think those chances compare to the chance of for example your car getting stolen or your house being burgled? We're willing to invest insurance products to mitigate the latter risks, so equally we should be willing to invest to try and mitigate the former. And I can't resist it: McNett uses this fantastic quote from Mark Twain, which Anton almost used a moment ago, that we should plan for the future, because that's where we're going to spend the rest of our lives.

So, I've had my mind blown twice – once as a seven-year-old, and once this year, chatting to Anton and to Vinay – and I firmly believe that if consumer power can be harnessed, then ESG blockchain also has the same sort of mind-blowing potential. Thanks very much! [applause]

Anton: Thank you very much, John. Next up we have Dr Bernhard Reinsberg, he is a Lecturer in International Relations here in Glasgow, at the University of Glasgow, in our host city. Bernhard is going to offer some reflections on what's been said so far, perhaps in an international context.

Bernhard: Thank you very much, Anton, and also thank you very much for the kind invitation to this great panel here. My keen interest is in global governance, that's the systems of rulebooks and the partnerships of actors – like states, international organisations and civil society – that uphold these rules, in helping to achieve the Sustainable Development Goals, and climate change of course is one big part of that.

I've got interested in this whole topic of blockchain really in trying to understand how this new technology can essentially help promote international cooperation, and I want to just offer really a couple of reflections, based on the excellent presentations we have just heard, which cover more sort of private sector and customer-to-customer market solutions. Based on some work that I've done and some research I've done that has been published in international theory, I've basically identified three ways in which blockchain can help promote international cooperation, and the first is basically using the low-hanging fruits of the technology as a transparency device. We have heard, both in the customer-to-customer market issues, but also in international cooperation there is really a lack of credible information that often prevents states from engaging with each other, or making commitments that are strong with each other.

The blockchain provides us with a unique way of giving us basically a ledger of all transactions that ever happened in history, for arbitrary kinds of transaction, and that is tamper-resistant. That is actually a very unique feature, and that could be used, if we think about climate change for instance, in the context of carbon credits. We have this ability to purchase carbon credits through projects abroad, but there is this problem of double-counting: can we really be sure that these projects have been done and are not counted twice? Having this ledger in a really decentralised way is a great and cheap way of bringing this information onto the chain and using it. So, these are the sort of low-hanging fruits really from using blockchain technology, but I argue that we can go much beyond, and it touches upon the idea that Vinay has discussed, with respect to the decentralised autonomous organisation.

We really need some sort of climate DAO moving forward, where we have a system with a common token, as well as a set of rules, governed by smart contracts, that can interact with each other. Because climate change in a sense is a very complex phenomenon, it is a multitude of issues across different sectors – energy, agriculture, and so on – and in each of these we have information problems, we have parties that need to come together, and basically at the level of individuals have market solutions, but also at the very top, at the international level.

My proposal includes a system in which states can interact on some sort of a master chain really, where they can make commitments to each other, and these commitments would be in a way translated into these tokens, let's call them green coins. And once we have operationalised these climate change commitments that states do, that are consistent with our 1.5C target of global warming, then all of a sudden these little decentralised activities that exist out there – people planting trees, building microgrids, and so on – would be rewardable, because they would essentially be able to collect these green coins that have value, because states have staked real money against these pledges. We know about the $100 billion pledge that states have made in 2009, so every year from 2020 onwards.

Now, of course we also know that this is a bit in delay, so that's what discussions at the moment are about, but clearly here the blockchain also can, in principle, offer a solution, because the second function that it has is to guarantee enforcement on the chain. Through smart contracts, blockchains enable you essentially to remove all uncertainty around enforcement. Whenever a participant has staked real money behind a claim, the smart contract would take that away if the claim was for instance found not to be fulfilled. And for that we need these validators, also something that Vinay has discussed in the market-based solution. And it's clear that the blockchain will not exist in isolation but in a social system, where trusted actors – like international organisations, NGOs, and others – will be able to validate certain actions that have happened on the ground.

And on top of that, we can also use AI, to use sort of plausibility probes around behavioural patterns out there, so all of that will be very useful in validating that information that we bring onto blockchain. Because that is the most important challenge we still face – garbage in, garbage out – so we do need verifiable information.

And the last point, and what I'm also most excited about, is climate ambition. We need more ambition, we need higher pledges for climate change reductions, and for that we need certainty that the green transition is going to happen, so that all actors will make investments. Big companies have pledged to go carbon negative even – like Microsoft, not so long ago – and if they were to put that in a smart contract, it would have much more credibility. It would also be an easy way to organise exchanges, side payments, things like that, which we know can have a positive effect on cooperation. Clearly, if we go ahead with the green transition, some actors will lose out, and these are the actors that are most opposed to it, so we'll need to think about compensation, and blockchains, through smart contracts, offer an easy way of organising and facilitating these side payments.

In a way, I see three ways that I've outlined in which blockchain can help international cooperation, in the area of climate change but it's also replicable to many other sectors: wherever there's transactions across borders involved – think about development, trade – where blockchain solutions have already been used, so there's huge potential. And if now, as we have seen, there are blockchains that are themselves also carbon-neutral and that don't use up energy and not contribute to the problem themselves, I think then we have made a really big step forward, so I'm optimistic when it comes to the future. [applause]

Anton: Thank you, Bernhard. We now come to Thomas Barker, my colleague at Mattereum, Mattereum's Lead Technologist, we are very grateful that he's been able to join us here today. Thomas is going to offer some thoughts on the technology which underpins all of the things that we've been talking about.

Thomas: Well, I thought, as the highlight of this has been the greening of the Avalanche blockchain, that I might talk a little bit about consensus mechanisms, and how they

actually differ, and how the Avalanche team were able to make the jump between the very crude consensus that exists in Bitcoin, and the much more sophisticated one that they're using. I wanted to have this by getting people to act out the consensus mechanisms, which would be very fun, but Vinay tells me we don't have the props or the time. So I'll just talk about it instead, which is a poor second-best to getting people to wave their arms around and hop up and down until everybody is doing the same thing, but hopefully we can do that some other time.

Vinay: Maybe we can get the panel to do it: smaller numbers, faster consensus? [laughs]

Thomas: Essentially, Avalanche uses a system called Snowball, which is just simply that you get a crowd of entities, and they will imitate each other until they reach a tipping point. So, in this case we would get two people to put out the left hands, put up their left arms, one person puts out their right arm, and tell the remaining people to pick two people at random, and when they got a definite consensus on which arm to raise, to raise their own arm in the same way, and to switch arms, if that was what the consensus said. Providing we're genuinely sampling random people, we'll always converge in one state or the other. And it doesn't really matter very much which one it actually is, as long as we all get to the same place. It's as simple as that.

The Bitcoin algorithm, on the other hand, works roughly like this: everyone takes out their wallets, you put it on the table, and then you get a lighter, and then you just pull out whatever... It is actually so random, you could just pull out any denomination of bank notes, and you just set fire to half of it. And the person who has four leading zeros on the serial number of their bank note – this may take some time, and it does – who has the first burnt, new, half-burnt bank note with four zeros at the beginning of the serial number, that person has won and gets to decide what wallet all of the transactions were in. This is actually quite elegant, as long as you don't care how much money you're burning, it's very robust. For as long as everybody has a wallet stuffed full of money, and is willing to set fire to it, it works incredibly well.

Vinay: Is that what you're going to have them do for the audience participation? If I'd known, we would have done it! [laughter]

Thomas: We can probably do Monopoly money and scissors. I'm not sure if the health & safety will allow us to set fire to thousands of pieces of paper...

Vinay: Next time we're doing this!

Thomas: I mean, we're supposed to have very good ventilation here, so, you know...

But, the reason that Bitcoin originally did this is because basically the model under which Satoshi Nakamoto, whoever he or she or they were, was operating was one of utter paranoia in which you could not trust the network, none of the participants had any reputation or history... Essentially like a hellscape in which everything you were told was a lie, and even the very Internet itself would be warped by nation state actors

desperately trying to shut down Bitcoin before it consumed their economies. It turns out that actually that was a little bit excessive, and therefore it is... Because that was a bit excessive, that does mean that the simpler one that I was talking about before, where we just imitate each other, can actually work. And one of the really big innovations of the Avalanche team was just working out the parameters in which that could happen: how much people could mess around with the network, how many people could pretend to be actually two or three people before ~it fell apart~; it turned out that was actually quite a lot, and, for all practical purposes, you didn't need to set fire to £10 or £50 notes.

But it is worth knowing that if we hadn't had Bitcoin, we would never actually really been able to figure out where those parameters were. And that is my thought for the day. [applause]

Anton: Thank you very much, Thomas. We started a little bit late, but we have about half an hour for questions. Who would like to start? If you could say who you are before you ask your question, please.

Mark: Hi, my name is Mark, and I have a question mainly just around to the panel: could you explain what Chia coin is? Because I did see that they had the logo on outside, and I know they promote themselves as like a really green blockchain, but I don't really know much about them. Could you maybe explain what the difference between them and Avalanche is?

Anton: I'm not sure we have that expertise here, but perhaps Thomas could take that one.

Thomas: I haven't studied it in any depth, I have to admit – I will do later. But essentially, Chia coin runs something very similar to a Nakamoto consensus, except that instead of burning £5 notes, or rather just a lot of electricity, it takes the much more environmentally friendly option of just filling up a lot of hard drives. So you prove that you are storing a lot of data, and that is how you gain weight within the network.

Anton: I hope that was the start of an answer for you, but, like I said, I don't think we have that much expertise on this stage in that. Are there any other questions?

John: Aloha! My name is John Miller from Maui, Hawaii, [~2] Pacific. We have something called ~Want to Pledge~, we're basically trying to unite the 22 Pacific ~Island Countries and Territories~, to basically reach 100% renewable energy, and then of course through that we're using blockchain and smart contracts to help bring them together.

We're trying to add too much at once, we've already reached critical mass and we're taking off, but one of the things that we really wanted to explore, and would like to your thoughts about it, was Bitcoin uses a bunch of energy, where it consumes energy just to make the coin, to mine it. What would be the problem if we just went ahead and had the state sponsor a coin between the islands, and then use the actual

generation of renewable energy to be the mining algorithm? That way we figure we're controlling the mining of it by a renewable energy source, it's clearly obviously not just net-zero but it would be net-positive we believe. And then the whole other concept there is that it would increase investors to come into the Pacific Islands basically, building renewable energy plants that would be both... Say Bitcoin miners making money off of the currency, as well as the fact they could make their own investment just on the renewable energy project themselves.

Anton: Thank you very much. Perhaps Bernhard you could start.

Bernhard: Yeah, absolutely. Through tokenisation you can basically reward any kinds of activities, and there are some exciting developments now in this space, to make green blockchains in a sense. I think what then needs to be discussed is how you operationalise these things, so what are the eligible actions for that, how do you validate and verify them... These are sort of the nitty-gritty details for these kind of things.

And perhaps if I may offer one more thought on the Bitcoin network... I mean, I'm not sure if sort of you can green the Bitcoin network, because the whole idea essentially is to make it explicitly very hard and very expensive, so for that energy must be expensive. There will always be a place for Bitcoin, due to its very decentralised and secure nature, but it also is just one network among many, so we can now start thinking about other blockchain networks that are greener. So, your thoughts are absolutely in the right direction.

Anton: Thank you. Vinay, do you have a view on this?

Vinay: Sure – I guess let's get out the can-opener here. So, the question is one of sovereignty. Sovereignty is a common term in the blockchain when people talk about things like self-sovereign identity, some people use the term sovereign transactions. I think that that is generally a fairly poor use of the word sovereignty within its context, but when you're dealing with nation states, particularly nation states which are being potentially driven out of existence by the irresponsibility of our energy production system, broadly, the prospect is that they can use their sovereignty to affect global change, because one flag is exactly the same as another when it comes to the ability to do things like issue currency.

We've seen this recent attempt to turn Bitcoin into legal tender in El Salvador: one state says, "We've declared that this is our legal tender. You other states don't have the right to override our sovereignty and tell us it isn't, and it's recognised now by international treaty that this is our legal tender, and you have to recognise it as such in your systems, or you're breaking the treaties by which states recognise each other's legal tender." Now, I don't know how that process is going to go, and whether they're going to be able to get all the way down that process or not, but certainly they're making it very awkward for people that don't want to think of Bitcoin as a currency, and this changes things like tax status.

So, the ability for relatively ~helpless/hapless~ – and I use the term very lightly – states to use the system of international treaties in which they appear as big guys to force global change, I think there's an enormous amount of room for action there.

Backing currencies with renewable energy generation is certainly not an unreasonable thing to do, but if you have a state, why not just back the currency with your sovereignty? Or, if you wanted to be really experimental, and I'm suggesting this off the cuff: in the even that these states truly are washed out, the damages will be enormous, and one could potentially tokenise those future damages, and then allow people to basically buy the risk that these states will sink, as a way of financing work to make sure that they don't. This is the sort of last-ditch situation that a lot of the low-lying island states are in: they have very little to lose, and aggressive use of their sovereignty, and aggressive use of the international system – close-reading of treaties, figuring out what their rights are, and what they can and cannot do – I think there is an enormous opportunity for them to draw attention to their plight, and cause general chaos in a way which will gum up the international works, to the point where people pay attention to the problem. I think there's a ton of room for this kind of work. I mean, I don't want to be too cold about this, but what do they have to lose? It's a thought.

Anton: Thomas, what about the technical implications of that question?

Thomas: I mean, I could go on for a long time but I'll try not to, because it really depends on what you want to do. Currently on the Ethereum chain there is a DAO, Klima I think, that lets you do carbon offsets continuously. I've seen renewable certificate trading actually happen; I don't think it ever got to any scale, but it's certainly there. And there also have been some attempts around having certifiably green Bitcoin, because of course you can see the addresses that it comes from... So, providing that you've got a regulatory system in the States that can say, "Everything that's mined from *this* address has come from renewable energy," you could well find that that would actually create a premium. But there are a lot of possibilities.

There have been various arguments made that Bitcoin encourages renewable energy, which I'm a little bit dubious about, simply because the cheapest power that's available now is actually peak-day solar, some grids like California are in the position where they're paying people to take the energy off the grids. I think it depends very much on the structure of your energy system. But I think it's an interesting argument, and it does show that these things depend a lot on what energy sources do you have available to you and when.

Anton: Thank you, Thomas. John, you've done a lot of work on the types of energy systems and how they allocate energy. What are your thoughts on this question?

John: I think I'd just repeat what I said, that renewable energy is precious, and there's an opportunity cost to using renewable energy, the opportunity cost of not using it for

something else. So I'd really come back to that message of our power, as consumers, as designers of community projects, to make choices in terms of the blockchain protocols that we're using, to choose those that are more efficient.

Anton: Thank you, John. Are there other questions? Perhaps I can ask a question: we've witnessed the historic occasion of the Avalanche blockchain going carbon-neutral, the first in the world. Does the panel think that the incentives are strong enough and in place for others to follow? Shall we start with Vinay?

Vinay: The size of the transformations that we need to get this kind of global impact... Middle-class Americans, the top 10% are currently at roughly 70 tonnes of CO2 per person, not even per household but per person. A sustainable limit, if we had implemented it 20 years ago, would have been two tonnes per person. So, to get from where they are now to a fully-sustainable level requires the total annihilation of the current energy system, and most of the manufacturing. Fortunately, that total annihilation is underway right now, and it's called solar panels are cheaper than coal, at which point nearly all of the energy which has been installed in America this year and the previous year is renewable. Nobody is really putting in coal or natural gas in the States anymore, and as America goes the rest of the world will follow.

That's the underlying kind of landslide megatrend which is moving us towards a sustainable world. Most of this stuff out here, with COP and all of that running around... It's basically circus. You can accelerate the transition to a renewable world by putting a price on carbon, that simply makes carbon more expensive, it accelerates the transition simply because you take situations where coal was kind of sort of holding its own, and now coal... well, you can't really afford to run the coal plant and pay the carbon taxes, so you just shut the thing down.

The harder questions are sort of "Then what?" Like, getting into a world where you have solar-powered robot chainsaws that are felling the remaining of your forests, and the hyperconsumption runs on but it's now all solar-powered, that's sort of the next wave that we're going to hit. Even as you begin to get some kind of a grip on the energy problem, the next problem right behind that is the land use problem, and that is the one where there is no easy fix. Mass vegetarianism, clean meat, the rest of that stuff is the best shot that we have on land use, but getting people to the point where they're just not eating animals anymore, and much of that land has gone back to nature... That's not an easy place to get to from where we are, unless the biotech guys deliver the same kind of miracle that the solar guys have delivered.

You know, the incentives make it possible to accelerate the development of things like solar, of things like the clean meat agenda... If you start saying, "In 10 years we're going to have 20 cents per burger hamburger tax," people can take that to venture capitalists, and say, "Fund our clean meat startup." And it's the certainty of those long-term actions that is really the point of something like COP: people commit to something in future, you can then take that commitment out to the investors, and the investors will then be able to act on it. This is where Professor Mainelli's stuff from

yesterday comes in, because his approach is that governments change their mind all the time, so they have to issue bonds which will have tracked their performance, and if they don't deliver and you bought those bonds, they have to pay you, and that allows you to hedge the risk that the governments will weasel on their commitments.

This is a very long way of saying that you can make this stuff work with incentives, but people need to be willing to tie themselves to the masts to get that done, and right now we are not in a position where anybody is willing to tie themselves to the mast. If you think of the kind of radical, furious enthusiasm that you have from the activists, and imagine that in government, then we could fix this problem. And that stuff happens in government all the time: that was the nuclear age, it was the Space Race, it was the laying of the fibre-optic cables on which we now run the Internet. Once in a while, government will get hold of something and they just go for it – the Iraq War is another example of that.

So, until you see that kind of attitude, that enthusiasm go from activists to government, we're not going to get the kind of nailing-your-collars-to-the-masts action that is required to create the incentives for capital to then back those radical options. And it's going to be a many, many tier fight: there is carbon, there is land use, right behind that there's the nanotechnology struggle, which is is the world going to wind up clogged up with misbehaving nanotechnology, and then we've got AI to contend with.

So, in a lot of ways, this is the first round in what's going to be a century of a fight between humans and capital for control of technology. Is any technology that generates money good technology, or do we have essentially a gate that opens and closes selectively, where we say, "Okay, this technology is okay and we let it through, this technology is not okay: moratorium." If you think of this entire struggle in that light, that regulation problem for technology and the ability to select what technologies we'll adopt and what technologies we won't is the encompassing struggle for all of these problems, from climate onwards through everything else that we're dealing with in the 21st century, which is a very volatile period.

And how you do incentives when you start thinking about technological gating, I think that is going to come down to a much more rigorous use of litigation, to punish the people who are responsible for technological disasters.

Anton: Thank you, Vinay. John, you talked about the power of ethical consumer choice to drive the net-zero vision, including net-zero blockchains. Do you think that power is strong enough to incentivise other blockchains in the near future, to follow Avalanche and go net-zero?

John: I mean, I certainly hope so. I think that more generally, this question of are incentives strong enough... We'll always live with this question. We live in a constantly-changing situation, and so the answer to that will constantly change. The good news I think is that we're developing more tools to help us engage with that, and my hope, from my

relatively brief engagement with blockchain so far, is that blockchains are providing us with a bigger and bigger armoury with which we can provide greater traceability, greater accountability, and just more tools.

Anton: So, in many ways, the blockchains themselves are the incentive.

John: I mean, I have hope that that will be the case, yeah.

Anton: Thomas, you talked about the various mechanisms by which the chains function. Are they capable of changing?

Thomas: To be honest, I'd argue that they kind of largely already have. I mean, really, proof-of-work is a bit like coal: it's dirty, it's cumbersome, it doesn't actually perform very well... It was just something that we kind of knew how to do. And, similarly to coal, I'm aware of any major proof-of-work blockchain having launched in the last four or five years. I mean, really there's Bitcoin, which is I would say an ideologically-committed group... I mean, "rigid" would imply that they couldn't change; I would say "committed", they don't want to change. And there's Ethereum, where, to be honest, it's just taking too long, and they know that they're going to move to proof-of-stake... So, I would say that, in many ways, the proof-of-work issue is kind of just legacy.

And the question of whether or not chains are going to offset themselves... I would say, at the slight risk of undermining our previous message, that it probably doesn't matter that much if they do or don't. Because once you've taken the "burning £20 notes" out of the equation, generally speaking, the screens of all of the devices of the people using the network will actually a much bigger draw anyway, but the very fact that it's possible is extremely encouraging. And I think for any chain that has a strong sponsoring organisation, or that can find an alternative mechanism for doing it, they probably will do offsetting, probably will go net-zero. Because it's good PR, and the costs are not actually that high, if your consensus mechanism doesn't rely on wasting electricity.

Anton: Thank you, Thomas. Bernhard, echoing back to what Vinay was talking about, do you think, from the work that you have done, that international mechanisms are capable of providing these incentives?

Bernhard: That's a very good question indeed. Theoretically there is potential, I think that is quite clear. Now, the big question is how do you get states, as the primary holders of sovereignty in the international system, to sign on to it? You need the powerful states on board. You know, things like enforcement certainty can also backfire, so I lay out some ways in which this could be made a little bit more incentive-compatible. But ultimately, it really hinges on bringing in all stakeholders, so that you can benefit from these cross-level interactions through a common token. So, in a way, yes, I am optimistic.

Anton: Thank you. We have time for one more question.

Ryan: My name is ~Ryan Sardar~. I suppose my question can go across the panel: if we see Bitcoin as the new coal, then what do you imagine the future for it to be?

Anton: Thomas, perhaps you can start, since that was your analogy.

Thomas: Gosh... In a lot of ways, I'm not actually that qualified to answer the question. Because as a pure cryptocurrency, the future of Bitcoin really depends on what happens about price, and I think that that is something that has long since ceased to be decided by people who write code for a living... I mean, the question of whether or not Bitcoin persists is probably a question of whether or not the crypto ecosystem as a whole actually matures. I think for as long as it's all a question of "number goes up", Bitcoin is a very, very, very strong brand, in that it's something everyone's heard of, a non-negligible percentage of the world's population hold it, even if it's not very much, and will carry on.

If we do get the hard rain that washes away the false solutions from the streets, as I think Vinay has been alluding to, then I would imagine that Bitcoin would probably just slink away like the altcoins. Although, generally speaking, any time that I've said something disparaging about Bitcoin it's just gone up, and... It's very hard to tell. The Lightning Network is very interesting, it might have a bit of resurgence.

Anton: Thank you, Thomas. Bernhard, what does the future of Bitcoin and other chains look like?

Bernhard: I think this comes right back to the question of blockchain governance, so to what extent is there an evolution possible in the hardwired rules through which the blockchain rules evolve. And I think blockchains will have to demonstrate that they can deliver on their promises, and offer shared prosperity for everyone. I think that is the best insurance against extinction.

Anton: Thank you. John, what are your thoughts?

John: Well, I guess one way to think about the question "Bitcoin is the new coal, then what will happen to Bitcoin?" is what is happening to coal. We've seen massive divestment from coal, and we've seen commitments in the past week or so by a lot of countries to end new coal projects. There's been talk about political will. If there is the political will, or if there is the consumer will, then it's clearly possible that Bitcoin could go that same way.

Anton: Thank you, John. Vinay, you've done a lot of thinking in your career about the future, not just of cryptocurrencies and blockchains but the future of humanity. What do you have to say?

Vinay: I think Bitcoin has basically picked a strategy on this, which is they're increasingly making Bitcoin using renewable energy, and it's pretty easy to figure out where Bitcoin was made. So, the notion that you take more or less the existing mining equipment, you plug it into a renewable grid, and then what comes out of that is green Bitcoin, it leaves some nasty questions about "But, are we just burning a bunch of energy now that we could have run cities on instead of using it for Bitcoin?" But Bitcoin's total consumption is about the same as the city of Las Vegas, so globally we're wasting like a Las Vegas' worth of renewable resources on Bitcoin mining... Eh, you can live with it. And the comparison here is probably coal to gold: gold mining is on the order of 100 million tonnes of carbon emissions a year, Bitcoin is on the order of 23 million, so you sort of think if we could tolerate the gold industry, we could probably tolerate Bitcoin running on solar panels.

I think that's how they're going to get out of the current environmental trap that they're in. You'll see a lot of people getting whacked pretty hard with "Oh, your Bitcoin is dirty Bitcoin, that was made with coal power, that's really terrible, we're not touching your coins," and so you'll get as a kind of soft fork, where there's just an increasing stigmatisation of coins that were made using dirty energy, and an increasing privileging of coins that were made using clean energy. And I think the American Bitcoin mining that is happening now, because the Chinese have gotten kind of pushed out a little by their government, a lot of that is coming online as green Bitcoin, and... Is that as green as you could get? Well, you're burning a lot of energy, but at least it's renewables... It's not a great thing, but it's good enough for Bitcoin to be able to survive, even in a world that is much more aggressive about CO2 emissions or green issues in general. I think they'll square the circle that way, and that's how they'll get by.

I think the bigger problem is that it's expensive to use. The high transaction fees that are on Bitcoin and are on Ethereum and that kind of stuff... I think the push to get transaction fees down, because people are using these currencies in the real world to make real payments for their rent and coffee and shoes and so on, I think that is going to be the thing that really puts pressure on Bitcoin, and again this is where the question about the Lightning Network's viability comes in... We'll sort of see what happens. Yeah. I mean, you know, you don't want to short Bitcoin.

Anton: Thank you very much, Vinay. Well, I think that concludes our event. I'd like to once again thank our panel: Professor Moriarty, Dr Reinsberg, Thomas Barker, and Vinay Gupta. Thank you so much to the Hub Culture team who have hosted us here, and thanks so much to the Mattereum team who have enabled these events to run so well and so smoothly: thank you Andrew, thank you Katie, thank you Jeremy.

Please come and talk to the panellists after the event, we have a space upstairs for doing that. Thank you again for joining us. I hope we'll come away with new ideas, new solutions, and a renewed vigour to do something positive. Thank you. [applause]

[01:54:22 – End of Transcript]

[1] *Shaping Things*, link to Archive.org version:

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