**Distributed ledger technologies for Measuring and Verifying Climate change**

Real estate allocation is defined by the methodology adapted by the investors in managing risks. The scale of risks will vary based on the scenarios for strategic asset allocation. There are several methodologies defined in identifying scenarios for strategic asset allocation, for example by UN IPCC - "Six 'emissions marker scenarios' Assesses scientific, technical and socio-economic information concerning climate change, its potential effects, and options for adaptation and mitigation", The long horizon and the "real" nature of infrastructure and real estate investments, increase the importance of climate-change risk factors.

Real estate fundamentals are improving globally and all property types and regions are in recovery. As the economic growth is giving business to expand the recovery is expected to continue accentuation in 2012 since its start in 2011. It is in this context the global assets and emission need to be correlated to the leading real estate markets. Correlation interprets that the highest emission regions are also the highest investing markets. So the concern for "green" real estate is rising in the higher investing markets.

Most of the growing economies has crossed the contraction stage and this should be supplemented by adequate policies by the national and international policy making bodies to lift the Real estate pricing cycles despite the impact of climate change. During the One Planet Summit on December 12, 2017 in Paris, France (the 2nd anniversary of the Paris Agreement), a multi-stakeholder group of organizations working on distributed ledger technology held a meeting to agree to collaborate and establish an open global initiative called the Climate Chain Coalition (CCC). This publication explores the impact of such coalitions on real estate markets as they help mobilize climate finance and enhance MRV (measurement, reporting and verification) to scale climate actions for mitigation and adaptation.



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## Introduction

"The Global Risks Report 2018 looks at five categories of environmental risks: extreme weather events and temperatures; accelerating biodiversity loss; pollution of air, soil and water; failures of climate change mitigation and adaptation; and risks linked to the transition to low carbon. September 2017 was the most intense month on record for extreme weather events, as well as the most expensive US hurricane season since 2005 with economic losses in excess of $300 billion. And the US was not alone in experiencing extreme weather: Ireland, for example, had its worst tropical storm in more than 50 years.

**Global Risks Report** — The 5 risks most likely to happen in the next 10 years

| | rank |
|---|---|
| Extreme weather events | 1 |
| Natural disasters | 2 |
| Cyber attacks | 3 |
| Data fraud or theft | 4 |
| Failure of climate change mitigation & adaptation | 5 |

Source: Executive Opinion Survey 2017, World Economic Forum

Figure 1 (Table 1) : Global risks report, the top 5 risks.

The past year is also among the three hottest years on record and the hottest year without an El Niño ever. As a consequence, 2017 was marked by major wildfires in the US, Chile and Portugal, leading to significant economic costs and sadly more than 100 deaths in Portugal alone. Rising temperatures are a major risk for agricultural systems, in particular, monoculture production. There is now a 5% chance per decade that natural disasters could cause a simultaneous failure of maize production in China and the US (which together produce 60% of the global supply), leading to widespread famine and hardship." (Martin, 2018)

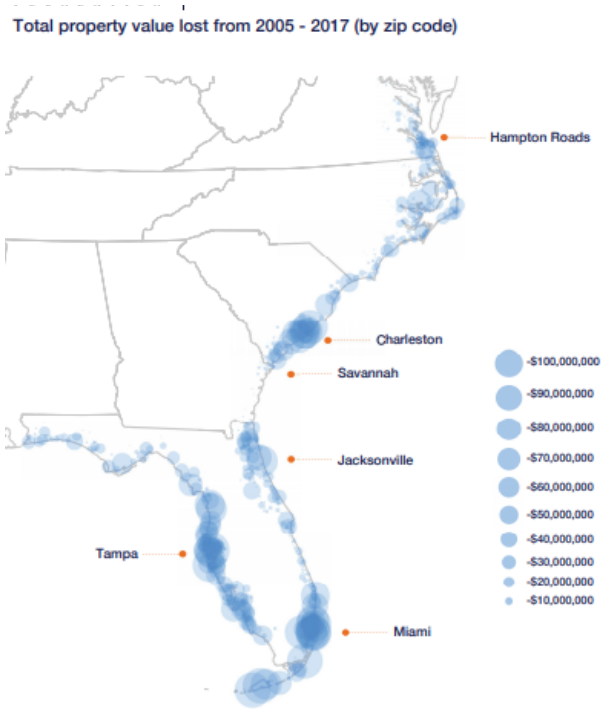
## Global climate action summit

The UN International climate change conference in 2009 stipulated start year for cutting GHG emission as 2013. 80% reduction has been set for developing countries as compared to the country's 1990 levels of emissions. The Global climate action summit will help demonstrate how much progress has been made on climate action since 2015 and how more is needed. It will mobilize bold new commitments by non-state actors that will contribute to meeting the Paris Agreement. It will also demonstrate to national governments in the run-up to COP24 that stronger commitments are necessary, desirable and achievable. Summit participants are expected to make substantial climate commitments to support climate action in five key areas: Healthy Energy Systems, Inclusive Economic Growth, Sustainable Communities, Land and Ocean Stewardship and Transformative Climate Investments.

The key themes are :

Healthy Energy Systems: A global shift toward clean and equitable energy and mobility systems advances climate progress and enable healthy people and places.
Inclusive Economic Growth: Climate leadership, and the clean technology and energy transition generate good jobs, broad-based economic opportunity, and inclusive, resilient growth.
Sustainable Communities: Sustainable buildings, cities, communities, and infrastructure are clean, healthy and livable and improve quality of life for all.
Land and Ocean Stewardship: Forests, food, lands and other ecosystems play a critical role in mitigating climate change and making our world more resilient, while also ensuring sufficient food supplies for a growing population.
Transformative Climate Investments: Investments are mobilized on the scale needed to achieve the Paris Agreement spur innovation and accelerate a clean and resilient economy.

This Summit is seen as key gathering from september 12-14, 2018 - of the non-state actors and sub-national governments who are central to doing the work of meeting the goals of the Paris Agreement. The Summit will also build on the One Planet Summit hosted by French president Emmanuel Macron in December 2017, and build momentum for COP24, when the world's leaders will gather in Poland to participate in the "stock-taking" of progress since the Paris Agreement was signed, as well as the Climate Summit being planned by United Nations Secretary General Guterres in 2019. This Summit aim to enable and support progress by national governments as they work towards their Nationally Determined Contributions under the Paris Agreement—and enhance those commitments by 2020




**Loss in Real estate prices due to climate change : Case study of USA**

"Scientists from the non-profit First Street Foundation find $7.4 billion has been lost in home value across 5 coastal states from 2005 to 2017 due to sea level rise flooding. These findings have been integrated into Flood iQ, a sea level rise flooding prediction tool from First Street Foundation, so individuals can find property-specific value loss and aggregated total city loss." (Mc Alpine, 2018)

Figure 2 : Map of the home value loss of the coastal states in USA.

While  in New York, New Jersey, and Connecticut and found $6.7 billion has been lost in home value from 2005 to 2017 due to sea level rise flooding. That's a total  of New York, New Jersey, Connecticut, Florida, Georgia, South Carolina, North Carolina, and Virginia by analyzing over 9.2 million real estate transactions, and extrapolating the results to 20 million properties. The expanded analysis has found a total home value loss of $14.1 billion across these eight coastal states since 2005 in USA alone.

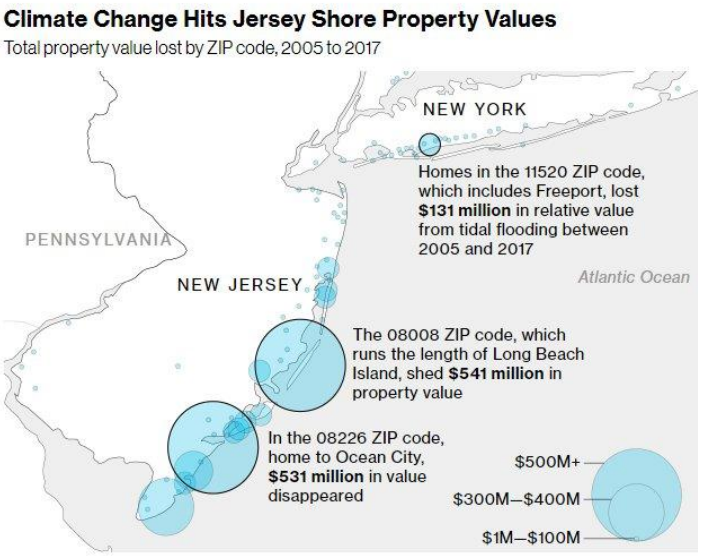



Figure 3: Loss of home values in Newjersey, Newyork and Connecticut. Let's examine if these losses are counteracted by way of financial commitments through other means more importantly through technological innovations.

**Financial commitments at One planet summit and paris agreement :**

At the second anniversary of the adoption of the paris agreement pledged the following financial commitments that will help to keep global temperature rises to well below 2 degrees and, in turn, safeguard the meeting of the 2030 Sustainable Development Goals.

- **Financial commitments**

- UNIDO has mobilized US$849m (20% of multilateral fund) to protect the ozone layer and reduce global warming, UNIDO has completed around 1,400 projects

- Green Bonds Pledge: Industrial issuers of €26 billion in Green bonds (EDF, Enel, ENGIE, Iberdrola, Icade, Paprec, SNCF Réseau, SSE and TenneT) pledge to double down on green financing.

- Storebrand Global Kreditt IG, a USD 1.3 billion fossil-fuel-free bond programme and urged investors to do more to curb climate change. The bond fund adds to USD 2.1 billion equity funds run by Storebrand (USD 80 billion worth of assets under management)

- AXA increased its contribution to green investments from Euro 3 billion to Euro 12 billion by 2020. Also increased divestment from companies that derive 30% of revenues from coal, , have a coal-based energy mix that exceeds 30%, actively build new coal plants, or produce more than 20 million tonnes of coal per year. The divestments has been increased from 0.5Billion Euro to 2.4Billion Euro.

- EBRD will provide over US$ 500 million in “first mover” financing aimed at leveraging additional third party contributions for the development and implementation of city action plans and projects worth a total of US$ 1.5 billion.

- Caribbean climate smart solutions : Caribbean leaders launched world’s first “climate smart zone” plan , with implementation of USD 8 billion climate investment plan

- Climate Action 100+: 225 investors with more than USD 26.3 trillion assets under management to engage with 100+ companies to accelerate climate action

- EU External Investment Plan: climate-smart investments worth EUR €9 billion unveiled at ‘One Planet Summit’. As part of the EU External Investment Plan (EIP), which is set to mobilise at least €44 billion of sustainable investment for Africa and the EU Neighbourhood countries by 2020. Climate Action and Energy Commissioner Miguel Arias Cañete announced climate-relevant investments in three targeted areas – sustainable cities, sustainable energy and connectivity and sustainable agriculture, rural entrepreneurs and agribusiness. These targeted areas are expected to generate up to EUR €9 billion investments by 2020.

- Sustainable Finance Facilities: UN Environment and BNP Paribas sign a milestone agreement to establish collaborative partnerships with a target of capital funding amounting to USD 10 billion by 2025 in developing countries. Sustainable Finance Facilities programme is the first of its kind in terms of collaboration between companies, investors, development sector partners, and civil society organisations, with the support of national governments. This agreement builds on the Tropical Landscapes Financing Facility, a partnership between UN Environment, BNP Paribas, World Agroforestry Centre and ADM Capital in Indonesia

**Distributed ledger technologies in climate change**

IIED estimates only 1 in 10 dollars of the US$60bn in public and private climate finance from dedicated climate funds is directly committed to local level activities. Part of the barriers stopping climate finance to reach local people could be reduced by using innovative technologies like the distributed ledger technologies.

Trust and transparency are key for the type of international cooperation and global solutions required to successfully address climate change. New options for financing open-up, and greater levels of security. The famous Paris Climate Agreement is a bottom-up agreement, essentially consisting of 195 different climate targets (NDCs) submitted by each of the participating countries. Ideally, emissions could be uniquely identified, and private and public stakeholders could transact peer to peer, across borders, on a global level. There are different types of market/exchange solutions needed, for which ownership should be in the network and not with any one participant/clearing.

The Climate Ledger Initiative (CLI) has the objective to foster innovation at the blockchain/climate intersection. CLI is a multi-stakeholder initiative promoting research and innovation. Hack4Climate is a CLI 'Call-out' activity. CLI has partnered with UNFCCC to hold Hack4Climate in parallel to the COP23 climate conference in Bonn during COP23 (November, 2017), and it mandated the Zurich-based not-for-profit foundation Cleantech21 for project management. For the event, Cleantech21 cooperates with Hackerbay, Rockstar, Validity Labs, and the Impact Hub Network. Hack4Climate has organised 17 workshops in 17 global centres directed at local blockchain communities, engaging over 1000 individuals.

There were 6 challenge areas -

- Identification & Tracking of Emissions : Develop ideas that capture emissions at source through IoT sensors, or in the supply chain, Enable an international carbon inventory, and trading in certificates or actual emission tons. , Can we build a system that uniquely identifies all global emissions? Check out our use case Example: Carbon Cockpit

- Carbon Pricing Leverage DLT to price carbon, incl. with tax/dividend schemes as well as with market-based mechanisms. Devise solutions to internally price carbon, for public and private organisations. Can we devise a global P2P exchange of carbon assets (i.e. liabilities)? Can DLT bring an efficient solutions for existing UN schemes promoting voluntary efforts? Example: Market-Chain

- Distributed Energy If we want to solve climate change, we need to solve energy. Develop new market models to improve energy market models and load management. Think bottom-up, think no central authority/utility, think about developed & developing countries Example: Selber

- Sustainable Land Use Land use, as energy, is a major source of emissions. Can we use DLT to register/account for land use or enable financing of sustainable land use? How can illegal land use be identified in an efficient and automated way? Can, what is applied to forest and agriculture, also be applied to oceans? Does DLT, in connection with IoT, have a role to play regarding sustainable buildings? Example: REDD-Chain

- Sustainable Transport Besides energy and land use, it's transport that still causes major emissions. How could we use DLT to improve private and as public transport? What can be done in mobility, what in logistics? Example: LET-Chain

**Climate chain action**

In January 2018, the climate chain coalition has been initiated by the UNFCCC secretariat to encourage use of the DLT to combat climate change. The UNFCCC Secretariat believed that "DLT and supporting technologies will strengthen monitoring, reporting, and verification of the impacts of climate action. The technologies also have the potential to improve the transparency, traceability, and cost-effectiveness of climate action. More current and available data can help build trust among stakeholders and ensure that incentive mechanisms are accessible to the poorest populations, as well as support green finance mobilization to scale mitigation and adaptation actions" (Mead, 2018)

The Climate Chain Coalition member charter includes guiding principles such as:

- alignment with the long-term goals of the Paris Agreement on climate change;
- advancement of DLT for better climate change solutions;
- collaboration;
- technology neutrality;
- commitment to standardization;
- dissemination of DLT benefits;
- mitigation of fraudulent activities associated with the application of DLT;
- taking responsibility for addressing challenges attributable to DLT applications; and
- encouraging the development of DLT-based innovations for climate change, which can also contribute to achieving the SDGs.

**Mathematics of blockchain and signing of data in smart contracts**

"The contract is based firstly upon a culture of mindfulness of the earth system and the sub-components thereof that are central to people (out of ecological responsibility, out of stewardship to the earth system, "ecological citizenship") (Dobson and Bell, 2005); secondly, on a culture of local and global stakeholding (out of democratic responsibility) (Leach et al., 2005; Koa, 2007; Scholte, 2007) […]" (Messner, 2015). These contracts in blockchain are smart contracts and require signatures that are digital and protected by secure keys.

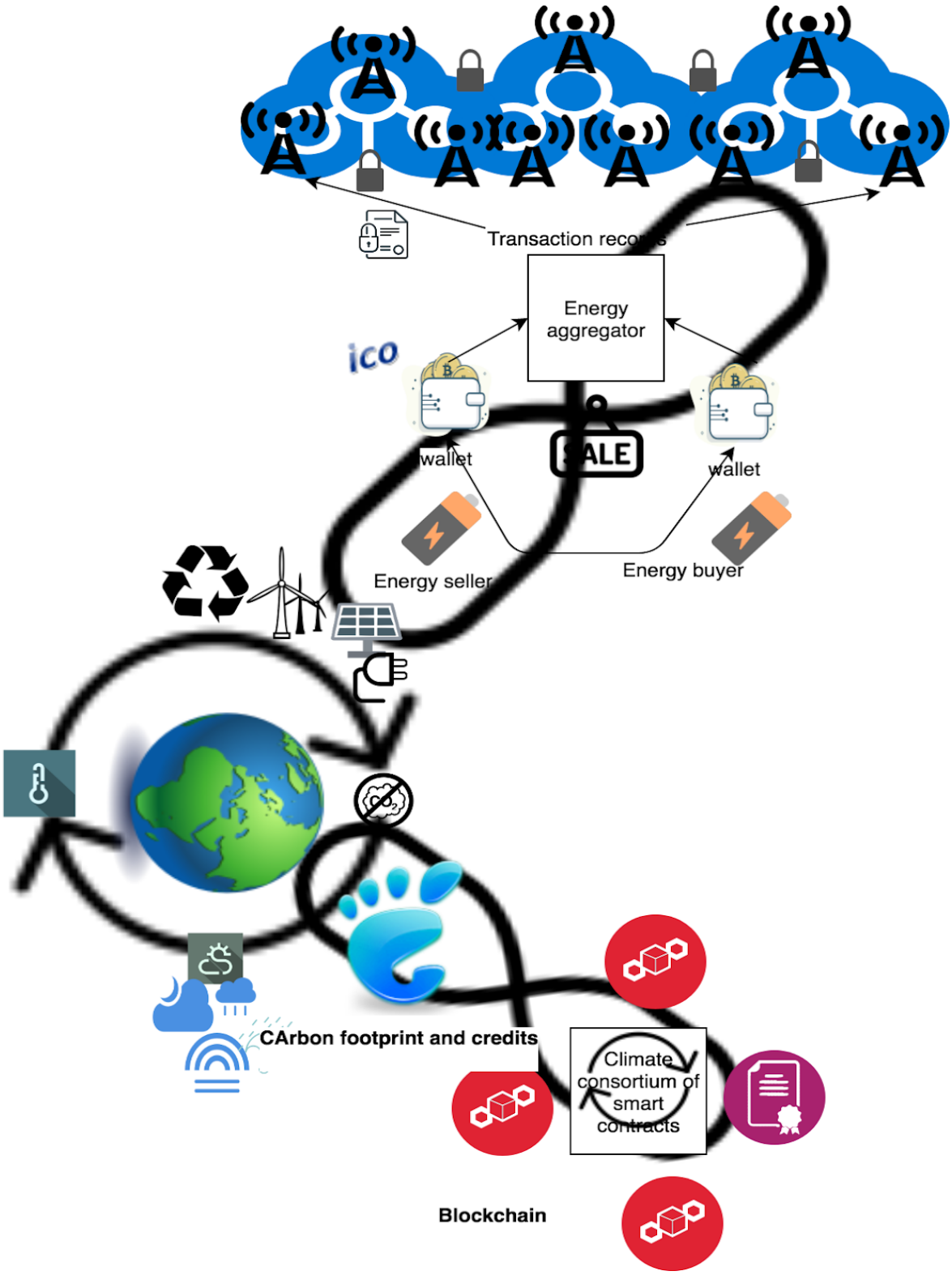



Figure 4 : Smart contracts and blockchain in Climate change



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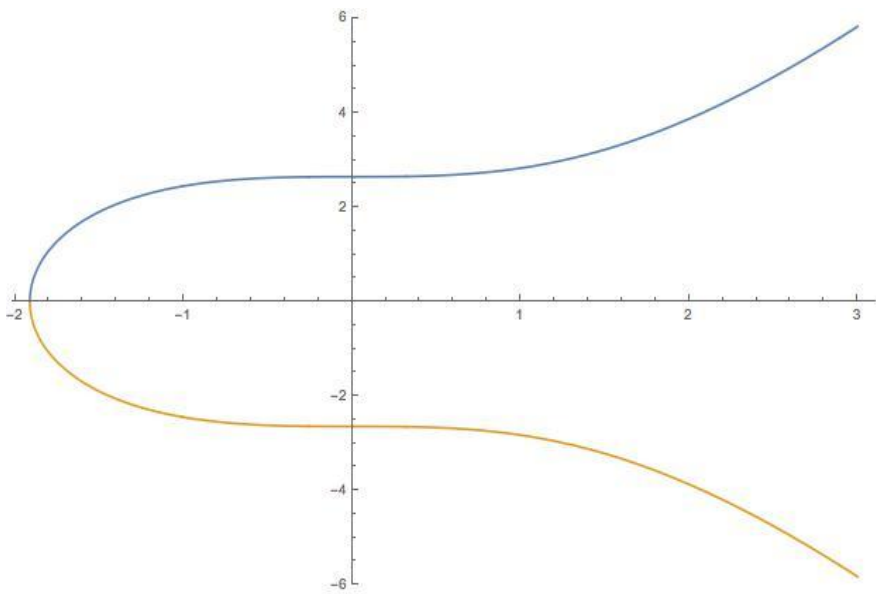
ECDSA is short for Elliptic Curve Digital Signature Algorithm. It's a process that uses an elliptic curve and a finite field to "sign" data in such a way that third parties can verify the authenticity of the signature while the signer retains the exclusive ability to create the signature.

y2 = x3 + ax + b For a = 0 and b = 7 (the version used by bitcoin)

A protocol such as bitcoin selects a set of parameters for the elliptic curve and its finite field representation that is fixed for all users of the protocol. The parameters include the equation used, the prime modulo of the field, and a base point that falls on the curve. The order of the base point, which is not independently selected but is a function of the other parameters, can be thought of graphically as the number of times the point can be added to itself until its slope is infinite, or a vertical line. The base point is selected such that the order is a large prime number. Bitcoin uses very large numbers for its base point, prime modulo, and order. In fact, all practical applications of ECDSA use enormous values. The security of the algorithm relies on these values being large, and therefore impractical to brute force or reverse engineer.

In the case of bitcoin:
The selection of parameters is based on secp256k1 and is part of a family of elliptic curve solutions over finite fields proposed for use in cryptography
Elliptic curve equation: y2 = x3 + 7
Prime modulo = 2256 – 232 – 29 – 28 – 27 – 26 – 24 - 1 = FFFFFFFF FFFFFFFF FFFFFFFF FFFFFFFF FFFFFFFF FFFFFFFF FFFFFFFE FFFFFC2F




Base point = 04 79BE667E F9DCBBAC 55A06295 CE870B07 029BFCDB 2DCE28D9 59F2815B 16F81798 483ADA77 26A3C465 5DA4FBFC 0E1108A8 FD17B448 A6855419 9C47D08F FB10D4B8

Order = FFFFFFFF FFFFFFFF FFFFFFFF FFFFFFFE BAAEDCE6 AF48A03B BFD25E8C D0364141 (SEC, 2000)

Figure 5: Elliptic curve the basis for algorithm to signatures.



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In ECSDA there exists a deep mathematical relationship between public and private keys ,

1< private key < order
public key = private key * base point
Max (Bitcoin addresses) = order

Computation from private key to public key is easy in comparison to deducing private key from public key (theoretically possible and computationally infeasible due to the large parameters used in actual elliptic cryptography). As with the private key, the public key is normally represented by a hexadecimal string. Signing of data could be done if the private and public key pair is available. The data to be signed can be hashed to generate number containing the same number of bits (256) as the order of the curve. The signing procedure is in five steps

1. Choose some integer k between 1 and n - 1.
2. Calculate the point (x, y) = k * G, using scalar multiplication.
3. Find r = x mod n. If r = 0, return to step 1.
4. Find s = (z + r * d) / k mod n. If s = 0, return to step 1.
5. The signature is the pair (r, s)

k = integer that is random or generated by deterministic means that are kept secret from third parties
G=base point
n=order, and
d = private key
z = data
r and s are encoded values.
k should not be repeated in different signatures and that it not be guessable by a third party leading to extracting the private key meaning the hack of the system.

Verification of signature using public key through third party could be done as follows :

- Verify that r and s are between 1 and n - 1.
- Calculate w = s-1 mod n
- Calculate u = z * w mod n
- Calculate v = r * w mod n
- Calculate the point (x, y) = uG + vQ
- Verify that r = x mod n. The signature is invalid if it is not.

Q = public key

The parameters involved are 256 bit numbers that enables the pair for signatures and also the verification of the signature. The aforesaid functions necessary to create the information asymmetry defines the ownership of cryptocurrency. Public blockchain serve as the public transaction ledger of the cryptocurrency bitcoin . These digital signatures are the key for the smart contract formation with contract having its terms of agreement and the unique ID being stored in block.

**Tokens and smart contracts based on Distributed ledgers to combat climate change**

IOTA is a distributed ledger designed to record and execute transactions between machines in the Internet of Things (IoT) ecosystem. IOTA has a cryptocurrency called mIOTA. IOTA's platform uses a Decentralized Acyclic Graph (DAG) instead of a blockchain used by other, similar systems. The main feature of this novel cryptocurrency is the tangle, a directed acyclic graph (DAG) for storing transactions. The current market capitalisation is it 1.6 Billion USD.

ICO's related to climate that are being traded and are planned to raise funds in the future are -

Earth Token and Natural asset exchange blockchain platform aim to tap the untapped natural asset capital estimated to be over 120 Trillion USD, and the 5 Trillion USD divestment of some specific assets from fossil fuels by creating a transparent mechanism connecting producers with buyers and consumers of these asset class. The following are the market capitalisations of the trading coins - Carbon coin, Ecocoin, Earthcoin, Ever green coin.

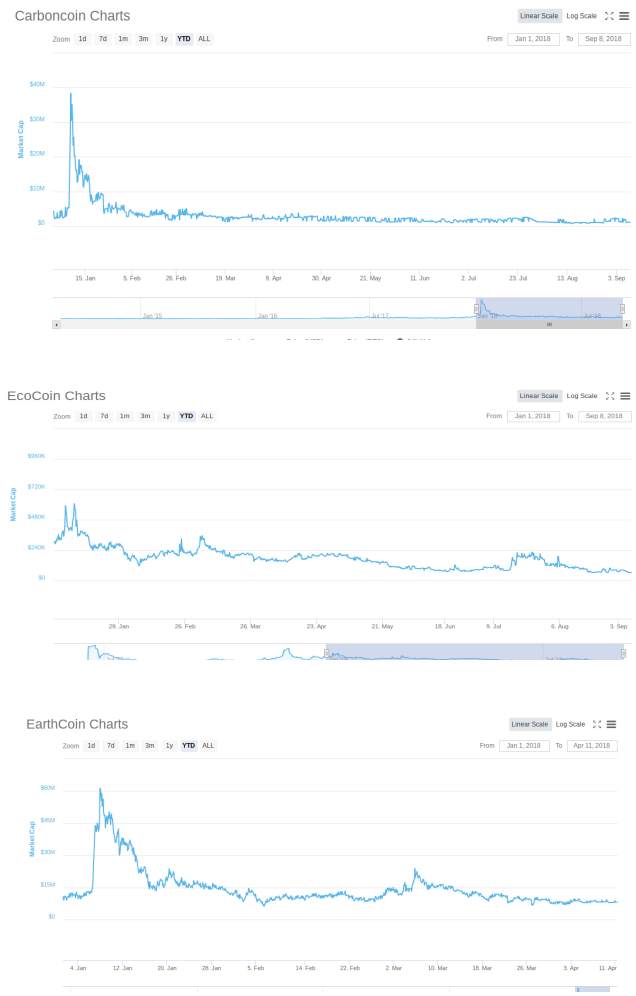



Figure 6 : Market capitalisation of CArboncoin, Ecocoin, Earthcoin, Evergreencoin.



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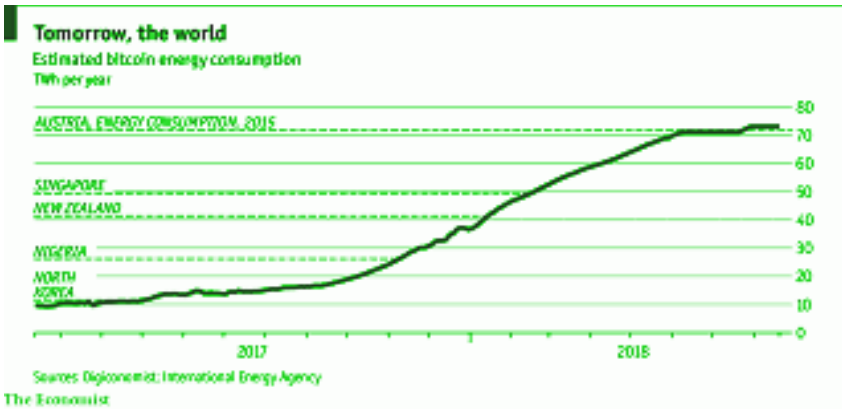
Poseidon and climate coin are yet to be tradeable on crypto exchanges.

“Gainforest is using smart contracts to incentivise small-scale Amazonian farmers to preserve the rainforest. Farmer ’caretakers’ receive rewards for preserving patches of rainforest over a 3-6 month period. The reward is crowdfunded by private individuals or institutional donors and the size is determined by the difficulty in preserving the particular area of land” (Greene, 2018)

**Challenges in using distributed ledger technologies to combat climate change**




if the bitcoin network keeps expanding the way it has done recently, it could lead to a continuous electricity consumption that lies between the output of a small power plant and the total consumption of a small country like Denmark by 2020.

Figure 7 : Bitcoin mining energy requirement compared to country’s energy consumption.

**Green Asset management in Real estate :**

Real estate management being part of “Asset management is confronted with threats related to the unpredictable impact of climate change on global markets as well as the impairment of equity valuations or equity/bond issues due to climate-related effects or mitigation policies. As a consequence, investment strategies will need to incorporate climate change by assessing, for example, forecasts of future carbon prices, and emission footprints of companies, revenue opportunities arising from climate change, and hedging strategies using carbon markets.” The physical impacts of climate change relevant to Real estate sector are mainly decrease in the durability and performance of the material, pressure on water resources, subsidence due to which delays in construction might become repetitive.

“Investment banking is a potential beneficiary of climate change given the role of primary and secondary capital markets during periods of economic change. Primary markets would benefit from any rapid technological change and associated investments to address the impact of climate change. Secondary markets would profit from new trading markets. If climate change leads to greater market volatility, trading revenues may be impacted. However, if monetary

authorities loosen monetary policy to offset economic dislocation, trading revenues are likely to increase. New business opportunities related to the renewable energy market and the global carbon market will emerge and increase in scope. Examples include initial public offerings for companies in the renewable energy sector, exploiting the Kyoto mechanisms, developing weather derivatives, providing emission trading services, and offering financial advice on climate change management" (Furrer and Hoffmann, 2009)

Real estate allocation is defined by the methodology adapted by the investors in managing risks. The scale of risks will vary based on the scenarios for strategic asset allocation. There are several methodologies defined in identifying scenarios for strategic asset allocation, for example by UN IPCC – "Six 'emissions marker scenarios' Assesses scientific, technical and socio-economic information concerning climate change, its potential effects, and options for adaptation and mitigation", our scope of scenarios for Real estate allocation is based on the 4 scenario model developed by Mercer et al 2011.

The 4 scenarios including one based on Stern, attempts to build on prior studies to explore the impact of climate scenarios on markets through asset class and regional analysis, undertaken by Mercer, climate change experts and some of the world's largest asset owners. " the value of green products lies in their contribution to the overall brand identity of an institution rather than in the individual revenue streams they might produce"(Furrer and Hoffmann, 2009). "Minimization of waste in construction, increased refurbishment rather than demolition, use of sustainable features in development processes, partnering and knowledge management can all be seen as sustainable-driven improvements within the development process". (Plimmer, 2009)

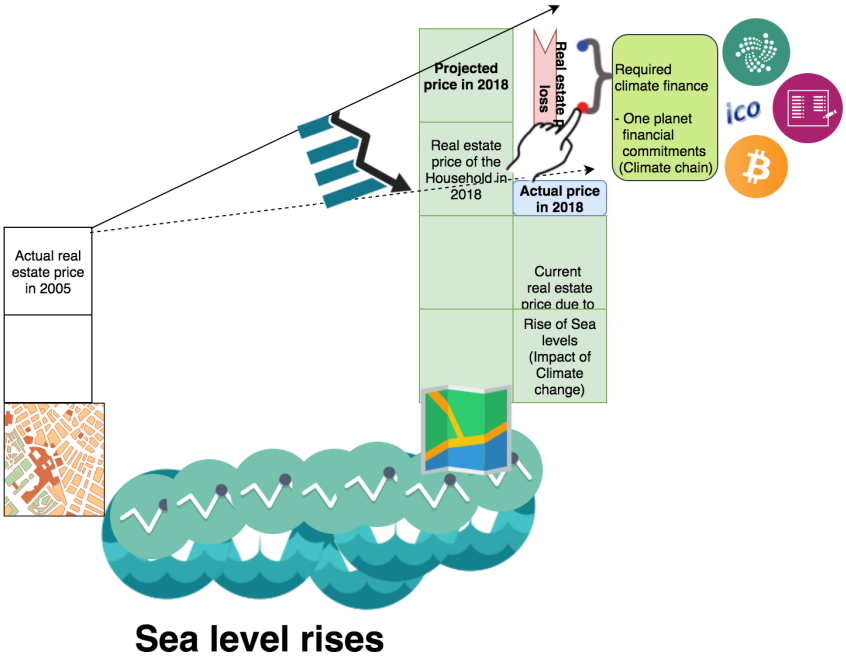



Figure 8 : Real estate price loss and required climate finance through technological innovations.

**Conclusion**

"Key current and anticipated future issues that may result from climate change are changing technological requirements and increasing higher operational costs and migration. The first two will have cost implications for the real estate sector, whereas the latest will affect demand."(Bienert, 2016)

The work from the climatographers presented an index of the blockchain in climate change and cryptocurrencies in climate web to position the use of technological innovation like DLT under the solutions for technology diffusion to combat climate change. (Figure 9). Challenges like the significant energy demand for mining and risks that are political in choosing the data to be stored in smart contracts still are to be explored to see the mathematical justification of using blockchain to combat climate change.

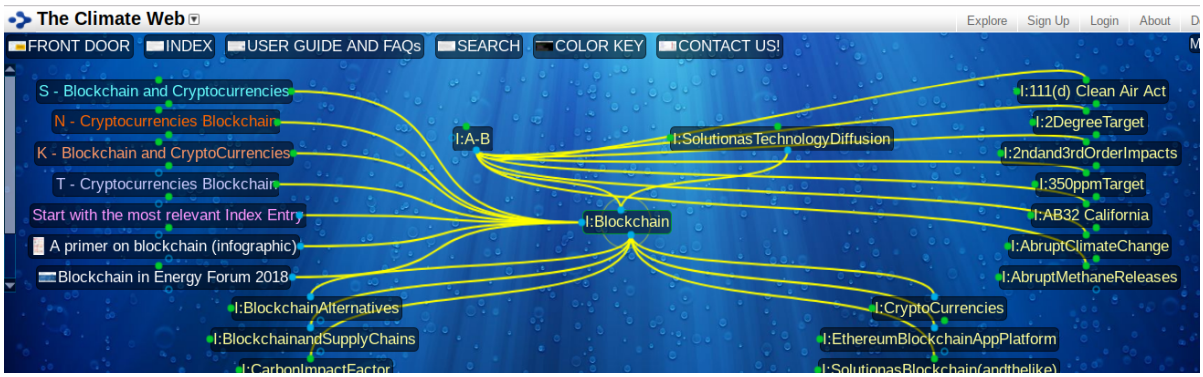
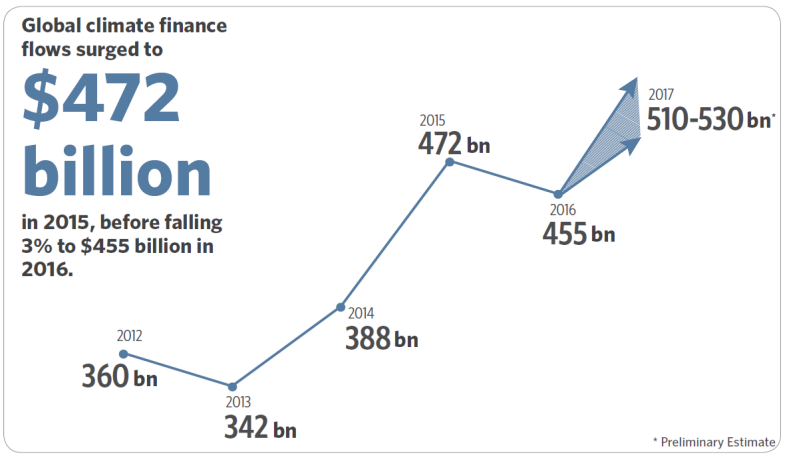


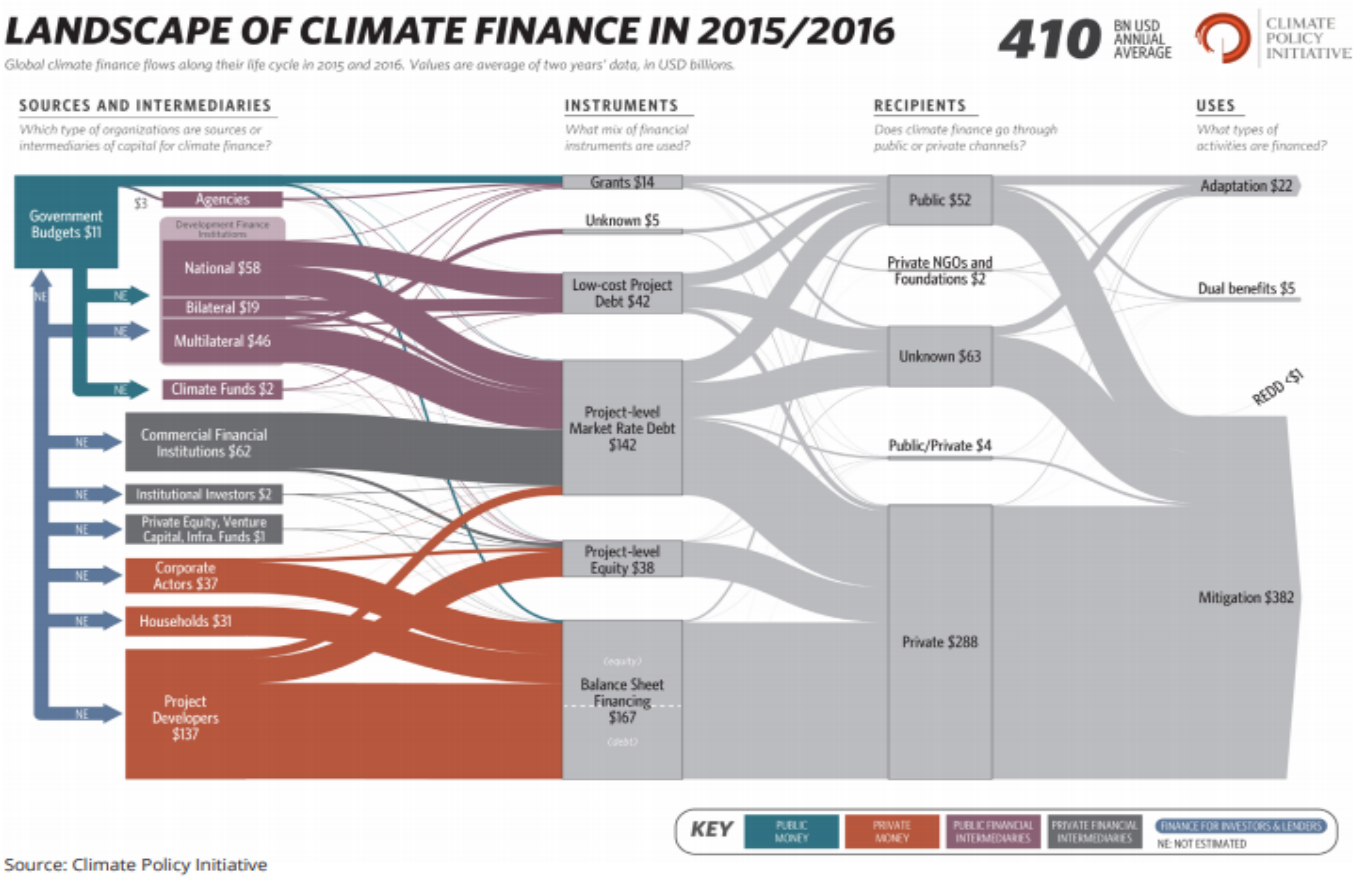

Figure 9 : Index of Climate change and positioning of Blockchain and its interdependencies (The Climate web, 2018). Further research will focus on aspects like Blockchains may entrench uneven power dynamics between donors and recipients. “Can this power dynamic be shifted to a model where both donor and recipient ‘own’ the conditions, enabling both groups to hold each other to account? How can we ensure that these kinds of contracts preserve trust within and between communities?” (Greene, 2018).

Lack of the scientific data is evident and hence mathematical analysis of the impact of DLT on climate finance is a continuous process. To sum it in the words of UNFCCC secretariat - “The Climate neutrality project has just started and we do not have yet developed the DLT. So far, the objective of climate neutrality was just focusing on scope 1 and 2 GHG emissions. And for that we have all the data and some of the UN organization such as the UNFCCC are already climate neutral. Now, we want to add scope 3 emissions. For that, we do not have the data and we also do not have the technology. For the time being, we have just developed the methodological framework”

The climate policy initiative released an updated version of the climate finance numbers during the sidelines of COP24. The estimates show an increase in global climate finance however there is less data to conclude the share of increase due to innovative technologies like the DLT.

Figure 1: Amount of global climate finance 2015-2017* (*estimate)




Source: Climate Policy Initiative



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## BIOGRAPHICAL NOTES

Manohar Velpuri works as the Secretary for Commission 9: Valuation and Management of Real estate, FIG office (Denmark) in addition to fulfilling his duties as executive director for Absolutum consultancy and Absolutum Soleil in Singapore. Manohar velpuri is a Harvard certified specialist in cybersecurity and MIT certified specialist in Blockchain and Distributed ledger technologies. Manohar velpuri is currently an observer in United nations innovation networks in addition to serving as stakeholder in United nations science and technology, innovation forums. Manohar Velpuri has been the liaison officer for ISO Technical committee 307 on Blockchain and Distributed ledger technologies since 2017. Manohar velpuri has been an active deep learning expert through deepsense.ai in collaboration with United nations Emerging and Innovation Technology department.

## CONTACTS

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