Framework Convention on Climate Change

TEC/2023/27/20

Technology Executive Committee

05 September 2023

Twenty-seventh meeting

19–21 September and 22 September 2023 (TEC-CTCN Joint session)

Distributed ledger technology

Concept note

I. Background

1. The Technology Mechanism included in its joint work programme for 2023-2027 a joint activity on digitalization. The TEC and CTCN Advisory Board (CTCN AB) at its joint session on 24 March 2023 decided to establish a joint taskforce to provide further guidance on this work inter-sessionally.

2. The TEC and the CTCN AB requested the joint taskforce to produce a draft concept note on distributed ledger to inform possible best ways for distributed ledger to be delivered to countries in terms of usability and effectiveness with a view to enhancing support for technology development and transfer.

II. Scope of the note

3. The annex to this note contains the concept note on distributed ledger prepared by the CTCN Secretariat under the guidance of the joint taskforce.

III. Expected action by the Technology Executive Committee

4. The TEC and the CTCN AB will be invited to consider the concept note contained in the annex and provide guidance on further work on this matter.

Annex

Concept note on distributed ledger

I. Background

1. This concept note has been produced as an outcome of the TEC-CTCN joint activity on digitalization and on the TEC and the CTCN Advisory Board request to the joint taskforce to produce a draft concept note on distributed ledger.

II. Introduction

2. IPCC AR6 has advocated for a systematic perspective on technological change which could provide insights for policymakers considering options for innovation policy instruments. The systemic view emphasises the role of various stakeholders in shaping the innovation systems towards the achievement of Sustainable Development Goals (SDGs), particularly SDG 13.

3. The Paris Agreement under the UNFCCC together with the SDGs set the vision for a sustainable future. The Paris Agreement aims to limit global warming to well below 2°C. However current policies and actions will lead to a potential global warming of approx. 2.5 to 2.9°C by 2100.[1] In order to achieve the Paris Agreement goal, urgent action is required towards global net zero emissions, shortly after 2050. For greater ambition, actions need to be accelerated and a number of challenges need to be addressed.

4. Emerging digital technologies, such as blockchain, may have the potential to act as a tool to unlock and accelerate global actions towards the Paris Agreement and the SDGs, and first successful applications in the areas of clean energy, climate finance, carbon markets and value chains have been tested and implemented. Blockchain technology opens new pathways towards energy targets contained in the United Nations Sustainable Development Goals and the Paris Agreement. The possibilities are multiplied when blockchain is combined with standard and other new digital technologies such as sensor networks, Internet of Things devices, edge computing, smart meters, enhanced broadband networks, biometrics and artificial intelligence. Well-integrated digital solutions can generate significant impacts on sustainable energy access and mitigation of the ongoing climate crisis that were not even conceivable in past decades.

5. In the face of these challenges, blockchain is an emergent technology that has significant potential to manage the data underpinning distributed clean energy infrastructure. With the help of additional emergent technologies, blockchain could also be applied to address the challenge of growing diversity in climate market mechanisms, by supporting interconnections between individual climate markets at the transnational, regional and national levels.

6. Blockchain (also known as distributed ledger technology or DLT) is a system in which a record of transactions in cryptocurrencies / tokens is maintained across several computers that are linked in a peer-to-peer network. Thereby, trust, security, transparency and traceability of data shared across a network can be increased, and cost savings with new efficiencies can be achieved.

7. Key features of blockchain technology, such as an immutable audit trail of transactions, borderless and cheap transfer of digital assets, and automated execution of contracts (smart contracts), can help address implementation challenges of climate action projects. Specifically, blockchain can be used as a transparency mechanism that incentivizes emissions reductions. Furthermore, financial flows can originate from anywhere and anyone in the world, directed towards specific projects under pre-defined conditions, and with a tamperproof documentation of every transaction. Finally, national accounting of GHG emissions reductions, connected through a ledger recording the international transfer of emissions reductions, enables transparency and accountability of all actors.[2]

[1] https://climateactiontracker.org/global/temperatures.

[2] https://unepdtu.org/wp-content/uploads/2019/02/udp-climate-change-blockchain.pdf.

8. There are a number of potential applications for blockchain technology in the climate space, the most promising are summarized below:

Clean Energy	**Climate Finance (Mitigation and Adaptation)**
• Decentralized renewable energy systems through peer-to-peer (P2P) energy trading / prosumers enabled by smart contracts • Higher transparency, trust, traceability and reliability of in energy savings insurance	• Increased trust and efficiency in parametric insurance through smart contracts • More accessible and transparent mitigation infrastructure investments through tokenization • Facilitating and enabling of climate-smart investments through traceability of financial flows
Carbon Markets	**Value Chains**
• Enabling mechanism for trading and accounting of mitigation outcomes	• Supply chain transparency across multiple participants through data immutability

9. This draft concept note aims to provide a clearer understanding of blockchain solutions in addressing climate issues, with a focus on low- to middle-income countries.

III. Positive attributes of distributed ledger

10. With its key benefits of security, transparency, and verifiability, distributed ledger technology (DLT) has the potential to tackle the challenges of effectiveness in climate action through tokenisation with a view to achieving SDGs. DLT offers extraordinary levels of accountability with immutable, trusted and decentralised databases, plus smart contracts that automate transactions and eliminate inefficient or expensive intermediaries. On top of these benefits, combining DLT applications with the deployment of artificial intelligence (AI) and the internet of things (IoT) enables automatic collection and verification of most climate investment project data could phase out the problem of fraudulent claims or double counting of carbon credits, especially in the Article 6.4 market under the Paris Agreement.

11. DLT enables the distribution of the task of keeping a ledger (i.e., electronic databases) across a network, eliminating the need for a central ledger keeper and effectively delegating the task to the ledger users by using ‘nodes’ (i.e. independent computers). It aims to solve the problem of ‘trust’ across networks. A distributed ledger is a list of all transactions digitally tokenised and recorded across a peer-to-peer network. It can be defined as “an [almost] incorruptible digital ledger of economic transactions that can be programmed to record not just financial transactions but virtually everything of value.”[3] In contrast, a centralised record or ledger is opaque and vulnerable to unauthorised irreversible alteration or deletion. The most well-known DLT is blockchain, which organises data into chains of blocks in an ‘append-only’ mode. This ‘chain of blocks’ is not stored centrally. Instead, each block is copied and distributed around an entire network of peers, namely individuals, public institutions, NGOs or businesses.

12. DTL provides the following five regulatory services:[4]

(a) Uniqueness: Transactions are taken as input to be run through a hashing algorithm. In other words, it is about taking an input string of any length and producing an output string of a fixed length of alphanumeric characters in order to produce a unique identifier for every transaction file;

(b) Validity: All transactions on the blockchain network must be verified by a validator for their legality to prevent malicious or double-spending. Each transaction made is broadcast to the entire network where ‘miners’ validate the legitimacy of a batch of transactions (a proposed update) in order to build a ‘block’. The most notable mechanism is proof-of-work;

(c) Consensus: DLT approves and records transactions through a ‘consensus algorithm’ process. Blocks of transactions are congregated and distributed for approval along to all network nodes which confirm them. Consensus entails agreeing on the ordering of validated transactions.

[3] D Tapscott and A Tapscott, Blockchain Revolution: How the Technology Behind Bitcoin is Changing Money, Business, and the World (Penguin Publishing Group 2016).

[4] A Marke, M Mehling and F Correa (eds.), *Governing carbon markets with distributed ledger technology* (Cambridge University Press 2022).

When there is a conflict of copies, the version of the truth supported by the majority on the network prevails;

(d) Immutability: Whereas most systems maintain a single, centralised copy of transactions and accounts, DLT spreads them across all the key points in the network through a database consensually distributed and synchronised at multiple sites. Also thanks to the consensus algorithm, it results in every location in the network having all the information needed to function autonomously; and tempering with transactional data or fraud is almost impossible because of the huge redundancy of good copies;

(e) Authentication: Whereas traditional system record only data in ledgers, DLT allows users to exchange digital agreements alongside financial and/or non-financial value with smart contracts, also known as “programmable ledger”. For example, a buy and seller of carbon credits can agree upon a transaction (including prices and numbers) which cannot proceed until the receipt of due diligence information as the condition is verified with an ‘oracle’. An oracle is a trusted party (or a technical source, such as a database or an institution assigned this role) functioning as a ‘source of truth’ for a smart contract.

IV. Key insights to some applications of distributed ledger

13. Based on some of the current application which have been tried in different countries on a pilot basis following insights could be derived:[5]

Use case	**Description**
Peer-to-peer energy trading	• While penetration of renewables is increasing, reckless additions can cause a host of issues for energy networks. These issues include, among others, frequency instability, network congestion and voltage disturbances; • There is a need to add renewable energy in a fit-for-purpose way to extract the maximum benefits while maintaining system reliability and without government subsidies; • Peer-to-peer energy trading allows energy produced from renewables to be assimilated locally. Through the creation of a network of localized energy markets, dynamics can be better managed while providing value to all stakeholders involved.
Market platform for renewable energy certificates	• Blockchain-based market platforms for energy attribute certificates can incentivize the leveraging of renewable energy investment to create an alternative revenue stream for renewable energy projects in the post feed-in tariff era; • Blockchain can be efficiently leveraged in renewable energy markets with the help of its open-source tool to build digital platforms for easily registering users and devices, tracking renewable energy, and issuing, trading and claiming corresponding energy attribute certificates in a regulatory-compliant way; • The public sector’s engagement in pilot projects is important to ensure alignment between solutions and energy market requirements and to complement policy goals.
Micro-leasing marketplace	• Blockchain-based financing platforms enable the distribution and receiving of funds in digital currency between various investors – such as individuals, corporations and foundations – and the recipients of these funds, while increasing transparency; • Blockchain-based platforms allow individual and corporate energy investors to buy solar cells that power businesses and organizations in sunny emerging markets and earn money from the clean electricity generated; • Enhanced efficiency and transparency are assured in energy and climate finance flows.
Trading of carbon offset credits	• The tokenization of carbon credits enables them to circulate on a carbon trading platform based on blockchain; • A lack of policy frameworks may lead to a lack of inter-operability among blockchain solutions for carbon markets. Guidelines regarding blockchain data structures, token standards, the legal nature of tokenized carbon credits, privacy and other aspects would help scale up blockchain solutions;

[5] Blockchain for Sustainable Energy and Climate in the Global South: Use Cases and Opportunities: Report is based on a collaboration between the Social Alpha Foundation (SAF) and the United Nations Environment Programme (UNEP). Blockchain for sustainable energy and climate in the Global South | UNEP - UN Environment Programme.

Use case	Description
	• International and inter-industry cooperation and collaboration are essential to advocate for global blockchain-based infrastructure for climate action, comprising multiple stakeholders and protocols.
Digital MRV	• Structured data collected via digital sensors (the Internet of Things) and secured in distributed ledger technologies in combination with digitized MRV methodologies increases the trust and utility of the data to support more efficient and effective decision-making and solutions for climate and sustainability; • Continued developments of digital MRV in individual sector climate actions, including energy, transport, industry, agriculture and others, are essential to bring key learnings on the way to scaling up the solution; • While digitalizing MRV can reduce the total costs surrounding conventional MRV, it adds the upfront costs of distributed ledger technologies and Internet of Things devices that require digital literacy to use. The costs and benefits should be assessed when considering adoption of the technology.

V. Bottlenecks of distributed ledger or blockchain

14. In 2021, the CTCN initiated capacity building activities on “Emerging Digital Technologies for Climate Policy Implementation” with a focus on Blockchain technology. The provided learning course and webinars were successful with more than 380 participants in total from 74 member states. The activities generated even more interest for the potential of blockchain for climate action, but also raised questions as to how blockchain technology can be leveraged best in developing countries.

15. Due to blockchain’s recent emergence, most use-cases and applications are still in their initial stages of development and many more will be identified in the coming years. This also means that this area is still full of uncertainty, technological challenges and information gaps that mean even greater barriers for technology adoption in developing countries. Some of these are highlighted below:[6]

(a) Costs and efficiency: The speed and effectiveness with which blockchain networks can execute peer-to-peer transactions comes at a high aggregate (operational) cost, which is greater for some types of blockchain than others. At the same time the conception and development of a blockchain application comes at high development costs;

(b) Consumption: Blockchain applications are generally known for their high energy consumption, directly linked to the efficiency considerations mentioned above. This poses an even greater challenge to energy systems in developing countries that suffer under grid stability and are still reliant on fossil fuels for electricity generation. However, there are new, low energy consumption protocols developed. Given that blockchain is still in its infancy, it is important to look not only at its positive implications, but also at potential negative environmental impacts from its use. The technology itself also needs to evolve to be applied to foster environmental sustainability or at scale, overcoming the challenges of scale and speed and a “trilemma” between scalability, decentralization and security;

(c) Regulation and governance: Blockchains are based on a decentralized logic which reduces oversight but also comes with challenges. Centralised systems, particularly in financial services, also act as “shock absorbers in times of crisis” despite their bottlenecks. Decentralised networks can be much less resilient to shocks, which can impact participants directly, unless thought is given to their design. Especially in developing countries, passing from centralized to decentralized systems will pose governance and cultural challenges. It is important to create and implement policies and regulations that are not counterproductive to innovative solutions for sustainable development, while at the same time preventing any risks brought through them. Regulatory “sandboxes”, in which solutions that build on blockchain and other innovative technologies could be tested in a controlled environment, can be beneficial to examine and explore the feasibility and challenges of applying blockchain to the relevant domains. The sandboxes can be used to explore the policy and regulatory implications from actual use cases;

[6] https://www2.deloitte.com/content/dam/Deloitte/uk/Documents/Innovation/deloitte-uk-blockchain-key-challenges.pdf.

(d) Required infrastructure: As a digital technology, blockchain requires a reliable infrastructure including energy supply and internet network. This poses challenges in parts of the developing world with low electrification rates, regular electricity outages, low internet connectivity and high internet costs. Furthermore, Driving the penetration of blockchain and relevant emergent technologies requires improving the digital infrastructure. This includes having affordable broadband internet access and smart devices;

(e) Awareness and understanding: One of the principal challenges associated with blockchain is a lack of awareness of the technology and a widespread lack of understanding of how it works. Specifically in the Global South, there is a lack of digital literacy and capacity among enterprises and the public sector to leverage blockchain. Neither is blockchain the solution for all problems, nor is it a synonym for bitcoin or only limited to cryptocurrencies;

(f) Technological complexity: Blockchain is, most of the time, not implemented as a stand-alone technology solution but combined with other technologies such as remote sensing, IoT, machine learning or artificial intelligence. This adds onto the complexity of designing and implementing technology interventions. Furthermore, a blockchain can be set up in many different ways which requires a clear understanding of what is needed as infrastructural decisions might be difficult to change at a later stage. It is important to ensure enough volume of qualified data to be used in the blockchain application. In itself, blockchain does nothing to improve the reliability of the data inputs.

16. All in all, challenges remain in successfully deploying innovative solutions such as blockchain in an inclusive and equitable way, especially in the Global South. Digital infrastructures in low- and middle-income countries are frequently not sufficiently developed and maintained, and evident obstacles remain for technological development and its thorough use. Furthermore, blockchain and other emergent technologies must always be designed following human-centred approaches. The challenges facing communities should guide the development of solutions, and community members should be part of the design, use and evaluation of digital solutions. Even if new technologies can offer alternatives, these solutions will only be effective if they can be operated on the ground, employing or developing local capacities.

VI. Way forward

17. Based on the above barriers for blockchain adoption in developing countries, the taskforce has identified the following areas of potential support to the developing countries:

Areas of potential support to the developing countries	
Technical Assistances	The focus for technical assistance should be on the earlier stages of technology development and the establishment of the enabling environment: • Development of a national roadmap for the adoption of blockchain technologies in support of the NDCs; • Identification of blockchain use cases in a certain sector / for a certain activity; • Pre-Feasibility study for blockchain applications in a certain sector / for a certain activity; • Piloting of blockchain applications in a certain sector / for a certain activity; • Analysis of governance requirements and development of regulatory framework for the application of blockchain technology in support of the NDCs. For this purpose, the CTCN shall identify members in its network with blockchain competencies or attract new members with these in-house competencies.
Capacity Building	• The course that was delivered in September – October 2021 can be made available (semi-)publicly to NDEs for continuous learning; • OR another improved course can be delivered that response to some of the gaps (stronger focus on developing countries, more use cases, different languages, etc.) that were identified during the first run of the course. Existing and new collaborations with network members in this field can be leveraged to provide continuous capacity building.
Knowledge Management	Knowledge management products should elaborate on: • Potential and barriers for blockchain in developing countries; • Clear information basis on blockchain technology (demystification: not equal to bitcoin and also not one-solution-fits-all).

Areas of potential support to the developing countries	
	TEC and CTCN shall coordinate with other UN entities and beyond for collaborative development of knowledge management products in this area.
Other	It can also be considered that the scope of this enhanced engagement of the technology mechanism reaches beyond blockchain to include also other emerging digital technologies including IoT / remote sensing and machine learning / artificial intelligence. Combined capacity building and knowledge management products can be developed.