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Role of blockchain in the sustainable energy transition in the Arab region

Summary

The present document provides an overview of blockchain technology and its role in supporting the energy transition in the Arab region. The material builds on ongoing work by the Economic and Social Commission for Western Asia (ESCWA) and the United Nations Secretary-General's Strategy on New Technologies, which calls for the implementation of blockchain and other emerging technologies to accelerate the achievement of the 2030 Agenda for Sustainable Development.

The present document also sets out key challenges and opportunities for blockchain in the Arab region, and reviews the outcomes of an ESCWA expert group meeting on the role of blockchain in the Arab sustainable energy transition, held online on 20 September 2022. It highlights promising use cases from around the world that leverage blockchain technology to accelerate the sustainable energy transition, and provides a set of strategic pillars and policy recommendations to ensure this emerging technology supports the energy transition in the Arab region. The Committee on Energy is invited to review the present document and comment on its recommendations.

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Introduction

1. The power sector is becoming increasingly complex, owing in part to a shift towards energy decentralization, digitalization and decarbonization. This requires more intelligent and transparent digital tools to manage this complexity and empower stakeholders across energy systems, including suppliers, network operators and prosumers. The proliferation of grid-edge smart entities, such as smart appliances, smart buildings, electric vehicles, rooftop solar systems and home batteries, generates a large amount of granular data. These data can be used to increase power system efficiency and match energy demand with production, reduce energy usage through better data exchange and communication, and further enhance these processes with advanced technologies and tools. Blockchain is an emerging tool that can help manage an increasingly complex energy system securely, efficiently and transparently, as part of a toolbox of innovations.

2. Overall, blockchain has the potential to accelerate the Arab sustainable energy transition by enabling more efficient, transparent and secure systems for effective resource management and service delivery. The present document focuses specifically on energy, discussing emerging use cases within the increasingly complex energy sector. The technology enables new business models in the energy sector, including innovative ways of financing renewable projects, energy attribute credit tracking and certification, distributed energy resource management, e-mobility solutions, and local peer-to-peer and wholesale power trading.

3. The document goes on to explore how blockchain mechanisms can be adapted and applied, with a focus on the Arab region. The successful implementation of blockchain solutions and the realization of its maximum potential will depend on a variety of factors, including regulatory frameworks and infrastructure availability. This will require collaborative efforts from Governments, private sector organizations, and civil society.

I. Role of blockchain in the sustainable energy transition

A. Increasing energy access

4. Access to electricity in the Arab region was almost 91 per cent in 2021, leaving nearly 42 million people without electricity access. Rural areas suffered the largest deficits, with only 83 per cent of rural populations having electricity access, compared with 98 per cent in urban areas. The rural-urban divide was most prominent in Arab least developed counties (LDCs) where urban electricity access was 84.5 per cent, while rural access was only 52 per cent. With respect to clean cooking, around 52 million people in Arab countries lacked access in 2021, with large subregional disparities.[1]

5. Using blockchain technology, innovative means of increasing access to modern energy have been developed, trialled and implemented, particularly on the African continent. Blockchain's role in increasing access to financing has been particularly potent, with thousands of megawatt hours (MWh) of renewable energy generated and tons of carbon dioxide avoided.[2] The decentralized technology has enabled new crowdfunding business models, particularly for those in rural areas.

Decentralized finance

6. Blockchain technology is increasingly used as a tool to leverage decentralized finance to accelerate sustainable energy access in developing countries with limited access to low-cost financing. Decentralized finance is an umbrella term for financial services on public blockchains, primarily Ethereum. Decentralized finance can provide most services that banks support (such as earning interest, borrowing, lending, buying insurance, trading derivatives, trading assets), but it can be faster and does not require paperwork or a third

[1] Data for electricity access is from the World Bank; data for clean cooking is from the World Health Organization.

[2] The Sun Exchange.

party. As with crypto generally, decentralized finance is global, peer-to-peer (meaning directly between two people, not routed through a centralized system), pseudonymous, and open to all.[3]

7. Using decentralized finance, funds can be distributed as micro-loans to residents of low-electrification communities, enabling them to gain affordable access to solar energy. Access to direct and low-cost financing, which unlocks capital from the global cryptocurrency market, is enabling small-scale off-grid consumers to install solar PV systems with no or minimal upfront costs. Instead, consumers pay a fixed rate for their renewable power to global investors, either in local currency or cryptocurrency, such as Bitcoin (BTC) or Ether (ETH). Investors are typically paid back their principal with interest for a fixed duration (for instance, up to 10 per cent interest in the case of the Engie Energy Access programme in Africa). The decentralized and borderless nature of cryptocurrency, with minimal transaction fees (depending on which blockchain is used), can make it an ideal medium of exchange for this purpose. The transparency and immutability of blockchain transactions also means these payments can be audited and verified at any point by all parties, further minimizing risk. The Sun Exchange, a peer-to-peer solar leasing platform in South Africa, has completed 66 projects with 17,405 MWh of solar power generated using decentralized project finance via blockchain.[4]

B. Accelerating the adoption of renewable energy

8. Renewable energy penetration rates in Arab countries continue to lag behind other regions, and most renewable energy comes from traditional biomass. Renewables accounted for only 5.1 per cent of total final energy consumption in the Arab region in 2020.[5] Electricity generation from modern renewables, however, continues to accelerate. Utility-scale solar PV projects have been especially prominent, with some of the largest projects globally, boasting record low prices for power, set to come online in the region, particularly in Gulf Cooperation Council (GCC) countries.

9. Crowdfunding is not only a tool for increasing access, but accelerating the adoption of small-scale renewable energy generation. In addition to innovative financing mechanisms, blockchain is already playing a key role in other ways. Blockchain technology can facilitate better tracking and tracing of renewable energy and sustainable fuels (such as hydrogen, methanol and ammonia), providing transparent information to regional and global buyers looking for assurance of the origin, supply chain, and sustainability of their fuels. Blockchain-based solutions can offer transparency, security, efficiency and predictability with fewer fees and less time, while providing real-time information on the movement and origin of goods, thus enabling better management of supply chains for fuels. They can help tackle challenges and issues related to trade facilitation, such as the need for innovation and digitization of trade procedures. They can also boost Governments' ability to exchange trade data across borders and enhance transparency for consumers.[6]

1. *Distributed energy resource management and trade*

10. When it comes to distributed energy resource (DER) management and energy trade, automated payments using smart contracts[7] and transparent tracking of trade using digital identities and wallets, while maintaining privacy, are some key use cases enabled via blockchain. The technology can also be used to transparently verify the source production of renewable energy, when paired with Internet of Things devices, so that customers can be sure that what they are purchasing is sustainable. In Australia, Project Edge from

[3] Coinbase, What is DeFi?, 2023.

[4] The Sun Exchange.

[5] Data provided by the International Energy Agency.

[6] United Nations Conference on Trade and Development (UNCTAD), Project explores blockchain solutions for trade facilitation, 2022.

[7] Smart contracts are programmes stored on a blockchain that run when predetermined conditions are met. They are typically used to automate the execution of an agreement so that all participants can be immediately certain of the outcome, without the involvement of an intermediary or time loss. They can also automate a workflow, triggering the next action when conditions are met.

Energy Web is trialling the capacity of DER to provide both wholesale and local network services within the limits of a local network. Under Project EDGE, power market actors leverage a shared distributed data exchange hub to enable customer assets to participate in wholesale markets, while also delivering local network services to the distribution grid. This unlocks new opportunities for customers to become prosumers, generating income from battery and solar panels, while also supporting overall grid reliability.

2. *E-mobility*

11. The rise in popularity of electric vehicles (EVs) is driving demand for renewable energy and creating opportunities for vehicles to provide grid services through vehicle-to-grid technology. As EVs become more common, the use of renewable energy for charging must be simplified for consumers. Blockchain technology can be used to give EV drivers and fleet operators the ability to choose their electricity supplier at public charging stations. Volkswagen, in collaboration with partners, is testing and implementing blockchain technology to decarbonize EV charging. The purpose of this proof of concept (PoC) is to enable granular matching between EV consumption and renewable generation. The PoC allowed EV owners to set preferences for electricity generation type and location that dictate the EV charging schedule, and to ensure real-time matching of consumption with locally sourced clean energy. Energy Web's blockchain solution provided the trusted audit trail so that EV owners could trace and prove the provenance of each kilowatt-hour used to charge their EV battery. Most tests took place near Wolfsburg, Germany, and took advantage of abundant clean energy from wind and solar farms in the surrounding area.[8]

3. *Renewable energy tracking and certification*

12. Blockchain's transparency and immutability makes it an ideal platform for managing renewable energy credits (REC), a certificate that represents proof that a certain amount of renewable energy has been generated and fed into the grid. These credits can be bought and sold by individuals, companies or public entities as a way to offset their own carbon emissions or to support the development of renewable energy. RECs can be issued for a variety of renewable energy technologies, including solar, wind and hydropower. They are often used as a compliance mechanism for renewable portfolio standards or carbon trading schemes. Each REC typically represents the environmental attributes of the generation of 1 MWh of electricity produced by renewable sources. The nature of RECs (uniqueness, reliability, transparency) makes them an ideal candidate for tokenization on a blockchain. RECs are unique products, not commodities. Every certificate is as unique as the generator that produced it.

13. Not only electricity can be tracked, but also non-fossil gas, hydrogen, carbon capture utilization and sequestration (CCUS), and any other products that rely on attribute tracking infrastructure. Such products can benefit from blockchain technology, leading to increased trust, understanding, use and growth of the underlying markets.[9] Besides the tokenization of these certificates (their digital representation on a blockchain), markets for these certificates can also be digitized and decentralized using blockchain technology, thereby allowing for the buying and selling of certificates at smaller scales and with reduced friction and fees. This helps to subsidize small-scale generators by providing access to global decentralized REC marketplaces with reduced fees (enabling smaller transactions). Organizations such as Reneum and Singapore Power are already experimenting with the certification of digital RECs, and facilitating the trade of these certificates on a blockchain.

4. *Carbon credits*

14. Blockchain technology can help prevent the "double spending" of carbon credits, increase access to these markets, and help resolve many of the governance issues that have plagued the industry. In the last three months of 2021, some $3 billion worth of tokenized carbon credits were traded, accounting for hundreds of

[8] Energy Web, Energy Web and Volkswagen deliver 24/7 renewable energy charging solution for electric vehicles, 2022.

[9] The International REC Standard (I-REC), An Introduction to REC schemes, 2022.

millions of metric tons of the greenhouse gas.[10] In the first six months of 2022, at least 23 million carbon credits were moved on-chain from centralized registries, representing about a quarter of credits listed at the time. In terms of investment, $423 million from venture capitalists has been invested in crypto-based carbon tracking initiatives over the 18-month period from January 2021 to July 2022.[11]

II. Current status and challenges in the Arab region

15. Blockchain technology is being adopted in the energy sector in the Arab region, led in part by the United Arab Emirates through initiatives like the digital transaction strategy of the Dubai Electricity and Water Authority (DEWA). The DEWA blockchain platform, established in 2017, automates processes such as tenancy contract renewals and activation of electricity and water services (without having to physically visit a service centre), as well as electric vehicle transactions, to make them faster, safer and more efficient. These efforts align with the Emirates Blockchain Strategy 2021 and the Dubai Blockchain Strategy, which aim to streamline and digitize government processes and reduce carbon emissions from the transport sector. DEWA also collaborates with organizations like Smart Dubai and the Roads and Transport Authority to establish a unified national EV charging blockchain network that connects all public and private partners across the United Arab Emirates.

16. In Saudi Arabia, the King Abdullah University of Science and Technology has been researching the use of blockchain technology in managing distributed energy resources and demand response programmes. This can help maintain grid stability, particularly in regions with high penetration of renewable energy sources.

17. The Abu Dhabi National Oil Company partnered with IBM to pilot a blockchain-based system to track the lifecycle of oil and gas products, from production to end-users. Regarding RECs and carbon credits, the Dubai Carbon Centre of Excellence has been exploring the use of blockchain technology to manage and track carbon credit transactions to facilitate their issuance, trading and tracking, thus helping to promote the adoption of renewable energy sources and reduce carbon emissions.

18. Progress in the region has been more muted when it comes to financing and investment in clean energy projects using blockchain. The technology is already being used in Africa to facilitate crowdfunding and investment in renewable energy projects, allowing for more efficient capital allocation and reduced transaction costs. The company SOLshare, which operates in Bangladesh, has been exploring the possibility of expanding its blockchain-based solar energy trading platform to the Arab region.

19. The Arab region is one of the fastest-growing cryptocurrency markets worldwide, with the volume of cryptocurrency received jumping 48 per cent between July 2021 and June 2022. While the region remains one of the smallest cryptocurrency markets, this $566 billion in growth shows adoption is rising rapidly, and familiarity and acceptance of blockchain technologies is growing.[12] Dubai in particular has become a hub for cryptocurrency companies that serve customers all across Asia and Africa, not just the Arab region. The Dubai Blockchain Center was inaugurated by Sheikh Mohammed bin Rashid Al Maktoum, Vice President and Prime Minister of the United Arab Emirates and Ruler of Dubai, in 2018 with the goal of bringing together blockchain thought leaders, developers, investors and educators.

20. Challenges to adoption of blockchain technology in Arab energy sectors include the following:

(a) In many cases, electricity and transport energy infrastructure in the Arab region is not sufficiently developed or requires modernization, as reflected in limited cross-border electricity connections and ageing

[10] KlimaDAO.

[11] CoinDesk, Crypto carbon credits: slapping lipstick on a pig, 2022.

[12] Chainalysis, The 2022 Geography of Cryptocurrency Report, 2022.

transmission lines and distribution networks. This can hamper progress on digital solutions to deliver energy efficiently and effectively;

(b) There may be inadequate technical expertise, particularly in rural communities lacking access to modern energy, to design, install and maintain sustainable energy systems and implement the latest digital technologies;

(c) There are often insufficient policy and regulatory frameworks in place to support the digitization of the energy sector and the development of sustainable energy in rural communities or urban areas;

(d) Challenges linked to electricity sector monopolies and limited participation and investment from the private sector, including inefficient resource allocation, insufficient power supply, limited innovation and advanced technology adoption, inadequate private investment, and dependency on government subsidies;

(e) Political and economic instability in some Arab countries can make it difficult to implement energy policies and projects, particularly emerging digital technologies that have not yet been implemented locally, and may be deemed unnecessary or risky from a technology and regulatory standpoint;

(f) Digital solutions for sustainable energy can be costly to implement, and many Arab countries may not have the financial resources to invest in them, particularly in rural communities;

(g) There is a limited public awareness and acceptance of new digital technologies and sustainable energy solutions in rural communities, which can make it more difficult to implement them.

III. Conclusions and recommendations

21. Arab countries can leverage blockchain technology as part of a toolbox of digital technologies to manage increasing energy sector complexity, while pursuing a just, inclusive and sustainable energy transition. Successful use cases are already being implemented globally and should be adapted and adopted within the region to accelerate progress. The following strategies can help to effectively develop energy sectors in line with these goals:

(a) Create a roadmap for the implementation of digital technologies, including blockchain, in the energy and related sectors to encourage private sector participation and investment;

(b) Identify, adapt and adopt best practices from around the region and the world. Applicable use cases must be tested and adapted based on locals needs and considerations, ensuring adoption is equitable and just in both rural off-grid areas and urban grid-connected areas;

(c) Restructure the energy markets and build out the required infrastructure to enable smart grids with multidirectional flow of power and data;

(d) Reform energy pricing systems and ensure complementary policies to mitigate unintended negative consequences on vulnerable groups;

(e) Empower consumers to become prosumers by enabling smart metering (with submetering at the asset level), country-level flexibility registry for DER, and other incentives to encourage participation;

(f) Invest in digital infrastructure and technology, including in high-speed Internet, cloud computing and data analytics, to support digitization initiatives in the energy sector;

(g) Promote digital skills and education to support the digitization of the energy sector, by investing in training and education programmes to ensure that the workforce has the skills needed to work with blockchain

and other new technologies. Strengthened energy governance and stronger institutions can accelerate the development of intellectual and technological capacity, and the reskilling of human resources;

(h) Encourage public-private partnerships given that collaboration between the public and private sectors can help bring in the necessary expertise and capital to implement digitization initiatives in the energy sector;

(i) Increase public investment in clean energy. Governments should prioritize clean energy access by setting ambitious targets and implementing renewable energy projects. Detailed implementation plans should be backed by public investments and supported with technical and financial resources by the international community;

(j) Accelerate progress on renewable energy. Arab countries have abundant solar and wind resources, which can be harnessed to generate clean, sustainable energy. Digital tools like blockchain and artificial intelligence can help manage the inherent variability of solar and wind power through more accurate weather forecasting and grid management, thereby enabling higher shares of variable renewable energy deployment. Mini-grids and peer-to-peer energy trading have the potential to extend renewable electricity access well beyond the limits of centralized grids,

(k) Enhance regional and international partnerships for energy. Arab countries can achieve gains through energy integration, including by operationalizing electrical grid connections, investing in joint infrastructure projects, and deepening market ties.
