

# **Unit 6**

## **CHAPTER 6**

# **Blockchain Case Studies**

### **University Prescribed Syllabus**

Prominent Blockchain Applications, Retail, Banking and Financial Services, Government Sector, Healthcare, IOT, Energy and Utilities, Blockchain Integration with other Domains.

#### **6.1 PROMINENT BLOCKCHAIN APPLICATIONS**

**GQ.** List and explain the applications of Blockchain technology.

**GQ.** Write a short note on: Applications of Blockchain technology.

- Blockchain is most promising and trustworthy distributed database technology implemented in various applications.
- A blockchain is essentially a distributed database of records or public ledger of all transactions or digital events that have been executed and shared among participating parties.
- As it is discussed in previous chapters, Blockchain technology has become an active area of research and a technological option form any businesses and industrial communities.
- With its distributed, decentralized, and trust less nature, blockchain can provide businesses with new opportunities and benefits through increased efficiency, reduced costs, enhanced integrity and transparency, better security, and improved traceability

## **► 6.2 BLOCKCHAIN INTEGRATION WITH OTHER DOMAINS**

This section explains in detail the applications in which blockchain has been used in recent years and the areas in which blockchain can be used in the future, with some pictorial representations.

### **❖ 6.2.1 Blockchain in Retail, Banking and Financial Services**

**Q.Q. How Blockchain technology can be used in financial and banking services?**

- For the banking and financial services markets, the Blockchain technologies provide various attractive features.
- Financial institutions and banks no longer see blockchain technology as threat to traditional business models.
- The world's biggest banks are in fact looking for opportunities in this area by doing research on innovative blockchain applications.
- Blockchain networks are usually different in their ability to secure that parties involved all have reliable and similar information.
- Bitcoin, the first popular digital virtual currency that presented a fundamental change in approaches.
- While using Community Validation to support distributed ledger technology, blockchain technology decentralized currency command, as a result, customer trust moves from humans to computers.
- Blockchain smart contract solutions are going to challenge the financial, legal and government sectors.
- With distributed ledger technology, smart contracts may automatically and in real-time track the performance of legal transactions.
- Bitcoin's blockchain requires the availability of a consensus algorithm operating on hardware spread across the globe.
- Bitcoin transactions are implemented into the blockchain, and

a computationally intense proof-of-work (PoW) function called mining is needed for this process.

- Bitcoin mining has grown into a highly vertically integrated network with one or more servers operated by individual companies, product design, and hardware maintenance.
- Today's Bitcoin miners send us a snapshot of the future of global computing with Application Specific Integrated Circuit (ASIC) clouds.

#### **❖ 6.2.1.1 Private Securities**

- It is very expensive to take a company public. A syndicate of banks must work to under write the deal and attract investors.
- The stock exchanges list company shares for secondary market to function securely with trades settling and clearing in a timely manner.
- It is now theoretically possible for companies to directly issue the shares via the blockchain.
- These shares can then be purchased and sold in a secondary market that sits on top of the blockchain.
- Some examples are as follows :
  - (1) **Medici** is being developed as a securities exchange that uses the Counterparty implementations of Bitcoin 2.0. The goal here is to create a cutting-edge stock market. Counter party is a protocol that implements traditional financial instruments as the self-executing smart contracts. These smart contracts facilitate, verify, or enforce the negotiation of contract and eliminate the need for a physical document. This eliminates the need for an intermediary, such as broker, exchange, or bank.
  - (2) **Block stream** is an open-source project with focus on side chains-interoperable blockchains-to avoid fragmentation, security and other issues related to alternative cryptocurrencies. Uses can range from registering securities, such as stocks, bonds, and derivatives, to securing bank balances and mortgages.
  - (3) **Bitshares** are digital tokens that reside in the blockchain and reference specific assets such as currencies or

commodities. The Token holders may have the unique feature of earning interest on commodities, such as gold, and oil, as well as dollars, euros and currency instruments.

#### 6.2.1.2 Insurance

- Traditional insurance policies are often processed on paper contracts, which means claims and payments are error-prone and often require human supervision.
  - Compounding this is the inherent complexity of traditional insurance, which are consumers, brokers, insurers and reinsurers, as well as insurance's main Product risk.
  - As a kind of distributed ledger of the blockchain, it improves insurance industry efficiency from four respects : fraud elimination, claims automation, data analysis with the Internet of Things (IoT), and Reinsurance.
  - Assets which can be uniquely identified by one or more identifiers which are difficult to destroy or replicate can be registered in blockchain.
  - This can be used to verify ownership of an asset and trace the transaction history. Any property (physical or digital such as real estate, automobiles, physical assets, laptops, other valuables) can potentially be registered in blockchain and the ownership, transaction history can be validated by anyone, especially insurers.
  - For example, *Ever ledger* is a company which creates permanent ledger of diamond certification and the transaction history of the diamond using blockchain.
  - The characteristics which uniquely identify the diamond such as height, width, weight, depth, color etc. are hashed and registered in the ledger.
  - The verification of diamonds can be done by insurance companies, law enforcement agencies, owners, and claimants.
  - *Ever ledger* provides a simple to use web service API for looking at a diamond, create/read/update claims (by insurance companies) and create/read/update police reports on diamonds.
  - Other financial-oriented areas may include commercial

property and casualty claims processing, syndicated loans, contingent convertible bonds, automated compliance, proxy voting, asset rehypothecation, and over-the-counter market. Finally, blockchain adoption.

- Finally, blockchain adoption by the financial sector will eventually lead to cost savings in areas like central finance reporting, compliance, centralised operations, and business operations.

### **6.2.2 Blockchain in Government Sector**

**GQ:** Write a short note on: Use of Blockchain technology in Government sector.

- Blockchain technology plays a vital role in the development of social and governmental activities for e-governance.
  - In the current system, data such as employee IDs are stored in a centralized database with multiple duplicate servers. However, this centralized system suffers from many cyber attack issues, such as denial of service (DoS) and distributed denial of service (DDoS).
  - Blockchain technology can initialize many flexible services, such as voting records, property registrations, patent exchanges, criminal records, and licenses for driving and other activities.
  - In a distributed system, shared and approved transactions are stored, and each block contains a hash value to ensure its integrity in the ledger.
  - In government sector, verifying authenticity of the document can be done using blockchain which eliminates the need for centralized authority.
  - The document certification service helps in Proof of Ownership (who authored it), Proof of Existence (at a certain time) and Proof of Integrity(not tampered) of the documents.
  - Since it is counterfeit-proof and can be verified by independent third parties these services are legally binding.
  - Using blockchain for notarization secures the privacy of the document and those who seek certification. By publishing proof of publication using cryptographic hashes of files into

- block chain takes the notary time stamping to new level.
- It also eliminates the need for expensive notarization fees and ineffective ways of transferring documents.
- The following are different application areas where blockchain can be involved in government and societal activities.

#### **6.2.2.1 Individual Identity**

- In the traditional system, personal records are stored separately in different systems, such as an employment file, educational file, and business file.
- The information about an individual that is stored in a government database maybe different from the information stored in other databases.
- This problem can be solved by using blockchain technology, where information about a person is permanently recorded at a single point in time and can be made available for anyone, or any institution, that wants it.
- Nowadays, verifying the identity of refugees and immigrants is a serious problem in the world because their records may be lost or difficult to access.
- With the help of a blockchain-based digital identity, records can be accessed by anyone in any location.

#### **6.2.2.2 Land and Property Registry**

- Ownership of property, such as a house or land, can be transferred using a blockchain-based smart contract.
- The rules of the transaction are maintained by the smart contract.
- The buyer keeps the total cost of the property in the blockchain and distributed system.
- Then, the seller can receive the transferred money, and this transaction is confirmed before the property is handed over.
- After that, the registration of the property is updated in the blockchain.
- For example, the valid owner of a lost car can be found by viewing the car's transaction history in the ledger.

- Only the valid owner can sell the car, and ownership must be confirmed. Blockchain technology rapidly confirms the identity of the owner and buyer and the buyer's financial status.
- It keep strack of the transaction history so that unauthorized or fraudulent persons cannot steal the car.
- This can reduce human involvement in registrations for cars or land and reduce the possibility of errors.

#### **6.2.2.3 Birth and Marriage Certificates**

- Some vital records such as birth, marriage, and death certificates can be permanently stored using blockchain technology.
- This ensures that the total number of citizens listed in the automated system cannot be changed.

#### **6.2.2.4 Vehicle Registrations**

- If someone wants to buy a used car, its mileage record can be analyzed by its vehicle identification number (VIN)using blockchain technology.
- Because the mileage and history records of the car are permanently stored, the seller cannot cheat the buyer.

#### **6.2.2.5 Electronic Voting System**

- Electronic voting systems have been widely studied for decades to reduce the costs of conducting elections while maintaining the fairness of elections in accordance with the standards of safety, privacy, and regulation.
- A modern blockchain-based electronic voting system that discusses some of the existing system drawbacks and evaluates certain of the common blockchain technologies for creating an e-voting system based on blockchain.
- The system is decentralized and does not depend on self-belief. Each voter registered will be able to vote via any Internet-connected device.
- The Blockchain can be confirmed and distributed to the public, in such a way that nobody can misuse it.

- In order to achieve a decentralized e-voting framework without a trusted Third Party, the key idea is to combine block chaining with hidden exchange scheme and homomorphous encryption.
- This offers a public and open voting process while ensuring that the identity of the voter, data transmission privacy and voting verification during the billing phase are secured anonymity.
- The method of democratic and open voting ensures the confidentiality of the identity of the elector and data transmission privacy and vote verification during the billing process.
- Blockchain technology is useful for voting systems, especially in national elections.
- A voter can cast a vote only once and check whether it has been correctly recorded or not.
- This process ensures data integrity. The use of a consensus protocol in the distribution and authentication process makes fraud easy to detect and prevents any type of alterations.

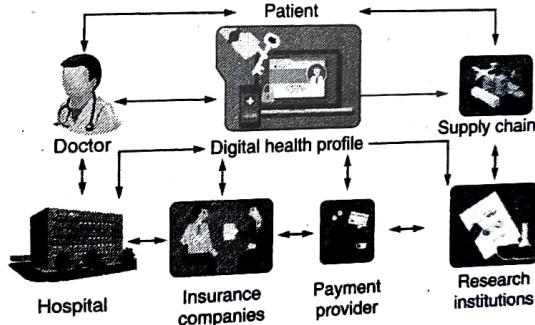
### **6.2.3 Blockchain in Healthcare**

**Q.Q.** State and explain different aspects of healthcare where Blockchain technology can be used.

**Q.Q.** What are the important challenges in adopting Blockchain technology in the healthcare domain?

- Blockchain is an emerging enabling technology that can provide solutions for real world problems including healthcare which is considered as one of the basic human rights.
- In the last few years, blockchain technology has gained reasonable confidence as a smart new trusted distributed system for performing and storing transaction record in the form of distributed ledger.
- However, according to the healthcare perspective, the stakeholders are more involved in discussing and questioning blockchain as a platform rather than focusing on healthcare issues that can be solved by blockchain.

- Blockchain must be transparent in the field of healthcare and scalable, secure and data privacy must be protected.
- The healthcare blocks primarily contain health documents, images, and documents.
- This includes a network of hospitals funded, managed, and controlled by a central organization.
- Data from patients are one of the most informative and important factors of healthcare.
- The medical record of a patient is usually spread over many networks owned and operated by one or more health providers.
- In order to digitalize patient data into what is generally referred to as the electronic medical record(EMR), the synthesis technology has developed.
- Due to many issues such as security and privacy, there are many hurdles to the exchange of EMRs with several healthcare providers and related organizations.
- Blockchain can be used to provide safe EMRs and other exchanging of health information between various vendors.



**Fig. 6.2.1 : Blockchain in Healthcare**

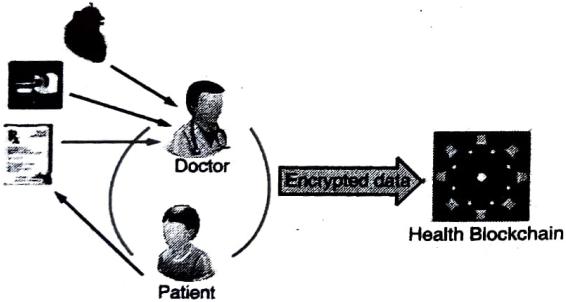
- Fig. 6.2.1 shows the conceptual ecosystem for the use of blockchain technology in healthcare.
- Fig. 6.2.1 highlights various stakeholders involved including patient, doctor, insurance companies, payment provider, and research institutions.

- Blockchain can facilitate the interoperability of updated digital health profile of patients in a timely manner alongwith other benefits, such as, patient data security, protecting patient's identity, and the coordination of care.
- following subsections highlight the major healthcare issues that can be addressed by the blockchain technology.

### **6.2.3.1 Secure Health Information Exchange Between Stakeholders**

#### **(1) Ensuring Privacy**

- The ensuring privacy of healthcare record is one of the major concerns while exchanging information between various stakeholders, such as, doctors, local and international research and development units, health organizations, government sectors, patient's history, and information forwarded to their caregivers.
- Fig. 6.2.2 depicts the healthcare transactions using Blockchain.



**Fig. 6.2.2 : Healthcare Transactions using Blockchain**

#### **(2) Improve Integrity of Health Records**

- Improving or maintaining the high level of data integrity is critical in healthcare as the prescription, lab test and major operation are suggested based on these records. Errors in the record could lead to wrong diagnosis and inappropriate care.

- These errors can be produced in electronic systems during exchange, sharing, and storing record.

### **(3) Decentralized Health Insurance Records**

- Most countries are following health insurance system in which insurance is used to pay the expenses against the healthcare services that are provided to the patient, both locally and internationally.
- Various models of health insurance are followed all over the world but mostly this insurance is provided through social insurance system or private insurance companies.
- Decentralization of these insurance record is critical for ensuring health services to patients irrespective of their resident country.

### **6.2.3.2 Cost of Healthcare Transactions**

- In healthcare system transaction, there are various factors that produces cost including redundant transmission cost, intermediary between related organizations, and near real-time processing.
- The challenge is to propose a model that will incur low-cost healthcare transactions between stakeholders.

### **6.2.3.3 Master Patient Identifier**

- In enterprise systems there is a concept of master patient index or identifier to maintain consistent and accurate medical record of patient across various organizations.
- Patient identification matching is a major problem when it comes to global healthcare services.
- Identification matching in healthcare transaction, such as, exchange of healthcare record, can violate the integrity of medical record and this could have severe consequences.

### **6.2.3.4 Limited Access to Health Records**

- In terms of healthcare information exchange, limited access to health record is provided to maintain security; however, this

- also creates hurdles in researching about the analyses of various diagnosis and effects of certain prescriptions.
- In general, it is an obstacle to further ethical research and development.

#### **6.2.3.5 Conflicting or Inconsistent Rules and Permission Related to Healthcare**

- This highlights the issues of allowing right health organization to access required patients medical record at the right time.
- There are different regulations by countries related to the access-rights of patients' medical record and this introduces challenges related to the availability of medical record for right stakeholder at the desired time.
- The smart contract concept in blockchain can reasonably address this issue.

#### **6.2.3.6 Interoperability with Healthcare Data and Applications**

- There are challenges of interoperability when it comes to access, exchange, and storage for healthcare application and data.
- It first requires establishment of trust between various stakeholders and then assurance of secure access and transactions.
- The blockchain has the capability to address these challenges.

#### **6.2.3.7 Challenges in using Blockchain as a Solution in the Healthcare Domain**

- Despite the benefits, when applied in the real world, blockchain faces several challenges.
- Each of blockchain's built health systems has its own challenges.
- Speed, immutability, absence of expertise, legislation, healthcare infrastructure, and cost of all in considered healthcare.

- In the blockchain-based healthcare system following are the key challenges :

##### **(1) Security and Privacy**

- A key concern of healthcare blockchain applications is that despite the use of the technology, personal identities maybe discovered because of confidential data which has been collected about the same individual patients would be tied to it.
- Moreover, there is a possible risk of infringements of protection that could result from deliberate malicious attacks by criminal groups or even government entities on the healthcare blockchain that could affect patient privacy.
- There have been many studies of crypto currencies strong attacks against the blockchain networks.
- The personal keys used in blockchain for encryption and decryption of data are also likely to pose a potentially unauthorized access to the saved health information.

##### **(2) Immutability**

- Although blockchain offers transparency via immutable auditrecords, immutability disappears, if poor quality or inaccurate information is entered into the chain for malicious purposes.

##### **(3) Scalability**

- A big obstacle to blockchain-based healthcare solutions is the high volume of data. With high volume biomedical data, there is likely to be serious performance issues.
- Another disadvantage is that blockchain-based processing can add substantial latency.
- So, as an example, all nodes on a network must agree to validate the process on the current Ethereum blockchain.
- It requires significant processing, particularly if the load is large.

**(4) Interoperability**

- The interoperability problem is due to the fact that there is not yet a healthcare-specific blockchain standard; thus, various healthcare applications might not be able to communicate with each other.
- Consider for example, the two medical monitoring apps, one of which were built on the Ethereum and the other on Hyperledger, it's difficult to interchange information between platforms.

**(5) Speed**

- Not all of the existing IoT facilities are capable of executing encryption algorithms easily and capably.
- Buying strong computing equipment is a huge investment for healthcare organizations before enabling blockchain use.

**(6) Lack of Expertise**

- The public and patient populations lack experience, awareness, and faith in blockchain.

**(7) Healthcare Infrastructure**

- In such a blockchain-based structure, incentive to keep nodes alive in one nation calls for major socio-technical changes and alignments.

**(8) Cost Undisclosed**

- No one is specific on the up-front costs of implementing and keeping a blockchain-based framework.
- The cost of maintaining the existing framework is balanced by the benefits of migrating to the blockchain.

**6.2.4 Blockchain in Internet of Things (IoT)**

**Q.Q.** Write a short note on: Application of Blockchain technology in Internet of Things (IoT).

- In recent years, IoT-based applications have gained popularity in various fields such as smart cities, healthcare, education, government, and social applications as it is discussed in previous sections.
- In IoT-based networks, many datasets are available publicly for all users.
- Blockchain is used to guarantee the privacy and integrity of these shared data sets.
- A huge volume of data is captured on the IoT platform by a cloud service. Many nodes are connected with a gateway in small networks. In a large network, many nodes are also connected with gateways based on the cluster.
- Each node contains a pair of public and private keys. Every node in the network uses its public key at the time of registration and creates a digital profile record on the blockchain.
- When a node receives a transaction, the private key is used for creating a digital signature, which is verified by the gateway.
- Different IoT devices are connected with the blockchain to synchronize and maintain a protocol for interacting with the blockchain network.
- Various intelligent devices and objects communicate with each other in an IoT environment to perform various tasks.
- Malicious activities in the network can occur through various types of attacks during this process.
- Blockchain technology for encryption and secrecy has been commonly used in the IoT network for this purpose.
- Blockchain in IoT will increase the power of the existing system, which can serve as a building block for creating new business models.
- There is limited protection in the modern IoT world when transmitting private information between IoT devices.
- A hacker may use the transaction data to access private data on devices and commit fraud.
- IoT tools, on the basis of computation efficiency, bandwidth, and resource usage, are detected and validated during transactions.

- After the validation process has been completed, the miner nodes are used in the blocks for storing data.
- The systems are synchronized with the miner nodes to get the latest information on the data blocks.
- Various protocols are applied in the blockchain-powered IoT systems for the synchronization process.
- Following are some of the application areas where Blockchain can be used along with Internet of Things.

#### **6.2.4.1 Smart City**

- A smart city is a diverse IoT-based network system that offers several applications and security solutions to citizens.
- Smart cities rely on the assembly, analysis, and digitalization of information. Fig. 6.2.3 shows the use of blockchain technology with Internet of Things (IoT).

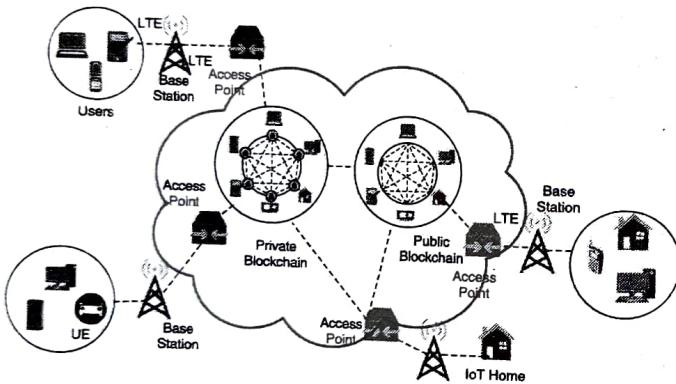


Fig. 6.2.3 : Blockchain with Internet of Things (IoT)

#### **6.2.4.2 Industrial Sector**

- Blockchain and IoT have opened numerous new opportunities and provided hope for improved productivity, efficiency, and transparency in the industrial sector.

- IoT provides real-time data by using sensors. Because the prices of sensors are falling day by day, sensors are becoming affordable for many industries.
- Blockchain is combined with IoT for sharing real-time data among users in a decentralized and distributed manner.

#### **6.2.4.3 Supply Chain**

- The supply chain is an area in which many business problems occur, such as late deliveries, absent suppliers, and untrustworthy intermediaries.
- There is a lot of paperwork involved in the shipping procedures for supplies. In addition, there are many losses of supplies and delays in deliveries of them.
- These problems can be resolved by using blockchain, which removes the dependency on an intermediary.
- IoT devices can be connected to components or products, and the blockchain captures the data from these devices.
- Using blockchain, the location of the shipping container and the time stamp of the transaction can be captured.
- This eliminates the need for paperwork, and delays can be minimized. Digitization creates more opportunities for many companies and drives the supply chain.

#### **6.2.4.4 Autonomous Vehicle**

- The autonomous vehicle is an attractive technology that may offer benefits for years to come.
- Sensors are attached to vehicles and all their information is captured on the IoT platform, which is connected to a blockchain.
- The data can show when a car needs to be refueled or repaired due to an engine breakdown or other problems.
- Because the blockchain keeps a permanent record of each transaction, the trust between the manufacturer and the consumer increases.

#### **6.2.4.5 Plane Asset Manufacturing Management**

- Blockchain and IoT can be used to predict and prevent failures of manufacturing products. IoT sensors can identify failures due to heat or extreme vibration.
- Proactive management with blockchain used with IoT can prevent these failures.
- This allows a factory to produce more reliable products.
- Recording and maintaining huge volumes of data can be handled by digitization with blockchain without the involvement of a third party.

#### **6.2.4.6 Smart Agriculture**

- Information and Communication Technology(ICT) plays an important role in improving the technologies of agriculture.
- ICT facilitates the e-farming system that promotes business efficiency and performance and reduces ambiguity and risks.
- The aim of e-agriculture is to allow farmers to share knowledge to help farmers become more successful, smarter and avoid possible risks.
- Blockchain will help use and promote this exchange of information.
- Introducing blockchain into efarm systems helps to build faith between participants who share their knowledge and use the e-farming servers provided to improve their agricultural operations.
- Such programs are designed to improve cost efficiency, enhance food security and reduce ambiguity and risks.
- In regard to main agriculture firms, blockchain technologies may also be used to report honey adulteration activities, to support intelligent pollution contracts and to improve the beehive insurance market in agriculture-related industries, like bee industries.

#### **6.2.5 Blockchain in Energy and Utilities**

- Q.** Describe the use of Blockchain technology in energy and utilities.
- The energy industry is working on new models and mechanisms to improve its service delivery to customers.
  - Similarly, consumers favor having new methods to buy energy and understanding the origins of their energy purchased.
  - Blockchain-based smart contracts can substantially accelerate a significant development in the energy industry, microgrids.
  - A microgrid is defined as, the cluster of multiple distributed generators (DGs) that supply electrical energy to consumers without any shortage.
  - Instead of the exclusive reliance on a power factory that supplies electricity for a district, amicrogrid enables all electric power consumers to manage their usage and possibly produce and sell energy using solar panels or any other energy alternative methods.
  - Residents can sell extraneous energy to other residents or back to the larger grid.
  - Blockchain can facilitate microgrid-related transactions. Blockchain-based smart contracts enable the application of power-exchange restrictions and regulations, payments management, and direct interaction between users, without a centralized microgrid authority.
  - In supporting unmanned aerial vehicles and connected electric vehicles, an important issue is how to exchange energy.
  - A blockchain-based energy exchange method has been proposed to support a secure and energy-efficient transportation system.
  - Blockchain is used to approve the energy requests of electronic vehicles in a delegated manner, in which the mining node verifies the validity of each request.
  - In addition, a software-defined backbone controller is used.
  - The potential applications of blockchain in the energy sector are far-reaching and may have an enormous impact both in terms of processes as well as platforms.

- Blockchain may reduce costs and enable new business models and marketplaces, can better manage complexity, data security, and ownership along grids, can engage prosumers in the energy market acting as enabler for the creation of energy communities, can enhance the transparency and trust of the energy market system, can guarantee accountability while preserving privacy requirements, can enhance direct peer-to-peer trading to support the smooth operation of the power grid, and can better handle demand response and provide a framework for more efficient utility billing processes and transactive energy operations.
- Blockchain technology may also be used for issuing certificates of origin, particularly for green energy production and renewable energy sources, for developing peer-to-peer energy transactions schemes, and for establishing energy management schemes for electric vehicles.
- It is also worth mentioning that blockchain is considered an enabler for the decarbonisation of the energy sector facilitating its move towards more decentralised energy source.
- In the end, while blockchain applications are being widely deployed, many issues have yet to be addressed.
- By doing so, blockchains will become not only more scalable and efficient but more durable as well.
- The features they offer are not unique if judged individually, and the bulk of the mechanisms they are based on are well-known for years.
- However, the combination of all these features makes them ideal for many applications justifying the intense interest by several industries and other domains.

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*Chapter Ends...*