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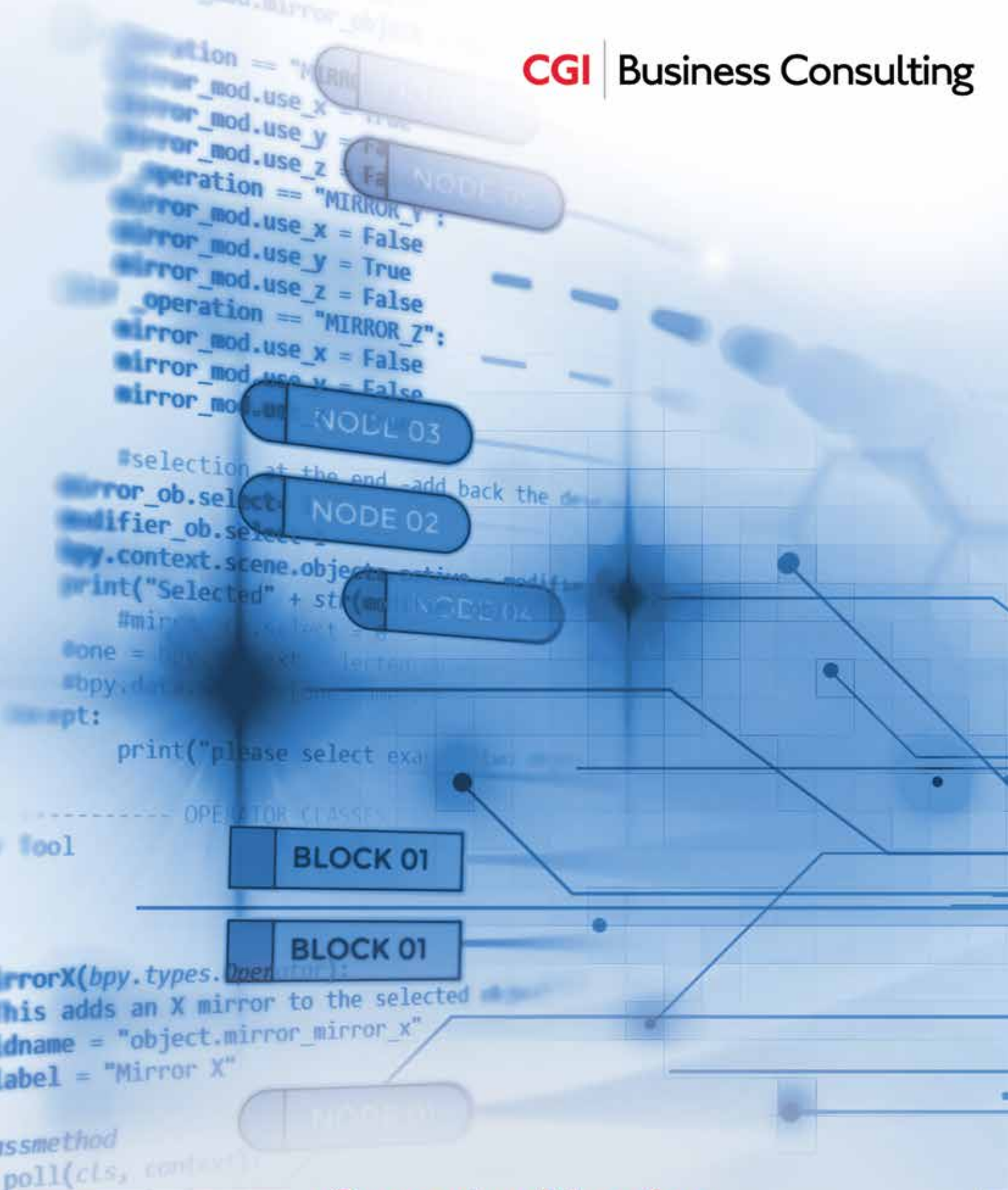


Opportunities for **blockchain** in the **energy** sector

Agenda

1 Introduction to **blockchain**
Challenges, principles, stakeholders and projects 4

2 Overview of
energy use cases
Energy use cases..... 12

3 Considering the
regulatory challenges
inherent to the energy sector..... 18

4 Conclusion and
perspectives
for energy stakeholders..... 22

5 **CGI's Business Consulting**
value proposition for your blockchain projects..... 24

Executive summary

The premise that blockchain has the potential to redistribute markets and redefine the entire economy is one that is widely shared today. Over the past three years, more than **2,500 patents** relating to this technology have been filed. In the first quarter of 2016 alone, more than **$1 billion** was invested in blockchain start-ups and the World Economic Forum even maintains that **10% of global GDP** could be created on blockchain platforms in 2025. In the light of this huge, emerging trend, organizations are beginning to ask the question: Is blockchain a threat or an opportunity?

A secure archive and exchange system

Blockchain is an information storage and transmission technology for data and transactions that uses a secure, distributed registry. Governance may be decentralized among peers. In blockchain, data is certified by certain members of the registry (the miners) and is verifiable by all others. If anyone wanted to corrupt this distributed consensus, it would be necessary to corrupt 51% of the servers on a public blockchain simultaneously—something that has never been done to date.

A relatively immature technology...

The most well known and mature blockchain technology is Bitcoin, although more than 700 other platforms exist on the market for a variety of uses that include cryptocurrencies. For the most part, these platforms are in beta. The accompanying APIs and documentation are still incomplete, REX are even less common and the capacity to industrialize and exploit developments still needs to be explored.

... yet a promising one

So why is there so much media hype and why are an exponential number of proof of concepts (PoCs) appearing every week? Actually, many people foresee potential for blockchain to revolutionize our societies, creating more of a societal change than a technological one.

Just like the Internet, blockchain is not in itself a technological revolution, but rather makes relevant use of existing technologies to create innovative use cases and business models in a wide range of sectors, particularly the energy sector.

Opportunities for blockchain in the energy sector

The main attractions of blockchain are its security, immutability, availability and transparency, as well as the ability to automate processes that are currently time-consuming, at reduced cost. They are applicable to a host of use cases from production to support and supply: traceability of assets and interventions, alert management for connected items, transparency of exchanges, ability to manage micro-transactions and reconcile flows (renewable production (REN), charging electrical vehicles, exchanging guarantees of origin, erasure, energy saving), creating new customer services (loyalty programs), publishing count data, etc. For these activities, blockchain would facilitate process optimization, reduce administrative costs and improve the customer experience.

Today there are about thirty experiments in the energy sector, of which the most hyped example is the photovoltaic energy trading model between the residents on President Street in Brooklyn, New York, USA.

Method under discussion

The aforementioned use cases provide a fairly adequate illustration of blockchain's potential to shake up current business models in the energy sector as well as its potential to reposition stakeholders.

Nevertheless, blockchain is not the universal solution to all problems relating to securing, exchanging and automating transactions. An accurate diagnosis of the organization, its processes and culture, and its applicable use cases is needed to assess blockchain's relevance compared to other existing solutions (such as database management system (DBMS), middleware, etc.)

Try fast, learn faster

The speed at which technology is adopted (and becomes obsolete) is increasing. When a promising, but as yet immature, solution presents itself, it is at least wise to explore options, analyze its impact on the organization and the market and, if need be, adapt its regulatory framework.

Experimenting, beyond the proof of concept method, will have to entail proving its value for the partner ecosystem. This implies a stage of acculturation for the stakeholders, co-construction of market rules and shared governance of the system—concepts that not all traditional trusted third parties are familiar with.

Favourable regulation yet to be defined

The European regulatory framework (including the Winter Package) forms a basis conducive to the development of blockchain, especially in relation to microgrids, charging electrical vehicles and managing guarantees of origin. However, some points still need to be clarified (the status of consumer-players, the responsibility to strike a balance and the funding of networks).

In a more general context, various processes can take advantage of the capacities for traceability, authentication and automation created by blockchain, but their legal status remains to be defined, as does dispute resolution, particularly in an international context.

Embracing a brave new world

By decentralizing trust, blockchain undermines the authority of the institutions and states that underpin it. It is clear that this great wave of "global disintermediation" will have an impact on citizens' and organizations' ways of thinking, even after Bitcoin has been replaced.

The six stages of a blockchain project

Introduction to
blockchain
Challenges, principles, stakeholders and projects

1 | Challenges, risks and opportunities of blockchain

An emerging and massive trend

The Internet of Value is advancing! The notion that blockchain has the potential to redefine business models and to shake up the status quo is now widely shared. After the finance sector, it is now the energy sector's turn for a burgeoning wave of pilot projects. In the energy market, peer-to-peer power trading, such as the power trading project in Brooklyn, is by far the most hyped, but RWE, Vattenfall, Wien Energy and Engie have also started their own experiments.

This technology of storing and transmitting information via a decentralized, secured and transparent registry is now high on the innovation agenda. Over the past three years, more than 2,500 patents related to this technology have been filed[1], and in the first quarter of 2016 alone, more than $1 billion has been invested in blockchain start-ups[2].

Challenges

The birth of Bitcoin in 2008 heralded disintermediation in the banking sector. Since then, several consortia, such as R3, have been examining the use of blockchain to replace current interbank payment systems. In the energy sector, blockchain has the ability to challenge market organization as it has been defined since the markets opened in the 1990s, using innovations such as participative funding of REN, direct transactions between producers and consumers, private networks, etc.

On the other hand, blockchain gives rise to new opportunities for traditional stakeholders to reduce their administrative costs, secure operations, develop new services for their customers and also to renew their status as trusted third parties.

The challenges for these stakeholders is therefore to know how to anticipate a shift that is both societal and technological in nature before they are affected by it, and to be able to respond to the following questions:

- Who will be the trusted third parties of tomorrow?
- How can blockchain generate value for my company?
- What are the real opportunities presented by blockchain and what are its limitations?
- How can we experiment with blockchain to validate its feasibility and evaluate its impact?
- What position will we adopt in the blockchain ecosystem?
- Who are good partners?
- What regulatory changes are required for blockchain?

As part of a voluntary strategy, it is first necessary to determine all relevant use cases of blockchain, objectivize their advantages, estimate their adoption rate and then define the company's adjustment strategy and ensure conditions for success.

This step is similar to that already taken by companies actively undergoing digital transformation. Although the exercise here requires knowing how to overcome current regulatory barriers and to adopt the position of a "barbarian economy." Like the regulatory barriers already lifted by the development of the Internet, the regulatory framework will also adapt to blockchain and we must start preparing for that adaptation now.

[4] World Economic Forum 2016

[5] Techcrunch

[3] Hyperledger.com

A tentative definition

Blockchain is a technology for storing and transmitting digital information that is decentralized, secure, transparent, chronological and reputed to be hack-proof. Each transaction is visible to all members, who can verify its authenticity.

It is also an active registry that is capable of performing simple processing, but whose code (or logic) and input data are also certified and verifiable.

The blockchain validation process for a piece of information is described hereafter (see figure 1).

Operating principle

A block (comprising a set of transactions) is validated by specific members (i.e. the nodes or miners). These miners are remunerated for performing the validation operations. All other members of the blockchain (simple nodes) can verify these blocks, thus increasing confidence in the transactions. Only validated blocks are integrated into the rest of the chain in chronological order. The set of blocks thus forms a registry that is basically unmodifiable, as modifying a single block would require the entire chain to be modified.

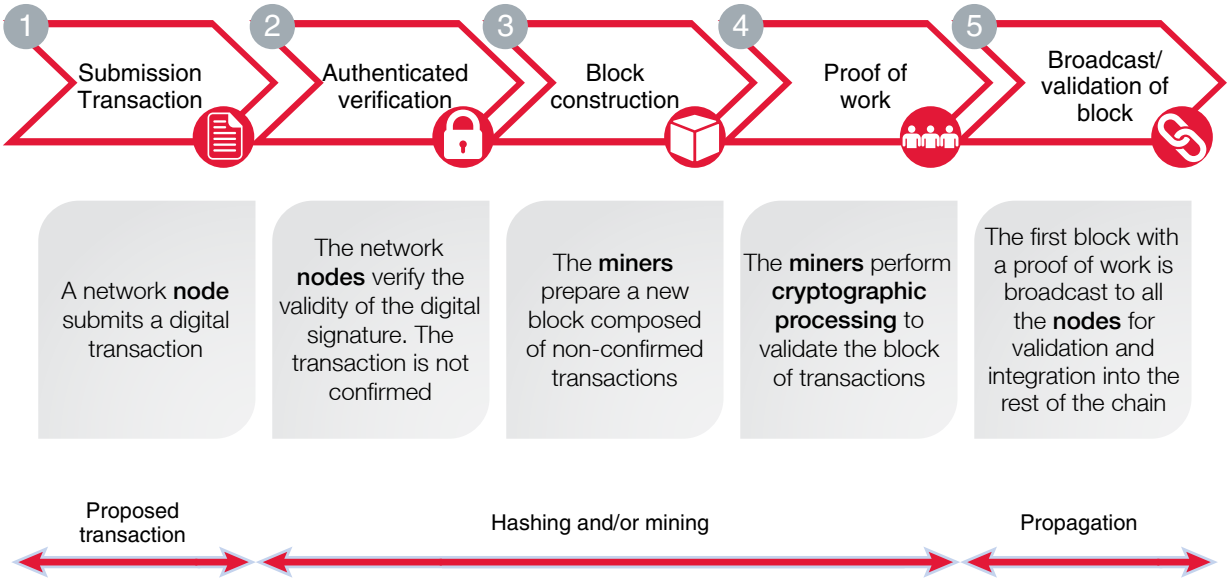


Figure 1: Main stages of a blockchain process

The 3 main features of a blockchain registry

Secure registry

The registry acts as a notary, storing transactions in authenticated, chronological and encrypted form, indefinitely. All the information is reputedly hack-proof.

Shared registry

The registry, which is accessible in the same way to all the members, makes it possible to generate a transaction by authenticating its involved parties, its content and its metadata (date and place).

Active registry

Based on the principle of smart contracts, the registry can execute a program autonomously (which is itself hack-proof), allowing transactions to be automated.

Applications

On the basis of the three main characteristics of blockchain cited earlier, we can deduce the technology's main advantages for stakeholders in the energy industry.

Proof of existence and ownership	By authenticating the sender of a message or the parties involved in a transaction, blockchain is able to certify the existence of an asset, its owner and its transfer between two stakeholders.
Confidentiality and non-repudiation of exchanges	By encrypting the transaction, blockchain ensures that only the authorized recipients will know its content.
Proof of veracity and anteriority	By preventing modification of the transaction's content and metadata (i.e., the date, time, and GPS coordinates), blockchain is able to substantiate the state of an asset at any specific time and location.
Transparency of exchanges	Blockchain is readable by all members and allows each member to verify the veracity of the information contained in the registry.
Automation	Using smart contracts, an action such as transferring an asset or sending an alert, can be initiated automatically.
Enumeration and validation	Smart contracts allow data, like meter data, to be validated automatically.
Reconciliation and compensation	Using assignment and prioritization rules, smart contracts ultimately make it possible to assign values or differentials to specific stakeholders.

Blockchain key words

Asymmetric cryptography

TThis is an encryption method using a pair of keys: the message is encrypted using the sender's private (secret) key and the recipient's public key.

Decryption is done in inverse sequence using the sender's public key and the recipient's private key. This process ensures that the message cannot be intercepted or modified. However, if a private key is lost, it cannot be recreated and all the data it has encrypted will then be indecipherable.

Hashing

Hashing is a unidirectional cryptographic function that allows the source information to be converted into a unique, fixed-size code (i.e., hash or stamp). It is impossible to recreate the source based on the hash. However, once the hashing key has been set, the same source may only create one unique hash.

Mining

Mining refers to the work done by the blockchain members responsible for validating the blocks (miners nodes), applying their calculation methods to verify the blocks and ensure that each copy of the chain remains coherent between nodes.

Proof of work

The proof of work is the most common method in blockchain to reach a consensus on the validity of the chain of blocks. This process demands a significant calculation capacity that is remunerated in cryptocurrency. Blockchain adapts the proof of work's level of difficulty over time. In the case of Bitcoin, a single networked computer takes around 10 minutes to perform this task. The difficulty is regularly adapted to maintain this time frame. Other methods exist, such as proof of stake.

Proven opportunities…

Today blockchain creates widely shared opportunities for process optimization, transparency and traceability (see figure 2). Its automation potential makes it possible to design a leaner approach to corporate processes and market mechanisms. Substituting institutional trusted third parties for a distributed consensus mechanism may herald an era of massive disintermediation.

In the energy sector, using the functionalities described above, blockchain applications would specifically facilitate micro-transaction management, network balancing, peer-to-peer power trading and the development of loyalty programs.

Many see blockchain as the great universal middleware of the future. We believe that the real opportunities still have to be defined in more detail (cf. Chapter 2).

… and surmountable limitations.

Currently the main restrictions of blockchain are the typical ones of an emerging technology: limited and unstable APIs, incomplete documentation and standardization, and non-assured scalability. On the other hand, there is no doubt that the time it will take for blockchain to mature will be faster than that of Internet technologies (cf. page 9).

As these are risks relating to security, we note that current attacks have only affected peripheral applications or weaknesses in smart contracts, but never affected the core of blockchain. A risk does remain if private keys are lost or stolen and there is also the oft-discussed risk of consensus distortion if more than 51% of the network nodes are corrupted. Platforms are working to limit these risks. Ethereum, for example, is planning to move away from a consensus using proof of work to a consensus using proof of stake (authorizing mining in proportion to the degree of confidence acquired).

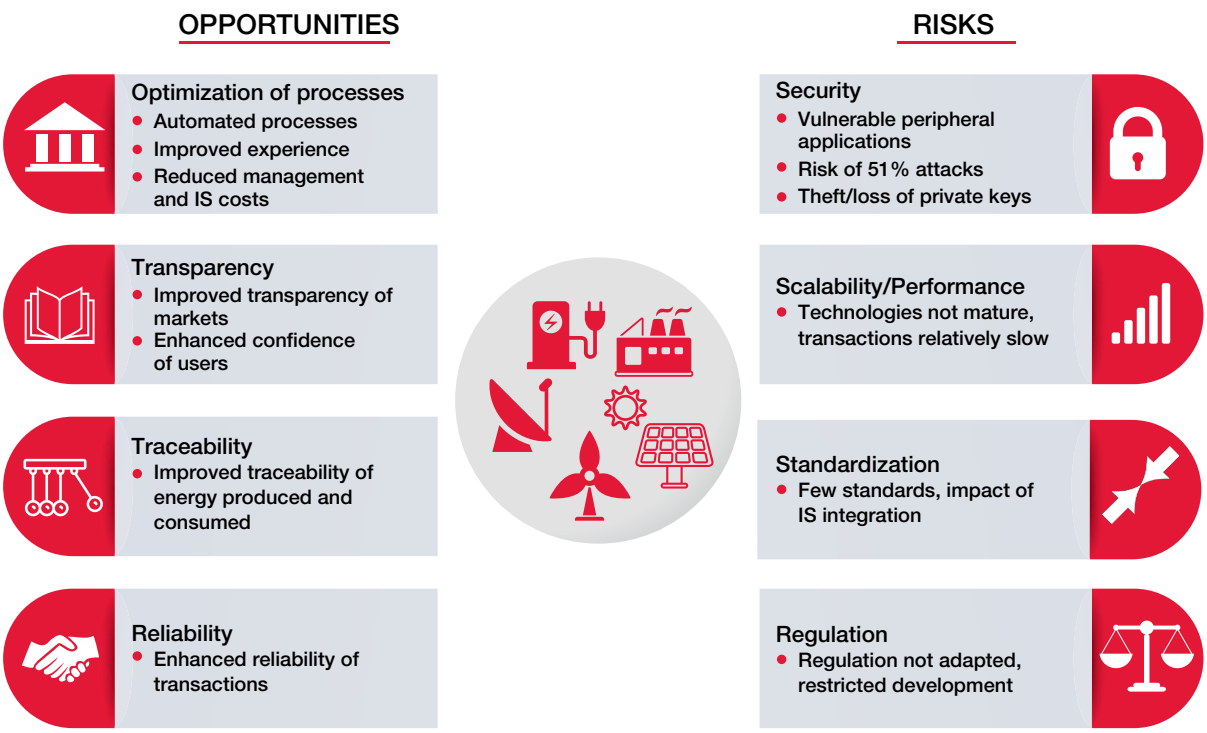


Figure 2: Main opportunities and risks of blockchain

Parallel between the development of the Internet and of blockchain

Does a plan to adopt a “fundamental” technology exist?

In less than 30 years, TCP/IP protocols, which came into being in the 1980s, have brought about a major upheaval of the global economy. Initially, the Internet was designed to connect computers located in different research centres. When first considering how to generalize these protocols, the architects were initially sceptical and particularly stressed on the security and scalability risks (see figure 2: Main opportunities and risks of blockchain).

Between the mid-1980s and the late 1990s, an increasing number of applications were developed on the “network of networks” until the HTTP protocol was developed in 1989. HTTP was designed to create pages connected via hypertext links, and went on to become the World Wide Web.

HTTP in turn generated an exponential number of applications, which was fed by the boom in professional micro-computers, followed by public micro-computers, thus launching the democratization of access.

In the 2000s, a new generation of companies emerged and took advantage of the reduced costs of connectivity and the appearance of mobile terminals offering commercial services. This was the advent of the Internet’s pure players, who challenged traditional brick and mortar players.

Exploiting a niche, substituting, and then changing the economy are the classic stages of adopting a “fundamental” technology.

It took about three decades of development for the Internet to reach its current form. Despite the clear similarities with blockchain, it is difficult to predict accurately how the adoption curve of blockchain will appear, although it will doubtless be swifter.

It could be considered that blockchain is currently at a stage similar to the Internet’s position at the end of the 1990s, when nobody could foresee its impending explosion (Bitcoin is now the only blockchain application in serial production, the others are currently being beta-tested).

Nevertheless, Goldman Sachs[5] foresees blockchain’s widespread use in about a decade from now, although this prediction does depend heavily on overcoming the regulatory barriers.

At present, society’s appetite for this kind of technology is apparent: see the advent of the consumer-player, decentralization of energy policies, REN development objectives, emergence of erasure, development of the zero marginal cost economy and the circular economy—everything indicates the rapid development of blockchain. It is imperative to prepare now in order to be in a position to anticipate tomorrow’s economy.

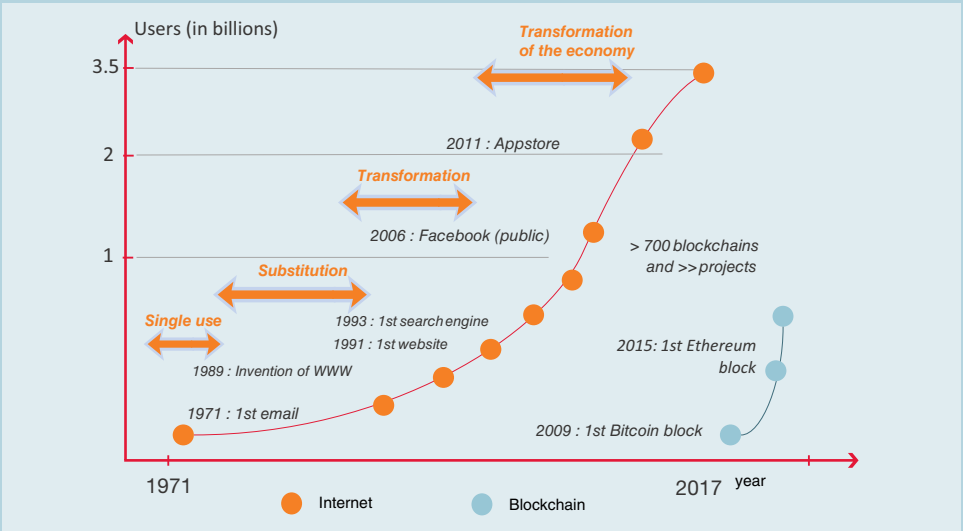


Figure 3: Development of the Internet compared to blockchain[4]

[4] Harvard Business Review, the truth about blockchain and CGI Business Consulting Analysis

[5] Profiles in Innovation blockchain, Goldman Sachs, 2016

Blockchain stakeholders

The **enablers** provide the technology per se, the blockchain core, e.g. Bitcoin, Ethereum, Hyperledger, etc. There are already more than 700 on the market.

The **embedders** are the API and BaaS (Blockchain as a Service) platform suppliers who extend the core functions of blockchain to facilitate its implementation. Integrators and editors develop blockchain-based applications. Some of them specialize in editing packaged solutions customized to a particular sector. These privileged partners have the role of accelerating the projects of energy stakeholders planning to conduct experiments.

The **enhancers** are consortia that have been created to promote and standardize blockchain. Around twenty consortia have already been established (e.g. R3 for the financial sector). These consortia have a major role to play in the adoption of this technology.

Ongoing projects

Several experiments have been conducted in the energy sector, most of which are in the B2C marketplace concerning peer-to-peer power trading and trading guarantees of origin. Figure 5 shows the most significant projects to date.

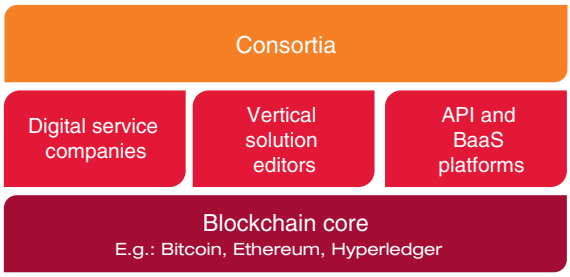


Figure 4: Blockchain stakeholders

LO3 Energy is a start-up that was established in 2015 and created a blockchain platform for peer-to-peer solar power trading in Brooklyn, New York, USA (the TransactiveGrid project, which was carried out in partnership with Consensys).

CGI Business Consulting launched a technological partnership with LO3 Energy to enable its energy customers to identify and implement blockchain use cases based on the return of experience for the TransactiveGrid project.

This convergence with LO3 Energy allows CGI Business Consulting to offer its customers an integrated consulting solution for blockchain on an international and technological scale.

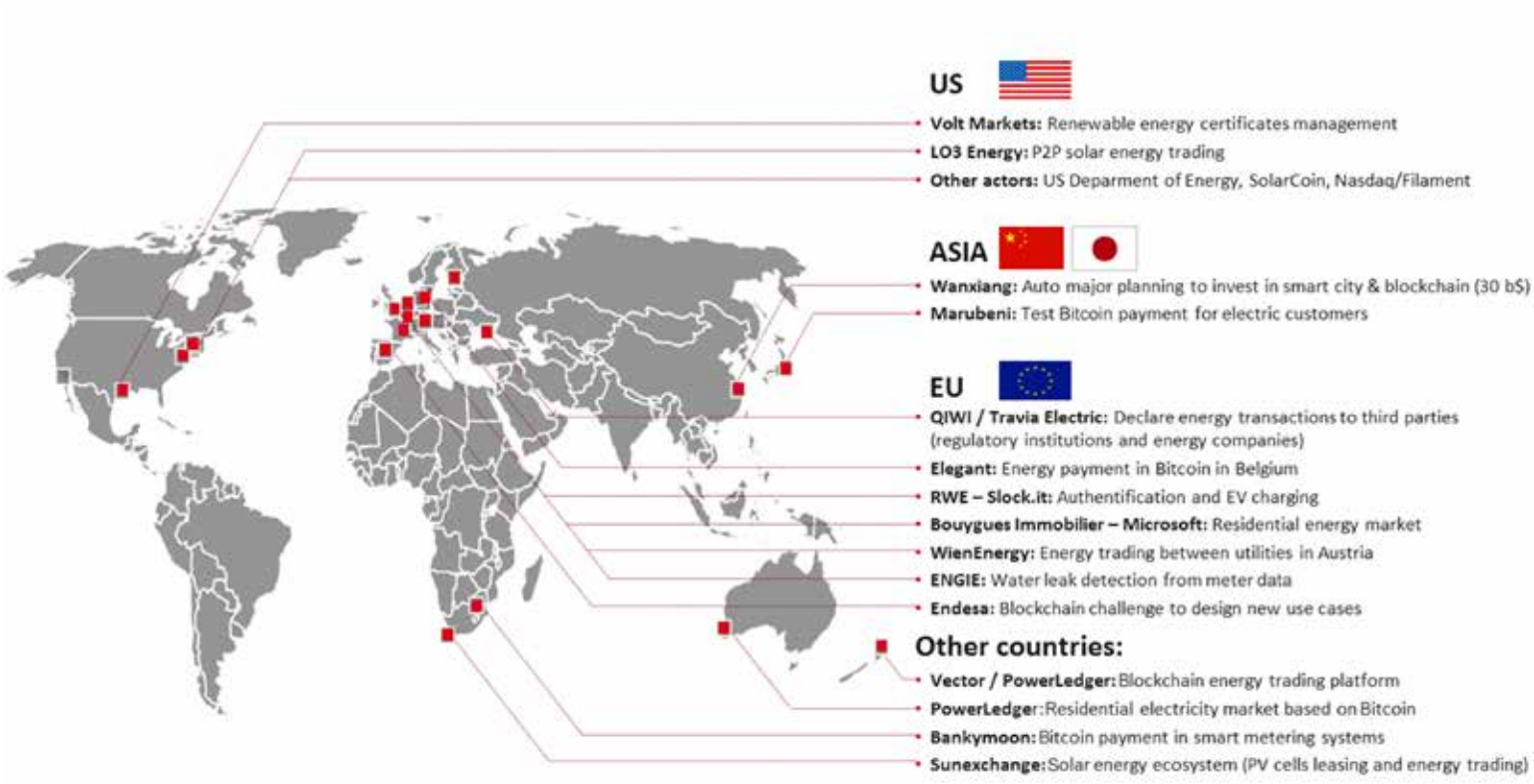
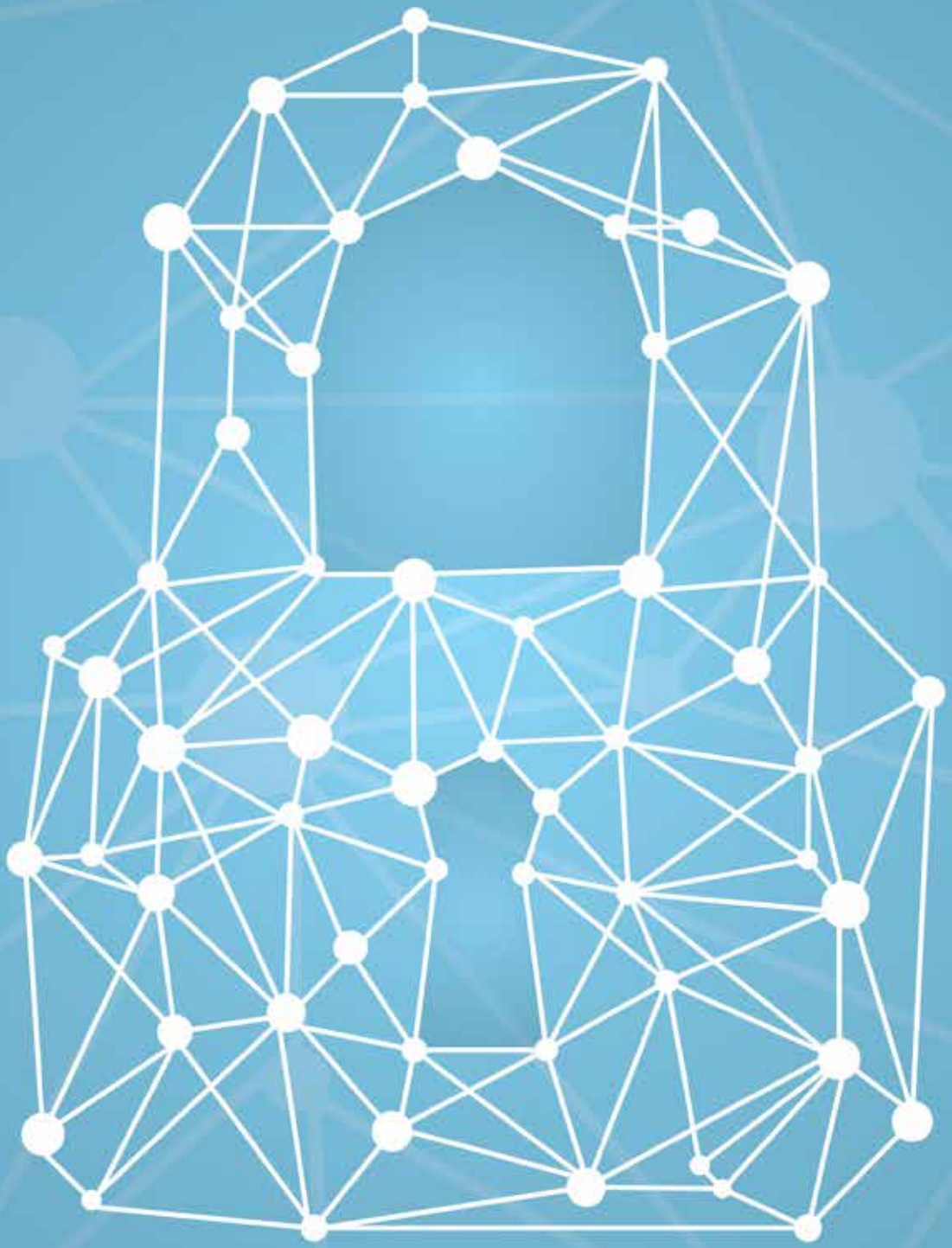


Figure 5: Main blockchain projects and stakeholders in the energy sector



Overview of

energy use cases

for blockchain

2 | Use cases in the energy sector

Identifying energy use cases

In order to verify the technological relevance of blockchain in relation to a job issue, it may be useful to employ an analysis grid, as shown in figure 7. The primary motivation for utilizing blockchain is the need to store and share data, in a secure and transparent manner.

There are also the challenges of optimizing complex tasks, reducing their costs or duration, confidentiality requirements and the lack of strong constraints for scalability and response times.

In the case of high-frequency trading, the speed of transactions offered by blockchain today (10 seconds for Ethereum and 10 minutes for Bitcoin) does not allow this technology to be used in its current state of development.

Applications in the energy sector

Various use cases are foreseeable in the energy sector and are presented in this section.

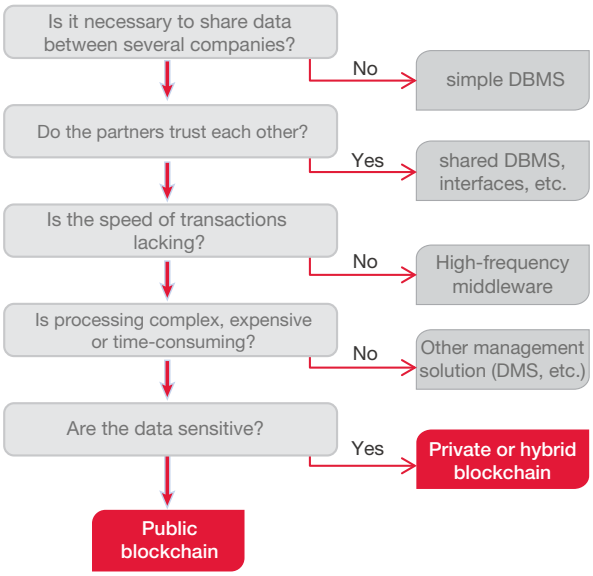


Figure 7: Relevance analysis flow chart

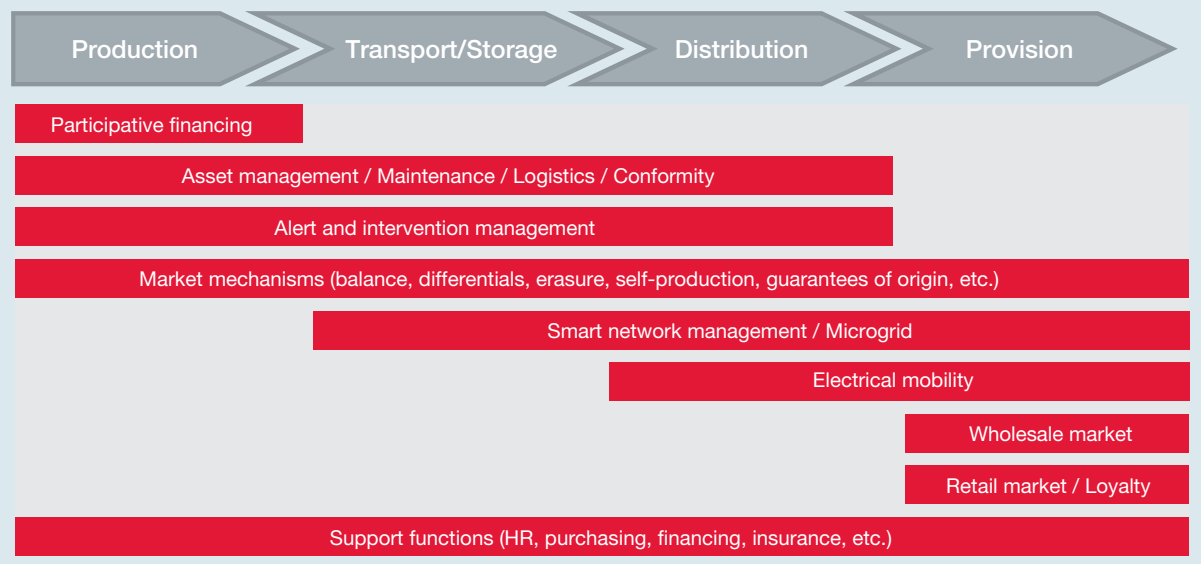


Figure 8: Blockchain use case in the energy value chain

There are options to use blockchain to develop **participative funding** for REN production projects by individuals, in particular if the blockchain is linked to remuneration by cryptocurrency. In France, start-up Lumo pays back investors in part in SolarCoins, which can be used as reduction vouchers with power producers.

Asset management, maintenance, logistics, inventory, asset retirement, conformity, Quality, Health, Safety & Environment (QHSE)
Blockchain can facilitate and help certify network inventory (equipment, status, geopositioning, event log, maintenance operations history, etc.) using a registry that is shared between all participants (owner and operator, licensor and dealer, supervisory authorities, etc.).

Blockchain also makes it possible to correctly identify parts that need replacing, verify the authenticity of spare parts and ensure that the correct version of the operating ranges is used. Blocs & Compagnie is a start-up offering auditing solutions for job process execution.

Traceability challenges are especially important for the supply chain. U.S. start-up CryptoSeal offers to update the wax seal for the digital era—an NFC chip containing identification data recorded and verified by blockchain. When attached to a product, this chip is able to track its exact course accurately from production to disposal. Sharing data between stakeholders can also simplify customs clearance for imported products, such as petrol.

Alert and intervention management
Blockchain functions associated with interconnected items on the network can send certified alerts that can optimize interventions. Engie is conducting an experiment of this type in Yonne, France, where water meters send automatic alerts to technicians in the case of suspected leaks.

Market mechanisms
Most market mechanisms implement reconciliation techniques for measured quantities, from the oldest, like reconstituting flows, to more recent ones, like erasing or managing guarantees of origin.

Like the use case of diamonds, which can be traced from the mine to the end customer, guarantee of origin transactions can be traced by blockchain. Secondly, the creation of guarantees of origin can even be automated via smart contracts. In the U.S., start-up Volt Market is experimenting with an exchange platform for green certificates. In the case of erasure, utilization of blockchain is being considered to certify unused kWh.

Smart network management
In transportation and distribution, blockchain also presents opportunities for network management, especially to facilitate local grid balancing by exploiting options to reconcile fluctuations.

Electrical (or gas) mobility
Blockchain offers interesting solutions for several requirements: automatic identification of vehicles connected to a charging station, assignment of flows to a self-producer, micro-transactions for billing power and using the charging station, smart charging (again a matter of local grid balancing), etc. In Germany, RWE has been trying out some of these use cases in collaboration with the start-up Slock.it.

Management of REN self-consumption is a particularly interesting use case as it covers several issues that include the assignment of flows to a user, billing and the generation of guarantees of origin, such as experiments by LO3 in Brooklyn and SunChain in France. For the issue of financing networks that are open everywhere, TURPE billing micro-transactions could also be considered.

Wholesale and retail markets

- The possibility to use **trading platforms** with blockchain is frequently quoted as having the benefit of facilitating its opening to end customers, in particular industrial customers, while simplifying international payments and ensuring the transparency of exchanges natively.
- **Customer satisfaction** can be assessed by using blockchain. For instance, Buuyers.com promises to certify the authenticity of customer comments using blockchain.
- **Loyalty programs** can also be managed using blockchain, as smart contracts manage the account balance as well as the balance of points earned versus points used. The loyalty program can thus be extended to many partners who do not know each other by streamlining accounting. In Dubai, a loyalty program for tourists is being tested in this way.
- **Customer data management** can be implemented by using blockchain to authenticate and manage data access privileges that meet the requirements for transparency, traceability and equal treatment of those requesting access to the data. There is therefore a foreseeable set of scenarios relating to digital identity.
- **Billing** activities of low face value can be transferred to blockchain. This makes it possible to reduce administrative costs while still being able to audit bills.
- **Publishing customer data** as open data can also be done anonymously using a blockchain platform.

Support functions

From authentication of diplomas for HR to paying suppliers upon delivery, as well as issuing off-market shares and auditing accounts, blockchain has a vast array of applications. Postme, for example, offers a billing flow management service that is fully automated and traceable using blockchain.

Key success factors

A range of elements was presented in the preceding pages to validate blockchain's relevance for various activities (cf. blockchain typologies, relevance analysis, overview of use cases in the energy sector, stakeholder typology etc.). To go even further, we also recommend applying the following best practices:

- Identify all the use cases by removing the current regulatory barriers and by adopting the position of a new "barbarian economy"
- Prepare to modify the regulatory framework, especially in the case of regulated activities
- Conduct a detailed analysis of blockchain's impact on the company's activities (risks and business and market opportunities), for example via a Business Process Reengineering approach
- Limit the first PoC technology to a simplified use case with a fixed number of stakeholders by assigning it quantifiable decision criteria
- Exploit this PoC to assess technical solutions: BaaS platforms, development languages, APIs and, at an overarching level, exploitability of the system
- Shift rapidly from a PoC to a MVP (Minimum Viable Product) that is both robust and capable of simulating target processes under real conditions
- Adopt an ROI approach (ETP and IS costs) to use cases and complete the technical PoC with a PoV (proof-of-value) analysis
- Conduct an energy and carbon assessment of the blockchain's operation, especially in the case of public blockchains
- Avoid "big bang" deployments, as few solutions to date are mature enough to handle them

Other defining criteria

In a blockchain prototype for commercial use, three other defining criteria need to be finalized before starting a blockchain project.

Public, hybrid or private blockchain
Blockchain was initially designed for open use by everyone, even if during the pilot stage restricting access allows for easier management of the perimeter and tests.

However, we are now seeing that most ongoing experiments are based on private blockchains. These precautions are explained either by the fear of the "51% attack," the public aspect of transactions or the inherent processing times of public blockchains.

On the other hand, private blockchains enable defining a trusted third party that governs the business rules for use and can resolve disputes.

Free versus governed blockchain
In a private or hybrid blockchain, all stakeholders of the blockchain are known. However, the following roles still need to be defined: who is the regulator, who are the miners, who can create smart contracts, etc. These questions are defined by means of a governance charter, which is capable of evolving and translating into the access permissions.

In the case of public blockchains, the governance challenges are different but just as important. For instance, who is responsible for coordinating developments in the blockchain and how can we influence these developments?

Modifiable versus fixed blockchain
Once blockchain data has been validated, they are generally not modifiable. To be able to modify blockchain elements at a later date and under certain conditions (e.g., when a smart contract is modified), the stakeholders propose modifiable blockchains, which entails the risk of reducing confidence in this technology.

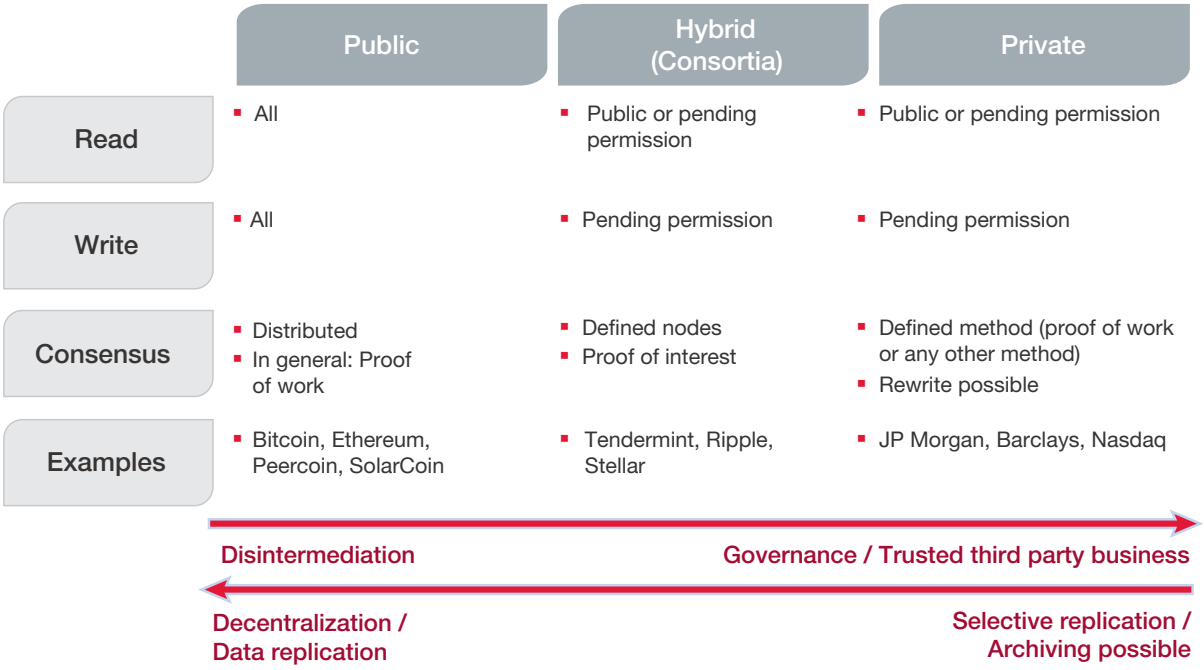


Figure 6: Blockchain typologies

Considering the
regulatory challenges
inherent to the energy sector

3 | Challenges and regulatory perspectives

The development of the European regulatory framework for energy has created a favourable framework for blockchain.

The European Commission wishes the EU to take the lead in transitioning towards clean energy and has defined three new targets for 2030:

- Reduce greenhouse gases by 40% from 1990 levels for the ETS (Emissions Trading System)
- Increase renewable energies to 27% of total European energy consumption
- Improve energy efficiency by 27%

The next European legislative package (the Winter Package) introduces a new approach that aims to reconcile energy transition, growth and consumer protection.

Better protection for citizens

The EU's 2030 strategic framework for energy presents a vision of an energy union centred around the citizen. Citizens will take charge of the energy transition by participating in new technologies to reduce their own bills and take an active role in the market. This focus on citizens also aims to protect the most vulnerable consumers.

New rights

The clean energy package embraces the notion that consumers have the right to produce, store, consume and sell self-produced electricity in all organized markets, either individually or via communities.

Blockchain is a response to these European ambitions in its capacity to facilitate peer-to-peer trading, to manage microgrids and to put platforms in place for open cross-border markets.

Blockchain likewise provides an answer for identifying consumers, certifying renewable production and providing traceability for energy efficiency operations.

Blockchain is a vehicle to meet the obligations of regulatory reforms

Standards to be applied
Rendering user data anonymous by means of blockchain ensures compliance with certain European regulatory obligations such as General Data Protection Regulation (GDPR). It can also provide a solution to the know your customer (KYC) directive that must be respected by banks and insurance companies.

Contradictions to be resolved
Contradictions between regulatory requirements will require a close analysis of the solutions available (skillful arbitration between private and hybrid blockchain, managing blockchain members' and miners' access privileges, etc.).

We should note that the digital right to be forgotten is also one of the questions requiring consideration for blockchain applications that use private data.

General Data Protection Regulations (GDPR)
The new European data protection law, which was adopted in April 2016, replaces the former Data Protection Directive from 1995. It adapts the principles of that directive to a now digital economy. It also reinforces personal data protection by harmonizing the restrictions placed on companies on a European scale. The GDPR imposes a fine of up to 4% of a company's global turnover if it fails to comply with the regulations. The law will come into force on May 24, 2018 and does not require transposition into national legislation.

Several legal questions remain

A new energy model?
The market design developed in Europe since the opening of the markets seems ill-adapted to the powerful forces of disintermediation caused by emerging technologies, which are frequently encouraged by consumers.

Collective self-consumption requires a responsibility for local balance, while rendering the responsibility of traditional players more complex.

What roles and responsibilities will the legislator grant to the various market players, and in particular to the "consumer player"?

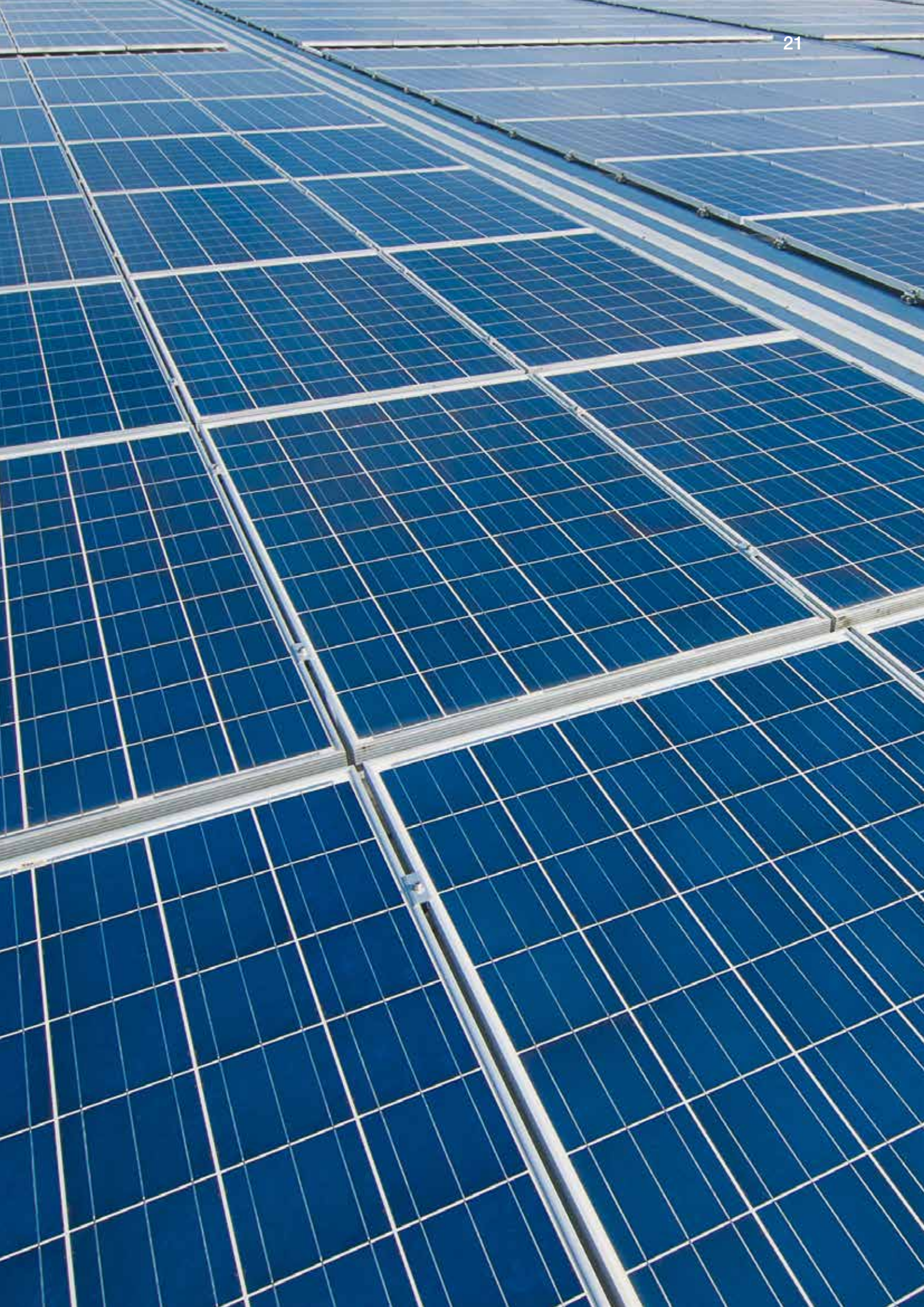
What is blockchain's legal status?
As blockchain is by its very nature supra-territorial, what regulation must it fall under, if any?

The anonymity underlying blockchain makes some people fear that it could foster illegal activities, while others see it as a tool to combat corruption.

The legal validity of smart contracts is also dubious. We can imagine that once both parties have agreed on the operating rules, it constitutes a contract. Nevertheless, the issue of modifying or terminating this contract remains, specifically in the case of dispute.

The great leap
As it is already capable of 'uberizing' Uber, will blockchain 'uberize' governments? By decentralizing confidence—or, as some maintain, by "democratizing confidence"—blockchain undermines the authority of the institutions and governments that underpin it. And even if they do manage to create a framework for blockchain, or if the technology disappears due to a lack of governance, the principles and hopes that it has created will leave their mark.

Are you ready to take the leap?



4

Conclusion and **perspectives** for energy stakeholders

4 | Conclusion and perspectives

Blockchain is a promising technology, however its value and relevance need to be demonstrated for each use case

The use cases cited in this document illustrate blockchain's potential both to upset current business models in the energy sector and to redefine stakeholder positions.

But blockchain is not a magic solution. As with any technology, it is important to start by conducting an accurate assessment of the organization's needs, resources and culture before evaluating blockchain's relevance in the organizational context. Analysis must also cover the technical feasibility and the overall ROI of the operation and include a significant component for internal and external change management. The analysis must not interfere with the energy and carbon assessment of the resulting system.

Blockchain in 2020 will doubtless be different from its 2017 form, and the players (editors and consortia) will possibly have been replaced. The choice of platform is ultimately secondary to the overall choice of architecture, such as implementing different abstraction layers, which will make it possible to isolate the company's critical processes for platform development. In the same vein, it is also important to be able to select integrator partners who are able to make a long-term commitment to maintaining these systems.

These precautions must not be an excuse for inertia. The risk associated with not implementing blockchain is just as great, and also needs to be qualified.

At this stage, blockchain has all the characteristics of a fundamental break, but in its current stage of development, it does not allow us to predict its future with any degree of certainty. The increased speed of adoption of new technologies prompts us to anticipate their impact and thus ensure there is a minimum command of these technologies, even if they are to be abandoned at a later stage.

The current European regulatory framework is less constrained and is advantageous for experimenting with blockchain at this stage.

The priority given to REN and energy efficiency, integration of European markets in service to the final consumer and encouragement of self-consumption are likewise opportunities for blockchain, especially due to its position as an integral part of a set of new digital technologies that can easily be combined (smart meters, smart grids, IoT, storage, VE, analytics, etc.).

Furthermore, if blockchain develops as predicted, the regulatory checks will develop to facilitate the next digital revolution.

CGI's Business Consulting

value proposition for your blockchain

5 | Our value proposition for blockchain

About CGI

Founded in 1976, CGI is one of the largest IT and business process services providers in the world. Operating in hundreds of locations across the globe, CGI helps clients become customer-centric digital organizations. We deliver high-quality business and IT consulting, systems integration and transformational outsourcing services, complemented by more than 150 IP-based solutions, to support clients in transforming into digital enterprises end to end. CGI works with clients around the world through a unique client proximity and best-fit global delivery model to accelerate their digital transformation, ensure on-time, within budget delivery, and drive competitive advantage in today's increasingly digital world. For more information **visit cgi.com**

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CGI business consulting provides the expertise needed to help grow your business, drive revenue, improve efficiency and become more agile. CGI is among the leading end-to-end IT services and business consultancy companies. We have the capabilities and scale required to combine cross-industry, operational and technology expertise to successfully manage transformation and provide for lasting business performance. We take a unique approach to consulting—listening and co-innovating with our clients to ensure lasting success.

CGI Business Consulting aide les entreprises en France et en Europe à mieux appréhender la diversité énergétique :

Cofely, Electrabel, GDF SUEZ, ERDF, GRTgaz, Solvay, GrDF, Storengy, Vattenfall, EDF, Enercal, Dalkia, Ecomeering, etc.

Innovate, experiment, generalize

At CGI, innovating for our clients is in our DNA. Our objective? To help our clients build the companies of the future. We do this by actively fostering dialogue and collaboration through shared think tanks, an active ecosystem of partners (start-ups, institutes, educational establishments and universities, professional networks, etc.) and a structured monitoring unit for analyzing market trends. In our view, the key to building the companies of the future is to transform the challenges of the future into the opportunities of today.

Innovate

Investigate to understand

- Defining new business models
- Identifying use cases
- Impact analysis
- Supporting partners' choices

Experiment

Test to understand

- Designing and implementing proofs of concept and value (implementation plans, IS architecture, KPIs)
- Pilot projects and return of experience

Generalize

Construct to gain advantage

- Industrialization
- Providing support for change
- Pilot projects and deployment follow-up