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Use Cases for Blockchain Technology in Energy & Commodity Trading

Snapshot of current developments of blockchain in the energy and commodity sector.

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Use Cases for Blockchain Technology in Energy & Commodity Trading

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This publication was drafted for information purposes for the benefit of our clients. Its content reflects the authors' state of knowledge at the time of publication. When it comes to solving specific problems, please refer to the sources stated in this publication or the contact persons mentioned. All views expressed in this publication reflect the opinion of the individual authors providing them. The charts provided in this publication may contain rounding differences.

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Introduction

This paper is meant as a current overview of blockchain activities in the Energy & Commodity Trading sector in Europe. Since the developments of these activities are moving fast across the globe, it gives a focused overview on current developments and trends we see in the market.

It is fascinating to see this new technology now picking up more and more speed fueled by all the activities around the globe and more and more players entering the scene. The latest developments like the Kick-Off of the "Energy Web Foundation", the project for transforming the "Bill-of-Lading" or the community which forms around the "Enerchain" developments demonstrate that the technology is now entering in the piloting phase with "real world" use cases in the energy and commodity sector. In this paper we try to desribe the latest developments and some of the most promising use cases we see currently evolving.

What is blockchain?

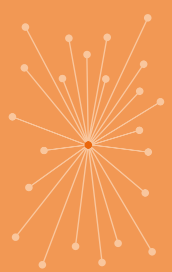
1 Leveraging blockchain technology could significantly impact energy & commodity trading

In our 20th CEO survey, 70% of the interviewed CEOs see speed of technological change as a top concern – a rise from 58% in 2015.[1] Within the technological advances, an internal PwC survey reveals that blockchain is considered to be the **biggest digital disruption** for our clients in the next five years. In essence, blockchain technology is a distributed, replicated and shared ledger for managing and recording transactions across multiple participants.

Transaction are no longer stored in a central database, but among the participants (nodes).

Fig. 1 Centralised versus distributed networks

Centralised



- Traditional transactional models are centralised, i.e. transactions between network nodes are only possible through a third party acting as an intermediary.
- Involvement of an intermediary is often necessary because it creates trust in an environment where transaction partners do not know each other.
- Intermediaries usually charge fees for their services. Also, using intermediaries, a transaction increases the processing time.
- The system has a single point of failure (SPOF). All relevant data, e.g. a ledger, is stored on a central server or infrastructure.

Distributed

- With blockchain as distributed ledger technology, all of these issues – high transaction costs, low speed, SPOF and lack of transparency – can be solved.
- In a distributed network, different network nodes can interact directly with each other without the presence of an intermediary.
- The single point of failure is eliminated and transparency is increased.

Today, start-ups and corporations across multiple industries and sectors are testing business applications of blockchain technology. A non-exhaustive view on start-ups from different industries is presented in figure 2.

[1] PwC, 20th CEO Survey, 20 years inside the mind of the CEO … What's next?, 2017.

Fig. 2 Use cases per industry with start-ups working on solutions

	Industry	Use cases	Start-ups
	Energy, utilities & mining	• Smart utility metering system • Decentralised energy data platform	Bankymoon AutoGrid
	Entertainment & media	• Control of ownership rights of digital media • Disintermediation of record labels	Ascribe Mycelia
	Financial services	• International P2P transactions • Anti-money laundering	Bitcoin Coinfirm
	Government & public services	• Land ownership records • Tamper-proof voting records • Digital identity of citizens	Factom Follow My Vote Tradle
	Healthcare	• Storage of healthcare records • Population health and clinical studies	HealthNautica Tierion
	Hospitality & leisure	• Loyalty programmes	Loyyal
	Insurance	• Peer-to-peer flight insurance policies • Micro-insurance	InsurETH Stratumn
	Transportation & logistics (freight transport)	• Trade documentation (e.g. Bill of Lading) • Trade finance • Supply chain transparency	Wave Skuchain Provenance
	Transportation & logistics (aviation)	• Distribution of tickets and ancillary services • Loyalty programmes (cf. H&L) • Passenger identity management	Loyyal

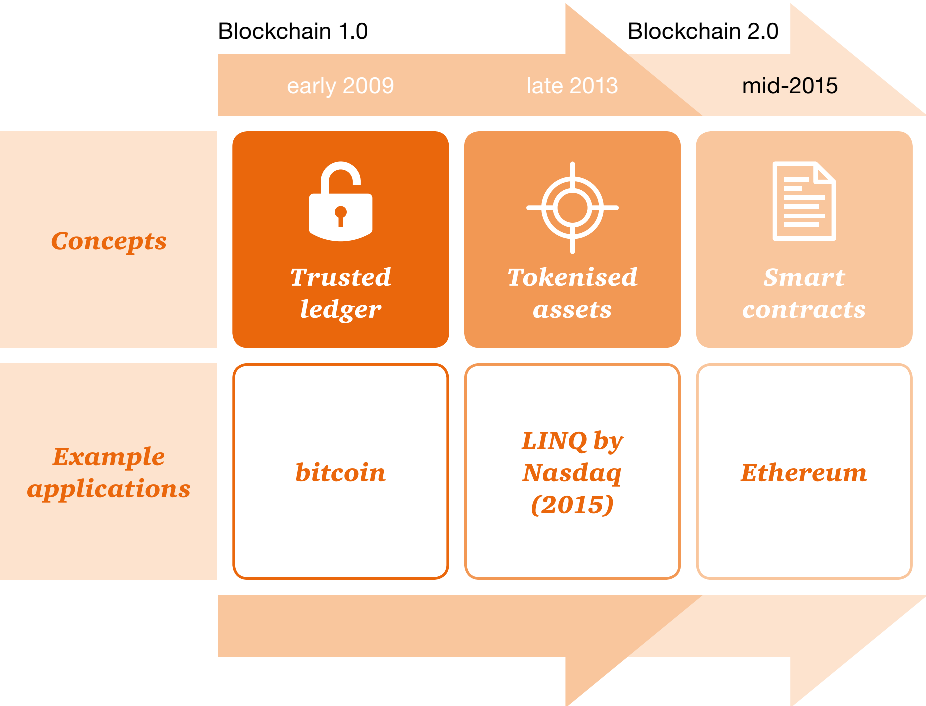
Applications of blockchain technology use each of the blockchain elements to a different extend, depending on the business requirements.

The potential of blockchain technology for commodity is twofold: in the short term, blockchain can help to streamline processes, while in the long run it could have a disruptive impact on the whole market structure. In particular, blockchain technology could simplify transactions on the wholesale power markets that are largely impacted through the renewable power generation.

2 We identify three key milestones in blockchain development

So far, most blockchain applications are still in an early phase of industrialisation. In the development of blockchain technology, we differentiate three key phases, illustrated by prominent examples.

Fig. 3 Milestones and examples of blockchain development



Bitcoin, the virtual cryptocurrency, introduced in 2009, mostly relies on the trusted and secured distributed ledger principle. Every new transaction is confirmed decentrally and integrated into the blockchain, making it impossible to alter the transaction. Bitcoin is the most common blockchain application with a market capitalisation of $19.2 billion (as of April 13th 2017) and a daily traded volume of $330 million. The validation of transactions generates transaction costs due to the process of integration blocks into the blockchain (Proof of Work).

Since 2013, **NXT** has used blockchain technology to facilitate the transfer of tokenised assets (another example from the same phase is Nasdaq's **LINQ**, developed in 2015). In addition to the trusted ledger functionalities, the second generation allows the exchange of files through the transaction. LINQ has six pre-IPO members – Chain, ChangeTip, PeerNova, Synack, Tango and Vera.

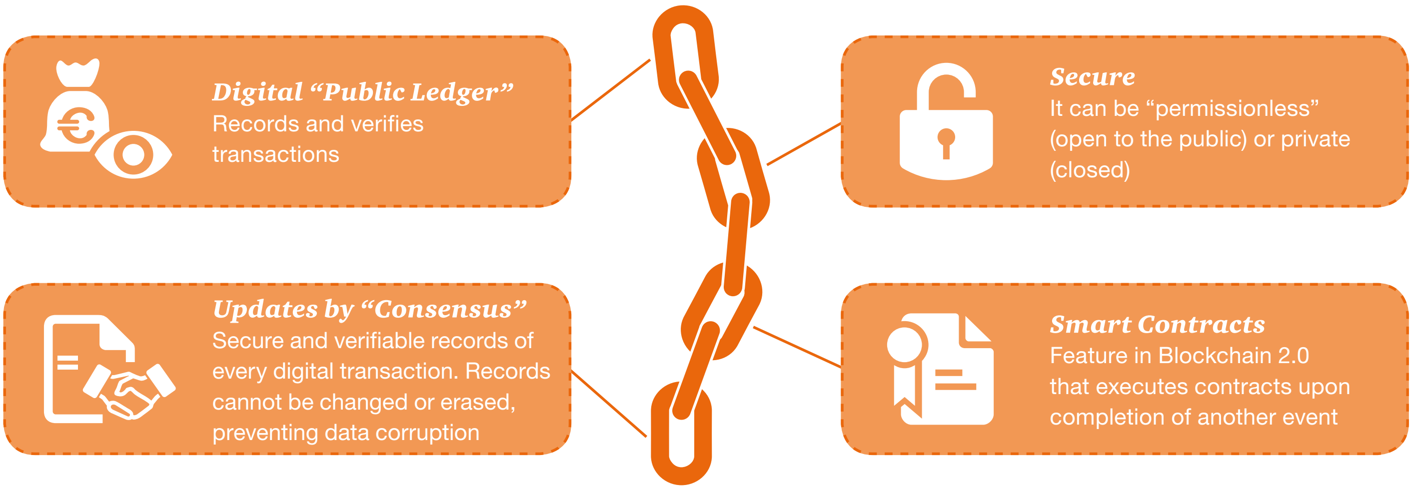
Ethereum was launched in mid-2015, allowing the use of smart contracts on a larger scale than Bitcoin. These smart contracts allow the automatic execution of code on the blockchain, generally for the purpose of causing an external action in the course of a defined trigger event. Examples are external calls from software applications that perform further bookings or the execution of other smart contracts. Ethereum is also a cryptocurrency and has a market capitalisation of $4.4 billion (as of April 13th 2017).

Potential benefits of blockchain

1 Benefits of blockchain technology in energy & commodity trading

Blockchain has attracted huge attention and is now being actively pursued in the energy sector. The blockchain technology has four key features that are applied to the different use cases.

Fig. 4 Key elements of blockchain technology applied to energy & commodity trading



These elements lead to the following benefits:

Transparency is guaranteed for all transactions, allowing settlement speeds close to real time and building the basis for traceability and trust between actors.

Trust is created through a shared reading of the blockchain, reducing the number of intermediaries. A lower number of intermediaries reduces the cost of compliance, reconciliation and transactions, allowing the creation of marketplaces with lower entry barriers, enabling the trading of smaller quantities.

Efficiency gains through blockchain reduce costs: it requires fewer intermediaries, simplifies processes and infrastructures and ultimately increases operational efficiency. The allocation mechanisms can be designed to provide incentives for "good" behaviour throughout the value chain. Operational efficiency is further improved through the digitisation of assets.

Control and security can be provided inherently through the blockchain design. Encryption levels are better for transactions, increased data protection and limited settlement risk and fraud risk. Decentralisation prevents market abuse through monopolies and requires less of the associated legislation, costs and regulatory oversight.

Fig. 5 Main benefits of blockchain technology

Transparency	*Trust*	*Efficiency*	*Control*
Make supply chains more transparent, leading to real price for value and linking milestones to actions.	Enable creation of marketplaces for sourcing in an ecosystem.	Lower cost of compliance and lower cost of reconciliation (between subsidiaries).	Auditing, cost control and accounting will be impacted as the handling of payments can be streamlined and automated.

2 Leveraging blockchain technology's benefits

To leverage the potential benefits of blockchain technology, the following six conditions define a first set of assessment criteria:

Fig. 6 Criteria for assessing potential of blockchain solutions

1. **Multiple parties share data –** multiple participants need to view common information
2. **Multiple parties update data –** multiple participants take actions that need to be recorded and change the data
3. **Requirement for verification –** participants need to trust that the actions that are recorded are valid
4. **Intermediaries add cost and complexity –** removal of "central authority" record keeper intermediaries has the potential to reduce cost (e.g. fees) and complexity (e.g. multiple reconciliations)
5. **Interactions are time-sensitive –** reducing delays has business benefits (e.g. reduced settlement risk, enhanced liquidity)
6. **Transaction interaction –** transactions created by different participants depend on each other

The potential benefits of blockchain in energy & commodity trading and the criteria for its application are the core elements for the development of blockchain use cases in energy & commodity trading.

Use cases for blockchain in energy & commodity management

1 Direct peer-to-peer trading to support the smooth operation of the power grid

Intermittent renewable power generation is on the rise, and system stability on local, national and European level is the key objective of power grid management. Direct peer-to-peer trading with aggregation to **virtual power plants** (VPP) is a viable solution and could build on blockchain technology.

A prerequisite for local P2P trading is the reduction of traded lot sizes

In energy & commodity trading, standardised units are defined according to size, quality and quantity. Standardised criteria and lot sizes are necessary to overcome transaction costs in the current market configuration. Actors are not able to sell on wholesale power markets if the offer does not match the standardised criteria. They are required by third-party intermediaries (brokers, banks) to draft contracts. Thus, commodity traders are de facto big clients or specialists.

Blockchain is able to reduce transaction costs through standardisation via smart contracts and the automatic execution of orders. Transaction costs decrease dramatically, allowing smaller lot sizes and bypassing intermediaries. In fact, one application of blockchain technology is in the distributed generation of renewable energy using smart meters to track electricity use.

In this setting, "prosumers" not only consume commodities but also dispose of generation capacity in the form of solar systems, small-scale wind turbines or CHP plants. Blockchain technology strengthens the market role of individual consumers and producers. It enables prosumers to buy and sell energy directly – manually or via automation – with a high degree of autonomy.

Aggregation of microgrids to virtual power plants

The term virtual power plant refers to clusters of electricity generators, loads and storage systems that are pooled in an intelligent manner and controlled jointly. The VPP proper represents a central platform from which dispersed assets can be monitored and controlled remotely. As VPP fleets are an aggregation of various asset types and energy sources, they provide a certain level of flexibility, allowing VPP operators to respond to market and price changes within very short time frames.

In order to be able to participate in energy exchange, plant operators have to produce forecasts so as to minimise fluctuations. The complexity involved in producing forecasts varies for each type of generation facility; deriving forecasts for wind and solar power output is a more complex task than for controllable power plants like gas-fired power plants. If a plant operator fails to forecast its output accurately, it will incur imbalance charges. Plant operators who can provide accurate forecasts can benefit from higher revenues.

If controlled intelligently, VPPs aggregating widely dispersed and strategically clustered assets can be used to optimise power flows, thus serving as a power flow optimisation tool complementing network development. Even today power flows can be optimised with the help of renewable power generation facilities, for example by aggregating wind turbines and controlling them jointly. In this way VPPs can contribute to compensating for and bridging insufficient network development.

A central actor could deploy a blockchain solution that automatically integrates local information and optimises local grids. The local grids are then aggregated to virtual platforms, providing stable power capacity at low cost. This aggregation can include multiple actors and have a central player or only one player could deploy it for several distributed grids.

In the past, the organisation and management of VPPs of different sizes was complex and costly. Blockchain technology has the potential to make this process more efficient. On a lower level the VPPs can – based on smart contracts – optimise themselves to a certain degree, and if the balance of the current optimisation level is not sufficient, then optimisation against the next higher level (e.g. distribution grid) can be done via blockchain very efficiently as well.

Examples for local trading between small consumers and prosumers via blockchain

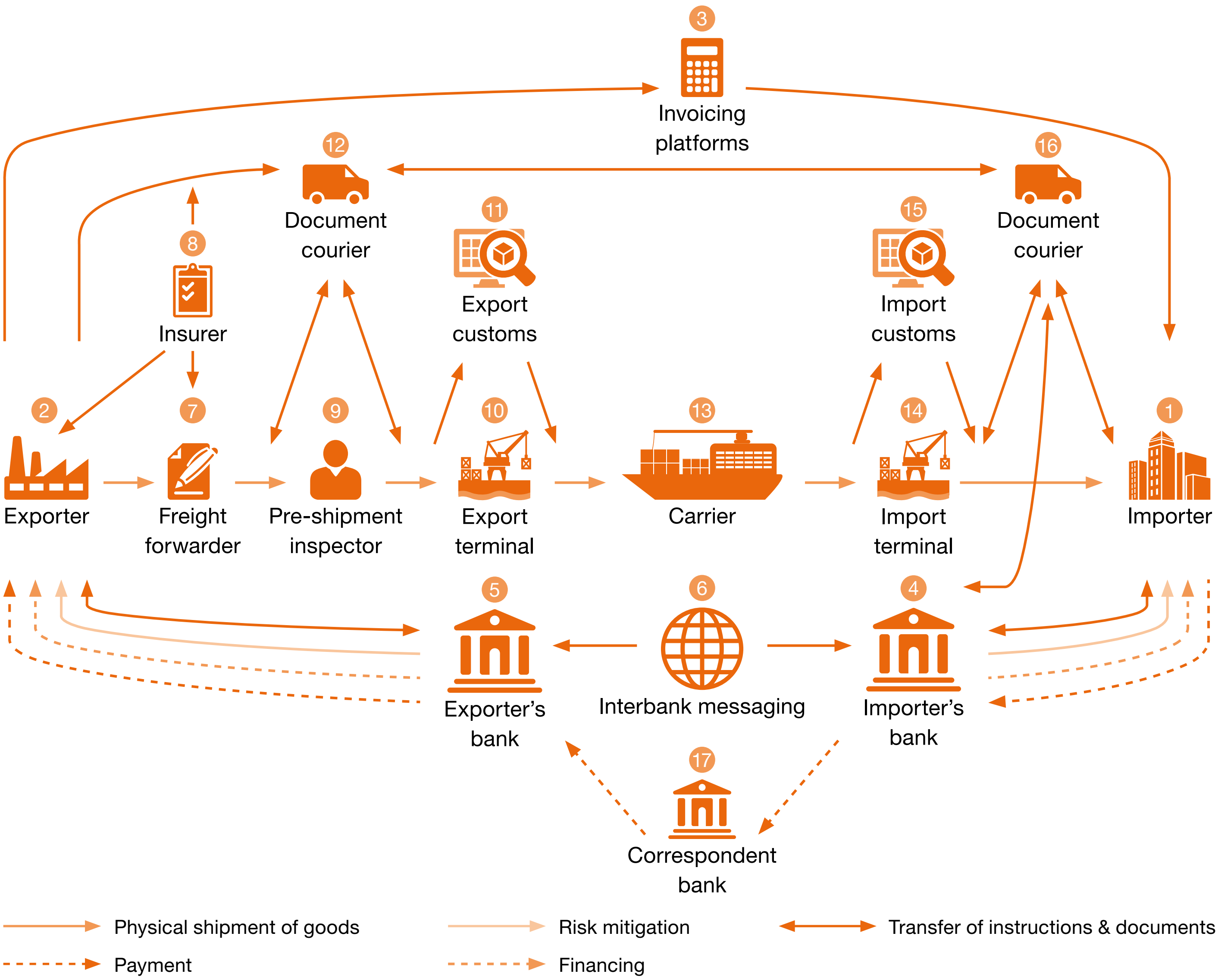
Ponton developed a simulation of a local energy market based on EPEX SPOT next-hour prices. This price curve is used to drive the behaviour of participating batteries and an electrolyser. For the electrolyser, Ponton developed a trading strategy with two goals: consume 1 MWh within the simulated runtime of 24 hours and buy hourly chunks of electricity, depending on the actual head-hour market price.

The system uses an agent-based architecture connecting the devices as market participants to the local marketplace. Each agent is controlled by an individual behaviour – acting as a consumer, a generator or both. The marketplace itself was built based on blockchain technology.

2 Supply chain and logistics optimisation

Supply chains are complex systems, involving on the physical side suppliers, producers and distributors. The logistics chain requires support streams for invoicing, documentation and regulatory requirements.

Fig. 7 Typical logistics chain



Asset Tracking, Bill of Lading, Transfer of Title

In the logistics chain all parties require continual consensus with other parties. These actors usually use completely different information tracking systems, leading to significant challenges for the optimisation of the shipment process. The key challenges Stratumn identifies are sharing information between systems, unsynchronised payments and deliveries, and auditing.

Currently, each party in the supply chain purchases goods, adds value and sells these goods to the next actor in the chain. The related transfers of ownership are often still recorded on paper and fraud remains a persistent risk. A blockchain solution for the tracking of physical commodities along the supply chain addresses the key challenges and can reduce costs significantly.

Financialisation of commodities

Physical trading between a buyer and seller in different countries is costly, prone to error and involves a financial intermediary to process the transaction. Commonly, **letters of credit** (LC) with security and guarantees from banks are used for these transactions.

Making use of blockchain technology tackles the disadvantages while maintaining the security LCs provide. The typical smart-contract application in goods trading could be designed as follows: via his node, the selling party receives a payment confirmation that will take place later, once a set of conditions is met. On the physical side, goods are tagged with QR codes that are linked to the smart contract. Upon arrival of the goods, the payment is automatically triggered through the execution of the contract.

The QR code/smart-contract solution is an example of how blockchain can improve the traceability of physical commodities. Today only the front end of commodities trading has been financialised, in the form of electronic trading. With blockchain, the infrastructure could be financialised as well.

Examples of data synchronisation and shipping solutions

Stratumn has developed a data synchronisation system running so-called trusted workflows, which synchronise data from multiple parties while generating an audit trail that can be used to ensure data integrity and regulatory compliance.

The Stratumn shipping solution is a trusted workflow which implements blockchain notarisation. It enables shipping partners to increase the interoperability between all parties and data security, leading to cost reductions and improving traceability and compliance.

3 Instant matching and settlement of trades

With the concept of distributed ledgers, blockchain replaces the central administrator or the central data storage with a consensus mechanism to validate transactions.

Fewer intermediaries through immutable records and reconciliation reporting

Blockchain technology is increasingly being seen as a commercial tool for transparency, visibility and security in numerous sectors. It could hence play the role of clearinghouses and brokers. The technology inherently and automatically provides all the confidence needed. In **over the counter** (OTC) energy & commodity trading, both counterparties confirm the deal details in order to minimise the risk of misunderstandings or errors. This process of "confirmation matching" is traditionally performed via fax or electronically at each commodity trader's back office.

According to Ponton, blockchain could be used to completely automate this process. With blockchain technology, the exchange of trade confirmations could be done on a peer-to-peer basis, i.e., directly between the counterparties without any middleman. OTC commodity derivative trading in particular could be a quick win for blockchain: OTC commodity derivatives have fewer clearing requirements and, overall, the smaller market size could favour a smart-contract rollout.

Ponton has launched its own blockchain platform, Enerchain. Enerchain is a platform for peer-to-peer trading in the wholesale energy market. The software allows traders to anonymously send orders to a decentralised order book, which can also be used by other organisations. Thanks to this technology, Enerchain does not require a central authority. To date, 23 European energy suppliers and traders have joined the Enerchain consortium.

Fulfil regulatory requirements

Today regulatory and reporting requirements are continuously increasing (EMIR, MiFID II). These regulations can either be an obstacle to or an opportunity for the development of blockchain solutions.

The capability of blockchain solutions to comply with regulatory requirements is not transparent. Applying the EMIR clearing obligations, the advantages of the technology would be immediately lost. On the other hand, blockchain itself could be used as a reporting mechanism. A smart contract would include all necessary aspects for reporting, which could be monitored directly by the regulator via his own node connected in the same distributed ledger. The reporting quality would be increased, while costs would decrease. These qualities are currently being assessed by the European securities and markets authority. Hence, the regulatory requirements themselves could evolve according to technological advances.

Outlook for blockchain in energy & commodity trading

1 Today's limitations are being addressed by current developments

Performance and scalability

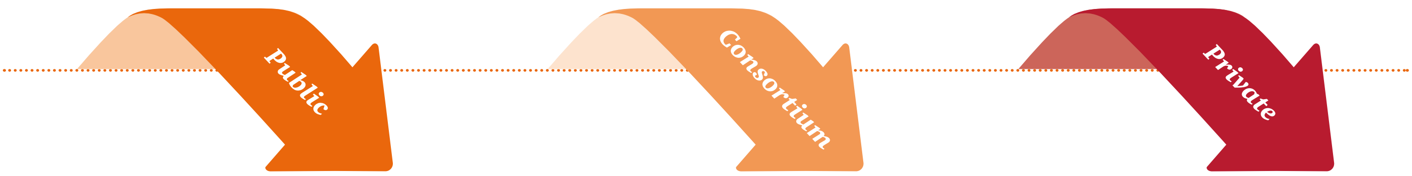
Blockchain applications such as Bitcoin have limited transaction capacity – currently it is three transactions per second; seven per second are the maximum. Different solutions are currently being developed to cope with this issue. The Lightning Network, for example, opens direct peer-to-peer channels and uses the blockchain Bitcoin as underlying only for some operations that need confirmation.

Performance is also limited by the consensus principle of proof of work. The concept is very energy-intensive. Developments such as the proof of stake principle aim at reducing this consumption. Furthermore, to scale blockchain to an industrial level, regulators will have to be convinced it is an operational resilient solution.

Security and confidentiality

To trade significant values of assets, firms need to ensure that they can match the legal title to the underlying assets, recorded by the tokenised asset in the distributed ledger. An identified challenge is achieving a uniform legal framework across a distributed set of peer parties with no centralised authority. Therefore, according to the necessity of security, privacy and control, different blockchain concepts are emerging. Besides public blockchains, such as Bitcoin, private blockchains and consortiums are on the rise.

Fig. 8 Blockchain concepts



Public blockchains

- Allow access to their full functionality to anyone who wants to become part of the network
- Are likely to be used by many actors, leading to network effects and lower susceptibility to hacking
- Create most value in advancing the technology, as innovation is most likely to come from independent developers using public blockchains

Consortium blockchains

- Represent a hybrid between a public and a private blockchain
- Consensus process is controlled by a predefined group of nodes

Private blockchains

- In a fully private blockchain, write permissions are centralised to one party and read permissions may be public or private
- Rules can be easily changed and transactions reverted, validators are known and transactions are cheaper
- Public blockchain can learn and benefit from developments in private blockchains

Critical mass and viable network

Today, blockchain is still in the beginning of its development. To deploy blockchain solutions on an industrial level, standards need to be agreed upon between participants to create a common set of protocols for individual firms to adopt. This is challenging given the number of participants that need to come to an agreement.

For some markets, a "critical mass" might be achieved by smaller groups being able to work together and to create de facto standards.

Regulation

The current legal and regulatory framework for consumers and prosumers in the energy sector is clearly defined and provides protection on many levels to consumers in particular. Furthermore, regulatory and reporting requirements exist for trading. However, in the medium to long term, these frameworks will probably have to be adjusted to reflect the requirements of decentralised transaction models.

2 These key success factors for blockchain can be identified

1. **Participants can agree on defined business rules –** participants will need to cooperate to agree to common standards and rules describing which transactions will be used for interactions
2. **A legal and regulatory framework can be agreed on –** there's a legal/regulatory/control framework that allows digital records to perfect real-world ownership
3. **Agreement on roles –** the roles and permissions of participants can be clearly specified and agreed upon
4. **Digital identity –** the digital identities of actors are adequate, binding and inalterable in the real world

3 Developments and outlook

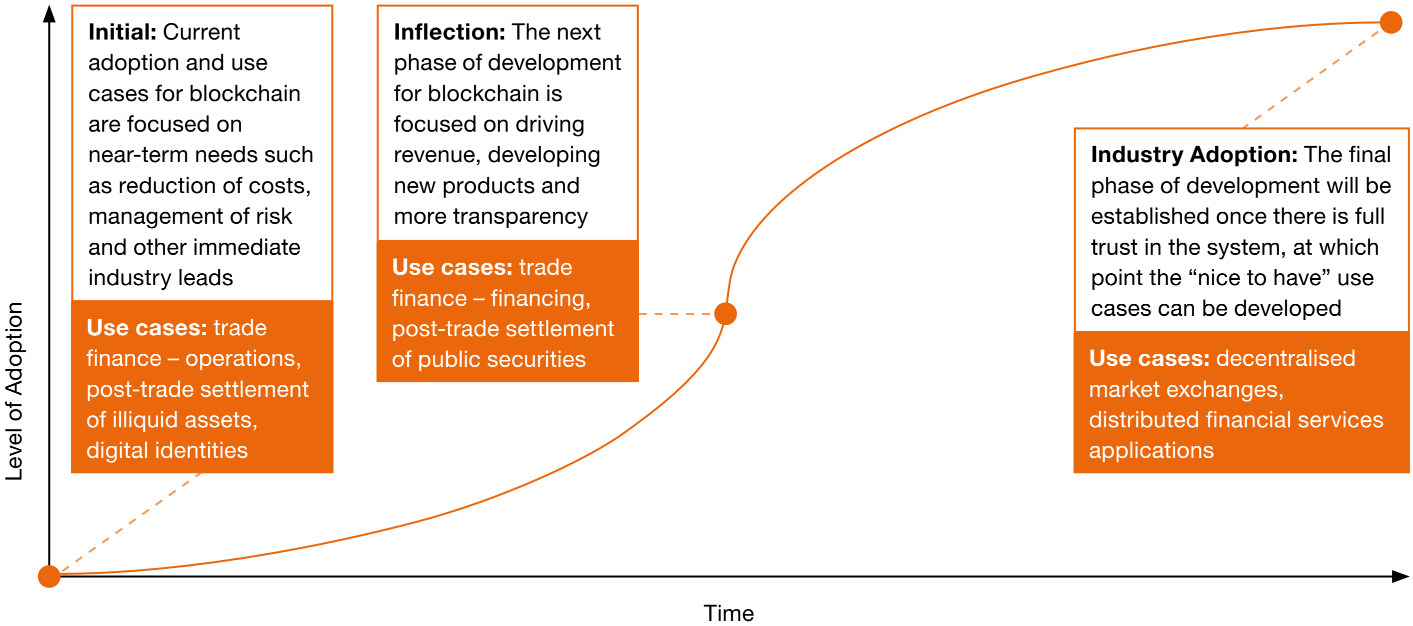
As of now, blockchain offers an opportunity for **large utilities** and commodity traders. They could individually or in consortia move to blockchain solutions, reducing transaction costs for their processes and maintaining their current position. One example of this development is the newly founded Energy Web Foundation. Another example is Poton's Enerchain project, where European utilities seek to create a standard for blockchain technology in the energy sector.

A less known application of blockchain technology are **business processes**. These processes are based on a case-by-case analysis of business processes with the identification of pain points that can be tackled with blockchain solutions. This approach can be applied in the very short term, aiming at increasing process efficiency and increasing automation.

The real potential of blockchain technology unleashes with the **Internet of things** (IoT). In an IoT environment machines communicate directly without any human interaction. This **machine to machine** (M2M) communication could be managed with blockchain(s), leveraging its benefits, such as immutability, speed and automatisation. It will be interesting to see, how these will create even more use cases in future.

Fig. 9 Future blockchain development

Blockchain's current and future use cases



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