Blockchain Competitiveness in the Energy Sector

JANUARY 2021

SUPPORTED BY THE DANISH INDUSTRY FOUNDATION
AS PART OF THE BLOCKCHAIN ACADEMY NETWORK

COPENHAGEN INSTITUTE FOR FUTURES STUDIES

INDUSTRIENS FOND FREMMER DANSK KONKURRENCEEVNE
The Danish Industry Foundation

Why this Panel?

The overall objective of the panel is to contribute to a **futures-oriented conversation** and facilitate a **shared understanding** of how blockchain can be translated into competitiveness in the Danish energy sector and across Danish industry.

The future role of blockchain and derived competitiveness depends on many aspects outside the potential and maturity of the technology itself. Hence, there is a need to consider different plausible blockchain scenarios that encapsulates wider developments across industry and society.

About the Panel

This initiative feeds into the wider work of the Blockchain Academy Network – supported by the Danish Industry Foundation – to generate knowledge and insight about blockchain competitiveness opportunities and challenges. The outset for the panel's work was the future of the Danish energy sector as a key industry sector towards 2030 from a blockchain perspective.

We put together a strong and diverse multi-stakeholder panel with expertise from across the energy sector value chain, blockchain in energy, and energy innovation in general. By leveraging the panel's collective insights and expertise we ultimately developed future scenarios for the Danish energy sector towards 2030 from a blockchain perspective. We firmly believe that this was an ideal forum to explore and co-create insights, which will shape and support a wider dialogue on the topic among policymakers and business decisionmakers.

The Copenhagen Institute for Futures Studies facilitated a structured scenario development process in the second half of 2020. During the process, the panel assembled twice.

Panel Participants

Name	Organisation	Role
Pierre Pinson	DTU Elektro	Professor, Head of Energy Analytics & Markets
Torben Bach Pedersen	Aalborg Universitet // FlexShape	Professor of Computer Science // Co-Founder & Chief Scientific Officer
Anders Stouge	iEnergi, Dansk Energi	Deputy Director General
André Bryde Alnor	Energinet	Head of Digitalization
Claus Møller	Siemens	Former CEO at Siemens A/S and Head of Siemens Smart Infrastructure
Henrik Langli	Barry Denmark	CTO
Thomas Vohs-Ahlers	Energy Cluster Denmark	Project Manager
Bjørk Paamand Olsen	Norfors // Holte Fjernvarme	CEO
Henrik Hvid Jensen	Corporate Blockchain	Senior Digital Business Advisor // Advisor to WEF
Deanna MacDonald	Blockchain Labs for Open Collaboration (BLOC)	CEO
Anders Bøje Larsen	GreenLab	Chief Technology Officer
Frederik Van Deurs // Joachim Almdal	Green Innovation Group	CEO & Co-Founder // Head of Business Development & Co-Founder
Trygve Skjøtskift	IBM, Environment, Energy & Utilities	Associate Partner
Leo Petersen-Khmelnitski	Independent Advisor	CIFS Associate Partner on blockchain technology

Process Overview

FROM EXPLORING DRIVERS & ASSESSING KEY UNCERTAINTIES TO BUILDING SCENARIOS & DEVELOPING IMPLICATIONS

Workshop I (24/08/2020)

DRIVERS & KEY UNCERTAINTIES

Explore main drivers and their potential implications...

...to develop a shared understanding and identify key uncertainties around the future of the Danish energy sector from a blockchain perspective.

Workshop II (21/10/2020)

SCENARIOS & IMPLICATIONS

Co-create future scenarios based on key uncertainties...

...to highlight potential futures for the Danish energy sector and support a futures-oriented dialogue on how blockchain can be translated into competitiveness.

Blockchain in the Energy Sector

IN BRIEF: THE TECHNOLOGY AND ITS POTENTIAL

We are in the midst of an energy revolution. The climate challenge, developments in advanced technologies, evolving business models and changing consumer-citizen behaviour are driving decisive societal and political shifts towards smart and clean energy systems.

The energy transition is centred around three topics: 1) decarbonisation (putting cleaner energy in energy systems); 2) decentralisation (integrating distributed energy sources in existing energy systems), and 3) digital transformation (enabling smarter and more integrated energy systems).

These developments are reshaping the basis of the value creation across the sector and, hence, driving a reinvention of how all actors in energy systems operate, do business and interact with their customers. Blockchain represents a significant innovation push for the energy sector as it can contribute to, and perhaps challenge, all three strands in different ways.

A Brief Introduction to Blockchain

Many different blockchains exist, all with specific characteristics in terms of their decentralisation, access and consensus mechanisms. Therefore, each type of blockchain has its own set of particular advantages and disadvantages and is suitable for different applications.

Blockchain technology is essentially a solution enabling the creation of a distributed network of digital ledgers which provides a transparent and immutable log of all changes made in the blockchain system. New information entries are verified and recorded by consensus in an automated, digital approval process between the network participants (i.e. the connected computers) in compliance with the inherent consensus mechanism (i.e. the rules for adding new data entries). Information is then processed in “blocks” of data, which are time-stamped and cryptographically connected to each other in a long “chain” of records that determines the sequencing order of events on the “blockchain”.

Sources: CIFS Members’ Report. 2018. Transformation of Trust. | Andoni et al.. 2019. Blockchain technology in the energy sector: A systematic review of challenges and opportunities. | German-Mexican Energy Partnership and Florence School of Regulation. 2019. Blockchain meets Energy.

In principle, the data stored and displayed on a blockchain can be any type of information. It can be financial transactions between individuals, but it could just as well be any data records taking place in energy systems, like energy transfers and green electricity certificates etc.

The most important conceptual advantage of blockchains is the “decentralised/distributed” element and, hence, the ability to facilitate trust for actors who do not necessarily (need to) know each other. In a blockchain system, the task of creating trust is shifted to the technology and the distributed network of users without a need for intermediaries.

A distinction is generally drawn between public (permissionless) and private (permissioned or shared permissioned) blockchains. The main difference between these different types is the level of access participants are granted. Public blockchains are open for everyone's participation, thereby pursuing decentralisation to the largest extent. Concerns over speed and scalability, unrestricted access and governance issues prevent some corporations or consortia from using this type of blockchain. Conversely, private blockchains only allow certain entities to participate in a closed network, and participants are granted specific rights and restrictions in the network. Thus, private blockchains are more centralised in nature as only a small group controls the network, but generally they have advantages in terms of speed, efficiency and scalability.

Blockchain technology is constantly evolving and newer blockchain generations have enabled novel business solutions and use cases, especially in combination with the automated execution of smart contracts and other decentralised applications that can be operated on the blockchain.

As an emerging technology that is still in its early days of development, blockchain needs to address several issues before achieving widespread adoption. One key challenge is that of scalability and cost, while maintaining desired properties of decentralisation and security. Some of the non-technical issues relate to the governance of blockchain systems – which often deviates from traditional practices adopted by governments and industry players – as well as adopting new and common technology standards around blockchain.

A blockchain is never a standalone-solution. Only in combination with other digital technologies can a blockchain enable high added value use cases. Often the question of whether a blockchain solution makes sense for any given industry application is not a technical one at all. Rather, the specific application scenario depends much more on its economic, regulatory, and ultimately non-technological aspects, and often requires fundamentally new, decentralised governance and collaboration structures.

Sources: CIFS Members’ Report. 2018. Transformation of Trust. | Andoni et al.. 2019. Blockchain technology in the energy sector: A systematic review of challenges and opportunities. | German-Mexican Energy Partnership and Florence School of Regulation. 2019. Blockchain meets Energy.

Blockchain Applications in the Energy Sector

Blockchain has the potential to optimise energy management processes in almost all links of the value chain. It offers avenues to control and manage increasingly decentralised and complex energy systems with many actors and has the potential to become an enabling technology for the low-carbon transition.

Several blockchain use cases have been proposed by different energy stakeholders, including the following:

- **Wholesale energy distribution:** Wholesale energy markets consist of complex procedures that require a range of intermediaries who all need to verify and settle transactions (e.g. brokers, financial intermediaries, retailers). Blockchain and smart contracts has the potential to allow energy to be sold directly from energy producers to energy consumers, significantly reducing transaction costs in the market.
- **Distributed energy generation and P2P energy trading:** Distributed renewable energy sources are expected to play an increasingly important role in the decarbonization of energy systems. Blockchain can facilitate P2P trading between e.g. prosumers and consumers in localized energy networks, and local surplus energy can be fed into the main grid.
- **Digital transformation and smart energy systems:** As energy systems become increasingly smart, blockchain can emerge as an enabling technology to manage integrity and security in e.g. microtransactions between the millions of smart devices in future energy systems. Combined with other technologies and digital solutions (e.g. virtual power plants) this can offer increased flexibility and better energy balancing.
- **Current practices of energy and utility companies:** Blockchain can be applied to a variety of use cases related to the operations and business models of energy companies. This includes new product development, automated metering and billing (e.g. micro payments), controlling and managing data sharing across various actors in energy systems, grid management etc.
- **Energy certification and carbon trading:** The documentation capacity of blockchain could change energy certification and carbon trading practices, especially when applied to proof of origin and emission trading systems, helping demonstrate the provenance of renewable energy supplies.
- **E-mobility infrastructure:** Future growth of EVs is highly dependent on the charging infrastructure. Blockchain can expand centrally managed EV charging infrastructure by enabling a decentralized, more transparent marketplace for EV charging, as well as vehicle-to-vehicle charging.
- **Tokenisation of renewable energy assets and “attributes”:** Blockchain can be utilised to mobilise financing for green energy investments and innovation and/or used to reward desired behaviour in production and consumption of energy by “tokenising” assets and/or “attributes”.

Sources: CIFS Members’ Report. 2018. Transformation of Trust. | Andoni et al.. 2019. Blockchain technology in the energy sector: A systematic review of challenges and opportunities. | German-Mexican Energy Partnership and Florence School of Regulation. 2019. Blockchain meets Energy.

Scenarios for Blockchain in the Energy Sector 2030

Working With Scenarios

Scenario development is not about making accurate predictions about the future. Rather, it is about exploring what could happen in the future, in order to provide context that expands the perception of plausible, yet structurally different, future development paths. Ultimately, scenarios are meant to challenge ingrained assumptions and better guide policy and business decisions on the future.

Our approach was anchored in a series of co-creational and collaborative panel workshops, to harvest the insights and perspectives from a diverse group of experts. Workshop I focused on exploring main drivers and assessing these drivers according to their potential impact and degree of uncertainty in relation to the future of the Danish energy sector from a blockchain perspective. This allowed us to infer key critical uncertainties, defined as drivers that are likely to have a high impact, but whose actual development and realization are highly uncertain. Subsequently, Workshop II focused on developing future scenarios with outset in these key uncertainties to explore future implications.

The following pages presents the key uncertainties and their polarities as scenario axis that constitutes the scenario matrix, as well as the scenarios in the form of narratives that highlight future context and implications.

WHAT SCENARIOS ARE. . .

- Scenarios are compelling, plausible narratives about potential futures to facilitate a futures-oriented conversation and understanding
- Scenarios focus on potential changes in the external environment which in turn influence the strategic environment and strategic decisions
- Scenarios guide and inform organisations and people about future threats and opportunities to better plan for the future
- Scenarios help to foresee potential outcomes “beyond the numbers”, in an era where forecasts and projections are not enough

WHAT SCENARIOS ARE NOT. . .

- Scenarios are not predictions of the future, nor do they generate futures to which we should assign probabilities
- Scenarios do not focus on operational options created from an inside-out perspective
- Scenarios are not strategies in and of themselves, but they provide insight for planning
- Scenarios are not the same as trend analysis, empirical forecasting or other foresight methods

VERTICAL AXIS

POLICY AND REGULATORY SUPPORT FOR BLOCKCHAIN ADOPTION

POLICY PARALYSIS

The policy and regulatory framework for blockchain remains unclear and uncertain. Even as industry players seek to integrate blockchain solutions and novel business models, uncertainty about the regulatory landscape and tech standardization continues to be major stumbling blocks.

POLICY PROACTIVENESS

The policy and regulatory framework for blockchain is clearly defined and stable, which has created a positive momentum for blockchain. Industry players and investors greatly benefit from clear policy and regulatory guidelines providing a solid foundation for implementation and industry-wide standardization.

HORIZONTAL AXIS

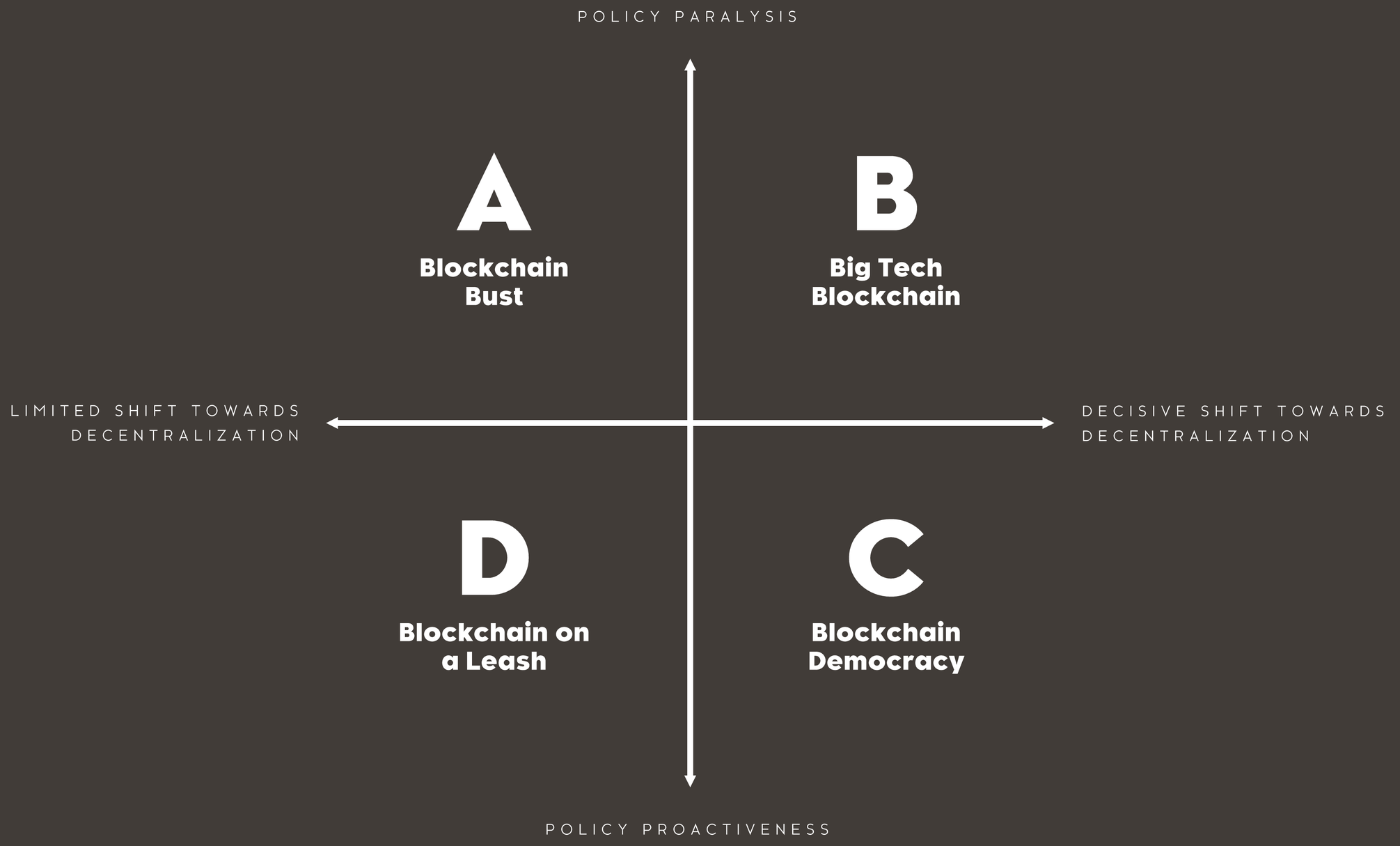
LEVEL OF DECENTRALIZATION IN ENERGY SYSTEMS

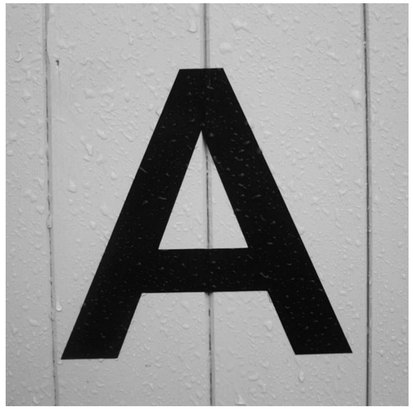
LIMITED SHIFT TOWARDS DECENTRALIZATION

There has been relatively little challenge or displacement of centralized, “utility-scale” structures and actors, who remain the backbone of energy systems. This setup has maintained operational advantages in meeting clean energy needs and proven invaluable in the continuous clean energy transition.

DECISIVE SHIFT TOWARDS DECENTRALIZATION

Decentralization is a defining feature of the ongoing clean energy transition and the number and diversity of players involved in energy systems grow. Decentralized technologies and approaches have greatly expanded and supported the clean transition through greater integration in energy systems.


POLICY PARALYSIS
A
Blockchain Bust
B
Big Tech Blockchain
LIMITED SHIFT TOWARDS DECENTRALIZATION
DECISIVE SHIFT TOWARDS DECENTRALIZATION
D
Blockchain on a Leash
C
Blockchain Democracy
POLICY PROACTIVENESS



Scenario A: Blockchain Bust

POLICY PARALYSIS //
LIMITED SHIFT TOWARDS DECENTRALIZATION

Summary – Energy Blockchain Competitiveness and Adoption

Blockchain adoption is limited to single use applications and low novelty solutions. Lack of trust in the technology and regulatory constraints pose hurdles to blockchain penetration into the energy sector.

2030 State of Blockchain in Society – In a Nutshell

When the dust of the blockchain hype storm settled, the technology never really matured in a commercially viable way for broad adoption. As of 2030, blockchain instead stands as a textbook example of what happens when expectations are inflated, and interest wanes as experimental deployment and implementations largely fail to deliver. In other words, blockchain never really made it past the dreaded “Trough of Disillusionment”, as coined by Gartner’s famous hype cycle.

Looking back at the early 2020’s, blockchain’s failure stemmed from the combination of technological and regulatory issues. The premature and uncoordinated implementation of blockchain solutions across industries backfired, as doubts about the capabilities and use cases of blockchain crept in. The fact that Denmark was lagging well behind on investments in new technologies, while industry suffered from an unclear and uncertain regulatory regime on blockchain, didn’t exactly help the matter either.

Consequently, business and industry became wary of blockchain and mainly doubled down on conventional technologies and models. However, some technological innovation had naturally occurred, and blockchain-powered solutions have found their way into niche applications across different sectors, mostly related to securing provenance and making current business operations more efficient.

Green Ambition

In 2030, Denmark is still considered to be a global climate frontrunner with high green ambitions. But actual climate action is hesitant and vague, and the attitude is that a small country like Denmark only has limited opportunities to act alone or be significantly more ambitious than its surroundings. In practice, limited economic growth over the past decade – in Denmark and globally – is to blame. Inward near-term political focus on improving the economy clashed with the desire to accelerate the long-term green transition. It remains expensive to achieve climate goals and speed up transformation, so policy changes which in the short term increase the costs of energy only occur sporadically and slowly. Businesses and consumers have limited means to proactively choose low-carbon options, and generally opt for a low risk, short-term value approach.

Many countries lack both the focus and the ability to act, while the EU and the UN only have limited mandate and opportunities for climate sanctions. International cooperation remains slow 15 years after the Paris Agreement, and the green transition continues at a similar pace to that in 2020.

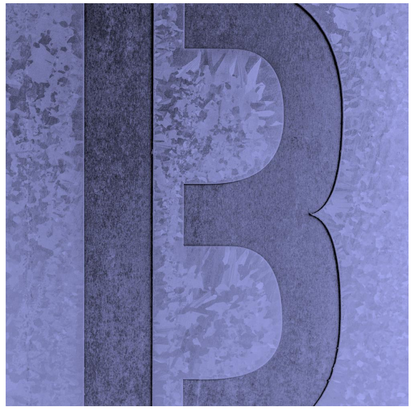
A steep increase in the carbon tax continues to be a political hot potato, as it is likely to increase the cost of goods and services and hamper economic competitiveness. Instead, the Government has looked for other avenues, like e.g. increased funding for businesses to invest in greener operations.

The Danish Energy System

Gradual progress is made towards a transition of the energy system with some government support and incentives in place to grow renewable and low-carbon technologies. Although there is an increase in such technologies, with limited capital available to spend and invest, the focus of green innovation is mainly on efficiency gains and incremental innovation in existing assets, infrastructures and systems.

The overall sentiment evolves around security of supply and short-term gains. Hence, “traditional” setups have maintained operational advantage – at least from an economic point of view – as it remains questionable when emerging, low-carbon technologies becomes cost-effective in view of high investment requirements. This has delayed demonstration of proven technologies at scale and slowed introduction and development of new innovative solutions. Centralized supply structures are consolidated, and energy largely runs “downwards” from central power plants, through retailers, to rather inactive end-consumers. Effectively, high entry barriers are keeping “outsiders” out and the options for innovation are limited.

The state of development and commitment to blockchain in energy is largely limited to single-use applications – low-novelty solutions related to better, more efficient operations of energy and utility companies, e.g., process automation, data-sharing purposes and transactions.



Scenario B:
Big Tech Blockchain

POLICY PARALYSIS //
DECISIVE SHIFT TOWARDS DECENTRALIZATION

Summary – Energy Blockchain Competitiveness and Adoption

Blockchain has become the “backbone” for a smart energy system, with e.g. blockchain-powered virtual power plants. Without clear regulation, tech standards are de facto defined by tech players with centralized platforms.

2030 State of Blockchain in Society – In a Nutshell

In 2030, technology is advancing faster than ever before. The hyper-convergence of key technologies – such as AI, IoT and blockchain – has led to wide and deep technological penetration, and most parts of society and people’s lives are data-driven and augmented by technology. Similarly, blockchain in combination with other advanced technologies drive new business- and organizational models.

While technology and innovation travelled well ahead of policy and regulation throughout the 2020’s, regulators found themselves trapped in a reality, where they had to opt for either reckless regulatory action or paralysis. Consequently, governing institutions are now for the most part perceived as encumbering and superfluous, as people have realized the limitations of old, centralized systems in a digital and interconnected world.

In the absence of clear leadership from policymakers, industry players have taken the lead as the primary driver for guidelines, standardization and interoperability as an essential foundation for the rapid development of blockchain across industry. This has resulted in giant leaps forward in terms of development and adoption of new, decentralized models. However, blockchain innovation is primarily being pushed forward by innovators and tech giants outside of Denmark and the EU – sometimes in uncontrollable and “unhealthy” ways, some observers would claim!

Green Ambition

At least on paper, Denmark anno 2030 is still firmly committed to reaching carbon neutrality by 2050, primarily by placing the bets on future break-through technologies like Power-to-X. However, there is still political hesitation to impose far-reaching climate action measures that would entail too drastic lifestyle changes or compromise other important political agendas. Even though emerging green technologies look ever more promising at scale, this way forward is risky business, as it continues to delay real action. Without the societal will to decisively break with unsustainable production and consumption patterns, even the best technologies won't be enough, the climate experts say. The public has become more climate-literate, but there is generally still some discrepancy between conscious intentions and conscious behavior.

The same overall story goes for the EU. Despite repeated declarations of intent at the EU-level, most countries are off the mark of reduction pledges. It seems as if only technology can close the reduction gap by now, as we are running out of time on our own deadlines.

Consequently, the green transition in Denmark and in the EU has become more market dominated and bottom-up. Venture capital flows to potential breakthrough green solutions, while more businesses take own climate action by becoming carbon negative.

The Danish Energy System

Rapid technological innovation by tech players, unclear policies, and cost-effective, decentralized energy has paved the way for new business models and a decentralized approach to green transition. Traditional utility providers generally found themselves in a "legacy trap", and many were failing to keep pace, opening the door to new actors with novel solutions.

For starters, tech players with platform business models quickly gained foothold in energy markets with a superior "digital first" customer-centricity and data-driven insights. Just as they have done in many sectors previously. The lock-in effect in such platform ecosystems is strong!

Investments in new digital energy infrastructures are heavily driven by the tech platforms. This in turn also positioned them to seize much more integrated business opportunities across the sector. Not by building actual power plants, but by making virtual ones*, largely running on blockchain and smart contracts. Blockchain emerged as the "backbone"-technology as the energy system has become truly "smart" and integrated across the entire chain, with energy production, distribution, and consumption linked together intelligently and flexibly. However, in the absence of clear regulation, the tech players more or less defined the de facto key technology standards. And while the energy system has become more decentralized as such, the centralized platforms are mostly in control!

*In a Virtual Power Plant (VPP), distributed, smaller/medium-scale (often renewable) power generation units are networked and operated by a single, centralised control system. Virtual Power Plants are integrated into the main grid.

Scenario C: Blockchain Democracy

POLICY PROACTIVENESS //
DECISIVE SHIFT TOWARDS DECENTRALIZATION

Summary – Energy Blockchain Competitiveness and Adoption

Blockchain has become the key technology to coordinate an increasingly intelligent, decentralized and complex energy system, with transparency across the entire system and broad prosumer participation.

2030 State of Blockchain in Society – In a Nutshell

In 2030, the second era of the digital economy has come of age. Technology has accelerated citizen-consumer expectations for increased transparency and democratization and created a movement towards new technology-enabled ways of participation. There is an appetite for, and commitment to, the potential of decentralized technologies – like blockchain – to drive transformation of society and industry alike.

During the 2020's, the Government reinforced the agenda that Denmark – as a small, open economy – must be a world-leading digital economy. While it is obvious that emerging technologies cannot be left completely unregulated, regulators embrace a clear and responsive framework that supports and leverages emerging technologies, e.g. through increased government funding and limited regulatory interference, to avoid stifling technological innovation and the freedoms of the market.

By setting a clear "way forward", regulators have provided certainty and stability for all stakeholders as a solid foundation for industry-wide blockchain deployment and continued growth. Blockchain has developed to be a crucial part of a larger toolkit of emerging, powerful technologies that have been harnessed for better performance and transparency. In that sense, blockchain has become a "utility service" that is relied upon by society and is thought of as simply a cost of doing business.

Green Ambition

Denmark still enjoys international flagship status in 2030, when it comes to a technology-driven green transition, and there is a strong interaction between Denmark's 2050 climate goal policies and the green technological development and implementation. Green business has been good business for Denmark over the past decades, and there is a continued commitment to spreading Danish climate solutions to the rest of the world. But equally important, as energy sources have shifted and technology evolved, there has been a strong political and market-driven commitment to transitioning towards more decentralized renewable energy supply. This is simply regarded as the fastest and most promising way to bring clean energy to all. The tech-empowered consumers value greater transparency and more control over the sources of the energy they consume.

The transition away from centralized energy production to smaller, localized and greener alternatives has also been well underway in Europe, as a central part of delivering on the European Green Deal targets. Denmark is leading the way and are reaping the rewards!

Alongside effective carbon taxes and public investments as the main drivers of green technology innovation, incentive schemes to facilitate and encourage a more decentralized green transition have been successfully put in place.

The Danish Energy System

After having been painfully overdue for modernization, the energy system has encountered tectonic shifts over the past decade – both in terms of digital transformation and in its structural architecture. New energy players and business models have emerged, while businesses and consumers (households, offices, factories etc.) participate in energy systems in new ways, as decentralized power generation technologies and infrastructures have become better and cheaper.

With distributed renewable generation, storage and trading in intelligent localized P2P networks (microgrids) turning mainstream, energy generation has moved much closer to the point of consumption. Hence, engaged "prosumers" – now mostly referred to as "energy citizens" – have become key energy system actors, which has led to further emancipation of energy consumers from the centralized established energy supply companies.

Blockchain has developed to be the key technology – combined with other technologies – that enables a real-time energy economy. This by offering the avenue to manage and coordinate an increasingly intelligent, decentralised and complex energy system with (micro)transactions across many more actors, billions of connected smart entities and wide coupling across sectors. Additionally, blockchain is central to securing transparency and provenance across the entire energy system.

Scenario D:
Blockchain on a Leash

POLICY PROACTIVENESS //
LIMITED SHIFT TOWARDS DECENTRALIZATION

Summary – Energy Blockchain Competitiveness and Adoption

Blockchain adoption focuses mainly on transparency and provenance in the energy system, but with no significant transformation of business models and the design of the energy system as such.

2030 State of Blockchain in Society – In a Nutshell

While technological potential in society is evident in 2030, overall tech-optimism has somewhat waned. Against the backdrop of high-level tech breaches and fails – and amid a real concern for tech overreach – a needed "tech-slowdown" has given the opportunity to consider how we ideally want technology to affect society. Part of the stagnation, too, is that current technology is stalling out, and the next wave just isn't ready yet.

On the policy and regulatory side of things, the 2020's have been all about walking the line to maintain a balance between fostering technological innovation, protecting consumers, and addressing the potential unintended consequences of disruption. Denmark has done well and is widely regarded as a flagship country demonstrating how a positive regulatory regime and responsible governance of new technologies should be implemented in an equitable and sustainable way that reflects Danish and European values in the digital age.

Consequently, blockchain – once seen as a "corporate cure-all" – suffered a slowdown, and the actual impact of blockchain on society and industry panned out less transformative up to this point. Blockchain has found its way into core business functions across industry, leading to evolutionary rather than revolutionary change. Adoption has been somewhat uneven, and takes different forms based on industry contexts.

Green Ambition

Expansive new policies and reinforced political green ambitions – guided by updated legally-binding targets set out in the Danish Climate Act – are keeping Denmark well on track towards 2050 targets. Reconciling economic growth with ambitious green policies continues to be a Danish hallmark in 2030, and in a recent amendment to the Climate Act, Denmark became one among the first countries to officially adopt a "Green GDP" measure to go alongside the conventional GDP growth benchmark. This green progression is helped along by the conviction that the green transition is not only a necessity, but also a sound economic decision in the long term. This has paved the way for increased green policy stringency and more sustainable production and consumption from conscious consumers.

At the EU-level there continues to be a great deal of commitment to the European Green Deal, albeit with regional differences. Europe – together with China, who has ramped up significantly on climate investments – has claimed global leadership in the green transition.

Denmark has sharply increased its carbon tax as a key policy intervention, and public-private partnerships are the main financing instrument for green energy projects. As society is seeing electrification happen at a faster pace, and with a strong political push to phase out cars running on fossil fuel, electric vehicles are now the most popular form of transport.

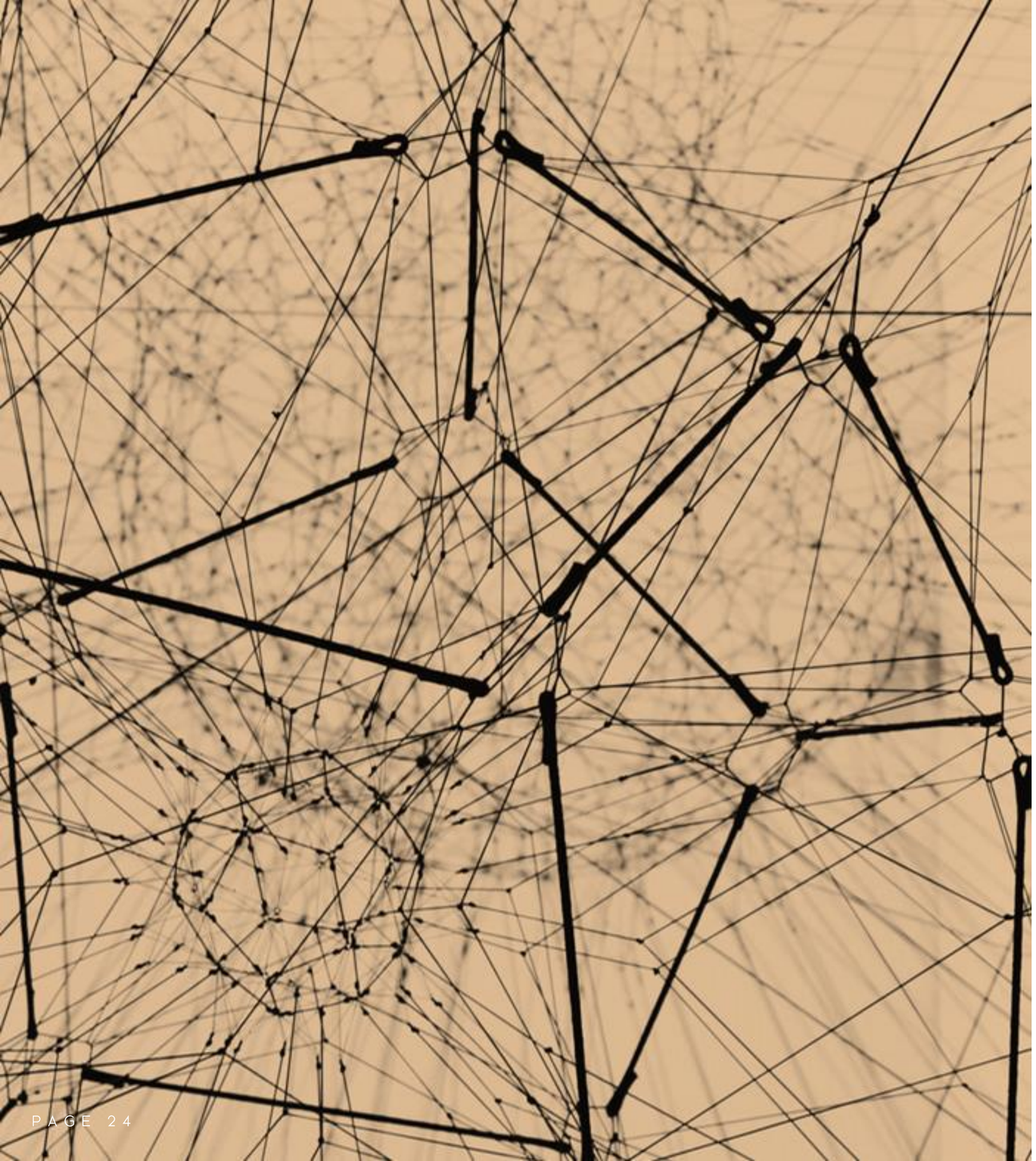
The Danish Energy System

Meeting the needs of an energy transition and delivering on the changing criteria of the energy market and the consumers, was clearly inconceivable without comprehensive digitalization and integration of legacy energy system infrastructure. In order to establish certainty and social acceptance in upgrading critical national infrastructure, this was done in a regulated and transparent manner, with trusted, established players (TSO and DSOs) at the helm – just like 5G was rolled out without the involvement of Huawei.

Close collaboration between state and industry have supported rapid large-scale deployment of proven clean energy and energy efficiency technologies in the energy system, while also accelerating demonstration of new green solutions, in which Denmark is banking on a leading global position. In practice this means that the green ambitions are realized mainly through a centralized pathway, e.g. with continued growth in offshore wind and a push for Power-to-X production at scale.

While the innovative potential of blockchain is being explored, it still hasn't significantly transformed energy markets, business models or the energy system as such. The most viable applications for blockchain in energy relates to the documentation and transparency capacity of the technology, e.g. documentation of ownership, guarantees of origin, and carbon trading practices, to secure the required provenance and compliance.

Implications in Relation to Blockchain Competitiveness



From Scenarios to Implications

Blockchain presents clear economic and competitiveness opportunities for Denmark and Danish industry broadly. But as with many emerging technologies, there are risks to manage, challenges to overcome and implications to consider. To ensure that Denmark positions itself as a leading blockchain adopter and innovator, and that the technology is leveraged to create competitiveness across Danish industry, Denmark must think boldly about how different players can ease the transition and actively push Denmark to the forefront of blockchain adoption and innovation.

The outset for the panel's work was the future of the Danish energy sector towards 2030 from a blockchain perspective. However, a broader objective was for the panel to contribute to a futures-oriented conversation and shared understanding of how blockchain can be translated into competitiveness in the Danish energy sector and across Danish industry.

Hence, against the backdrop of the scenarios and the co-creating approach of the panel, we can summarize a series of broader implications for blockchain competitiveness to be considered. These are not exhaustive, and should be subject to further analysis and qualification, but can nevertheless serve as a starting point for a discussion to help pave the way for a quicker road to blockchain competitiveness in Danish industry.

Policy and Regulation

There is a need for…

- …an **overall clear policy focus and regulatory certainty** that promotes blockchain dissemination, application and innovation as part of the wider digitization of Danish society as a whole, and as a prerequisite for energy sector actors to leverage the competitiveness potential in blockchain. As with any emerging, disruptive technology, blockchain and its uses pose new challenges in terms of policy and regulation. Ensuring that regulatory systems are fit for purpose for the future is a key challenge for policymakers, and ultimately the technology adopters.
- …a **flexible and intelligent regulatory framework** that enables experimentation by allowing for a "regulatory sandbox" that brings together regulators, companies, entrepreneurs and tech experts to test innovative energy sector solutions and identify obstacles that arise in deploying them. The inclusion of relevant stakeholders in such work is a crucial component for the future frameworks to act not only as regulators, but also as facilitators and enablers.
- …a **conducive environment for entrepreneurs and SMEs** wanting to experiment with novel blockchain solutions, use cases and business models, such as by improving access to finance, talent, resources and mentorship, and by avoiding unnecessary bureaucracy.
- …**encouraging public and private investment** in blockchain research, innovation and scale-up. Access to risk capital is crucial for businesses to develop, test and start commercially applying blockchain to energy sector use cases. Lagging behind comparable countries with regards to investment in this area specifically may challenge competitiveness of Danish industry in the longer term.

Technology, Interoperability and Standards

There is a need for…

- …**blockchain solutions to prove they can deliver on scalability, speed and cost**, while maintaining desired properties of decentralisation and security. It is clear that blockchain technologies have already passed the proof-of-concept stage for several energy sector use cases but require further development to achieve desired operational and performance objectives.
- …**interoperability and common standards** to support broader adoption of blockchain solutions and achieve scale. Standards for blockchain architectures need to be developed to allow interoperability between technology solutions, and data interoperability and harmonization should be promoted. This interoperability will depend on the industry sector and the degree of data and technology standardization therein.
- …establishing **blockchain as a key enabling technology** in the wider context of the digital energy transition, with smarter and more integrated energy systems. Blockchain represents a significant innovation push for

the energy sector in convergence with other advanced technologies like AI, IoT and advanced computing. A blockchain is never a standalone-solution, and only in combination with other digital technologies can a blockchain enable high added value use cases.

Governance & Business Models

There is a need for...

- ...organizations and businesses to **adopt flexible policies towards blockchain** that are ready for a fast-paced and ever-changing technology landscape. For blockchain solutions to create high added value, it likely implies reform or even displacement of current business models, rather than adapting a blockchain to a present business model, where other solutions have an operational advantage.
- ...in any blockchain system, to **identify the appropriate design in level of power and ownership over key governance functions** for each participant (e.g. verifying transactions, changing market rules, etc.). This includes incentives and methods for members of the system to coordinate and establish a clear set of criteria for justifying inclusion/exclusion. Unless completely private, decentralization of at least some governance functions will be necessary.
- ...a strong focus on **the value creation of the solution**, and not on the technology as such. Often the question of whether a blockchain solution makes sense for any given energy sector application is not a technical one at all. Rather, the specific application scenario often depends much more on the business reality, and the organizational and collaborative setup, that the solution needs to function within.
- ...**industry organizations to play a central role in establishing industry specific blockchain ecosystems**, fostering industry-wide and cross-industry collaboration and synergies, and help businesses assess the possibilities blockchain brings to the industry. There are currently no such targeted initiatives in Denmark to establish ecosystem/cluster synergies.

Capacity Building and Awareness

There is a need for...

- ...promoting a **narrative around blockchain** that supports “everyday users” in placing their trust in blockchain as a potentially commercially viable technology within the energy sector and wider industry.
- ...supporting the **development of specific digital skills by executives and managers**, by providing training related to the potential and possible industry applications of blockchain technology, to improve the blockchain-related literacy and skills of decision-makers.
- ...developing the needed **“blockchain-mindset” to evaluate business opportunities** and challenges around potential blockchain solutions in the energy sector, in order for companies and organizations to determine if there is strategic value in blockchain that justifies investment. Blockchain will not always be the right solution.