

Blockchain in the energy transition.
A survey among decision-makers in the
German energy industry

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Abstract

Blockchain is a distributed, digital transaction technology that allows for securely storing data and executing smart contracts in peer-to-peer networks. In a survey among German energy executives, the Deutsche Energie-Agentur GmbH (dena) – the German Energy Agency - and the European School of Management and Technology (ESMT Berlin) have compiled their opinions, current and planned actions, and visions of the future role of Blockchain in the energy sector.

More than half of the 70 respondents have already experimented with Blockchain or plans to do so. 21 percent consider Blockchain a game changer for the energy supply industry. 60 percent of the respondents believe that a further dissemination of the Blockchain is likely, and 14 percent expect niche applications. The survey also covered potential use cases: Around half of the use cases mentioned by respondents are related to process optimization, including billing, sales and marketing, automation, metering and data transfer, mobility, communication, and grid management. The second half is linked to public and private trading platforms, in particular peer-to-peer trade, and decentralized energy generation.

Respondents urge decision-makers to speed up the process of putting Blockchain at the top of their agendas and express concerns that Germany and the European Union might be lagging behind in a global comparison. The rapid launch of prototypes should verify the functionality of the technology and attract a sufficient amount of users to rapidly reach a critical mass. They also fear that the current regulatory framework is not suited at all to accommodate Blockchain applications.

The dena / ESMT analysis reveals that the cost-cutting potential of Blockchain applications has its limitations. Especially in markets where digital solutions already exist, the technology will have to compete with fairly efficient processes. By contrast, nascent markets, such as public charging and billing transactions for electric vehicles, offer possibilities of the Blockchain to become the dominant design.

1 Introduction

Blockchain is a distributed, digital transaction technology that allows for securely storing data and executing smart contracts in peer-to-peer networks (Swan, 2015, p. IX). This is potentially disruptive, as trusted intermediaries could become obsolete. Banks and, more generally, the financial sector were the first ones to become aware of the technology via the cryptocurrency Bitcoin, which operates on the basis of Blockchain. But with the recently added possibility to conduct smart contracts via a platform called Ethereum, Blockchain has gained increasing attention outside the financial sector. Conferences on Blockchain-based cryptocurrency Bitcoin are flourishing, startup competitions are held to spot the Blockchain equivalent of Amazon and Uber, and venture capital so far has raised \$1.1bn to scale business models of the future (Weusecoins.com, 2016).

US-based consulting practice Gartner analyzes emerging technologies and locates them within a recurring sequence that Gartner's consultants call the "Hype Cycle."¹ According to Gartner's 2016 edition of the "Hype Cycle for Emerging Technologies" (Walker et al., 2016), cryptocurrency Bitcoin is already "sliding into the trough [of disillusionment]," but Blockchain is located at the "peak [of inflated expectations]." Albeit qualitative, this categorization exemplifies the frenzy that surrounds Blockchain – even the World Economic Forum (WEF), as a discursive platform for global leaders, emphasizes the "explosive" potential of the technology: "The Davos elites were not scrambling to listen to the debates that have dominated the WEF agenda in recent years, namely the financial crisis and regulatory reform; these are largely absent from the agenda this year. Instead the current hot issue is how financial technology or fintech could revolutionize the world of money; topics such as Blockchain have eclipsed discussions on Basel III." (Kaminska and Tett, 2016)

Meanwhile, another major disruption is occurring in the energy sector. Germany's energy transformation, or *Energiewende*, is seen as a role model for the move toward a carbon-neutral energy supply. The process of reshaping the German energy system had already started in the 1990s, when it was decided to expand the share of power generation from largely carbon-neutral – albeit intermittent – renewable energies. In 2011, the German government decided to phase out its nuclear power fleet by 2022, which accelerated the transition.

In 2015, approximately a third of Germany's electricity consumption was generated from renewables, with more than 1.5 million photovoltaic micro-generation units (BSW, 2016), 26,000 wind turbines (BWE, 2015), and 9,000 biomass power plants (Fachverband Biogas, 2016) having been installed. These power plants alone amount to an installed capacity of 97 GW (BMW, 2016d), almost half of Germany's total capacity. By 2025, the capacity of photovoltaics, wind, and biomass is estimated to rise to almost 145 GW. By 2030, a new high of almost 167 GW is predicted (own calculations, based on BMW, 2016c, BMW and AgEE, 2016).

Yet, the German energy transformation is currently undergoing dramatic changes: The government has reduced financial incentives for the installation of new renewables, in particular photovoltaics. Investments in renewable energies declined from €27.3 billion in 2010 to €18.9 billion in 2014 (BDEW,

¹ The Hype Cycle typically consists of five phases, namely *Technology Trigger*, *Peak of Inflated Expectations*, *Trough of Disillusionment*, *Slope of Enlightenment*, and *Plateau of Productivity*.

2016). The electricity price on the wholesale market is in decline, but average household tariffs remain at around €0.28 per kilowatt hour, including taxes and fees, partially because they have to reimburse owners of renewable energy installations that benefit from the feed-in tariffs. In the long run, this may lead to social frictions and fuel consumers' discontent with government policies. Meanwhile, grid interventions to stabilize the system – and the associated expenses of transmission grid operators – have risen to record levels.

After years in which the energy transformation essentially concerned the growth rate of renewables, now systemic challenges move into the focus of policymakers and executives, in particular the diverse primary energy mix in power supply and how to integrate new players with new technologies into the market. Phase two of the transformation has begun – the “*Energiewende 2.0*”.

Can Blockchain be an ingredient for the next phase? This study sheds light on current business models and potential future use cases, applications for energy markets, and regulatory issues. Most importantly, it complements existing studies, in particular Hasse et al. (2016), by providing the results of a survey among decision-makers within the networks of the German Energy Agency GmbH (dena) and the European School of Management and Technology (ESMT Berlin). Dena and ESMT have compiled findings on German energy executives' current opinions, actions and visions of the Blockchain. Clustered by application fields, the survey shows in which fields they expect Blockchain to have an impact on the energy sector and complements existing studies, in particular Hasse et al. (2016).

2 Blockchain: What is it?

2.1 Blockchain: The basics

As mentioned in the introduction, Blockchain is a decentralized internet protocol that facilitates transactions between peers without an intermediate institution, for example a bank. Cryptocurrencies such as Bitcoin operate on the basis of Blockchain, but Blockchain applications can be also non-monetary, for example, so-called smart contracts that are automatically executed once specific conditions are fulfilled.

In short (based on Tapscott and Tapscott, 2016), Blockchain operates as a distributed database that contains a continuously growing list of data records, the so-called blocks. These blocks are time-stamped, shared, unalterable, and connected to preceding blocks; they contain data and programs, batches of individual transactions, and executables. Transactions are verified by computers run by the network's users, the so-called nodes, in short intervals; they are distributed, public, and encrypted. If a hacker wanted to modify a contract, the whole Blockchain would have to be reconfigured at every node – a computationally and organizationally difficult task.

A transaction platform based on Blockchain may be set up as a private network with authorized access, for example as an internal strategy of a bank to reduce transaction costs, or as a public network with open access, creating censorship-resistant transactions, maybe even outside the current legal framework (for a comprehensive description of the underlying technology, see Frøystad and Holm, 2016).

A typical transaction on Blockchain consists of five steps (as described in Frøystad and Holm, 2016, p. 11):

- A message is transmitted to the network, which contains information on the value of the transaction and a digital signature that confirms the authenticity of the sender, transaction, and receiver's address.
- The nodes of the network receive the message and authenticate the validity of the message by decrypting the digital signature. The authenticated transaction is placed in a pool of pending transactions.
- One of the nodes in the network aggregates pending transactions in a block that contains consensual, replicated, shared, and synchronized digital data. At a specific time interval, the node broadcasts the block to the network for validation.
- The validator nodes of the network receive the proposed block and validate it through an iterative process, which requires consensus from a majority of the network.
- If all transactions are validated, the new block is integrated into the existing Blockchain, and the new current state of the ledger is communicated to the network.

Processing the transaction requires a substantial amount of time and computational effort, which has led to delays and record levels of customer complaints at Blockchain's most popular cryptocurrency, Bitcoin (Gilbert, 2016), with some critics doubting whether customers – at least in the context of industrialized countries with established and trustworthy payment systems, such as credit cards – would

substitute their traditional payment method with a currency based on Blockchain (Trentmann et al., 2016).

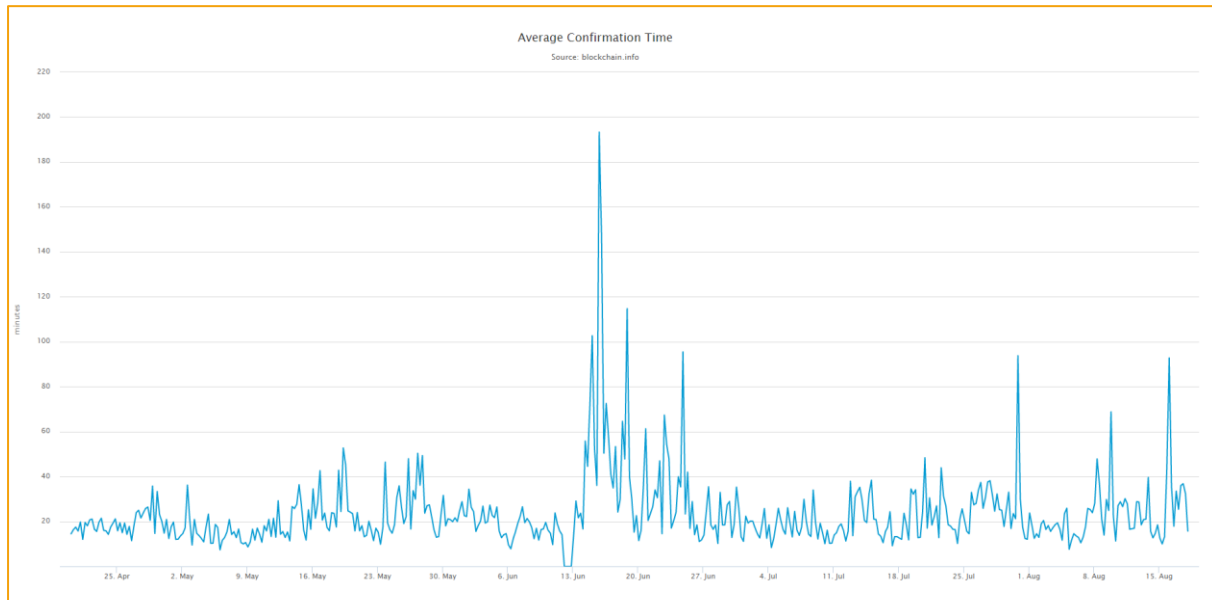


Figure 1: Average confirmation time at Bitcoin.²

However, more recent Blockchain scripts, such as Ethereum, are expected to substantially reduce the computational effort.³ Consulting practice Goldman Sachs comments (Boroujerdi and Wolf, 2015): “[Blockchain] has the potential to redefine transactions and the back office of a multitude of different industries. From banking and payments to notaries to voting systems to vehicle registrations to wire fees to gun checks to academic records to trade settlement to cataloguing ownership of works of art, a distributed shared ledger has the potential to make interactions quicker, less expensive and safer.”

New platforms such as Ethereum might increase scalability and enable the technology to potentially become part of nearly every digital process in the future.

2.2 Processes: Digitization and the Internet of Things

Almost all areas of life, such as commerce, communication, and leisure, are increasingly shaped by the process of digitization. In 2016, approximately 6.4 billion devices and machines will be linked via the internet. It is estimated that this number will reach 20.8 billion by 2020. In 2016, 5.5 million new things will be connected every day (Gartner, 2015). This process itself is changing, as the digital environment grows more mobile and connected. Digitization disrupts the existing rules and spreads into all commercial and industrial sectors. It redefines nearly all existing business models, causing major shifts in business and society, the working environment, consumption, co-operation, and communication. Countries that open up new markets early and quickly are the ones that set standards for the decades to come (BMW, 2016a).

² Source: Blockchain.info (2016)

³ Please see Appendix I for details on Ethereum.

The same holds true when it comes to the ongoing trend of the automatized and autonomous exchange of information between entities. Every mobile phone automatically connects to a wireless local area network (WLAN) once the respective password is saved, and automatically downloads emails, updates, or instant messages. When devices interact without human interference, machine-to-machine (M2M) communication occurs, leading to “Industry 4.0” (Kagermann et al., 2013) in the context of manufacturing and, more generally, the “Internet of Things.”

Digitization transforms the energy sector across the entire value chain. In summer 2016, both chambers of the German parliament approved the “Act on the Digitization of the Energy Transition”, which sets minimum technical requirements to ensure data protection and security for the launch of Smart Grid and Smart Homes in Germany, and the rollout of Smart Meters (BMW, 2016b). The “Smart Home,” that means, residential dwellings with connected devices, such as a fridge, washing machine, and the heating, ventilation, and air-conditioning system, would not be possible without digitization. In power generation, digitization is able to address many challenges that arise with renewable energies. The negative effects of the volatility in the availability of wind and solar energy can be mitigated by matching electricity demand with generation through automated digital alignment strategies. Instead of managing power generation to demand, demand must be matched to the power available. The number of companies offering demand-side management is growing, and the cost reductions in battery storage will accelerate dissemination in residential applications and mobility. Such solutions require market information to be available to electricity consumers at all times. Consumers can then react to this information and adjust their demand accordingly. Even further, electricity consuming units could react autonomously to signals of power availability and grid stability. The electricity sector becomes fully automated.

Assuming that each decentralized solar resource installed today in Germany would be combined with a storage system, there would be more than 3 million units that would have to be integrated into a smart grid. Several kinds of storage solutions, such as electric vehicles or systems that automatically adjust energy usage in households in combination with solar panels, might be integrated as additional devices in the energy system.

For electric utilities, digitization offers an opportunity to save costs in many parts of their operations, be it in the control of their infrastructure via sensors, in billing processes, supply chain management, or in their internal accounting and human resources organization.

It also means exploring new ways of innovation. As electric utilities strive to emulate innovation practices from other industries, their old model of incremental innovations, which often occurred in research and development (R&D) centers or functional silos, is complemented by new units specifically established to fund or stimulate business model innovation (Burger et al., 2015). Niches for employees are created to explore and develop new digital business models and Blockchain-based solutions. For example, German utility RWE (Innogy), sends its intrapreneurs to GTEC, the German Tech Entrepreneurship Center in Berlin, where they benefit from a working environment that is directly connected to the Berlin startup ecosystem, including weekly meetups of the Berlin-based Blockchain community.

2.3 Platforms: Blockchain as a Peer-to-Peer marketplace

Many digital businesses serve as digital platforms that match decentralized supply and demand. They are part of a new societal trend commonly called the “sharing economy.” Generally, these business models take advantage of the fact that the internet offers a much higher speed for interactions and the possibility of involving a large number of participants in real time. As opposed to classical manufacturing, many digital business platform models have relatively low fixed costs when starting their business. Startups are able to establish themselves in markets that were previously dominated by a few large players. Due to the low barriers to entry in the digital world, platforms may initially compete. When a sufficient amount of suppliers and consumers use one specific platform, the individual user’s benefit for using that platform is enhanced by so-called positive network externalities. Over time, digital platforms often reach a state of oligopoly, or even monopoly.

This new business world is characterized by dominant players such as Ebay, Uber, PayPal, Airbnb, and Skype. One of the most striking observations when analyzing these digital businesses is the absence of physical assets. This is, for example, the case for business models such as Airbnb and Uber, which offer accommodations and car rides, respectively, without actually owning the physical assets (apartments and cars). This way, fixed costs can be held at a rather low level compared to businesses in the analog world. A similar situation can be observed when applying Blockchain technology to the energy world. Instead of having to invest in generation technology (e.g., solar, wind) or metering and broadband technology, the business model focusses on providing a (secure) connection between existing entities that allows them to trade the electricity they generate.

The physical assets are linked with the users of the platform – be it apartments (Airbnb), solar power units, or other goods and services. They often turn into “prosumers.” For example, in the world of Airbnb, this means that residents of an apartment may at the same time act as landlords and use the service of other members of this community when they travel themselves. The same principle holds true for solar systems installed on decentralized housetops: The owners of photovoltaic solar units may both use the electricity they generate for themselves and sell the electricity to others.

For example, ride-sharing startup Arcade City directly competes with Uber for individual mobility services. Arcade City has established an open marketplace where riders connect directly with drivers by leveraging Blockchain technology. Most prominent examples of energy exchanges between decentralized producers and consumers are the Brooklyn Microgrid (Mihm, 2016) and Power Ledger in Australia.

In the sharing economy, assets are used more transparently than in the old business world. For example, an Airbnb customer receives instant information on what he or she can expect through photos of the flat as well as other customers’ evaluations on the platform website. Equally, Blockchain offers the chance to provide anonymous transparency, for example on the origins of the electricity a consumer buys (e.g., type and location of the power unit). This satisfies the increasing demand from customers for easy and fast access to clear and comprehensible information about the goods and services they are purchasing. Startups such as Abra allow customers to send money from one consumer to another via the Bitcoin Blockchain. The founders of Abra state that their model “is 100% peer to peer, with no middle man ever holding, managing or touching your funds at any point in any transaction” (Abra, 2016).

The Blockchain movement emerged in the aftermath of the financial crisis, echoing a general distrust of the commercial banking system (Tapscott and Tapscott, 2016). As it coincided with other, above-mentioned peer-to-peer network solutions, it follows an ideology of dismantling established hierarchies, diverting societal influence from organizations to individuals, using democratic instead of autocratic decision processes, and empowering consumers, based on the claim of following the high ethical standards of the new, decentralized world order: “Blockchain technology is not just a better organizational model functionally, practically, and quantitatively; by requiring consensus to operate, the model could also have greater liberty, equality, and empowerment quantitatively” (Swan, 2015, p. 29). In the energy sector, this claim may be directed against established utilities, which are often branded as guardians and preservers of the centralized fossil and nuclear age, as opposed to the sustainability and participatory approaches that are envisioned by Blockchain supporters.

3 Blockchain and energy: Current business models

The projected evolution of Blockchain in the energy sector parallels the three phases of development that are commonly coined as Blockchain 1.0, 2.0, and 3.0 (Swan, 2015, p. IX): Phase 1.0 is characterized by the deployment of cryptocurrencies as an alternative to other digital payment systems; phase 2.0 extends the use case of Blockchain to Smart Contracts and more sophisticated financial instruments, such as bonds, mortgages, and property transactions – generally any type of transaction between two parties that can be represented through a digital equivalent; phase 3.0 will be reached when Blockchain is deployed in Big Data and predictive task automation. The visionaries of Blockchain believe that it “could be an important tool for protecting and preserving humanity and the rights of every human being, a means of communicating the truth, distributing prosperity [...]. Admittedly, a bold statement” (Tapscott and Tapscott, 2016, p. 52).

In the energy sector, the trajectory starts with cryptocurrencies as a means for paying electricity bills (phase 1.0) and already extends to Smart Contracts grounded in physical transactions (phase 2.0). The following sections present some of the startup and business ideas of phases 1.0 and 2.0. Phase 3.0 is envisaged by some startups, but has not yet been reached.

3.1 First use cases: Bankymoon, SolarCoin, BlockCharge

Using cryptocurrencies for monetary transactions is the most obvious use case in the energy sector. This movement is mostly being triggered by startups, but utilities are catching up in these applications of Blockchain and are launching joint ventures and cooperations.

The value proposition that new ventures present to potential customers and investors is similar to initiatives in the banking sector: Any necessity for an intermediary between two parties is removed. For making the switch to a decentralized energy system, detaching the related financial transactions from a central control unit can be interpreted as the next step toward full decentralization.

Different use cases of Blockchain 1.0 are in the pilot project and first implementation stages. One application consists of smart prepaid meters that only release power to residential customers once they have topped up their accounts and transferred money to the electricity provider – a kind of mini smart contract. This system brings benefits for the supplier by increasing the payment discipline of its customers, but it may also have advantages for residential consumers: In countries with high inflation rates, payments result in lower expenses for them if they have paid in advance, precluding any accumulation of debts. This idea has been developed by a South African startup called Bankymoon.

Bankymoon also uses Bitcoin as a cryptocurrency to perform remote payment transactions, using their Bitcoin-compatible Smart Meters, for example, in cash-deprived public schools. Donors from, say, industrialized countries who want to support the schools can send crypto-money directly to a Smart Meter to a school of their choice, thereby allowing the schools to be supplied with electricity automatically. During the Cambridge MIT Enterprise Forum in early 2016, one Bitcoin was transferred to the Emaweni Primary School in Soweto, South Africa, sufficient for around three weeks worth of electricity supply for the school (Higgins, 2016).

Two members of the SolarCoin Foundation have come up with the idea of an energy-backed currency, similar to the gold reserves that are supposed to stabilize “real” currencies: “The DeKo thesis is that electrical energy in the unit form of delivered kilowatt hours – a DeKo – can be a more stable asset for backing a currency than gold or debt.” (Gogerty and Zitoli, 2011) Since then, the idea has transformed into a reward system for renewable energy installations based on cryptocurrencies: “SolarCoin is already present in 17 countries and is intended to be circulated worldwide: any owner of a solar photovoltaic installation may apply and claim his SolarCoins for free. To do so, the solar owner simply registers his solar installation online with data proving the existence and operation of his solar installation.” (Kastelein, 2016) What is the value proposition behind that business model? The currency could offer “a real marketing opportunity for brands whose positioning is based on ecological values and environmental protection” (Clapaud, 2016). However, there are some minor flaws in the concept, for example, a Megawatt hour peak has the same value as the same amount of energy during base load. The target of the SolarCoin Foundation to attain an exchange rate of \$20 for one SolarCoin by 2018 (ibid.) seems fairly ambitious, given that one SolarCoin traded at around \$0.06 in mid-August 2016, and the deployment of photovoltaic panels all across the world may not lead to greater stability of the currency, but rather to a depreciation due to inflationary pressures.

Using the Ethereum Blockchain to facilitate charging for electric vehicles is a project that was launched by German utility innogy, assisted by a startup called Slock.it, which specializes in providing Blockchain expertise to large corporations. They call their venture BlockCharge and promise seamless and affordable charging of electric vehicles. As opposed to many other ideas revolving around Blockchain, BlockCharge has a physical artifact, the “Smart Plug,” which can be used like a normal plug but has an identification code linked to it. Users install an app on their smartphones to authorize the charging process. It connects to Blockchain, which manages and records all of the charging data. BlockCharge is aiming for a worldwide authentication, charging, and billing system with no intermediary. Owners of electric vehicles can use any electric plug to charge their vehicles. The app automatically negotiates the best price and manages the payment process automatically. Once induction charging for electric vehicles, say, at traffic lights, becomes a reality, BlockCharge will take over the entire charging process. BlockCharge’s business model is based on the one-time purchase of a Smart Plug and a micro-transaction fee for the charging process (Stöcker, 2016).

As opposed to many other startups using Blockchain, BlockCharge benefits from RWE’s (Innogy) leading position as a provider of charging stations in Europe. The utility entered the market for electric vehicle charging with solutions from their R&D team as a first-mover and has successfully exported its technology to cities outside Germany, including Amsterdam, cooperating with companies such as Daimler, Renault/Nissan, and the leading German automobile club, ADAC. As of August 2016, more than 1,400 RWE (Innogy) charging stations for electric vehicles had been installed across Europe and the United States (RWE, 2016).

3.2 From a local exchange to a global platform: TransActive Grid, Power Ledger and Grid Singularity

Moving toward phase 2.0, Blockchain serves as a platform for more complex services and interactions. For example, US-based startup TransActive Grid enables its members to trade energy using smart contracts via Blockchain. Its first transaction was successfully launched in early 2016, connecting five homes that produce energy through solar power on one side of a street in Brooklyn with five consumers on the other side of the street, who are interested in buying excess energy from their neighbors (Rutkin, 2016). A similar initiative is launched by a startup called Power Ledger in Perth, Australia (Potter, 2016).

Austrian startup Grid Singularity aims to move beyond an energy exchange platform and host a range of applications, including energy data analysis and benchmarking, Smart Grid management, trade of Green Certificates, a decentralized mechanism for investment decisions, and energy trade validation (Grid Singularity, 2016). The applications envisioned by Grid Singularity reach far into phase 2.0 of the Blockchain movement.

Ewald Hesse, founder of Grid Singularity, sketches use cases of Blockchain or similar decentralized platforms that can be envisioned for the future of the energy sector (Bitcoin TV, 2016). For example, collected technical and financial data can be used for real-time asset valuation of power plants. This would in turn enable refinancing or selling a power plant to a potential investor who could perform due diligence online. Other use cases include assessments of generation capacity and availability, pricing and origin, forecasting, energy trading, virtual power plants, and micro-grid management. Every household may become a single trading entity, negotiating clean or cheap energy for its electric vehicle or for residential consumption. More macro-oriented uses cases such as grid balancing mechanisms and the generation of emission certificates may be feasible.

Grid Singularity is also partnering with the Rocky Mountain Institute to establish an energy industry consortium with the goal of a more effective deployment of Blockchain to facilitate more effective operations in the energy sector (Hesse, 2016). The new consortium aims to conduct R&D in Blockchain and energy in order to help utilities, application developers, customers, and renewable energy companies understand how the technology could support, disrupt, or transform existing business models.

4 Results of the survey among German energy executives

Will Blockchain be able to contribute toward accelerating the speed of the energy transition? What are the opinions of German decision-makers in the energy sector about Blockchain? Have they heard about it at all? Would they see any potential applications in the energy sector? Is it just hype, or does it have real potential to disrupt the functioning of the industry? How big do they estimate the potential of Blockchain to be, and in which areas? Will it become a niche application, or a game changer?

In July/August 2016, the link to an online questionnaire was sent to members belonging to the dena network as well as ESMT alumni who work in the energy sector or energy-related industries. In total, 70 responses were received.⁴

This survey is not intended to provide a representative view of all German executives in the energy sector, though. By contrast, it most likely suffers from a positive selection bias: Recipients of our request to fill in the questionnaire may be more inclined to submit a response if they had prior knowledge of the topic. If they did not have prior knowledge, they may have just discarded the survey, because they deemed it irrelevant. Those who responded may be the ones who push the technology into the market and who serve as multipliers.

Responses came from executives all along the value chain in the electricity industry, starting from manufacturers to utilities, grid operators and service providers to employees at the electricity exchange. The three largest groups of respondents were employed at electric utilities, service companies, and grid operators, respectively. The following figure shows the responses according to our classification.

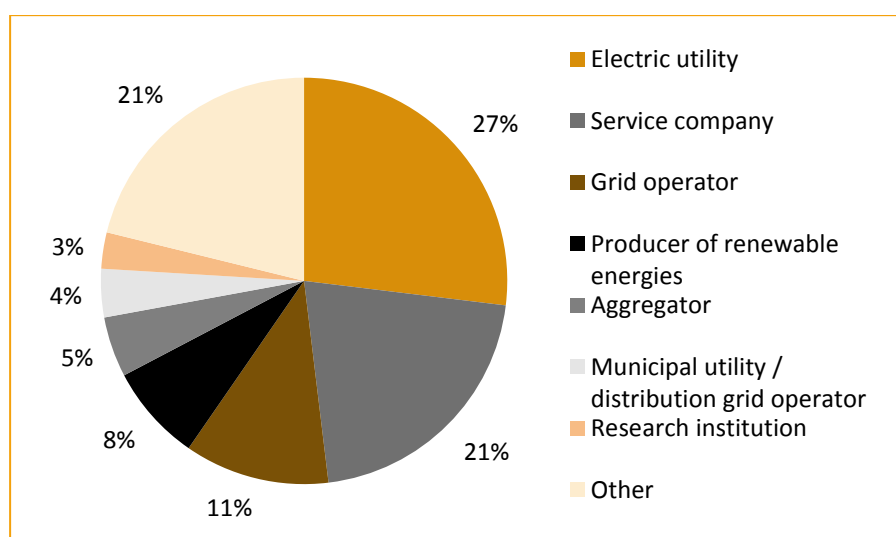


Figure 2: Structure of survey respondents.⁵

⁴ The survey was anonymous and all information about the companies and organizations of the respondents were provided voluntarily. Please note that not all participants responded to each question.

Table 1 in appendix 2 provides an overview of additional job specifications (other) that respondents mentioned.

Of the 70 respondents, more than two thirds of the respondents work in a company with more than 500 employees, 22 percent in companies with 50–500 employees and about 10 percent in a company with fewer than 50 employees.

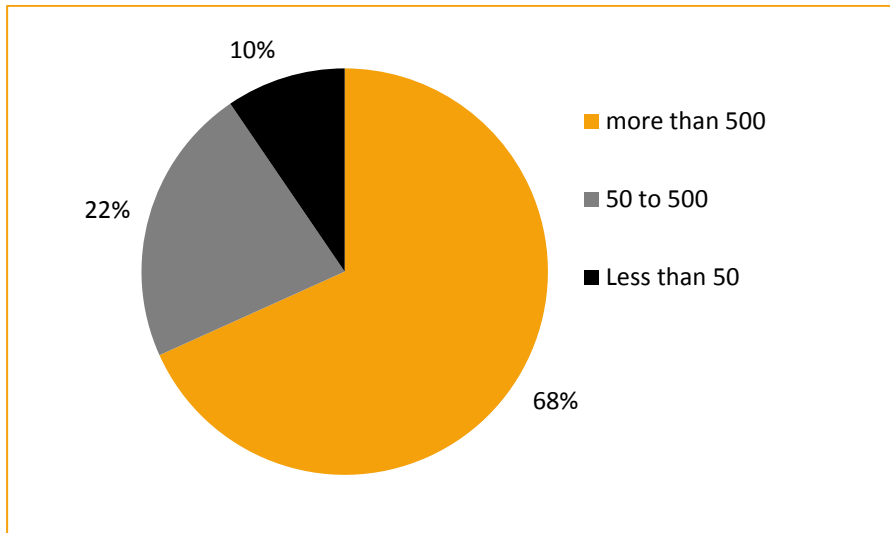


Figure 3: Company size of survey respondents.

4.1 Awareness of Blockchain in the energy industry

Respondents were asked whether they have already heard about applications of Blockchain in the energy sector. Almost 70 percent answered “yes.”

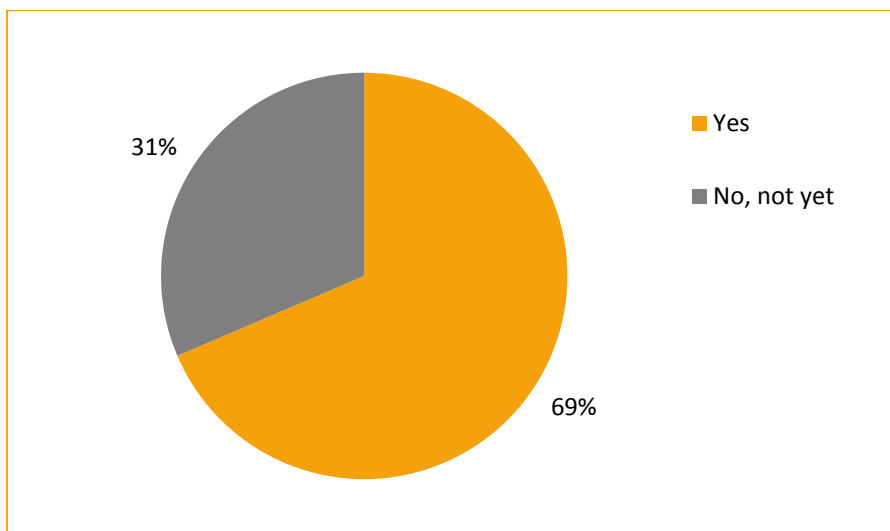


Figure 4: Awareness of Blockchain among survey respondents.

⁵ All Figures 2-7, Source: dena / ESMT survey results (Aug/ Sep 2016), n=70

4.2 Actual and planned activities with respect to Blockchain

When asked whether their respective companies or organizations have already taken steps in that direction, 13 percent responded that they are already in the process of experimenting with Blockchain and 39 percent are planning to do so, including pilot tests, studies, analyses, and research projects.

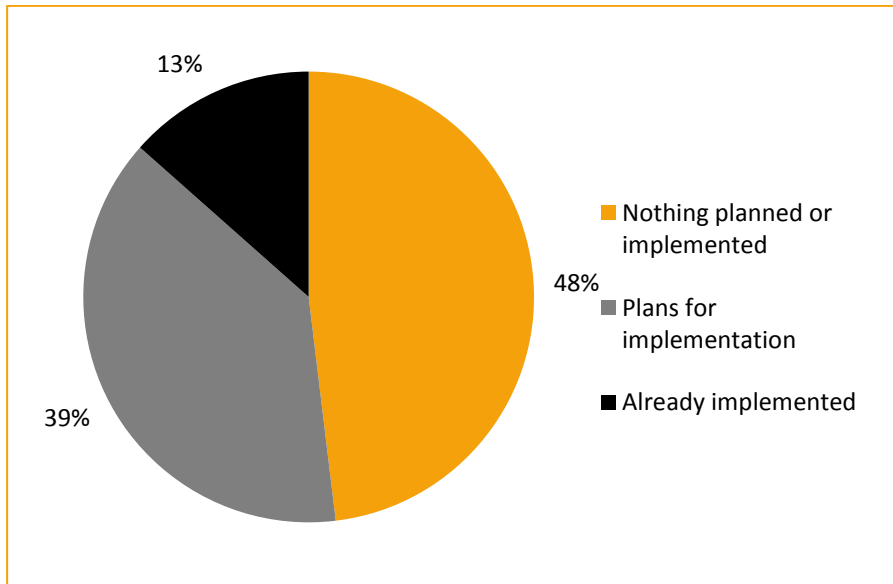


Figure 5: Activities regarding Blockchain among survey respondents.

The respondents who are in the implementation phase mention, for example, actively scouting startups, business development, and dealing with Blockchain element Proof-of-Concept. One respondent reported that his organization has three projects running, including P2P Trading, charging of electric vehicles, and using Blockchain for payment processes. Another participant mentioned that his or her firm has already established competence in the area of use case analysis.

Among the respondents whose organizations plan to act, research and development activities, analyses, pilot projects, and cooperations with universities were mentioned. One respondent shared the plan to establish a peer-to-peer community among owners of PV installations with a capacity of less than 10 kW_{peak}. One respondent replied that current Blockchain activities of his or her firm are being planned but that they are confidential and cannot be revealed yet.

A list with all actual or planned activities can be found in table 2 in Appendix 2.

4.3 Potential applications and use cases

Going beyond the current stage of implementation, respondents of the dena/ESMT survey were asked about their judgment with regard to the future of Blockchain in the energy sector and future use cases.

Sixty percent of the respondents believe that a further dissemination of the Blockchain is likely. 21 percent consider Blockchain a game changer for the energy supply industry, and 14 percent expect niche applications. 5 percent either do not see any potential or an almost inexistent potential of Blockchain in the energy sector.

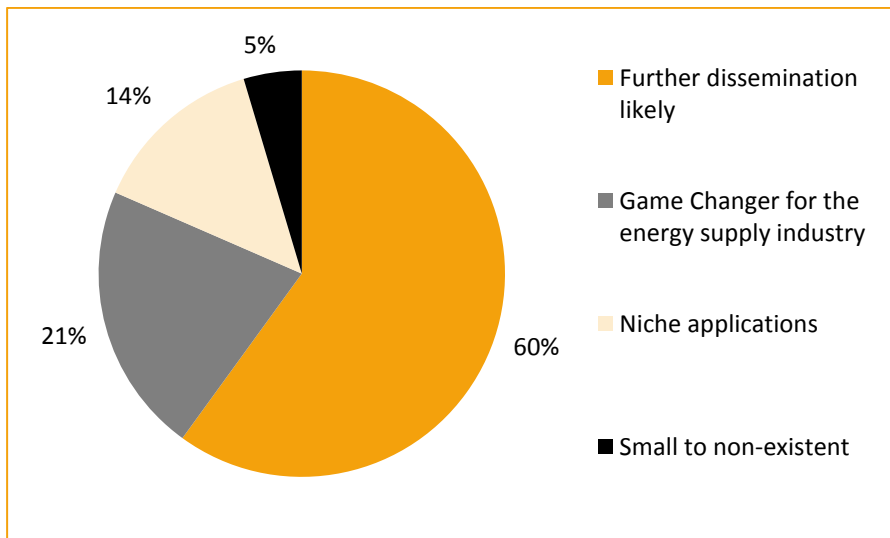


Figure 6: Potential of dissemination of Blockchain.

More specifically, respondents were asked to qualitatively identify potential use cases and applications of Blockchain in the energy sector and provide a judgment according to the classification used in the previous question, that means, ranging from small to non-existent potential to game changer. In total, respondents identified more than 110 potential use cases and their respective potentials.

From a conceptual perspective, the responses can be differentiated into two main clusters: *processes* and *platforms*. Figure 7 shows an overview of the answers according to applications and use cases. The size of each circle corresponds to the number of individual responses. The color scheme ranges from black (“Game changer”) to White (“small to non-existent potential”).



Figure 7: Results of potential use cases of Blockchain in the energy sector.

The color scheme indicates that respondents see the highest potential in security, followed by decentralized generation, P2P Trading, mobility, metering & data transfer, and trading platforms. In descending order, the lower half of the clusters is led by automation, billing, grid management, and communication. The *least* potential is expected from sales & marketing. With the exception of security, which was only mentioned by four participants of the survey, all the clusters in the top half correspond to fairly new and emerging markets, whereas in the lower half markets are already established. By and large, these results suggest that participants see a greater disruptive potential in new markets than in existing ones.

Appendix 3 contains the survey results with all individual answers that were received without aggregation.

Cluster 1: Process optimization

Digital and lean software solutions might replace humans to make existing services cheaper. Blockchain bears a potential for cost-cutting in the internal processes of firms and in the interaction with clients and customers. In the energy sector, the availability of increasing amounts of data on the overall state of the system, on customers, and on internal processes coincides with an existential need of many companies to cut costs. Hence, companies may have an intrinsic motivation to exploit the efficiency of the Blockchain protocol to increase their internal performance and efficiency, as the R3 Consortium in the finance sector confirms.

In the fall of 2015, nine of the world's largest banks founded a joint venture called the R3 Consortium. By August 2016, the number of members had increased to 55, including Microsoft as a software company and Thomson Reuters as its first major data and technology provider (Kelly and Chavez-Dreyfuss, 2016). Other initiatives have been launched in parallel, for example the Hyperledger Project with companies such as IBM, JPMorgan Chase & Co., Cisco Systems Inc., Digital Asset Holdings, and others (Maras, 2016). These industry-driven attempts to standardize and disseminate Blockchain may accelerate the move toward mainstream adoption.

Considering the small size of many renewable power generation units, management costs become important. Digitization allows for lowering these costs by relying on remote maintenance and control. For system operators, for example, aggregated information could help to better manage the grid. However, it is difficult to quantify the overall effect on cost-cutting in the energy sector. Fintech company Abra – which was introduced in Section 2.3 of this report and uses Blockchain to repatriate remittance money to poor countries from expats – claims that its service has reduced transfer times from one week to one hour, and transfer costs from a 7 percent transaction fee to a 2 percent transaction fee.

As Figure 7 shows, responses regarding process optimization can be clustered according to the following categories (in descending order of the amount of responses):

- **Billing** (13 responses), including applications in the field of Smart Meters, decentralized energy, and micro-payments; one respondent expects the billing process to become more transparent;
- **Sales and marketing** (9), ranging from package solutions for household devices and the electricity they consume, improvements in customer services and new products, to a change in existing sales practices;

- **Automation (7)**, including the control and optimization of decentralized energy systems and micro-grids, and systemic integration according to SCADA (supervisory control and data acquisition);
- **Metering and data transfer (6)**, encompassing topics such as data exchange between stakeholders of Smart Grid applications, intelligent control systems, as well as the standardization of data transfers;
- **Mobility (6)**, more specifically electric mobility with the management of energy supply contracts and decentralized billing processes of public charging stations for owners of electric vehicles;
- **Communication (5)**, ranging from data exchange with partners, communication with grid operators, to a general exchange of knowledge and social networks;
- **Grid management (5)**, predominantly related to services in decentralized energy installations, but also to the use of market-based flexibilities to reduce the extension of the grid;
- **Security (4)**, including transactions such as authentication and identification of data, protection of the private sphere, and IT security.

Cluster 2: Platforms and markets

The second main cluster is related to platforms, which means a digital instrument to facilitate interaction between two or more agents, be it a peer-to-peer network composed of residential prosumers, or a business-to-business market, including demand response and virtual power plants, which both require the role of an aggregator to transfer these capabilities to market.

Most of the responses in the survey relate to public platforms, which benefit from Blockchain's decentralized structure of ledgers and the anonymity of all transactions. However, some respondents also mentioned the potential of platforms that are typically privately owned (see also Hasse et al., 2016), for example data exchange with partners or the management of grid and storage capacity.

More specifically, the following clusters can be identified:

- **Peer-to-peer trading (26 responses)**, including communication for security of supply, the potential to reduce trading volumes on conventional trading platforms, and peer-to-peer marketing;
- **Trading platforms (17)**, including public platforms, such as balancing markets, capacity markets, and intraday trading, as well as private platforms such as demand-side management, the coordination of the existing power plant portfolio, industrial energy supply, and virtual power plants;
- **Decentralized generation (9)**: As this cluster is a hybrid between processes and platforms, it contains elements such as decentralized energy management, neighborhood solutions, and renewable installations.

5 Conclusions and recommendations

The results of the survey show that German energy executives see a broad range of possible applications of Blockchain in the energy system, both in terms of processes as well as platforms. According to their statements, it has the potential to reduce costs and to enable new business models and market-places; it will be instrumental to manage complexity, data security, and ownership. The responses suggest that it seems to be one possible enabler for the move to *Energiewende 2.0*.

However, the Blockchain technology is competing with existing solutions and has to prove its attractiveness to users. From a market perspective, establishing Blockchain as the dominant transaction technology might be more difficult in existing markets than in new markets where new applications do not yet exist. Taking a practical case from the energy sector, the rollout of Smart Meters has just begun in several countries, such as the United Kingdom. Germany plans the official start of a sequential rollout at the beginning of 2017, targeting first customers with high electricity demand. It is not clear which software solution will become dominant in multi-directional Smart Meter transactions. Similarly, establishing a homogeneous payment system for public charging stations of electric vehicles is still a work in progress. Startups such as BlockCharge are trying to push a standard based on Blockchain. Wherever a peer-to-peer trading network that does not rely on an intermediary – a trusted institution – has not yet been established on a large scale, Blockchain has the chance to become the dominant design.

Blockchain might have a more contestable position in applications where technologically sophisticated platforms and processes already exist and are accepted among market participants. Electricity exchanges such as the European Electricity Exchange in Leipzig (EEX) serve as platforms that were established under the paradigm of liberalization to allow parties to trade energy, emissions, and their derivatives. Even though Blockchain alters the configuration of trading by establishing a peer-to-peer network, it has to compete with the existing solution. Only if its applications have tangible, monetary, or timely advantages will Blockchain-based solutions be able to convince a critical number of market participants to switch from the current status quo to the new platform, generating sufficient liquidity and establishing itself as an attractive alternative.

In its current development stage, the technology does not necessarily have a competitive advantage, compared to many other software platforms that can equally deliver on reducing costs. In addition, many estimates on the savings potential of Blockchain rest on the assumption that a functioning ICT infrastructure, such as broadband, Smart Meters and the Smart Grid, exists and can be used by Blockchain applications. How much of the related investment costs and operating expenditures should then be attributed to Blockchain? The results of such a cost-benefit analysis depend on the definition of factors that are taken for granted, and the choice of system boundaries.

The attractiveness of the target market hence depends on three factors: the efficiency gain in any individual transaction (competitiveness versus other technologies), the amount of transactions being performed (market potential), as well as customer acceptance.

5.1 Implications within current regulatory system

Liberalized electricity markets typically contain regulated and market-based segments. In most countries, power and gas grids are considered natural monopolies, and fall under national or regional regulation. Grid operators are responsible for serving all parties involved. Regulation ensures a level playing field for all players along the value chain as well as fair pricing for stakeholders. Costs are controlled by the regulatory authority. Grid fees are determined by one-off investment costs to renew or extend the grid and revolving operating and maintenance costs. Those investments are exclusively a question of the costs for the assets and the necessary grid expansions and conversions. Companies need to be cost-efficient to fulfill the requirements set by the regulatory authority. Performance and success are mostly influenced by lean and cost-efficient processes. Blockchain has the potential to reduce grid costs through better balancing, reducing metering costs, making information streams faster and more immediate, and adding customer value through more detailed and transparent information about energy origin and evolution.

However, its impact on investments into grid infrastructure, which – in some cases – account for up to 80 percent of the fees, according to dena estimates, is practically non-existent under the current regulatory regime. The most likely way how Blockchain might influence these costs would be by accelerating the emergence of local markets with peer-to-peer trading – but this effect can only be expected in the medium to long term.

According to the survey, the market-based segments of the electricity value chain, in particular purchase and retail, will benefit from Blockchain applications, such as enhancing the efficiency of trading platforms, establishing Smart Contracts, and facilitating demand response management and virtual power plants. Similar to the regulated segments, Blockchain can provide a lean solution for many of those transactions, but its potential to significantly reduce overall costs is limited, too. In addition, many transaction mechanisms are already in place and automatized.

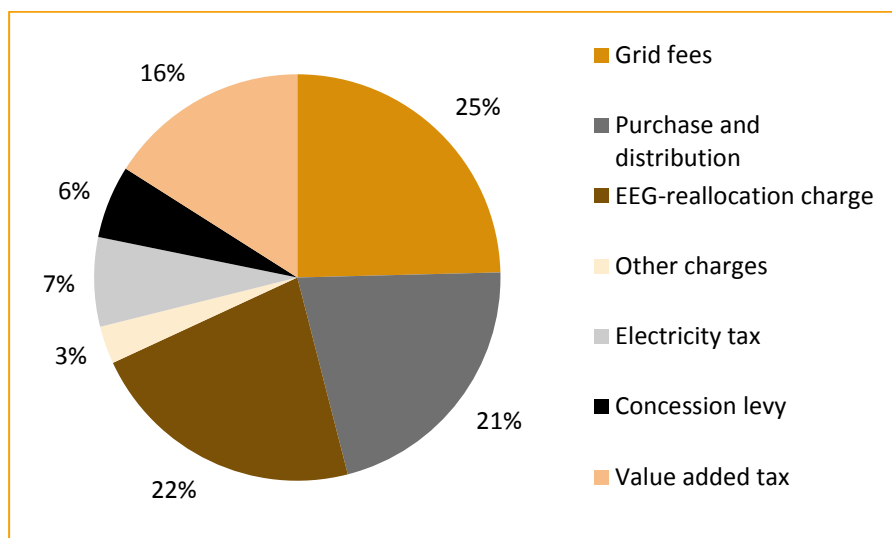


Figure 8: Decomposition of residential electricity tariffs⁶

Residential electricity tariffs in Germany are dominated by taxes, levies, and charges, which account for 54 percent of the total tariff. For the remaining 46 percent – around 24 percent grid fees in the regulated segment and 21 percent purchase and distribution in the primarily market-based segment, respectively – operations might be positively affected by Blockchain technology, but, as stated above, only to a minor extent.

5.2 Implications beyond current regulatory system

Originating from a latent distrust of established institutions, say, the central government, big corporations, or the energy supply company), the principle of the Sharing Economy is less about *what* citizens share – be it food, language classes, or electricity – but *how* they do it. Blockchain technology epitomizes consumer autonomy. The idea is not only to become independent from a corporate energy supplier but to share and exchange electricity one generates with other prosumers by trading it without any intermediary, from peer to peer and in a data-secure manner. However, this type of peer-to-peer transaction still faces regulatory challenges in many jurisdictions, because it uses the utility's power grid to connect local producers and consumers.

Blockchain also addresses the trend of an increasing demand for transparency. Consumers expect to easily access relevant information that allows them to take informed decisions. Blockchain may serve as the underlying technology for a range of services that offer full transparency.

Although there are a number of Blockchain systems that are successfully operating in the financial sector, most notably Bitcoin, the energy market contains technological hurdles to the implementation

⁶ Source: BDEW (2016)

of Blockchain. Unlike financial transactions in cryptocurrencies, in the power sector electricity must be delivered physically. Hence, a Blockchain-based energy market has to reflect the physical configurations of power grids. If it caters for isolated microgrids and closed systems, such as commercial parks or autonomous energy communities with few interconnectors to the outside grid, Blockchain may become the dominant design. As soon as it starts interfering with the distribution and transmission system run by grid operators, it has to overcome similar hurdles that providers of virtual power plants or companies that offer demand response services are confronted with.

Furthermore, the stability of a digital energy system is crucial; it must run without internal complications as well as be protected from external interference such as cybercrime and espionage. The impact of Blockchain on both the security of energy supply and data security has to outweigh the costs of establishing and maintaining this infrastructure. It must prove to be more effective than alternative, more centralized approaches to digitization.

The advent of Blockchain technology has to be further differentiated between industrialized and developing countries, both in the overall economic institutions of a country and in the specific field of energy. In industrialized countries, Blockchain applications compete with a highly sophisticated and technologically advanced set of existing solutions embedded in a framework of trustworthy public institutions that enforce laws and regulations and maintain checks and balances for corporations on the national and supranational political levels. This environment may be missing in developing countries. In that context, sometimes even basic services, such as access to a bank account, may not be available for a substantial share of the population. It does not come as a surprise that smartphone penetration in many developing and emerging countries is as high as in industrialized nations, because applications based on smartphones offer services that overcome the economic niches that public institutions and private investors were not able (or willing) to target.

The rise of decentralized energy generation in rural sub-Saharan Africa may serve as an example of leapfrogging: Instead of costly extensions of the existing distribution grid into remote villages, electrification omits one stage of development that has characterized the evolution of public infrastructure in industrialized countries. Startups such as Mobisol and SolarKiosk offer rural customers an opportunity to have access to advanced energy services, which public utilities are not able – or obliged – to deliver.

Attracted by the quest for empowerment as well as business opportunities of Blockchain, founders are starting to establish first implementations in developing countries. As Bithub Africa (2016) states: “Africa has been adopting mobile money platforms like M-Pesa, that enable digital transactions using fiat currencies, faster than any other region in the entire globe.” Given the increasing role of digitization in energy infrastructure, it is only a matter of time until Blockchain finds its way into the energy sector across the developing world.

5.3 Recommendations

Actual use cases of Blockchain technology in the energy sector are still scarce, but German energy executives have identified a broad range of potential applications. In our survey, respondents were asked to name relevant topics to be further explored. Based on their statements, the following activities should be envisaged:

- **Speed:** Respondents urge decision-makers to speed up the process of putting Blockchain at the top of their agendas. They see analogies to developments in services such as PayPal and WhatsApp and expect demand for Blockchain services to “explode” once apps are available. In addition, they express concerns that Germany and the European Union might be lagging behind in a global comparison. The rapid launch of prototypes should verify the functionality of the technology and attract a sufficient amount of users to rapidly reach a critical mass.
- **Regulation:** Market players may be intrinsically motivated to exploit the cost-reduction potential offered by Blockchain, but the creation of new markets is also subject to the regulatory environment: Respondents fear that the current regulatory framework is not suited at all to accommodate Blockchain applications; it is of primary concern how regulation will be adapted to the technological possibilities of the technology.
- **Information:** Respondents report that they are analyzing the potential of Blockchain internally and have expressed a wish to obtain more information on current use cases and mechanisms, ideally complemented by a presentation of concrete business models related to Blockchain applications.

In our analysis, we found that it is difficult to reliably estimate the cost reduction potential of Blockchain within the current regulatory system, given the uncertainty around the direct costs, such as the distributed computational review process performed on each block, and indirect costs of the Blockchain, and the complex cost allocation in both regulated and market-oriented segments of the electricity sector. We therefore propose the following steps:

1. To enhance transparency among market participants; assessments on process efficiency, similar to fintech, should be conducted, in particular for distribution system operators (DSOs).
2. As Blockchain is a technology that offers the opportunity to conduct financial transactions across regulatory systems, national borders and regions – for example, by sending Bitcoins from Europe or North America to Blockchain-enabled Smart Meters in South Africa, as startup Bankymoon has shown – an international knowledge platform to exchange experience might be beneficial for understanding the pros and cons of the technology.
3. How can local markets and peer-to-peer trading co-exist or be integrated into the regulatory framework? Case studies may provide further insights on the fit of Blockchain in the current energy system.

Blockchain has the potential to enable new entrants to become part of the current energy supply structure; it may serve as a platform to reorganize regional or local markets more effectively, and it may be used by energy companies to optimize their processes. Our survey suggests that decision-makers in the energy sector believe that it has the potential to reshape various aspects of their companies and, more generally, the electricity market. It is likely to experience further dissemination and use cases, both in process optimization as well as in peer-to-peer transactions. Its impact on the overall success of *Energiewende 2.0* and the transformation of global energy supply structures should not be over-estimated, though.

Appendix 1: The history of Blockchain from a perspective of technological innovations

Following Campbell (1969) and Anderson and Tushman (1990), technological change can be described as a sociocultural, evolutionary process of variation, selection, and retention. If this approach is limited to the description of innovations such as Blockchain, it can be observed that innovations often follow a pattern of idea, initial experimentation, diversity/schisms, consolidation, and eventually (but not always) the emergence of a dominant design.

Based on the pioneering work on dominant designs by Suarez and Utterback (1995), the trajectory of Blockchain as a technological innovation can be interpreted as follows⁷:

Phase 1: Satoshi Nakamoto and the advent of decentralized transaction technologies

The beginning of each new industry is characterized by discontinuity (Utterback and Suárez, 1993), a new idea, or a new design principle. In the case of Blockchain, an individual or group of individuals with unknown identity who call themselves(s) Satoshi Nakamoto describe a protocol facilitating peer-to-peer transactions via a cryptocurrency called Bitcoin “without going through a trusted third party” (Tapscott and Tapscott, 2016, p. 5). The network uses a “proof-of-work to record a public history of transactions that quickly becomes computationally impractical for an attacker to change if honest nodes control a majority of CPU power” (Nakamoto, 2008). Due to the decentralized nature of the network, transactions can be tracked and verified, and a trusted intermediary, such as a bank, is no longer necessary.

The theoretical paper inspires programmers and entrepreneurs to design the foundations of cryptocurrencies. In early 2009, the first Bitcoins were issued, and the first transaction took place on January 12, 2009 (historyofbitcoin.org, 2016). The cumulated value of all Bitcoins reached €5.8 billion by April 2016, compared to €10.9 trillion value of the Euro currency (Trentmann et al., 2016).

The emergence of Bitcoin and its underlying technology Blockchain coincides with a range of peer-to-peer developments in other markets, with the most prominent examples being Airbnb (founded in 2008), an online marketplace that enables people to list, find, then rent vacation homes, and Uber (founded in 2009), a multinational online transportation network company. These internet platforms share a disruptive potential of established industries such as for taxis and the hospitality sector. One additional trigger for the advent of cryptocurrencies may be found in the general skepticism vis-à-vis the traditional banking sector in the aftermath of the financial crisis (Trentmann et al., 2016).

⁷ For a more comprehensive history of Blockchain, see SWAN, M. 2015. *Blockchain: Blueprint for a New Economy*, O'Reilly Media, TAPSCOTT, D. & TAPSCOTT, A. 2016. *Blockchain Revolution: How the Technology Behind Bitcoin Is Changing Money, Business, and the World*, Penguin Publishing Group.

Phase 2: Ferment, variations, and schisms

While Bitcoin remains the dominant cryptocurrency, a number of alternative peer-to-peer platforms have emerged, and the era of “ferment” has started. As Anderson and Tushman (1990, p. 611) observe: “This era of ferment is characterized by two distinct selection processes: competition between technical regimes and competition within the new technical regime.” In the case of Blockchain, multiple niches are filled by cryptocurrencies. Figure 9 shows an excerpt of the evolution of Bitcoin into different cryptocurrencies.

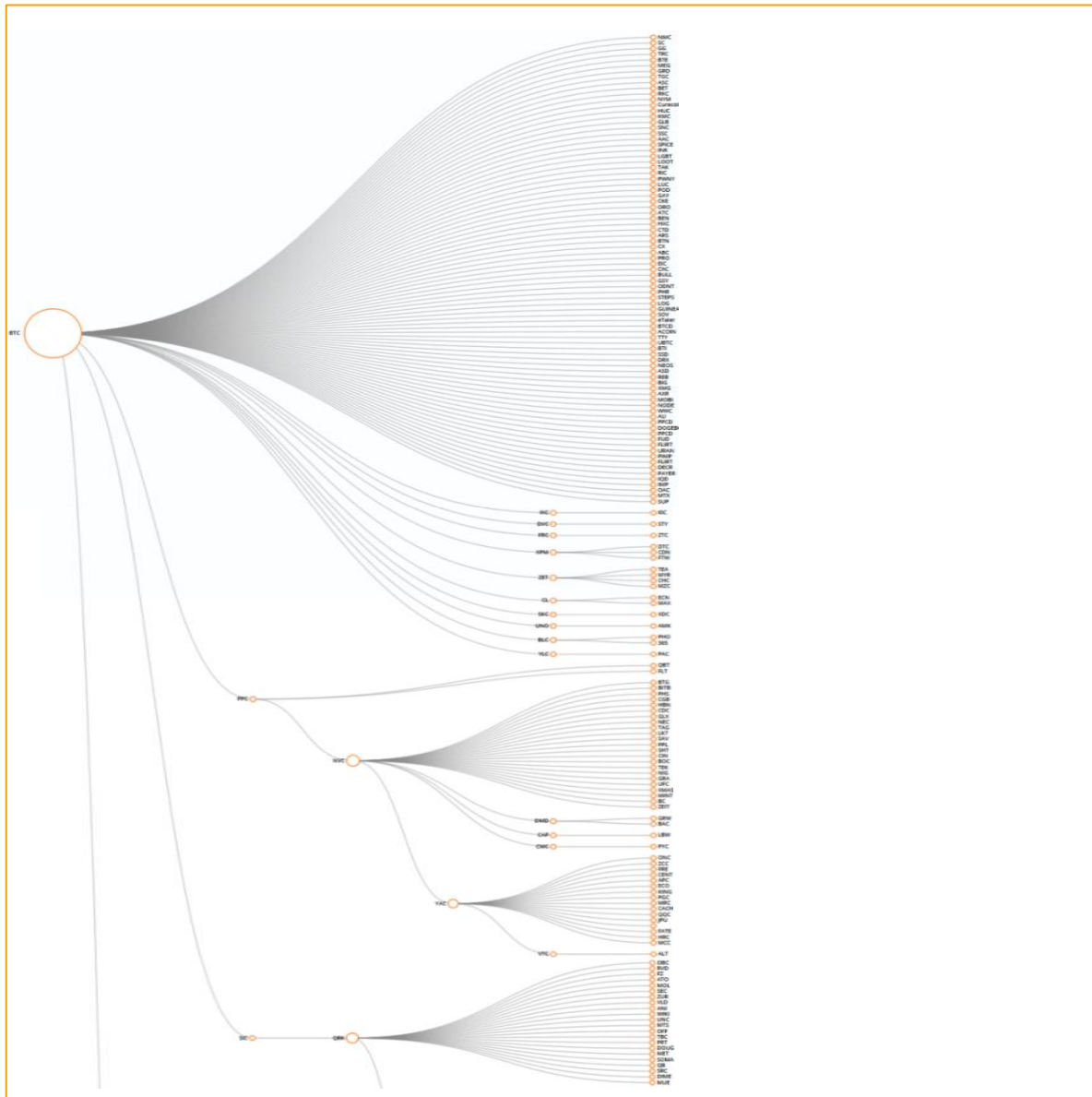


Figure 9: Excerpt of “Forks map” – variations of cryptocurrencies based on Bitcoin (BTC).⁸

⁸ Source: mapofcoins.com (2016)

While these variations exemplify minor modifications of the initial Blockchain protocol, a first major variation emerges with the rise of Ethereum in 2014. Invented by Russian programmer Vitalik Buterin, Ethereum extends the range of transactions based on Blockchain to any other object that can be represented by a computer: “Rather than simply sending and receiving money, this [Ethereum] community wanted to use bitcoins to represent commodities, derivatives or even deeds to real estate, in a sense, anything for which a secure, fixed unit of code could function as a digital asset.” (Dienelt, 2016, p. 6)

Ethereum removes some of Bitcoin’s limitations, for example the upper cap of all Bitcoins that will ever be issued (a constraint that could only be removed by a consensus decision of all Bitcoin participants), which is set at 21 million BTC. Most notably, Ethereum allows for more complex transactions, such as smart contracts and distributed applications (Dapps), and serves as the basis for “The DAO,” the first Decentralized Autonomous Organization on the Ethereum Blockchain. The DAO raised \$160 million in a short time period during spring 2016 and is intended to become a platform “to collect ether investments and distribute those funds to projects voted on by an open community of donors and members” (Dienelt, 2016, p. 35).

The creation of Ethereum can be interpreted as a logical consequence of the evolution of Blockchain; it operates in a non-confrontational manner and in co-existence with the different platforms. By contrast, a so-called Hard Fork led to an outright schism within the Ethereum community (Coppola, 2016a). Triggered by a flaw in the project’s code, an unknown attacker was able to channel funds of around \$60 million to a private account in June 2016 (Wiebe, 2016). Subsequently, the community faces a fundamental philosophical dilemma: Should irreversibility – one of the core pillars of Blockchain ideology – be compromised for the sake of recapturing the funds lost in the transaction? Eighty-five percent of the miners involved in Ethereum voted for the “Hard Fork” of reversing the hack, whereas 15 percent opted for accepting the attack and sticking to the principles they had set up. Coppola comments on this decision in *Forbes*: “The puritans who objected to the bailout on the grounds that it fatally compromised the ‘immutability’ of Blockchain were never going to win. [...] The fact is that Ethereum has compromised its principles in order to rescue a client. Or, in the language of another world, the Ethereum central bank has directly recapitalized the DAO commercial bank by monetizing its debts” (Coppola, 2016b). Since then, a sub-group of supporters of the “immutability” of Blockchain have remained with the old cryptocurrency and are actively mining, that means, generating a competing cryptocurrency they call “Ethereum Classic” in parallel with the dominant Ethereum currency.

From a perspective of the common structures of innovation, Blockchain, with its multiple incarnations, has not yet reached the state in which a dominant design has appeared, as can be observed with Microsoft’s Office software or Google as the Western hemisphere’s preferred search engine. By contrast, it seems likely that the phase of variation will continue. When exactly a stable configuration of the system will be reached is not yet predictable, given the pace of innovation in information and communication technologies and the fact that the cryptocurrency community represents – in both organizational and ideological aspects – the antithesis of a large corporation that would have the financial muscle and strategic conformity to establish a dominant design.

Figure 10 shows the authors’ shared opinion on the temporal and temporary positioning of Blockchain. For a dominant design to emerge, it emphasizes two drivers: On the one hand positive network

effects, that means an individual user's utility increases with the number of other users. These network effects can be direct, for example by increasing the liquidity of the currency on exchange platforms, or indirect when complementary products, such as apps for smartphone software, are available (Srinivasan et al., 2006). On the other hand, regulatory convergence may limit further bifurcations, impose a standard, and force participants to adhere to a single standard (Schilling, 2010, p. 75).

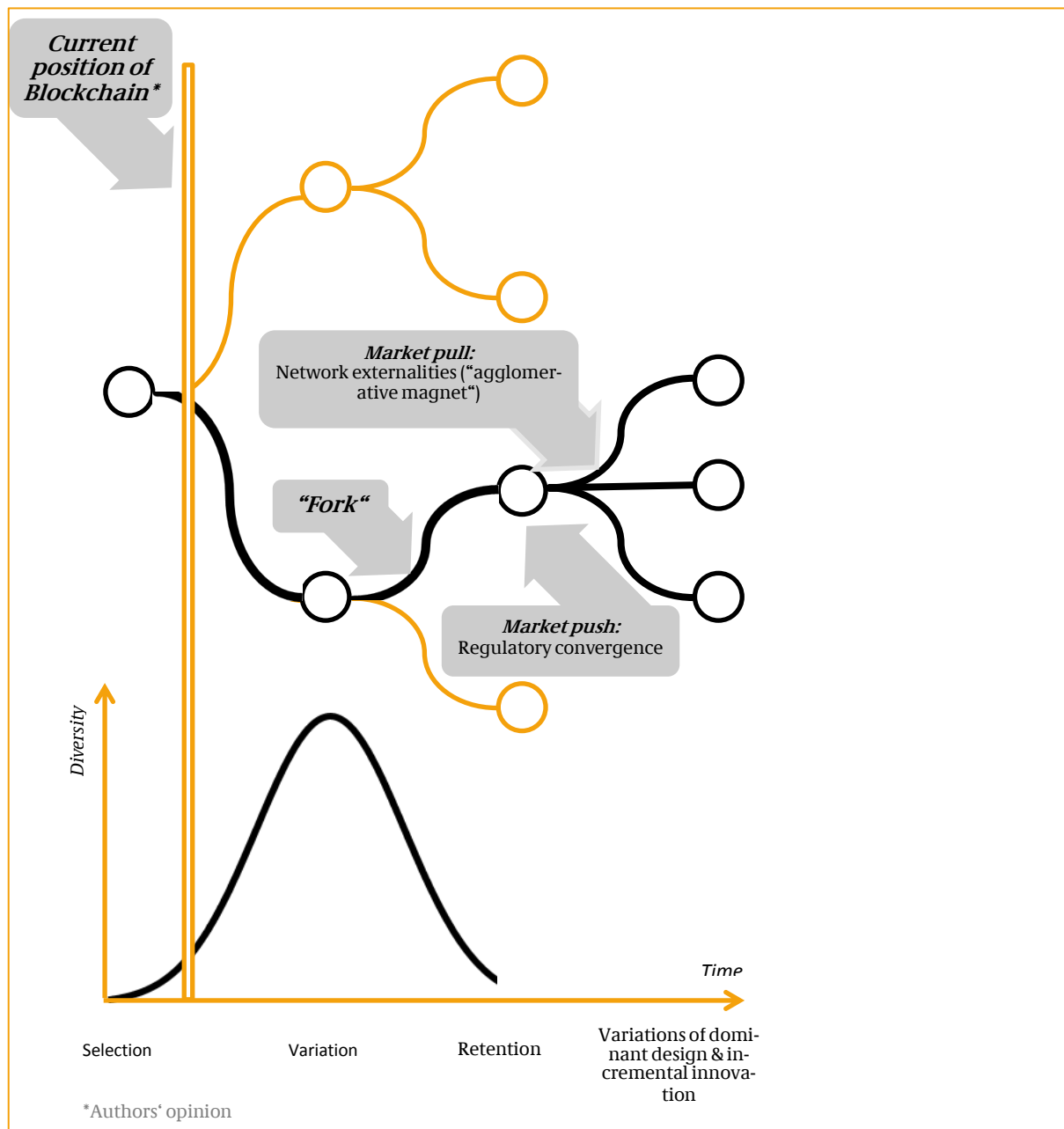


Figure 10: Evolution of Blockchain from a perspective the structure of innovations.⁹

⁹ Source: Authors' interpretation, loosely based on Utterback and Suárez (1993)

Phase 3: Consolidation and the emergence of a dominant design

Identifying the sharing economy and distributed trust as one of six megatrends, the World Economic Forum (WEF) asked 800 experts about the year in which they expected specific technologies to hit the mainstream market, the so-called tipping point. For Bitcoin and Blockchain, the WEF defines the tipping point to be when 10 percent of global gross domestic product is stored on Blockchain technology. More than half of the experts predicted that this tipping point will occur in 2025. However, a fifth of the respondents stated that this would never happen (World Economic Forum, 2015). According to US-based consulting practice Gartner, it is estimated that Blockchain will reach market maturity in five to ten years (Walker et al., 2016).

The increasing pace of innovations, most recently the smartphone as a physical artifact, the deployment of photovoltaic panels, and – even more drastically – the realm of digital innovation, may prove the WEF/Gartner estimates to be conservative.

In the search for new business ideas, companies may either be biased by inflated expectations created by a collective overconfidence that the new technology will succeed in the marketplace and make “cash [...] ‘cease to exist’ in its current form in a decade,” as the chief executive of one big European bank told the audience in Davos (ibid.), or show an opportunistic, mimetic behavior of “bandwagoning,” that means following a crowd of entrepreneurs in an informational cascade (Bikhchandani et al., 1992).

With the rise of decentralized, renewable energy generation and the subsequent decline of wholesale prices, utilities all across Europe (and in some states of the United States) have realized that the key to corporate success lies in service orientation and a close customer relation in retail markets. Providing a tangible value added to customers increases loyalty. From an innovation perspective, customers can be split into two groups: Following the dichotomy introduced by Bass (1969), the first group are the early adopters and *innovators*. They are tech-savvy, curious, and open to new solutions. They accept minor flaws in the system configuration for the sake of participating in a collective movement of pioneers. Their benefit for participating in a Blockchain-based solution is related to the status of belonging to a societal avant-garde.

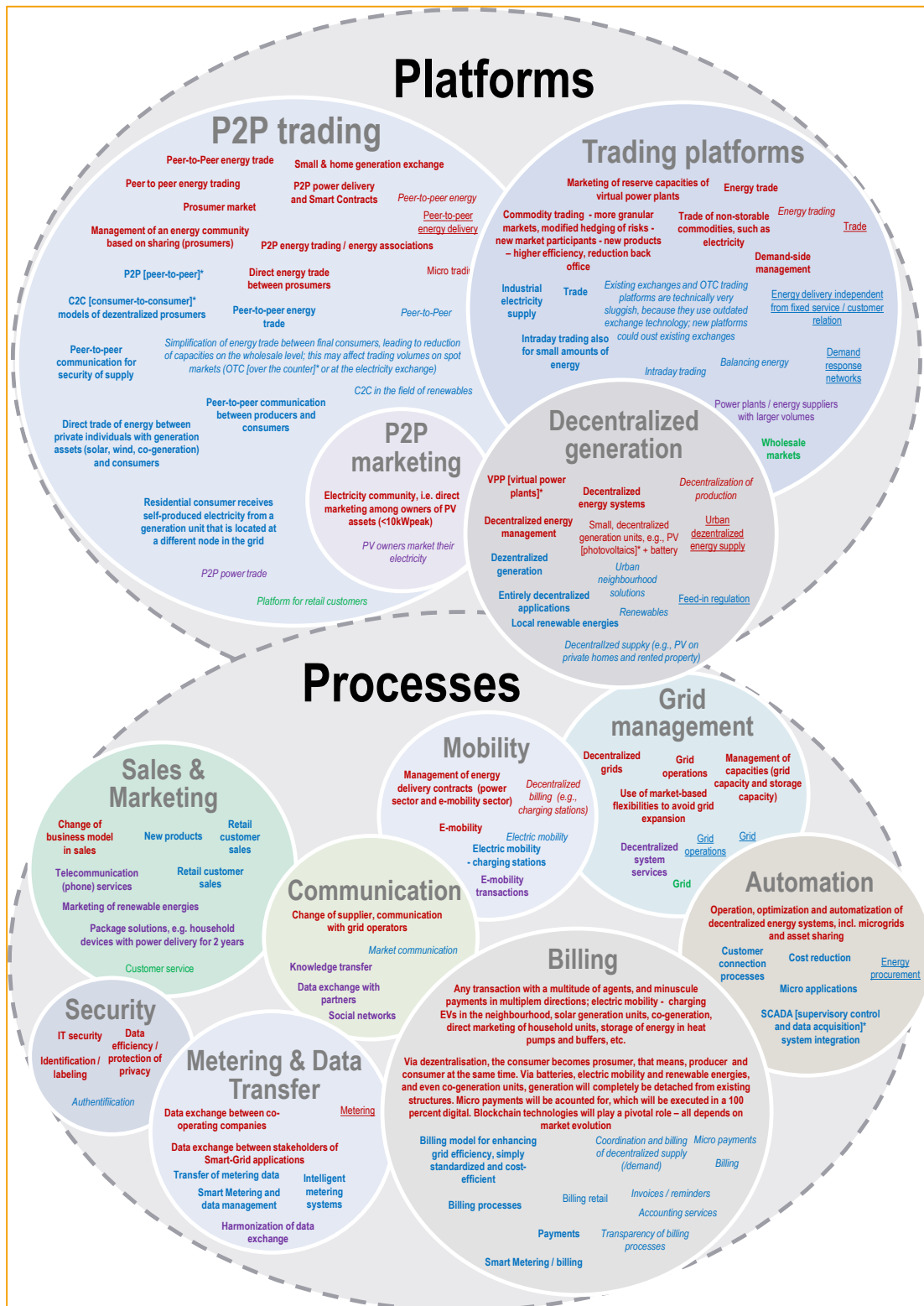
The second group of customers are the *imitators*. Their value proposition is primarily related to convenience, including the seamless functioning of their devices and personal infrastructure. In particular residential and commercial clients value the convenience factor of transferring specific responsibilities to an external provider. However, they are more price-sensitive than innovators and show a lower degree of loyalty.

Appendix 2: Qualitative answers of the survey

Qualitative answers to the professional position
Association
Association of municipal utilities
Consulting (2x)
District heating in property management
Energy exchange
Energy infrastructure
Energy storage
Local public transport
Manufacturer
Manufacturer of power plant components
Manufacturer of power plant components and distribution infrastructure
OEM
OEM fossil power generation
Research & Development
System components manufacturer

Blockchain activities planned or implemented	
<i>“Do you or your company already have taken action regarding the Blockchain?”</i>	
Already implemented	<ul style="list-style-type: none"> – Establishing competencies for use case analysis – Active scouting of startups, business development – Basic study of the topic and an assessment how Blockchain technology can be implemented in P2P services under the current regulatory regime – Capacity building of foundations of Blockchain – First initiatives launched – Patents; pilot projects – Proof-of-concept implementation for 3 ongoing projects - P2P trading, EV charging, identity/ payment processes/ payment gateway; conceptual studies on Blockchain as a transaction layer for M2M economy
Plans for implementation	<ul style="list-style-type: none"> – Analysis and observations – Analysis of use cases and potentials – Co-operation with university – Currently testing the technology to use it for proprietary developments – In discussion / conceptual level – Lectures – No activities, because the legal framework of standard load profiles does not allow this business model to be commercially viable – Participation in trainings on Blockchain, exploratory studies – Pilot tests – Pilots – Research & development – Research projects – Study – Testing possibilities for peer-to-peer trade – We are trying to understand the technology in detail, we conduct various discussions and participate in the Blockchain event in Berlin; in addition, we have established a new company on the EUREF campus – Yes, but confidential

Appendix 3: Individual answers in the survey



Source: dena / ESMT survey results (Aug/ Sep 2016), n=70

Legend.

- Square brackets indicate explanations added by the authors of this study
- Red color of letters indicates category “Global game changer”
- Blue color of letters indicates category “Further dissemination likely”
- Violet color of letters indicates category “Niche applications”
- Green color of letters indicates category “Negligible/ almost non-existent”
- Bold letters indicate respondent works in a company with more than 500 employees
- Italic letters indicate respondent works in a company with more than 50 and less than 500 employees
- Underlined letters indicate respondent works in a company with less than 50 employees

Please note that the size of the circles does not reflect the amount of answers!

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