Fostering energy markets, empowering **consumers**.

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CEER Report on Smart Technology Development

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INFORMATION PAGE

Abstract

This document (C17-RMF-101-04) seeks to identify emerging trends, technologies and business models in the energy sector, that may have a significant impact on the functioning of the retail market and to assess the potential need for regulation.

The focus in this document is the emergence of five technologies which are changing the traditional role of the customer and how they engage with retail energy markets. The five technologies are: 1.) smart home technologies and Internet of Things; 2.) electricity self-generation; 3.) electrical energy storage; 4.) charging stations and electric vehicles; and 5.) blockchain applications for the energy sector. Examples of emerging trends in commercial technologies or business models are provided, and the changes that they are driving in are highlighted.

To optimise the use of each of these technologies, Regulators and Members States may need to consider regulatory changes. CEER's report explores such cases and identifies the need for further analysis in several cases.

Target Audience

NRAs, European Commission, Member States, energy industry, gas/electricity consumers, consumer representative groups, academics and other interested parties.

Keywords

Emerging technologies; regulation; consumer protection & empowerment; smart home technologies; Internet of Things; self-generation; energy storage; charging stations; electric vehicles; blockchain

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Related Documents

CEER documents

- "The Cybersecurity Act in the Energy Context", December 2017 https://www.ceer.eu/documents/104400/-/-/2b66f429-2c3d-8e2c-13ba-7515562db4ae
- CEER Regulatory White Papers on Clean Energy, 2017 https://www.ceer.eu/white-papers
- "Conclusions Paper on Incentives Schemes for Regulating Distribution System Operators (DSOs), including for innovation", January 2017, C16-DS-28-03 https://www.ceer.eu/documents/104400/-/-/f04f3e11-6a20-ff42-7536-f8afd4c06ba4
- "CEER Review of Current and Future Data Management Models", December 2016, C16-RMF-89-03 https://www.ceer.eu/documents/104400/-/-/1fbc8e21-2502-c6c8-7017-a6df5652d20b
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External documents

- "Proposal for a Directive of the European Parliament of the Council on common rules for the internal market in electricity", European Commission, February 2017, COM(2016) 864 final/2, 2016/0380 (COD) http://eurlex.europa.eu/resource.html?uri=cellar:c7e47f46-faa4-11e6-8a35-01aa75ed71a1.0014.02/DOC_1&format=PDF
- "Towards an Integrated Strategic Energy Technology (SET) Plan: Accelerating the European Energy System Transformation", European Commission, September 2015, COM(2015) 6317 final https://ec.europa.eu/energy/sites/ener/files/documents/1_EN_ACT_part1_v8_0.pdf
- "Energy Efficiency and its contribution to energy security and the 2030 Framework for climate and energy policy", European Commission, July 2014, COM(2014) 520 final

https://ec.europa.eu/energy/sites/ener/files/documents/2014_eec_communication_adopted_0.pdf

EXECUTIVE SUMMARY

The energy sector is currently facing deep transformations. Innovations might significantly affect its operations and may require new or changed regulations in order for the sector to adapt to these innovations. In this context, CEER is developing a forward-looking view on regulation. The goal of this document is to identify emerging trends, technologies and business models, that have an impact on retail market functioning and to assess the potential need for regulation.

This document assesses whether certain emerging trends require changes to regulation. However, it is not intended to take positions on the final regulations that must be set at European level. Those will be discussed in future publications. Moreover, given the fast-evolving scenario, CEER acknowledges that the identified trends discussed in this document may need to be further broadened by possibly also considering different energy vectors and technologies.

As a first step, CEER has decided to focus on five emerging trends. These are: 1.) smart home technologies and Internet of Things (IoT); 2.) electricity self-generation; 3.) electrical energy storage; 4.) charging stations and electric vehicles; and 5.) blockchain applications for the energy sector.

The current analysis of these trends has led to CEER identifying the need for further investigation into the need for new/changed regulation in four major areas:

- In the context of increased need for data exchange, CEER will work along with other relevant authorities on cybersecurity, data privacy, standardisation and monitoring;

- The development of additional services or bundled products related to self-generation, storage, energy efficiency and maintenance sold along with energy supply: CEER will continue its work to promote a fit-for-purpose market design that addresses concerns on how competition, customer protection, empowerment, transparency and monitoring shall be ensured in the future;

- Electric vehicle (EV) charging: CEER regards publicly-accessible EV charging points to be part of the competitive market and EV drivers using this infrastructure to be buyers of charging services. CEER will consider whether there is a need for energy-specific rules for charging infrastructure, depending on the type of EV charging points, in order to ensure an appropriate level of competition and customer protection and empowerment linked to the development of electric vehicles;

- CEER will pursue work on removing potential barriers in the market in order to enable these emerging technologies to not be unduly impeded, as well as consider regulation in light of changes to the ways consumers interact with and participate in energy markets.

1 Introduction

The emergence of smart technologies is driving change in energy markets. It is beginning to change the traditional role of the customer, providing them with greater opportunities. With these continuing changes, it is important that regulatory frameworks adapt and seek to drive the best outcomes for the customer. In this context, CEER is developing a forward-looking view on regulation. This document is a starting point for this analysis. It seeks to identify key emerging trends in technology and business model developments that may have an impact on retail market functioning. It also considers whether these trends may drive a potential need for changes/additions to regulation. While the regulatory assessment mainly will relate to the responsibility of National Regulatory Authorities (NRAs) within energy markets, legislation and authorities in other markets will be touched upon.

As a first step, CEER has decided to focus on five emerging trends. They are: 1.) smart home technologies and Internet of Things (IoT); 2.) electricity self-generation; 3.) electrical energy storage; 4.) charging stations and electric vehicles; and 5.) blockchain applications for the energy sector. The document does not consider advanced metering and Renewable communities and Energy communities as they have been or will be covered elsewhere[1]. For each trend, this paper describes the new technology or the business model involved, shows a real-world example, evaluates its impact on consumers and assesses the potential need for regulation.

For four of these trends, the document contains one or several examples of related commercial technologies or business models. The examples have been picked for illustration purpose only, based on the knowledge of CEER members. It does not imply any support from CEER for those specific commercial products or companies.

This document aims to reflect on the future of regulation. It assesses how the emerging trends may lead to changes to regulation. However, it is not intended to take positions on the final regulations that should be set at European level. Those will be discussed in future publications.

Some of the topics addressed in this document enter into the scope of recently-proposed regulations and directives on the internal electricity market (the "Clean Energy for All Europeans" legislative package)[2]. The final legal provisions of the regulations and directives of this package may affect the position that CEER could take in the future. However, at this stage, it has been decided not to rely on the proposed provisions that are still subject to change via the ongoing (at the time of this paper's publication) legislative process.

Additionally, this document focuses on retail market functioning. It is not intended to address issues regarding wholesale markets and distribution systems. Nevertheless, many of the issues raised will have effects on the rest of the energy system, as many aspects of the value chain are increasingly overlapping.

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[1] Cf. "CEER Advice on Customer Data Management for Better Retail Market Functioning", 19 March 2015; the upcoming (2018 Work Programme) CEER paper on "Regulatory Aspects of New Practices Such as Self-Consumption and Local Energy Communities", as well as numerous external publications on these topics.

[2] https://ec.europa.eu/energy/en/topics/energy-strategy-and-energy-union/clean-energy-all-europeans

2 Emerging technologies

There is a global trend toward smart technologies arising from the demand to make energy consumption more efficient and transparent. These technologies can help consumers have greater control over their consumption and costs and drive the wider energy transition and associated reduction of emissions[3]. However, at European level, there are concerns regarding whether the legislation in place fully enables consumers to be active and engage in the electricity market. CEER considers in this document the impact of five emerging trends and whether they may drive a potential need to change the regulatory framework.

In order to allow for consumers to store and/or sell self-generated electricity to the market and for new technology developments, it is essential that unjustified legal and commercial barriers or excessive administrative burden could be removed while it should be ensured that self-generating consumers contribute adequately to system costs.

2.1 Smart home technologies and Internet of Things

As one of the European Union's priority action areas in its Strategic Energy Technology plan[4], smart homes can help to reduce overall demand for energy by providing smart solutions to energy consumers. Along with rapid growth in Internet of Things (IoT), the role of smart homes is becoming more crucial as consumers realise the potential benefits that it may bring, such as energy savings and a more convenient and secure home environment.

2.1.1 What are smart home technologies and Internet of Things?

The European Parliament refers IoT as a *distributed network connecting physical objects that are capable of sensing or acting on their environment and able to communicate with each other, other machines or computers.*[5] The IoT concept has emerged in a variety of contexts, such as production environments, vehicle-to-infrastructure communication, and, most relevant to this report, smart home applications. Energy management is often, but not always an important dimension of IoT projects.

IoT is an integrated part of smart homes. It provides for the smart home's online management of appliances, devices and sensors, which can communicate with each other and be controlled remotely. Generally, smart home technologies require constant internet connection to provide real-time data with the customer and service provider, third parties with customer consent. In compliance with data protection laws and the new General Data Protection Regulation (GDPR), which comes into force in May 2018.

[3] With respect to the benefits, the detrimental impact of those technologies on the environment, such as energy and raw material consumption, should also be taken into account.

[4] "Towards an Integrated Strategic Energy Technology (SET) Plan: Accelerating the European Energy System Transformation", European Commission, September 2015, COM(2015) 6317 final

[5] http://www.europarl.europa.eu/RegData/etudes/BRIE/2015/557012/EPRS_BRI(2015)557012_EN.pdf

The integration of smart home devices with the energy system varies depending on the devices' application and sophistication. Some smart home devices do not actively interact with energy consumption (e.g. smart locks), while others directly control energy consumption (smart thermostats, smart lights) Some smart home systems go as far as providing constant measurements of detailed consumption, and can enable consumers, or an appointed agent, to control and monitor the household's energy usage in order, for instance, to shift loads according to changes in energy price. Information generated from smart home technologies may be used to change the household's consumption behaviour and create value by taking advantage of this information. For the smart home to interact with the network and the energy market, a smart meter and a demand-response contract are crucial.

Smart thermostats and smart plugs and switches are examples of smart home technologies. A smart thermostat enables the consumer to change the indoor temperature from a device (smart phone, computer, tablet or smartwatch) as well as to set the thermostat to automatically lower the temperature during the night or when residents leave home. The automatic changes in temperature can be linked to the customer's smart phone location and can also be affected by programming set by the customer. In a similar way, with sensors, smart plugs and switches can automatically turn on and off the lights in accordance with a pre-programmed schedule or the customer's location. An illustrative example of smart home technology with IoT applications is given in the box below.

Nest Thermostat, Google

The Nest Learning Thermostat, developed by Google's Nest Labs, is an electronic and programmable thermostat that automatically adapts to a household's living habits and consumption behaviour. One week following installation, the Wi-Fi-enabled thermostat can recognise, amongst other things, the time when the resident goes to sleep at night and the time that he or she wakes up. It then adjusts the heating and cooling of the household according to these patterns.

In addition, with continuous communication with indoor and outdoor sensors as well as tracking of the resident's smart phone's location, the thermostat can automatically adjust the temperature across the home to save energy.

2.1.2 Smart homes' and Internet of Things' impact on the energy market and consumers

The deployment of smart home technologies relies on consumers' perceiving clear benefits with acceptable levels of risk related to price valuation on the wholesale market, and an equivalent or better perceived quality of services. A decrease in energy consumption followed by a potential reduction of the household's utility bill is one potential benefit, along with useful consumption feedback and educational information on how to optimise the usage.

The benefit of reduced energy demand and load shifting can also be applied to the energy market. With home automation linked to dynamic or time of use tariffs an additional benefit for the consumer is the potential for lowered energy costs by shifting consumption from peak to off-peak hours. This could also potentially have benefits for the electricity system.

2.1.3 Need for regulation?

In order to fully interact with the wholesale energy market, a smart home would require a smart meter. While most EU Member States have initiated a systematic roll-out, others may retain it as an option, or not even offer it at all, which raises an issue on who will bear associated costs. Furthermore, in Member States where consumers have not had smart meters installed yet, a number of suppliers are introducing their own metering system in order to allow them to benefit from dynamic price contracts. However, it is crucial that these additional meters are fit for purpose to avoid problems due to inconsistency in metering data and to ensure that the implementation of such meters does not impact on the customer's experience (e.g. the ability to switch supplier). Member States could therefore consider whether to regulate this type of meter.

Home automation, combined with dynamic or time-of-use tariffs, requires a market where consumers, or a service provider acting upon their behalf, can react to short-term price signals. This, in turn, would rely on the ability for the consumer to sign a dynamic or time-of-use contract. Consumers may earn from flexibility on the market by other means, such as accessing balancing markets through aggregators. Building on the previous CEER advice on customer data management for better retail market functioning[6], CEER will consider whether there is a need for further regulation in order to remove barriers for consumers to achieve the financial benefit from smart home technologies that results from price variations.

The key feature of smart home technology is the online management system where data is shared between different market actors. This raises a few concerns that regulators may act upon: First, as real-time data on customer's usage of capacity, as well as on his/its energy consumption is shared with the customer and service provider, as well as third parties with customer consent, data security and privacy are of utmost importance. Protection of personal data will be regulated by the GDPR,[7] however, where the regulation allows, Member States may assess whether there is a need to adopt stricter terms. Secondly, for an efficient market deployment of smart home technologies, data interoperability is vital.

2.2 Self-generation of electricity

The intensified environmental focus in all Member States in addition to potential reductions in energy costs have led to a steadily increasing interest in self-generation among consumers. At EU level, there is the binding target that energy consumption will be comprised of at least 27 percent renewable sources by 2030[8].

[6] "CEER Advice on Customer Data Management for Better Retail Market Functioning", 19 March 2015

[7] Article 20, Regulation (EU) 2016/679 of the European Parliament and of the Council 27 April 2016 on the protection of natural persons with regard to the processing of personal data and on the free movement of such data, in force May 25, 2018.

[8] "Energy Efficiency and its contribution to energy security and the 2030 Framework for climate and energy policy", European Commission, July 2014, COM (2014) 520 final

2.2.1 What is self-generation?

Self-generation is a process by which a final customer uses on-site generation to partially or entirely cover his/its own electricity needs. On-site generation includes, for example, rooftop-mounted solar photovoltaics (PVs), micro wind turbines or small cogeneration (combined generation of heat and power). There are several ways of understanding what self-generation could be: consumed instantaneously; fed into the grid and consumed whenever desired; or stored at site and consumed at a later date. The latter will be discussed under section 2.3.

2.2.2 Self-generations' impact on the energy market and consumers

From a market perspective, self-generation is probably an important piece in the transition to climate-neutral energy markets. Other market impacts of self-generation differ depending on the features of the production site. Generated electricity that is fed into the grid could lead to lower levels of network losses and less power requested from the grid at peak times, but CEER has also found that if decentralised energy sources are located far from [other] consumption centres or if generation does not coincide with consumption, losses might increase.[9] However, this phenomenon will inevitably change how the grid is managed and network operators will have to adapt to this to ensure stable and secure operation of the grid. With an increasing interest in self-generation, effective grid management becomes even more important.

From a consumer perspective, the impacts of self-generation vary. Self-generators who feed generated electricity into the grid may benefit from lower electricity bills, protection against volatile electricity prices and have greater ability to make active choices on their consumption behaviour. Self-generation is, hence, empowering consumers.

2.2.3 Need for regulation?

For self-generators to actively participate in renewable generation activities, it is important that policies are adapted to the maturity of the technology, market and the level of competition. There are also things that may inhibit self-generators from participating. These include the fact that consumers may find the process of connecting the on-site generation to the grid complex and experience difficulties with understanding the terms and conditions of selling excess electricity.

For the self-generator to be able to feed excess electricity into the grid and be financially compensated for it, they must sign a contract with a supplier that also sells electricity to the self-generator when it does not produce enough to cover its consumption or with any other third party. The market and contractual conditions of this relationship must be assessed in order to make sure that it does not restrict the self-generator's choice of supplier. Furthermore, being a sometimes-self-generator may lead to a more complex comparison of different offers as both the electricity sales and purchase prices are included. Comparison tools (CTs) that reflect these market developments can help consumers to compare these offers and better participate in the energy market in an active and effective way.

The financial revenues for selling excess electricity raises another concern: the self-generator's right to relevant information on the bill or other communication channels. Thus, it raises the question of whether there is a need for additional regulation concerning the bill and billing information for self-generators, while also taking into account the potential development of energy communities.

[9] For more on this, see the "CEER Report on Power Losses", 18 October 2017 (especially section 5.1).

2.3 Electrical energy storage

For the European Union to reach its 2030 target for renewables-based consumption and with an increasing use of intermittent renewable electricity, storage is recognised as a potentially important element in the electricity market.

2.3.1 What is energy storage?

The European Commission, in the proposed Electricity Directive of the Clean Energy package defines energy storage as *the act of deferring an amount of the energy that was generated to the moment of use, either as final energy or converted into another energy carrier*[10]*.*

Energy storage can provide the customer with greater flexibility as to when they can use electricity generated on site or, indeed, electricity imported from the grid. Batteries and electricity night storage heaters are some examples of energy storage devices.

2.3.2 Energy storage's impact on the energy market and consumers

The role of energy storage is multifaceted. It can be deployed either by final customers or market players, whilst its usage by grid operators should be limited to buying flexibility services through competitive mechanisms[11]. With an increasing interest in self-generation among consumers, energy storage can help to improve stability of the grid and protect against power network failures, followed by overall reductions in costs of the electricity system. From a consumer perspective, as far as energy storage is cost efficient, it can lead to lowered household utility bills as the self-generator can store electricity bought at non-peak periods when the price is relatively low and then use it during peak periods when the price is more expensive. The case study below illustrates how self-generators can benefit from selling self-generated electricity stored in batteries to the grid.

Moixa GridShare – United Kingdom

With smart batteries and trade of excess electricity stored in these batteries, Moixa, a developer of distributed energy storage enables households to sell stored energy self-generated from solar panels while obtaining financial benefits from yearly profit shares through the GridShare membership scheme. The service provider manages all processes within the Moixa value chain, i.e. from installation of solar panels and smart batteries to trading of the customer's excess electricity with National Grid (the England and Wales System Operator).

Currently, a Moixa smart energy trial is taking place in a South Yorkshire village where 30 households connected to the grid have had solar panels and smart batteries installed. While solar panels may lead to overcapacity on the grid on sunny days, potentially followed by operators limiting the numbers of panels permitted according to a particular scheme, the purpose of the trial is to overcome that problem. At the same time, the household customers experience reductions in their electricity bills.

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[10] Proposal for a DIRECTIVE OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL on common rules for the internal market in electricity (recast)Energy Storage – Proposed policy principles and definition COM(2016) 864 final/2

[11] Other than in some limited exceptional circumstances.

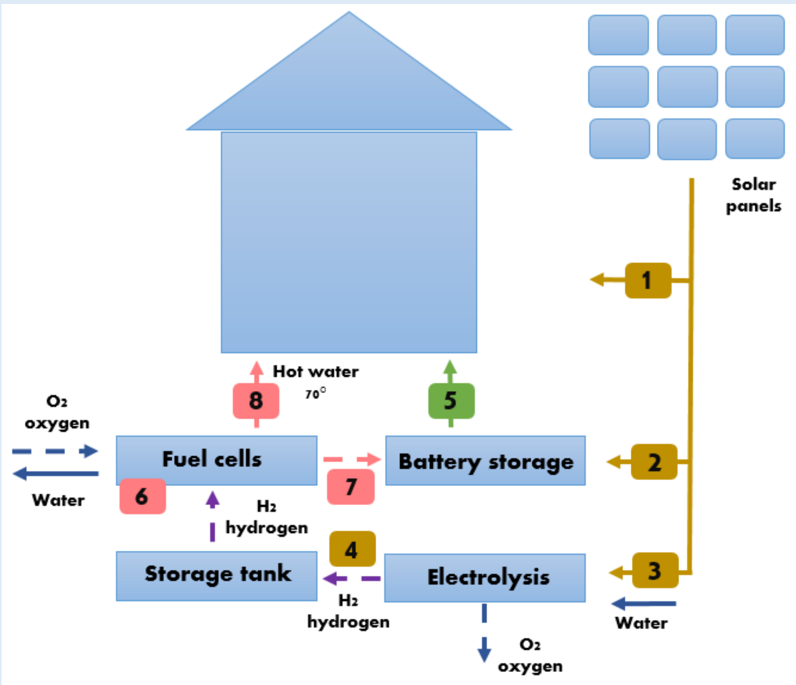
The household customers in South Yorkshire are able to consume electricity in the evenings and nights as the batteries are managed by software that calculates generation and demand for power. Moreover, the software takes into account each household's consumption behaviour to maximise the benefits of storage.

With efficient and cost-competitive self-generation in combination with energy storage, a customer may be able to install sufficient energy storage devices so as to no longer be dependent on the grid. A potential market impact of this is that self-generators disconnect from the grid. This may result in stranded assets for market players and much higher costs for remaining consumers still connected to the grid. This is a point of attention for network regulation. Also, self-generators disconnecting from the grid would no longer be entitled to be classified as a 'final customer'. The case study below shows an example of a combination of self-generation and energy storage followed by disconnection from the grid in Sweden.

Zero Sun project[12] – Sweden

A house manufacturer in collaboration with an electricity supplier are currently carrying out a real-time experiment where a household villa in the northern part of Sweden will be 100 percent energy self-sufficient throughout the year. The self-sufficient energy system consists of solar panels, storage batteries, hydrogen and fuel cells that interact and communicate. They will enable the household villa to disconnect permanently from the grid.

The fact that the household villa is located in a geographical area where the weather conditions fluctuate dramatically between summer and winter (including the extreme scenario of zero sunlight hours and an average temperature of -11.0° C in the winter) complicates the settings for self-sufficiency. The figure below illustrates how the different technologies will manage the seasonal variations in generation.



[12] https://www.skekraft.se/om-oss/foretaget/zero-sun/ (in Swedish only)

Flow of energy, sun and daylight
1. The household consumes generated electricity.
2. If excess of production, the batteries are charged.
3. Batteries are loaded – the electrolysis starts to split water into oxygen and hydrogen.

Flow of energy, night time
5. The household's electricity usage is covered by the battery storage.

Flow of energy, winter season
6. The fuel cells start as the batteries have been discharged to a predetermined level.
7. Electricity from the fuel cells charges the batteries.
8. Thermal energy for the household's heating system and hot water.

2.3.3 Need for regulation?

Customers' improved access to viable and affordable energy storage may raise legislative issues for Member States to consider regarding redistributive economic effects. While this is not within the scope of this paper, CEER has already analysed the potential impact of cross-subsidisation between final consumers and self-generators on the distortion of the retail price signal.[13] Additionally, similar to electricity generated from on-site production, there is a matter of transparency as consumers may experience difficulties with understanding the costs, risks and benefits of energy storage.

From a supplier perspective, a reduction in electricity demand may have a direct impact on profitability. In Europe, one can already perceive a shift where conventional suppliers are re-considering their role on the electricity market and starting to position themselves as energy service providers. Therefore, a key question is what future energy suppliers will look like and how they will need to be regulated. Depending on the legal nature of additional energy storage services, there may also be concerns regarding the regulatory approach and competitive implications on supply offers, including bundled products or services that would rely on general customer protection legislation.

2.4 Charging stations and electric vehicles

2.4.1 What is an electric vehicle?

Concerns regarding air pollution and global warming related to mobility, in city centres and beyond, is leading to increasingly restrictive regulations regarding automotive engine emissions[14]. Many major cities across Europe have already introduced regulatory and financial incentives for low or zero emission vehicles and several are planning a ban on liquid hydrocarbon-powered vehicles within the next 10 to 20 years.

At the same time, electricity chemical storage (batteries) has improved significantly in terms of cost and of energy density (the ratio between energy capacity and battery weight). As a consequence, new generations of vehicles are emerging that take advantage of the benefits of electricity to improve their power efficiency and to reduce emissions. There are:

[13] For more on this, see "CEER Position Paper on Renewable Self-Generation", 16 September 2016.
[14] http://urbanaccessregulations.eu/low-emission-zones-main/what-are-low-emission-zones#where

- hybrid vehicles which use a petrol or diesel-powered engine to charge batteries and work in combination with the electric engines to improve energy efficiency[15];

- plug-in hybrids which work like hybrid vehicles, but have larger batteries that can also be charged from the grid and offer the capability of full electric-power mode over a limited range (~30 to 70 km);

- full electric vehicles, equipped with a large battery charged exclusively from the grid, that offers an extended range (~80 to 600 km, with the potential for further increase).

Regarding electricity regulations, only the two last categories are relevant as they need to be connected to the grid.

Plug-in hybrids and full-electric vehicles remain significantly more expensive than comparable petrol- or diesel-powered ones. But, considering the lower cost of electricity per kilometre driven, the trend in battery and general electric vehicle cost reduction and the regulatory and financial incentives, there is little doubt that they will represent a significant market share in the near future.

As mentioned, though hybrid vehicles are fully independent from the grid, electric vehicles and plug-in hybrids rely on/use charging infrastructure for their supply. This infrastructure covers a large range of situations that must be addressed individually, as they may have different regulatory implications, for example:

- Charging infrastructure as part of the private home network: some charging infrastructure can be installed within the home network, behind the meter. In this situation, electric vehicle consumption cannot be differentiated from the rest of the household's consumption.

- Specific charging infrastructure in an individual parking space within a common dwelling: in this situation, the consumption of the electric vehicle can potentially be differentiated from the rest of the individual household consumption. But, depending on the metering infrastructure in place, the consumption of the common dwelling consumption and the actual consumption of each vehicle might or might not be differentiated.

- Charging infrastructure publicly accessible in a private space (typically, in public car parks or fuel stations).

- Charging infrastructure publicly accessible in a public space (typically on the street). This might be operated by the owner of the infrastructure, either a public body or by private operators. The choice of private operators may rely on a concession from the public owner, exclusive or not.

It is worth recalling that Directive 2014/94/EU[16] on the deployment of alternative fuels infrastructure sets the minimum standards for charging infrastructure for vehicles.

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[15] These are further distinguished between hybrid vehicles where the petrol/diesel engine is connected to the drivetrain and powers the wheels along with the electric motor and those where the petrol/diesel engine only charges the electric motor. This second type is electric-only when the battery is not being charged.

[16] Directive 2014/94/EU of the European Parliament and of the Council of 22 October 2014 on the deployment of alternative fuels infrastructure Text with EEA relevance.

Belib' – France (Paris)

Belib' is the new charging infrastructure and commercial offer for on-street charging in Paris. Each station is equipped with 3 chargers, one with a domestic plug offering up to 3 kW and two with a larger range of plugs offering 3 to 22 kW.

Belib' offers two types of commercial offers: one for registered users and one without a subscription. Billing includes parking fees. It is exclusively based on the duration of the charge, regardless to the amount of energy consumed or the power available at the charging station. For registered and non-registered users, prices are lower for the first hour (0.25€/quarter-hour for registered users and 1€/quarter-hour for non-registered) and significantly higher for the next hours (4€/quarter-hour) in order to incentivise vehicle rotation at the station. Charging is free for registered users on the 3 kW plug at night, from 8pm to 8am.

Belib' can also be accessed through subcontracted service providers. Such companies contract roaming access to third party charging stations across the country and abroad in order to allow a driver to access charging infrastructure seamlessly without having to register with each charging station operator. They define their own prices and offers are very diverse: some offer prices aligned with the charging operators' prices plus service fees, others do not.

2.4.2 Electric vehicles' impact on the energy market and consumers

An electric vehicle represents a significant volume of electricity consumption for those households possessing such vehicles. Estimates based on the current vehicle usage across Europe show that it might represent, on average, between one-quarter and one-third of such households' consumption.[17]

If the reduction of local emissions is already a strong contribution of electric vehicles to a better environment, the decarbonisation logic of the energy sector, specifically on mobility, should lead to the promotion of the use of low-carbon energy sources.

The mobile nature of electric vehicles raises practical issues regarding customer information on energy prices as they connect to different charging station during a journey. Indeed, from an electricity system perspective, the use of electric vehicles could generate power peaks if not properly managed. On the other hand, while connected to a charging station, electric vehicles could be regarded as static storage facilities, allowing for charging and discharging depending on the balance between demand and supply in the system overall and making consumers, at least implicitly, flexibility services providers. Although "vehicle-to-grid" (V2G) and "vehicle-to-home" (V2H) technologies are still at the prototypal level of development, these developments raise concerns on how to send the appropriate price signal to users to allow them to react accordingly.

[17] This is a calculation based on the average distance driven by a European household, EV average consumption and household average electricity consumption. Some variations may exist on these assumptions across Member States. Some additional assumptions behind this calculation are: (1) the household only uses the EV and no longer relies on an oil-powered car; (2) the use of an EV does not change the average usage pattern (same distance driven). In most cases, these assumptions are not completely fulfilled today as, due to limited range, many household use the EV as an alternative/second vehicle for short/urban journeys. But, if batteries' typical range increases, the usage pattern of EVs could change in the future.

Customers may travel from one country to another in their electric vehicles. Such cross-border travel will inevitably become more widespread as the number of electric vehicles increases and the range of these vehicles improves. This raises concerns regarding coordination of solutions across Europe, while also allowing Member States to evolve at different paces depending of the maturity of technology in their country.

2.4.3 Need for regulation?

First, it should be clarified whether, depending on their situations, drivers who plug their vehicle to a charging station should be regarded as electricity consumers (individual or professional) or a buyer of charging services, which may affect consumers' rights.

Under existing European Directives, electricity consumers' rights include:
- the choice of suppliers;
- the choice of offers, including the possibility:
  - to compare offers;
  - to opt for renewable energy;
- certain types of billing information;
- the right to be settled based on the actual metered consumption; and
- the right to be protected as a vulnerable or energy-poor consumer.

If drivers are to be considered as buyers of charging services, which should be the case for publicly accessible charging stations under Recital 30 of the Directive 2014/94/UE[18] and is generally CEER's position, specific electricity consumer rights do not apply. The rights of the consumer may therefore be sufficiently protected through competitive pressure among charging service suppliers and general consumer protection rules that apply to any sort of service activity.

However, even if the charging service is regarded as a competitive activity (which is generally CEER's position) there might be a need for regulation to mitigate the risk of market power, though this is not necessarily an NRA responsibility. Depending on the circumstance, responsibility could lie with local authorities who are in charge of allowing the implementation of charging stations on their territory, or with national competition authorities.

In addition, charging of electric vehicles raises the issue of consumer rights protection and price transparency in the context of bundled offers; for example, vehicle charging might be offered as a bundled service with parking.

Ultimately, drivers' rights will depend of the type of charging infrastructures they are accessing. The rights might be different if they connect from home, from a publicly-accessible charging station in a private building or from a publicly-accessible charging station in a public space. The need for regulation, whether it comes from the NRAs or other authorities, may vary. In addition, because electric vehicles can be used as a means of transportation crossing EU borders, there are particular issues regarding the portability of consumer rights and the authority in charge of complaint handling (ombudsman).

[18] *"The establishment and operation of recharging points for electric vehicles should be developed as a competitive market with open access to all parties interested in rolling-out or operating recharging infrastructures."*

In this perspective, and considering the diversity of situations, CEER will consider whether there is a need for energy-specific rules in order to ensure an appropriate level of competition and customer protection and empowerment in this specific market segment, or if the general consumer and competition legislation is sufficient.

2.5 Blockchain application in the energy market

2.5.1 What is a blockchain?

A blockchain is a continuously growing list of records, called blocks, which are linked and secured using cryptography. Each block typically contains a hash pointer[19] as a link to a previous block, a timestamp and transaction data. A blockchain can serve as an open, distributed ledger that can record a sequence of verified bilateral transactions in a permanent way. It is typically managed by a peer-to-peer network collectively adhering to a protocol for validating new blocks. Once recorded and validated, the data in any given block cannot be altered retroactively without the alteration of all subsequent blocks. By design, blockchains are inherently resistant to any undesired alteration of the data integrity.

For illustrative purpose, the reasoning focuses on blockchains. But it may also apply to other technologies as long as they are based on similar key principles that place the transaction out of the scope of regulated entities, such as peer-to-peer relations, decentralisation and, in some cases, full anonymity by design.

2.5.2 Blockchain's impact on the energy market and consumers

The future energy retail market design relies on advanced interactions between traditional actors, such as suppliers and consumers, and a vast number of new actors promoting innovative business models, such as self-generators, aggregators, energy service companies and renewable and/or local energy communities. These often rely on an improved information technology environment.

In this context, blockchain can be used to manage any form of transaction, notably supplier switching or energy supply. There are also some attempts to use blockchain to validate devices connecting to a grid (working mainly on the "supply chain" side of the energy sector).

In parallel, the proposed revision to the Electricity Directive promotes more-decentralised initiatives, such as renewable communities and local energy communities where a limited number of participants can initiate transactions among themselves. Although it might appear a bit experimental at this stage, blockchains may be suitable to manage such transactions. Several experiments in this area are already underway.

To some extent, the full implication of the use of blockchains in the energy sector are less well understood at this stage than the other technologies identified in this paper. A comparison with blockchain development in other sectors should be considered.

[19] A hash function is any function that can be used to map data of arbitrary size to data of fixed size. The values returned by a hash function are often called simply a 'hash'. A hash pointer adds the hash of the value along with the reference to make the data temper proof. In a blockchain a hash pointer points to the next data with its hash. A change of data in the chain would be easily detected by the hash value. Even if all the hash pointers all the way back in the chain were changed, the genesis block cannot be changed. In this way, the hash pointer is the backbone of blockchain security.

In addition, the impact on electricity consumption could be considered as computing needs increase with the large number of transactions that greater use blockchain-type technologies entails. This may lead to the implementation of limits to the size of a blockchain(s) in certain operational contexts.

Sunchain – France

Sunchain is a local, small-scale initiative aimed at implementing a virtual private network on the physical one.

Sunchain's purpose is the off-site self-generation of solar energy. The solution offers the opportunity to use solar energy away from the production point, thanks to blockchain technologies. In the context of self-generation, the excess power generated by the solar plant is directed to another point of consumption through the distribution network.

The implementation of this solution in a charging station, public or private, enables the direct use of home-based self-generated power to charge a car. In an apartment or office building, it allows for the possibility of solar self-generation. By measuring the real-time production and consumption, solar power is injected into the building's electrical network and allocated to the different users. Furthermore, in the process of self-generation, instead of selling the excess energy through the grid, it can be supplied to another building. For an eco-district, this results in a collective self-consumption from one or several solar plants.

Sunchain's activities rely on blockchain. Sunchain is designing its own private blockchain, a distributed database that stores the transaction history in each node that composes the network. After a computed validation process, the measures are certified, encrypted and secured in the blockchain.

Electron – United Kingdom

Electron designs systems to support the industry's transition to smart grid infrastructure and new market norms of decarbonisation, decentralisation, digitalisation and democratisation using decentralised technology to advance the shared infrastructure of the energy markets.

One of their products is a meter registration platform for all UK gas and electricity supply points to facilitate faster switching. This technology is now being extended to cover new types of assets. They are also developing a flexibility trading platform to allow demand-side response as well as peer-to-peer and micro-grid trading. They have partnered with a number of other businesses to develop this platform.

2.5.3 Need for regulation?

The emergence of blockchain to manage transactions, together with the development of decentralised initiatives in the energy sector may challenge regulators' traditional approach to data exchange, centralised at DSO and market operator levels.

It may also raise issues regarding the ability of regulators to monitor transactions in the energy sector, in accordance with the Regulation on Wholesale Energy Market Integrity and Transparency[20] and with other monitoring tasks assigned to energy regulators. In a broader sense, it also raises the question of whether it is possible to regulate this market, considering its decentralised nature and possible lack of transparency resulting from peer-to-peer transactions.

3 Conclusions

The emerging technologies described in the present report seek to lower energy costs, improve comfort for consumers and/or promote more efficient energy consumption for the sake of climate-neutral energy markets in a context of stronger environmental regulation. These technologies may also impact consumers and retail market functioning in a way that may require regulatory changes in the future in order to realise their full benefits and prevent any detrimental effects. These regulatory changes could include facilitation for an efficient market deployment of customer-related technologies as well as reviewing and revising consumer empowerment and protection measures.

In this perspective, the current analysis has led to the identification of the need for further investigations in four major areas:

- The context of digitalisation and the development of home automation increase the need for data exchange. Therefore, CEER will work along with other relevant authorities, and possibly other organisations, on cybersecurity, data privacy, interoperability and monitoring. This effort should also take into account the potential of decentralisation and peer-to-peer transactions, like blockchain.

- The development of additional services or bundled products related to self-generation, storage, energy efficiency and maintenance along with energy supply and the progressive shift from energy suppliers to energy service providers raises concerns on how competition, customer protection, empowerment, transparency and monitoring shall be ensured in the future. CEER will continue its work to promote a fit-for-purpose market design and the well-functioning of retail energy markets.

- CEER regards publicly-accessible EV charging points to be part of the competitive market and EV drivers using this infrastructure to be buyers of charging services. CEER will consider whether there is a need for specific rules for charging infrastructure in order to ensure an appropriate level of competition and customer protection and empowerment linked to the development of electric vehicles. The analysis should consider the large diversity of situations and the specificities related to customer mobility, including cross-border mobility.

- CEER will pursue work on removing potential barriers in the market in order to facilitate these emerging technologies as well as consider regulation in light of changes to the way consumers interact with and participate in energy markets.

In addition, CEER plans to analyse the impact on regulatory practices of these emerging trends in conjunction with governance issues, including new structures such as the development of energy communities and local initiatives.

[20] Regulation (EU) No 1227/2011 of the European Parliament and of the Council on wholesale energy market integrity and transparency (REMIT)

Some of the topics addressed in this document enter into the scope of the recently proposed regulations and directives on the internal electricity market (the “Clean Energy for All Europeans” legislative package). The final legal provisions of the regulations and directives of this package may affect the position that CEER could take in the future.

In the framework of CEER’s Partnership for the Enforcement of European Rights (PEER) an initiative that brings together interested authorities responsible for protecting and enforcing European consumers’ rights across a range of sectors. In 2017, CEER brought together regulators from different sectors in a regulatory roundtable on bundled products. This work will continue in 2019.

With new technologies and ideas continuously bringing change to the market one thing is clear: regulation will have to adapt and seek the best outcomes for customers. These emerging technologies and business models will drive further CEER work in the coming years.

Annex 1 – List of abbreviations

Term	Definition
CEER	Council of European Energy Regulators
IoT	Internet of Things
CT	Comparison tool

Annex 2 – About CEER

The Council of European Energy Regulators (CEER) is the voice of Europe's national regulators of electricity and gas at EU and international level. CEER's members and observers (from 36 European countries) are the statutory bodies responsible for energy regulation at national level.

One of CEER's key objectives is to facilitate the creation of a single, competitive, efficient and sustainable EU internal energy market that works in the public interest. CEER actively promotes an investment-friendly and harmonised regulatory environment, and consistent application of existing EU legislation. Moreover, CEER champions consumer issues in our belief that a competitive and secure EU single energy market is not a goal in itself, but should deliver benefits for energy consumers.

CEER, based in Brussels, deals with a broad range of energy issues including retail markets and consumers; distribution networks; smart grids; flexibility; sustainability; and international cooperation. European energy regulators are committed to a holistic approach to energy regulation in Europe. Through CEER, NRAs cooperate and develop common position papers, advice and forward-thinking recommendations to improve the electricity and gas markets for the benefit of consumers and businesses.

The work of CEER is structured according to a number of working groups and work streams, composed of staff members of the national energy regulatory authorities, and supported by the CEER Secretariat. This report was prepared by the Retail Market Functioning Task Force (now the Innovation and Retail Markets Work Stream) of CEER's Customers and Retail Markets Working Group.

CEER wishes to thank in particular the following regulatory experts for their work in preparing this report: Ms Louise Goding and Mr Julien Janes.

More information at www.ceer.eu.