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The Law for Energy Prosumers

The Case of the Netherlands, New Zealand and Colombia

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Blurb

The electricity sector is on the verge of significant change because of technological innovation, together with distrust in conventional energy companies and increasing awareness of climate change. Such a shift implies a more active role for consumers who can generate and manage their energy supply and trade or store their energy surplus or respond to market signals. The expression used to describe this situation is 'energy prosumer' or active consumers. These terms refer to the combination of production and consumption in one entity, the prosumer. New technologies and business models, such as distributed generation, peer-to-peer trading, smart grids, demand-side management and energy storage, offer a brilliant opportunity for making energy prosumers a reality. Nevertheless, the rise of energy prosumers brings new challenges to legal systems. Current legal systems underpin the traditional electricity supply, which was established based on the technologies available at the time and the clear distinction between consumers and producers. The emerging and overlapping roles of energy prosumers create uncertainty, legal gaps and questions for the current legal system, resulting in outdated regulation and regulatory disconnections.

This book argues that law has a vital role in shaping the electricity system to enable a more active role for consumers in liberalised electricity industries. To do that, this book offers a unique legal perspective of the Netherlands, New Zealand and Colombia to help understand some of the current legal approaches to prosumers and therefore the legal challenges and opportunities facing. Law and regulation have the role of creating a level playing field for emerging participants, such as prosumers, to participate and compete in the market together with traditional actors, bringing not only more competition but also representing a more sustainable, environmental and democratic way to supply energy. Furthermore, law and regulation have the role of responding to innovation and creating space for technological advances to procure the changes in the industry without delay.

This book examines some of the legal barriers for the raise of energy prosumers. The traditional role of the distributor when responding to increasing distributed generation in the network; prosumers unable to decide to whom they can sell their electricity to; the price of the energy or even whether to participate more actively in demand response programs. A further issue is the lack of clarity about whether small

prosumers are entitled to consumer protection rights and legal challenges regarding configuration, access to the network, access to markets and strict unbundling rules for community energy projects. This book provides a clear, analytical and informed approach to understanding the regulatory framework around energy prosumers. It will appeal to policymakers, lawyers, individuals, business entrepreneurs or communities wanting to engage in energy projects, as well as academics, researchers and students.

Introduction

Background

According to ancient Greek mythology, the Titan Prometheus, feeling sorry for the unfair state and darkness in which humankind lived, stole the fire from Zeus, the supreme ruler of the Gods. He gave it as a gift to humanity, bringing progress and enlightenment. For this generous act, Zeus punished Prometheus and chained him to a rock, where every day an eagle came to eat his liver, which would grow again by the next day, endlessly tormenting the Titan. After many years, luckily for him and humankind, Hercules, the hero, half-god, half-human, came to his aid, killed the eagle and freed Prometheus from the chains.[1]

This legend introduces the topic and objective of this work. Scientists, entrepreneurs, engineers, innovators (Prometheus) have created new technologies (the fire) that today allows consumers (humanity) to no longer be dependent on large energy companies (Zeus) to supply them with electricity. These new technologies enable them to generate, in situ, their energy, manage their energy needs and interact actively with the electricity system in a sustainable manner (enlightenment). However, these emerging technologies and business models face multiple obstacles, including financial, technical, institutional, cultural and legal challenges (eagle and chains). The twenty-first Century Prometheus deserves to be free from chains and be reunited with humankind because everyone should have access to fire, both humanity and the Gods. The question that remains is, who will be Hercules? Who will take on the responsibility of removing the chains that limit innovation and restrict consumers in managing their own energy needs?

The electricity sector is on the verge of significant change because of technological innovation, together with distrust in conventional energy companies and increasing awareness of climate change. Such a shift implies a more active role for consumers who can generate and manage their energy supply and trade or store their energy surplus. The expression used to describe this situation is ‘energy prosumer’. This term

[1] Robin Hard “The Rise of Zeus and Revolts against his Rule” in *The Routledge Handbook of Greek Mythology* (Routledge, New York, 2008) at 92.

refers to the combination of production and consumption in one entity, the prosumer. New technologies and business models, such as distributed generation, peer-to-peer trading, smart grids, demand-side management and energy storage, offer a brilliant opportunity for making energy prosumers a reality. This emerging model could lead to enormous benefits including enhancing energy security, mitigation and adaptation to climate change, improved sustainability and efficiency, energy democracy, a more economical and efficient energy supply service and a growth in customer benefits.

Nevertheless, the rise of energy prosumers brings new challenges to legal systems. Current legal systems underpin the traditional electricity supply, which was established based on a clear distinction between consumers and producers. The emerging and overlapping roles of energy prosumers create uncertainty, legal gaps and questions for the current legal system, resulting in outdated regulation and regulatory disconnections. Such disconnection is the gap between the emerging technologies that bring a new set of values and possibilities and the applicable regulations which cannot adapt fast enough to the changing circumstances. As a result, we do not know what new legislation and regulation are needed or what the role of law should be. Thus, the question of how to adapt the present legal system or whether there is a need to create a new one is now open for debate.

This book focuses its attention in three countries with liberalised electricity markets to help understand some of the current legal approaches to prosumers. The three selected countries are the Netherlands, New Zealand and Colombia. Such diverse and geographically distant countries were chosen to analyse how electricity systems and legal frameworks experiencing different energy policy challenges are responding to the new technologies that enable a more active role for consumers.

On one hand, New Zealand is a developed country with a small population distributed throughout the territory whose primary centralised energy generation resource is hydropower with immense renewable energy potential. On the other hand, Colombia is a developing country with a much larger population concentrated in the big cities, and a small proportion of citizens living in off-grid areas. As with New Zealand, hydropower is the main energy resource, and the country also has significant renewable energy potential. The third country is the Netherlands. It is in a unique position, as a member of the European Union, it must follow European energy and electricity policies and regulations but has a level of discretion in the implementation of these. Its electricity mix relies mainly on fossil fuels, principally gas and liquid fossil fuels but its use of renewable generation has been increasing in recent years. This diversity in the energy mix and its characteristics is important when analysing the different approaches used by countries with liberalised electricity markets when dealing with prosumers.

The book's premise is that the current legal framework is tailor-made for the centralised-traditional electricity system in which the role of the consumer is passive. All consumers are required to do is to pay the electricity retailer for the energy that they consume. In opposition to a more active role of consumers, in which they self-generate power, manage their energy demand and participate in the system's costs and benefits.

The book examines the contrast between the traditional-centralised legal framework and the emerging demands and opportunities created by new technologies and the changing nature of energy supply. This comparison aims to explore whether the legal and regulatory framework of the three jurisdictions can incorporate these new needs and to what extent they can adapt to the changing perspectives. It does this by identifying existing legal barriers that present challenges to the participation of active consumers in the market. The role of law also needs to consider the emerging energy and social values such as climate change concerns, the democratisation of energy and energy justice while ensuring energy security and energy efficiency.

Although this study recognises the relevance of the right to access data, which has become of enormous importance in the presence of smart and IT technologies, facing cybersecurity or data appropriation, the analysis of this issue is beyond the scope of this book, and will be better covered in specific research on data protection in its own right. The thesis does not engage with the legal analysis of energy storage by prosumers, but instead, focuses on distributed generation and demand response with some consideration of smart grids.

This book has seven chapters. Chapter 1 begins with a technical explanation of how the traditional and centralised system works in order to understand some of the challenges that a more active role for consumers creates. This explanation is followed by an introduction to the implications of liberalisation in the electricity industry. It continues with a discussion contrasting the characteristics of the traditional-centralised system with the characteristics of the emerging technologies and functionalities that empower consumers. The chapter will then introduce the disruptive technologies and concepts that make technological change possible, and their implications for the system. These concepts are demand response, distributed generation, smart grids, advanced-metering infrastructure and micro-grids.

Chapter 2 undertakes an initial legal analysis of the coexistence of traditional-centralised aspects encountered with decentralising approaches in the three chosen jurisdictions. Each of the different sectors involved in the traditional supply of power (generation, transmission, distribution, wholesale and retail market and consumers) will be analysed. Such analysis is followed by recognising whether the current legal and regulatory framework incorporates a decentralised approach (distributed generation, smart meters and demand response) and in which manner.

Chapter 3 will develop knowledge and understanding of the many socio-political constructions that have foreseen consumers becoming more active and their political and market relevance. In this sense, we will explore the origin and significance of ‘prosumers’, the sharing economy and the concepts of localism and bioregionalism. This chapter will also explore the values underpinning the emerging system, which addresses climate change, community involvement, energy security, energy efficiency, energy transition, energy democracy and energy justice. The chapter will conclude by exploring the multiple regulatory perspectives that constitute the theoretical framework of the thesis. In this sense, we will ask about the role that regulation plays, the form that it takes and who can regulate, followed by an analysis of the relationship between regulation and technological innovation and the concept of smart

regulation. Building on the description and preliminary legal analysis of the traditional regulatory system and the challenges that emerging concepts bring, especially a more active role for consumers, the thesis presents some of the legal challenges. The main legal challenges are access to the networks, access to the markets, consumer legal protection and the legal aspects of community energy.

Chapter 4 will discuss access by prosumers to the distribution network. Because of the increasing injection of energy by prosumers to the network, distributors have to change the way they manage and operate the distribution network. This chapter will explore both the functions of the distributor and the procedures for connection of distributed generation and whether the components of price-control over the distribution activity recognise or promote investment in new technologies for the more efficient management of the network.

In Chap. 5, two issues will be discussed. One of these issues relates to access to markets for prosumers for a fair and transparent remuneration. Consideration will be given to selling energy surplus and participation in demand response programmes. In doing this, we will refer to the participation of prosumers in the wholesale, retail and emerging markets and remuneration through net-metering, feed-in tariff and net billing, among others. The second issue is whether small prosumers should be entitled to consumer protection rights. Such rights include the ability to self-generate, universal access, the right to change supplier, access to relevant information, the right to specific and simplified procedures and access to the technology for vulnerable consumers.

Chapter 6 will address distinctive issues relating to community energy projects. A more active role for the consumer can also result in him or her deciding to belong to a community to satisfy energy need as a collective. Such an energy community may face different legal challenges regarding its size, market participation and even legal setting. The section includes an analysis of how the literature describes and understands community energy and explores legal examples or practices of the concept. The section will conclude with an analysis of the legal challenges that community energy projects face and how this emerging legal entity has been introduced in the selected jurisdictions and its legal treatment.

Having explored some of the most important legal challenges that prosumers are facing in countries with liberalised electricity markets and having analysed the multiple approaches that the three chosen jurisdictions have implemented, Chap. 7 can finally give an answer to 'What is the role of law in shaping the electricity system for more active participation of the consumer?' The answer involves rethinking the role of the traditional actors in the system and the opportunities for emerging actors, such as prosumers, interacting with others and being integrated effectively within the system. The answer to this question requires an understanding of the role of law in dealing with innovation in the electricity sector.

Throughout, this book will refer to the terms consumer and prosumer. Consumers who become prosumers can be either residential, commercial, community or medium or large customers. In this work, the principal focus is on residential and community prosumers, though some consideration will be given to large prosumers. This difference is essential because it highlights the different regulatory and market treatment

of prosumers according to their size. Therefore, when referring to small prosumers, it refers to households and small commercial consumers while larger prosumers refer to industrial customers.

Contents

Chapter 1
The Power System: Present and Future

Since humans first made fire, they have found different ways to not only warm places and cook food but also to bring light to the sometimes dark world. For thousands of years and throughout different civilisations, artificial lighting was possible thanks mainly to the combustion of fuels. Gas, coal, kerosene lamps and even whale oil were used to bring light into homes once the sun set. However, by the end of the nineteenth century, the invention of the light bulb and the alternating current changed the way we interact within society.

In 1879, Thomas Edison invented the light bulb and an electricity system based on 'direct current', which means energy is generated and consumed within only a few miles from the power plant.[1] In the early days of electricity generation, distributed generation was the norm, and the first power plants supplied electricity to customers in nearby locations, albeit the supply voltage was limited. Later, through technological evolution, grids allowed electricity to be transported over longer distances in high voltages.[2] In 1896, Westinghouse Electric, helped by Nikola Tesla, introduced the technology of the 'alternating current', allowing an expansion of the reach of power plants to cover significant distances.[3] The shift from direct to alternating current made it possible to construct larger, centralised electricity systems which we called in this thesis the 'traditional-centralised electricity system'. The world, as we know it today, is here thanks to the traditional-centralised electricity system: artificial lighting in every urban house, appliances that work every time we switch them on, industries that work 24/7, beautiful Christmas lights that decorate houses and streets, bridges and avenues lit by thousands of lights.

[1] David Tuttle, Gurcan Gulen and Robert Hebener *The history and evolution of the US electricity industry* (The University of Texas Energy Institute, Texas, 2016) at 3.

[2] Guido Pepermans and Dries Haeseldonck "Distributed generation: definition, benefits and issues" (2005) 787 Energy Policy 787 at 788.

[3] Tom McNichol *AC/DC, The savage tale of the first standards war* (Wiley & Sons, Washington, 2006) at 48.

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However, a changing world and industry are dictating new perspectives. Thanks to new inventions and technologies, a new way of producing and consuming electricity is possible. Information and communication technologies (ICT), solar panels, energy storage, wind turbines, smart meters and electric vehicles, among other technologies, allow multiple functions that were once unthinkable. Consumers are now able to produce energy on site, exchange energy surplus with the network and other consumers or store energy. It is vital then to integrate these new realities into the electricity system.

The purpose of this chapter is to compare the process behind the traditional centralised electricity system with a more complex system that decentralises some functions, opens new market opportunities and enables consumers to become more active. In doing so, this chapter is organised in the following way: the first section will explore and describe how the traditional centralised system works by characterising the main activities of which it is composed. This is followed by discussion about liberalisation in the electricity industry which introduced more specific characteristics into the power system. Once the traditional system has been explained, the second part of this chapter will focus on the characteristics of the emerging technologies and functionalities that empower consumers. Thereby, this chapter will explore the emerging functionalities and technologies and the benefits and challenges to the power system.

1.1 How the Traditional-Centralised Systems Works

The traditional system is a centralised and uni-directional structure that takes the power generated on one side by a large generator to another location further away, where it is consumed. The generation and consumption points are connected by an interconnected system that is composed of a national grid and multiple distribution lines. The output generated is transported by the high voltage transmission grid. It is then converted to lower voltages and distributed to end users through multiple distribution networks, where the voltage is adjusted as necessary for residential and business use. The interconnected system consists of generation plants and equipment, interconnection networks, regional and interregional transmission networks, distribution networks and users' electrical charges. Such components determine the different activities that are performed in order to supply power to households, industries and businesses throughout the country. Thus, a centralised electricity system consists of four main sections or activities that interact in a top-down approach: generation, transmission, distribution and customers. In the following paragraphs, the main characteristics of each activity will be explained further.

Generation. Electricity comes from different resources, including hydro, geothermal, fossil fuels, wind and solar. Generators are generally large and usually located close to primary energy sources. The output of these generators often cover relatively large distances in only one direction of flow to where the electricity is consumed. There are two key reasons why electricity generation is often located a

long way from loads which increases the need for electricity transmission and distribution networks. The first is that it is often more economical to transport energy in the form of electricity than to carry the natural resource. Historically, it was cheaper to construct large plants close to the energy source rather than build large plants close to consumers and transport the energy resource. Whilst this applies to generation using geothermal, hydro, wind and solar, in the case of coal, although it is possible to transport it, it is cheaper to locate the plant close to the mouth of a coal mine. The second reason is that the system was designed using technologies that were more cost-effective when used in a large-scale way and other technologies were not yet invented or not available at that time. Solar panels or wind turbines are examples of this.[4]

The demand for electricity can vary depending on the time of day, the day or season. Accordingly, the conventional design and planning of power plants and the network have been structured to meet the 'peak-load' or highest demand. Traditionally, the demand for electricity is divided into three categories: base-load, intermediate and peak-load.[5]

(i) The base-load is the minimum amount of electricity that needs to be supplied at all times, regardless of changes in consumption behaviour. Base-load plants run most of the time at stable levels of output where capital costs are high but operational cost are low, even though they have expensive start up times. The resources used are mainly coal, nuclear and hydro. Being a base-load resource does not require much flexibility and tends to run without interruption for long times.[6] For instance, in New Zealand and Colombia, the base-load plants are hydro plants and in the Netherlands they are coal.

(ii) The intermediate load varies depending on consumption within different sectors including households, business and industry. Intermediate load plants are designed to adjust their output to accommodate changes in demand throughout the day and to start and stop frequently. Some of these plants are combined-cycle gas turbine, hard-coal plants and some hydro plants.[7]

(iii) Peak-load deals with the highest demand of the day, which means a small number of hours with a system peak for heating or cooling, driven for changes of season. These plants have very short start up times and the cost structure requires a reduced fixed cost and high operating costs. The traditional electricity system has been designed to meet the highest level of demand, which means that the system requires investment in capacity and, during non-peak times is underutilised.

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[4] Darryl Biggar and Mohammad Reza Hesamzadeh *The Economics of Electricity Markets* (John Wiley & Sons Ltd, Sussex, 2014) at 33.

[5] International Energy Agency *Status of Power System Transformation: System Integration and Local Grids 2017* (International Energy Agency, Paris, 2017) at 33.

[6] At 34.

[7] At 33.

Even though large-size plants have ensure access to energy to large parts of the population, it is worth mentioning that these plants have created impacts in the environment and society where the project is located, depending on the selected generation resource. Depending on the size of the project, these impacts can be considerable. For instance, in the case of fossil fuel use, it affects the environment through air pollutant emissions or CO_2, affecting more than the local population. Large scale hydropower developments causes the flooding of many hectares at the location of the proposed reservoir. This causes the displacement of population, impacts on animals and vegetation and changes to the river course. Also, conflicts often result over the use of land because such projects require large spaces to operate. Even large non-conventional renewable resources, such as solar or wind, are creating impacts because of low social acceptability given the impact on the landscape and animal migration.

The **transmission grid** consists of power lines suspended from poles and towers or insulated cables which run underground or submerged in water. They carry large volumes of electricity at high voltages because the higher the voltage, the lower the current, and the lower the current, the lower the energy losses. For this reason, transmission networks tend to use very high voltages, with the highest voltages utilised for the longest and most heavily loaded transmission lines. Usually, a transmission network is connected from the largest generator to either a few directly linked customers (large customers) or, more frequently, distribution systems. Globally, the voltages used for transmission range from 100 kV to as high as 1000 kV, with 132, 220, 275, 330 and 550 kV being the most common.[8] The transmission lines are interconnected with one another at switching stations and substations. There are also switching devices, reactive power control, monitoring, and control and communication devices. Therefore, the transmission networks customers are the larger generators, whose supply is transported through the system and the distribution lines and the large electricity customers such as large industries, e.g. dairy and steel industries, who consume largest amount of electricity.[9]

Given it is impossible to store electricity in traditional electricity systems, the system operator as a central control is in charge of constantly balancing supply and demand to ensure system stability and power quality. However, nowadays, due to the increasing use of distributed generation, imbalances and congestions may become more frequent at the distribution level and the management of these imbalances is becoming the responsibility of the distributor. Both transmission and distribution networks are natural monopolies because competition is neither sustainable nor desirable.[10]

Distribution lines take power at a limited number of points of connection within the transmission network and transport it and deliver it to a large number of geographically densely populated points in a given geographic region.[11] In consequence, distribution lines transport the energy to customers at a specific voltage level and are not

[8] Biggar and Hesamzadeh, above n 4, at 52.

[9] At 53.

[10] Biggar and Hesamzadeh, above n 4, at 53.

[11] Abdelhay A Sallam *Electric Distribution Systems* (IEEE Press, New Jersey, 2010) at 21.

used to dealing with generation of energy on the distribution side. Both transmission and distribution require continued investment to maintain reliability and quality of power.[12]

Consumer. The power is supplied to consumption points and the consumer pays an electricity bill for the power supplied, without interacting in any other way with the system. Dependant on the consumption level, they can be classified as large customers, e.g. industries, or end customers, e.g. households or small businesses. This distinction determines different services that one or another has access to. For instance, large customers are well integrated into the wholesale market, their production or consumption decisions are closely metered throughout the day being able to respond to the conditions of the market.[13] Unlike end or small customers who historically have being isolated from these conditions, as they do not receive price signals from the market and cannot adjust their consumption behaviour. The electricity consumed is measured by a manual meter that measures and records the energy consumption, and provides information to the system for planning, operation, and billing the consumer for the energy used.[14] Traditionally, the electromechanical or analogue meter is being used for these purposes, which is not highly accurate and the measurement requires manual or human reading (meter reader) which increases operational measuring costs for the electricity company.

Having explained the activities involved in the traditional electricity system, some questions remain. How are prices set? How are different actors involved in the process? Before answering these questions, it is important to recall that this research is focused on countries with liberalised electricity markets. In doing this, it is vital to explore the main characteristics of this model to be able to understand not only what the features of a liberalised industry are but also how liberalisation interacts with a traditional-centralised power system.

1.1.1 Traditional-Centralised and Liberalised Electricity Industry

Together with the four sectors (generation, transmission, distribution and consumption), which in an interconnected system makes it possible to generate and transport the energy that is produced by the generators to consumers, there are two other important activities that are required for the electricity supply in liberalised electricity sectors: the wholesale market and the retail market. To be able to understand the importance of these markets and the way they are arranged to fit the purposes of the traditional and centralised electricity system, we will explain what a liberalised electricity industry is and how its values contrast with other regulatory models.

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[12] Biggar and Hesamzadeh, above n 4, at 57; Sallam, above n 11, at 14.

[13] Biggar and Hesamzadeh, above n 4, at 66.

[14] F. D. Garcia, F. P. Marafão, W. A. d. Souza and L. C. P. d. Silva "Power Metering: History and Future Trends" (2017) IEEE. www.ieeexplore.ieee.org at 27.

Liberalisation, as an economic ideology, was initiated in Chile and Britain in the last decades of the twentieth century and spread worldwide.[15] It aims to integrate free market principles for a fully competitive industry, reducing the state involvement. Liberalisation has been applied to different economic sectors, such as, water, gas, telecommunication or electricity. For the electricity sector, liberalisation involves the participation of the public and private sector under equal terms, open competition to activities in the sector that are not considered natural monopolies. It also requires the unbundling of activities, the development of wholesale and retail markets and the role of an independent regulator in promoting competition and regulating natural monopolies. Liberalisation of the electricity industry contrasts with other economic processes which represent a different political and economic view regarding the best way to supply electricity to the consumers. These other models are public monopoly and public utilities. Before proceeding to explore the values of liberalisation in the electricity industry, it will be necessary first to briefly introduce such contrasting models, to better understand the implications of liberalisation in the industry as opposed to other models.

A **Public Monopoly or Traditional State Ownership** is based on the central role of the state to satisfy the public objectives and general wellbeing. Some of the reasons why a state decides to follow a public monopoly model may include national sovereignty or political convictions that locate the country in a socialist regime or central decision-making over economic development and industrialisation.[16] Other reasons, quite apart from the ideology, are historical reasons, in which the state was the first structure to manage the supply of public services. Public monopoly applied to the electricity industry implies the absence of free competition, the existence of a single buyer and vertical and horizontal integration of companies. The principal legal instruments underpinning this model are: public ownership of the utility companies; the possibility of private participation in activities not considered public services; planning and regulation within a single regulatory authority that controls the market and the existence of either one company or several public companies where natural monopoly predominates.[17] There are numerous historical examples of public electricity monopolies across the world. Some countries experienced public monopoly regimes at the beginning of the electricity industry, e.g. the United Kingdom[18] and

[15] Dieter Helm *Energy, the State, and the Market* (Oxford University Press, Oxford, 2004) at 15.

[16] Luis Ferney Moreno *Regulación del mercado de energía eléctrica en América Latina: la convergencia entre libre competencia e intervención estatal* (Universidad externado de Colombia, Bogotá, 2012) at 45. (Translation: *Regulation of the electricity market in Latin America: the convergence between free competition and state intervention*).

[17] Luis Ferney Moreno Castillo "Los modelos de regulación de electricidad en América Latina y en particular el modelo de Colombia" in Luis Ferney Moreno (ed) *Derecho de la Energía en America Latina Tomo I* (Universidad Externado de Colombia, Bogotá, 2017) at 24. (translation: Electricity regulation models in Latin America and in particular the Colombian model in *Energy Law in Latin America*).

[18] In the UK, for most of the post-war period and until the government of Margaret Thatcher, the British state ran the energy sector through integrated monopolies which were characterised for the creation of single companies to span industries and to be locked together through the planning

other European or Latin-American[19] countries. Other monopolies resulted from the arrival of socialist or communist regimes such as Venezuela or China.[20]

On the other hand, in the United States, traditionally the model of **Public Utilities** has developed most of the energy infrastructure and supplies energy around the country. It is a private monopoly, where utility companies agreed to supply all the customers within a territory and, in return, were granted an exclusive service territory earning a reasonable rate of return and income. Thus, the twentieth century was characterised by large vertically integrated utility companies which controlled the entire supply chain, with the state overseeing the activity through Public Utility Commissions (PUCs).[21] Over time, this model progressively changed, sometimes allowing a more active role by the state to oversee the activity and provide the service though public agencies.[22] Later, in the 1990s, competition was introduced to the sector.[23]

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processes. This monopoly and integrated structures facilitated both long-term contracts, energy assets and cross-subsidies needed at the time. The British state was responsible for building the main part of the infrastructure that later became part of the privatisation process in the late 1980s and 1990s. Most of the nuclear and coal power stations were built within this framework, as well as the electricity grid and the gas transmission and distribution networks. Tom McGovern and Tom McLean "The genesis of the electricity supply industry in Britain: A case study of NESCo from 1889 to 1914" (2017) 59 Business History 667 at 670; Markku Lehtonen and Sheridan Nye "History of electricity network control and distributed generation in the UK and Western Denmark" (2009) 37 Energy Policy 2338 at 2339. John Vickers and George Yarrow "The British Electricity Experiment" (1991) 6 Economic Policy 187 at 191. Steve Thomas "A perspective on the rise and fall of the energy regulator in Britain" (2016) 39 Utilities Policy 41 at 42.

[19] In Latin America some electricity industry infrastructure were built as the result of the spontaneous growth of private companies in the first third of the twentieth century. However, the state began to intervene in rate setting around this time and also by being in charge of electricity planning. Given the Latin American financial crisis in the 1930s and the start of World War II in Europe, both of which affected power companies' investment capacity, the state had to intervene directly, placing huge financial resources into the industry. However, some of the resources were provided by financial institutions, such as the World Bank, which later pressured governments to liberalise different sectors including electricity. Since the 1990s, countries in Latin America are divided between those that continue following the public monopoly model and those following liberalisation. Carlos Batlle, Luiz A Barroso and Ignacio J Pérez-Arriaga "The changing role of the state in the expansion of electricity supply in Latin America" (2010) 38 Energy Policy 7152 at 7153. Moreno, above 17, at 37.

[20] Two of the key features that characterise the electricity industry in China are planned economy and decentralisation with provincial governments in control of generation assets and provincial grids. China is one of the current examples of significant state involvement, not because it is an example of purely public ownership, but for being a planned economy, where a private investor can participate but closely follow state plans. Qiang Wang and Xi Chen "China's electricity market-oriented reform: From an absolute to a relative monopoly" (2002) 51 Energy Policy 143 at 145; Chung-Min Tsai "The Reform paradox and regulatory dilemma in China's electricity industry" (2011) 51 Asian Survey 520 at 525.

[21] Inara Scott "Dancing backward in high heels: examining and addressing the disparate regulatory treatment of energy efficiency and renewable resources" (2013) 43 Environmental Law 255 at 261.

[22] Michal C. Moore "The issue of governance and the role of the regulator: lessons from the California deregulation experiment" (2002) 2 Journal of Industry, Competition and Trade 75 at 83.

[23] Daniel Hagan, Jane Rueger and John Forbush "United States" in *Getting the Deal Through Electricity Regulation 2018* (16th ed, Law Business Research, London, 2017) at 229.

Having explored other economic models which contrast with liberalisation, we are going to introduce the key implications of it in the electricity sector when aiming to promote competition such as: unbundling, the role of the regulator and the introduction of the wholesale and retail markets.

Unbundling is the separation of activities in the supply chain, identifying those activities where it is possible to implement competition from those which are natural monopolies.[24] The concept of unbundling comes in opposition to models where a single entity is in charge of carrying out all the supply chain activities in a vertical and horizontal integration of companies. This is the case in either public or private monopolies within the electricity industry. Thus, the importance of unbundling of activities in the liberalisation process is to encourage competition wherever it is possible and avoid anti-competitive behaviours by maintaining an independent network. Unbundling and non-discriminatory access to the network determines access to customers at a retail level. Then, the idea of unbundling is to separate distribution of generation and supply services, to avoid conflicts of interest between the distribution system operator and the production and the supply side.

Role of regulator. In a liberalised industry, the primary role of the regulation is the promotion of competition, regulation of monopolies and correcting market failures and is intended to be light-handed. However, as a result of changing needs and the failures of competition and free market, such regulation has become stronger and more detailed, involving more state control and oversight.[25] The role of the regulator and the role of regulation will be further explored in Chap. 3.

Markets. One of the most important mechanisms that came with liberalisation, beyond unbundling the activities, was the creation of the 'pool' or the wholesale market and the retail market.[26] In the wholesale market, large amounts of energy are traded, with active participation by large-generators, purchasers/retailers and more passively, the transmission company. In this type of market, larger power generators and loads are typically well integrated. Generators are usually paid the wholesale price for the amount they produce by submitting bids and offers directly to the wholesale market and take instructions from the market about how much to produce. Large customers may participate in the market directly or through an intermediary while small customers are passive and unresponsive to wholesale market conditions. The design of the pool in the liberalised electricity sector will differ from place to place and will have different characteristics dependant on the country and what is expected to be valued by the market. Conversely, the retail market refers to the sale of electricity from the retail company to consumers. If this market is liberalised, the

[24] Barry Barton "Law and Regulation for Energy Networks in New Zealand" in Martha M. Roggenkamp and others (eds) *Energy Networks and the Law: Innovative Solutions in Changing Markets* (Oxford Scholarship, Oxford, 2012) 274 at 280.

[25] Barry Barton "The theoretical Context of Regulation" in Barry Barton and others (eds) *Regulating Energy and Natural Resources* (Oxford University Press, Oxford, 2006) 12 at 17.

[26] Biggar and Hesamzadeh, above n 4, at 66.

consumer has the right to choose their supplier based on the various deals or offers available in the market.[27]

According to the above explanation, we are able to state the essential characteristics of the traditional centralised electricity system in a context of liberalisation:

- Reliance on large generating units located far away from consumption areas;
- Top-down and unidirectional energy flow;
- Electricity transmission and distribution networks are natural monopolies;
- Transmission companies are in charge of balancing the system;
- The system is designed to meet the highest level of demand which means that the system requires investment in capacity. During non-peak times, the system is underutilised;
- Distribution companies are not used to dealing with generation;
- Storage of electricity is not possible;
- There is a separation of activities, mainly distribution from retail;
- Small consumers hold a passive role in the industry, only paying for the power, in contrast to large customers, who can more easily respond to conditions of the market and the grid.

These characteristics remained unchanged for a long time. However, currently, these features are being challenged by new technologies, business models and, most importantly, a more active role of consumers. As a result, a more dynamic and complex approach is underway, which defies the traditional technical, legal and market settings. The next section is going to introduce the new functionalities and opportunities that emerging technologies allow and in particular those empowering consumers.

1.2 What Could the Future Look Like?

Imagine a power system where the customers not only buy energy from the electricity company and pay their power bill but also self-generate energy at their own installations or within their neighbourhood. A system where the customer can consume the energy that they produce and sell it back into the power system or to their neighbours, friends and families. One where a group of people, maybe neighbours, pursue an energy project to supply power for their own community and may also trade energy with close by neighbourhoods. Imagine a system that allows a person to decide whether to wash clothing now or later because there are financial incentives to consume power at a specific time. Imagine a system that enables people to do all these transactions in a two-way flow of power and data and in an interactive and easy way. This system that we are describing is now becoming possible, thanks to existing and emerging technologies and business models that are working to further

[27] Markus Burger, Bernhard Graeber and Gero Schindlmayr *Managing Energy Risk: An Integrated View on Power and Other Energy Markets* (Wiley, Sussex, 2014) at 23.

empower the customer and invigorate the power system. It results in new questions being raised regarding the role of the market in integrating these initiatives, dealing with increasingly more complex relationships between industry actors, efficient and safe management over the network to ensure a quality service, and industry and regulatory standards over new players. Therefore, the role of law is to integrate those new solutions while ensuring that the system as a whole does not become impacted negatively by the new possibilities. Let us start with each of those functionalities and some emerging technologies that enable it to do so.

1.2.1 Distributed Generation

One can begin with the possibility of generating your own power. You may come across an advertisement: "It's your roof, your free solar energy. Harness what's yours." This is the slogan of a New Zealand solar company, Skysolar. The company offers a series of deals for residential or business customers who are interested in "powering your home with sunlight".[28] The customer can decide whether to depend 100% on solar energy and storage batteries or to stay connected to the network and use it when solar is not available and export the excess back to the network. This service does not sound like a traditional- centralised retail company which only sells power. This company is selling the means of generating and consuming your own energy. However, what is the main idea behind the business? What is the cost of such technologies? Who will be in charge of managing the impacts of increasing load on the distribution lines? What are the benefits on the industry and for the consumer? These are some of the questions we are going to explore in this section.

The power that is generated at the consumption point or near to it (as opposed to a traditional-centralised electricity system the generators are located far away from the consumption points), is called 'distributed generation'. It is also known in North America as 'dispersed generation' whilst in some parts of Asia and Europe it is known as 'decentralised generation'.[29] Some authors use the term 'distributed energy resources (DER)',[30] which include energy storage and responsive loads.[31] Regardless of the terminology used, the main idea is that instead of consumers passively receiving energy from the grid, they can now inject energy into the system on the distribution side[32] (as opposed to the traditional centralised system where the

[28] Skysolar "Residential Solar: Powering you home with sunlight" Skysolar. www.skysolar.co.nz.

[29] Nur Asyik Hidayatullah "Analysis of Distributed Generation Systems, Smart Grid Technologies and Future Motivators Influencing Change in the Electricity Sector" (2011) 2 Smart Grid and Renewable Energy 216 at 219.

[30] Ignacio Perez-Arriaga *From Distribution Networks to Smart Distribution Systems: Rethinking the Regulation of European Electricity DSOs* (European University Institute, Florence, 2013) at 3.

[31] JA Peças Lopes "Integrating distributed generation into electric power systems: A review of drivers, challenges and opportunities" (2007) 77 Electric Power Systems Research 1189 at 1189.

[32] W El Khattam and MM Salama "Distributed generation technologies, definitions and benefits" (2004) 71 Electric Power Systems Research 119 at 120.

injection of energy is only by large generators into the transmission grid) reducing the cost and dependency on transportation (mainly on the transmission grid).[33]

Different technologies are used for distributed generation. These include reciprocating engines with diesel or gas, gas turbines, micro-turbines, fuel cells, wind, thermal solar, small hydro, geothermal or ocean power in small-scale[34] and, of course, solar photovoltaic (solar PV). The technology involved in solar PV will be explained, as an example, to provide a better understanding of the implications of distributed generation.

Solar PV devices convert sunlight directly into electricity. They consist of two or more thin layers of semiconducting material, such as silicon. When this material is exposed to light, electrical charges are produced which later are conducted away by metal contacts as direct current (DC). The output from a single cell is small, so multiple cells need to be connected and encapsulated to form a module or panel. This is the reason why PV systems can be built in any size because more cells and more panels can be easily added to increase the energy output. Since its first mass production and commercialisation in 1963 by the Japanese company Sharp,[35] the price of buying a solar panel has dropped over time and more significantly since China started the large-scale manufacturing of PV panels.[36] According to data from the International Energy Agency,[37] distributed solar PV capacity is forecast to increase by over 250% during the 2019 to 2024, reaching 530 GW by 2024. Residential solar PV in 2018 was 58 GW and is expected to grow to 143 GW in 2024. Currently China is the largest growth market for solar PV, followed by the United States.[38]

There are two basic types of solar PV: the stand-alone and the grid-connected systems. A stand-alone system, as its name indicates, is able to be fully independent from the grid, a good option for off-grid areas. This kind of system usually consists of the PV module, batteries (to store surplus energy for later use), a charge controller and an inverter which converts the direct current (DC) generated by the PV to alternating current (AC) which is required by household appliances. In the case of grid-connected application, the solar PV is connected to the local network. In this system, when the energy is generated and is not self-consumed, theoretically it can be sold back to the power system. For instance, on weekdays, people are at work or school and therefore are consuming little energy at home. Compared to evenings when people are at home watching TV, washing clothes and have all the lights on. In this case, when the solar panel is generating energy during the day and the energy is not used,

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[33] Johann Hernandez, Francisco Santamaria and Cesar Trujillo "Impacts of regulation in the development of distributed generation" (2015) 28 The Electricity Journal 83 at 84.

[34] Pepermans and Haeseldonck, above n 2, at 791.

[35] Sharp "Sharp History". www.global.sharp.

[36] Soteris A Kalogirou *Solar Energy Engineering: Processes and Systems* (Elsevier, Oxford, 2009) at 10.

[37] IEA *Renewables 2019: Market analysis and forecast from 2019 to 2024* (IEA, Paris, 2019) at 22.

[38] At 23.