European Energy Studies

The European Energy Transition

Actors, Factors, Sectors

Edited by
Susanne Nies

Preface by
Jacques Delors

CLAEYS & CASTEELS
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The European Energy Transition: Actors, Factors, Sectors

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Susanne Nies

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Foreword by Jacques Delors

Founding President of the Jacques Delors Institute

Since 2008, national and European leaders have been dealing with crisis management on a daily basis. Their efforts have resulted in the Eurozone and the Schengen area being saved, and our Union strengthened.

Yet our Union must continue with its long-term objectives and promote positive messages, opening up new frontiers for European integration. We must work towards building a desirable future for all Europeans. As I often say, while Europe needs firefighters, it also needs architects.

If there is one project today which carries a positive vision for Europe, it is definitely the energy transition. Energy is the foundation of our nations' power and is a key element in our daily lives: to transport the food we eat, heat the buildings we live in, power our televisions, phones and computers. As we shape our energy model, we shape the future of our societies.

If Europe's architects are preparing a democratic, innovative, economically viable and socially fair Energy Union, it will contribute to a Europe that serves its citizens and paves the way for the rest of the world. If we fail in this project, the architects will have to give way to the firefighters, who will exhaust themselves putting out the fires caused by our past mistakes: climate refugees, dependence on Russia and Saudi Arabia, worsened energy poverty, the bankruptcy of energy suppliers who failed to adapt their strategy.

The Energy Union, which we have been championing since 2010,[1] was started by President Juncker. It is an ambitious project which can already be bolstered by the successes achieved by the European Union.

Back in 2005, the Hampton Court Summit was the meeting during which our energy-climate targets emerged. It led to the articulation of three target-goals: to reduce EU greenhouse gas emissions, to develop renewable energy sources, and to improve energy efficiency. The European Union is now broadly on track to meet its 2020 energy-climate targets.

The European Union now has the framework for the 2020 decade, with the 'Clean Energy for all Europeans' Package that has just been adopted. This package builds on past successes and significantly increases the European ambition to improve energy efficiency and develop more renewables in the 2020 decade.

As an architect needs to have an idea of how a house is going to look like in the end, the EU now has a clear objective for its Energy Union. The Paris Agreement, reaffirmed at COP24, is itself a European success, building on decades of continuous efforts to reach a global agreement to ensure the best chance that mankind avoids catastrophic climate change. We can now turn to the future with a clear purpose: net-zero emissions, a world where human activities will not emit a gram of $C0_2$ more than they can capture. This objective embedded into the Paris Agreement is now the objective of the European Union, with the European Commission asking the EU to reach carbon-neutrality by 2050, while several Member States have already set their own national targets to reach carbon neutrality by 2045 (*e.g.* Sweden, Finland) or by 2050 (*e.g.* France).

Those targets are necessary to provide certainty to all citizens, workers and businesses. But targets themselves will not perform the radical transformation of our way of life that we ought to perform.

Europe's strength in the energy transition lies in the drive of millions of citizens, consumers, local elected representatives, researchers, innovators, entrepreneurs and workers, who make the energy transition a reality. Our mayors show everyday how the energy transition improves people's life, as it reduces air pollution,

1 Delors Jacques, Buzek Jerzy, "Towards a new European Energy Community", Tribune, Jacques Delors Institute, 9 May 2010; Andoura Sami, Hancher Leigh, Van der Woude Marc, "Towards a European Energy Community: a policy proposal", Studies & Reports No.67, Jacques Delors Institute, March 2010; Andoura Sami, Vinois Jean-Arnold, "From the European Energy Community to the Energy Union", Studies & Reports No.107, Jacques Delors Institute, January 2015; Pellerin-Carlin Thomas, Vinois Jean-Arnold, Rubio Eulalia and Fernandes Sofia, "Making the Energy Transition a European Success", Report No. 114, Jacques Delors Institute, June 2017.

traffic problems and stamps out energy poverty. Our wind power and energy efficiency companies are already the world leaders, providing jobs to thousands. We are already designing and manufacturing the clean energy solutions of today and tomorrow.

Europe has all the assets to succeed in its energy transition. We are the first in the world to have launched it and have paved the way for other global powers, such as China, to commit through the Paris Agreement. The US withdrawal from this Agreement further strengthens European leadership and enables us to attract innovators and investors who understand the opportunity created by the energy transition.

We have made great strides forward but there is still a great amount of potential. We must now leverage, increase and achieve it, to serve a long-term positive vision. Such vision was clearly defined by the European Commission in its Communication dated 25 February 2015 and confirmed at the highest level, by the commitment of all EU Member States to the Paris Agreement. This positive vision of our energy future has received widespread acclaim from citizens who support the fight against climate change by means of a European energy policy based on energy solidarity, energy efficiency, and renewables. I wish this element to be one of the defining topics of the European Parliament elections of 23-26 May 2019.

EU citizens, and the policy makers they will pick to lead the European Union for the next five years, need sound analysis of the stakes of the energy transition, and policy recommendations to make the energy transition a European success. This is what this book is about.

With the clean energy for all Europeans Package now adopted, we wish our national and European leaders to further understand the strategic importance of the Energy Union for our Europe, our nations and our way of life. The European elections and its aftermath are the opportunity to pave the way for the decisions that make the common aspirations of European citizens a reality: a socially-fair energy transition, guided by a European energy policy for all 27 Member States, based on energy efficiency and renewables, able to provide clean, safe and affordable energy to all Europeans. A lack of progress in achieving the Energy Union would cost citizens dearly and be detrimental to our ideal of a Europe which is democratic, prosperous, socially-fair and united in diversity.

PART 1 – SETTING THE SCENE: CLIMATE, SECURITY OF SUPPLY AND COMPETITIVENESS – INSEPARABLE

CHAPTER 3

EU CLIMATE POLICY AS A DRIVER OF CHANGE

Jos Delbeke & Peter Vis

1. Introduction

The scientific imperative to address climate change is taken as accepted. The Paris Agreement succeeded in acknowledging universal recognition of the problem and the need for action by (almost) all countries, developed as well as developing ones. The question for policymakers has been and remains, what policies will get us to where we need to be while maintaining jobs and growth?

For the past 25 years the EU has been progressively building a toolbox of European policies to address climate change. To do this there needed to be accurate emissions data, excellent economic analysis, and the ability to learn through experience, adjusting existing policies if needed and establishing new policies when necessary. Learning-by-doing has been essential. The result since 1990 has been a reduction of emissions by 22% to 2016 and a clear decoupling of greenhouse emissions from economic growth in the European Union.

CHAPTER 4

SECURITY OF SUPPLY: A NEW FOCUS ON ELECTRICITY

Susanne Nies

1. Risks are changing

Security of energy supply was seen in the 1970s as related to oil, then, in Europe, to gas, and today it centers around electricity. The increasing attention for electricity security is resulting from the shift from primary fuels to power, to the increasing electricity consumption, as well as to the rising complexity of a power system built upon variable renewables and the rise of an 'internet of energy things'.[1]At once oil- and gas supply challenges remain and deserve continued attention. Different from the 'traditional', largely import related risks in primary fuels, the ones in the fast changing and regionalizing electricity system are yet subject to discovery and the formulation of appropriate responses.

Marc Elsberg describes in his bestseller 'Blackout' how a terrorist group hacks into the European power system through the Italian smart meter, and takes it down.[2] Electricity, that replaces primary fuels in a number of areas – cooling, transport and partly heating – and the consumption of which increases naturally with the rise of the digital society is more a service then a good, and is indispensable to everyone. The new 'central fuel' electricity is exposed to a variety of risks, that are presented in this contribution together with the risks on oil and gas.

1 *See* the chapter by Laurent Schmitt, Susanne Nies in this book.
2 Marc Elsberg Blackout, first German edition 2012.

The EU imports 54% of all its energy. Oil is imported to 90%, natural gas to 69%, coal and other solids to 42%, and uranium and other nuclear fuels to 40%. The cost of importing energy accounts for roundabout 1 billion Euros every day and represents one fifth of Europe's overall imports. However, let us state clearly here that autarky can't be an objective in a globalized world, and that trade- and physical links contribute in a paramount way to improving and maintaining links between nations.

The European Union's 28 Total Primary Energy Demand[3] corresponded in 2016 to 1965 Mtoe.[4] This number equals 14,28% of the global primary energy demand. Power generation uses about 42% of the total primary energy. In 2016 the EU has produced a total of 4.080 TWh and will see its production further increase in the forthcoming years. This trend is confirmed by all IEA scenarios. The most remarkable increase however can be spotted in the IEAs so called Current policies scenario, and that reflects the implementation of existing regulation: power generation will reach here 4468 TWh in 2025, 4662 in 2030 and a spectacular 5082 TWh in 2040.[5] At once, and due to the Renewables deployment, capacity will further increase from 2016 total installed capacity of 1262 GW to 1401 in 2025 already. If one would try to translate this into the number of onshore windmills and an assumed capacity for each of 8 MW (meaning 0,008 GW), or into PV panels on household level with each a capacity of 265 Watts[6] (meaning 0,265 KW= 0,000265 MW or 0,000000265 GW) the scale of the many decentralized installations becomes obvious: the previous big blocks, like nuclear with 600 MW per block, gas or coal with similar capacity are increasingly replaced by a huge number of largely privately owned generators, as the greenfield table below illustrates:

3 TPED represents domestic demand and is broken down into power generation, other energy sector and total final consumption ; IEA World Energy Outlook 2017 :747.

4 Mtoe-million tons of oil equivalent ; source IEA World Energy Outlook 2017 :66 !

5 IEA World Energy Outlook 2017 :671.

6 The capacity for a solar panel of 65x39 inches. Also note that the same panel would have had a capacity of only 20 in the 1950s. Source https://solarpowerrocks.com/solar-basics/how-much-electricity-does-a-solar-panel-produce/.

CHAPTER 5

THE DISTRIBUTIONAL EFFECTS OF CLIMATE POLICIES

Gustav Fredriksson & Georg Zachmann

1. Introduction[1]

In order to avoid potentially disastrous consequences of climate change, greenhouse gas emissions need to be reduced drastically in the coming decades. To achieve this objective, a suite of intrusive polices is needed, most notably putting a meaningful price on emissions but also engendering public support for the deployment of low-carbon technologies and bans on inefficient technologies.

Consequently, climate policies will play a substantial role in this deep transformation. Given the challenge, policies need to be quite intrusive. Such intrusive policies are likely to have substantial side-effects. One important aspect is distributional effects. Depending on the general policy tool, the addressed sector and the design of the concrete policy, individual climate policy measures can have very different distributional effects.

To combat increasing inequality and improve the political acceptability of decarbonisation, the distributional effects of climate policies need to be addressed. Should this not occur, there is a real possibility that decarbonisation policies will face a political backlash.

The chapter is structured as follows. First, we describe how households and individuals of different income levels are impacted by climate policies. Second, we discuss the distributional effects of individual climate policies. Third, we il-

1 The research underpinning this chapter has been kindly funded by Cariplo foundation.

CHAPTER 9

THE EU, THE UK AND ENERGY: NOT MUCH SHARED AMBITION POST-BREXIT

Sir Philip Lowe

1. Continuing uncertainty over future UK-EU relations…

At the time of writing this article, the UK House of Commons had yet to vote on the draft UK-EU agreement on UK withdrawal from the EU and the framework for future UK-EU relations. At that time there was therefore still considerable uncertainty over the framework for future EU-UK trade, in particular whether the UK would remain, in the short or longer term, within the EU customs union and whether it would continue to participate in some way or another in the EU single market for goods.

The terms of the Political Declaration on future UK-EU relations which has now been agreed between the UK Government and the EU may be reinforced or weakened by the outcome of the current political debate in the UK.

2. … but so far a consensus that Brexit will only have a limited impact at least in the short term

Most commentators have so far concluded nonetheless that the impact of Brexit in the energy sector will be relatively limited in the short term, even if there were some hard choices to make in the longer term.[1] After all, UK and EU energy and

1 'The Impact of Brexit on the EU Energy System'. Study for the ITRE Committee of the European Parliament, Bruegel, 2017. 'Energy and Climate Policy after BREXIT'. Professor Dieter Helm. Energy Futures Network: Paper 21. 'Brexit and Energy: Time to make some hard choices'. Philip Lowe. Centre for European Reform. September 2017. 'Impact of Brexit on the energy sector'. Norton Rose Fulbright. July 2018.

CHAPTER 10

REGIONALISATION AND REGIONAL COOPERATION IN THE EUROPEAN ELECTRICITY MARKETS

Klaus-Dieter Borchardt & Maria Eugenia Leoz Martin-Casallo

1. Introduction

The Treaty on the Functioning of the European Union defines that Union policy on energy shall aim to ensure, in a spirit of solidarity between Member States, the functioning of the internal market and security of energy supply, aim to promote energy efficiency and energy savings, the development of new and renewable energy sources as well as promote the interconnection of energy networks.[1]

Regional cooperation and regionalisation are increasingly being relied upon to advance the EU's energy policy objectives. The main advantage of the regional approach is that it can lead to faster results and is better suited to address issues that arise in a specific regional context.[2]

What is regional cooperation? And regionalisation? **Regional cooperation** is a voluntary and bottom-up approach to several aspects of transmission and cross-border trade of electricity. Regional cooperation has taken place in a wide range of areas, *e.g.* day-ahead flow-based market coupling, regional security coordination initiatives, balancing projects. By contrast, **regionalisation** is a top-down approach generally used by the Commission and the European legislator to translate voluntary regional cooperation initiatives into a mandatory

1 Article 194 TFEU.

2 For the purposes of this paper, the term 'region' is to be understood at at macro-level, comprising two or more Member States.

CHAPTER 12

THE ENTSO-E EXPERIENCE

Konstantin Staschus

1. Rationale for TSO cooperation

1.1 Advantages of interconnection

The advantages of interconnection between areas hundreds of km apart have been clear to electricity system planners since 100 years ago. They have been pursued systematically and in cooperation across country borders even more after World War II:

– *Trading benefits due to daily or seasonal patterns of availability of resources – back then particularly of Alpine hydro power:* exporting hydro surpluses during runoff season and importing thermal power to hydro regions in winter saves both regions money.

– *Reliability benefits:* The cost of reliable supply goes down in larger interconnected systems, as the larger number of generators of cost-effective size implies a lower probability of simultaneous forced outages of a given percentage, and thus a need for less percentage reserves to achieve a given reliability level.

When the 1980s brought combined cycle gas turbines (CCGT) of an efficient size much smaller than many internally well connected electricity markets, competition in generation and supply became economically advantageous. This added a third advantage to interconnection:

– *Competition benefits:* Small markets might have difficulties even with CCGT power plants to make an effective switch from the prior monopoly structure to competition in generation. But with more interconnection, the effective market size becomes bigger, more generation companies can offer reliable supply to the country's customers, and different countries' generation companies can begin to compete with each other. Functioning competition is to lower cost and allow for better service for customers than in the monopoly case and all other things being equal.

With the onset of the energy transition and introduction of variable renewable energy sources (RES) since the early 2000s, a fourth advantage to interconnection started manifesting itself:

– *Extracting more value from wind and solar generation:* With strong interconnections, regional surplus renewable energy does not need to be curtailed at zero value, but can be transported to other parts of Europe where their value at the same time is higher (because the weather or the resource mix there are different).

1.2 European TSO associations: Already a technical success story 1951-2009

Interconnection needs to be managed cooperatively between the involved transmission system operators (TSOs), for ensuring adequate balance of resources, loads and transmission, for secure system operations rules, and for trading and market rules. TSO associations have been the focus and foundation of such cooperation and rulemaking since 1951, when the UCPTE was founded. For the decades until the late 1990s, these associations covered primarily system operations, adequacy and statistics, as the need for operational cooperation was especially clear for a synchronous interconnection where disturbances can spread in milli-seconds into a wide blackout if fast-acting reserves are insufficient or poorly managed). These associations' rules remained voluntary and beginning on 1 July 2005 contractual among the TSOs until electricity market liberalization.

In line with the appearance of the third reason for interconnections, *i.e.* competition benefits, TSO cooperation on market rules was added in 1999 with a parallel EU-wide association ETSO, in close cooperation with the European Commission and national regulatory agencies. Also in 1999, UCPTE changed its statutes and became UCTE since due to market liberalisation and unbundling, there was no longer any coordination of production of electricity. ETSO was first a cooperation of the four synchronous areas' TSO associations UCTE,

CHAPTER 14

THE ENERGY COMMUNITY – READY FOR THE CLEAN ENERGY TRANSITION?

Dirk Buschle

1. The Energy Community – mission accomplished?

The Energy Community's mission has evolved since the time when its founding document, the so-called Athens Treaty of 2005,[1] was drafted and signed. Its objectives were multi-fold from the beginning and broadly correspond to European energy policy's famous trilemma – market opening and integration, security of supply and sustainability. This is not surprising given that the Energy Community was designed to export European policy and law to a number of non-EU countries (at the time all located in South East Europe). As the Energy Community operates in the context of enlargement and external energy policy, promoting these objectives is not entirely altruistic but (also) in the self-interest of the European Union. The motivations driving the European Union to engage in the process, and ultimately to sign up to the Energy Community Treaty as a Party, can be seen through the lenses of two different policies, enlargement preparation and external energy relations.

In the following, we will assess to what extent the Energy Community's objectives have been accomplished some 13 years later. We will look at that from both the (non-EU) Contracting Parties' perspective and the European Union's. From the perspective of the Contracting Parties, the process of achieving the Energy Community's objective by implementing the *acquis communautaire* may be referred to as the Energy Community's first energy transition, as opposed to the

1 The negotiations for the agreement on establishing the Energy Community for South Eastern Europe began in May 2004. On 25 October 2005, the Treaty establishing the Energy Community was signed in Athens. It entered into force a good six months later, on 1 July 2006.

CHAPTER 20

RUSSIA – EU RELATIONS AND THE ENERGY TRANSITION

Kirsten Westphal

1. Introduction

Energy Relations between the Russian Federation and the EU are based on hydrocarbons. However, at the same time both have committed themselves under the Paris Agreement to address climate change. European Member States and Russia/ the Soviet Union have a long-standing energy relationship which originated in the 1950s for oil deliveries and for natural gas supplies in the 1970s.

The official energy dialogue between the Russian Federation and the EU was inaugurated in 2000. Since then, EU-Russian energy relations have experienced ups and downs till today. Natural gas trade has received most of attention because of its historical relevance as part of the rapprochement and détente during the Cold War, diverging historical experiences in Eastern and Western member states and the Russian-Ukrainian gas crises. Since the annexation of Crimea in 2014 and the ongoing fights in Eastern Ukraine, the geopolitical dimension of natural gas trade and pipelines has been predominant in the relationship.

This chapter aims at looking into EU-Russian energy relations between 2000 and 2018. It starts with figures and facts about the development of Russian hydrocarbon imports to the EU. In a second step, it takes a historical retrospective. Whilst it is evident that Russia's aggression against Ukraine and the consequential security crises in Europe has been a caesura in EU-Russian (energy) relations, the energy transition itself will also be impacting on the trade relations dominated by hydrocarbons.

PART 5 – INNOVATION AND NEW PLAYERS IN THE ENERGY TRANSITION

CHAPTER 22

COMMUNICATING THE ENERGY TRANSITION

Claire Camus

The energy sector has drastically changed over the last decades and the transformation has just about started. From an analogue, centralised, monopolistic, unidirectional to a digital, decentralised, competitive and multidirectional world. How did this transformation impact communication and branding in the energy sector? Has the change in communication and branding reached all parts of the energy sector or only those open to competition? What are the most disruptive factors to date and what could the future be like for communication professionals in the energy sector.

The following chapter is an introduction on how the communication and branding in the electricity sector have been tipped off their axis. Three main factors are pointed out (liberalisation, energy transition and digitisation) and a special focus is given to the case of transmission system operators (TSOs).

Some examples will be given of how companies but also associations have adapted their communication and brand to the new context.

1. Definitions

Communication encompasses many different fields: strategic positioning and branding, definition of audience types, of messaging and of dissemination channels. It covers customer relations, crisis communication, promotion, corporate communication, etc. Communication cannot indeed be limited to information

CHAPTER 23

DIGITAL ENERGY

Jesse Scott[1]

Of the three great revolutions that the European energy system is experiencing – market liberalisation, decarbonisation, and digitalisation[2] – the digital revolution relies the least on policy to drive it forward. Market liberalisation and harmonisation are positive political choices; decarbonisation is essential but will only happen at sufficient pace if motivated and shaped by policy. In contrast, digitalisation is an exogenous force for change throughout the wider economy: it flows from technological innovation and the economic decisions of diverse actors working both inside and outside the energy sector.

This chapter will argue first that digital energy is becoming a fact of life. This has profound implications for the future of the energy system, many of which are not yet well recognised. The chapter will argue second that although digitalisation is not primarily policy-driven, it can nonetheless be a powerful tool to help achieve EU energy policy goals, in particular the transition to deep decarbonisation.

The International Energy Agency (IEA) notes that digital technologies 'can be a means to help achieve a variety of energy policy objectives', with benefits including 'increased productivity and efficiency, improved safety, enhanced revenue collection, and accelerating the pace of innovation.'[3] At the same time, digital

1 This chapter benefits greatly from research and ideas developed together with colleagues for the International Energy Agency report Digitalisation & Energy, November 2017, https://www.iea.org/digital/, and for the Council on Foreign Relations report Digital Decarbonization, June 2018, https://www.cfr.org/report/digital-decarbonization.

2 Jorge Vasconcelos, The energy transition from the European perspective, in Vicente López-Ibot Mayor (ed), 2017, Clean energy law and regulation, Wildy, Simmonds & Hill Publishing.

3 IEA, 2017.

energy introduces important challenges and large uncertainties. These can impact the objectives of security of supply, affordability and sustainability: as elsewhere in the world, European energy policy-makers need to seek to understand and guide digitalisation.

The chapter concludes with some recommendations. It should be read together with other chapters in this book on prosumers, cybersecurity, grids, disruptive innovations, decentralised energy resources and new business models.

1. What is digital energy?

Digitalisation is the application of powerful information and communications technologies (ICT) in equipment, analytics and user interfaces.[4] Examples of digital technologies in today's energy systems include smart meters, networked sensors on grids, drones (robotics), and "digital twins" – a digital simulation of a real-life asset to enable the virtual testing of features, feasibility and durability. Older digital technologies have long been used in energy, for example in oil and gas exploration and in 1970s mainframe computers in powerplant control rooms.

Over the last decade digitalisation has accelerated into a "digital transformation" that is changing many aspects of how society, government and business function. The Going Digital project of the Organisation for Economic Co-operation and Development (OECD) is tracking this process and its drivers. Key features are the rapid fall in ICT unit costs and exponential increases in computing power and digital connectivity that have enabled the creation of new platforms for communications and market transactions, the near real-time measurement and management of equipment, and massive unprecedented data collection. Advanced analytics such as machine learning (artificial intelligence) are bringing new opportunities to better understand complex multi-source datasets and to introduce automation, for example self-driving vehicles.[5] Blockchain (distributed ledgers) are facilitating peer-to-peer exchanges which cut out intermediaries. Digital energy is one part of this mega-trend.

4 *See* for further definitions: Gartner, OECD etc. Digitization has a narrower meaning and refers to the process of converting information into a digital format (organised in bits) for data processing, storage and transmission.

5 *See* OECD http://www.oecd.org/going-digital/

CHAPTER 27

HOW INNOVATION CAN ACCELERATE THE ENERGY TRANSITION: LESSONS LEARNT AT KIC INNOENERGY

Pierre Serkine & Diego Pavia

The energy transition supported by the Member States, the European Parliament, and the European Commission, notably with the Energy Union launched in February 2015, is an opportunity to boost the European economy, creating jobs and growth, while showing effective European leadership in implementing the planet commitments coming out of COP21. For the ambition of having a low carbon economy by the end of the century, it is necessary to understand the vital role innovation has to play in the Energy transition, and how the European Union is addressing it. The first clear signal was sent when publishing the architecture of the "Clean Energy for All Europeans Package – 2016", which identified **research and innovation** at the same level as the upcoming new regulation and directives on renewables, security, energy efficiency and market design.

Already then KIC InnoEnergy was formally identified as one of the key players in the research, innovation and competitiveness dimension. This chapter intends to share the **lessons learnt** from the first 8 years of achievements of the Knowledge and Innovation Community dedicated to Energy, aka KIC InnoEnergy, which can be relevant elements to be considered in the current negotiations on the 2021-2027 EU budget and on its Energy and Research & Innovation dimensions (Horizon Europe).

CHAPTER 28

MANAGING THE NEW REALITIES OF DECENTRALISED ENERGY RESOURCES

Frauke Thies

When Europe started decarbonising its energy sector in the 1990s and early 2000s, political actors were focussed on driving technology for emissions reductions. Shifting to less carbon-intensive fuels, developing renewable energy solutions and increasing energy efficiency were at the centre of attention. Now that renewable energy has become mainstream, digitalisation is enabling the flexible management of millions of industrial sites, homes, appliances and devices, storage technology is maturing, and electric vehicles are about to break through on the European market, it has become clearer than ever that the energy transition is about more than a change in technology. The rise of largely decentralised resources and smart management opportunities have led to a rapid evolution in the prevalent roles and actors, business models and forms of interaction in the energy system.

Consumers are evolving into generators and flexibility providers, and individuals, cooperatives, large energy users, and pension funds may now invest in owning their own energy asset. Several traditional energy companies, who previously managed portfolios of largely conventional power generation, are selling off their power plants and investing in decentralised solutions management and customer services. New market entrants, such as independent aggregators, are firmly establishing themselves as important players, specialising in the identification and pooling of on-site generation and flexibility resources, while helping their customers at industrial, commercial, and residential levels to monetise their flexibility potentials. IT companies, telecommunications and web-service providers are also entering into the energy domain, both by offering direct customer solutions and through platform services for energy businesses. Last but

not least, the electrification of heating and transport is also leading manufacturers of automotive and heating equipment to explore integrated energy solutions and new customer services.

Most of the new actors and business models are characterised by the smart operation, management, and bundling of variable and dispatchable generation, demand response, and storage. In doing so, these upcoming market participants react to different signals and pursue different revenue streams.

1. The imperative of smart energy management

From a systems perspective, these new technologies, services and business models are particularly interesting, because they respond to the opportunities and challenges of decentralisation and variability of power supplies, brought about by the energy transition.

Various studies have demonstrated that system volatility is going to increase in Europe, with both times of limited electricity generation when renewable energy output is low, and times at which power generation from low-marginal cost resources like wind and solar exceeds regular demand. At the same time, within less than 25 years, hourly ramp rates for flexible backup resources – *i.e.* the rates at which generators need to change their output to keep the system in balance - are expected to double in the UK or even triple in a country like Germany, compared to today's situation.[1]

Without sufficient incentives to react to the electricity system's flexibility needs, the ongoing electrification of transport and heating could exacerbate the challenges even further. Electric vehicles, for example, are expected to reach 14% of all new car sales in Europe by 2025, growing to more than half of new sales in 2040.[2] If electric vehicles were primarily charged at home at the end of the working day during the current evening consumption peak, and assuming that an electric vehicle increases a home's electricity use by an approximate 80%, it is clear that this would add an enormous amount of strain to the electricity system at a local and wholesale level.[3] On the other hand, the charging of vehicles has

1 *See e.g.* Bloomberg New Energy Finance, Beyond the Tipping Point: Flexibility Needs in Europe, 2017, www.eaton.com/tippingpoints

2 Bloomberg New Energy Finance, Long term electric vehicle outlook 2018, 2017, https://about.bnef.com/electric-vehicle-outlook/

3 This is based on the assumption that an average household without electric vehicle consumes 10kWh per day and adds the charging of an electric vehicle to drive a daily distance of 40km using 8kWh.

CHAPTER 30

TRAINING FOR THE ENERGY TRANSITION: COMMUNITY LEARNING AT FLORENCE SCHOOL OF REGULATION

Leonardo Meeus & Jean-Michel Glachant

In this chapter, we illustrate how training at Florence School of Regulation evolved together with the energy transition. We first discuss the training challenges that emerged during the energy transition in Europe (section 1). We then describe the different training formats that have been developed in the School to address these challenges (section 2). We finally focus on the importance of training partnerships at Florence School of Regulation (section 3).

1. Training challenges

In this section, we discuss the three training challenges that gradually emerged during the transition. In the first phase, the main challenge was to work in multi-disciplinary teams with engineers, economists, and lawyers. In the second phase, new entrants and consumers became more important. These phases have not yet been fully completed, but a third phase is already accelerating. In this third phase, the borders between the energy sector and other sectors are fading.

1.1 Multi-disciplinary engineers, economists, and lawyers

In the first phase of the energy transition in Europe, the vertically integrated companies were broken up into pieces to separate the monopolistic transmission and distribution network activities from the competitive production, trading, and supply activities. Different players emerged for each of these roles. Initially, most of the debate was on who is responsible for what, and on how to organize competition at the national and European level.

PART 6 – FACTS, MAPS AND SCENARIOS

CHAPTER 31

FACTS AND STATISTICS ON THE ENERGY TRANSITION[1]

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Tom Howes

1. Historical picture of the energy sector in the EU

Whilst there have been some major changes and transformations of different sectors in economies around the world over the last decades, the transformation that has begun in the EU energy sector is one of the most significant and far reaching.

The EU energy sector has by tradition consisted of publicly owned monopolies managing each countries national energy resources, predominantly coal, and striving to provide access to sufficient levels of energy to provide the fuel needed for economic growth.

Given the critical nature of energy as fundamental for both the daily existence of citizens and of all industry, primacy was given by governments and their voters, to provide affordable and reliable energy. This chapter outlines with statistical evidence the transitions occurring: (1) market liberalisation and the creation of the single market/coupled markets; (2) the transition in the energy mix to become sustainable, as well as affordable and secure energy; including the particular transformation in the electricity sector.

1 All data is from Eurostat unless otherwise stated. (https://publications.europa.eu/en/publication-detail/-/publication/99fc30eb-c06d-11e8-9893-01aa75ed71a1/language-en).

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Prof. Dr. Klaus-Dieter Borchardt holds a law degree from the University of Hamburg (1974-1979) and a PhD from the Free University of Berlin (1985). Since 1987 Mr Borchardt is a Civil servant at the European Commission where he served in different Directorates General ("Employment, Social Affairs and Education", Legal Service, Agriculture and Rural Development) and as first Deputy and then Head of Cabinet of Commissioner Mariann Fischer Boel (Agriculture and Rural Development). Mr Borchardt also worked as a Member of the Cabinet of the German Judge at the European Court of Justice in Luxemburg. Since 1 April 2013 he is working in the Commissions Directorate-General for Energy, first as Director responsible for the Internal Energy Market and since 1 January 2019 as Deputy Director General. Mr Borchardt is Teaching Professor at the Faculty of Law at the Julius-Maximilians-University in Würzburg since 2001.

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As the previous Chief Digital Officer of Enedis, also in charge of Europe and International Development, he drove during three years the digital and big data transformation of the company, with the goal of bringing it at the forefront of digital in the electricity distribution sector in France and Europe and to offer a better public service. He is also Chairman of EDSO for Smart grids, the European association representing leading electricity distribution system companies that are cooperating to make the European smart grid vision a reality.

Prior to this, Christian Buchel held various top-management positions within the EDF Group. He was notably a Member of the Board and COO of Energie Baden-Württemberg (EnBW) in Germany as well as CEO of Electricité de Strasbourg. In the late 1990s, Christian Buchel also served as an advisor to EDF's CEO. During his early career, he held both managerial and operational responsibilities, covering the entire value chain of the electricity industry.

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Claire Camus is a Belgian national who has studied and worked in the United States, the United Kingdom and Slovenia. She graduated in Political Science with a specialization in International Relations before spending all her career in communication. Firstly, in a diplomatic representation, moving on to the European financial services before entering for the last ten years the world of energy. Claire worked as Communication Advisor in a national regulator before joining ACER and being the first Press and Communication Officer of the newly created European Agency. She then started working for ENTSO-E since 2014 and is now heading the communication team.

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