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Smart grids in the European Union: Assessing energy security, regulation & social and ethical considerations

Rafael Leal-Arcas
Feja Lasniewska
Filippos Proedrou

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By

Rafael Leal-Arcas,* Feja Lasniewska♣ **and Filippos Proedrou**♦

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Abstract

The purpose of this article is to provide an analysis of smart grids in the European Union (EU) as a way forward to reach sustainable energy. It does so by assessing the energy security, regulatory, and social and ethical aspects of smart grids in the EU. The article represents a significant milestone in the upscaling of the various aspects of smart grid technology across the EU. It deals with smart grid deployment and their impact on energy security with a view to a stronger role of prosumers in the energy market. It also analyses smart grid regulation. Specifically, it examines the existing legal frameworks that impact smart grids in the EU. It outlines existing EU Directives and assesses the level of implementation of these Directives in various EU Member States. This article also assesses the extent to which the existing legal frameworks facilitate the development of smart grids and proposes areas of further regulatory consideration. The article then explores the social and ethical dimension of smart grids in the context of the collaborative economy, the circular economy, and digital technology, including cybersecurity and data-management issues.

Keywords: smart grids; prosumers; sustainability; energy security; demand response; electricity storage; collaborative economy; circular economy; cybersecurity; data protection

* Jean Monnet Chaired Professor in EU International Economic Law and Professor of Law, Queen Mary University of London (Centre for Commercial Law Studies); Visiting Scholar, Masdar Institute of Science and Technology, United Arab Emirates; Member, Madrid Bar. Ph.D., European University Institute; J.S.M., Stanford Law School; LL.M., Columbia Law School; M.Phil., London School of Economics and Political Science; J.D., Granada University; B.A., Granada University. Some of the ideas in this Article were presented at two roundtables: "The 35th Round Table on Sustainable Development," OECD Headquarters, Paris, France, 28-29 June 2017 and "The Future of International Energy Governance," Vanderbilt University Law School, Nashville, Tennessee, USA, 28-29 April 2017. I have also benefited from discussions with colleagues at the 2nd Yale Sustainability Leadership Forum, which took place in September 2017 at Yale University. The financial help from two EU grants is greatly acknowledged: Jean Monnet Chair in EU International Economic Law (project number 575061-EPP-1-2016-1-UK-EPPJMO-CHAIR) and the WiseGRID project (number 731205), funded by Horizon 2020. I am grateful to Nelson Akondo, Juan Alemany Rios, Eduardo Alvarez Armas, and Alessandra Solazzo for research assistance.

♣ Teaching Fellow, School of Oriental and African Studies, University of London, Queen Mary Uni of London, UK. PhD., SOAS, University of London; M.A., International and Comparative Legal Studies, SOAS, University of London; M.Sc., Human Ecology, University of Edinburgh; M.A., (Hons) Economic and Social History, University of Edinburgh.

♦ Research Fellow in Social Policy (International Affairs), University of South Wales; Ph.D., Democritus University of Thrace; M.A., University of Warwick; B.A., Aristotle University of Thessaloniki. Research assistance of Bernardo Rangoni is acknowledged.

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1 INTRODUCTION

The 20th century was characterized by a top-down approach to the governance of climate change mitigation and energy. The 21st century, however, offers a bottom-up approach.[1] One of the mega-trends of the 21st century is the shift to this bottom-up approach in the democratic[2] implementation of climate change mitigation plans[3]—a creation of the Paris Agreement on Climate Change,[4] which has become the locomotive of climate action. The same is true in energy governance, where we are witnessing an energy democratization in the decentralization of energy security governance and creation of new actors such as prosumers.[5] This article aims to explain why we are witnessing a paradigm shift in the governance of international economic law, broadly defined, and how citizens can play a greater role to make this transition more solid.[6] In other words, we seek to explain the shift from the core (i.e., centralized approaches to governance) to the crowd (i.e., decentralized, self-organizing approaches to governance).[7]

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[1] See generally Leal-Arcas, R. "Sustainability, common concern and public goods," *The George Washington International Law Review*, Vol. 49, Issue 4, 2017.

[2] The term 'democratic' is used in the true sense of the term, namely that power remains with the people.

[3] Several factors exacerbate climate change. For instance, increasingly, the world is experiencing frequent cases of floods and they are predicted to increase exponentially. One cause is global warming. Warmer seas evaporate faster and warmer air can retain more water vapour, which provokes the violence of storms and the intensity of heavy rains. See The Economist, "How to cope with floods," p.11, 2 September 2017. Also, eating meat from animals has negative effects on climate change. See The Economist, "Feed as well as food," pp. 13-14, at 13, 2 September 2017.

[4] The Paris Agreement on Climate Change is one of four major legal instruments used to mitigate climate change. The other three are the UN Framework Convention on Climate Change (UNFCCC), the Kyoto Protocol and the Copenhagen Accord. The UNFCCC distinguishes itself because its objective (Article 2) is *qualitative*, not quantitative (namely it does not provide any guidance about temperature reduction in numerical terms). Another feature that makes the UNFCCC a prominent legal document of climate change mitigation is the principle of common but differentiated responsibilities (Article 3.1). They Kyoto Protocol imposes legally binding obligations to reduce greenhouse gas emissions to specific countries (so-called Annex I countries). Unlike the Kyoto Protocol, the Copenhagen Accord is not legally binding, which means that it is a political agreement to mitigate climate change. Moreover, unlike the UNFCCC, the Copenhagen Accord provides a *quantitative* objective, namely 'to hold the increase in global temperature below 2 degrees Celsius' (paragraph 2). The Paris Agreement on Climate Change is more flexible than the UNFCCC in that it does not create categories of countries, but instead offers nationally determined contributions to mitigate climate change.

[5] R. Leal-Arcas and Proedrou, F., "Prosumers: New actors in EU energy security," *Netherlands Yearbook of International Law*, Vol. 48, forthcoming 2017.

[6] See for instance the development at the sub-national level in the US, where cities and states, via their mayors and governors, are determined to implement the Paris Agreement on Climate Change, despite the decision of the federal government to withdraw from it. See Lumb, D. "61 US cities and three states vow to uphold Paris climate agreement," Engadget, June 1, 2017, available at https://www.engadget.com/2017/06/01/61-us-cities-and-three-states-vow-to-uphold-paris-climate-agreem/. See also an open letter to the international community and parties to the Paris Agreement from US state, local and business leaders by a bottom-up American network called 'We Are Still In,' at http://wearestillin.com/. Similarly, see the role of the United States Alliance at https://www.usclimatealliance.org/ or America's Pledge at https://www.bloomberg.org/program/environment/americas-pledge/, both platforms committed to fight climate change. Other ways in which citizens can have a greater involvement in the energy-transition phenomenon is in solar energy, where people could install solar panels on the roof of their houses. This option would solve the delicate debate over where to place wind farms as part of the energy-transition phenomenon.

[7] For a similar approach to explain how work happens, see McAfee, A. and Brynjolfsson, E. *Machine, Platform, Crowd: Harnessing our Digital Future*, W.W. Norton, 2017.

Sustainable energy is a burning issue in a world where 1.2 billion people still have no access to electricity.[8] One solution for sustainable energy is better governance of energy trade.[9] Energy security, or access to energy at an affordable price, is one of the main problems humanity faces.[10] Without access to energy, people and countries cannot develop their potential. Today's environmental challenges are driving a shift from fossil fuels towards clean and renewable energy, i.e., energy from sustainable sources, as opposed to conventional sources such as oil, natural gas, or coal.[11] These three necessities — energy that is affordable, secure, and clean — can be encompassed by the term "sustainable energy." This transition away from fossil fuels will, however, come at a cost.[12] Others argue that the goal of sustainable energy should be "to curb global warming, not to achieve 100% renewable energy."[13] One way to enhance energy security could be through greater energy efficiency, which may prove more effective than the deployment of renewable energy when it comes to reducing greenhouse gas (GHG) emissions.[14] Trade provides another way: north-eastern Germany is not very industrialized and therefore does not consume much energy, which is needed in south Germany and other more industrialized parts of the country. Here is where trading energy can help enhance energy security.

The purpose of this article is to provide an analysis of smart grids in the European Union (EU) as a way forward to reach sustainable energy. It does so by assessing the energy security, regulatory, and social and ethical aspects of smart grids in the EU. We ask the question whether the level of deployment of smart grids, the degree of their current regulation, and their social and ethical dimension are adequate to make the transition to a low-carbon economy happen. We argue that there is still a long way to go before we reach a desirable outcome. This article represents a significant milestone in the upscaling of the various aspects of smart grid technology across the EU and pushes the frontiers of its existing regulatory regimes. Thus, a detailed evaluation of regional and local[15] regulatory frameworks is provided to ensure the successful realization of smart grid deployment in various EU jurisdictions.

This article discusses, among other issues, the role of electric vehicles (EVs) in decarbonizing the transport sector. Research shows that, if all new cars were electric, they would make up 90% of the world's two billion cars by 2040, thereby saving 11 billion barrels of oil every year (or almost half of annual global production) and 4.7 billion tons of CO2 (this figure excludes emissions and oil used to make electric cars).[16] This plausible reality raises questions such as: how can consumers influence the vehicle industry to make them go electric?[17] How can mobility become renewable?

Some European governments seem to be moving firmly in the direction of EVs: in July 2017, the United Kingdom (UK) government announced that it would ban the sale of new cars that run solely on petrol

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[8] See International Energy Agency, "Energy access database," available at http://www.worldenergyoutlook.org/resources/energydevelopment/energyaccessdatabase/.

[9] Leal-Arcas, R. *et al.*, *Energy Security, Trade and the EU: Regional and International Perspectives*, Edward Elgar Publishing, 2016.

[10] Leal-Arcas, R. *The European Energy Union: The quest for secure, affordable and sustainable energy*, Claeys & Casteels, 2016.

[11] Massai, L. *European Climate and Clean Energy Law and Policy*, Routledge, 2011.

[12] "100% renewable energy: At what cost?" *The Economist*, 15th July 2017, pp. 58-59.

[13] "Renewable-energy targets: A green red herring," *The Economist*, 15th July 2017, p. 10.

[14] Idem.

[15] For an analysis of how transformation can happen locally, see R. Hopkins, The Power of Just Doing Stuff: How local action can change the world, 2013.

[16] See The Economist, "A flash in the sky," Annual Supplement: The World if, 15th July 2017, pp. 16-17.

[17] All of this said, in the case of cars, their sales are falling because better cars and roads mean longer car life, which means fewer new-car sales, and it is a headwind for electric vehicles. See Kyle Stock, "The Real Reason Car Sales Are Falling," *Bloomberg*, 2 August 2017, available at https://www.bloomberg.com/news/articles/2017-08-02/the-real-reason-car-sales-are-falling.

or diesel by 2040.[18] The French government spoke in similar terms in its own announcement.[19] Carmakers are heading in the same direction: Volvo announced in 2017 that all Volvo cars will be electric or hybrid as of 2019.[20] BMW, Porsche, and Audi have electric models that will enter the market by 2020.[21] Outside of Europe, although no timeline has been suggested, China's government would like to move towards a ban on gas vehicles, which will have profound implications for global carmakers, given China's market size.[22] This Chinese move is quite promising as China has some of the world's biggest battery producers and is very active in electronics manufacturing.[23]

Morgan Stanley, an investment bank, expects that, of the one billion cars on the road, half will be powered by battery by 2050, since the price of batteries is decreasing.[24] Moreover, when it comes to GHG emissions, aviation and shipping are two key players in the transportation sector—they are responsible for GHG emissions equivalent to those of some countries that are major GHG emitters.[25] For the mitigation of climate change, electric or hybrid engines in aviation and shipping would be very effective. For instance, hybrid planes, with a capacity of 100 passengers, could take off and land using jet engines, but during the cruise, they could make use of electrically powered engines.[26] Similarly, lighter electric engines for aviation have been developed.

This article is divided into five sections. After this short introduction, Section 2 deals with smart grid deployment and its impact on energy security. Section 3 analyses smart grid regulation. It examines the existing legal frameworks that impact smart grids in the EU. It outlines existing EU Directives and assesses the level of implementation of these Directives in various EU Member States. It also assesses the extent to which existing legal frameworks facilitate the development of smart grids and proposes areas of further regulatory consideration. Section 4 concerns the social and ethical dimension of smart grids, including data-management issues. Section 5 provides the conclusion of this article.

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[18] The Economist, "Business," 29th July 2017, p. 8.

[19] Idem.

[20] A. Vaughan, "All Volvo cars to be electric or hybrid from 2019," The Guardian, 5 July 2017, available at https://www.theguardian.com/business/2017/jul/05/volvo-cars-electric-hybrid-2019.

[21] The Economist, "Cleaning up cars," 30 September 2017, p. 31.

[22] The Economist, "Electric cars in China: Zooming ahead," 16 September 2017, p. 68.

[23] Ibid.

[24] The Economist, "Charge of the battery brigade," 9 September 2017, pp. 63-64. However, battery production is not emissions free.

[25] Leal-Arcas, R. *Climate Change and International Trade*, Edward Elgar Publishing, 2013, Chapters 3 and 6.

[26] The Economist, "Let's twist again," 16 September 2017, pp. 81-82, at 82.

2 SMART GRID DEPLOYMENT AND THE IMPACT ON ENERGY SECURITY

2.1. SETTING THE SCENE

2.1.1. The geopolitical context

The global energy market is still monopolized to a great extent by the production, trade, and consumption of oil and gas.[27] The EU is no exception to this rule, with a high import ratio of both oil and gas. Unreliable oil producers, geopolitical instability in many oil-rich countries, economic and resource nationalism,[28] transportation-related hazards, and the high volatility of international oil prices are constraining importers to face significant risks.[29]

In the gas sector, the EU is confronting a practically oligopolistic external market with Russia, Algeria, and Norway supplying most of the imported gas.[30] Azerbaijan and more distant Liquefied Natural Gas (LNG) suppliers also contribute to the EU's import portfolio, without changing the EU's dependence on a few exporters.[31] Relations with the most important gas supplier, Russia, have become overtly problematic. This state of play must be borne in mind insofar as politics and international relations have a crucial influence on energy policies and international trade relations.

Diversification of sources, routes, and suppliers has been high on the EU's agenda. The Southern Gas Corridor[32] and a few LNG initiatives are the only tangible steps towards this direction. Nevertheless, these efforts have not produced sea changes in Russia's pivotal market role.[33] The rationale of liberalization and competition is in accordance with the logic of diversification. This is so as both premises aim to create a level playing field for external actors in a market well-shielded from monopolistic structures and practices.[34] While the application of the Third Energy Package[35] has blocked some of Russia's future investment moves, it cannot by itself substantially alter the EU's import portfolio.[36]

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[27] The International Energy Agency, "World Energy Outlook," OECD/IEA, Paris, p. 5, 2016, available at https://www.iea.org/publications/freepublications/publication/WorldEnergyOutlook2016ExecutiveSummaryEnglish.pdf.

[28] Economic nationalism is a threat to global sustainable development.

[29] D. Yergin, The Prize: The Epic Quest for Oil, Money & Power, New York: Simon & Schuster, 2011.

[30] Eurostat, "Main origin of primary energy imports, EU-28, 2005-2015 (% of extra EU-28 imports)," Eurostat, [Online]. Available: http://ec.europa.eu/eurostat/statistics-explained/index.php/File:Main_origin_of_primary_energy_imports,_EU-28,_2005-2015_%28%25_of_extra_EU-28_imports%29_YB17.png. [Accessed 25 July 2017].

[31] F. Proedrou, EU Energy Security in the Gas Sector: Evolving Dynamics, Policy Dilemmas and Prospects, Farnham: Ashgate, 2012.

[32] The Southern Gas Corridor is a term used to describe planned infrastructure projects aimed at improving EU energy security by bringing natural gas from the Caspian region to Europe. See Trans Adriatic Pipeline, "Southern Gas Corridor," Trans Adriatic Pipeline, 2017. [Online]. Available: https://www.tap-ag.com/the-pipeline/the-big-picture/southern-gas-corridor. [Accessed 25 July 2017]. The Southern Gas Corridor is also known as the Fourth Corridor (the other three corridors running from North Africa, Norway and Russia). See R. Leal-Arcas *et al*., "The European Union and its Energy Security Challenges," *The Journal of World Energy Law and Business*, vol. 8, p. 19, 2015.

[33] M. Sidi, "The scramble for energy supplies to South Eastern Europe: the EU's Southern Gas Corridor, Russia's pipelines and Turkey's role," in *Turkey as an Energy Hub?* , Baden-Baden, Nomos, 2017, pp. 51-66.

[34] F. Proedrou, "EU Energy Security beyond Ukraine: Towards Holistic Diversification," *European Foreign Affairs Review,* vol. 21, no. 1, pp. 57-73, 2016.

[35] The EU's Third Energy Package is a legislative package for an internal gas and electricity market with the purpose of further opening up these markets in the European Union. It consists of two directives and three regulations: Directive 2009/72/EC, concerning common rules for the internal market in electricity; Directive 2009/73/EC, concerning common rules for the internal market in natural gas; Regulation (EC) No 714/2009, on conditions for access to the network for cross-border exchanges in electricity; Regulation (EC) No 715/2009, on conditions for access to the natural gas transmission networks; and Regulation (EC) No 713/2009 of the European Parliament and of the Council of 13 July 2009 establishing an Agency for the Cooperation of Energy Regulators.

[36] A. Goldthau &. N. Sitter, "Soft Power with a hard edge: EU policy tools and energy security," *Review of International Political Economy,* vol. 22, no. 5, pp. 941-965, 2015; A. Goldthau, "Assessing Nord Stream 2: regulation, geopolitics & energy security in the EU, Central Eastern Europe & the UK," European Centre for Energy and Resource Security, London, 2016.

This is mainly due to the fact that Member States and their energy companies are responsible for negotiating and signing supply contracts. Indeed, Gazprom traditionally retains strategic alliances with several European oil and gas companies[37] (such as Italy's ENI, Austria's OMV, France's Gaz de France, and Germany's EON Ruhrgas and Wintershall).[38] Indeed, Russo-German relations have been remarkably cordial over the last decades, with energy cooperation being at the center of this partnership. Interestingly, the recent fallout between Russia and Ukraine, and Russia's actions (invasion of Crimea and hybrid war in Eastern Ukraine) that evidently go against fundamental international law principles enshrined in several international treaties, have not resulted in any interruption of Russia-EU gas trade.[39]

Having said this, several actors within the EU (particularly the European Commission, the European Parliament, and the Member States located in Central and Eastern Europe) are striving to counter Russia's leverage in the EU energy market.[40] While liberalization and diversification can be considered significant roadblocks but not game-changers, the need remains for holistic, innovative energy policies that will curtail the EU's import dependence and ensuing energy insecurity.[41]

2.1.2. The institutional context

The key issue to be considered is how, by whom, and in what ways energy is governed at the EU level. Energy governance can be defined as multi-level management and regulation of energy supply, calling for variable degrees of coordination and cooperation between several actors.[42] In the words of Florini and Sovacool, energy governance refers to "collective action efforts undertaken to manage and distribute energy resources and provide energy services," and can hence serve as "a meaningful and useful framework for assessing energy-related challenges."[43] As a result, international cooperation is crucial for tackling collective-action problems.

Regarding EU energy governance, a definite dualism is at play. On the one hand, Member States implement energy policies at the national level. On the other, the European Commission sets the energy blueprint at the EU level. In particular, Member States retain their sovereignty in the energy sector on the grounds that energy is a strategic good. Consequently, decisions on the domestic energy mix should lie solely with national authorities.[44] Since the Lisbon Treaty, energy has come under the shared competences of the EU and the Member States.[45] National energy measures must be designed in conformity with EU policies. Examples of such strategies include the 2020 climate and energy

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[37] It is interesting to note that, as of 2013, 90 companies caused two-thirds of anthropogenic greenhouse gas emissions. See Goldenberg, S. "Just 90 companies cause two-thirds of man-made global warming emissions," The Guardian, 20 November 2013, available at https://www.theguardian.com/environment/2013/nov/20/90-companies-man-made-global-warming-emissions-climate-change.

[38] A. Aissaoui *et al.*, Gas to Europe: The Strategies of Four Major Suppliers, Oxford: Oxford University Press, 1999.

[39] T. Casier, "Great Game or Great Confusion: The Geopolitical Understanding of EU-Russia Energy Relations," *Geopolitcs,* vol. 21, no. 4, pp. 763-778, 2016.

[40] A. Goldthau &. N. Sitter, "Soft Power with a hard edge: EU policy tools and energy security," *Review of International Political Economy,* vol. 22, no. 5, pp. 941-965, 2015; A. Goldthau, "Assessing Nord Stream 2: regulation, geopolitics & energy security in the EU, Central Eastern Europe & the UK," European Centre for Energy and Resource Security, London, 2016.

[41] F. Proedrou, "EU Energy Security beyond Ukraine: Towards Holistic Diversification," *European Foreign Affairs Revew,* vol. 21, no. 1, pp. 57-73, 2016.

[42] See generally Leal-Arcas, R. *et al*., *International Energy Governance: Selected Legal Issues*, Edward Elgar Publishing, 2014.

[43] A. Florini and B. K. Sovacool, "Who governs energy? The challenges facing global energy governance," *Energy Policy,* vol. 37, no. 12, pp. 5239-5248, 2009.

[44] T. Maltby, "European Union energy policy integration: A case of European Commission policy entrepreneurship and increasing supranationalism," *Energy Policy,* vol. 55, pp. 435-444, 2013.

[45] Energy, in its wide sense, is expressly referred to as a matter of shared competence between the EU and its Member States. See Article 4 TFEU.

package[46] and the 2030 climate and energy framework.[47] The Commission has thus pioneered an ambitious climate-change mitigation agenda that is bound to impact the Union's energy policy.[48]

EU energy policy is driven both by Member State governments and supranational institutions. It is within this institutional framework that the European Commission is currently fostering research on ground-breaking technologies, the elaboration of forward-looking regulation, the transformation of the traditional energy market towards low-carbon systems, and the establishment of prosumer markets.[49] Such schemes are deeply rooted in the EU's vision to revitalize its energy security.

2.2. SMART GRIDS: A MULTIVALENT INSTRUMENT[50]

Smart grids, together with the promotion and integration of renewable energy generation in the electricity network, bear significant potential for achieving low-carbon energy security, protection from the vagaries of international energy markets, affordable energy costs, enhanced access to energy, existent and future climate goals, empowerment of citizens, and enhanced competitiveness for the European economy.[51]

As the International Energy Agency (IEA) underlines, the sweeping renewable energy generation revolution has propelled a profound debate over the design of the evolving power market and electricity security.[52] What makes the ongoing energy transition different to previous ones is the parallel change in both the energy and digital technology sectors. The contemporary energy transition is characterized by common changes in integrated systems.[53] As such, the scope and scale of this transformation is ubiquitously potent and unprecedented.

This transition basically concerns the electricity sector. This industry expands exponentially at the cost of other sectors, and is projected to account for an increasing percentage of energy consumption growth, from 25% in the last 25 years to nearly 40% by 2040.[54] The electricity industry fosters crucial spill-overs to other sectors as well. The transportation sector, with the use of EVs as an inherent part of the grid, is an indicative example. Verbong, Beemsterboer, and Sengers highlight the differences between the old and the emerging energy system as follows: "[it] will be more hybrid, in terms of the location and type of generation; lower carbon because of a larger contribution of renewable energy sources (RES); more complex and vulnerable; and less hierarchical."[55]

These changes are bound to profoundly impact society at large and energy users in particular.[56] Indeed, smart grids can serve a multitude of goals, such as spearheading economically optimal performance; fostering energy market competition; managing energy consumption and efficiency;

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46 European Commission, "2020 climate and energy package," European Commission, 26 July 2017. [Online]. Available: https://ec.europa.eu/clima/policies/strategies/2020_en. [Accessed 26 July 2017].

47 Conclusions of the European Council of 23 October 2014, available at http://www.consilium.europa.eu/uedocs/cms_data/docs/pressdata/en/ec/145397.pdf.

48 T. Maltby, "European Union energy policy integration: A case of European Commission policy entrepreneurship and increasing supranationalism," *Energy Policy,* vol. 55, pp. 435-444, 2013.

49 European Commission, "Clean Energy for All Europeans – unlocking Europe's growth potential," European Commission, 30 November 2016. [Online]. Available: http://europa.eu/rapid/press-release_IP-16-4009_en.htm. [Accessed 5 September 2017].

50 This section draws from F. Proedrou, "Are smart grids the key to EU energy security?," in R. Leal-Arcas and J. Wouters, (eds.), Research Handbook on EU Energy Law and Policy, Edward Elgar, 2017.

51 European Commission, "Smart grids and meters," European Commission, 7 September 2017. [Online]. Available: http://ec.europa.eu/energy/en/topics/markets-and-consumers/smart-grids-and-meters. [Accessed 7 September 2017].

52 The International Energy Agency, "World Energy Outlook," OECD/IEA, Paris, 2016, p. 1, available at https://www.iea.org/publications/freepublications/publication/WorldEnergyOutlook2016ExecutiveSummaryEnglish.pdf

53 International Energy Agency, "Perspectives for the energy transition. Investment needs for a low-carbon energy system," International Energy Agency, Paris, 2017.

54 *Ibid.,* p. 3.

55 G. P. Verbong, S. Beemsterboer and F. Sengers, "Smart grids or smart users?: involving users in developing a low carbon electricity economy," *Energy Policy,* vol. 52, pp. 117-125, 2013.

56 *Ibid.*

achieving maximum possible carbon emissions reductions; maximizing network efficiency; fomenting system and technology safety, security, and resilience; altering and cleaning the energy mix; creating storage capacity and new technologies in the storage sector; expanding to the transportation sector through electric, plug-in vehicles; democratizing the energy systems; and empowering citizens/customers.

Smart grids are not only being deployed in the EU, but in several other countries as well, most prominently in China, Japan, South Korea, and the United States (US).[57] It is important to stress that there are different drives for the roll-out of smart grids in each case. The frequent outages in the US electricity system, usually caused by ageing infrastructure, have motivated the substitution of the conventional grid with smart grids.[58] China's main preoccupation has been with air quality and pollution.[59] Smart grids have been part of the answer to this environmental question.

The EU is set to proceed with the large-scale roll-out of smart grids to fight climate change and improve energy efficiency in order to hit climate and energy goals set for the next several decades.[60] In this context, smart grids are not *per se* climate policy instruments, but speak to a wider set of goals.[61] As Eid, Hakvoort, and de Jong put it, the way power markets evolve depends on "the innovators' and designers' imagination producing market designs and outcomes better aligned with their political and value preferences."[62]

2.3. THE OPERATION OF PROSUMER MARKETS

From the 1990s onwards, the EU electricity sector underwent a transition from vertically organized electricity companies that controlled production, transmission, distribution, and supply activities, to the unbundling of these services.[63] Transmission System Operators (TSOs)[64] were responsible only for

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[57] International Trade Administration, "Smart Grid Top Markets Report. Update, January 2017," International Trade Administration, 2017.

[58] Scientific American, "Preventing Blackouts: Building a Smarter Power Grid," Scientific American, 14 August 2017. [Online]. Available: https://www.scientificamerican.com/article/preventing-blackouts-power-grid/. [Accessed 5 September 2017].

[59] As a result, China has been very active in climate action in recent years and intends to do so in years to come. See, for instance, China's ambition to spend over $360 bill on renewables by 2020, M. Forsythe, "China Aims to Spend $360 billion on renewable energy by 2020," *The New York Times*, 5 January 2017, available at https://www.nytimes.com/2017/01/05/world/asia/china-renewable-energy-investment.html?mcubz=0; on wind energy, China's investment has been remarkable: S. Evans, "Mapped: How China dominates the global wind energy market," 19 April 2016, available at https://www.carbonbrief.org/mapped-how-china-dominates-the-global-wind-energy-market; see also S. Lacey, "China adds more than 5GW of solar PV capacity in the first quarter of 2015," 21 April 2015, available at https://www.greentechmedia.com/articles/read/china-adds-more-than-5gw-of-solar-pv-capacity-in-the-first-quarter-of-2015#gs.pgeEFKg; on solar energy, in 2017 China opened the world's largest floating solar plant (https://www.weforum.org/agenda/2017/06/china-worlds-largest-floating-solar-power/) and built a 250-acre solar farm shaped like a giant panda (www.sciencealert.com/china-just-built-a-250-acre-solar-farm-shaped-like-a-giant-panda).

[60] C. Eid, R. Hakvoort and M. de Jong, *Global trends in the political economy of smart grids: A tailored perspective on 'smart' for grids in transition,* UNU-WIDER Working Paper 22/2016.

[61] *Ibid.*

[62] A. Bressand, "The Role of Markets and Investment in Global Energy," in *The Handbook of Global Energy Policy*, A. Goldthau, Ed., West Sussex, John Wiley & Sons, 2013, pp. 15-29, p. 25.

[63] European Parliament, "Understanding electricity markets in the EU," European Parliament, November 2016. [Online]. Available: http://www.europarl.europa.eu/RegData/etudes/BRIE/2016/593519/EPRS_BRI%282016%29593519_EN.pdf. [Accessed 5 September 2017].

[64] A Transmission System Operator (TSO) can be defined as a natural or legal person responsible for operating, ensuring the maintenance of and, if necessary, developing the transmission system in a given area and, where applicable, its interconnections with other systems, and for ensuring the long-term ability of the system to meet reasonable demands for the transmission of electricity See Article 2 (4) Directive 2009/73/EC of the European Parliament and of the Council of 13 July 2009 concerning common rules for the internal market in natural gas and repealing Directive 2003/55/EC and Article 2 (4)

the balancing of the load and its transmission from large electricity production plants at high voltage levels. From there, Distribution System Operators (DSOs)[65] distributed electricity to every corner. As we move to an electricity sector comprised of multiple large and small producers, Virtual Power Plants (VPPs), and decentralized energy production, the role, rationale for, and competences of the TSOs remain mired in uncertainty. DSOs, on the other hand, seem well-placed in the new energy setting. Indeed, according to the European Commission's proposed internal electricity market directive, their role will be significantly enhanced, principally when it comes to coordinating and managing the energy produced by the new decentralized energy producers.[66] DSOs are anticipated to absorb the energy thus produced, manage the load, and efficiently distribute electricity to households and corporate premises.[67] The digitalization of services through advanced metering infrastructure (AMI) will massively facilitate their upgraded role.[68]

This being the case, one could anticipate the TSOs' reaction and their pledge for a place in the sun. This potential friction raises questions as to how the competences of the new actors are going to be divided in the new energy landscape.[69]

Energy policy goals and correspondingly relevant national jurisdictions will play a pivotal role in moving the transition forward. Top-down, bottom-up, and hybrid (both top-down and bottom-up)[70] energy policy blueprints mandate variable leeway for different actors across the energy chain. Some aspects can be legally binding and perhaps commissioned to specific market players (e.g., smart meter roll-outs). Another energy policy goal would be allowing utilities, DSOs, and consumers to decide the ways, and pace at which, they move forward. For now, a hybrid model seems to be emerging. In this architecture, climate goals have been set at the higher governance level but the smart grid transition is carried out at the lower governance level. For example, environmental targets are set out by supranational instruments such as the 2020 Climate and Energy Package,[71] whereas the deployment of smart meters is effectively carried out on a national basis. Thus, certain EU Member States such as Spain are already well on their way to hit a 100% smart meter roll-out.[72] Conversely, other EU Member States such as the Czech Republic and Portugal have foregone replacing conventional meters with

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Directive 2009/72/EC of the European Parliament and of the Council of 13 July 2009 concerning common rules for the internal market in electricity and repealing Directive 2003/54/EC.

[65] A Distribution System Operator (DSO) can be defined as a natural or legal person responsible for operating, ensuring the maintenance of and, if necessary, developing the distribution system in a given area and, where applicable, its interconnections with other systems and for ensuring the long term ability of the system to meet reasonable demands for the distribution of electricity or gas. See Article 2 (6) Directive 2009/73/EC of the European Parliament and of the Council of 13 July 2009 concerning common rules for the internal market in natural gas and repealing Directive 2003/55/EC and Article 2 (6) Directive 2009/72/EC of the European Parliament and of the Council of 13 July 2009 concerning common rules for the internal market in electricity and repealing Directive 2003/54/EC.

[66] Proposal for a Directive of the European Parliament and of the Council on common rules for the internal market in electricity, at p. 68, COM(2016) 864 final/2 (23 February 2017).

[67] *Ibid.*

[68] European Commission, Proposal for a Regulation of the European Parliament and of the Council on the internal market for electricity, at pp. 4-5, COM(2016) 861 final (30 November 2016).

[69] *Ibid.*

[70] A top-down approach to a problem is a situation that begins at the highest conceptual level and works down to the details. An example of such an approach would be where targets are set out at the international level and must be attained through national policies and measures. A bottom-up approach to a problem is one that begins with details and works up to the highest conceptual level. An example of such an approach would be where action starts at the national level based on each country´s circumstances through a patchwork of national policies and measures (which are not necessarily binding) until they develop into unified policies at the international plane.

[71] These environmental targets aim to 1) reduce greenhouse gas (GHG) emissions by 20%; 2) reach 20% of renewable energy in the total energy consumption in the EU; and 3) increase energy efficiency to save 20% of EU energy consumption, all by 2020. See European Commission, "2020 Climate and Energy Package," European Commission, 9 September 2017. [Online]. Available: https://ec.europa.eu/clima/policies/strategies/2020_en. [Accessed 9 September 2017].

[72] Comisión Nacional de los Mercados y la Competencia, "El 62% de los contadores analógicos ya han sido sustituidos por contadores inteligentes," *Nota de Prensa,* 2017, p. 1.

smart metering systems due to economic reasons.[73] Such stances are in accordance with the EU law principle of subsidiarity, according to which Member States are given the discretion to decide for themselves how they are going to reach the goals mutually agreed upon at the top EU political level.[74]

The previous reform of the electricity markets carries its important heritage to today's transition. Unbundling[75] has taken place in different ways in the various Member States.[76] In cases where legal unbundling took place, corporate links between the generation and distribution network companies, although they constitute two different legal entities, may well be maintained. This will create benefits to actors in the retail market. This is not the case in ownership unbundling, where the generation and network companies are fully separated. A level-playing field is indispensable if we are to avoid privileging certain actors *vis-à-vis* others.[77]

The specific market conditions also impact the pace and scale of investments. For example, market players with dominant market shares naturally prioritize retaining their central position, rather than investing in new network infrastructure and smart grid roll-outs, as the benefits that will accrue are unlikely to match the costs of reduced revenues resulting from a lessened market share.[78] On the other hand, investments are very pertinent not only in consideration of existing legislation, but also for tackling and anticipating market competition. In this context, DSOs are keen to invest in AMI.[79] Private investors can find a niche investing in control boxes downstream from the meter. A significant caveat is that private investment can render customers captive in light of the long contractual lead times that are imposed so that costs are recovered.[80] This in itself obstructs competition. Such issues must be seriously considered when designating the new regulatory framework for smart grid deployment. Waiting games are also typical corporate tactics that should be anticipated and treated appropriately, since existing market power determines future over- or under-investment plans.[81]

In this new energy landscape, opportunities are opening for new energy actors as well. One such type is energy aggregators. The rationale for their emergence is to provide flexibility and join the Balancing Responsible Parties (BRPs)[82] in what will be a much more variable corporate electricity landscape. Such a role can also be taken up by incumbents. In the new market, however, flexibility services and packages will be crucial, and hence there seems to be much space for new corporate actors, services, and associated innovation. These services revolve around collecting decentralized prosumers' savings and energy generation and selling it back to utilities and BRPs in the form of "flexibility packages."[83]

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[73] Report from the Commission "Benchmarking smart metering deployment in the EU-27 with a focus on electricity", at p. 4, COM(2014) 356 final (17 June 2014).

[74] C. Eid, R. Hakvoort and M. de Jong, *Global trends in the political economy of smart grids: A tailored perspective on 'smart' for grids in transition,* UNU-WIDER Working Paper 22/2016, p. 10.

[75] Ownership unbundling is the "process by which a large company with several different lines of business retains one or more core businesses and sells off the remaining assets, product/service lines, divisions or subsidiaries. Unbundling is done for a variety of reasons, but the goal is always to create a better performing company or companies." See Investopedia, "Unbundling," Investopedia, [Online]. Available: http://www.investopedia.com/terms/u/unbundling.asp. [Accessed 5 September 2017].

[76] European Parliament, "Understanding electricity markets in the EU," European Parliament, November 2016. [Online]. Available: http://www.europarl.europa.eu/RegData/etudes/BRIE/2016/593519/EPRS_BRI%282016%29593519_EN.pdf. [Accessed 5 September 2017].

[77] *Ibid*., p. 9.

[78] J. Donoso, "Self-consumption regulation in Europe," Energetica International, no. 7, 2015, p. 37.

[79] EDSO, "European Distributed System Operator for Smart Grids," EDSO, 2014.

[80] C. Clastres, "Smart grids: Another step towards competition, energy security and climate change objectives," *Energy Policy,* vol. 39, no. 9, pp. 5399-5408, 2011.

[81] *Ibid.*

[82] Balance Responsible Party (BRP) can be defined as a market participant or its chosen representative responsible for its imbalances in the electricity market. See European Commission, Proposal for a Regulation of the European Parliament and of the Council on the internal market for electricity, at p, 38 COM(2016) 861 final (30 November 2016).

[83] For further details on prosumers, see Leal-Arcas, R. and Proedrou, F. "Prosumers: New actors in EU energy security," *Netherlands Yearbook of International Law*, Vol. 48, 2017.

Yet, another type of actors to emerge may be small storage providers. These can store the energy they have produced (in batteries or EVs, for instance) and resell it for a high premium in a market in dire need of flexibility, back-up capacity, and last resort solutions. Such services can be developed at the community, district, or neighborhood level. In this case, the emergence of energy co-operatives may take shape. Integrated energy services companies are the key to the new electricity market.[84]

At an even lower level, individuals, households, and energy cooperatives can become energy actors themselves. They can sell the energy they produce or conserve to utilities and/or aggregators. Both flexibility and network optimization are achieved in this way. Distributed energy resources and storage facilities are central to the energy transition.[85]

Whether storage capacity will be incorporated successfully in smart grids will be critical to their eventual performance. Leaving aside the contested debate over the likelihood of success, storage capacity will tackle peak consumption, reduce system-wide generation costs, and minimize network congestions, thereby optimizing the operation of the electricity network.[86]

EVs are a storage capacity option that is also highly contested.[87] Charging infrastructure costs, logistics, and issues regarding charging time and efficiency both for the vehicle and for the grid must still be resolved. Nevertheless, EVs have the potential to decarbonize the transport sector. This would represent a huge leap forward in meeting the EU's climate targets and contributing to climate change mitigation.[88]

The development of prosumer markets is based on two pillars. The first regards hardware (infrastructure); the other concerns software (the associated legislation and regulation). In this vein, the European Commission made a handful of important steps forward. Firstly, it recognized consumers' right to self-consumption. This will lead to all national jurisdictions gradually embracing self-consumption. Moreover, prosumers are explicitly encouraged to sell their energy surplus to other energy actors, adding in this way to the energy market's resilience and becoming active stakeholders in the energy transition.[89] Secondly, the European Commission explicitly referred to energy communities, granting the right to prosumers to group together and join the market.[90] Finally, the European Commission strongly recommended advancing energy performance-related information as well as information regarding the sources of district heating and cooling systems. This will further empower prosumers and energy communities to improve their energy performance (including production consumption and trading). In addition, the quality of information that consumers obtain will come under the scrutiny of regulatory authorities. This also includes the refinement of the Guarantees of Origin system for energy resources.[91]

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[84] L. Boscan and R. Poudineh, "Flexibility-Enabling Contracts in Electricity Markets," The Oxford Institute for Energy Studies, p.2, 2016.

[85] European Commission, Proposal for a Directive of the European Parliament and of the Council on the promotion of the use of energy from renewable sources, COM(2016) 767 final (23 February 2017).

[86] C. Eid, R. Hakvoort and M. de Jong, *Global trends in the political economy of smart grids: A tailored perspective on 'smart' for grids in transition,* UNU-WIDER Working Paper 22/2016, p3.

[87] Clean Technica , "Tesla CTO JB Straubel On Why EVs Selling Electricity To The Grid Is Not As Swell As It Sounds," Clean Technica , 22 August 2016. [Online]. Available: https://cleantechnica.com/2016/08/22/vehicle-to-grid-used-ev-batteries-grid-storage/. [Accessed 5 September 2017].

[88] The International Energy Agency, "World Energy Outlook," OECD/IEA, Paris, 2016, pp. 3 and 5, available at https://www.iea.org/publications/freepublications/publication/WorldEnergyOutlook2016ExecutiveSummaryEnglish.pdf

[89] European Parliament, "Electricity "Prosumers"," European Parliament, November 2016. [Online]. Available: http://www.europarl.europa.eu/RegData/etudes/BRIE/2016/593518/EPRS_BRI%282016%29593518_EN.pdf. [Accessed 5 September 2017].

[90] Proposal for a Directive of the European Parliament and of the Council on common rules for the internal market in electricity, at p. 68, COM(2016) 864 final/2 (23 February 2017). The proposal defines the concept of local energy community as "an association, a cooperative, a partnership, a non-profit organisation or other legal entity which is effectively controlled by local shareholders or members, generally value rather than profit-driven, involved in distributed generation and in performing activities of a distribution system operator, supplier or aggregator at local level, including across borders." *Ibid.*, p. 52.

[91] European Commission, Proposal for a Directive of the European Parliament and of the Council on the promotion of the

The advent of prosumer markets entails the commercialization, rationalization, and economization of consumer behavior. Through demand response, the European Commission expects prosumers to take full control of their energy usage. Prosumers will be able to adjust their patterns and be economical and efficient. The inflow of relevant information will allow them to adjust, conserve, and choose flexible contracts. Switching off unnecessary appliances or turning down the thermostat at peak hours not only provides monetary benefits, but also contributes to balancing the grid. Conversely, consumers are incentivized to use electricity when it is cheap (e.g., doing the laundry at late hours).[92]

Smart applications can substantially enhance energy efficiency. Instructing the washing machine to wash the clothes at the lowest price of electricity during the day can lead to optimal results for both the consumer and the grid. Dynamic price contracts are also a useful tool for demand management. Based on their consumption patterns, consumers are encouraged to negotiate suitable contracts with electricity suppliers. From the side of utilities, well-targeted, flexible contracts should increasingly become part of their corporate strategy to cater to customers' individualized needs. Competition forces can work well in this sector and lead to a wave of easily adjustable contracts.

Moreover, a number of pricing mechanisms (e.g., real-time pricing, time-of-use pricing, critical-time pricing, and variable peak pricing) can also be put to good use. They not only reflect market fundamentals, they also render consumers more aware of price variations according to market dynamics.[93] Thus, last resort solutions like load-shedding and self-rationing can be altogether abandoned. However, dynamic pricing contracts entail several difficulties. It is hard for utilities to create spot-on abstract models of "representative agents," taking the heterogeneity in the energy use patterns of different consumers into account.[94] Devising effective contracts is also challenging from the supply side, since different utilities face different costs in the energy they buy to respond to their customers' needs. This is especially true when it comes to buying flexibility packages themselves. It is natural then to anticipate that they may remain averse to making even more sophisticated contracts.[95]

An important aspect of the deployment of smart grids lies in revisiting the philosophy behind their functioning rather than borrowing the one underpinning the functioning of the conventional grid. The conventional grid has been premised on the worst-case dispatch philosophy.[96] With the supply side being *a priori* known, utilities focused their efforts on balancing it every second with demand. The danger lay in an imbalance occurring either due to a supply disruption (e.g., an accident in a generation plant) or an unpredictable surge in electricity demand (e.g., a heat wave). To avert such mishaps, utilities retained large reserve capacity to ensure that electricity dispatch would still be possible when demand exceeded predictions or supply was decreased. Such a policy was neither sustainable nor cheap but at least hedged against the danger of power cuts and load-shedding.[97]

These principles and rationale are unsuitable for smart grids. The dynamic nature of both supply and demand in the new electricity landscape calls for a new philosophy.[98] The increase of intermittent solar and wind energy, the lack of storage capacity as of now, the development of micro-grids, the increased variability regarding consumer preferences, and the way consumers will operate smart appliances result in increased uncertainty in both supply and demand. Smart meters, sensors, and demand response mechanisms can mediate and manage the variability and unpredictability of power

use of energy from renewable sources COM(2016) 767 final (23 February 2017).

[92] *Ibid*.

[93] J. Rodríguez-Molina *et al.*, "Business Models in the Smart Grid: Challenges, Opportunities and Proposals for Prosumer Profitability," Energies, vol. 7, no. 9, pp. 6142-6171, 2014.

[94] L. Boscan and R. Poudineh, "Flexibility-Enabling Contracts in Electricity Markets," *The Oxford Institute For Energy Studies*, p.10, 2016.

[95] *Ibid.*

[96] P. P. Varaiya, F. F. Wu and J. W. Bialek, "Smart Operation of Smart Grid: Risk-Limiting Dispatch," *Proceedings of the IEEE,* vol. 99, no. 1, pp. 40-57, 2010.

[97] *Ibid.*

[98] L. Boscan and R. Poudineh, "Flexibility-Enabling Contracts in Electricity Markets," *The Oxford Institute For Energy Studies*, p.10, 2016.

markets by providing both mechanisms for controlling energy use and precise information on the state of the power system and the supply-demand equilibrium.[99]

It is thus essential to redefine the risks in the operation of the power markets and their management. What is considered acceptable risk now must be adjusted to the new operating conditions of smart grids and power markets. The demand response of all consumers will need to be factored into a probabilistic demand curve, which will be analogous to the generation availability curve of intermittent renewable energy.[100] The focus will continually be on the movements in the *net load,* the difference between aggregate demand (load) and variable generation. The capacity, ramp rate, duration, and lead time for increasing or decreasing supply will have to be factored into such analyses as well, to optimize the smart grids' responses to the fluctuating supply-demand dynamics.[101]

Finally, it is necessary to integrate cross-border markets and capacity into risk management analysis. The EU has managed to establish a functional cross-border power market through its day-ahead market with many national markets now coupled.[102] This has been instrumental in fomenting price competition, providing further leverage for load balancing, optimizing back-up capacity, and increasing resilience.[103] A handful of physical barriers such as congestion, lack of transmission capacity, and/or underutilization remain, leading to sub-optimal transmission returns and hub market differentials.[104] These block, rather than enhance, cross-border trade. A further step regards the extension of such schemes into Energy Community members that are not EU members as well as to neighboring states outside the Energy Community. A more critical challenge regards the adjustment of the cross-border market to the new reality of "real-time" intra-day trade.[105]

2.4. SMART GRIDS AND ENERGY SECURITY[106]

The transition to low-carbon energy systems is the crucial political economy issue for the EU, as it stands in the nexus of energy, politics, and markets. With power markets developing into dynamic energy system integrators, smart grids emerge as the most suitable structures to help the EU achieve its three principal energy security goals (sustainability, security of supply, and affordability). Smart grids are power networks that utilize two-flow transmission of information to maximize the balancing capacity of the system and achieve optimal electricity transmission and services.[107] In doing so, they provide resilience *vis-à-vis* supply-demand disequilibria and power outages. Moreover, they also create new markets and commodities.[108] Smart grids therefore impact the electricity industry and carry the potential to "smarten" houses and all kinds of premises in terms of energy use and efficiency.[109]

Smart grids integrate renewable sources at the upstream level, advance overall renewable generation,

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[99] *Ibid.*

[100] P. P. Varaiya, F. F. Wu and J. W. Bialek, "Smart Operation of Smart Grid: Risk-Limiting Dispatch," *Proceedings of the IEEE,* vol. 99, no. 1, pp. 40-57, 9 November 2010.

[101] L. Boscan and R. Poudineh, "Flexibility-Enabling Contracts in Electricity Markets," The Oxford Institute For Energy Studies, p.10, 2016.

[102] International Energy Agency, "Energy Policies of IEA Countries. Belgium. 2016 Review," International Energy Agency, Paris, 2016.

[103] *Ibid.*

[104] L. Boscan and R. Poudineh, "Flexibility-Enabling Contracts in Electricity Markets," The Oxford Institute For Energy Studies, p.10, 2016.

[105] *Ibid.;* D. Buchan and M. Keay, "EU energy Policy - 4th time lucky?," The Oxford Institute for Energy Studies, 2016.

[106] This section draws from F. Proedrou, "Are smart grids the key to EU energy security?," in R. Leal-Arcas and J. Wouters, (eds.), Research Handbook on EU Energy Law and Policy, Edward Elgar, 2017.

[107] P. P. Varaiya, F. F. Wu and J. W. Bialek, "Smart Operation of Smart Grid: Risk-Limiting Dispatch," *Proceedings of the IEEE,* vol. 99, no. 1, pp. 40-57, 9 November 2010; C. Eid, R. Hakvoort and M. de Jong, *Global trends in the political economy of smart grids: A tailored perspective on 'smar' for grids in transition,* UNU-WIDER, 2016.

[108] C. Clastres, "Smart grids: Another step towards competition, energy security and climate change objectives," *Energy Policy,* vol. 39, no. 9, pp. 5399-5408, 2011.

[109] M. Wissner, "The Smart Grid - A saucerful of secrets?" *Applied Energy,* vol. 88, no. 7, pp. 2509-2518, 2011.

including self-generation, enable energy efficiency and conservation, promise to achieve low-carbon energy security, and hedge against the volatility of international energy markets. On the other hand, the establishment of smart grids requires high upfront investment costs and the creation of operational markets to promote the understanding of smart grids and their benefits as well as an assortment of incentives for their optimal utilization. Demand response management is key in this process.

For decades, EU energy policy has been preoccupied with a number of issues, including threats of supply cuts, diversification schemes, mitigation of dependence on external producers, fluctuating prices, and providing dynamic responses to a warming planet.[110] The deliberations around the establishment of an Energy Union naturally focus on these aspects in an effort to effectively provide security of supply, integrate the energy market, enhance demand-side policies, ensure de-carbonization of the economy, and further research and innovation.[111]

Interestingly, the European Commission has been calling for a paradigm shift. This focuses on placing EU citizens at the heart of energy security by means of self-consumption, distributed generation, and the creation of prosumers' markets and local energy communities.[112] Such far-reaching developments could also bring about uncertainty in energy production and consumption. Hence, it is imperative to create mechanisms that will ensure the optimal balance of the electricity load at all times.

2.4.1. Sustainability prospects

2.4.1.1. Advantages

Smart grids play a decisive role in the proliferation of indigenous renewable energy generation. Priority dispatch mechanisms ensure that RES enter the grid.[113] High-efficiency photovoltaics installations bear the highest energy return factor as well as the largest life-cycle carbon emissions offsets, assuming that land availability is not an issue.[114] Consequently, the integration of Information and Communications Technologies (ICT) systems into the network would only serve to augment the efficiency and benefits of RES.

It is a well-known fact that development leads to increasing per capita energy consumption. The introduction of digital technology is promising since it will enable European consumers to be aware of, adjust, and optimize their energy consumption.[115] Therefore, one can reasonably anticipate that energy consumption will be rationalized and reduced. Smart meters convey all the information regarding supply, demand, transmission, and real-time consumption so that prosumers can consume energy in an optimal manner.[116] Additional AMI, such as in-home automation and in-home displays, will serve the same goals.[117] The use of sensors by utilities so that voltage at the consumers' end

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[110] D. Helm, "The European framework for energy and climate," *Energy Policy,* vol. 64, pp. 29-35, 2014.

[111] K. Szulecki, *et al.*, "Shaping the 'Energy Union': between national positions and governance innovation in EU energy and climate policy," *Climate Policy,* vol. 16, pp. 548-567, 2016; M. Sidi, "The EU's Energy Union: A Sustainable Path to Energy Security?," *The International Spectator,* vol. 51, no. 1, pp. 131-144, 2016.

[112] European Commission, "Commission proposes new rules for consumer centred clean energy transition", available at https://ec.europa.eu/energy/en/news/commission-proposes-new-rules-consumer-centred-clean-energy-transition.

[113] J. Jansen and A. van der Welle, "The Role of Regulation in Integrating Renewable Energy: The EU Electricity Sector," in *The Handbook of Global Energy Policy*, A. Goldthau, Ed., West Sussex, John Wiley & Sons, 2013, pp. 322-339, p. 325.

[114] S. A. Halasah, D. Pearlmutter and D. Feuermann, "Field installation versus local integration of photovoltaic systems and their effect on energy evaluation metrics," *Energy Policy,* vol. 52, no. C, pp. 462-471, 2013.

[115] K. B. Jones and D. Zoppo, A Smarter, Greener Grid, Forging Environmental Progress through Smart Policies and Technologies, California: Praeger, 2014, p. 7.

[116] M. Wissner, "The Smart Grid - A saucerful of secrets?," *Applied Energy,* vol. 88, no. 7, pp. 2509-2518, 2011; S. S. Depuru *et al.*, "Smart Meters for Power Grid - Challenges, Issues, Advantages and Status," *Renewable and Sustainable Energy Reviews,* vol. 15, no. 6, pp. 2736-2742, 2011.

[117] C. Eid, R. Hakvoort and M. de Jong, *Global trends in the political economy of smart grids: A tailored perspective on 'smart' for grids in transition,* UNU-WIDER Working Paper 22/2016.

remains low also results in optimized energy conservation.[118]

Smart grids are a striking development in that they provide consumers with the possibility of generating energy themselves. This will lead to an exponential increase of overall renewable energy production. Together with the anticipated increase in energy savings and efficiency, this can translate into a significant reduction of oil and gas imports. Belgium features here as an excellent case in point. Enhanced incentives[119] for the installation of solar panels have rendered private households producers of their own energy. This releases pressure from the grid and supplies renewable energy to it.[120]

The architecture of smart grids allows the creation of local energy communities by means of distributed generation (micro-generation). In turn, distributed generation reduces the associated costs of investment in new traditional large power generation plants. Moreover, energy can also be consumed at the point of its production. This minimizes not only leakages but also logistical problems. Another effect of self-consumption and distributed generation is that they release pressure from the transmission grid and effectively prioritize the use of renewable energy.[121] In this context, the European Commission has been encouraged to propose the escalation of the EU's energy efficiency target for 2030 from 27% to 30%.[122]

Increased production of renewable energy, self-consumption, and distributed generation can substantially clean the mix and dwindle imports of fossil fuels.[123] A recent study has convincingly shown that:

> Utilizing existing infrastructure such as existing building roofs and shade structures does significantly reduce the embodied energy requirements (by 20–40%) and in turn the EPBT [energy pay-back time] of flat-plate PV systems due to the avoidance of energy-intensive balance of systems (BOS) components like foundations . . . [while] a greater life-cycle energy return and carbon offset per unit land area is yielded by locally-integrated non-concentrating systems, despite their lower efficiency per unit module area.[124]

The increase of renewable energy generation and the need to continually balance the electricity load raise the issue of storage. EVs that can be plugged into the grid and serve as batteries hold high promise for extending the benefits of the electricity sector to transportation, a sector that accounts for a significant percentage of total EU carbon emissions.[125]

2.4.1.2. Risks and challenges ahead

Smart grids and their full-scale roll-out face important challenges. The further electrification of consumption systems with a view to promoting energy efficiency may lead to higher energy consumption. Indeed, requiring less energy for one function or service does not necessarily lead to lower overall energy usage. For instance, a "smart" household using an EV with a fast charging point

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[118] K. B. Jones and D. Zoppo, A Smarter, Greener Grid, Forging Environmental Progress through Smart Policies and Technologies, California: Praeger, 2014.

[119] G. Masson, J. I. Briano and M. J. Baez, "Review and Analysis of PV Self-Consumption Policies," International Energy Agency - Photovoltaic Power Systems Programme*, Report IEA-PVPS T1-28:2016, p.* 13, 2016.

[120] *Ibid.*

[121] M. A. Brown and B. K. Sovacool, "Climate Change and Global Energy Security: Technology and Policy Options," MIT, Cambridge, 2011, p. 22; K. B. Jones and D. Zoppo, A Smarter, Greener Grid, Forging Environmental Progress through Smart Policies and Technologies, California: Praeger, 2014, p. 7.

[122] European Commission, "Commission proposes new rules for consumer centred clean energy transition", available at https://ec.europa.eu/energy/en/news/commission-proposes-new-rules-consumer-centred-clean-energy-transition

[123] P. Lehman and E. Gawel, "Why should support schemes for renewable electricity complement the EU emissions trading scheme?," *Energy Policy,* vol. 52, pp. 597-607, p. 603, 2013.

[124] S. A. Halasah, D. Pearlmutter and D. Feuermann, "Field installation versus local integration of photovoltaic systems and their effect on energy evaluation metrics," *Energy Policy,* vol. 52, no. C, pp. 462-471, 2013.

[125] *Ibid.*, p. 117; S. Ruester *et al.*, "From distribution networks to smart distribution systems: Rethinking the regulation of European electricity DSOs," *Utilities Policy,* vol. 31, pp. 229-237, 2014.

might find that, owing to the high voltage requirements of the EV's fast-charger, its net consumption is still relatively high. This may be so despite having technology to help reduce its everyday consumption. Hence, energy efficiency as an end in and of itself is not enough to lower energy consumption. Additional policies and market support measures are required if this goal is to be achieved.[126]

Furthermore, electricity markets and their regulation have failed to catch up with the pace of renewable energy production. It is surprising that Greece and Spain, two Mediterranean countries that enjoy substantial solar irradiance, have only recently established a regulatory framework for self-consumption. Spain did so in 2015, while Greece did so previously, in 2014.[127] Even if this constitutes a positive step, it hardly balances the priority given to larger solar and wind parks via financial mechanisms.[128] Conversely, the regulation and policies in place fail to promote self-consumption. In Spain, small-scale investors must pay an obscure tax, dubbed "tax on the sun," to be allowed to carry out these activities.[129] On top of that, the most common type of self-consumer is not entitled to any remuneration should they wish to export their electricity surplus to the domestic grid.[130] As a result, such self-consumers have no incentive to do so. Efforts to encourage a cleaner energy mix and lower emissions are hampered by such provisions.[131] In other Member States, such as Belgium and Germany, self-consumers are charged for exporting electricity to the national grid.[132] Such policies represent a substantial disincentive for promoting clean energy production.[133] What is more, RES were not used due to the network's failure to accommodate the energy produced.[134] Micro-LNG grids[135] have emerged as the first significant market response and challenge to renewable energy-run smart grids. Micro-LNG grids can surpass conventional smart grids because they feature the critical advantage of storage capacity.[136]

For now, Member States maintain back-up capacity through capacity mechanisms, which allow coal and gas-fired plants to operate and provide energy when needed. These constitute a backdoor to the perpetuation of energy derived from fossil fuels throughout the energy transition.[137] In particular, the

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[126] G. P. Verbong, S. Beemsterboer and F. Sengers, "Smart grids or smart users?: involving users in developing a low carbon electricity economy," *Energy Policy,* vol. 52, pp. 117-125, 2013.

[127] The International Energy Agency, "Royal Decree 900/2015 on Self-Consumption", available at https://www.iea.org/policiesandmeasures/pams/spain/name-152980-en.php; Res Legal, "Net-Metering (Law No.3468/2006 amended by Law No.4203/2013)," Res Legal, 24 February 2017. [Online]. Available: http://www.res-legal.eu/search-by-country/greece/single/s/res-e/t/promotion/aid/net-metering-law-no34682006-amended-by-law-no42032013/lastp/139/. [Accessed 13 July 2017].

[128] G. Masson, J., I. Briano and M. J. Baez, "Review and Analysis of PV Self-Consumption Policies," International Energy Agency - Photovoltaic Power Systems Programme*, Report IEA-PVPS T1-28:2016,* p. 13, 2016.

[129] I. Tsagas, "Spain Approves 'Sun Tax,' Discriminates Against Solar PV," Renewable Energy World, 23 October 2015. [Online]. Available: http://www.renewableenergyworld.com/articles/2015/10/spain-approves-sun-tax-discriminates-against-solar-pv.html. [Accessed 10 July 2017].

[130] J. López Prol and K. Steininger, "Photovoltaic self-consumption regulation in Spain: Profitability analysis and alternative regulation schemes," Energy Policy, vol. 108, 2017, p. 743.

[131] M. Galanova, "Spain's sunshine toll: Row over proposed solar tax," BBC, 7 October 2013. [Online]. Available: http://www.bbc.co.uk/news/business-24272061. [Accessed 29 June 2017].

[132] The European Environment Agency, "Country Profile- Belgium. Energy Support 2005-2012"

[133] *Ibid.*

[134] M. Wissner, "The Smart Grid - A saucerful of secrets?," *Applied Energy,* vol. 88, no. 7, pp. 2509-2518, 2011; C. Eid, R. Hakvoort and M. de Jong, *Global trends in the political economy of smart grids: A tailored perspective on 'smart' for grids in transition,* UNU-WIDER Working Paper 22/2016.

[135] A microgrid is a small-scale power grid that can operate independently or in conjunction with the area's main electrical grid. Any small-scale localized station with its own power resources, generation and loads and definable boundaries qualifies as a microgrid. See WhatIs.com, "microgrid," WhatIs.com, [Online]. Available: http://whatis.techtarget.com/definition/microgrid. [Accessed 5 September 2017].

[136] Natural Gas World, "Siemens Rolls Out Micro-LNG in the US," Natural Gas World, 20 January 2017. [Online]. Available: https://www.naturalgasworld.com/siemens-rolls-out-micro-lng-in-us-35447?utm_medium=email&utm_campaign=Natural%20Gas%20World%20Newsletter%20January%2019%202017&utm_content=Natural%20Gas%20World%20Newsletter%20January%2019%202017+CID_3075bf421815cdc13fa0d66.

[137] C. Eid, R. Hakvoort and M. de Jong, *Global trends in the political economy of smart grids: A tailored perspective on 'smart'*

EU has legislated that all new generation plants launched from 2020 onwards as well as every generation plant after 2025 will have to comply with an emission performance standard of 550 grams per kilowatt hour to be included in the capacity mechanism.[138] Modern gas plants meet this threshold.[139] Coal-fired plants are also likely to meet it if they follow appropriate carbon abatement techniques.[140] These numbers contrast sharply with the IEA's projected carbon intensity of electricity generation, which brings performance standards to 335 grams in the baseline scenario and to only 80 grams by 2040 in the most optimistic deep de-carbonization scenario (in comparison with 515 grams today).[141] The more prices remain at reasonable levels, the more reliance on fossil fuel plants decreases. This entails a greener energy mix and the reduction of CO_2 emissions.[142] In this context, one should also anticipate the fossil industry's resistance to the substitution of the capacity mechanism with a profusion of other schemes, such as clean energy storage capacity (including EVs and batteries), cross-border functional interconnections, and market-based real-time congestion management.[143]

While the transition to clean energy has discouraged oil and gas imports, it has brought about an increase in coal use.[144] Germany's *Energiewende*[145] is a good case in point.[146] More generally, the electrification of the energy sector means that the sources feeding it become even more significant for climate change mitigation. In this context, electric heating makes sense if it is powered by sun and wind rather than coal. The same holds true for the transport sector. While petrol emissions are significant, emissions from coal-fired electric cars will be even more harmful to the environment.[147]

This brings us to the fundamental importance of policy to prioritize clean energy and foster green smart grids. Two instruments that enhance renewable generation have come under criticism. The first is the RES-E (Electricity from Renewable Energy Sources) scheme that subsidizes renewable energy generation in the form of either feed-in tariffs or premiums.[148] The second is the RES dispatch priority mechanism.[149] The main argument underpinning their censure is that these schemes unwittingly favor the least competitive forms of energy generation, compromising other, sounder investments, and increasing the bill.[150] The situation in the UK illustrates this trend. Criticisms to feed-in tariffs have led

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for grids in transition, UNU-WIDER Working Paper 22/2016.

[138] D. Buchan and M. Keay, "EU energy Policy - 4th time lucky?," The Oxford Institute for Energy Studies, p. 7, 2016.

[139] *Ibid.*

[140] *Ibid.*

[141] The International Energy Agency, "World Energy Outlook," OECD/IEA, Paris, 2016, p. 4, available at https://www.iea.org/publications/freepublications/publication/WorldEnergyOutlook2016ExecutiveSummaryEnglish.pdf

[142] European Commission, "Commission proposes new rules for consumer centred clean energy transition", available at https://ec.europa.eu/energy/en/news/commission-proposes-new-rules-consumer-centred-clean-energy-transition.

[143] P. P. Varaiya, F. F. Wu and J. W. Bialek, "Smart Operation of Smart Grid: Risk-Limiting Dispatch," *Proceedings of the IEEE,* vol. 99, no. 1, pp. 40-57, 9 November 2010; L. Boscan and R. Poudineh, "Flexibility-Enabling Contracts in Electricity Markets," The Oxford Institute For Energy Studies, p. 2, 2016.

[144] However, see the views by Tom Randall on coal's prognosis, "The latest sign that coal is getting killed," Bloomberg, 13 July 2015, available at https://www.bloomberg.com/news/articles/2015-07-13/the-latest-sign-that-coal-is-getting-killed.

[145] The concept of *Energiewende* describes Germany's efforts to move away from fossil fuels and nuclear power by promoting renewable energy instead, whilst remaining a major industrial power. See D. Buchan "The Energiewende – Germany's gamble" *The Oxford Institute for Energy Studies*, 2012, p. 1.

[146] O. Renn and J. P. Marshall, "Coal, nuclear and renewable energy policies in Germany: From the 1950s to the "Energiewnde"," *Energy Policy,* vol. 99, pp. 224-232, 2016.

[147] A. Bressand, "The Role of Markets and Investment in Global Energy," in *The Handbook of Global Energy Policy*, A. Goldthau, Ed., West Sussex, John Wiley & Sons, 2013, pp. 15-29, p. 23.

[148] F. Muhammad-Sukki, et al., "Revised feed-in-tariff for solar photovoltaic in the United Kingdom: A cloudy future ahead?," Energy Policy, vol. 52, pp. 832-838, 2013.

[149] *Ibid.* Priority dispatch is the obligation on TSOs to schedule and dispatch energy from renewable generators ahead of other generators as far as secure operation of the electricity system permits. The purpose of Priority Dispatch is to further the objective of the integration of renewable energy into the electricity system to promote sustainability and security of supply for Europe. See The European Wind Energy Association, "EWEA position paper on priority dispatch of wind power," The European Wind Energy Association, 2013.

[150] F. Muhammad-Sukki, et al., "Revised feed-in-tariff for solar photovoltaic in the United Kingdom: A cloudy future ahead?,"

to revised tariff rates that are projected to yield lower returns, especially compared to those in other EU Member States. Accordingly, the likelihood of depressed investments in renewable generation seem rather high.[151] On the other hand, smart grids have the potential to render renewable energy more profitable through proper energy management, which should result in energy conservation.[152] Smart grids are very promising but may also impinge on the three main dimensions of energy security (sustainability, security of supply, and affordability in accordance with the vision of the Energy Union).[153]

Another argument against subsidy schemes for renewable energy derives from the existence of the Emissions Trading System (ETS). The ETS is supposed to deliver on the climate front and thus renders renewable energy feed-in tariffs redundant. However, the ETS addresses climate policy goals appropriately only under determined circumstances which hardly apply in practice. First, energy technology choices are distorted by market and policy failures, which tilt the advantage towards business-as-usual solutions rather than facilitating the emergence of new technologies (such as distributed generation, smart meters, blockchain technologies, storage facilities, and electric vehicles) in the electricity system. Subsidies on renewables can be understood as mechanisms to counter distortions that perpetuate technological lock-in. Feed-in tariffs increase the availability of renewable energy, allowing stricter caps to be set in the ETS. Second, subsidies on renewables have the potential to reach other goals beyond climate change mitigation such as achieving renewable energy targets, gleaning other environmental benefits, improving air quality, strengthening security of supply, and boosting industrial policy and economic competitiveness.[154]

Contemporary emphasis on extensive gas infrastructure clashes with the EU's agenda on smart grid deployment. This friction can generate profound lock-in effects by obstructing a faster transition to low-carbon energy systems.[155] The fact that half of the funding of the Connecting Europe Facility scheme is directed to two gas projects deemed to be of strategic importance is revealing of this dichotomy.[156] The ongoing gas glut equips gas proponents with important arguments for its significance for the energy mix. Nevertheless, horizontal fracking constitutes a nocuous practice for the environment and produces higher emissions than conventional gas.[157] The globalization of gas markets, facilitated by the shale revolution, meddles with global gas supply-demand equilibria. Such events are contributing to an increased gas import portfolio.

2.4.2. Strengthening supply security

While smart grids' impact on sustainability, energy efficiency, affordability, and competitiveness has been considerably examined, security of supply remains an unexplored topic in relevant academic

Energy Policy, vol. 52, pp. 832-838, 2013.

[151] *Ibid.*

[152] P. P. Varaiya, F. F. Wu and J. W. Bialek, "Smart Operation of Smart Grid: Risk-Limiting Dispatch," *Proceedings of the IEEE,* vol. 99, no. 1, pp. 40-57, 9 November 2010.

[153] Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee, the Committee of the Regions and the European Investment Bank, "A Framework Strategy for a Resilient Energy Union with a Forward-Looking Climate Change Policy", COM(2015) 80 final (25 February 2015).

[154] *Ibid.,* p. 603.

[155] T. Raines and S. Tomlinson, "Europe's Energy Union: Foreign Policy Implications for Energy Security, Climate and Competitveness," Chatham House Royal Institute of International Affairs, 31 March 2016. [Online]. Available: https://www.chathamhouse.org/publication/europes-energy-union-foreign-policy-implications-energy-security-climate. [Accessed 29 June 2017]; S. Chignell and R. J. K. Gross, "Not locked-in? The overlooked impact of new gas-fired generation investment on long-term decarbonisation in the UK," *Energy Policy,* vol. 52, pp. 699-705, 2013.

[156] Natural Gas World, "EU Approves €444MN CEF Grants," Natural Gas World, 20 February 2017. [Online]. Available: http://www.naturalgasworld.com/eu-approves-444mn-cef-grants-36013?utm_medium=email&utm_campaign=Natural%20Gas%20World%20Newsletter%20February%2021%202017%20-%20AM&utm_content=Natural%20Gas%20World%20Newsletter%20February%2021%202017%20-%20AM+CID_d023afdd8.

[157] D. G. Victor, *The Gas Promise,* Laboratory on International Law and Regulation, ILAR Working Paper 7, p. 21, 2013.

debates.[158]

2.4.2.1. Advantages

The new energy architecture with smart grids at the center aims at strengthening security of supply and the energy markets' resilience. A mix of solar, wind, and other renewable sources constitutes a much more decisive diversification policy than gas imports from alternative suppliers.[159] The planned connection of EVs to smart grids can provide added resilience by enhancing congestion management.[160] While the modern centralized electricity grid has been exposed to terrorist attacks, threatening physical security, the decentralized nature of smart grids makes any meaningful attack on energy infrastructure impossible.[161] However, though the decentralized grid increases the level of resilience, it also increases the number of potential targets. Furthermore, new threats are emerging such as cyber and cyber-physical threats, targeting the massive use of ICT in network management.

Energy poverty remains an urgent issue in the EU.[162] Indeed, smart grids seem to be an ideal response to this problem. Self-consumption directly combats energy poverty at the root. Poor households can produce their energy and consume it rather than having to pay volatile prices.

In introducing smart energy systems, EU Member States face a set of strategic choices. First, Member States can decide whether to embark on a "make" or "buy" choice. The first choice ("make") refers to Member State's ability to produce electricity itself. The second choice ("buy") is importing energy supplies. If a Member State can produce its own energy, it eradicates any dependencies. Further, favoring energy that is generated nationally will cascade into much needed domestic investment and generate new employment. The "make" option entails higher costs, at least for most Member States. The "buy" option offers efficiency and flexibility but retains some dependencies to external suppliers. What is more, the "buy" option will burden national economies.

Second, EU Member States can opt for a centralized or de-centralized architecture of energy production. This requires Member States to:

> [d]ecide whether they prefer centrally or decentrally produced electricity and whether to rely on incumbent energy companies and grid operators or empower households and local communities with their own production and distribution networks (connected to the grid or not). If the distributed option is chosen, energy markets become locally oriented, likely to involve a mix of private and communal companies. This choice in generation capacity adds a strategic consideration within the make or buy context.[163]

An important caveat regards flexibility and whether the reversion of the initial decision is likely and possible in the "make" option. For Member States opting to produce their own energy, a centralized architecture is more flexible since it can accommodate reversion to the "buy" option in case the "make" option underperforms. This is so because central grids can be connected to grids of other countries and hence carry imported energy from third countries. Importing energy is less functional and practical than producing it locally.[164]

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[158] A. Boston, "Delivering a secure electricity supply on a low carbon," *Energy Policy,* vol. 52, pp. 55-59, 2013; P. Lehman and E. Gawel, "Why should support schemes for renewable electricity complement the EU emissions trading scheme?," *Energy Policy,* vol. 52, pp. 597-607, p. 603, 2013.
[159] F. Proedrou, "EU Energy Security beyond Ukraine: Towards Holistic Diversification," *European Foreign Affairs Review,* vol. 21, no. 1, pp. 57-73, 2016.
[160] S. Ruester *et al.*, "From distribution networks to smart distribution systems: Rethinking the regulation of European electricity DSOs," *Utilities Policy,* vol. 31, pp. 229-237, 2014.
[161] M. A. Brown and B. K. Sovacool, "Climate Change and Global Energy Security: Technology and Policy Options," MIT, Cambridge, 2011.
[162] The Greens. European Free Alliance, "A Green Energy Union," The Greens. European Free Alliance, 2015, p. 3.
[163] D. Scholten and R. Bosman, "The Geopolitics of Renewable Energy; a Mere Shift or Landslide in Energy?," *Technological Forecasting and Social Change,* vol. 103, pp. 278-279, 2016.
[164] *Ibid.*, p. 279.

The exact shape of smart grid deployment is significantly contextualized and contingent upon both local conditions and national regulation. A one-size-fits-all approach is unfeasible. In Greece, for example, geography plays a critical role in the energy security of the mainland on the one hand, and the myriad of islands on the other, calling for different treatment, as is reflected in Greece's institutional energy structure and associated regulatory provisions.[165] The existence of a big number of small islands in the Aegean Sea creates a strong rationale for autonomous energy generation since connection to the main grid is rather costly. Utilizing the rich potential of energy generation through strong winds and abundant solar irradiance could substantially boost indigenous energy generation.[166] A smart grid architecture that interconnects the grids of several adjacent islands and then creates interconnection points for these different groups of islands, most probably on the basis of existing administrative divisions, could also provide for the appropriate scale as well as offer interconnectivity options necessary to ensure strong security of supply.

2.4.2.2. Risks and challenges ahead

The evolution of smart grids also presents formidable challenges. The load in the electricity networks must be continually balanced to store electricity surplus during low demand spells and release it when demand increases. This can be achieved in two ways: through the maintenance of the supply and demand balance via market mechanisms or by means of adequate storage capacity. The low-carbon transition has been based on the proliferation of solar and wind energy. Both are intermittent in nature, which means that one would need storage capacity, thus raising the issue of what happens at the times when they underperform.[167] Moreover, it is necessary to have large empty areas to produce solar energy at a large scale, especially because solar energy is already competitive with fossil fuels in sunny places.[168] As the transition proceeds and renewable energy starts to play a central role in the energy mix, the continual supply-demand balancing is anticipated to take center stage. Sophisticated weather forecast tools will assist in predicting the supply side with increasing accuracy, thus providing benchmarks and minimizing uncertainties.

These issues notwithstanding, in case of balancing failure, the result will be either load-shedding (in other words, a power cut) or increased electricity prices. Load-shedding amounts to a failure to provide supply security while increased electricity prices accentuate energy poverty and contravene the affordability goal.[169] A concerted demand response management program is being developed to correct such mishaps in time and avert negative outcomes.[170] Demand response management includes decentralized control automation, real-time and scarcity pricing, self-rationing, intra-day markets, and flexible, targeted contracts.[171] At the same time, it allows consumers to take full control of their energy usage and optimize both the services they enjoy as well as the operation of smart grids.

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[165] HEDNO, "Regulatory Framework", available at http://www.deddie.gr/en/i-etaireia/ruthmistiko-plaisio.

[166] Commission Staff Working Document. Best practices on Renewable Energy Self-consumption. Accompanying the document Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. Delivering a New Deal for Energy Consumers, at p. 3, COM(2015) 33 final (15 July 2015).

[167] Scientific American, "Renewable Energy Intermittency Explained: Challenges, Solutions, and Opportunities," Scientific American, 11 March 2015. [Online]. Available: https://blogs.scientificamerican.com/plugged-in/renewable-energy-intermittency-explained-challenges-solutions-and-opportunities/. [Accessed 5 September 2017].

[168] See for instance the case of a floating solar farm in China, which is the largest in the world. Daley, J. "China turns on the world's largest floating solar farm," Smithsonian.com, 7 June 2017, available at http://www.smithsonianmag.com/smart-news/china-launches-largest-floating-solar-farm-180963587/. Other places where there would be potential for solar mega-farms would be the Arabian and Sahara deserts because there is a lot of sunlight and they are not cloudy.

[169] The Greens. European Free Alliance, "A Green Energy Union," The Greens. European Free Alliance, 2015, p. 3.

[170] C. Clastres, "Smart grids: Another step towards competition, energy security and climate change objectives," *Energy Policy,* vol. 39, no. 9, pp. 5399-5408, 2011.

[171] *Ibid.*

While the emphasis remains on the capacity mechanism, the further development of cross-border trade and the optimization of available electricity across borders is a key issue.[172] Poor data availability, sub-optimal coordination, and limited infrastructural interconnection result in prices that are not set at the right level.[173] Thus, participants do not receive adequate market signals, which leads to the suboptimal delivery of electricity.[174] Member States' emphasis on national measures and tools to tackle security of supply risks accentuating the problem of loosely coordinated national electricity markets.[175] Assuming the capacity mechanism is not ruled out in the following decades, it makes sense to move from national assessments to an EU adequacy assessment, and design multiple cross-border electricity flows accordingly.[176]

The European Commission aims to deal with these shortcomings by introducing "a wider regional and European aspect first into the assessment of capacity needs" and seeking "to better coordinate national capacity mechanisms."[177] Under the new rules, all Member States are free to set their desired level of security of supply. However, these rules should be transparent and verifiable. More importantly, capacity mechanisms will be governed not just by state aid guidelines but also by a European framework that will mandate and regulate cross-border participation and eventually lead to integrated capacity markets in the EU.[178]

The premise that smart grids and smart meters necessarily equate to quasi-automatic energy savings is not supported by recent research surveys.[179] Indeed, these studies have moderate expectations. On the one hand, smart meters are found to provide a wealth of information to consumers. On the other, this AMI develops over time into a normal background monitor fully embedded in household routines and practices. Consequently, smart meters fail to continuously nudge consumers to further economize on energy. Usually, supplementary savings are hard to materialize beyond a certain threshold. The potential for additional energy savings is frustrated due to the absence of wider policy and market support.[180] Considering the above, security of supply is in practice only marginally improved.

2.4.3. Affordability and competitiveness gains in prosumer markets

2.4.3.1. Advantages

Europe's energy systems require investments. There is evident discordance when it comes to which projects will be financed and which will be left out of the agenda.[181] This is a fundamentally political conflict which impacts the allocation of funding and the distribution of benefits across corporate sectors.

On the affordability front, smart grids can bring two positive results. First, a reduction of energy bills should arise from self-consumption and demand management. In turn, these will lead to lower energy quantities being transmitted from the grid. Second, prosumers have the option to install the infrastructure to generate their own energy. Prosumers can then sell their electricity surplus to

[172] European Commission, "Electricity interconnection targets," [Online]. Available: https://ec.europa.eu/energy/en/topics/infrastructure/projects-common-interest/electricity-interconnection-targets. [Accessed 22 May 2017].
[173] D. Buchan and M. Keay, "EU energy Policy - 4th time lucky?," The Oxford Institute for Energy Studies, 2016.
[174] *Ibid.*
[175] *Ibid*.
[176] *Ibid.*
[177] European Commission, "Commission proposes new rules for consumer centred clean energy transition", available at https://ec.europa.eu/energy/en/news/commission-proposes-new-rules-consumer-centred-clean-energy-transition.
[178] *Ibid.*
[179] T. Hargreaves, M. Nye and J. Burgess, "Keeping energy visible? Exploring how householders interact with feedback from smart energy monitors in the longer term," Energy Policy, vol. 52, pp. 126-134, 2013.
[180] *Ibid.*
[181] A. Goldthau and B. K. Sovacool, "The uniqueness of the energy security, justice, and governance problem," *Energy Policy,* vol. 41, pp. 232-240, 2012.

aggregators, DSOs, and other energy services companies.[182]

An important benefit of smart grids *vis-à-vis* fossil fuel imports is the resulting predictability of prices. Fossil fuel prices are renowned for their volatile nature compared to renewable energy prices.[183] Abrupt increases in fluctuating energy prices create severe hurdles for the poorest citizens in the EU. There is a considerable disparity between the decreasing costs on renewable energy generation and the frequent boom and bust cycles of global energy markets.[184] Smart grids may lead to higher prices in the case of ineffective load balancing. This raises the importance of developing effective demand response mechanisms that will optimize the benefits accruing from digital technologies.[185]

2.4.3.2. Risks and challenges ahead

In the absence of reliable electricity storage technologies, reserve capacity is ensured through capacity mechanisms. This policy tool puts a premium on electricity prices. The same is true of the priority dispatch mechanism, which prioritizes the utilization of renewable energy even when this is not the most competitive option. Therefore, it is safe to say that "structural changes to the design and operation of the power system are needed to ensure adequate incentives for investment and to integrate high shares of variable wind and solar power."[186]

Considering the underperformance of the ETS, the question of a carbon tax is of notable importance. The need to somehow put a price on carbon means that fossil fuels will be more expensive in the near future. There is hardly any rationale for investments in new coal-fired power plants to materialize. While one could argue that carbon pricing[187] has been successfully kept at bay by influential fossil fuel corporations,[188] two points should be considered. First, certainty is key in markets in general. It is for this reason that a price on carbon—one that can create a level-playing field and guide corporate policies for future decades—may transpire. Second, there are reasons for optimism in the wake of the open letter that six major energy companies signed prior to the Paris Agreement, asking for a carbon tax to be established.[189] The setting of sub-national and regional emissions trading schemes around the world is arguably paving the way for such a tax.[190]

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[182] European Commission, "Clean energy for all. New Electricity Market Design: A Fair Deal for Consumers," 2016.

[183] BBC, "Volatile fossil fuel prices make renewable energy more attractive," BBC, 21 March 2013. [Online]. Available: https://www.theguardian.com/sustainable-business/blog/fossil-fuel-prices-renewable-energy-attractive. [Accessed 7 September 2017].

[184] The International Energy Agency, "World Energy Outlook," OECD/IEA, Paris, 2016, p. 4, available at https://www.iea.org/publications/freepublications/publication/WorldEnergyOutlook2016ExecutiveSummaryEnglish.pdf

[185] P. Bradley, M. Leach and J. Torriti, "A review of the costs and benefits of demand response for electricity in the UK," *Energy Policy,* vol. 52, pp. 312-327, p. 313, 2013.

[186] The International Energy Agency, "World Energy Outlook," OECD/IEA, Paris, 2016, p. 4, available at https://www.iea.org/publications/freepublications/publication/WorldEnergyOutlook2016ExecutiveSummaryEnglish.pdf

[187] Putting a price on carbon (whether a carbon tax or an emissions trading scheme, i.e., tradable permits) is a way to combat climate change by making people pay for the environmental damage created. A carbon tax provides an added cost to the cost of the product. A tradable permit system sets a cap on the amount of GHG emissions. Firms must buy a permit to emit and there is only a limited number of permits. The cost of the permit is an added cost to the cost of the product. The price is based on the carbon content of the product. Doing so provides an incentive to find low-cost ways to reduce GHG emissions. If a measure costs less than the price, it would make sense to implement the measure, rather than paying the price. If a measure costs more than the price, it would make sense to pay the price. Conversely, people should be rewarded for protecting the environment. There are ethical considerations with putting a price on carbon because it affects the poor the most. Ideally, there should be harmonized carbon taxes, i.e., have the same carbon tax in all countries. See W. Nordhaus (2007) "To Tax or Not to Tax," Review of Environmental Economics & Policy.

[188] L. Summers, "Let this be the year when we put a proper price on carbon," Financial Times, 4 January 2015. [Online]. Available: https://www.ft.com/content/10cb1a60-9277-11e4-a1fd-00144feabdc0. [Accessed 7 September 2017].

[189] The Editorial Board, "The Case for a Carbon Tax," The New York Times, 6 June 2015. [Online]. Available: https://www.nytimes.com/2015/06/07/opinion/the-case-for-a-carbon-tax.html. [Accessed 30 June 2017].

[190] M. Paterson, "Selling Carbon: From International Climate Regime to Global Carbon Market," in *The Oxford Handbook of*

The above illustrates the complexity of policy-making in terms of subsidy mechanisms. This task is even more challenging considering that subsidy schemes can lead to significant market distortions. For example, national support schemes for renewable energy in Spain have led to huge tariff deficits in the domestic electricity market against which this EU Member State is still grappling.[191] In turn, these distortions thwart adequate market signals to the detriment of consumers. A suggested course of action boils down to the gradual phase-out process that would naturally culminate in a carbon tax. This carbon tax should incentivize renewable energy generation instead of fossil fuels imports.[192] Alternatively, a feed-in premium tariff for renewable energy production should be placed as the only subsidy to further encourage renewable energy production when needed.

The European Commission is renowned for its tough stance regarding subsidies and ensuing market distortions.[193] In this context, it aims to replace capacity mechanisms by scarcity pricing. Not only would supply-demand dynamics not be disturbed, but scarcity pricing would also lead to the optimal operation of the electricity market.[194] Indeed, demand response management maximizes network efficiency and minimizes associated costs, including capacity mechanisms. Such a development would constitute "a triple win – encouraging investment, enabling demand response and lessening the need for capacity mechanisms."[195]

A potential weakness resulting from effectively managing the electricity load at all times is that it may lead to higher prices, jeopardizing access to affordable energy. Energy politics are also against "perfect markets," as controlled electricity markets are more conducive to government interests.[196] This is because markets may lead to higher prices to reflect the state of supply and demand. However, this conflicts with the political aspirations of governments who want to meet their citizens' expectations. Low electricity prices are a way to achieve this.

More importantly, the advent of prosumer markets will mean that the same actors will have conflicting interests in their dual roles. On the one hand, prosumers will seek high prices for selling their electricity surplus, while on the other, they will prefer low prices for their energy usage. This contradiction may lead to sub-optimal profits from demand response schemes. At the same time, aggregators and other actors who can obtain significant market power may be able to reap the benefits of higher prices by passing them on to consumers, thereby neutralizing the benefits of demand response. A way out of this impasse may be through further emphasizing self-consumption. Hence, a fraction of households' energy needs are covered by the energy they produce themselves, thereby mitigating the importance of prices. This will indeed mark the democratization of the energy system. Energy access will be, at least in part, directly provided without the mediation of market mechanisms that may yield adverse results.

Broadly speaking, the rationale for prosumer markets draws from neo-classical economic presuppositions. However, such premises hardly apply in practical terms. Mainstream economics regard prosumers as rational actors that will endeavor to reach optimal energy consumption.[197] Prosumers have access to the necessary information to make the best decisions. Nevertheless, these

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Climate Change and Society, J. S. Dryzek, R. B. Norgaard and D. Schlosberg, Eds., Oxford, Oxford University Press, 2011, pp. 611-624.

[191] International Energy Agency, "Energy Policies of IEA Countries. Spain. 2015 Review," International Energy Agency, Paris, 2015, p. 10.

[192] D. Buchan and M. Keay, "EU energy Policy - 4th time lucky?," *The Oxford Institute for Energy Studies*, p. 8, 2016.

[193] Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, "Making the internal energy market work", at p. 8, COM(2012) 66 final (15 November 2012).

[194] *Ibid*.

[195] *Ibid.,* p. 3.

[196] J. Roberts and S. Skillings, "The market design initiative: Towards better governance of EU energy markets," *ClientEarth and E3G - Regulatory Assistance Project publication,* 2015, p. 3.

[197] S. Lavrijssen and A. Carillo Parra, "Radical Prosumer Innovations in the Electricity Sector and the Impact on Prosumer Regulation," *Sustainability*, no. 9, 2017, p. 9.

abstract expectations are usually frustrated in practice. This is because the average prosumer tends to display a limited capacity to process all the information, thereby falling short of maximizing his or her energy consumption.[198] Indeed, the available data might prove to be more than a regular consumer can comprehend and subsequently amend consumption patterns in an optimal manner.[199] Considering the above, expecting prosumer markets to perform automatically is wishful thinking. Educating prosumers is necessary to reap all the benefits tendered by smart grids. Specific emphasis should be given to the social groups that are likely to need the most guidance, such as senior citizens.

Bradley, Leach, and Torriti argue that the success of smart grid deployment relies on the trust between prosumers and other actors across the energy market.[200] They assert that "to maximise benefits from DR [demand response], it must be ensured that implementation of smart metering and other technologies is done in such a way as to ensure trust, maximum customer acceptability and satisfaction as well as education along with implementation."[201]

The costs associated with the deployment of smart grids will be contingent on the degree of customer engagement and trust. Should customers fail to recognize the benefits offered by smart meters, it will be harder for customers to engage with the process and trust the corporate players implementing the roll-out. This would certainly lead to a suboptimal roll-out of smart meters. Higher costs, limited benefits, and a hugely mismanaged opportunity will result. [202]

The new architecture of smart grids currently leaves the competences of the amalgam of actors in a policy vacuum. While DSOs are anticipated to invest, there are hardly any incentives in place for them to do so. Conversely, the benefits of such investments accrue predominantly to suppliers and consumers as well as local and national authorities that can meet their climate targets. Providing compensation to DSOs to upscale the development of smart grids is hence the first necessary step.[203] Rationalizing these compensation schemes by considering access to energy as tantamount to a public good may enhance the reception of such schemes among citizens.[204] What should be considered in-depth is the question of who pays for hedging against emergencies. Peak prices and scarcity pricing places costs on consumers. The development of storage capacity (e.g., EVs) adds an additional layer of costs that can either be funded through tariffs or passed on through retail prices. Hence, taxpayers pay for this. The same is true for capacity mechanisms.

2.5. CONCLUSION

The overhaul of the energy systems through the implementation of smart grids is crucial to drive the EU's low-carbon transition. While the smart grids' benefits make large-scale deployment compelling across the sustainability, security of supply, and affordability fronts, caveats remain and call for caution by policy-makers.

In conclusion, smart grids entail several benefits as they create the conditions for the proliferation of renewable energy generation; allow for self-consumption; boost energy efficiency via demand

[198] T. Dolphin and D. Nash, "Complex new world: Translating new economic thinking into public policy," Institute for Public Policy Research Paper, London, 2012.
[199] S. Lavrijssen and A. Carillo Parra, "Radical Prosumer Innovations in the Electricity Sector and the Impact on Prosumer Regulation," Sustainability, no. 9, 2017, p. 9.
[200] P. Bradley, M. Leach and J. Torriti, "A review of the costs and benefits of demand response for electricity in the UK," Energy Policy, vol. 52, pp. 312-327, 2013.
[201] *Ibid.*
[202] *Ibid.*
[203] C. Eid, R. Hakvoort and M. de Jong, *Global trends in the political economy of smart grids: A tailored perspective on 'smart' for grids in transition,* UNU-WIDER Working Paper 22/2016.
[204] R. Wustenhagen and E. Menichetti, "The Influence of Energy Policy on Strategic Choices for Renewable Energy Investment," in *The Handbook of Global Energy Policy*, A. Goldthau, Ed., West Sussex, John Wiley & Sons, 2013, pp. 373-388, p. 376.

response; alleviate energy poverty; lead to decreases in fossil fuel imports; decrease dependence on unreliable oil and gas suppliers, and volatile prices; promote low-carbon energy security; and boost aggregate demand.

On the negative side, smart grids require high upfront investments costs; call for large-scale citizens' engagement, incentivization and education; presuppose functional markets; and require high attention on cybersecurity issues. The transition to the new energy architecture may also generate supplementary adverse results, such as higher prices, abuse of market power, and increase in overall energy consumption. These possibilities create the need to communicate these likely outcomes to European citizens in a timely and efficient manner, devise relevant policy tools, and engage with the emerging prosumers.

As the deployment of smart grids and the energy transition constitute uncharted waters, there is a voluminous regulatory vacuum. For instance, the role of both TSOs and DSOs remains unclear in the new energy setting. The emergence of integrated energy services companies, aggregators, and energy co-operatives is also going to be determined to a great extent by future regulation. How cross-border markets will develop is another unresolved issue. The roll-out of smart meters also raises critical questions regarding data privacy that go to the root of human rights issues. Finally, the policy tools that will incentivize renewable energy generation and pave the way for a cleaner future are of central importance. Feed-in tariffs, feed-in premiums, and a carbon tax can all provide stimuli to the cause.

3. SMART GRID REGULATION

3.1. SMART METERING: PAVING THE WAY FOR SMARTER GRIDS

3.1.1. Background

"Smart grids" can be defined in a variety of ways. The following definition is proposed by the European Regulators Group for Electricity and Gas (ERGEG) and used also by the Council of European Energy Regulators (CEER) and the Commission:

> A smart grid is an electricity network that can cost-efficiently integrate the behaviour and actions of all users connected to it – generators, consumers and those that do both – in order to ensure economically efficient, sustainable power systems with low losses and high levels of quality and security of supply and safety.[205]

It might be interesting to note that this definition does not define smart grids by the kind of technology used. The term describes the complex connection between electricity generation, transmission, distribution, utilization, and information communication platforms via a system of sensors and other equipment across various levels of the electricity market.[206] One major purpose of smart grids is to target future behavior of the most important grid user, namely the consumer, with a view to finding more means to use energy when and where necessary, and under more convenient conditions.

Smart metering issues are of course related to smart grid issues. Yet, while smart meters are enablers

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[205] European Regulators Group for Electricity & Gas (ERGEG), "Position Paper on Smart Grids: An ERGEG Public Consultation Paper," ERGEG, E09-EQS-30-04, 2009, p.12; European Regulators Group for Electricity & Gas (ERGEG), "Position Paper on Smart Grids; An ERGEG Conclusion Paper," ERGEG, E10-EQS-38-05, 2010; European Commission, Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions "Smart Grids: from innovation to deployment", COM (2011) 202 final, Brussels, 12 April 2011; Council of European Energy Regulators (CEER), "CEER Status Review on European Regulatory Approaches Enabling Smart Grids Solutions ("Smart Regulation")," CEER, C13-EQS-57-04, Brussels, 2014; see also: M. Swora, "Intelligent Grid: Unfinished Regulation in the Third EU Energy Package," *Journal of Energy and National Resources Law,* vol. 28, pp. 465-480, 2010.

[206] F. Xiufeng, "Smart Grids in China: Industry Regulation and Foreign Direct Investment," *Energy Law Journal,* vol. 37, no. 1, pp. 135-176, p. 154, 2016.

for smart grids, they are merely one of many components of a smart grid. The ERGEG suggests that it is technically possible to develop smart grids and to roll out smart meters independently of each other.[207] Indeed, smart grids represent an amalgam of existing energy infrastructure and new information technology. Consequently, smart grid regulation transcends energy law and policy; it represents a balance between promoting the development of new technologies aimed at promoting the development of renewable energy, and the need to protect consumers and consumer interests.

3.1.2. The EU legal basis

Historically, the first legally binding instrument mentioning smart grids was the Measuring Instruments Directive.[208] It established the requirements for the deployment and use of instruments for measuring water, gas, electricity, and heat.[209] More recently, the Third Energy Package,[210] adopted in 2009, which seeks to further integrate the EU energy market, set out a more detailed agenda for the development of smart grids.[211] It enjoins Member States, subject to a positive cost-benefit analysis, to ensure the roll-out of smart meters. The implementation of intelligent metering systems aims to facilitate the active participation of consumers in electricity markets. Directive 2009/72/EC states that subject to an economic assessment of all the long-term costs and benefits to be conducted by September 2012, the Member States or any competent authority they designate shall prepare a timetable with a target of up to 10 years for the roll-out of smart meters.[212] Where the assessment is positive, at least 80% of consumers shall be equipped with smart meters by 2020.[213]

While the Directive is not an obligation on Member States to introduce smart grids, Article 3(10)-(11)[214] represents the legal foundation on which Member States can facilitate the development and

[207] European Regulators Group for Electricity & Gas (ERGEG), "Position Paper on Smart Grids; An ERGEG Conclusion Paper," ERGEG, E10-EQS-38-05, 2010.

[208] Directive 2004/22/EC of the European Parliament and of the Council of 31 March 2004 on measuring instruments, OJ L 135, 30.4.2004. 1-80.

[209] V. Papakonstantinou and D. Kloza, "Legal Protection of Personal Data in Smart Grid and Smart Metering Systems from the European Perspective," in *Smart Grid Secuirty. SpringerBriefs in Cybersecurity*, London, Springer, 2015, pp. 41-129.

[210] The Third Energy Package is a piece of European legislation for internal gas and electricity market in the EU whose aim is to open up the gas and electricity markets in the EU. The Third Energy Package consists of two Directives and three Regulations: Directive 2009/72/EC concerning common rules for the internal market in electricity and repealing Directive 2003/54/EC; Directive 2009/73/EC concerning common rules for the internal market in natural gas and repealing Directive 2003/55/EC; Regulation (EC) No 714/2009 on conditions for access to the network for cross-border exchanges in electricity and repealing Regulation (EC) No 1228/2003; Regulation (EC) No 715/2009 on conditions for access to the natural gas transmission networks and repealing Regulation (EC) No 1775/2005; and Regulation (EC) No 713/2009 of the European Parliament and of the Council of 13 July 2009 establishing an Agency for the Cooperation of Energy Regulators. For further details, see https://ec.europa.eu/energy/en/topics/markets-and-consumers/market-legislation.

[211] Directive 2009/72EC concerning common rules for the internal market in electricity and repealing Directive 2003/54/EC; Directive 2009/73/EC concerning common rules for the internal market in natural gas and repealing Directive 2003/55/EC; Regulation (EC) No. 714/2009 on conditions for access to the network for cross-border exchanges in electricity and repealing Regulation (EC) No. 1228/2003; Regulation (EC) No. 715/2009 on conditions for access to the natural gas transmission networks and repealing Regulation (EC) No. 1775/2005; Regulation (EC) No. 713/2009 of the European Parliament and of the Council of 13 July 2009 establishing an Agency for the Cooperation of Energy Regulators.

[212] Annex 1, paragraph 2, Directive 2009/72/EC of the European Parliament and of the Council of 13 July 2009 concerning common rules for the internal market in electricity and repealing Directive 2003/54/EC.

[213] *Ibid.*

[214] (10) Member States shall implement measures to achieve the objectives of social and economic cohesion and environmental protection, which shall include energy efficiency/demand-side management measures and means to combat climate change, and security of supply, where appropriate. Such measures may include, in particular, the provision of adequate economic incentives, using, where appropriate, all existing national and Community tools, for the maintenance and construction of the necessary network infrastructure, including interconnection capacity.

deployment of smart grids. The Directive also includes rules designed to benefit European energy consumers and protect their rights. One of these rights is the right to choose or change suppliers without extra charges. To make this a reality, a review of the existing technical and operational landscapes, together with their attendant regulatory framework is required.

The patchwork of binding directives set out in the Third Energy Package is further supplemented by several non-binding policy instruments, opinions, and recommendations issued by various EU institutions, including the Digital Agenda for Europe (2010),[215] the European Commission's policy document "Smart Grids: from innovation to deployment," and the Commission's recommendation on the preparation for the roll-out of smart metering.[216]

3.1.3. Current status in Europe

According to a 2014 study conducted in 27 European states by the CEER, 42% of participating countries already had a strategic roadmap to implement smart grids.[217] Expressed in absolute numbers, 10 countries had established such plans, while 17 had not.[218] Table 1 provides an overview of smart grid implementation plans across European States. Specifically, Austria, Cyprus, Denmark, Finland, France, Greece, Luxembourg, and Norway published national implementation plans. In 11 of the countries, these plans were established at the national level, while in Belgium, this plan is being developed at local levels.[219] Implementation plans were not created, for example, in the Czech Republic, Slovenia, and Spain. Although Great Britain had not established an implementation plan, it did develop a high-level route-map, which is the responsibility of the national GB Smart Grid Forum.[220] There is no convergence across Europe in terms of timeframe for the implementation of smart grids. In most of them, national governments and DSOs are responsible for implementation, while National Regulatory Authorities (NRAs) have monitoring functions.[221]

As far as actual implementation is concerned, Italy is a forerunner. Italy has completed smart metering implementation covering 99% of electronic metering points.[222] The DSO is the owner and responsible

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(11) In order to promote energy efficiency, Member States or, where a Member State has so provided, the regulatory authority shall strongly recommend that electricity undertakings optimise the use of electricity, for example by providing energy management services, developing innovative pricing formulas, or introducing intelligent metering systems or smart grids, where appropriate.

[215] Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, *A Digital Agenda for Europe,* Brussels, 26 August 2010, COM (2010) 245 final/2.

[216] Commission Recommendation of 9 March 2012 on preparations for the roll-out of smart metering, COM(2012) 1342 final, 2012/148/EU, OJ L 73, 13.2.2012, pp. 9-22.

[217] Council of European Energy Regulators (CEER), "CEER Status Review on European Regulatory Approaches Enabling Smart Grids Solutions ("Smart Regulation")," CEER, C13-EQS-57-04, Brussels, p.7, 2014.

[218] Since the publication of the CEER Report, Greece and Romania have implemented national programmes for the roll out of smart grids. See also: European Technology Platform (ETP), "National and Regional Smart Grids initiatives in Europe; Cooperation opportunities among Europe's active platforms," Brussels, 2016.

[219] For instance, the Flemish government approved the concept note "Digital meters: roll-out in Flanders" on 3 February 2017. The Flemish regulatory body VREG was asked by the Flemish government to update its earlier cost-benefit-analysis on the basis of the principles of the new concept note. VREG concluded that the roll-out of the smart meters in Flanders would be a correct policy decision. See VREG, "Kosten-batenanalyse slimme meters," VREG, 18 May 2017. [Online]. Available: http://www.vreg.be/nl/nieuws/kosten-batenanalyse-slimme-meters. [Accessed 11 July 2017].

[220] Council of European Energy Regulators (CEER), "CEER Status Review on European Regulatory Approaches Enabling Smart Grids Solutions ("Smart Regulation")," CEER, C13-EQS-57-04, Brussels, p.17, 2014.

[221] *Ibid.,* pp.7, 17.

[222] GEODE, "From Theory to Reality," in *GEODE Workshop*, Brussels, p. 9, 2014; European Commission, *Cost-benefit analyses & state of play of smart metering deployment in the EU-27,* Brussels: EC SWD(2014) 189, p.33, 2014.

party for implementing the smart grid and for guaranteeing power quality.[223] Remarkably, the Italian implementation is not merely aimed at achieving a roll-out of AMIs, but envisages their progressive improvement. For instance, given that the low voltage remote control meters that were first rolled out in 2001 have a lifespan of fifteen years, the first replacement campaign was launched in 2016.[224] These first generation (1G) meters have since reached their end-of-life. True to expectation, some companies have started installing 2G meters. The Italian experience is also a regulatory paragon because the law laid down functional specifications for 2G meters and identifies some crucial criteria. The requirements include: 2G meters, once installed, shall remain in operation, presumably, for another 15 years; and, over this period, they must be able to support every electric system transformation, such as the new distributed production paradigm and the changes of the electricity market.[225]

Other countries, such as Spain, have not developed an implementation plan for smart grids. Yet, the roll-out of smart meters is ongoing and is planned to be completed by 2018.[226]

Country	National or local level	Details
Austria	National level	National Smart Grids Technology Platform (www.smartgrids.at), published roadmap in 2010
Belgium	Local level	Wallonia: http://www.cwape.be/?dir=4&news=122 Flanders: http://www.vreg.be/nl/nieuws/kosten-batenanalyse-slimme-meters
Croatia	No	
Cyprus	National level	
Czech Republic	No	Under construction.
Denmark	National level	http://www.kebmin.dk/sites/kebmin.dk/files/klima-energi-bygningspolitik/dansk-klima-energi-bygningspolitik/energiforsyning-effektivitet/smart/smart%20grid-strategi%20web%20opslag.pdf

[223] The metering activity in Italy is regulated by the Regulation ARG/elt 199/11 (TIT).

[224] Enel S.p.A., "Enel Presents Enel Open Meter, The New Electronic Meter," Enel S.p.A., 27 June 2016. [Online]. Available: https://www.enel.com/en/media/press/d201606-enel-presents-enel-open-meter-the-new-electronic-meter.html. [Accessed 5 September 2017].

[225] Italian legislative decree 102/2014; Autorita per l'energia elettrica il gas e il sistema idrico (AGEESI), "Smart metering secon-generation systems for the measurement of electricity in low voltage," 6 August 2015. [Online]. Available: http://www.autorita.energia.it/it/docs/dc/15/416-15.jsp#. [Accessed 30 June 2017].

[226] European Commission, *Cost-benefit analyses & state of play of smart metering deployment in the EU-27,* Brussels: EC SWD(2014) 189, p.35, 2014.

Finland	National level	http://energia.fi/sites/default/files/haasteista_mahdollisuuksia___ja__hiilineutraali_visio_vuodelle_2050_20091112.pdf and http://www.emvi.fi/files/Tiekartta%202020%20-%20hankkeen%20loppuraportti_15_11_2011%20(2).pdf
France	National level	Published by the Energy Agency (ADEME), current version is available at: http://www2.ademe.fr/servlet/getDoc?sort=-1&cid=96&m=3&id=84680&ref=&nocache=yes&p1=111
Germany	No	
Great Britain	No	High-level route map has been developed.
Greece	National level	
Hungary	No	
Italy	National level	Incentives were deliberated by the energy authority (AEEG-SI) in 2010: http://www.autorita.energia.it/it/docs/10/039-10arg.htm The latest update concerns the second generation of smart meters, published in August 2016: http://www.autorita.energia.it/it/docs/dc/15/416-15.jsp
Lithuania	No	
Luxembourg	National level	For smart meters: http://www.eco.public.lu/documentation/etudes/2012/Etude_ComptageIntelligent.pdf
Norway	National level	www.nve.no/ams
Poland	No	
Portugal	No	
Romania	National level	http://www.anre.ro/ro/legislatie/smart-metering
Slovenia	No	Under construction.
Spain	No	

Sweden	National	A roadmap with recommendations on how to stimulate the deployment of smart grids for the years 2015 to 2030 is currently under construction by the Swedish Coordination Council for Smart Grid (http://www.swedishsmartgrid.se). Due date December 2014.
Switzerland	No	
The Netherlands	No	There is a vision document from the Taskforce Smart Grids established by the Ministry of Economic Affairs: http://www.rijksoverheid.nl/documenten-en-publicaties/rapporten/

Table 1 – Development of smart grid implementation plans in European Member States

Source: adaption and update of CEER Status Review on European Regulatory Approaches Enabling Smart Grids Solutions ("Smart Regulation"). C13-EQS-57-04, 18-Feb-2014, pp.42-43

With a view to promoting smart grids, many Member States have adopted regulatory incentives. In the CEER study, 79% of the countries were found to use tools for price regulation and 63% use performance indicators. In contrast, tools to regulate the provision of information, charges, and licensing are used significantly less. In most of the countries (76%), regulatory instruments will need to be adapted to facilitate the deployment of smart grids.[227] For example, in Belgium, as of 2018, Atrias will provide a new clearing house with new MIG6 market protocol implementation. This means that from 2018 onwards, new market models for prosumers with PV<10 kW peak will be established, making dynamic tariffs and sale of injection possible.[228] In Great Britain, the value of demand side flexibility for the electricity system will have to be reflected in the incentives to invest in smart grids.[229] In Lithuania, reaping the benefits of smart grids and managing related data privacy issues will require amendments to the current regulatory framework. In Italy, an "input-based" type of incentive regulation has been used for the transmission network as well as to support smart grid pilot projects in distribution networks. In Poland, in order to assess the benefits of smart metering for consumers, two new performance indicators were introduced. In Spain, the deployment of smart meters is ongoing, and it is viewed as a necessary step towards the development of smart grids. As part of Spain's efforts, the low voltage code has been proposed to be changed and a new discriminatory tariff that, thanks to smart meters, promotes charging of EVs at times of lower demand and prices has been established.[230] Despite what appear to be wide-spread attempts at regulatory reform within the continent, some actors in some of these market believe that regulatory reform may not be necessary as the current regime already provides an enabling ground for smart grids.[231] While this may be true

[227] Council of European Energy Regulators (CEER), "CEER Status Review on European Regulatory Approaches Enabling Smart Grids Solutions ("Smart Regulation")," CEER, C13-EQS-57-04, Brussels, p.14, 2014.

[228] Energy Outlook by Sia Partners, "Atrias and MIG6.0: Towards a new energy market model in Belgium," Energy Outlook by Sia Partners, 1 July 2016. [Online]. Available: http://energy.sia-partners.com/20160701/atrias-and-mig60-towards-new-energy-market-model-belgium. [Accessed 12 July 2017].

[229] Council of European Energy Regulators (CEER), "CEER Status Review on European Regulatory Approaches Enabling Smart Grids Solutions ("Smart Regulation")," CEER, C13-EQS-57-04, Brussels, p.14, 2014.

[230] *Ibid.*

[231] *Ibid.*

in some cases, the reality is that the existing regimes for electricity regulation are skewed towards the traditional grid and do not take into account the dynamic nature of smart grids.[232] Consequently, if smart grids are to be afforded an opportunity to enter what is currently often an oligopolistic market, regulatory reform will be essential.

Given that smart grids are largely experimental, demonstration projects have played a pivotal role in the development and deployment of the new technologies developed. Different countries in Europe have adopted various approaches towards promoting these demonstration projects. 61% of countries which participated in the CEER study use a combination of sources for funding.[233] 56% of the countries have been funding demonstration projects through industry funding, public funding institutions, the European Commission, and integrated municipal energy suppliers.[234] In 61% of the countries, governments are responsible for making decisions about granting funds.[235] For example, Finland passes costs onto consumers to a certain extent, but also adopts efficiency targets for companies.[236] Italy uses a cost-benefit indicator to select projects.[237] Austria finances demonstration projects through a combination of funding from industry, public institutions, and the national budget.[238] The federal government established the Climate and Energy Fund (Klima- und Energiefonds - KLIEN) to support the implementation of the climate strategy. KLIEN is responsible for providing most of the funds for demonstration projects.[239] Remaining costs are audited and covered through network charges during the regulatory period, with the application of efficiency targets. Great Britain does not apply efficiency targets to demonstration projects.[240] However, a key criterion for awarding funding is the project's value for consumers and its long-term efficiency. The NRA, rather than the government, is responsible for most decisions.[241]

Regarding more general incentives to encourage DSOs to adopt and fund smart grid innovation projects and how they are funded, most European countries use a combination of regulatory mechanisms, national government initiatives, and European initiatives. 63% of the countries assessed by CEER use general incentives not specific to smart grids to promote the development of smart grids.[242] For example, Austria incentivizes cost reductions through efficiency targets that do not distinguish between traditional and smart grids. As a result, regulated companies favor smart solutions when they are more cost efficient than other alternatives. Belgium has not yet specifically defined incentives, while Cyprus currently has no incentives in place. In the majority of countries, incentives

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232 E. Veldman, D. A. M. Geldtmeijer, J. D. Knigge and J. Slootweg, "Smart Grids Put Into Practice: Technological and Regulatory Aspects," *Competition and Regulation in Network Industries,* vol. 11, no. 3, pp. 287-306, at pp.288-289 2010; A. de Hauteclocque and Y. Perez, *Law & Economics Perspectives on Electricity Regulation,* European University Press (EUP), 2011.

233 Council of European Energy Regulators (CEER), "CEER Status Review on European Regulatory Approaches Enabling Smart Grids Solutions ("Smart Regulation")," CEER, C13-EQS-57-04, Brussels, p.19, 2014.

234 *Ibid.*

235 *Ibid.,* p. 20.

236 *Ibid.*

237 *Ibid.;* World Energy Council, "World Energy Perspective; Smart grids: best practice fundamentals for a modern energy system," World Energy Council, London, p.14-15, 2012.

238 Council of European Energy Regulators (CEER), "CEER Status Review on European Regulatory Approaches Enabling Smart Grids Solutions ("Smart Regulation")," CEER, C13-EQS-57-04, Brussels, p.20, 2014; Energy Research Knowledge Centre (ERKC), "SETIS Energy Research - Austria," European Commission, [Online]. Available: https://setis.ec.europa.eu/energy-research/country/austria. [Accessed 5 September 2017].

239 *Ibid.*

240 Council of European Energy Regulators (CEER), "CEER Status Review on European Regulatory Approaches Enabling Smart Grids Solutions ("Smart Regulation")," CEER, C13-EQS-57-04, Brussels, p.20, 2014.

241 *Ibid*.

242 *Ibid*., p.21.

for DSOs to innovate are funded through distribution network charges. National and European funding is also used to a significant extent. Many European countries adopt a combination of sources of funding. For instance, Austria, Finland, Italy, and France use network charges, national funding, and European funding. The Netherlands, Poland, and Norway use network charges as well as national funding. Lithuania and Slovenia use network charges and European funding. Greece and Spain use European as well as national funding.[243]

Finally, with regard to issues of data privacy and security, it is a commonly held view that the technology associated with smart grids poses significant risks to data privacy and cybersecurity; both require concerted regulatory reform if these risks are to be adequately managed.[244] However, according to the CEER status review on European regulatory approaches enabling smart grids solutions, there is no clear consensus about whether NRAs for the energy sector will and should be responsible for data security regulation in relation to smart meter data.[245] Be that as it may, different countries are considering different proposals and approaches for dealing with the problem of data protection and security for smart grids. For example, in the UK, data aggregation plans will be proposed by the DSO and then approved by the NRA, and data privacy requirements will be regulated in the context of license conditions.[246] In Slovenia, a cost-benefit analysis carried out by the NRA will also look at security issues.[247] In Spain, energy suppliers are precluded from having access to any information other than that of their own customers.[248] In contrast, in the Czech Republic, the Office for Personal Data Protection is responsible for data security.[249] Similarly, in France there is a separate and dedicated agency with competence over data security. In Germany, this is the responsibility of the Federal Office for Information Security.[250] Finally, in countries such as Belgium and the Netherlands, the NRA for the energy sector and the Data Protection Authority will work jointly on data security issues.[251]

The ERGEG Guidelines of Good Practice on regulatory aspects of smart metering recommend that:

> it is always the customer that chooses in what way metering data should be used and by whom, with the exception of metering data required to fulfil regulated duties and within the national market model. The principle should be that the party requesting information shall state what information is needed, with what frequency and will then obtain the customer's approval for this. Furthermore, full transparency on existing customer data should be the general principle.[252]

Table 2, from the CEER status review of regulatory aspects of smart metering, shows that many

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[243] *Ibid*.

[244] International Energy Agency (IEA), "Technology Roadmap; Smart Grids," OECD/IEA, France, p. 16, 2011; C. M. Hoerter, N. Feyel and A. Awad, "The Smart Grid: energy network of tomorrow - legal barriers and solutions to implementing the Smart Grid in the EU and the US," *International Energy Law Review,* vol. 8, pp. 291-300, p. 297, 2015.

[245] *Ibid*., pp.15-16.

[246] Ibid., p.16.

[247] *Ibid.*

[248] EnerConsultoría. Derecho de la energía, "contadores inteligentes y protección de datos," EnerConsultoría. Derecho de la energía, 8 December 2015. [Online]. Available: http://www.enerconsultoria.es/BlogLeyesEnergia.aspx?id=36002236&post=Contadoresinteligentesyprotecciondedatos. [Accessed 15 June 2017]

[249] Council of European Energy Regulators (CEER), "CEER Status Review on European Regulatory Approaches Enabling Smart Grids Solutions ("Smart Regulation")," CEER, C13-EQS-57-04, Brussels, p.16, 2014.

[250] *Ibid.*

[251] *Ibid.*

[252] European Regulators Group for Electricity & Gas (ERGEG), "Final Guidelines of Good Practice on Regulatory Aspects of Smart Metering for Electricity and Gas," ERGEG, E10-RMF-29-05, Brussels, p.12, 2011.

European countries indeed provide customers with information about, and ensure control over, their metering data, free of charge. However, the same table also shows that, in a number of countries, customers are not given control over their own data.[253]

	In control and informed	In control and not informed	No control over data	Not available
Free	**AT, BE, DK, FI, FR, DE, GB, IE, IT, LU, NO, PL, NL**			
Not free				

Table 2 – Data privacy and security regulation in European Member States

Source: CEER Status Review of Regulatory Aspects of Smart Metering. C13-RMF-54-05, 12 September 2013, p.16

3.1.4. Towards regulatory policy recommendations

The most relevant issues now revolve around network planning, priorities about grid reinforcement, and the ways DSOs are incentivized by national regulation to invest in smart grids. In simplified terms, one crucial issue concerns how to convince DSOs to test and innovate more. The "obvious" answer seems to lie in the regulatory incentives set by the NRAs. Yet, these agencies must also protect consumers from potentially excessive charges that natural monopolists such as DSOs could charge. This problem might be made even more acute when DSOs are state-owned and a major source of public revenue. Therefore, a balance must be struck between incentivizing DSOs to invest in smart grids and avoiding the imposition of high tariffs on consumers. Another important concern is the possibility of conflicts of interest between DSOs and self-producers. The desire of DSOs to optimize the economic benefits of grid utilization inherently conflicts with the idea of self-production. Consequently, without regulatory interventions, DSOs would be opposed to the development of technology that potentially affects their bottom line.[254] To achieve this, the support of the DSOs who have historically benefitted from the status quo is required.[255] Indeed, as has been demonstrated in Italy, DSOs are capable if the enabling environment is created to spearhead the desired change.

The European Commission as well as CEER and ERGEG hold that DSOs should be "market facilitators."[256] The notion of a market facilitator in this context means that DSOs should play a crucial

[253] Council of European Energy Regulators (CEER), "CEER Status Review on European Regulatory Approaches Enabling Smart Grids Solutions ("Smart Regulation")," CEER, C13-EQS-57-04, Brussels, p.16, 2014.

[254] Union of the Electric Industry (Eurelectric), "Regulation for Smart Grids," Eurelectric, Brussels, p. 14, 2011.

[255] A. de Hauteclocque and Y. Perez, *Law & Economics Perspectives on Electricity Regulation,* European University Press (EUP), p. 5, 2011.

[256] Council of European Energy Regulators (CEER), "CEER Status Review on European Regulatory Approaches Enabling Smart Grids Solutions ("Smart Regulation")," CEER, C13-EQS-57-04, Brussels, 2014; European Regulators Group for Electricity & Gas (ERGEG), "Position Paper on Smart Grids: An ERGEG Public Consultation Paper," ERGEG, E09-EQS-30-04, 2009.

role in setting up and managing the infrastructure necessary to perform new services, for example, demand side and load aggregation functions. But they should not be directly involved in the provision of such functions, which instead should be left to actors competing against each other (e.g., suppliers, aggregators, and Energy Service Companies (ESCOs)).

An additional set of regulatory challenges relate to the use of, and access to, smart meter data for smart grids. In most EU Member States, smart grids will make use of, and indeed rely on, smart meter data and infrastructure. In general, how consumers' data will be managed and by whom will have to be clearly explained. Otherwise, concern about privacy issues will be inevitable. Indeed, access to, as well as ownership of, data appear to be the key issues. These are not specific to the energy sector alone, but represent challenges that have been discussed thoroughly in other domains from which lessons may be drawn, such as "big data,"[257] which may be very useful for environmental performance improvement and therefore presents a big opportunity. While the regulatory nature of data protection for smart grids remains unclear, it seems likely that national bodies (e.g., independent regulatory agencies for energy), will play a central role. Regulators and policymakers more generally can learn from other sectors which have already had to face similar issues (e.g., internet search engines).

It is also important to consider the standardization of smart grid technology with a view to improving the security and integrity of the infrastructure. Although the smart grids' various components are at different levels of development, the concept of standardizing smart grid technology envisages their interconnection. Consequently, the absence of minimum technological requirements might result in, or facilitate the development of, vulnerabilities such as cyber-attacks. Similarly, situations where substandard assets that interface with a smart grid network and inhibit the smooth operation of the network or damage it are not inconceivable. For instance, smart grids connected to home communication networks could pose safety risks during lightning storms if the ground reference for equipment such as a smart meters and phone lines differ. The resulting high voltage surge through devices connected to the network could not only damage the equipment but pose severe electrocution risks.[258] Granted that standardization may occur at different levels, differing national standards increase costs, which are often passed on to consumers. It may therefore be prudent for the Agency for the Cooperation of Energy Regulators (ACER)[259] to take the lead on standardization efforts and provide an international framework to guide national, local, or enterprise-based standardization, and perhaps delineate the relevant levels of standardization. This will go a long way towards facilitating international interoperability and the market integration efforts of the EU.[260]

Furthermore, a significant barrier to smart grid deployment would be insufficient, or lack of, consumer demand for such technology. Given fears associated with cybersecurity, government espionage, and data protection, as well as public skepticism on the utility of such technology, concerted action must be taken to create sufficient awareness to tackle this barrier. It is therefore critical that more information be provided to citizens about the benefits of smart grids, and specifically about why smart meters are being deployed. This would increase consumer awareness and engagement in energy

[257] D. Drewer and V. Miladinova, "The BIG DATA challenge: impact and opportunity of large quantities of information under the Europol Regulation," *Computer Law & Security Review,* vol. 33, no. 3, pp. 298-308, 2017; I. S. Rubinstein, "Big data: the end of privacy or a new beginning?," *International Data Privacy Law,* vol. 3, no. 2, pp. 74-87, 2013; P. Leonard, "Customer data analytics: privacy settings for "big data" business," *International Data Privacy Law,* vol. 4, no. 1, pp. 53-68, 2014.

[258] A. R. Martin, "Safety issues and damage to equipment with both Smart Grid and home network connections," in *Product Compliance Engineering (ISPCE), 2010 IEEE Symposium*, Boston, 2010.

[259] ACER was established under the Third Energy Package as an independent agency of the European Union to oversee the completion of the internal energy market for electricity and natural gas by fostering cooperation among European regulators.

[260] M. Swora, "Smart Grids after the Third Liberalization Package: Current Developments and Future Challenges for Regulatory Policy in the Electricity Sector," *Yearbook of Antitrust and Regulatory Studies,* vol. 4, no. 4, pp. 9-22, p. 15, 2011; J. B. Eisen, "Smart Regulation and Federalism for the Smart Grid," *Harvard Environmental Law Review,* vol. 37, pp. 101-156, p. 123, 2013.

markets and, in turn, facilitate the development of smart grids.

3.2. DEMAND RESPONSE

3.2.1. Background

Demand response is defined by ACER as "changes in electric usage by end-use consumers from their normal load patterns in response to changes in electricity prices and/or incentive payments designed to adjust electricity usage, or in response to the acceptance of the consumer's bid, including through aggregation."[261] It has increasingly gained prominence as a tool to improve energy efficiency and the reliability of grids through the lowering of demand, especially during peak periods.

Demand response programs can be divided into two types: implicit and explicit demand response.[262] In price-based (implicit) demand response, consumers choose to become exposed to time-varying prices that reflect the value and cost of electricity at different time periods. Thus, consumers do not pay fixed prices but rather respond to wholesale market price variations and/or dynamic grid fees. Such flexible prices for consumers do not necessarily require "aggregators."[263]

In contrast, in incentive-based (explicit) schemes, consumers receive direct payments to change their consumption patterns upon request. This can be triggered by activation of balancing energy, differences in prices of electricity, or grid constraints. Consumers may earn from their consumption flexibility by acting individually or by contracting with an aggregator, which in turn might be either a third party or the customer's supplier. Aggregated demand side resources are then traded in the wholesale, balancing, and/or capacity markets.

Aggregators are new actors within the European electricity markets, occasioned by the new market design heralded by the Third Energy Package. They are service providers that employ demand facilities to sell pooled loads of electricity. As their name suggests, they perform the function of "aggregating" flexibility. They agree with industrial, commercial, and/or residential consumers to aggregate their capacity to reduce energy and/or shift loads on short notice. They then create a "pool" of aggregated controllable load, made up of smaller consumer loads. Finally, they sell the pooled load as a single resource to system operators, which use it for their technical needs. Aggregation allows smaller consumers who are excluded from the markets due to the size of their loads to participate in the markets.[264] It should be noted that while load aggregators are new actors emerging in several power markets in Europe, load aggregation is a service which might be performed by a variety of actors. This goes well beyond load aggregators to include "traditional" suppliers or other new companies (e.g., ESCOs). It is important to note that the two distinct forms of demand response are not necessarily substitutes. Indeed, customers might well participate in incentive-based demand response through either an aggregator or a "traditional" supplier and, at the same time, participate in a price-based demand response program based on time-varying prices.[265] Beyond "aggregating" consumers (demand), aggregators also have a role to play in "aggregating" prosumers (consumption, production, and storage).

Given that demand response gives rise to complex relationships between energy suppliers, customers, aggregators, and BRPs, a critical examination of the implications of these relationships is necessary to

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[261] Agency for the Cooperation of Energy Regulators (ACER), "Framework Guidelines on Electricity Balancing," ACER, FG-2012-E-009, Ljubljana, p.8, 2012; M. V. Balijepalli, *et al.*, "Review of demand response under smart grid paradigm," in *IEEE Xplore*, India, 2011.

[262] Smart Energy Demand Coalition , "Mapping Demand Response in Europe Today," Brussels, 2015.

[263] Smart Energy Demand Coalition, "Mapping Demand Response in Europe Today," Brussels, p.21, 2015.

[264] P. Baker and M. Hogan, "The Market Design Initiative: Enabling Demand-Side Market," Regulatory Assistance Project (RAP), p. 3, 2016.

[265] *Ibid*. pp.7, 21-22.

develop a suitable regulatory framework that enables and facilitates market participation for these actors and ensures that the full benefit of demand response mechanisms are reaped.

3.2.2. The EU legal basis

The Third Legislative Package provides a supranational legal foundation for the development of demand response in Europe. Article 3(10) of the directive on the common rules for the internal market enjoined Member States to adopt, amongst others, "demand-side management" measures as part of efforts to combat climate change and improve energy security. Further progress was made with the Energy Efficiency Directive (2012/27/EU),[266] Article 15(4) of which requires Member States to:

> ensure the removal of those incentives in transmission and distribution tariffs that are detrimental to the overall efficiency (including energy efficiency) of the generation, transmission, distribution and supply of electricity or those that might hamper participation of demand response, in balancing markets and ancillary services procurement.[267]

It also requires Member States to:

> ensure that network operators are incentivised to improve efficiency in infrastructure design and operation, and, within the framework of Directive 2009/72/EC, that tariffs allow suppliers to improve consumer participation in system efficiency, including demand response, depending on national circumstances.[268]

Furthermore, Article 15(8) of the Directive, establishes that:

> Member States shall ensure that national regulatory authorities encourage demand side resources, such as demand response, to participate alongside supply in wholesale and retail markets. Subject to technical constraints inherent in managing networks, Member States shall ensure that TSOs and DSOs, in meeting requirements for balancing and ancillary services, treat demand response providers, including aggregators, in a non-discriminatory manner, on the basis of their technical capabilities. Subject to technical constraints inherent in managing networks, Member States shall promote access to and participation of demand response in balancing, reserves and other system services markets, inter alia by requiring national regulatory authorities […] in close cooperation with demand service providers and consumers, to define technical modalities for participation in these markets on the basis of the technical requirements of these markets and the capabilities of demand response. Such specifications shall include the participation of aggregators.[269]

The set of rules ("network codes") drafted by the European Network of Transmission System Operators for Electricity (ENTSO-E) also emphasizes the importance of promoting demand response.[270] These rules are based on Framework Guidelines from ACER, which are based on priorities set by the European Commission. Specifically, the ACER Framework Guidelines on Electricity Balancing

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[266] Directive 2012/27/EU, on energy efficiency, amending Directives 2009/125/EC and 2010/30/EU and repealing Directives 2004/8/EC and 2006/32/EC, 25 October 2012.

[267] Directive 2012/27/EU, on energy efficiency, amending Directives 2009/125/EC and 2010/30/EU and repealing Directives 2004/8/EC and 2006/32/EC, 25 October 2012, Art.15.4.

[268] Directive 2012/27/EU, on energy efficiency, amending Directives 2009/125/EC and 2010/30/EU and repealing Directives 2004/8/EC and 2006/32/EC, 25 October 2012, Art.15.4.

[269] Directive 2012/27/EU, on energy efficiency, amending Directives 2009/125/EC and 2010/30/EU and repealing Directives 2004/8/EC and 2006/32/EC, 25 October 2012, Art.15.8.

[270] Article 8 (6) of Regulation (EC) No. 714/2009 on conditions for access to the network for cross-border exchanges in electricity and repealing Regulation (EC) No. 1228/2003 of the Third Energy Package set out the areas in which network codes are to be developed. They include balancing rules including network-related reserve power, data exchange and settlement rules, interoperability rules, network connection rules, network security and reliability rules, operational procedures in an emergency, amongst others.

provide that "[t]hese terms and conditions . . . including the underlying requirements, shall, in particular, be set in order to facilitate the participation of demand response, renewable and intermittent energy sources in the balancing markets."[271]

Finally, the Commission Guidelines on State aid for environmental protection and energy 2014-2020, in clarifying the conditions under which Member States are allowed to introduce "capacity remuneration mechanisms," requests Member States to consider alternatives such as demand response.[272] Specifically, the Guidelines state that:

> Member States should therefore primarily consider alternative ways of achieving generation adequacy which do not have a negative impact on the objective of phasing out environmentally or economically harmful subsidies, such as facilitating demand side management and increasing interconnection capacity.[273]

Furthermore, "the measure should be open and provide adequate incentives to both existing and future generators and to operators using substitutable technologies, such as demand-side response or storage solutions."[274] In addition:

> the measure should be designed in a way so as to make it possible for any capacity which can effectively contribute to addressing the generation adequacy problem to participate in the measure, in particular, taking into account the following factors: the participation of generators using different technologies and of operators offering measures with equivalent technical performance, for example demand side management, interconnectors and storage.[275]

These supranational frameworks are designed to ensure that fundamental modalities required for the successful deployment of demand mechanisms are possible. These modalities fall into three categories: the legal recognition of demand response, thereby allowing consumer loads to compete with other generation assets in all markets; the legalization and enablement of aggregation services in the markets; and the adjustment of technical specifications in recognition of consumer capabilities and requirements.[276] The transposition period for the Energy Efficiency Directive expired in June 2014.[277] The expectation was that, by this date, the modalities necessary for implementation across Member States would have been in place.

3.2.3. Current status in Europe

The CEER's study on regulatory approaches for smart grids revealed that, in order to promote demand response, 71% of the European countries sampled use static time of use tariffs and 58% of them use load control to incentivize demand side response.[278] In countries such as Italy, load control is limited

[271] Agency for the Cooperation of Energy Regulators (ACER), "Framework Guidelines on Electricity Balancing," ACER, FG-2012-E-009, Ljubljana, pp. 12-13, 2012.

[272] European Commission, *Guidelines on State aid for environmental protection and energy 2014-2020,* EC, (2014/C 200/01), 2014.

[273] *Ibid*.

[274] *Ibid*.

[275] *Ibid*.

[276] P. Bertoldi, P. Zancanella and B. Boza-Kiss, "Demand Response status in EU Member States," European Union, Italy, p.6, 2016.

[277] Directive 2012/27/EU, on energy efficiency, amending Directives 2009/125/EC and 2010/30/EU and repealing Directives 2004/8/EC and 2006/32/EC, 25 October 2012, Art.28.

[278] Council of European Energy Regulators (CEER), "CEER Status Review on European Regulatory Approaches Enabling Smart Grids Solutions ("Smart Regulation")," CEER, C13-EQS-57-04, Brussels, p.12, 2014.

to large industrial customers through remote means.[279] In countries such as Belgium, different types of load control are used by the TSO in the tertiary reserve ancillary services of TSO Elia. In countries such as Greece, there are differential tariffs for peak and off-peak consumption for households.[280] However, not all European States apply "price signals" to induce customers to change their consumption patterns.

Figure 1 maps the status of incentive-based (explicit) demand response in Europe as of 2015. The assessment carried out by the Smart Energy Demand Coalition (SEDC)[281] was based on the following four criteria: enabling consumer participation and aggregation, appropriate program requirements, fair and standardized measurement and verification requirements, and equitable payment and risk structures.[282] Overall, the SEDC suggests that, in Europe, incentive-based (explicit) demand response is still in its early development.[283] In a few cases, the SEDC suggests that markets do not permit consumer participation and are therefore "closed" to explicit demand response.[284] European countries have widely varying regulatory frameworks, each with its own participation requirements and rules. There generally are no standardized contractual arrangements governing the roles and responsibilities of the distinct actors involved. Furthermore, it is often impossible, or even illegal, to aggregate consumers' flexibility in practice.[285]

In some countries, demand response is a commercially viable product. For example, in Belgium, demand response can participate in a number of balancing markets, namely the primary and tertiary reserves.[286] However, a key obstacle is the requirement for aggregators to get the prior agreement of the customer's supplier or BRP[287] in order to be able to contract with the customer.[288] There are at least two private aggregators active on the market ("Restore.eu" and "Actility") as well as a tertiary off-take reserve scheme specifically for aggregators ("Dynamic Profile").[289]

Great Britain is deemed to have competitive energy markets and open balancing markets, though the emerging capacity market has raised uncertainties for demand response. Great Britain was the first EU Member State to open many of its electricity markets to the demand side.[290] Currently, all balancing markets allow the participation of demand response in general and aggregated load in particular.[291] However, according to the SEDC, the UK's measurement, baseline, bidding, and other procedural and operational requirements are not appropriate. Thus, even though the markets are formally open, in practice, results in terms of demand-side participation have been worsening over

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[279] *Ibid.*

[280] Hellenic Public Power Company SA (PPC), "Residential Night Tariff," PPC, 2013. [Online]. Available: https://www.dei.gr/en/oikiakoi-pelates/timologia/oikiako-timologio-me-xronoxrewsi-oikiako-nuxterino. [Accessed 4 July 2017].

[281] Smart Energy Demand Coalition, "Mapping Demand Response in Europe Today," Brussels, pp.8-12, 2015.

[282] J. M. R. Fernandez *et al.*, "Renewable generation versus demand-side management. A comparison for the Spanish market," *Energy Policy,* vol. 96, pp. 458-470, 2016.

[283] Smart Energy Demand Coalition, "Mapping Demand Response in Europe Today," Brussels, 2015.

[284] Id.

[285] *Ibid.,* pp.11.

[286] *Ibid. pp.* 47-54; REstore, "Belgian TSO Elia in demand response first," 5 September 2016. [Online]. Available: https://www.restore.eu/export/pdfNews/113. [Accessed 6 September 2017].

[287] Given that market players have an implicit responsibility to balance the electricity system, the balance responsible parties are financially responsible for keeping their own position (sum of their injections, withdrawals and trades) balanced over a given timeframe.

[288] Smart Energy Demand Coalition (SEDC) Mapping Demand Response in Europe Today – 2015, p.47.

[289] *Ibid.,* p.51.

[290] *Ibid.,* p.85.

[291] *Ibid.*; PA Consulting, "OFGEM: Aggregators - Barriers and External Impacts," PA Consulting, London, 2016.

time.[292] Furthermore, the capacity remuneration mechanism introduced in 2014 is said not to place demand-side resources on a "level playing field" with generation resources. Indeed, only one demand-side aggregator out of around 15 operating in the market managed to secure a contract in the first capacity market auction.[293]

France and Switzerland have redrafted their program requirements and defined clear roles and responsibilities precisely to allow independent aggregation.[294]

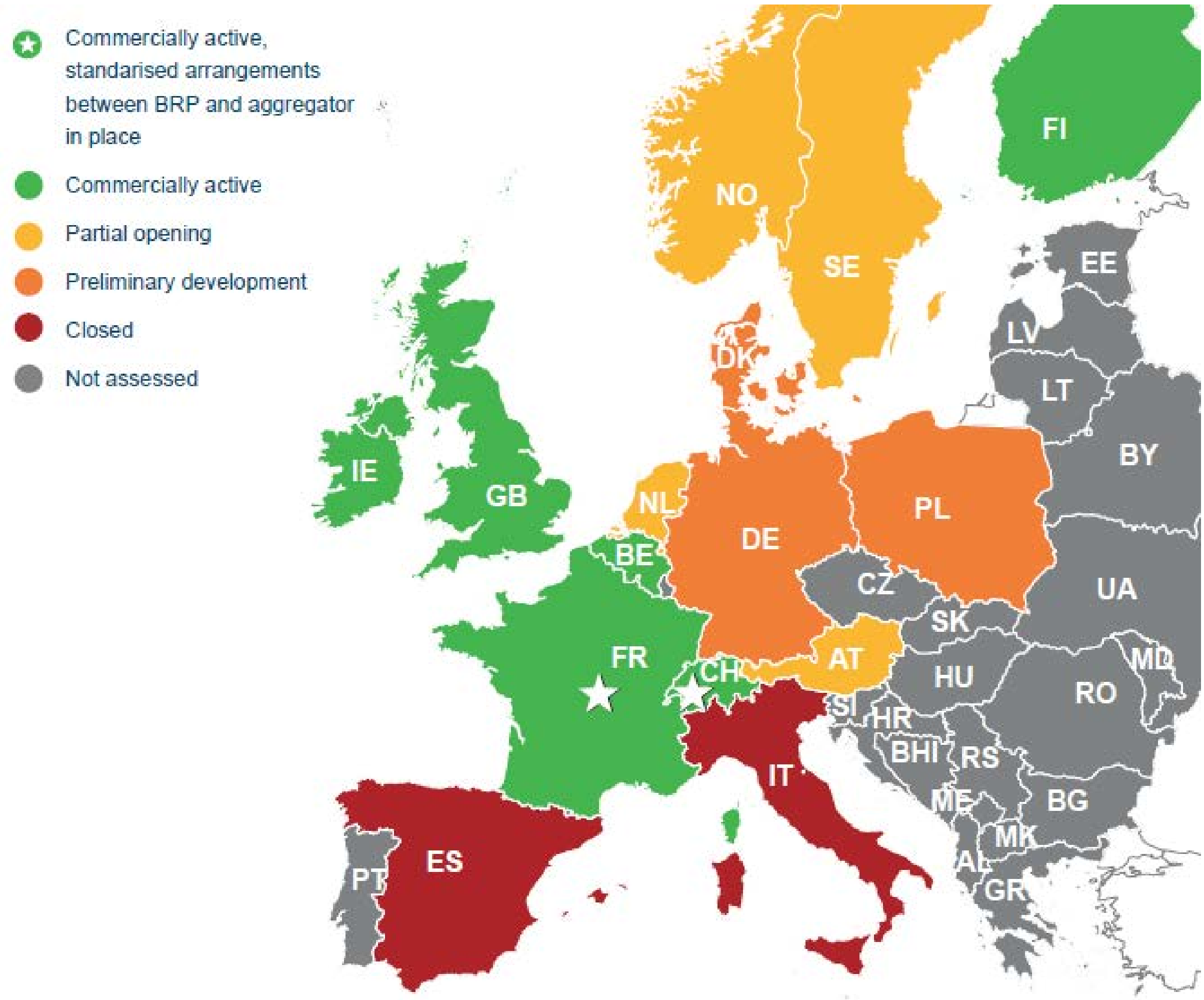

Figure 1 – Map of incentive-based (explicit) demand response development in Europe today

Source: Smart Energy Demand Coalition (SEDC) Mapping Demand Response in Europe Today – 2015, p. 9.

Other European countries still present important regulatory barriers, notably program participation requirements not yet tailored for both generation and demand-side resources. For example, Austria requires consumers to install a secure and dedicated telephone line in order to participate in the balancing market.[295] Norway requires TSO signals to be delivered over the phone, thus making the

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[292] Smart Energy Demand Coalition (SEDC) Mapping Demand Response in Europe Today – 2015, p.85.

[293] *Ibid.,* p.85.

[294] *Ibid*., p.10.

[295] *Ibid.*; P. Bertoldi, P. Zancanella and B. Boza-Kiss, "Demand Response status in EU Member States," European Union, Italy, 2016, p. 31.

minimum bid-size high.[296] As a result, the participation of consumers other than large industrial consumers is hindered.[297] Similarly, technical and organizational rules do not consider some of the requirements for the provision of balancing services in sufficient detail.[298] This includes the negative impact of complex and lengthy approval procedures and their associated costs on market entry and participation.

In still other European countries, aggregated demand response is either illegal or its development is seriously hindered due to regulatory barriers. For example, in Italy, the notion of load aggregator is not formally recognized and no regulatory framework currently exists.[299] Poland and Spain do not seem to be taking the steps required to foster the development of incentive-based (explicit) demand response.[300] Indeed, load aggregators do not exist in every EU Member State. The analogous consideration applies to regulatory frameworks governing their operation.

Italy relies mostly on hydro and gas generation to satisfy its flexibility requirements, while the framework governing consumer participation in balancing markets has not been set up yet. Interruptible contracts are a partial exception and constitute a dedicated demand response program.[301] Load aggregation is not allowed, nor is there currently any regulatory framework in place to govern such activity.[302] Yet, the strategic guidelines for the period of 2015-2018 published by the NRA included an evaluation of demand-side mechanisms and hence might reflect the possible opening of balancing markets to demand response.[303]

Like Italy, Spain also uses mainly hydro and gas generation for its flexibility needs.[304] Even though some smart grid pilot projects are currently being developed, incentive-base (explicit) demand response is currently modest. Even though there is one interruptible load program that allows incentive-based (explicit) demand response, the scheme is only open to large consumers and has not been used for years. Importantly, load aggregation is illegal. Yet, proposals to open balancing markets to demand response could prompt changes in 2016-2018, especially in light of the smart meter roll-out expected by 2018.[305]

3.2.4. Towards regulatory policy recommendations

Overall main regulatory barriers found repeatedly across European countries include:

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[296] Smart Energy Demand Coalition (SEDC) Mapping Demand Response in Europe Today – 2015, p.10.

[297] *Ibid*.

[298] *Ibid.,* p. 45.

[299] P. Bertoldi, P. Zancanella and B. Boza-Kiss, "Demand Response status in EU Member States," European Union, Italy, 2016, p.69.

[300] Smart Energy Demand Coalition (SEDC) Mapping Demand Response in Europe Today – 2015, pp.10-11.

[301] *Ibid*., p.98.

[302] *Ibid.*, p.151.

[303] AEEG "DCO 528/2014/A, consultation document". Published on 30 October 2014, available at: http://www.autorita.energia.it/allegati/ docs/14/528-14.pdf.

[304] Smart Energy Demand Coalition (SEDC) Mapping Demand Response in Europe Today – 2015, p.131; P. Bertoldi, P. Zancanella and B. Boza-Kiss, "Demand Response status in EU Member States," European Union, Italy, 2016, p. 81.

[305] Smart Energy Demand Coalition (SEDC) Mapping Demand Response in Europe Today – 2015, p.131.

1. **Demand response might not be accepted as a flexibility resource:** in some European countries wholesale, balancing and/or capacity markets do not accept aggregated demand as a flexibility resource.[306]

2. **Inadequate and/or non-standardized baselines:** in some European countries, standardized measurement and baseline methodologies are absent. Current methodologies are designed for generators and, consequently, do not accurately measure changes in consumption. This could hinder demand response, because consumers might not receive adequate payment for their flexibility.[307]

3. **Technology-biased program requirements:** program participation requirements, historically designed for national generation, might not include demand side resources.[308] Power markets more in line with demand response timeframes have to be established (e.g., based on 15- rather than 60-minute timeframes).[309]

4. **Aggregation services are not fully enabled:** prequalification, registration, and measurement may still be conducted at the level of individual consumers, rather than at the level of pooled loads brought together by the aggregator, which hinders entry by placing heavy administrative and legal burdens on individual consumers.[310] Moreover, there is often no real definition of load aggregators. To promote the possibility for consumers to contract with aggregators, load aggregators must be legally acknowledged as facilitators of demand side flexibility.

5. **Aggregators, where existing, are currently active at the high and medium voltage levels, rather than the low voltage level:** load aggregators exist in some countries, such as France and Belgium. Yet, their activities are currently focused on the high and medium voltage levels, namely at transmission and dealing with TSOs. We therefore must learn how these activities might be translated, if at all, at the low voltage level, namely at distribution and when dealing with DSOs.

6. **Lack of necessary infrastructure:** while there is much discussion about the emergence of load aggregators, it must not be forgotten that aggregators rely on certain infrastructures to provide load aggregation services. The key step here is to install smart meters, which in some of the European member states are not yet deployed.[311]

7. **Lack of standardized processes between consumers, BRPs, and aggregators:** it is important that standardized processes protect the relationship between customers and aggregators, and govern bidirectional payment of sourcing costs as well as compensation between the BRPs (often the traditional suppliers) and the aggregators.[312] In other words, it is crucial to put contracts in place between DSOs, load aggregators, and customers. It is vital that the right of

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306 Smart Energy Demand Coalition, "Mapping Demand Response in Europe Today," Smart Energy Demand Coalition, Brussels, 2015, p. 11.

307 *Ibid.*

308 *Ibid.*

309 *Ibid. p.82*; P. Bertoldi, P. Zancanella and B. Boza-Kiss, "Demand Response status in EU Member States," European Union, Italy, 2016, p. 54.

310 Smart Energy Demand Coalition, "Mapping Demand Response in Europe Today," Smart Energy Demand Coalition, Brussels, 2015, p. 11.

311 European Commission, "Benchmarking smart metering deployment in the EU-27 with a focus on electricity," European Commission, COM(2014) 356, Brussels, 2014.

312 *Ibid.*

consumers to offer their flexibility on the market be acknowledged, while guarantees are put in place so that consumers maintain their rights when they sign up for demand response. There should be a provision for the network side to ensure some minimum balancing support through demand response schemes. Thus, demand response schemes could really contribute in reducing other capacity mechanisms.

8. **Provision of information to consumers:** this relates not only to energy prices and how much customers could save by changing their consumption patterns, but also to other kinds of information. Consumers could feel more motivated to engage in demand response programs and choose among suppliers and aggregators depending on the mix of energy sources from which the electricity they consume is produced. Consumers could prefer a program and service provider that produces energy from cleaner sources, even if the monetary gains they could make were limited.

9. **Differences across consumers that could hinder their participation**: in addition to different monetary incentives and regulatory frameworks primarily set at the national level, consumers within same countries could, *de facto*, find themselves facing different possibilities for joining demand response schemes. Just as in the case of the installation of micro-generation renewable plants (e.g., solar panels on the rooftop), it might be that consumers living, say, in a flat, rather than in a house with a garden, do not have the same possibility to engage in demand-side flexibility solutions. Hence, it might be appropriate for the relevant authorities at the national level and, if appropriate, also at the EU level, to consider how to create a more level playing field on the consumer side.

10. **Lack of financial incentives for consumers, especially through automatic adjustments within comfort levels**: it is now well-known, especially thanks to studies from the discipline of economics, that the efforts of policymakers to empower consumers are often frustrated by the fact that consumers do not react to efforts to alter their consumption patterns.[313] Ironically, perhaps this is because they do not see the financial gain as sufficient reward for altering their consumption. Considering this difficulty, in addition to increasing financial incentives and promoting more cost-reflective tariffs that provide price signals for customers to adjust their consumption patterns, regulation could also consider providing fiscal incentives. Governments might consider putting in place policies that, through taxation, support demand-side adjustments. Another aspect that could be considered is a stronger use of “negative” financial incentives. These could manifest as increases in the penalties, rather than rewards for changing consumption patterns, which might be more effective than “positive” incentives.

11. **Automatization of demand response mechanisms**: consumer participation in demand response programs should be made as easy as possible. In addition to concentrating on the rewards side of the equation, attention should be devoted also to the cost side. Consumers should have to invest as little time and effort as possible, so that they might engage in demand response even if the financial rewards are not very high in absolute terms. Automatization of responses appears to be crucial in this context. Consumers will not have to do anything, because adjustments in their consumption patterns will be automatic. The North American market is more experienced in the automatization of changes in consumption patterns within

[313] S. Nolan and M. O'Malley, “Challenges and barriers to demand response deployment and evaluation,” *Applied Energy,* vol. 152, pp. 1-10, 2015.

customers' "comfort zone."[314] For example, changes in the intensity of lighting within a flat that will not be noticed by its residents and will be activated automatically when appropriate. The US power markets are also more experienced with load aggregators. Hence it appears desirable to look at these experiences and learn from them.

3.3. ELECTRICITY STORAGE AND ELECTRIC VEHICLES

3.3.1. Background

While solutions to the problem of large capacity energy storage are still in experimental stages of development,[315] the importance of energy storage in future energy management systems cannot be underestimated. Current storage systems meet the temporary storage needs of small to medium-scale generation, usually from RES. Despite the lack of technological advancement, energy storage is beneficial to all levels of the electricity market. First, they provide an option to redress the problem of the intermittence of RES generation.[316] Further, the ability to store energy when prices are low and possibly sell when prices increase presents an opportunity for arbitrage.[317]

However, the nearest term benefit is evident at the consumer level where it can contribute to the integration of decentralized production.[318] This benefit is further augmented when EVs are integrated into a smart grid design. EVs have traditionally been lauded as climate-friendly alternatives to internal combustion engines, which emit greenhouse gases. However, more recently, the lithium-ion batteries used in EVs have been recognized as a potential storage device that can be used to provide reserve capacity to a grid, under what has come to be known as the Vehicle to Grid (V2G) system.[319] Further, the integration of EV charging infrastructure with the appropriate management systems will allow the charging of EVs to become a controllable load. This would go a long way towards improving the reliability of the distributed power system,[320] while ensuring that the EV is charged at the most convenient time. Despite the inability to store large volumes of electricity to meet traditional modes of supply in traditional electricity markets, current storage technology could play an important role in VPPs.

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[314] Smart Energy Demand Coalition, "Mapping Demand Response in Europe Today," Smart Energy Demand Coalition, Brussels, 2015; P. Zancanella and B. Boza-Kiss, "Demand Response status in EU Member States," European Union, Italy, 2016, p. 42.

[315] 1. Fluid storage, particularly pumped hydroelectric plants are the most common. They use off-peak electricity to pump water from a low reservoir uphill into an elevated reservoir. The water is then released through turbines to generate power at very short notice. 2. Compressed Air Energy Storage (CAES) operates similarly although still experimental and not developed enough as a commercial storage application – electricity is used to compress air underground caverns, then tapped later to drive gas turbines. 3. Hydrogen storage which involves the hydrolysis of water to produce hydrogen gas, which is then compressed and stored, then converted to power when needed. However, the high explosion risk associated with the technology has impeded its viability.

[316] X. Luo, J. Wang, M. Dooner and J. Clarke, "Overview of current development in electrical energy storage technologies and the application potential in power system operation," *Applied Energy,* vol. 137, pp. 511-536, 2015; G. Masson, J. I. Briano and M. J. Baez, "Review and Analysis of PV Self-Consumption Policies," International Energy Agency - Photovoltaic Power Systems Programme, p.61, 2016.

[317] Committee on Industry, Research and Energy (ITRE) European Parliament, "Energy Storage: Which Market Designs and Regulatory Incentives Are Needed?" European Commission, p.17, 2015.

[318] E. Stoppani, "Smart Charging and Storage: bridging the gap between electromobility and electricity systems," *International Energy Law Review,* no. 1, p. 17, 2017.

[319] G. Masson, J. I. Briano and M. J. Baez, "Review and Analysis of PV Self-Consumption Policies," International Energy Agency - Photovoltaic Power Systems Programme, p.63, 2016; D. Changala and P. Foley, "The Legal Regime of Widespread Plug-In Hybrid Electric Vehicle Adoption: A Vermont Case Study," *Energy Law Journal,* vol. 32, pp. 99-124, at pp. 108-109, 2011.

[320] E. Veldman, D. A. M. Geldtmeijer, J. D. Knigge and J. Slootweg, "Smart Grids Put Into Practice: Technological and Regulatory Aspects," *Competition and Regulation in Network Industries,* vol. 11, no. 3, pp. 287-306, p. 300, 2010.

VPPs aggregate energy produced by diverse distributed generation sources, including small scale generators. Consequently, unused electricity stored in batteries from small scale RES could be fed-into a VPP. Similarly, energy stored in the lithium-ion[321] batteries used in EVs could also be fed-into VPP or grids under the V2G system.

There are predictions that electric vehicles will make up 14% of total car sales by 2025, up from 1% in 2017.[322] The Organization for Petroleum Exporting Countries expects 266 million EVs to be on the street by 2040, up from 46 million.[323] Regulations are tightening (which will be analyzed in the following sections) to the extent that the UK and France, among other European countries, have announced that all new cars must be zero-emission by 2050.[324] If implemented in other jurisdictions beyond Europe, this sort of policy will have serious implications. For instance, in the US, around 85% of workers commute by car[325] and around 65% of oil consumption comes from driving on roads.[326] China, which accounted for about 50% of the electric vehicles sold in 2016, aims at 2 million electric and plug-in hybrid cars on China's roads by 2020 and 7 million by 2030.[327] Most of the nearly 1 billion cars on the road today are powered by fossil fuels.[328] Moreover, existing electric cars reduce CO2 emissions by 54% compared with petrol-powered cars.[329]

In addition to the high price, two major concerns seem to arise for electric car buyers: where can one charge an electric car and how long will it take? Currently, over 90% of charging is done at home.[330] However, in the US, public EV charging stations have been growing steadily since 2011.[331] Carmakers such as Mercedes, BMW, Volkswagen, and Ford have said that they will together install a total of 400 public charging points in Europe, which will deliver 350KW.[332] In Europe, countries such as Germany, France, the Netherlands, and Norway are committed to improving access to public charging.[333] In 2017, China is installing 800,000 public charging points, including semi-public charging points for taxis and commercial vehicles at workplaces.[334] The owner of a small electric car can have its battery charged in eight hours with a standard residential electricity supply and a 3.5KW charger.[335] An acceptable solution to these two concerns is crucial for the EV revolution to take off.

3.3.2. The EU legal basis

The legal framework governing electricity storage in Europe is provided at the EU level by the Third

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[321] It will be interesting to see whether Chile, a very rich country in lithium, will end up a new Saudi Arabia as a result of large amounts of lithium.

[322] Peter Campbell, "Electric car costs forecast to hit parity with petrol vehicles," Financial Times, 19 May 2017.

[323] "OPEC Drastically Increases 2040 Electric Vehicle Forecast," *Manufacturing*, 18 July 2017, available at https://mfgtalkradio.com/opec-drastically-increases-2040-electric-vehicle-forecast/.

[324] The Economist, "Roadkill," 12 August 2017, pp. 7-8.

[325] *Ibid*.

[326] *Ibid*.

[327] The Economist, "Electrifying everything," 12 August 2017, pp. 13-15, at 13.

[328] The Economist, "Roadkill," 12 August 2017, pp. 7-8.

[329] *Ibid.* (citing the National Resources Defense Council in the USA).

[330] The Economist, "Charge of the battery brigade," 9 September 2017, pp. 63-64, at p. 64.

[331] Idem, citing the US Department of Energy.

[332] The Economist, "Charge of the battery brigade," 9 September 2017, pp. 63-64, at p. 64.

[333] Idem.

[334] Idem.

[335] Idem.

Energy Package.[336] At the same time, laws are under development at the national level that will regulate electricity storage applications.[337]

It is important to note that Directive 2009/72/EC[338] does not expressly mention energy storage. However, the proposal for a new directive on common rules for the internal electricity market of February 2017 does regulate energy storage. The text of the proposal clarifies that DSOs should not be allowed, directly or indirectly, to own storage facilities.[339]

In respect of EVs, the EU has set for itself an ambitious target of reducing the use of internal combustion engine vehicles by 50% by 2030 and phasing them out entirely by 2050 as part of efforts to reduce GHG Emissions.[340] The alternative fuels directive[341] encourages Member States to develop systems that enable EVs to feed power back into the grid. In addition, the Commission has recently published a strategy for low-emission mobility, which seeks to promote the removal of obstacles to the scaling up of the use of EVs.[342]

3.3.3. Current status in Europe

After conducting an overview of the distinct electricity storage technologies used in Europe at the end of 2012 and their expected increase in the ensuing five years, the CEER memo on development and regulation of electricity storage applications concluded that hydro-pumping storage is currently the most commonly used electricity storage technology.[343] This picture is not expected to change considerably in the next several years. Although other technologies will be employed (e.g., flywheels, compressed air electricity storage, and electrochemical storage), they will still represent less than 3% of installed power.[344] Even if they increase in number of applications, the associated growth in energy capacity will be minor. It is expected that electrochemical storage will increase by up to 100MW thanks to new demonstration projects.[345] However, this stands in contrast with hydro-pumped storage, which represents about 37GW in storage capacity in the CEER member states.[346] Of course, the situation

[336] Directive 2009/72EC concerning common rules for the internal market in electricity and repealing Directive 2003/54/EC; Directive 2009/73/EC concerning common rules for the internal market in natural gas and repealing Directive 2003/55/EC; Regulation (EC) No. 714/2009 on conditions for access to the network for cross-border exchanges in electricity and repealing Regulation (EC) No. 1228/2003; Regulation (EC) No. 715/2009 on conditions for access to the natural gas transmission networks and repealing Regulation (EC) No. 1775/2005; Regulation (EC) No. 713/2009 of the European Parliament and of the Council of 13 July 2009 establishing an Agency for the Cooperation of Energy Regulators.

[337] Council of European Energy Regulators, "Development and Regulation of Electricity Storage Applications," Council of European Energy Regulators, Brussels, 2014, p.3.

[338] Directive 2009/72/EC of the European Parliament and of the Council of 13 July 2009 concerning common rules for the internal market in electricity and repealing Directive 2003/54/EC.

[339] Proposal for a Directive of the European Parliament and of the Council on common rules for the internal market in electricity, at p. 82, COM(2016) 864 final/2 (23 February 2017).

[340] Roadmap to a single European Transport Area – Towards a competitive and resource-efficient transport system, at p. 9, COM(2011) 144 Final (28 March 2011).

[341] Directive 2014/94/EU of the European Parliament and of the Council of 22 October 2014 on the deployment of alternative fuels infrastructure.

[342] Communication from the Commission to the European Parliament, The Council, The European Economic and Social Committee and the Committee of the Regions. A European Strategy for Low-Emission Mobility COM(2016) 501 Final of 20 July 2016.

[343] P. Crossley, "Defining the Greatest Legal and Policy Obstacle to "Energy Storage"," *Renewable Energy Law & Policy Review,* vol. 4, p. 268, 2013.

[344] Council of European Energy Regulators, "Development and Regulation of Electricity Storage Applications," Council of European Energy Regulators, Brussels, 2014, pp. 2-3.

[345] *Ibid.*

[346]

might change, even dramatically, thanks to breakthrough technologies.[347]

The regulation of storage assets faces many conceptual and practical challenges. Conceptually, there is no consensus on the definition of storage assets. The question of whether they should be treated as generation assets or consumption units is particularly unresolved. This lack of clarity stems from the fact that, while storage assets can generate electricity in the literal sense of "generation," the amount of electricity generated is typically not enough to provide a net positive flow to the electricity system.[348] On the other hand, they cannot be properly classified as consumption units because they do not actually consume the energy that they take up. Could they also be classified as part of a transmission or distribution network, given that they can be a bridge asset between generators and final consumers? The answers to these questions is fundamental to the development of an appropriate regulatory regime because they impact, *inter alia*, ownership, pricing, and the imposition of taxes and levies.

Regarding issues of ownership, the CEER memo shows that in most European countries, storage applications are owned by generators even though, in some countries, network operators may, to a certain degree, own storage applications.[349] In most European countries, storage can provide services to both network operators and generators and its primary users are owners.[350] The ownership of storage assets is one of the challenges that impinges the development of appropriate regulation. While there is no doubt that market operators such as TSO would benefit from owning storage assets, their unique position in the market presents an information asymmetry which would operate unfairly to their advantage against other market players. This is particularly true if stored energy is participating in the balancing and ancillary markets. It is in response to this problem that current proposals for the Electricity Directive seek to proscribe the ownership of storage assets by the owners or operators of network infrastructure.[351] The proposed proscription is in keeping with the EU's unbundling policy as a bid to prevent counter-competitive activity in electricity markets.

In Spain, although there is no general regulatory framework for electricity storage, there are hydro-pumped storage power plants that perform the function of providing power during hours of peak consumption.[352] The only exception relates to regulation of storage for small self-consumption systems. Under the Electricity Sector Law 24/2013, battery owners do not only have to pay an additional tax, but are also not allowed to reduce the maximum power they have under contract with their supplier.[353] While it may be argued that this is intended to maintain grid integrity, when coupled with the high self-consumption tax, the regulatory regime for self-consumption and storage appears to be ill-considered.

In some cases, the regulatory framework not only does not promote, but actually hinders the development of storage. For example, in some countries, taxation is not favorable to storage, as

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[347] *Ibid.*; European Commission, "Energy storage – the role of electricity", Commission Staff Working Document, SWD (2017) 61, Brussels, 2017.

[348] G. C. Gissey, P. E. Dodds and J. Radcliffe, "Regulatory barriers to energy storage deployment: the UK perspective," RESTLESS Project, London, p.2, 2016.

[349] Council of European Energy Regulators, "Development and Regulation of Electricity Storage Applications," Council of European Energy Regulators, Brussels, 2014, p.3.

[350] G. C. Gissey, P. E. Dodds and J. Radcliffe, "Regulatory barriers to energy storage deployment: the UK perspective," RESTLESS Project, London, p.3, 2016.

[351] Directive 2009/72/EC of the European Parliament and of the Council of 13 July 2009 concerning common rules for the internal market in electricity and repealing Directive 2003/54/EC

[352] G. Masson, J. I. Briano and M. J. Baez, "Review and Analysis of PV Self-Consumption Policies," International Energy Agency - Photovoltaic Power Systems Programme, p.26, 2016.

[353] J. Deign, "Spain's New Self-Consumption Law Makes Batteries Impractical for Homeowners," GreenTech Media, 16 October 2015. [Online]. Available: https://www.greentechmedia.com/articles/read/spanish-self-consumption-law-allows-batteries-at-a-cost. [Accessed 31 July 2017]; *Ibid*.

typified by the "Grid Fee System."[354] Ordinarily, grid fees are paid by the final consumers of power as a fee for the transportation of electricity through the grid network.[355] In the case of storage, operators of storage assets are first charged for charging the storage asset. The operators are then also charged for discharging it because of the notional double flow of electricity. In real terms, the storage asset is neither a producer nor consumer. Therefore, the strict application of the traditional grid fee model should not extend to storage assets. Often, this double taxation is higher than power prices and results in a very strong disincentivization of electricity storage.[356]

Regarding EVs, the European Environment Agency reports that in 2015, 150,000 new EVs were sold in the EU. However, 90% of these sales were in the Netherlands, the UK, Germany, France, Sweden, and Denmark.[357] Despite a steady growth in the number of EVs sold in the EU over the years, the 2015 numbers represent only 1.2% of total vehicle sales. **Figure 2** shows the trend of EV sales since 2010.

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[354] P. Crossley, "Defining the Greatest Legal and Policy Obstacle to "Energy Storage"," *Renewable Energy Law & Policy Review,* vol. 4, p. 268, 2013, p.19.

[355] Committee on Industry, Research and Energy (ITRE) European Parliament, "Energy Storage: Which Market Designs and Regulatory Incentives Are Needed?," European Commission , 2015.

[356] *Ibid*.

[357] European Environment Agency, "Electric Vehicles in Europe," European Environment Agency, Copenhagen, 2016, p. 47.

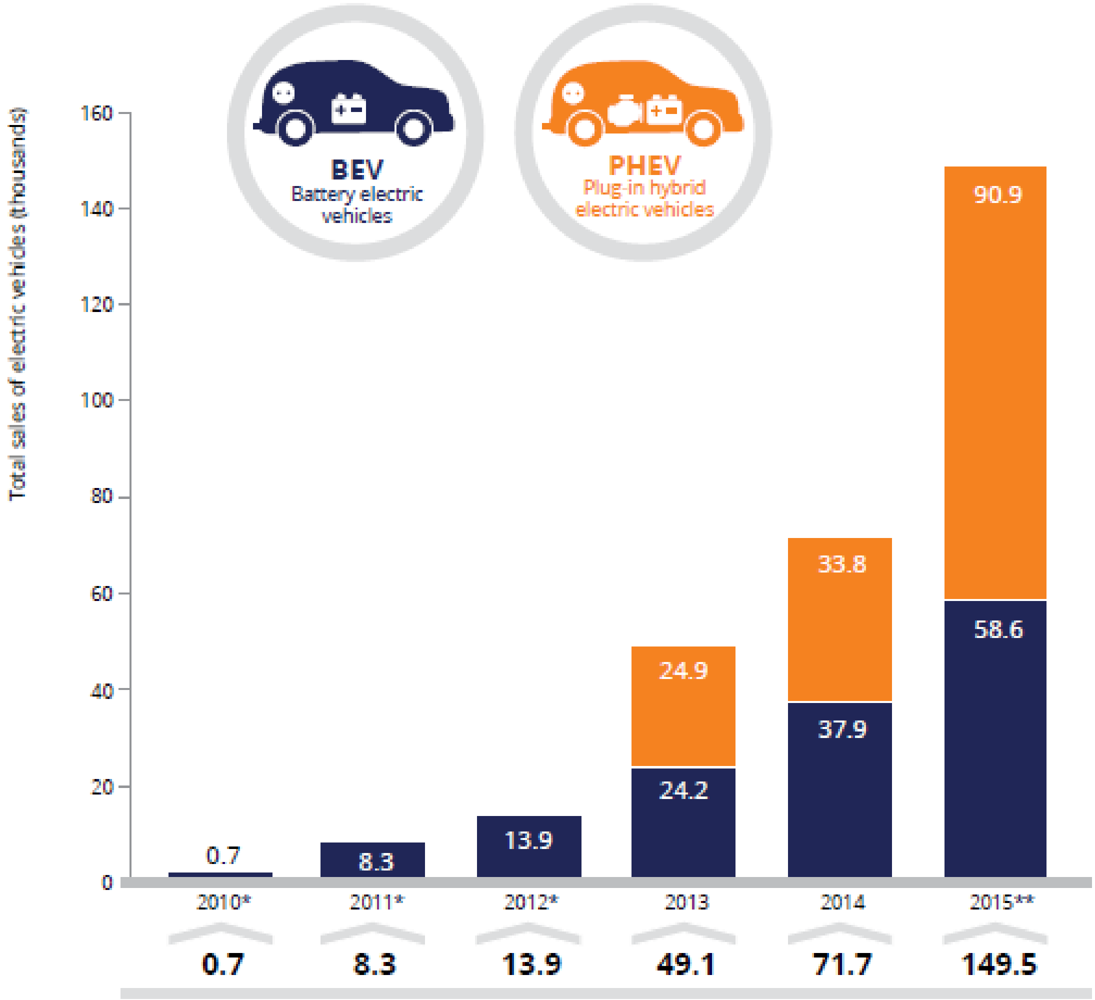

Figure 2 – EV Sales in the EU

Source: European Environment Agency, *Electric Vehicles in Europe* (EEA Report, 2016), p. 49

Note: * In 2010, 2011, and 2012, only statistics for battery electric vehicles are available. ** The data for 2015 are provisional.

In countries such as Norway and the Netherlands, where EV sales are very high, regulatory incentives have played a large role in promoting consumer interest.[358] These incentives include tax exemptions on EV purchases, one-off grants, and the imposition of taxes on fossil fuels. **Figure 3** summarizes the use of incentives for EVs across Europe. In Belgium, Greece, Hungary, Latvia, and the Netherlands, there is a full registration tax exemption on EV Purchases, while Denmark and Finland provide a partial

[358] P. Hockenos, "With Norway in Lead, Europe Set for Surge in Electric Vehicles," Yale Environment 360, 6 February 2017. [Online]. Available: http://e360.yale.edu/features/with-norway-in-the-lead-europe-set-for-breakout-on-electric-vehicles. [Accessed 27 April 2017]; The International Council on Clean Transportation, "European Vehicle Market Statistics, 2015/2016," The International Council on Clean Transportation, 25 November 2015. [Online]. Available: http://www.theicct.org/european-vehicle-market-statistics-2015-2016. [Accessed 27 April 2017].

exemption.[359] Other financial schemes employed by governments are fixed grants, as employed in France and Portugal for replacing an end-of-life vehicle with a new electric vehicle.

Beyond promoting consumer interest, many countries also support research and development with a view to promoting innovation in the EV sector. Finland, for instance, instituted the Electric Vehicles Systems Programme in 2011 with a budget of EUR 100 million to support the growth of the EV sector.[360]

Governments have also taken various actions to support the development of infrastructure, particularly charging points. France, for instance, set up a special fund, for the construction of charging infrastructure, which led to the construction of 5,000 charging points in 2015.[361] In Sweden, individuals who installed charging points in their homes obtained a tax reduction for the associated labor cost.[362] However, an emerging barrier to the large-scale deployment of charging infrastructure is that new, fast charging technology is not only expensive to install, but also requires high voltage input. The associated consumption fee is therefore high.[363]

Non-financial measures, particularly at the local government level, have also been instrumental towards the promotion of EVs in Europe. In the UK, for instance, some local councils have adopted a procurement policy that requires at least one EV amongst their fleet of vehicles.[364] In Bulgaria, the National Action Plan for the promotion of EVs gave EVs free parking in all its cities.[365] In other countries like Spain and Norway, road toll exemptions and discounts apply to EVs.[366]

As national responses to climate change and air pollution continue to increase in response to EU Directives, it is expected that many more countries will adopt policies that would enhance EVs and storage technology.

[359] European Environment Agency, “Electric Vehicles in Europe,” European Environment Agency, Copenhagen, 2016, p. 60.

[360] *Ibid.*, p. 62

[361] Hybrid & Electric Vehicle Technology Collaboration Programme, “Hybrid & Electric Vehicle Technology Collaboration Programme,” International Energy Agency, [Online]. Available: http://www.ieahev.org/by-country/italy-policy-and-legislation/. [Accessed 22 June 2017].; K. Seaton, “The push for electric cars,” The Connexion, 19 September 2013. [Online]. Available: https://www.connexionfrance.com/Archive/The-push-for-electric-cars. [Accessed 7 September 2017].

[362] *Ibid.*

[363] *Ibid.*, p. 26.

[364] P. McAllister, “Huge New Study Compares Every UK Council’s Electric Vehicle Usage.,” Intelligent Car Leasing, 23 January 2015. [Online]. Available: http://www.intelligentcarleasing.com/blog/new-study-compares-every-uk-council-electric-vehicles/. [Accessed 27 April 207].

[365] L. Macdonald, “Bulgarian city introduces free parking for electric cars,” Eltis. The urban mobility observatory, 12 November 2014. [Online]. Available: http://www.eltis.org/discover/news/bulgarian-city-introduces-free-parking-electric-cars. [Accessed 27 April 2017].

[366] European Environment Agency, “Electric Vehicles in Europe,” European Environment Agency, Copenhagen, 2016, p. 62.

	PURCHASE SUBSIDIES (purchase-related tax exemptions or reductions, registration tax, import tax, co-funding or other finantial purchase support)	**OWNERSHIP BENEFITS** (annual tax exemption, reduction of electricity or energy costs)	**BUSINESS AND INFRASTRUCTURE SUPPORT** (business development or infrastructure support)	**LOCAL INCENTIVES** (free parking, access to bus lanes, no toll fees, free charging, access to restricted areas in city centres)
AUSTRIA	✔	✔	✔	✔
BELGIUM	✔	✔	✔	
BULGARIA	✔	✔		✔
CROATIA	✔		✔	
CYPRUS		✔		✔
CZECH REPUBLIC	✔	✔	✔	
DENMARK	✔	✔	✔	✔
ESTONIA			✔	✔
FINLAND	✔	✔	✔	
FRANCE	✔	✔	✔	✔
GREECE	✔	✔		✔
GERMANY	✔	✔	✔	✔
HUNGARY	✔	✔		✔
ICELAND	✔	✔	✔	✔
IRELAND	✔	✔	✔	✔
ITALY	✔	✔	✔	✔
LATVIA	✔	✔		✔
LIECHTENSTEIN				
LITHUANIA	✔			✔
LUXEMBOURG	✔		✔	
MALTA	✔	✔	✔	✔
NETHERLANDS	✔	✔	✔	✔
NORWAY	✔	✔	✔	✔
POLAND		✔		
PORTUGAL	✔	✔	✔	✔
ROMANIA	✔	✔		
SLOVAKIA		✔		
SLOVENIA	✔			✔
SPAIN	✔	✔	✔	✔
SWEDEN	✔	✔	✔	✔
SWITZERLAND	✔	✔	✔	✔
TURKEY	✔	✔	✔	
UNITED KINGDOM	✔	✔	✔	✔

Figure 3 – Use of incentives for EVs across Europe

Source: European Environment Agency, Electric Vehicles in Europe (EEA Report, 2016), 65

3.3.4. Towards regulatory policy recommendations

Given the importance of unbundling of energy suppliers under the Third Energy Package, a definition of storage is necessary. Particularly, a clear delineation of which operators in the market can own, operate, or control these assets.

Regulatory intervention would also be required to incentivize investment in the development of storage technologies. In the case of prosumers, given that they arguably contend with a double economic hurdle typified by the high cost of storage technology as well as uncertain and sometimes unfavorable market structures for self-generated electricity, the need for investment incentives must be coupled with favorable policies related to demand response mechanisms and self-generation/consumption of renewables. Ultimately, the impact of storage on electricity markets hinges largely on the economics of storage solutions. Therefore, the institution of appropriate regulatory incentives is critical to ensuring the desired level of storage solutions.

A review of grid fees structure is also necessary to avoid situations where storage assets pay double grid fees. Better consideration should be given to the kind of service provided by storage assets in determining the applicability or otherwise of grid fees or other similar taxes. In the grander scheme of facilitating the development of smart grids and electricity markets, the regulatory framework should not discriminate between DERs, thereby ensuring that storage resources are granted equal access to flexibility markets to enable them to compete equally with fossil-fuel based generation units.

Policy-makers should create incentives for consumers and companies to use EVs, in addition to the construction and operation of electric vehicle charging facilities. Such incentives might include lower taxes for EVs, higher taxes for vehicles using gasoline, the possibility for EVs to use exclusive taxi or bus lanes, and support for research and development activities.

There are potential concerns. One is how realistic it is to expect states under financial and budgetary distress to pursue measures such as those enumerated above. Another is whether pursuing such measures could go against the State aid regime at the EU level. A further issue is under what conditions these support measures could be accepted and/or whether it would be desirable to amend the current State aid regime (e.g., through State aid guidelines that the Commission regularly produces over time across domains).

It is also worth noting that the increase in the use of EVs will contribute to the increase in demand for electricity. The IEA research scenarios estimate that the transport sector will make up 10% of total electricity consumption by 2050, owing largely to the increase in EV and plug-in electric vehicle use.[367] Therefore, it is critical that EV deployment is done as part of a larger smart grids strategy to ensure strategic low-cost vehicle charging.

[367] International Energy Agency (IEA), "Technology Roadmap; Smart Grids," OECD/IEA, France, p. 12, 2011.

4. SOCIAL, ENVIRONMENTAL, AND ETHICAL ISSUES OF SMART GRIDS

4.1. INTRODUCTION

In this section, the development of smart grids will be analyzed regarding its implications for social and ethical matters. This section draws primarily on the EU context, although it has its conceptual background in international law and policy. Indeed, the ethical framework is founded on international human rights law as incorporated into the Treaty on the Functioning of the European Union (TFEU). The primary aim of considering the ethical framework when dealing with the development of smart grids is to ensure that smart grids contribute to the further realization of economic and social rights within a period of transition to a low-carbon society. Society needs to be engaged and should benefit from the technological transformations occurring in energy generation and consumption. This paper highlights opportunities and potential downsides of the path towards the achievement of such goals.

In section 4.2, the article focuses on how smart grids can contribute to a broader economic transformation. It considers the economic transition occurring globally towards collaborative economics and how the EU aims to incorporate new market exchange models into smart grids energy systems. The section considers the potential social and environmental benefits in addition to the challenges that lie ahead in realizing policy goals about the future.

Section 4.3 explores how the EU is working towards fostering more flexible, open, transparent, and dynamic policies within the energy sector. To achieve a low-carbon sustainable society that is fair and equitable for all, the new model also has to reduce the use of resources and to use them efficiently. The section also outlines the importance of new concepts in the management of resources, such as circular economy, which aims at closing the loop on waste and inefficiency throughout whole product lifecycles, including the design phase.

In section 4.4, the article takes up issues relating to ICT and smart grids. The first two sections give an overview of the key issues raised by the integration of ICT into energy systems and address the cybersecurity and privacy issues of smart grids. The final section considers international and EU legal responses to those issues, focusing on privacy and data protection, and Digital Systems Security.

4.2. SMART GRIDS: CONTRIBUTING TO THE EU COLLABORATIVE ECONOMY

The introduction of smart grids into the EU energy grid heralds a crucial transformation. The EU is in the process of investing in radical reform of the economic foundations upon which it depends. The strategic decisions that the EU adopts are driven by many interconnected factors and the main difficulties seem to be found not much within the technical aspects, but more within the policy-related, social, or regulatory issues.[368]

The approach to the transition to a low-carbon economy that the European Commission has embraced is based on new, flexible, dynamic, digital, and resource-efficient economic models.[369] This will increase the reuse of materials to add value to each product's life-cycle and reduce dependency on sourcing natural resources externally. Such a moment of transition could be a substantial opportunity to overcome existing inequalities throughout the EU Member States while the EU economy continues to recover from the 2008 economic crisis.[370]

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[368] V. Giordano *et al.*, "Smart Grid projects in Europe: Lessons learned and current developments," JRC Scientific and Policy Reports, 2013, p. 9.

[369] European Commission, "Europe 2020: Commission proposes new economic strategy in Europe", IP/10/22, Press Release, Brussels, 3rd March 2010. [On-line]. Available http://europa.eu/rapid/press-release_IP-10-225_en.htm?locale=en [Accessed 03 August 2017]. European Commission, "A Roadmap for moving to a competitive low carbon economy in 2050", COM(2011) 112 final. [On-line]. Available http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52011DC0112&from=EN [Accessed 03 August 2017].

[370] A. Papandreou, "The Great Recession and the transition to a low-carbon economy", FESSUD, Working Paper Series no. 88, http://fessud.eu/wp-content/uploads/2015/01/The-Great-Recession-and-the-transition-to-a-low-carbon-economy-

This section highlights the interlinkages between the different policy and governance approaches to sustainable development[371] and resource efficiency within a collaborative economy. It considers such approaches to emphasize the role that smart grids could play towards achieving the EU's policy goals.

An introduction to the concept of the collaborative economy will be provided in section 4.2.1. Section 4.2.2 focuses on the EU context, while section 4.2.3 specifically links the potential of a collaborative economy with a smart grids energy system. The final section focuses specifically on energy poverty, as an example of the social benefits that the collaborative economy can provide.

4.2.1. The Collaborative Economy: A "Disruptive Innovation"

The collaborative economy has become a major phenomenon in recent years due to increased business opportunities made possible by advances in digital ICT.[372] The digital economy has opened up new innovative ways for people to engage in the market exchange of goods and services that circumvent existing institutional economic structures.[373] The collaborative economy provides the opportunity for individuals and/or communities to offer their assets, time, and skills within the digital market place.[374] This is particularly relevant to those looking to develop market mechanisms to tap into low-carbon energy generation and distribution from decentralized energy communities.[375]

The collaborative economy is a phenomenon that can profoundly change the way consumers buy or rent goods and services. It can also allow consumers to enter the market to provide goods, services, time, or skills themselves and become prosumers. Within such business models, the traditional business-to-consumer relationship is no longer the norm. A trilateral relationship is created instead: the consumer, the provider of a service or good, and the intermediary platform, with anyone being one or more of these actors.[376] The collaborative economy business models, unlike traditional markets, are based on relationships of trust, reputation, and reviews systems.

The advent of the collaborative economy, also referred to as the sharing economy, is what economists call a "disruptive innovation" while some even talk of it being, alongside the digital economy, "the fourth industrial revolution."[377] The concept of sharing goods and services is not without historical precedence. What differentiates traditional collaborative economic activities with the proper collaborative economy is that the sharing/collaborative model "has progressed from a community practice into a profitable business model."[378] The concept has a certain dynamism that fits within the

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[371] Sustainable development has been one of the main objectives of the European Union since it was included in the Treaty of Amsterdam (signed in 1997) as an overarching principle that inspires all the other EU policies objective of EU policies.

[372] Various terms are used, mostly interchangeably, such as collaborative economy, sharing economy, peer to peer (P2P) economy, access economy, collaborative consumption and demand economy – among others – to describe the new economic phenomena. See V. Hatzopoulos and S. Roma, "Caring for sharing? The collaborative economy under EU law," *Common Market Law Review,* vol. 54, no.1, pp. 81-127, 2017. This article will use the preferred term by the European Commission 'collaborative economy'.

[373] Communication from the Commission, Entrepreneurship 2020 Action Plan, Reigniting the entrepreneurial spirit in Europe, COM(2012) 795 final. [On-line]. http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52012DC0795&from=EN [Accessed 04 August 2017].

[374] G. Lougher and S. Kalmanowicz, "EU competition law in the sharing economy," *Common Market Law Review,* vol. 7, no. 2, p. 87, 2016.

[375] C. N. Ciocoiu, "Integrating Digital Economy And Green Economy: Opportunities For Sustainable Development", Theoretical and Empirical Researches in Urban Management, Vol. 6, No. 1 (February 2011), pp. 33-43.

[376] G. Lougher and S. Kalmanowicz, "EU competition law in the sharing economy," Common Market Law Review, vol. 7, no. 2, p. 87, 2016.

[377] K. Schwab, "The Fourth Industrial Revolution: What It Means and How to Respond," Foreign Affairs, 12 December 2015. [Online]. Available: https://www.foreignaffairs.com/articles/2015-12-12/fourth-industrial-revolution. [Accessed 15 February 2017].

[378] M. Böckmann, "The Shared Economy: It is time to start caring about sharing; value creating factors in the shared economy," 2013. [Online]. Available: https://static1.squarespace.com/static/58d6cd33f5e231abb448d827/t/58ea595e1b10e3a416e8ab5b/1491753311257/boc

advent of artificial intelligence, big data, and 3D printing.[379] The collaborative economy represents a big change from traditional markets by bringing operators to modernize their offer and business models. This competition is generally good for consumers.[380] It can indeed make consumer markets more efficient, as it brings down transaction costs and is able to offer cheaper products and services.

As the phenomenon penetrates more into people's everyday lives, it is important that appropriate regulatory frameworks are adopted in order to provide essential services, such as energy. This must be done in such a way that the dynamism and flexibility of the exchanges between new small-scale enterprises providing services is not undermined. The collaborative economy offers many benefits to consumers and prosumers. But it also presents risks. Advantages and disadvantages of the collective economy will be analyzed in the following sub-section, which focuses on the European context.

4.2.2. The EU and the Collaborative Economy

Assisting consumers, businesses, and public authorities to participate and contribute to the success of a collaborative economy is central to the future economic strategy of the EU and the EU sees the collaborative economy as a new opportunity.[381] Commission Vice-President Jyrki Katainen even stated that "Europe's next unicorn could stem from the collaborative economy," stressing the innovative potential that might be revealed through the collaborative economy in the area of products or services.[382] When considering such a new business model, the EU is also aware of the scale of challenges faced by the delivery of such benefits.[383] The new economic model should happen without undermining existing consumer and employment rights, alongside other regulations on health, safety, and the environment. The European Commission cautions that a "fragmented approach to new business models creates uncertainty for traditional operators, new services providers, and consumers alike and may hamper innovation, job creation, and growth."[384]

The implications of the sharing economy for law, regulation, and policy-making are only beginning to be considered.[385] The European Commission, national competition authorities, and consumer protection regulators in Europe are currently in the process of formulating their regulatory approach to address some idiosyncratic issues raised by the sharing economy. When adopting the Single Market Strategy in 2015, the European Commission announced that it "will develop a European agenda for the collaborative economy, including guidance on how existing EU law applies to collaborative economy business models."[386] Currently, the non-regulatory approach followed by the EU relies on many pre-existing legal concepts. These concepts are often ill-adapted to this new model of doing

kmann-shared-economy.pdf. [Accessed 15 February 2017].

379 K. Schwab, "The Fourth Industrial Revolution: What It Means and How to Respond," Foreign Affairs, 12 December 2015. [Online]. Available: https://www.foreignaffairs.com/articles/2015-12-12/fourth-industrial-revolution. [Accessed 15 February 2017].

380 G. Beltra, "The consumer-policy nuts and bolts of the sharing economy", BEUC. The European Consumer Organisation, 2016 October 11. [Online]. Available: http://www.beuc.eu/blog/the-consumer-policy-nuts-and-bolts-of-the-sharing-economy/. [Accessed 15 February 2017].

381 European Commission, "A European agenda for the collaborative economy", Press Release Database, 2 June 2016. [Online]. Available: http://europa.eu/rapid/press-release_IP-16-2001_en.htm. [Accessed 13 April 2017].

382 G. Beltra, "The consumer-policy nuts and bolts of the sharing economy," BEUC. The European Consumer Organisation, 2016 October 11. [Online]. Available: http://www.beuc.eu/blog/the-consumer-policy-nuts-and-bolts-of-the-sharing-economy/. [Accessed 15 February 2017].

383 European Commission, "A European agenda for the collaborative economy," Press Release Database, 2 June 2016. [Online]. Available: http://europa.eu/rapid/press-release_IP-16-2001_en.htm. [Accessed 07 September 2017].

384 *Ibid.*

385 See D. Rauch and D. Schleicher, "Like Uber, But for Local Governmental Policy: The Future of Local Regulation of the 'Sharing Economy'," *George Mason University Law & Economics Research Paper,* no. 15-01, pp. 1-61, 2015; C. Koopman *et al*., "The Sharing Economy and Consumer Protection Regulation: The Case for Policy Change," *The Journal of Business, Entrepreneurship & the Law,* vol. 8, no. 2, pp. 530-545, 2014; and V. Katz, "Regulating the Sharing Economy," *Berkeley Technology Law Journal ,* vol. 30, no. 4, pp. 1068-1126, 2015.

386 Commission Staff Working Document Accompanying the document Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions - A European agenda for the collaborative economy - supporting analysis, SWD(2016) 184 final (2 June 2016).

business, thus bearing the risk of extreme fragmentation along national lines.[387] This will frustrate efforts to incorporate the collaborative economy into the updated Single Market Strategy, [388] including the European Energy Union.[389]

The collaborative economy's expansion and success is intrinsically linked with new technologies. Cloud computing[390] facilities are considered integral by the European Commission for creating new opportunities to foster innovative business models, including the collective economy, because many new innovations depend on access to data at reduced costs.[391] Special Rapporteur Hans Graux notes that "small businesses in particular can benefit from the cloud, as they can gain access to high-performance IT solutions, which will help them to adapt quickly to new market developments and to innovate and grow their businesses faster."[392] Given this perspective, the cloud has an enormous role to play in delivering decentralized energy provisions in the EU energy generation. It will open up opportunities for new small- and medium-scale actors to manage data from wireless and internet applications that increasingly constitute smart grids.

4.2.3. Smart Grids: A Platform for the Collaborative Economy

Smart grids are "an integrated system that includes technologies, information (availability, accessibility, utility), human and social influences, organizational and managerial supporting arrangements, and political (policy) constraints as well as facilitation considerations."[393] Smart metering systems are one stepping stone towards smart grids, empowering consumers to actively participate in the energy market. Under Directive 2009/72/EC and Directive 2009/73/EC of the European Parliament and of the Council, EU Member States are required to "ensure the implementation of intelligent metering systems to assist the active participation of consumers in the electricity and gas supply markets."[394] It is also an initiative to increase the number of energy providers within the European Energy Union Strategy.[395]

The European Commission explicitly acknowledged its Energy Union as a strategy "with citizens at its core, where they take ownership of the energy transition, benefit from new technologies to reduce their bills, participate actively in the market, and where vulnerable consumers are protected."[396]

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[387] V. Hatzopoulos and S. Roma, "Caring for sharing? The collaborative economy under EU law," *Common Market Law Review,* vol. 54, no.1, pp. 81-127, 2017.

[388] The Single Market Strategy aims at enabling people, services, goods and capital to move more freely, offering opportunities for businesses and lowering prices for consumers. It also makes possible for citizens to travel, live, work or study wherever they prefer. In 2015, the European Commission presented a new Single Market Strategy to deliver a deeper and fairer Single Market, that takes into account new concepts and other strategies, such as the European Energy Union and the Digital Single Market Strategy. Communication from the Commission, "Upgrading the Single Market: more opportunities for people and business", COM(2015) 550 final.

[389] The European Energy Union was launched in February 2015 by the Commission, and it aims at ensuring that consumers and businesses have access to secure, affordable and climate-friendly energy and making the internal energy market a reality across the EU. The last report on the state of the Energy Union has been released in February 2017: Communication from the Commission, "Second Report on the State of the Energy Union Monitoring progress towards the Energy Union objectives – key indicators", SWD(2017) 32 final.

[390] Cloud computing makes possible for users to access scalable and shareable pool of remote computing resources (such as networks, servers, storage, applications and services). This, consequently, means that investing in their own IT infrastructure is not necessary and that they can better share that IT infrastructure. The current policy on cloud computing is set within the Digital Single Market Strategy for Europe. A. Shawish and M. Salama, "Cloud Computing: Paradigms and Technologies", in F. Xhafa and N. Bessis (eds.), Inter-cooperative Collective Intelligence: Techniques and Applications, Studies in Computational Intelligence 495, Springer-Verlag Berlin Heidelberg, 2014.

[391] Communication from the Commission, "Unleashing the Potential of Cloud Computing in Europe", COM(2012)529 final

[392] European Commission, "Establishing a Trusted Cloud Europe," European Commission, Brussels, 2014, p. 8.

[393] P. F. Katina *et al*., "A Criticality-based Approach for the Analysis of Smart Grids," *Technology and Economics of Smart Grids and Sustainable Energy,* vol. 1, no. 1, pp. 1-20, 2016.

[394] Energy Efficiency Directive (2012/27/EU), para 31.

[395] European Commission, Speech, M. A. Cañete - Commissioner for Climate Action & Energy "Smart grids for a smart Energy Union", Brussels, 31 March 2015.

[396] Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee, the Committee of the Regions and the European Investment Bank. A Framework Strategy for a Resilient Energy

Local energy consumers are crucial to delivering a new power market design that enables consumers to participate in the market through demand-side response, auto-production, smart metering, and storage. In the Winter Package proposed by the European Commission in 2016, EU Member States are required to provide an enabling regulatory framework for local energy communities and users.[397]

With the appropriate regulatory and legal frameworks to incentivize the participation of consumers, the energy economy has the potential to switch from a traditional supply-side driven system controlled by energy cartels into a demand-led decentralized model that fosters competition from localized providers.[398] This potentially opens economic and societal space for the emergence of the energy prosumer at a level that is truly transformative. Political priority will need to support decentralization, countering decades of investment of political capital—and the requisite legal infrastructure—for large-scale energy business, including national companies. This demonstrates that decentralization can deliver secure, affordable, and sustainable energy supplies and could potentially provide the necessary persuasion to governments and citizens alike to embrace new energy systems.

4.2.4. Delivering Social Benefits in a Collaborative Economy

The relationship between new technologies and social change is at the core of the energy/climate debate.[399] There is an overwhelming belief that informed individuals will make rational choices that will benefit society and the environment. Nonetheless, the embedding of new technologies within society can have unforeseen consequences. It is very interesting to consider the unplanned consequences, and perhaps even the distorted incentives, that the upscaled adoption of new technologies into the very structure of society and our economy can have. There is a need to question the "smart utopia" being offered.[400]

One goal underpinning energy reforms is to address energy poverty across Europe. On average, 11%—over 54 million—of EU citizens experienced some form of energy poverty (being unable to keep homes at ambient temperatures, having difficulty with bill payments and/or living with inadequate energy infrastructure services).[401] The situation is especially pervasive in Central Eastern and Southern European Member States.[402]

In addition to the cost in economic terms, the negative social and environmental impacts of energy poverty severely curtail the quality of life of vulnerable individuals and communities. Despite this, only a few EU countries have adopted legal definitions recognizing energy poverty.[403] The causes of energy poverty are multiple. A key issue is the structure of energy markets, which impacts energy pricing and determines, to some level, incentives for more efficient energy use. Investments in upgrading and incorporating modern digital ICT into the energy system need to tackle energy poverty at the forefront

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Union with a Forward - Looking Climate Change Policy, at p. 2, COM(2015) 080 final (25 February 2015).

[397] Proposal for a Directive of the European Parliament and of the Council on common rules for the internal market in electricity, at p. 68, COM(2016) 864 final/2 (23 February 2017). The proposal defines the concept of local energy community as "an association, a cooperative, a partnership, a non-profit organisation or other legal entity which is effectively controlled by local shareholders or members, generally value rather than profit-driven, involved in distributed generation and in performing activities of a distribution system operator, supplier or aggregator at local level, including across borders." *Ibid.*, p. 52.

[398] C. Clastres, "Smart grids: Another step towards competition, energy security and climate change objectives," *Energy Policy,* vol. 39, no. 9, pp. 5399-5408, 2011.

[399] K. Bickerstaff *et al*., "Decarbonisation at home: the contingent politics of experimental domestic energy technologies," *Environment and Planning A,* vol. 48, no. 10, pp. 2006-2025, 2016.

[400] Y. Strengers*, Smart Energy Technologies in Everyday Life: Smart Utopia?,* London: Palgrave Macmillan, 2013.

[401] INSIGHT_E, "Energy poverty and vulnerable consumers in the energy sector across the EU: analysis of policies and measures," INSIGHT_E, 2015, p. 1.

[402] S. Bouzarovski and S. Petrova, "The EU energy poverty and vulnerability agenda: An emergent domain of transnational action", in J. Tosun, *et al.* (eds.), Energy Policy Making in the EU: Building the Agenda, Berlin: Springer, 2015, pp. 129-144, p. 7.

[403] They are the UK, Ireland, France and Cyprus. INSIGHT_E, "Energy poverty and vulnerable consumers in the energy sector across the EU: analysis of policies and measures," INSIGHT_E, 2015, p. v.

of their ambitions.

The potential of smart grids to contribute to addressing energy poverty in the EU will be determined by key policy and regulatory decisions. Policy design needs to take account of the interconnections with other related strategies being pursued by the EU. The Digital Single Market Strategy is central to smart grids' achieving economic value. Such a strategy focuses on maximizing the growth of Digital Economy potential by boosting competitiveness.[404] It is clear that ICT is already leading to new business models—as part of the new collaborative economy—and there is great speculation that, with the appropriate regulation, such new models could facilitate a more social just and equitable economy within Europe, and globally.[405] Nonetheless, whether these models can actually play a role in tackling some of the energy poverty issues remains to be seen.

To determine how best to ensure energy poverty is addressed, a distinction needs to be made between traditional consumers and those who are active service providers in the collaborative economy. The demographic affected by energy poverty and new service providers within the collaborative economy are by no means aligned. Energy poverty occurs largely in marginalized, vulnerable, and poorer communities, often in rural areas and small towns.[406] The actors driving the collaborative economy tend to be from urban and affluent communities.[407] Individually, the profiles also differ from that those who are active in forming and benefitting from the opportunities of the collaborative economy come from well-educated, younger, and technologically literate cohorts of the population.[408] However, it is argued that the collaborative economy opens up opportunities to young marginalized communities, who can enter the business sector without the need to meet professional cultural standards.[409] There are also concerns that transnational corporate players within the collaborative economy could appropriate emergent micro-entrepreneurs. Such companies have actively sought to lobby the law-making process within the EU. In a 2016 open letter to the Netherlands Presidency of the Council of the European Union, 47 commercial sharing platforms, including Uber and Airbnb, urged the EU Member States to "ensure that local and national laws do not unnecessarily limit the development of the collaborative economy to the detriment of Europeans" by citing the benefits stemming from sharing services.[410] It is integral that "benefits" are understood to be social ones and not just "commercial" benefits. For the collaborative economy to be socially sustainable, these benefits need to be available not just to those who can become market providers, but also to service users.[411]

The collaborative economy as a fluid, flexible organizing market, will not per se result in affordable energy pricing targeting those most in need.[412] However, it can deliver opportunities in terms of efficiency and affordability to consumers. Such potential depends on the structure of the energy market. Decentralization to increase competition, although part of the EU energy reform packages, has resulted in limiting competition even amongst large-scale providers. The goal under EU energy

[404] Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. A Digital Single Market Strategy for Europe, at p. 15, COM(2015) 192 final (6 May 2015).

[405] A. Halff, B. K. Sovacool, J. Rozhon, "Energy Poverty: Global Challenges and Local Solutions", Oxford: OUP, 2014.

[406] INSIGHT_E, "Energy poverty and vulnerable consumers in the energy sector across the EU: analysis of policies and measures," INSIGHT_E, 2015, p. 1.

[407] Joint Research Centre, "The Passions and the Interests: Unpacking the 'Sharing Economy'," Joint Research Centre, Seville, 2016.

[408] T. Dillahunt and A. Malone, "The Promise of the Sharing Economy among Disadvantaged Communities," *CHI '15 Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems ,* no. 23, pp. 2285-2294, 2015.

[409] Joint Research Centre, "The Passions and the Interests: Unpacking the 'Sharing Economy'," Joint Research Centre, Seville, 2016.

[410] G. Newlands *et al*., "Power in the Sharing Economy," Report from the EU H2020 Research Project Ps2Share: Participation, Privacy, and Power in the Sharing Economy, 2017.

[411] E. Nica and A. Potcoravu, "The Social Sustainability of the Sharing Economy," *Economics, Management and Financial Markets,* vol. 10, no. 4, pp. 69-75, 2015.

[412] M. Bauwens and V. Kostakis, "From the Communism of Capital to Capital for the Commons: Towards an Open Co-operativism," *Triple C - Journal for a Global Sustainable Information Society,* vol. 12, no. 1, pp. 356-361, 2014.

strategies to increase energy cooperatives that can deliver energy locally with the greatest efficiencies requires clear policy incentives. This will need government intervention to ensure that social opportunities are realized. Delivering social and environmental benefits to all must be at the core of the pathways to achieve a low-carbon energy transition. The next section considers how the EU is approaching the challenges.

4.3. LOW-CARBON TRANSITION PATHWAYS AND SMART GRIDS

4.3.1. Conceptualizing issues

The adoption of smart grids can have a vast positive impact on EU policy on energy and climate. The 2015 Paris Agreement has provided a significant boost to deliver the policies agreed by the EU countries on energy and climate.[413] The Agreement is a global driver of investment in technology, law, and policy to achieve a low-carbon world. The potential pathways to achieve this energy transition are many but principles of justice, equity, and fairness should inspire the whole approach to the change.

The United Nations (UN) Paris Agreement's stated goal for the maximum increase of the global average temperature is between 2°C and 1.5°C above pre-industrial levels.[414] A warming of 2°C will result in a new climate regime, particularly in tropical regions, whilst 1.5°C of warming will bring the Earth to a climate at the outer edge of historical experience for human civilization.[415] The risks associated with the rising global temperature are driving action that will have political, economic, environmental, and social impacts.[416] Either temperature outcome under the Paris Agreement will have impacts on existing energy systems, especially the infrastructure for generation and distribution.[417] Both the 2°C and 1.5°C targets are likely to be missed. Maintaining security and resilience requires engineers, policy-makers, and regulators to create climate-proofed energy systems as part of the process towards a low-carbon new model.

The EU has recognized the scale of the task. The EU's Sixth Environmental Action Programme (EAP) identified climate change as the "outstanding challenge of the next 10 years and beyond."[418] It has deliberately interlinked climate change policy with energy policy to develop pathways towards a low-carbon economy.[419] To encourage the transition to a more secure, affordable, and decarbonized energy system,[420] the EU adopted climate and energy targets to be achieved in the coming decades.

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[413] Speech by Miguel Arias Cañete on "How will the Paris agreement impact EU climate and energy policies?" Bruegel, 8 February 2016, [On-line]. Available: http://bruegel.org/2016/02/speech-by-miguel-arias-canete-on-eus-climate-and-energy-policies-after-cop21/ [Accessed 05 September 2017].

[414] Paris Agreement, Article 2.1(a).

[415] C. Schleussner *et al.*, "Differential climate impacts for policy-relevant limits to global warming: the case of 1.5 °C and 2 °C," *Earth System Dynamics,* vol. 7, no. 2, pp. 327-351, 2016.

[416] M. Burke *et al*., "Global non-linear effect of temperature on economic production," *Nature,* pp. 235-239, 2015.

[417] J. Rogelj *et al*., "Paris Agreement climate proposals need a boost to keep warming well below 2 °C," *Nature,* pp. 631-639, 2016.

[418] Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions on the Mid-term review of the Sixth Community Environment Action Programme, COM(2007) 225 final (30 April 2007). However, recent research shows that climate researchers have been under-estimating the amount of carbon dioxide that is possible to emit to be compatible with the ambitions expressed in the Paris Agreement on Climate Change. In other words, the world may be in a position to emit significantly more CO2 in the next few decades than was previously announced and still be in compliance with the requirements of the Paris Agreement. See R. Millar et al., "Emission budgets and pathways consistent with limiting warming to 1.5 °C," Nature Geoscience, 2017.

[419] The issue of climate change mitigation has even reached democratic levels as close to citizens as teenagers suing the US federal government as part of efforts to force action to request climate action. See M. Nijhuis, "The teen-agers suing over climate change," The New Yorker, 6 December 2016. See also N. Geiling, "In landmark case, Dutch citizens sue their government over failure to act on climate change," Think Progress, 14 April 2015, available at https://thinkprogress.org/in-landmark-case-dutch-citizens-sue-their-government-over-failure-to-act-on-climate-change-e01ebb9c3af7/.

[420] R. Leal-Arcas, "The transition towards decarbonization: A legal and policy examination of the European Union," *Queen Mary School of Law Legal Studies Research Paper No. 222/2016,* pp. 1-31, 2016.

In 2007, the "Europe 2020 Strategy" set three key targets: 20% cut in GHG emissions (from 1990 levels), 20% of EU energy from renewables, and 20% improvement in energy efficiency.[421] In 2014, the EU set the target to reduce GHG emissions by at least 40% by 2030 from 1990 levels.[422] The EU also adopted a long-term goal aiming at reducing EU greenhouse gas emissions by 80-95% below 1990 levels by 2050.[423] In February 2015, the Energy Union Strategy was launched, with the goal of leading to a sustainable, low-carbon, and environmentally friendly economy.[424]

Despite such ambitious targets, the link between energy and climate-related issues is relatively new within the EU. Although energy issues have always been at the heart of European integration, energy-related topics (such as climate change policy, renewable energy, energy planning, and energy security of supply) have only gained in importance to the EU's policy and regulation agenda since the concept of sustainability increased in importance at the European and international[425] level.[426] Such a different approach has resulted in considering the three dimensions of sustainability (economic, environmental, and social) within any EU policy. It is encouraging that energy and environmental regulation are now clearly understood to be two sides of the same coin, whereas previously they were perceived as separate competences.[427] Developing strategies to achieve both climate and energy targets will require effective institutional management and good multilevel governance involving existing and new actors. A new transitional approach will help to achieve such a goal from an institutional point of view.

Until quite recently, the concept of transitional justice has been associated only with post-conflict truth and reconciliation processes.[428] However, an increasing number of justice scholars are seeing the value of applying the concept to other political and legal developments related to human rights, including natural resources management and climate change law.[429] A multidisciplinary approach to exploring the discourse and practice of transitional strategies within EU climate and energy policy can offer a conceptual foundation for understanding the justice dimension of the dynamic normative transition within other jurisdictions and contexts. A transitional justice approach to the transformation from a carbon-dominant energy system to one based on smart grids and renewables could offer the EU a methodological pathway that will help address pressing social issues such as energy poverty. This approach already exists in varying degrees in all European countries, as discussed in section 4.2.4.

It is evident that the EU is seeking to undertake a transformation towards a low-carbon economy that

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[421] Communication from the Commission, "A strategy for smart, sustainable and inclusive growth" COM(2010) 2020 final.

[422] Conclusions on 2030 Climate and Energy Policy Framework, SN79/14 (23 October 2014).

[423] Communication from the Commission to the European Commission, Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, "Energy Roadmap 2050," COM(2011) 885 final (15 December 2011). N. Fujiwara, "Overview of the EU climate policy based on the 2030 framework," in *Delivering Energy Law and Policy in the EU and the US*, R. Heffron and G. Little, Eds., Edinburgh University Press, 2016, pp. 605-609.

[424] Communication from the Commission "Unleashing the Potential of Cloud Computing in Europe", COM(2012)529 final.

[425] Indeed, at the international level, a relatively new initiative called the International Solar Alliance, launched by India's Prime Minister Modi and France's President Francoise Hollande, is very promising as a mechanism to mitigate climate change. It is expected to channel $300 billion in 10 years for the promotion of renewable energy projects. See T. Mishra, "Sun shines on $300-billion global fund for clean energy," The Hindu Business Line, 1 May 2017, available at http://www.thehindubusinessline.com/economy/sun-shines-on-300billion-global-fund-for-clean-energy/article9675599.ece.

[426] I. Solorio *et al.*, "The European Energy Policy and its green dimension – discursive hegemony and policy variations in the greening of energy policy," in *Sustainable Development and Governance in Europe*, P. Barnes and T. Hoerber, Eds., Routledge, 2013.

[427] E. Orlando, "The Evolution of EU Policy and Law in the Environmental Field: Achievements and Current Challenges," in *The EU, the US and Global Climate Governance (Hardback) book cover*, C. Bakker and F. Francioni, Eds., Routledge, 2014, p. 74.

[428] N. Roht-Arriaza and J. Mariezcurrena, Transitional Justice in the Twenty-First Century Beyond Truth versus Justice, Cambridge University Press, 2006.

[429] R. Teitel, Globalizing Transitional Justice: Contemporary Essays, Oxford University Press, 2014; H. Franzki and M. Olarte, "Understanding the political economy of transitional justice: A critical theory perspective," in *Transitional Justice Theories*, S. Buckley-Ziste, T. Beck, C. Braun and F. Mieth, Eds., Routledge, 2014, pp. 201-218.

can meet these challenges. The EU is increasingly seeking to include such principles within those laws and policies that aim at achieving resilient economic, social, and environmental systems.[430] The intersection of social, economic, environmental, and political rights across all communities of energy users, including marginalized and vulnerable groups, needs to be explored as part of a more interconnected examination of each of the EU's actions, especially considering its leading position of addressing environmental issues adopting a more inclusive, holistic and integrated approach.[431]

The Fifth EAP (1993) was a reaction to the perceived failure of regulatory measures to achieve environmental goals. The Fifth EAP abandoned the traditional "command-and-control" approach in favor of innovative regulatory models that implied "shared responsibility between various actors: government, industry, and the public."[432] The EU welcomed the principle of sustainable development, combining economic, social, and environmental aspects in 1997 when EU Member States adopted the Amsterdam Treaty.[433] This is now incorporated in Article 3(3) of the Treaty on European Union (TEU) and it can be considered a "constitutional objective" of the EU.[434] In 2001, the European Council adopted the EU Sustainable Development Strategy, "a long-term strategy dovetailing policies for economically, socially, and ecologically sustainable development."[435] After this important step, the Sixth EAP (2002) advocated "a more inclusive approach including more specific targets and an increased use of market-based measures."[436] This aims at strengthening the integration of environmental concerns into other policies, in an attempt to foster greater engagement and implementation by EU Member States.[437] The most recent EAP, the Seventh EAP (2013),[438] emphasizes decoupling economic growth from carbon emissions and establishing a circular economy.[439] To achieve its goals, the Seventh EAP commits to a better integration of environmental concerns into other policy areas and ensures coherence when creating new policy. Strategic initiatives feeding into the Seventh EAP include the Roadmap to a Resource Efficient Europe[440] and the Roadmap for a low carbon economy by 2050.[441]

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[430] ClientEarth, "Sustainable Development as a Key Policy Objective of the European Union", Identifying Opportunities for Sustainable Public Procurement, Briefing Series Briefing No.1, October 2011.

[431] *Ibid.*

[432] European Commission, ""Towards Sustainability" the European Community Programme of policy and action in relation to the environment and sustainable development," [Online]. Available: http://ec.europa.eu/environment/archives/action-programme/5th.htm. [Accessed 15 February 2017].

[433] Treaty of Amsterdam Amending the Treaty on European Union, the Treaties Establishing the European Communities and Certain Related Acts, Amsterdam, 2 October 1997, [On-line]. Available: http://www.europarl.europa.eu/topics/treaty/pdf/amst-en.pdf [Accessed 05 September 2017].

[434] The objective of sustainable development can be found in the Constitutions of other jurisdictions (such as South Africa), but the European Union as a supranational region is the only one that refers to such objective for more than one country. Article 3(3) of the Treaty on European Union (TEU) provides that "The Union shall establish an internal market. It shall work for the sustainable development of Europe based on balanced economic growth and price stability, a highly competitive social market economy, aiming at full employment and social progress, and a high level of protection and improvement of the quality of the environment. It shall promote scientific and technological advance". Also, according to Article 3(5) TEU, the EU shall contribute to 'the sustainable development of the Earth, solidarity and mutual respect among peoples, free and fair trade, eradication of poverty and the protection of human rights.'

[435] European Commission, "Strategy for sustainable development", [Online]. Available: http://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=LEGISSUM:l28117&from=EN. [Accessed 15 February 2017].

[436] European Commission, "Environment 2010: Our Future, Our Choice. 6th EU Environment Action Programme", European Commission, 2001, [On-line]. Available http://ec.europa.eu/environment/air/pdf/6eapbooklet_en.pdf [Accessed 07 September 2017].

[437] *Ibid.*

[438] Decision No 1386/2013/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 20 November 2013 on a General Union Environment Action Programme to 2020 'Living well, within the limits of our planet'.

[439] European Commission, "Environment Action Programme to 2020", [Online]. Available: http://ec.europa.eu/environment/action-programme/. [Accessed 15 February 2017].

[440] Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, "Roadmap to a Resource Efficient Europe" COM(2011) 571 final.

[441] Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, "A Roadmap for moving to a competitive low carbon economy in 2050", COM(2011) 112 final.

The EU Climate and Energy Package focuses on the fact that some contradictions can arise between the instruments to reduce GHG emissions and the protection of the environment. Although the EU is still not sure whether the package succeeds in balancing climate change mitigation with other environmental protection goals, it succeeds in supporting climate change mainstreaming.[442] The EU's climate policy and leadership on sustainability governance contrasts with the complexities of the internal energy market. Sustainability governance is still rather underdeveloped,[443] despite the overuse of the term "sustainability" in a significant number of legal instruments advocating for it.[444] Meeting renewable energy demands in a low-carbon economy will need to be done in a manner that does not result in negative impacts on the environment.[445]

The EU, as a governance body, continues to invest in advancing innovative approaches to policy-making in its pursuit of realizing sustainable development.[446] In the 1990s, Collier observed that environmental policy integration is necessary for "achieving sustainable development and preventing environmental damage; removing contradictions between policies as well as within policies, and realizing mutual benefits and the goal of making policies mutually supportive."[447] Given today's challenges of energy security of supply, climate change, biodiversity conservation, and the need for an equitable allocation of resources, sustainable development is perceived as a new constitutional paradigm, and is now even more essential to the EU's regulatory frameworks than when the concept was coined in 1987.[448] The adoption of the Sustainable Development Goals[449] by the international community at the UN General Assembly in September 2015 provided the EU with an opportunity to push forward the key principles of the TFEU and incorporate them into the very fabric of policy-making, both substantively and procedurally.[450]

As part of the 2030 Agenda for Sustainable Development,[451] the EU is keen to reform its policy-making approach to ensure that it considers long-term impacts. In measuring progress towards sustainable transitions and human well-being within the physical limits of the planet, it is necessary to assess environmental sustainability. The so-called "planetary boundaries"[452] for carbon emissions, water use, and land use are being modelled to determine the ecological space available for sustainable

[442] M. Montini and E. Orlando, "Balancing climate change mitigation and environmental protection interests in the EU Directive on carbon capture and storage," *Climate Law*, pp. 165-180, 2012.

[443] For an analysis, see Leal-Arcas, R. "Sustainability, common concern, and public goods," The George Washington International Law Review, Vol. 49, No. 4, 2017, pp. 801-877.

[444] M. D. Sánchez Galera, "The Integration of Energy Environment under the Paradigm of Sustainability threatened by the Hurdles of the Internal Energy Market," *European Energy and Environmental Law Review,* vol. 26, no. 1, pp. 13-25, 2017.

[445] R. Hastik *et al*., "Using the "Footprint" Approach to Examine the Potentials and Impacts of Renewable Energy Sources in the European Alps," *Mountain Research and Development,* vol. 36, no. 2, pp. 130-140, 2016.

[446] European Commission - Press release "State of the Union 2016: Strengthening European Investments for jobs and growth", Strasbourg, 14 September 2016, [Online]. Available: http://europa.eu/rapid/press-release_IP-16-3002_en.htm [Accessed 05 September 2017].

[447] U. Collier, Energy and Environment in the European Union, Aldershot, 1994, p. 36.

[448] M. D. Sánchez Galera, "The Integration of Energy Environment under the Paradigm of Sustainability threatened by the Hurdles of the Internal Energy Market," *European Energy and Environmental Law Review,* vol. 26, no. 1, 2017, p. 13.

[449] The 17 Sustainable Development Goals (SDGs) are part of the 2030 Agenda for Sustainable Development. They call for action by all countries, poor, rich and middle-income, to promote prosperity while protecting the planet. End of poverty must be achieved together with economic growth, considering both social needs, climate change and environmental protection. The SDGs are not legally binding, but governments are expected to take ownership and establish national policy strategies for their achievement. Resolution adopted by the General Assembly, "Transforming our world: the 2030 Agenda for Sustainable Development", 25 September 2015 (A/70/L.1), 70/1.

[450] European Commission - Press release, "Sustainable Development: EU sets out its priorities", Strasbourg, 22 November 2016.

[451] Communication from the Commission to the European Parliament, The Council, The European Economic and Social Committee and the Committee of the Regions Next Steps for a Sustainable European Future European Action for Sustainability, COM(2016) 739 final (22 November 2016).

[452] J. Rockström *et al.*, Planetary Boundaries: Exploring the Safe Operating Space for Humanity. Portland State University PDXScholar Institute for Sustainable Solutions Publications Institute for Sustainable Solutions 1-1-2009. For a 2015 update: W. Steffen, Planetary boundaries: guiding human development on a changing planet, Science, Vol 347, Issue 6223.

development. “Growing scientific evidence for the indispensable role of environmental sustainability in sustainable development calls for appropriate frameworks and indicators for environmental sustainability assessment.”[453] Most decision-support systems and recommendations developed to analyze trade-offs between low-carbon energy generation and other interests have focused on single energy sources such as biomass, wind energy, and hydropower. A way to represent the pressure that humanity exerts on the Earth’s ecosystems is to measure humanity’s environmental footprint.[454] Recently, a growing list of such footprints has been created such as the ecological footprint, the carbon footprint, and the water footprint.[455] The anthropogenic impact on the planet needs to be taken up by policy-makers, economists, and lawyers when designing long-term strategies for pathways to a low-carbon world, including those working on smart grids energy systems.

The concept of building resilience into the system has increasingly complemented the debate on sustainability[456] and has focused on long-term solutions. The European Environmental Agency has called for:

> increased use of foresight methods, such as horizon scanning, scenario development and visioning [which] could strengthen long-term decision-making by bringing together different perspectives and disciplines, and developing systemic understanding. Impact assessments of the European Commission and EU Member States, for example, could be enhanced if they were systematically required to consider the long-term global context.[457]

Technologies can either undermine or enhance the resilience of systems.[458] The energy/climate debate is one infused with a faith in the positive relationship between the introduction of new technologies and social change.[459]

It is not only the technological system, but also the social-ecological systems that need to be resilient to reduce the chances of exposure to shocks. “Social-ecological systems and socio-technical systems are understood to display complex, dynamic, multiscale, and adaptive properties; recommendations for their sustainable governance emphasize learning, experimentation, and iteration.”[460] The transition phase is one where multiple pathways are being pursued and the social-ecological ecosystem is at its most dynamic and vulnerable stage.[461]

Research into the slow uptake of smart grids has emphasized the importance of developing a diverse approach and establishing multiple pathways for transformation amongst all stakeholders to build resilience within the system.[462] There is a need for flexible, responsive regulatory frameworks that are

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[453] K. Fang *et al*., “The Environmental Sustainability of Nations: Benchmarking the Carbon, Water and Land Footprints against Allocated Planetary Boundaries,” *Sustainability,* vol. 7, no. 8, pp. 11285-11305, 2015.

[454] The notion of measuring the carbon footprint as part of a sustainable world is even vivid in the ‘Clean Label’ movement, which aims to provide honest information to the consumer and food professionals on questions such as what there is in our food, who made it, what is the carbon footprint and related issues. See https://gocleanlabel.com/about/.

[455] Sustainable Europe Research Institute (SERI), How to measure Europe’s resource use, June 2009, [On-line]. Available: http://www.foeeurope.org/sites/default/files/publications/foee_seri_measuring_europes_resource_use_0609.pdf [Accessed 05 September 2017].

[456] European Commission, “Sustainability Now! A European Vision for Sustainability,” European Political Strategy Centre Stategic Note Issue 18, Brussels, 2016.

[457] European Environment Agency, “The European Environment State and Outlook 2015. Assessment of Global Megatrends,” European Environment Agency, Copenhagen, 2015.

[458] A. Smith and A. Stirling, “The Politics of Social-ecological Resilience and Sustainable Socio-technical Transitions,” *Ecology and Society,* vol. 15, no. 1, 2010.

[459] K. Bickerstaff *et al*., “Decarbonisation at home: the contingent politics of experimental domestic energy technologies,” *Environment and Planning A,* vol. 48, no. 10, pp. 2006-2025, 2016.

[460] A. Smith and A. Stirling, “The Politics of Social-ecological Resilience and Sustainable Socio-technical Transitions,” *Ecology and Society,* vol. 15, no. 1, 2010.

[461] B. Chaffin *et al*., “A decade of adaptive governance scholarship: synthesis and future directions,” *Ecology and Society,* vol. 19, no. 3, 2014, p. 56.

[462] S. Muench, “What hampers energy system transformations? The case of smart grids,” *Energy Policy,* vol. 73, pp. 80-92,

fit for a transformational social-economic system. This requires lawyers and policy-makers to recognize uncertainties within systems—in this case smart grid-based energy systems—and adopt a more adaptive approach to governance, which takes our incomplete knowledge of social-ecological systems into account.

The transition to a low-carbon world will need the EU Member States and others to carefully balance the new opportunities arising from ICT alongside societal and environmental needs in a just, fair, and equitable manner. The Member States must focus on delivering integrated sustainable outcomes across all sectors. One area where this is most necessary is the use and disposal of resources.

4.3.2. Smart Grids within a Circular Economy

One threat to EU economic security and growth is access to raw materials. Increasing energy efficiency is part of a broader goal to increase resource efficiency in the EU.[463] One strategy is to develop a circular economy. This section outlines the concept and the reasons why it is needed, especially in relation to smart grids. The discussion covers themes of design obsolescence, extended product responsibility, and e-waste management. This section considers how responsibilities should be allocated during the life cycle and value chain of products in a decentralized digital energy system, and to whom. The life cycle assessment is a process used to evaluate the environmental burdens that come with a product, production process, or activity throughout its entire life cycle from the phase of raw material extraction to final disposal.[464]

The transition to a low-carbon economy will not be without waste. It is imperative that forethought goes into business modelling and resource management for the entire lifecycle of the product to limit impacts on the environment and contribute to increasing energy efficiency. Today, much is wasted in three key resources: materials, food, and energy. Around 60% of energy in the US economy is wasted.[465] About 40% of food produced in the US in never eaten.[466] Up to 18% of water treated in the US is wasted.[467] The situation is not much better in the rest of the world: around 33% of energy is lost.[468] Between 30-50% of all food produced is wasted.[469] Up to 60% of water is lost through leaky pipes worldwide.[470] Researchers in Austria are currently studying the notion of socio-metabolism, which will help us describe and understand the transition to a new kind of society, namely the concept of a circular economy. In their words, "socio-economic systems depend on a continuous throughput of materials and energy for their reproduction and maintenance. This dependency can be seen as a functional equivalent of biological metabolism, the organism's dependency on material and energy flows."[471] For instance, the metabolism of a city implies the transformation from raw materials, water,

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2014; M. L. Tuballa and M. Lochinvar Abundo, "A review of the development of Smart Grid technologies," *Renewable and Sustainable Energy Reviews,* vol. 59, pp. 710-725, 2016.

[463] Commission Staff Working Paper, Analysis associated with the Roadmap to a Resource Efficient Europe, Part I, Accompanying the document Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of Regions, Roadmap to a Resource Efficient Europe, SEC(2011) 1067 final, Brussels, 20.9.2011.

[464] See for instance life cycle assessment of energy and environmental impacts of LED lighting products, at https://www1.eere.energy.gov/buildings/publications/pdfs/ssl/lca_factsheet_apr2013.pdf.

[465] Lawrence Livermore National Laboratory 2014.

[466] *Wasted: How America Is Losing Up to 40 Percent of Its Food from Farm to Fork to Landfill*, Natural Resources Defense Council.

[467] *The Case for Fixing the Leaks,* American Water Works Association.

[468] IIEA 2014.

[469] Global Food Report, Institution of Mechanical Engineers, January 2013.

[470] *Is the world thirsty for water management?,* IBM.

[471] Alpen-Adria University, "Institute of social ecology," at https://www.aau.at/en/social-

and fuel into goods, human biomass, and waste. It has been defined as "the technical and socioeconomic processes that occur in cities, resulting in growth, production of energy, and elimination of waste."[472] The goal, therefore, is to move towards an industrial ecosystem, where "the consumption of energy and materials is optimized, waste generation is minimized, and the effluents from one process serve as the raw material for another."[473]

The global growth in renewable energy capacity will soon bring end-of-life cycle waste management issues to the fore. First, planning ahead is necessary to manage the existing waste stream from established renewables. Second, it is necessary to promote a circular closed-loop approach to the whole life-cycle of products and contribute to a green economy.[474] Countries need to undertake reforms of existing laws and develop innovative policy and regulation to meet these challenges. The risks are high, primarily because renewable energy is far from being "clean."

The EU's energy targets promote energy efficiency, renewable energy, and decentralization, but these goals also need to fit within the broader 2030 EU Agenda for Sustainable Development[475] and the Circular Economy Action Plan to increase resource efficiency and decrease waste.[476] Rising costs, driven by the growing demand for primary resources, including those needed for smart grid systems, requires new approaches to resource management along the entire life cycle value chain. The EU is increasingly recognizing that the current economic model dependent on the linear use of materials is no longer viable. This is the reason why closing the material loop is prioritized.[477]

4.3.2.1. The Circular Economy Concept and the EU

The circular economy, also known as a "closed loop" economy, aims to reach holistic sustainability goals and is based on the concept of "no waste."[478] It is related to the concept of dematerializing. Circular economy is part of the relatively new science of industrial ecology,[479] which is critical to sustainable development. The concept of circular economy has the great advantage that, if you are re-using something, you do not need to go back to the extraction of natural resources and the production process when making a product.[480] Instead, in a circular economy, the end-of-life stage of

ecology/research/social-metabolism/.

[472] Kennedy et al., "The changing metabolism of cities," Journal of Industrial Ecology, 2007 (11), 43-59.

[473] R.A. Frosch and N. Gallopoulos, "Strategies for Manufacturing," *Scientific American,* 260 (3), 144, 1989.

[474] E. Morgera and A. Savaresi, "A Conceptual and Legal Perspective on the Green Economy," *Review of European Comparative and International Environmental Law,* vol. 22, no. 1, pp. 14-28, 2013.

[475] Communication from the Commission to the European Parliament, The Council, The European Economic and Social Committee and the Committee of the Regions Next Steps for a Sustainable European Future European Action for Sustainability, COM(2016) 739 final (22 November 2016).

[476] Communication from the Commission to the European Parliament. Closing the Loop – An EU action plan for the Circular Economy, COM(2015) 614 final (2 December 2015).

[477] S. Boulos *et al*., The Durability of Products: Standard Assessment for the Circular Economy Under the Eco-innovation Action Plan, Publications Office, 2015.

[478] I. C. De los Ríos and F. Charnley, "Skills and capabilities for a sustainable and circular economy: The changing role of design," Journal of Cleaner Production, vol. 160, pp. 109-122, 2017. See also the Zero Waste Europe initiative at http://www.zerowasteeurope.eu/category/products/epr-extended-producer-responsibility/.

[479] Industrial ecology examines "the influences of economic, political, regulatory, and social factors on the flow, use, and transformation of resources." See White, R. 1994, Preface, in B. Allenby and D. Richards, (eds.) *The Greening of Industrial Ecosystems*, Washington, D.C., National Academy Press. "The aim of industrial ecology is to restructure the industrial system, inspired by our understanding of biological ecosystems (cyclic use of resources, food webs, etc)…" See Erkman, S and R. Ramaswamy (2003), *Applied industrial ecology: A new platform for planning sustainable societies*, Bangalore, India: Aicra Publishers.

[480] See the work of the Ellen MacArthur Foundation on circular economy, https://www.ellenmacarthurfoundation.org/.

products and materials must be replaced by restoration.[481] In other words, it is about the notion of "cradle to cradle."[482] Even Mother Nature uses a circular-economy approach. Reducing waste is therefore at the core of the circular economy model.[483] It is a concept that recognizes the continuous potential value of materials to reduce resource inefficiency in both production and consumption, showing thereby that efficiency is an important resource. This must be the objective of a profound transformation. Consequently, the standard approach to creation, fabrication, and commerce of products must change as well.

The EU is heavily dependent on imported raw materials, especially metal ores and non-metallic minerals that are found in electrical and electronic equipment (EEE).[484] Since the design of a product directly influences the way a value chain is managed, building circular, globally sustainable value chains inevitably implies a fundamental change in the practice of design.[485] Recently, EU waste law became part of a wider policy discourse on sustainable production and consumption, moving towards the adoption of a circular economy. For example, as part of the Circular Economy Package, the European Commission proposed the addition of an obligation to ensure that, by 2030, the amount of municipal waste put into landfills will be reduced to 10% of the total amount of such waste.[486]

The EU Commission has committed to analyze the current situation of critical raw materials in the context of the circular economy with a focus on material-efficient recycling of electronic waste, waste batteries and other relevant complex end-of-life products.[487] With the transition to renewable energy systems set by the 2020 EU Climate and Energy Package and the 2030 EU Climate and Energy Framework, greater efforts are required to incorporate the Circular Economy principles into systems infrastructure design. The implications of this new approach are yet to be fully be appreciated. It is clear, however, that existing waste regulation needs to be revised and all actors throughout the supply chain of products need to assume new responsibilities to change the EU's current production system and close the loop, as required by the circular economy.

4.3.2.2. EU Waste Regulation: Key Principles for Renewable Energy and Smart Energy Grids

The EU has an extensive legal framework on waste management.[488] The 1975 Framework Directive on Waste (FDW) lays the foundation for EU waste law. It defined key concepts, established major principles such as the waste hierarchy, and allocated responsibilities between different actors including authorities, producers, and households.[489] Another important directive is the 1999 Landfill of Waste Directive which introduced the end-of-life cycle principle. It requires EU Member States to draft a national strategy for the implementation of measures aiming at developing a whole life-cycle approach to waste management and landfills.[490] It "sets targets to progressively reduce the level of biodegradable waste going to landfill and bans the landfilling of certain hazardous wastes, such as liquid waste, clinical waste and used tyres."[491] The overall goal within the EU is to reduce the

[481] I. C. De los Ríos and F. Charnley, "Skills and capabilities for a sustainable and circular economy: The changing role of design," Journal of Cleaner Production, vol. 160, pp. 109-122, 2017.

[482] Braungart, M. *Cradle to Cradle: Remaking the Way We Make Things*, 2009.

[483] Communication from the Commission to the European Parliament. Closing the Loop – An EU action plan for the Circular Economy, COM(2015) 614 final (2 December 2015).

[484] Directive 2012/19/EU of the European Parliament and of the Council, 4 July 2012 on Waste Electrical and Electronic Equipment (WEEE), L 197/38, 24.7.2012.

[485] I. C. De los Ríos and F. Charnley, "Skills and capabilities for a sustainable and circular economy: The changing role of design," Journal of Cleaner Production, vol. 160, pp. 109-122, 2017.

[486] Proposal for a Directive of the European Parliament and of the Council amending Directive 1999/31/EC on the landfill of waste, COM(2015) 594 final (2 December 2015).

[487] See Annex 1 Communication from the Commission to the European Parliament. Closing the Loop – An EU action plan for the Circular Economy, COM(2015) 614 final (2 December 2015).

[488] D. Langlet and S. Mahmoudi, EU Environmental Law and Policy, Oxford University Press, 2016.

[489] Framework Directive on Waste 75/442/EEC [1975].

[490] See Article 1 Council Directive 1999/31/EC of 26 April 1999 on the landfill of waste.

[491] R. Cherrington, *et al*. "Producer responsibility: Defining the incentive for recycling composite wind turbine blades in Europe", Energy Policy, Volume 47, August 2012, pp. 13-21, p. 14.

percentage volume of waste being discarded in landfills. Additional Directives include the Packaging and Packaging Waste Directive,[492] the End-of-Life-Vehicles Directive,[493] and the Waste Electrical and Electronic Equipment Directive (WEEE).[494] Each of such directives took forward the FDW waste hierarchy and extended responsibility principles.

In 2008, a new Waste Directive (the 2008 Directive) developed the waste hierarchy and extended the applicable responsibilities, especially for producers.[495] The Directive was based on Article 192(1) of the TFEU, which aims "to protect the environment and human health by preventing or reducing the adverse impacts of the generation and management of waste and by reducing overall impacts of resource use and improving the efficiency of such use."[496] The 2008 Directive explains the concept of product and material life-cycles, encourages the recovery of waste and the use of recovered materials, and develops end-of-waste criteria for specified waste streams.[497] Under the 2008 Directive, top priority is given to prevention, followed by preparing for re-use, recycling, and other recovery, including energy recovery. Disposal is the least desirable option and is at the bottom of the hierarchy.

Furthermore, the 2008 Directive expanded the principle of responsibility. It places responsibility for waste treatment upon the original waste producer. Under Article 15 of the 2008 Directive, EU Member States can specify the conditions of responsibility and decide in which cases the original producer is to retain responsibility for the whole treatment chain and in which cases the responsibility of the producer and the holder can be shared or delegated among the actors of the chain.[498] This includes scenarios in which the original waste producer bears the cost of waste management.

The trend in the EU is towards recognizing an extended producer responsibility (EPR) for new products, product groups, and waste streams such as electrical appliances and electronics.[499] However, the effectiveness of EPR within the EU Member States is variable. Having different national EPR interpretations for waste EEE hampers the effectiveness of recycling policies. For this reason, in 2012, the Commission proposed that essential criteria needed to be decided by the EU and minimum standards for the treatment of waste EEE should be developed.[500]

The EU is taking steps to address the impacts of renewable energy and smart grids—including the upscaling of solar PV,[501] wind turbines, and batteries for EVs. One substantive initiative in this regard is the amendment of the WEEE Directive for the collection and recycle of solar PV panels. [502]

Most of the EU Member States have revised national EEE waste regulations to include solar PV in

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[492] European Parliament and Council Directive 94/62/EC of 20 December 1994 on packaging and packaging waste.

[493] Directive 2000/53/EC of the European Parliament and of the Council of 18 September 2000 on of-of-life vehicles.

[494] Directive 2002/96/EC of the European Parliament and of the Council of 27 January 2003 on waste electrical and electronic equipment (WEEE) – recast as Directive 2012/19/EU of the European Parliament and of the Council of 4 July 2012.

[495] Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on waste and repealing certain Directives, L 312/3, 22.11.2008, where the principle of "extended producer responsibility" is introduced for the first time.

[496] See Article 1 Directive 2002/96/EC of the European Parliament and of the Council of 27 January 2003 on waste electrical and electronic equipment (WEEE).

[497] Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on waste and repealing certain Directives.

[498] See Article 15 Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on waste and repealing certain Directives.

[499] Organisation for Economic Co-operation and Development, "Extended producer responsibility," OECD, [Online]. Available: http://www.oecd.org/env/tools-evaluation/extendedproducerresponsibility.htm. [Accessed 15 February 2017].

[500] See Recital 6 Directive 2012/19/EU of the European Parliament and of the Council of 4 July 2012 on waste electrical and electronic equipment (WEEE).

[501] Beyond the EU boundaries, research shows that "solar PV systems are now at or approaching retail electricity prices in many markets, across both residential and commercial user segments." See Report: Solar at grid parity in 80% of world by 2017, available at http://www.utilitydive.com/news/report-solar-at-grid-parity-in-80-of-world-by-2017/370346/.

[502] Directive 2012/19/EU of the European Parliament and of the Council of 4 July 2012 on waste electrical and electronic equipment (WEEE).

national law (e.g., Spain[503] and Italy[504]).

The principle of producer responsibility could be extended to manufacturers for recycling wind turbine blades in the same way it has so effectively been done with the WEEE Directive amendment.[505] If legislation is introduced within the wind energy industry, it is likely to be similar to the end-of-life vehicles legislation that introduces set recycling and recovery targets for manufacturers. This would require the producer to have more responsibilities. Some EU Member States have adopted measures to deal with the problem of wind turbine blades landfill dumping. Since 2005, Germany has banned all types of untreated municipal solid waste from its landfills.[506] Consequently, materials with a high organic content (e.g., wind turbine blades) need to find different end-of-life routes. Cherrington *et al.* state that "landfill bans effectively divert waste from landfill and drive towards energy recovery."[507] EU legislation increasingly discourages the disposal of waste in landfills, setting steeper reduction targets, for example the reduction of 10% by 2030 included in the Circular Economy Plan.[508] Wind turbine manufacturers could take the initiative. Investing in solutions now will provide time to develop efficient systems and reduce technology costs.[509]

The amendments to the WEEE Directive to increase recycling of solar PV panels and proposals to limit the discarding of wind turbine blades in landfills are important steps to manage the end-of-life waste from these renewable energy sectors.

4.3.2.3. New Concepts and Principles to Close the Smart Grid Loop

EPR was intended to incentivize manufacturers to increase waste management efficiencies through better product design. EPR's rationale is that financial and/or physical responsibility makes producers internalize waste management considerations in their product strategies.[510] Reports illustrate, however, that EPR remains a distant goal within the EU.[511] A new model is needed. The EU Circular Economy Action Plan[512] moves in that direction as it tackles one of the main obstacles to fair management of the life-cycle of EU products: planned obsolescence.

The term "planned obsolescence" dates to the Great Depression, when Bernard London recommended the strategy as a means to foster economic recovery.[513] London perceived the economic value of stimulating repetitive consumption. Lightbulbs were the first items to be designed

[503] Royal Decree 110/2015 of 20 February.
[504] Legislative Decree No. 49, 14 March 2014, Implementing Directive 2012/19/EU on Waste Electrical and Electronic Equipment (WEEE).
[505] R. Cherrington *et al*., "Producer responsibility: Defining the incentive for recycling composite wind turbine blades in Europe," *Energy Policy,* vol. 47, pp. 13-21, 2012.
[506] 2006 Municipal Solid Waste Management Report, Municipal solid waste management in Germany TASi one year on – no wastes landfilled without pretreatment in Germany since 1 June 2005 – A new era has dawned in municipal solid waste management, 1 September 2006, [On-line]. Available http://www.bmub.bund.de/fileadmin/bmu-import/files/pdfs/allgemein/application/pdf/bericht_siedlungsabfallentsorgung_2006_engl.pdf. [Accessed 05 September 2017].
[507] R. Cherrington *et al*., "Producer responsibility: Defining the incentive for recycling composite wind turbine blades in Europe", *Energy Policy,* vol. 47, pp. 13-21, 2012.
[508] Proposal for a Directive of the European Parliament and of the Council amending Directive 1999/31/EC on the landfill of waste, COM(2015) 594 final (2 December 2015).
[509] K. Ortegon *et al*., "Preparing for end of service life of wind turbine," *Journal of Cleaner Production,* vol. 39, pp. 191-199, 2013. R. Cherrington *et al*., "Producer responsibility: Defining the incentive for recycling composite wind turbine blades in Europe," *Energy Policy,* vol. 47, pp. 13-21, 2012.
[510] H. Kalimo *et al*., "What Roles for Which Stakeholders under Extended Producer Responsibility?," *Review of European Community and International Environmental Law ,* vol. 24, no. 1, pp. 40-57, 2014.
[511] Report from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions on the Thematic Strategy on the Prevention and Recycling of Waste, COM(2011) 13 final (19 January 2011).
[512] Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, Closing the loop - An EU action plan for the Circular Economy, Brussels, 2.12.2015, COM(2015) 614 final.
[513] B. London, Ending the Depression through Planned Obsolescence, University of Wisconsin, 1932.

with planned obsolescence in mind.[514] By contrast, the circular economy is based on the principle of planned durability, of which manufacturers have full responsibility. Improving product durability and reparability is important to reducing pressure on natural resources, reducing import costs for manufacturers, and saving money for consumers.[515]

There is no legal definition of durability, but so far, the European Commission has proposed the following:

> Durability is the ability of a product to perform its function at the anticipated performance level over a given period (number of cycles/uses/hours in use), under the expected conditions of use and under foreseeable actions. Performing the recommended regular servicing, maintenance, and replacement activities as specified by the manufacturer will help to ensure that a product achieves its intended lifetime.[516]

The practicalities of delivering planned durability are numerous and challenging.[517] Manufacturers generally want to restrict access to spare parts and limit repair and reuse of old products.[518] Key issues include not only the cost of spare parts but also access to information and skills development. The EU has produced reports exploring the potential for using regulations to stimulate durability, reparability, and reusability of products.[519] It has also developed rules to increase design durability for some products, such as lighting and vacuum cleaners. Several EU Member States have introduced national legal measures to reduce planned obsolescence and increase reparability.[520] France, for instance, introduced a law to address planned obsolescence. Article L. 213-4-1 of the Consumer Code now reads: "[p]lanned obsolescence is defined by all the techniques by which a person that places goods on the market seeks to deliberately reduce the lifespan of a product to increase the substitution rate."[521] Although limited in scope due to pressure from manufacturers lobbying during the negotiation of the law, judicial interpretation could provide positive developments to reduce design obsolescence. Another example is Norway, which requires companies to extend consumer guarantees on certain products, which increases the responsibility of the manufacturer.[522]

To overcome excessive and unnecessary consumption, product designers need to factor in durability and reparability. Spare parts should be made easily available at an affordable price that incentivizes repair. Design models should be able to incorporate old components into newer versions of a product. Regarding software, making new software compatible with older models can deter consumers from

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514 M. Krajewski, "The Great Lightbulb Conspiracy," IEEE Spectrum, 24 September 2014. [Online]. Available: http://spectrum.ieee.org/geek-life/history/the-great-lightbulb-conspiracy. [Accessed 15 February 2017].

515 *Ibid.*

516 S. Boulos *et al*., The Durability of Products: Standard Assessment for the Circular Economy Under the Eco-innovation Action Plan, Publications Office, 2015, p. 4.

517 European Environmental Bureau, "Delivering Resource-Efficient Products: How Ecodesign Can Drive a Circular Economy in Europe," European Environmental Bureau, Brussels, 2015. F. Ardente and F. Mathieux, "Identification and assessment of product's measures to improve resource efficiency: the case-study of an Energy using Product," *Journal of Cleaner Production,* vol. 83, pp. 126-141, 2014.

518 C. Dalhammar, "Industry attitudes towards ecodesign standards for improved resource efficiency," *Journal of Cleaner Production,* vol. 123, 2016, p. 155.

519A. M. Bundgaard *et al*., "Ecodesign Directive 2.0. From Energy Efficiency to Resource Efficiency," Environmental project No. 1635, 2015, Aalborg, 2017; F. Ardente *et al*., "Recycling of electronic displays: Analysis of pre-processing and potential ecodesign improvements," *Resources, Conservation and Recycling,* vol. 92, pp. 158-171, 2014; RREUSE, "Improving Product Reparability: Policy Option at the EU Level," RREUSE, 2015.

520 RREUSE, "Improving Product Reparability: Policy Option at the EU Level", RREUSE, September 2015, [On-line]. Available http://www.rreuse.org/wp-content/uploads/Routes-to-Repair-RREUSE-final-report.pdf [Accessed 07 September 2017].

521 Law No. 2015-992 on Energy Transition for Green Growth (Energy Transition Law); « I.-L'obsolescence programmée se définit par l'ensemble des techniques par lesquelles un metteur sur le marché vise à réduire délibérément la durée de vie d'un produit pour en augmenter le taux de remplacement. » https://www.legifrance.gouv.fr/affichCodeArticle.do?cidTexte=LEGITEXT000006069565&idArticle=LEGIARTI000031053376 [translation from French by Rafael Leal-Arcas].

522 E. Maitre-Ekern and C. Dalhammar, "Regulating Planned Obsolescence: A Review of Legal Approaches to Increase Product Durability and Reparability in Europe," Review of European Community and International Environmental Law, vol. 25, no. 3, pp. 378-394, 2016.

upgrading to new versions. The electronic equipment industry notoriously exploits incompatibility across new models and fosters design obsolescence. This has driven a global e-waste disposal crisis, especially in several developing countries such as Nigeria.[523] Apple even has the battery built into its computers and phones. Batteries are a component that can be easily replaced, but are also a high-level toxic waste requiring safe disposal using the best available technology.

The Eco-design Directive is a key instrument for promoting durability.[524] Already used to set binding minimum energy efficiency requirements, the directive is being used to develop new eco-design requirements for manufacturers. The directive obligates manufacturers to provide mandatory information on proper disposal, disassembly, and recycling at the end-of-life stage, especially for product groups with toxic content (e.g., mercury).[525] Lifetime extension is specifically listed in the Directive and for certain products is "expressed through: minimum guaranteed lifetime, minimum time for availability of spare parts, modularity, upgradeability, reparability."[526] A different way of tackling the issue would be through an indirect approach, through voluntary agreements signed with manufacturers. Even if such agreements are not compulsory, they would imply that manufacturers are willing to commit to these issues. A voluntary approach is sometimes even more effective than legal or regulatory rules, which leads to better and longer-term results in terms of contribution to the circular economy.[527]

The definition of durability does not refer to reparability. Design for reparability is difficult to measure and can lead to legal complexities if not addressed.[528] Durability and reparability are two sides of the same coin.[529] The circular economy opens opportunities for small and medium scale enterprises to provide reparability and recycling services. Remanufacturing and repair industries need rules that clarify that the repairer, or anyone putting the product into re-use, should not be considered the manufacturer/producer of the repaired/re-used product. Re-manufacturers will seek to avoid becoming a "producer" in the meaning of some EU Directives because they would be economically responsible for the collection and recycling of the product. They would also need to comply with the requirements of "new" products, such as respecting the rules on energy efficiency.[530] Similarly, being a re-manufacturer implies being carbon-negative, which is a desired outcome.

The complexity of smart grid systems will undoubtedly lead to demand for manufacturers and service providers to offer support services to consumers. It will benefit consumers, the collaborative economy, and the environment, as well as future generations if the legal and regulatory framework are in place to ensure this occurs in a circular economy where all the loops are closed.

4.4. DIGITAL TECHNOLOGY, SMART GRIDS, AND THE LAW

4.4.1. Background

ICT, especially new digital applications for smart grids, plays a central role in enabling new energy

[523] G. Pickern, "Making connections between global production networks for used goods and the realm of production: a case study on e-waste governance," *Global Networks,* vol. 15, no. 4, pp. 403-423, 2014.
[524] Communication from the Commission to the European Parliament. Closing the Loop – An EU action plan for the Circular Economy, COM(2015) 614 final (2 December 2015).
[525] European Environmental Bureau, "Delivering Resource-Efficient Products: How Ecodesign Can Drive a Circular Economy in Europe," European Environmental Bureau, Brussels, 2015.
[526] See Part 1.3, point (i) of Annex I Directive 2009/125/EC of the European Parliament and of the Council of 21 October 2009 establishing a framework for the setting of ecodesign requirements for energy-related products.
[527] Directorate General for Internal Policies, Policy Department, A Longer Lifetime for Products: Benefits for Consumers and Companies, IP/A/IMCO/2015-11 June 2016
[528] S. Boulos *et al.*, The Durability of Products: Standard Assessment for the Circular Economy Under the Eco-innovation Action Plan, Publications Office, 2015,
[529] E. Maitre-Ekern and C. Dalhammar, "Regulating Planned Obsolescence: A Review of Legal Approaches to Increase Product Durability and Reparability in Europe," Review of European Community and International Environmental Law, vol. 25, no. 3, pp. 378-394, 2016.
[530] *Ibid.*

providers to monitor and process data, and in creating opportunities to meet the various EU energy policy goals, including efficiency, security, and sustainability.[531] New digital technologies have made it possible to re-design the traditional analogue electricity power system infrastructure that has dominated the energy landscape in Europe since World War II. A transformation in the energy system will provide new opportunities not only to energy suppliers, but also to consumers.[532] Through advanced sensing technologies, it is now feasible to provide predictive information and bespoke recommendations based on almost real-time data to all stakeholders (e.g. utilities, suppliers, and consumers). Smart grids exactly refer to this new digital networked energy infrastructure.[533]

Smart grid services, which include intelligent appliance control for energy efficiency and better integration of distributed energy resources, can reduce carbon emissions. They offer the potential of higher level capabilities to meet current and future energy demands.[534] Smart grids could deliver improved reliability, resiliency, environmentally friendly generation, transmission, and distribution. This would help the EU to achieve strategic economic, environmental, and social goals.[535] These changes, which ultimately make energy systems more complex, have led to concerns regarding cyber-attacks on critical infrastructure, energy and data theft, fraud, denial of service, hacktivism, and design obsolescence adding to energy poverty.[536] Also, the regulation of smart grids and smart meter[537] technologies directly impacts the way data privacy is implemented in technical systems, such as smart meters and energy saving services.[538]

An argument exists that intelligent control and adequate economic management of energy consumption require greater interoperability between consumers and service providers: "[u]nprotected energy-related data will cause invasions of privacy in the smart grid."[539] Law and policy-makers need to consider the trade-offs to enable smart grids to deliver low-cost and green energy within locally, regionally, and nationally secure networked systems. Given the dependency of smart grids on digital technology, their uptake is intricately interlinked with law and policy on ICT more generally.

This section outlines developments in ICT law that are relevant to smart grids, both internationally and in the EU. The first section provides a survey of key law and policy issues related to security and privacy when dealing with smart grids and ICT, including an analysis of concepts such as cybersecurity, cyber-crime, and data management. The first section is followed by an outline of existing and emerging EU and international legislation addressing the above-mentioned issues and will be divided into privacy and data protection (4.4.3.1) and digital systems security (4.4.3.2).

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[531] As mentioned, for instance, in the European Commission's communication "Energy 2020 — A strategy for competitive, sustainable and secure energy", COM(2010) 639 final (10 November 2010.)

[532] The Climate Group, GeSI, "SMART 2020: Enabling the low carbon economy in the information age", 2008. [On-line]. Available: http://gesi.org/files/Reports/Smart%202020%20report%20in%20English.pdf [Accessed 04 August 2017].

[533] European Commission Directorate-General Information Society and Media, ICT for Sustainable Growth Unit, "ICT for a Low Carbon Economy", Smart Electricity Distribution Networks, July 2009.

[534] J. Liu *et al*., "Cyber Security and Privacy Issues in Smart Grids," *IEEE Communications Surveys & Tutorials,* vol. 14, no. 4, pp. 981-987, 2012.

[535] K. Polinpapilinho *et al*., "A Criticality-based Approach for the Analysis of Smart Grids," *Technology and Economics of Smart Grids and Sustainable Energy,* vol. 1, no. 1, pp. 1-20, 2016.

[536] C. Wueest, "Attacks Against the Energy Sector," Symantec Official Blog, 13 January 2014. [Online]. Available: https://www.symantec.com/connect/blogs/attacks-against-energy-sector. [Accessed 5 May 2017].

[537] Smart meters are advanced metering systems which provide real-time information on consumers' energy use or generation. They use digital technologies, regularly update information and provide two-way electronic communication between consumers and the grid. H. Joachain and F. Klopfert, "Coupling smart meters and complementary currencies to reinforce the motivation of households for energy savings", Ecological Economics, Volume 105, September 2014, Pages 89-96.

[538] REScoop, "6.1 European Legislative Environment", REScoop, 2017. European Parliamentary Research Service, "Smart electricity grids and meters in the EU Member States", EPRS, September 2015. [On-line]. Available: http://www.europarl.europa.eu/RegData/etudes/BRIE/2015/568318/EPRS_BRI%282015%29568318_EN.pdf [Accessed 04 August 2017].

[539] J. Liu *et al*., "Cyber Security and Privacy Issues in Smart Grids," *IEEE Communications Surveys & Tutorials,* vol. 14, no. 4, pp. 981-987, 2012.

4.4.2. Smart Grids: Cybersecurity and Privacy Issues

Smart grids bring risks. Some risks are known, old, and foreseeable issues. Other risks are new and less predictable. Cybersecurity is likely to become more important in the next few years.[540] Cyber-technologies are becoming less expensive and easier to acquire, which allows states and even non-state actors to potentially inflict considerable damage.[541] Cyber-operations may not only be used for industrial espionage or intelligence collection, but also to delete, alter, or corrupt software and data resident in computers. This could entail negative repercussions on the functionality of computer-operated physical infrastructures, including disabling power generators.[542] Smart grids increasingly couple information in the energy sector with digital communication systems. This has created new vulnerabilities and resulted in smart grids becoming a security issue beyond traditional energy security framing and including cybersecurity.[543]

Smart grids are integrated systems that include technologies, information, social and organizational components, policy and political requirements, and legislative and regulatory compliance.[544] Consequently, this increases the risk of compromising the ultimate objective of smart grids: reliable and secure power system operation. In 2008, the European Commission acknowledged that the electricity sector constitutes "an essential component of EU energy security." [545] Some even argue that the current interdependence between the electricity and communication infrastructures is so profound that it could be conceived within an "energy-and-information" paradigm.[546] This inter-dependence becomes even more intricate when considering the energy systems' critical infrastructure status and the potentially catastrophic impact of cyber-attacks.

An effective regulatory framework manages both known and unknown risks, with the latter involving a precautionary approach. Smart grids need to ensure the security of sensitive customer information transmitted over an increasing number of "internet of things" (IoT) devices. Smart grids must also ensure that communication between stakeholders is reliable enough to deliver stable operation. There is a need to develop resilient formulations of risk related to holistic considerations.[547] An integrated multilevel governance approach is required to integrate smart grids securely within society, although this approach presents new legal challenges for lawyers and policy-makers.

Unlike traditional energy systems, smart grids fully integrate high-speed and two-way communication technologies to create dynamic and interactive infrastructure with new energy management capabilities.[548] Smart grids energy systems are "a literal IoT": networks with billions of interconnected

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[540] C. Cerrudo, "Why Cybersecurity Should Be The Biggest Concern Of 2017", Forbes, https://www.forbes.com/sites/forbestechcouncil/2017/01/17/why-cybersecurity-should-be-the-biggest-concern-of-2017/#4a61899c5218 (17 January 2017.)

[541] M. Roscini, Cyber Operations and the Use of Force in International Law, Oxford University Press, 2014, p. 2.

[542] *Ibid.* -CRIME, "D6.2 Executive summary and brief: The economic impact of cyber-crime on non-ICT sectors," E-CRIME, 2016.

[543] M. Masera, "The Security of Information and Communication Systems and the E+I Paradigm," in *Critical Infrastructures at Risk: Securing the European Electric Power System*, V. Gheorghe, M. Masera, M. Weijnen and L. De Vries, Eds., Springer, 2016, pp. 85-116.

[544] K. Polinpapilinho et al., "A Criticality-based Approach for the Analysis of Smart Grids," *Technology and Economics of Smart Grids and Sustainable Energy*, vol. 1, no. 1, pp. 1-20, 2016.

[545] Commission Staff Working Document accompanying the Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. Second Strategic Energy Review an EU energy security and solidarity action plan. Europe's current and future energy position. Demand-resource-investments, SEC(2008) 2871 (13 November 2008)

[546] I. L. G. Pearson, "Smart grid cyber security for Europe", *Energy Policy*, vol. 39, pp. 5211–5218, 2011.

[547] K. Polinpapilinho et al., "A Criticality-based Approach for the Analysis of Smart Grids," *Technology and Economics of Smart Grids and Sustainable Energy*, vol. 1, no. 1, pp. 1-20, 2016.

[548] W. Wang and Z. Lu, "Cyber security in the Smart Grid: Survey and challenges," *Computer Networks,* vol. 57, no. 5, pp. 1344-1371, 2013.

smart objects, such as smart meters, smart appliances, and other sensors.[549] As a cyber-physical system, an IoT-based smart grid presents risks across different domains (i.e., generation, transmission, distribution, customer, service-provider, and operations markets).[550] The EU acknowledges that smart metering systems and smart grids foreshadow this impending IoT. The EU also acknowledges that with this development come potentially increasing risks associated with the collection of detailed consumption data.[551] Sander Kruese, privacy and security adviser at Alliander, a DSO in the Netherlands, noted that "[e]very component in the grid that has become digitized is becoming an attack-point."[552] Providing securitization across the entire system, a system that continuously incorporates new software systems and hardware from a range of providers, is a demanding task. The EU has adopted a strategy on cybersecurity.[553] Operationalizing the goals contained in the strategy will be integral to addressing new potential threats posed by embedding ICT into the European Union's energy system.[554]

Threats that were not possible in the traditional electric grid[555] are now the main concern.[556] When combined with data from other multiple independent data sources,[557] smart meter data becomes part of a broader and more open meta-data system.[558] In different ways, all users are potential victims of attacks in such a context. In addition, their vulnerabilities could be drawn from previous experience gained in different sectors, such as IT and telecommunications.[559] As an example, automated smart meters rely on tracking, in real time, actual power usage, and allow for two-way communication between utilities and end-users. Hackers targeting this technology may induce disruptions in power flows, create erroneous signals, block information (including meter reads), cut off communication, and/or cause physical damage.[560]

Digital ICT has accelerated the expansion of personal data systems—making them more extensive and consequential in the lives of ordinary citizens.[561] The costs of using personal data in today's computerized record-systems are all but negligible. The result is that all sorts of personal data that

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549 K. Weaver, "Smart Meter Deployments Result in a Cyber Attack Surface of "Unprecedented Scale"," Smart Grid Awareness, 7 January 2017. [Online]. Available: https://smartgridawareness.org/2017/01/07/cyber-attack-surface-of-unprecedented-scale/. [Accessed 8 February 2017].

550 K. Polinpapilinho et al., "A Criticality-based Approach for the Analysis of Smart Grids," Technology and Economics of Smart Grids and Sustainable Energy, vol. 1, no. 1, pp. 1-20, 2016.

551 Article 29 Data Protection Working Party, "Opinion 07/2013 on the Data Protection Impact Assessment Template for Smart Grid and Smart Metering Systems ('DPIA Template') prepared by Expert Group 2 of the Commission's Smart Grid Task Force," 2064/13/EN WP209, Brussels, 2013.

552 A. Gurzu, "Hackers threaten smart power grids," Politico, 1 April 2017. [Online]. Available: http://www.politico.eu/article/smart-grids-and-meters-raise-hacking-risks/. [Accessed 3 May 2017].

553 Joint Communication to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. Cybersecurity Strategy of the European Union: An Open, Safe and Secure Cyberspace, JOIN(2013) 1 final (7 February 2013).

554 Ibid.

555 Such as energy theft and fraud, sensitive information theft, service disruption for the purpose of extortion, cyber-espionage, vandalism, hacktivism and terrorism

556 K. Weaver, "Smart Meter Deployments Result in a Cyber Attack Surface of "Unprecedented Scale"," Smart Grid Awareness, 7 January 2017. [Online]. Available: https://smartgridawareness.org/2017/01/07/cyber-attack-surface-of-unprecedented-scale/. [Accessed 8 February 2017]. F. Umbach, Electricity supplies are highly vulnerable to cyber-attacks (2013) [Online]. Available: http://www.worldreview.info/content/electricity-supplies-are-highly-vulnerable-cyber-attacks [Accessed 3 May 2017].

557 Such as geo-location data, tracking and profiling on the internet, video surveillance systems, radio frequency identification systems, etc.

558 Recommendation CM/Rec(2010)13 of 23 November 2010 of the Committee of Ministers to member states on the protection of individuals with regard to automatic processing of personal data in the context of profiling.

559 J. Liu *et al*., "Cyber Security and Privacy Issues in Smart Grids," *IEEE Communications Surveys & Tutorials,* vol. 14, no. 4, pp. 981-987, 2012.

560 US Department of Energy, "Transforming the Nation's Electricity System: The Second Instalment of the QER," US Department of Energy, 2017.

561 J. Rule and G. Greenleaf, Global Privacy Protection: The First Generation, Edward Elgar, 2010.

would otherwise be "lost" are now "harvested" by different actors that do everything from allocating consumer credit to preventing cyber terrorist attacks.[562] New technologies allow for an unprecedented level of information-integration, "providing the possibility to combine new and existing data and technologies (interoperability) and cope with growing resources and number of users (scalability), through the adoption of distributed systems (cloud computing)."[563]

Information gathered from energy users is integral to empowering individuals, households, and organizations to change their consumption patterns, increasing efficiency, and reducing energy costs and carbon emissions.[564] In 2010, the European Commission noted that "the ICT sector should lead the way by reporting its own environmental performance by adopting a common measurement framework."[565] There is an assumed positive relationship between data access, processing, and dissemination to achieve beneficial behavioral change by citizens that underpins the EU policy on why ICT is pertinent for this purpose.

Unlike oil, "a product that does not generate more oil (unfortunately) . . . the product of data (self-driving cars, drones, wearables, etc.) will generate more data."[566] According to a 2012 estimate, "90% of the world's data was created in the last two years alone. In fact, 2.5 quintillion bytes of data are created each day, which is more data than was seen by everyone since the beginning of time."[567] However, a consequence of increased data availability, especially in the form of meta-data, is to narrow the realm of anonymity—so that fewer interactions, relationships, and transactions are possible without identifying one's self.[568] This leads to questions about privacy and security.[569]

In 1890, Louis Brandeis and Samuel Warren defined the individual's need for privacy and solitude as a fundamental right, due to the increasing intensity and complexity of life.[570] Privacy is going to be even further challenged in the digital era.[571] Computer technologies increasingly make it possible to capture and use personal data in all sorts of settings and for all sorts of purposes that would once have been inconceivable. Leading figures amongst online corporations have argued that privacy is no longer a social norm or even possible: "Facebook and its CEO Mark Zuckerberg have taken the position that sharing of information and connectedness is the new social norm, and that privacy, on the contrary, is now outmoded."[572] Key questions at stake include what personal information institutions and other non-state actors collect, how it is collected, where it is stored, who can access it, and what actions can be taken on its basis.[573] It can be argued that this pressure on information privacy is not the result of a new social norm, but the consequence of a desire for profit at the expense of eroding privacy

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[562] Public opinion seems to be meeting these developments with concern, and suggestions are being put forward in order to empower users to gain better control of the situation. See in this sense B. X. Chen, "How to Protect Your Privacy as More Apps Harvest Your Data", New York Times, https://www.nytimes.com/2017/05/03/technology/personaltech/how-to-protect-your-privacy-as-more-apps-harvest-your-data.html?mcubz=1 (2 May 2017.)

[563] Z. Zulkafli et al., "User-driven design of decision support systems for polycentric environmental resources management," Environmental Modelling & Software, vol. 88, pp. 58-73, 2017.

[564] As a practical example, see, for instance, the analysis provided by J. Cai and Z. Jiang, "Changing of energy consumption patterns from rural households to urban households in China: An example from Shaanxi Province, China", *Renewable and Sustainable Energy Reviews*, Volume 12, Issue 6, pp. 1667-1680, 2008.

[565] Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. A Digital Agenda for Europe, COM(2010)245 final (19 May 2010).

[566] M. Shah, "Big Data and the Internet of Things," in *Big Data Analysis: New Algorithms for a New Society*, N. Japkowicz and J. Stefanowski, Eds., Springer, 2015, p. 208.

[567] International Telecommunication Union, "ICT Facts & Figures. The world in 2015," ITU, 2015.

[568] J. Rule and G. Greenleaf, Global Privacy Protection: The First Generation, Edward Elgar, 2010.

[569] E. McKenna et *al.*, "Smart meter data: Balancing consumer privacy concerns with legitimate applications," *Energy Policy,* vol. 41, pp. 807-814, 2012.

[570] L. Brandeis and S. Warren, "The Right to Privacy," *Harvard Law Review,* vol. 4, no. 5, 1890.

[571] For a brief discussion of this topic, see S. Sengupta, "U.N. Urges Protection of Privacy in Digital Era", New York Times, https://www.nytimes.com/2014/11/26/world/un-urges-protection-of-privacy-in-digital-era.html?mcubz=1, (25 November 2014.)

[572] M. Roggensack, "Face It Facebook, You Just Don't Get It," Huffington Post, 25 5 2010. [Online]. Available: http://www.huffingtonpost.com/human-rights-first/face-it-facebook-you-just_b_589045.html. [Accessed 3 May 2017].

[573] J. Rule and G. Greenleaf, Global Privacy Protection: The First Generation, Edward Elgar, 2010.

protection.[574] Governments and citizens in the EU are pushing back on these incursions on privacy. The EU has always paid much attention to personal and domestic privacy, unlike Asian countries.[575]

The perceived threat to the security of personal and family life has led to citizen resistance to smart meters: with their personal sphere is at stake, some react with distrust, suspicion, and hostility towards such new systems. [576] "Surveillance" via smart meters and IoT, therefore, results in extortion and fraud of the domestic sphere.[577] Ensuring privacy appears to be crucial in order to address social barriers and support the new energy system technologies.[578] The European Commission has recognized that, in order to achieve its broader energy and climate policy goals, building consumer trust in smart grids and data management must play a central role in its smart grids policy. In 2011, the European Commission advised that:

> [d]eveloping legal and regulatory regimes that respect consumer privacy in cooperation with the data protection authorities . . . and facilitating consumer access to and control over their energy data processed by third parties is essential for the broad acceptance of Smart Grids by consumers."[579]

Increasing consumer and business confidence in smart grids requires good governance and effective regulatory frameworks and laws.[580] In the following section, the legal approaches adopted to deliver increased privacy and reduce cybersecurity risks from ICT and smart grids technologies are critically examined.

4.4.3. International and EU Law

Dependence on energy systems based on smart grids and ICT poses two major risks: one to privacy and data protection; the other to digital systems security. This section considers the evolving legal frameworks, especially within the EU, for providing a reasonable regulatory architecture to ensure the risks are managed effectively.

4.4.3.1. Privacy and data protection

Internationally, privacy is embedded in fundamental legal documents. Privacy is included as a normative principle in the post-war Universal Declaration of Human Rights (1948) and the legally binding International Covenant on Civil and Political Rights (1966).[581] Developments in technology in the late 1960s and 1970s led both the US and Europe to recognize the need to guarantee data protection alongside the right to privacy. Each jurisdiction, including the various EU Member States, adopted differing approaches.[582]

The EU has separate legislation and guidelines on data protection. They promulgate data protection and guidelines that are technology neutral. Explicit recognition of the legal basis for data protection is

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[574] J. Stoddart, *Why Privacy Still Matters in the Age of Google and Facebook and How Cooperation Can Get Us There,* 2010.

[575] European Commission, "Flash Eurobarometer 443," European Commission, Brussels, 2016.

[576] N. Balta-Ozkan *et al*., "Social barriers to the adoption of smart homes," *Energy Policy,* vol. 63, pp. 363-374, 2013.

[577] J. Lazar *et al*., Ensuring Digital Accessibility through Process and Policy, Morgan Kaufmann, 2015.

[578] *Ibid.*

[579] Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, Smart Grids: from innovation to deployment, COM(2011) 202 final (12 April 2011).

[580] See Dow "Dow Launches 2025 Sustainability Goals to Help Redefine the Role of Business in Society," 15 April 2015 (arguing that "By 2025, Dow will work with other industry leaders, non-profit organizations and governments to deliver six major projects that facilitate the world's transition to a circular economy," available at http://www.dow.com/news/press-releases/dow%20launches%202025%20sustainability%20goals%20to%20help%20redefine%20the%20role%20of%20business%20in%20society.

[581] Convention for the Protection of Human Rights and Fundamental Freedoms as amended by Protocols No. 11 and No. 14.

[582] O. Lynskey, The Foundations of EU Data Protection Law, Oxford University Press, 2015.

contained in Article 16 TFEU.[583] Article 7 of the EU Charter of Fundamental Rights (the Charter) protects the fundamental right to the respect for private and family life, home, and communications and Article 8 provides specifically for the protection of personal data. EU data protection law has been decentralized in each Member State. The decentralization of this governance structure has led to jurisdictional tensions amongst the relevant public authorities with respect to the identification of both the domestic law applicable to data processing operations and the relevant enforcing national authority.[584] Additionally, the Member States of the Council of Europe have a positive obligation to act in a proactive manner in order to secure the effective enjoyment of those rights protected under the European Convention on Human Rights (ECHR); if it could be established that a State failed to take appropriate measures to protect individuals under its jurisdiction from privacy violations, the State would be liable under the ECHR.[585]

The European Commission has addressed data privacy matters and it has also specifically referred to smart grid technologies. The 1995 Data Protection Directive provides the foundational legal architecture for subsequent regulation.[586] Subsequent regulation and directives added to these initial foundations in an *ad hoc* manner. The 2002 e-Privacy Directive,[587] which was subsequently amended by Directives 2006/24/EC and 2009/136/EC, has failed to live up to the challenges of technological developments. The 2016 EU General Data Protection Regulation (GDPR), however, repealed the e-Privacy Directive. Other key legal developments included the 2008 Data Protection Framework Decision[588] and the Regulation 45/2001.[589]

The EU data protection framework establishes a number of general principles applicable to the process of any personal data (see **Figure 4** below).[590] The 2002 e-Privacy Directive constitutes a layered system consisting of three levels.

[583] Article 16 of the Treaty on the Functioning of the European Union reads as follows: "*1. Everyone has the right to the protection of personal data concerning them. 2. The European Parliament and the Council, acting in accordance with the ordinary legislative procedure, shall lay down the rules relating to the protection of individuals with regard to the processing of personal data by Union institutions, bodies, offices and agencies, and by the Member States when carrying out activities which fall within the scope of Union law, and the rules relating to the free movement of such data. Compliance with these rules shall be subject to the control of independent authorities. The rules adopted on the basis of this Article shall be without prejudice to the specific rules laid down in Article 39 of the Treaty on European Union.*"

[584] O. Lynskey, "The Europeanisation of data protection law", *Cambridge Yearbook of European Legal Studies*, pp. 1-35, 2016.

[585] E. Izyumenko, *Think before you share: Personal data on the Social Networking Sites in Europe; Article 8 ECHR as a tool of privacy protection,* Lund, 2011.

[586] Directive 95/46/EC of the European Parliament and of the Council of 24 October 1995 on the protection of individuals with regard to the processing of personal data and on the free movement of such data.

[587] Directive 2002/58/EC of the European Parliament and of the Council of 12 July 2002 concerning the processing of personal data and the protection of privacy in the electronic communications sector (Directive on privacy and electronic communications).

[588] Council Framework Decision 2008/977/JHA of 27 November 2008 on the protection of personal data processed in the framework of police and judicial cooperation in criminal matters.

[589] Regulation (EC) No 45/2001 of the European Parliament and of the Council of 18 December 2000 on the protection of individuals with regard to the processing of personal data by the Community institutions and bodies and on the free movement of such data.

[590] V. Papakonstantinou and D. Kloza, "Legal Protection of Personal Data in Smart Grid and Smart Metering Systems from the European Perspective," in *Smart Grid Security*, V. Papakonstantinou and D. Kloza, Ed., Springer, 2015, pp. 41-129.

- **Fairly and lawfully processed**—Art 6(1)(a) of the 1995 Data Protection Directive
- **Data minimization**
  - collected for specific, explicitly defined, and legitimate purposes—Art 6(1)(b)
  - not further processed in a way incompatible with those purposes—Art 6(1)(b)
  - retained only for as long as is necessary to fulfil those purposes—Art 6(1)(c) (implicitly)
- **Data quality**
  - adequate, relevant, and not excessive in relation to the purposes for which they are collected and/or further processed—Art 6(1)(c)
  - accurate and, where necessary, kept up-to-date—Art 6(1)(d)
- **Based on one of the legitimate bases for processing**—Art 7
  - unambiguous consent of the data subject
  - performance of a contract to which the data subject is a party
  - compliance with a legal obligation of the data controller
  - protection of the vital interest of the data subject
  - performance of the task carried out in the public interest or exercise of official authority
  - legitimate interest pursued by the controller
- **Data anonymization**—Art 6(1)(e)
  - kept in a form that permits identification of data subjects for no longer than is necessary for the purposes for which the data were collected or for which they are further processed
- **Processed confidentially**—i.e., "any person acting under the authority of the controller or of the processor, including the processor himself, who has access to personal data must not process them except on instructions from the controller, unless he is required to do so by law"—Art 16
- **Processed securely**—i.e., appropriate technical and organizational measures to protect personal data against accidental or unlawful destruction or accidental loss, alteration, unauthorized disclosure or access, in particular where the processing involves the transmission of data over a network, and against all other unlawful forms of processing—Art 17
- **Notified to a relevant supervisory authority**—i.e., controller must notify the national supervisory authority before carrying out any wholly or partly automatic processing operation—Art 18(1); subject to certain exceptions (e.g., appointing the in-house data protection official) (Art 18(2)).

Figure 4 – Key EU Data Protection Principles

Source - Vagelis Papakonstantinou and Dariusz Kloza, 'Legal Protection of Personal Data in Smart Grid and Smart Metering Systems from the European Perspective', in Vagelis Papakonstantinou and Dariusz Kloza, *Smart Grid Security* (Springer, 2015) 69

The first level is the general level that applies to every processing of personal data. The second level, which extends from the first level, applies when sensitive data are being processed. The third level is applicable when personal data are transferred to third countries. Hence, if this happens, all three levels apply.[591] All subsequent data protection legislation at the EU level must to comply with these

[591] C. Cuijpers and B.-J. Koops, "Smart metering and privacy in Europe: lessons from the Dutch case," in *European Data Protection: Coming of Age*, S. Gutwirth *et al*., Ed., Springer, 2012, pp. 269-293.

principles. Courts must also follow them when interpreting related legislation. These principles are incorporated into the GDPR, which will apply to all EU Member States in April 2018.[592] It is important to consider how these new principles will be incorporated into the law and policy related to smart grids.

Each principle needs to be applied according to certain conditions. Understanding the principles is essential to interpreting data protection laws in any given context, for example, with smart grids.[593] The following section considers the key principles in greater detail:

Lawful processing: to understand this principle, it is necessary to refer to Article 52(1) of the Charter[594] and Article 8(2) ECHR.[595] The processing of personal data is only lawful when it is done in accordance with the law, pursues a legitimate purpose, and is necessary in a democratic society to achieve that legitimate purpose. However, there is no definition of what constitutes "lawful processing" in Article 5 of the Convention 108[596] or in Article 6 of the 1995 Data Protection Directive.[597] The GDPR does not include a definition, either. The obligations to meet the principle fall on the data gatherer and user. As such, it is imperative in developing regulations related to smart grids that lawmakers clearly identify what legitimate purposes might be for data gatherers and users.

Data minimization: Data minimization requires that the purpose of processing data be visibly defined before processing is started. This requirement, although part of EU law, is left for Member States to interpret in domestic law. However, there will be less scope for such flexibility under the GDPR. Data specification requirements regulations are designed to limit the accumulation of data gathered and prevent the processing of data for undefined purposes. [598] This is a procedural requirement based

[592] O. Lynskey, "Deconstructing data protection: the 'Added-value' of a right to data protection in the EU legal order," *International and Comparative Law Quarterly,* vol. 63, no. 3, pp. 569-597, 2014.

[593] For a full overview, see European Union Agency for Fundamental Rights, "Handbook on European data protection law," European Union Agency for Fundamental Rights, 2014.

[594] Article 52 of the Charter of Fundamental Rights of the European Union: "*Article 52 Scope of guaranteed rights 1. Any limitation on the exercise of the rights and freedoms recognised by this Charter must be provided for by law and respect the essence of those rights and freedoms. Subject to the principle of proportionality, limitations may be made only if they are necessary and genuinely meet objectives of general interest recognised by the Union or the need to protect the rights and freedoms of others. 2. Rights recognised by this Charter which are based on the Community Treaties or the Treaty on European Union shall be exercised under the conditions and within the limits defined by those Treaties. 3. In so far as this Charter contains rights which correspond to rights guaranteed by the Convention for the Protection of Human Rights and Fundamental Freedoms, the meaning and scope of those rights shall be the same as those laid down by the said Convention. This provision shall not prevent Union law providing more extensive protection.*"

[595] Article 8(2) of the European Convention on Human Rights reads as follows: "*2. There shall be no interference by a public authority with the exercise of this right except such as is in accordance with the law and is necessary in a democratic society in the interests of national security, public safety or the economic well-being of the country, for the prevention of disorder or crime, for the protection of health or morals, or for the protection of the rights and freedoms of others.*"

[596] Convention for the Protection of Individuals with regard to Automatic Processing of Personal Data. For further details, see https://www.coe.int/en/web/conventions/full-list/-/conventions/treaty/108.

[597] Article 6 of Directive 95/46/EC of the European Parliament and of the Council of 24 October 1995 on the protection of individuals with regard to the processing of personal data and on the free movement of such data (Official Journal L 281 , 23/11/1995 P. 0031) reads as follows: "*1. Member States shall provide that personal data must be: (a) processed fairly and lawfully; (b) collected for specified, explicit and legitimate purposes and not further processed in a way incompatible with those purposes. Further processing of data for historical, statistical or scientific purposes shall not be considered as incompatible provided that Member States provide appropriate safeguards; (c) adequate, relevant and not excessive in relation to the purposes for which they are collected and/or further processed; (d) accurate and, where necessary, kept up to date; every reasonable step must be taken to ensure that data which are inaccurate or incomplete, having regard to the purposes for which they were collected or for which they are further processed, are erased or rectified; (e) kept in a form which permits identification of data subjects for no longer than is necessary for the purposes for which the data were collected or for which they are further processed. Member States shall lay down appropriate safeguards for personal data stored for longer periods for historical, statistical or scientific use. 2. It shall be for the controller to ensure that paragraph 1 is complied with.*"

[598] Article 5.1.(b) of Regulation (EU) 2016/679 of the European Parliament and of the Council of 27 April 2016 on the protection of natural persons with regard to the processing of personal data and on the free movement of such data, and repealing Directive 95/46/EC (General Data Protection Regulation), Official Journal L 119, 4/5/2016, p. 001,

upon the principle of transparency. The use of collected data for another purpose needs an additional legal basis if the new processing purpose is incompatible with the original one.[599] An additional legal basis is also necessary if data is transferred to third parties. The onus is placed on the data controller to comply with the obligations. The data controller must specify and make it clear to data providers the purpose for which data is being processed.[600] There is space for flexibility only if data is used for a compatible purpose. Both the Convention 108 and the Data Protection Directive resort to the concept of compatibility: the use of data for compatible purposes is allowed on the ground of the initial legal basis.[601] Neither law defines "compatibility," leaving this open to interpretation when determining if the initial legal basis for collecting the data is valid for a purpose different than the original one for which it was collected. The Data Protection Directive explicitly declares that the "further processing of data for historical, statistical or scientific purposes shall not be considered as incompatible provided that Member States provide appropriate safeguards."[602] There is no requirement on the data controller to obtain the consent of the data subject where collected data is used for a purpose compatible with the original one. This flexibility gives data controllers freedom to use collected data further. This could result in uses that data subjects would, if they were made aware, object to. It is also a way to keep data beyond the time period the original data was gathered for. Despite a lack of reference to consumer rights in even the more recent GDPR, the European Data Protection Supervisor has stated that consumer protection law has a part to play in data protection, especially on the subject of transparency of data usage.[603]

Data quality, retention, and accuracy: all processed data must be "adequate, relevant and not excessive in relation to the purpose for which they are collected and/or further processed."[604] The data controller must ensure that the purpose for gathering the data is clear, that gathering is kept to a minimum, and that the data collected are relevant for processing operations purposes. The data quality principle is aligned with the principle of limited data retention. Data should be deleted as soon as it is no longer needed for the purposes for which it was collected by the data controller. The obligation lies with the data controller to ensure that the principle of retention is met. As with the data minimization principle, exemptions to the principle of data retention must be established in law. Consumers need safeguards to ensure that their data are not used in contravention to the retention principle. Data controllers are obliged to ensure that the data held is as accurate as can reasonably be expected. This is essential for billing purposes, for example.[605]

Fair processing: this principle upholds procedural transparency between data subjects and data controllers. Controllers must inform data subjects on whose behalf they are processing their data and whether the controller has any intentions to process the data for other purposes. Fair processing prevents secret or covert processing that may be against the wishes or interests of the data subject. This principle is perhaps the most significant for developing trust between the data subject and the data controller.[606] For this principle to be effective, the terminology used to communicate with data subjects by data controllers must be understandable. Where data subjects have specific needs, these

[599] *Ibid.*
[600] Article 29 Data Protection Working Party, "Opinion 03/2013 on purpose limitation," 00569/13/EN WP 203, Brussels, 2013.
[601] Article 6.1.(b) of Directive 95/46/EC of the European Parliament and of the Council of 24 October 1995 on the protection of individuals with regard to the processing of personal data and on the free movement of such data, Official Journal L 281, 23/11/1995, P. 0031.
[602] See Chapter II of Directive 95/46/EC of the European Parliament and of the Council of 24 October 1995 on the protection of individuals with regard to the processing of personal data and on the free movement of such data.
[603] European Data Protection Supervisor, "Preliminary Opinion of the European Data Protection Supervisor. Privacy and competitiveness in the age of big data: The interplay between data protection, competition law and consumer protection in the Digital Economy," European Data Protection Supervisor, Brussels, 2014.
[604] Art. 6 (1) (c) Directive 95/46/EC of the European Parliament and of the Council of 24 October 1995 on the protection of individuals with regard to the processing of personal data and on the free movement of such data.
[605] J. Shishido, Smart Meter Data Quality Insights, EnerNOC Utility Solutions. [On-line]. Available: http://aceee.org/files/proceedings/2012/data/papers/0193-000375.pdf [Accessed 04 August 2017].
[606] Fairness of processing is referred to, notably, in recital 45, and paragraphs 2 and 3 of Article 6 ("Lawfulness of processing") of the GDPR.

should be taken into account by the data controller in order to meet their transparency principle obligations. Indeed, fair processing also means that controllers are prepared to go beyond the mandatory legal minimum requirements, if the legitimate interests of the data subject so require.[607] Going beyond what it is expected can be demonstrated by adopting data management standards. Data subjects should have free, easy access to their data. Data controllers should be able to demonstrate how their procedures meet data protection requirements under EU law. This emphasis on accountability and legitimacy is integral to building secure and trustworthy relations between data generators and data controllers. According to the 2013 OECD privacy guidelines, "a data controller should be accountable for complying with [data management] principles."[608] Also, according to the Article 29 Working Party's opinion,[609] the essence of accountability is the controller's obligation to put in place measures that would—under normal circumstances—guarantee that data protection rules are adhered to in the context of processing operations, and to have documentation ready that proves to data subjects and to supervisory authorities what measures have been taken to comply with data protection rules.[610]

Data Anonymization/Pseudonymization: pseudonymization is central to significantly reducing the risks associated with data processing, while also maintaining the data's utility. The concept of pseudonymization is central to the GDPR. The GDPR defines pseudonymization as "the processing of personal data in such a manner that the personal data can no longer be attributed to a specific data subject without the use of additional information."[611] To pseudonymize a data set, the "additional information" must be "kept separately and subject to technical and organizational measures to ensure non-attribution to an identified or identifiable person." Any "personal data," which is defined as "information relating to an identified or identifiable natural person 'data subject,'" falls within the scope of the Regulation. There are limits to pseudonymization: it is "not intended to preclude any other measures of data protection."[612]

Ongoing interpretation of principles in data protection law is important in considering their relevance for smart grids. All actors involved in the supply and demand of energy via smart grids need to understand and consider how to meet the legal obligations they face. As noted above, the failure to address regulators' and customers' privacy concerns will pose a major obstacle to successfully moving forward with establishing the new systems.[613]

Aware of this significant problem, in 2010, the European Commission established an institution body to examine the multiple regulatory matters relating to smart grids: the Smart Grid Task Force (SGTF). The SGTF brings together eight different Commission Directors General including energy, climate, environment, and justice along with thirty European organizations representing all relevant stakeholders in the smart grids arena, from both the ICT and the energy sector.[614] Given its cross-sectoral representation, the SGTF is key to regulatory development on ICT and energy interconnections.

The SGTF's main purpose is to advise the Commission on policy and regulatory frameworks at the

[607] European Union Agency for Fundamental Rights, Handbook on European Data Protection law", European Union Agency for Fundamental Rights, 2014, p. 75.
[608] Organisation for Economic Co-operation and Development, "OECD Guidelines on the Protection of Privacy and Transborder Flows of Personal Data," OECD, 2013.
[609] Article 29 Data Protection Working Party, "Opinion 3/2010 on the principle of accountability," 00062/10/EN, WP 173, 2010.
[610] European Union Agency for Fundamental Rights, "Handbook on European data protection law," European Union Agency for Fundamental Rights, 2014, p. 75.
[611] Article 4.(5) of the GDPR.
[612] DSB-MIT-SYSTEM, "Recital 28 EU GDPR," [Online]. Available: https://www.privacy-regulation.eu/en/r28.htm. [Accessed 5 May 2017].
[613] J. Liu *et al.*, "Cyber Security and Privacy Issues in Smart Grids," *IEEE Communications Surveys & Tutorials,* vol. 14, no. 4, pp. 981-987, 2012.
[614] Smart Grid Task Force Group 3, "Smart Grids Task Force (SGTF), Workshop on experiences and conditions for successful implementation of storage," Smart Grid Task Force, Brussels, 2016.

European level and to assist in coordinating initial steps towards the implementation of smart grids under the provision of the Third Energy Package.[615] Four expert working groups were established in April 2011 to explore the key challenges to smart grid deployment.[616] Expert group 2 (EG2) specifically focuses on privacy and security issues, including developing a data protection template and an energy-specific cybersecurity strategy, and identifying minimum security requirements. The mandate of EG2 was to create a Smart Grid Data Protection Impact Assessment (DPIA) template. In 2014, the EG2 published a template for data protection impact assessment for smart grids and smart grid metering systems.[617] The purpose of the DPIA is to provide guidance on how to perform an assessment for smart grid and smart metering systems. The template will help organizations to take the "necessary measures to reduce risks, and as such, reduce the potential impact of the risks on the data subject, the risk of non-compliance, legal actions and operational risk, or to take a competitive advantage by providing trust."[618] The DPIA is intended to help achieve holistic implementation of data protection principles and rules. The SGTF believes this holistic approach will safeguard confidentiality, integrity, and information assets for the smart grid system. Under the GDPR, it is mandatory to conduct a DPIA.

The new regulatory landscape within the EU, dominated by the reform of data protection under the GDPR, is largely considered to provide more effective data protection and privacy arrangements for data subjects than previously. However, concerns remain, especially with the rapid development of technology, including the upscaling of IoT and Big Data, and it seems that legislators are perpetually fighting a losing battle on privacy.[619] The GDPR arguably restrains this slightly but only to a relatively limited degree, and is arguably easily circumvented by procedural formatting over "consent" protocols.[620] Purtova argues that "personal data will be appropriated in proportion to the de facto power of the data market participants to exclude others."[621] It may be that the boundaries within which the legal concept of privacy is interpreted are changing. Schwartz, who considers that the normative function of privacy lies in the formation of community and personal identity, argues that the individual-specific privacy focus is now challenged. Schwartz further argues that privacy should be a condition of social systems instead of a feature of "inborn" autonomy or a means to control personal data.[622] The shifting nature of this debate will no doubt be evident in Court cases brought to interpret the EU GDPR in the coming years. What is certain, however, is that the principles for data protection will provide the foundations upon which the substantive law will continue to evolve.

4.4.3.2. Digital Systems Security

For all actors engaged in delivering a digital ICT-based energy system across Europe, security is a priority. The previous section considered security in data handling by data controllers of data subjects' information with respect to the fundamental right to privacy. This section surveys efforts within the EU to address risks posed by the increasing dependence of all sectors in society on ICT. It frames this within the context of upscaling smart grids energy systems that see a rise in the number of service providers.

[615] *Ibid.*

[616] Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. Smart Grids: from innovation to deployment, COM(2011) 202 final (12 April 2011).

[617] Expert Group 2: Regulatory Recommendations for Privacy, Data Protection and Cyber in the Smart Grid Environment, "Data Protection Impact Assessment Template for Smart Grid and Smart Metering systems," Smart Grid Task Force 2012, 2014.

[618] *Ibid.*

[619] V. Mayer-Schönberger and Y. Padova, "Regime Change? Enabling Big Data through Europe's New Data Protection Regulation," *The Columbia Science and Technology Law Review,* vol. 17, pp. 315-335, 2016.

[620] E. Kosta, Consent in European Data Protection Law, Brill, 2013.

[621] N. Purtova, "Illusion of Personal Data as No One's Property," *Law, Innovation, and Technology,* vol. 7, no. 1, pp. 83-111, 2015.

[622] P. M. Schwartz, "Beyond Lessig's Code for Internet Privacy: Cyberspace Filters, Privacy Control and Fair Information Practices," *Wisconsin Law Review,* pp. 743-788, 2010.

In 2013, the EU launched the Cybersecurity Strategy.[623] It was understood that the goal of achieving a Single Digital Market would flounder if cybersecurity issues were not addressed: The strategy acknowledged that "for new connected technologies to take off, including e-payments, cloud computing or machine-to-machine communication, citizens will need trust and confidence" and that this would be undermined by "threats [from] different origins — including criminal, politically motivated, terrorist or state-sponsored attacks as well as natural disasters and unintentional mistakes."[624] The key initiative by the EU to secure critical digital ICT systems, such as banking, energy, health, and transport, is the 2016 Directive on Security of Network and Information Systems (NIS Directive).[625] The NIS Directive strengthens and modernizes the mandate of the European Network and Information Security Agency that was established in 2004.[626] The NIS Directive will apply to operators of "essential services" and to "digital service providers." EU countries have until 9 May 2018 to transpose the Directive into national law. There will be some overlaps with the obligations under the GDPR, but organizations, both large and small, will face new requirements. A significant distinction can be made regarding the type of data protected under the NIS Directive and the GDPR. The NIS Directive covers any type of data breaches whereas the data protected under the GDPR is limited to "personal data."[627]

Unlike the GDPR, which revised existing data protection law within the EU, according to the European Commission Vice-President for the Digital Single Market, Andrus Ansip, the NIS Directive is the first comprehensive piece of EU legislation on cybersecurity and a fundamental building block in that area.[628] As a Directive, the NIS Directive requires Member States to adopt legislation to transpose it. This is different from the GDPR, which is a Regulation and, per its very nature, directly applies to all EU Member States.[629] Consequently, there is space for differences in the approaches adopted by Member States in how to meet the NIS Directive's requirements. This could impact its effectiveness in terms of securing transboundary critical energy digital ICT infrastructure, however, the NIS Directive does actively promote network collaboration and cooperation.[630]

The NIS Directive provides guidelines for "essential service operators," for example within the energy, transport, banking, financial market infrastructure, health, drinking water, and digital infrastructure sectors, as well as "digital service providers," including entities such as online marketplaces, online search engines, and cloud computing service providers. National governments are to play a key coordinating role amongst other actors nationally and within the EU as the NIS Directive requires each Member State to set up a Computer Security Incident Response Team Network (CSIRT) to promote swift and effective operational cooperation on specific cybersecurity incidents and to share information about risks.[631] Critical service providers who will need to cooperate with national CSIRTs are defined under the NIS Directive as entities who "provide a service which is essential for the

[623] Joint Communication to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. Cybersecurity Strategy of the European Union: An Open, Safe and Secure Cyberspace, (JOIN)2013 1 final (7 February 2013).
[624] *Ibid.*
[625] Directive (EU) 2016/1148 of the European Parliament and of the Council of 6 July 2016 concerning measures for a high common level of security of network and information systems across the Union.
[626] Regulation (EC) No 460/2004 of the European Parliament and of the Council of 10 March 2004 establishing the European Network and Information Security.
[627] Jones Day, *"The New EU Cybersecurity Directive: What Impact on Digital Service Providers?"* Jones Day, [Online]. Available: http://www.jonesday.com/the-new-eu-cybersecurity-directive-what-impact-on-digital-service-providers-08-24-2016/. [Accessed 10 June 2017].
[628] *Ibid.*
[629] In the European Union's legal system, European Regulations are self-executing; they require no "transposition" into the legal orders of the different Member States, they are directly binding, and can be directly resorted to by individuals. See Article 288 (in Chapter 2 "Legal acts of the Union, Adoption Procedures and other provisions", Section 1 "The Legal Acts of the Union") of the Treaty on the Functioning of the European Union.
[630] Article 11 Directive (EU) 2016/1148 of the European Parliament and of the Council of 6 July 2016 concerning measures for a high common level of security of network and information systems across the Union.
[631] Article 9, Article 11 and Annex I, *Ibid.*

maintenance of critical societal and/or economic activities; that the provision of the service depends on network and information systems and that an incident would have a significant disruptive effect on the provision of that service."[632]

Operators of essential services have obligations to "take appropriate and proportionate technical and organizational measures to manage the risks posed to the security of network and information systems."[633] To achieve this, service providers are encouraged to adopt internationally accepted standards and specifications in order to secure networks and information systems. [634] Annex 11 of the NIS Directive lays out the entities considered to be "essential service operators." Electricity is a subsector of the energy sector. The NIS Directive provision applies to several entities as outlined in Article 2 of the 2009 Electricity Directive.[635] These include DSOs[636] and TSOs, who are engaged in an "electricity undertaking," which includes at least one of the following functions: generation, transmission, distribution, supply, or purchase of electricity.[637] The NIS Directive clearly applies to the electricity sector. Providers of the service, whatever the size of the operation, need to comply with the NIS Directive's requirements.

It is important that small-scale energy providers, such as prosumers and energy cooperatives, are given the necessary support to adopt appropriate measures to reduce the risks to their technical and information networks. The focus of the observers is often on large-scale cyberattacks across national systems, however targeted criminal activities on relatively small-scale energy providers could inflict harm on customers (as well as on service providers) in many ways, from loss of power to fraud. The national government as well as service providers have an obligation to ensure this situation does not occur. One area that will require further security risk measures is the financial transactions between service providers and customers. This could become more challenging with the emergence of virtual currencies and smart contracts.[638]

[632] Article 5 (2), *Ibid.*
[633] Article 14, *Ibid.*
[634] Article 19 (1), *Ibid.*

[635] Directive 2009/72/EC of the European Parliament and of the Council of 13 July 2009 concerning common rules for the internal market in electricity and repealing Directive 2003/54/EC (Text with EEA relevance).
[636] Annex II, *Ibid.* - as defined in Article 2 (4) and (6) of Directive 2009/72/EC of the European Parliament and of the Council of 13 July 2009 concerning common rules for the internal market in electricity and repealing Directive 2003/54/EC.
[637] Article 2 (35) of Directive 2009/72/EC of the European Parliament and of the Council of 13 July 2009 concerning common rules for the internal market in electricity and repealing Directive 2003/54/EC.
[638] R. Caillière, "Managing energy markets in future smart grids using bilateral contracts," *Frontiers in Artificial Intelligence and Applications,* vol. 285, pp. 133-140, 2016.; M. Mihaylov, "NRGcoin: Virtual Currency for Trading of Renewable Energy in Smart Grids," *11th International Conference on the European Energy Market,* pp. 58-63, 201.

5 CONCLUSION

Many of today's big changes are demographic: a shift in power from the West to the East, rapid urbanization, technology, health and well-being, and climate change and natural resources. These last two points are crucial to the arguments made in this article in the broader context of inclusive prosperity. Access to affordable and clean energy as well as climate action are two of the seventeen UN Sustainable Development Goals, which the international community is committed to meeting by 2030. The Earth is our home and common inheritance. We need to make sure it is sustainably managed. We now have enough scientific knowledge to know that climate change is a problem. But the policies in place are wrong and good leadership is essential to meet the agreed targets.

We must act now to conserve our living environment for future generations. The deployment of smart grids, their improved regulation, and careful consideration of their social and ethical dimensions are all necessary to make the transition to a low-carbon economy happen. Arguably, oil-producing countries may lose out in the transition to a low-carbon economy because most of their GDP comes from fossil fuels. But similarly, most of these countries are blessed with unique solar irradiance and, therefore, the potential to generate wealth out of renewable natural resources. Intermittency is currently one of the issues of solar and wind energy, as is safety in the case of nuclear energy. Carbon capture of fossil fuels will also move forward the agenda of a transition to a low-carbon economy.

This article has shown the advantages and disadvantages of smart grids. Some of the benefits are that smart grids create the conditions for the proliferation of renewable energy generation. They allow for the self-consumption of energy. They boost energy efficiency via demand response. They alleviate energy poverty. They lead to decreases in fossil fuel imports. They decrease dependence on unreliable oil and gas suppliers and volatile prices and they promote low-carbon energy security. However, the transition to the new energy architecture may also generate adverse results, such as higher prices, abuse of market power, and an increase in overall energy consumption.

This article has also analyzed the legal framework related to smart grids in the EU. We find that the EU legal framework on smart grids is fragmented and needs to be streamlined. Although sufficient direction for the roll-out of an "intelligent grid" exists at the regional level, there is still much legislation and policy that needs to be put in place, particularly at the national level. We also find that regulation may exist, but is not in force or is incoherent. The various components envisaged by smart grids are at different levels of development. Consequently, legislative responses towards more ecological regulation has been insufficient or lacking. Although specific legislation, and perhaps standardization, is desirable, the absence thereof should not operate as a hindrance to the successful deployment of smart grids, given that sufficient legal bases exist at the regional level, along with apparent political support at the national level. We also find that, in the context of smart grids in the EU, there is a need for stronger legislation on data protection and cybersecurity. Setting the rules, however, is not enough. Execution is necessary, for instance, by providing incentives to get things done.

Finally, technological advancement is key for a successful decarbonization process. However, technology alone is not enough; we also need the right public policies to reach our decarbonization goals. Smart grids are clearly part of the EU's future economic, social, and environmental policy landscape. Key strategies on the economy, the environment, and technology provide opportunities for the radical transformation in Europe's energy infrastructure through smart grids to take place. It is also evident that the EU needs to work towards the energy transition in a manner that ensures balanced, equitable, fair, and just outcomes for all citizens. The collaborative economy, for example, should not undermine employees' rights or environmental standards. Moreover, the concept of circular economy needs to be embedded in public policy, and private-sector product design and resource management will play a crucial role in the future. All of this will be possible with the right public policies in place and changes in behavior: change is difficult, even when the status quo is bad, but it is necessary. As a result, one may be a short-term pessimist, but a long-term optimist.

Moving forward, society needs to find a way to make sure that corporations see incentives for green growth, so that they can make a profit and protect the environment (for instance, by selling solar panels or electric vehicles).[639] Short-termism is a great challenge for sustainable development and needs to be avoided at all costs. Since energy is the driver for much of what we do, clean energy is a sure way to reach sustainability. But the question remains: in the transition to clean energy, can clean energy sources be implemented on a scale that will replace fossil fuels? Ultimately, following the invisible-hand concept introduced by Adam Smith in the 18th century, an invisible "green" hand will bring sustainability to the economy.

[639] One can think, for instance, of the National Industrial Symbiosis Program, at http://www.nispnetwork.com/about-nisp.