

BOOK REVIEWS

Capacity Mechanisms in the EU Energy Market—Law, Policy and Economics, edited by Leigh Hancher, Adrien de Hauteclocque, and Małgorzata Sadowska. (Oxford University Press, 2015). Hardback, 400 pages. ISBN: 978-0-19-874925-7.

In the European power sector, amid growing market integration across borders and security of supply targets largely defined at national level, capacity mechanisms are a hot topic in the current regulatory debate. This is a four parts, 22 chapters, and 400 pages strong book that takes account of this debate in an excellent fashion. First, the various contributions are written by a wide range of authors from academia, policy, industry, and in parts written also by the three editors Leigh Hancher, Adrien de Hauteclocque, and Małgorzata Sadowska. Second, this book covers all areas that are of importance to the debate: economic arguments, legal aspects, policy implications, and relevant case studies.

The objective of this book is to provide a “first point of reference” for regulators and policy-makers, and to offer a “resource for academics and practitioners in the fields of energy, regulation, and competition”. The book’s subtitle is *Law, Policy, and Economics* and the first three parts are structured accordingly, albeit in different order. The fourth part (and largest in terms of pages) offers a comprehensive set of case studies on capacity mechanisms in European power markets.

It should be noted right away that this book, obviously, holds most of its merit for readers interested in the *European* regulatory debate, although certainly general lessons are included in between. These might especially arise with respect to cross-border impacts of capacity mechanisms. In addition, one joint contribution from Carlos Batlle, Paolo Mastropietro, Pablo Rodilla, and Ignacio J. Pérez-Arriaga (chapter 7 of the book) draws from experiences on the American continent and, in a rare and valuable way, boils down the ingredients to capacity market design.

The policy dimension of this book is emphasized by placing the policy part at the beginning. Part I (“*Policy*”) sets the scene with three distinct chapters. In chapter 1, Francisco Enrique González-Díaz lays out all required ingredients for this discussion: the question of “missing money”, how renewable energy sources might increase missing money, what types of capacity mechanisms exist as potential remedy, and how EU energy policy attempts to integrate all this into its overarching goal of an internal EU energy market. On the latter issue, then, one regulatory and one academic position are presented in chapter 2 and 3 respectively. Both chapters bring forward arguments and thoughts on how such cross-border integration of national markets – and diverging regulations therein – can proceed. In chapter 2 Alberto Pototschnig and Martin Godfried represent the views of ACER (the European regulatory body) and argue that coordination in the design of security of supply measures minimizes risks of potential market distortions. Nicely following up on this, part I then closes with chapter 3 and a discussion by Arthur Henriot and Jean-Michel Glachant on a set of conditions for a successful coordination of national policies at EU level.

Part II (“*Economics*”) deals with the economics behind supply security in general and capacity mechanisms in particular. It starts, in chapter 4, with a discussion on the workings of energy-only markets by Jens Perner and Christoph Riechmann. They offer a detailed analysis of potential market failures and find that a range of reforms to remove current energy-

only market flaws should be exploited before introducing large-scale capacity mechanisms. In chapter 5, Fabien Roques and Charles Verhaeghe take capacity mechanisms as given in their analysis. They formulate potential market distortions with capacity mechanisms within the common European market. Using a list of local specificities they illustrate the different national motivations for introducing capacity mechanisms. Drawing from these, they then identify the potentials for regulatory coordination across Member States. In the subsequent chapter Dominique Finon studies the integration of capacity mechanisms across borders along the notion of implicit and explicit cross-border participation. He argues in favor of implicit cross-border participation in capacity mechanisms and discusses his findings vis-à-vis the common EU rationale for explicit cross-border participation. Chapter 7, as already mentioned above, presents lessons learned from the American continent when it comes to actual capacity market design. The part on economics closes with chapter 8 by Bert Willems. This chapter frames the part on economics by providing a thorough formal analysis of capacity mechanisms – explicitly without any prior on whether or not capacity mechanisms are needed as part of an efficient power market design. Using a screening curve approach, Bert Willems discusses the investment reducing role of critically low price caps and shows how capacity payments can restore efficiency if price caps are set too low.

Finally, part III (“Law”) consists of three chapters on state aid, antitrust, and the underlying free European (power) market. Two of these three chapters are written by the editors. First, in chapter 9 Leigh Hancher analyzes the establishment of national capacity mechanisms in the light of state aid guidelines. She illustrates how in the absence of other “suitable weapons” the European Commission in its pursuit to finalize a common internal energy market is left with EU state aid rules only. In principle, these guidelines form its only mean to adjust capacity remuneration schemes *ex ante* their implementation. Chapter 10 focuses on antitrust law. Here, Adrien de Hauteclocque and Małgorzata Sadowska discuss legal ways of keeping costs to consumers in check *ex post* the implementation of capacity mechanisms. They elaborate under what conditions antitrust rules can be applied to mitigate market power abuse and to guarantee competitive capacity payments. In the last chapter of this part on legal aspects, Peter Oliver critically discusses the free movement of goods, especially energy, in the European Union. Using a variety of court cases he illustrates the still existing barriers to trade within the European internal energy market.

A big part of this book is devoted to case studies, which are presented at last in part IV. Eleven chapters (chapter 12 to 22) examine the implemented or planned capacity mechanisms in eleven EU Member States. The authors of these case studies are too numerous to name here. All case studies are structured in a similar fashion, briefly presenting the country-specific key features and implemented or planned regulatory measures to promote security of supply. Given the currently changing energy regulation landscape in Europe, I have not come across another source of reference that summarizes country-specific developments in a structured way for such a number of countries.

As an economist I enjoyed reading contributions on the legal side (although, as it happened to me, abbreviations and links to court case numbers in the text may place some obstacles for the inexperienced, non-law trained reader). In fact, I would consider this as a strength of the book: economists getting to read about the legal side of this debate, and legal professionals getting to read about the economic arguments behind the different regulatory rationales.

As is the law part, also the policy and economic parts are a big help in enabling the reader to construct a more comprehensive picture of the current debate. There exist plenty of rela-

tively new terms that the debate has coined. I found it helpful reading an entire book clarifying these terms (in parts) and the mechanisms behind different arguments. The fact that many authors have been involved in presenting their take on this debate, and merging their views into this one book with occasional cross-references, indeed makes the book a well suited point of reference, as the editors promise in their preface.

Views of the authors of different chapters are not always entirely consistent in answers to essential questions, i.e. on the regulatory remedies, and if market failures exist in the first place. A fact that, however, is not to the disadvantage of the book.

Probably unavoidable within an edited book with so many authors who all contribute with rather self-contained chapters, some arguments and thoughts are presented repetitively. However, readers willing to pick-up different arguments and views will find what they seek. On the content side, I especially enjoyed reading and found novel the economic and policy arguments on the coordination and integration of different national mechanisms. As a drawback of the topical nature of this book, readers may have to consume it rather sooner than later, depending on how long-lived institutional details that the book draws from will be.

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Climate Shock: The Economic Consequences of a Hotter Planet, by Gernot Wagner and Martin Weitzman. (Princeton University Press, 2015). 264 pages. ISBN: 9780691159478

The past decade was the warmest in human history. The one before that was the second-warmest. The one before that was the third-warmest. [. . .] Climate change is here and it's here to stay." (p.9)

This is the lead-in by Gernot Wagner and Martin Weitzman in their recent book "Climate Shock". The authors mean business and go straight to the heart of the matter. Weitzman, the legendary Harvard Professor of environmental economics, has been joined in this endeavor by Gernot Wagner, a Harvard researcher – brilliant young thinker and great writer. Together they manage in this book to give a compelling, clear and pedagogical overview of climate science since its origins in 1896 and up till today. Based on their own conservative calibration after a review of numerous scientific papers they conclude that there is a 10 percent chance that climate change will lead to an eventual temperature increase of 6°C, which in turn could cause damages beyond our imagination. So why does the world not act if there is such a high risk that severe damage will occur? And what are the possible solutions to climate change? These questions, in combination with the fundamental problems of climate change—the "Big Four" as the authors refer them to, are the major focus of "Climate Shock".

The worst effects of global warming will be felt long after our lifetimes, likely in the most unpredictable of ways. (p.7)

Climate change is *irreversible*, *long-term*, *uncertain* and *global*. Four not very nice attributes when it comes to policy-making. The irreversibility means that even if we stopped emitting carbon today we would still feel the effects of global warming far into the future because

carbon stays in the atmosphere for centuries – even millennia. As a consequence, the already melting ice sheets and consequent sea level rise may be unstoppable.

The long-term aspect means first of all that “climate change is here and it is here to stay”. However, even if we already feel some effects of climate change (e.g. more severe droughts, storms and flooding) many of the consequences will not be felt until the far future –decades or centuries away.

And then come the uncertainties. Uncertainty pervades all aspects from the amount of greenhouse gases we emit, through the links to atmospheric concentrations and temperature levels, the link between temperatures and physical damages, the link between physical damages and their consequences and ultimately how society will cope with these consequences. Models trying to make sense of climate change and putting a price on carbon emissions therefore are subject to all these uncertainties. As the authors say:

The underlying models do their best to capture the “known knowns”, and even there they miss quite a bit. By definition they don’t yet capture the “known unknowns”. And as so often is the case, it may well be the “unknown unknowns” that define the final outcome. (p.37)

The last of the “Big Four” is the global scale. The costs of combating climate change are national whereas the benefits are global, making climate change a classic free-rider problem and thus so problematic in terms of international policy-making.

Against this ominous backdrop, Wagner and Weitzman provide an excellent description and discussion of geoengineering – for instance, the practice of shooting sulfate aerosols into the atmosphere, reflecting sunlight and, thus, decreasing global temperatures. Geoengineering is described as a “free-driver” meaning that it has huge potential in reducing global temperatures in combination with being so cheap, that practically any nation could implement it. These features were, coincidentally, demonstrated following a 1991 volcano eruption of Mount Pinatubo in the Philippines. The volcano emitted 20 million tons of sulfur dioxide into the stratosphere, which reduced global temperatures by about 30 thousand times as much as the same amount of carbon dioxide would have increased them. It thereby decreased global temperatures by about 0.5°C,—equivalent to the human-caused temperature increase up till that date.

The free-driver characteristic, making it a tempting quick-fix to the problem of climate change, should however be viewed with utmost caution. While having potential to reduce the indirect effects of carbon emissions – i.e. rising temperatures – it does not counteract the direct effects (such as ocean acidification following absorption of carbon dioxide). Also, it is not known what potential other consequences the shooting of sulfates into the atmosphere would cause. The Mount Pinatubo eruption was, for example, blamed for causing flooding and droughts in different areas of the world, although no causal links have been established. Finally, also, geoengineering brings us back to the initial problem of global governance. Because it is so cheap to implement, how do we decide on when to stop? What are the optimal global temperatures and who is to decide this? And again, geoengineering does not deal with the problem (i.e. carbon emissions) but merely with the symptoms (i.e. temperature rise).

This brings us to the final issue—how to deal with carbon emissions. Here, as the authors put it “The ultimate goal is clear: *price carbon*. [. . .] The question we are left with is: how high should that price on carbon be?” (p.81). The discussions on this issue could go on forever, but the fact is that we (all nations) need to act now. The U.S. government estimate the social cost of carbon to USD 40 per ton of carbon dioxide. In reality, however, we are far from that

figure. On average the global price on carbon instead is *negative* USD 15 per ton. This is because of fossil fuel subsidies that are still common in many countries. Further, entities that have actually implemented a price on carbon (e.g. California and the EU) still tax at rates below USD 40 per ton. The most notable exception and most ambitious carbon tax implemented so far is that of Sweden, at more than USD 120 per ton.

What the world needs to do is to remove fossil fuel subsidies and implement a positive and high (probably above USD 40 per ton) price on carbon. And that needs to happen now. In the words of Wagner and Weitzman:

If you had a 10 percent chance of having a fatal car accident, you'd take necessary precautions. If your finances had a 10 percent chance of suffering a severe loss, you'd reevaluate your assets. So if we know the world is warming and there's a 10 percent chance this might eventually lead to a catastrophe beyond anything we could imagine, why aren't we doing more about climate change right now? We insure ourselves against an uncertain future, why not our planet?

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The Economics and Uncertainties of Nuclear Power, by François Lévêque. (Cambridge UK: Cambridge University Press, 2015). 341 pages. ISBN: 9781107087286

Nuclear power is without doubt our most controversial source of energy. The main argument against it is of course the dangers of commercial nuclear power. The meltdown at Harrisburg and the disasters at Chernobyl respective Fukushima serve as reminders of those risks. The main argument in favour of nuclear power is that it provides a cheap and reliable supply of electricity. That nuclear power emits very little carbon and therefore can be a tool in the fight against climate change, is an argument that has become increasingly popular in recent years. In light of those key controversies, it makes sense that “The Economics and Uncertainties of Nuclear Power” by François Lévêque is organized around (i) the costs of nuclear power; (ii) risks and regulation of nuclear power; (iii) nuclear policy.

The costs of nuclear power. To calculate the social cost of nuclear power, one must first assess how expensive it is to build a reactor and attach it to the grid, then to operate and maintain it in accordance with specifications and safety regulations over the lifetime of the reactor. Even this first step of calculating the *private cost* of nuclear power is challenging and unlikely to produce one “correct” number. The reason is not only because different reactor designs have different construction and operating costs, but also because those costs vary across locations and depend on construction times. Lévêque devotes considerable attention to the escalating costs of nuclear power, which he mainly attributes to increasingly complex reactor designs, lack of standardization and improper management.

In addition to the private costs are the external effects associated with supply security, carbon emissions, decommissioning and waste management. Although difficult to quantify, Lévêque argues that such costs are likely to be small in magnitude compared to the private costs. He presents a numerical example showing that even full liability for accidents would add only two per cent to the average cost of nuclear power, because of the miniscule probability

of a nuclear disaster. Instead, the first-order effects on the total costs of nuclear power are the construction costs, the capacity (utilization) factor and the discount rate. Variations in these parameters usually deliver unit cost estimates in the range between 34-162 USD per MWh.

A main problem with the profitability of nuclear power is that so many of the competing technologies have smaller private costs. Gas and coal are competitive owing to technological development and under-pricing of carbon emissions, renewable technologies because of learning effects and subsidies. In Lévêque's view "nuclear seems doomed to suffer a steady decline in its competitiveness."

Risks and regulation of nuclear power. The expected cost of a nuclear catastrophe can be calculated as the cost to society of the disaster multiplied by the probability of its occurrence. Estimating this cost is rendered more difficult by the (fortunate) fact that there have been so few disasters. The book gives a solid account of the potential pitfalls associated with such calculations, but also shows that even the worst case scenarios do not produce expected costs that seem terrifying. A damage of 1 trillion USD, and a probability of 1 in 100 000 per reactor year of a core meltdown lie well above most estimates. Yet, the expected cost of a nuclear disaster is around one USD per MWh in this example. The lesson is that the huge uncertainties associated with calculating accident probabilities and costs do not necessarily have much impact on the expected social cost of nuclear power.

Safety regulation and enforcement are essential aspects of nuclear power operation. The crucial problem with nuclear safety is that owners might have insufficient incentives to internalize all risks because the cost of a disaster far outweighs the asset value of the firms. Lévêque argues in favour of unlimited civil liability to maximize internalization, coupled with mandatory insurance for complimentary damages. However, total insured damages should be subject to an upper bound, or else it would be impossible to purchase such insurance in the market. In practice, therefore, the public would insure part of the nuclear risk.

Lévêque illustrates in a number of case studies the importance of independent authorities for efficient regulation. He accounts for how political pressure and effective lobbying by the industry prevented Japan from modernizing its safety regulations and implied improper monitoring of the country's fleet of nuclear plants. The Japanese nuclear industry leading up to the Fukushima disaster appears to have been a textbook example of a captured regulator susceptible to influence by politicians and industry. Nuclear regulation in the US and France represent counterexamples to the worst case scenario of Japan. Lévêque advocates them as examples for other to follow. Both countries have strong and independent safety authorities with clear responsibilities, although with fundamental differences between them. The US regulator oversees a diverse fleet of nuclear plants operated by multiple companies. The authority maintains arms' length distance and a high degree of formalism in its contacts with the industry. In France, a single firm, EDF, operates all nuclear plants. The authority is much more directly involved with the operator, and there is little legislation to govern the relationship. As Lévêque points out, the French system makes it crucially dependent on "an enlightened regulator" i.e. an office capable of resisting capture.

Nuclear policy. The last part of the book first gives a historical account of the rise and decline of nuclear power across the world. The increasing opposition to nuclear energy has in many countries been associated with the evolution of environmentalist movements into parties with political power. Political leaders catering to local green parties with pivotal influence seem to have been important factors behind the German policy reversal and the increasing opposition to nuclear policy in France after Fukushima.

Decisions to build and operate nuclear power plants are national. However, the integration of electricity markets and the geographical dimension of environmental damages imply that the consequences of nuclear policy and regulation extend beyond national borders. The EU has addressed this potential source of conflict between countries by establishing a common legal framework for nuclear safety. Another important task of supranational governance refers to the prevention of nuclear weapons' proliferation. Here, organizations such as the International Atomic Energy Agency (IAEA) and the Nuclear Suppliers Group (NSG) have important roles to play, the latter because many more countries use nuclear power than there are countries with the technology to build new reactors, and proliferation is intimately associated with nuclear trade.

Remarks. A first conclusion is that new nuclear power definitely does not seem to be a cheap source of energy. It is hard to see how it can regain competitive strength given the relatively small and declining costs of alternative energy sources. The huge and escalating construction costs represent main challenges. A salvation could occur if standardization and scale effects in reactor construction were allowed to play out much stronger than what has previously been the case, or if some technological breakthrough produced completely new and highly efficient reactor designs. A second conclusion is that the expected environmental costs plausibly are very small and only account for a few percent of the unit cost of a new reactor. It appears as if the main arguments in favour and against nuclear power all are incorrect: Nuclear power neither produces inexpensive electricity nor is it associated with devastating expected social costs.

The vigorous opposition to nuclear power seems puzzling in light of the apparently modest expected costs of a nuclear disaster. Lévêque largely attributes this discrepancy to the cognitive inability of people to appraise probabilities. However, it is notoriously difficult for everyone to correctly assess the likelihood of very rare events. Also, the upside of existing nuclear power, a more stable and cheaper supply of electricity, may seem limited to many people compared to its potential downside, a full scale meltdown with massive environmental damage and human casualties. In this case, it is not unreasonable to pursue a policy that aims at avoiding the worst case scenario. This is sometimes known as a *maximin* strategy and merely represents an alternative decision rule to that of expected utility maximization considered in the book. This simpler rule is even more reasonable insofar as history has taught us that worst case scenarios *do* happen - and on a regular basis, too. A related explanation, mentioned only in passing in the book, is that people are risk averse. If so, the upside of nuclear power carries much less weight in people's minds than the potential downside. A sufficient degree of risk aversion would be enough to render it completely rational to oppose nuclear power even based upon "correct" probabilities.

Another environmental concern, besides accidents associated with nuclear production, is that of nuclear waste disposal. Nuclear waste remains highly toxic for centuries, and final storage is for the most part an unresolved problem. Many people are naturally concerned with the problems nuclear waste may cause for numerous generations to follow. Unfortunately, the challenges and consequences of nuclear waste disposal are given very little consideration in the book.

The deck is stacked against nuclear power in most western countries. The book goes a long way in laying down the economies and uncertainties of nuclear power, as promised.

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Green Capital—A New Perspective on Growth, by Christian de Perthuis and Pierre-André Jouvét. (New York: Columbia University Press, 2015). Pp. vii, 274. ISBN 978-0-231-17140-3.

Are we in the process of destroying the water cycle, the diversity of the ecosystems and (through increased concentration of greenhouse gases) the regulatory functions of the climate, thereby undermining the reproduction of natural resources that constitute required conditions for life on Earth? And if so, what can be done to prevent this perilous development? In their book, “Green Capital”, Christian de Perthuis and Pierre-André Jouvét argue that such natural “regulatory systems”, which are essential in sustaining and enhancing our green capital, must be protected. In particular, markets do not do so to a sufficient extent because green capital is not correctly priced. Through the book’s 19 chapters they provide a theoretical and practical discussion on how best to price green capital and thereby sustain the natural foundation of our economic and social well-being.

In the first four chapters the authors point out that human activity is threatening major regulatory functions of natural capital, like climate stability and biodiversity. They also acknowledge that human ingenuity has substantially extended the physical limits to growth imposed by the finiteness of natural resources (thereby disproving the predictions of the Club of Rome report more than 40 years ago). This sets the stage for the next five chapters which pose the following question: how is it possible to move the attention from the limits to growth based on the scarcity of natural resources to a concern for the preservation of the regulatory systems of natural capital. The authors argue for the necessity of letting the services of green capital enter the production function as a paid factor of production alongside capital and labor, thereby moving towards a green economy. They discuss the different distributional effects that such a policy may have, depending on how it is implemented.

Chapters 10 through 13 contain a discussion on how to value the services of the climate system through a “carbon price”, and whether appropriate methods for pricing the uses of biodiversity can be developed. The following four chapters highlight the challenges that must be faced by the energy sector in the transition to a green economy. The authors are critical to the effects of energy policies in different countries. The U.S. energy revolution through large-scale exploitation of shale gas and shale oil expands the available amount of fossil fuels and thereby poses an enhanced long-term threat to climate stability. The French emphasis on nuclear power might not represent a viable alternative to fossil fuels as the real costs of this non-CO₂ emitting primary energy source have not been declining. In chapters 18 and 19 the authors outline their recommendations:

- deploying environmental pricing through taxation and cap-and-trade systems,
- redirecting public support towards R&D that studies reproduction of natural capital,
- considering the long-term environmental consequences when designing new infrastructure,
- introducing greater intelligence into networks,
- developing governance structures that can better cope with the long term.

They compare these suggestions to the fragmented policies currently adopted by E.U. member states. In the conclusion the authors return to their main message: the need to

introduce pricing for the services of natural capital, while paying attention to the distribution effects that such policies will have.

The messages that this book delivers in a clear and efficient manner are not new to economists working in the field of environmental and resource economics. With the challenges posed by climate change and reduced biodiversity, it is clear that the real scarcity rent does not stem from fossil fuel reservoirs in the ground, but is associated with the services provided by the atmosphere and elsewhere in nature. We have too much fossil fuels and not enough assimilative capacity. Efficient allocation of resources requires that consumers and producers pay for the use of natural regulatory systems, so that its services go to the most valuable applications, and so that these services will be maintained also for future generations. However, such a change of the economic system requires collective action on a global scale, including an agreement on the distributional consequences of these rents, functionally between the factors of production, and internationally between rich and poor countries.

These insights are not as easily conveyed to the general public when climate and energy issues are discussed in the media. Hence, to the extent that this book reaches a broad readership, it can contribute to a more informed public debate. Moreover, also for economists not specializing in the analysis of global environmental problems this book might contribute to a deeper understanding of the challenges that confront us. E.g., it reminds us that the reduction in U.S. CO₂ emission during the last years as a result of substitution of shale gas for coal might not contribute to a solution of the climate problem at a global and long-term scale; rather, it might constitute an increased threat to the climate system by expanding the availability of fossil fuels.

It is a strength of this book that it does not provide simple solutions to problems that are indeed hard to solve, being constrained by e.g. informational limitations and political feasibility. Introducing a carbon price is a necessary tool to solve the climate problem, but it is difficult to implement in practice. The services that biodiversity provide must be priced, but it is very hard to value these services in practice. On the other hand, this is also the book's weakness, as most recommendations are too general and imprecise to serve as concrete advice for policy-makers and stakeholders. However, the authors do not shy away from giving concrete advice to policy-makers in the case of E.U. climate policies: they point out how the effectiveness of the European CO₂ emission trading scheme is undermined by the national policies that are implemented by different European governments.

The book's main purpose is to provide insights into the grave long-term problems that we might face, and inspiration for the quest of finding solutions to these problems. Judged by this benchmark, it succeeds. I believe it is a useful book also for economists, as it opens up perspectives that might be forgotten when concentrating on specialized research topics. The authors provide an informed and accessible discussion of the important long-term problem that the protection of green capital represents.

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The Sustainability of Renewable Energy in Europe, by Simona Bigerna, Carlo Andrea Bollino, and Silvia Micheli. (Springer International Publishing Switzerland, 2015), 137 pages. ISBN: 978-3-319-12342-4

Renewable energy sources (RES), such as wind and solar energies, hydroelectricity, or biofuels, are a key element towards a sustainably developed world, as they help reduce greenhouse gases (GHG) emissions, especially in the electricity and transport sectors. However, their development faces many challenges, as they need to be subsidised to be able to compete with conventional energy sources, and especially fossil fuels, that emit much more GHG during their life-cycle. They will also require a profound modification of our infrastructures to be fully effective. For example, wind turbines and solar panels provide intermittent electricity, that needs to be dispatched on the distribution and transmission networks, that need to be operated more and more efficiently.

This book examines in details the case of RES in the European Union (EU), from several complementary angles, and examines the particular role of Europe in the global economic transition. Thus, the first chapter sets the context of climate change and the need for RES by focusing on the European legal frameworks that will help the continent reach several targets on its path towards “decarbonization”. Going backward from the 2050 roadmap to the Kyoto Protocol of 1997 and the past trends of global GHG emissions, this chapter delivers an interesting overview of international and European legislation for sustainable development. An appendix finally gives a comprehensive description of the functioning of the Kyoto Protocol and its chronological developments.

Chapter 2 logically follows, providing many useful information concerning power generation from RES, in terms of installed and cumulative capacity as well as energy production, along with a description of the various technologies available. Figures are first given at the world level and allow to compare Europe with other major entities, and afterwards data concerning all the EU countries is given. The chapter ends with several RES outlooks from the International Energy Agency (IEA) scenarios, that can be compared to past values and 2020 targets. The authors find out that though RES development has been strong in Europe, efforts still need to be made to strengthen its position as a leader on RES, while it is only a minor GHG emitter compared to China or the United States.

This leads us to the third chapter, which explains why public intervention is required in order to develop RES. It first presents the main barriers to the development of RES, and the need to internalise the learning curve phenomenon in economic decisions. The main feature of such policies is to give economic incentives to produce RES, through the subsidisation of their installations. The several subsidy instruments available are exposed, with their advantages and drawbacks, and a comparison of the chosen instruments and their level of subsidy is given per European country. These subsidies can then be compared to the levelised cost of electricity (LCOE), given for the main technologies. Finally, a comparison between the two most popular instruments, feed-in-tariffs and feed-in-premiums, the former being substituted by the latter at the European level is provided.

Chapter 4 then exposes the strategic choices for RES sustainability, first giving comprehensive information on National Renewable Energy Action Plans (NREAP) of all European countries, with their RES allocation plans, followed by a broad analysis of where Europe and some countries stand with respect to their objectives for each RES technology. We understand that growth rates of RES are highly heterogeneous, with some RES expected to exceed their target while others will hardly reach them, or even be well below them. The chapter finishes with a brief description of research activities dedicated to RES, and in particular smart grids, highlighting their necessity to reach sustainability of RES.

The fifth and final chapter is dedicated to European scenarios for the development of RES. After describing several scenarios from the IEA’s World Energy Outlook and from the

EU 2030 Framework, the authors develop their own scenarios, in which they see the development of RES as a cost minimisation problem subject to a target constraint. The originality of their work is the assumption that the cost reduction in each country is proportional to its relative importance as an energy consumer (ENESH scenario) or as a RES-advanced country (RESSH scenario). From their results, they advocate for a united Europe that should act as a whole rather than as an aggregate of several countries in order to reach an efficient and sustainable development of RES. They call for the use of price driven rather than quantity driven instruments to encourage each country to choose an appropriate combination of the several RES available, depending on its own characteristics. The authors humbly conclude this chapter by raising the limits of their study.

One may agree or not with the authors' recommendations to sustain the development of RES, but this ambition needs to be put in perspective with the context of a moderated electricity demand and the situation of overcapacity in Europe. In particular, the impact of RES production on already depressed electricity prices could be discussed, since RES support mechanisms are going to be more and more market-oriented. However, the message of the authors remains clear and unambiguous.

Finally, although this book has a global coherence, and consists in a logical sequence that can be read linearly, each chapter can also be apprehended on its own, depending on the need of the reader. A natural counterpart of this feature is the redundancy of some information, such as outlooks from scenarios and European or national objectives, that can be found in several chapters—albeit not in the exact same way, since it is necessary to bring specific pieces of information to address a particular subject. Also, an important feature of this work is the comprehensiveness of the data, with an analysis of each RES technology and of each EU country, which enables to make comparisons very easily. Thanks to historical and projected data we can also visualise past evolutions and those to come, while the main challenges raised by the development of RES are explained in a concise but fully understandable manner, which makes this book highly accessible as well as a reference on the matter.

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