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Simona Bigerna  
Department of Economics  
University of Perugia  
Perugia  
Italy

Silvia Micheli  
Department of Economics and Business  
Science  
Guglielmo Marconi University  
Rome  
Italy

Carlo Andrea Bollino  
Department of Economics  
University of Perugia  
Perugia  
Italy

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# Preface

The main guidelines for energy and environmental policy have been the same for a long time now. The development of the energy sector is essential for economic development and competitiveness of all countries in the world and this development must be sustainable in terms of natural resources depletion and environmental quality.

This perspective is an ongoing challenge not only to the basic paradigm of efficient market decentralization and infinite supply of inputs in the long run, but also to the imperfect market and externality models. There is now recognition that the very survival of our society is at stake if we do not solve the issue of sustainability of our economic development. Indeed, the acknowledgement that fossil fuel reserves are finite or that emissions are dangerous to our health is not enough. We need comprehensive policies, credible policies, which can spur the necessary investment for the future of the Earth.

But if the objectives are clear—renewable energy sources development, competitiveness, diversification, energy saving—we must be humble enough to understand and study the complex relations between targets and instruments, in order to be able to offer instruments that are effective, that cost less, and that are adapted to the evolution of the economic system.

This book offers a very stimulating analysis of the most relevant issues of future European development of renewable energy sources, analyzing the available policy options.

In the first two chapters, the authors review the European policy strategies, assessing how much we have accomplished and what still needs new thinking and action.

In the next three chapters, the discussion of European policies for renewable energy sources is cast clearly to study the quantitative burden needed to support the instruments. In this respect, a crucial question seems to emerge from this book. We know that there is need for new investment in both physical capital (hardware and finance) and human capital (R&D and inventions), but will we be able to deal with the sacrifices necessary to make sustainable the development of our society?

I leave it to the reader to discover in the last chapter the answers to this question, namely when the authors discuss new scenarios for renewable energy sources development and advance precise policy proposals, which sound ethically appealing, but politically provocative.

In fact, they call for coherent and cooperative policies among all EU member countries, which can minimize the overall cost for the EU, i.e., for the entire European society. However, this requires overcoming national egoism and adopting a collective vision for the future.

Pier Carlo Padoan

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# Chapter 1

## The EU Legal Frameworks

Energy and environment today are the subjects of a number of initiatives and programs by the European Union (EU). Climate change has become the main pillar of EU policies aimed at accelerating the transition towards sustainable development, a future with low emission of greenhouse gases (GHG). The development of multidisciplinary and multidimensional strategies by the community institutions to face climate change has occurred and is still evolving within a particularly complex system. This chapter provides an analysis on current EU policies, with targets up to 2050, and prior agreements that led to the current ones. The analysis starts from the recent agreement called “roadmap for moving to a competitive low-carbon economy in 2050” promoted by the EU, and focus on the 2030 framework for climate and energy policies presented on January 2014 by the European Commission (EC 2014) as an intermediate step to achieve the goal of longer term to 2050. The chapter then proceeds backwards, illustrating the main agreements that have led the EU to the current situation, that are the 2020 climate and energy package and the implementation of the Kyoto Protocol at EU level. Finally, it provides a description of trends in carbon dioxide (CO<sub>2</sub>) emissions at global and European levels.

### 1.1 Road Map for Moving to a Competitive Low-Carbon Economy in 2050

The evolution of the energy and environmental policy of the EU is an ongoing process for the changes related to energy and environmental markets. The European Commission has recently presented as part of the Europe 2020 strategy, the flagship initiative “A resource-efficient Europe” (European Commission 2011a); it proposes a series of long-term strategic plans in areas such as transport, energy, and climate change. The Europe 2020 strategy for smart, sustainable, and inclusive growth includes five main objectives that define the goals that the EU should achieve by 2020. One of these concerns the climate and energy: the member states have committed themselves to reducing GHG emissions by 20%, to reach a 20% share of

renewable energy sources (RES) in the EU mix energy, and to get a 20% increase in energy efficiency by 2020. Currently, the EU has already achieved the first two objectives, and there are all the conditions to achieve an improvement in energy efficiency by 2020. The worldwide objective related to climate change is to contain within 2°C global warming produced by climate change. The 2°C cap on global warming was established in the Copenhagen Conference on climate change in 2009. The agreement has replaced by the Kyoto Protocol which would have been expired in 2012. The ambition of the conference was to be able to extend the Kyoto targets in 2020 or 2050, engaging in a binding even those nations which had not acceded to the Kyoto Protocol (i.e., the USA) or who were exempted from the cuts in emissions of GHG for not curbing their growth (such as China, India, Brazil, emerging nations among the developing countries). In this framework, the European Commission re-confirmed in February 2011 the EU objective of reducing GHG emissions by 80% by 2050 compared to 1990 levels.

To this end, the European Commission on 22 January 2014 has recently proposed new and important goals for 2030 through the “2030 framework for climate and energy policies” as an intermediate step to achieve the goal of longer term to 2050 (European Commission 2014).

The key elements of the climate and energy package in 2030 established by the European Commission are as follows.

- *A binding goal of reducing GHG.* Essential element of EU policy, it establishes a 40% reduction in GHG emissions compared to 1990 levels, to be achieved through action at national level. The reduction of the maximum annual emissions of the sectors included in the EU emissions trading system (ETS) would increase from the current 1.74 to 2.2% after 2020. The emissions from sectors not covered by the ETS should be reduced by 30% below the level of 2005, with efforts equitably shared among the member countries.
- *A binding target on the overall consumption of RES.* On the basis of a more market-oriented approach, the EU abandons national targets for an overall EU target of 27% of RES by 2030. To member states will thus be accorded some flexibility on how to transform their energy system. This is certainly an important and controversial point since the new directive does not contain any mandatory target for individual nations in terms of RES, but only a target “to achieve all together.”
- *Energy efficiency.* The role of energy efficiency in the context in 2030 will be further considered with a review of the Energy Efficiency Directive ready by the end of 2014. The European Commission will assess the potential need for changes to the existing rule once the review is completed.
- *New indicators.* The European Commission proposes a new set of key indicators to assess progress over time, such as the energy price gap between the EU and major trading partners, diversification of supply and self-supply of domestic energy sources, and the ability of member states’ liaison.
- *Reform of the EU ETS.* The European Commission proposes to establish a reserve for the stability of the market at the beginning of the next trading period of the EU ETS in 2021, in order to deal with the surplus of allowances that is made over recent years, to improve the system’s resilience to shocks, by automatically adjusting the supply of allowances to be auctioned.

- *Governance.* The European Commission proposes new system of governance based on national energy plans proposed by the member states and coordinated by the Commission.

The 2030 framework for climate and energy policies package is raising some controversy among member states. The first observation is on clarity of objectives: only two of them, reducing the GHG emissions by 40% and expanding the share of RES up to 27% compared to 1990, are expressed in quantitative terms. The other objectives are not yet associated with measurable commitments and therefore, at this stage, appear more generic than the first two.

In addition, only the first target concerning GHG emission reduction is binding both for the EU as a whole and for member states, while the second objective relating to the RES is binding only for the EU but not for member states.

Can a macro entity, which is the sum of  $n$  micro entities, hit a target if its constituents are not subject to the same constraint? Many environmental problems share the features that when many countries are involved in international agreements, it is possible that some of them do not actually participate (Cremer and Gahvari 2002; Kolstad 2000; Stavins 1995). Participation to environmental agreements is related to the gains countries can get: climate change is a global problem and each country believes to get only small benefits compared to its effort.

With the 2030 framework for climate and energy policies package, there might be problems regarding cooperation to achieve RES' goal: when member states differ from each other with respect to costs and benefits of implementing RES, some of them might find affordable to free ride.

Moreover, the characteristic of public good of environmental policy implies that free riders may benefit from others' efforts without bearing any costs.

Most of the literature on free-riding states that if all countries are convinced to cooperate, an efficient treaty would specify the joint abatement policy corresponding to the internationally optimal objectives (actually, this is what happened previously with the binding targets per member state within the 2020 climate and energy package. It follows a description in Sect. 1.2). For some countries, however, the environmental policy may be so costly that it makes them worse off to cooperate, compared with the noncooperative equilibrium, i.e. the business as usual (BAU) scenario.

Another controversial aspect concerning the not-binding RES' goal at national level of the 2030 framework for climate and energy policies package is related to RES production decision. On the one hand, the lack of national constraints allows to choose the best RES to be implemented throughout the EU taking into account their productivity compared to the territory, that is geo-referencing at regional-level RES' production. For instance, each EU member states is characterized by different levels of solar radiation, wind intensity, and crop productivity for biomasses which reflects in different productions' marginal costs.

On the other hand, multinational companies in the electricity market can leverage their oligopolistic position and locate RES production in a suboptimal way. It is tricky to say whether or not liberalized electricity markets are likely to adopt the

cost-saving, GHG-reducing technologies. If an investment opportunity exists to increase profit for a private power generating company, it is likely that the company will adopt it. RES' systems are in general characterized by high capital costs, low operation and maintenance costs, and zero fuel costs with the exception of systems using purchased biomass, but they are still more expensive than conventional sources. Then, the package should be able to induce participation and compliance, and, without binding objectives per member state, it might be hard to achieve the goal.

The EU had already embarked on the path of the indicative and nonbinding expansion of RES with the 2001/77/EC Directive (European Commission 2001; European Parliament 2001) on the promotion of electricity produced from RES in the internal electricity market with the indicative target of 12% of European gross domestic energy consumption from RES in 2010, and the result was not encouraging because the target was not reached. On the other hand, at world level, something similar happened with the indicative target of Kyoto Protocol (a detailed description of the Kyoto Protocol is provided in Appendix 1).

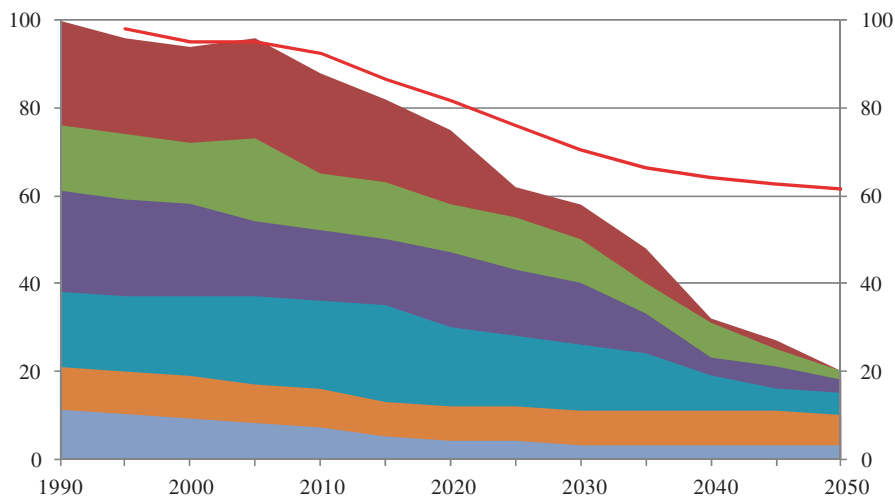
Another observation that emerges from the member countries is the consistency of the objectives in relation to the overall EU strategies. By looking at the long term, the road map calls for an 80% reduction in GHG emissions compared to 1990 levels by 2050. More complex is the assessment of the quantitative consistency since the stages of the path to the target of 80% GHG emission reductions are as follows. Kyoto: 8% in 2010; climate and energy package: 20% in 2020; 2030 framework for climate and energy policies: 40% in 2030; target 2050: 80%. The succession of goals highlights two periods: until 2020, it requires a reduction of 10% every decade; after 2020, the reduction required for each decade becomes 20%.

Beyond question, however, very important on the feasibility of the final objective (80% GHG reduction by the year 2050) and the definition of consequential intermediate targets, it can be said that the main target of the 2030 framework for climate and energy policies, i.e., the reduction of emissions by 40%, is nothing more than a consequence of the long term. On this level, the EU demonstrates consistency: the target for 2030 is not rhetoric but a result of a commitment already declared.

Then, looking beyond 2020, existing and currently planned measures could bring the EU onto a pathway to achieving long-term emission reduction objectives. Anyway, achieving a reduction of emissions by 80% by 2050 compared to 1990, as agreed by European Commission, will require enhanced efforts from member states.

The road map to achieve the objectives to 2050 indicates a gradual transition and effective in terms of cost, as indicated by the COM 112 (European Commission 2011b) on Roadmap for moving to a competitive low-carbon economy in 2050.

The COM 112 (European Commission 2011b) with the White Paper on Transport and the Energy Efficiency Plan is one of the key documents on the efficient use of resources, and it illustrates the cornerstones on which actions promoted by the EU should be based to facilitate the transition to a competitive low-carbon economy by 2050. The road map sets out a series of steps aimed at verifying whether the EU is on track to achieve its objective, policy challenges, the need for investment, and



**Fig. 1.1** GHG emissions (%) of the EU towards an 80% in internal reduction (100%=1990). Non-CO<sub>2</sub> GHG. Although the majority of GHG emissions comes from CO<sub>2</sub>, non-CO<sub>2</sub> GHG such as methane, nitrous oxide, and fluorinated greenhouse gases contribute significantly to climate change. *GHG* greenhouse gases, *EU* European Union. (Source: COM 2011b, p. 112)

opportunities in the various sectors. To make the transition to a competitive low-carbon economy, the EU must be prepared to reduce its domestic GHG by 80% by 2050 compared to 1990 levels.

The European Commission has suggested, through an accurate analysis of modeling, possible scenarios of intervention to achieve this objective. One effective option would be to implement effective internal GHG reductions by 25% by 2020, 40% by 2030, and 60% in 2040. With this approach, compared to 1990, there would be an annual reduction of about 1% in the first decade (until 2020) of 1.5% in the second decade (2020–2030), and 2% in the last 2 decades until 2050.

The GHG emissions reduction would increase over time due to the increase in technology with a good cost-effectiveness relation. The path that would lead to an 80% reduction by the year 2050 is shown in Fig. 1.1.

The projection “BAU” (business as usual) in the upper part of the graph shows what would be the trend of the EU GHG emissions with only existing policies and without the implementation of the road map to 2050. The road map scenario consistent with a reduction of 80% domestic shows what would be the trend of global and sectoral GHG emissions whether additional strategies are adopted on the basis of technological options available in 2050.

The European Commission’s analysis has also explored possible ways for action for the most important sectors, examining a number of scenarios based on different rates of technological innovation and fossil fuel prices. They have arisen convergent results regarding the extent of the reductions needed in each sector in 2030 and 2050. In particular, the COM (2011b) 112 states the electricity sector will

play a central role in the low-carbon-intensity economy; it could almost completely eliminate CO<sub>2</sub> emissions by 2050 and replace fossil fuels in transport and heating. It is estimated that the share of low-carbon technologies in the electricity mix will increase from about 45% in 2011 to 60% in 2020 (due to the achievement of the target for RES) and from 75 to 80% in 2030 to nearly 100% in 2050. The EU ETS will play an essential role to market a wide range of technologies with low carbon intensity, so that the energy sector can adjust their business strategies and investment to evolution of technologies and energy prices. For the EU ETS to fulfill this function, it is necessary to reduce the maximum amount of emissions allowed under the ETS, and that the price of permits could be predictable in the long run. RES play a crucial role in low-carbon economy: investments in the networks are necessary to ensure continuity of supply at any time. In fact, in order to have an electrical system at low carbon intensity, it is essential to invest in smart grids, which allow to manage electricity demand more effectively, to increase the share of RES, and to achieve the electrification of transport. With regard to the transport sector, technological innovation can lead to an efficient and sustainable transport system through the introduction of biofuels and the efficiency of the vehicles. The built environment offers the possibility to reduce emissions in the short term, primarily due to improved energy efficiency in buildings. The analysis conducted by the European Commission shows that in this area it would be possible to break down GHG emissions by approximately 90% by 2050, which represents an above-average contribution in the long term.

Concerning the industrial sector, its GHG emissions could be reduced by 83% in 2050. The use of plants and industrial processes more efficiently in terms of energy and resources, an increased recycling, and the use of technologies for the reduction of non-CO<sub>2</sub> emissions could provide a decisive contribution in polluting emissions reduction.

Even the agricultural sector will be able to cut its non-CO<sub>2</sub> emissions by between 42 and 49% compared to 1990 levels by 2050, thanks to the efficient use of fertilizers, the biogasification and a better management of organic fertilizers, diversification, and marketing of production at local level.

Different energy sources with low carbon emissions with associated systems and supporting infrastructure, including smart grids, carbon capture and storage, advanced industrial processes, and the electrification of transport (including energy storage technologies), are the pillars of energy policy for the period after 2020.

## 1.2 The 2020 Climate and Energy Package

In order to understand the 2030 framework for climate and energy policy, it is important to analyze and understand the 20–20–20 climate and energy package. In early 2007, the EU proposed an integrated energy and climate change package to cut emissions for the twenty-first century, based on a strong commitment in favor of a low energy consumption economy, more competitive economy, and sustain-

able development. The novelty of the approach lies in the centrality of the issue of the integration of energy policy with environmental and with the Lisbon strategy<sup>1</sup> for competitiveness. On 23 April 2009, it officially adopted a legislative package called 20–20–20 climate and energy package, through which the EU is proving to be ready to assume the global leadership to tackle climate change, to address the challenges of energy security, making Europe a model of sustainable development for the twenty-first century.

An important merit of the package is the introduction of legally binding targets to be achieved by 2020:

- A reduction in GHG emissions by at least 20% compared to 1990 levels, with the aim of further reducing these emissions by 30% by 2020 if other developed countries commit themselves to comparable efforts.
- Raising the share of EU energy consumption produced from RES to 20%.
- A 20% improvement in the EU's energy efficiency.

The targets were set by EU leaders in March 2007, when they committed the EU to become a highly energy-efficient, low-carbon economy, and were enacted through the package in 2009 (Directive 2009/28/EC). Targets are calculated with reference to 2005 taken as the base year with respect to which they are presented increases or reductions of shares of energy from RES and GHG emissions. The package responds to the appeal launched by the European Commission on real actions for the transition to sustainable development.

The package includes a series of closely related major policy proposals, such as:

- The revision of the directive on the EU ETS.
- A proposal on the allocation of efforts by member states in order to reduce GHG emissions in sectors not covered by the EU ETS (such as transport, buildings, services, smaller industrial installations, agriculture, and food industry).
- A directive on the promotion of RES to achieve the targets for reducing GHG emissions.

The importance of the EU ETS lies in creating a market and an artificial price for a public good like clean air. Firms subject to the EU ETS have to face costs when they emit CO<sub>2</sub> emissions: on the one hand, if a firm needs for its activities a larger number of permits than it has available, then it must incur a cost to buy them; on the other hand, opportunity costs increase because permits can be sold in case of nonproduction.

The changes made by the package on the system of emissions trading shall come into force during the period 2013–2020, and they are done in order to overcome the problems arisen during the early years of implementation within the Kyoto Protocol.

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<sup>1</sup> The European Council on 23 and 24 March 2000 in Lisbon has launched a series of ambitious reforms that have taken the name of the “Lisbon Strategy” for the years 2000–2010, in order to strengthen employment, economic reform, and social cohesion in the context of knowledge-based economy. The priority areas identified by the Lisbon Strategy are investments in knowledge and innovation, unlocking business potential, especially of small and medium enterprises, employment of priority categories, and energy policy for Europe.