Computers & Operations Research 66 (2016) 327–335

Contents lists available at ScienceDirect

Computers & Operations Research

journal homepage: www.elsevier.com/locate/caor

Costs assessments of European environmental policies

Simona Bigerna [a], Carlo Andrea Bollino [a,*], Silvia Micheli [b]

[a] Department of Economics, University of Perugia, via Pascoli 20, 06123 Perugia, Italy
[b] Department of Economics and Business Science, Guglielmo Marconi University, Via Plinio, 44, 00193 Rome, Italy

ARTICLE INFO

Available online 17 March 2015

Keywords:
Simulation model
Renewable energy
Cost function
Opportunistic behavior

ABSTRACT

The evolution of energy production in the European Union (EU) is going through a big change in recent years: the incidence of traditional fuels is diminishing gradually for increasing renewable energy sources (RES), due to international concerns over climate change and for energy security reasons. The aim of this paper is to construct a simulation model that identifies and estimates costs that may arise for a community of negotiating countries from opportunistic behavior of some country when defining environmental policies. In this paper, the model is applied specifically to the new 2030 Framework for Climate and Energy Policies (COM(2014) 0015) (EC, 2014 [11]) on the promotion of RES that commits EU governments to a common goal to increase the share of RES in final consumption to 27% by 2030. Costs faced by EU countries to achieve the RES target are different due to their endowment heterogeneity, the availability of RES, the diffusion process of cost improvements and the different instruments to support the development of the RES technologies. Given the still undefined participation agreement to reach the new overall RES target by 2030, we want to assess the potential cost penalty induced by free riding behavior. This could stem from some EU country, which avoids complying with the RES Directive. Our policy simulation exercise shows that costs increase more than proportionally with the non-participating country size, measured with GDP and CO_2 emissions. Furthermore, we provide a model to analytically assess the likelihood each EU country may have to behave opportunistically within the negotiation process of the new proposal on EU RES targets (COM(2014) 0015).

1. Introduction

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. The development of multi-disciplinary and multi-dimensional strategies by EU institutions to face climate change has occurred and is still evolving within a particularly complex system. Indeed the evolution of energy consumption in the EU especially in the electricity sector, linked to concerns about climate change and energy security, offers important opportunities for the development of RES.

We analyze the two main instruments of the EU Climate change policy, namely the target setup to 2020 and the new target setup to 2030. The Renewable Energy Directive on the promotion of the use of RES (2009/28/EC) [8] has committed EU member states to reach 20% share of RES in the EU energy consumption by 2020 and it has set national RES targets for all EU member states by implementing the National Renewable Energy Action Plans.[1] In particular, member states adopted National Renewable Energy Action Plans with binding goals for heating and cooling, electricity and transport biofuels from renewables; it remains up to EU member states to decide on the mix of contributions from these sectors to reach their national targets, choosing the means that best suit their national circumstances.

The new EU proposal for 2030 has set several targets within the 2030 Framework for climate and energy policies (COM (2014) 0015) [11], to make the EU energy system more competitive, secure and sustainable.[2] We focus on the new RES target, based on a more market-oriented approach, which is set at 27% for the EU as

* Corresponding author. Tel.: +39 075 585 5421; fax: +39 075 585 5299.
E-mail address: carloandrea.bollino@unipg.it (C. Andrea Bollino).

[1] The allocation of different national target rests on a flat rate approach adjusted for the GDP of each country. System of incentives and support for RES are quite costly and recovery times are long. Indeed the EU RES directives 2001/77/EC, 2003/30/EC [6] and 2009/28/EC [9] oblige member states to introduce support schemes to RES technologies to allow RES enter the commercial market and to become competitive in the long term with respect to fossil fuel technologies [20].

[2] These targets are related to GHG reduction, RES increase, increase in energy efficiency, reform of the EU emissions trading system etc. More specifically, the EC has established a 40% reduction in GHG emissions compared to 1990 levels, to be achieved through action at the national level.

http://dx.doi.org/10.1016/j.cor.2015.03.003
0305-0548/

a whole by 2030. Thus, the EU abandons the policy of setting binding national targets.[3] We deem that this makes the need for a new round of negotiation and cooperation within the EU extremely important. EU member states will enjoy some flexibility on how to transform their energy system. This is certainly an important and controversial point since the new communication does not contain any mandatory target for individual nations in terms of RES, nor it discusses the implications in terms of additional costs for the European citizens. Indeed, according to recent estimates, investments resulting from RES target of reaching 30% in final consumption by 2030 are estimated to range between €73 billion and €90 billion per year [12,16,30]. We consider investment costs as the direct costs for reaching the RES targets by 2030, while the indirect ones as the reputation costs of not achieving the 2030 EU target and the climate change issues are not considered in our paper.

The new approach of the COM 2014(0015) policy is radically different from the Directive 2009/28/EC RES policy which imposes precise RES national targets in 2020. On the contrary, the new EU RES policy imposes a common target to be achieved all together. This raises an immediate question: can a macroentity, such as the EU be successful in defining and then achieving a common target if its constituents are not subject to some binding constraint? We reckon that possible opportunistic participation to environmental agreements may arise from the gain that each country can get. Climate change is a global problem and each country believes to get only small benefits compared to her effort. The results of recent negotiations confirms that countries individually are primarily concerned about potential economic disadvantages arising from financing of RES.

The maximization of national welfare can lead to unilateral actions at the expenses of the European community, i.e. European electricity consumers. Whether a coalition is stable or not it also depends on the opportunities available in a bargaining situation of collaborate for the mutual well-being. As demonstrated by past negotiations, an agreement with full participation of all parties involved is difficult to obtain. What most often happens in reality is that some countries act unilaterally to maximize their own welfare [19]. Indeed, achievement of full cooperation in an agreement with such EU principles, with reference to RES, is relatively difficult when the underlying game poses a dilemma for players. Notwithstanding the fact that cooperation is socially optimal, it is often the case that a number of players will have the temptation of stealing away from the game, still enjoying the benefits without having to bear the costs of implementing RES technologies [23]. Thus, we find evidence in most of the literature that the behavior of nations is characterized by some opportunism in both the formation and implementation of environmental policies.

The aim of this paper is to construct a simulation model, which is able to identify and estimate costs that may arise because of potential opportunistic behavior of some country, in the process of negotiation and definition of environmental policies. In our model, we use as a starting point the available national data of the 2020 RES targets and we simulate the results for the new EU environmental policy by 2030, which has to be achieved at the EU aggregate level. More specifically, we assume that there is an indirect relation between CO_2 emission reduction and RES development[4] (see among others [15,28]). More generally, the failure of meeting a given RES policy does not necessarily have negative consequences, if there is a compensatory effect of a more aggressive decarbonization policy. In this sense, we assume that there is a linkage between the opportunity cost of achieving a RES target and that of achieving a CO_2 target. This is an interesting issue, because the total cost of a given RES is also a function of the mix of different RES technologies, which have different unit costs. However, in this paper we do not explore this issue further.

Although the RES Directive does not impose costs on other countries within the EU if countries fail to meet RES targets, according to Nordhaus [27], opportunistic behavior of countries in environmental agreements is always possible, requiring the implementation of sanctioning mechanisms, as it is the case of the EU legislation. Such sanction mechanisms have been applied to Poland and Cyprus as a daily penalty imposed by the European Commission (€133,228.80 and €11,404.80 for Poland and Cyprus respectively [10]).

In this framework, we estimate the potential additional costs suffered by all other EU countries. We want to clarify that we refer to the opportunity cost that is faced by the abiding countries as a consequence of the behavior of the reneging country. We acknowledge that the Renewable Directive has no mechanism for imposing to other countries the burden resulting from the failure of some to meet their targets. However, if the overall target has to be met, in principle, the remaining countries have to make up for the non-participating ones, upgrading their effort, and this has a cost. Alternatively, the remaining countries give up the goal of achieving the original target for the whole EU. In this case, the remaining countries abide to their original commitment but they incur in a loss of not achieving the overall climate change policy target and this has a cost, too.[5]

This is crucially dependent on the fact that the marginal cost to deploy RES is a convex increasing function [26]. In fact, starting with any given efficient RES allocation among EU countries, consider a country reneging on its share. If the remaining countries have to make up the difference, they will have to increase their quantity and therefore their cost will increase. In our analysis, we assume that RES marginal costs rise if some EU member countries renege on their targets. The relevant novelty of our model is that we empirically estimate the increasing marginal cost function and therefore we provide empirical evidence of the convexity of marginal costs. The degree of convexity of the marginal cost of abatement is related to the opportunistic behavior of some participants.

We take into account explicitly the relationship between costs for implementing different RES technologies, i.e. photovoltaic (P), wind (W) and biomass (B) technologies, and costs arising from less than full participation. In our model, the non-participation in the agreement to reach the RES target can be partial or total. The analysis is conducted using an empirically estimated functional model, which captures the endogenous feedback from the environmental policy to the overall macroeconomic equilibrium, capable of measuring the non-participation costs.

Empirical results yield a precise measure of the cost imposed by some non-participating country to all others. These costs increase more than proportionately with the non-participating country size expressed in terms CO_2 emissions and provide an analytical base to assess the likelihood that each country may have to attempt to behave opportunistically within the negotiation process of the new proposals on EU RES targets. The amount of CO_2 emitted by a country expresses indirectly also the size of GDP, given the positive relationship shown by most of the literature between CO_2 emissions and GDP [32,31,34].

[3] We have considered the case of RES' goal but our simulation model can be applied to other environmental goals to estimate costs that may arise for a community of negotiating countries from opportunistic behavior of some country when defining environmental policies.

[4] For a given level of electricity generation, if an additional kWh generated by RES displaces a kWh generated by traditional fossil sources, the result is an additional reduction in CO_2 emissions.

[5] We are grateful to an anonymous referee for raising this point.