Energy 92 (2015) 577–591

Contents lists available at ScienceDirect

Energy

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

Lessons learnt from a sectoral analysis of greenhouse gas mitigation potential in the Balkans

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ARTICLE INFO

Article history:
Received 9 December 2014
Received in revised form
23 April 2015
Accepted 25 April 2015
Available online 16 May 2015

Keywords:
Climate change
Carbon cost curves
Abatement measures
Socio-economic effects
Balkan

ABSTRACT

Balkan countries in the process of joining the European Union shall adopt greenhouse gas emissions reduction targets and implement appropriate mitigation policies and measures. This paper presents a simplified methodological framework based on marginal abatement cost curves for estimating the technical and economic mitigation potential at sectoral level (buildings and road transport) in selected Balkan countries. The results of the analysis provide to decision makers useful information regarding the availability of background data, the potential for setting ambitious mitigation targets, and detailed tools for assisting the selection of policies and measures to meet these targets. The analysis performed shows that a significant part of the greenhouse gas emissions abatement potential can be achieved through win–win measures. The incorporation of environmental externalities associated with these interventions, estimated through benefits transfer, further improves the economic performance of these measures, especially in the buildings sector. Moreover, the implementation of these measures is shown to result in positive macroeconomic effects through increases in GDP (gross domestic product) and creation of new jobs. Finally, the rebound effect may restrict the estimated greenhouse gas emission reductions in the buildings of the countries examined due to the low energy performance of the existing building stock.

1. Introduction

The European Union (EU), in order to respond to the global challenge of mitigating the risk of climate change, has set up a process for moving gradually to a low carbon society by 2030–2050. The energy sector plays a crucial role in this transition as it generates the vast majority of greenhouse gases (GHG) emissions at all EU countries. The EU process includes a range of commitments for its Member States, such as legally binding national targets aiming to reduce GHG emissions at the EU by at least 20% by 2020 (the so-called '20-20-20 targets' or 'Climate and Energy Package'), a number of reporting and monitoring procedures, etc. Therefore, countries which are in the process of joining the EU have to comply with the EU climate acquis by developing all necessary infrastructure and actions. To this end, energy modelling constitutes a useful tool for supporting decision making and develop appropriate policies.

In general the various energy models used for projecting future evolution of GHG emissions and analyzing low carbon policies and measures can be classified in two broad categories, namely top-down and bottom-up energy models [1]. Top-down energy models can provide consistent scenarios in terms of economic growth, labour productivity, consumption and investment expenditure, government balance, etc. [2] but have a rather poor representation of the energy system and do not fully incorporate technological options to reduce GHG emissions. Bottom-up energy models (engineering bottom-up models or energy system, usually partial equilibrium, models) have a better representation of the technical determining factors of emissions and incorporate better engineering data and technological choices [1,3,4].

Marginal abatement cost (MAC) curves have been widely used in the assessment of climate change options, at global [5], national [6,7], regional [6], and sectoral [8–18] level. Regarding the latter, MAC curves have been developed not only in the energy sector, but

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http://dx.doi.org/10.1016/j.energy.2015.04.068
0360-5442/

also in agriculture, waste, forestry, and industry. MAC curves fall into three broad categories on the basis of the modelling approach applied for their construction [19,20]: (i) expert-based MAC curves (or technology cost curve) derive from engineering bottom-up models and present (on an increasing order of cost) the emissions abatement potential and the corresponding cost of each of the technical measures examined; (ii) model-derived MAC curves are constructed on the basis of a systems' approach, through partial or general equilibrium models; and (iii) MAC curves based on models that rely on production theory in order to derive the marginal abatement costs which can be interpreted as opportunity costs in a given market and under given technological conditions.

Expert-based MAC curves give a good first approximation of the technological and economic emission reduction potential that can be achieved (for a detailed presentation of MAC curves, their usefulness in decision-making process and their limitations see Refs. [20,21]). These bottom-up constructed MAC curves are particularly useful in countries and sectors with significant data gaps, highlighting those interventions that can be achieved with economic benefits or even with a relatively low cost. Therefore, they can be used to highlight priority interventions or even those measures whose implementation requires appropriate supportive policies. On the other hand, the traditional use of bottom-up constructed MAC curves in decision-making process has certain limitations: they do not take into account the co-effects associated with mitigation actions as their monetization is not always an easy task; they do not capture implementation barriers and wider cost definitions; they do not take into account various intersectoral, behavioural, macroeconomic and international interdependencies; they do not provide input for the optimal timing of GHG emissions reductions towards a specific target, etc. [22–25].

Climate change mitigation policies have the potential to generate synergies and co-benefits (but also risks) with other economic, social and environmental objectives. Energy conservation, RES penetration and fossil fuels substitution contribute to the reduction of local air pollution and improved air quality, resulting in reduced mortality and morbidity and less stress on the ecosystems [26–29]. In addition, mitigation measures can improve indoor living and workplace conditions, and reduce traffic congestion, generating co-benefits related to public health (e.g. reduced indoor pollution, fuel poverty alleviation), increased productivity and reduced time loss [30–32]. Mitigation measures resulting in fossil fuels substitution contribute to the security of energy supply though the diversification of energy sources, the increased share of domestic energy sources used, the strengthening of power grid reliability [33,34]. Greater use of RES, energy conservation measures and new business opportunities result in positive economic effects through reduced energy subsidies, increase of income, job creation [35–38].

The extent to which these co-benefits are considered in the economic assessment of climate change mitigation clearly affects the outcome of the assessment. For example, GEA [39] found that the monetary value of co-benefits associated with energy efficiency in buildings is at least twice the resulting operating cost savings. Thus, when quantification and valuation of co-benefits is possible, it is useful to include these estimates into cost-benefit analysis and examine the effect on the economic attractiveness of mitigation options. The resulting MAC curves where the monetary value of the various co-effects associated with mitigation options is incorporated generating (i.e., Social Marginal Abatement Cost (SMAC) curves) provide useful insights to decision-makers on mitigation measures that maximize social welfare [12,40,41].

Most Balkan countries, after facing deep economic and social crises in the 1990s and the first years after 2000, are now in the process of joining the European Union. In this context, they are in the process of developing a range of policies to address climate change [42–45]. However, the use of detailed energy models to support decision-making is still low in most of the countries of the region due to limited human and economic resources and, in many cases, the lack of detailed background data that are necessary for developing this type of energy models. Therefore, considering these difficulties, the present paper shows how to design policies for tackling climate change through a combination of simplified energy modelling tools, cost-benefit analysis and consideration of co-benefits associated with climate change mitigation. In addition, the paper also provides useful information on the current situation and the future prospects of the energy system and the associated GHG emissions in Balkan countries, for which there are still limited data available in literature.

The analysis presented thereafter focuses on four Balkan countries (Albania, Croatia, the Former Yugoslav Republic of Macedonia, and Montenegro) and on two sectors (namely buildings and transport) that were identified by stakeholders in the public administration as priority ones. In this context, a bottom-up model for each priority sector was developed, including all major structural characteristics of the sector (e.g. energy uses, key technologies, energy sources). Several mitigation measures were analyzed as regards their GHG emissions abatement potential and their cost-effectiveness. On the basis of the results obtained, an expert-based MAC curve was constructed in each case. Then, co-benefits of those mitigation actions were assessed and included in MAC curves generating SMAC curves, while macroeconomic effects from the implementation of these options such as impacts on employment and the gross domestic product (GDP) at national level were also estimated in order to provide a more complete picture to decision-makers.

The paper has the following structure. In Section 2 the methodological framework implemented for assessing the technical and economic emissions abatement potential as well the socio-economic effects of mitigation measures is presented. In Section 3 the results of the analysis performed in four Balkan countries are shown. Finally, in Section 4 the basic conclusions of the study are summarized and conclusions are drawn.

2. Methodological framework

2.1. Energy modelling

As already mentioned the analysis of the GHG emissions abatement potential in this paper focuses on energy demand and is based on bottom-up models, which have been developed for each sector in question (namely buildings and transport) and incorporate the basic engineering characteristics of those sectors. The models simulate the main energy uses in each sector that generate GHG emissions, while energy consumption per use is analyzed and broken down to specific technologies and energy sources contributing to GHG emissions.

More specifically, in the sector of *buildings* one has to take into account that a detailed assessment of the various low carbon measures needs a detailed but manageable classification of buildings, as the various characteristics of the building stock need to be accurately represented [12]. Therefore, within the model developed, buildings are classified on the basis of the following criteria: (i) age of buildings which is related to the thermal characteristics of the building shell, (ii) type of buildings (residential and tertiary) and (iii) size of residential buildings (low rise single dwellings, and high rise apartment buildings).

Consequently, six types of dwellings (i.e., high rise apartment buildings and detached houses built before 1980, during 1980–2010 and after 2010) and 15 types of tertiary buildings (i.e.,