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Linking least-cost energy system costs models with MCA: An assessment of the EU renewable energy targets and supporting policies

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ABSTRACT

There are several technoeconomic modeling approaches that provide quantitative results such as costs and the level of achievement of certain renewable energy (RE) policy targets. These approaches often do not consider other important factors for policy implementation (such as socio-political aspects and stakeholders' preferences). Recent multicriteria analysis (MCA) approaches attempt to integrate these multiple aspects in decision making process. In this respect, aim of this paper is to combine technoeconomic modeling and MCA approaches in a general analytical framework incorporating multiple aspects. Each method in an RE policy interaction problem can feed in the necessary policy information for the subsequent steps of an ex-ante and an ex-post assessment in a decision tree, starting from recognizing the need for implementing a new policy in parallel to the incumbent ones, assessing the actual policy costs and finally identifying the social acceptability of these RE policies.

1. Introduction

The increase of the contribution of renewable energy (RE) in energy supply, and in particular to power generation has been targeted by several initiatives in the past (Flamos et al., 2008). Such initiatives were characterized by direct government action and the provision of capital incentives (often in the form of a fixed percentage contribution to capital costs) and, more recently, by ensuring a remunerative fixed price of uptake for electricity generated by RE (which could or could not depend on the particular RE technology used) or by imposing a certain percentage of the electricity to be generated by RE and allowing the market to choose the technology renewable portfolio standard (RPS). Although the fixed uptake price system has obtained very good results in diffusing some RE technologies in several countries (e.g. wind generators in Germany and Spain (Flamos et al., 2009)) it does not make full use of market mechanisms to minimize the cost of such diffusion, and the RPS system is gaining more general acceptance. The RPS system is based on the possibility of trading Green Certificates corresponding to the electricity generated by RE, so that the market fixes the value of such electricity and encourages the diffusion of the most cost-effective technologies.

Next to the RPS, based on the International Energy Agency (Information Climate Change Policies and Measures database), several policy instruments exist, which address RE supply. More specifically, as shown in Fig. 1 for ongoing and planned policy instruments in the European Union (EU), RE objectives are addressed at large by financial instruments, mainly feed-in tariffs for specific technologies, followed up by regulations and at a much lesser extent with other types of instruments.

As these policy instruments are designed and implemented in an already policy crowded environment, interactions between them are taking place. These interactions can take different forms and shapes and are considered as complementary if they carry over positive impacts on the policy mix, or overlapping if they reduce the overall effects that each instrument (stand-alone) could generate in the market in achieving policy objectives. There are several approaches in literature attempting to identify the outcome of policy interactions (PI) (see Oikonomou and Jepma (2008) for a review), mainly from technoeconomic perspectives.

One such approach has been developed in the framework of the Intelligent Energy Europe (IEE) project "RES2020: Monitoring and Evaluation of the RES directives implementation in EU27 and policy recommendations for 2020". The authors in order to develop a model for analyzing the renewable energy targets set

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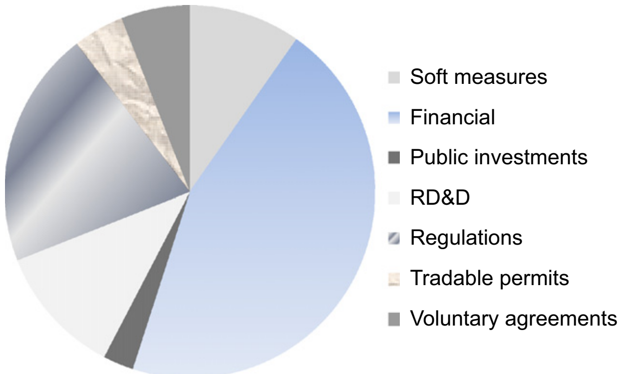

Fig. 1. Shares of policy instruments for RE supply.
Source: International Energy Agency Global Renewable Energy Policies and measures Database (2010).

by the European Union for 2020, have used the Integrated MARKAL-EFOM System (TIMES) model generator.[1]

For the identification of the above PI, the authors have applied the Energy and Climate Policy Interactions (ECPI) Decision Support Tool (Oikonomou et al., in press, 2010) in scenarios of the RES2020 project.

Energy policy decision making has been traditionally an issue of high complexity (Doukas et al., in press). Recently, this complexity has been further increased. Climate change and supply security issues should have to be taken into account within our days' economic crisis seeking for competitiveness increase and rationalization of investments.

Both TIMES and ECPI have been used as "stand alone" tools (approaches) for energy policy decision making facilitation. However, both approaches have advantages and disadvantages. For example, integrated technoeconomic (equilibrium) models, although sophisticated, are not incorporating socio-political aspects and usually are considered as a "black-box" by policymakers. In this respect, multicriteria analysis (MCA) approaches attempt to integrate policymakers' preferences in the modeling of Decision Support Systems.

In line with the above analysis, by employing a technoeconomic (TIMES) and a multicriteria decision support tool (ECPI) we link least-cost energy system cost models with MCA. In this respect, quantitative results from the technoeconomic model are applied to the multicriteria decisions support tool, with the aim to provide insight on the added value of implementing combinations of selected energy policy instruments in order to achieve RE targets, as the latter are being expressed by criteria preferences. In other words, the main goals of this paper are to evaluate impacts of alternative energy policies on EU energy system using a cost minimization model (PET) and to combine the numerical results using a qualitative framework (ECPI).

The structure of this paper is as follows: Section 2 describes the methodology employed in the PET model and ECPI tool and their basic characteristics in a nutshell. In Section 3 we present results from scenarios of the PET model on the grounds of their effectiveness and cost-effectiveness. Furthermore, Section 4 deals with the results from the ECPI tool, when testing interactions of the same policy instruments (as employed in PET). Finally, in Section 5 we discuss the adopted approach and in Section 6 we provide concluding remarks of the paper.

2. Methodological approach

The methodology we employ in this paper is based on a multicriteria decisions support tool developed by some of the authors, called ECPI (Energy and Climate Policy Interactions decisions support tool) (more information can be found in Oikonomou et al., in press). The results we generate from such a tool are predominantly qualitative, as they express preferences of policymakers towards selecting policy instruments for achieving RE goals. The input for the ECPI tool originates from the technoeconomic model TIMES, which provides quantitative results of these policies towards achieving the targets.

2.1. TIMES model

The PET[2] model represents the energy system of the European Union (plus Iceland, Norway and Switzerland) and its possible long term developments. The actual system encompasses all the steps from primary resources in place to the supply of the energy services demanded by energy consumers, through the chain of processes that transform, transport, distribute and convert energy into services. The PET model is designed to explore the development of the EU27+ energy system till 2050.[3]

PET model is then synthesized by allowing trade of energy commodities among the countries. This model has been used as a starting point for building the RES2020 model. The level of analysis per sector of economic activity in each country, in the Pan European model, is rather detailed. On the energy demand side we distinguish the residential, commercial, agricultural, industrial and transport sectors. The PET model was partly recalibrated in the EC project RES2020. In this second project the model was improved by adding new, more detailed technologies in the supply and demand chain of the renewable energy sources, more detailed representation of technologies for electricity production from RES and finally policies and constraints related to their availability.

2.2. ECPI decision support tool

The ECPI tool provides a qualitative framework for analyzing interactions among policy instruments in various policy mixes through developing a whole policy cycle and the instruments' respective pairwise combinations. The key concept is that policymakers select instruments to be examined for interaction and demonstrate their preferences, when assessing options of integrating various schemes. In the tool we make use of a traditional policy condition, which assumes that an optimal policy solution preconditions the relationship one policy instrument for one policy target (Tinbergen, 1952, 1954; Arrow, 1958; Lindblom, 1958). ECPI tool consists of four methodological steps, which are explained in detail in Oikonomou et al. (2010).

In this paper we depart from the results of the PET model runs in the RES2020 project and translate them to qualitative

[1] The Pan European TIMES model (PET) has been originally developed in the EC-FP6 NEEDS project (Integrated Project on New Energy Externalities – Developments for Sustainability, 2004–2009). The model is built with a common structure for each single region but the country specific data were assembled under the responsibility of the organizations and experts. In the RES2020 project, scenarios for RE deployment through introducing several policy instruments were tested and evaluated.

[2] TIMES is an acronym for The Integrated MARKAL EFOM system of the ETSAP community of the International Energy Agency. An extensive use of TIMES model was made in NEEDS4 project, funded by the 6th Framework Programme and in its framework. The model employed there modeled the energy system of each one of the thirty countries (EU-27, Iceland, Norway and Switzerland) separately in detail.

[3] More information and an analytical description of the PET model can be found in the RES2020 project webpage (http://www.res2020.eu).