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ANALYSIS

The impact of hydrocarbon resources and GDP growth assumptions for the evolution of the EU energy system for the medium and long term

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ABSTRACT

Economic development and the evolution of fossil fuel import prices constitute important drivers for the future development of the EU energy system and for the successful implementation of climate policies and GHG emission reduction targets. In this paper we evaluate the effects of alternative growth and fuel price developments on the achievement of the 2020 targets and analyse the time frame up until 2050.

Economic growth -in a globalised economy- and fossil fuel prices even more so are often out of the control of direct policy initiatives of the EU, but affect the achievement of the internal EU energy and climate policies; in this paper we present scenarios which assume higher and lower economic growth and higher and lower fossil fuel prices than the Reference scenario 2013 as well as the most likely combinations of the two and we explore their implications for: the intensity of climate policies required to achieve the 2020 binding climate targets, the evolution of EU energy demand and power generation in the medium and long term and the fossil fuel import bill as well as total energy system costs.

1. Introduction

In the past two decades, the European Union (EU) has played a particularly important role in international climate policy negotiations and in 2011 the European Commission (EC) confirmed its long-term objective to reduce GHG emissions by 80–95% [5] compared to 1990 levels in 2050.[1] The interim target of 40% GHG reduction by 2030 has recently been confirmed as a cost-effective milestone for the long-term decarbonisation objective in the "2030 energy and climate policy framework [12]" adopted by the EC. The EU has established the largest emissions trading system in the world (EU-ETS), has adopted a 20% emission reduction target for 2020 relative to 1990 as part of its climate and energy package [10] and has already implemented a number of additional emissions reduction policies (most important of which are the RES directive [14], the GHG[2] Effort Sharing Decision [2] and CO_2 standards for vehicles).

Apart from climate change mitigation policies, another important issue for European policymakers is security of energy supply [9], as the European Union imported 53% of the energy it consumed during the period 2010–2013. The rate of energy import dependence is higher for crude oil and oil products (about 90%) and natural gas (almost 65%) relative to solid fuels (41%). In 2013, the EU-28 energy import bill represented about €400 billion (which translates into more than €1 billion per day) and accounted for more than 20% of total European imports [9].

The dependence on imported natural gas increases geopolitical energy risks, as events of political nature (like the recent crisis in Ukraine or the Arab Spring) can impact European objectives on security of energy supply and lead to an increase in expenditures for energy imports [9]. Despite the implementation of energy efficiency and

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[1] This emissions trajectory should allow keeping global average temperatures below 2 °C provided that strong emission reducing actions are also adopted worldwide.

[2] Greenhouse gas.

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emissions reduction policies, the EC Reference scenario [4] projects that the EU-28 import dependence will steadily increase from the current 53%–58% by 2050. The Reference scenario also projects constantly increasing EU fossil fuel import prices, as a result of increased global energy demand, lack of ambitious climate policies in most world regions and fossil resource scarcity. Hence, the exposure of the European economy to hydrocarbon import prices combined with the high volatility of these prices constitutes a source for concern throughout the period 2010–2050. Relative fuel prices can affect the degree of achievement of the emission reduction and RES targets, as well as the more general development of the energy system, e.g. the ratio of gas to coal prices can to a great extent influence investment choices in the power sector. A relatively low gas to coal price ratio in the decade 1990–2000, together with the emergence of the gas turbine combined cycle technology, led to increased investments in gas fired power plants, which decreased afterwards due to significant increases in import prices of natural gas.

Another fundamental driver for the evolution of the European energy system is the future activity growth, which is characterized by strong uncertainty in the aftermath of the persisting slowdown of GDP growth in the EU due to the recent economic and debt crisis. Alternative growth projections would have significant implications on the projected EU energy demand and supply and the associated GHG emissions, as higher GDP would directly lead to higher energy demand and thus to increased emissions. This increase can be moderated, as higher economic growth allows for faster capital turnover so that higher amounts of energy efficient equipment enter the capital stock sooner and thus the overall energy intensity of GDP would decline [3,16]. Furthermore [21], showed that high economic growth can stimulate investments in low and zero carbon technologies and in energy efficiency leading to reduction in energy intensity per unit of economic activity.

Despite the high importance of macro-economic and hydrocarbon resource assumptions for the cost-effective design of energy and climate policies, limited research has been devoted to analyse in quantitative terms these aspects of the energy system and their effect on achieving the 2020 targets, while most studies (which usually use energy-economy models) have focused on the model-based analysis of the binding EU climate targets [4], the required energy system transformation towards decarbonisation and the associated costs [3,5], the implications of unilateral EU climate action resulting in carbon leakage [19] and the role of specific energy technologies and policies (such as the viability of CCS technologies or nuclear policies) [15].

The current analysis explicitly explores the role of alternative assumptions with regard to hydrocarbon resources and economic activity growth, which have only seldom been analysed. International fuel prices as well as macro-economic developments are strongly influenced by events/developments outside the EU: fossil fuel resources and extraction prospects in Europe are very low (as the EU currently owns only a mere 3.3% of global fossil fuel resources [20]), and its impact on the evolution of global economic activity is rather limited and is projected to decline further by 2050, due to the increasing contribution of rapidly developing emerging economies (China, India and Brazil). Furthermore, shale gas has a limited potential to drastically reshape the European energy supply (as occurred in the US) due to the relatively low resources and the limited prospects for large-scale extraction, with the exception of Poland, the United Kingdom and the Netherlands.

Mantzos and Capros [18] have analysed the implications of three alternative oil and gas prices scenarios on the global and European energy system using the POLES and PRIMES models. The EU Energy Roadmap 2050 [3] provided an in-depth model-based assessment of the alternative activity growth and hydrocarbon resource assumptions and how they influence the development of the European energy system and the achievement of climate targets. The POLES energy model quantified the implications of stringent climate policies on the evolution of global energy system and fossil fuel prices [28]. The ROSE project systematically explored the impact of economic growth and fossil resource scarcity on baseline and climate change mitigation scenarios using multiple Integrated Assessment models. The main conclusion of the analysis was that the uncertainty regarding future economic development and fossil fuel availability are crucial for the effectiveness of climate policies and associated mitigation costs [16,21]. However, the emphasis was placed on long-term implications for the global energy system and the implications for hydrocarbon importing regions (as the EU) were not explicitly analysed [17]. The energy system and macro-economic implications for the EU of differentiated oil resource assumptions have also been investigated in Ref. [29], while IEA assessed quantitatively the vulnerability of OECD and developing economies to a sustained period of high oil prices [30].

The current study constitutes the first comprehensive model-based assessment of the impacts of alternative hydrocarbon resource assumptions and GDP growth for the European energy system. The purpose of the analysis is both to assess the intensity of policies required to achieve the 2020 binding climate targets (ETS prices, RES policies) under alternative resource and GDP growth assumptions and to quantify their long term implications by 2050 for the EU energy system, GHG emissions and costs. The alternative scenarios are undertaken with the same modeling tools as the EC Trends scenario 2013 [4] and other EC benchmark energy-climate studies [3,5]. The Reference scenario 2013 [4] is used as a basis scenario for this study and provides a robust benchmark to compare the alternative scenarios examined.

We use a comprehensive modeling suite consisting of three well-established and extensively used energy-economy models: PRIMES (partial equilibrium energy system model for the EU-28 MS), PROMETHEUS (global energy model with focus on international price formation) and GEM-E3 (global CGE[3] model.) The three modeling frameworks can be used in a complementary manner in order to provide a comprehensive assessment of alternative developments of the EU energy and economic system; the PRIMES model takes as an exogenous input the EU fossil fuel import price trajectories (projected with PROMETHEUS) and macro-economic projections (derived from GEM-E3) and can consistently quantify their impacts on the development of the EU energy system and especially on policy relevant topics, such as the accomplishment of targets for emissions reduction, energy efficiency, security of energy supply and deployment of RES by 2020 and 2030.

The paper is structured in seven sections. The following section includes a description of the energy-economy models used in the analysis. Section 3 introduces the Reference projection and the alternative fossil fuel import price and activity growth scenarios examined. The study explores the impacts of alternative EU fuel import prices (section 4) and economic growth assumptions (section 5) for the evolution of the European energy system, GHG emissions and climate targets. Section 6 investigates the implications of the most policy relevant combinations of the above assumptions, while section 7 concludes.

2. Modeling methodology

The quantification of the scenarios was undertaken with the PROMETHEUS world energy model for international fuel price trajectories, GEM-E3 for macro-economic projections and PRIMES for the EU energy system projections.[4] These energy-economy models have been used to quantify the EC Reference scenario 2013 [4] and to provide model based assessment for the "Roadmap for moving to a low carbon economy in 2050" [3,5].

[3] Computable general equilibrium.

[4] All models are developed and maintained at E3Mlab of the National Technical University of Athens.