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Energy system impacts and policy implications of the European Intended Nationally Determined Contribution and low-carbon pathway to 2050

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ABSTRACT

In March 2015 the European Union (EU) submitted to the United Nations Framework Convention on Climate Change (UNFCCC) the Intended Nationally Determined Contribution (INDC) in view of the Paris Conference of Parties (COP21). The binding target of lowering domestic greenhouse gases emissions by at least 40% by 2030 compared to 1990 levels, coupled with long-term decarbonisation goals, will have profound energy system, macroeconomic and policy implications. EU targets are qualitatively discussed and quantitatively assessed with the simulation of a Reference and an alternative decarbonisation scenario to 2050. Simulations are carried out with the technology-rich PRIMES energy-system model and the GEM-E3 Computable General Equilibrium model. Restructuring of the EU energy system induces changes in the energy mix and production with small effects on the EU GDP, 0.4% in 2030 and 1% in 2050 compared to the Reference scenario. Energy efficiency improvements, increasing penetration of renewables, fuel switching towards natural gas, and technical progress in process related to emissions abatement are identified as essential options to the EU INDC implementation. The electrification of final energy demand, particularly transport electrification, complemented with decarbonised power supply is found to play a critical role in the successful transition towards a low-carbon economy by 2050.

1. Introduction

Mitigation of climate change has been identified as one of the greatest challenges of global policy as it requires international, ambitious and cooperative initiatives. Additional challenges are related to the complexity resulting from the interaction of climate with economic development, energy system evolution, and effective resource management among others. Thus assessment of the mitigation policies necessitate cross-disciplinary knowledge and integrated approaches combining energy, environmental and economy aspects. Global actions have focused on stabilising atmospheric Greenhouse Gases (GHGs) as a way of mitigating climate change.[1] Indicative actions are the adoption of the Kyoto Protocol in 1997 and the climate pledges made by major carbon-emitting economies in Copenhagen and Cancun UNFCCC conferences.[2] At the UN Climate conference in Durban in 2011 all parties recognised the urgent need to act collectively with greater ambition by 2020 and beyond (see UNFCCC (2011a)). Governments also agreed that GHG emissions need to be reduced significantly so that global temperature increases are limited below 2 °C by the end of the century as compared to the pre-industrial levels.

In 2014 the Conference of Parties (COP) invited all members to initiate or intensify domestic preparations for their Intended Nationally Determined Contribution (INDC) with specific quantified climate targets for the period to 2030 in the context of adopting a protocol, a legal instrument or an agreed outcome with legal force under the UNFCCC negotiations. The Paris Agreement reached by 195 nations in December 2015 constitutes an historic accord to combat climate change and unleash actions and investments towards a low carbon and sustainable future. The Agreement and the outcomes of the Paris Conference of Parties (COP21) cover crucial areas such as fast reduction of emissions so as to achieve the temperature goal, a transparent and global accounting system for climate action, strengthening of countries' ability to deal with climate impacts and recover from them, and support that includes finance for the nations to build

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[1] A plethora of studies shows that increasing atmospheric concentrations of Greenhouse Gases (GHGs) emissions have severe implications for climate change with significant subsequent environmental and economic effects (see Arnell (2004), Tol (2009), Gouldson et al. (2015), Ochuodho et al. (2016) and Elshennawy et al. (2016) among others).

[2] For indicative assessment and applications see: Lixon et al. (2008), Reneses and Centeno (2008), Quirion (2010),, Peterson et al. (2011), den Elzen et al. (2011), Wada et al. (2012), Lucas et al. (2013), Dixon et al. (2013) and Riahi et al. (2015).

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clean, resilient futures.[3]

EU has been an international front runner in climate change mitigation efforts. In March 2015 the EU became one of the first members to submit INDC for 2030 to the UNFCCC. EU Member States have adopted national programs that include a series of measures like increased use of renewable energy sources (RES) and combined heat and power installations, improved energy efficiency in buildings, industry and household appliances, reduction of CO_2 in transport sector, abatement measures in industry, labelling directives driving accelerated energy efficiency improvements and measures to reduce emissions from landfills. Complementary legislation has also been put in place regarding aspects like binding national emission and renewable energy targets, a legal framework to promote the development and safe use of carbon capture and storage (CCS), improvements in energy efficiency, EU strategy towards enhancement of energy security, etc.

A growing volume of recent literature has shown that ambitious GHG emission reductions imply profound energy and economic effects with significant policy implications (see for instance Tol et al. (2009), Edenhofer et al. (2010), Knopf et al. (2013), Hubler et al. (2013), Capros et al. (2014) and Riahi et al. (2015)). This paper aims at complementing the understanding of the implications for the energy system and the macroeconomy as well as the policy ramifications of the EU INDC, as combined with the targets set out in the EU 2030 Package for Energy and Climate (European Commission, 2014a, 2014b) and the long-term decarbonisation goals of the EU that are in line with the 2 °C temperature stabilization objective. For this we undertake a qualitative review of the EU INDC and a quantitative assessment of the EU INDC and of the EU decarbonisation targets to 2050. A Reference and an alternative decarbonisation scenario that considers the EU INDC and the longer term decarbonisation ambitions of the EU are simulated. The Reference scenario assumes continuation of current policies and full implementation of energy and climate policies adopted by 2012. The decarbonisation scenario reflects the implementation of the EU INDC and the long-term EU climate policy goals. The quantitative assessment is based on a dual modelling framework that combines PRIMES and GEM-E3 models. Both models are well established and have been extensively used for climate-related and impact assessment studies by the European Commission and in numerous research projects.[4] PRIMES is an energy system model that provides projections on the evolution of energy demand and supply, associated CO_2 emissions, power generation mix and energy-related costs and prices. GEM-E3 is a Computable General Equilibrium model that closes the loop between energy-climate and the overall economy and it quantifies the macroeconomic, employment and trade implications of alternative decarbonisation policies. Scenario simulations make use of the advanced engineering information included in the energy modelling and the detailed macroeconomic representation of the EU economy in a long-term horizon.

The paper contributes in a useful manner to the understanding of the economic and energy implications of climate targets pursued in the EU and their policy ramifications. The analysis covers a global topic through a local EU perspective that is of wider policy significance and of current ongoing interest to international agencies, governments, public and private sector entities. The qualitative assessment of the EU INDC is an early reaction to its announcement indicating areas of consideration for policy making and design of future decisions regarding the EU INDC. The dual modelling employed provides a first-time quantitative assessment of the EU INDC and the long-term decarbonisation targets of the EU where detailed emissions, energy system and macroeconomic effects are simulated. The quantitative assessment extends to 2050, providing thus long-term insights and a reference point for the understanding of the long-term implications of the EU INDC and decarbonisation targets. The combination in the analysis of energy and macroeconomic models allows for a complete assessment of the climate targets set by the EU that will look beyond GHG emissions reduction as an indicator in order to discuss the implications of the policies followed. The results provide evidence on the changes in the energy system required so as to achieve the ambitious EU goals. They also support the understanding of the macroeconomic effects of the low-carbon goals and provide insights on the sectoral trajectories and benchmarks against which structural transformations in the EU economy can be assessed.

The rest of the paper is organised as follows: Section 2 summarizes and discusses the EU INDC and long-term climate policies. Section 3 presents the methods and the scenarios simulated. Section 4 discusses the simulation results. Last section concludes.

2. European INDC and long-term perspectives of the EU climate policies

The EU INDC submitted to the UNFCCC commits EU Member States to a binding target of at least 40% reduction from 1990 in GHGs emissions by 2030 to be fulfilled jointly from 2021 to 2030 as set out in the conclusions by the European Council of October 2014 (EU2015.LV, 2015). The INDC targets cover all sectors and all GHGs not controlled by the Montreal Protocol.[5] EU INDC builds upon the EU 2030 Climate and Energy Framework reached by the European Heads of State at the European Council in October 2014 (European Commission, 2014a, 2014b). The EU INDC envisages that the specified target for 2030 will be implemented domestically with no contribution from international credits and (non-EU) market based mechanisms, such as emissions trading with other regions, Clean Development Mechanism and Joint Implementation programs. The intended contribution is based on the existing EU climate policies that target a 20% emission reduction by 2020 compared to 1990 and a long-term objective of 80–95% domestic GHG reductions by 2050.[6] The EU mid-term target to 2030 is grounded in this longer-term target to 2050, which was developed and analysed in the Impact Assessment of the European Commission in the run up to political agreement on the EU 2030 Framework.[7]

The policies necessary to achieve the 40% reduction target laid out in the EU INDC are summarized in the 2030 Climate and Energy Policy

[3] See: http://newsroom.unfccc.int/unfccc-newsroom/finale-cop21/

[4] Indicative model applications include among others: European Commission (2010, 2014a, 2014b), Capros et al. (2012a, 2013a, 2014), Tsani et al. (2013), Paroussos et al. (2015) and Karkatsoulis et al. (2016).

[5] These include: Carbon Dioxide (CO_2), Methane (CH_4), Nitrous Oxide (N_2O), Hydrofluorocarbons (HFCs), Perfluorocarbons (PFCs), Sulphur hexafluoride (SF_6) and Nitrogen trifluoride (NF_3). GHG emissions in the EU Member States are calculated using the Global Warming Potential metrics on a 100 year timescale in accordance with the IPCC's 4th Assessment Report (IPCC, 2007), while the estimation of emissions is based on the IPCC Guidelines 2006 (IPCC, 2006) and IPCC 2013 KP Supplement (IPCC, 2014). The INDC specifies the main sectors and sources of GHG emissions that include: i) Fossil fuel combustion in the energy sector (Energy industries including power generation plants, manufacturing industries and construction, transport, households, agriculture, services, transport and storage of CO_2 and other sectors), ii) Fugitive emissions from the extraction of fossil fuels (coal, oil, natural gas and lignite) and other emissions from energy production, iii) Emissions from industrial processes and product uses (including mineral industries, chemical and metal industries, non-energy products from fuels and solvent use and other product manufacture and uses), iv) Agriculture, including enteric fermentation manure management, rice cultivation, agricultural soils, burning of savannahs, field burning of agricultural residues and other carbon-containing fertilizers, v) GHG emissions from waste, including solid waste disposal, biological treatment of solid waste, incineration, wastewater treatment and discharge and vi) Land Use, Land-Use Change and Forestry: afforestation, reforestation, deforestation, cropland, grazing land and forest management and other categories/activities elected by the EU and its Member States as Parties to the Kyoto Protocol and its Doha Amendment.

[6] In 2011 the European Union confirmed its long-term climate objective to transit to a low-carbon economy and reduce domestic GHG emissions by 80–95% compared to 1990 levels in 2050. The trajectory of such emissions is consistent with keeping the increase of global average temperatures below 2°C, provided that strong climate change mitigation policies are also adopted worldwide and especially in major carbon-emitting economies (see European Council (2011), European Commission (2011)).

[7] See: http://eurlex.europa.eu/legalcontent/EN/TXT/PDF/?uri=CELEX:52014SC0015 & from=EN