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Renewable energy deployment in Europe up to 2030 and the aim of a triple dividend

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HIGHLIGHTS

- Our modelling of a dedicated 2030 RES policy provides evidence on the triple dividend hypothesis.
- EU imports of fossil fuels can be reduced by €154/180 bn, related CO_2 emissions by 930/1195 Mt.
- Net GDP changes amount to 0.1–0.8% of EU GDP, net employment effects amount to 90–1500 thousand jobs.
- Strengthened national policies show larger macroeconomic benefits in the medium term.

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ABSTRACT

Renewable energy sources (RES) play a key role in the European Commission's 2030 Climate and Energy Framework, which aims for a low-carbon economy that increases the security of the EU's energy supplies and creates new opportunities for growth and jobs, among other benefits. We assess whether renewable energy deployment in Europe can provide this "triple dividend", at which ambition levels of 2030 RES targets and what the role of the support policy scheme for electricity is. We apply two types of models: a detailed techno-economic sector model of the deployment of RES and two macroeconomic models. Our findings suggest that up to 2030 our triple-dividend hypothesis holds even under a declining role of Europe as technology provider for the rest of the world. Additional emission reductions of up to 1040 Mt CO_2, as compared to a baseline scenario in 2030, are possible. Demand for fossil fuels can likewise be reduced due to the deployment of renewable energy sources by up to 150 Mtoe. More ambiguous is the order of magnitude of the effects on GDP and employment, which differs noticeably depending on the economic theory applied in the different models. Nevertheless, both models predict slightly higher GDP and employment in 2030 when implementing ambitious RES targets.

1. Introduction

Renewable energy sources (RES) play a key role in the European energy and climate strategy. In the EU's 2020 and 2030 climate and energy framework, the definition of a RES target in addition to a greenhouse gas reduction target and an energy efficiency target highlights this prominent role. The EU Energy Roadmap (EC, 2011) emphasises renewables' contribution to several of the EU's goals: they help to reduce the amount of greenhouse gas emissions from the energy sector and thus to combat climate change. At the same time, they allow for a reduction of Europe's dependence on imported fossil fuels, thereby increasing energy security in Europe. A further hope is that the promotion of renewable energy technologies (RET) results in the creation of new industries and jobs in the EU for technology providers as well as the service sector. The development of lead markets can increase export opportunities to other parts of the world and contribute further to employment and economic growth in the EU.

In contrast to these positive expectations, warnings are coming from energy-intensive industries and civil society. Higher costs for RET compared to conventional energy technologies (CET) result in higher energy prices in those countries particularly supporting the

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deployment of RET. There are fears that this hampers competitiveness of energy-intensive industries and increases energy poverty as particularly low-income households suffer from energy price increases.

While there is hardly any doubt that renewables contribute to European energy security, contributions to the other two objectives are more controversial. Critics object that as European CO_2 emissions are capped by the EU Emissions Trading System, additional support policies for renewable electricity result in shifts between emitting sectors rather than additional emission reductions. At the same time, more cost-effective emission reduction options are not being realised, thus contradicting the main objective of an emissions trading system which is to reduce emissions at lowest costs (Frondel et al., 2010). Further, price decreases for energy carriers such as coal or natural gas due to demand reductions increase the use of fossil fuels and hence greenhouse gas emissions in other parts of the world.

Effects on employment and economic growth are ambiguous: demand from increased renewable deployment on the one hand is counteracted by demand reductions from conventional deployment and higher energy prices on the other hand, making it difficult to predict which of the effects will dominate.

In this paper, we assess if RES are able to positively contribute to the three objectives of European energy policy: combating climate change, improving security of supply and resulting in economic benefits such as job creation and economic growth (cf. Duscha et al., 2014). We call this a triple dividend hypothesis for RES. Furthermore, our analysis examines different policy options with regards to ambition of the RES deployment target and the chosen support policy system for electricity. While the overall assessment is conducted in the timeframe up to 2050, in accordance with the ongoing debate on a European energy and climate policy framework for 2030, we focus on the 2030 timeframe. For the analysis we use two types of models: a techno-economic sector model (Green-X) is used to provide detailed scenarios of increased renewable energy technologies deployment including the estimation of renewable energy sources deployment by technology, expenditures for capital, fuel and operation & maintenance as well as a technology-specific calculation of additional costs. The detailed RES scenarios provide the basis for a modelling of the macroeconomic impacts such as GDP and job development with two macroeconomic models (NEMESIS, ASTRA). The two models focus on different aspects of macroeconomic mechanisms: NEMESIS is an econometric model with a demand-driven, neo-Keynesian core including a detailed consumption module which allows for highly adaptive consumption behaviour to income and price impulses. ASTRA is based on a System Dynamics methodology and portrays the economy as consisting of multiple interacting feedback loops, which makes the model sensitive to changes in final demand but also in input and product prices.

Five different scenarios are being implemented regarding the ambition of the RES target as well as the chosen support policy framework for electricity. In particular, a continuation of the current national support policies is compared to an EU-wide harmonised, technologically neutral support scheme. This reflects the discussion on the ambition of the RES targets on the one hand and a harmonisation of the support schemes on the other hand.

This paper fits into the extensive amount of impact assessments (see Wei et al. (2010) and Cameron and van der Zwaan (2015) for meta-studies) which are commonly used to analyse the impacts of policies and measures on political targets as well as on other key political issues such as economic growth and employment. However, two characteristics distinguish our analysis from others. In contrast to many existing studies, it combines detailed technological depiction of RES scenarios with dynamic macroeconomic modelling of the policies' net effects, i.e. changes in employment or growth including all positive as well as negative effects in the directly and indirectly (intermediate industry) affected industries or sectors (e. g. households) are taken into account. This combination allows for a detailed analysis of energy system and climate effects and a more realistic portrayal of macroeconomic effects (Fankhauser et al., 2008; Frondel et al., 2010; Lehr et al., 2012). Similar attempts of capturing macroeconomic net effects of renewable energy deployment can be found in Blazejczak et al. (2014), Böhringer et al. (2013), EPIA (2009), Kemfert et al. (2010), Knopf et al. (2015), Lehr et al. (2008, 2012), Ragwitz et al. (2009), Staiß et al. (2006) and Hillebrand et al. (2006). A comparison shows that the macroeconomic model applied affects the results. Recent studies using general equilibrium approaches found ambiguous effects of renewable deployment on employment and growth, e. g. Böhringer et al. (2013) found minor benefits for small subsidy rates if an electricity tax is used to fund RES-E, and negative effects otherwise. In contrast, Blazejczak et al. (2014) use an econometric model to assess the employment impacts of renewable energy support in Germany and find positive net effects on both economic growth and employment. Also the impact assessment of the EU energy and climate targets for 2030 EU, 2014b) and a recent assessment on a global level (IRENA, 2016) both using the econometric model E3ME, find positive employment impacts of increased renewable energy shares. All those modelling attempts, however, are based on a rather aggregated modelling of the energy system and policy support schemes. Studies that focus on the energy system and policy instruments (e.g. Pfluger, 2013; IEA, 2015 or McKinsey, 2010) do not look at macroeconomic effects. The paper is organised as follows: In Section 2, the modelling framework is presented and the different models are introduced. Section 3 provides an overview on the scenarios analysed. Model results are presented in Section 4, Section 5 concludes.

2. Methodology

The analysis applies two different types of models: an energy impact model and two macroeconomic models. These models are combined in a three-stage approach.

At the first stage, EU climate targets are translated into renewable energy technology deployment scenarios using the energy economic model Green-X. These RES deployment scenarios are then broken down into economic impulses for the macroeconomic modelling using techno-economic data on renewable technologies (stage two). These bottom-up impulses serve as the inputs for the top-down macroeconomic modelling at the third stage (see Figure 1). Two models, NEMESIS and ASTRA, with different model dynamics and corresponding reaction to bottom-up impulses are applied at this stage to highlight different macroeconomic aspects of an increased RES deployment within the EU. The following subsections give a brief introduction to the models and methodologies applied at each of the three stages.

2.1. Stage 1: Modelling of RES deployment with the Green-X model

Detailed scenarios of future RES deployment are derived using the Green-X model, a simulation model for energy policy instruments for all 28 countries of the European Union. The Green-X model provides a great level of detail on renewable energy supply-side generation technologies. Deployment pathways are derived from dynamic cost-resource curves for every renewable energy option. Next to the formal description of potentials and costs, this allows for a representation of dynamic aspects such as technological learning and technology diffusion. In addition, Green-X allows for the investigation of the impact of different energy policy instruments such as quota systems based on tradable green