CAN GREEN POWER LEAD TO GREEN GROWTH? A STUDY FOR PORTUGAL

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Overview

It is well recognized that the decarbonization of power sector, namely trough renewables deployment, may represent a pivotal strategy to reduce greenhouse gas (GHG) emissions and mitigate climate change. Renewable energy sources (RES) may also have other benefits as promoting energy security, improving air quality, as well as creating new jobs and fostering economic growth [1], [2]. However, RES technologies require substantial upfront investments and will substitute conventional energy industry employment, which may be counterproductive [3]. The magnitude of the impact of RES on the economy will depend on each country's economic structure, the prices and availability of fossil fuels, and on whether the new renewable power technologies and the required services are imported or produced domestically. It is known that national production leads to more positive effects [5].

In the last decades, renewable power generation (RES-E) has undergone a great expansion and is gaining relevant market shares due to enabling policies, as well as technology cost reductions. In Europe, RES-E represents 28% of power generation and the projections show a continued growth up to 55% by 2050 [6]. Countries like Portugal, with high natural resources potential, are expected to increase its RES-E share to around 90% by 2050. This raises the very relevant question on how the deployment of RES-E will drive the country’s economy? Due to its high capital-intensive nature, renewable technologies may bring benefits in sectors that produce investment goods and services associated with equipment manufacturing and installation (e.g., basic metals, non-metallic minerals, construction and engineering services). However, if these goods are imported, will RES-E bring positive economic impacts? How feasible is to meet the demand for renewable equipment locally? Although there is extensive literature analysing the economic impacts of GHG mitigation and RES-E promotion (see [7] for a review), the majority of these studies do not assess the role of national renewables manufacturing clusters and tend to treat RES technologies as one group not differentiating the effects of the deployment of different RES technology types (hydro, onshore wind, solar PV, etc).

In this paper, we pursue a twofold objective: i) evaluate the net economic effects of RES-E expansion in Portugal up to 2050, considering different RES-E technology portfolios; ii) analyse how different visions for renewables equipment manufacturing, i.e., imports versus domestic production, would affect the Portuguese economy.

Methods

In this analysis, the HYBTEP modelling platform is used to generate a set of scenarios combining different power generation structures (Table 1), and distinct degrees of substitution between domestic and imported goods linked to renewables equipment, which roughly represent different levels of national manufacturing. By assuming historic and energy models outcomes for power sector, we guarantee that the electricity generation profile considers peak and base loads and is consistent with renewables’ seasonal and daily variability, both usually neglect by CGE models.

Table 1 – Power generation profile scenarios

Scenario	Power sector profile	*RES-E in 2015/50*	*Share of the main technologies in 2050*
BAU	Equal to 2015 considering the normalization of hydro to average hydrologic conditions	*52% / 52%*	*Coal:27%, Natural Gas 19%; Hydro:22%; Onshore Wind:22%, PV:2%*
REF	Estimated by the TIMES_PT cost-effective results	*52% / 95%*	*Coal:0%, Natural Gas 4%; Hydro:37%; Onshore Wind:37%, PV:28%*
EU-PT	*Estimated by TIMES_PT with higher share of RES and emergent technologies*	*52% / 97%*	*Coal:0%, Natural Gas 3%; Hydro:37%; Onshore Wind:37%, PV:15%*
RES+	Estimated by PRIMES for Portugal under the *EU Reference Scenario 2016* [5]	*52% / 97%*	*Coal:0%, Gas 1%; Hydro:19%; Onshore Wind:29%, PV:23%;Offshore Wind:20%*

HYBTEP is defined by the soft-link between the energy system model TIMES-PT and the computable general equilibrium (CGE) model GEM-E3-PT. In this paper, GEM-E3-PT incorporates a bottom-up representation of the power sector set by thirteen discrete technologies, including eight renewable power plants. Each technology combines different input shares of labour, capital, materials/services and primary energy resource, sustained by the TIMES_PT database, which considers technology improvements and reduced costs over time. The investment in each technology is allocated between distinct sectors (e.g., the investment of hydropower is mainly associated with the construction sector, while for wind is composed by a relevant share of electric equipment). This enables us to assess in a more comprehensive manner the economic impacts of different RES-E technology portfolios.

Results

Our computable general equilibrium analysis of electricity generation in Portugal suggest that the prospects of economic growth and global employment gains associated with the increase of renewable electricity may be limited. Compared with a BAU scenario (RES-E share of 52%) the REF scenario (RES-E of 95% in 2050) has a slight increase of GDP of around 0.4% per year during the 2020-2050 period. This increase is due to the growth of private consumption (up to 0.4% in average) as a result of the reduction of 4.8% of the electricity price. The EU-PT scenario does not lead to any relevant impact on GDP during the period, showing in some years a maximum GDP growth of 0.1%. With the deployment of high shares of RES-E (97%) combined with emergent technologies in the RES+ scenario, the electricity price increases 2.7% in 2050 with consequent contraction of private consumption in around 0.5%, and GDP losses of 0.2% for that year.

Despite the significant increase of employment in power generation in REF and EU-PT scenarios (32%/36% higher than BAU on average), on overall terms this macroeconomic indicator is not affected by the increase of RES-E because: i) in the Portuguese economy power technologies' employment represents a small fraction of the employment; ii) other economic sectors reduce their associated employment, namely gas distribution, counteracting the gains. Moreover, the gains in the trade balance due to the reduction of fossil fuels imports are offset by the increase of imports in other sectors, particularly in electric and other equipment goods. This is one of the most relevant sectors in terms of the renewable technologies investment matrix.

To test the relevance of manufacturing RES technologies domestically we carry out a sensitivity analysis for all scenarios varying the substitution elasticities between domestic and imported "electric and other equipment goods" from near zero to double the base value. Results show that although the domestic demand for such goods supplied with internal production vary 37% to 63% during the 2020-2050 period, this range does not affect significantly the previous GDP and employment outcomes.

Conclusions

This paper identifies the role of RES-E expansion in economic development by considering different power generation profiles and analysing the relevance of imported versus domestic manufacturing renewables equipment. Results show that increasing RES-E from 52% to a cost-effective share of 95% by 2050 have limited positive impacts on the Portuguese economy, even when assuming that the domestic demand for "electric and other equipment goods", necessary for RES-E investment, is mainly satisfied by national production. However, our analysis is limited since we do not consider in our scenarios: i) explicit CO2 prices; ii) a significant increase in RES-E generation, namely for exports of both power and of RES-E technologies, and iii) we have only varied the domestic/imports elasticities for "electric and other goods", when in fact other sectors will also be affected, namely construction, other market services, iron & steel, etc. These will be addressed in our further work.

References

[1] O. Edenhofer, L. Hirth, B. Knopf, M. Pahle, S. Schlömer, E. Schmid, et al. *On the economics of renewable energy sources*. Energy Econ, 40 (2013), pp. S12–S23.

[2] M.K. Farooq, S. Kumar, R.M. Shrestha. *Energy, environmental and economic effects of renewable portfolio standards (RPS) in a developing country*. Energy Policy, 62 (2013), pp. 989–1001.

[3] C Böhringer, A Keller, E. van der Werf. *Are green hopes too rosy? Employment and welfare impacts of renewable energy promotion*. Energy Economics, 36 (2013), pp. 277–285.

[4] International Renewable Energy Agency and Clean Energy Ministerial. *The Socioeconomic Benefits of Solar and Wind Energy*. Abu Dhabi, UAE (2014).

[5] European Commission. *EU Reference Scenario 2016 - Energy, transport and GHG emissions, Trends to 2050*. Luxembourg (2016).

[6] Dai H, Xie X, Xie Y, Liu J, Masui T. *Green growth: the economic impacts of large-scale renewable energy development in China*. Applied Energy, 162 (2016), pp. 435–449.