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Distributional costs of wind energy production in Portugal under the liberalized Iberian market regime

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ABSTRACT

Wind generation in Portugal and Spain has grown due to a decrease in technology cost and the availability of renewables electricity generation incentives. There is a strong interconnection between Spain's and Portugal's transmission systems, resulting in common prices in both countries. However, Portuguese and Spanish producers receive the incentives for producing wind-based electricity that are specified in their own national policies, resulting in different costs to rate-payers. In this paper, we estimate the costs to Portuguese rate-payers associated with the current market design and policy incentives. To do so, we regress hourly spot electricity market prices as a function of hourly wind generation, and estimate the resulting feed-in-tariff costs distributional effects over the various rate-payer categories. Total costs for rate payer are at the minimum level if joint wind generation in Portugal and Spain increases by 5.5% from what it is today. If wind generation increases much further, then the costs increase due to the FiT overcost increase. If wind generation decreases from current levels, then costs also increase due to the merit-order effect. Furthermore, we find that rate-payer categories will endure different portions of the costs, with an increase in wind generation penalizing predominantly $\leq$ 20.7 kVA rate-payers.

1. Introduction

Concerns over climate change, sustainability, and affordability of energy services have led to the implementation of policy mechanisms in several European countries to increase the share of renewable electricity generation (European Parliament and Council, 2009; Kalkuhl et al., 2013). The European Union (EU) aims to reduce its greenhouse gas (GHG) emissions to 80% by 2050 below 1990's levels (European Commission, 2011). Furthermore, European leaders adopted a set of interim climate change and energy targets that include: (1) a legally binding target for a reduction in EU GHG emissions of 40% by 2030 compared to 1990; (2) a legally binding target of at least a 27% share of renewable energy consumed in the EU in 2030; (3) an indicative (nonbinding) target of an improvement of at least 27% on EU's energy efficiency by 2030 compared to projections of future energy consumption (Ackermann et al., 2015).

Under this framework, member-states developed and implemented national policies to encourage renewable energy integration using several policy mechanisms. One of such widely used policy mechanisms are the Feed-in Tariffs (FiT) (Groba et al., 2011; Jenner et al., 2013). A FiT provides a special regime to renewable electricity producers, with a specific guaranteed price for the electricity generated. This guaranteed price is generally higher than the average electricity market price. Portugal and Spain (i.e., the countries sharing the Iberian Peninsula) have both implemented a FiT for wind power, although later Spain substituted that regime with a premium monetary incentive over the market price at which wind electricity generation is sold.

In Portugal, the so called "Special Regime Producer"[2] (SRP) mechanism was created in 1988, through the Decree-Law 189/88. This decree has suffered posterior modifications, as described in (Peña et al., 2017, 2014). Decree-Law 172/2006, as re-published through the Decree-Law 215-B/2012, regulates SRP, allowing the producers to choose selling the energy in ordinary regime (in the Iberian open market or through bilateral contracts) or through a FiT, whose conditions and

Abbreviations: EU, European Union; TSO, Transmission System Operator; DSO, Distribution System Operator; VHV, Very High Voltage; MV, Medium Voltage; HV, High Voltage; LV, Low Voltage; FiT, Feed-in Tariff; GSU, Global System Use tariff; GHG, Greenhouse gas; PV, Photovoltaic; SRP, Special Regime Producer

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[2] "Produtor em Regime Especial" (PRE), in Portuguese. It is referred to as "Producción de energia eléctrica en regimen especial" in Royal Decree 413/2014.

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Nomenclature

α	Fixed term of the linear regression relating wind energy production and spot market price (€/MW h)
α'	Fixed term of the linear regression relating wind energy share of production and spot market price (€/MW h)
β	Variable term of the linear regression relating wind energy production and spot market price (€/MW h^{-2})
β'	Variable term of the linear regression relating wind energy share of production and spot market price (€/MW h)
ε_i	Error term
ε_i'	Error term
$E_{M,FiT}$	Sum of energy cost for total energy produced in Portugal added with Portuguese wind energy production overcost (€)
FiT	FiT cost associated with wind energy production in Portugal (€/MW h)
FiT_Y	Total FiT overcost associated with wind energy production in Portugal during the year y (€)
TEP_i	Total energy produced in the Iberian Peninsula during hour i (MW h)
TEP_i^{PT}	Total energy produced in Portugal during hour i (MW h)
WEP_i	Wind energy produced in the Iberian Peninsula during hour i (MW h)
WEP_i^{PT}	Wind energy produced in Portugal during hour i (MW h)

value are to be set by the Government. The established rules concerning the value of the FiT were defined through Decree-Law 33-A/2005, defining the parameters considered in the FiT determination.[3]

In Spain, the FiT framework was initially regulated through the Royal Decree 661/2007, which allowed SRP to opt between a fixed FiT or to participate in the market. Should they choose the latter option, the producer would receive the energy price determined by the market plus a premium, subject to a cap and a floor to the total price received, associated with the production technology used.

The Spanish remuneration framework of SRP was changed through the Royal Decree 413/2014. This decree describes the profitability expected of well-managed renewable generators (based in the assessment of standard plants as defined in the decree), permanently substituting the FiT by the market plus premium principle. The total price received by the power plant is thus calculated in order to guarantee it an allowed profitability, which is determined by the Government. At the European level, a similar transition to the one that occurred in Spain is expected, which would lead to a competitive procedure for setting renewable energy support (CEER, 2016).

According to ERSE (the Portuguese electricity regulator) (ERSE, 2014a), energy policy costs associated with the Portuguese electrical energy tariffs amounted to 2250 M€ in 2015. These costs include 1600 M€ associated with the overcost of sustaining the special regime energy production (difference between the FiT and the energy market price). Other energy policy costs are associated with issues such as compensations to municipalities that operate low voltage networks through concessions, or the overcost associated with power purchase agreements and other energy policy costs including in the tariffs.

For 2015, the overcost associated with wind electricity production is estimated to be about 47.56 €/MWh and wind electricity production was forecasted to be 10.8 TWh, when defining the tariff system parameters (ERSE, 2014a), resulting in an overcost from wind's FiT of 514 M €.[4] The remaining FiT overcost is due to other type of generation besides wind that also receives FiT, such as cogeneration units (417 M€), and solar PV (125 M€). Special regime production accounted for 37% of total electrical energy production in Portugal, in 2015 (and 38% of electrical energy produced in Spain in that year was also associated with the special production regime as defined for that country).

In 2015, the total energy value from meeting overall electrical energy demand in continental Portugal was 2800 M€ (ERSE, 2014a) (this includes the commercialization revenue, and excludes the overcost associated with energy policy decisions, such as the FiT overcost). The revenue associated with the electrical energy sector in continental Portugal, in 2015, had the breakdown shown in Fig. 1.

While some authors argue that the increase in renewable energy use

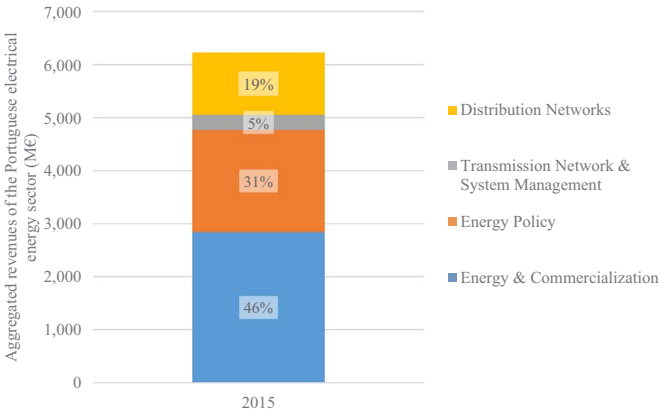

Fig. 1. Aggregated revenues of the Portuguese electrical energy sector (2015), based in (ERSE, 2014a).

in the EU has not increased consumer prices (Krozer, 2013), the overall economic consequences and, more importantly, the distributional effects of different policy mechanisms to promote renewables have been largely understudied, even though these policy mechanisms play a central role in policy debates. One contribution to this analysis of the redistribution effects of energy and climate policies is provided by Hirth and Ueckerdt (2013), who argue that energy and climate policies redistribute wealth between consumers and producers. Cludius et al. (2014) described the merit-order effect of renewables in Germany and the redistributive effects of the incentives associated with renewable energy sources, concluding that policy makers need to integrate distributional assessments into policy design and implementation.

One particular emerging concern is that whereas liberalized energy markets have been consolidated – as is the case with the MIBEL (Iberian Electricity Market), the Iberian liberalized market – such transitions did not extend to the national energy policies and respective electricity generation sources' incentives (such as the Fit or market premium mechanisms) in Portugal and in Spain.

Most of the large generation units in Portugal trade in the liberalized market.[5] Overall, 75% of total electricity produced in the Iberian Peninsula to be traded in the daily market, including the participation from some wind generators. The remaining electricity generating units operate under bilateral contracts. Units that do not operate under bilateral contracts are mandated to submit bids in the daily market (OMIE, 2016).

However, the liberalized energy production market consolidation was not followed by an energy policy consolidation. Indeed, wind power producers sited in Portugal that bid in the market still receive the

[3] Since some of the equations presented in Decree-Law 33-A/2005 were inaccurate, the Statement of Rectification ("Declaração de Retificação) 29/2005 was enacted, in April the 15th, rectifying those equations.

[4] Actual wind energy production in Portugal, in 2015, was 11.3 TW h.

[5] Two power plants operate with Power Purchase Agreements. These are Tejo Energia, and Turbogas, with 600 MW and 990 MW of installed capacity, respectively.