

The merit-order effect in the Italian power market: The impact of solar and wind generation on national wholesale electricity prices[☆]



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HIGHLIGHTS

- We find empirical evidence of the merit-order effect in the Italian market.
- 1 GWh from solar and wind (hourly average) reduces prices by 2.3€/MW and 4.2€/MWh.
- The impact of RES on price has declined as RES production has increased.
- Monetary savings from solar production do not compensate the cost of the incentives.
- Monetary savings from wind production are higher than the cost of the incentives.

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ABSTRACT

Italy promoted one of the most generous renewable support schemes worldwide which resulted in a high increase of solar power generation. We analyze the Italian day-ahead wholesale electricity market, finding empirical evidence of the merit-order effect. Over the period 2005–2013 an increase of 1 GWh in the hourly average of daily production from solar and wind sources has, on average, reduced wholesale electricity prices by respectively 2.3€/MWh and 4.2€/MWh and has amplified their volatility. The impact on prices has decreased over time in correspondence with the increase in solar and wind electricity production. We estimate that, over the period 2009–2013, solar production has generated higher monetary savings than wind production, mainly because the former is more prominent than the latter. However, in the solar case, monetary savings are not sufficient to compensate the cost of the related supporting schemes which are entirely internalized within end-user tariffs, causing a reduction of the consumer surplus, while the opposite occurs in the case of wind.

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1. Introduction

The Italian power market has undergone significant changes in recent years. Among these changes, one of the most relevant is the growth in wind and photovoltaic (PV) power capacity promoted by national support schemes for renewable energy sources (RES). While wind power capacity has been mainly supported through a Green Certificates Scheme, solar power capacity has been directly subsidized through a Feed-in Premium, known as Conto Energia.

The Conto Energia represents one of the most impressive PV supporting schemes in the world (IEA, 2011). Thanks to massive investments in wind and solar installed capacity² (EPIA, 2012; IEA, 2013), wind and solar power generation substantially increased – by 23 TWh from 2008 to 2013 – constituting “an undisputed world record” according to the IEA (IEA, 2013). Over the same period, energy demand decreased by 43 TWh in conjunction with the financial crisis and the subsequent economic recession (Fig. 1).

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² In a first phase 2005–2007, RES support schemes promoted some initial investments in intermittent RES power capacity which, however, covered only a marginal position: 3 GW in 2007 or 1.6% of total installed power capacity according to data on power installed capacity provided by the Italian Transmission system operator (Terna s.p.a.). In the period 2008–2010, wind and solar power capacity grew from 4 GW to 9 GW (+49% annual average growth rate), while in the years 2011–2012, it surged from 9 GW to 25 GW, covering 12% of total national power capacity. At the time of writing this article, official data on installed capacity for 2013 were not yet available.

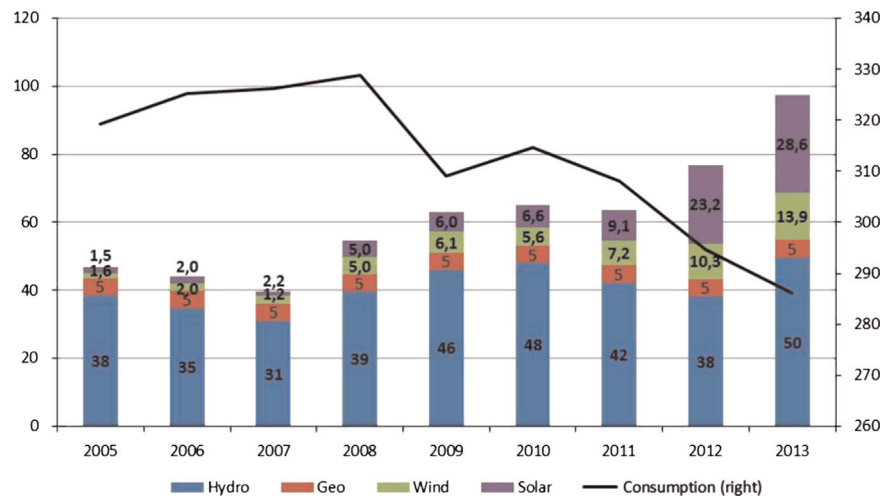


Fig. 1. RES power generation by source in the day-ahead Italian market (2013 data refer to the period January–October) (TWh). Source: own elaboration on GME.

The contraction in electricity consumption as well as the significant growth in solar and wind power generation have drastically changed the Italian electricity mix, with a sharp increase in the RES share. Indeed, in less than ten years, the share of RES in the day-ahead power market increased from 17% in 2005 to 40% in 2013.³ This growth comes almost entirely from non-programmable wind and solar RES.

These changes on both the demand and supply side of the day-ahead power market had a non-negligible impact on the Italian wholesale electricity price. Subsequently to the bullish trend over the period 2005–2008, the wholesale electricity price sharply collapsed during the financial crisis. Then, following a subsequent recovery, from the beginning of 2012 the price trended again downward, in conjunction with both the economic recession and RES penetration (Fig. 2).

The penetration of intermittent RES can explain part of this decline. Wind and solar energy sources have very low operational costs and they are dispatched on a legal priority basis with respect to electricity generated by non-renewable sources. In particular, the GSE (Gestore dei Servizi Energetici)⁴ works as a non-programmable RES collector as it bids in the day-ahead market at a zero price an amount of electricity equal to the forecasting of the intermittent RES power generation.⁵ Thus, wind and solar power generation effectively enters the day-ahead market at the base of the merit-order function and shifts it to the right (the same process is described by Ketterer, 2012; Nicolosi and Fürsch, 2009; Zachman, 2013). Most expensive marginal plants are driven out of the market, thus favoring a decline in the clearing wholesale electricity price (Fischer, 2006).⁶ Various papers find empirical

³ Details on the energy mix by source and its change over time are reported in the Appendix A.

⁴ The GSE (Gestore dei Servizi Energetici) is the public institution which directly pays the economic incentives to the producers of power generated by renewable sources.

⁵ When the day-ahead forecasting deviates from the day-of effective RES power generation, traditional sources are called to cover the gap in the day-of balancing market (mercato di aggiustamento), whose analysis goes beyond the scope of this paper.

⁶ This effect has been represented also in an alternative way: an increase in RES power generation shifts the residual demand function to the left along a given supply curve (Sensfuss et al., 2008; Hirth, 2013; O'Mahoney and Denny, 2011). At the same time, self-produced and consumed electricity reduces the net demand and shifts it to the left along a given supply curve. While these representations are equivalent in terms of market equilibrium, we opt to represent the merit-order effect in terms of supply curve shift (see Fig. 3–5), because RES generation effectively bids via the GSE in the day-ahead market and enters the market at the base

evidence of the merit-order effect in various countries: Germany (Ketterer, 2012; Würzburg et al., 2013), Spain (Gelabert et al., 2011), Israel (Milstein and Tishler, 2011), Denmark (Jonsson et al., 2010), Texas (Woo et al., 2011) and Ireland (O'Mahoney and Denny, 2011). These studies differ with respect to econometric approach, types of renewable sources and country analyzed, as well as frequency of the data used; but they all converge towards the conclusion that RES penetration has lowered wholesale electricity prices.⁷ For the purpose of this paper, we recall that Gelabert et al. (2011) and Würzburg et al. (2013) both find that the reduction in wholesale electricity prices induced by higher RES production offsets the increase in final electricity retail prices induced by RES support schemes (subsidies directly paid by consumers in the final energy bill). They respectively conclude that in Spain and Germany the increase in electricity production from RES has generated a net benefit to consumers.

Our paper aims to extend this empirical literature by assessing the merit-order effect in the Italian day-ahead wholesale power market over the period 2005–2013. Since Italian RES supporting policies have been subject to political debate due to the cost of the subsidies internalized within end-user tariffs, we are interested in assessing to what extent the penetration of solar and wind electricity sources has lowered day-ahead wholesale electricity prices and whether such a reduction has been sufficient to offset the cost of the RES support schemes borne by final consumers.

Based on a consolidated empirical approach (Woo et al., 2011), we develop a quantitative analysis to assess the extent to which variations in consumption patterns and in the energy mix have had an impact on the national wholesale electricity price (PUN).⁸ While existing literature has mainly focused on wind generation, or has treated wind and solar generation jointly (named intermittent RES), we disentangle the differential impact of solar and wind generation on Italian day-ahead wholesale electricity prices over the period 2005–2013. Moreover, as RES production has increased greatly from year to year during the considered period, we are interested in understanding whether the impact of

(footnote continued)

of the merit-order function.

⁷ Würzburg et al. (2013) develop an exhaustive review of this literature and a meta-analysis of various studies on the German market and conclude that 1 additional GWh produced by wind technology reduces the German wholesale electricity price between 0.5 and 2.0 €/MWh. A similar result is found by Gelabert et al. (2011) concerning the Spanish market.

⁸ Prezzo Unico Nazionale (Single National Price).

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