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IS THE ANSWER BLOWIN' IN THE WIND (AUCTIONS)? AN ASSESSMENT OF ITALIAN AUCTION PROCEDURES TO PROMOTE ONSHORE WIND ENERGY

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Is the answer blowin' in the wind (auctions)? An assessment of Italian auction procedures to promote onshore wind energy

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Abstract: This article provides a quantitative data-based assessment of the onshore wind auctions conducted in Italy from 2012 to 2016. More specifically, this paper investigates the policy effectiveness and cost efficiency of onshore wind auction schemes and explores the determinants of the incentives granted in accordance with current auction arrangements. Our objective is to provide new insights in the ongoing policy debate on policy measures for the promotion of renewable energy sources (RES). The extreme simplicity of the Italian auction design undoubtedly has promoted competition, encouraging many onshore wind project developers to bid. Our results show that localisation factors did not represent a competitive constraint for project developers. When many sites are available and auctioned capacity is not sufficiently high, the administratively setting of ceiling prices becomes a central issue. Doubts also exist on the policy effectiveness of the current support scheme which makes difficult to control the total amount of support provided thus justifying stop-and-go cycles of financing distorted bidding behaviour by project developers and potential favouring.

Keywords: support; auction design; on-shore wind; cost-efficiency; policy effectiveness.

Highlights:

- A quantitative data-based assessment of Italian on-shore wind auctions is provided.
- Our investigation outlines effectiveness and cost-efficiency of current auction design.
- Project-related, firm-specific and auction design determinants of awarded base tariffs are also explored.
- Results provide relevant findings for better understanding of auction potential outcomes in RES context.

1 Introduction

This article provides a quantitative data-based assessment of the onshore wind auctions conducted in Italy from 2012 to 2016. More specifically, this paper investigates the policy effectiveness and cost efficiency of onshore wind auction schemes and explores the determinants of the incentives granted in accordance with current auction arrangements. Our objective is to provide new insights in the ongoing policy debate on policy measures for the promotion of renewable energy sources (RES). A growing number of countries have held auctions to encourage the generation of electricity from onshore winds as well as from other renewable sources in the last few years (IRENA and CEM, 2015; Wigand et al., 2016; McCrone et al., 2017). The increasing popularity of this method can be explained: they provide the opportunity of ensuring the increasing penetration of RES in a transparent, economical and well-planned manner (Maurer and Barroso, 2011). The number of countries utilising tendering mechanisms increased to 64 in 2015 from just 9 in 2005 (REN21, 2016). Reliance on these competitive procurement methods is also growing more common in the European Union despite negative experiences, like the United Kingdom's Non-Fossil Fuel Obligation (NFFO), while many winning projects that have not been followed up or completed initially limited their implementation (Butler and Neuhoff, 2008; Mitchell and Connor, 2004). Auctions to purchase long-term contracts were recently held in France, Germany, Italy, and Spain. In its Guidelines on State Aid for Environmental Protection and Energy for 2014-2020 (European Commission, 2014), Member States were asked to introduce auctioning or competitive bidding processes for RES as a means of leading to cost-efficient support levels and the gradual phasing out of subsidies.

Much of the literature on RES support mechanisms to date has focused on feed-in-tariffs (FITs) and renewable portfolio standards (RPS) (Haas et al., 2011; IEA, 2011; Mahalingam, 2014; Sun and Nie, 2015). As a consequence of their growing popularity, studies of experiences with auction programmes for providing electricity from RES are rapidly increasing; they aim to assess their environmental effectiveness and cost efficiency, both in static and dynamic terms, as well as to provide guidance on how best to auction RES technologies (Ausubel and Cramton, 2011a; Mastropietro et al., 2014; Wigand et al., 2016). The main finding of the extant literature on RES auctions is that, while auctions can ensure comparatively lower and steadily falling over time, positive outcomes are highly dependent on context and technology: no one-size-fits-all solutions exist (del Río and Linares, 2014). Major drawbacks are still potential failure to start operating commercially and difficulties in attaining the initial capacity target (Azuela and Barroso, 2011; Butler and Neuhoff, 2008; Kreiss et al., 2016). As a result, there is still room for further in-depth analysis especially for finding out which factors make the success of RES auctions more likely and how and whether different design elements influence auction results in the light of overall RES policy objectives. Additionally, the lack of suitable data on RES auctions gives limited opportunities for comprehensive research and there are few empirical studies based on quantitative analysis (Shrimali et al., 2016).

In July 2012, a descending price auction scheme was introduced in the Italian electricity system as a part of a new incentive regime for supporting electricity generation by RES plants. The main driver of the reform was the opportunity to reduce the overall direct and indirect costs of RES support for electricity consumers by introducing more cost-reflective incentive schemes and by constraining RES deployment volumes (Cassetta and Monarca, 2013; Monarca et al., 2015). The rather generous incentive schemes previously adopted, together with the prolonged fall in final electricity demand caused by the economic crisis, have resulted in overcompensation and excessive demand for new installations, as well as in growing difficulties (and rising costs) in ensuring the operational security of the power generating system, which contains an increasing proportion of intermittent RES. The tendering scheme applies to RES plants which exceed a given installed capacity threshold and to the limits set by yearly annual quotas of supported capacity for each technology. Incentives are awarded to bidders that offer the highest tariff reduction from the preset ceilings. There were three initial rounds after the introduction of the new support scheme (2012-2013-2014), and a fourth round was held in 2016 after the capacity cap and price ceiling were reviewed.

Onshore wind power auctions are especially interesting since they have been perceived as enormously successful, while there is growing doubt regarding the realisation rate of winning projects (GSE, 2015; Tiedemann et al., 2016). The Italian experience of onshore wind auctions allows a preliminary quantitative data-based assessment of their results to be made which provides valuable insights into the design and use of auction procedures to promote RES. More specifically, using an original database created from the results of the Italian onshore wind renewables energy auctions held in the period from 2012 to 2016, integrated with accurate information about the bidding firms, our study investigates how different design elements, bidders and the economic characteristics of the projects, as well as other contextual and technological factors, may affect award incentives and hence the overall outcome of the auction procedures in addition to the determinants of the base tariff selected by the auction participants. Our results may have potential applications in designing tendering mechanisms for RES support.

The remainder of this paper is organised as follows: in Section 2, the literature background is presented and the design elements of Italian onshore auction schemes are briefly overviewed while, building on this conceptual background, Section 3 presents the empirical strategy and data sourced, Section 4 discusses the results and their implications and Section 5 draws conclusions and provides some policy implications.

2 Renewables auctions: theoretical background

2.1 Literature review

In the last few years, a number of studies have investigated the different RES support schemes to evaluate their performance in terms of environmental effectiveness and cost efficiency (Batlle et al., 2012; Cassetta and Surdi, 2011; Fouquet and Johansson, 2008; Haas et al., 2011; IEA, 2011; IRENA, 2012; Lewis and Wiser, 2007; Linares et al., 2013; Mahalingam, 2014; Sun and Nie, 2015; Verbruggen and Lauber, 2012). Nevertheless, mostly because of the random use made of thee schemes around the world compared with feed-in-tariffs (FITs) and renewable portfolio standards (RPS), far too little attention has been paid to RES auction schemes. As observed, the opportunity to control the costs of RES support and deployment volumes as well as recent positive results achieved in some countries explain a renewed interest in auction programmes both at government and scientific level as a means for procuring supplies of renewable energy (Becker and Fischer, 2013; Cozzi, 2012; European Commission, 2013; IRENA, 2013; Kreycik et al., 2011; Shrimali et al., 2016).

Literature traditionally places auction-based approaches among quantity driven as opposed to price driven policy instruments, though they often include some characteristics of the latter (IRENA and CEM, 2015; Verbruggen and Lauber, 2012; Weitzman, 1974). Indeed, RES auction schemes are usually applied as follows (Haufe and Ehrhart, 2016; IRENA, 2013; Meier et al., 2015); a public authority sets an RES target, either technology-specific or technology-neutral (IRENA, 2015), a tendering procedure is then set up to select from different RES projects meeting predetermined technical and financial criteria those able to produce electricity at the lowest prices per unit. Sealed bid or descending clock auctions are the types which have been commonly used, although many types of auctions can be conceived (Ausubel and Cramton, 2011b). Public authorities may also consider including additional criteria, such as the project's contribution to local industrial development, technological specifications and environmental requirements. A long-term contract for the production of renewable electricity is then offered to winning bidder, often for between 15 and 20 years and based on the prices it proposes.

Extant studies have emphasised some theoretical features of RES auction schemes which are particularly attractive for both government and RES producers (del Río et al., 2015; Haufe and Ehrhart, 2016). The origin of the concept was that it gave the opportunity of taking advantage of the efficiency gains deriving from the competition that auctions create among producers of large scale renewable projects, which are relatively standardized products (Ausubel and Cramton, 2011a). Assuming a competitive market and to the extent that auctions are properly designed and conducted, auction-based approaches are better means of managing the uncertainty and asymmetry of information about production costs and other relevant variables, i.e. the LCOE, Levelised Cost of Electricity; they help to minimise the total cost of RES support and to prevent potential windfall profits not to speak of underpayments (Ausubel et al., 2014; Klemperer, 2002; Maurer and Barroso, 2011; Mcafee and McMillan, 1987; Schäfer and Schulten, 2015; Weitzman, 1974). As reported by McCrone et al. (2017), an average reduction of 30% in renewable energy project tariffs has been achieved when a country moves from a feed-in tariff or green certificate programme to its first auction. Moreover, competition among RES developers provides incentives for the better exploitation of RES in terms of technologies and local availability as well as for minimizing costs throughout their supply chains (Conti, 2012). By revealing the reduction in the costs of technologies, auctions can also enable adjustments to be made to RES support costs over time, especially when a clear schedule for the new power capacity is provided (del Río and Linares, 2014). As for FIT approaches, long-term contracting provides RES producers with a guaranteed income, thus limiting investment risk, but auction schemes also allow governments better to manage the total amount of support they give; the exponential increase in the cost of support is one of the main reasons for the reduced political feasibility and social acceptability of RES deployment in many countries, e.g. Italy and Spain (del Río and Linares, 2014).

Major pitfalls of RES auction schemes arise when RES developers do not succeed in delivering the contracted capacity on a commercial basis because they have underbid, or as a result planning restrictions, such as building and environmental permits (Mitchell and Connor, 2004). Underbidding may depend on what auction theorists call the "winner's curse" which reflects the danger that the RES developers offering the lowest prices are likely to be those having overestimated their ability to finance and realise the project (Ausubel and Cramton, 2011a; Klemperer, 2002). In turn, this may result in governments not hitting the RES capacity target initially set (Butler and Neuhoff, 2008). High bureaucratic and administrative costs, including those required for making plans in advance when there is uncertainty about project costs and energy yield, may seriously lessen the attractiveness of an auction, especially for smaller firms and/or new entrants. Too few potential bidders may increase their ability to collude implicitly or explicitly thus diminishing the theoretical advantages of auction schemes (Klemperer, 2002). Finally, further concerns arise from the difficulties of RES auction schemes to take into account additional benefits other than lowest prices per unit of electricity, such as regional development and the growth of domestic industries (IRENA and CEM, 2015; Lewis and Wiser, 2007) and in fostering the effective integration of RES producers in electricity markets (Monarca et al., 2015).

Auction programme experiences for RES electricity around the world have been analysed primarily using qualitative approaches based on case and/or desktop studies (IRENA, 2013; Wigand et al., 2016). Opportunities for empirical assessments are restricted by the limited use of auctions for RES-E support and the lack of suitable data on tenders. Reviews of different countries' experiences can be found in recent works such as Azuela et al. (2014); Barroso and Batlle (2011); Eduardo and Parente (2013) regarding the Brazilian case; del Río (2016a); Eberhard (2014); McKinsey&Company (2013); Montmasson-Clair and Ryan (2014); Toke (2015) regarding the South-African auctions; Shrimali et al. (2016) regarding the Indian experience; Mastropietro et al. (2014); Moreno et al. (2010) regarding the South American experiences; del Río (2016b); Fitch-Roy and Woodman (2016); Förster (2016); Kitzing and Wendring (2015); Noothout and Winkel (2016); Steinhilber (2016a); Tiedemann (2015); Tiedemann et al. (2016) respectively for Portugal, UK, France, Denmark, Netherlands, Germany, and Italy; and Steinhilber (2016b) regarding the onshore wind concession auctions in China. As regards RES technologies in particular, onshore wind auctions, either technology-specific or all-encompassing, have been held in most of the countries analysed. The high degree of the maturity of the necessary technology, which mitigates price discovery uncertainty and encourages competition, as well as its competitiveness in terms of grid parity proximity in many geographic areas, make onshore wind the pre-eminent candidate for renewable tendering schemes (IEA-ETSAP and IRENA, 2016; RSE, 2014).

Important findings of all these studies are that auctions can potentially offer better contracted price outcomes with fewer risks of windfall profits and that they can also reduce the cost of RES support over time (del Río and Linares, 2014; Henrique and Santana, 2016). The policy effectiveness and efficiency gains of auction schemes, however are highly context and technology dependent since no one-size-fits-all solutions can be identified (Butler and Neuhoff, 2008; Moreno et al., 2010). Likewise, most of the research also makes governments and regulators aware that "the devil is in the details" (Ausubel and Cramton, 2011b; Klemperer, 2002; Maurer and Barroso, 2011; Verbruggen and Lauber, 2012). Positive auction outcomes crucially depend on the structural characteristics of specific markets and on design features that influence the degree of initial competition and facilitate the entry of as many bidders as possible and their ability to participate on a level playing field basis (Azuela et al., 2014). Auction policy objectives and energy policy concerns, the nature of the auction, the choice of RES technology choice, location constraints, pricing rules, the setting of reserve prices, the types of contracts awarded, the periodicity and frequency of tendering procedures, pre-qualification requirements and penalties for ensuring that new generation projects procured are built and have an adequate operating performance, uncertainties and risks for bidders, and unambiguous and transparent auction rules are all regarded as essential elements for successful RES auction schemes (del Río and Linares, 2014; Wigand et al., 2016).

2.2 Auctions for Renewable Energy Support in Italy

The Italian auction scheme was launched in 2012 by a Ministerial Decree of 6 July 2012 (hereafter the 2012 Decree) as a part of a major revision of RES electricity support schemes (Cassetta and Monarca, 2014; MISE, 2012). The main driver of the reform was the opportunity to reduce the overall direct and indirect costs of RES support for electricity consumers by introducing more cost-reflective incentive schemes and by constraining RES deployment of volumes (Cassetta and Surdi, 2011; Monarca et al., 2015). The reform also set indicative total cost ceilings for incentive measures, respectively at 5.8 billion euro for non-PV RES and at 6.7 billion euro for solar power system[1].

The scheme set out in the 2012 Decree was recently amended by a Ministerial Decree of 23 June 2016 (hereafter the 2016 Decree), which maintains the overall structure of the previous Decree while fully aligning the non-PV RES support scheme to the EU rules on state aid for environmental protection and energy projects (MISE, 2016). The Italian non-PV RES support scheme provides four ways of accessing the incentives according to an installed capacity threshold based on the type of RES:

1. direct access for new construction, complete reconstruction, reactivation or upgrading with installed capacity not exceeding a specific threshold (50 KW for onshore wind and offshore wind plants);

2. entry in registers for new construction, complete reconstruction, reactivation or upgrading with installed capacity included in specific ranges (from 60kW to 5 MW for onshore wind and offshore wind plants);

3. award of incentives via participation in descending price auctions for new construction, complete reconstruction, reactivation or upgrading with installed capacity above fixed threshold (5 MW for onshore wind and offshore wind plants);

4. entry in registers for projects for the renovation of plants with installed capacity after the renovation exceeding the threshold for direct access.

Descending price auctions applied for large onshore wind installations are multiple-item auctions in which bidders offer a discount percentage over a reference feed-in tariff (base tariff). Table 1 shows capacity thresholds, conventional useful life and base tariffs for new onshore wind plants.

[1] This ceiling was reached in June 2013 so that PV systems can no longer benefit from support mechanisms (GSE, 2017).

Table 1: Conventional useful life, feed-in tariffs and incentives for new wind plants (Source: own elaboration)

		Decree 2012		Decree 2016	
Type	Capacity (kW)	Useful life (years)	Base feed-in tariff (/MWh)	Useful life (years)	Base feed-in tariff (/MWh)
On-shore	1<P≤20	20	291	20	250
	20<P≤60	20	268	20	190
	60<P≤200	20	268	20	160
	200<P≤1000	20	149	20	140
	1000<P≤5000	20	135	20	130
	P>5000	20	127	20	110

Table 2: Relevant design elements of on-shore wind auction scheme (Source: own elaboration)

Year of introduction	2012
Auction product	Capacity (MW)
Single/Multiple-item	Multiple-item
Support auctioned	Capacity is tendered, electricity is remunerated
Volume or budget cap	Volume cap
Auction procedure	Reverse auction
Technology differentiation	Technology specific
Frequency	Once a year
Pricing rules	Pay as bid
Ceiling price	floor -2%; ceiling -40% (-30% from 2013 to 2016)
Physical Prequalification	Late auction
Financial Prequalificatio	Bid bond (5% of total expected investment cost)
Penalties	0.5% FIP reduction for each month of delay. After 24 months of delay, the FIP is withdrawn and the bid bond is withheld
Concentration rules	No maximum awarded capacity constraints
Form of support auctioned	Sliding FIP
Support duration	20 years

The auction rules are completely straightforward: (a) in each round, auction caps are set in the form of capacity (MW to be installed); (b) bidders compete on price; (c) submitted bids are binding; (d) bidders offering the lowest percentage discount wins (until the capacity cap has been reached); (e) the winning bidder receives the feed-in amount offered, the base tariff minus the hourly zonal energy market price (i.e. a sliding Feed-In-Premium, FIP); (f) the energy produced by the plants eligible for the incentive thus remains available to the producer.

Allowed discounts may range from 2% to 40% (30% in the first three rounds held under the 2012 Decree). There are no seller concentration rules, either in the form of restriction on maximum awarded capacity or maximum number of bids.

Each bidder has to satisfy the qualification criteria set in the 2012 Decree in order to prevent underbidding and to ensure a higher realisation rate. More specifically, as guarantees of project completion, prior to the bidding stage bidder must provide a building permit and/or concession, a connection offered by the grid operator formally accepted by the plant owner and a bid bond of 5% of the estimated investment cost (increased to 10% in the event of success in the auction). There is also provision for penalties for delay. Failing to meet the prescribed 31-months deadline (28 months under the 2012 Decree) for the construction and commissioning of the project carries a 0.5% reduction for each month of delay. After 24 months' delay the incentive is withdrawn and the bid bond is retained. As regards the tendering process timetable, in t_0 GSE publishes a notice for the coming tender; the tender is opened 30 days from t_0; the tendering process last for between 90 days and 150 days from t_0; and GSE publishes the ranking 150 days after t_0. Table 2 summarises the main elements in the design of the Italian onshore wind auction scheme.

3 Methodology

As noticed, the onshore wind auction procedure adopted by the Italian Government is a relatively clear-cut model whose main policy objective is to award support to companies able to develop projects punctually and generate electricity at the lowest cost during the wind farms' conventional useful life (Ausubel and Cramton, 2011b). In addition to prescribing ceiling deductions, the possibility of projects that are awarded being not financially viable or failing to deploy is reduced by pre-qualification criteria related to environmental permits, grid connection and bid bond guarantees.

Italian onshore wind auction design is examined by firstly investigating its overall outcomes in terms of cost efficiency and policy effectiveness. Determinants affecting awarded base tariffs are then empirically analysed further to explore the roles of different design elements, bidders, the economic characteristics of the projects and other contextual and technological factors.

3.1 Policy effectiveness and cost efficiency

Literature on RES support schemes traditionally assesses their effectiveness by looking at the ability to achieve a desired quota, usually with a target date, and/or to encourage the deployment of RES (Haas et al., 2011). Also taking into account potential underbidding problems as well as intrinsic uncertainty in valuation in the early stage of the project, the effectiveness of auction schemes must depend on both contracted capacity and project realisation. While the percentage onshore wind capacity contracted out of the total capacity auctioned in each auctioning round can be easily calculated and examined, however a time span of several months after an auction is held is required to assess whether awarded projects have been actually realised and the desired RES quotas have been achieved (del Río and Linares, 2014). The recent introduction of the auction scheme and the lack of consistent data on the stages of construction of awarded projects make an assessment in terms of project realisation partly speculative. Nevertheless, we analyse the percentage capacity so far entered into operation in order to make a preliminary assessment of the deployment effectiveness of auction schemes.

Cost efficiency involves the ability of an auction scheme to reduce the level of the costs of supporting the desired RES target, thus limiting the subsidy needed to the minimum (Meier et al., 2015; Verbruggen and Lauber, 2012). Cost efficiency may be evaluated both in static and dynamic terms, the latter being related to the opportunity to drive down RES electricity generation costs by fostering innovative solutions (Wigand et al., 2016).

As described, Italian onshore auction design requires project developers to bid a percentage reduction on a ceiling price. The sliding FIPs is awarded are then calculated according to the 2012 Decree and change periodically depending on the prices emerging in the electricity market zone where the wind farms are located. For each project we estimate expected FIPs, defined as the premium wind power producers could expect when formulating their bids, as follows:

$$CP_t \times bid_{it} - ZP_i \tag{1}$$

where CP is the ceiling price in year t of the auction, bid is the percentage reduction that a firm i bids in the auction round held in year t and ZP is the average of the hourly zonal prices recorded in the last five years in the market zone where firm i's project will be located. We can bear in mind that the premium changes hourly according to zonal prices. More specifically, the premium is zero when zonal prices are above the base tariff, minus the amount of price reduction bid in the auction. Otherwise its value increases with decreasing zonal prices.

To assess the cost effectiveness of an auction scheme, we first examine changes in FIPs awarded to onshore wind developers in successive rounds of auctions (Toke, 2015). Secondly we compare the discovered FIPs of each auction are with a benchmark tariff. Since, by definition, a counterfactual subsidy does not exist (Shrimali et al., 2016), we thus consider the FIPs resulting from the previous incentive scheme which finally expired in 2015. In 2016 green certificates started to be replaced by a FIP for the residual incentive period. Onshore wind plants that began operating on or before 31 December 2012 are awarded a premium on top of the market price which is calculated every year on the basis of the following formula:

$$I = (180\,\text{€/MWh} - Re) \times 0.78 \tag{2}$$

where Re is the average electricity price, which is determined each year by the Italian Electricity, Gas and Water Authority (AEEGSI). For 2016, the AEEGSI determined the average electricity price as 51.69 euro/MWh, resulting in a premium of 100.08 euro/MWh for each green certificate.

3.2 Empirical analysis

Further to investigate auction outcomes, we use a multiple linear model for an empirical analysis of project-related, firm-specific and auction design determinants of awarded base tariffs, i.e. the tariffs resulting from the application of the percentage reduction bid by firms in each auction round to ceiling prices.

As can be imagined, low base tariffs positively influence project ranking in the auction round but negatively affect wind farm revenues in the incentive period. Since the incentive awarded is a sliding FIP that can assume the minimum value of zero, the total amount of support provided increases as the hourly zonal market price decreases, while it is zero when the hourly zonal market prices are higher than the base tariff. The base tariff is then fully equivalent to a floor price for project developers. From a policy perspective, the base tariff affects the likelihood of a project being actually realised.

A well designed price-only auction should award FIPs to project developers submitting comparatively lower projected costs of generating electricity, often proxied by the levelised cost of electricity (LCOE)[2], while preserving attractiveness to favour a high number of bidders and curb underbidding in order to increase the realisation rate. For mature technologies, such as onshore wind, a general understanding of the relevant engineering and economic issues may be acquired by taking it into account that potential annual energy production is mainly dependent on wind conditions and the length of the rotor blades (IEA-ETSAP and IRENA, 2016). The investment cost breakdown of wind systems is typically 64%-84% for wind turbines, 9%-14% for grid connection, 4%-10% for construction cost, and 4%-10% for other capital costs including development and engineering costs, clearance procedures and consultancy and permit fees

[2]LCOE is the sum of all costs over the lifetime of a given wind project, discounted to the present time and levelised on the basis of annual energy production (Schwabe et al., 2011).

(IEA-ETSAP and IRENA, 2016). Finally, operating and maintenance costs account for 20-25% of the LCOE for wind power. Given that project developers do not manufacture wind turbines themselves and that they may also make use of the same widespread technologies, potential competition is highly dependent on location. Other things being equal, better locations mean higher potential electricity generation and lower capital costs.

Our empirical analysis is based on information from different institutional sources, accurately matched to obtain the variables listed in Table 3.

Table 3: Variable description

Variable	Description	Source
	Dependent variable	
BASE TARIFF	Tariff resulting from the percentage reduction bid in the auction	Own elaboration from GSE data
	Independent variables	
	Project-related	
PRODUCIBILITY	Annual potential energy output per unit of installed capacity of a representative wind turbine	Wind Atlas of Italy
SCALE	MW of on-shore wind power capacity offered by each bidder in the auction round	GSE S.p.A.
	Firm-specific	
TURNOVER	Firms turnover in the auction year	AIDA Database
N_BIDS	Number of firms bids in the same auction round	GSE S.p.A.
LEARNING	Whether the firm participated to previous auction rounds (yes = 1, no = 0)	GSE S.p.A.
	Auction design	
ATTRACTIVENESS	Total number of project developers bidding in each auction round	GSE S.p.A.
CERTAINTY	Age of the environmental permit (months)	GSE S.p.A.

More specifically, we make use of the free downloadable Italian onshore wind auction information from the website of GSE S.p.A. (Gestore dei Servizi Energetici, the Italian Electricity Services Operator - www.gse.it), for data on auction results, such as discount bids, bidding capacity, project site (municipality), age of the environmental permit, etc. Project site features are omitted from the Italian Wind Atlas (atlanteeolico.rse-web.it), while we retrieved the financial bidders' data from the Aida (Analisi Informatizzata delle Aziende Italiane) by Bureau Van Dijk database.

We categorise significant variables under three groups (Table 3): project-related, firm-specific and auction design. Project-related factors include site-specific annual energy production, the annual potential energy output per unit of installed capacity of a representative wind turbine, in order to consider the main technical features of single project sites directly: rotor diameter, hub height, and other significant parameters not available (Casale, 2009) and bidding capacity (scale), i.e. the total MW of onshore wind power capacity offered by each bidder in the auction round, in order to consider the extent to which economies of scale are important for project realisation. Firm-specific characteristics cover firm turnover, as a proxy of the existence of some monetary advantages related to firm size including those arising from planning uncertainty, purchasing inputs, running and maintaining the wind farm and administrative procedure costs; the number of firms bidding in the same auction round, so as to consider the existence of synergies and complementarities between different projects; and participation in previous auctions, as this takes potential learning etc. into account. Finally, auction design factors include the number of bidders, as a proxy of the attractiveness of the auction in terms of design simplicity and the low level of transaction costs; and the age of the environmental permit, as a proxy of the uncertainty related to project realisation and construction costs as well as of the priority assigned to projects with older environmental permits.

4 Results and Discussion

A first descriptive analysis shows a significant increase in the number of firms, as well as bidding projects, participating in the auctions over the years (see Table 4). A time effect also occurs in the geographical location of wind project auctions. Figure 1 shows the location of wind projects awarded or not awarded incentives. The first round (2012) only involved 16 firms with projects located in merely three Regions (Basilicata, Calabria and Puglia). On the other hand 73 firms made offers in the last round (2016), while project sites were located in thirteen Regions (see Figures 3 and 4 in the appendix). The increase in the number of bids has resulted in a higher level of competition which undoubtedly affects the likelihood of firms being awarded incentives.

Table 4: Number (and %) of bids and firms that partecipate to the wind auction along years, awarded and not.

	Number of bids	%	Number of firms	%	Awarded	% Awarded	Not Awarded
2012	18	0.08	16	0.09	18	100%	0
2013	47	0.22	42	0.226	16	34%	31
2014	61	0.28	55	0.296	15	25%	46
2016	92	0.42	73	0.392	37	40%	55

Focusing on policy effectiveness, we see that awarded onshore wind capacity in four auctioning rounds in the period form 2012 to 2016 totalled 1,998 MW, about 97% of the government's cumulative volume target. Received bid capacity rose from 88.4% of auction capacity in the first round to 354% in the third, afterwards falling to 247% in the last round of 2016. The realisation period for onshore wind capacity awarded in the first two auction rounds ended respectively in May 2015 and in May 2016 (28 months after the date of commissioning). According to GSE (2016), the proportion of awarded capacity operational as at 30 June 2016 is about 69% for the first auction round and 75% for the second one.

The realisation rate for awarded projects in the third auction round, whose realisation period

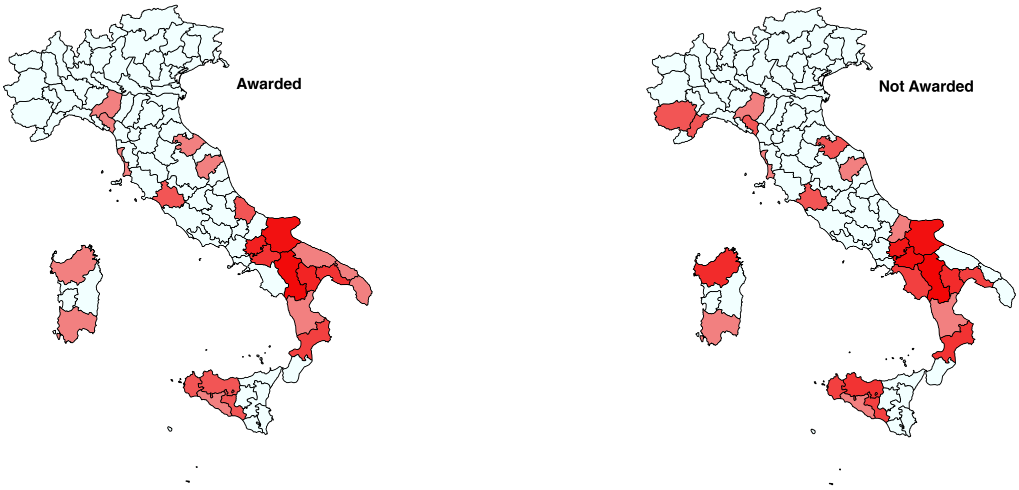

Figure 1: On-shore wind projects localisation according to the resulting ranking: awarded (left) - not awarded (right)

has not ended yet is about 16%. Figure 2 summarises the capacity auctioned, granted, applied for and commissioned in each of the four auction rounds.

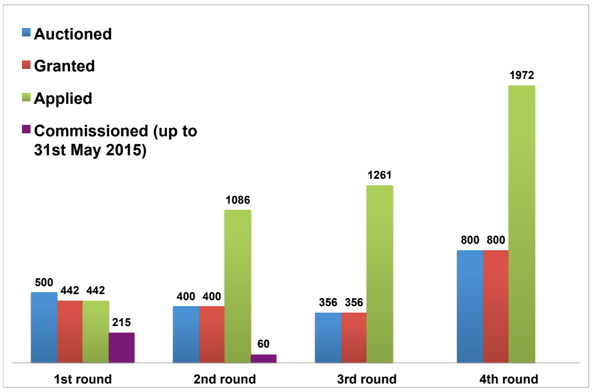

Figure 2: On-shore wind capacity auctioned, granted, applied and commissioned in the four round auctions (MW). Source: own elaboration based on GSE (2016).

The lack of consistent data on single awarded projects makes it extremely difficult to make any additional assessments of the determinants of deployment effectiveness (Tiedemann et al., 2016), even if the realisation rate was primarily hindered by grid connection problems as well as financial pre-qualification criteria that were not reliable enough (Negri, 2015). The onshore wind capacity that is not in operation yet, however, is still eligible for incentives for up to 24 months more, albeit with a monthly base tariff cut of 0.5%, after the 28 month deadline for the construction and commissioning of projects.

As for cost-efficiency, it is worth noting that all auction rounds reported sensible efficiency gains in terms of increasing rebates and, as a consequence, of the base tariffs granted (see Table 5).

Table 5: Ceiling Price, Discount Bid, Bidding Capacity, Base tariff, Estimated FIP and Bidder Turnover mean and standard deviation, according to auction round.

	2012-2016	2012	2013	2014	2016
Ceiling Price	117.87	127.00	124.46	121.97	110.00
	(6.87)	(0.00)	(0.00)	(0.00)	(0.00)
Bidding capacity	21.2666	24.5556	20.1745	22.0816	20.6407
	(14.38)	(16.29)	(16.22)	(14.13)	(13.24)
Deduction Bid	0.24542	0.09248	0.0839	0.2196	0.3750
	(0.13)	(0.06)	(0.04)	(0.06)	(0.06)
Base Tariff	89.74807	115.25462	114.01304	95.18741	68.75490
	(20.53)	(8.23)	(4.53)	(7.45)	(6.89)
Expected FIP	29.958	46.215	41.244	34.805	17.799
	(13.76)	(8.23)	(6.33)	(11.82)	(6.58)
Bidder Turnover	22421.94	76715.51	28387.67	10773.39	16146.91
	(112074.71)	(294305.11)	(143823.23)	(33063.88)	(37774.48)

Average percentage discounts ranged from 9% in the first round to 37% in the fourth round. The concentration of projects developers' bids in terms of bidding capacity, as proxied by the first four bidders' concentration ratio, has fallen over time, passing from 45% in the first round to 17% in the last. The average base tariffs granted to winning bidders progressively decreased as a result: 123 euro/MWh in the first round, 110 euro/MWh in the second round, 87 euro/MWh in the third round, 66 euro/MWh in the fourth. Referring to the average prices for the last five years in the different market zones of winning projects and to the base tariffs granted, we can estimate the average FIPs awarded according to equation (1) as 62 euro/MWh in the first round, 56 euro/MWh in the second round, 31 euro/MWh in the third round, 10 euro/MWh in the fourth round. In the last round all the winning projects that are to be located in Sicily will not receive any FIP because their net electricity generation would be remunerated only by zonal prices. Furthermore, these values are consistently lower than FIPs currently awarded to green certificates assigned to onshore wind plants that started operating on or before 31 December 2012. As we noted in Section 3, the 2016 premium is 100.08 euro/MWh.

Additionally, the total amount of support may vary greatly depending on hourly zonal market price trends during the twenty years of the incentive period, as well as on the net electricity generation that is fed into the grid by the successful wind farms. In its turn, the latter will also depend on the awarded capacity which actually enters into operation. Since the base tariff is fully equivalent to a floor price for project developers, the risk of increasing electricity prices is entirely assumed by the government and, thus by final consumers, who pay the entire cost of RES support schemes through their electricity bill.

We show an econometric analysis in Table 6 which illustrates the empirical estimates based on the multiple linear regression model.

Table 6: Base Tariff determinants - ols estimates

	Dependent variable:						
	Base Tariff						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Project-related factors							
Producibility	-0.017^{***}			-0.005^{***}	-0.016^{***}		-0.006^{***}
	(0.002)			(0.001)	(0.002)		(0.001)
Scale	0.124			-0.005	0.105		-0.004
	(0.085)			(0.042)	(0.082)		(0.042)
Firm-related factors							
Turnover		0.208		0.169		0.292	0.117
		(0.613)		(0.578)		(0.634)	(0.598)
N_Bids		-0.780^{***}		-0.726^{***}		-0.767^{***}	-0.717^{***}
		(0.026)		(0.027)		(0.028)	(0.028)
Learning		0.103		0.722		0.336	0.962
		(1.399)		(1.331)		(1.412)	(1.343)
Auction design factors							
Attractivenss			-2.580^{***}		-1.266^{*}	-0.351^{*}	-0.045^{*}
			(0.756)		(0.689)	(0.366)	(0.349)
Certainty			-0.313^{***}		-0.268^{***}	-0.039^{*}	-0.043^{*}
			(0.069)		(0.061)	(0.034)	(0.032)
Constant	126.315^{***}	142.361^{***}	96.469^{***}	151.325^{***}	128.466^{***}	142.267^{***}	151.425^{***}
	(4.787)	(1.836)	(1.805)	(2.445)	(4.648)	(1.845)	(2.480)
Obs.	218	211	218	211	218	211	211
R^2	0.256	0.819	0.124	0.842	0.324	0.820	0.843
Adjusted R^2	0.249	0.816	0.116	0.838	0.311	0.816	0.838
Residual SE	17.790	8.806	19.308	8.266	17.038	8.805	8.270
	(df = 215)	(df = 207)	(df = 215)	(df = 205)	(df = 213)	(df = 205)	(df = 203)
F Statistic	37.037^{***}	311.508^{***}	15.200^{***}	218.078^{***}	25.535^{***}	187.356^{***}	155.890^{***}
	(df = 2; 215)	(df = 3; 207)	(df = 2; 215)	(df = 5; 205)	(df = 4; 213)	(df = 5; 205)	(df = 7; 203)

Note: $^{*}p<0.1$; $^{**}p<0.05$; $^{***}p<0.01$

As expected, project-related factors and auction design elements generally have a significant impact on the value of base tariffs, whereas firm-specific variables do not prove to have any significant effect. These results support the qualitative assessments and can be easily explained when we consider the overall auction design in the light of the characteristics of onshore wind power which we have described. Under the Italian auction scheme, project developers bid a discount reduction on a ceiling price which is calculated by regulators on average market conditions. The resulting price, if awarded, is the minimum revenue for each unit of net electricity generated through the contract period. Making the project profitable is a firm's incentive to seek the best combinations in terms of location and technologies. Under-performing sites are consequently abandoned *a priori* since they do not allow firm to offer discount reductions great enough to win the bidding procedure. Indeed, the current auction design, like that of the previous green certificates regime, progressively encourages developers to concentrate wind projects in locations that are relatively similar in terms of local wind conditions and annual potential energy output (see Figures 1 and 4). The analysis of average wind variance, carried out on all the projects presented either by successful bidders or not, supports this view, as the result is 0.608. As regards project-related variables, site annual potential energy output, therefore, is important for the base tariff reduction but the relative coefficient is quite modest, even if significant. Conversely, scale factors such as those proxied by bidding capacity, do not have a significant impact on the base tariff. Onshore wind auctions are only held for plants with a capacity higher than 5 MW, medium-sized and small onshore installations being supported via another scheme. Moreover, beyond a certain size, large-scale wind farms can be installed by simply adding additional turbines, even if the latest technological advances have mainly involved larger turbines which reduce both the number of turbines and the land area needed per unit of output. IEA-ETSAP and IRENA (2016); Schwabe et al. (2011). When jointly considered, the empirical results on project-related factors are consistent with the evidence that the availability of wind resources has not constituted a competitive constraint for project developers in the fourth auction rounds conducted in Italy. From a policy perspective, this can be regarded as a positive outcome to the extent that the auction scheme has effectively impelled project developers to select the best sites.

The attractiveness of auction design, as proxy of the number of bids submitted in each auction round, has a significant and positive effect on base tariff. The attractiveness of an auction to potential bidders remains one of its most important features (Klemperer, 2002). As a result, the higher the number of bids the lower are the base tariffs awarded. In this perspective, Italian onshore wind auctions work well in designing pre-qualification requirements which do not prevent auctions from having a large number of potential bidders, which would otherwise undermine price-only competition. Pre-qualification requirements, however, play an essential role in the policy effectiveness outcomes of the auction in terms of the onshore wind capacity that actually enters into operation. Additional site-specific data, in particular those related to grid connection costs, would be required to provide further evidence regarding the relative weight of localisation factors. as regards the uncertainty about project realisation and construction costs, the results show that the age of the environmental permit for a project has quite a significant effect on base tariff, even if since the last auction specific priority has now been assigned to anti corruptions firms rating in the merit order for contracting in case of equivalent bids. Older environmental permits are thus associated with lower base tariffs. Projects in more advanced stages of the planning process probably justify aggressive bidding in order to obtain a return on the investment already made.

Firm-specific factors do not have a significant effect on base tariff, except for the variable related to the number of firms bidding in the same auction round. This finding could justify the possibility of not laying down seller concentration rules, such as a maximum number of bid constraints: a maximum number of bids per seller and the total size of bids per seller (Steinhilber, 2016a). For the installation of large-scale wind farms, potential cost reductions are related to savings in the cost of transport, installation, operation and maintenance. These monetary advantages seem to be project-related since firm size does not have a statistically significant effect on the basic tariff offered (see the effect of the bidder turnover variable). This finding may confute the effectiveness of the bid bond guarantee provided for the auction design (5% of the administratively estimated investment cost, increased to 10% after successful participation). The introduction of bid bonds may increase the effectiveness of the incentive scheme by pre-selecting potential bidders, while avoiding, at least in part, some market distortions which emerged in the past. The absence of any pre-qualification criteria in the previous support scheme acted as a spur for the creation of a secondary market for clearances in which economic agents without any financial reliability systematically acquired wind rights for the best sites and applied for green certificates with the aim of offering the realisation of the projects to industrial companies. The bid bond guarantee places the responsibility of verifying project developers' financial reliability on financial institutions, thus limiting potential deployment problems.

Finally, the findings do not show the existence of potential learning effects or monetary advantages arising from having participated in previous auction. Auction design simplicity and the resulting low level of administrative burdens and transaction costs have not penalised the participation of new bidders, including smaller enterprises. Winners in one bidding round were automatically excluded from participating in other rounds.

A final comment on the analysis proposed in Table 6 refers to model selections. Among the different proposed linear models, the best one is the first, as confirmed by the adjusted R^2. In particular, it also reports all meaningful independent variables, as well as the lower number of regressors.

5 Conclusion and Policy Implications

This paper provides a quantitative data-based assessment of onshore wind power auctions held in Italy from 2012 to 2016. So far out little experience of RES auctions has limited opportunities for comprehensive studies based on empirical analysis. The number of countries utilising tendering mechanisms for RES support has increased in the last few years, while EU Member States have been asked by the European Commission increasingly to adopt competitive bidding processes on the basis of clear, transparent and non-discriminatory criteria in order to encourage new electricity capacity from RES (Kitzing and Wendring, 2015).

The Italian experience of onshore wind auctions can thus offer useful insights for a better understanding of potential auction outcomes in the RES context as well as of the most appropriate different design elements for specific policy goals. Although perceived as a successful experience, as the cumulative government target volume of onshore wind capacity has been fully awarded and support has been reduced both in static and dynamic terms, a comprehensive assessment requires data on the effective realisation rate of awarded projects. Historically, potential failures to achieve the volume of commercial operations of the contracted capacity have been the main drawback of RES auction schemes. As observed by Conti (2012) "in some markets auctions have been *bid* but then not necessarily *built*". As a consequence, some caution is needed in interpreting Italian auction outcomes.

The extreme simplicity of the auction design has undoubtedly stimulated competition, encouraging many project developers to make bids during there first years from 2012 to 2016. The sealed bid reverse auction has proved to be a robust mechanism for price discovery in the onshore wind power sector, where uncertainty and information asymmetries mainly arise from having to identify the sites with the best wind resources rather than from generation technologies, which, on the contrary, are mostly mature and largely accessible to all project developers. Our results show a positive but limited impact of localisation factors, as proxied by wind speed and potential annual energy output (producibility), on the basic tariff offered, suggesting that wind resources are not yet scarce and they still do not constitute a competitive constraint for project developers. From an auction design perspective, when a maximum discount on the preset ceiling price has been prescribed to avoid underbidding, as in Italian auction schemes, the administrative determination of ceiling prices becomes a major issue (Rego, 2013). The higher the preset ceiling price the greater is the resulting base tariff, even when competition is fierce because of wide availability of wind resources.

For price-only auctions and mature and widespread technologies, like onshore wind, firm-specific factors are not relevant in determining bid tariffs or, consequently, the likelihood of being awarded incentives. Project developers have the incentive to seek the best combinations in terms of location and technologies, as under-performing sites do not allow them to bid reductions great enough to win the bidding procedure. Pre-qualification criteria, including physical requirements and financial guarantees, have not acted as a barrier for smaller players, thus making seller concentration rules, such as restrictions on in the maximum number of bids as well as on the total amount of bids, unnecessary. While not limiting competition, it is too early to assess the effects of pre-qualification criteria on the realisation rate and on the policy target for RES expansion. As Kreiss et al. (2016) noted, setting the correct parameters of the different measures still remains one of the most difficult challenges for auction designers. When the effective realisation of auctioned capacity is taken into account, however, the total amount of support provided can be difficult to control. Moreover, policy makers need to keep in mind that what is remunerated is the net electricity fed into the grid by the auctioned onshore wind farms which, in turn, depends on turbine performance over the twenty years of the contract. Finally, the total amount of support provided also changes as a result of hourly zonal electricity market price trends, increasing as electricity prices fall. The difficulties that have been described probably justify a stop-and-go cycle of financing where a regular schedule for RES auctions has not been organised and published and their future conduct will be contingent on the failure to achieve the yearly cumulative spending limit for RES support. To date, onshore wind auctions are not planned for 2017. However, this entails more risk for project developers (del Río and Linares, 2014) and may consequently cause some distorted bidding behaviour, further reducing the policy effectiveness and cost-efficiency of the support mechanisms.

A Appendices

Table 7: Correlation matrix among price ceiling, deduction bid, base tariff, yearly average zonal prices and expected FIP

	Base Tariff	Ceiling Price	Deduction Bid	Expected FIP
Base Tariff	1.00	0.92	-0.99	0.90
Ceiling Price	0.92	1.00	-0.87	0.79
Deduction Bid	-0.99	-0.87	1.00	-0.91
Expected FIP	0.90	0.79	-0.91	1.00

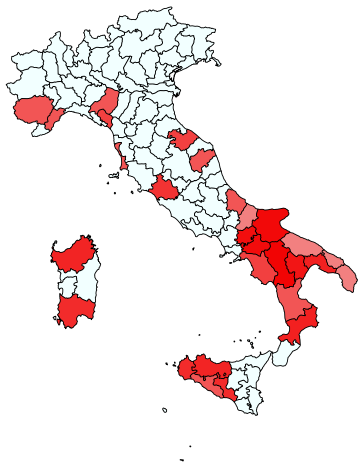

Figure 3: On-shore wind farm projects localisation in the four auction rounds (2012-2016).

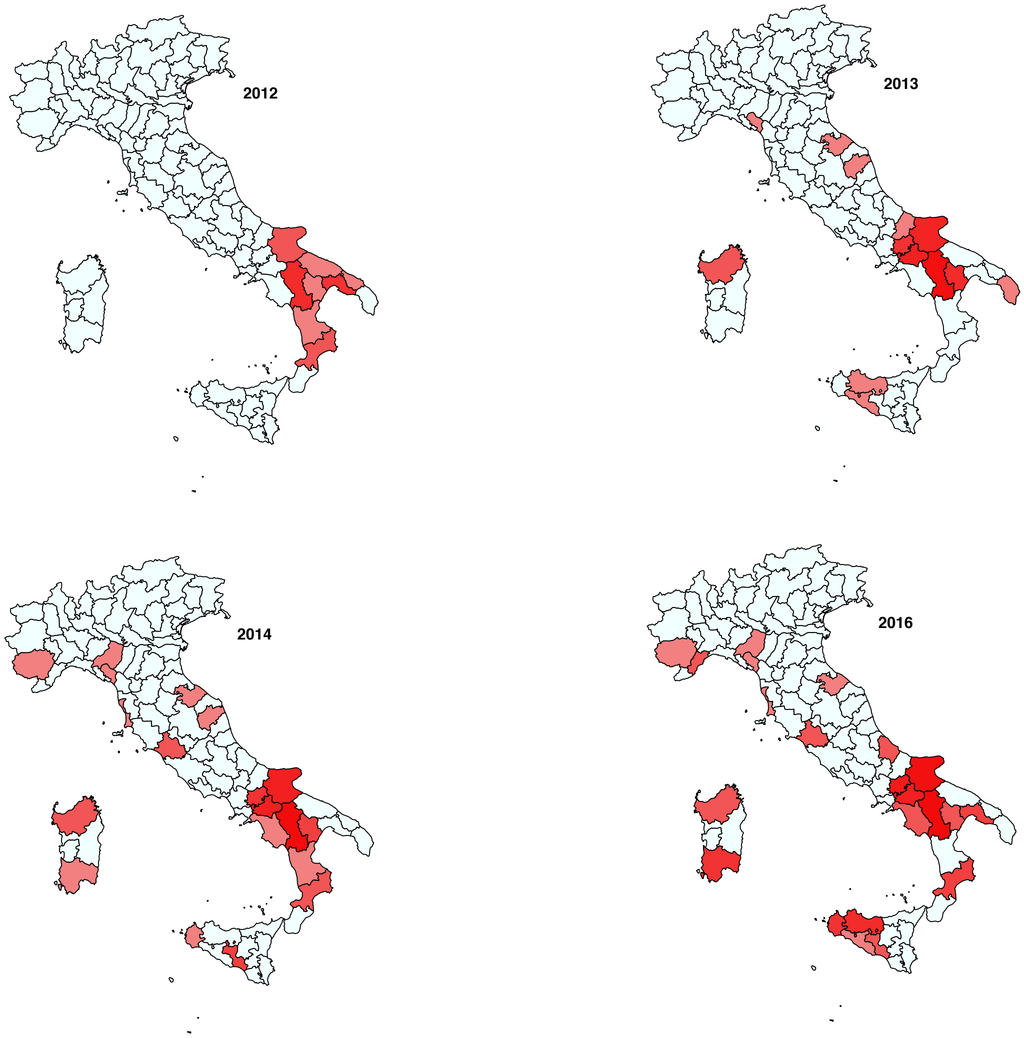

Figure 4: On-shore wind farm projects localisation in each auction round (2012-2016 from the top left)

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