Working Paper 6/2017
17 April 2017

Assessing the design elements in the Spanish renewable electricity auction: an international comparison

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Summary

The aim of this working paper is to contextualise the choice of design elements used in the first auction for renewable electricity in Spain, considering the international experiences from around the world, and to assess this choice taking into account the literature on the design elements in auctions. The analysis of the RES-E auction in Spain has shown that it is quite different from other international experiences regarding key design elements, namely investment-based support, uniform pricing, lax prequalification and penalties. The absence of a schedule for regular auctions in the future, seller concentration rules and organising stakeholder dialogue processes in the Spanish auction, which can be considered examples of best practices, are also uncommon features of renewable electricity auctions in most countries. In contrast, other design elements in the Spanish auction are widespread and are either best practices (disclosure of volumes) or their choice can be justified according to specific criteria (sealed-bid auctions, absence of local content rules, volume defined as capacity, technological specificity and price-only auctions).

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(1) Introduction

Spain had a long tradition in supporting electricity from renewable energy sources (RES-E) through a feed-in tariff (FIT) scheme since the 1990s. However, this came to an end after a moratorium on support for RES-E was passed in 2012. This led to virtually an absence of new RES-E installations being built on Spanish territory. The new support scheme based on auctions which took place in January 2016 put an end to the moratorium and 700 MW of RES-E (500 MW of wind, 200 MW of biomass) were awarded contracts and the installations will have to be built in four years. A total volume target of 3,000 MW is expected to be auctioned further along in 2017 (MINETAD, 2016). The aim of this working paper is to contextualise the choice of design elements used in the first auction for renewable electricity in Spain, considering the international experiences from around the world, and to assess the choice taking into account the literature on the design elements in auctions.

The use of instruments to support electricity from renewable energy sources (RES-E) is widespread all over the world. Until recently, feed-in tariffs (FITs) have dominated. Under FITs, a total payment per kWh (or MWh) of RES-E generated, paid in the form of guaranteed prices and combined with a purchase obligation by the utilities is provided. The remuneration is set administratively. FITs have generally been more effective in promoting RES-E investments than other instruments (eg, quotas with tradable green certificates), given the certainty on (guaranteed) revenue flows.[1] FITs have been a particularly suitable instrument to support the least mature technologies or small-size applications (Held *et al*., 2014).

However, FITs have frequently been considered problematic in terms of support costs. For example, the impact assessment accompanying the Communication from the Commission Guidelines on State aid for environmental protection and energy for 2014-20 (henceforth Guidelines) says that 'administratively established support levels do not ensure cost-efficiency due to the information asymmetries between the regulator establishing the support level and the producers that benefit' (EC, 2014a, p. 18). Although FITs have led to reasonable support levels (relatively low unitary support) (Ragwitz *et al*., 2014), the total costs of support have skyrocketed in some cases since they have been quite effective in triggering RES-E deployment, given their lower risks compared with other instruments (Rathmann *et al*., 2011).

This increase in the costs of support in some countries (especially in the EU), and the need to integrate RES-E in the electricity market has led to the search for alternatives in order to reduce the cost. And this is how auctions have emerged as an attractive option. An auction is a process in which a good or several goods are offered up for bidding. For the support of RES-E, we consider so-called procurement auctions. That is, an auctioneer will buy the good (RES-E) from the bidder(s) offering the best bid, ie, the lowest support level (AURES, 2017).

[1] It is not the purpose of this working paper to compare the different support schemes for the promotion of RES-E. For extensive revisions of this topic, see Mitchell *et al*. (2011), EC (2013), Held *et al*. (2014), REN21 (2015) and Río *et al*. (2017), among others.

Therefore, auctions have recently been regarded everywhere as a useful alternative to induce further investments in RES-E without excessively burdening the consumers' pockets. The use of auctions has experienced an impressive growth worldwide. According to REN21 (2015, 2016), at least 60 countries had held RES-E auctions as of early 2015, up from nine countries in 2009. Furthermore, in the European context, the Guidelines on State aid from the Directorate General on Competition of the European Commission (EC, 2014b) propose that Member States use auctions to provide support for new RES-E installations from 2017 onwards. The proposal for a new RES Directive also supports the use of this instrument when it says that 'Member States shall ensure that support for renewable electricity is granted in an open, transparent, competitive, non-discriminatory and cost-effective manner' (art. 4).

Auctions can potentially be suitable for RES-E support because they can mitigate information asymmetries (they are a competitive market mechanism through which valuable information can be generated), are effective in controlling costs, expansion and the technology mix and are allocative-efficient, since the cheapest projects, technologies and locations are encouraged.

Work carried out in the AURES project has found evidence that auctions can be a suitable instrument for allocating support under budget and volume limitations and can achieve significant short-term efficiency gains, but it has not been proved that auctions in general are better suited to support renewable energy than other support instruments. The use of auctions entails several new implications that policy makers have often not had to deal with before: ensuring sufficient competition for a well-functioning price formation, avoiding undesired strategic incentives, collusion and other market distortions, and –importantly– dealing with the risk of low realisation rates, eg, those caused by underbidding or by the existence of non-cost barriers (Kitzing *et al*., 2016).

Several authors are critical of the role of auctions. For example, EWEA (2015) mentions that there were serious shortcomings associated with auctions in the past, including investor uncertainty over the price, which deterred investment, underbidding and underbuilding, complex tender procedures and financial risks, which discouraged small players from participating, sites selected without regard to environmental impacts that resulted in public opposition and/or undesired environmental consequences leading to projects being blocked and little or no competition in some cases. Toke (2015) argues that cost reductions that are associated with renewable energy auctions are not caused by the auction systems themselves but rather are linked to general declines in the cost of renewable-energy technologies. Auctions would be more effective in limiting renewable energy deployment than in reducing the costs of RES-E projects. Some authors have concluded that auctions have not been less effective in the past to promote RES-E than alternative instruments (Río & Linares, 2014; and IRENA 2013).[2] A recent analysis confirms that auctions for RES-E in the EU have not been very effective. Although the volumes auctioned have been awarded to bidders in five of the eight

[2] The effectiveness of auctions has been assessed according to two subcriteria: their capacity to contract new RES-E capacity and the achievement of the RES or RES-E targets (the actual realisation of projects). The reasons for ineffectiveness have been diverse and often interrelated: low bids led to projects not being profitable when project developers started to build them and penalties for non-compliance were absent (as was the case with the NFFO in the UK in the 1990s).

countries being assessed, the complete realisation of projects is seldom achieved and delays are frequent (Wigan *et al*., 2016).

The Guidelines themselves consider several opt-outs for auctions by MS, indirectly recognising that they might not be suitable in specific circumstances. Under Article 126, Member States may opt-out from tendering if only one or a very limited number of projects or sites is eligible, if tendering leads to higher support levels or results in low project realisation rates. Article 127 provides a *de minimis* rule which exempts installations below a given installed capacity threshold from participating in auctions.

As with other support schemes, whether auctions fulfil the expectations and result in a successful promotion of RES-E depends on the choice of design elements, ie, the devil is in the detail. In fact, neither the proposal for a new Directive nor the Guidelines on State Aid require that auctions are designed in a specific way, ie, they do not prescribe the adoption of a given design element. Therefore, the choice is left to the discretion of Member States. In fact, Member States have implemented different design elements in their RES-E auctions. Likewise, the design elements differ widely across the non-EU countries using auctions to support RES-E investments (see section 4). Often, the specific design solutions to address potential problems in auctions are highly context-specific and what works in one market is not necessarily applicable to another.

Accordingly, this paper is structured as follows. Section 2 discusses the analytical framework and methodology used for the analysis of the advantages and disadvantages of different design elements. Then, the method used in the analysis of the Spanish RES-E auction in the context of international experiences is provided in section 3. Section 4, which is the core of this paper, identifies the design elements used in the Spanish RES auction, compares it with the choices made in other auction schemes around the world and assesses their pros and cons. The paper closes with some concluding remarks.

(2) Analytical framework: components for the assessment of design elements in auctions

Before auctions are adopted and design elements are chosen, their role has to be contextualised (2.1). A crucial assumption in the analysis is that the links between specific design elements (2.2) and criteria to assess those design elements (2.3) are mediated by the effects on bidders and the market (2.4). Therefore, these three components and their interrelationships must be described and discussed (2.5).

(2.1) Putting design elements into context

Before an auction is adopted to promote RES-E investments, governments must consider whether this is an appropriate mechanism taking into account their energy policy priorities. A main aspect in this context is the setting of long-term targets. Then, an analysis of the market should be carried out, including potential bidders, potential barriers to RES-E deployment, the situation of the supply chain, grid infrastructures etc… And, finally, if auctions are deemed an appropriate instrument and those aspects are considered, specific design elements can be chosen and their suitability can be analysed with different assessment criteria.

It should be taken into account that the specific design elements are highly context-specific and that what works in one market is not necessarily applicable to another. In addition, different design elements might mitigate some issues but affect other factors. Policy makers often pursue several policy goals (secondary objectives) with energy support policy, eg, increasing security of supply or encouraging actor diversity. Finding a compromise between encouraging different policy goals without hindering well-functioning price formation, proves to be a challenging task. Because of different market conditions, ongoing institutional learning processes and specific policy goals, auction rules must be adaptable (Kitzing *et al*., 2016).

(2.2) Design elements in auctions for RES.

This section describes the main design elements in RES-E auctions.

(2.2.1) Volume

There are three main ways to set the volume auctioned: capacity, generation or budget.

- Capacity targets: a total quantity in terms of MW is auctioned.
- Electricity generation targets: there is a goal of a total amount of MWh.
- Budget targets: there is an overall amount of support to be provided. It can be combined with the other two alternatives.

A main challenge in RES-E auctions is to set the volume at appropriate levels, ie, neither too high nor too low. Whether or not to disclose the volumes is also a relevant design choice.

(2.2.2) Timing

The length of the period between the announcement of the call for the auction and the time when the actual bidding occurs is a key feature of the auction, and may be set either too long or too short. Most importantly, the existence of regular rounds with a schedule is a design element worth considering. Setting the number of rounds in a year is a difficult, technology-specific issue.

(2.2.3) Diversity

Policy makers may be willing to introduce design elements which increase diversity with respect to technologies, locations, actors and sizes of the installations for a number of reasons (see Río *et al.,* 2015b, for an extensive explanation). Diversity could be promoted in an auction by organizing different auctions per alternative (eg, technology-neutral vs technology-specific), by including minimum quota per alternative, by providing different remuneration levels for different alternatives or by lowering prequalification requirements or penalties for specific categories (ie, small actors).

(2.2.4) Participating conditions: facilitation and requirements

Several elements may facilitate the participation of actors in an auction, while others are rather requirements for this participation:

- Streamlining administrative procedures. Administrative procedures may severely restrict participation in an auction and, thus, competition levels. Therefore, measures to streamline them may facilitate such participation.

- Supporting dialogue with stakeholders and information provision. In some countries, policy makers meet with potential bidders to inform them about auction design and to get their feedback for improving such design. Critical information which may also enhance participation in the auction can be provided (eg, renewable energy resource potentials).

- Prequalification requirements. These are required in order to participate in the bidding procedure and are checked before the auction. They can refer to specifications of the offered project (such as technical requirements, documentation requirements and preliminary licenses) or to the bidding party (providing evidence of the technical or financial capability of the bidding party) (Held *et al*., 2014). They are chosen to prove the seriousness of the bid and/or the likelihood of the realisation of the project. As with other elements, the challenge is to set them at appropriate levels (ie, neither too stringent nor too lenient).

- Local content rules refer to the requirement to use renewable energy equipment which is manufactured by local firms.[3]

- Seller concentration rules might be implemented (as in California, India and Portugal) in order to mitigate the risk of market power. Successful winners in one round may be prevented from participating in a later round or the size of the bidding share by a single actor might be limited.

(2.2.5) Support conditions: types and forms of remuneration

Remuneration in an auction can be provided for generation (MWh, generation-based) or capacity (MW, investment-based). In addition, there are several instruments to set the remuneration for energy. Generation-based remuneration can be provided through feed-in tariffs (FITs) or feed-in premiums (FIPs). Under FIPs, a payment per kWh on top of the electricity wholesale-market price is granted. Within FIPs, a main distinction is between fixed and sliding FiPs. Fixed FiPs are set once and do not change. The total remuneration thus depends on the market prices. Sliding FiPs (also called contract for differences, or CfD in the UK) are set at regular intervals to fill the gap between the average market price perceived by all generators of a given technology and a pre-determined strike price. If the electricity price is below the strike price, the RES-E dedicated remuneration is positive. If it is above, it is negative. Sliding FIPs provide a

[3] They can be set by requiring that a percentage of the renewable energy equipment is manufactured by local firms or by organising two auctions: one with domestic content requirements and the other one without them.

good balance between low investment risks (highest under fixed FIPs and lowest under FITs) and high market integration of RES-E generation (highest under fixed FIPs and lowest under FITs) (see Río *et al*., 2017, and Held *et al*., 2017, for further details). Auctions can set the remuneration level both in fixed FIPs and in sliding FIPs (in this case, auctions set the strike price).

(2.2.6) Selection criteria

Price-only auctions are organised using only one criterion (the bid price). In multi-criteria auctions, the price is the main criterion among other criteria (eg, local content rules, impact on local R&D, industry and jobs and environmental impacts) (Held *et al*., 2014).

(2.2.7) Auction format

Depending on whether the auctioned object can be split between multiple winning bidders, auctions are referred to as single-item or multi-item. In a single-item auction there is a single product which is allocated to a single owner and the product cannot be split. In a multi-item auction the auctioned product is split among different owners and bids are submitted for only part or the total auctioned amount (AURES, 2016).

(2.2.8) Auction type

A main distinction is between static (sealed-bid) and dynamic auctions. Under sealed-bid auctions, project developers simultaneously submit their bids with an undisclosed offer of the price at which the electricity would be sold. An auctioneer ranks and awards projects until the sum of the quantities offered covers the volume of energy being auctioned. Under the multi-round descending-clock auction, the auctioneer offers a price in an initial round, and developers bid with offers of the quantity they would be willing to provide at that price. The auctioneer then progressively lowers the offered price in successive rounds until the quantity in a bid matches the quantity to be procured. Hybrid models may use the descending clock auction in a first phase and the sealed-bid auction in a second phase, as in Brazil (IRENA, 2013).

(2.2.9) Pricing rules

There are basically two different ways to set support levels in sealed-bid auctions. Under uniform pricing, all winners receive the strike price set by the last bid needed to meet the quota or the first bid that does not meet the quota. Thus, either the highest accepted bid determines the award price or the lowest rejected bid determines the award price (highest accepted bid, or HAB and lowest rejected bid, or LRB, respectively). Under the pay-as-bid (PAB) alternative, the strike price sets the amount of generation eligible for support and each winner receives his/her bid.

(2.2.10) Price ceilings

In order to limit the costs of support, the auctioneer can set a ceiling (reservation) price for each technology, above which bids are not considered (IRENA, 2013). A main choice to be made if a maximum price is implemented is its level. Again, setting the ceiling price at an ‘appropriate’ level is not a trivial exercise. Finally, a main decision is whether or not to disclose the price.

(2.2.11) Realisation period

Deadlines are needed for the projects awarded contracts to be built. How long this ‘grace period’ should last for is a key issue, with a risk of either too long or too short periods.

(2.2.12) Penalties

Penalties can take different forms: they can forbid participation in successive auctions, reduce the level of support, reduce the length of the support period by the time of the delay, lead to the confiscation of bid bonds and result in penalty payments. Again, a main issue is whether they are set too high or too low.

(2.3) Assessment criteria

Defining ‘success’ in the choice of design elements is certainly not a trivial issue. Assessment criteria are used for this purpose. Although effectiveness and (static) efficiency are the most common criteria used in the assessments, several contributions expand the set of relevant criteria to include other aspects, such as dynamic efficiency, social acceptability and political feasibility (see Río *et al*., 2015a). However, there is no prior unambiguously preferred ranking of criteria in the literature. A proposed design element would be better than the alternative if it scores better in most of the aforementioned criteria. Figure 1 describes the criteria considered in this paper.[4]

[4] Full details on the description of these criteria as well as on how they were derived are provided in Río *et al*. (2015a).

Figure 1. Description of the criteria and indicators

Criteria	Description
Effectiveness	Degree to which auctions result in deployment of RES-E projects (% realisation rate).
Static efficiency 1 (allocative efficiency, direct generation costs)	Reaching the target at the lowest possible generation costs (€, €/MWh). An auction outcome is efficient if the bidders with the lowest generation costs are awarded. The relevant costs here include generation costs and transaction costs.
Static efficiency 2 (indirect generation costs)	Balancing, profile and grid costs (€, €/MWh).
Dynamic efficiency	This refers to long-term technology effects, including impact on innovation and cost reductions over time.
Support costs	Average support level per technology (net of generation costs)(€/MWh), total support costs net of total generation costs (€).
Local impacts	Socioeconomic and environmental effects at the national, regional or municipal level (impacts on the value chain, industry creation, local employment, lower fossil-fuel dependence…).
Actor diversity	The participation of small actors is actively encouraged.
Sociopolitical feasibility	Degree to which the design elements and the whole support scheme are socially acceptable and politically feasible. This partly depends on other criteria (minimization of support costs, local impacts, etc…).

Source: adapted from Río *et al*. (2015a).

Static efficiency is interpreted in this article as minimisation of the (system) costs of RES-E generation. System costs can be disaggregated into direct and indirect costs. The former include installation, operation and maintenance of renewable energy technologies. Direct generation costs refer in this working paper to allocative efficiency, to which the equimarginality principle applies.[5] Indirect costs refer to balancing, profile, grid and transaction costs.[6]

[5] According to Tietenberg (2008, p. 18), the least cost means of achieving an environmental target occurs when the marginal costs of all possible means of achievement are equal.

[6] Balancing costs occur due to deviations from schedule of variable RES-E power plants and the need for operating reserve and intraday adjustments in order to ensure system stability. Profile costs are mainly back-up costs, ie, additional capacity of dispatchable technologies required due to the lower capacity credit of non-dispatchable RES-E. Grid costs are related to the reinforcement or extension of transmission or distribution grids as well as congestion management, including re-dispatch required to manage situation of high grid load (Breischoft & Held, 2013).

(2.4) Market, bidders and system effects

The impact of design elements can take place at different (but interrelated) levels, depending on the aggregation considered, from micro (bidders) to meso (system) and macro (regional) (see Figure 2).

Design elements affect the participation of bidders in the auction by influencing the costs, risks and expected benefits of participation (bid levels with respect to generation costs). In general, the higher the costs, the higher the risks or the lower the expected benefits, the lower the number of participants. Design elements also influence strategic bidding behaviour by the bidders. The impact at the bidders' level translates into market effects, which include the number of bidders in the auction, the diversity of those bidders and their market concentration. In turn, these aspects have consequences on the functioning of the auction (assessed with the aforementioned criteria). Finally, there might be relevant effects at the system level, including impacts on the regional distribution of deployment.

Figure 2. Main indicators for the effects on bidder, market and system level

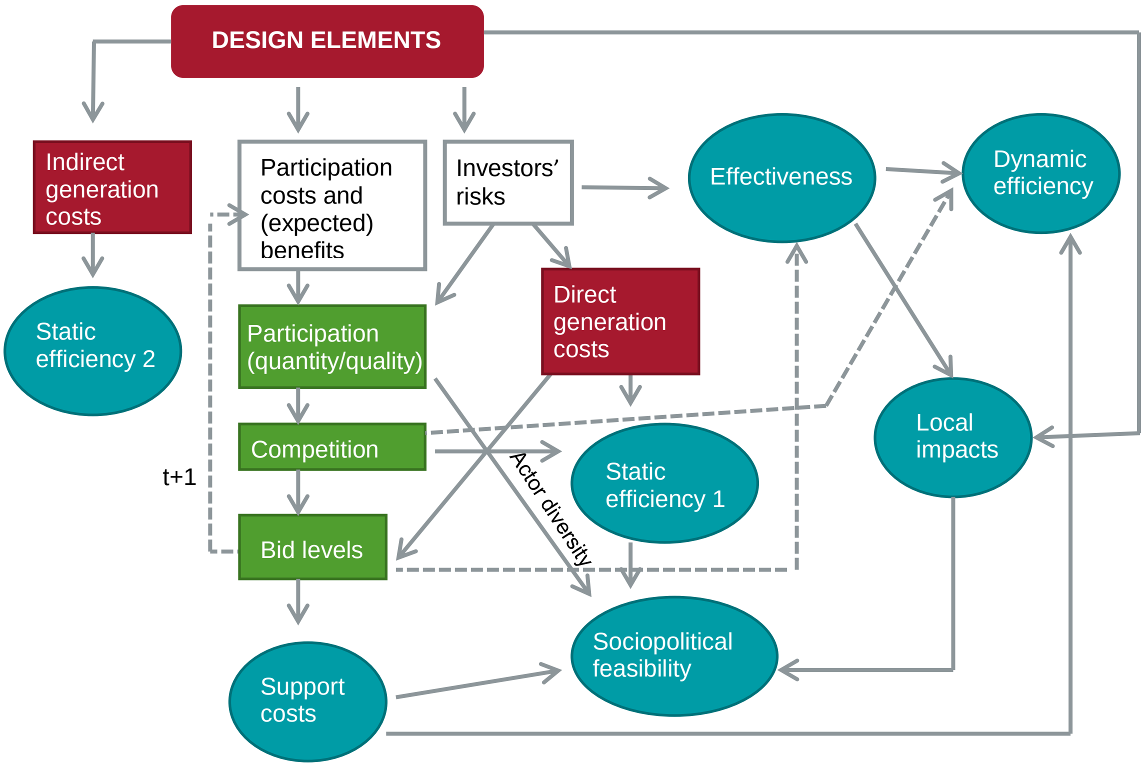
Type of effect	Subcategory
Effects on bidder level	Participation risks
	Participation costs
	Expected benefits (bid levels minus generation costs)
Effects on market level	Number of bidders
	Diversity of bidders
	Market concentration
Effects on system level	Regional distribution of deployment

Source: Río (2015).

(2.5) Linking the components

Figure 3 illustrates the main links between design elements, market/bidder/system effects and assessment criteria. The links between components are both empirically-based and theory-based. The incentive to participate in the auction (which depends on the expected benefits, costs and risks) takes a central role in this analytical framework because it affects a critical element (competition), which has a quantitative and a qualitative aspect. The design element may induce a higher number of participants, making collusion more difficult (positive quantitative impact on competition). But it may also increase the diversity of actors and encourage the participation of stronger bidders instead of weaker ones. These qualitative aspects positively affect competition (Río *et al.*, 2015a; Río, 2015; and Kreiss, 2016). A greater and better competition affects static efficiency (since the cheapest technologies/locations are selected) and support costs (given lower bid levels). Design elements may also influence investors' risks directly and, thus, generation costs (a greater LCOE results from higher capital costs due to greater risks), with a detrimental impact on allocative efficiency and support costs (higher risks are factored into higher bids). Other criteria are influenced by those mechanisms. A main one is effectiveness, which is affected by those design elements with an impact on investors risks' (negative influence), competition (a higher level of competition induces more aggressive bidding and, eventually, underbidding and underbuilding) and bid levels (the higher these levels, the higher the realisation rate). In turn, effectiveness positively affects other criteria: local impacts (socioeconomic and environmental benefits depend on the actual deployment of RES-E projects) and dynamic efficiency (the prospects of a future market encourages R&D investments, and deployment triggers learning effects and investments in the renewable energy supply chain). Local impacts may be directly influenced by design elements (ie, local content requirements). Dynamic efficiency is, in addition to effectiveness, also positively influenced by elements with a positive impact on innovation: a higher competition and a higher support level (since higher profit margins may be partially reinvested on R&D, see Menanteau *et al*., 2003). Sociopolitical feasibility is positively affected by other criteria: lower support costs, higher static efficiency, higher actor diversity and local benefits. Deployment may also bring negative environmental impacts, and affect social acceptability (NIMBY syndrome). Finally, indirect costs are directly influenced by design elements (eg, geographical diversity).[7]

Figure 3. Relating different components in the assessment of design elements in RES-E auctions



Source: the author.

[7] A detailed discussion on the interrelationships, overlaps and links between those components is provided in Río (2015).

Río (2015b) found that design choices in an auction may lead to interactions between criteria (synergies, complementarities and conflicts). Most design elements involve trade-offs between criteria, ie, their choice may improve one criterion at the expense of worsening another.[8]

(3) Method

The analysis of the pros and cons of different design elements in RES-E auctions draws on several complementary methods. First, economic theory has been used to assess the impact of different design elements on bidder and market effects and, thus, on the assessment criteria. In addition, those theoretical relationships have been supported by empirical findings. The empirical assessment of the pros and cons of different design elements for RES-E auctions has been based on several sources of information of past and current schemes around the globe (see Box 1).

Box 1. Information sources on auctions from around the world

(1) Top academic energy, energy policy and climate policy journals. Terms such as 'tender', 'auction' or 'bidding' were inserted in the journals' internal search engines. The corresponding articles were filtered manually in order to discard those which were not directly related to RES-E auctions.

(2) Reports with an extensive coverage of auctions for RES-E from international institutions such as IRENA (IRENA, 2013, 2015) or the World Bank (Maurer & Barroso, 2011), EU projects (Held *et al*., 2014) and others (Ragwitz *et al*., 2014, Lovinfosse *et al*., 2013).

(3) Grey literature. A Google search has been performed, using relevant terms. The search led to useful documents on the design of auctions in particular countries.

(4) A previous review of the literature on auctions for RES (Río & Linares, 2014) that, however, does not cover all the past and present schemes.

(5) The paper also draws heavily on empirical research on auctions for RES carried out in the EU-funded AURES project. Sixteen country case studies on auctions around the world were undertaken in this project, some of them by the author of this working paper. They are publicly available at the AURES project website (http://www.auresproject.eu/). These case studies were carried out using a combination of data sources, including official documents and interviews with key stakeholders in each country. As a result of the analysis in the AURES project, some best and worst practices have emerged.[9]

The analysis of the Spanish RES-E auction builds on the case study for this country carried out for the AURES project (see Río, 2016b). Key stakeholders were interviewed for the project.

[8] In particular, conflicts between effectiveness and support costs/allocative efficiency are common. Also quite frequent are the trade-offs between support costs/allocative efficiency and other criteria (system costs, local impacts, dynamic efficiency and actor diversity) (Río, 2015a).

[9] The project provides a set of recommendations on which design elements should be included in the proposal for a new RES Directive (Kitzing *et al*., 2016). According to them, MS should be required to: (1) publish a long-term auction roadmap and more detailed auction plans for shorter time horizons; (2) set up appropriate processes and participation enhancing measures including, eg, processes for stakeholder consultation, sufficient consultation time and sufficient time for bid preparation; (3) set ceiling prices; and (4) implement both pre-qualification requirements and penalties.

(cont.)

The analysis has considered 27 international experiences from around the world, with different temporal and technology scopes (Figure 4). Some of them have been analysed in depth in the past (Brazil and the UK NFFO), the analysis for others is more recent, and builds on work carried out by the author and colleagues in the context of the EU-funded AURES project (Spain, Denmark, France, Germany, Ireland, the Netherlands, Portugal, Poland, the UK CfD,[10] Brazil and South Africa) or by IRENA (Morocco, Peru, China and South Africa). Finally, other more recent experiences have not been analysed in depth, given their very recent implementation (Chile, Zambia, Argentina and Mexico).

[10] In the UK there have been two experiences with auctions, one in the 1990s (the Non-Fossil Fuel Obligation, or NFFO) and another very recent (the contracts-for-differences, or CfD). An explanation of the functioning of CfD (or sliding premiums) is provided in subsection (2.2.5).

Figure 4. RES-E auctions around the world considered in this study

Europe	America	Rest of the world
Spain 2016- WN, B	Brazil 2007-2009, W, H, B	South Africa 2011-2014 All RES
Denmark 2005-2015, WF, W nearshore	California 2011-2015, all RES	Zambia 2016 pv
France 2012-2014, PV	Peru 2009-2015 All RES	Morocco 2011-2013 WN, PV, CSP
Germany 2015- ground-mounted PV	Chile 2015- All RES	India 2010-2014 PV, CSP
Ireland 1995-2003 W, H, B	Argentina 2016-All RES	China 2003-2007 WN
Italy 2013-2015, W, H, G, B	Mexico 2016-All RES (nuclear and cogeneration). In reality, solar PV and wind won	Dubai 2012-2016 PV
Netherlands 2011-2016, all RES (also RES H&C)	Quebec 2005-2009 W	Australia (Australian Capital Territory, ACT) 2012-2016, PV, W
Portugal 2006-2008 w, b		Uganda 2015- Small PV (< 5 MW)
UK NFFO 1990-1998, all RES		
UK CfD 2015- all res		
Poland 2016- all RES		
Russia 2013- Small H, W, PV		

W: wind; WN: wind on-shore; WF: wind off-shore; PV: solar photovoltaics; CSP: concentrated solar power; B: biomass; H: hydro; G: geothermal; H&C: heating and cooling.

Source: the author.

(4) Analysis of the design of the Spanish RES-E auction in an international context

The aim of this section is to contextualise and analyse the design elements used in the Spanish RES-E auction, taking into account the international experience with RES-E auctions as well as the assessment of different design elements (advantages and disadvantages according to different criteria), identifying the best and worst practices from around the world.

The first auction for RES in Spain took place in January 2016 under the relevant regulations.[11] The auction is part of a regulatory framework set up in the Law 24/2013 of the Electricity Sector and developed in RD413/2014. According to the Annex to the Resolution of 30 November 2015, the concrete 'objective of the auction for the allocation of the specific retribution regime for biomass and wind installations will be to determine the percentage reduction of the standard value of the initial investment of the reference standard plant for new plants producing electricity from biomass... and wind energy as well as the value of the capacity allocated to the winning bidders'. The main motivation of the auctions is to end up the moratorium of support for new RES plants (in 2012) in order to comply with the Spanish target under the RES Directive for 2020 and do so at the lowest possible costs for consumers.

It is first important to take into account the Spanish energy context in which auctions have been applied before assessing their design choices (see Río & Janeiro, 2016, and Río & Mir-Artigues, 2014, among others, for a detailed comment on these features). Spain is basically an electricity island with limited interconnections with other countries and with overcapacity in electricity generation. It has a comparatively high penetration of RES and is in a good compliance path with its 2020 RES targets (20% in 2020).[12] In 2012 the government established a moratorium on RES and, since then, only 1.800 MW have been added, of which 1.000 MW correspond to large hydro and only 281 and 129 MW to wind and PV, respectively. In 2015, there were 51.749 MW of renewable energy installed capacity, including large hydro, ie, the additions between 2012 and 2015 represent 3% of the total installed capacity in 2015.

It should also be taken into account that retail electricity prices are higher than the EU average (despite lower wholesale prices) and the country has been hard hit by a deep economic crisis.[13] The tariff deficit, the large increase in the costs of RES-E support and a sluggish electricity demand in the context of a deep economic crisis were the factors

[11] RD 947/2015 (16/X/2015) set a call for the provision of the specific remuneration regime to new biomass and wind installations, Order IET/2212/2015 (23/X/2015) regulated the procedure for the provision of the specific remuneration regime to new biomass and wind installations, Resolution of the State Secretary for Energy (30/XI/2015), which calls for an auction for the provision of the specific remuneration regime to new biomass and wind installations and Resolution of the General Directorate for Energy Policy and Mines (MINETUR) (18/I/2016), which clears up the auction for the provision of the specific remuneration regime to new biomass and wind installations.

[12] According to the Spanish government, Spain will achieve its RES target since it is currently overcomplying with its indicative trajectory (in 2014 RES penetration was 17.3%, versus the expected indicative RES Directive trajectory (two-year averages) for 2013-14, which is 12.1%). This is also in line but more optimistic than the assessment of the European Environmental Agency (2016), which shows that the average share of RES in Spain in 2013-14 was 15.3%, three percentage points above the aforementioned 12.1% and the European Commission. According to the European Commission progress report (towards 2020 targets), the RES share in Spain in 2013 was 15.4% (EC 2015). The share has increased over time, mainly as a result of increasing renewable electricity generation, but also as a result of increasing renewable energy use for heat and transport fuels and decreasing final energy consumption (IEA, 2015, p. 128).

[13] According to Eurostat, retail electricity prices in 2014 in Spain were as high as €235/MWh for households, whereas the EU27 average was €205/MWh. Retail electricity prices for industrial consumers were €141/MWh for industrial consumers, slightly below the EU-27 average (€149/MWh).

leading the government to stop support for new RES-E installations (see the explanatory memorandum of Royal Decree Law 1/2012).

The technology-specific auction took place with a volume of 500 MW for wind and 200 MW for biomass. The outcome of the auction is a discount on the standard value of the initial investment of the reference standard plant (RSP). This will allow lead to obtaining the standard value for the initial investment of the standard plant (SP). From this last value, plus the rest of retributive parameters, the remuneration for the investment of the SP will be obtained (applying the methodology set in RD 413/2014). The capacity allocated to each participant for each technology will also result from the auction. Bidders bid for a given capacity, not for a given project/plant. The winners will have 45 days to inscribe the installation in the pre-register. They will inscribe the amount of kW that they have won, but those kW will not be associated to a specific installation.

The outcome of the auction was a 100% discount on the initial values, which means that the amount of investment remuneration (Rinv) for both technologies and all the standard plants was zero. One single company (Consorcio Aragonés de Recursos Eólicos) was awarded 60% of the total wind volume (300 MW) and Forestalia won 54% of the volume of biomass being auctioned (108 MW).

Figure 5 summarises the main design elements of the Spanish RES-E auctions and compares them with those which are more frequent in the auctions organised in the EU, America and the rest of the world. We do not equate 'best practices' with 'most common practices'. Indeed, there can be very good design elements in theory or proved useful in real practice which have seldom been adopted.

Figure 5. Design elements in the Spanish auction and internationally (the numbers refers to the amount of countries which have adopted the alternative design elements)

Design element	Options	Spain	Europe	America	Rest of world
(1) Volume	Generation (GEN), budget (BUD) or capacity-based (CAP)	CAP	CAP: 7 BUD: 4 GEN: 1*	CAP: 6 BUD: 0 GEN: 3**	CAP: 8 BUD: 0 GEN: 0
	Disclosure (Y/N)	Y	Y: 11 N: 0	Y: 6 N: 1	Y:7 N:1
(2) Periodicity schedule (Y/N)		N	Y: 5 N: 6	Y:3 N:4	Y:2 N:6
(3) Diversity	Technology-neutral (TN), multi-technology (MT) and technology-specific (TS)	TS	TS: 8 MT:1 TN: 2	TS:4 MT:1 TN:3	TS:8 MT: 0 TN: 0
	Geographically-neutral (Y/N)	Y	Y: 9 N: 2	Y:4 N: 3	Y:4 N:4
	Actor-neutral (Y/N)	Y	Y:10 N:1	Y:7 N:0	Y: 8 N:0
	Size-neutral (Y/N)	Y	Y:5 N:6	Y:4 N:3	Y: 1 N:7

(4) Participation conditions	Supporting dialogue with stakeholders (Y/N)	N	Y:3 N:8	Y:1 N:6	Y:2 N:6
	Prequalification requirements	€20/kW, no previous experience, no administrative permits	Financial capability, bid bonds, permits	Permits, financial capability, previous experience, bid bonds	Financial capability, previous experience, bid bonds, land acquisition
	Local content rules (Y/N)	N	Y:4 N:7	Y:3 N:4	Y:4 N:4
	Seller concentration rules (Y/N)	N	Y:3 N:8	Y:1 N:6	Y:3 N:5
	Information provision (Y/N)	N	Y:1 N:10	Y: 0 N:7	Y:5 N:3
(5) Support condition	Type of remuneration (I) (capacity vs generation)	CAP	Cap: 2 Gen: 10	Cap: 1 Gen:6	Cap: 0 Gen: 8
	Form of remuneration (FIT, sliding FIP, fixed FIP).	Based on capacity	FIT: 4*** sFIP: 6 fFIP:1	FIT: 7 sFIP:0 fFIP:0	FIT:6 sFIP:2 fFIP:0
(6) Selection criteria (price-only vs multicriteria)		Price	Price:9 Multi:2	Price:4 Multi:3	Price:5 Multi:3
(7) Auction format (single-item vs. multi-item)		Multi	Single:2 Multi:9	Single:0 Multi:7	Single:4 Multi:4
(8) Auction type (static, dynamic, hybrid)		Static	Static:11 Dyn.: 0 Hybrid0:	Static:6 Dyn.: 0 Hybrid:1	Static:8 Dyn.: 0 Hybrid:0
(9) Pricing rules (PAB vs uniform)		Unif.	PAB:10 Unif.:2*****	PAB:7 Unif.:0	PAB:4 Unif.:1 First-price: 3
(10) Ceiling prices	Y/N	Y	Y:9 N:2	Y:6 N:1	Y:4 N:4
	Disclosure (Y/N)	Y	Y:9 N:1 ******	Y:4 N:2	Y:2 N:2
(11) Realisation period (deadlines for construction, years)		4	Variable	Variable	Variable
(12) Penalties		Confiscation of bid bonds	Confiscation of bid bonds, reduction of support with delay, exclusion from future rounds	Confiscation of bid bonds, contract termination, payments	Contract termination, bid bonds withheld

(*) Poland applies both budget and generation targets (volumes).

(**) Peru applies generation targets, except for small hydro (capacity targets). Mexico has generation, capacity and green certificate targets.

(***) In Poland both sliding FIP (>500 kW) and FIT (<500kW) are applied.

(****) Mexico: FITs +CELs.

(*****) In Germany and the UK NFFO, uniform in the first two rounds, PAB ever since.

(******) In Denmark, ceiling price disclosed for wind offshore, not disclosed for wind nearshore.

Source: the author.

A discussion of the Spanish scheme, its comparison with the international experience and an analysis of the design choices being made taking into account the pros and cons of the different alternatives is provided in the rest of this section.[14] We focus on the design elements which we deem more relevant in this discussion.[15]

(4.1) Volume auctioned

This was a technology-specific auction whereby 500 MW of on-shore wind energy and 200 MW of biomass were auctioned. The volume was set as capacity, which is a common design element in other schemes in Europe and around the world. However, this volume may have been too small for wind, taking into account the moratorium and compliance with 2020 targets for RES, that four years had passed since the moratorium and, also, that more projects will need to be built beyond those 700 MW in order to comply with Spain's 2020 targets.

First, 500 MW were awarded. This might have been too small a volume taking into account that as much as 2.500 MW participated in the auction and 10.000 MW were in the pipeline (Río, 2016b). In its Report on 18 June 2015, the National Commission of the Markets and Competition (CNMC) noted that the volume auctioned for wind was too low and for biomass too high (too ambitious) with respect to the already installed capacity of each technology (CNMC, 2015). 200 MW represented 39% of the currently operative biomass capacity, whereas 500 MW represented 2.2% of the operative wind capacity (CNMC, 2015).

Secondly, those technologies are expected to substantially increase their contribution according to the Energy Planning document (Plan for the Development of the Electricity Transport Grid 2015-20), approved by the Ministry of Industry, Energy and Tourism (MINETUR) in 2015. In this document, it was expected that conventional electricity generation sources would experience a reduction (oil and coal) or a small increase (natural gas and nuclear) in a 2020 horizon. RES will experience the main increase in 2013-20 among the electricity generation technologies (8.535 MW), with wind and solar PV accounting for 92% of the increase (6.473 MW and 1.370 MW, respectively) and biomass accounting for 3.2% (275 MW). The small volume of 700 MW in the Spanish auction compared with the 8.535 MW and the relative closeness of the 2020 deadline (taking into account the lead times to build the projects) suggests a too low auction volume. On the other hand, recall that there is electricity generation overcapacity in the Spanish electricity system, that Spain seems to be on track to comply with those targets (see above) and that the government has announced that 3.000 MW will be auctioned in 2017 (MINETAD, 2016).

[14] For a detailed description of the Spanish scheme, see Rio (2016b).

[15] Other design elements include: fully transferable rights, coverage of administrative costs by successful bidders, who will have to pay €0.17/kW to cover the 'the costs related to the organisation of the auction' and duration of support (20 years for wind and 25 years for biomass).

A low auction volume has implications for the correct functioning of the auction. It encourages aggressive bidding, underbidding and, eventually, underbuilding (ineffectiveness). In the Netherlands, a relatively low capacity of onshore wind was offered in the first round (Noothout & Winkel, 2016). Indeed, setting the appropriate volume level remains a major challenge. If it is set too high, as in Italy (Tiedemann *et al.*, 2016), France (Förster, 2016), South Africa (Eberhard, 2013; and IRENA, 2015) and Peru (IRENA, 2013), low competition and high bids are likely, although this problem can be mitigated with a ceiling price.[16]

Capacity-based volume is also the most common metric to set the volume everywhere. It is dominant in the EU, America and the rest of the world. Budget-based and generation-based volumes have only some presence in the EU and America, respectively, and none in the rest of the world.

Compared with generation-based and budget-based volumes, capacity-based volumes allow an easier and faster assessment of effectiveness. In addition, they provide the strongest signal to equipment manufacturers on the relevant market size for the future. However, they lead to less predictability in the amount of electricity generation and target achievement (with the RES Directive targets) than generation-based generation and certainty less in the total support costs than budget-based auctions. The latter comments should not apply to the Spanish scheme because, given the zero remuneration level, there is total certainty on the support costs being provided.

The volume, a main variable to estimate competition, may or may not be disclosed. The volume of the auction was made public in the case of Spain, which is in line with the experience elsewhere. Disclosure of the auction volume provides certainty, transparency and reliability for potential bidders, leading to lower risks for bidders and, thus, higher participation and competition and lower bids and costs of support. Furthermore, in addition to the higher risks (higher financing and capital costs, lower static efficiency), a hidden volume may also induce other allocative inefficiencies if bidders underestimate the competition level and submit less aggressive bids. Equipment manufacturers benefit from information on the market volume, which encourages innovation (better dynamic efficiency). However, some countries decided not to disclose volumes in order not to provide too much information and discourage strategic behaviour and collusion, which would lead to higher support costs, as in Brazil (Förster & Amato, 2016) and South Africa (Río, 2016a).

(4.2) Auctioned product

Spain provides investment-based support. The outcome of the auction is a discount on the standard value of the initial investment of the reference standard plant (RSP). This will allow obtaining the standard value for the initial investment of the standard plant (SP). From this last value, plus the rest of retributive parameters, the remuneration for the investment of the SP will be obtained (applying the methodology set in RD 413/2014).

[16] Also note that a higher volume increases the likelihood of winning and makes it more attractive for potential bidders to participate. This higher incentive to participate might increase competition levels (Kreiss, 2016).

This is unprecedented, with Russia being the only country to provide investment-based support (see IFC, 2013). A scheme which provides investment-based remuneration may cause fewer distortions on the power market compared to another which remunerates electricity generation (since the effects on electricity prices is much lower), but also provides a lower incentive to deploy the plants on the sites with the best renewable energy resources (wind, solar radiation...), with negative implications in terms of static efficiency and, possibly, target achievement. In the case of capacity-based remuneration, the amount granted and the functioning of the plant are not connected and, thus, there is no incentive to run the plant efficiently. The revenues of the plant owner would not be affected should the plant be run inefficiently. Therefore, generation-based remuneration increases the incentive for a better design and functioning of plants. Furthermore, a generation-based metric provides better system integration. Capacity-based metrics can lead to greater certainty on support costs. A generation-based metric may induce a greater competition between equipment suppliers to provide technologies that maximise the revenue of RES-E generators in line with system requirements (and, thus, a greater incentive to innovate). But equipment suppliers have an incentive to sell technologies that are cheaper than their competitors', and this incentive exists whichever metric is used (Río *et al*., 2016). Therefore, we recommend a metric that, as virtually elsewhere, remunerates the electricity generated and not the capacity installed, possibly with sliding feed-in premiums.

(4.3) Auction type

The Spanish auction is a static one (sealed bid), as virtually elsewhere (only Brazil has a hybrid design, with a dynamic stage followed by a static one). Sealed bids are simpler than dynamic ones. Thus, participation costs are lower (Maurer & Barroso, 2011). In addition, not revealing information during the auction process becomes an advantage of sealed-bid auctions when competition is weak because bidders could use that information to coordinate their bidding, increasing the final price of the auction. Static auctions are less vulnerable to implicit collusion than dynamic ones (Haufe & Ehrhart, 2015).

The main disadvantage of sealed bids is that they are generally less incentive-compatible.[17] Incentive-compatibility refers to suppliers having incentives to reveal their true costs in their bidding strategy. Not allowing bidders to acquire information on the price of the products is more likely to lead to the winner's curse, which occurs when bidders do not know their actual valuation for the good. Uncertainty related to the price of a product is translated into a single bid, which cannot be adjusted when more information is revealed. The descending clock auction design allows for strong price discovery, which is particularly relevant when there is uncertainty on the costs of renewable energy projects. An alternative is a hybrid scheme, which mitigates the negative aspects of the two alternatives (Río & Linares, 2014).

[17] Except in the case of sealed bids with uniform pricing and lowest rejected bid.

(4.4) Pricing rule

In the Spanish auction all the winners will receive the discount of the last bid being accepted, which will set such discount (uniform pricing). An overwhelming majority of countries use the pay-as-bid rule instead of the uniform pricing rule.

In the uniform-pricing option there are two alternatives (either highest-accepted-bid, HAB or lowest-rejected-bid, LRB). In contrast to the PAB, the uniform pricing with LRB is incentive compatible, eg, there is no incentive for strategic bidding or cost exaggeration (Haufe & Ehrhart, 2015). The reason is that, in the LRB, the bidders' own prices do not influence the price they will be paid in case of winning. Thus, participants bid their true cost.[18] A clear and common price signal is provided. Although the uniform price auction is viewed as fair by some authors because all winners receive the same price (Haufe & Ehrhart, 2015), it might be difficult to justify providing the same level of remuneration to projects with different costs.

Compared to PAB, uniform pricing leads to uncertainties regarding award prices for bidders in case of winning. Furthermore, in practice, the uniform pricing rule creates a risk of irrational behaviour (underbidding), underbuilding and, thus, ineffectiveness. Some bidders improve their chances by entering bids below their costs, hoping that the marginal bidder will set an attractive price for all winning projects (Steinhilber, 2016b). Fitch-Roy & Woodman (2016) suggest that this might have been the case in the UK auction. According to them, uniform pricing contributed to the perception by some bidders that a very low bid was the only way to win a contract and encouraged bidders to keep away from the margin with some very low bids. Most stakeholders interviewed in the context of the AURES project believe that the uniform pricing rule (among other factors) contributed to underbidding in the Spanish auction (see Río, 2016b). The uniform pricing rule was initially used in Germany, but it was replaced by PAB after noting that it did not bring additional benefits (Klessmann *et al*., 2015).

(4.5) Selection criteria: price-only/multicriteria auctions

The Spanish auction has been a price-only auction. This is also the most common design element elsewhere.

Price-only auctions would result in the lowest bidders being awarded contracts, whereas selection of the preferred bidder on criteria other than price allows for the achievement of multiple policy objectives (eg, local employment, local environment, industrial development, etc) (Río *et al*., 2015b), as was the case in Portugal (Río, 2016c), or to promote local social acceptability, as is the case in the nearshore wind auction in Denmark (Held *et al*., 2014). However, the least-cost bidders might not be selected in multicriteria auctions. Thus, a lower allocative efficiency and higher support costs would result. This extra cost has to be weighted with the benefits of the other policy objectives which might be more effectively and efficiently tackled with measures outside the auction scheme.

[18] With the exception of multi-project (since bidders may behave strategically, bidding their true costs with some projects while trying to drive up the price with secondary projects) and uniform pricing with highest accepted bid (Haufe & Ehrhart, 2015).

(4.6) Schedule of auctions

Periodicity is not defined in the Spanish auction. According to the preamble of the Resolution, this will be the first (pilot) auction of others to come. Somehow surprisingly, this is in line with most countries, where a schedule of auctions has not been set.

It is surprising because there are numerous examples of the detrimental consequences of auctions at irregular intervals or infrequent ones. Lack of a schedule (as in the Danish Anholt tender (Kitzing & Wendring, 2015), the recent UK auction (Fitch-Roy & Woodman, 2016) and the UK NFFO in the 1990s (Butler & Neuhoff, 2008), low frequency (as in Poland, Kitzing & Wendring, 2016) or irregular intervals (Ireland, Steinhilber, 2016a) are likely to lead to underbidding, since losing in an auction means a long waiting time. In addition, higher investor risks and, thus, financing costs can be expected. Kitzing *et al*. (2016) recommend publishing a long-term auction roadmap with sufficient anticipation and more detailed auction plans for shorter time horizons. A long-term schedule decreases investor risks, encourages participation in the auction, avoids stop-and-go of the renewable industry and facilitates the budgeting and allocation of RES-E support costs. The lower risk improves the financing conditions and reduces generation costs (higher static efficiency). Furthermore, the expectation that there will be more rounds mitigates the risk of underbidding (since bidders do not need to bid so aggressively in a given round) and facilitates the development of a robust supply chain, since equipment manufacturers can plan their investments accordingly. The certainty given to investors and technology developers about a future market for their technology encourages technological progress (Río & Linares, 2014). Frequency at fixed dates in California and Brazil has led to high participation and a robust supply chain, respectively (Fitch-Roy, 2015; and Förster & Amato, 2016). Elizondo *et al*. (2014) argue that, with periodic auctions providing a steady stream of newly contracted wind power projects, the wind equipment industry throve in Brazil.

Although a pre-set schedule of auctions is positive for most criteria, stand-alone auctions allow the government to retain flexibility to adjust the auctioning schedule in response to changes in market conditions (IRENA, 2015). This might be the reason for their widespread implementation.

(4.7) Technological neutrality vs specificity

As mentioned above, the Spanish auction has been technology-specific (wind and biomass). This is also a common design element everywhere. The non-inclusion of solar PV, an already mature, low-cost technology in which Spain has a substantial resource potential, is striking and was not motivated. Recall that the Energy Planning document expects quite a relevant role for other technologies besides wind and biomass in a 2020 horizon (PV: 1370MW, CSP: 211MW) (see section 1).

Policy makers may be willing to introduce design elements which increase diversity with respect to technologies, plant sizes, actors and locations for several reasons (see Río *et al*., 2015a). In general, a problem with increasing diversity in RES-E auctions is market segmentation, which could lead to few bidders and low competition in a given contingent, resulting in higher bids (higher support costs) and higher generation costs (lower static efficiency).

Technology-differentiated support aims at support for the local industrial value chain (an argument in China, Brazil, France, Portugal and South Africa), system integration (California and France) and participation of small actors/social acceptance (Denmark and France). A technology-neutral auction would lead to stronger competition than technology-specific auctions due to a potentially higher number of participants. Projects with the lowest costs would be awarded a contract and lower bids and support costs would result. Technology-neutral support usually leads to the least mature technologies not being promoted, as in the Netherlands (Noothout & Winkel, 2016), the UK (Mitchell & Connor, 2004; and Lipp, 2007) or Ireland (Finucane, 2005).

(4.8) Seller concentration rule

There is no selling concentration rule in the Spanish auction, similarly to most schemes in the world. The concentration of the winning bids in the hands of only two of these 'outsiders', with family ties between each other (Consorcio Aragonés de Recursos Eólicos and Jorge Energy) raises the concern among some stakeholders about the effective construction of their wind farms (see Río *et al*., 2016b). In the wind auction, Consorcio Aragonés de Recursos Eólicos was awarded 300 MW and Jorge Energy was awarded 102 MW, together 80% of the total auctioned volume. A seller concentration rule whereby the volume allocated to each participant would be limited (for example, to 10% or 5% of the auctioned volume) may enhance competition and actors' diversity and diversifies the risk than one single actor winning a large share of the auction volume does not build the projects, leading to ineffectiveness.[19]

(4.9) Prequalification requirements

Both prequalification criteria and qualification requirements have been adopted in the Spanish auction (Box 2). Basically, only an economic guarantee of €20/kW is required.[20] This is deemed a weak requirement in an international context. In the auction schemes in the EU, proof of financial capability and having the necessary permits seem to be a common requirement, in addition to bid bonds whereas, in addition to all those, previous experience or land acquisition is usually an additional requirement in non-EU schemes. According to interviews carried out in the context of the AURES project, some stakeholders believe that the requirements were too lax. More specifically, some mention that the auction should have been based on projects in specific locations, with a connection point and deadline for construction before December 2019 (see Río, 2016b).

[19] Interestingly, there is a seller concentration rule for Spanish islands. There is a limit on the bidders' size in non-peninsular territories (islands). According to RD947/2015 (art. 2), 'the specific retributive regime will not be provided to plants in the electricity systems in the non-peninsular territories which are owned by firms with a share of more than 40% of the installed electricity generation capacity in such a system'.

[20] Initially, an economic guarantee of €50/MW was set in a draft of the regulation. The CNMC (2015) argued that €50/MW was high enough. This was later reduced to €20/MW. The CNMC argued that including additional requirements would limit the competition in the auction.

Box 2. Prequalification and qualification criteria in the Spanish auction

Prequalification

Pre-qualified bidders will be allowed to receive information on the auction, to participate in the training sessions (in the event of being organised) and to ask for qualification. This phase is cost-free for the potential bidders. They are required to provide the following documents: basic information on the bidder (name of the firm, contact person, telephone, mail, etc.), submission of a certificate to access the bidding system, a commitment against collusion and a commitment for confidentiality.

Qualification

Participants need to be 'prequalified' in order to be 'qualified'. Qualification entails the provision of the following documents and information: (1) the maximum volume of qualification for each product, ie, the maximum amount which the bidder will bid for each product in the auction, which cannot be above the quantity to be auctioned for each product; (2) a document accepting the rules of the auction; (3) a document confirming the powers of the person acting as the legal representative; and (4) economic guarantees (€20/kW).

The economic guarantees can be provided in three ways: (1) a cash deposit on the account of OMEL Diversificación; (2) a joint bank guarantee; and (3) a certificate of a joint guarantee insurance provided by an insurance company located in Spain. There is another economic guarantee: the amount of the economic guarantee is also a requirement for registration in the Registry of the 'specific retributive regime (in pre-allocation state)' (IET, 2012, p.16). The amount will be €20/kW times the auctioned amount.

Source: Río (2016b).

Prequalification criteria aim to ensure the seriousness of bids and ensure that winning projects are built (see Kreiss *et al*., 2016, for a theoretical analysis). But they may discourage the participation of actors by increasing the costs of participation, leading to lower levels of competition and higher bid prices and policy costs. On the other hand, they increase the likelihood that stronger bidders participate (ie, higher quality of bids) (Kreiss, 2016). Competition in the auction also increases if weaker bidders are replaced by stronger ones (Haufe & Ehrhart, 2015; and Kreiss, 2016).

As with other design elements, setting them at appropriate levels represents a crucial challenge. If they are too weak, as seems to be the case in Spain, they may lead to ineffectiveness, as in the Netherlands and Ireland (DMNR, 2003; and Steinhilber, 2016a). Too strong prequalification requirements reduce participation and, thus, competition, ending in higher bids and support levels and a lower allocative efficiency, as in France (Förster, 2016) and Peru (IRENA, 2015). But too strong prequalification requirements may also lead to overly aggressive bidding behaviour because the cost of prequalification will be lost if the bidder is not successful in the auction and winning therefore becomes more important (Rosenlund, 2016).

(4.10) Ceiling price

Bidders bid on a discount from an initial remuneration for standard plants (€1.2 million/MW for wind on-shore) and, thus, the Spanish auction has an inherent price ceiling. The latter are the norm rather than the exception in the EU and America, but not so in the rest of the world.

Ceiling prices limit the risk of high support costs, for instance in the event of low competition. A different issue is whether the prices should be disclosed. Doing so would increase transparency, investor confidence, the attractiveness of the support scheme, participation and competition. But, on the other hand, disclosure may bias the results of the auction if the bidders propose relatively high bids marginally close to the ceiling price (‘anchoring’), as in Peru (IRENA, 2013), South Africa (Eberhard, 2013) and India (IRENA, 2015).

(4.11) Realisation period

In Spain, the deadline to build the project is 48 months (counting from the publication of the Resolution in the official government journal BOE). This is deemed an appropriate length of time. It is not too short in order to have the required permits in the Spanish context, and it is not too long in order to contribute to the RES Directive target. It is also within the ranges for wind on-shore in EU countries (not reported in Figure 5).

Too short periods lead to higher risks for investors, low participation and competition and higher bids, as in the recent UK auction (Fitch-Roy & Woodman, 2016) and in the Danish Anholt auction (Kitzing & Wendring, 2015). While long grace periods give temporal flexibility to bidders in achieving compliance, too long periods increase the risks of an excessive remuneration (if the costs of technologies decrease more than expected), underbidding (if those costs do not decrease as much as expected) and ineffectiveness. Underbidding was the case in the UK NFFO (Ackerman *et al*., 2001; and Edge, 2006).

(4.12) Penalties

In the event of non-compliance by the agreed date (48 months), OMIE would enforce the bank guarantees of €20/kW. OMI-Polo Español SA (OMIE), through its subsidiary OMEL Diversificación, is in charge of the management of the auction. In other countries, apart from the confiscation of bid bonds and contract termination, additional penalties are applied, such as exclusion from future rounds or direct payments (fines).

Penalties are commonly regarded as an essential feature of auctions. Their absence or low level is likely to lead to underbidding and, thus, underbuilding (ineffectiveness), as in India (Khana & Barroso, 2014), the UK NFFO auction (Ackerman *et al*., 2001; and Edge, 2006), Poland (Kitzing & Wendring, 2016) and Denmark (Kitzing & Wendring, 2015). Too high penalties would lead to lower levels of participation and competition, higher bids and support costs, as in France (Förster, 2016) and Denmark (Kitzing & Wendring, 2015).

(4.13) Stakeholder consultation

Participation in the auction can be significantly improved by supporting the dialogue with stakeholders, eg, through the organisation of stakeholder dialogue meetings. For example, an open dialogue with stakeholders has led to broad support for the programme in California (Fitch-Roy, 2015). In Denmark there was a strong stakeholder dialogue in the auction process of Horns Rev 3. Meetings with pre-qualified bidders were reintroduced, after the lack of a possibility for investors to discuss the auction conditions before submitting the final offer had been identified as a reason for the low participation in the previous Anholt auction (Kitzing & Wendring, 2015). In South Africa a conference is organised at the beginning of the auction which, together with a dedicated website, allows the government to communicate any changes to all market agents equally and simultaneously (Río 2016a; and Toke, 2015). These formats to encourage dialogue with stakeholders have not been used in Spain. Stakeholders commented on a first draft of the regulation in the first quarter of 2015 and some changes were made later (for example, the financial guarantee of €50/kW being reduced to €20/kW). There is a formal consultation procedure, through the Consejo Consultivo de la Electricidad, but the sector associations felt that many of the allegations which were presented there have not been taken into account (see APPA's and AEE's –the wind energy association– press releases) (APPA, 2015; and AEE, 2015). Appropriate participation enhancing measures including, eg, a process for stakeholder consultation, sufficient consultation time or sufficient time for bid preparation should be set, as recommended in Kitzing *et al*. (2016).

To sum up, the RES-E auction model in Spain seems to be very different from the approach followed by other EU (and perhaps non-EU) countries in several key respects: investment-based support, uniform pricing, lax prequalification and penalties. The absence of a schedule for regular auctions in the future, the lack of seller concentration rules and a limited stakeholder dialogue process that characterise the Spanish RES.E auction model at present, which can be considered best practices, are also uncommon features of RES-E auctions in most countries.

Yet the outcome of the Spanish auction has been a 100% discount on the standard value of the initial investment of the reference standard plant. Recent auctions from around the world have also shown impressive results in terms of very low bid prices. An analysis of the outcomes of the auctions in 2016 carried out by the International Energy Agency (IRENA) shows that several price records were set during the year: in Chile and the United Arab Emirates for solar PV (with average prices of US$29.1/MWh and US$24.2/MWh, respectively), Morocco for onshore wind (US$30/MWh) and Denmark for offshore wind (US$53.9/MWh). In countries such as Chile and Mexico, renewables were more competitive than conventional energy technologies and won a large share of contracts at record-breaking prices (IRENA, 2017, p. 4). In countries where successive auctions have taken place since 2012, bid prices have experienced a sharp reduction over the years (eg, Peru, South Africa, Morocco, India and France for PV, Italy, South Africa, Morocco and Peru for wind on-shore) (see IRENA, 2017, for details). However, comparing bid prices across countries might be difficult, since the prices are influenced by factors beyond auction design, ie, related to the country's socioeconomic and institutional conditions.

In price-only auctions, strong competition has been a main factor behind the low costs. This has allowed capturing the sharp reductions in the costs of technologies, which is particularly the case with PV. It remains to be seen whether the projects will be built at these very low prices. In multicriteria auctions there is a trade-off between higher positive local impacts and higher bid prices, as shown in the multicriteria auctions in South Africa and Portugal (Río *et al*., 2016a, 2016bc).

Finally, it should be taken into account that other factors affect the success of auctions beyond auction design. For example, an analysis of the case of South Africa has shown that, in addition to programme design, there were other factors that have had an impact on the success of the auction, including programme management factors (such as a high level of political commitment, a supportive institutional setting, the experience and knowledge of the programme management team, the management style, the largely off-budget programme financial resources and the quality of advice given to bidders) and market factors (including the slow-down of RES-E support in OECD markets, favourable characteristics of the South African banking sector and the existence of other advisory services) (Eberhard *et al*., 2014; and Río *et al*., 2016a).

(5) Conclusions

Auctions for RES-E are here to stay. Their widespread implementation everywhere and their institutional push from the European Commission is based on their cost containment potential. Whether the expectations they have raised in terms of high static efficiency and low support cost will be met while simultaneously promoting the deployment of RES-E (effectiveness) will clearly depend on their design. This paper has analysed the design elements of the Spanish RES-E auction, putting them in the context of international experiences and best practices. The new auctions (the first one and those envisaged in 2017) could be expected to contribute to the effective and efficient energy transition which should lead to the decarbonisation of the electricity system. They open up the Spanish market to RES-E investments after a period of stagnation due to the moratorium.

The choice of design elements is instrumental in achieving different (and sometimes conflicting) energy policy goals. Depending on the goals, the choice of one or another design element will make more sense. In short, the choice of a specific design element is generally not a win-win solution and depends on the priorities of the respective governments. And the other way around: the choice of a specific design element reveals to some extent which are the government's main priorities.

Taking these general aspects into account, the analysis of the RES-E auction in Spain has shown that it is quite different from other international experiences regarding key design elements, namely investment-based support, uniform pricing, lax prequalification and penalties. This is partly shaped by the regulatory package in 2013-14, an unprecedented complex regulation that determines a main choice being made, ie, investment-based support. Some 'best practices', such as a schedule for regular auctions, seller concentration rules and organising stakeholder dialogue processes, have been absent in the Spanish auction, but they are also uncommon features of RES-E auctions in most countries. In contrast, other design elements are widespread and are either best practices (disclosure of volumes) or their choice can be justified according to specific criteria (sealed-bid auctions, absence of local content rules, volume defined as capacity, technological specificity and price-only auctions).

Acknowledgements

The author acknowledges support from the European Commission Horizon 2020 programme through the AURES project (Grant Agreement 646172). However, the views expressed in this paper are the author's own and not necessarily those of the AURES project. The author is also grateful to Gonzalo Escribano and Lara Lázaro (Elcano Royal Institute) for their useful comments. The usual disclaimer applies.

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