Back to the future? Rethinking auctions for renewable electricity support

Pablo del Río,

Institute for Public Policies and Goods

CSIC, Spain

Pedro Linares

IIT

Universidad Pontificia de Comillas, Spain

Abstract

The abundant literature on renewable electricity promotion has mostly compared two main types of instruments (feed-in tariffs and quotas with tradable green certificates) according to two criteria: effectiveness and cost-effectiveness. Due to negative past experiences with a third instrument (auctions), this instrument has been broadly dismissed in academics and, until recently, also in policy practice. However, and based on an in-depth review of experiences with auction schemes for renewable electricity around the world, this paper argues that some of the problems with auctions in the past can be mitigated with the appropriate design elements and that, indeed, auctions can play an important role in the future implementation of renewable electricity support instruments around the world[1]. The paper provides a proposal for the coherent integration of several design elements.

1 Introduction. Why should we rethink renewable electricity support instruments?

The abundant literature on renewable electricity (RE) promotion has mostly compared two main types of instruments (feed-in tariffs or FITs and quotas with tradable green certificates (TGCs)) according to two criteria: effectiveness and cost-effectiveness. Effectiveness refers to increases in deployment of RE projects. Cost-effectiveness refers to minimisation of generation and support costs (€/MWh) (see Huber et al 2004). Although

[1] The terms "auction", "tendering" and "bidding" are used interchangeably throughout the text.

usually treated separately, administrative and transaction costs are also part of the cost-effectiveness criterion. Other relevant (and interrelated) criteria include dynamic efficiency concerns (mostly related to the ability of instruments to encourage innovation, technology cost reductions and technological diversity) and social acceptability (mostly related to the NIMBY phenomena, but also to the total costs of RE support).

The literature has traditionally focused on the comparison between FITs and TGC schemes and has shown that FITs have been more effective and cost-efficient than TGCs in Europe. Support levels minus generation costs (€/MWh) have been greater in countries with TGCs than in countries with FITs and in the later countries deployment levels (adjusted by the resource potentials) have also been larger (CEER 2011, European Commission, Ragwitz et al 2007, IEA 2008, 2011). This is (partly) attributed to the high risk and volatile and high TGC prices (e.g., Ford et al 2007). In addition, mature technologies have been oversupported with TGC schemes, since, typically, all technologies receive the TGC price, which is set by the marginal technology needed to comply with the RE quota (Verbruggen 2009, Bergek and Jacobsson 2010). In contrast, FITs have provided greater revenue certainty and stability and, since they usually are technology-specific, support is generally better adjusted to generation costs, although this has sometimes not been the case with immature or expensive technologies with large (yet uncertain) potential for cost reductions, such as solar PV. In turn, auctions, although featuring low prices, have not delivered in terms of installed power (see section 2). Some countries (e.g. Ireland, China, and the UK) have moved from auctions or TGC to FIT-based systems. Auctions have been broadly dismissed in academics and, until recently, also in policy practice.

However, a deeper review does not provide such a clear-cut picture. There are counter-examples of well-functioning TGC systems, such as the Texas RPS (Langniss and Wiser 2003, Swisher and Porter 2006), And, although tendering schemes have proven ineffective in the past, this might be related to the design elements chosen (see sections 2 and 3). In fact, a sensible conclusion of this review is that instrument choice is very context-dependent, but also that the critical element is not the type of instrument, but its design: as usual, the devil is in the details. FIT systems with low support levels resulted in very little installed power (e.g. Greece, see Rowlands 2005). When the tariff was too high, or adjusted too slowly (PV in Spain) the scheme created a bubble that burst with significant collateral damage.

Auctions and FITs share some advantages. In contrast to TGCs, both ensure a reliable, long-term income for RE investors and they also allow regulators to know in advance the level of support awarded[2]. However, under tendering schemes, the total amount of support provided can be more easily capped than under either FIT or TGCs, allowing investors to compete until the whole budget is gone[3]. FIT schemes for solar PV in the past (Spain, Czech Republic, Italy, among others) led to a dramatic increase in the total costs of support and reduced the social legitimacy for all renewables. In addition, auctions deal better with the asymmetric information problem, i.e., they perform better than FITs when trying to know the true level of support required, especially for those technologies with large uncertainties about their cost trends, like off-shore wind[4]. Auctions reveal better the reduction in the costs of technologies over time and allow the support to be adapted accordingly. This ideally brings more efficiency into the system by preventing RE producers to be overcompensated. It also encourages competition between RES-E generators. Banded bidding schemes with pay-as-bid mechanisms allow support to be tied to generation costs, in contrast to TGC schemes (whether banded or not).

An additional argument for auctions is Weitzman (1974), which states that, under uncertainty, when cost curves are rather flat (the usual assumption for most RE technologies, see e.g. Uyterlinde et al 2003, Huber et al 2004), quantity instruments are better than price instruments, since potential mistakes in achieving a predetermined target are smaller.

Unfortunately, these theoretical advantages of auctions come at a cost. Due to the complexity of the bureaucratic procedures, and also to the planning required ahead, auctions have higher transaction costs (Finon and Menanteau 2008) which, together with uncertainties on the final price and the tendering schedule, deter participation by smaller firms, resulting in a low degree of competition (Butler and Neuhoff, 2008), and creating opportunities for market power. In turn, this may eliminate the higher theoretical efficiency of this instrument.

Moreover, if transaction costs are passed through to the final bid price, the cost of support increases. Dynamic efficiency (incentive for innovation) is usually also argued to be lower than under FITs (see section 2). Finally, particularly when the bid price is not the only criterion, the auction process is more opaque than the FIT. In turn, the lower cost of participation of FIT has also allowed for a more inclusive distribution of the benefits (Lipp, 2007), particularly at the local level (Edge, 2006), thus promoting regional development and typically increasing the social acceptability of this instrument. In contrast, Morthorst et al (2005) argues that auctions encourage concentration of RES in certain locations and, thus reduces social acceptability. However, this can also happen with FIT, and in fact, auctions can do better here, by incorporating regional-national coordination mechanisms.

---

[2] In fact, auctions allow them to know the quantity and the price, and therefore the total cost, whereas FIT only reveal the price, but not the quantity, unless complemented with a quantity cap (which can also be ineffective, as shown in the Spanish case).

[3] It can be argued that, since RE generation is capped under TGCs, the total amount of support would also be capped. However, this is not the case, since total support depends on the amount of RE generation times the level of support, which depends on the a priori unknown interactions between the demand and supply sides in the TGC market.

[4] In this case, tendering could reveal the real costs and thus reduce the problem of asymmetric information, leading to higher cost efficiency gains compared to onshore wind (Ruokonnen et al 2010).

One usually cited disadvantage of auctions is that they do not give the right market signals to RE producers, which are therefore not encouraged to produce in peak times, to focus maintenance on lower demand seasons, or, generally, to increase operational efficiency. However, this is not a problem exclusive of auctions, it can also happen with FIT when the tariff is fixed.

Therefore, auctions present advantages and disadvantages compared to FITs and TGCs. However, many of these issues may be minimized by a careful design. In section 2, we review the past experiences with auctions, and identify the major problems encountered so that solutions may be offered in section 3. Our aim is thus to identify key design elements of auctions which would likely result in an effective and cost-effective deployment of RE. This will become even more relevant in the future, due to the coming challenges for RE policy, particularly in Europe: the significant increase expected for the share of RE in power systems (Beurskens and Hekkenberg 2011), and the willingness to harmonize RES-E support policies. The first one will amplify the two arguably major problems of FIT systems: overshooting the tariff, and therefore the RE target and the total cost of the system[5]; and the lack of coordination between national governments (who set the tariff) and regional ones (who usually have the final say in permitting, and also collect some of the benefits of RE installation), which usually results in a loss of efficiency (Iglesias et al 2011). By introducing a price-discovery element and a physical cap, auctions help control the total cost of RE support; and they can also integrate coordination concerns into the auction design. The harmonization of RE policies in Europe will add another layer to this coordination problem

Accordingly the paper is structured as follows. Section 2 reviews past experiences with RE auctions, identifying their main problems. The causes behind these problems are analysed in section 3 in order to understand the role of design elements as a determinant and mitigation factor of those problems. Based on this analysis, section 4 presents a proposal for the design of RE auctions, which addresses all the critical elements. Section 5 concludes.

2. Past and present experiences with auctions: advantages and drawbacks.

There are several experiences with RE auctions from which to learn[6]. Auctions have been used to promote RE development in several countries in Europe and Latin America, Quebec, California, India and China. Tables 1

[5] It may be argued that there is also a problem in undershooting the tariff, and therefore not achieving targets. However, that one is less likely nowadays.

[6] Auctions are not exclusive of RE promotion and, therefore, the field for learning is much broader. Indeed, auctions have been used extensively to allocate public goods such as telecommunication licenses, and also for the procurement of energy. Latin America in particular is a region where auctions have been used recently to a large extent, and for which good assessments of their performance exist (Maurer and Barroso, 2011). Indeed, auctions have been very effective for conventional energy. Why not for RE? These broader applications of auctions will also inform our analysis.

and 2 summarize the main results and design elements of those experiences[7]. The design elements of tenders vary significantly across countries. They refer to several aspects:

-Scope. Whether the bidding procedure is used to set the support level or whether the support level is set by a different instrument (i.e., FITs) and the bidding is used to grant procurement rights to deploy the project. This paper focuses on tendering schemes used to set the support levels.

-Organisation of the tender. Support levels in the tendering procedure may be set in different ways, i.e., either uniform pricing, pay-as-bid, Vickrey or Median price auctions[8].

-Penalties for non-compliance and deadlines. Penalties can be either be a fixed amount (i.e., the performance bond in the Netherlands) or be modulated by the delay (as in Denmark and India). It can be set per MW (as in Quebec, India, Peru and Argentina), per kWh (Denmark) or as a percentage of the investment made (Brazil).

-Banding. Tenders may be technology-neutral (i.e., all technologies are included in the same tender) or they may be technology-specific with are several bands.

-Duration of the project. The length of support affects investors' risks and profitability.

-Other relevant design elements include eligible technologies, requirements for administrative authorizations, minimum or maximum project sizes, maximum (reserve) prices, local content requirements and tender schedule.

---

[7] There are other experiences with tendering schemes for RE, but they are too recent and, to our knowledge there has not been any analysis on their functioning. South Africa switched from a FIT to tenders in 2011. Egypt relies on tenders for large scale onshore wind. Turkey, Indonesia (geothermal), Sri Lanka (large scale RES), Saudi Arabia, Algeria and Chile are other countries which have recently switched or are on the way to switch to tenders (IEA 2011, IEA 2012, Elizondo and Barroso 2011). There is no data yet on some of the experiences reported in table 1. This is the case of California and some EU countries.

[8] Under uniform pricing, the strike price is set by the last bid needed to meet the quota, and all winners receive this price. Under pay-as-bid, the strike price sets the amount of generation eligible for support, but winners receive their bid. Under Vickrey auctions, the winner receives the second best price; the second receives a third best price etc. In median price bids, the median bid price sets the strike price.

Table 1. Design elements of tendering in several countries.

	Scope	Organisation	Penalty	Deadline	Band	Duration (years)	Other	References
Ireland (AER)(1995-2003)	Tender to set support level	Pay-as-bid	No	N.A.	Yes	15	On-shore wind, small-scale hydro, CHP, biomass-landfill gas, biomass-CHP, biomass-anaerobic digestion and offshore wind. Price cap set by the DCMNR. Offers ranked in ascending order of bid price for each type of RES, until there were no more bids of the target capacity or the AER round was met. Requirements for bidders: valid planning permission, Commission for Electricity Regulation authorisation/ licence, evidence of site ownership/leasehold interest and a valid grid connection offer from the network operator.	Finucane (2005), Wiser (2002), DCMNR (2003), Gallachoir et al (2006)
U.K. (NFFO) (1990-1998)	Support level	Uniform pricing until 3rd round. Pay-as-bid since.	No	Grace period in NFFO 5	Yes	8 (NFFO1 and 2) Up to 21 (NFFO3, 4 and 5)	Under NFFO1 (1990), 2/3 of contracted capacity awarded to plants already generating and payments per kWh agreed between authorities and generators before they entered their contract bids. Since NFFO3 (1994): smaller and larger sized wind farm bands, to enable community projects.	Frontier Economics (2001), Mitchel and O´Connor (2004), Madlener and Stagl (2005), Menanteau et al (2002), Butler and Neuhoff (2008), Wiser (2002)
France (EOLE 1996)	Support level (tenders 1996-2004 for wind, 2000-2007 for biomass)	Pay-as-bid	N.A.	N.A.	Only wind initially, other RES>12MW since 2000	15 (EOLE) 15-20 (Law 2000-18)	A committee formed by Ministries, the French Environment Agency and EDF selected the winning projects based on the offer price, the industrial and economic interest and environmental impact of the project, the technology used, the opinion of regional committees and the geographic location of the project.	Gipe (2006), Laali and Bernard (1999), ADEME (2001), CRE (2006), Menanteau et al (2003), Ruoknonen et al (2010)
France (PPI)(1996-2004 for wind, 2000-2007 for biomass)	Support level	Uniform price	Yes	Yes	Yes	10-20		
Denmark	Procurement	Pay-as-bid	Yes	Yes	Only off-	15-20	Long-term plan for the targeted capacity increase.	DEA (2009),

(2008-)	rights				shore		The Energy Agency (DEA) is a "One-stop-shop" for project developers. All Danish offshore wind projects must get permission either through a call for tenders or the open-door procedure. Pre-approved list of sites. Tenders may be cancelled if tender prices are "too" high.	Ruokonen et al (2010), Winkel et al (2011)
Italy (2013-)	Support level	N.A.	N.A.	N.A.	Yes	N.A.	Periodical tenders envisaged. All RES (except biomass) >5MW. Starting price of the auction based on the incentive applying to the last bracket below the installation threshold. Minimum admission requirements for projects and participants.	Winkel et al (2011)
Latvia (2006-2009)	Procurement rights.	FIT	N.A.	N.A.	Yes		-Biomass, biogas, solar, wind. Annual tenders from 1 to 31 October.	Winkel et al (2011)
Lithuania (2009-)	Support level	Pay-as-bid	N.A.	N.A.	Yes	N.A.	Projects >30kW. Hydro, wind, biomass, solar PV.	Winkel et al (2011)
The Netherlands (SDE)(2009-)	Support level	Pay-as-bid.	YES (performance bond of 20M€)	YES (wind farm operational within 5 years).	Wind Offshore	N.A.	The best offers (cost per kWh) are granted subsidy until the budget is gone. Pre-approved list of sites. Non-winners will not have a second chance to offer the project as their permits will be cancelled.	Ruokonen (2010), Winkel et al (2011)
Portugal (2005-2008)	Support level (wind and biomass) Procurement rights (solar PV and small hydro).	N.A.	N.A.	N.A.	N.A.	N.A.	Wind, small hydro, solar PV and biomass	Langniss and Heer (2007), Winkel et al (2011)
China (2003-2009)	Support level	Pay-as-bid	No	No	Wind on-shore >50MW	25(i)	70% of the components should be domestically made and the wind turbines should be assembled in China. Initially, the lowest bid won the tender. Revision in 2005: bid price was given 40% of the total weight in deciding winning bids, reduced to 25% in 2006. In 2007, the wining criterion was set	Yu et al (2009), Wang (2010), Ma (2011), Yu and Zheng (2011), Wang et al (2010), Li (2010), Li et al

							as the bid closest to the average bidding price, excluding the highest and lowest bids. In practice, the bidder offering the lowest price and highest local content wins the bid (Yu et al 2009, Wang 2010).	(2007), Li et al (2006), Cyranoski (2009), Wang et al (2005)
India (NSM)(2009-	Support level	Pay-as-bid	Yes (bid bond: 10000-50000 rupees/MW) and other bank guarantees.	Yes Project should be commissioned within 13 (PV) and 28 (solar thermal) months of PPA signing.	Solar PV (5-10MW 1st round, 5-50MW, 2nd round), and solar thermal (5-100MW)	25	Total capacity of solar PV projects allocated to a Company is limited to 50 MW. Mandatory for all the projects to use crystalline PV cells and modules manufactured in India. Solar thermal: 30% local content in all plants/installations. Thin film PV is exempted. Project Developer needs to submit proof of land possession. Target: 22 GW of solar in 2020, rolled out in three phases. Bidders should have a minimum net worth of $3 million.	Vasandani 2011, Government of India 2011, Bajaj 2012, The Economist 2012, Ghosh et al 2012
California (RAM1, 2011-)	Support level	Pay-as-bid	Yes ($20/kW of contract capacity for projects <5MW, 60$/kW for projects >5MW	Yes. The term start date must occur within 18 months of CPUC approval.	Solar PV	20	Reverse auction. Projects>1MW but <20MW. Four rounds in two years. 761 MW will be procured. Demonstration of site control upon submitting bid; demonstration of developer experience; deployment of a commercialized technology; and filed interconnection application prior to bid submission. Existing capacity eligible for support. Seller concentration rule.	CPUC (2010, 2011, 2012)
Québec (2003-	Support level	Pay-as-bid	Yes	YES (delivery between 2013 and 2015).	Wind on-shore (<25MW)	20 years (3rd call).	Minimum 30% to 60% regional content required for each wind farm. Winning bidders should obtain the administrative permits after the contracts have been signed. Criteria: 30% cost of electricity, 70% non-monetary criteria (feasibility of the project, experience and financial capacity of bidders and regional and regional content. Wind measurement requirements for bidders.	MNRF 2011, Hydro-Québec 2010, Vilder and Godfroy 2009, Lewis and Wiser 2006
Brazil (2007-)	Support level	Pay-as-bid	Yes	Yes (first delivery in July-2012)	Yes	20 (wind), 15 (cogeneration)	-Wind, cogeneration of sugarcane bagasse, small hydro. Requirement of granted environmental licenses prior to participation in auctions. Grid access studies showing a feasible and available connection point. New wind turbines must be used and wind measurement requirements for bidders. If the difference between the lowest bid and other bids is > than 5%, the submitter of the lowest bid wins the tender. If the difference is ≤ 5%, the auctioneer may set minimum amounts to be submitted	ANEEL 2011, Elizondo and Barroso 2011, BNEF 2010, IEA (2012), IEA (2011), Müller et al (2011),

							between the bids. The lowest bid wins the tender.	
Argentina (2010)	Support level	Pay-as-bid	Yes (1000$ per MW of capacity contracted)	Yes (Capacity should be built in two years)	Yes (1-50MW)	15	Wind, geothermal, biomass, solar and small hydro. Equipment should mostly be manufactured or assembled in Argentina. Penalty for non-compliance with this local content requirement.	Cherni 2011, Barroso and Batlle 2011, MPFIPS 2009, MPFIPS 2011, IEA (2011), Müller et al (2011), Giralt (2011)),
Uruguay (2009)	Support level	Successful bidders will receive the average weighted bid price of successful tenders.	N.A.	Yes (projects must come online within three years)	On-shore wind (30 MW -50 MW)	15	Requirement for previous experience (in practice: incorporation of foreign operators). At least 20% of the total investment should correspond to national components. A two-round auction system: first participants bid without transmission costs and they have to rebid with such costs. A single bidder can not contract more than 50MW. Reserve price: 65$/MWh.	Barroso and Batlle 2011, Sciaudone 2011a, Uruguay XXI 2009, MIEM (2011), SoWiTec (2011), Sciaudone (2011b)),
Peru (2009)	Support level	Pay-as-bid	Yes (100000€/kW guarantees required)	Yes (projects should start production before 2013)	Yes	20	Small hydro, wind, solar and biomass. Bi-annual tenders. Reserve prices were not revealed in the first call ex-ante in order to avoid collusion. They were published ex-ante in the second call. Tenders will take place at least every two years.	Mitma 2010, Mitma and Quintanilla 2010, OSINERGMIN 2010, Novoa 2011, Cherni 2011, Rios 2011, Barroso and Batlle 2011),

(1) For the first 30,000 full-load hours (10 to 15 years, based on average Chinese wind resources), the project owner will receive their bid price as the FIT. After 30,000 full load hours, the project owner will receive the average local FIT on the power market at that time (Yu et al 2010).

Source: Own elaboration.

Table 2. Main results of tendering schemes for RES-E around the world.

Country	Effectiveness	Cost-effectiveness.	Other impacts: administrative costs, technology diversity, industrial and local impacts
Ireland (AER)	In all rounds, the electricity commissioned was lower than the objective initially set (built projects were 43% in relation to targets, 33% in relation to MW awarded).		Poor quality of equipment. No biomass-anaerobic digestion or offshore wind projects finally commissioned. High administrative costs reported (administration time around 1 year).
U.K. (NFFO)	Total amount of contracted capacity in all rounds: 3638.9 MW. Installed capacity initially contracted: 960 MW.	The price paid under NFFOs 3, 4 and 5 decreased after each auction the average being 3,3 p/kWh (wholesale electricity price: 2,6 p/kWh).	Low technological diversity: Landfill-gas and wind on-shore projects dominated.
France (EOLE)	Only 70 MW were built (20% of those winning the tenders).	Avg. price of 5.2 ECU cents in first round, higher than the NFFO4 round organized in parallel (but wind resources are better in the UK).	Diversity concerning the location of projects was emphasized. Local aspects and public acceptance were seen as important.
France (PPI)	Construction expected to be completed by 2012. Delays in the calls for tenders for offshore wind.	Avg. FIT obtained during the 2006 call for tender: 128€/MWh. Avg. FIT in the 2009 call for tender: 45€/MWh.	
Portugal (2005-2008)	Positive impact on the contracting of biomass and wind capacity, but most of it has not been built.	Price for wind and biomass was lower than the previous FIT.	-Project concentration regarding wind, leading to NIMBY initially and public opposition.
China Wind Farm Concession Program (2003-2009)	As of 2008, a total of 8800 MW of wind energy contracted in five rounds, expected to come on-line by 2010. Significant delays in connecting to the grid.	Price ranged between 55 US$/MWh and 86 US$/MWh in different wind farm concession projects in 2007 with internal return on investment <8%.	A total of 59 participants, split as follows: 13 (1st round), 8 (2nd), 12 (3rd) and 26 (4th). Administrative costs and time have been low, since it is a negotiated process. Low prices and pressing deadlines have pushed the manufacturing sector to produce poor quality products, with capacity factors of wind farms using domestic technology 5% to 20% lower than those using foreign technology. .Most turbines are imported.

India	Contracted solar capacity: 650MW (1st round, 2010), 350MW (2nd round, 2011). 506.9 MW cumulative installed capacity as of April 2012. Of this capacity, 203.4 MW was commissioned under the NSM. However, by early 2012, the Indian government had fined 14 PV project developers for failing to meet their commissioning deadlines and warned another 14.	Successful in driving down prices: Average prices in round one (2010): 12.25 rupees/kWh, Round two (2011): 8.77 rupees/kWh (17.36-12.43€cent/kWh), about half the fixed price at which the government was initially willing to buy power (15.4 rupees).	Only marginally effective in creating a vibrant domestic manufacturing base. Strong thin film bias. Great geographical concentration. 3/4 of MWs are contracted in Rajasthan
Quebec (2005-2009)	First tender (2005): 990 MW of wind allocated, out of 1000 MW initially tendered. Second call (2008): 2,004 MW of contracted capacity. Electricity production will start between 2011 and 2015.	Relatively low prices, but increasing in the three successive tenders (8.3 ¢/kWh, 10.5¢/kWh and 11.5¢/kWh, respectively.	Several component manufacturing and assembly plants for wind turbines have been built in eastern Québec.
Brazil (2007-2011).	First auction (2007): unexpectedly low participation. 2009 auction (only wind): 1800MW contracted. 2010 auction: wind (2050MW), sugarcane cogeneration (713MW), and small hydro plants (132MW). 2011 auction: wind (976 MW, 81% of total capacity contracted). The construction of some of the first RE plants is already delayed.	2009 auction: 77 US$/ MWh (wind). 2010 auction: US$75/MWh (wind), US$82/MWh (biomass) and US$81/MWh (small hydro), 42% lower than the FITs under the earlier PROINFA scheme. 2011 auction: $56.83/MWh (wind). Bid prices for wind in the lower bound of other countries.	A diverse mix of investors won the contracts. Installation of three wind turbine factories.
Argentina (2010-)	895MW of contracted capacity, 754MW (wind), 110MW (biomass), 10MW (small hydro) and 20MW (solar).	Weighted average price of all bids fixed as auction cutting price: 136 US$/MWh (wind), 259-297 $/MWh (biomass), 150-180 (small hydro) and 547-598 (solar PV).	All RE technologies except large hydro were represented. Minimum required capacity shares in the tender. Wind: 84% of this capacity.
Uruguay (2010-	2010 Tender: auction to acquire 150 MW of wind power expected to come online by 2014. 2011 tender: 192MW contracted.	2010 Tender: prices around 85 US$/MWh. 2011 tender: tender price: 63 $/MWh, i.e., steep reduction.	
Peru (2010-)	2010 tender contracts: 142MW (wind). 180MW (small hydro), 80MW (solar) and 27MW (biomass). Initial quotas were not covered (500 MW for biomass, solar and wind and 500 MW for small hydro).	2010 tender: Average prices: 80 US$/MWh (wind), 60 US$/MWh (small hydro), 221 US$/MWh (solar), 63 US$/MWh (biomass). These prices were 47% (biomass), 27% (wind) and 18% (solar and small hydro) lower than the price cap. 2011 tender prices: 69 US$/MWh (wind), 47-56 US$/MWh (small hydro), 119 US$/MWh (solar) and 63 US$/MWh (biomass).	Winning investors: mostly foreign private companies.

Source: Own elaboration from the references in table 1.

Positive aspects from existing experiences

-Comparatively low support prices. Although there is a lack of data and international comparisons, auctions have delivered prices below other countries. This is the case of Brazil (Elizondo and Barroso 2011), France (Gipe 2006, ADEME 2001, CRE 2006) and U.K. (Ruokonen 2010, Frontier Economics 2001), Ireland (Finucane (2005), DCMNR 2003) and China (Ma 2011), although not in Argentina[9].

-Reductions of support levels over time. Support has been reduced over time with tenders (Butler and Neuhoff 2008). Under the NFFO, prices went down from 2.4-3.1 p£/kWh in 1994 to between 2.43 and 3.1 p£/kWh in 1998 (Ackermann et al 2001). There is similar evidence in Portugal (Langniss and Heer 2007), Peru, Uruguay and Brazil (Barroso and Batlle 2011). Although a greater level of competition is often assumed for tenders, competition between the project developers has not been significant in the U.K. (Lipp 2007). Butler and Neuhoff (2008) observe that the long and non-predictable intervals between NFFO rounds inhibited the development of a competitive market.

Negative aspects from existing experiences.

-Low effectiveness. Ineffectiveness refers to the electricity commissioned being lower than the objective initially set, as in Ireland or to the contracted capacity not being built, as in the U.K. or France[10]. There is also recent evidence of ineffectiveness (not in terms of contracted capacity but regarding projects actually being built) in the case of Portugal, Peru and Brazil (see references in table 2). However, it is too early to tell whether the contracted capacity has led to actual deployment of projects in the recent experiences with tendering.

Several may be the causes of ineffectiveness. In the U.K., the poor installation rate may be attributed to planning restrictions and to the low prices in the bidding procedure, or “underbidding” (Lipp 2007, Edge 2006, Gipe 2011). Those project developers offering the lowest prices were also those with a lower probability to finance the project (Butler and Neuhoff 2008). Since project developers had a 5-year “grace period” in order to initiate their projects, some of them based their bids on the expected significant cost reductions in the following 5 years. Since expectations on cost reductions were not met, and there was no penalty for failing to develop the project, many developers fail to build the project (Ackermann et al 2001, Edge 2006). Edge (2006) argues that the lack of information on the schedule for the next rounds in the U.K. was also detrimental for RE deployment. There is also evidence that underbidding is causing some delays in Brazil (Elizondo and Barroso 2011) and India (Ghosh et al 2012, The Economist 2012).

The uncertainty on the financial viability of the project at the moment of the tender in EOLE2005 led to difficulties for project developers. When the projects were presented to the tender, their economic viability depended on several uncertain

---

[9] Argentina has had comparatively higher prices for wind auctions than in Brazil (IEA 2011, Cherni 2011) and similar wind resource potentials (Barroso and Batlle 2011).

[10] In Nova Scotia (not reported in the table) of the 276MW contracted between 2002 and 2004, only 63MW actually came online (Benjamin 2009).

factors (especially, the availability of materials) which made it difficult to access financing (ADEME 2001). This also happened in Ireland (Finucane 2005). Furthermore, there was some uncertainty in France with respect to the profitability of projects, since developers incurred in high preparation costs (Menanteau et al 2003). However, while these risks were high before the bidding procedure, after winning the tender a project developer had certainty about his operating income and could use and negotiate favourable financing terms.

-Low technological diversity. The instrument has shown a limited ability to promote technologies with different maturity levels. The more expensive technologies were not promoted in the U.K. (Lipp 2007): Waste-to-energy and on-shore wind dominated (Mitchell and Connor 2004). No biomass-anaerobic digestion or offshore wind projects were commissioned in AER (Finucane 2005). This is also the case in Brazil (Elizondo and Barroso 2011) and Argentina (IEA 2011, Cherni 2011). Technology neutrality leads to only a few technologies and a few locations. However, this problem may be circumvented with bands.

-Modest impacts on the early stages of the innovation process. The evidence in this respect is quite thin, although no country that has used bidding exclusively has developed a vibrant and sustainable manufacturing sector. Butler and Neuhoff (2008) suggest that the greater certainty on the return on investments in countries with FITs allows producers to invest more in R&D and consolidate their industrial base with respect to countries with tendering.

-High transaction and administrative costs. Although empirical evidence (i.e., data) is scarce, there is some consensus that transaction costs are high[11], due to the complexity of bidding procedures, the lead times between proposing bids and the start of generation and the project planning before the bidding procedure (Uyterlinde *et al*, 2003, Huber et al 2004). Administrative costs have been reported to be high in EOLE (Gipe 2006), AER (Finucane 2005, Cochet 2000, Szarka 2007) and NFFO (Madlener and Stagl (2005), Menanteau et al (2002))), although in the NFFO and China they were low according to Ruokonen et al (2010) and Li et al (2006). They are likely to be high in the Danish tendering scheme for off-shore wind, given the strong role played by the administration in controlling the location, time and amount of new capacity (Ruokonnen et al 2010). However, administrative costs may be minimized if similar mechanisms are in place. For example, in Colombia, where a tendering system for capacity payments exist, administrative costs have been estimated to be lower than $0.5/MWh (Ceballos, 2012).

-Low social acceptability. It has been argued that the high degree of competition introduced by tendering led to pressure for developers to seek sites of high wind speeds, encouraging concentration of RES-E in certain locations, aggravating the NIMBY syndrome and increasing the hurdles encountered in obtaining planning permissions, as shown by Langniss and Heer (2007) for Portugal and Mitchell and O'Connor (2004) and Redlinger et al (2002) for the U.K. The low level of acceptability is partly attributed to the disincentive to the participation of small actors (Gipe 2011). However, this problem has also occurred in countries using

---

[11] Ireland (Finucane 2005 and DCMNR 2003), U.K. (Agnolucci 2007, Menanteau et al 2003) and France (ADEME 2001).

FITs (i.e., regions of Valencia and Catalonia in Spain) and, as other problems, it can be mitigated through design elements, an issue to which we now turn.

3-. Factors behind these problems.

Table 3 relates the main causes (factors) to the problems discussed in the previous section and suggests design elements that may be behind these factors. The link between problems and factors is discussed below, leaving the discussion on design elements for the next section.

Table 3. Relating problems, factors behind those problems and design elements.

Problem	Factors	Design elements
Effectiveness	-Sporadic, intermittent, stop-and-go bidding rounds -Too short support period. -Support for existing plants. -Underbidding (overestimation of capacity factors), strategic behaviour in bidding. -Difficulties in the planning procedure and planning period required ahead (risks for investors). -Developers are able to back-off without consequences (no guarantees required and no deadlines for constructing the project). -Inherent incentive to concentrate wind farms in specific locations (affecting social acceptability). -Long period between the resolution of the bidding procedure and starting construction.	-Irregular and unknown auction schedules -Short-term contracts -Existing plants allowed to participate -Information failure, particularly for small bidders (underbidding). -Need to obtain planning permits after winning the auction -No regional coordination -Lack of penalties and deadlines for constructing the project
Low social acceptability	-Inherent incentive to concentrate wind farms in specific locations (affecting social acceptability). -Total costs may not be capped.	-No regional coordination -Need to obtain construction permits after winning the auction.
Low level of competition, low participation of small actors, market power (cost-efficiency negatively affected).	-Information failure for small bidders. -Difficult access to finance (especially for small actors). -Too many bands with respect to total tendering capacity may increase the risk of market power. -High guarantees required would deter small bidders.	- High uncertainty and administrative costs that deter participation from small bidders - Auction design not optimized to minimize market power -Inadequate design of banding -High risk for the government (non-compliance) and investors
Total costs	Total costs may not capped.	Auction design.

Low level of technological diversity. Small influence on innovation in immature technologies	Cheapest technologies get most of the installed power.	No banding.
High administrative and transaction costs	-Difficulties in the planning procedure and planning period required ahead (risks for investors).	Design of the auction and administrative process, provision of information.

Source: Own elaboration.

A single factor is unlikely to trigger these negative effects shown in the table and some factors may affect more than one problem, suggesting that some criteria or problems are interrelated. Finally, some problems are not the sole influence of tendering schemes, but are common to other RES-E support schemes (small influence on the innovation in immature technologies, which requires public R&D support).

Below we review the main factors highlighted in the table. A proposal for design elements that address these factors is presented in section 4.

1) Sporadic, intermittent, stop-and-go bidding rounds. The intermittent nature of the calls for tenders results in stop-and-go tender schemes not conducive to stable conditions (EC 2005), leading to greater risks for investors and possibly lower levels of participation, greater bid prices and negative impacts on the RE supply chain[12].

2). Too short support period. Initially, tenders were granted based on short-term contracts. This led to high prices per kWh so that projects could recoup their capital within the short time-span (higher cost of finance). While the cost per kWh may have been high, the total amount of support may not, since support has a short time span. If access to finance is more difficult for smaller actors, these will be more affected by the too short support periods.

3). Contracted capacity awarded to existing plants. Obviously, if contracts are awarded to existing plants (as in NFFO1), there would be fewer resources left for new installations.

4). Underbidding (overestimation of capacity factors), strategic behaviour in bidding. A tender scheme creates competition between bidders and, thus, inherently encourages them to bid as low as possible. However, the evidence in France, Portugal, Nova Scotia, U.K., India, China and Brazil shows that they may overestimate their capacity factors, underestimate their costs (because, for example material costs turn out to be higher than they were expected to be) and follow strategic behaviour in bidding (i.e., win the bid, then adjust)[13]. The low bids in

[12] For example, in the tranche-oriented system of the NFFO, a call for bids was made every 2 years and it was unknown when the next NFFO round would take place.

[13] According to Cochet (2000, p.98), submitted projects in EOLE applied as low as 51€/MWh. The EU Commission (2005) evaluates the French long-term minimal generation cost at 50€/MWh. Gipe (2006) notes that U.K. projects were bid at low prices to win contracts and then when it was realized they were not sufficiently profitable, many bidders walked away. In Brazil, the low prices that resulted

the case of China are related to the especial characteristics of this central-planned economy[14]. Some bidders intentionally underestimated operating costs to get a lower grid-connection price compared to other bidders (Li 2010, Han et al 2009). Underbidding results in delays and projects finally not being built. It is generally coupled with other factors such as lack of penalties, which allows investors to walk away, and long "grace periods" between winning the bid and being required to start construction, which increases the probability that "uncertain" factors such as increase in material costs play a role.

5) Difficulties in the planning/permitting procedure. Difficulties in obtaining planning and other permits increase investors' risks (especially the smaller ones) and transaction costs, acting as a deterrent to investors. Although they are common to other instruments, these problems are aggravated under tenders if the bidding procedure and the granting of administrative permits are not coordinated.

6). Developers are able to back-off without consequences. If there are no deadlines for project construction and no penalties if the project is delayed or not built, then, together with the other factors, ineffectiveness would occur. Successful projects not being built block projects which have not been successful in the tender.

7). The inherent incentive to concentrate power plants in specific locations affects social acceptability by leading to NIMBY phenomena, feeding back negatively to the granting of authorisations.

8). Inappropriate banding. A single band discourages technological diversity, since only the mature technologies are promoted. But too many bands may lead to a lack of qualified bidders in each band and too few actors, reducing the benefits of competition. It may also lead to market power.

9) Unfriendly for small projects and actors. A major empirical lesson of tenders is that they are unsuitable for small installations and smaller actors. Competition may thus be affected. It has been argued that some of the aforementioned factors and, namely, information failure and difficult access to finance, have a disproportionately negative impact on small actors and, thus, that the instrument is not suitable for small actors, suggesting that smaller projects should be promoted with a different instrument (Morthorst et al 2005, Mitchell 1995). It is difficult to tell a priori if encouraging large installation or actors instead of small ones is a negative aspect. Although it is explicitly assumed to be so in the specialised literature, size is a double-edged sword. Larger installations facilitate economies of scale in production but a model of distributed generation calls for

---

from the reserve energy auctions to deploy wind-based generation have raised the fear of non-implementation of projects because of financial insolvency. The 2009 auction did not result in a clear correlation between capacity factors and prices (Elizondo and Barroso 2011). In China, the average resulting price of the tenders has been for some analysts too low (table 2). In India, very aggressive bid prices have caused fears that many projects may not be commissioned (Balasubramanyam 2012, The Economist 2012, Bajaj 2011). In Portugal, support levels were too low for wind and biomass projects to be profitable and these were not built (Langniss and Heer 2007). Underbidding has also occurred in Nova Scotia (Benjamin 2009).

[14] Successful bidders have been state-owned enterprises (SOEs) which are prepared to sacrifice short-term profitability to win the projects. The principle for RES development investment from Chinese SOE is not for profits, but to comply with government targets (Yu et al 2010).

smaller plants scattered around the territory. Furthermore, some RE projects are inherently large (offshore wind and concentrated solar power) and tenders may be particularly suitable for these technologies. In contrast, smaller projects may need to be promoted with another instrument.

4- A revised design for RE auctions. Basic elements of a proposal.

The aim of this section is to address the problems observed in the past implementations of auctions for RE support, and propose an integrated package of design elements that would tackle these problems.

Auction design

There is a large literature on how auctions should be designed to be efficient and effective[15]. Following the literature recommendations, we propose the RE auction to be a hybrid one: a descending-clock phase which will allow for price discovery and minimizes the winner's curse followed by a sealed-bid one which prevents collusion, and also induces a higher participation rate (and probability of success) for small participants[16] (Maskin and Riley, 2000). This indeed has been the system chosen for RE auctions in Brazil. More sophisticated, strategy-proof mechanisms might be included (see e.g. Montero, 2008).

The auction will include potential renewable energy sites. Bidders will submit a price per MWh of electricity produced from every site[17]. The bid must also include an amount of electricity to be produced annually, although the total production does not need to be binding, or can be expressed as a range.

Although having site-specific bids may reduce the overall efficiency of the system, since it may decrease competition and lose some of the cost-cutting that would be facilitated by a greater flexibility, site-specificity is an important feature in order to reduce uncertainty and to achieve good regional coordination (see below).

Once bids are submitted, the auction moves from site-specificity to a global approach: The number of projects awarded is decided globally. And it is not based on the total energy procured or the sites auctioned, but on the total budget available in the overall tender, i.e. bidders do not compete for the energy, but for the money. This mitigates the concerns of policy makers regarding the uncertainty about the total costs of RE support, which is very convenient for budgetary purposes but also for allocating that cost to e.g. electricity consumers. This issue will become even more relevant as RE penetration increases[18].

---

[15] We will not review this literature here. We rather direct interested readers to Klemperer (2004) or Cramton (2009) for an overview of general and natural resource auctions, respectively, and to Maurer and Barroso (2011) for a more energy-sector-specific analysis.

[16] Therefore addressing simultaneously the problem of social acceptability

[17] This auction does not consider existing facilities.

[18] An alternative for controlling the cost (and also to deal with collusive behaviour) would be to set a reserve price. However, this usually biases the results of the auction when known beforehand since

Therefore, bids are ordered from cheapest to most expensive, and are awarded for all sites until the total budget available is gone. Every winning producer receives the amount he bids for a specific site, i.e., it is a pay-as-bid system. Unlike uniform pricing, pay-as-bid allows support to be adjusted to the costs of different bidders, reducing the overall policy costs.

Technology-specific tenders (bands)

The total budget is allocated to different technologies and, thus, technology-specific caps on total amount of support are available. This mitigates the concerns that a single technology band may lead to a low deployment level of immature technologies. Bands also have disadvantages: they lead to a fragmentation of the tendering process and, thus, lower competition levels. Criteria for setting quotas for different technologies should be defined.

Pre-approved list of technology-specific RE sites

The list of technology-specific RE sites should have several characteristics:

- It should have been agreed by national and regional/local governments[19]. Regional governments could present their candidates, and then decide jointly how to allocate the total amount of sites to auction for each region, in order to keep a reasonable geographical balance. If the budget comes from the national government, this decision will clearly involve a regional distribution of funds, so regional governments will have an incentive to maximize the installed power allocated to them. Thus, it is important for the national government to participate, and eventually, have the final say, in order to control the location of sites and the total amount of capacity to be deployed[20].
- When the final list is decided, regions should grant a pre-approval for the installation license. This removes most of the uncertainty in the construction process, and also maximizes the likelihood that the projects will actually be built.
- The list should also be approved by the Transport System Operator which may introduce considerations regarding the cost of RE integration into the grid, and also take these sites into account for grid planning.

This pre-approved list, and the volume of information that accompanies it (including resource measurements, ideally conducted by independent, verified bodies), will minimize transaction and administrative costs, since then the processes is much more streamlined before and after the auction. It will also remove part of the information failure affecting smaller bidders, and also the

bidders tend to propose bids marginally close to that price. Reserve prices might be set either too high or too low.

[19] Although this design element is of utmost relevance for countries with a federal structure, this framework can be extended to the supra-national level, something very relevant in the European context with the desire to harmonize support mechanisms.

[20] Indeed, the lack of coordination of the national and regional levels has proven to be a problem in Spain (see Iglesias et al 2011).

uncertainties in estimating the revenues of the RE plants. It addresses a main source of ineffectiveness in previous experiences, i.e., the granting of permits. This is different to requiring bidders to have their sites previously approved, which increases participation costs, because bidders must incur significant costs to get permits, which are sunk costs if they do not win the auction. In our proposal, the cost falls on the auctioning entity. Thus, risks are minimized and not transferred to bidders.

Auction schedule

In order to avoid stop-and-go problems, a schedule for regular auctions to be organised by the regulator should be published with sufficient anticipation (i.e., 3 years, depending on the technology). This provides more certainty to investors, avoids stop-and-go of the renewable industry and facilitates the budgeting and allocation of RE support costs. A long-term, regular and high-frequency schedule for auctions gives certainty to investors and technology developers about a future market for their technology, encouraging technological progress. To address the risk of underachievement, monitoring provisions should be included, allowing changes in the design to dynamically correct deviations from the expected goal.

Minimum number of bidders.

This may be required to prevent that, if there is only a single bidder, he captures the whole budget with a very high bidding price (given that there is no reserve price) and relatively small deployment (generation). Seller concentration rules might be implemented as done in California, India and Portugal[21]. Another alternative would be to cancel the biding procedure if the bidding price is excessively high (as done in Denmark for off-shore wind), but this would involve an arbitrary administrative decision, entailing substantial investors' risks.

Contracts awarded

Each project winner will sign a long-term contract (typically 10 to 20 years, depending on the technology) with the relevant entity (be it the market operator, the system operator, or the utility). Long-term contracts make it easier to raise finance and may lead to lower bid prices[22]. Contracts may differ depending on the technology: when it is interesting (and feasible) for the technology to receive the electricity market signal so that it can improve its operational efficiency, then it could be a contract-for-differences (Rivier et al, 2008), cleared at an annual basis. This way the RE producer ensures receiving a guaranteed income, while simultaneously encouraging him/her to operate when the system needs it most (i.e., at peak times, when electricity prices are higher). An alternative is to use a fixed

---

[21] In California, one seller could not contract for more than 50% of capacity or revenue cap in each auction (across all bids) (CPUC 2009). In Portugal successful bidders in one round can not participate in the next round (Langniss and Heer 2007). In India, the total capacity of solar PV projects to be allocated to a company is limited to 50 MW.

[22] A longer duration period in NFFO3 (15 years) with respect to the NFFO2 was one of the factors leading to a reduction in the price, since the capital repayment costs per kWh decreased (Ruokonen et al 2010).

tariff with the obligation to pay balancing costs (Batlle et al, 2012), or as a take-or-pay contract (Johnston et al, 2008).

The contracts should include minimum and maximum levels of electricity generation (as in Brazil), again to ensure a correct performance and integration into the system.

Penalties for non-compliance

One of the usual problems of existing auction schemes is that, after winning the auction, many projects were not built because, among other factors, there was no penalty to ensure construction. Therefore, some penalty, which can be implemented as a requirement for a guarantee, should be implemented to deter winners from not building.

It may be pointed out that penalties may just increase the cost and that, by themselves, they will not ensure that projects are built; they may also deter participation, especially of small actors, and, thus, reduce the number of bids and competition[23]. If there is a significant risk of not complying (i.e., paying the penalty), the bidder will include that into the bid price, and the project may still not be implemented.

However, the risks which cannot be controlled by bidders (RE resources, permitting process) have already been mitigated by the list of pre-approved RE sites, so the penalty is just a last-resort instrument to deter speculative behaviour and unreasonably low bids. That is, credibly enforced penalties do not mitigate those risks, the other design elements do. So it is an issue of how penalties should be implemented and what their level should be rather than whether they should be there. There are mostly two alternatives: progressive penalties and performance bonds, or some combination of both[24]. Their level should neither be too low (rendering them meaningless) nor too high (discouraging participation by actors).

Deadlines for construction

Another relevant issue, related to the above, is whether to set a deadline for the winner projects to be built if they are to receive the contract, and how long this deadline should be. A short deadline increases investors' risks (of not deploying the project) and may put upward pressure on bids. A longer deadline will allow technology progress to take place, and therefore may result in lower expected prices for RE. However, it may also induce overoptimism, and introduce significant uncertainty into the process. Therefore, we suggest setting short technology-dependent deadlines so that uncertainty (and also overoptimism) is minimized.

---

[23] Peru provides an example of too high bids discouraging participation of actors, especially small ones. Initial quotas in Peru were not covered (500 MW for biomass, solar and wind and 500 MW for small hydro). One of the reasons for the relatively low participation in the first call was the high guarantees required (between 20000 and 100000€/kW) (Novoa 2011).

[24] Progressive penalties for delays and non-compliance have been adopted in Denmark. Penalties (€/kWh) increase over time. A performance bond of 20M€ that the bidder has to place before participating in the tender and that the state can cash in case the developer fails to build the plant in time has been implemented in the Netherlands.

This may even be incorporated in the scoring of the auction (Lewis and Bajari, 2011).

5.- Conclusions

The future brings many challenges for RE policy, including the need to adapt to a much greater penetration of RE into electricity systems, with its corresponding more salient costs, requirements for coordination between administrative levels and impacts on the rest of the electricity system. At the European Union level, an additional challenge is the aspiration towards the harmonization of RE support.

Controlling the cost of RE support is absolutely critical for its political feasibility and social acceptability. Cost containment involves an adaptation of support levels to technology costs and the absence of excessive total costs (generation times support levels). FITs do not necessarily do the job, since the regulator does not necessarily know the real costs of the different RE technologies and their evolution and, thus, support levels are likely to be set high above technology costs. While FITs have proven better than TGCs in adjusting support levels to the costs of low-cost gap technologies (i.e., on-shore wind), this has not been the case with high-cost gap ones (i.e., solar PV). While TGCs hardly support the most expensive technologies (Verbruggen 2009, Bergek and Jacobsson 2010), support levels under FITs for these technologies have been excessive in some countries (Spain, Czech Republic and Italy for solar PV).

Therefore, other instruments may be required which, by providing better information about the real cost of technologies, help adjust the total costs of RES-E support. Auctions have some advantages compared to FIT, whereas their disadvantages can be minimized (although probably not eliminated) through a careful design. Auctions place regulators in the right place: rather than have them guess industry costs, they will become providers of public information. In addition, by incorporating a coordination mechanism, this instrument ensures an efficient interaction between the different administrative levels involved in RE deployment. The lack of coordination between different entities has been one of the factors for the past problems, with auctions, FITs or TGCs.

In this paper we have presented a proposal for the design of auctions for RE, which, besides addressing some of their major problems, includes also elements to control the total cost of the support and to facilitate the coordination between different administrative entities.

Of course, one size does not fit all, and this is not a perfect solution for all countries and technologies. The choice of instrument and its design should be context-dependent and technology-dependent. Tendering may work for certain situations and aspects (promotion of large projects and actors) and not for others. Auctions will be more successful in mature, stable markets, with a sufficient number of players to achieve competition (Elizondo and Barroso (2011). However, other less-mature, smaller markets may also benefit from this instrument, provided that there is enough regulatory and administrative capacity (Maurer and Barroso, 2011).

Finally, political economy considerations should be very present when designing RE support systems, and may clearly affect the outcome. Indeed, stakeholders' interests may explain why some systems are chosen over others. Why, for example, have auctions been abandoned instead of trying to fix them? Was it because the major players pressed against them, and for a system where they could do better? It may be argued that auctions are difficult to sell politically because the only agent that is better off with them is the consumer (and its representative, the regulator). Developers, investors, or manufacturers all stand to lose, given the reduction induced in the producer surplus. Unfortunately, the consumer is usually underrepresented in the political process, and has less bargaining power in this field[25]. But that does not mean that we should disregard the merits of RE auctions, and that our proposal is useless. We believe it addresses some of the political feasibility issues, and that its implementation is perfectly viable, at least in most European countries.

Acknowledgements

This paper was presented at the Energy Economics Group at the Technical University of Vienna, on May 2012. We would like to thank attendants to this presentation for their comments. Comments made by Gonzalo Sáenz de Miera (Iberdrola) and Félix Hernández (CSIC) to a previous version of this paper are also gratefully acknowledged. Pedro Linares acknowledges partial support from the Spanish Ministry of Economy and Competitiveness (ECO2009-14586-C02-01). The usual disclaimer applies.

References

Ackermann, T., Andersson, G., Söder, L. (2001). "Overview of government and market driven programs for the promotion of renewable power generation". Renewable Energy 22:197–204.

ADEME (2001). *Éolien : un développement programmé*. Lettre ADEME n. 75, Mars 2001.

Agencia Nacional de Energía Electrica (ANEEL)(2011). *Transmission auction lots negotiated with average discount of 53.27% 10/06/2011* www.aneel.gov.br/

Agnolucci, P. (2007). "The importance and the policy impacts of post-contractual opportunism and competition in the English and Welsh non-fossil fuel obligation". Energy Policy 35(1): 475-486.

Bajaj, V. (2011). "In Solar Power, India Begins Living Up to Its Own Ambitions". The New York Times. December 29th.

Balasubramanyam, K. (2012). "Sunny side up". Business today, February 5th.

Batlle, C., Barroso, L. (2011). "Support schemes for renewable energy sources in South America". MIT-CEEPR Working Paper 11-001.

---

[25] For example, if investors/developers oppose this system and are well organized they could refuse to bid and therefore stall the system.

Batlle, C., Pérez-Arriaga, I., Zambrano-Barragán, P. (2012). "Regulatory design for RES-E support mechanisms: Learning curves, market structure and burden – sharing". Energy Policy 41: 212-220.

Benjamin, C. (2009). "Wind power breaks down in Nova Scotia". The Coast. September 10th. http://www.thecoast.ca/halifax/wind-power-breaks-down-in-nova-scotia/Content?oid=1263640

Bergek, A., Jacobsson, J. (2010). "Are Tradable Green Certificates a cost-efficient policy driving technical change or a rent-generating machine? Lessons from Sweden 2003–2008". Energy Policy 38(3): 1255-1271

Beurskens, L., Hekkenberg, M. (2011). Renewable Energy Projections as Published in the National Renewable Energy Action Plans of the European Member States. Report ECN-E--10-069.

BNEF (2010). *Wind Tender Analysis in Brazil: Winner's Curse?. Research Note BNEF.* London.

Butler, L., Neuhoff, K. (2008). "Comparison of Feed-in Tariff, Quota and Auction Mechanisms to Support Wind Power Development". Renewable Energy 33: 1854-1867.

California Public Utilities Commission (CPUC)(2009). *System-Side Renewable Distributed Generation Pricing Proposal Energy Division Staff Proposal* - August 26, 2009.
http://docs.cpuc.ca.gov/efile/RULINGS/106275.pdf

Ceballos, A. (2012). *Incentivos para el desarrollo de la generación de electricidad a partir de fuentes de energía renovable en Colombia. Master Thesis.* Universidad Pontificia Comillas.

CEER (2011). *Report on Renewable Energy Support in Europe. Ref: C10-SDE-19-04a.*

Cherni, J. (2011). *Promotion of Renewable Energy in Latin America: Policy and Lessons. Magnum Custom Publishing New Delhi, India*

Cochet Y. (2000). *Stratégie et moyens de développement de l'efficacité énergétique et des sources d'énergie renouvelables en France, Rapport au Premier Ministre, September.*

CPUC (2010). *Decision adopting the renewable auction mechanism. Date of Issuance 12/17/2010.* http://www.cpuc.ca.gov/

CPUC (2011). *Resolution E-4414. Pacific Gas and Electric Company, Southern California Edison Company, and San Diego Gas & Electric Company. August 18, 2011* http://www.cpuc.ca.gov/

CPUC (2012). Submission of Contracts for Procurement of Renewable Energy Resulting from the Renewable Auction Mechanism (RAM) Solicitation. Advice Letter 2712-E http://www.cpuc.ca.gov/

Cramton, P. (2009). How Best to Auction Natural Resources. In: Philip Daniel, Brenton Goldsworthy, Michael Keen, and Charles McPherson (eds.), Handbook of Oil, Gas And Mineral Taxation, Chapter 10, Washington, DC: IMF.

CRE (2006). *Avis sur le projet d'arrêté fixant les conditions d'achat de l'électricité produite par les installations utilisant l'énergie mécanique du vent telles que visées par l'article 2(2°) du décret n. 2000-1196 du 6 Décembre 2000, 27 July 2006.*

Cyranoski D. (2009). "Renewable energy: Beijing's windy bet". Nature 457: 372–4.

DCMNR (2003). *Consultation document, Options for future renewable energy policy, targets and programmes – DCMNR, 22nd December 2003, prepared for the Department of Communications, Marine and Natural Resources by SEI, Section 4.*

DEA (2009). Tender specifications for Anholt offshore wind farm 30 April.

Edge, G. (2006). A harsh Environment: The Non-Fossil Fuel Obligation and the U.K. Renewables Industry. In: Mallon, K. (ed.). Renewable energy policy and politics: a guide for decisión-making. London: Earthscan, 163-184.

Elizondo, G. Barroso, L. (2011). *Design and Performance of Policy Instruments to Promote the Development of Renewable Energy: Emerging Experience in Selected Developing Countries. Discussion Paper 22. World Bank.*

European Commission (2005). *Commission Staff Working Document SEC(2005) 1571. Annex to the Communication from the Commission. The support for electricity from renewable energy sources—impact assessment {COM(2005) 627 final}. Brusselas.*

Finon, D., Menanteau, P. (2008). "The Static and Dynamic Efficiency of Instruments of Promotion of Renewables". Energy Studies Review 22(1): 53-83

Finucane, M. (2005). Ireland-RE Support. "Mecanismos de Retribución y Desarrollo de las Energías Renovables". Club Español de la Energía. Madrid. May 18th.

Ford, A., Vogstad, K.. Flynn, H. (2007). "Simulating price patterns for tradable green certificates to promote electricity generation from wind". Energy Policy 35(1): 91-111

Frontier Economics (2001). Evaluation of DTI Support for New and Renewable Energy under NFFO and the Supporting Programme, December 2001DTI Evaluation Report Series No. 5

Gallachoir, B.P.O., Bazilian, M., McKeogh, E. (2006). Moving from Competitive Tender to Feed in Tariff - Wind Energy Policy in Ireland. Proc. European Wind Energy Conference. Athens.

Giralt, C. (2011). "Energía eólica en Argentina: un análisis económico del derecho". Revista Letras Verdes: 9.

Gipe, P. (2006). *Renewable Energy Policy Mechanisms*. http://www.wind-works.org/FeedLaws/RenewableEnergyPolicyMechanismsbyPaulGipe.pdf

Gipe, P. (2011). *Request for Proposals, Bidding, & Tendering: Successful Policy Mechanisms or Multiple Paths to Failure?* http://www.wind-works.org/FeedLaws/RFPsSuccessfulPolicyMechanismsorMultiplePathstoFailure.html

Government of India (2011). Jawaharlal Nehru National Solar Mission. Ministry of New and Renewable Energy (MNRE). http://www.indiaenvironmentportal.org.in/files/file/jnnsm-gridconnected-24082011.pdf

Ghosh, A. (2012). *Laying the Foundation for a Bright Future Assessing Progress Under Phase 1 of India's National Solar Mission. Council on Energy, Environment and Water Natural Resources Defense Council. New Delhi.*

Han, J., Mol, A., Lu, Y., Zhang, L. (2009). "Onshore wind power development in China: challenges behind a successful story". Energy Policy 37(8): 2941–51.

Heer, K., Langniss, O. (2007). *Promoting Renewable Energy Sources in Portugal: Possible Implications for China. Centre for Solar Energy and Hydrogen Research Baden-Württemberg, Stuttgart.* http://www.resource-solutions.org/pub_pdfs/Heer.and.Lagniss.Portugal.Study.pdf

Hydro-Québec (2010). Appel d'offres de 2 000 MW d'énergie éolienne initié par le gouvernement du Québec. http://www.hydroquebec.com/distribution/fr/marchequebecois/index.html

Huber, C. et al. (2004). *Green-X. Deriving optimal promotion strategies for increasing the share of RES-E in a dynamic European electricity market. Final report of the project GREEN-X, Energy Economics Group. Technical University of Viena.*

International Energy Agency (IEA) (2008). Deploying renewables. Paris.

IEA (2011). Deploying renewables. Paris.

IEA (2012). Global Renewable Energy Policies and Measures Database. www.iea.org/textbase/pm/?mode=re.

Iglesias, G., del Río, P., Dopico, J. (2011). "Policy analysis of authorisation procedures for wind energy deployment in Spain". Energy Policy 39(7): 4067-4076

Johnston, A., Kavali, A., Neuhoff, K. (2008). "Take-or-pay contracts for renewables development". Energy Policy 36: 2481-2503.

Klemperer, P. (2004), Auctions: Theory and Practice, Princeton University Press.

Laali, A.R., Benard, M. (1999). "French Wind Power Generation Programme Eole 2005. Results of the first call for tenders". Renewable Energy 16: 805-810.

Langniss, O., Wiser, R. (2003). "The renewables portfolio standard in Texas: an early assessment". Energy Policy 31(3): 2003, 527–35.

Lewis, J.I., Wiser, R. (2006). *Support localization of wind technology manufacturing through large utility tenders in Quebec: lessons for China. Centre for Resource Solutions.*

Lewis, G., Bajari, P. (2011)." Procurement Contracting With Time Incentives: Theory and Evidence". The Quarterly Journal of Economics 126 (3): 1173-1211

Li J, Shi J, Xie H, Song Y, Shi P. (2006). *A study on the pricing policy of wind power in China. CREIA, GWEC/Greenpeace.*

Li, J., Gao, H., Shi, P., Shi, J., Ma, L., Qin, H., Song, Y. (2007). *China wind power report. Beijing: China Environmental Science Press.*

Li, J. (2010). "Decarbonising power generation in China—Is the answer blowing in the wind?" Renewable and Sustainable Energy Reviews 14(4): 1154–1171

Lipp, J. (2007). "Lessons for effective renewable electricity policy from Denmark, Germany and the United Kingdom". Energy Policy 35: 5481–5495

Ma, J. (2011). "On-Grid Electricity Tariffs in China: Development, Reform, and Prospects". Energy Policy 39: 2633-2645.

Madlener, R., Stagl, S. (2005). "Sustainability-guided promotion of renewable electricity generation". Ecological Economics 53: 147– 167

Maskin, E., Riley, J. (2000). "Asymmetric Auctions" Review of Economic Studies 67: 413–438.

Maurer, L., Barroso, L. (2011). *Electricity auctions : an overview of efficient practices. World Bank. Washington.*

Menanteau, P., Finon, D., Lamy, M. (2002). "Feed-in-tariffs versus quotas: how to promote renewables and stimulate technical progress for cost decrease?" ENER Bulletin 25.02.

Menanteau, P., Finon, D., Lamy, M. (2003). "Prices versus Quantities: Choosing Policies for Promoting the Development of Renewable Energy". Energy Policy 31: 799-812.

Ministère des Ressources naturelles et de la Faune (2011). *Wind energy projects in Québec November 29, 2011.* http://www.mrn.gouv.qc.ca/english/energy/wind/wind-projects.jsp

Ministerio de Industria, Energía y Minas (MIEM)(2011). *Incremento de la generación proveniente de fuente eólica*. http://www.energiaeolica.gub.uy/

Ministerio de Planificación Federal, Inversión Pública y Servicios (MPFIPS). (2009). *Programa "GENREN" Licitación de generación eléctrica a partir de fuentes renovables. MPFIPS and Enarsa.*

Mitchell, C. (1995). "The renewables NFFO. A review". Energy Policy 23(12), 1077-1091.

Mitchell, C., Connor, P. (2004): "Renewable Energy Policy in the UK 1990-2003" Energy Policy 32(17): 1935-1947.

Mitma, R. (2010). "Resultados de la primera subasta de suministro de electricidad con energías renovables". Revista De la Red de Expertos Iberoamericanos en Energía 7: 9-14.

Mitma, R. Quintanilla, E. (2010). Peru: Análisis económico de la subasta de electricidad con energias renovables. 5º Congreso Iberoamericano de Regulación Económica. Lima, 24 de noviembre de 2010.

Montero, J.P. (2008). "A Simple Auction Mechanism for the Optimal Allocation of the Commons" American Economic Review 98(1): 496–518

Morthorst, P.E., Jorgensen, B., Chander, H., Kjaer, C. (2005). *RE-Xpansion.Evalution of renewable support schemes. Final Report.*

MPFIPS (2011). *Detalle de adjudicación GENREN. Adjudicación de Contratos de Abastecimiento de Energía Eléctrica a Partir de Fuentes Renovables.*

Novoa, A. (2011). Interview. http://www.youtube.com/watch?v=k4Ait73Ab3Y

OSINERGMIN (2010). "Régimen remunerativo de la generación eléctrica basada en recursos energéticos renovables". El Informativo 4: 1-8

Ragwitz, M., A. Held, G. Resch, T. Faber, R. Haas, P.E. Morthorst, S.G. Jensen, R. Coenraads, M. Voogt, G. Reece, I. Konstantinaviciute, B. Heyder (2007). *Assessment and optimisation of renewable energy support schemes in the European electricity market. Final report of the OPTRES project,* http://www.optres.fhg.de/

Redlinger, R., Andersen, P., Morthorst, P.E. (2002). *Wind energy in the 21st century.* United Nations Environment Program. Antony Rowe, Great Britain.

Rios, A. (2011). Análisis del proceso de subasta de energías renovables en el Perú.

Rivier, J., Passey, R., Macgill, I., Outhred, H. (2008). *Contracts for Differences: a possible new role in supporting renewable energy generation. IIT Working Paper*

Rowlands, I. (2005). "Envisaging feed-in tariffs for solar photovoltaic electricity: European lessons for Canada". *Renewable and Sustainable Energy Reviews* 9: 51–68

Ruokonen, J., Sinnemaa, A., Lumijärvi, A., Nytun-Christie, I. (2010). *Opportunities to utilise tendering as a part of a feed-in tariff system. Final Report JR-100115-P7320-007.*

Sciaudone, C. (2011a). "Uruguay tender. Bids chosen amid claims of irregularities". Recharge January 28th 2011. www.rechargenews.com

Sciaudone, C. (2011b). "UTE sticks to Uruguay wind tender verdict despite criticism". Recharge June 6 2011 www.rechargenews.com

SoWiTech (2011). Uruguay wind-power prices fall sharply in second tender

Swisher, R., Porter, K. (2006). "Renewable Policy Lessons from the U.S.: The Need for Consistent and Stable Policies. In: Mallon, K. (ed.). Renewable energy policy and politics: a guide for decisión-making. Earthscan, London, 185-198.

Szarka, J. (2007). "Why is there no wind rush in France?" European Environment. 17(5): 321–333.

The Economist (2012). Solar power in India. April 28th.

Uruguay XXI (2009). *Renewable Energy in Electric power generation. Uruguay XXI (Investment and export promotion agency). http://www.uruguayxxi.gub.uy/*

Uyterlinde et al (2003). *Assessment and Dissemination of Major Investment Oppprtunities for Renewable Electricity in Europe using the REBUS tool. Final Report of the EU-funded ADMIRE-REBUS project. ECN, Petten.*

Vasandani, B. (2011). NVVN Guidelines for Batch II Phase I Solar Projects.

Verbruggen, A. (2009). "Performance evaluation of renewable energy support policies, applied on Flanders' tradable certificates system". Energy Policy 37(4): 1385–1394.

Vilder, S., Godfroy, A. (2009). *Developments Regarding Calls for Tenders in Quebec in Wind Energy and Biomass Cogenerated Energy Industries*

Wang, Q. (2010). "Effective policies for renewable energy—the example of China's wind power—lessons for China's photovoltaic power". Renewable and Sustainable Energy Reviews, 14(2): 702-712.

Wang, W., Yin, H., Li, S. (2010). "China's renewable energy policy: Commitments and challenges". Energy Policy 38: 1872–1878.

Wang, Z., Hu, R., Qin, H., Yang, X., Shi, P., Li, J., Qi, H. (2005). *National action plan for wind power industralisation. Report prepared for CRESP*

Weitzman, M.L. (1974). "Prices vs quantities". The Review of Economic Studies 41(4), 477–491.

Winkel, T., Rathmann, M., Ragwitz, M., Steinhilber, S., Winkler, J., Resch, G., Panzer, C., Busch, S., Konstantinaviciute, I. (2011). *Renewable energy policy country profiles. Report prepared within the Intelligent Energy Europe project RE-Shaping.* www.reshaping-res-policy.eu

Wiser, R. (2002). *The U.K. NFFO and Ireland AER Competitive Bidding Systems. Berkeley Lab and the Clean Energy Group* http://eetd.lbl.gov/ea/ems/cases/

Yu, J., Ji, F., Fuxing, J., Zhang, L., Chen, Y. (2009). "An overpainted oriental arts: evaluation of the Chinese renewable market". Energy Policy 37: 5221–5225

Yu, J., Zheng, J. (2011). "Offshore wind development in China and its future with the existing renewable policy". Energy Policy 39(12): 7917-7921

Yu, X. (2010). "An overview of legislative and institutional approaches to China's energy development". Energy Policy 38(5): 2161-2167.

Winkel, T., Rathmann, M., Ragwitz, M., Steinhilber, S., Winkler, J., Resch, G., Panzer, C., Busch, S., Konstantinaviciute, I. (2011). *Renewable energy policy country profiles. Report prepared within the Intelligent Energy Europe project RE-Shaping*. www.reshaping-res-policy.eu

Wiser, R. (2002). *The U.K. NFFO and Ireland AER Competitive Bidding Systems. Berkeley Lab and the Clean Energy Group* http://eetd.lbl.gov/ea/ems/cases/

Yu, J., Ji, F., Fuxing, J., Zhang, L., Chen, Y. (2009). "An over-painted oriental arts: evaluation of the Chinese renewable market". Energy Policy 37: 5221–5225

Yu, J., Zheng, J. (2011). "Offshore wind development in China and its future with the existing renewable policy". Energy Policy 39(12): 7917-7921

Yu, X. (2010). "An overview of legislative and institutional approaches to China's energy development". Energy Policy 38(5): 2161-2167.