OBTAINING BEST VALUE FOR MONEY IN RES AUCTIONS: A CAPACITY-BASED WITH AN EMBEDDED MENU OF CONTRACTS APPROACH

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Abstract

Climate change mitigation and cost reductions are driving the development of larger shares of renewable energy sources (RES) worldwide, particularly wind and solar PV. As the impact of RES on energy markets has become more noticeable, the appropriate design of support schemes, still needed in many jurisdictions, has gained in importance within the policy agenda. Production-based mechanisms promote the maximization of the energy yield of RES capacity but distort efficient short-term market operation. The alternative approach, capacity-based support schemes, avoid market distortions, but may not lead to the installation of the highest-value RES capacity. This paper proposes a new auction-based RES support scheme aimed at minimizing market distortions while at the same time trying to maximize energy outputs. The key feature of this mechanism is that the support includes a capacity-based payment (€/MW) and a bonus payment that depends on the operational profits earned by the RES generators from their market participation, to discriminate in favor of those installations which market value is larger. The incentive properties of this scheme are illustrated with a simple case study and some future developments are discussed.

Keywords

Renewable Energy Sources, power system economics, renewable support schemes, auction design.

1 INTRODUCTION

Most widely used RES support schemes have been production-based incentives, i.e. plain or more sophisticated versions of the so-called feed-in tariffs and feed-in premia, renewable portfolio standards or production tax credits. These mechanisms have proven to distort an efficient RES operation as they incentivize to generate below marginal costs, which has led negative prices in a good number of markets, e.g. Germany or Texas (IEA, 2016). Even if not so shocking, supported CHP generation below marginal cost of operation (usually linked to the natural gas price) is also widespread.

The more straightforward solution to the previous distortion is to avoid directly linking the support to the volume of energy produced, so as to prevent operational inefficiencies (Huntington et al., 2016). RES generation supported through these capacity-based schemes enjoys two income streams: (i) the subsidy (€/MW) for each MW of installed capacity and (ii) the revenues (€/MWh) obtained in the electricity markets in which they operate in.

The main problem related with capacity-based support mechanisms is that, as they depend on the investment costs vs operating profits trade off, they do not necessarily promote the maximization of the energy yield of RES capacity. This is a relevant issue in most jurisdictions, due to the fact that the targets set by policy makers, as for instance the RES objectives in the EU (European Commission, 2016) are expressed as a minimum RES energy production (expressed in MWh, as for instance a percentage of energy demand). Thus, it is in most cases perceived that the required RES capacity is the one that has high capacity factor or conversely the one that produces energy with a high market value (for it produces when most needed for the system).

Regardless of whether production- or capacity-based support schemes are used, auctions are already widely used worldwide to determine the level of support, i.e. the remuneration per MW or MWh received by RES generators. Auctions are widely considered a powerful policy tool to reveal technology costs in an environment with rapidly changing and uncertain costs (Maurer & Barroso, 2011; IRENA & CEM, 2015).

RES auctions are usually technology-specific, i.e. there are auctions exclusive for solar PV, onshore wind and so on. Nonetheless, auctions that allow the simultaneous participation of different technologies are increasingly found. In order to clear the auction, bids must be ordered according a common metric. In principle, this is rather straightforward, when auctioning any sort of volumetric fee (production-based support schemes) the order is based on €/MWh bids, while for the case of capacity-based ones would be based on €/MW installed bids. But with these latter is which obviously we hit a significant drawback, as the installed capacity does not appear to be a reasonable metric to compare different sorts of RES installations. Again, the underlying concern is to try to maximize the overall value of the outcomes, i.e. market value or even beyond that something that we could call overall energy and environmental policy value, reflected by the trade-off between price and green energy output.

An attempt to auction capacity-based subsidies while at the same time allowing different technologies to compete was the one implemented in Spain (Royal Decree 413/2014), consisting of normalizing the required capacity support by a standard production for each technology (e.g. 1,600 hours/year for PV and 2,100 hours/year for wind), in order to be able to compare all the bids on a common basis. The obvious main disadvantage is that resource availability can considerably vary from one RES project to another one (e.g. in the Spanish context there are wind projects with 1,900 full-load hours (FLHs) and others with 2,300). Thus, administratively setting a production level for reference can lead to a distorted allocation.

The new RES support mechanisms proposed in this paper intends to minimize these problems. The proposal is based on auctioning a capacity-based subsidy (Newbery, 2017), to try to minimize short-term market distortions, but adding two main features:

1. A bonus payment proportional to the market margins of each installation, in order to discriminate in favor of those ones providing larger added value to the system.

2. The granting of the support through a contracts menu auction approach that induces truthful revelation of the expected profits, that are a proxy of the expected operation.

As discussed later, the contracts menu feature allows, inter alia, the accurate setting of the total capacity (MW) to be auctioned given an energy-related (MWh) policy goal. It also allows for other design features aimed to correct claimed shortcomings of capacity-based subsidies. On the other hand, the contracts menu is implicit in the optimal bonus payment scheme and does not add complexity either to the design or to the clearing of the auction. These claims are supported below.

The sequel of the paper is organized as follows. Next section makes explicit the basic structure of the proposed mechanism. Section III introduces the rationale and use of the proposed contracts menu. Section IV presents an illustrative example presented in order to clarify how the proposed scheme would work. Section V deals with the setting of the scheme Regulatory parameters. Section VI addresses a miscellanea of other relevant issue. Finally, section VII concludes.

2 LINKING SUBSIDIES TO MARKET MARGINS TO ENHANCE SYSTEM VALUE

2.1 Amplifying system/market value

The key idea to avoid short-term market distortion is to design a subsidy either not linked to the operation of the generators or directly related to their market margins. Along these lines, as stated, we advocate for a capacity-based subsidy (€/MW).

But on top of this, as mentioned in the introduction, we part from the basic assumption that the Regulator aim is to procure enough RES capacity to meet a predefined target, in most cases set in terms of RES production. We take as a sufficiently good assumption that market income is a reasonable proxy to production maximization, or even better than that, to system value. So the proposal is to enhance the subsidy resulting from the auction with the addition of bonus payment that multiplies the net margins obtained by the installation in the energy market (i.e. this bonus is nothing but a multiplier of the operational profits)[1].

The fundamental behind this sort of regulated incentive is that it should not affect operational decisions: there is no reason why a plant should deviate from its efficient dispatch if, let us say, three times the market profit is to be maximized instead of simple one.

Summarizing, the objective is to discriminate in favor of those installations that maximize the value for the system, without distorting the efficiency of the short-term market outcomes, by amplifying their market margins, but at the same time, trying to find a way to assign to each installation the bonuses they need to make their investment sufficiently profitable but if possible not more than that. So, the challenge is first how to estimate the market margins, and then how to adjust these bonuses to the different sorts of installations, to promote the most valuable resources at the lowest cost for the system.

Right next, we discuss the problem of estimating the short-term market margins. The methodology proposed to face the second matter is largely discussed in the next section.

2.2 Estimating operational margins

Multiplying the net margin instead of the income has the obvious beneficial consequence to avoid promoting high (non-zero) variable cost RES-E (e.g. certain types of biomass), but its implementation obviously entails the complication of properly estimating the actual net profit, as the difference between market revenues and operational costs.

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[1] Narbel (2014) argues in favor of implementing a multiplicative coefficient unique to all technologies, which would multiply the market prices.

Market revenues should be directly observable in the electricity markets, although a sufficiently liquid power exchange would be necessary to provide a sufficiently representative and not manipulable index (such as EPEX or the US ISOs real time markets).

However, information on the operation cost part might be more difficult to elicit. The most commonly supported technologies (PV, wind…) have low and standard operational costs, mostly related to maintenance. In these cases, the Regulator should be able to obtain quite accurate cost estimations. Things might be more complex for RES generation with significant variable costs, such as biomass facilities. Liquid biomass markets and facilities audits might be useful to address these issues.

For the discussion that follows, it will be assumed that the Regulator is able to accurately assess the market profit during every single year of operation of the plants, and consequently to accurately estimate the suitable function relating the bonus payment with expected market profits. The magnitude of the distortions caused by difficulties in assessing the market profit will be, however, briefly discussed at the end of the paper.

Therefore, the key part that remains to be determined is how to correctly design this bonus payment. In this paper, an approach based on offering potential bidders in the auction a menu of contracts is proposed. As explained in the next section, the goal is for promoters to reveal the optimal multiplier in order to strike the best possible trade-offs.

3 REVEALING EXPECTED PERFORMANCE: AUCTIONING A MENU OF CONTRACTS

As stated, the main obstacle the proposed mechanism needs to deal with is informational asymmetry: the Regulator lacks precise information on the RES costs as well as the production levels of the different RES projects. The way to adjust the right level of bonus for each considered investment to promote those ones adding larger value for the system while at the same time trying to avoid excessive returns is through the implementation of this menu of contracts approach. This type of mechanism is already used to regulate, for instance, electricity distribution companies (Crouch, 2016).

The Regulator target is set in terms of the expected operating profit or, more likely, the closely related full load hours. In order to achieve this, the proposed auction mechanism must establish simultaneously the supported capacity Q_i (MW), the capacity support σ_i (€/MW) and the bonus payment for each accepted project *i*. It is assumed that the additional support is to be paid each year for a predefined number of years (e.g. 15 or 20), as typically done in most renewable auctions. The bonus payment comes from a contract relating the bonus to the market operational profit:

$$B_c = \left[b_c^{ref} + s_c\left(\pi_c - \pi_c^{ref}\right)\right]Q_i \tag{1}$$

where B_c denotes the yearly bonus payment, π_c the yearly operating profit per installed capacity, Q_i the project capacity (MW), b_c^{ref} (a parameter) the reference bonus per installed capacity (€/MW), π_c^{ref} (another parameter) the reference yearly operating profit per installed capacity (€/MW), and s_c (yet another parameter) the operational profit multiple. Sub-index $c = 1, \dots, C$ identifies each one of the possible contracts offered by the regulator.

Prior to the auction, the Regulator publishes a list of contracts (that is, a list of C parameters b_c^{ref} , π_c^{ref} and s_c) out from which each promoter must choose one at the time of bidding. They also must submit a bid made up a capacity Q_i (MW) and a capacity support t_i (€/MW).

The auction is cleared in the standard way for capacity-based auctions, that is, bids are ordered by increasing bid capacity support t_i and capacities Q_i added until reaching a total sought capacity Q_T, to be determined as shown below. The highest accepted capacity support t_* is paid to all accepted bids. Therefore, total yearly support for project i is calculated as:

$$t_{*}Q_i + b_c^{ref}Q_i + s_{c(i)}\left(\pi_{c(i)} - \pi_{c(i)}^{ref}\right)Q_i = \left(t_{*} + b_c^{ref} - s_{c(i)}\pi_{c(i)}^{ref}\right)Q_i + s_{c(i)}Q_i\pi_{c(i)} = \quad (2)$$
$$= \sigma_i Q_i + s_{c(i)}\Pi_i$$

where $c(i)$ denotes the contract chosen by project i, and $\Pi_i = Q_i\pi_{c(i)}$ the yearly operational profit. So, as stated above, total support is a capacity payment plus a multiple of the operational profit.

The purpose of the contracts menu is to elicit truthful revelation of the expected plant operation, i.e. to attain incentive compatibility. In order to do so, offering a low number of possible contracts would render very limited results since these contracts would not be enough to capture the conditions (FLHs/operational profits expected, and investment costs) of a wide range of potential projects. Therefore, it is assumed that a higher enough number of contracts are offered as different combinations of the parameters b_c^{ref} , π_c^{ref} and s_c. Being this the case, parameters b_c^{ref} , π_c^{ref} and s_c must be derived as the tangents of a convex function, as shown in the figure.

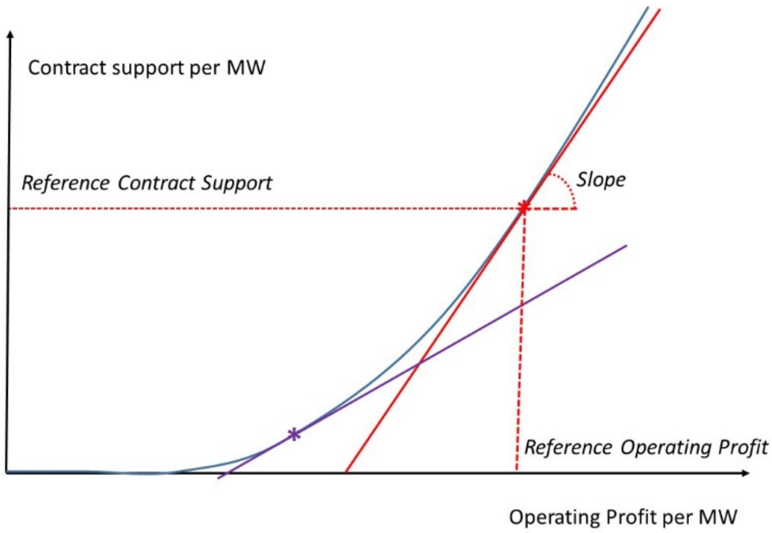

Figure 1. Contract parameters: b_c^{ref} Reference Contract Support, π_c^{ref} Reference Operating Profit, s_c Slope

Recall that the chosen contract has, under perfect competition assumptions, no bearing in the auction clearing, that only depends on the bid pair (Q_i, t_i). As a consequence, the promoter will chose the contract that maximizes the bonus coming from the expected operating profits since this is the contract that would maximize its competitiveness in the capacity auction[2]. Because of the convexity assumption, he will choose the contract coming from the tangent closest to the expected operating profit. For instance, if a promoter expects to obtain the operating profits in the red point of the figure, he will not choose the magenta contract, as bonus at the expected operating profit is below the provided by the red contract. The same applies to every other possible contract.

Let us denote by $b(\pi)$ the convex curve from which the contracts are derived. Let us also assume that there is a high enough number of contracts in order that every project can chose a contract that perfectly matches their expected operational profits. Then, project i expects, if accepted, to recoup $b(\pi_i)$ €/MW from the bonus contract, plus π_i €/MW from the market. If the specific investment cost (€/MW) is κ_i, he will submit (under competitive assumptions) a bid just enough to break even, that is

$$t_i = \kappa_i - (b(\pi_i) + \pi_i) \tag{3}$$

After clearing the auction, the accepted projects will obtain a specific rent (€/MW) equal to the difference $t_* - t_i$.

There are two auction design elements that require careful attention: the setting of the total procured capacity Q_T, and the setting of the convex curve by $b(\pi)$. Both issues will be dealt with in section V. However, in order to better understand the proposed support scheme and lay the groundwork to analyze these issues, a short case study will be shown next.

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[2] Alternatively, a project expecting relatively low operational profits (low production, low value of its production or both) would opt for a higher capacity support, thus losing competitiveness in the auction.

4 ILLUSTRATIVE CASE STUDY

In order to illustrate the properties of the support scheme proposed, we will consider a list of potential RES installations that could be interested in investing in a specific country. The list of potential bidders and their main techno-economic characteristics are shown in Table i. For the sake of simplicity, we have assumed that all of them are either wind or solar PV generators, and many of the relevant parameters are technology-specific (WACC, economic life, peaking ratio).

Table i. Main characteristics of potential RES projects[3]

Name	Investment M€/MW	Economic life (yrs)	WACC	FLH	OPEX €/MWh	Peaking ratio
PV1	0,8	30	7,50%	1600	15	1,1
PV2	0,85	30	7,50%	1800	15	1,1
PV3	0,95	30	7,50%	1950	15	1,1
PV4	0,95	30	7,50%	1600	15	1,1
PV5	0,8	30	7,50%	1950	15	1,1
W1	0,97	25	8,00%	2700	15	0,8889
W2	1,05	25	8,00%	3000	15	0,8889
W3	1,15	25	8,00%	3500	15	0,8889
W4	1,15	25	8,00%	2700	15	0,8889
W5	0,97	25	8,00%	3500	15	0,8889

The remainder of this section compares the results that would be obtained in a conventional capacity auction as compared to the new scheme proposed in this paper that combines the capacity auction with a bonus payment that depends on the operating profits. In order to do that, we need to estimate the bids that each project promoter would submit to the capacity auction under both designs.

[3] FLH are the equivalent full-load hours of each project, whereas the peaking ratio represents the ratio between the prices in the hours where each project would be producing and average market prices. In this case study, this ratio has been estimated with data from the Iberian sport electricity market.

Conventionally, these bids would be calculated as the difference (measured as a net present value) between the annualized investment costs and the expected operating profits, calculated as the market revenues (average price times the peaking ratio times the full-load hours) minus the operating costs[4]. An average market price of 35€/MWh will be assumed for the calculations shown hereafter. The results for the previous list of RES projects are shown in Table ii.

Table ii. Calculating project bids in a conventional RES capacity auction

Name	Peaking ratio	FLH	Operating profit k€/MW-yr	NPV Operating profit M€/MW	Investment M€/MW	Capacity auction bid M€/MW
PV1	1,1	1600	35,20	0,42	0,8	0,38
PV2	1,1	1800	39,60	0,47	0,85	0,38
PV3	1,1	1950	42,90	0,51	0,95	0,44
PV4	1,1	1600	35,20	0,42	0,95	0,53
PV5	1,1	1950	42,90	0,51	0,8	0,29
W1	0,8889	2700	48,00	0,51	0,97	0,46
W2	0,8889	3000	53,33	0,57	1,05	0,48
W3	0,8889	3500	62,22	0,66	1,15	0,49
W4	0,8889	2700	48,00	0,51	1,15	0,64
W5	0,8889	3500	62,22	0,66	0,97	0,31

Under the RES support scheme proposed in this paper, the auction bids would be calculated similarly to the previous case, but deducting from the previous bids the expected income from the bonus payment that complements the capacity payment. As mentioned above, this bonus payment would be calculated as a function of the operating profits of each generator. In this paper, the formula in (1) is considered[5] (the operating profits should be expressed in k€/MW-yr). The calculation of the corresponding bids is shown in Table iii.

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[4] For the sake of simplicity, only the participation in the spot market will be considered in this paper.

[5] How to obtain this formula falls outside the scope of this paper. Nonetheless, finding the appropriate formula is not straightforward and it is indeed a key aspect in the design of the proposed support scheme. Further details are discussed in the last section of the paper.

$$b(\pi) = (\pi - 27.5)^2/40 \tag{4}$$

Table iii. Calculating project bids under the new support scheme

Name	Operating profit k€/MW-yr	NPV Operating profit M€/MW	Investment M€/MW	Capacity auction bid M€/MW	Bonus payment k€/MW-yr	NPV bonus payment M€/MW	Bid under new scheme M€/MW
PV1	35,20	0,42	0,8	0,38	1,48	0,02	0,37
PV2	39,60	0,47	0,85	0,38	3,66	0,04	0,34
PV3	42,90	0,51	0,95	0,44	5,93	0,07	0,37
PV4	35,20	0,42	0,95	0,53	1,48	0,02	0,52
PV5	42,90	0,51	0,8	0,29	5,93	0,07	0,22
W1	48,00	0,51	0,97	0,46	10,51	0,11	0,35
W2	53,33	0,57	1,05	0,48	16,68	0,18	0,30
W3	62,22	0,66	1,15	0,49	30,14	0,32	0,16
W4	48,00	0,51	1,15	0,64	10,51	0,11	0,53
W5	62,22	0,66	0,97	0,31	30,14	0,32	-0,02

To analyze the implications of the proposed support scheme, the changes in the auction merit order need to be analyzed. Firstly, the merit order (value of the bids) in the capacity auction under both support scheme designs is compared against the "efficiency" of each project (understood as the value of the clean energy produced per MW). This can be measured, for instance, through the specific investments for each project, i.e. investment costs per kWh produced by the installation. The results are plotted in Figure 2. It can be seen that the new proposed scheme does a much better job at incentivizing RES capacity that provides more value to the power system.

In order to assess in more detail how the changes in the merit order affect each project, the position within the merit order of each RES project is depicted in Figure 3. It can be seen that whilst some projects remain largely unaffected (essentially the ones with high investment costs and low operating hours), other projects can see significant changes in their positioning. For instance, project W5, which presents high investment costs but very high full-load hours, goes from the 8th position to the 2nd. On the contrary, project PV1 goes back three positions due to its low operating hours in spite of the low investment costs.

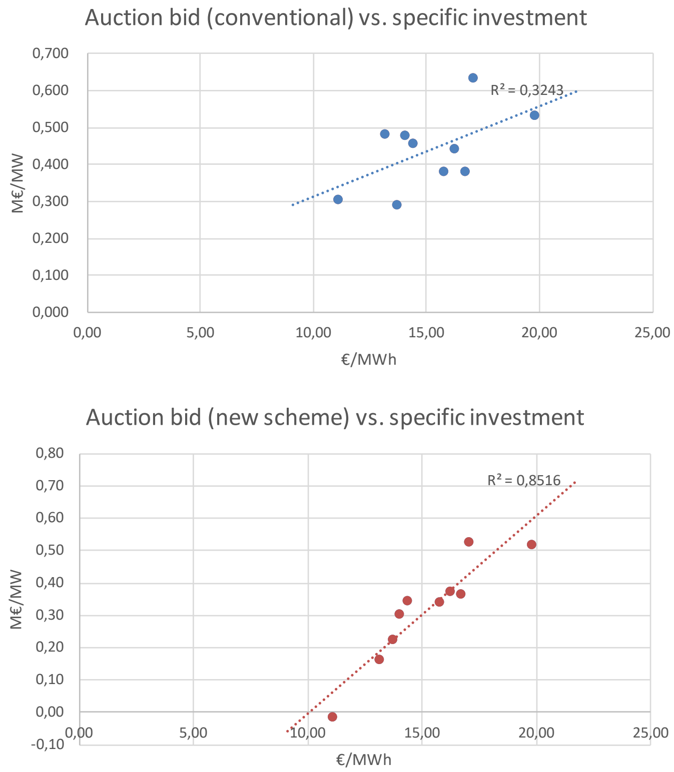

Figure 2. Auction bids vs. specific investments per RES project under a conventional capacity auction (top) and under the new proposed support scheme (bottom)

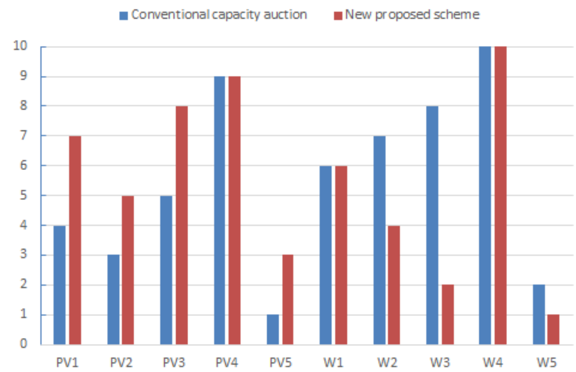

Figure 3. Position in the merit order of each RES project under both support scheme designs.

5 SETTING THE AUCTION PARAMETERS

As stated in section 3, there are two things to be set when designing the RES auctions under the method proposed: the total procured capacity Q_T, as well as the convex curve by $b(\pi)$.

Regarding the total procured capacity, in principle, this can be set as in a conventional capacity-based auction. However, Regulators and policy-makers oftentimes seek to attain not a certain RES capacity (i.e. MW), but a certain amount of renewable production (i.e. MWh) or CO_2

emissions reduction. Being this the case, the proposed mechanism can facilitate achieving the regulator's objective.

The revelation of the chosen contract faithfully informs on the expected market revenue, from which accurate information on operation can be derived. For instance, let us assume that the Regulator intends to procure a certain amount of "green energy (MWh)". Then, from the expected operating profit he can infer the FLH (by taking into account the expected market price and the peaking ratio[6]), and from the estimated FLH and the capacity bid the expected generated energy. Therefore, the auctioneer can add up the estimated generated MWh as he accepts offers from the cheapest to the dearest until reaching his target.

On the other hand, setting the optimal bonus curve $b(\pi)$ is a more complex task. A natural goal is to try to minimize the expected support, i.e. achieve the regulator's goal at the minimum cost:

$$\mathbb{E}\left[\sum_i Q_i\left(t_* + b(\pi_i)\right)\right] \tag{5}$$

Another goal might be the expected total rent earned by the accepted projects:

$$\mathbb{E}\left[\sum_i Q_i(t_* - t_i)\right] \tag{6}$$

In principle, this is a difficult optimization problem that can be only solved analytically by making heroic assumptions. However, numerical approaches are feasible. In the following, an instance of such an approach is proposed. The main elements are:

[6] There are uncertainties regarding both the peaking ratio and the expected market price. Market price uncertainties are also related to uncertainties in the support that might also impact the strength of the investment incentive. These issues will be briefly touched below.

- Uncertainty modelling. As in all contract menu approaches, the right modelling of the Regulator lack of precise knowledge on the project cost and technical characteristics is crucial. Especifically the Regulator would have doubts on all the economic and technical parameters in Table i. A way to represent the Regulator's uncertainty is by mean of scenarios. That is, there are a (huge) number of scenarios ("Tables i") S with associated probabilities p_s.

- Contracts menu representation. The contracts menu is a set of triples $(\pi_c^{ref}, b_c^{ref}, s_c)$. The set of Reference Operating Profits (π_c^{ref}) might be arbitrarily set as, for example, C equally spaced points between a minimum and a maximum. However, these sets of three must be tangents of some convex function. A set of constraints that guaranties this condition is:

$$b_c^{ref} + s_c\left(\pi_{c\prime}^{ref} - \pi_c^{ref}\right) \leq b_{c\prime}^{ref}; \forall c, c' \tag{7}$$

These convexity constraints will be denoted as

$$\left(b_c^{ref}, s_c\right) \in \mathcal{C}\left(\pi_c^{ref}\right) \tag{8}$$

- Auction simulation. For each scenario *s* and each contract menu $(\pi_c^{ref}, b_c^{ref}, s_c)$ it is not difficult to code a function that computes each project bid (Q_i, t_i) as well as if the bid has been cleared or not (e.g. by a binary variable the cleared support level $\nu_i = \{0,1\}$ taken value 1 if the project has been cleared and 0 if not) and the cleared support level t_*. This function will be denoted as:

$$\{(Q_i, t_i), \nu_i, t_*\} = \mathcal{f}\left(s, (\pi_c^{ref}, b_c^{ref}, s_c)\right) \tag{9}$$

With these elements, the optimization problem might be:

$$\begin{gathered}\min_{\left(b_c^{ref}, s_c\right)} \textstyle\sum_s p_s [\sum_i \nu_{is} Q_{is}(t_{*s} - t_{is})] \\ s.t. \begin{cases} \left(b_c^{ref}, s_c\right) \in \mathcal{C}\left(\pi_c^{ref}\right) \\ \{(Q_{is}, t_{is}), \nu_{is}, t_{*s}\} = \not{f}\left(s, (\pi_c^{ref}, b_c^{ref}, s_c)\right) \end{cases}\end{gathered} \tag{10}$$

This problem might be solved with standard numerical techniques. This issue will be subject of future research.

6 OTHER ISSUES

This section deals with a number of additional issues not considered previously but that might be relevant if the proposed support scheme or a similar one were to be implemented.

Reducing investment risk.

One argued advantage often quoted by RES investors in favor of subsidies that do not depend on the market evolution (e.g. the so-called feed-in tariffs) is that they minimize future cash-flows volatility, decreasing investor risk and capital cost, and easing projects bankability. First, it should be recalled that at this stage, taking into account that the main RES technologies can be considered fully mature, this problem does equally affect any other generation and demand response resource (IRENA, 2017)[7].

The proposed scheme seems to be riskier, as the bonus support component is linked to the market revenues and, as a consequence, reflects the market volatility. However, there are ways to reduce this inherited volatility without compromising the scheme virtues. For instance, if the sought projects are wind or PV projects with very low variable cost, the operational profit is almost the market revenue that can be scaled to a reference market price, eliminating in this

[7] Maybe if this argument is accepted, the conclusion should be that the whole energy market mechanism should be put into question. It could be argued that the widespread implementation of all sorts of capacity mechanisms hints that already this is largely the case.

way most of the inter-yearly volatility. In mathematical terms, the bonus will be derived ex-post every year according the corrected curve:

$$b^{corr}(\pi) = \frac{\text{Reference Mkt Price}}{\text{Realized Mkt Price}}\, b(\pi) \tag{11}$$

Note that the support is still a combination of a capacity payment plus a multiple of the operational profit, so that efficient short-term behavior is incentivized. Correction formulae for supported energy with relevant operating costs are more complex, and are left for future discussion.

Errors in operating costs estimation

Errors in the Regulators' estimation of operating costs have two impacts. On the one hand, it is just another uncertainty, as the one related to investment costs, that might be handled in the very same way. On the other hand, and more importantly, it is also conducive to incentives to deviate from the optimal operation. The authors do not see any easy solution to this problem. However, note that the distortions should be similar to those of a feed-in-tariff equal to the error (that is, the difference between the real and the estimated operational cost) and, therefore, rather small in most cases.

Avoiding "junk" investments

A common criticism to capacity support based mechanisms is that they might allow investments in "junk" capacity, cheap but unable to generate much or even any electricity. Under the proposed mechanism, projects are incentivized to reveal an expected market profit, and by implication an estimated of expected FLHs. This expectation can be used to tighten the regulatory framework, imposing a penalty were realized FLHs being below a certain threshold (let us say, 80%) of the revealed FLHs.

7 CONCLUSION

This paper has proposed and illustrated a new support scheme for RES that combines a capacity-based remuneration determined through an auction and a bonus payment that depends on the market operating profits earned by each RES generator. This allows supporting more efficient RES capacity whilst preventing market distortions created by production-based support schemes.

Moreover, this paper has proposed to combine this mixed auction mechanisms with a menu of contracts approach that encourages potential bidders to reveal their expected performance. Both mechanisms together would allow regulators and policy-makers to achieve their goals whilst minimizing the cost of RES support. This is particularly relevant nowadays since many countries are facing important challenges derived from the rising cost of RES support required to achieve increasingly ambitious decarbonization targets.

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