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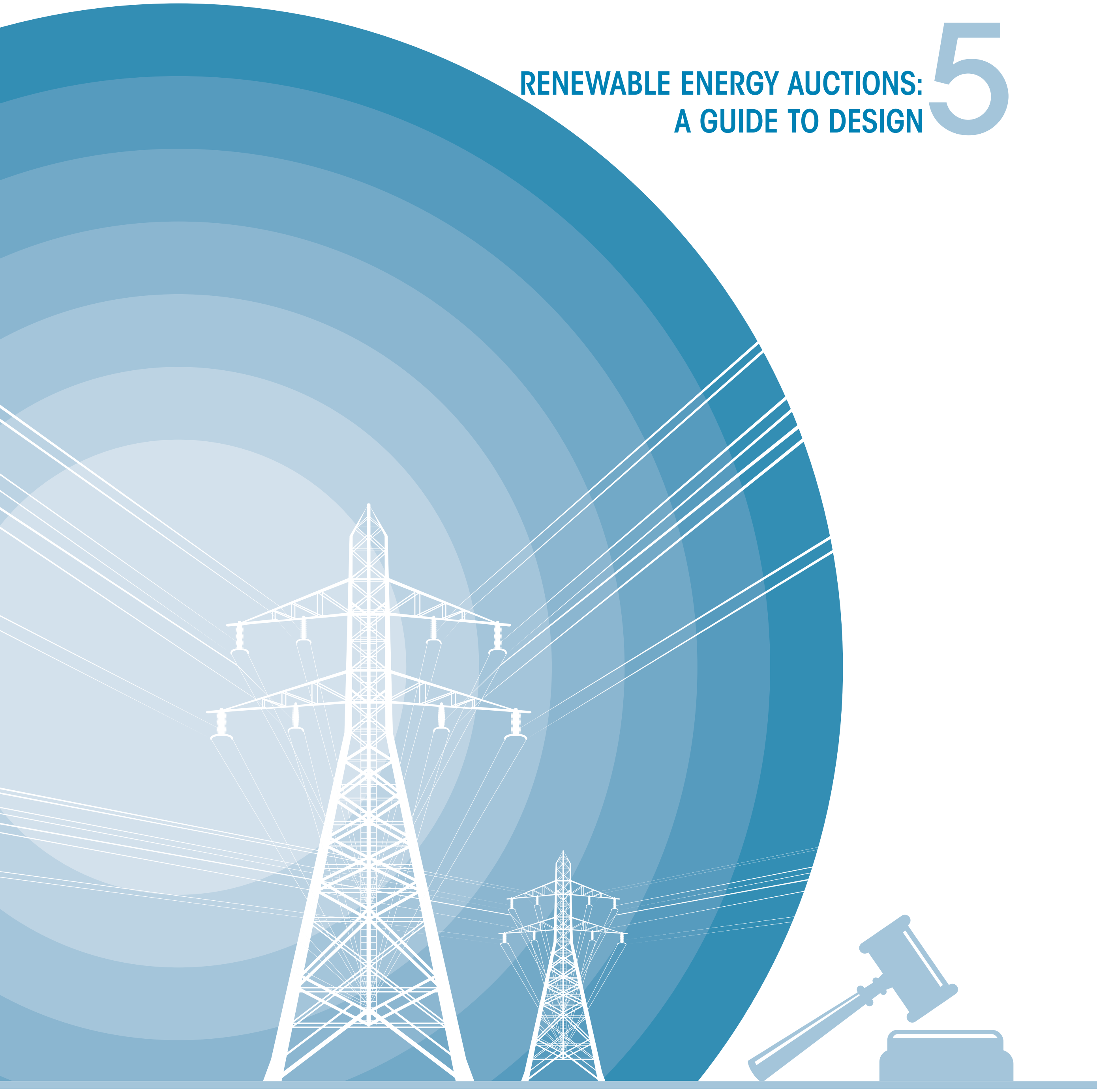
RENEWABLE ENERGY AUCTIONS:
A GUIDE TO DESIGN 5



AUCTION DESIGN:
WINNER SELECTION PROCESS

About IRENA

The International Renewable Energy Agency (IRENA) is an intergovernmental organisation that supports countries in their transition to a sustainable energy future, and serves as the principal platform for international co-operation, a centre of excellence, and a repository of policy, technology, resource and financial knowledge on renewable energy. IRENA promotes the widespread adoption and sustainable use of all forms of renewable energy, including bioenergy, geothermal, hydropower, ocean, solar and wind energy, in the pursuit of sustainable development, energy access, energy security and low-carbon economic growth and prosperity. www.irena.org

About CEM

The Clean Energy Ministerial (CEM) is a high-level global forum to promote policies and programs that advance clean energy technology, to share lessons learned and best practices, and to encourage the transition to a global clean energy economy. Initiatives are based on areas of common interest among participating governments and other stakeholders.

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This guidebook comprises of six chapters and can be downloaded from *www.irena.org/Publications.*

AUCTION DESIGN: WINNER SELECTION PROCESS

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The following definitions reflect the nomenclature used by the International Renewable Energy Agency (IRENA) and are strictly related to the renewable energy industry; definitions used by other organisations and publications may vary.

Auction : Auctions refer to competitive bidding procurement processes for electricity from renewable energy or where renewable energy technologies are eligible. The auctioned product can be either capacity (MW) or energy (MWh).

Auction demand bands: Different categories within the total demand of an auction that require specific qualification requirements for submitting the bid (*e.g.* demand bands dedicated to specific technologies, project sizes, *etc*.).

Auctioned volume: The quantity of installed capacity (*e.g.* MW) or electricity generation (*e.g.* MWh) that the auctioneer is aiming to contract through the auction.

Auctioneer: The entity that is responsible for setting up the auction, receiving and ranking the bids.

Bid: A bidder's offer for the product awarded in the auction – most usually a power purchase agreement for the renewable energy generation or capacity.

Bidder: A physical or juridical entity that submits its offer in the auction process. Also referred as project developer, seller.

Levelised cost of electricity (LCOE): The constant unit cost of electricity per kWh of a payment stream that has the same present value as the total cost of building and operating a power plant over its useful life, including a return on equity.

Power Purchase Agreement (PPA): A legal contract between an electricity generator (the project developer) and a power purchaser (the government, a distribution company, or any other consumer).

Project developer: The physical or juridical entity that handles all the tasks for moving the project towards a successful completion. Also referred as seller and bidder, since the developer is the one who bids in the auction.

Off-taker: The purchaser of a project's electricity generation.

Overcontracting capacity: Contracting more capacity than the auction volume.

Underbidding: Offering a bid price that is not cost-recovering due to high competition and therefore increasing the risk that the projects will not be implemented.

Underbuilding: Not being able to bring the project to completion due to underbidding.

Undercontracting capacity: Contracting less capacity than the auction volume.

Acronyms

ANEEL	Agência Nacional de Energia Elétrica (Brazil)
BNEF	Bloomberg New Energy Finance
BNDES	Brazilian National Development Bank
CCEE	Câmara de Comercialização de Energia Elétrica (Chamber for Commercialisation of Electrical Energy, Brazil)
COD	Commercial Operation Date (or deadline)
CSP	Concentrated Solar Power
DEA	Danish Energy Authority
DEWA	Dubai Energy and Water Authority
DOE	Department of Energy (South Africa)
EIA	Environmental Impact Assessment
EC	European Commission
EPC	Engineering, Procurement and Construction
EPE	Empresa de Pesquisa Energética (Energy Research Company, Brazil)
EU	European Union
FEC	Firm Energy Certificates
FIP	Feed-In Premium
FIT	Feed-In Tariff
GDP	Gross Domestic Product
GNI/CAP	Gross National Income per Capita
IEA	International Energy Agency
IOU	Investor-Owned Utility
IPP	Independent Power Producer
kWh	kilowatt-hour
LCR	Local content requirements

MASEN	Agence Marocaine de l'énergie Solaire (Moroccan Agency for Solar Energy)
MEMEE	Ministry for Energy, Mines, Water and the Environment (Morocco)
MEN	Ministerio de Energía y Minas de Perú (Ministry of Energy And Mines of Peru)
MME	Ministério de Minas e Energia (Ministry of Mines and Energy, Brazil)
NDRC	National Development and Reform Commission (China)
NEA	National Energy Administration (China)
NERSA	National Energy Regulator of South Africa
NFFO	Non Fossil Fuel Obligation (UK)
NREAP	National Renewable Energy Action Plan
NREL	National Renewable Energy Laboratory
NSM	National Solar Mission (India)
PPA	Power Purchase Agreement
PROINFA	Programme of Incentives for Alternative Electricity Sources (Brazil)
PV	Photovoltaic
RAM	Renewable Auction Mechanism
REC	Renewable Energy Certificate
RPO	Renewable Purchase Obligation
RPS	Renewable Purchase Standard
REIPPP	Renewable Energy Independent Power Producer Procurement (South Africa)
TSO	Transmission System Operator
VGF	Viability Gap Funding
WTO	World Trade Organization

5 Auction design: winner selection process

The winner selection process is at the heart of the auction procedure and involves the application of the bidding and clearing rules as well as awarding contracts to the winners. Within this category, the following design elements are addressed: 1) the *bidding procedure*, defining how the supply-side information is collected for the competitive process; 2) *requirements of minimal competition*, which include special provisions to promote a minimum degree of competition in the bidding procedure; 3) the w*inner selection criteria*, dictating how to rank the bids and select the winners; 4) the *clearing mechanism and marginal bids*, defining the rules for allocating contracts in case the supply does not exactly meet the demand; and 5) *payment to the auction winner*, establishing how the project developer will be remunerated after winning the contract. Figure 5.1 summarises these design elements, which are further developed in this chapter.

Figure 5.1: Overview of the design elements in the winner selection process

Bidding procedure Collecting supply side information: » Sealed bid process - all bid info is directly provided to the auctioneer » Iterative process including descending clock auction - bid info is disclosed gradually during the auction » Hybrid process	**Winner selection criteria** » Minimum-price auctions » Adjusted minimum-price auctions - using a "correction factor" » Multi-criteria auctions
	Clearing mechanisms and marginal bids Clearing the auction's supply and demand through flexible demand schemes, price-quantity bidding or ex-post adjustments
Requirements of minimal competition » Maximum awarded capacity constraint- prevents a single player from becoming dominant in the auction » Ceiling price mechanisms - "anti-monopoly" mechanism, preventing dominant players from bidding high » Other mechamisms	**Payment to the winner** » Pay-as-bid pricing - most common implementation, despite the dependence of one's bid on its remuneration » Marginal pricing schemes - encourage disclosure of real project development costs » Nonstandard pricing schemes

5.1 BIDDING PROCEDURE

The bidding procedure is the first step of the auction procedure and involves collecting information on the price levels at which bidders would be willing to develop new renewable energy generation capacity. Bidding can be carried out via three main approaches: 1) *sealed-bid processes*, in which all bid information is provided to the auctioneer beforehand; 2) *iterative processes*, in which information is provided gradually during the auction; and 3) *hybrid processes*, in which an iterative phase is followed by a sealed bid phase.

Sealed-bid process

Sealed-bid auctions are straightforward processes in which bidders are required to provide their bid information directly to the auctioneer. Typically, offers are kept sealed until the day of the auction to prevent players from getting an advantage through privileged information. The main advantage of this type of scheme is its simplicity. However, depending on how the bidding procedure is structured, sealed-bid schemes may be associated with a lack of transparency, especially if the winner selection process is complex (see Section 5.3). In addition, there can be a large time gap between the opening of the sealed bids and the disclosure of the winners which may deter bidders. Moreover, given that bidders are required to disclose the minimum price they are willing to receive for the auctioned product, this issue could drive away potential participants.

Despite these concerns, sealed-bid schemes are among the most commonly implemented auctions worldwide. Project developers tend to be reasonably comfortable with its design, and the relative familiarity of sealed-bid processes from the bidders' standpoint can be a positive aspect of this alternative. China, Dubai, India, Morocco, Peru and South Africa are all examples of jurisdictions that have opted for this type of mechanism.

Iterative process

Iterative processes, in contrast, allow bidders to only gradually disclose their bid information during the auctioning rounds. The most common way to implement this type of scheme is via a so-called *descending clock auction*[1] (or Dutch auction), in which at each round the auctioneer proposes a new, slightly lower price than in the previous round, and the participants make their offers, in terms of quantity they are willing to provide and this price. This iterative procedure continues until the supplied and demanded quantities match.

The main benefits of a descending clock auction are associated with its transparency and the revealing of information by bidders. One example of iterative bidding is found in the Italian renewable energy auctions organised for plants larger than 5 MW in order to gain access to the tariff-based incentive (see Box 2.5). In this particular implementation, the auctioneer gradually increases the discount percentage from the original feed-in tariff (FIT) offered to the participants, which could accept the

[1] *Ascending clock auctions are also an example of iterative process, but typically they are not used in the context of renewable energy procurement*

deduction or refuse it (leaving the auction). This iterative procedure continues until the target capacity is reached.

In theory, a descending clock auction could lead to better price discovery, since bidders are able to revise their bids dynamically as the auction evolves. However, evidence seems to suggest that potential suppliers rarely revise their bids over the course of the auction. Another potential downside is that this type of dynamic revision usually relies on information being disclosed by the auctioneer at every bidding round. In general, policy makers tend to avoid revealing too much information in order to prevent collusion and/or strategic bidding.

Another limitation of the descending clock auction is that the bidders that were dismissed at previous auctioning rounds are usually excluded from the auction. Moreover, there is an implicit assumption that the optimal allocation will not involve a higher-priced bid, which is not always the case when there are indivisible bids (see Section 5.4). Furthermore, the descending clock auction is unidimensional, since the offers at each round must be synthetised into a single number (the price). This means that, in order to introduce compound winner selection criteria (see Section 5.3) in a descending clock auction, it is necessary to acquire non-price information from bidders beforehand, and to aggregate this information into a bonus (or penalty) to be accounted for in the price bid during the descending clock rounds. Brazil has adopted this mechanism in its auction schemes (see Box 5.1).

Hybrid process

Hybrid processes attempt to combine characteristics of both sealed-bid and iterative processes. They typically involve an initial descending clock phase followed by a sealed-bid phase, although other mechanisms also could be adopted. Because all the bidders that remain in the auction until the end must disclose the minimum price they are willing to receive, hybrid processes do not protect bidders' secrecy as well as the purely iterative auction mechanisms.

However, hybrid auctions allow for some price discovery: the moment in which the descending-clock phase is interrupted and the sealed-bid phase begins represents a key point at which participants may revise their bids. Having a sealed-bid auction as a second phase in a hybrid process allows a pay-as-bid criterion to be used to determine the payment to the auction's winner (see Section 5.5). Following the descending clock auction, the auctioneer does not have any information on the minimum price that bidders would be willing to bid; this is why pure iterative auctions tend to be strongly associated with marginal pricing. The desire to implement a pay-as-bid criterion may be a motivation for countries to adopt hybrid schemes rather than the simpler descending clock alternative. Brazil is one example of a country that has adopted this hybrid scheme in its electricity auctions since 2005 (see Box 5.1).

BOX 5.1: EXPERIENCE WITH HYBRID AUCTIONS IN BRAZIL

Brazil represents a classic example of hybrid design of the bidding process in electricity auctions. The mechanism is a combination of a descending clock auction followed by a pay-as-bid round. Brazilian auctions are carried out fully via an online platform, and involve three well-defined steps:

- The initial step, phase zero, involves bidders confirming the quantity of electricity (in GWh per year) that they are willing to commit at the auction's ceiling price (disclosed in advance). This quantity cannot be revised in later rounds, even as the offered price decreases.
- Phase one of the auction involves multiple rounds, in which the auctioneer informs the new price level (decrementing a constant value in USD/MWh from the previous round's price), and bidders confirm whether they wish to continue in the auction (using the full quantity offered in phase zero) or not. Phase one is terminated when the overall supply matches the auction's demand plus a certain adjustment factor unknown by the bidders. Those that remain in the auction proceed to phase two.
- Phase two functions as a sealed-bid auction for the bidders that remain. However, bidders are not allowed to revise the quantities offered during phase zero, and they cannot offer a price higher than the ceiling price at which phase one was terminated.

Therefore, phase one of the Brazilian mechanism has some of the benefits of the iterative process – such as the price discovery and possibility of adaptation throughout the process – but bidders proceed to phase two with incomplete information due to the undisclosed "adjustment factor" on the demand. Bidders do not know how close they are to meeting the demand, although they know that there is some surplus in supply, which incentivises them to lower their bids further in the sealed-bid phase. Table 5.1 summarises the price difference between the two phases in Brazilian auctions held between 2006 and 2011 (see Box 5.2).

Table 5.1: Prices in the first and second phase of Brazilian auctions

Auction [1, 2]	**LER 2009**	**LFA 2010**	**LER 2010**	**A-3 2011**	**LER 2011**	**LER 2014**
Renewable energy source	Wind	Wind, biomass[3]	Wind	Wind, biomass	Wind, biomass	Solar
Total volume contracted (MW)	753	666	255.1	468	460	202
Final price in the first phase (descending clock) – USD/MWh	77.6	69.8	63.6	52.5	51.5	110.5
Maximum winning price in the auction (after second phase) – USD/MWh	76.5	69.0	63.1	52.4	51.0	110.4
Minimum winning price in the auction (after second phase) – USD/MWh	65.5	65.3	60.5	48.2	47.5	100.4

[1] Brazilian auctions are named A-5 and A-3, meaning that the lead time is five and three years, respectively, for the winning projects. LER and LFA are the Portuguese abbreviations for Reserve Energy Auction and Alternative Sources Auction (renewable energy sources), respectively.
[2] Prices in Brazilian reais were converted to US dollars using a fixed exchange rate of 2 BRL/USD for all values in this table. However, the market exchange rate was approximately 1.7 BRL/USD during 2009-2011 and 2.2 BRL/USD during 2014.
[3] In LFA 2010, A-3 2011 and LER 2011 wind and biomass competed with each other and the prices represent the results of the whole auction, they are not per technology.

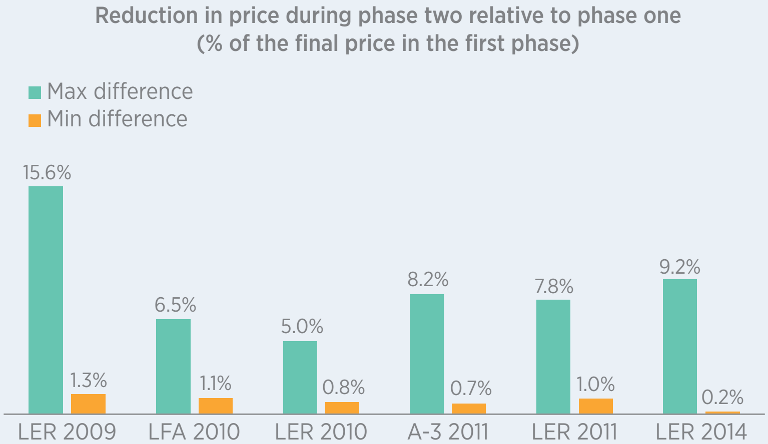
The hybrid process has contributed to further decreasing the price resulting from the Brazilian auctions (see Box 5.2) through the second phase which is the sealed-bid auction with vaying percentages of reduction (see Figure 5.2).

BOX 5.2: PRICE REDUCTION THROUGH HYBRID AUCTIONS IN BRAZIL

The second phase of the hybrid process in Brazil succeeded in further reducing the price established during the descending clock phase. Figure 5.2 shows the maximum and minimum difference in price achieved following the implementation of the second phase. One criticism of this mechanism, however, is that it still includes the main drawback of the pay-as-bid auction (see Section 5.5) and could lead participants to engage in the "winner's curse" phenomenon, meaning that they underbid in order to win the auction, and ultimately undergo economic losses as a result.

Another drawback of the Brazilian auction scheme (or of any descending clock auction in general) is that the process could last too long. The 2014 auction for solar power plants, for example, lasted eight hours, as the closing price proved to be much lower than the opening price (while the price decrement and duration of each round were fixed).

Figure 5.2: Price differences between the Brazilian auction phases



Souces: (ANEEL, 2015), (Elizondo-Azuela, Barroso et al., 2014), (Maurer, Barroso, 2011).

Another advantage of adopting a hybrid process is that it helps reduce the risk of collusive or strategic behavior – more prominent when a few participants account for a considerable share of supply – through the second phase of the sealed-bid auction (see Box 5.3). When competition is significant – with a large number of bidders with similar cost structures and risk preferences, and little concentration – opportunities for collusion decrease dramatically. In these cases, 1) a minor subgroup of participants behaving strategically is likely to be outbid by suppliers bidding competitively, and 2)

BOX 5.3: PREVENTION OF COLLUSIVE BEHAVIOR

Efforts to increase the number of bidders in an auction can help in preventing opportunities for collusion. These efforts are related, for instance, to reducing entry barriers, as discussed in Chapter 4. It is the competition within each demand segment that is relevant for opportunities for collusion. Therefore, explicit (*e.g.,* per technology) or implicit segmentation (*e.g.*, spatial limitation of demand due to transmission constraints) should be considered carefully. Segmentation results in auctions being multi-product in their nature, which may offer opportunities for collusion (for instance, co-ordination among bidders to allow the predominance of different bidders within different segments). Yet achieving high competition within the auction may not always be possible. In this case, explicit measures may be adopted to prevent collusion from affecting auction results.

The first category of such measures relates to design choices that make collusion more difficult. For instance, the adoption of a sealed-bid auction (or hybrid designs) hinders collusive behavior, since it makes the exchange of information and the explicit or tacit co-ordination among bidders more difficult. The auctioneer may opt not to reveal, before the auction, some information that is crucial for the design of strategies by colluding bidders – such as information on the auction demand. Attempts to prevent communication and exchange of information among bidders during the auction also can be made. The effectiveness of such measurements should be evaluated with care, since co-ordination and information exchange before the auction are still possible, and agents may attempt to use intricate signaling techniques[1] when direct communication is not possible.

A second category involves design choices that prevent abnormally high prices resulting from collusion, such as the adoption of ceiling prices.

Finally, the monitoring of bids and auction results by regulators – eventually aided by competition-monitoring authorities – enables the identification of collusion. Specific bidding phenomena to be addressed includes signaling (*e.g.*, conveying relevant information with the goal of co-ordinating bids) and punishment (*e.g.*, bids that aim at punishing an agent for failing to comply with specific behavior patterns).

Legally challenging any identified collusive behavior is often difficult, and it may require imposing formal rules that severely constrain bidding flexibility. Yet the monitoring and identification of collusive behavior offers opportunities to improve subsequent auction designs. This is particularly relevant when a series of auctions is held (systematic auction schemes). When such repeated auctions are held, bidders have opportunities to learn how to co-operate and may develop inter-auction strategies for signaling and punishment. Naturally, these repeated auctions offer regulators and policy makers opportunities to gradually improve the auction design in response to attempts of collusion.

[1] An example of such elaborate signaling techniques refers to code bidding in the spectrum auctions held by the US Federal Communications Commission: it has been suggested that some bidders used the last digits of their dollar-nominated bids – when these last digits did not have a material impact on the total amount of the bid (e.g., the sequence '378' in a bid such as 313,378, as reported in Cramton and Schwartz (2002) – to convey information to others.

Source: (Cramton, Schwartz, 2002), (Klemperer, 2002).

it is unlikely that any agreement involving a sufficient number of bidders will be stable, since co-ordination costs and the likelihood of some bidders failing to act according to the agreed strategy to maximise their profits, increases significantly.

Main findings

From evaluating several international auction implementations, it seems that policymakers most often tend to adopt the more straightforward sealed-bid mechanism. Descending clock auctions and hybrid auction mechanisms remain as alternatives, if the price discovery process is found to be important for bidders to adjust their bids during the auction. A potential impact of different options on the outcome of the auction is summarised in Table 5.2.

Table 5.2: Summary comparison of the bidding process options

Criteria \ Options	Sealed-bid process	Iterative process	Hybrid process
Simplicity	Straightforward	Requires gathering all the bidders	More difficult to implement and communicate
Transparency and fairness	Possibly opaque mechanism once offers are opened	Open real-time information	Ensured by the iterative phase
Bidders' ability to react	Information must be dis-closed before-hand	Gradual disclosure of information, allowing agents to respond	Only during the iterative phase
Preventing collusion and price manipulation	Undisclosed in-formation makes bid coordination more difficult	Bidders may force the auc-tion to terminate early	Second phase makes collusion more difficult
Matching supply and demand	Supply and demand curves fully known	Requires some assumptions for optimal results	Supply and demand curves fully known in the second phase

Characteristics of the relevant attribute: *Poor* *Medium* *Very good*

5.2 REQUIREMENTS OF MINIMAL COMPETITION

Auction schemes can include special provisions to ensure a minimum degree of competition in the bidding procedure, as measured by a few criteria assessed by the auctioneer. This type of mechanism may take several forms, such as 1) *maximum awarded capacity constraints* to a single bidder; 2) *ceiling price mechanisms,* beyond which no bids may be accepted; and 3) *other constraints* to the awarding of auctioned products.

Maximum awarded capacity constraints

Maximum awarded capacity constraints typically seek to prevent a single player from becoming too dominant in the auction. In a sense, this type of constraint can be similar to maximum project size constraints (see Section 4.2), although it is broader because it ensures that a company cannot dominate the auction even if it submits bids for multiple separate projects. Similar to imposing a maximum project size, maximum awarded capacity constraints may help the participation of smaller players in the auction. This would result in a beneficial portfolio effect by diversifying risks for the successful implementation of the awarded capacity.

On the other hand, caps to the maximum awarded capacity may reduce opportunities for economies of scale (as described in Section 4.2). Examples of jurisdictions that have implemented measures to limit the capacity awarded to a single player include California (in which a bidder could not bid for more than 50% of the auctioned demand on aggregate) and Portugal (where successful bidders in one round of the auction were not allowed to participate in the subsequent round).

Ceiling price mechanisms

Ceiling price mechanisms imply that bids beyond a certain price cap will be rejected automatically, even if there are no other bids and the auction will fail to meet its demand target as a consequence. Typically, this maximum price level is calculated as a "reasonable" price that is compatible with the expected costs of building and operating the power plant, preventing a player from offering a much higher bid and receiving windfall profits for the contract's duration. Because dominant players could have an incentive to bid high, using their market power to drive prices upwards, ceiling prices often are interpreted as "anti-monopoly" mechanisms. This scheme also can be considered a particular case of a price-sensitive demand curve (see Section 5.2.), in which the demanded quantity abruptly falls to zero at a certain threshold.

By introducing a ceiling price, the government acknowledges upfront that there is a risk that the auction scheme may not fulfil its intended role (achieve low prices) and that, in this case, the government will not fulfil all of its goals, such as contracting all the auctioned volume. However, a downside is that if the ceiling price cap is not set properly, there is a risk that a suboptimal amount of renewable energy will be contracted, as it could lead to the outright rejection of certain perfectly reasonable bids (representative of developers' actual costs of building and operating some viable, but not extremely cost-effective, plants).

Another decision that needs to be made is whether or not the price ceiling should be disclosed prior to the auction. Full disclosure tends to involve slightly greater transparency. However, one potentially negative aspect of disclosing a ceiling price is that it may anchor bidders' perceptions of what is a "fair" price and affect their bidding behavior. Yet one potentially negative aspect of keeping the ceiling price undisclosed is that there is an increased chance that a "reasonable" bid will be rejected when it is only slightly higher than the ceiling price, resulting in a suboptimal contracted quantity. In practice, the choice between disclosed and undisclosed ceiling prices tends to matter only in situations in which competition is relatively low. When competition is able to drive prices downwards substantially, bids that are close to the ceiling price should have little bearing on the auction's results.

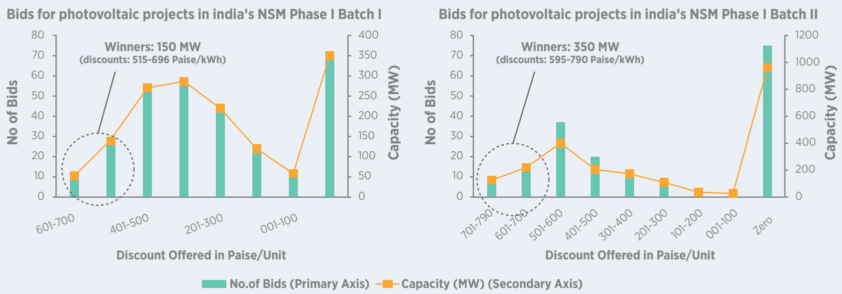
Fully disclosed ceiling prices are an intrinsic feature of certain auction design alternatives, such as mechanisms in which bids are in the form of a "discount" over a reference remuneration level, as in Italy, the Netherlands, and India (in the 2010-2011 national-level auctions) (see Box 5.4). Likewise, the auction's opening price in descending clock schemes (see Section 5.1) represents a natural price cap, as implemented in Brazil. In turn, undisclosed ceiling prices have been implemented in Peru, South Africa and other countries (see Box 5.5).

In Peru's sealed-bid auctions, the regulator sets a volume cap and an undisclosed ceiling price for each technology, above which no offer can be accepted. The ceiling price is determined by the regulator based on typical capital and operating costs, project size and connection costs (for a rate of return of 12% per year over 20 years). The ceiling price is only disclosed after the auction if 1) the auction's demand is not entirely met by the bids received in that round and 2) at least one bid was rejected for being higher than the price cap. In such an event, the ceiling price is incremented

BOX 5.4: EXPERIENCE WITH DISCLOSURE OF CEILING PRICES IN INDIA

India's National Solar Mission auctions in 2010 and 2011 involved a fully disclosed ceiling price. Contrary to the South African experience, there were major price discounts relative to the disclosed ceiling price. As illustrated in Figure 5.3, a large fraction of the bidders did offer the maximum allowed price (rightmost column in the figures, representing a discount of zero from the price ceiling), which suggests that full disclosure of the price cap does result in an anchoring effect. However, because the amount of bids received vastly outnumbered the desired capacity additions (by ten to one in the 2010 auction, and nearly nine to one in 2011), these bids did not truly matter for the auction's results – as only the bids in the leftmost columns, representing the lowest price offers, were ultimately contracted. Therefore, largely due to the stronger level of competition, India was able to procure solar power at extremely competitive prices.

Figure 5.3: Bids for PV projects in India[1]



[1] *OBS: a discount of 100 Paisa per kWh (as shown in the horizontal axis of the figure) corresponds to approximately 16 US$/MWh at an exchange rate of 62 INR/USD. The ceiling price (corresponding to an offered discount of zero) was approximately equal to 298 USD/MWh in the Batch I auction (figure on the left), and to 256 USD/MWh in the Batch II auction (figure on the right).*

Sources: (IRENA, 2013a), (Rycroft, 2013), (Eberhard, Kolker, Leigland, 2014), (Elizondo-Azuela, Barroso et al., 2014), (Ministry of New and Renewable Energy, 2012).

by an undisclosed factor, and a new auction is called. There are concerns that this arrangement could allow bidders to behave strategically, as they can intentionally bid too high in the first iteration in order to have the ceiling price revealed and increased for the re-called auction – as project developers may simply re-submit a bid that had exceeded the ceiling. In some cases, the previous FIT is used as a ceiling price, when a jurisdiction moves from FIT to an auction with the aim of reducing the cost of support, as occurred in South Africa (see Box 5.5).

Country experience with ceiling price was also analysed in the 2013 IRENA report *Renewable Energy Auctions in Developing Countries*.

BOX 5.5: EXPERIENCE WITH DISCLOSURE OF CEILING PRICES IN SOUTH AFRICA

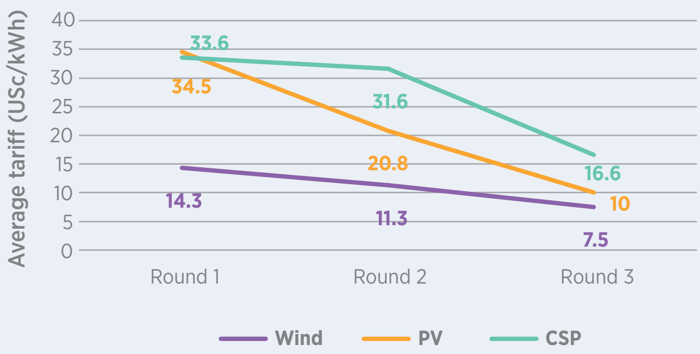
In 2011, South Africa launched the Renewable Energy Independent Power Producer Procurement (REIPPP) programme, with the aim of promoting renewable energy development through auctions. Five auction rounds were planned, with a total target of 3 725 MW.

The first round of the programme took place in August 2011. Although the auction was successful in contracting 28 new renewable energy plants (representing all bids that passed the qualification phase), the contract price obtained in the first round was relatively high, suggesting that the auction was unable to substantially drive prices downwards. Two features of the auction design influenced the result: 1) the ceiling prices were fully disclosed to the public, as they were based on the preceding programme's FIT levels – thus providing a benchmark that anchored project developer's expectations; and 2) there was no capacity limit set other than the 3 725 MW target for the entire programme (involving five auctions), which meant that demand far outstripped supply. As a consequence, all projects that satisfied the qualification requirements were selected, and the lack of competition failed to create pressure on bidders to reduce their offered prices. The average price of this first phase was very close to the ceiling price.

For subsequent rounds, the ceiling prices for each technology were set at slightly lower levels (and were kept undisclosed), and the allocation of capacity in each round was limited for each technology (the volume cap was set at 1 275 MW in the second round and 1 473 MW in the third round). Therefore, prices received for the second and third rounds were very competitive and lower than expected.

Although the success of the South African experience can be attributed to some extent to the non-disclosure of the ceiling prices in the second and third auction rounds, the higher competition in these later rounds deserves much of the merit. The introduction of a volume cap meant that bidders were effectively competing and only the lowest offers would be contracted. The decrease in the average contracted price through the first three bidding rounds can be seen in Figure 5.4.

Figure 5.4: Evolution of the prices in the REIPPP rounds



Note: Exchange rates used were equal to 8 ZAR/USD, 7.94 ZAR/USD and 9.86 ZAR/USD respectively, according to the date of each round.

Other mechanisms to promote competition

Countries can adopt other means to minimise market concentration and promote competition. These approaches are similar to price cap mechanisms in the sense that they offer conditions (fully or partially disclosed) to declare an auction void, representing an "insurance" against the auction not functioning properly. There are several ways to implement this type of scheme, although it tends to be less common than the two alternatives described above.

In Brazil, for example, an auction's demand is revised downwards automatically to be always slightly lower than the available supply, ensuring that the participants would always need to compete for the lowest price to some extent (see Box 3.5). Although this mechanism helps in promoting competition, it also implies that a certain percentage of the total potential supply always will be rejected – which may lead to suboptimal contracted quantities in situations in which the supply-demand balance is tight. The Brazilian auctions also do not disclose the auction's demand to avoid collusive behavior.

Another example is the auction in California, where the IOUs (California's three large investor-owned utilities) may reject bids at their own discretion whenever there is evidence of market manipulation or when prices are not competitive with other procurement options (see Box 5.6).

BOX 5.6: CALIFORNIA'S RAM PROGRAMME

Under California's renewable auction mechanism (RAM), after the qualification phase, the state's three large investor-owned utilities may reject the bids at their own discretion whenever there is evidence of market manipulation or when prices are not competitive with other procurement options, with the goal of protecting ratepayers against unwarranted increases in electricity prices. If the IOU wants to utilise this discretion, it must submit a letter to the California Public Utilities Commission (CPUC) explaining its decision to reject a bid before the capacity cap was exhausted.

As a result, a majority of projects that passed the qualification phase were rejected in the selection process on the grounds that they were not cost-competitive. Therefore, the RAM succeeded in achieving lower prices than any other procurement methods in California, and the programme did not meet its capacity targets in full in any of the auctioning rounds. An important concern is that the programme might be too competitive, because of the high number of rejected bids. Table 5.3 illustrates the low percentage of winning projects, for one of the IOUs during the four RAM rounds. A similar situation was seen for the other two IOUs.

Table 5.3: Winning projects versus qualified projects in results of California's RAM programme

	RAM 1	RAM 2	RAM 3	RAM 4
Number of qualified projects	46	113	93	65
Number of winning projects	9	10	22	10
Percentage of projects selected from the qualified projects	20%	9%	24%	15%

Because the specific bid prices are confidential, it is difficult to assess the competitiveness of the bids that were rejected, and the threshold for what constitutes a competitive project may have been modified throughout the auctions. However, given that procurement targets have not been met in past auctioning rounds despite more than sufficient eligible bids, it would seem that the IOUs are using this mechanism liberally.

Because of the many qualified projects rejected in the selection process, it is possible that the RAM created a "development bubble", with many developers investing time and money in analysing and documenting projects that will never be financed through the RAM. Therefore, it might be worth evaluating whether too much of a burden is placed on the project developers in an early stage. The programme's ongoing viability may be harmed if developers lose faith in it after wasting considerable resources in unsuccessful projects.

Sources: (California Public Utilities Commission, 2015), (Wentz, 2014).

Main findings

The most effective way of maximising the success of an auction is by attracting a greater number of bidders – which in general results in a more cost-effective allocation of contracts and results in reduced prices. In this context, adopting requirements of minimal competition most often function as a "stopgap" mechanism when the auction has not fulfilled its main role of promoting competition between project developers. This does not mean that provisions to prevent market concentration are undesirable – indeed, the auction mechanism will be more robust if it properly anticipates certain "worst-case" outcomes and introduces provisions to deal with them. However, policy makers should be aware that these requirements are not a substitute to actual competition between multiple bidders.

A summary comparison of different options for ensuring a minimum degree of competition is presented in Table 5.4.

Table 5.4: Summary comparison of options to ensure competition

Options / Criteria	No requirements of minimal competition	Maximum awarded capacity constraints	Ceiling price mechanisms
Level of participation of bidders	Risk that larger players will dominate the auction	May incentivise small players to participate	May exclude some players if ceiling price is too low
Risk of Undercontracting	Lowest risk of undercontracting	Some risk if the number of bidders is small	Substantial risk if price cap is not calibrated properly
Cost-effectiveness	Neutral	May reduce opportunities for economies of scale	May have an effect in reducing equilibrium prices
Prevented collusion and price manipulation	No specific provisions	Impose some limits to individual companies	"Anti-monopoly" mechanism

Characteristics of the relevant attribute: Poor Medium Very good

5.3 WINNER SELECTION CRITERIA

The winner selection criteria, which dictate how to rank the bids and select the winners, is another topic that is at the core of an auction. Although it is possible to consider multiple criteria, translating these attributes into a one-dimensional "index" allows for the direct comparison of bids in order to ensure consistency in the selection mechanism. According to their winner selection criteria, auctions can be roughly classified as: 1) *minimum-price auctions*, which represent the most straightforward way of comparing bids; 2) *adjusted minimum-price auctions*, which maintain the cost-centric criterion but introduce a few adjustment factors; and 3) *multi-criteria auctions,* which tend to depart more strongly from minimum-price auctions by assigning a considerable weight to non-price parameters.

Minimum-price auctions

Minimum-price auctions represent "classical" implementation, in which the key objective is to contract the desired product at the lowest cost. While there may be several reasons for taking other criteria into account when selecting the most desirable bids, an important benefit of standard minimum-price auctions is their simplicity and objectiveness. Standard minimum-price criteria have been the norm in India and Peru, among other countries.

Among other criteria, the price was included in China's wind auction winner selection, the bid closest to the average would benefit the most, with the highest and lowest bids being excluded (see Box 5.11).

Adjusted minimum-price auctions

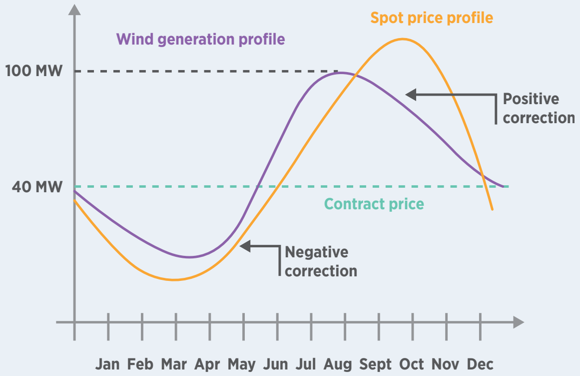
Adjusted minimum-price criteria are necessary when different products are involved in the auction, requiring a "correction factor" that makes it possible to compare the different bids on the same basis (see Box 5.7). In most implementations, project developers may bid for the different products, or demand bands, knowing how this choice will be reflected in either a bonus or a penalty on their bid for comparison purposes. This design element can be used in competitive auctions (see Section 3.1) that may involve products with very different characteristics. Brazil, for example, has allowed for the direct competition between biomass and wind power in certain auctions (see Box 5.7).

BOX 5.7: FACTORING IN RENEWABLE PRODUCTION COMPLEMENTARITY IN THE AUCTION PRICE IN BRAZIL

Brazil adopts a adjusted minimum-price criteria in its auctions, introducing a "correction factor" which correlates the average spot price profile and the power plant's production profile. The regulation authority estimates the future spot price profile and the project developer indicates the generation profile of the plant. Therefore, different generation bids, such as for wind and biomass, can be compared on the same basis, considering the economic value of their generation accordingly.

Figure 5.5 provides a theoretical example of how the scheme works. The wind bid is adjusted according to the plant's generation profile compared to the system's spot price profile: when the plant generates mostly at times when the spot price is high, the adjustment will turn into a bonus, whereas when the plant generates mostly at times when the spot price is low, the adjustment will turn into a penalty. The average of all the bonuses and the penalties, using the generator's declared production profile and a set of long-term price expectations produced by the government, will result in the "correction factor" (positive or negative) to be added to the bid price. For the purpose of the winner selection process, the auctioneer will take into consideration the adjusted bids of each project developer; however, once a project is selected, its remuneration will be based on its original price bid – as the correction factor essentially represents an externality.

Figure 5.5: Example of the wind generation profile, the spot price and the contract price



In Brazil's A-5 auction in 2014, the correction factor for all of the winning wind projects was negative, as wind production for typical plants in the country's northeast tends to be concentrated in the dry season, when spot prices tend to be higher (see Table 5.5).

Table 5.5: Coorrection factors in A-5 Auction in 2014 in Brazil

Project name	Installed capacity (MW)	Auction bid (USD/ MWh)	Correction factor (USD/MWh)	Price for evaluation (USD/MWh)
Aura Lagoa do Barro 01	27	69.8	-2.1	67.8
Laranjeiras III	26	71.1	-2.8	68.3
Ventos da Santa Dulce	28	70.0	-2.4	67.6
Boa Esperança I	28	69.3	-1.5	67.7
Canoas	30	70.7	-2.6	68.1

The exchange rate used to convert values from Brazilian reais to US dollars was approximately 2.2 BRL/USD during 2014.

Sources: (ANEEL, 2015), (Elizondo-Azuela, Barroso et al., 2014), (Bezerra, Cunha, Ávila, Barroso, Carvalho, Pereira, 2013).

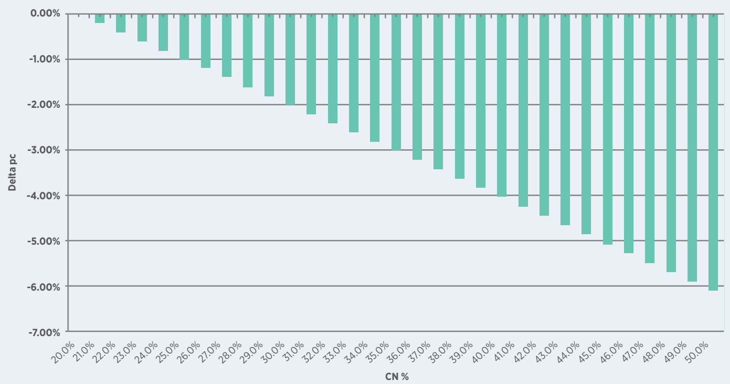
In mechanisms where the bidder is allowed to select the most suitable alternative, characteristics of the auctioned product could include the lead time for the project's commercial operation date (see Section 6.2) and the indexation and escalation clauses involved in the contract (see Section 6.3). Because projects with different lead times and/or indexation cannot be directly compared, an adjustment factor must be calculated in order to maintain a cost-centric winner selection criterion.

Another example of an adjusted minimum-price mechanism was Uruguay's 2013 wind auction, where the price used to determine the priority order was adjusted through a coefficient that reflects the local content of the project, as described in Box 5.8.

BOX 5.8: COMPARATIVE PRICE IN URUGUAY'S AUCTIONS

During the winner selection process in Uruguay's 2013 wind auction, the bid price for a project was modified upwards according to the local content share, using a coefficient to determine "the comparative" price. The local component of the projects ranged between the minimum 20% required and a maximum of 49%. Figure 5.6 illustrates the impact of the local component on the comparative price, indicating that a 1% increase in it reduced the comparative price by 0.2%.

Figure 5.6: The impact of national component participation on the comparative price (%)



However, the price stipulated in the PPA is not the comparative price, but a price that reflects the sum of the generation bid price and the unitary connection cost. Table 5.6 summarises the results.

Table 5.6: Comparison of the winning projects in Uruguay

Winning project	Bid price (USD/MWh)	Awarded price (USD/MWh)	Comparative price (USD/MWh)	Local component (%)
Venti Consortium	84	84.93	81.16	42.9
Fingano	NA	84.53	84.53	20
Palmatir	85	86.6	86.26	22

Sources: (Mercados Energeticos Consultores, PSR, 2013), (Proyecto Energía Eólica, 2015).

Multi-criteria auctions

Multi-criteria auctions involve introducing additional criteria in the comparison of bids. Unlike adjusted minimum-price schemes, however, they do not necessarily seek to represent proxies for actual costs. Instead, multi-criteria auctions tend to involve "virtual" costs that typically represent a preference but not a requirement for certain aspects of the bid. In this sense, multi criteria auctions are like introducing "soft" qualification requirements, as bidders that meet certain desirable qualities receive bonuses for the purpose of bid comparison. It is possible, for instance, to attribute a "grade" to the bidder's reputation and past experience rather than imposing a strict requirement (see Chapter 4), or to offer a bonus to plants that use locally manufactured equipment, rather than necessarily introducing hard domestic content constraints (see Section 4.5).

To ensure fairness and transparency of the auction process, it is desirable that the procedures to translate relevant attributes into comparable bids are known beforehand, so that suppliers may select the most attractive combination of attributes for their bid. However, this greatly increases the complexity of the mechanism, since the auctioneer must prepare a full set of grading criteria to be disclosed to the bidders. Nonetheless, there are multiple examples of successful multi-criteria auctions in China, France, South Africa and elsewhere.

In South Africa, socio-economic development factors were used as eliminatory requirements in the qualification phase, by setting thresholds for different indicators, such as local content, job creation and ownership (see Box 5.9). In addition, socio-economic benefits were important elements in the compound winner selection in the second phase of the auction.

BOX 5.9: COMPOUND WINNER SELECTION PROCESS IN SOUTH AFRICA

Three key objectives of renewable energy auctions in South Africa have been 1) increased generation capacity, 2) diversification of the energy mix towards less carbon-intensive technologies at low prices and 3) the creation of economic development opportunities. As such, the project selection criterion was based on a 70/30 split between price and economic development considerations (see Box 4.9).

In the selection phase, the bids were "graded" according to their degree of compliance with each of the economic development features, based on a target level for each variable (which is higher than the minimum level required for participation). Ten points were awarded for achievement between threshold and target levels, and an additional ten points for achievements above the target level. The resulting grade for economic development compliance receives a 30% weight in the compound winner selection criterion.

For instance, in the job creation criteria, a fraction of 18% of skilled black employees is the minimum to pass the qualification phase, but the target used in the second phase is 30%. Similarly, the minimum share of employees that must belong to local communities must be 12%, but a share of 20% guarantees the highest grade in the second phase. In parallel, the value of local content spending has a minimum of 25% but a target of 45%, and so forth.

Yet the tender's economic development requirements have been controversial, as they are often confusing as well as expensive for bidders to comply with. However, these requirements have helped to generate political support for the programme from politicians and the general public. By increasing the role of these factors to 30% of bid value, the programme helped increase the visibility of economic development considerations and underscore their importance.

Table 5.7 illustrates the results of solar PV and wind winning projects along the four bidding rounds, in terms of local content and local job creation. As observed in the case of wind projects, the local content spending barely exceeded the threshold of 25% in the first round, increasing until almost reaching the target of 45% in the fourth round.

Table 5.7: Socio-economic benefits criteria in South African auctions

	Round 1		Round 2		Round 3		Round 4	
Technology	Solar PV	Wind	Solar PV	Wind	Solar PV	Wind	Solar PV	Wind
MW contracted	632	634	417	563	435	787	415	676
Local content %	38.4	27.4	53.4	48.1	53.8	46.9	64.7	44.6
Job Creation: construction (citizens)	2381	1810	2270	1787	2119	2612	3825	2831
Job Creation: Operations (citizens)	6117	2461	3809	2238	7513	8506	9273	8161

Sources: (IRENA, 2013c), (Eberhard, Kolker, Leigland, 2014), (Department of Energy – Republic of South Africa, 2015).

The French experience, discussed in Box 5.10, resembles that in South Africa and uses a compound winner selection criteria aimed at cost efficiency, location, technological diversity, and support for research and development (R&D).

BOX 5.10: THE COUMPOUND WINNER SELECTION CRITERIA IN FRANCE

In France's renewable energy auctions, the price is an important criteria in the winner selection – but it is not the only one. In designing the auctions, the French government emphasised a mix of factors such as the cost efficiency of production, support for research and development (R&D), local aspects and emergence of new technology.

France's first auction was held in 1996, aiming to install between 250 and 500 MW of wind power by 2005. The main goals were to diversify the French energy mix, to incentivise geographic diversity (while taking into consideration public opinion and acceptance of the sites) and to encourage technological diversity, motivating R&D of different turbines and products. The government also aimed to develop a local wind industry, and the programme was a big incentive for the development of local wind turbine producers.

The country's pay-as-bid auction assessed the bids based on the following criteria:

- Price per kWh
- Economic benefits of the project
- Long-term benefits of the chosen technical solutions
- Technical and financial reliability
- Environmental aspects
- Local stakeholder opinion.

The compound winner selection criteria results in several priorities being met, although it likely sacrifices price efficiency in the process. Possible evidence of this can be found by comparing the prices resulting from wind auctions held in parallel in France and the UK: the first round of the French auction resulted in a higher average price (approximately 68 USD per MWh[1]) than the UK NFFO, whose only criteria for bid selection was the electricity price. Prices achieved in the UK NFFO in rounds 4 and 5 were respectively equal to 65 USD/MWh[1] and 51 USD/MWh[1].

Another example illustrating that price was not the main criteria in the French renewable energy auctions is the PPI (Programmation Pluriannuelle des Investissement / Multi-Year Invesment Programme) tender round for biomass in 2006. The projects were ranked according to a pre-defined point scale, in which the maximum amount of points was 30, based on the following criteria:

- Price (10 points)
- Plan for supply of biomass resources (12 points)
- Energy efficiency of the installation (7 points, elimination if lower than 50%)
- Technical and financial capabilities (1 point or zero, the latter meaning elimination).

This division of criteria is certainly not typical compared to most other renewable energy auctions, as price is not the main criteria, but accounts for a modest one-third of the selection process.

[1] *Average exchange rates used were of ca. 1.3 USD/EUR and 1.45 EUR/GBP (1.9 USD/GBP).*

Sources: (Green Stream, 2010), (IRENA, 2013a).

In order to reduce the risk of underbidding, China implemented an alternative multi-criterion scheme to select auction winners, with mixed results. In the country's last wind auction, in 2007, an average-price criterion was included as one of the selection criteria, together with benefits to the local economy and other indicators associated with bidders' technical and managerial experience (see Box 5.11).

BOX 5.11: CHINA'S MULTI-CRITERIA AUCTIONS WITH AN "AVERAGE-PRICE" CRITERION

In China's project-specific auctions for wind power, the selection criteria included not only the price, but also benefits to the local economy and indicators associated with the bidders' technical and managerial experience. The contribution of price to the final score was reduced to 40% in the third wind power auction in 2005, and to 25% in the fourth wind power auction in 2006.

In its fifth wind power auction, in 2007, the price criterion, still accounting for 25% of the bid score, was completely redesigned to benefit the bid closest to the average (with the highest and lowest bids being excluded). Notably, this scheme can be justifiable only in a project-specific auction; otherwise, the most promising projects with higher capacity factors would be excluded. One reason for adopting this mechanism is its ability to protect against "adventurous" bidders who might not be able to honour the contract. It also discourages bidders from offering below-market prices: in previous auctions in China, state-owned companies were able to bid artificially low by benefiting from a cross-subsidy. This situation led to the discouragement of foreign and small developers.

Nevertheless, this scheme presents two main drawbacks. First, it forces contenders to bid based mostly on their competition instead of their costs (with the aggravating factor that it is not below the competition). Second, it still tends to harm the most competitive bidders (*e.g.*, the ones with higher technological productivity, etc.) to the detriment of those which can hit closer to the average price. And in the case that the most competitive bidder strategically bids the average price, he will provide more-expensive energy than he could otherwise. Consequently, the average price achieved in the 2007 auction was approximately 12% higher than in the previous auction.

Sources: (Elizondo-Azuela, Barroso et al., 2014), (Wang, 2010).

Finally, the GET FiT programme in Uganda organises auctions for small power producers to gain premium payments in addition to the FITS. In the case of biomass, hydro and bagasse power plants, the developers compete based on a scoring system that uses a mix of non-price factors (see Box 5.12).

BOX 5.12: NON-PRICE COMPETITION IN UGANDA'S SMALL POWER PRODUCER AUCTIONS

In auctions for biomass, hydro and bagasse power plants in Uganda, developers compete based on a scoring system that uses a mix of non-price factors: financial and economic performance (35 points), environmental and social performance (30 points) and technical and organisational performance (35 points). Participants that receive an overall score of less than 70 points out of the total 100, or that score less than half of the points in any of the three categories, are eliminated. Since the premium payments are already established by the programme, based on the levelised cost of electricity (LCOE) for each of the technologies, there is no price competition.

For solar PV projects, price is included in the auction's winner selection criteria, with a weight of 70%, and the same non-price factors as for the other technologies compounding the other 30%. The government in Uganda made this decision because the solar PV market is changing so rapidly, making the LCOE more difficult to calculate. Given the major decline in the cost of PV panels over the last several years, the price of solar PV electricity has decreased as well, putting project developers in a better position to decide the current cost of production. The winning bids from Uganda's competitive bidding for small-scale plants connected to the main grid were publicly announced in December 2014.

Uganda's GET FiT provides a "top-up" payment in addition to the FIT, as summarised in Table 5.8.

Table 5.8: GET FiT premiums in Uganda

Technology	Current FIT ($/kWh)	GET FIT premium ($/kWh)
Solar PV	0.11	0.054
Biomass	0.103	0.01
Bagasse	0.095	0.005
Hydro	0.085	0.014
Job Creation: Operations (citizens)	6117	2238

Sources: (Multiconsult and Norplan, 2015), (Tenenbaum, 2015).

Main findings

Auction schemes have historically been strongly associated with the "classical" minimum-price criterion and this type of winner selection criterion remains a popular design choice, in large part due its simplicity. More recently, however, this approach has been challenged in many jurisdictions, as other criteria have been incorporated in the winner selection process. Introducing a small number of correction factors with transparent and market-oriented criteria to compare different bids can actually increase the perceived fairness of the process. However, certain difficulties may emerge if the winner selection process becomes dominated by non-monetary criteria, application of which tends to result in higher equilibrium prices. It may also lead to a perception of unfairness if the bidding criteria seem to favour a certain category of bidders.

A summary comparison of different options for determining the winner selection criteria is presented in Table 5.9.

Table 5.9: Summary comparison of winner selection criteria options

Criteria / Options	Minimum price	Adjusted minimum price	Multi-criteria auctions
Simplicity	Straightforward	Slightly more complex	High complexity
Cost-effectiveness	The main objective of this implementation	If implemented well, corrects biases in the pure price criterion	Price is not the main objective
Transparency and fairness	Straightforward comparison	Allows the comparison of different products on the same basis	Criteria may be perceived as unfair or arbitrary
Guidance from the auctioneer	Comparison based only on price, no other criteria	Some flexibility in selecting which adjustments to apply	One of the main objectives of this implementation
Development of a local industry	Does not offer specific advantages	In principle, does not offer specific advantages	May represent these objectives in the winner selection criteria

Characteristics of the relevant attribute: *Poor* – *Medium* – *Very good*

5.4 CLEARING MECHANISM AND MARGINAL BIDS

Another relevant aspect of the winner selection process relates to clearing the auction's supply and demand once all bids are properly ranked. Clearing is important where individual projects are large in size and non-divisible ("bulky" bids), which implies that strict equality between supply and demand is not always attainable. In such situations, the selection process requires either: 1) *demand-side flexibility*, meaning that the auctioned quantity accommodates inflexible price-quantity bids; or 2) *supply-side felixibility*, meaning that the bidder announces how the contracted quantity may be revised prior to the auction. Alternatively, if no *ex-ante* settlements have been done, 3) *ex-post* adjustments are a way to equalise demand and supply, involving some flexibility in demand allocation after the bids are made public.

In general terms, clearing mechanisms do not directly impact the auction outcomes and therefore they need to be as simple as possible. This is especially true in the case of renewable energy auctions, as renewable generation projects tend to be much more modular than conventional generation projects, and having "bulkier" bids is less of a concern. In addition, clearing is typically a non-issue in project-specific auctions, since the demanded quantity is generally equal to the total capacity of all candidate projects.

Demand-side flexibility

Flexible demand schemes are associated with fully indivisible price-quantity bids, which implies that the total contracted quantity will not always be equal to the predetermined volume auctioned (see Section 3.2). In some cases, such as in the electricity auction carried out in Guatemala (see Box 3.3), an optimisation problem is explicitly solved to determine which of the qualifying bids to contract so that the demand is met in the most optimal way. However, this type of allocation scheme introduces a substantial degree of complexity in the winner selection process, which may not be justifiable or transparent.

Instead, it may be preferable to adopt a simpler heuristic way to determine how the auction demand should be adjusted. In Brazilian auctions, for example, the auction demand can be adjusted upwards, but never downwards, and the next-lowest price bid is always fully accepted. Even though the Brazilian approach may result in a slight risk of overcontracting, it also leads to a simpler scheme overall.

In general, the flexible demand scheme is the most attractive alternative from the bidder's standpoint, since the complexity costs (in a mechanism such as Guatemala's) and the risks of an undesirable outcome (in a mechanism such as Brazil's) are borne by the auctioneer.

Supply-side flexibility

Supply-side flexibility implies that the bidders must adjust their offers in order to properly accommodate a fixed quantity demand. In most cases, this type of implementation involves price-quantity bidding, meaning that the bids submitted must contain information that allows the auctioneer to adjust the contracted quantity (and potentially the contracted price) in order to ensure that the auction's demand is met exactly. In theory, this type of mechanism allows for a more detailed representation of the supply and demand curves, implying that the equilibrium could be identified with greater accuracy. In practice, however, it is not always clear whether these gains offset the additional complexity involved. One way to reduce the underlying complexity of this mechanism (albeit at some cost to flexibility) is to impose constraints on the bids' format. In India, for example, generators may only bid for quantities of solar power capacity in multiples of 5 MW: thus, bidders give up some of their flexibility to determine the optimal quantity to be offered.

When the flexibility is placed on the suppliers' side, the bidders are slightly more constrained when submitting their offer as often the bid needs to respect a certain format, which implies more information to be revealed about their supply curve. In turn, supply-side flexibility schemes reduce the amount of concessions that must be made on the demand side, since the bids will be adjusted to meet the exact quantity auctioned.

Ex-post adjustments

Ex-post adjustments imply that the auction process terminates with a "tentative" allocation of winning projects, subject to confirmation among the interested parties. This type of adjustment can take many forms, from a binary "go/no go" decision (such as in the Chilean conventional energy auctions) to a demand-side decision to adjust the demanded quantity in order to achieve lower prices (such as in Dubai, see Box 5.13). In general, *ex-post* adjustments tend to increase the complexity of the auction mechanism, since the precise conditions for revisiting the relevant quantities after the auction should be completely clear before it takes place. Otherwise, the legitimacy of the process could be questioned, leading to a loss in project developers' confidence. If the conditions for awarding the auctioned product are open to interpretation, negotiation rounds would need to be carried out with the auctioneer, which defeats the key purpose of the auction procedure.

BOX 5.13: EX-POST ADJUSTMENTS ON DEMANDED QUANTITY IN THE PROJECT-SPECIFIC AUCTION IN DUBAI

In November 2014, Dubai's solar auction set a record low price for solar power with a winning bid of 5.98 USc/kWh from Acwa Power (well below the previous lowest price of 8 USc/kWh in Brazil's PV market).

The initial capacity target of the auction was set at 100 MW, but instead of submitting a price for the required capacity, the bidder opted for a price-quantity scheme and put additional alternative proposals to guarantee even lower prices if awarded with greater capacity (200, 800 or even 1 000 MW, with 5.4 USc/kWh for the 1 000 MW option). In this case, the flexible bid offers were initiated by the bidder in an attempt to provide alternatives for the project's capacity at lower prices, not to facilitate the clearing mechanism.

Consequently, *ex-post* adjustments have been made by the Dubai Electricity and Water Authority (DEWA), who accepted an alternative proposal with a higher capacity. Therefore, the expanded 200 MW phase will lower the price to 5.84 USc/kWh over a 25-year period contract. The *ex-post* adjustment in Dubai allowed DEWA to provide economies of scale to the generator, enabling the addition of 100 MW in the procured capacity and achieving simultaneously larger volume and lower prices.

Sources: (Apricum, 2014), (ACWA Power, 2015).

Main findings

Even though some jurisdictions have implemented sophisticated clearing mechanisms for matching supply and demand, as it is the case of Guatemala and Dubai, these tend to be the exception rather than the rule. Most renewable energy auction schemes tend to prefer simpler mechanisms, such as the ones adopted in Brazil (involving demand-side flexibility) and India (involving supply-side flexibility). It is relevant to point out that a clearing mechanism tends to be most important for the auction design when generators' bids are bulky and indivisible. However, the relatively modular nature of many renewable technologies (wind turbines, solar panels, etc.) makes it much easier to adjust the project size than it would be for conventional generators (*e.g.* a coal or gas plant). Ultimately, there are many viable implementations for the clearing mechanism, and the most important conditions are that it is clearly understood and adopted consistently.

A summary comparison of the different alternatives for clearing mechanisms is presented in Table 5.10.

Table 5.10: Summary comparison of clearing mechanism options

Criteria / Options	Demand-side flexibility	Supply-side flexibility	Ex-post adjustments
Simplicity	Auctioneer must determine rules to adjust demand	More complex bids and comparison processes	Depends on interest of both parties
Investors' confidence	Demand accommodates indivisible bids	Investors accept some uncertainty in contracted quantity	Subject to ex-post negotiations
Risk of (over) undercontracting	Overcontracting tends to be common	Bids are adjusted to meet the demand	Risk of parties not reaching an agreement
Matching supply and demand	Typically results in (over) undercontracting	Matches a more refined supply curve	Good, provided that parties reach an agreement

Characteristics of the relevant attribute: *Poor* *Medium* *Very good*

5.5 PAYMENT TO THE AUCTION WINNER

Another issue is how the winners' remuneration for the auctioned product is to be determined based on the results of the bidding procedure. In essence, the following approaches are possible: 1) *pay-as-bid pricing*, in which the project developer's remuneration is dictated by the developer's own bid; 2) *marginal pricing schemes*, in which other project developers' bids are used as a basis for remuneration; and 3) *nonstandard pricing schemes*, which refer to any unique options that do not fall into these typical categories.

Pay-as-bid pricing

Pay-as-bid pricing mechanisms are the most common approach in renewable energy auctions. In this type of scheme, the optimal bidding strategy is more complicated, as the bidders do not seek simply to win the auction, but rather to win while submitting the highest possible bid. Thus, estimating other players' bids plays an important role. In addition, in an attempt to bid lower than the other participants, the auction's winners might fall victim to the "winner's curse", whereby the players tend to underbid and eventually may not be able to fulfill the contract.

Pay-as-bid implementations are typically seen as a means to minimise costs, offering bidders no more than their bid, which is supposed to be the minimum required for developing the renewable energy project. This gives these schemes much wider appeal from a social and political standpoint. The cost-effectiveness of the auction mechanism tends to be an important driver behind the widespread adoption of pay-as-bid pricing.

Marginal pricing schemes

According to the classic economic theory of auctions, marginal pricing schemes tend to be preferred over pay-as-bid mechanisms. This is because, by making project developers' remuneration independent from their price bid, bidders are encouraged to disclose their actual costs. In auctions that seek to satisfy a certain demand for renewable energy on aggregate, the standard implementation involves uniform pricing, in which each of the many auction winners is remunerated based on the same price, given by the most expensive of the accepted bids (or alternatively, by the least expensive of the rejected bids).

One downside of marginal pricing schemes is a possibility of losing social and political support, due to the perception that the auction mechanism imposes a needless burden on consumers (when remuneration is based on the most expensive of the accepted bids). This design alternative typically results in winning projects being remunerated at a value that is higher than their asking price, which may lead to criticism – particularly if the original bids are known to be substantially lower than the equilibrium price. The use of a descending clock bidding mechanism (see Section 5.1) can be one way of mitigating this effect, since a bidder's minimum disposition to receive can be kept undisclosed.

Nonstandard pricing schemes

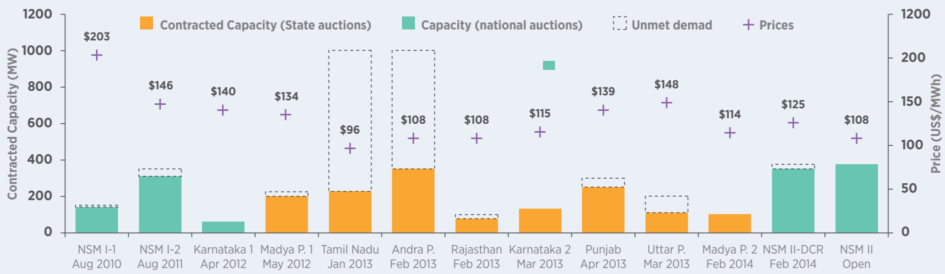
Nonstandard pricing schemes represent a catchall category for any means of pricing the winning contracts that cannot be described as either marginal pricing or pay-as-bid. Most often, these mechanisms involve some kind of *ex-post* negotiation between the auctioneer and the auction winner. However, even though these negotiations may help the auctioneer to negotiate a better deal in the short term, in the longer term, this model can lead to a perception that the auction mechanism is not as fair or transparent as it claims to be. The "L1" pricing scheme adopted in certain Indian states is one example of a nonstandard pricing implementation (see Box 5.14).

BOX 5.14: LOWEST BID CONTRACT PRICING SCHEME IN INDIA

The Indian states of Rajasthan, Tamil Nadu, Andhra Pradesh and Odisha adopted a remarkable and controversial pricing scheme known as L1. In this mechanism, the final contract price is given by the lowest bid offered in the auction. Therefore, the bidders who are able to accept this price will be awarded the PPA. The economic benefit of the scheme is questionable. Although it could be successful in decreasing prices, it mostly resulted in a large number of competitive bidders refusing the PPA.

The L1 bidding scheme did have an immediate effect in reducing prices, but at a cost of a large unmet demand. Figure 5.7 shows that the states where L1 pricing has been implemented (Tamil Nadu, Andhra Pradesh and Rajasthan in January-February 2013; Odisha not pictured) tend to present the lowest prices, but also the highest amount of unmet demand.

Figure 5.7: Overview of the results from recent auctions in India



Note: "Due to the very different nature of the auctioned products (such as the shorter 10-year PPA in Uttar Pradesh and the very different schedule of payments implied by the VGF mechanism from the NSM Phase II), several assumptions needed to be made in order to obtain reasonably comparable values for this Figure. For this reason, the auctioned prices listed here should be interpreted only as rough estimates rather than exact values." The currency conversion used an exchange rate of 60 INR/USD

Source: (Elizondo-Azuela, Barroso et al., 2014), (Bridge to India, 2011-2014)

Main findings

The preferred alternative in most renewable energy auctions seems to involve pay-as-bid payments to the auction winners with fewer jurisdictions adopting marginal pricing schemes and other nonstandard pricing schemes. The greatest disadvantage of marginal pricing implementations is that they may lead to a perception of unfairness, especially if the auctioned price is substantially higher than the cheapest bids (which will result in a large surplus remuneration to those low bids). For this reason, marginal pricing is most often applied in the context of iterative auctions (see Section 5.1), in which bidders' supply curve is not fully disclosed. Pay-as-bid schemes, in contrast, are more straightforward to implement from the auctioneer's standpoint and can be more easily defended politically.

A summary comparison of the different winner remuneration options is presented in Table 5.11.

Table 5.11: Summary comparison of winner remuneration options

Criteria \ Options	Pay-as-bid pricing	Marginal pricing	Nonstandard pricing
Price signals for performance	◔ Efficient generators capable of bidding low receive less than less-efficient ones	● Cheaper suppliers receive surplus remuneration	◑ Depends on the scheme's design
Better appearance of low price achievement ("political" benefit)	◕ No generator receives more than their requested price	◔ Possible perception that consumers are overpaying for renewables	◔ Possible impression of opacity or unfairness in the long run
Collusion and price manipulation	◕ Bidders have an incentive to submit similar offers	◔ The marginal bid has the power to define all winners' remuneration	◑ Depends on the scheme's design
Transaction costs	◑ Optimal bid strategy depends on competitors' bids	● Optimal bid strategy involves revealing actual costs	○ Nonstandard design requires building a new bid strategy

Characteristics of the relevant attribute: ○ *Poor* ◔ ◑ *Medium* ◕ ● *Very good*

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