RENEWABLE ENERGY AUCTIONS:
A GUIDE TO DESIGN

3

AUCTION DESIGN: DEMAND

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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

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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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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

3 Auction design: Demand

The auction demand involves key decisions on what exactly is to be procured in the auction and under which conditions. It thus comprises demand-side considerations and topics that fall in this category include: 1) the *specific demand bands*, which define whether and how the total demand is shared among different "products"; 2) the *volume of products* to be auctioned; 3) the *periodicity and long-term commitments*, which determines whether a pre-set auction schedule is adopted, and 4) the *demand-side responsibilities* that ensure the creditworthiness of the auctioneer. Figure 3.1 summarises these design elements, that are further discussed in the chapter.

3.1 SPECIFIC DEMAND BANDS

Demand bands are associated with how the total energy demand is structured and allocated to products with different characteristics. A product can be defined by the particular attributes of the Power Purchase Agreement (PPA) signed after the auction (see Chapter 6) or by the different qualification requirements requested in order for the developer to be eligible to participate in the auction (see Chapter 4).

Perhaps the most typical example of separating auctioned volumes into demand bands is according to different renewable energy technologies (see Section 4.2). However, in practice, it is possible to partition the demand in many other ways: some renewable energy auctions have split their demand based on locally manufactured versus internationally manufactured equipment, project size and geographical location, among others.

Figure 3.1: Overview of demand-side considerations

Specific demand bands	Volume auctioned
Related to the partitioning of renewable energy demand based on different criteria (technology, size, location, *etc.*): » Exclusive demand bands » Competitive demand bands » Partially competitive demand bands	Key input in the auction process, consistent with the renewable energy policies and electricity system's technical capabilities: » Fixed auctioned volume » Price-sensitive demand » Multi-criteria volume setting
Periodicity and commitments	**Demand-side responsibilities**
» Standalone auctions – used to achieve economies of scale, mainly in smaller countries with less mature technologies » Systematic auctions – may attract a larger number of bidders, leading to gradual renewable energy penetration	» Allocation of costs » Contract off-taker » Contracting schemes Consumers → Contract off-taker → Generator

Regardless of the criterion used to distinguish the demand bands, multi-product renewable energy auctions can be classified as being 1) *exclusive*, when separate capacity targets are allocated to two or more renewable energy products in such a way that the demanded quantities do not intermingle (*i.e.*, the products do not compete with each other); 2) *competitive*, when different products compete for the same total demand on relatively equal terms, for example, when the auctioneer establishes a capacity target to be installed for which more than one renewable energy technology compete; or 3) *partially competitive*, which represents a middle point between the first two options.

Exclusive demand bands

In auctions that involve multiple products, setting pre-determined demand bands is in principle no different from organising multiple independent auctions for the different products – although organising a single auction may reduce the burden on the auctioneer. Since the earliest auctions, exclusive demand bands have been implemented to foster the development of specific technologies. The first renewable energy auctions, which were organised in the United Kingdom (UK) in the 1990s, awarded contracts as a result of a competitive bidding process within exclusive technology bands, which allowed each technology to progress at an appropriate pace rather than competing with other technologies (discussed later in Box 3.11).

Multiple criteria besides the renewable generation technology can be used to define exclusive demand bands – such as the project size as in the case of India (see Box 3.1) and France. India has also had some experience with splitting the auction's demand into projects that fulfill a given level of local content requirement (LCR) and projects that did not (see Section 4.5).

One of the main benefits of adopting exclusive demand bands is that it offers better guidance to potential project developers. Furthermore, reserving demand bands to less mature technologies encourages the development and deployment of those technologies and the diversification of the energy mix. A similar argument can be made for promoting smaller-scale projects and domestically manufactured equipment. However, one disadvantage is that the fragmentation of demand could result in less competition among suppliers, which in turn may result in higher prices for the renewable energy purchased. In addition, there is a higher chance that at least one of the bands may fail to attract enough bidders, leading to an increased risk of undercontracting.

In order to mitigate this risk, some countries have allowed a transfer of demand between sub-auctions when one of them is undersupplied. For example, in 2011, in the Indian state of Karnataka, the auction originally foresaw contracting 50 MW of solar PV and 30 MW of solar thermal generation, but this split was revised to 60/20 when only one 20 MW bid was received for the second technology.

BOX 3.1: EXCLUSIVE DEMAND BAND BASED ON PROJECT SIZE IN PUNJAB, INDIA

A common downside of exclusive demand band auction schemes is that they could limit the participation of small and/or new players, a topic that is discussed in Section 2.2 and Box 2.8. One possible way to address this risk is by introducing them for small-sized projects. In the Indian state of Punjab's 2013 solar power auction, for example, a portion of the demand (50 MW in total) was reserved to relatively small-scale projects (1-4 MW), and only newly established companies were able to participate. The remaining 250 MW was reserved for well-established companies with project sizes of 5-30 MW.

In December 2014, the state of Punjab organised a new auction for the installation of 250 MW of solar PV projects. This time, the auction demand was divided into three categories: 50 MW was allocated to small-scale projects (1-4 MW), 100 MW to medium-sized projects (5-24 MW) and 100 MW to large installations (25-100 MW). However, the undersubscription of eligible bids in the first category and the predominance of maximum-sized bids in the second category (24 MW) showed an overall preference for larger projects among the project developers, indicating that further incentives may be needed to overcome the transactions costs.

Source: (Elizondo-Azuela, *et al.*, 2014), (Pillai and Banerjee, 2009).

Similarly, in the 2010 auction in Peru, the bids received for the biomass generation product amounted to only 143 GWh per year, whereas the available capacity on auction for that product was 813 GWh per year. As a consequence, some of this unmet demand was transferred to the wind power demand band, which resulted in 571 GWh per year of wind being contracted, 178% higher than the original demanded quantity (320 GWh per year). This type of decision is usually made after bids are received and surpluses and deficits in different products are identified. There are more complex *ex ante* transferring schemes that can also be considered, approaching the situation of *partially competitive* schemes described later.

Competitive demand bands

Another way of auctioning multiple products is through competitive auctions that involve a single pool representing the entire auction demand, to be allocated by means of the winner selection process only (see Chapter 5), with no products being entitled to a minimum awarded quantity. In its purest version, fully competitive auctions involve only a single product, and once suppliers satisfy the criteria to participate in the auction (see Chapter 4), they are all treated equally. A competitive auction could be, for example, one in which various renewable generation technologies compete for a single quantity target, with the most extreme case being a technology-neutral auction. For example, the 2011 auctions that were held in Brazil were technology-neutral, and renewable energy technologies were competing with natural gas.

Because competitive auctions seek to maximise competition in order to achieve the most cost-effective results, they tend to favour the most attractive technologies and sites available, at the expense of other potentially promising- but ultimately costlier projects. While this is a feature that allows competitive auctions to drive prices down, it tends to favour mature technologies.

By definition, in a competitive auction, all bids must be compared according to the same selection criterion; however, this does not mean that competitive auctions are necessarily completely neutral. It is possible, for example, to propose a contract with specified demand bands that are better suited to certain renewable energy generation profiles (such as a contract that involves energy delivery obligations concentrated in the daytime, catered to solar power), allowing other technologies to compete for this product if they are willing to accept the higher price/quantity risks. California's Renewable Auction Mechanism is an interesting case study of this type of implementation (see Box 3.2), and Chile has adopted a similar strategy in its recent conventional electricity auctions.

In summary, in an auction involving exclusive demand bands, each bid is pre-allocated to a particular band depending on its characteristics (technology, size, etc.). In contrast, an auction involving competitive demand bands may allow the project developer to choose the product with the most suitable risk preferences and generation profile, with the option to even bid for more than one product. By promoting product differentiation without an explicit separation between the bids, this type of implementation tends to highlight the competitive nature of the auction mechanism.

Partially competitive demand bands

Partially competitive auctions, in turn, seek to find a balance between the two alternatives described above, with the aim of achieving the best of both worlds by combining the improved guidance of exclusive auction schemes with the greater cost-effectiveness of competitive schemes. As is often the case with hybrid implementations, this typically comes at the cost of higher complexity, since there is a larger number of variables that need to be determined to achieve the desired result.

One reasonably straightforward way to implement an auction involving partial competition is to assign minimum exclusive volumes to each demand band, while leaving the remainder of the auction demand after these minima to be allocated in a competitive fashion to the best offer. Guatemala's 2012 auctioning scheme, which involved auctioning both renewable and non-renewable energy sources for new and existing suppliers, used this type of scheme. It allocated minimum demanded

BOX 3.2: AUCTION DEMAND BANDS IN CALIFORNIA

The U.S. state of California introduced its Renewable Auction Mechanism (RAM) in 2011, aimed specifically at promoting geographically distributed, small-scale generation projects of various renewable energy sources. Originally intended as a one-time programme involving four auctions organised in a period of two years for procuring a total of 1 000 MW, the programme has since been extended.

A very specific characteristic of the RAM is the way in which the auctioned volume has been shared among demand bands. Although the bands are technology-neutral, they are designed to implicitly favour one or another technology through the product definition and commitment profiles. In the Californian scheme, the auction demand is split into three different categories: 1) baseload electricity (suited for biomass, biogas, landfill gas and geothermal), 2) peaking electricity (suited for solar PV and solar thermal) and 3) non-peaking electricity (suited for wind and small hydro).

This categorisation favours competition among similar technologies, and results seem to indicate a major representation of wind power in the non-peaking category and a total dominance of solar PV in the peaking group. However, this is not a hard rule: it is the generators' responsibility to define the type of product that they can most properly deliver. Unlike the classic technology-specific bands, in which a specific project can bid in only one of the categories, in the competitive demand bands, a project has the possibility to bid in more than one category.

For instance, different hydropower projects have been accepted both in the baseload and in the non-peaking electricity categories. Ultimately, this type of auction structure leads to greater competition, with the aim of achieving the lowest price regardless of the technology.

Results from the first four auctions suggest that the RAM is an economically efficient mechanism for the procurement of wholesale distributed generation. However, one important concern is that the winning projects may not represent a diverse array of renewable energy sources, as might have been intended: in the first auctions, for example, solar PV accounted for 95% of all bids, with 13 out of 15 winning bids. This is because solar PV technology is relatively well developed and less expensive compared to other distributed generation options.

Since RAM 1, the number of baseload and non-peaking bids has increased steadily (at the expense of peaking electricity products), and the procurement of these resources has grown, although at modest rates.

Sources: (California Public Utilities Commission, 2013), (California Public Utilities Commission, 2015), (Wentz, 2014).

quantities to the most desirable products and maximum quantities to less-desirable ones (see Box 3.3).

BOX 3.3: PARTIAL COMPETITION SCHEME WITH MINIMUM BAND ALLOCATIONS IN GUATEMALA

Guatemala has organised three iterations of a competitive auctioning scheme in which a wide array of types of projects can participate – including renewable and non-renewable energy sources, new and existing generators, and international players.

These schemes have been carried out in a partially competitive fashion, such that specific technologies are allocated a minimum capacity to be contracted. Volume caps are also set on other technologies, to ensure some competition among the technologies for the demanded quantity above the technology-specific minimum.

The main parameters set in 2012 Guatemala's auction were as follows:

- A total auctioned volume from all technologies of 600 MW, out of which a minimum capacity of 300 MW is to be contracted from renewable energy sources, out of which a minimum capacity of 200 MW is from hydropower, and a minimum capacity of 30 MW is from biomass and wind. Therefore, a capacity of 70 MW represents a competitive demand band for all the renewable energy technologies;
- As such, a maximum capacity from non-renewable energy sources of 300 MW was set, out of which a cap of 80 MW is set on coal and a cap of 200 MW is set on natural gas;
- The auction required also a minimum capacity of 300 MW to be contracted from new suppliers, as a way to encourage new players in the market and a maximum capacity of 300 MW to be contracted from international players, in order to limit the foreign participation and to encourage the domestic one.

To comply with all of these criteria while minimising the cost of the electricity purchased, Guatemala uses a linear optimisation model to select the auction winners. Despite the benefits of this design, it comes with a high level of complexity, increased costs for the auctioneer and reduced transparency from the bidders' point of view (given that they do not explicitly know how the winner selection process took place).

Source: (Comisión Nacional de Energía Eléctrica, 2012)

Main findings

Even though single-product auctions can in principle be more focused on fulfilling objectives, auctioning multiple products simultaneously has also been a common strategy – enabling the reduction of transaction costs, and allowing policy makers to provide better guidance. There is a wide array of implementation options for distributing the auctioned demand into bands, as both exclusive and competitive auctions have been implemented worldwide. The experience with partially competitive schemes is limited, but, where applied, this type of mechanism has proven to be successful as well. There is little consensus on which design alternatives are the most desirable, indicating that this is a very context-dependent choice.

The main advantages and disadvantages of the different demand band alternatives presented in this section are summarised in Table 3.1.

Table 3.1: Summary comparison of demand band options

Options / Criteria	Exclusive demand bands	Competitive demand bands	Partially competitive demand bands
Simplicity	Straightforward division of demand	Rules to compare different bids competing in the same demand band	More complex set of rulings
Guidance from the auctioneer	Strict criteria for each category	Bidders are treated equally, with more moderate guidance	A mix of moderate and strict criteria
Competition	Segmentation of demand may lead to less competition	Allows competition among all the bidders	Allows limited competition among classes of bidders
Avoided under-contracting	Any of the sub-auctions might fail to attract bidders	High flexibility in matching bids to demand bands	Moderate flexibility in matching bids to demand bands

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

3.2 DETERMINING THE AUCTIONED VOLUME

A key input to the auction is the desired amount of renewable energy to be contracted – a target that must be consistent both with government policies for renewable energy development and with the existing system's technical capabilities to absorb the renewable energy (see Section 4.4). There are essentially three ways to determine the auctioned volume: 1) under a *fixed volume method*, the government simply determines the desired demand level in a unilateral fashion; 2) in a *price-sensitive demand curve* mechanism, demanded quantities are affected by the auction's equilibrium prices according to a rule that is determined ahead of time; and 3) in a *multi-criteria volume setting* method, other parameters and more complex guiding principles may be used to determine the demand level. In all three options, there is an additional decision to be made regarding whether or not the determined volume will be disclosed to potential bidders.

Fixed auctioned volume

Fixed volume schemes, in which the auction demand (in energy or capacity terms) is determined by the auctioneer and assumed to be fixed, are the most common and straightforward to implement. This approach has the benefit of offering guidance to the bidders, and is also regarded as simple and transparent. In order to increase transparency, the demanded quantity is most often fully disclosed.

One consideration regarding full disclosure, however, is that letting the market have full knowledge of the auction demand can be undesirable if bidders can use this information to influence the outcomes. For example, in a descending clock auction (see Section 5.1), if bidders have information on the supply-side quantity at each round, they can bid strategically in an attempt to end the auction prematurely and increase their own remuneration. When a bidder knows that s/he is a pivotal player to meet the demand, s/he can choose to leave the auction, which forces the auction to terminate at a higher equilibrium price, unless the auctioneer accepts some undercontracting. For this reason, in Brazil's renewable energy auctions and Colombia's conventional energy auctions – both involving descending clock rounds – an effort is made to keep the demanded quantity undisclosed until after the auction.

Price-sensitive demand curves

In the case where the volume is set using a price-sensitive demand curve, if the auction's equilibrium price is lower than the government's original estimates, the demanded quantity could rise in response, and vice versa. This representation of the volume as a function of equilibrium price could result in more desirable outcomes, especially if the bids received depart substantially from the government's original expectations. For example, if the auctioneer had estimated a much higher price for developing solar PV projects, the volume contracted can be increased from the initial plan if investors offer much lower prices due to the falling costs of technology.

Despite the increased flexibility, following a price-sensitive demand curve adds a slightly higher level of complexity to the mechanism and makes it more difficult to clearly communicate the auction's demanded quantity to the market.

Price-sensitive demand curves may be defined, for example, by determining a total budget for renewable energy expansion, which results in the auction demand being inversely proportional to the equilibrium price, as in the case of the Netherlands (see Box 3.4). If the price resulting from the auction is lower than the equilibrium price, the volume can be adjusted upwards, and vice versa. This type of representation is often practical from the auctioneer's standpoint, in the sense that policies to support renewable energy deployment are generally limited by the maximum amount of resources that can be allocated to the initiative.

BOX 3.4: PRICE-SENSITIVE DEMAND ON MULTIPLE BANDS BASED ON A TOTAL BUDGET IN THE NETHERLANDS

Since 2011, the Netherlands' renewable energy programme SDE+ (Stimulering Duurzame Energieproductie/Encouraging Sustainable Energy Production) has combined auctions with feed-in premiums (FIP) in a unique way. Contracts are awarded by means of technology-neutral auctions, while compensation takes place based on a FIP that results from the auction. The FIP is calculated as the difference between the price offered during the bidding process and the monthly average electricity price, and it is paid for 15 years.

The support scheme is based on a well-defined annual budget and is meant to achieve least-cost promotion of renewable energy. Since 2012, both renewable electricity and heating technologies have been included under the same scheme. The SDE+ is operated in the form of sequential bidding rounds with increasing prices. For each bidding round, the government sets the support levels that increase from one round to the next. In 2013, for example, these were 70 EUR/MWh (92 USD/MWh) for the first round, 80 EUR/MWh (105 USD/MWh) for the second round, 90 EUR/MWh (119 USD/MWh) for the third round, *etc.*

In this way, low-cost renewable energy technologies are the first to submit their bids and be granted financial support, as the selection takes place on a "first come, first served" basis. Renewable energy technologies with higher costs can participate in subsequent bidding rounds, which will be held until the maximum amount of the available budget has been allocated (EUR 1.5 billion in 2011, roughly USD 2.08 billion, EUR 1.7 billion in 2012, roughly USD 2.17 billion, EUR 2.2 billion in 2013, roughly USD 2.9 billion, and EUR 3.5 billion in 2014, roughly USD 4.65 billion, distributed over the lifetime of the plants). Therefore, bidders waiting for a higher remuneration level round may risk having the auction's budget exhausted before reaching that round. In 2012, for example, the available budget was already exhausted during the first bidding round, resulting in project bids of 70 EUR/MWh (92 USD/MWh), most of which was allocated to heating and to combined heat and power.

There is also a free category in each bidding round, in which project developers have the opportunity to request a lower level of compensation than the one of the respective bidding round.

Due to the fact that the SDE+ scheme allows the deployment of only the most cost-effective technologies, the overall budget is usually exhausted before reaching higher-compensation bidding rounds. As such, the Dutch government is planning to organise separate tenders for offshore wind energy in 2015.

Sources: (IRENA, 2014a), (Ecofys, 2014), (Agora, 2014), (Del Río, Linares, 2014).

Multi-criteria volume setting

Multi-criteria volume setting methods are more complex than the price-sensitive demand curves described previously, as the volume set is not simply a function of the price. This approach can be the best way to represent certain more sophisticated demand allocation procedures which involve multiple demand bands (see Section 3.1), although in general, it is more difficult to communicate these criteria to the public. One example of this type of multi-criteria implementation can be found in Brazilian auctions, in which the auctioned demand depends on the number and capacity of potential suppliers (see Box 3.5).

Main findings

Fixed auction volume schemes have been the most common option implemented worldwide, and they seem to be reasonably functional. Indeed, adjusting demanded quantities may not be an option for many jurisdictions, given the strict policy commitments that various countries have engaged in, such as the 2020 targets set in the European Union. Under a fixed auction volume scheme, governments can accomodate to a limited budget for the support of renewables by implementing a price cap mechanism (see Section 5.2); and if the prices resulting from the auction are lower than expected, policy makers can consider the possibility of holding another auction.

Introducing price-sensitive demand curves and/or multi-criteria volume setting methods allows policy makers to automatically incorporate some flexibility to the contracted quantity, to the extent permitted by budgetary allocations and the government's policy objectives. Although these alternatives tend to imply a higher mechanism complexity, the benefits of having a more refined demand curve can outweigh the potential downsides.

The main advantages and disadvantages of the different auction volume options presented in this section are summarised in Table 3.2.

Table 3.2: Summary comparison of auction volume options

Options / Criteria	Fixed auctioned volume	Price-sensitive demand	Multicriteria volume setting
Simplicity	Simple to implement and communicate	Slightly more complex (for some implemen-tations)	Potentially more complex; cannot be described as a function of price
Guidance from the auctioneer	Policy mak-ers' goals are unidimentional (quantity only)	More flexibility in setting goals (price and quantity)	Greater flex-ibility: multi-dimensional goals
Matching supply and demand	Cannot respond to prices	Capable of reaching optimal demand and price	Depends on the criteria selected

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

BOX 3.5: COMPETITION AS A CRITERION TO SET THE AUCTION VOLUME IN BRAZIL

Brazil's renewable energy auctions have two distinct features regarding their volume setting method: 1) a feature for adjusting the auction's total volume as a function of supply, and 2) a feature for allocating this volume to the various renewable energy products according to the total supply registered to each product.

The first feature aims to promote competition and prevent the price from being too close to the cap. Prior to the auction, two parameters are defined and kept undisclosed: the "total demand", which represents the maximum amount of energy that will be contracted from all products, provided that there is sufficient supply; and the "demand parameter", which is used to force a minimum level of competition.

For example, if the demand parameter is equal to 1.5, this means that the auction's supply must be at least 50% higher than the total volume. If supply is insufficient, then the volume will be automatically adjusted downwards: Volume auctioned = Min {Total Demand; Total Supply/Demand Parameter} (the demand parameter is always greater than one).

The second feature is used to allocate the total volume to the various renewable energy products according to the number of bidders in each product. Brazilian auctions have so far designated a total volume to be allocated to various products representing different technologies. The 2013 auction allowed the participation of wind, solar and biomass.

For example, if the volume auctioned is 500 GWh, and the bids received in the first round correspond to 1 600 GWh of wind power, 800 GWh of solar power and 100 GWh of biomass, then the auction demand would be distributed proportionally: 320 GWh for wind, 160 GWh for solar and 20 GWh for biomass.

In addition, the government also sets a "reference factor" for solar and biomass, representing the maximum share of the auction demand that can be allocated to these two products. For example, in the case above, 32% of the volume is allocated to solar; however, if the government had set a reference factor of 25% for that technology, then the demand for solar would be revised to 125 GWh rather than 160 GWh. Because wind has the lowest reference price of the three products offered in that auction, it is treated as the "default" technology. Therefore, demand for wind would be increased so that the total auction demand is still equal to 500 GWh.

Even though the procedure for determining the volume is described in the Brazilian auction documents, all relevant parameters are kept undisclosed.

Sources: (Elizondo-Azuela, Barroso *et al.*, 2014), (Maurer, Barroso, 2011), (Porrua, Bezerra, Barroso, | Lino, Ralston, Pereira, 2010)

3.3 PERIODICITY AND LONG-TERM COMMITMENTS

The periodicity of auctions are associated with a country's energy policy and long-term commitment to renewable energy deployment. A country that seeks to introduce an auction scheme has two options: 1) a *standalone auctioning scheme*, in which each auction is organised individually, without the commitment to further bidding rounds in the future; and 2) a *systematic auctioning scheme*, which involves longer-term planning and pre-commitment to an auction schedule to be carried out over an extended period, typically along with a total quantity to be awarded in the course of those future auctions.

Standalone auctions

Concentrating the entire demanded quantity into a single standalone auction may be desirable if the policy target is small. This approach may also help promote economies of scale (although this can have some drawbacks, as discussed in Section 4.2). Several Indian states as well as Dubai, Peru and Uruguay have chosen the route of standalone auctions. In addition, the government may be hesitant to commit to a long-term schedule for newly introduced renewable energy technologies, as it can be difficult to predict the auction's success in attracting bidders and developing projects, especially in the case in which country's experience with auctions is limited.

The main benefit of standalone auctions is that the government retains its liberty and flexibility to adjust the auctioning schedule in response to any shifts in market conditions. If the government overcommits and eventually finds itself in a situation where it must revise its prior commitment, this could have a negative impact on the investors' confidence in the system.

The main downside of adopting a standalone auction, however, is that it tends to magnify the "stop-and-go" characteristic of the auction scheme, as developers and manufacturers find it more difficult to plan for the development of a renewable energy supply chain in the country. Brazil is one example of a country that has chosen this route: even though renewable energy auctions have been organised almost every year since 2008, the decision of how much to contract and from which technologies is made on a year-by-year basis.

Systematic auctioning scheme

Systematic auctioning schemes involve a commitment to a longer-term auctioning schedule. This alternative allows market agents to better adjust their expectations and to plan for the longer term. Additionally, introducing a steady stream of new projects rather than a substantial, aperiodic influx (as it is typically the case with standalone auctions) helps the government promote the development of a local industry. In addition, having a long-term auction schedule provides better guidance for planning the grid infrastructure, so that the stream of new projects are smoothly integrated. Choosing this option, however, may result in a risk of overcommitment, forcing the government to dynamically adjust the auction schedule and quantities according to perceived shifts in market conditions.

The upside of splitting the demand into several auctions according to a long-term plan seems to be significant, as the success of earlier auctioning rounds seems to result in more success in later rounds. Generally, there is a steep learning curve for the first few rounds of an auctioning scheme, as the auctioneer goes through a learning by doing process and the project developers, as well as other market agents such as financiers, gain confidence in the programme. In India the National Solar Mission has shown the advantages of a systematic auctioning scheme (see Box 3.6).

BOX 3.6: SYSTEMATIC AUCTIONS IN INDIA

When launching its National Solar Mission (NSM), India aimed to support the development of the solar power sector and committed early on to a systematic auctioning scheme in three phases announced ahead of time. Phase I was planned to take place between 2010 and 2013, Phase II between 2013 and 2017, and Phase III from 2017 to 2022. Periodic evaluations of progress were scheduled regularly, during which the capacity targets for subsequent phases could be revisited based on observed cost and technological trends, (domestic and global). The idea was to protect the government from exposure in case expected cost reduction did not materialise or was more rapid than expected.

Therefore, the first phase involved relatively modest capacity additions in grid-connected systems. In the second phase, taking into account the experience of the initial years, capacity increased significantly.

Sources: (Eberhard, 2013), (Elizondo-Azuela, Barroso *et al.*, 2014), (Wentz, 2014), (Bloomberg, 2015).

In a number of jurisdictions, the move towards multiple round auctions (see Box 3.7) has had positive learning curve impacts (see Table 3.3).

Table 3.3: Systematic auctions and the learning curve impact

Country	Renewable energy technology	First iteration	Second iteration	Learning curve impact
South Africa	Various	2011: 53% bids qualified	2012: 64.5% bids qualified	+11% increase in bid qualification rate
India	Solar PV	2010: 12.16 INR/kWh	2011: 8.77 INR/kWh	28% decrease in contracted price
California (USA)	Various	2011: 92 bids received	2012: 142 bids received	+54% of bids received

BOX 3.7: SYSTEMATIC AUCTIONS IN CALIFORNIA AND GERMANY

California

Four auctions were planned from the get-go, to be carried out in the timespan of two years, with predetermined demand levels (although those quantities were later revised upwards). See Box 3.2 for more detailed info on the auctions in California.

Germany

One of the main features of the newly designed auction in Germany is the longer-term planning and a pre-commitment to a schedule. Nine auctions are planned over the course of 2015-2017, and all of them will take place every year in April, August and December and will be announced by the German regulatory agency, Bundesnetzagentur, six to nine weeks before the auction. The reason for having a systematic auctioning scheme is to ensure a continuous renewable energy project pipeline, while at the same time to test different design elements in different auction rounds.

Sources: (Eberhard, 2013), (Elizondo-Azuela, Barroso *et al.*, 2014), (Wentz, 2014), (Bloomberg, 2015).

In South Africa, for example, the commitment to multiple rounds has had a positive impact in terms of building investors' confidence in the programme (see Box 3.8).

BOX 3.8: SYSTEMATIC AUCTIONS IN SOUTH AFRICA

In 2011, the South African Renewable Energy Independent Power Project Procurement Program (REIPPPP) was changed from a standalone tender to a series of bidding rounds. The first three rounds took place in 2011, 2012 and 2013, and two more rounds are planned until 2016. Overall, the number of bidders increased by 49% from the first round to the second, and by 18% in the third round (see Table 3.4).

To stimulate competition, rules for allocating volumes for each round were developed, and the multiple-round auction allowed both bidders and auctioneers to learn by doing. Table 3.4 illustrates the increase in competition throughout the rounds, both in the number of bidders and in the difference between the total bid capacity and awarded capacity (see Box 5.5 for further discussion on the auction results).

Table 3.4: Results of multiple auction rounds in South Africa

	Round 1	Round 2	Round 3
Number of bidders	53	79	93
Qualified bidders (and % increase)	28 (53%)	51 (64.5%)	74 (79.6%)
Projects awarded	28	19	17
Bids capacity (MW)	2 128	3 255	6 023
Capacity auctioned (MW)	3 725	1 275	1 473
Capacity awarded (MW)	1 415.5	1 044	1 456

Main findings

Organising an extended renewable energy programme that involves multiple auction rounds facilitates long-term planning for bidders and other market agents such as equipment suppliers, which have several well-documented benefits. As such, systematic auction schemes may attract a larger number of bidders and be beneficial to the country's renewable energy industry and to the grid planning.

However, standalone auctions have also been used often, and may be particularly appropriate when dealing with less-mature technologies or when the total quantity to be auctioned is small. Standalone auctions also allow the government to retain maximum liberty and flexibility to adjust the auctioning schedule in response to shifts in market conditions. The main advantages and disadvantages of the two periodicity options for auctions presented in this section are summarised in Table 3.5.

Table 3.5: Summary comparison of the auction frequency options

Criteria \ Options	Standalone auctions	Systematic auctions
Policy makers' ability to react to changing market conditions	Full flexibility, no long-term commitments	Limited, although caveats can be introduced ex ante
Investors' confidence	Unpredictability may detract some investors (costs of entering a new market)	Enables long-term planning; learning curve during the first auctioning rounds
Development of a local industry	"Stop and go" dynamics	Gradual renewable energy integration

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

3.4 DEMAND-SIDE RESPONSIBILITIES

Another consideration with regard to auction demand is that, typically, the auctioned product will involve some payment stream to the project developer once the renewable energy plant comes online, and the bidders need to be assured that the auctioneer will keep his/her side of the contract. In this regard, there are decisions to be made relating to: 1) the selection of the *contract off-taker*; 2) the *allocation of costs* to consumers; and 3) defining *contracting schemes* in a way that offers certainty to project developers.

Contract off-taker

The contract off-taker is the entity that signs the contract with the auction winner and becomes responsible for the contract payments – often functioning as a mediator between electricity consumers (or government entities responsible for carrying out the payments) and the project developer. In many cases, a state-owned company plays the role of the contract off-taker. The utilities that service the regional load are also good candidates, since they typically already collect a regulated tariff from electricity consumers in exchange for providing connection services. This would facilitate the task of passing through the costs of the auctioned contract.

The most important attribute for the contract off-taker is its creditworthiness; otherwise, concerns about counterparty risks may drive away potential bidders. If a jurisdiction's state-owned companies and utilities are not financially stable, it is sometimes desirable to seek alternative entities to play this role.

Peru is an example of a country that revised its contracting arrangements, changing the contract's off-taker. In hydropower-exclusive auctions carried out in 2009 and 2011, distribution companies had been used as off-takers. However, in the country's renewable energy-exclusive auctions in 2010 and 2011, the Peruvian government itself was the contract's off-taker (represented by the Ministry of Mines and Energy), likely in order to eliminate any doubts about counterparty creditworthiness. The issues faced by Indian states represent another interesting case study (see Box 3.9).

Allocation of costs

The allocation of costs can follow multiple methods of implementation. Even by only taking into account the "standard" implementation, in which the costs of renewable energy contracting mechanisms are simply passed on to consumers, it is possible to adjust the cost allocations to different consumer classes. In certain implementations, industrial consumers pay the lion's share of the costs of renewable energy contracting, whereas in other mechanisms, more cost is allocated to residential consumers.

In addition, sometimes the burden of this cost on electricity tariffs is reduced (or even entirely eliminated) by the introduction of some kind of subsidy structure. In this case, the remuneration for renewable energy initiatives comes (partly or entirely) from government budgets, state-owned companies, or in some cases development banks or international aid entities. More often than not, taxpayers are ultimately responsible for funding this type of scheme.

As for the allocation of costs, the design selected impacts the outcome in different ways. In most instances, the cost of the scheme is passed on to the consumers and the risk perception usually depends on the credibility of the distribution companies and if they have stable schemes in place to ensure collection of the consumers' payments.

BOX 3.9: THE IMPORTANCE OF THE CONTRACT OFF-TAKER IN INDIAN STATE-LEVEL AUCTIONS

Inspired by the National Solar Mission programme, multiple state authorities in India have sought to promote similar state-level policies, most of which have involved auctions. However, one major challenge faced by the states that was not as prominent in federal-level auctions was the absence of creditworthy off-takers for the auctioned contracts. The financial situation of government-owned utilities varies heavily from state to state, and this is a factor that has influenced investors' participation and bidding.

Table 3.6 llustrates the total amount of capacity that subscribed to participate in the renewable energy auctions of Tamil Nadu and Andhra Pradesh (these two experiences are comparable because they have similar dates of realisation and target quantities). Andhra Pradesh attracted a substantially higher number of bidders than Tamil Nadu. While it is impossible to properly address all factors that influenced this result, the very different bankability of the two states' utilities has been cited as an important factor behind the significant difference in the two auction' ability to attract investors.

Table 3.6: Evidence of the effect of the contract off-taker's creditworthiness on the level of participation

Indian State	Auction date	Utility's bankability	Demanded quantity (MW)	Bid quantity (MW)	Difference in bid quantity
Tamil Nadu	Jan 2013	Poor	1 000	499	+168%
Andhra Pradesh	Feb 2013	Good	1 000	1 339	

The importance of the creditworthiness of the contract off-taker is also illustrated in the auctions carried out in the Indian state of Rajasthan. In 2011, a 200 MW solar auction was called, in which the contract off-takers were the three distribution companies active in the state. In mid-2012, the auction was postponed and upon its redesign later that year, the off-taker was shifted to the state's nodal agency, the Rajasthan Renewable Energy Corporation Limited (RRECL), which is in better financial health. The increased competition in Rajasthan's auction was likely due to this shift.

Source: (Elizondo-Azuela, Barroso *et al.*, 2014).

In Brazil, for example, the allocation of costs differs between the types of auctions and their scope. In the regular auctions, which are addressed to cover the distribution companies' demand, the costs are allocated to them, while in the reserve auctions, meant to ensure a security of supply margin, the costs are allocated to all consumers, as detailed in the Box 3.10.

BOX 3.10: COST ALLOCATION OF RENEWABLE ENERGY AUCTIONS IN BRAZIL

In Brazil, there are two main classes of auctions organised by the government that can be used as a renewable energy support scheme:

In regular auctions, the demand is determined by the distribution companies, which declare how much electricity they wish to contract to ensure that their load remains fully backed by long-term contracts. Usually these auctions involve conventional electricity, although in 2007 and 2010 there was a decision that they would be renewable energy-exclusive. Distribution companies pass on the costs of these contracts to regulated consumers.

Reserve auctions are summoned at the government's discretion – the main objective bring to enhance security of supply, although in practice they have been used as a renewable energy support mechanism (exclusive to wind, solar, biomass and/or small hydro). This type of contract is signed with the wholesale electricity market operator, the Chamber for Commercialisation of Electrical Energy (CCEE) (rather than with individual distribution companies), and costs are socialised among all consumers via a specific charge (including free consumers that are not served by a distribution company).

Figure 3.2 illustrates the different contract structures and payment flows in these two types of schemes. It is relevant to point out that the two arrangements differ not only in terms of cost allocation (which is specific to each distribution company and shared only among regulated consumers in the case of regular auctions, but socialised among all customers in the case of reserve auctions), but also in terms of the contract off-taker. In the case of the regular auctions, the contracts signed between the auction winners and the distribution companies are settled in a fully bilateral fashion. Although the contracts have special provisions to ensure projects' bankability and offer financial guarantees, the government does not partake in these arrangements.

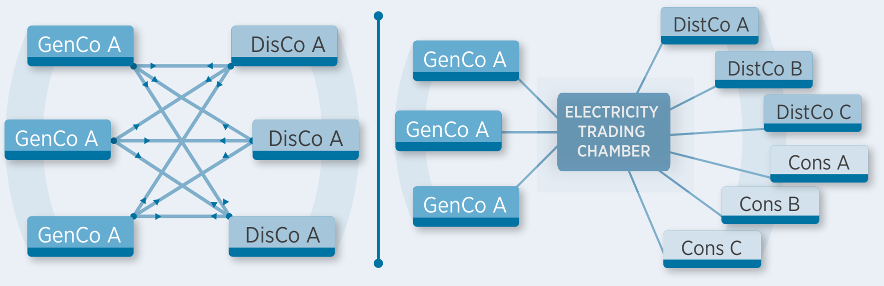
Figure 3.2: Contracting schemes in Brazilian regular and reserve auctions

Regular auctions

» Demand decided by distribution companies (discos).
» Winning projects sign contracts with each participating disco.
» Energy costs are passed on to regulated consumers in tariffs.

Reserve auctions

» Government decides the demand.
» Winners sign contracts with the electricity trading chamber (central institution).
» Contract costs are passed to regulated and free consumers via a reserve energy charge.



Sources: (Barroso, Bezerra, Rosenblatt, Guimarães, Pereira, 2006), (Maurer, Barroso, 2011), (Elizondo-Azuela, Barroso et al., 2014).

In the United Kingdom (UK), the subsidies paid for renewable energy in the contracts awarded came from a tax on electricity paid by all the consumers, as explained in Box 3.11. The main advantages and disadvantages of the different options regarding the contract off-taker and the allocation of costs are summarised in Table 3.7.

Table 3.7: Summary comparison of the off-taker and cost allocation options

	Contract off-taker		Allocation of costs	
Options / Criteria	Furthest from government	Closest to government	Least centralised	Most centralised
Brief description	Independent entities: *e.g.* utilities	Government-backed contracts	Passed-through to consumers	Fully funded by the state
Investors' confidence	May have issues with credit-worthiness	Usually very credible	As long as tariffs are cost-reflective	As long as state companies are solvent
Simplicity	Experience in collecting tariffs	More bureaucracy	Utilities usually collect tariffs	Centralised payments

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

Contracting schemes

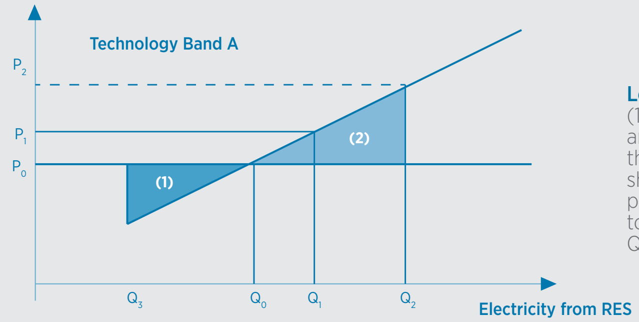
Contracting schemes may be altered in an attempt to offer developers better security to address any investment uncertainty. An example of such an implementation is to organise an auction for the engineering, procurement and construction (EPC) rights of a given power plant – rather than an auction for a long-term contract that includes the obligation to operate and maintain the plant over an extended period of time. In Morocco, this type of EPC auction has been carried out before the implementation of auctions that result in a PPA. Even though this type of arrangement differs from "traditional" auction-based renewable energy policies in several important ways, past experiences in this regard may be valuable to evaluate certain design elements.

Another way to alter the contracting scheme is to involve the government in the project's equity. This solution can be implemented when the jurisdiction may have difficulties to offer credible contract guarantees. One example of this type of arrangement was observed in the Dubai solar power auction in 2014, where the Dubai Electricity and Water Authority (DEWA) has a mandated 51% equity share in the project. It should be noted, however, that having the government as active involved may result in undesirable side-effects – such as greater bureaucracy, limited management flexibility, and possibly giving a perception that the government will shield the developers from risks.

BOX 3.11: SUBSIDISATION OF PRICES IN THE UK'S NFFO AUCTIONS

The economic rationale of the Non-Fossil Fuel Obligation (NFFO) auctions organised in the UK in the 1990s is shown in Figure 3.3. The price in the pool market (P_0) was used to determine the subsidy granted to the renewable energy generated. The projects that are price competitive with conventional electricity, ($q < Q_0$), would not receive any subsidy (as they will be carried out anyway), whereas a project with a higher cost (P_1) would receive a subsidy equal to its generation cost minus the pool price (P_1-P_0). A ceiling price for different technology bands was fixed (P_2 for technology A).

Figure 3.3: Economic rationale of the NFFO

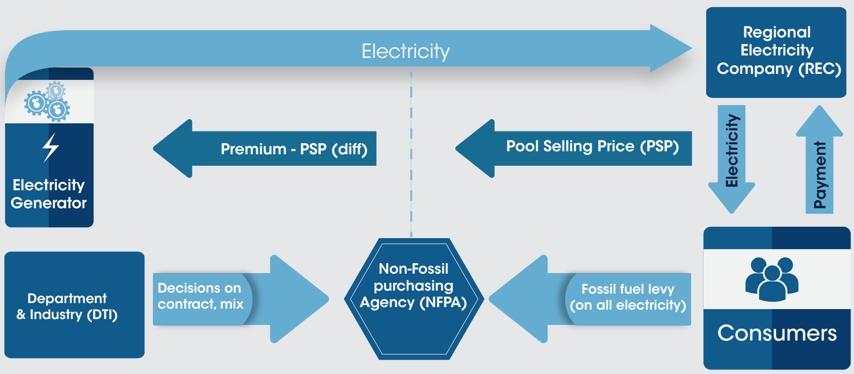


Legend: The shaded area (1) is the producer's surplus arising from the production of the electricity flow Q_3-Q_0. The shaded area (2) is the subsidy paid by an ideal NFFO in order to generate the electricity flow Q_2-Q_0

Source: (Agnolucci, 2005)

The policy instrument aimed to give each project the subsidy needed to make the generation cost per kWh equal to the pool price. A diagram of the subsidisation process can be seen in Figure 3.4. The Regional Electricity Companies (RECs) purchases electricity at the market price -the Pool Selling Price(PSP). The Non-Fossil Purchasing Agency (NFPA) reimburses the REC the difference between the premium price – established in the contract awarded as a result of the auction – and the PSP. The subsidy is paid out of the funds that come from the Fossil Fuel Levy (FFL), a tax on all electricity (not only on electricity from fossil sources). This amount was originally set at 10%, but by the end of the NFFO it had dropped to 1%. This led to a restriction in technology bands in later rounds of the NFFO, such that technologies like biomass or offshore wind were not allowed in NFFO because of their high cost.

Figure 3.4: The NFFO subsidisation process



Source: (Cozzi, 2012)

Another potential solution is to get multilateral development banks to assume part of the senior debt, thereby obtaining the assured reliability of international financial institutions. However, this is not always an easy task, despite the fact that more and more renewable energy development loans and funds are made available. Export credit agencies also could insure the political risk of the government defaulting, thereby reducing the risk exposure of the project developer. The main advantages and disadvantages of the different contract schemes are summarised in Table 3.8.

Table 3.8: Summary comparison of contract scheme options

	Contract schemes	
Options / Criteria	**Least government involvement**	**Government**
Brief description	Classical PPA arrangement	Government retains asset ownership
Investors' confidence	Developers maintain full responsibility	Government becomes co-responsible
Simplicity	Straightforward	More bureaucratic
Cost effectiveness	Straightforward price signals for performance	Assignment of responsibility may be muddled

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

Main findings

Demand-side responsibilities can be structured in multiple different ways. However, a common trend among the various topics described in this section is that there is often a "sliding scale" between the multiple options in which the government may play a greater or lesser role. In most mature electricity markets, it is generally desirable to minimise government involvement in these design choices: which would imply using utilities as contract off-takers, allocating contract costs to consumers (without additional subsidies), and adopting a straightforward PPA as a contracting scheme. However, if a jurisdiction cannot reasonably offer credible guarantees to project developers, a "second best" solution may be needed.

References

ACWA Power. (2015). ACWA Power wins 200 megawatts (260MWp) phase II Mohammed bin Rashid Solar Park by Dubai Electricity. Retrieved from: *www.acwapower.com/news/post/55/acwa-power-wins-200-megawatts-260mwp-phase-ii-mohammed-bin-rashid-solar-park-by-dubai-electricity-.html*

Agnolucci, P. (2005). Opportunism and competition in the non-fossil fuel obligation. *Tyndall Centre for Climate Change Research.*

Agora Energiewende. (2014). Auctions for Renewable Energy in the European Union. Retrieved from: *www.agora-energiewende.de/fileadmin/downloads/publikationen/Hintergrund/Ausschreibungsmodelle/Agora_Auctions-Paper_056_web.pdf*

ANEEL. (2015). Editais de Geração. Retrieved from: *www.aneel.gov.br/area.cfm?idArea=53.*

Apergis, N., Payne, J. E. (2013). Another look at the electricity consumption-growth nexus in South America. *Energy Sources, Part B: Economics, Planning, and Policy 8,* 171-178.

Apricum. (2014). Dubai's DEWA procures the world's cheapest solar energy ever: Riyadh, start your photocopiers. *Berlin.*

Barroso, L., Bezerra, B., Rosenblatt, J., Guimarães, A., Pereira, M. (2006). Auctions of Contracts and Energy Call Options to Ensure Supply Adequacy in the Second Stage of the Brazilian Power Sector Reform. *IEEE PES General Meeting 2006, Montreal, Canada.*

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

Batlle, C., Barroso, L. A. and Pérez-Arriaga, I, J. (2010). The changing role of the State in the expansion of electricity supply in Latin America. *Energy Policy, vol. 38, iss. 11, pp.* 7152-7160. doi: 10.1016/j.enpol.2010.07.037.

Batlle, C., Barroso, L. A., Echevarría, C. (2012). Evaluación del marco normativo e institucional del Perú para la promoción de energía eléctrica a partir de recursos renovables (in Spanish). *Banco Interamericano de Desarrollo, Nota Técnica # IDB TN 480.*

Batlle, C., Mastropietro, P., & Gómez-Elvira, R. (2014). Toward a fuller integration of the EU electricity market: physical or financial transmission rights? The Electricity Journal, 8-17.

Bezerra, B., Cunha, G., Ávila, P., Barroso, L., Carvalho, M., Pereira, M. (2013). Análise do percentual máximo para a inserção de energia eólica na matriz elétrica brasileira sob a ótica energética. *XXII SNPTEE.*

Bloomberg New Energy Finance. (2015). The five 'W's of the German PV tenders. Available from *http://about.bnef.com/landing-pages/fi ve-ws-german-pv-tenders/*

Bridge to India (2011-2014). India Solar Compass. *Quarterly reports, October 2012 to April 2014.*

Bundesnetzagentur. (2015). PV-Freiflächenanlagen. Retrieved from: *www.bundesnetzagentur.de/DE/Sachgebiete/ElektrizitaetundGas/Unternehmen_Institutionen/ErneuerbareEnergien/PV-Freiflaechenanlagen/Gebotstermin_15_04_2015/Gebotstermin_15_04_2015_node.html*

California Energy Commission. (2015). Electric Generation Capacity & Energy. Retrieved from *http://energyalmanac.ca.gov/electricity/electric_generation_capacity.html*

California Public Utilities Commission. (2013). Renewables Portfolio Standard Quarterly Report: 2nd Quarter 2013. Retrieved from: *www.cpuc.ca.gov/NR/rdonlyres/64D1619C-1CA5-4DD9-9D90-5FD76A03E2B8/0/2014Q2RPSReportFINAL.pdf*

California Public Utilities Commission. (2015). Renewable Auction Mechanism. Retrieved from: *www.cpuc.ca.gov/PUC/energy/Renewables/hot/Renewable+Auction+Mechanism.htm*

Cetinkaya, S. (2013). Turkey: Solar Power Market in Turkey. U.S. Commercial Service. Retrieved from *http://www.iberglobal.com/files/turquia_energia_solar.pdf*

Colthorpe. (2015, April 29). Regulator reveals 'intense competition' in oversubscribed German PV auction. PV Tech. Retrieved from *www.pv-tech.org/news/federal_regulator_reveals_intense_competition_in_oversubscribed_german_pv_a*

Comision Nacional de Energía Electrica. *(2012). Dictamen de Evaluación de las Ofertas Económicas y Adjudicación; Junta de Licitación PEG-2-2012. Retrieved from www.cnee.gob.gt/pdf/resoluciones/2012/CNEE%20266%202012.pdf*

Cozzi, P. (2012). Assessing Reverse Auctions as a policy Tool for Renewable Energy Deployment. *The center for international environment & resource policy.*

Cramton, P., Schwartz, J. (2002). *Collusive Bidding in the FCC Spectrum Auctions. Contributions to Economic Analysis & Policy, Vol. 1, No. 1, Article 11.*

Cunha, G., Barroso, L., Bezerra, B. (2014). Lessons learned from auction-based approach to integrate wind generation in the Brazilian electricity market. *CIGRE.*

Cunha, G., Barroso, L., Porrua, F., Bezerra, B. (2012). Fostering Wind power through auctions: the Brazilian experience. *IAEE Energy Forum.*

Danish Energy Agency. (2009). Tender specifications for Anholt offshore wind farm 30 April 2009.

Danish Energy Agency (2013). New Offshore Wind Tenders in Denmark. Available from *www.ens.dk/offshorewind.*

Del Río, P., Linares P. (2014). Back to the future? Rethinking auctions for renewable electricity support. *IIT Working Paper -12-038.*

Denmark.dk. (2015). Wind Energy. Retrieved from *http://denmark.dk/en/green-living/wind-energy/*

Department of Energy – Republic of South Africa. (2015). Renewable Energy IPP Procurement Programme.

Eberhard, A. (2013). Feed-in Tariffs or Auctions? Viewpoint: Public Policy for the Private Sector. *Note 338, Word Bank, International Finance Corporation.*

Eberhard, A., Kolker, J., & Leigland, J. (2014). South Africa's Renewable Energy IPP Procurement Program: Success Factors and Lessons. *World Bank Group.*

Ecofys. (2013). Lessons for the tendering system for renewable electricity in South Africa from international experience in Brazil, Morocco and Peru. Retrieved from: *www.ecofys.com/fi les/fi les/ecofys-giz-2013-international-experience-res-tendering.pdf.*

Ecofys. (2014). Design features of support schemes for renewable electricity. Retrieved from: *www.ecofys.com/files/files/ec-fraunhofer-isi-ecofys-2014-design-features-of-support-schemes.pdf*

European Commission (EC). (2013). Communication from the Commission: Delivering the Internal Electricity Market and Making the Most of Public Intervention. Retrieved from *http://ec.europa.eu/energy/sites/ener/files/documents/com_2013_public_intervention_en.pdf*

European Commission (EC). (2014). Communication from the Commision: Guidelines on State aid for environmental protection and energy for 2014-2020. Retrieved from *http://ec.europa.eu/smart-regulation/impact/ia_carried_out/docs/ia_2014/swd_2014_0139_en.pdf*

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

Elizondo-Azuela, G., Barroso, L., Khanna, A., Wang, X., Wu, Y., Cunha, G., (2014) Performance of Renewable Energy Auctions: Experience in Brazil, China and India. *World Bank Energy and Extractives Global Practice Group Policy Research Wording.*

Energy Market Regulatory Authority. (2015). Renewable Energy Regulations & Incentives in Turkey.

EU. (2006). Directive 2005/89/EC of the European Parliament and of the Council of 18 January 2006 concerning measures to safeguard security of electricity supply and infrastructure investment. OJ L 33, 4.2.2006, p. 22–27.

German energy blog. (2015). 97 MWp PV Capacity Installed in Germany in March 2015 – 38,555 MWp Total. Retrieved from *www.germanenergyblog.de/?p=18533*

German Solar Industry Association. (2014). Statistic data on the German Solar power (photovoltaic) Industry. Retrieved from *www.solarwirtschaft.de/fileadmin/media/pdf/2013_2_BSW-Solar_fact_sheet_solar_power.pdf*

Gestore Servizi Energetici. (2014). Italian Experience in Deploying Renewable Energy. Retrieved from *www.res4med.org/uploads/focus/Rabat_16-09-2014-BENEDETTI.pdf*

Green Stream. (2010). Opportunities to utilise tendering as a part of a feed-in tariff system.

GWEC. (2007). China Wind Power Report. *China Environmental Science Press, Beijing.*

Henriot, A. (2014). Beyond national generation adequacy: Europeanizing the building of capacity mechanisms? Policy Brief from Robert Schuman Centre for Advanced Studies.

IRENA. (2012). Workshop on renewable energy tariff-based mechanisms.

IRENA. (2013a). Renewable Energy Auctions in Developing Countries. *www.irena.org/DocumentDownloads/Publications/IRENA_Renewable_energy_auctions_in_developing_countries.pdf*

IRENA. (2013b). 30 years of policies for wind energy – Lessons from 12 Wind Energy Markets. *www.irena.org/DocumentDownloads/Publications/GWEC_WindReport_All_web%20display.pdf*

IRENA. (2013c). Financial mechanisms and investement frameworks for renewables in developing countries. *www.irena.org/Finance_RE_Developing_Countries.pdf.*

IRENA. (2014a). Adapting Renewable Energy Policies to Dynamic Market Conditions. *www.irena.org/DocumentDownloads/Publications/policy_adaptation.pdf*

IRENA. (2014b). Rethinking Energy: Towards a new power system. *www.irena.org/rethinking/.*

IRENA. (2014c). The Socio-economic Benefits of Solar and Wind Energy. *www.irena.org/Publications/Socioeconomic_benefits_solar_wind.pdf*

IRENA. (2015a), "Renewable Energy Target Setting", *www.irena.org/documentdownloads/publications/IRENA_RE_Target_Setting_2015.pdf*

IRENA. (2015b), "Renewable Energy and Jobs – Annual Review 2015", *www.irena.org/DocumentDownloads/Publications/IRENA_RE_Jobs_Annual_Review_2015.pdf*

IRENA. (2015c), "Renewable Energy in the Water, Energy and Food Nexus", *www.irena.org/documentdownloads/publications/irena_water_energy_food_nexus_2015.pdf*

K.A.CARE. (2013), Proposed Competitive Procurement Process for the Renewable Energy Program, *http://saudi-sia.com/wp-content/uploads/2013/05/K.A.CARE-Proposed-Competitive-Procurement-Process-for-the-Renewable-Ener...9.pdf*

Kreycik, C., Couture, T. D., Cory, K., (2011). Procurement Options for New Renewable Electricity Supply. *NREL Technical Report, 2011.*

Lang, M. (2015). German Energy Blog. Available from *www.germanenergyblog.de*.

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

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

Mercados Energéticos Consultores and PSR. (2013). 2013 Uruguayan Wind Farm Tender Analysis.

Ministerio de Energía y Minas del Peru. (2014, November 12). Matriz de generación eléctrica del Perú tendrá 60 por ciento de energía renovable. Retrieved from *http://www.minem.gob.pe/_detallenoticia.php?idSector=6&idTitular=6374*

Ministry of New and Renewable Energy (MNRE). (2010). Jawaharlal Nehru National Solar Mission – Towards Building Solar India.

MNRE. (2012). Jawaharlal Nehru National Solar Mission – Phase II Policy Document.

MNRE. (2015). Available from *http://www.mnre.gov.in/*

Multiconsult and Norplan. (2015). GET FIT Uganda. Annual Report 2014.

Norton Rose Fulbright. (2015). The new tender mechanism for grond-mounted pv-plants in Germany. Retrieved from *www.nortonrosefulbright.com/knowledge/publications/126113/the-new-tender-mechanism-for-ground-mounted-pv-plants-in-germany*

National Renewable Energy Laboratory (NREL). (2011). Procurement Options for New Renewable Electricity Supply.

NYSERDA. (2014). New York State Renewable Portfolio Standard - Annual Performance Report Through December 31.

Osinergmin otorgó buena pro a 19 proyectos de energía renovable (2013, December 13). *Gestión.* Retrieved from *http://gestion.pe/economia/osinergmin-otorgo-buena-pro-19-proyectos-energia-renovable-2083604*

Osinergmin. (2015). Sistema de Información de Energías Renovables. Retrieved from *http://www2.osinerg.gob.pe/EnergiasRenovables/EnergiasRenovables.html*

Pillai, R., Banerjee R. (2009). Renewable energy in India: Status and potential. *Energy, Volume 34, Issue 8,* Pages 970-980.

Proyecto Energía Eólica – MIEM/DNE. (2015). Convocatorias. Retrieved from *http://www.energiaeolica.gub.uy/index.php?page=convocatorias*

REKK. (2013). Regulatory Practices Supporting Deployment of Renewable Generators through Enhanced Network Connection. *Commissioned by ERRA.*

REN21 Renewable Energy Policy Network. (2014). Renewables 2014 Global Status Report.

Renewable Energy Policy Project. (1999). Renewable Energy Policy Outside the US. Retrieved from *http://www.uea.ac.uk/~e680/energy/energy_links/renewables_Obligation/Nffo_review.htm*

Ristau, O. (2013, June 11). Spain: Another deep cut for renewables to come *Global PV markets, industry & suppliers, investor news, markets & trends.* Retrieved from *http://www.pv-magazine.com/news/details/beitrag/spain--another-deep-cut-for-renewables-to-come_100011666/#axzz3U6OxE8jx*

Rudnick, H., Barroso, L., Llarens,D., Watts, D., Ferreira, R. (2012). "Transmission challenges in the integration of renewables in South America". *IEEE Power & Energy Magazine, Vol.10, issue: 2,* pg. 24-36.

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

St. John, J. (2015, January 5). California Governor Jerry Brown Calls for 50% Renewables by 2030. *Greentech Media.* Retrieved from *http://www.greentechmedia.com/articles/read/calif.-gov.-jerry-brown-calls-for-50-renewables-by-2030*

Stadelmann, M., Frisari, G., Konda C. (2014). The role of Public Financing in CSP – Case Study: Rajasthan Sun Technique, India. *Climate Policy Initiative.*

Tenenbaum, B. (2015). Uganda's Bidding Program for Solar SPPs In The Get FiT Program: Is It Relevant for Tanzania?

Tsanova, T. (2015, April 22). Germany's solar auction attracts 170 bids beating offered capacity. SeeNews. Retrieved from *http://renewables.seenews.com/news/germanys-solar-auction-attracts-170-bids-beating-offered-capacity-473417*

Uruguay tendrá 240 MW fotovoltaicos en 2015. (September 23, 2013). *PV Magazine.* Retrieved from *http://www.pv-magazine.de/nachrichten/details/beitrag/uruguay-tendr-240-mw-fotovoltaicos-en-2015_100012505/*

Vázquez, S., Rodilla, P., Batlle, C. (2014). "Residual demand models for strategic bidding in European power exchanges: revisiting the methodology in the presence of a large penetration of renewables". Electric Power Systems Research, vol. 108, pp. 178-184, 2014.

Veiga, A., Rodilla, P., Herrero, I., Batlle, C. (2015). Intermittent RES-E, cycling and spot prices: the role of pricing rules. *Electric Power Systems Research, vol. 121,* pp. 134-144.

Wang, Q., (2010). Effective policies for renewable energy—the example of China's wind power—lessons for China's photovoltaic power. *Renewable and Sustainable Energy Reviews, Volume 14, Issue 2,* Pages 702-712, ISSN 1364-0321, 10.1016/j.rser.2009.08.013.

Wang, X., (2012). Maximizing Leverage of Public Funds to Unlock Commercial Financing for Clean Energy in East Asia. *World Bank.*

Wang, X., Wu, Y. (2013). China Renewable Energy Development Story. World Bank, *forthcoming.*

Wentz, J. (2014). Balancing Economic and Environmental Goals in Distributed Generation Procurement: A Critical Analysis of California Renewable Auctions Mechanism (RAM). *Journal of Energy and Environmental Law.*

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

Wiser, R. (2002). Case Studies of State Support for Renewable Energy. *Berkeley Lab and the Clean Energy Group.*

World Nuclear Association (updated in 2015). Nuclear Power in Saudi Arabia. Retrieved from *http://www.world-nuclear.org/info/Country-Profiles/Countries-O-S/Saudi-Arabia/*

Wynn, G. (2013, February 21). The growing cost of Germany's feed-in tariffs. *Business and Climate Spectator.* Retrieved from *http://www.businessspectator.com.au/article/2013/2/21/policy-politics/growing-cost-germanys-feed-tariffs*

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