

Hitting Record-Low Solar Electricity Prices in Indonesia

A study on global solar auctions and
Indonesia's existing conditions



IMPRINT

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Foreword

Global energy transition, particularly in the power sector, has been dominated by the rapid uptake of renewables such as solar and wind power over the last decade. About 638 gigawatts of solar photovoltaic (PV) power was added between 2009–2019, overtaking coal power capacity addition at 529 GW—where wind followed closely in third place with 487 GW. This is all thanks to the rapid decline of solar PV module prices that has resulted from a multitude of factors such as technology improvement, manufacturing scale-ups (primarily in China), a combination of public policies push for clean energy and fierce competition in large-scale solar auctions, as many countries have now shifted from a fixed feed-in tariff pricing regime into a competitive-based tariff pricing regime through renewable energy auctions.

Indonesia itself is currently seeking to increase its ambition in renewable power generation to meet its renewable energy target through solar PV. Although still unfinalized by the time of this writing, a working document on energy policy strategy (National Grand Energy Strategy) has indicated an increased ambition to install 17.6 GW of solar PV by 2035 (or about one-third of total installed clean power capacity in 2035—although unstated). More recently, the reveal of the much-anticipated PLN's electricity supply business plan draft (or RUPTL 2021–2030 draft) has also signaled an increased ambition by adding 6.45 GW of solar by 2030—a seven times increase from the previous planned solar capacity addition in RUPTL 2019–2028. While the ambition can still certainly be increased to align with a zero-emission pathway by 2050, for instance, where it requires at least 18 GW of installed solar capacity by 2025 and 107 GW by 2030, there is another crucial issue to address regarding the realization/implementation of the said increased ambition, that is utility-scale solar procurement.

Utility-scale solar procurement in Indonesia so far has been carried out sporadically, without a clear scheduling, using individual one-off auctions (tenders). Not to mention the lack of auctioned projects between 2017–2020 to begin with, the procurement practices are somewhat opaque and not yet standardized, making the negotiation process lengthy and may shun potential investors away. This situation calls for a reform in utility-scale solar procurement practices by PLN, and the government more broadly, to really benefit from the “price discovery” effect (revealing record-low solar electricity prices as have been seen in many countries) and to realize said ambition by conducting systematic and well-designed utility-scale solar auctions. Through this study, we hope to offer insights into some of the best practices in utility-scale solar auction design from several countries that have successfully done lessons for Indonesia in order to propel massive solar growth in Indonesia.

Jakarta, August 2021,

Fabby Tumiwa
Executive Director

Executive Summary

Energy transition towards renewable-based energy has begun to emerge globally. Countries have set targets and introduced supporting policies for the development of renewable energy. Among available renewable technologies, solar contributes the most to the global capacity addition in the last decade. The declining trend of solar price subsequent to the development of solar technology has contributed to the rapid incline in large-scale solar installations. Many countries have utilised auctions to procure bulk sizes of solar capacities while also driving the costs further down.

Indonesia also implements auction for large-scale solar installations, but it has not been effective enough in reducing the price. This study finds that power system planning that includes energy sourced from solar energy in Indonesia is still lacking, thus affecting the number of solar projects being auctioned. Furthermore, the procurement practices have not been transparent enough to give potential bidders confidence in bidding in the auctions. Indonesia's solar auctions so far have been small in size, scattered, infrequent, and are usually carried out in individual one-off auctions/tenders, which give poor signals for investors or financial institutions to provide capital needed for the projects. Equally important to highlight is the supporting policy and regulation, which are unattractive or even hinder the development of solar installations through auctions.

India, Brazil, and the United Arab Emirates (UAE) are good examples of countries that have successfully held auctions for large-scale solar installations, with record breaking prices being offered by interested bidders. By learning from their experiences, Indonesia can design auctions that will encourage competition among bidders and eventually lead to price decline. The three countries have a commonality in which they have strong government commitment to support solar development in their respective countries. They even set up a new institution or build the capacity of the existing institution that is in charge of conducting the whole procurement process. Having standards throughout every auction, followed by consistent auction schedules are helpful in attracting bids. The governments are also focused on reducing project risks and transaction costs to encourage further cost-competitive biddings. The three countries also have their auction processes available publicly to ensure transparency. In terms of supporting regulations such as the local content requirements, these countries really pay attention to encourage the development of large-scale solar while also protecting local industries.

Key Recommendations

Learnings from the case studies can assist Indonesia in designing better auctions for large-scale solar installations. Moreover, Indonesia's recent solar auction, which has revealed a record-low bid price to below four cents per kWh, might prove to be a case study on its own. In order to replicate its recent success, presented is the list of key recommendations for policymakers to propel utility-scale solar development in the country:

1. Establish a national solar program that is integrated with the power system planning to be procured using systematic solar auctions

Indonesia must start by setting an ambitious solar target and work toward executing it through a national solar program. The national solar program should also be integrated with respective power system planning from the state-utility PLN, although the program does not have to be limited only to

utility-scale solar (i.e., large-scale ground-mounted and floating solar) but may as well be extended to other segments such as distributed (rooftop) solar, as a way to implement the mandate in Presidential Regulation No. 22/2017 to install rooftop solar at government buildings.

Demand aggregation for the national solar program is also important. By working closely with local governments and its respective PLN jurisdictions, the government could determine the volume to be auctioned to achieve the national solar target. The government should then divide these auction volumes into systematic solar auctions into several phases, for example, for a five-year period or longer. As showcased in the lessons learned from India, an integrated and executable national solar program exhibits the government's commitment to procure large-scale solar energy, sending positive signals to long-term international players in solar energy, and creates a competitive solar market in the country.

2. Support solar project development to de-risk project and improve bankability

Large-scale solar projects in Indonesia have already started showing cost-competitiveness (to below four cents per kWh) recently, as demonstrated by Indonesia Power's solar auction in two of its floating solar projects. This means that given an adequate project size (in the hundreds of megawatts) and the right auction design, tariff pricing may not be an issue anymore. Arguably, the main lessons learned from the auction are related to project development and land selection, which determines the development risk and eventual bankability.

To replicate this success, Indonesian government could give support in project development (i.e., land selection) to reduce development costs generally borne by the developers. In addition, the government could further support by providing free lands (or at least supporting land selection with cheap lease) and ensuring grid access for solar projects, as implemented by the UAE that results in a very cost-competitive auction and one of the cheapest record-low bids in solar history. Floating solar on hydropower dams, for instance, can enjoy minimal land use issues compared to land-based solar projects and can be developed relatively fast in just a few years.

3. Establish auction and bankable PPA standards, and revise “component E” negotiation clause to speed up PPA signing

The government should establish both an auction standard and a “bankable” PPA standard if Indonesia were to create a competitive solar market. Auction standard is crucial because it tells potential investors (developers and financiers) about what to expect from solar auctions in Indonesia. Drawing lessons from India, SECI publishes many auction documents in the past and each shows a uniformed information showcasing the standard for solar projects. In addition, the auction documents are made available to the public. In Indonesia, while there are only relatively few auctions in recent years, none of the documents are made public, as it is conducted by a business entity (PLN). This will make it hard for interested developers or even policymakers to review and decide whether or not changes are needed.

The government should also consider revising the PPA negotiation terms related to interconnection cost (component E) in MEMR 50/2017 as it prolongs the negotiation process. In all of the country case studies, most auctions use a pay-as-bid criteria as their winning selection criteria. This means that the submitted bids are final and will be used as the tariff they receive when they sign the PPA with the offtaker. In Indonesia, this process is different as the winner should negotiate the interconnection cost of the tariff, which is usually very lengthy. Therefore, in addition to PPA standardisation, this clause can also be revised to speed up the PPA signing.

4. Create separate solar auctions “market” for projects with local content requirements

Current domestic solar manufacturing might not have sufficient capacity both in terms of quantity and quality to supply the growing demands from the utility-scale solar market. Given the current domestic supply chain readiness (e.g., no single manufacturer to supply a single 100 MW project) and bankability criteria for international lenders, the government could consider separating the local content requirements into two separate markets by project size. By doing so, the government can create a “win-win” situation where it will not hinder the economics of large-scale projects, while still ensuring growth for domestic solar modules at smaller scale projects.

Drawing lessons from Brazil, the government could also give supporting incentives in the form of a soft loan with extremely attractive interest rates (0.9% for Brazil from their national development bank) when the LCRs are fulfilled, which is currently missing in Indonesia. This way, there is an incentive for developers to use LCRs compared to imported ones. Alternatively, the government could also provide special funding such as viability gap funding (VGF) to projects that meet LCRs requirements.

5. Centralise auctions and transfer auction authority to an independent auctioneer

The government could consider centralising solar auctions and transferring the auction authority to an independent auctioneer. This independent auctioneer could either be a new or an existing government institution with improved capability and responsibility within the renewables and electricity sector. This should be done primarily for two reasons: 1) to avoid conflicting responsibilities and interest of PLN (as both off-taker and auctioneer), and 2) to distribute responsibility between developing projects, aggregating demand, and auctioning with the role of an offtaker.

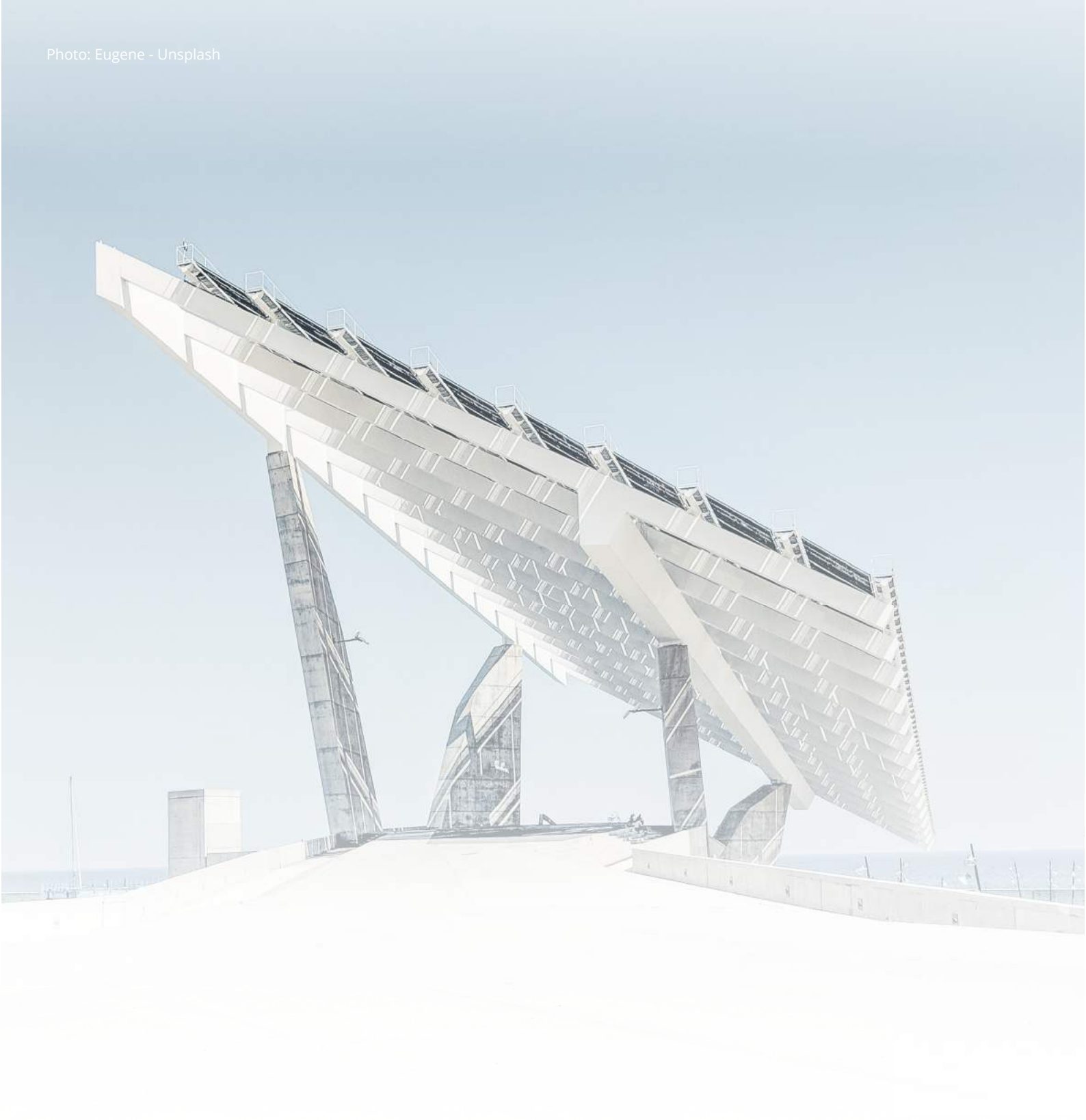
A new institution/body could also be established to perform the role as an auctioneer, as with the case in India with the establishment of Solar Energy of India Ltd. (SECI) to facilitate the implementation of its National Solar Mission. The independent auctioneer should also be responsible for developing solar projects (from determining the appropriate land or site location and grid connection), aggregating the demand by coordinating with local governments and its respective regional PLN office, and eventually, to decide on the auctioned volume capacity offering. Additionally, the auction should also be made online (electronically) from the pre-qualification, bid invitation, bidding, down to the final announcement to improve information transparency, as was already done in the past (2013/2014's auction).



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1 Introduction

In 2020, global investment in the energy transition¹ reached US\$0.5 trillion, a significant increase compared to 2010 at only US\$235 billion (BloombergNEF, 2021). Investment in renewable energy (power) accounts for 60% of that half a trillion dollars (US\$300 billion). This investment is split between two major renewable energy technologies, namely solar photovoltaic (PV) and wind, at almost fifty-fifty shares. In terms of capacity addition, solar PV's installed capacity reached 638 GW in the last decade, growing by a factor of 16 compared to only 40 GW in 2010 (BloombergNEF, 2020a; IRENA, 2020). Coal power plants, on the other hand, have only seen capacity additions of 529 GW from 2009 to 2019, mainly in China (BloombergNEF, 2020a).

The year 2020 also highlights the resilience of renewable energy amidst the COVID-19 pandemic. The global pandemic has hit the energy sector through travel restrictions and lockdowns as well as industry capacity reduction that have reduced the energy demand (Oxford Business Group, 2020). Despite this, total global installations of renewable technologies had seen an increase by 260 GW—dominated by solar installations of 126 GW— from the previous year while investment in renewable power was at US\$281 billion (IEA, 2020b, IRENA, 2021).

The huge investment and rapid deployment in solar PV are driven by several factors but primarily due to the drastic decline in solar panel costs. Over the last decade, the cost of solar panels has declined by 90% from around US\$2/W in 2010 to only US\$0.2/W in 2019 (BloombergNEF, 2020a). This cost decline has made solar PV very competitive compared to other technologies with an average global levelized cost of energy (LCOE) of US\$40/MWh (4 cents/kWh) (BloombergNEF, 2021). The rapid cost decline itself is the result of several factors such as technology improvement, manufacturing scale-ups (mainly in China), and a combination of public policies push for clean energy and, particularly, fierce competition in solar auctions (Kavlak et al., 2018).

Competitive auctions (or procurement) have accelerated the realisation of the rapidly declining costs of solar modules by creating a competitive market environment, compared to direct incentives models like feed-in tariffs (Attia et al., 2020). By the end of 2018, there were at least 106 countries that have used a competitive procurement program to procure solar energy (IRENA, 2019). Further, in 2020 alone, the global record of low tariff for a utility-scale solar PV project was broken several times by India (2.7 cents/kWh), Saudi Arabia (1.61 cents/kWh), Qatar (1.6 cents/kWh), the United Arab Emirates (UAE) (1.35 cents/kWh), and Portugal (1.3 cents/kWh). As more countries show interest to build solar energy, technological innovation and reductions in the cost of components, financing, as well as operations and maintenance for utility-scale solar projects have been incentivised.

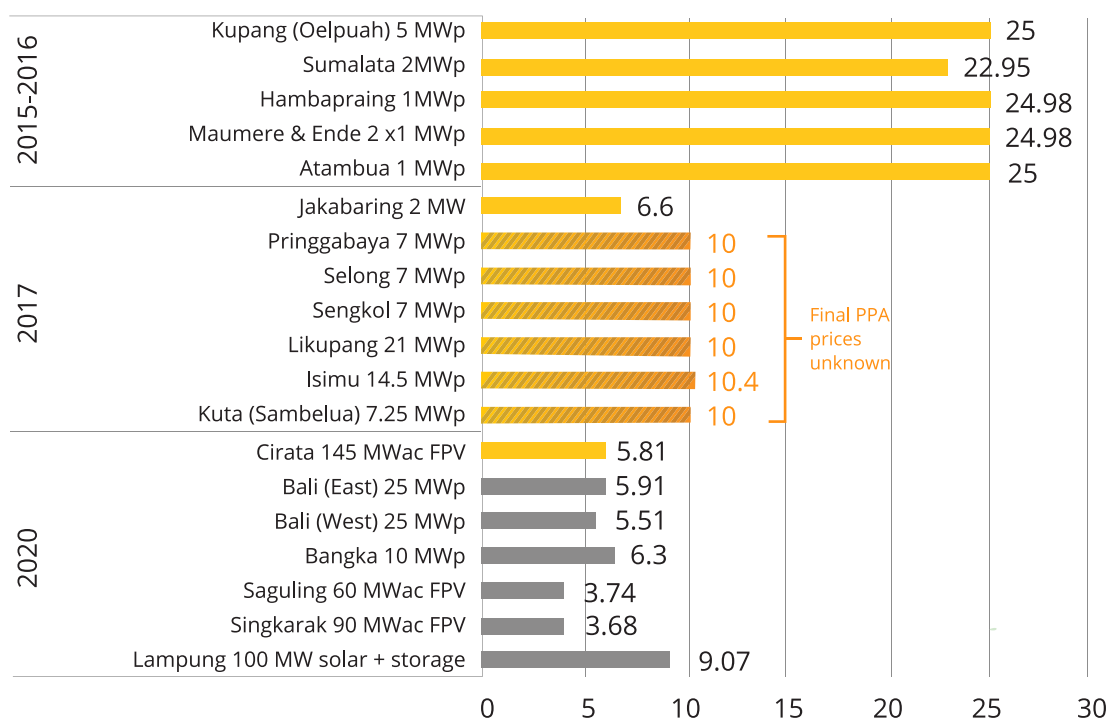
Solar uptake in Indonesia has been slow. By the end of 2020, total installed solar capacity only reached 186 MW where the majority (45%) is contributed by off-grid projects that were largely funded by state budget or PLN (*Perusahaan Listrik Negara*)'s budget (IESR, 2021). **Utility-scale solar**² only accounts for 33% of total installed capacity and most of the commissioned projects range only from 5 to 15 MWac (see Appendix A for more details). While the solar PPAs' prices have declined significantly between 2015 and 2020 (**Figure 1**), through different policies and procurement methods (see Section 3.2.1), Indonesia's utility-scale solar sector has been deemed unattractive and unbankable by the industry. This stems from various issues such as the lack of projects, project's bankability and other commercial issues ranging from land acquisition, tariff pricing, local content requirements, and unbalanced risk allocation (Bridle et al., 2018; IEEFA, 2019; Suharsono, 2020; Sungkono, 2021). Most importantly, poor procurement practices (and planning) that fail to make the best use of deflationary cost of solar PV and economies of scale.

¹ Energy transition investment includes renewable energy (power), electrification of transportation, heating, energy storage (battery), hydrogen, and carbon capture and storage (CCS).

² **Utility-scale solar** is defined in this work as a solar PV project built by an independent power producer (IPP)—or colloquially, solar project developer—with a power purchase agreement (PPA) with state-owned power utility PLN. Note that we do not distinguish it by project size, although historically, at minimum, the size seems to be at least 1 MWp (see Appendix A for more details).

Indonesia's historical solar PPAs and bid prices, 2015-2020

PPA price, US¢/kWh (winning bid price in gray, "unfinalized PPA")



Note: Year on y-axis reflects the year of PPA signing or winning bid prices.

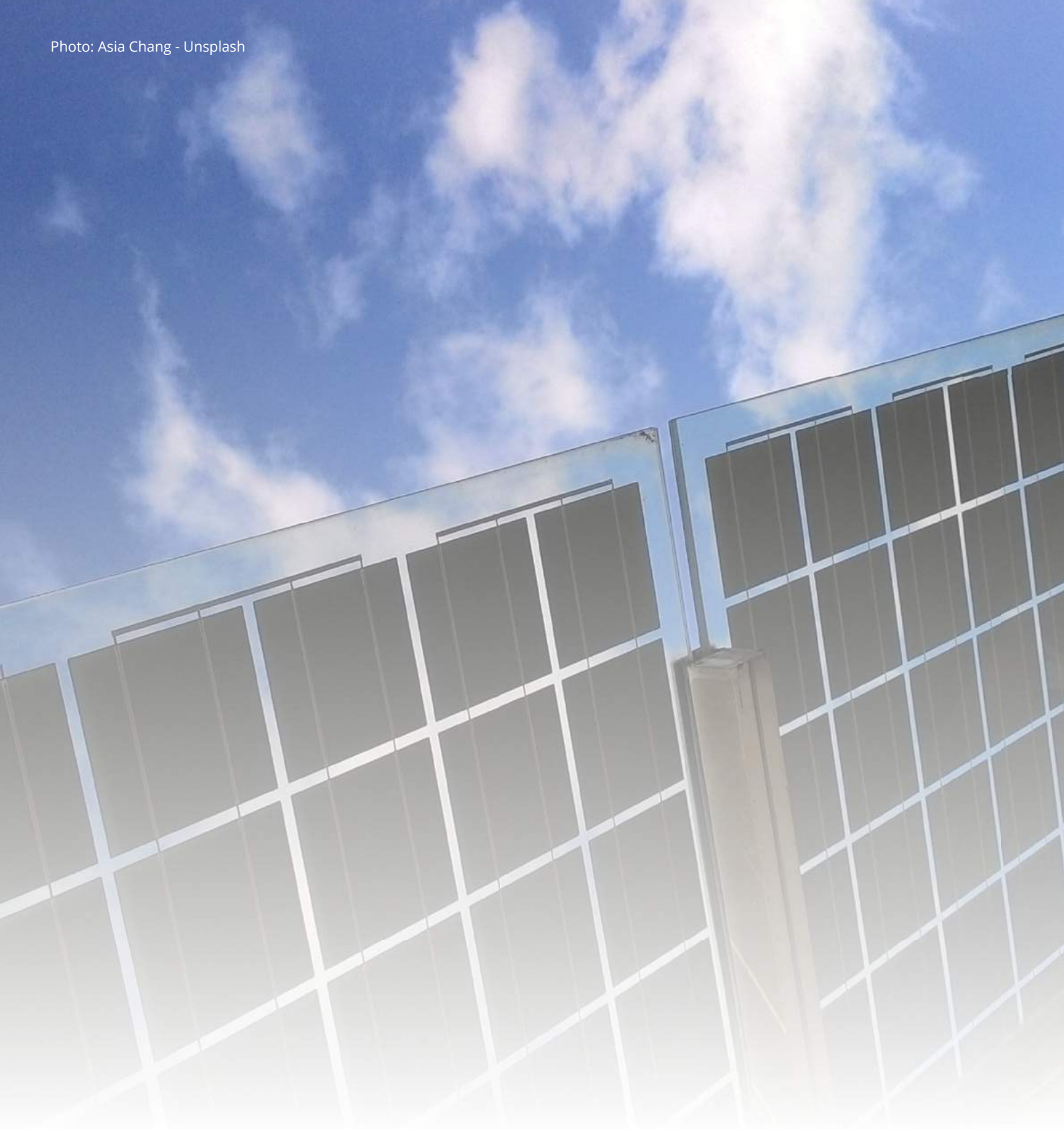
Bar in **gray** color reflects bid price (unfinalized PPA), while bar in **yellow** reflects final PPA price.

Bar with pattern fill reflects the maximum BPP price at the time because final PPA prices is not available publicly.

Figure 1. Indonesia's historical PPA prices during 2015–2020 (Source: IESR analysis)

Indonesia's solar sector suffers from the infamous tariff pricing policy through Ministry of Energy and Mineral Resources (MEMR) 50/2017 "Permen 50" that caps the electricity price using historical power generation cost (*biaya pokok produksi*, BPP) to that of mostly fossil-fuel power plants (Bridle et al., 2018; Suharsono, 2020). This landscape needs to change in order to propel utility-scale solar development. An effective tariff pricing policy could be key, favoring solar and other renewables, particularly at the early stage of development. Vietnam, for example, has benefited greatly from a supportive tariff pricing policy (i.e., the feed-in tariff, FIT), where its solar capacity grew from only 100 MW to 16.5 GW in a mere four years. Indonesian government, similarly, is working on a presidential regulation on FIT for smaller scale projects (<5 MW) and is expected to follow Vietnam's success.

Although feed-in tariff policy may attract investment in the sector, particularly for the early stages of solar development, competitive auctions (or procurement) have proven to be effective in driving costs down. Currently, utility-scale solar in Indonesia is procured using a standalone, one-off auction by means of traditional request for proposal (RFP) by the state-owned utility PLN that is often lacking in size and regularity. In many countries, carefully planned and designed solar auctions have shown declining bid prices of 58% (in India) to 74% (in the UAE) over the last five years. By addressing the current challenges in the policy and regulatory framework, power system planning, and particularly PLN's utility-scale solar procurement practices, this study will try to reveal some insights and lessons learned from three countries that have successfully adopted solar auctions to procure cheap solar energy, namely Brazil, India, and the United Arab Emirates. The insights and lessons learned from these countries can assist Indonesian government to construct an auction design that will drive down the cost of solar energy installations in the country.



② Renewable Energy Auctions

2.1. Definition

Auction is a process of procuring a product or a service in which a procurer issues a call for bidders to purchase a pre-decided quantity of goods or services. In renewable energy auctions, which are also known as “demand auctions” or “procurement auctions”, the government issues a call for tenders to bid on a certain capacity of renewable energy-based electricity that they are going to install. In the submitted bids, tenders need to specify the price per unit of electricity they can offer to realise the project. Once the closing date for submission has passed, the government assesses the offers on the basis of price and other prescribed criteria, and signs a power purchase agreement (PPA) with the successful bidder (IRENA & CEM, 2015).

Electricity auctions often are “reverse auctions” in which, instead of multiple buyers bid to buy services/goods from a single seller, multiple sellers try to sell services/goods to a single buyer (Shrimali et al., 2015). Sellers have to bid-down the price which is typically set by the buyer as the “benchmark price” to be able to win the projects.

2.2. Types

Auctions can be classified into three types based on price determination technique. However, it is noteworthy that there could be various ways to classify the types of auctions. These types of auctions can be chosen based on the objective and target set by the auctioneer; thus, there is no best auction for all.

Discriminatory price auctions

In discriminatory price auctions, the winning bidders of the auction receive the price they bid, resulting in different prices. Discriminatory price auctions are commonly seen in pay-as-bid and some hybrid auctions, and are typically used to allocate multiple units of an identical product such as electricity (Shrimali et al., 2015).

For example, in a typical pay-as-bid auction, all eligible bids are stacked from lowest to highest price to create a supply curve that matches with the quantity that needs to be procured. Then, a “market-clearing price” is determined at the spot where supply equals demand. The bidders who have bid below the market-clearing price win the auction and will be paid at their submitted prices.

Discriminatory auctions enable a maximisation of consumer surplus as bidders would compete to offer the cheapest bid for the project. It is a favorable type of auction to ensure a rapid price decline resulting from the competition. This type of auction tends to be less predictable since bidders have to forecast the range of acceptable bid offers in the market (Fabra et al., n.d.). There is also a possibility of inefficiencies when bidders submit a lower bid despite higher cost that might incur and/or yield smaller revenue. In worst cases, the aggressive bid can cause poor execution or lead to a default when the bid winner is unable to cover the cost.

Uniform price auctions

If a procurer adopts a uniform price auction, all successful bidders will receive a uniform price for the projects they won regardless of the price they have offered in the bids. In this case, uniform price is the “market-clearing price” which, similar to discriminatory price auction, is the point where supply equals demand. Uniform price method is used in many popular auction mechanisms such as sealed bids and descending clock auctions. While only the latter allows price discovery—which is the process of setting the real price of a purchase through the interactions of buyers and sellers—as part of the auction process, in both auctions, all winners will receive the same price.

Uniform price auctions are ideal for markets with certain demands that are known even before bidders submit their bids. Bidders will be able to anticipate future bids and prepare their offers accordingly. This will ensure efficiency since bidders can offer their bid at the marginal cost. Many see this type as a fair auction; thus, it is able to attract participation of small businesses (Maurer & Barroso, 2011). However, due to its predictability, this type of auction arguably has a potential to encourage collusive behaviours of bidders. In addition, uniform price auctions cannot contribute to price discovery (Maurer & Barroso, 2011).

Two-sided auctions

In two-sided auctions, unlike either type of auctions mentioned above, participants from both supply and demand sides are allowed to actively bargain with each other. A transaction occurs when the asking price matches the bid price. This enables competition both in supply and demand sides that will simultaneously optimize profits for both sides (Singh & Fozdar, 2019). Two-sided auctions operate similar to the stock market, where shares are traded when both sellers and buyers arrive at the same price.

If conducted efficiently, this type of auction can control market power and increase social welfare of the market (Maurer & Barroso, 2011). When demand-side is more responsive, there is a possibility that inefficient generation units might not be dispatched and eventually allows discovery of cheaper prices for electricity (Maurer & Barroso, 2011). Despite the potential benefits, this type of auction is complicated as there are multiple objectives to address, and is therefore less likely to be implemented compared to the other types (Maurer & Barroso, 2011).

Alternatively, renewable energy auctions can be distinguished based on how the project location is set up. Under a location agnostic auction, developers will bid for a certain capacity (or generation) at a certain price that they are willing to offer (for example, 200 MW at US\$0.04/kWh). Developers will also need to independently find and secure the land before bidding. On the other hand, an auction can also be project-specific³, meaning the site is already determined, usually by the government or the central utility, and developers will not need to find and select the location on their own, which means lower development risks.

An example of project-specific auctions is a solar park, whether it is ground-mounted or floating (see Chapter 4.3 for more details). This distinction is important because the economics of the project will be very different. This topic will be discussed in more detail in the case studies section in Chapter 4.

2.3. Auction design elements

While auctions have long been used by the government worldwide to procure electricity, the design of auctions has been constantly changing and evolving. The success of an auction will require the design to be fit-for-purpose which means one could not simply use a one-size-fit-all auction model but carefully design and scrutinise each component of the model in the context of objectives. In general, there are four mechanisms that could be used by auction designers, as illustrated in **Figure 2** (IRENA & CEM, 2015).

³ Some literatures refer to project-specific auctions as “tenders”. In this paper, we will use the denomination of “auctions” without highlighting this distinction.

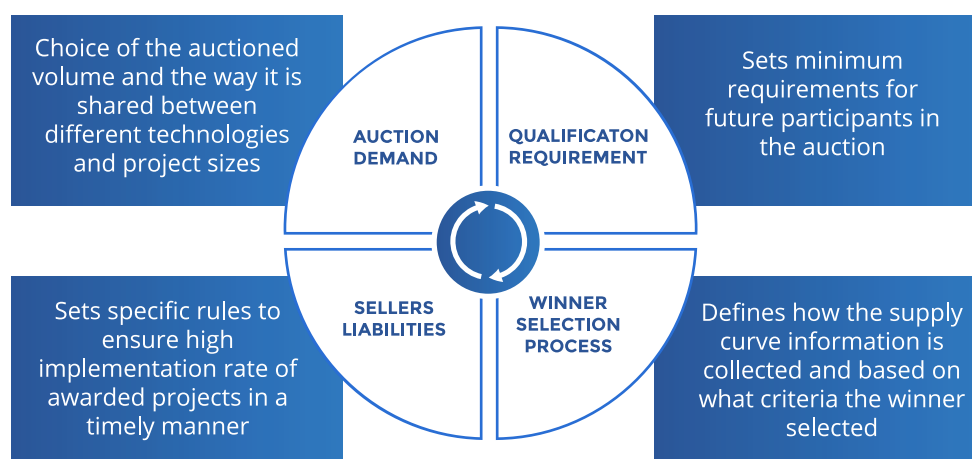


Figure 2. Categories of auction design elements (Adapted from IRENA & CEM, 2015)

2.3.1. Auction demand

Policymakers need to decide the size of the electricity to be procured, and the way it is allocated to each round of auction and desired technology. The decisions should be made based on the evaluation of the energy demands or renewable energy ambition against cost-effectiveness.

If the objective is to achieve renewable capacity targets within a limited time, policymakers may choose to auction the total planned volume at once through a standalone auction. If the objective is to enhance policy certainty and develop investors' confidence in a most cost-effective way, policymakers may need to divide the total volume into several rounds through systematic auctioning schemes each with a cap. By paving out steps of renewable development, all stakeholders including policymakers, developers, and equipment suppliers can roll out their long-term plan accordingly which would also be beneficial to the country's renewable energy industry as well as the general grid planning.

If the objective is to develop certain favoured technologies, policymakers can do so by limiting the types of technology through a technology-specific auction. Or if the objective is to procure electricity at minimum costs, then auctions need to be technology-neutral meaning all types of technology are allowed which maximises competition and consequently drives down the price. However, it does imply that mature and cost-competitive technologies would have more advantages.

2.3.2. Qualification requirements

Policymakers may want to mandate certain requirements to pre-assess all auction participants by asking bidders to submit relevant documentations. Such requirements can include criteria such as reputation, experience, equipment, site selection, grid/land access, and local socio-economic development.

Right level of qualification requirements should be chosen to balance competition and underbidding risks. Generally, technical project experience and financial strengths are two of the main qualifications for renewable energy auctions as both are required to ensure project completion, avoid underbidding, as well as to add competitiveness to the auction's outcome. If extensive technical project experience is required to participate in the auction, it could increase the likelihood of timely completion of projects, however, it may also result in exclusion of small and/or new players (especially when the financial requirements are strict). For another example, putting constraints such as specific technology, project size or location requirement in place may grant policymakers sufficient controls and lead to desired

outcomes. Nevertheless, it may increase the contracted price due to the costs associated with complying with all the requirements.

Additional requirements can be incorporated if there is a need to address broader development goals. One good and common example is local content requirement which, if placed well, can create local industry demand and job opportunities along with other socio-economic benefits. India and Brazil are among the countries that succeeded in implementing local content requirements which eventually boost the economy. This will be discussed further in the case study of the respective country.

2.3.3. Winner selection process

The winner selection process involves not only setting up the rules for selecting the winners, but also how the contracts are awarded, such as if further negotiation is needed after a certain criteria (generally minimum-price, but could be a combination of other criteria) is passed. A simple selection process is often welcomed by bidders as it implies greater transparency and lower transaction costs which ultimately lead to lower contracted price. But it is worth noting that some degree of complexity is still needed to achieve the objectives.

Minimum-price (least cost) criteria is commonly seen in many countries whose objective is to procure the cheapest electricity. While price is a key criteria, it is possible to incorporate other criteria in this step of the auction as well, such as location, job creation and developer's experience. Therefore, selections are made based on multi-criteria assessment instead of price alone.

Setting a ceiling price, above which bids are not considered, can add cost effectiveness to auctions. The pitfall is that the optimal volume of renewable energy may not be able to be assigned if this ceiling price is not properly determined. In other words, perfectly reasonable bids could be rejected due to the poorly determined ceiling price. Policymakers can also keep the ceiling price either disclosed or undisclosed. The risks are, if the ceiling price is disclosed, bidders may collectively bid right below the ceiling price; or if undisclosed, good bids may be disqualified for not meeting the price requirement.

2.3.4. Risk allocation and liabilities

Last but not least, risk allocation and liabilities consist of responsibilities and obligations once the winners are announced. It entails commitments to contract signing, contract schedule, financial risks, remuneration and settlement rules, and performance-based rewards and penalties. In essence, it is about allocation of financial, operational, and implementation risks between the **project developers (sellers), the auctioneer, and the off-taker**.

The enforcement of stringent compliance rules can reduce the risk of project delays and underbidding, but customers will need to pay a higher price due to increased transaction costs. The over-allocation of the liabilities could also scare off potential bidders which limits the competition. A balanced risk allocation and liabilities are needed to improve a project's bankability and attractiveness in an auction. The government can also help derisk some of the major risks in project development such as land provision and grid access to make the risk allocation more balanced and attractive to developers. In general, risk allocation should be designed as a win-win situation for all parties involved.

Policymakers should also be wary about the risk for the off-taker or the government in general. In this case, the auctioneer can design certain penalties such as bid bond, performance bond, and completion bond to make sure that the project is completed. With regard to this, the government can also set stricter

technical and financial requirements for the qualification round (or pre-qualification) to minimise the risk of project default.

Although risks are common in business activities, uncertainty should be minimised as much as possible. Policymakers should make the risk transparent and quantifiable, and communicate clearly with developers. By eliminating uncertainties, developers are more likely to be confident to submit bids at better prices.

2.4. Solar auctions

To better illustrate how these auction design elements come into play, consider the following example in solar auctions. As briefly mentioned earlier, solar auctions can be location agnostic or project-specific. However, due to its intermittency, there are several other variations on solar auction (see **Figure 3**).

Generally, solar auctions can be divided into standard auction and solar park auction. In standard auction, the government or utility will auction a predetermined capacity or energy in which developers are allowed to select their preferred project location. This is the case in India as will be discussed in more detail in Chapter 4.2. Local governments, through a decentralised auction, can also auction certain solar capacity in identified provinces to promote smaller capacity grid-connected solar projects. Another variation of the standard auction is the substation auctions, where the government or central utility will auction certain solar capacity at identified substations up to a level capped by the grid interconnection limits (as solar generation is intermittent in nature). This is the type of auction currently used in Indonesia (otherwise known as “capacity quota”).

In solar park auction, the government has pre-identified and pre-developed the site before the auction. Typically, solar park auctions can obtain the cheapest bids or tariffs because of the significantly reduced development risks (as land, supporting infrastructure, and grid connectivity are already prepared by the government or central utility, as is the case in the United Arab Emirates which will be discussed in Chapter 4.3).

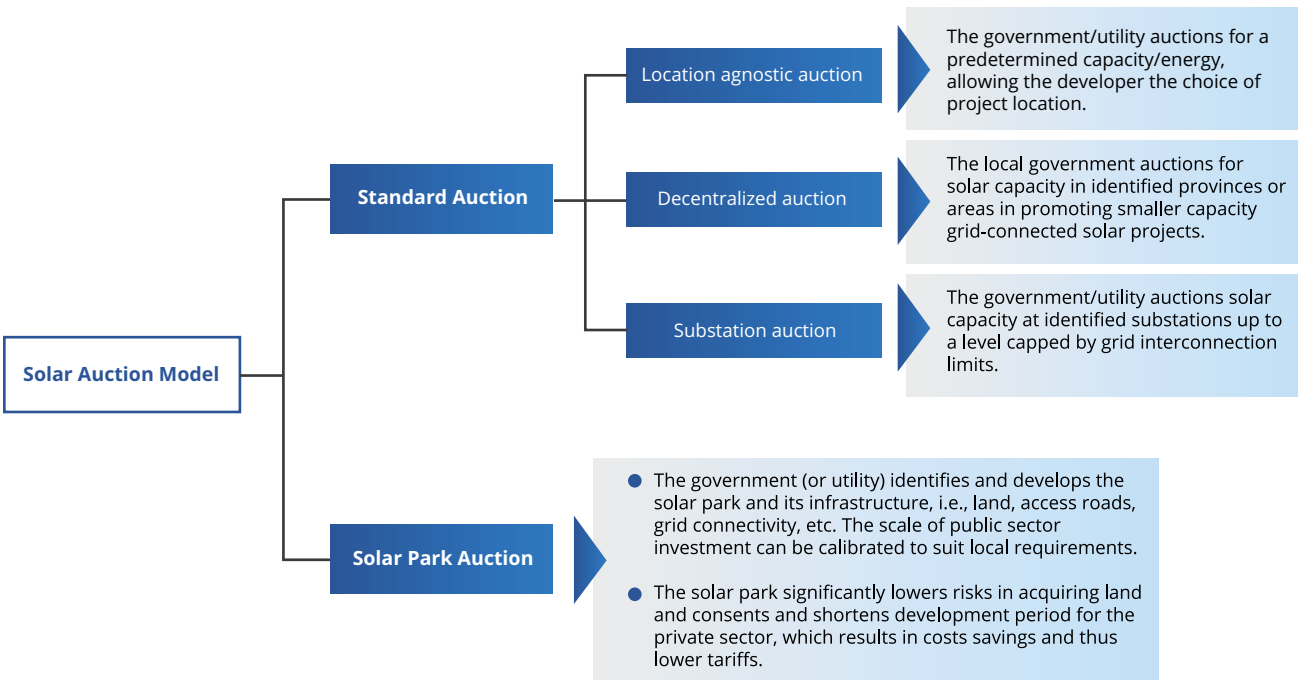


Figure 3. Solar auction models and variation. Adapted from World Bank (2019).

Returning to the four auction design elements framework mentioned above, by *auction demand*, solar auctions are technology-specific auctions (although it can be a technology-neutral auction in the case of location agnostic auctions). As mentioned previously, policymakers should first determine whether their objective is to develop a particular technology or to find a cost-effective solution between technologies. Furthermore, in designing the *qualification requirements*, policymakers (or the auctioneer) should determine which suppliers (bidding companies) are eligible to participate in the auction and most importantly, the auctioneer should decide who is responsible for site selection, as this will determine the overall project development risks and the auction's outcome. The auctioneer can then select the most suitable *winner selection process*, and design the most appropriate *risk allocation*, that is the risk allocation between project developers, the auctioneer, and contract off-taker (if different from the auctioneer).

It is also worth noting that there are some potential downsides to renewable energy auctions, if not designed carefully and properly.

1. Project incompleteness

Perhaps one of the most unwanted outcomes of an auction is project incompleteness. This could be due to lax qualification requirements set in the auction design. For example, if the qualification requirements (both technical project experience and financial strengths) are too lenient, it could risk project incompleteness due to the fact that the winner might lack technical experience, not have financial stability to complete the project, or face difficulty in finding financing since the default risk is too high (or some combination of other factors). Therefore, finding the right qualification is the key to ensure both project completion and competitiveness of the auction.

2. Exclusion of small players and domination of big businesses

As a trade-off of the previous point, while putting a strict requirement can ensure project completion and adds competitiveness to the auction, it might, as a consequence, exclude small players with relatively less experience and lower capital. Although it is beneficial to have big businesses compete to have the most cost-competitive (cheapest) results, it is sometimes necessary to balance the auction design so that the small players can still have some share of the market. Depending on the auction's objective, policymakers may carefully design the auction to incorporate small players' involvement in the bigger auction, for example, by mandating bigger businesses to involve small (local) players as a consortium. Through this, small players can acquire some project experience for future auctions.

3. Price fixing (collusion between bidders)

Another crucial point on auction is to prevent bidders from colluding on a bid (or doing price fixing). Price fixing is an agreement between participants (bidders) on the same side to sell (bid) on electricity at a fixed price (agreed upon on the same side). This could happen when the ceiling price is disclosed at a certain level (especially when it is high), and bidders will bid just right below the ceiling price as they are incentivised to sell electricity as expensive as possible. In other words, it goes against the purpose of having an auction, which is to reveal the most cost-competitive price possible. As a precaution, the auctioneer can set an auction system that will not allow bidders to collude. Not revealing the ceiling price can also be of interest to the auctioneer.

4. Risks of underbidding

There is also an unwanted risk of underbidding in renewable energy auctions. Underbidding is a practice where a bidder offers a dangerously low bid compared to other bidders. In this case, without considering their own capability to deliver the project (default). Underbidding might happen if there are various incentives and support, and without strict project completion bonds to prevent the risk of underbidding, as will be discussed in more detail in Brazil (Section 4.1) and India's case studies (Section 4.2). To anticipate this, the auction regulator should find the right level of qualification requirements to balance the competition (ensuring price discovery) and underbidding risks.

Summary

Auctions have recently become an increasingly popular policy tool to procure renewable energy in many countries. The deflationary costs of renewable energy technologies, the increased interest of project developers, and the policy-design experience acquired over the last decade have all contributed to the uptake of renewable energy auctions. When designed properly, auctions can help to achieve renewable deployment in a cost-effective and regulated manner, avoiding potential windfall profits and underpayments.

National context and renewable energy market are two key elements in auction design which determine each country's priorities in terms of technology, volume and location. For example, technology-specific auctions can promote certain technologies while technology-neutral auctions create more space for competition. Other national priorities can also be integrated in the auction design. Local content requirement is a common one that has been put in place in countries such as Brazil to foster its domestic manufacturing and R&D capabilities in renewable energy technologies. Furthermore, the successful implementation of auctions also needs to be supported by an appropriate regulatory and institutional framework, relevant skills and adequate infrastructure (IRENA, 2013), which will be further discussed later in this report.

③ Utility-Scale Solar Procurement in Indonesia

3.1. Overview of Indonesia's Power Market Structure

Historically, Indonesia's power market is operated and managed solely by the state-owned electric utility monopoly, PT Perusahaan Listrik Negara (Persero), or PLN for short. However, through several market reform attempts, especially through Electricity Law in 1985, 2002, and 2009, today, private participation in the power generation sector is allowed (PwC Indonesia, 2018). Private participation in power generation is done through independent power producers (IPPs) or public-private partnership (PPP) arrangements (BKPM, 2015). Specific to solar power generation, however, it has been procured mainly by IPP arrangements through projects listed in PLN's Electricity Supply Business Plan (*Rencana Umum Penyediaan Tenaga Listrik* or "RUPTL").

Overview of Indonesia's legal and regulatory framework on the electricity sector

The electricity sector in Indonesia is governed mainly by two laws: Law No. 30/2007 on Energy (**the Energy Law**) and Law No. 30/2009 on Electricity (**the Electricity Law**), as amended by Law No. 11/2020 on Job Creation (as depicted in **Figure 4**). The Energy Law serves as the basis for all implementations related to the National Energy Policy (*Kebijakan Energi Nasional*, or "KEN"), as stipulated in the Government Regulation No. 79 of 2014, along with other implementation regulations related to national energy and national electricity planning, i.e., the National Energy General Plan (*Rencana Umum Energi Nasional*, or "RUEN") and the National Electricity General Plan (*Rencana Umum Ketenagalistrikan Nasional*, or "RUKN"). RUKN acts as the policy basis for PLN to structure the Electricity Supply Business Plan (RUPTL).

The Electricity Law, on the other hand, serves as the legal basis for any business activities surrounding the provision of electricity, such as power generation, transmission, distribution, and the sale of electricity (PwC Indonesia, 2018). The implementation of this law is further regulated under the Government Regulation No. 14/2012 jo. Government Regulation No. 23/2014 on Electricity Supply Business Activity (as amended by the Government Regulation No. 5 and 25 of 2021, as an implementation of the Job Creation Law), as seen in the right-hand side of **Figure 4**. Other regulations relating to technical matters, such as electricity business licenses, sale of power, national and transnational interconnection, and land procurement are further enacted at the presidential, ministerial, and director general levels. In addition to that, provincial governments may issue electricity regulations (i.e., licensing and tariffs) in line with the Electricity Law by virtue of the laws and regulation on regional autonomy (PwC Indonesia, 2018). More recently, through the Job Creation Law (Law No. 11/2020), there are several changes in the law that cut a number of permits as well as authority from municipal government to the central government, including the stipulation of electricity supply business license and electricity tariff setting (mainly for concessions outside PLN's business concession, or "*wilayah usaha*").

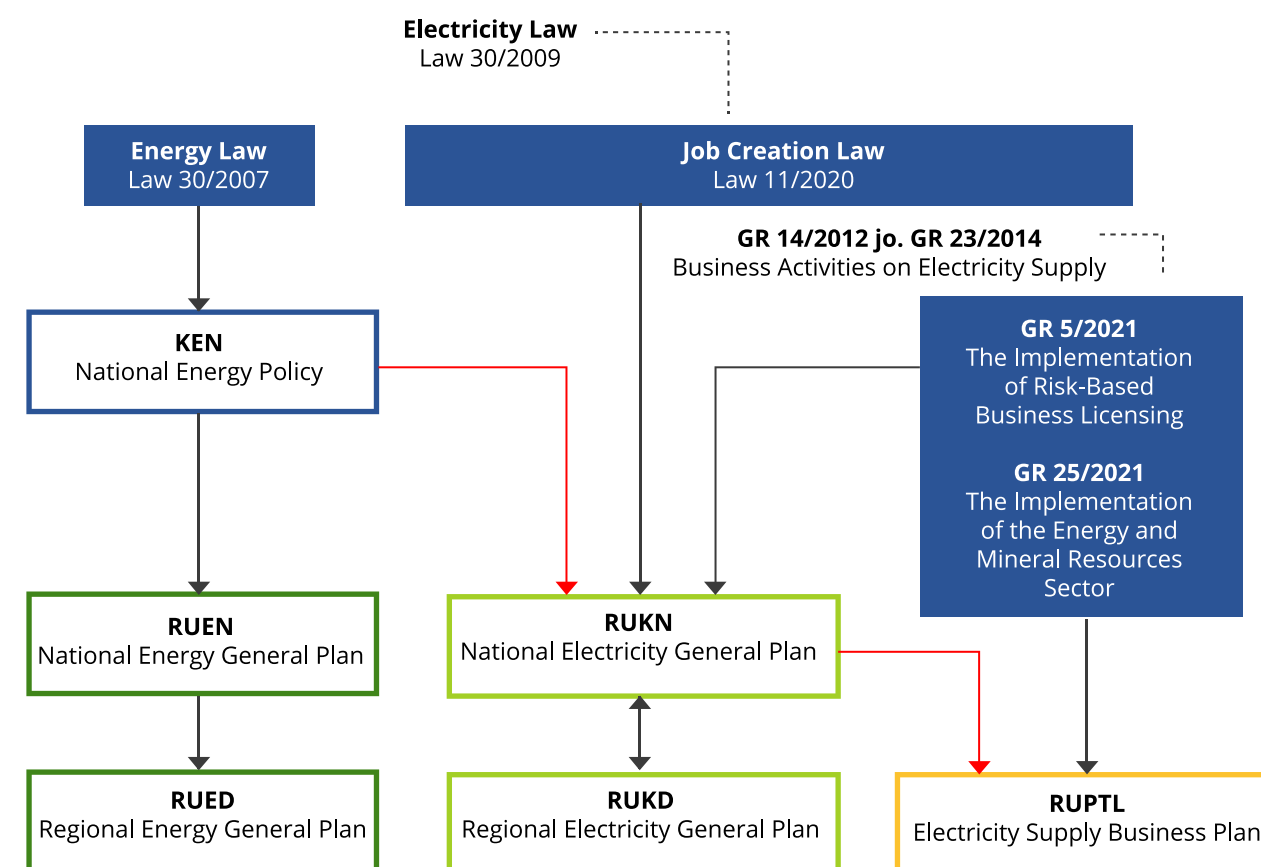


Figure 4. Regulatory framework on energy and electricity planning in Indonesia (MEMR, 2021)

As briefly mentioned in the introduction of this chapter, Indonesia's current power market structure follows that of a vertically integrated monopoly with some degree of private participation on the power generation side (Setyawan, 2015). This market structure is also known as the single buyer model, where a public utility, i.e PLN, will outsource power generation to the private sector (IPPs) and buy it at an agreed price for a certain contract period, typically between 20 to 30 years. Indeed, the 2009 Electricity Law allows a certain degree of privatization by one business entity within a specific business territory (*Wilayah Usaha*). That said, PLN is given priority rights over electricity business supply throughout Indonesia, except for certain business territory given to private enterprises, cooperatives, and self-reliant community institutions involved in the electricity supply business (PwC Indonesia, 2018).

As an implementation of the 2009 Electricity Law (including its recent amendment on Job Creation Law and its implementation regulations, see **Figure 4**), PLN must prepare its Electricity Supply Business Plan (RUPTL), which spans ten years and is reviewed annually. The plan contains the forecast of electricity demand, planning for power generation, distribution, and transmission for each province in PLN's business territory (*Wilayah Usaha*). In particular, the document details PLN's plan to build power generation either by outsourcing the construction to *engineering, procurement, and construction* (EPC) contractors or to buy the electricity from IPPs.

3.2. Utility-Scale Solar PV Procurement in Indonesia

Utility-scale solar PV is generally defined as a large-scale solar power generation facility that generates and feeds power into the grid of an electric utility. When discussing utility-scale solar, however, it is usually difficult to agree on the size of what constitutes a “utility-scale” (GTM, 2013). Mendelsohn et al. (2012) at NREL chose 5 MW as a minimum threshold for utility-scale solar, while some others have a slightly higher threshold of 10 MW, or even as low as 1 MW (GTM, 2013). It is therefore more useful to look at utility-scale solar from the way the project is structured. Owing to its large scale and project economics, virtually every utility-scale solar needs a power purchase agreement (PPA) with a utility company, which guarantees off-take agreement to purchase the produced electricity for a certain period of time (somewhere between 20 to 30 years) (GTM, 2013). In this paper, utility-scale solar refers to IPP solar PV projects that require a PPA with the state-owned utility PLN, otherwise locally known as “PLTS IPP”.

3.2.1. Overview of solar policy and IPP solar procurement developments in Indonesia

Before diving into the current regulatory framework in IPP solar PV auction, it is useful to look at the historical solar auctions timeline as well as solar policy developments in Indonesia. Solar auctions have been adopted in Indonesia—although with different design, mechanism, and regulatory framework—as early as 2014. As seen in **Figure 5**, there have been only eight (or nine if cancelled ones are counted) solar auctions between four discrete years, i.e., 2014, 2017, 2019, and 2020. The way auctions were designed and carried out differ depending on the relevant regulatory framework at the time, as noted in the figure. For example, 2014’s auction were held by the Directorate-General of New, Renewable Energy, and Energy Conservation (“EBTKE”) of the MEMR, while other auctions are generally held by PLN (except PJB’s Cirata floating PV and the more recent Indonesia Power’s Hijaunesia project, which were equity partner auctions for PLN’s subsidiaries).



Other notable projects:

March 2017

Jakabaring 2 MW solar project

Developed by South Sumatra govt with Sharp Corp. (Japan) to support Asian Games 2018 (Joint Credit Mechanism)

- **Regulatory framework:** Unclear
- **Mechanism:** B2B with PLN
- **Status:** Commercial operation

November 2017

1. MoU signing between Masdar and PT PJB to develop Cirata FPV 200 MW (later changed to 145 MWac)

2. Lols signing between PLN and developers for Bali-1 50 MW (East Bali) and Bali-2 50 MW (West Bali)

Status: Lols cancelled and re-tendered in 2019 (and downsized to 2 x 25 MW)

Figure 5. Historical solar auctions and projects timeline in Indonesia. Notes: 2013-2017's data from PwC Indonesia (2016, 2017, 2018); 2019-2020's data from IESR Analysis

In 2014, the Indonesian government through the EBTKE of MEMR launched Indonesia's first solar auction totaling 80 projects in 11 different locations across the country with a total capacity of 140 MW. The auction used a quota capacity mechanism and introduced a capped ceiling price tariff scheme as stipulated in the MEMR Regulation No. 17/2013. The MEMR Reg. 17/2013 regulates a maximum tariff cap of US\$0.25/kWh (if no local content is used) and a tariff cap of US\$0.30/kWh (if minimum local content requirements are followed). This option to opt-out from the local content requirements was challenged by the Indonesian Solar Panel Manufacturing Association (APAMSI) and derailed the procurement process due to the legal action taken (IEEFA, 2019). Because of that, only 7 out of 80 projects successfully reached PPA signing as they were already signed prior to the legal action (contracts signed are allowed to proceed). However, only 5 projects eventually reached commercial operation (see Table A-1 for more details). The legal challenge was successful and the regulation was later revoked in 2015 (PwC Indonesia, 2016).

After the legal setback, in 2016, the MEMR issued a well-priced fixed feed-in tariff (FIT) scheme for solar PV through MEMR Regulation No. 19/2016 (Devine et al., 2016; IEEFA, 2019). Announced in early 2016, the regulation originally aimed to offer a 5 GW solar PV capacity quota in stages. The first phase of the procurement was planned for 250 MW across Indonesia with feed-in tariffs ranging from US\$0.145–0.25/kWh (depending on region). It should be noted that this procurement does not use a tender/bidding, but rather on a first-come, first-served basis⁴ (PwC Indonesia, 2016). However, the regulation was short-lived and soon revoked by the release of the MEMR Regulation No. 12/2017 due to the changing priority of the newly appointed energy minister, said to be driven by increasing concerns about PLN's increasing fixed electricity generation cost, or locally known as *biaya pokok produksi pembangkitan* (BPP) (IEEFA, 2019).

Soon after, regulations released in 2017, i.e., MEMR Reg. 12/2017 (as amended by MEMR Reg. 43/2017), and later revoked again by MEMR Reg. 50/2017, became the basis of today's utility-scale (IPP) solar PV procurement.

3.2.2. Current regulatory framework for IPP solar procurement

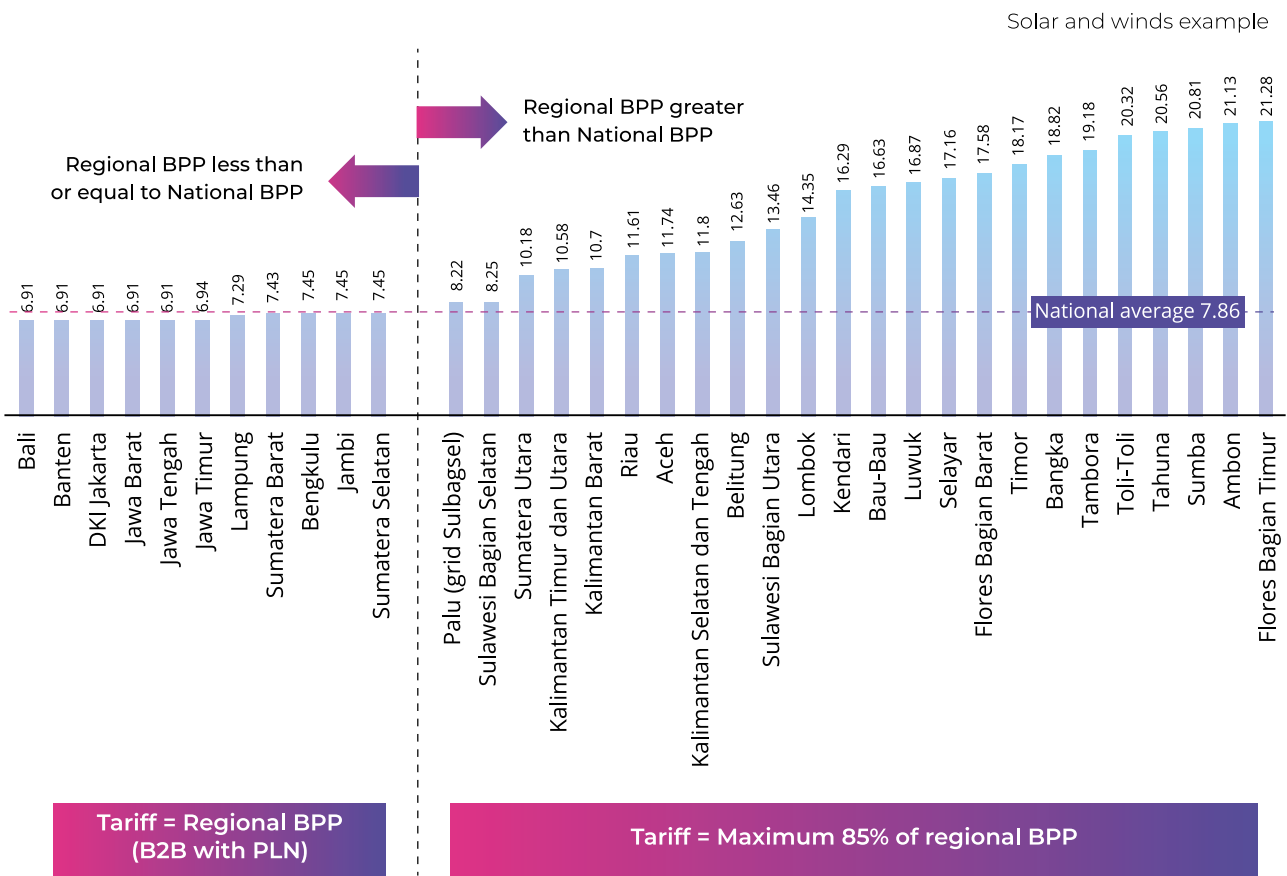
Since 2017, utility-scale solar procurement has been carried out by PLN under a mechanism called **direct selection based on capacity quota**, as regulated by the ministerial regulation of the Minister of Energy and Mineral Resources No. 50 of 2017 (MEMR Reg. 50/2017). Direct selection is a type of limited tender/auction that requires at least two bidders from a pre-approved developers/providers list (locally known as *daftar penyedia terseleksi*, or "DPT"). The term "based on capacity quota" refers to a type of auction specific to intermittent power generation (i.e., solar and wind), in which a power utility (PLN) will decide and offer a certain capacity to be auctioned. This type of auctioning can also be referred to as substation auctions, as explained in Chapter 2.4. Furthermore, this capacity quota is reflected in PLN's RUPTL and will vary depending on the region's power system. Additionally, in RUPTL 2019–2028, the plan to install solar PV totals 908 MW (until 2028)⁵.

⁴ Under a first-come, first-served basis, interested developer submits their application and may be appointed directly by the auctioneer without a bidding given the complete requirements

⁵ The draft for RUPTL 2021–2030 was still in the finalization stage during the writing of this paper

MEMR Reg. 50/2017 does not only specify the procurement mechanism for electricity generation from renewable energy sources, but also specifies the tariff setting (or pricing) for its purchase. The regulation benchmarks the tariff to the cost of electricity generation in a particular power system (otherwise locally known as *biaya pokok produksi*, or “BPP”) based on power generation in the previous year (including all power plants owned by PLN and IPPs), which varies regionally. Specific to solar pricing, tariff is capped to 85% of local BPP, if the local BPP is higher than the national BPP average. When the local BPP is equal to or lower than the national BPP average, the tariff will then be decided based on a business-to-business (B2B) negotiation between the IPP and PLN (see **Figure 6**).

Local average power generation cost (BPP)
(cents per kWh, 2018)



Notes: 1 USD = 14,246 IDR (2018 rate). List not exhaustive.
Source: MEMR Decision 55/2019.

Figure 6. Illustration of tariff ceiling price set by the mechanism under the MEMR 50/2017

It is important to note that MEMR Reg. 50/2017 It is important to note that MEMR Reg. 50/2017 also specifies that electricity purchase from solar energy can be done in the case of: 1) when the local system (grid) can receive electricity supply from intermittent power (solar), 2) intended to reduce local power generation cost (local BPP), and 3) satisfy electricity demand when no other primary energy source is available. This rationale, which was driven by the concern of increasing electricity generation cost in 2017, has hindered renewable energy adoption in general and signified a shift from a supportive and well-priced fixed FIT regime for solar PV (MEMR 19/2016) into a regime that puts unsubsidised renewable (solar) energy pricing to the historical generation cost of subsidised fossil-fuels (mainly coal)—when it should be incentivised in early stages (Bridle et al., 2018).

3.2.3. IPP solar auctions by PLN

In Indonesia, utility-scale solar auction is divided into two: substation auction and site-specific solar auction, as illustrated in **Figure 7**. **Substation auction** follows the previously mentioned “based on capacity quota” mechanism in which PLN auctions a certain capacity at an identified substation. Under this type of auction, developers must find, select, and develop a project (i.e., conducting feasibility study, grid connection study, and land acquisition, etc.) somewhere around the identified interconnection before the actual bidding. **Site-specific solar auction**, on the other hand, refers to utility-scale solar auction with predetermined location and capacity. The auction is either developed by PLN itself, proposal submissions (feasibility study) by developers, or by the government, although the latter has not been seen so far. Under this type of auction, the land is usually predetermined, and hence lowers development risks and costs significantly. Therefore, bidders can bid more competitively, as there is minimum development cost involved.

It is important to note, however, that the site-specific solar auction currently has not been auctioned by PLN so far but rather through an assignment (“*penugasan*”) to PLN’s subsidiaries (e.g., Pembangkitan Jawa Bali “PJB” or Indonesia Power “IP”) such as the case with PJB’s Cirata 145 MWac floating solar project, and Indonesia Power’s recent Hijaunesia’s bundled four solar projects auction, in which both PJB and IP seek for an equity partner (49% of project’s share) to later sign a PPA with PLN as a consortium (see **Box 1** and **Box 2**).

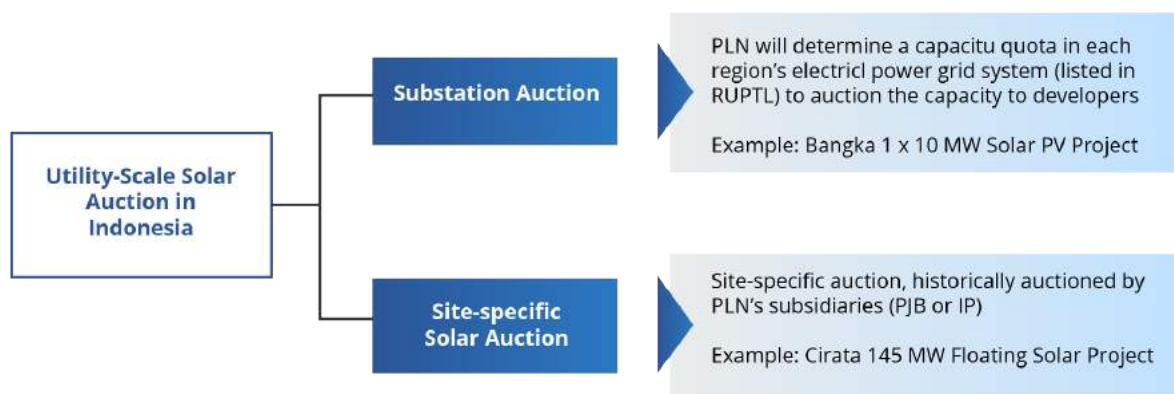


Figure 7. Utility-scale solar auction types in Indonesia

A more detailed overview of PLN’s utility-scale solar procurement by direct selection (auction) is illustrated in **Figure 8**. As explained earlier, PLN can list verified unsolicited proposal(s) by developers and auction it as a location-specific project. However, the entire procurement process is the same. It starts with a pre-qualification round or the so-called DPT (*Daftar Penyedia Terseleksi*) selection. It is worth noting that for solar auction with a capacity less than and equal to 10 MW (≤ 10 MW), the auction will be held by PLN’s regional office (*unit induk wilayah*), whereas for capacity above 10 MW (> 10 MW), the auction will be done by PLN’s headquarters. **For small solar projects (≤ 10 MW)** this can be inefficient and time consuming as developers have to undergo every single PLN’s regional offices’ pre-qualification in order to participate in the auction. This is not the case for projects larger than 10 MW, where developers have to undergo and pass just one pre-qualification which lasts for three years.

Box 1: PJB's Cirata 145 MWac floating solar (equity partner) auction

Cirata floating solar auction is an exceptional case because it was originally developed as a part of government-to-government (G2G) partnership between Indonesia and the United Arab Emirates (UAE) through a Memorandum of Understanding (MoU) signed on July 16, 2017 (Primadhyta, 2017). Following the MoU, a project development agreement was signed between PJB and Masdar to develop 200 MWac (originally) of floating solar PV at Cirata Dam (Primadhyta, 2017). However, since the regulatory framework (MEMR 50/2017) does not allow direct appointment (*penunjukkan langsung*) by PLN for solar project, PLN used a different mechanism, that is through assignment ("*penugasan*") of its subsidiary, PJB, to continue with the development and find a strategic partner through an **equity partner auction** instead. This was made possible through PT PLN (Persero) Directors Regulation "**Perdir PLN" No. 0036.P/DIR/2017** on the *Assignment Guideline to Subsidiary in the Framework of Acceleration of Development of Electricity Infrastructure* as amended by **Perdir PLN No. 0061.P/DIR/2019**, which—to our knowledge—is not available for review online.

More importantly, under the G2G partnership framework, Masdar was given a **right-to-match** (or matching right), that is the right to match the offer made by whoever made the lowest offer in the bid (CNN Indonesia, 2019). While it was recorded that there were *eight* developers who joined the auction, only one (Masdar) eventually submitted the bid (Sulmaiati, 2019). Several developers who were familiar with the process admitted that the terms are unattractive since Masdar is already "predetermined" to win given the right-to-match. This was because submitting a bid will incur cost and, given the *right-to-match* clause, it was not so favourable to bid as its competitor could "match" theirs; therefore, most decided not to submit their bids.

The project has signed a PPA in January 2020 with an electricity purchase price of 5.8179 ¢/kWh and is currently at financing stage (IESR, 2021; MEMR, 2020).

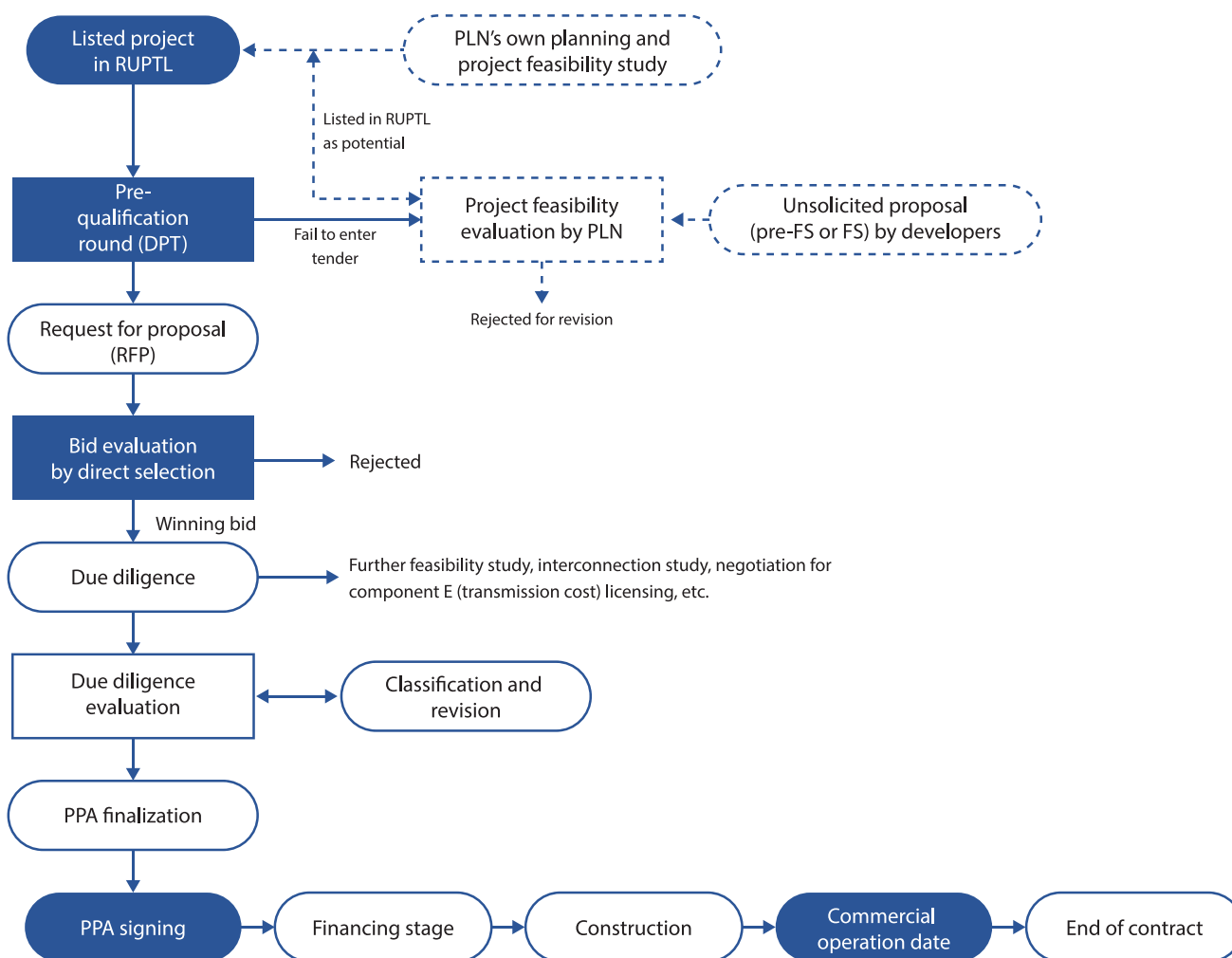


Figure 8. PLN's utility-scale solar procurement by direct selection (KPMG et al., 2019; PLN, 2019, 2020)

After passing the pre-qualification round, which mainly assesses the financial strength and technical experience of developers, pre-qualified developers will be invited to collect the request for proposal (RFP) document and submit their proposal and bid within a period of time, which may take about two to three months until bid submission. The bid normally consists of three parts: i) administrative requirements, ii) technical requirements/offers, and iii) the bid/offer document, which contains bid price, financial models, and calculations related to the tariff structure. The bids from all pre-qualified bidders are then evaluated based on the three criteria: administrative, technical, and bid/price (lowest).

It should be noted that if the first two criteria are not met, then the bid will not be considered. And only when the first two criteria are met, **then the lowest bid will be considered as the winning bid**. Note that the submitted bids are compared to PLN's self-estimated price (owner's estimate), otherwise locally known as *harga perkiraan sendiri* (HPS), that took into account the aforementioned tariff pricing policy set by the MEMR 50/2017. It is important to note that PLN's owner's estimate (HPS) is the ultimate tariff benchmark in an auction because it features every component of the tariff structure, i.e. component A (capital cost recovery), component B (fixed operations & maintenance charge), and component E (transmission/interconnection cost, if any), which is detailed in the RFP prior to bidding.

There will be a refute period before the winner enters a due diligence and feasibility study period. The winner will then have to submit further feasibility and grid interconnection studies to PLN before eventually obtaining a letter of intent (LoI) and approvals by the director(s), and also negotiating the final PPA. In the PPA negotiation, interconnection cost (special facility, or “component E”) is negotiated through a business-to-business (B2B) between PLN and the verified winner. Once the PPA is signed, the winner should find financing for a certain period of time, usually 6 months or more. If the winner cannot receive financial closure until the specified required financing date, then the PPA might be terminated. If the winner receives financial closure, then the project can start the construction phase, followed by commercial operation date (COD), and will be operated for the agreed years (usually 20 to 25 years) until the end of contract period (see **Figure 9** for an overall business process on a solar IPP project).

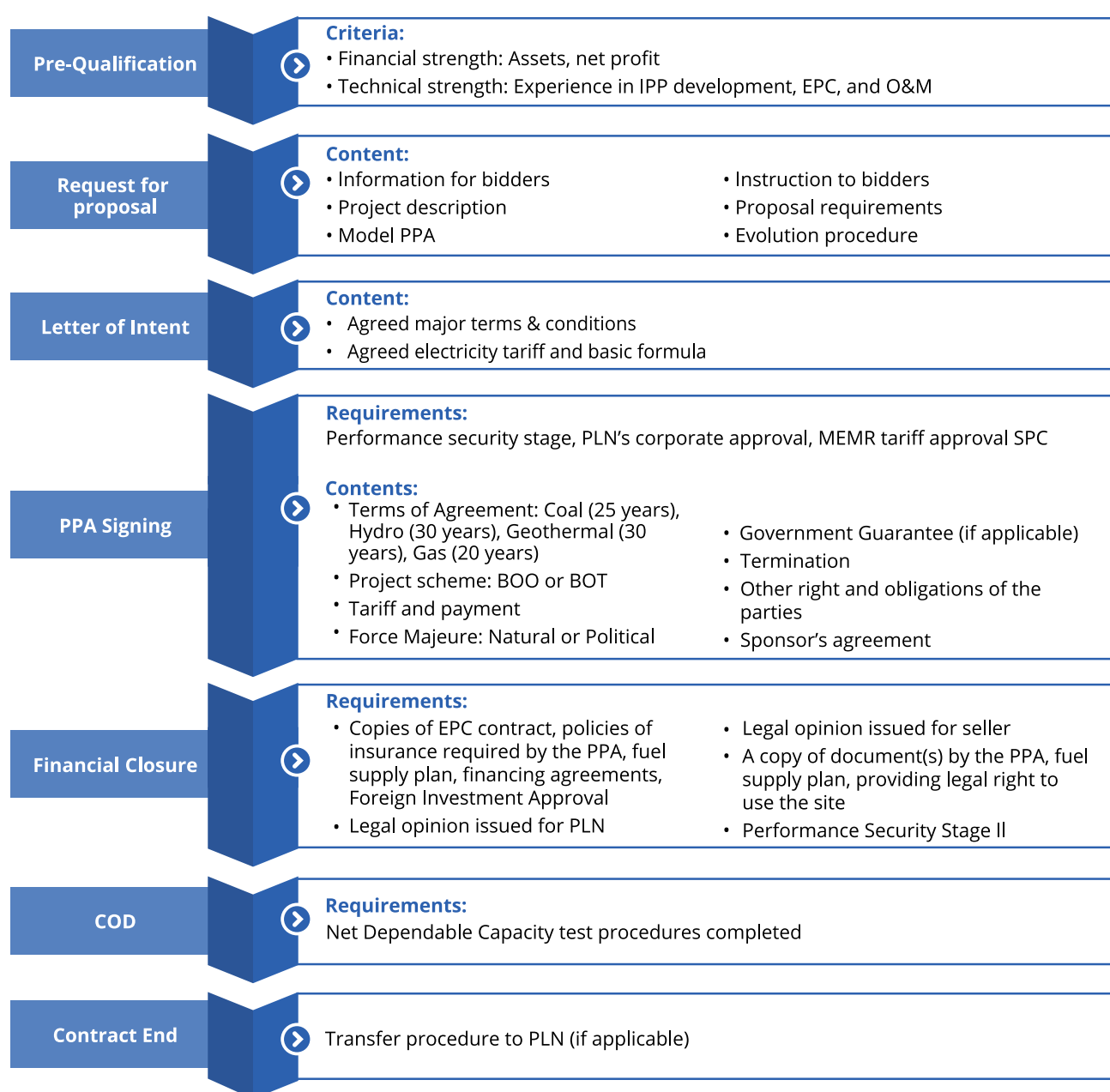


Figure 9. IPP business process flowchart with the requirements (PLN, 2017; Suharsono, 2020).

3.2.4. Challenges and barriers in the current utility-scale solar development and procurement

This section will detail the major challenges in the current utility-scale solar development and procurement practice. In general, the challenges can largely be attributed to two main aspects: i) **poor power system planning and opaque procurement practice**; and ii) **unattractive policy and regulatory issues that affect project bankability**. These challenges and barriers have hindered efforts to accelerate the downward trend in solar auction prices.

1. Auction demand: Lack of projects due to the lack of commitment in incorporating solar in the power system planning

Perhaps one of the major, if not main, impediments to utility-scale solar development can be attributed to the power system planning by PLN and, to a lesser degree, MEMR. This is because the eventual capacity quota auctioned will depend entirely on PLN's RUPTL. Meaning, if the planned capacity addition is minimal, there will not be adequate auctioned volume.

PLN clearly has not been prioritising or incorporating a huge amount of solar PV in their power system planning, as reflected in the RUPTL. In RUPTL 2019, solar PV only accounted for 1.6% (908 MW) of the total planned capacity of 56.4 GW (all generation technologies), or only 5.4% of the total planned renewables capacity addition of 16.7 GW for the span of ten years (2019–2028). It is important to note that even if the planned solar capacity addition is stated in RUPTL, there is no guarantee that it will be executed (auctioned) by the year it was originally planned. This is because the capacity addition plan is often several years away from the year the RUPTL is released and that RUPTL is revised every year. For example, in RUPTL 2019, PLN plans solar capacity addition in 2023 to be 160 MW (assumed to be already commissioned by then). However, in years leading to 2023, the RUPTL may have already revised three times in 2020, 2021, and 2022—this is even more difficult to predict if we factor in the recent COVID-19 pandemic and the demand projection adjustment it entails.

Granted, in the past, PLN could argue that this is due to a combination of factors such as grid readiness (2017's Sumatra solar auction was cancelled because of it), solar's intermittency and low capacity factor, and the notion that solar PV was deemed expensive. More recently, however, as the installed cost of solar PV power plants declined, this should not be seen as a threat anymore but rather an opportunity. PLN does seem to show an interest of making use of this opportunity in the upcoming RUPTL 2021–2030 where it is revealed that the capacity addition for solar will be at least 5 GW by 2025 and 5.9 GW by 2030, according to MEMR and PLN's presentation at a parliamentary hearing in May 2021.

As a result of inadequate planning to incorporate solar PV, most utility-scale solar (IPP solar) auctions in the past lacked both volume and size. As explained in Section 3.2.1 (Figure 5), most commissioned solar projects to date, which were auctioned in 2014 and 2017, only range between 1 to 15 MWac (see Table A-1 in Appendix A for more details). It is important to note that 2014's capacity quota offering (and 2016's failed capacity quota offering) was done by the MEMR (EBTKE) as opposed to PLN. Since 2019, Indonesia's solar auction has seen much increase in project size such as with Bali 2 x 25 MWp solar project (although this was a re-tender of 2017's auction), PJB's Cirata 145 MWac floating solar project, and Indonesia Power's recent Hijaunesia Auction in 2020 that features four large solar projects, including two floating solar projects (Singkarak 90 MWac and Saguling 60 MWac), 100 MW solar + storage in Lampung, and another (to be announced) solar project in Kalimantan (see Table A-2 and Table A-3 in Appendix A) (IESR, 2021). That said,

except these four recent auctions, Indonesia's solar auction lacks size and volume, not to mention, Indonesia has only conducted relatively few auctions; three in 2019 and one in 2020 (**Figure 5**).

Solar auctions with minimal project size and volume are certainly not ideal, especially when it comes to financing. A study by IEEFA (2019) finds that financing is rarely seen as the most critical barrier, so long as they have a sufficient size to qualify for financing. According to the study, many IPPs confirmed that there are a sufficient number of local and international banks to finance utility-scale solar projects, including some Development Finance Institutions (DFI) such as the International Finance Corporation (IFC) and Asian Development Bank (ADB). Therefore, the challenge is more about finding sizable projects to qualify for financing, which stems back from the power system planning.

Another important point to highlight is the discrepancy between the national energy policy target, which is reflected in RUEN, and the execution in RUPTL. In RUEN, the government targets 6.5 GW of solar PV installation by 2025; however, RUPTL only plans 0.9 GW of solar PV installation until 2025 (even relatively unchanged by 2028). Given the recent, although not final, announcement of the Grand Strategy for National Energy (*Grand Strategi Energi Nasional*, GSEN) that aims to install 17.6 GW of solar PV by 2035, the government should be able to translate their national policy target into a well-designed, pragmatic, and executable plan that is reflected in the RUPTL (IESR, 2021).

2. Project development and land selection: Developers have to bear significant development (sunk) cost in developing projects for substation auction (“*kuota tersebar*”) due to the lack of (sizeable) projects

Due to the lack of (sizeable) projects in the current power system planning, developers may have to bear significant burden to develop projects. Under the current practice (see **Figure 8**), **developers may choose to submit unsolicited proposals (feasibility studies) for a project to be auctioned outside the planned capacity in RUPTL**, so long as the system's grid allows (so-called scattered quota “*kuota tersebar*”). In doing so, however, developers have to bear the project development cost and risk (i.e., sunk costs) without much “incentives”, as they will not have any privilege in the auction process. According to some developers interviewed for this research, the sunk costs are simply too great compared to the benefit (that is if they won the bid at all). Moreover, the project development can take about 2 years just to get the project auctioned by PLN.

It is worth noting that development challenges, especially those related to land acquisition, might differ depending on the type of solar auction in question. From a project development standpoint, it is far more favourable for developers to bid on **a site-specific auction** than a substation auction, as **the development risks—particularly those related to land acquisition and grid connectivity—are lower**. This is because developers would not need to find and select the land prior to bidding, and can “compete” directly on price. However this scheme has not been explored much in Indonesia's solar auction context, especially for ground-mounted solar projects due to various reasons namely limited capacity of solar installation, reluctance of both PLN and MEMR to determine locations, and blockage of the online single submission (OSS) of the Jawa-Bali system by the Indonesian Investment Coordinating Board.

Floating solar, for instance, is another good example of a site-specific auction. It differs slightly compared to ground-mounted solar projects in terms of land selection and acquisition. For

floating solar, land selection and provision are relatively easier since most dams are within the government's jurisdiction under the management of *Balai Besar Wilayah Sungai (BWS)*, therefore it will only require a certain permitting to use the reservoir area as opposed to buying private land and making speculative land purchases for a typical ground-mounted solar project, for instance. That said, since floating solar development in Indonesia is still at a very early stage, technical criteria and standards on permitting are also understandably still being developed.

Several relevant showcases on floating solar projects include Cirata 145 MWac floating solar project, which received a PPA price of 5.81 ¢/kWh, and the more recent floating solar project bids at Singkarak 90 MWac in West Sumatra and Saguling 60 MWac in West Java, which both received winning bids at 3.68 and 3.74 ¢/kWh, respectively (see **Box 2**). All three projects have shown a promising sign of the declining cost of solar bid prices in Indonesia, in part due to the site-specific auction scheme, which reduces the development cost for land. Not to mention, grid connection can also be cheaper and easier when there is already existing infrastructure for hydropower dams. It is also worth noting that the current site-specific solar auction scheme has been carried out by PLN's subsidiaries instead so far (such as PJB's for Cirata floating solar project equity partner auction and Indonesia Power's Hijaunesia equity partner auction for a bundled four solar projects). Despite the competitive prices it revealed, it is still unclear whether PLN will adopt a similar auction scheme in the near future.

In comparison, substation auction (based on scattered quota) **requires developers to find and secure (acquire) the land for development prior to bidding**, which is usually one of the main issues with solar energy development, and can add more to costs and the bid price reflected in the auction (A.T. Kearney & APINDO, 2019).

Box 2: Indonesia Power's Hijaunesia four solar projects (equity partner) auction

Indonesia Power's recent equity partner solar auction in 2020 makes an excellent case study for Indonesia to replicate its solar auction in the future. Officially dubbed "Hijaunesia Project", the auction consists of *four* separate substantially large solar projects, including two floating solar projects in West Sumatra (90 MWac) and West Java (60 MWac), one 100 MWac solar + 70 MW/350 MWh storage project in Lampung, and one undetermined capacity and location in Kalimantan (see Table A-3 in Appendix A for more details). According to IJGlobal (2020), the solar projects in West Sumatra and Lampung received bids from five companies, while the auction for Saguling floating project received bids from six companies, all of which are international bidders. Note that the auction was participated by at least 19 bidders, all of which are multinational companies, according to PT Sarana Multi Infrastruktur (Persero) (SMI) and ADB. Further, it should be noted that Indonesia Power's procurement mechanism also follows Perdir PLN No. 0036.P/DIR/2017 (see Box 1 for more details), and PT Indonesia Power Directors Decree "Perdir IP" No. 166.K/010/IP/2017 on the *Guidelines for Selection of Electricity Business Partners* as recently amended by Perdir IP No. 036.K/010/IP/2020.

The auction, which was conducted virtually in 2020 during the onset of the COVID-19 pandemic, has received praise from developers and, more importantly, has revealed record-low bids in Indonesia's solar auction history. These include the first-ever low bids in Indonesia of 3.682 cents/kWh and 3.748 cents/kWh for both the floating solar projects in West Sumatra and West Java, respectively. Not only that, the auction also revealed one of the first "large" solar + storage projects with a winning bid of 9.075 cents/kWh. The record-low bid of 3.682 cents/kWh is at least 37% lower than the bid received in Bali 2 x 25 MWp ground-mounted solar project that received a winning bid of 5.86 cents/kWh and 36% lower than Cirata's 145 MWac floating solar project that received a PPA price of 5.8179 cents/kWh (IESR, 2019b, 2021).

The outcomes from this auction are clear, especially to highlight the difference **between** substation auction and site-specific auction. Since both have relatively large size (>50 MW), the main differences in these two auctions are related to project development and land selection (and acquisition). As discussed in challenges #1 and #2, this signifies the lessons learned that Indonesia can apply in future auctions. First, it is important to develop a large enough project size (at least 50 MW) to benefit from the economies of scale. Second, to leave land selection (and project development pre-auction) to utilities (PLN or its subsidiaries). Floating solar fits perfectly with this as it may have minimal land issues and if there is already an existing transmission from hydropower, it will significantly reduce risks and costs for developers, thereby showing a very competitive bid.

Notes: The record-low winning bid—which is quite far from the average value of the bids—might be possible due to a combination of factors (such as better financing cost or other factors), not only the reduced (land) development cost (from FPV) alone. Also, it should be noted that the bids in IP's equity partner auction refer to *base equity base technical* (BEBT) and *alternative equity base technical* (AEBT), and that their structure might be fundamentally different from the bids mentioned in PLN's regular solar auctions.

3. Lack of auctions' regularity: Infrequent one-off auctions are unattractive to long-term investors

As a consequence of the lack of commitment to incorporate solar PV in the power system planning, PLN has been carrying out infrequent one-off auctions to procure utility-scale solar PV, although it could really benefit from designing a large and repetitive auction. More importantly, without auctions' regularity (regular scheduling), it may be difficult to attract long-term investors, such as developers and manufacturers, to set up and invest their business in the country for the long-term.

Periodicity will reflect the government's commitment to develop the solar-based power generation sector according to the planned total capacity. Lack of it will reduce the certainty of the upcoming projects and discourage participation from bidders which would lower competition. **Sizable competition is important to drive the PPA price down** and even create a downward price trend for solar projects. Consequently, the trend will alert potential investors, developers and suppliers to prepare for the future auctions. Therefore, periodicity is crucial for a long term development of solar.

Besides the price (or the trend thereof), the **frequent and large-scale solar auctions can also boost the domestic solar industry if local content requirements are imposed**. In addition, regular and big auctions could also attract foreign solar module manufacturers to invest in Indonesia. According to data from the Ministry of Industry (2020), there are 12 local solar module manufacturers with a total production capacity of 620 MWp per year. However, given the relatively small market (average annual capacity addition of 20 MW between 2015-2020), local manufacturers struggle to maximise their production output, let alone scale up. According to a study by IEEFA (2019), one manufacturer admitted that their production did not even reach 30% of their production capacity. Furthermore, the quality of the products are often inferior to international (imported) modules, and not trusted by the banks (IEEFA, 2019). There is only one company that produces tier 1 modules in the whole country and there is a possibility of the said company to leave Indonesia. **The lack of auction's periodicity hinders the development, or more specifically foreign investment**, for solar PV module manufacturing. Without a clear and regular schedule, most manufacturers will only "wait and see" until Indonesia's solar market booms.

In terms of financing, **the lack of auctions' periodicity sends a poor signal to the financial sector**, as the solar projects are still often seen as high risk, and therefore have only been providing capital at a high interest rate (10–12%) for domestic banks (IESR, 2019a). With a clear and regular scheduling for procuring solar power generation, it will improve the financial sector's experience for financing solar projects, and hence, will improve long-term investors' confidence.

4. Local content requirements (LCRs): Unrealistically high even when the domestic industry does not scale to both the demand and quality

Another major roadblock to solar power development, which greatly affects project bankability due to the increased project cost of using more expensive (yet inferior) local modules, is the unrealistically high local content requirements (LCRs) for solar PV power generation, as stipulated by the Ministry of Industry Regulation No. 5 of 2017 (MoI Reg. 5/2017). The regulation is an update of MoI Reg. 54/2012 that serves as a guideline for the use of domestic products for electricity infrastructure development, which includes every other power generation. MoI Reg. 5/2017 made several changes to the original LCRs for solar PV generation (i.e. for distributed

and centralised off-grid solar PV) and added an additional term for centralised grid-tied solar PV power generation.

The regulation requires 34% to 40% for goods (which include solar modules, inverter, mounting structure, and remaining balance of system (BOS) such as distribution panel, and wiring), and 100 percent for services (i.e., logistics, installation, and construction). The combined goods and services of local content requirements for grid-tied centralised solar PV is 40.68%. Specifically on solar modules, the regulation requires a minimum LCR of 40% in 2017 and to gradually increase this requirement to 50% in 2018 and 60% in 2019. However, after much lobbying and resistance from developers, the requirement still remains at 40% as of 2021.

Table 1. Local content requirements for solar PV power generation

Category	Distributed off-grid	Centralized off-grid	Centralized on-grid
Goods LCRs	39.87%	37.47%	34.09%
Services LCRs	100%	100%	100%
Combined LCRs	45.90%	43.72%	40.68%

This is such a high and unrealistic portion of the LCR, especially for the newly-growing industry such as solar. For instance, the existing domestic production of solar modules only reaches 40% of component level, since many parts such as glasses and cells are still imported (Mahrofi, 2020). Furthermore, although there is already a domestic company that can produce solar panels, it only reaches the printing cell stage with a capacity of 50 MWp (ESDM, 2019). There is also an innovation by a local company on Maximum Power Point Tracker (MPPT) and inverter that can meet about 13.5% of the LCR (Kusumawanti, 2020). Despite the capabilities, the solar PV industry is not ready yet for mass production since the market demand is still low (Mahrofi, 2020).

The high LCR in utility-scale solar projects has contributed to the higher cost of installation, which is then reflected in the higher bid price offered during the solar auction. In 2019, the price for Indonesian solar PV modules ranges between US\$0.40–0.47/Wp, whereas imported modules can reach almost half of that at US\$0.23–0.37/Wp (depending on technology) (IESR, 2019a). The use of a more expensive module (and sometimes of lesser quality) increases the overall system cost and greatly affects the levelized cost of electricity (LCOE), and eventually project bankability. Additionally, some financial institutions will only provide financing to solar projects that use Tier-1 solar PV modules, as local modules are not deemed reliable enough (IEEFA, 2019).

5. Project bankability: Lack of standard PPA for solar power project leading to lengthy negotiation

The main concern in a solar auction is project bankability, which is usually reflected in a tender's model PPA. Bankability represents the ability of a project to generate a return at a reasonable (or favoured) rate. It also represents the willingness of financial institutions to finance a project, and is a function of risk and reputation. In the end, all bankability concerns lie in how the PPA is structured.

According to an analysis by Sungkono (2021) at HHP Law Firm, current issues related to renewable energy PPAs (in general, not just solar) in Indonesia can be divided into two main aspects: bankability (direct impact) and other main commercial issues. There are at least seven points with respect to bankability issues that is noted by the firm, including the take or pay clause, lenders' guarantee, government force majeure with regard to reduced generation (deemed dispatch) and construction delay (deemed commissioning clause), currency risks, and indexation to USD, just to name a few. In other words, at this point, a more balanced and fair allocation of risks should reflect a better bankability for renewable energy projects in general, not just solar projects.

Another point to highlight is the lack of a standard PPA. According to MEMR Reg. 50/2017, PLN must prepare and publish a standard PPA for all renewable energy power plants. However, to date, there is only a standard PPA for dispatchable renewable power generation, i.e., geothermal, biomass, and hydropower, as stipulated in the MEMR Reg. 10/2017 (as amended by MEMR 49/2017 and MEMR 10/2018) on the Principles of PPAs. Other power generation technologies, such as wind and solar currently do not have standard PPAs (ADB, 2020).

This lack of standard PPA leaves ambiguity regarding interconnection cost (special facility, or more popularly known as "Component E"), which often leads to a lengthy negotiation and perceived unbalanced risk allocation, especially regarding who will be responsible for building the transmission line (supposing there is a need to build one) (ADB, 2020; A.T. Kearney & APINDO, 2019). According to our interview conducted for this research, the negotiation process can go for months and can lead to the cancellation of the auction result if the agreement is not reached within a year. Standard PPAs with international standard and balanced risk allocation to both parties are needed to ensure the bankability of solar power generation in Indonesia.

In comparison, past auctions such as Indonesia's first auction in 2014 (which follows MEMR 17/2013) and updated regulation in 2016 through MEMR 19/2016—although no outcome from this as the regulation is short-lived (as explained in Section 3.2.1)—provide better (more bankable) PPA terms in relation to PPA price and in particular, regarding interconnection cost. In those auctions, interconnection cost is already included in the tariff pricing (i.e., capped ceiling price in MEMR 17/2013 or fixed FIT in MEMR 19/2016), meaning there is no further PPA negotiation after the winner is selected. Although the procurement method, selection method, and tariff pricing are indeed different from the current MEMR 50/2017, a similar approach can be applied to future regulatory revision, making the interconnection cost (component E) non-negotiable, which is already final in the winning bid.

Box 3: Challenges in Indonesia's solar projects prior to 2021

1. Inefficient pre-qualification rounds

Prior to 2021, pre-qualification rounds, or the so-called pre-approved developer list (*daftar penyedia terseleksi*, "DPT"), were done separately within each of PLN's regional jurisdictions. As explained in Section 3.2.3, the division of who will be responsible to conduct the auction is determined by the auctioned capacity. For auctioned capacity less than or equal to 10 MW (≤ 10 MW), it is handled by PLN's regional unit (*unit induk wilayah*, "UIW"). Whereas for auctioned capacity higher than 10 MW (> 10 MW), it will be handled by PLN's headquarters. Given the already lacking in size with auctioned capacity of ≤ 10 MW, this process is inefficient and time consuming as interested bidders would have to join every DPT in order to participate in the auction. That said, the latest update suggests that PLN will centralise the entire administration process of the pre-qualification rounds (DPT) to PLN's HQ, and hence is expected to cut down the lead time to procure solar PV for both PLN and interested developers (IPPs).

2. The previous BOOT structure and land ownership

In addition to the negotiation regarding interconnection cost, the previous build-own-operate-transfer (BOOT) structure has also been regarded as a major barrier to project bankability, although this has been changed into just build-own-operate (BOO) structure in 2020 by the MEMR 4/2020 (IEEFA, 2019). Under the BOOT structure, utility-scale solar projects (assets) have to be transferred to PLN after the contract (PPA) expires. While it is generally understood that the regulation (MEMR 50/2017) does not require IPPs to own (buy) the land, land ownership has been translated as a prerequisite in the bidding process by PLN in the request for proposal (RFP) document, according to developers. Meaning, land lease is ruled out and that there is a high risk associated with speculative land purchase prior to the PPA, not to mention the lengthy legal requirement for land acquisition (IEEFA, 2019). While BOOT structure has been removed in the second amendment to MEMR 50/2017 (MEMR 4/2020), its implementation and effectiveness remain to be seen as there has not been any auction that uses this regulation in 2020.



4 Case Studies

4.1. Brazil

4.1.1. Historical narrative/background

Brazil has a unique market structure for power in which there are two markets, a free market and a regulated market. However, the registration and processes of the volume of all the energy contracted in the electricity power market will be done by the Electricity Trading Chamber (CCEE). The free market, known as the ACL, consists of non-captive power consumers, power generators and trading companies, where they can negotiate their own volume, prices and contracts (Thomson Reuters Practical Law, 2021). Whereas, the regulated market is fully regulated by an auction committee led by the National Electricity Regulatory Agency (ANEEL). This market, known as ACR, is composed of distribution companies and captive consumers (Thomson Reuters Practical Law, 2021).

There are two types of public energy auctions in the regulated market, namely the regular auctions and reserve auctions. The regular auctions include a series of A-1 to A-7 auctions which were held in advance of the supply year. For example, an A-3 auction indicates that the auction held in the current year is meant for electricity delivery of the “new energy” source three years later. The reserve auctions, on the contrary, are held sporadically at the government’s discretion. The aim is to procure surplus energy to maintain a safe level of reserve margin. Historically, the reserve auctions have been used to promote renewable energy in Brazil. But nowadays, both renewable and non-renewable energy auctions can be conducted through both types.

Brazil has a high penetration of renewable energy in its energy mix. However, for a long period of time, the country used to mainly focus on hydropower and biofuel (Held, 2017). Brazil was a late bloomer when it came to utilising the tremendous solar potential in its vast territory despite the high sun exposure (Förster & Amazo, 2016; Osava, 2020). In 2015, the total PV installed capacity in the country was only 15 MW, lagging far behind the foremost countries in the development of this energy such as Germany (35.7 GW), France (4.67 GW) and Spain (5.37 GW) (EPIA, 2014).

Although the solar PV capacity was limited, Brazil soon came to realise that solar energy could be very promising as a source of energy in the country. Especially with the concern of potential energy crisis from drought and the lack of sufficient alternative energy sources that causes a rise in energy price (Held, 2017; Veirano Advogados, 2020). The fast-decreasing solar PV price, rising electricity tariffs in Brazil, and increasing environmental and climate pressure, had all together created favourable conditions for promoting the development (Stilpen & Cheng, 2015). The deployment of technology-only auctions has further increased the economic viability of solar PV projects which also allows the domestic solar industry to grow (Stilpen & Cheng, 2015). Solar energy is now the fastest growing energy source in Brazil. Now it is estimated that the installed solar energy capacity will grow by 1 GW per year until 2026 and has the potential to contribute to 32% of Brazil’s total capacity by 2040 which means it would surpass hydropower and become the leading source of energy in the country.

4.1.2. Current status/achievements

The energy sector in Brazil is among the top least carbon-intensive ones in the world (IEA, 2019). While Brazil sees heightened electricity demand and impact of droughts, large-scale intermittent renewable energy projects such as wind and solar have started to gain traction. Installed solar capacity was sitting at 84 MW when it started to take off in 2016 and soon reached 2.5 GW in 2019 (IRENA, 2020), and managed to hit 7 GW by end of 2020 (Molina, 2020). With solar keeps growing, it seems Brazil is well on track to meet its 8.3 GW solar energy target by 2024 (Lindon, 2016). In December 2020, The Ministry of Mines and Energy and the state-run Empresa de Pesquisa Energetica (EPE) agency announced Brazil's energy plan (PNE) until 2050, which includes renewable energy target of around 45% by 2030 (Molina, 2020).

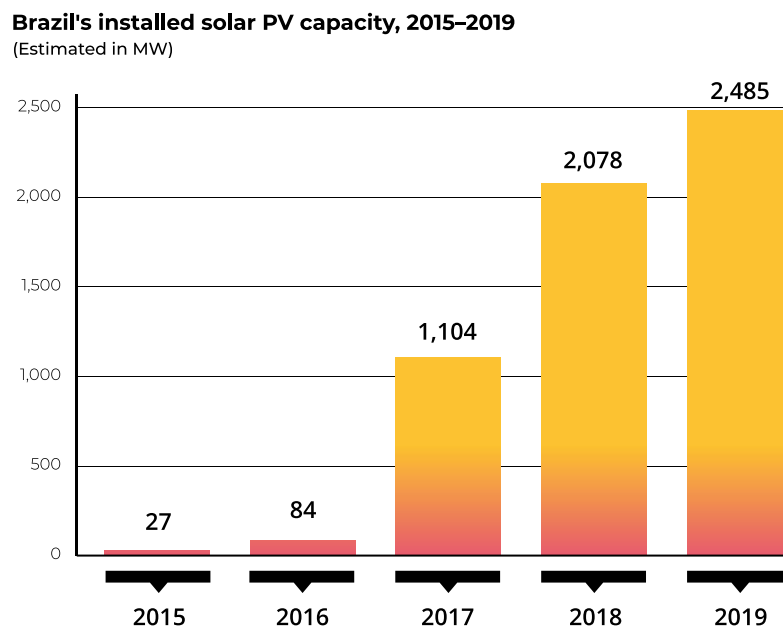
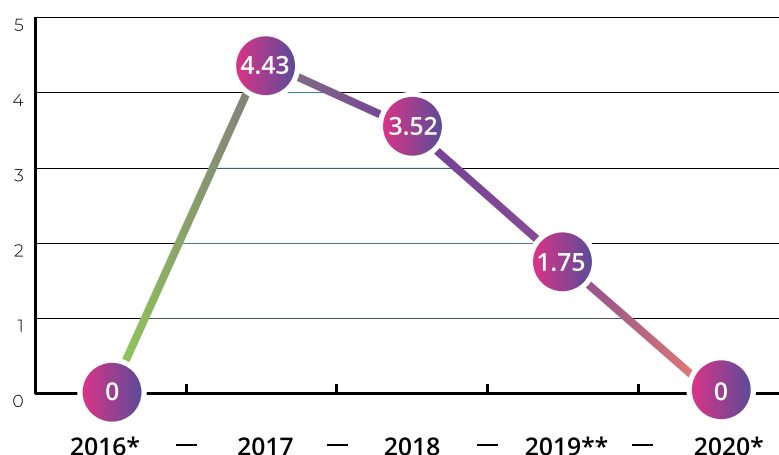


Figure 10. Brazil's installed solar capacity, 2010–2019 (Source: IRENA, 2020).

In addition, Brazil so far has successfully held six solar PV auctions and managed to procure solar power at an increasingly competitive price. In 2014, the average solar price was 8.8 US\$/kWh when Brazil had its first solar auction and lower prices were revealed in the subsequent years. Brazilian auctions continue to record declining tariffs. The most notable moment was in 2019 when 1.75 US\$/kWh was announced which was record-low in the world (IESR, 2019a). Noteworthy, the 2019 low price was feasible because half of the contract capacity would be traded in the free market (Bellini, 2019). The capacity auctioned was small compared to the previous years while the competition was high in the free market (Greener, 2020). Brazil holds auctions every year but each can be cancelled when there is lack of interest from bidders. In both 2016 and 2020, the government has announced auctions but soon were cancelled.

Brazil's average solar bids, 2016–2020

in US¢/kWh



Notes: * Auction cancelled, ** Lowest bid

Figure 11. Brazil's average solar bids, 2016–2020 (Source: IESR Analysis)

4.1.3. Primary driver & auction objectives

Brazil started to develop solar power to answer the increasing electricity demand by the growing population and to reduce the threat of potential energy crisis (Held, 2017). Solar is one of the best choices to diversify the electricity mix because Brazil has an ideal condition for solar power due to abundant sunlight the country receives year round (Stilpen & Cheng, 2015, Held, 2017). Furthermore, there is a global pressure to promote renewable energy due to the threat of fossil-based energy on the environment and climate (Stilpen & Cheng, 2015).

Initially, Brazil used Feed-in Tariff for renewables before fully shifting to auctions. The reason why Brazil conducts solar auctions is because of the price revelation ability of the auction system (Global Environment Facility, 2017). There are three objectives for the auctions in Brazil. The first objective is to attract new generation capacity that can address the gap between the supply and demand of energy. The second objective is to ensure supply adequacy based on load forecast. The third objective is to disclose the true cost of electricity and increase efficiency in the procurement process through reduction of information asymmetry between the industry and the government (Ecofys, 2016).

4.1.4. Auction design

The auction for solar can be conducted through the regular auction and the reserve auction. Since solar installations are considered as projects with shorter construction periods, they typically fall into the A-3 auction in the regular auction. However, regardless of the auction types, winners of the bids will be awarded with 20 to 30 year contracts. The only difference between the two auctions is the counterparty of the energy contracts. Distribution companies are the counterparty for the regular auction, since the project will assist them in procuring power to meet their load growth. The whole procurement costs are passed to regulated consumers. As for the reserve auction, the counterparty of the contract is the Electricity Trading Chamber (CCEE) since the reserve auctions are held through the discretion of the government. Therefore, the procurement costs under the reserve auctions are passed to both regulated and free consumers alike.

Brazil uses prequalification before the auction, which is under the responsibility of the energy research office (EPE) (Global Environment Facility, 2017). During this time, the bidders are required to submit a bid bond of at least 1% of the estimated investment cost. When a bidder won, it must present a completion bond of 5% of the estimated cost of the investment (Global Environment Facility, 2017). This is important to showcase the ability of bidders to pay for the development costs; therefore, the risk of undelivered projects is reduced.

The country uses the hybrid auction scheme which consists of a **descending-clock auction in phase 1** and a **pay-as-bid round in phase 2** which is exclusive to the winners in phase 1. Bidders need to meet certain criteria such as environmental license, a grid access approval issued by the system operator, and resource assessment measurements undertaken by an independent authority (IRENA, 2013). ANEEL and CCEE updated all documents generated during the auction in their respective websites that are accessible to the public to ensure transparency of the whole auction processes (Global Environment Facility, 2017).

In phase 1, auction is initiated with a high price (a pre-disclosed ceiling price) at which bidders would declare the quantity of electricity (in GWh/year) they are able to supply (Hochberg & Poudineh, 2018). While the initial high price intends to create a supply surplus, the auctioneer decreases the price until the desired supply level is reached, plus a certain margin to maintain competition in the next phase (Hochberg & Poudineh, 2018). **In phase 2, bidders are invited to submit their final price which cannot be higher than the price disclosed in phase 1.** The clearing price is determined when supply equals demand, and bidders below the clearing price are awarded contracts at their final bidding price (IRENA, 2013).

In addition, “total demand” and “demand parameter” are determined but kept disclosed to the bidders (Förster & Amazo, 2016). “Total demand” defines the maximum quantity of electricity to be contracted. “Demand parameter” mandates a minimum level of competition. For example, if the demand parameter is 1.5, it means the total quantity of bids must be at least 50% higher than total demand. In case of insufficient bidding quantity, total demand will be scaled down accordingly. Brazil allows losing bidders to participate in future auctions without having to resend all the necessary documents if no information has changed; thus, helping to reduce administrative costs for prospective developers (Global Environment Facility, 2017).

4.1.5. Enabling policies

A suite of policies has been put in place to support renewable energy development in Brazil. Before 2010, all renewable energy auctions were technology-specific which boosted the market development and increased price competitiveness of renewable energy technologies (e.g., wind-only auction in 2009, biomass-only auction in 2008, or the alternative energy-only auctions in 2007 and 2010). As wind has become a strong competitor in Brazil, concerns are raised that other renewable energy technologies such as solar may only have limited space to grow. For this reason, other supporting regulations have been introduced to foster the solar industry. For large scale solar PV, ANEEL suggested the government could carry out technology-specific auctions again (IRENA, 2013).

Renewable energy projects, if qualified, also have access to soft loans provided by the Brazilian Development Bank (BNDES). The concessional interest rate is 0.9% for solar projects which is extremely attractive especially when compared to other country's interest rate for solar projects. Furthermore, BNDES can loan up to 80% for project financing or the maximum debt to equity ratio (Bellini, 2018). This has contributed to the average loan rate in the country that reached 53.57% in April 2019 (IESR, 2019a). BNDES offers a long tenor -the longest contract term was granted for 20 years- with flexibility that will

enable developers to choose the rate that suits their financing structure (Andalaft, 2019; Bellini, 2017).

However, in order to get the loan from BNDES, **projects have to meet local content requirements (LCR)** by using the accredited equipment that has been produced/assembled locally. For instance, solar project developers could receive financing from 65%, if minimum LCR is met, to 80% of total project costs, if higher LCR is met. LCR is designed to gradually ramp up until 2020 after which a blanket 60% is applied to all modules (Förster & Amazo, 2016). It should be noted that LCR only ties to the eligibility for the BNDES loan, and is not a prerequisite for the auctions; thus, it does not exclude any bidders who do not meet LCR.

LCR is used to help build local manufacturing industries and attract foreign manufacturers to invest in Brazil. The country divides the development of local manufacturing industries into several stages and imposes LCR accordingly. This is known as Progressive Nationalization Program (PNP) which specified items required to be locally assembled or manufactured (IESR, 2019a). As a result, Brazilian government manages to foster the growth of domestic module manufacturing.

In terms of **land acquisition** for solar projects, there is no clear information on the ownership for solar projects. However, foreign companies have to follow Federal Law No 5.709/71, and its regulatory Decree No 74.965/74 regarding rural property ownership by foreigners (Daiuto & Lobo, n.d.). Therefore, it was an obstacle where international companies had to either establish local subsidiaries or cooperate with local companies. However, a new bill was approved at the end of 2020, which stated that foreign national or foreign companies can purchase or lease properties in rural areas as much as 25% of a municipality area and must serve a social function (Araujo, 2020). If passed, this bill could attract more investments for utility scale solar which will stimulate growth and energy access.

The **access to the grid** varies between states in Brazil. It is reported that 26.5% of the solar PV projects that have won the auctions are connected to the standard grid (≥ 230 kV) (Greener, 2020). In terms of permit, the government had mandated since 2013 that developers must have access to the grid and use the sale of electricity to cover the cost of investment for the grid connection (Global Environment Facility, 2017). Initially, the government assisted the transmission establishment of renewable projects by tendering for the infrastructures, but the lack of coordination has caused delays in implementations (Global Environment Facility, 2017). For solar projects auctioned prior to January 1st of 2016, the government still gives discounts on the transmission and distribution costs (IESR, 2019a).

Renewable energy projects benefit from federal taxes deferral and exemptions (valid through 2021). Goods eligible for these benefits include the imported equipment, machines and services used in the energy infrastructure projects. Considering that some renewable energy developments, especially solar PV, still imports a considerable amount of goods (IESR, 2019a), this tax policy can increase their price competitiveness by reducing the CAPEX (Capital Expenses).

With various incentives and support available for solar PV development in Brazil, the auctions have attracted many bidders. This will increase the risk of underbidding as bidders might incline to offer the cheapest price without considering their capability to deliver the project. To prevent underbidding, Brazil has established a bid bond requirement of at least 1% of the estimated investment cost and a completion bond of 5% of the estimated cost of the investment if the bid is won. This will at least demonstrate the financial capability of the bidder to deliver the project.

4.1.6. Institutional Framework

The auction process is administered by the National Electricity Regulatory Agency (ANEEL) under the guidelines of the Ministry of Mines and Energy (MME). The main auction tasks are carried out by a dedicated committee who defines the auction, suggests price caps, prepares the auction documents, and coordinates with transmission planning (Förster & Amazo, 2016). The committee members are distributed among different institutions: the MME, ANNEL, the Chamber for Commercialisation of Electrical Energy (CCEE), and the Energy Research Company (EPE) (IRENA, 2013).

It is apparent that the auction committee consists of a diverse representation of government agencies. This diversity ensures that all key government agencies are invited to the table for decision making, so that more comprehensive and effective actions can be taken. Besides diversity, clear and adequate allocation of responsibilities is equally important. It can be found that each agency is responsible for well-defined tasks matched with its functionality and level of bureaucracy. For example, CCEE manages detailed power pricing and settling while MME provides overarching guidelines for the auction process.

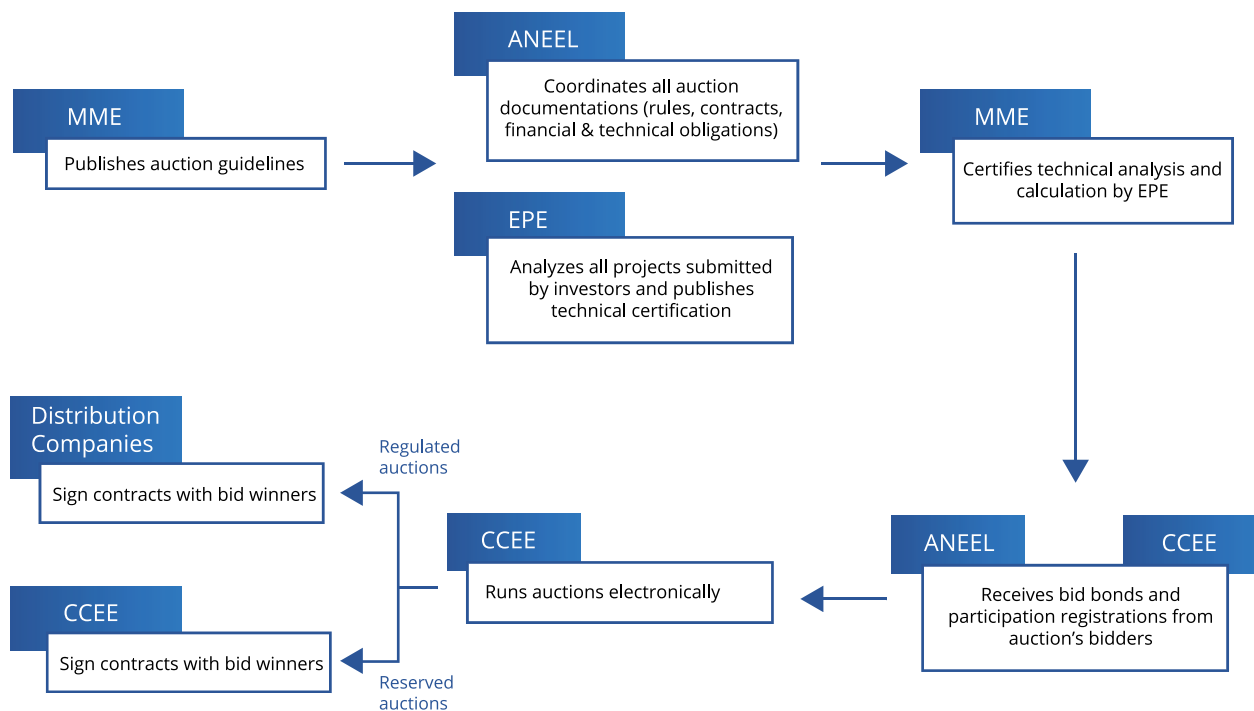


Figure 12. Brazil's institutional framework on solar auctions (Viana, 2019)

4.2. India

4.2.1. Historical narrative/background

In 2010, the government of India established Jawaharlal Nehru National Solar Mission (JNNSM), a national initiative to promote solar power in India, in order to establish India as a global leader in solar energy through the creation of policies for national deployment of solar power (IEA, 2018). At the beginning, the government committed to reach 20 GW of solar installation by 2022, which will be done through 3 phases (IEA, 2018).

This initiative was effective in triggering a rapid development of solar installations across the country. In addition to JNNSM, there are other supporting initiatives that further advance the solar deployment in India. The Ministry of New and Renewable Energy (MNRE) actively supported research institutions to conduct research and development on various aspects of solar technology to further drive down the cost of clean energy, besides conducting various public awareness campaigns and events (DST (Department of Science and Technology) India, 2021; Helioscp, 2012; Karan, 2019). The “Made in India” initiative promoting domestic manufacturing also contributed to the increasing solar installation capacity (Kumar, 2019). After the establishment of JNNSM, the installation had grown past 1 GW in less than five years, a significant increase from 65 MW in 2010 (IRENA, 2020).

In 2015, given the rapid development of renewable energy installations, India revised its target of increasing renewable energy capacity to 175 GW by 2022, in which 100 GW would be sourced from solar (Goel, 2016, Kashyap et al., 2020). The solar target is further divided into 60 GW for utility scale and 40 GW for rooftop.

4.2.2. Current status/achievements in adopting solar PV

India is one of the most advanced countries in terms of renewable energy development. By January 2021, India has reached more than 92 GWp of renewable energy installation, of which **38.8 GWp** comes from **solar energy**. India has given maximum importance to solar energy. In addition, India runs domestic solar industries that are growing to keep up with the country's target (Goel, 2016). India sees solar energy as economical, scalable, and relatively less dependent on location (WBCSD, 2018).

India's installed solar PV capacity, 2015–2019
(Estimated in MW)

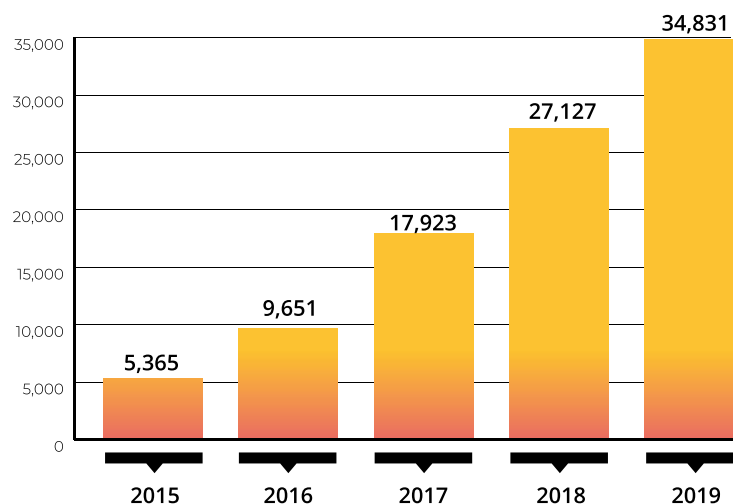


Figure 13. India's installed solar capacity, 2015–2019 (Source: IESR Analysis).

The country's commitment to solar power is showcased through the adoption options, which are utility-scale solar and rooftop solar (Srivastava & Giri, 2015). As of January 2021, the installed capacity for utility scale solar stood at 34.6 GWp (MNRE, 2021). Majority of the solar projects are located in Rajasthan, Jammu & Kashmir, Maharashtra, and Madhya Pradesh (Kashyap et al., 2020). Understandably, these areas receive the most sun exposure among the states in India, and are committed to develop solar power.

India does not establish a uniform regulation on how to procure solar energy; the country only published competitive bidding guidelines for renewable power generation (Kumar. J & Majid, 2020). However, auction becomes a major policy for solar procurement in many states to meet the installation target and keep the price low (CPI et al., 2015; IESR, 2019a). Each auction is announced through the official website and mass media (SECI, n.d.).

Through auction, India had broken many records for the cheapest procurement for solar. The most recent was in December 2020, when 500 MW PV capacity was granted at a price of 2.69 cents per kWh for utility-scale installation in Gujarat (Scully, 2020). The price trend for solar has rapidly declined since the announcement of JNNSM in 2010, when the record of lowest solar bid was at US\$0.16/kWh (IESR, 2019a).

Solar auctions in India often become oversubscribed. The bidders -including the winners- come from both local and international solar companies. The 500 MW project in Gujarat, for instance, received at least 11 bids which showed positive response from solar developers (Rakesh Ranjan, 2021). The project was won by NTPC Limited for 200 MW, Torrent Power Limited for 100 MW, Aditya Renewables for 120 MW, and Al Jomaih Energy and Water Company Limited for 80 MW (Rakesh Ranjan, 2020). The last company is a Saudi Arabia-based company.

India's average solar bids, 2016–2020

in US¢/kWh

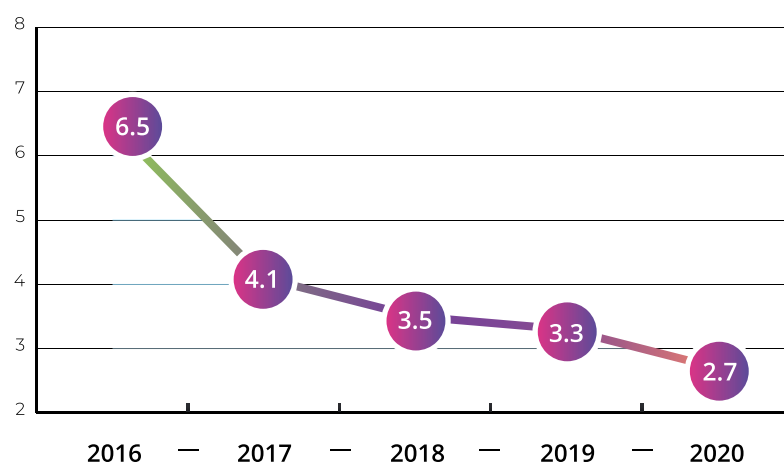


Figure 14. India's solar bids, 2016–2020 (Source: Mercom India, 2020).

4.2.3. Primary drivers & auction objectives

The rapid development of solar energy in India is triggered by several drivers, which are also the drivers of renewables in India. The first driver is the heavy reliance on fossil fuels. Within a period of 5 years (2013-2018), India had imported 794 million tons of coal to generate electricity from coal-fired power plants (Kumar. J & Majid, 2020). The country has realised that building and operating solar farms are cheaper than continuing the operation of existing coal-fired power plants (Karan, 2019).

The second driver -related to the first driver- is the realisation of the country's potential in renewable energy, especially solar and wind power. India has a potential of 748 GW solar and 100 GW wind that can be utilised to generate power for the whole country (MNRE, 2020, Memon et al, 2019).

The third driver is the increasing need to meet the high growth rate of total energy demand, including rural electrification (Memon et al, 2019). As the country is still growing in terms of population and economy, the power consumption will inevitably rise. Therefore, adopting renewable energy will be beneficial in balancing the growth and sustainability of the environment.

The fourth driver is related to the commitment India has on climate change mitigation and adaptation as reflected in the National Action Plan on Climate Change (NAPCC) 2008. NAPCC outlines the steps for India to advance their development and climate change-related objectives, and establishes JNNSM as one of the national missions to focus on (Pandve, 2009). Renewable energy benefits the environment; thus, could drive India to meet the carbon emission reduction targets (Karan, 2019).

There are several reasons why India chooses to conduct auctions for solar PV: it promotes competitive procurement of electricity to protect consumer interests, facilitates transparency and fairness in the procurement process, provides a framework for inter and intra state sale-purchase of long term power, provides standardisation and uniformity in processes and a risk-sharing framework between shareholders to encourage investments, as well as enhance bankability and profitability of the projects (Ministry of Power, 2017).

4.2.4. Auction design

Through the JNNSM, India established a **systematic auction** scheme divided in three phases, which are phase I: 2010-2013, phase II: 2013-2017, and phase III: 2017-2022 (Goel, 2016; IRENA, 2015). These phases, which were announced at the beginning of the establishment of JNNSM, have encouraged solar project developers and investors to participate and prepare for the future projects. In phase I, JNNSM aimed to build 1000-2000 MW grid-connected solar power with 1000 MW contracted through a centralised auction (Azuela et al., 2014). During phase II, the government of India encouraged a decentralised initiative of the states to conduct their own solar power auction schemes (MNRE, 2012). The government also introduced a notable institution known as Solar Energy Corporation of India (SECI) to assist with the nation's solar development (Azuela et al., 2014). SECI is a company of the MNRE designated to facilitate the implementation of national solar -and now extended to other renewable energy- in India. SECI's responsibility includes auctioning projects in every phase.

In each phase, auction demand is split into different project sizes and locations. SECI will announce the request for proposal in several batches with specific criteria, eligibility, and instructions for bidders (SECI, 2013). The announcements along with other information are available online- primarily on SECI's web page- making it easier for developers to access. SECI also announced the auctions through the offline media. This has increased the transparency of the auction process while also reduced the transaction costs as auctions are centralised through the internet.

Each bid will be designed in terms of a package, with either tariff or VGF (Viability Gap Fund, with predetermined tariff) as a bidding parameter (Ministry of Power, 2017). The PPA period should be no less than 25 years from the scheduled commissioning date (Ministry of Power, 2017). The announcement is not limited to the national project auctions, but also includes the state-level project auctions. In case of solar parks, developers are able to identify the potential location already listed in the guidelines for solar parks released by the MNRE in 2015. However, there is a possibility of solar projects to be location-neutral if the developers wish to conduct their own site selection (IESR, 2019a).

Both local and international bidders are allowed to participate in the auction. Alternatively, local and international companies could build a consortium if it is deemed necessary. Local companies can also be backed up by foreign investors. This is possible because the government of India allows Indian companies to issue shares up to 100% of their capital to foreign investors to develop renewable energy (FDI India, 2021). By allowing local and international bidders to participate in auctions, the Indian government increases competition that can drive prices down. Each auction's winner(s) will be selected based on the technical and price aspects offered in the tender period. However, there is no special pre-qualification round to ensure participation of competitive bidders. If the technical bids have met the eligibility criteria, then they can be considered further for the evaluation of price bids (Ministry of Power, 2017).

An example from Rewa auction (ESMAP & World Bank IFC, 2019) shows that after bidders submitted their price and technical criteria in stage I of the auction, the auctioneer will eliminate the highest bids to identify eligible bidders and the best quote. Then, in Stage II, those eligible bidders will participate in bidding quotes to beat the best quote of each unit until no further bids are submitted. At the end of each auction, the selected bidder(s) will be identified. Through the auction practices, India has seen more than 86% decline in solar tariff from 2010 (IESR, 2019a). The auctions have also resulted in many competitive and record-breaking tariffs among the states and even globally (Chandrasekaran, 2020).

However, it should be noted that the initial auctions had caused underbidding problems as many developers were eager to win the bid; thus, they offered extremely low prices that were too cheap to be delivered. As a result of these underbidding, many solar projects ended up becoming default. Therefore, to solve this issue, the government of India established a financial requirement in which the developers have to submit a bid security or Earnest Money Deposit (EMD). EMD is a bank guarantee or a Payment on Order instrument that is no more than 2 percent of the estimated capital cost of the solar PV power project cost (Ayush Verma, 2020). If the developer failed to execute the solar project, the deposit will be forfeited.

Besides the national guidelines, each state in India has the right to design its own procurement policies. This paper takes the examples of the policies in Rajasthan that specifically uses auction for utility-scale solar installation. The state of Rajasthan has conducted several solar park auctions. In MNRE guidelines for solar parks, the state committed to use their listed locations to develop a total of 3,180 MW of solar capacity (MNRE, 2015). In addition to the list, through Rajasthan Renewable Energy Corporation Limited (RRECL), the government also provides a list of locations where the low rental land is available for setting up solar projects (IESR, 2019a). The auction process is similar to the national level auction in which the government will submit a price and technical offer. Additionally, the participating bidders must meet the financial criteria and deposit 20% of bid security required by the government in order to demonstrate their financial capacity to develop the project (RAJASTHAN SOLARPARK DEVELOPMENT COMPANY LIMITED, 2019). This is also important to avoid project default when the bid price is too low and developers cannot fund the project.

Bhadla solar park in Rajasthan is divided into four phases of development (SECI, 2017). Of the total capacity, the state government itself will develop 745 MW, a joint venture company and Rajasthan government will develop 1000 MW, and another joint venture company and Rajasthan government will develop 500 MW (IEEFA, 2020). In 2017, two auctions for 750 MW capacity in Bhadla Park were announced. Around 250 MW capacity was secured at US\$0.041/kWh, the lowest price for solar auction in that year (IEEFA, 2020). Just two days later, another 200 MW capacity was secured at US\$0.038/kWh, which set an unrivalled price for solar park development in India and was even breaking the world record of lowest solar bid for quite some time (IEEFA, 2020; Prabhu, 2017). The following auctions for Bhadla Park also resulted in a low tariff offered by bidders while increasing the installations of solar capacity in the park. As of late 2020, Bhadla solar park holds the world's record as the largest solar park with a capacity of 2,245 MW (Sanjay, 2020; Todorovic, 2020).

4.2.5. Enabling policies

There are some specific regulations that are established by the government of India to foster the development of solar energy. In addition to the national regulations, each state can formulate policies it deems appropriate to accelerate solar installation in its region. In this section, policies related to land acquisition, access permits into grids, local content requirements and incentives that support the advancement of solar development will be discussed.

India pays attention to **land acquisition** as they plan to build several large-scale solar installations. When announcing the plan to develop solar parks, MNRE received consent from the states to list potential locations in their respective states, which was then included in the solar park development guidelines (MNRE, 2015). In some states, the local government also provided the additional lists of land locations for the solar park that are unproductive and non-agricultural land (IESR, 2019a). However, this does not mean that the land is already available for the development of solar parks. The proposed lands might be owned by the local government or the private sector. On the earlier version of solar park guidelines, the national government required state governments to keep the price of land for solar park development as low as possible, while the solar park developer is responsible to acquire the land, which includes obtaining the land-related clearances and providing roads and basic drainage (MNRE, 2015).

The government recognised that land acquisition is a significant element to build solar parks. Therefore, the government provides funds through SECI to assist companies in acquiring lands (IESR, 2019a). Recently, the government has released a modification for land acquisition and power evacuation infrastructure of the solar park guidelines. Based on the modification, SECI will be assisted by the state government in making both government and private lands available for solar park development. In return, the project developer will pay a facilitation charge of Rs 0.02/unit of power generated from the solar park, in addition to any land cost (MNRE, 2019). This facilitation charge will be included by SECI in the auction for solar parks (MNRE, 2019).

The ease of obtaining **permits for grid access** also plays a significant role in the installation distribution across the country. Utility-scale solar installations are subject to open access charges and regulation imposed by the state government. Therefore, the installation of utility-scale solar power generation is significantly high only in states with favourable charges and regulations (WBCSD, 2018). The ease to access the grid lowers the costs for developers to connect with the grid; thus, attracting them to work on the project. States like Rajasthan, Karnataka, and Andhra Pradesh that had granted open grid access benefits to renewable projects are the states with numerous utility-scale solar projects (JMK Research, 2019).

The government of India also provides support for the domestic solar industry development. In order to protect the domestic solar PV modules industry, the government initially attempted to impose **Local Content Requirements** (LCRs) and import duty for solar projects (Azuela et al., 2014; IESR, 2019a). These regulations were the result of the import market dominance by Chinese modules for more than half of the solar projects in India (IESR, 2019a). However, official complaints from the World Trade Organization (WTO) against the LCR had forced the Indian government to limit the requirement (Azuela et al., 2014). Therefore, the Indian government decided to divide the auctions for solar projects into two categories where the first category is limited to only the suppliers with domestic content, while the second category is open for all participants (Azuela et al., 2014). This LCR resulted in a ~6% per kWh increase in the cost of solar power generated from those projects (Probst et al., 2020).

Furthermore, it has been found that the effectiveness of the domestic content requirement and import duty is questionable. There is evidence of a short-term increase in India's solar PV modules manufacturing capacity but not enough to increase its market share, let alone the export market (Probst et al., 2020). The price of modules produced domestically was relatively high compared to the imported ones; cheapest local modules could cost US\$0.25 to US\$0.27 per piece, which is about the same as the price of import modules after tax (Chandrasekaran, 2020). These modules are currently not competitive as their lifetime and performance have not been proven, which would require utilisation in large-scale projects and for a significant amount of time (Probst et al., 2020).

Solar development projects require a large amount of financing. India's government allows for a 15% to 30% equity and 70%-85% debt for every project (first green, 2020). This debt financing will require collateral unless it is taken by large companies with proven track records and large solar installations (first green, 2020). In addition, both private and public banks set an interest rate of 9.55%-10.75% for all renewable energy projects (IESR, 2019a). Meanwhile, the tenure of the debt is only available for a period up to eight years (ADB Institute, 2018). This has discouraged private entities to take up infrastructure projects including solar energy projects. Therefore, the government provides institutions and mechanisms as alternative funding sources such as National Clean Energy and Environment Fund (NCEEF), and soft loans from Indian Renewable Energy Development Agency (IREDA) (ADB Institute, 2018).

The government of India also provides incentives as it realises that the return on investment for public infrastructure might take a long time while the developer has to bear all costs. One most notable incentive is **Viability Gap Funding** (VGF), which is a financial assistance from the Ministry of Finance implemented since 2006 to support viability gaps up to 20% of the cost of an infrastructure project (Ministry of Finance, 2005). The state government or its agencies that own the project are allowed to provide additional grants out of their budget, but should not exceed further 20% of the total costs (GIDB, 2020). The government requires the project to be implemented by a private company selected through a competitive public bidding (Ministry of Finance, 2005).

India also provides several **tax incentives** such as a limit of 5% for component's goods and services tax, exemption of excise duty payments for some imported components, and partial or basic custom duty waivers for selected components that have to be obtained from abroad (IESR, 2019a). Besides the fiscal incentives, the government of India also established non-fiscal incentives in the form of **Renewable Purchase Obligation** (RPO) for all states. Through the RPO, the government requires all large energy consumers to ensure a certain percentage of the energy mix comes from renewable sources (IESR, 2019a). Since 2016, the country has increased RPO for solar annually; it was 2.75% in 2016-2017, and 8.75% in 2020-2021 (Ministry of Power, 2019).

4.2.6. Institutional framework

The auctions for solar power in India is mainly conducted by SECI with provision from MNRE. State nodal agencies have been mandated by the MNRE to further expand the growth of efficient energy use of renewable energy in respective states. The state nodal agencies can also develop their solar development through coordination with SECI.

SECI is responsible for collecting demands and auctioning them; thus, it acts as a facilitator of solar development in India. It publishes every progress of solar auctions on its web starting from the announcement of solar tender through the announcement of bid winners. The winners will make PPA with the NVVN (NTPC Vidyut Vyapar Nigam) at the national level or with each state's Urja Vikas Nigam (UVN). However, in cases where SECI is the entity that filed a petition to discover the tariff, CERC (Central Electricity Regulatory Commission) will be in charge of approving the petition at the national level, whereas SERC (State Electricity Regulatory Commission) will be in charge at the state level.

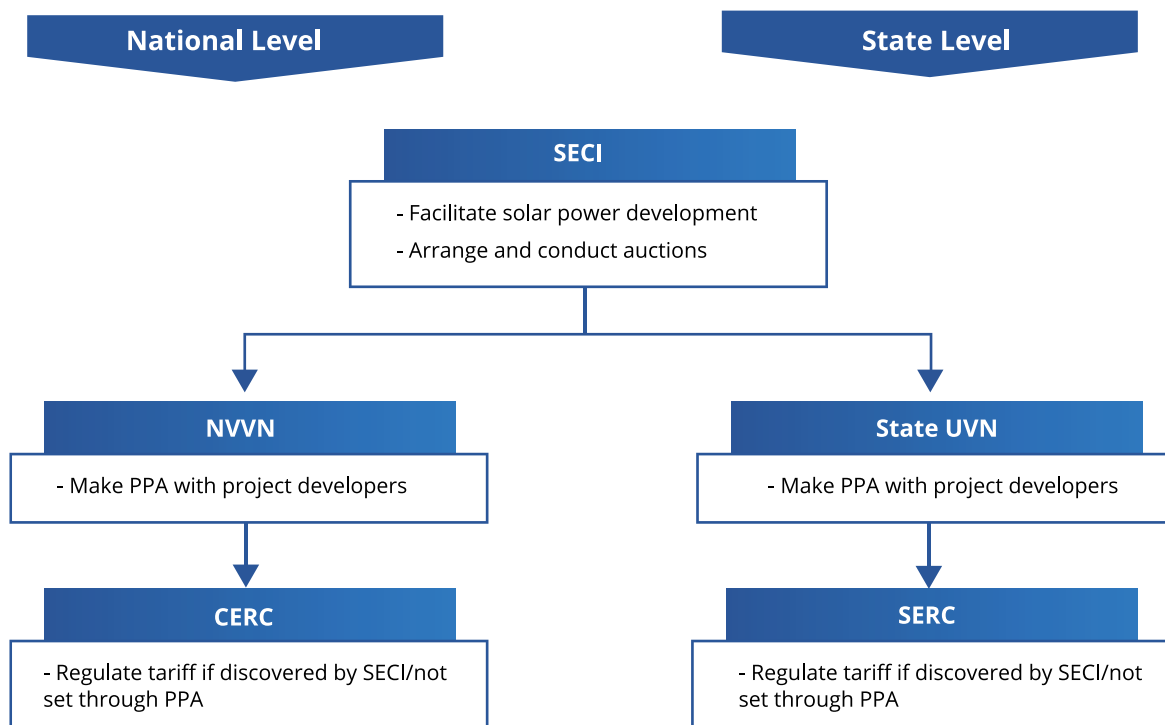


Figure 15. India's institutional framework for solar auctions (source: IESR analysis)

4.3. The United Arab Emirates (UAE)

4.3.1. Historical narrative/background

In 2012, the Emirates announced the launch of the Mohammed bin Rashid Al Maktoum Solar Park (MBR Solar Park) in Dubai, the largest single-site solar energy project in the world with a total planned capacity of 5 GW by 2030 and a total investment of AED 50 billion (US\$13.6 billion) (DEWA, 2019). The MBR Solar Park was initiated as a part of Dubai Clean Energy Strategy 2050 that aims to diversify the energy mix away from fossil fuel (i.e. natural gas) to 75% clean energy by 2050 (Government of UAE, 2019). More specifically, the strategy aims to reduce the dependence on natural gas for electric power generation to 61% by 2030 (from almost 100% now) and increase clean energy mix from solar energy (25%), nuclear power (7%), and clean coal (7%) by the same year.

At federal-level, the Emirates also launched the UAE Energy Strategy 2050 in 2017 (Government of UAE, 2020). The federal strategy aims to increase the contribution of clean energy in the total energy mix from 25% to 50% by 2050, of which 44% is from renewable energy and the other 6% from nuclear energy, reduce carbon emissions from the power generation sector by 70% by 2050, and improve energy efficiency by 40% by the middle of the century, compared to the baseline year of 2013 (Gulf News, 2017; UAE's Ministry of Energy and Infrastructure, 2019). Although the target for solar energy is not defined in the federal strategy, solar energy is chosen as its primary choice to develop because of the country's abundant solar resource with an average potential of 2,150 kWh/m²/y (or 5.8 peak sun hours per day) (DEWA, 2019).

4.3.2. Current status

Although the country's energy mix is still predominantly supplied by natural gas (88%) and oil (8%), the growth of solar PV has started to take off since 2014 (IEA, 2020a). As of 2020, the UAE's solar power installed capacity reached 1.88 GW, of which 100 MW was concentrated solar power (CSP). The remaining installed capacity are solar PV plants from the MBR solar park which has reached its commercial operation up to its third phase (partially) with a total of 413 MW, and the 1.17 GW Sweihan solar farm in Abu Dhabi which came online in 2019. The 1.17 GW Sweihan project was auctioned in 2016 and recorded a PPA price of 2.42 US\$/kWh in 2017, a world record at the time (pv magazine, 2017).

UAE's installed solar PV capacity, 2015–2019
(Estimated in MW)

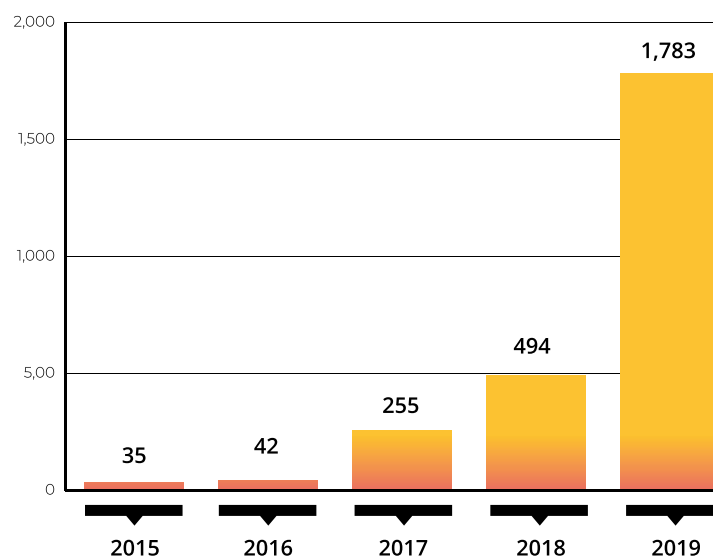


Figure 16. The UAE's installed solar capacity, 2015–2019 (Source: IRENA, 2020).

The UAE may not have many solar projects in their portfolio except the five-phase MBR solar park in Dubai and two other gigawatts-scale solar projects (i.e., 1.17 GW Sweihan and 1.5 GW Al Dhafra solar projects) in Abu Dhabi. However, the UAE is home to many of the world's record low bids in solar auctions. In 2015, the country set the then-record-low solar price at 5.98 US¢/kWh from the 200 MW MBR solar park (Phase II) auction and proceeded to halve that record (2.99 US¢/kWh) in 2016 with the 800 MW MBR solar park (Phase III) auction (CleanTechnica, 2020; pv magazine, 2017). In 2020, the country yet again set another world's lowest bid of 1.35 US¢/kWh in a 1.5 GW solar project in Al Dhafra, Abu Dhabi, although it was immediately overtaken by Portugal's second solar auction in August 2020 which recorded the current record low bid of 1.3 US¢/kWh (pv magazine, 2020; Taiyang News, 2020). The auction at Al Dhafra reportedly has received at least 48 expressions of interest from both domestic and international parties (pv magazine, 2019). **Figure 17** summarises the winning bid prices in the UAE's solar auctions from 2015 to 2020. Through auctions, the UAE has seen a 77.4% decline in solar auction prices since 2015 (from 5.98 ¢/kWh in 2015 to 1.35 ¢/kWh in 2020).

Winning bid prices in UAE's solar auctions, 2015–2020

Bid price, US ¢ /kWh

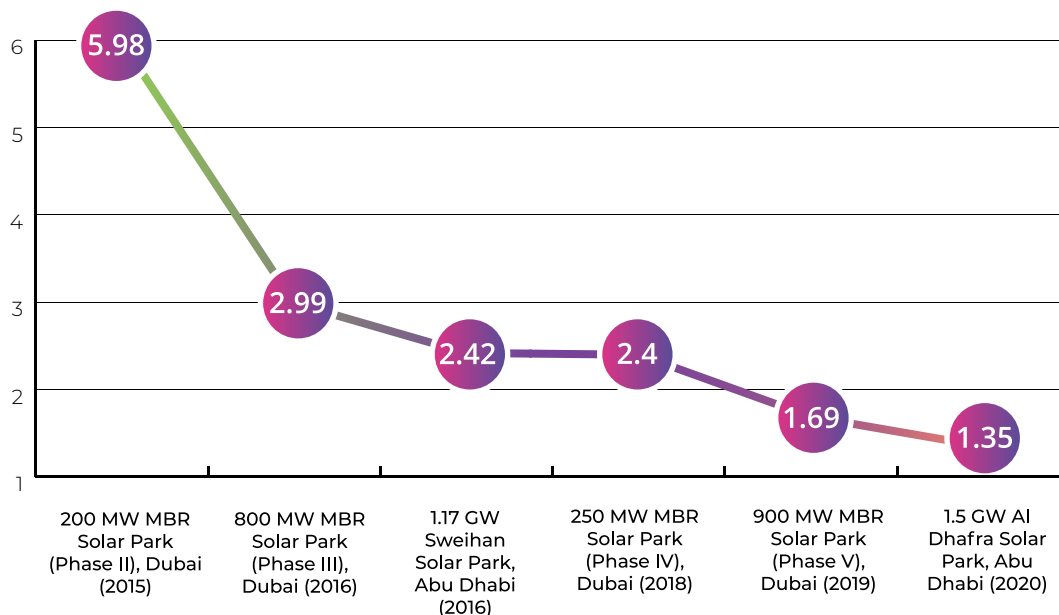


Figure 17. Historical winning bid prices in UAE's solar auctions (Source: DEWA, 2019; pv magazine, 2017, 2020)

4.3.3. Primary driver & auction objectives

The primary driver for solar energy development in the UAE is related to the push toward economic diversification to avoid commodity downturns associated with a fossil fuel-based economy in the future. Not only that, it is also coupled with the UAE's international commitment on climate change, where the UAE has recently submitted their second Nationally Determined Contribution (NDC) in 2020 to reduce carbon emissions by 23.5% compared to business as usual for the year 2030 (Emirates News Agency, 2020).

The two main drivers are further reflected in the country's federal strategy, UAE Energy Strategy 2050, which was launched in 2017. As a country with one of the highest solar exposure in the world, the UAE has prioritised solar energy as one of its main strategies for clean energy development, although the target for solar energy is not specified in the federal strategy. In the emirate-level, Dubai also sets the target to increase clean energy mix for electricity power generation—25% by 2030 and 75% by 2050—mainly from solar energy, followed by nuclear power and clean coal by 2030 (Government of UAE, 2019).

The auction objective conducted by the Emirates follows both its national and emirate-level strategies that is to adopt solar energy (including both PV and CSP) at the cheapest price possible. The UAE's solar auctions follow that of the solar park auction scheme explained in Section 2.4, where the project's location has typically been predetermined.

4.3.4. Auction design

The UAE has only auctioned three major solar projects to date, all of which are solar park auctions. This includes the five-phase MBR Solar Park in Dubai and two gigawatt-scale solar parks in Abu Dhabi (1.17 GW Sweihan and 1.5 GW Al Dhafra solar projects). Both solar projects in Dubai and Abu Dhabi are auctioned by their respective state utility companies, i.e., Dubai Electricity and Water Authority (DEWA) and Abu Dhabi Water and Electricity (ADWEA), which are also the off-taker for the auctioned power generation.

With regard to the auction demand, the strength of solar auctions conducted by the UAE boils down to two important things: 1) the announcement of a long-term procurement plan, specifically for Dubai 5 GW MBR solar park, which indicates auctions' periodicity (scheduling), and 2) large-scale (gigawatt-scale) project-specific auction with predetermined sites and ensured grid access, which significantly reduces risks and costs for developers (IRENA, 2017). The systematic auction conducted in the five-phase MBR Solar Park auction also ensured that there is a learning curve for both the auctioneer and the bidders, especially in the first rounds of the auction (see **Table 2** for more details on the MBR Solar Park).

Table 2. Mohammed bin Rashid Al Maktoum Solar Park (DEWA, 2019)

Phase	Capacity	PPA Price	Status
Phase I	13 MW PV	N/A	Commissioned (Oct 2013)
Phase II	200 MW PV	US\$5.98/kWh	Commissioned (April 2017)
Phase III	800 MW PV	US\$2.99/kWh	
	Stage 1: 200 MW		Commissioned (May 2018)
	Stage 2: 200 MW		Under construction
	Stage 3: 300 MW		Under construction
Phase IV	700 MW CSP + 250 MW PV		Q2 2022 (Expected commissioning)
	Stage 1: 600 MW CSP	US\$7.3/kWh	
	Stage 2: 100 MW CSP		
	Stage 3: 250 MW PV		
		US\$2.4/kWh	
Phase V	900 MW PV	US\$1.69/kWh	2021 (Expected commissioning)

Qualification criteria in the UAE's solar auctions are very stringent, limiting the participation to only experienced and big players in the solar power industry. Typical pre-qualifications include detailed technical (project experience) and financial strength, mainly to avoid underbidding (Kruger et al., 2018). For instance, in Dubai's MBR solar park Phase III auction, only 14 out of the 97 parties that submitted an expression of interest (EOI) were pre-qualified and invited to submit bids, and only 5 consortia eventually submitted their final proposals (IRENA, 2017). In addition, information on the auction was somehow restricted, which further limited participation of interested developers and created an artificial barrier to entry. This type of qualification criteria might make sense for the UAE's gigawatt-scale solar auctions, as the objectives are to get both the cheapest electricity price while ensuring project completion (and quality) at the same time. In addition, to ensure bidder's compliance and project realisation, bidders must agree to a bid bond with at least 10% of the project's value (Kruger et al., 2018).

In terms of the winner selection criteria, the UAE's solar auctions adopt a minimum-price criteria (least cost), followed by pay-as-bid mechanism, meaning the PPA will be awarded to the lowest bid price offered (IRENA, 2017). Moreover, there is no upper limit on the project size for bidders, meaning all 800 MW (MBR Phase III) or 1.17 GW (Sweihan project) can be won by a single bidder (or consortia). This also means that significant economies of scale can come into play. This applies to all three of the UAE's major solar auctions.

Lastly, relating to the liabilities and risks, project's co-ownership with government-owned utilities (51% to 60% of equity) greatly reduces bidders' risk from the cost of financing perspective. Partnering with a state utility also makes perfect partnership sense, as it provides noteworthy safety against bureaucratic risk that could emerge (IRENA, 2017). Not only that, this type of arrangement also allows for a very attractive financing as the state-owned utilities have a high credit rating (AA with stable outlook by Standard & Poor), further enhancing investor's confidence (IRENA, 2017).

4.3.5. Enabling policies

The main policy enablers for the UAE's highly competitive price outcomes can be attributed to the **ambitious national energy policy planning**, **government-supported land provision** and **ensured grid access**, **shared project ownership**, and **access to finance** (IRENA, 2017). As mentioned, the UAE has set an ambitious target to increase the share of clean energy by 25% to 50% by 2050, of which renewable energy is targeted to represent 44% of the clean energy mix. While the target for solar energy is not defined in the national strategy, the strategy helps set the context for solar energy development as it also aims to reduce carbon emissions in the power sector.

That said, energy policy targets alone are usually not enough to ensure the realisation of the target. In the UAE's case, this is further supported by a **strong government support** for solar projects development, specifically for **land provision** (and permitting) and ensuring grid access. All of the UAE's solar auctions are site-specific and predetermined by the government for free, thereby reducing the development cost associated with land acquisition (IESR, 2019a). Furthermore, the government (through the state-owned utility) also ensures **grid access** that lowers payment risk as there is an off-take guarantee by the government; thus, making the project even more bankable.

Aside from government support for project development, **project ownership structure** plays a big role in keeping the cost of capital low and boosting investor confidence (IRENA, 2017). The UAE prefers a public-private partnership (PPP) structure where government-owned utilities own the majority share of the project equity (51-60%). This type of ownership also allows the project to receive **very attractive**

financing terms, as in low interest rates (2.6-3.6%) over a long tenor (over 20 years), as the **country has a high credit rating** (AA with a stable outlook by Standard & Poor) (Deloitte & ISRA, 2019; IRENA, 2017). Additionally, this attractive financing, which has been made possible by the lower country risk, also allows the project to use a higher leverage (as in higher debt share) from 70% (D/E ratio = 70:30) up to 86% (D/E ratio = 86:14), as seen in Dubai's MBR solar park Phase II (IESR, 2019a).

4.3.6. Institutional framework

In the UAE, the electricity sector is controlled by each emirate rather than the central federal. In Abu Dhabi, the Department of Energy of Abu Dhabi (DOE-AD), previously known as Abu Dhabi Water and Electricity (ADWEA), is responsible for both the electricity and water sector, while in Dubai, Dubai Electricity and Water Authority (DEWA) is responsible for both. The DOE-AD accounts for 53% of the Emirates' total capacity, followed by DEWA with 29% (IAEA, 2019).

Solar auctions in both Dubai and Abu Dhabi are handled by their regulatory and implementing bodies, as presented in **Figure 18**. In both cases, there is a policy & regulatory body at the top, namely Dubai Supreme Council of Energy (DSCE) and Abu Dhabi Department of Energy (previously Abu Dhabi Water and Electricity Authority, ADWEA), respectively. These policy and regulatory bodies plan and develop their respective energy planning for the emirate and coordinate with the related executive/implementing authorities, such as the Regulatory & Supervisory Bureau (RSB) and the state utility of both Dubai and Abu Dhabi.

State utilities, such as DEWA and Abu Dhabi Water and Electricity Company (now Emirates Water and Electricity Company, EWEC) act as both the procurer (auctioneer) and off-taker of the solar auction, where they also hold the majority of the project's share (51-60%).

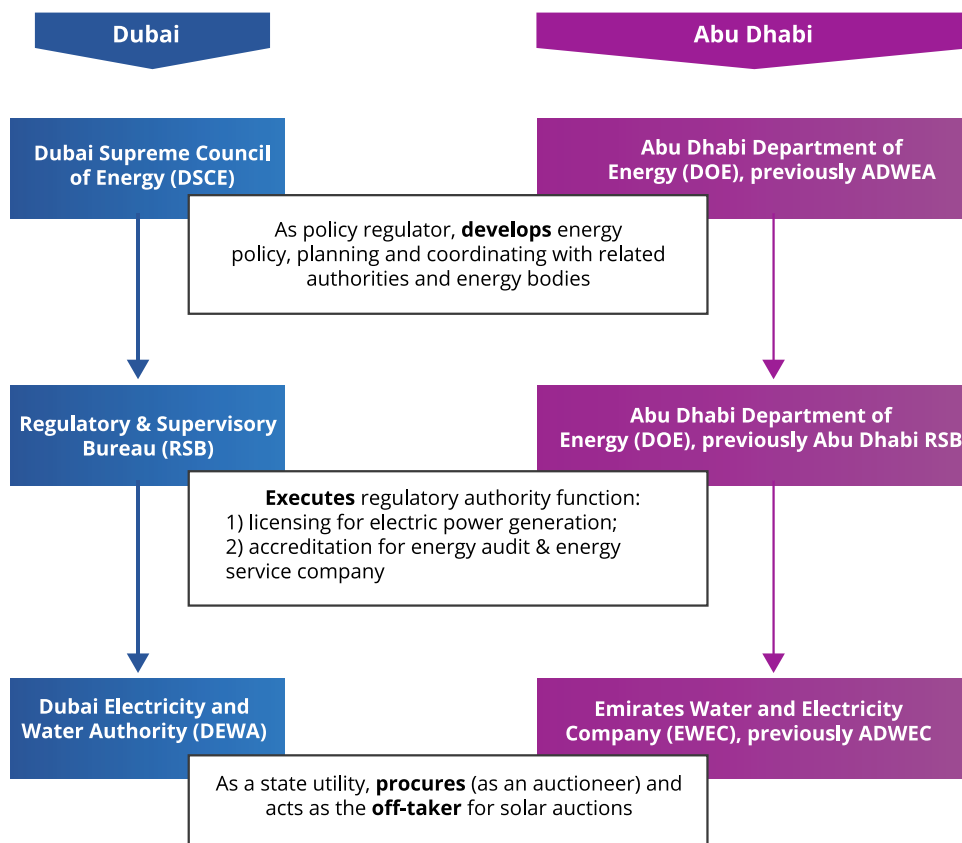


Figure 18. Institutional framework on Dubai and Abu Dhabi's solar auctions (IAEA, 2019; United Nations, 2018).



5 Lessons Learned from Country Case Studies

Although the solar auction process varies in the aforementioned countries, there are common aspects of auction design that can be extracted and used as insights to design an auction that can help reveal the most competitive prices of solar PV projects.

1. Strong government commitment and leadership, shown through but not limited to concrete plans in the power system planning and setting up regular auctions, are prerequisite to create a competitive utility-scale solar developments

It is clear from the case studies that private sector participation is imperative to accelerate the deployment of solar energy and this participation requires the government to send positive and affirmative signals to the market. When there is increased participation, there will be competition that can drive prices down. Therefore, the government can take several actions to attract a large number of bidders that can turn into increased competition, namely establishing national programs, aggregating demand to create large-scale projects, and conducting regular auctions.

A national solar program often highlights a country's solar energy development goals and outlines a phased procurement plan. More importantly, it shows the government's support and commitment. A national solar program allows developers and investors to see certainties in the market which gives them confidence to participate in solar projects. The national solar energy program can detail the sizes, locations, and schedule for auctions. Furthermore, the national program will be able to realise a number of solar projects, and with certain project size reach economies of scale that drives the cost of installation down.

India's JNNSM showcases the effectiveness of having a national solar program that sends signals to solar developers to participate in solar power generation in the country while also keeping the prices low. Similarly, in 2017, the government of UAE adopted MBR Solar Park in Dubai into the UAE Energy Strategy 2050 (Bayut, n.d.). By making it a national strategic project, the UAE demonstrates a very strong government commitment at strategy and project implementation, not only locally but also at the national level.

In the case of Indonesia, although the country has already expressed a renewable energy target in the National Energy Policy (KEN), and specific target for solar PV (6.5 GW by 2025) in the National Energy General Plan (RUEN), there has not been a concrete procurement plan to achieve that target, as explained in Section 3.2.4. The absence of a planned execution to realise the target could then support the argument that there is a need for a specific national solar energy program that could trigger further installations of solar.

Currently, there is a national initiative called "Gerakan Nasional Sejuta Surya Atap" (GNSSA) in Indonesia. Its purpose is to push the installation of one million solar panels on rooftops across Indonesia, which eventually contributes to the fulfillment of the 23% RE target by 2025 (Gerakan Nasional Sejuta Surya Atap, 2021). This initiative was established in 2017 by various stakeholders and supported by government agencies namely the MEMR and the Ministry of Industry (MoI). However, it should be highlighted that GNSSA is not an official program supported by legislation or regulation. GNSSA initiative demonstrates that it is possible to establish a national solar energy program that includes large scale solar projects.

PLN should also be involved in the formulation of the national solar program as it is the only off-taker and the one who owns the majority of solar projects in the country. Therefore, it is already familiar with the whole procurement process. It is also responsible for the distribution of electricity; thus, if the government wants to ensure grid connectivity of the solar projects, PLN cannot be left behind in the planning process.

Demand aggregation contributes to the creation of large-scale solar projects in a country. Thus, identification of the potentials for solar installation and the needs of certain areas are important to understand and gather the demands (Solargis, n.d.). In order to do so, the involvement of local government and utility companies are instrumental as they have more knowledge regarding the local solar potential and electricity demand. Once demand has been aggregated, the government can plan on how to conduct an auction for each project which includes the installation of new transmission and connection from the project site to the demand center.

In India, the government has auctioned many solar parks over the last 10 years, which are 500 MW and above. The minimum size of the package is 50 MW to reach economies of scale (Ministry of Power, 2017). This has attracted many bidders to participate, both from national and international companies. They are able to offer low prices -even breaking the world record of cheapest solar tariff- due to the lower transaction costs resulting from economies of scale. Similarly, the UAE auctioned large sizes of solar projects in both Dubai and Abu Dhabi, which also enabled the project to reach economies of scale. The MBR solar park has seen large size - at least 100 MW, starting from phase 2- installations are auctioned as one project in each phase.

The government can choose to auction the whole project like the case in the UAE or it can split the project into several auctions similar to India's case. Regardless of the auction preference after the demand is aggregated, the government would need to establish a standard auction process that all stakeholders can follow. At the same time, it is crucial for the government to ensure diversification of bidders. The variations of bidders that participate in the auctions--including their bid volume and their country origin- can prevent collusion among bidders that might increase the price.

Although the establishment of the national solar program will showcase the nation's commitment and push the local government to execute the program, insufficient information could hinder the creation of a proper national solar program. For example, the information regarding the potential location and capacity of each province to develop solar projects are known by provincial governments. Therefore, they need to be involved in the identification process for the national solar program to ensure demand is aggregated across the country. Similarly, since PLN already has its own electricity planning (RUPTL) that serves as a guideline for developing potential solar projects, it can contribute to the demand aggregation effort. With the demand aggregated from various sources, auction planning will become more coherent and comprehensive as it could also identify the availability of transmission and distribution systems across the country.

The **frequency of auctions** further enables developers to prepare and plan ahead of the upcoming auctions. As demonstrated in the case studies, auctions are held several times annually along with public announcements for each auction. This predictability also attracts new participants because there is a confidence regarding the certainty of future auctions. Frequent auctions also display strong government commitment to solar development that later would help lower the risks perceived by the financial sector. The increasing number of bidders will lead to more competition that could drive down the price of solar energy.

In Indonesia's case, although the RUPTL is updated annually, there is no guarantee that the solar capacity stated in the document will be auctioned by PLN. The scale of solar projects is not large enough to accelerate the country's renewable energy installations, nor is it large enough to attract many solar developers. A more ambitious electricity auction planning by PLN to absorb large-scale solar projects in their pipeline is thus needed. Depending on the objectives, Indonesia can choose to auction large volumes at once or divide them into smaller volumes and auction them in various rounds. The former option can help the government to meet certain targets in a short period of time, while the latter option not only gives the government the opportunity to learn lessons from previous auctions and better plan its future power development, but also allows the developers and domestic solar industry to prepare accordingly for the upcoming rounds.

2. Set standardised qualifications, bidding penalties, and standard PPA for the bid winner

An **auction standard** is a crucial guide on what to expect from the ongoing or future project auctions. The auction standard includes the explanation of typical instructions and processes for auctions, general bidding qualifications—such as commercial, technical and financial eligibility criteria—, as well as bid evaluation and selection procedures, although **details might vary depending on the projects**. These qualifications are important to filter participation of eligible bidders in the auction. Therefore, the government should pay extra attention in the establishment of these criteria to ensure the quality of each competing bidder. In the case of India, SECI has published many projects in the past and each document for auction shows the uniformed information showcasing the auction standard for solar projects. Commercial, technical, and financial criteria are explained in detail at the early chapter of the announced RFP documents.

At the same time, the government has to determine penalties to discourage bidders from failing to deliver the project. When auctions are attractive enough, there will be fierce competition among bidders to win the project. Sometimes this could lead to bidders offering prices too low, especially when they underestimate the costs of projects. As a result, during the project implementation, they are unable to meet the agreed upon tariff. This has happened in India where many projects were default due to underbidding. To prevent underbidding, many countries have started to require a bid bond at the beginning of the auction and performance bond when the bid has been won. In case the auction turns out to be underbid, the auctioneer is entitled to take the bond. By establishing such a penalty as the standard, the tendency of underbidding can be minimised.

Currently, Indonesia has implemented commercial, technical, and financial criteria as the pre-qualification for bidders that want to participate in every auction. According to the developers interviewed for this study, the criteria set by the government in the projects are acceptable. Besides the qualifications, the government of Indonesia has also established standard bonds that act as guarantee against the risk of project default. During the bidding period, Indonesia sets a bid bond of 1% of the project costs. Once the winner has been announced, the winner is obligated to submit a performance bond, which is 10% of the project costs. When interviewed, solar developers that have participated in the previous auctions see the percentage as fair enough for the projects. However, since there are only a few auctions held in Indonesia, there is insufficient evidence to prove the effectiveness of the bond in deterring underbidders or covering the consequences of default.

Equally important is the PPA standard once the winner has been determined. Such a document will give a long term certainty that the developer will gain from its capital investment in exchange for the solar installation service it provides. A standardised PPA will ensure bidders of what is expected once they

win a solar bid; thus, it can assist them when preparing for the upcoming auction. In the case of India, SECI published a public document on the website showing the standard PPA that the successful bidder will receive. While the details are omitted because the information might be exclusive and confidential, it is sufficient to serve as a template for the overall picture of the content of the agreement.

Through the provision of an auction and PPA standards for solar projects, the government can ensure **visibility and predictability of auctions** that will encourage participation of bidders. Auction standard that is mostly applicable -with adjustments- to solar projects across the country will contribute to the high number of bidder participations regardless of the location, as shown in India's auction in November 2020 that attracted 14 bidders, both local and international (BloombergNEF, 2020b). Auction standard also helps with price discovery since bidders can look at the historical bid trends that use the same standard to determine their proposed tariff.

An auction standard can be the guide for stakeholders interested in participating in the Indonesian solar auction process. With a standard in place, both current and future bidders can prepare for the auction in certainty, and can even attract new bidders to participate. At the same time, having a uniformed standard in every auction will ensure that the quality of each auction is similar to each other. However, the stringency of the criteria can vary depending on the project.

Indonesia is still falling behind compared to other countries that also use auctions for large scale solar projects. According to an interview conducted for this study, developers pointed out that there is no standardised PPA across different auctions that have been conducted so far. Furthermore, there is no fixed time to determine the PPA signing after the winner's announcement. Some auctions have not completed the PPA signing, even months after the bidders are announced, due to an extended PPA negotiation process regarding the interconnection cost (Component E). This sends a poor signal on certainty of the project's execution and the rights and responsibilities that follows, especially for future bidders. Therefore, a standard PPA for large-scale solar projects in Indonesia is important to ensure the attractiveness of the auction in general.

3. Have a credible auctioneer with clear responsibilities to avoid conflict of interests

The establishment of a dedicated institution that leads the auction process has been beneficial, since the solar projects are large in size and the procurements are often a recurring process. This dedicated institution can specialize in solar development without intervention from other responsibilities. At the same time, it must have a clear definition regarding its scope of responsibilities. India, Brazil and the UAE's experiences have showcased that the government can choose to either establish a new institution to specialise in solar procurement or expand an existing institution to add solar procurement as its responsibility. There are different reasons and requirements in choosing whether to establish a new one or expand an existing one.

India chose to establish a new institution (SECI) because the government has an ambitious solar target to achieve (as stated in JNNSM) and would like to conduct many auctions over a period of time. This institution is also responsible for identifying the potentials, and aggregating demands from across the country. Meanwhile, **Brazil established a new committee that consists of the representation of multiple key stakeholder agencies from various government bodies, such as the ministry, utility, and research institutions** (IRENA, 2013). The representatives have distinct responsibilities and play roles in the decision making process; thus, the winners of the auctions are chosen based on mutual understanding between the stakeholder agencies. Although this method seems to be ideal as

all parties are aware and being involved in the decision making process, it has the potential to raise the conflict of interests among the representatives.

In contrast to these countries' experience, **the UAE chose to utilise the existing institutions (i.e., state utilities: DEWA and ADWEA) as the projects are initiated at the local level and centralised in a specific location.** Furthermore, currently the size of the total large-scale solar projects managed by these utilities is relatively small compared to projects in Brazil and India (7 GW total; 2 GW in Abu Dhabi, and 5 GW in Dubai). However, utilising the existing institution would bear risks when solar development is expanding since there will be many entities that need to be involved and solar projects at the national level would require more resources.

Regardless of the institution establishment—new or existing—ensuring collaboration among government institutions, both at local and national level is equally important. Most agreements on policies or decisions can be reached through collaboration. Without it, there will be frictions and push backs that will hinder the development of solar projects. However, it is understandable that not all government agencies will work together due to other interests or objectives that need to be pursued. Therefore, to reach the national target, the collaboration should allow room for flexibility.

In the case of Indonesia, PLN is currently the only institution in charge of implementing utility-scale (IPP) solar auctions. Its duty includes preparing for auction, being the auctioneer, and signing the PPA as an off-taker while also generating, transmitting and distributing electricity. This may create problems, particularly if the government depends on the existing capacity of PLN to handle solar installation expansion. In the past auctions, different auction sizes determined the levels of PLN—local or national—that would be in charge. Doing so helped PLN to distribute its responsibilities from the national to the local level, but the implementation of such system creates redundancy. Developers have to register at both national and local level to participate in the auction. For example, if PLN in Bangka Belitung plans to conduct an auction, then interested developers have to register into the local DPT even though the said developers already registered at the national level. To address this redundancy, the auction announcement has been centralised although there is no stated regulation yet.

Increasing the number of large-scale solar installations would require Indonesia to expand PLNs capacity to be able to aggregate demand, develop projects and conduct auctions. Nevertheless, there are some potential problems that PLN might face if the utility continues to bear the responsibilities of being both the auctioneer and the off-taker of large-scale solar projects. The execution of solar projects could potentially create conflict of interests within PLN. For example, as an auctioneer, PLN would want to conduct many auctions and attract many bidders to participate. However, as an off-taker, PLN has to be careful to negotiate the tariff, which might delay the auction process that in turn could discourage participation. Therefore, pay-as-bid is the best option that would make the auction process more efficient and transparent while also ensuring that there is no conflict of interest.

Another potential problem is the coordination with other government agencies that are involved in the electricity sector such as the MEMR, or with the local governments. PLN will also need to coordinate with the bid winners as the entity that will provide electricity. In order to have better coordination, PLN would need more human resources (i.e. engineers and experts) with deep understanding of the auction process and technicalities that can work along with other stakeholders and developers to ensure the success of large-scale solar installation projects.

4. Set transparent process and clear auction rules publicly

A well-prepared auction design is not sufficient without proper execution. Transparency and clarity are instrumental to ensure this. With the advancement of technology and information, this can be achieved through an online auction system. **Many countries have conducted online auctions and some have even posted their auction rules in official websites so that the interested developers can follow or prepare for the upcoming auctions.** Furthermore, the timeline of each process in the auction is publicly reported through the media, from the auction to the announcement of the winner, the size won and the tariff offered.

India has centralised and publicly available information about its solar auctions through SECI's official website, which has proven to attract participation from many developers; thus, increasing the competition at every auction. The detail of every tender is clearly stated in the SECI's website, including the relevant documents, list of bidders, and the auction results. In addition, there are news articles that announce the auctions and the results. Therefore, the auction processes are transparent to the public and are accessible, even to international parties.

Similarly, **Brazil announces its auctions and the results online through ANEEL's website.** The website also specifies the type of auction (electricity generation and transmission) that the country holds. ANEEL has even provided interactive reports regarding the auctions it had held across the country so that interested parties can easily gather the data insights. However, unlike SECI, ANEEL does not publish the relevant documents on any specific tenders. The auction and its result announcements are also covered by the news articles.

The efforts of SECI and ANEEL show their commitments in making the solar auction process as transparent as possible to the public. Transparency and clarity of the auction can be a guarantee for the development of large-scale solar installations in the country while also attracting more bidders to participate in the auctions. Without transparency and clarity, there will be uncertainty regarding the projects and even trigger corruption practice that can hinder fair competition and efficiency (Olaya & Boehm, 2006). Therefore, both the information and the process of every auction should be available publicly.

In Indonesia, large scale solar auctions are announced through the PLN's e-procurement website and invitation email; thus, developers must be registered in the DPT list to participate in the auction. If interested parties want auction information but they have not received any invitation, they have to look for it on the website among various auctions conducted by PLN. Furthermore, although the winners of the auctions are announced, the process of the auction is not posted on the website or other PLN-related websites. Only those participating in the auction will have the timeline of the auction process, which according to this study's interview, is explained in the RFP and during the tender explanation (*aanwijzing*) meeting.

The limited public information regarding the timeline or the result of each stage in the auction makes it difficult to observe the actual process of the auction. Furthermore, although the RFP has the detailed information of the auction procedures, developers might need to clarify aspects of the RFP -such as the land ownership- to PLN. This undermines the transparency and clarity of the crucial part of the auction, especially in the component negotiation process. Transparency and clarity are important to ensure that there is no party that plays by its own rules or has special bargaining that guarantees its success in winning the bid.

Having an institution with a mix of stakeholders can help increase transparency of the auction because different parties will monitor the process. Prior to Regulation 50, Indonesia actually assigned EBTKE to conduct the auction, with PLN and the directorate general of electricity as the other stakeholders with distinct responsibilities. However, the reason for changing the responsible parties is not clear. Regulation 50 vested the responsibility to plan and execute auctions solely on PLN, which will seek approval from the Minister of Energy and Mineral Resources regarding the PPA tariffs. It is also not clear why the Minister has to be involved in the PPA tariff determination process.

5. Review the supporting regulations such as local content requirement and tariff pricing policy

In the development of large-scale solar energy, there are some supporting regulations that are set in place with the expectation to achieve certain goals other than the increased number of solar power installations or the decrease of solar price. While it is good to have supporting regulations on solar power, the government must ensure that effective regulations are established to promote the acceleration of solar power development.

One regulation closely related to large-scale solar development is about local content requirements. A reasonable local content requirement in solar development should be clearly defined to avoid unwanted response. If the LCR is set too low, then the local manufacturers will be exposed to the competition from experienced and mature foreign manufacturers. In contrast, if the LCR is set too high, it could discourage participation in the auction. There are two reasons for this. First, it is because oftentimes a higher level of local goods mandated in solar projects will significantly drive up the costs due to the relatively high local goods price. To compensate for the price increase, government's assistance is needed. In Brazil's case, the local content is preferred but not mandated for each project. By linking LCR to the soft loan from BNDES, the country has successfully provided extremely competitive loan rates and reduced the financial burden on the developers, while encouraging the use of local goods and services. Many developers have chosen to use local content in order to access the loan. The gradual improvement of LCR gives the domestic solar industry time to improve its manufacturing capacity and establish partnerships with the developers.

Second, the domestic industries might not have sufficient capacity, at least initially, to provide for the projects. This can make developers hesitate to take the projects, or choose to break the LCR (and pay for the penalty if any) then use imported goods. In India, the imported material was cheaper than the domestic one; thus, LCR faced many backlash from developers that wanted to participate in the auctions (IESR, 2019a). Arguably, LCR failed to aid the growth of the domestic industry, nor did it help the development of solar energy. However, by conducting two separate auctions, one with LCR and the other without, the government can get more auction participation while also protecting the domestic manufacturers.

Indonesia has a high percentage of local content requirements for solar projects. Although the intention is to protect the local industry, imposing this regulation is not ideal because currently, the local producers have limited capability to provide for the scaled-up solar projects. As aforementioned, the stringent local content requirements have stalled the development of solar IPPs in Indonesia (IEEFA, 2019).

It is estimated that a significant 30% reduction on LCOE of solar PV could be achieved if Indonesian solar module prices follow the global market (IESR, 2019a). It means using more imported goods can rapidly reduce the costs of solar PV projects and increase their bankability. Additionally, mandatory LCR should be either revised to a lower level or suspended at the initial stage. The relaxed LCR can help solar PV capacity to at least start growing in Indonesia before the government can gradually increase the LCR as the domestic solar industry matures.

6.Reduce project risks and transaction costs: ensuring the consistency between the stated regulation and the actual implementation of the business process

Project risk is a major factor considered by developers and investors in decision-making, and higher risks normally cause higher costs. To encourage more cost-competitive bids, the government can reduce project risks by providing necessary assistance. For instance, many solar projects have identified land acquisition and grid access as main risks. In some cases, the capital and time costs associated with securing land and grid access may discourage potential developers. Hence, it is ideal if the government can identify the land -and even own the land- with grid access for solar development.

From the beginning of the solar project, the UAE government has allocated specific government-owned sites to build large scale-solar projects, because the UAE realised that land acquisition and grid access lead to high project risks. Furthermore, the involvement of the utility company in solar projects has reduced the additional costs for developers, since the company can guarantee access to the grids. These solutions lower the project's risks which lead to low bid price offered by bidders.

Similarly in India, with the lists of identifiable lands submitted by each state and the flexibility of the state government to provide additional land for solar development, land acquisition is easier for the developers. In addition, since each state's energy company is also involved in the procurement process, grid access is not a significant problem in India. The government of India has even made it possible for states to share grid access for interstate solar energy transmission. By doing so, the government ensures that solar energy is accessible to all which would also further attract more bidders to participate in the procurement process.

In contrast, land acquisition is a difficult issue for solar projects in Indonesia. Developers often have to purchase land for solar installations from a third party, sometimes including any property in that location. Therefore, the developer has to bear the cost of purchasing and compensating for the land. In addition, the developer will also bear the time loss while waiting for the land permit and/or vacancy. These reasons make potential developers reluctant to submit their bids.

Another issue is the grid connection, in which developers are currently responsible for ensuring the connectivity of the solar project to the main electricity grid. Developers have to obtain permits and then build the grid, which often results in higher costs, especially in places where there is still a lack of grid connection. At the same time, although PLN is responsible for the overall grid connectivity in Indonesia, the company is actually facing a difficulty in solving the connection challenge. Therefore, it is crucial that the utility company also has a share in each solar project. This allows the financial burden especially from the grid connection costs to be shared proportionally, and increases the confidence of the financial sector to give loans for developers.

Although the government has reduced the risks for solar project developers, it still needs to reduce the risks caused by solar project developers, particularly regarding the project completion. With more auction-induced competition, developers might be inclined to offer the cheapest price by overestimating their ability to deliver the project. As a result, many projects failed due to default. To address this issue, some regulations should be set in place to minimise the risk of project default, as discussed previously in lesson 2.

Besides project risk, developers will consider participating in a bid when they are able to limit their transaction costs. One way is by choosing large projects because the economies of scale of the project will allow them to allocate the transaction costs throughout the project. Therefore, the government should aggregate demands for solar so that auctions can offer large-scale solar projects. Further explanation on demand aggregation is already discussed in lesson 1.

Transaction cost can potentially increase when there is a delay between the winner announcement and PPA signing. During this period in Indonesia's case, there is a possibility of tariff change as well, which adds to the uncertainty of the result of the procurement process. Furthermore, the result of Indonesian auction is not available publicly, and since the timeline is only known by limited parties, it is challenging to determine the exact duration of each auction. Some developers agree that the most unpredictable process is the negotiation of component E which can happen after the winner's announcement. In the RFP document, it takes 30 days for the negotiation, but the actual time varies.

The country can learn from India's case. India has descriptive announcements and uploaded necessary documents for every solar auction on the SECI website. The tariffs can easily be found in the SECI website and the news website as the winners and their tariffs are announced publicly. India's solar project auctions do not take a long time -only takes a couple of months from the auction announcement to the PPA signing- and documents posted in the website show that the actual process follows the timeline. The certainty of solar auctions in India has attracted participants from various bidders, even to a point of oversubscription. This shows that if the actual implementation can follow the regulation, the confidence of developers in Indonesian auctions can increase.

⑥ Recommendations

Drawing lessons learned from Brazil, India, the UAE, and Indonesia's recent solar auctions, presented are several key recommendations for key policymakers that can be done to propel utility-scale solar development in the country:

1. Establish an executable national solar program that is integrated with the power system planning and procured using systematic solar auctions

Indonesia must create an ambitious and executable national solar program that is designed and integrated with its power system planning with state-utility PLN. Note that the solar program does not have to be limited to utility-scale solar but may as well be extended to other segments such as distributed (rooftop) solar, including to fulfill the mandate in Presidential Regulation No. 22/2017 to install rooftop solar at government buildings.

The government should first establish a national solar target (for example 10 GW by 2025 then 20 GW by 2030), and then aggregate demands for solar projects by working together with local governments and respective PLN jurisdictions to determine the auction volume. The government could then decide on how to divide these demands into systematic (regular) solar auctions into several phases for a five-year period or longer, for instance. As showcased in the lessons learned from India, an integrated and executable national solar program exhibits the government's commitment to procure large-scale solar energy, sending positive signals to long-term international players in solar energy, and creates a competitive solar market in the country.

2. Support solar project development (i.e. land selection) to derisk project and improve bankability

Solar projects in Indonesia have already started showing some cost-competitiveness (to below four cents per kWh) recently, as demonstrated by Indonesia Power's solar auction in two of its floating solar projects. This means that given an adequate project size (in the hundreds of megawatts) and the right auction design, tariff pricing may not be an issue anymore. Arguably, the main lessons learned from the auction are related to project development and land selection, which determines the development risk and eventual bankability. To replicate this success, Indonesian government could give support in project development (i.e. land selection) to reduce development costs generally borne by the developers. In addition, the government could further support by providing free lands (or at least supporting land selection with cheap lease) and ensuring grid access for solar projects, as implemented by the UAE that results in a very cost-competitive auction and one of the cheapest record-low bids in solar history. The government can consider its state-owned asset management agency (*Lembaga Manajemen Aset Negara*) or state-owned enterprises with huge land areas, such as the unproductive land of PT Perkebunan Nusantara (PTPN). More importantly, by utilising hydropower dams or reservoirs to develop floating solar projects, the government can at least enjoy minimal land problems.

3. Establish auction and bankable PPA standards, and revise “component E” negotiation clause to speed up PPA signing

Besides the lack of projects, other challenges in the current solar procurement practice are the lack of standardised auction rules, the lack of a standardised “bankable” PPA, and a lengthy PPA negotiation. These challenges discourage both local and international players who want to participate in Indonesian market. The government should establish both an auction standard and a “bankable” PPA standard, if Indonesia were to create a competitive solar market. Auction standard is crucial because it tells potential investors (developers and financiers) about what to expect from solar auctions in Indonesia. Drawing lessons from India, SECI publishes many auction documents in the past and each shows a uniformed information showcasing the standard for solar projects. In addition, the auction documents are made available to the public. In Indonesia, while there are only relatively few auctions in recent years, none of the documents are made public, as it is conducted by a business entity (PLN). This will make it hard for interested developers or even policymakers to review and decide whether or not changes are needed.

With regard to the lack of a PPA standard, each PPA is different as it is tailored for each specific project, meaning it lacks long-term predictability for interested bidders. A standardised PPA with proper terms and risk allocation will create a huge difference when talking about certainty, and it ultimately leads to project bankability. Again, drawing lessons from India, SECI releases a public document that showcases the standard PPA that the bidders receive prior to the bidding.

The government should reconsider the PPA negotiation terms related to interconnection cost (component E) in MEMR 50/2017, as it prolongs the negotiation process. In all of the country case studies, most auctions use a **pay-as-bid criteria** as their winning selection criteria. This means that the submitted bids are final and will be used as the tariff they receive when they sign the PPA with the off-taker. In Indonesia, this process is different as the winner should negotiate the interconnection cost of the tariff, which is usually very lengthy. Therefore, in addition to PPA standardisation, this clause can also be revised to speed up the PPA signing.

4. Create separate solar auctions “market” for projects with local content requirements

Dealing with the consideration of protecting domestic solar manufacturing and unlocking the solar market is a difficult task, but it is not impossible to solve. On the one hand, the development of the domestic solar manufacturing industry is in the national interest. On the other hand, the implementation of too strict LCRs may hinder the development of solar energy in the power market—with higher electricity purchase cost.

Drawing lessons from Brazil and India, there are at least two options that the Government of Indonesia could do. First, the government could offer assistance (or supporting incentives) in the form of a soft loan with extremely attractive interest rates (e.g. 0.9% in Brazil) from a national bank when LCRs are fulfilled. This way, there is a huge incentive for developers to use LCRs compared to imported ones. Alternatively, the government could also provide special funding such as viability gap funding (VGF) to projects that meet LCRs requirements.

Second, Indonesia's domestic solar manufacturing might not have sufficient capacity, at least initially, to supply demands from the growing utility-scale solar market (when it reaches hundreds of megawatts per project). In this case, the government could consider separating LCRs into two different auctions (i.e. creating a separate market), one where LCRs are imposed, and one where they are not. This way, the government will not risk hindering large projects to become more cost-competitive, especially when the domestic solar industry has not been able to scale up.

Further, by doing so, domestic solar manufacturing will still be able to have its market to supply and grow in the coming years, therefore a win-win for both. In addition, the government should consider international financiers' requirements that may only want to provide financing to developers who are using Tier 1 solar PV modules (generally still imported), which the current domestic solar module manufacturers are still limited.

5. Centralise auctions and transfer auction authority to an independent auctioneer

The Government of Indonesia could consider centralising solar auctions and transferring the auction authority to an independent auctioneer. This independent auctioneer could either be a new or an existing government institution with improved capability and responsibility within the renewables and electricity sector. This should be done primarily for two reasons: 1) to avoid conflicting responsibilities and interest of PLN (as both off-taker and auctioneer), and 2) to distribute responsibility between developing projects, aggregating demand, and auctioning with the role of an off-taker. A new institution/body could also be established to perform the role as an auctioneer, as with the case in India with the establishment of Solar Energy of India Ltd. (SECI) to facilitate the implementation of its National Solar Mission. The independent auctioneer should also be responsible for developing solar projects (from determining the appropriate land or site location and grid connection), aggregating the demand by coordinating with local governments and its respective regional PLN office, and eventually, to decide on the auctioned volume capacity offering. Additionally, the auction should also be made online (electronically) from the pre-qualification, bid invitation, bidding, down to the final announcement to improve information transparency, as was already done in the past (2013/2014's auction).

7. References

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Appendix A – Indonesia's list of IPP solar projects

Table A-1. Indonesia's completed IPP solar projects (2014–2020)

No.	Project name	Location	Capacity		Type	Developer	PPA signing	PPA price (US¢/kWh)	Contract (year)	COD	Status
			DC (MWp)	AC (MW)							
1	Kupang (Oelpuah)	Kupang, East Nusa Tenggara	5	5	Ground-mounted PV	PT Len Industri (Persero)	9-Jan-15	25.00	20	Mar 2016	Operation
2	Sumalata	Gorontalo	2	2	Ground-mounted PV	PT Brantas Energi-Adyawinsa Consortium, SPC: PT Brantas Adya Surya Energi (BASE)	2015	22.95	20	2016	Operation
3	Hambapraing	East Sumba, East Nusa Tenggara	1	0.88	Ground-mounted PV	PT Sumber Energi Surya Nusantara (SESNA)	2014	24.98	20	Feb 2017	Operation
4	Maumere & Ende	Flores, East Nusa Tenggara	2 x 1	1.76	Ground-mounted PV	PT Sumber Energi Surya Nusantara (SESNA)	2016	24.98	20	Mar 2019	Operation
5	Atambua	East Nusa Tenggara	1	1	Ground-mounted PV	PT Global Karya Mandiri	2016	25	20	July 2019	Operation
6	Kotabaru	South Kalimantan	2		Ground-mounted PV	PT Global Karya Mandiri	N/A	25	20	Failed	Failed
7	North Lombok	East Nusa Tenggara	2		Ground-mounted PV	PT Berkah Surya Madani	N/A	18.36	20	Failed	Failed
8	Jakabaring	South Sumatra South Sumatra		2	Ground-mounted PV	Perusahaan Daerah Pertambangan dan Energi Sumatera Selatan-Sharp Corporation, Japan	2017	6.6	20	Mar 2018	Operation
9	Pringgabaya	West Nusa Tenggara	7	5	Ground-mounted PV	PT Infrastruktur Terbarukan Adhiguna (Vena Energy)	2017	10*	20	2019	Operation
10	Selong	West Nusa Tenggara	7	5	Ground-mounted PV	PT Infrastruktur Terbarukan Buana (Vena Energy)	2017	10*	20	2019	Operation
11	Sengkol	West Nusa Tenggara	7	5	Ground-mounted PV	PT Infrastruktur Terbarukan Cemerlang (Vena Energy)	2017	10*	20	2019	Operation
12	Likupang	North Sulawesi	21	15	Ground-mounted PV	PT Infrastruktur Terbarukan Lestari (Vena Energy)	2017	10*	20	2019	Operation
13	Isimu	Gorontalo	14.5	10	Ground-mounted PV	PT Quantum Energy	2017	10.4*	20	2020	Operation
14	Kuta (Sambelia)	West Nusa Tenggara	7.25	5	Ground-mounted PV	PT Delapan Menit Energi	2017	10*	20	2020	Operation

TOTAL 57.64

Table A-2. Indonesia's current solar projects pipeline (2021)

No.	Project name	Location	Capacity		Type	Developer	PPA signing	PPA price (US¢/kWh)	Contract (year)	COD	Status
			DC (MWp)	AC (MW)							
15	Cirata FPV	West Java	175	145	Floating PV	PT PJB Investasi-Masdar	2020	5.8179	25	(exp.) 2023	Financing
16	Bali 2 x 25	Bali	50		Ground-mounted PV	PT Medco Power Indonesia -Solar Philippines consortium	(exp.) 2021		(exp.) Q4 2022	-	PPA negotiation
17	Bangka	Bangka Island	10	10	Ground-mounted PV	PT Jasa Tirta Energi-PT Surya Energi Indotama				-	Tender won
TOTAL				205							

Table A-3. Indonesia Power's recent equity partner solar auctions ("Hijaunesia project")

No.	Project name	Location	Capacity		Type	Bid Winner	PPA signing	Bid price (US¢/kWh)	Contract (year)	COD	Status
			DC (MWp)	AC (MW)							
1	Singkarak 90 MW	West Sumatra		90	Floating PV	Acwa Power		3.682	25	N/A	Tender won
2	Saguling 60 MW	West Java		60	Floating PV	Masdar		3.748	25	N/A	Tender won
3	Lampung 100 MW	South Sumatra		100	Ground-mounted PV + + battery energy storage system (70 MW/350 MWh)	Acwa Power		9.075	25	N/A	Tender won
4	Kalimantan (TBA)	Kalimantan									To be tendered
TOTAL				250							

Table A-4. Indonesia's announced upcoming IPP solar auctions (2021)

No.	Project name	Location	Capacity		Type	Developer	PPA signing	PPA price (US¢/kWh)	Contract (year)	COD	Status
			DC (MWp)	AC (MW)							
1	West Java 50 MW	West Java		50	Ground-mounted PV	IPP				(target) 2023	Plan
2	Central Java 50 MW	Central Java		50	Ground-mounted PV	IPP				(target) 2023	Plan
3	East Java 50 MW	East Java		50	Ground-mounted PV	IPP				(target) 2023	Plan
4	West Java 5 MW	West Java		5	Ground-mounted PV	IPP				2021	Plan
5	Tambora, 2 x 5 MW	West Nusa Tenggara		10	Ground-mounted PV	IPP				2021	Plan
6	Diesel conversion	Spread across 200 locations		660*	Ground-mounted + BESS	Unallocated				N/A	Plan
TOTAL				320							

***Notes:** Based on available information on RUPTL 2021–2030 draft at the time of writing