D2.1-CSP, December 2019

Auctions for the support of renewable energy from Concentrated Solar Power (CSP)

Main results and lessons learnt

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D2.1-CSP, December 2019, Auctions for the support of renewable energy from Concentrated Solar Power (CSP)

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1 Introduction to the technology

CSP is a dispatchable renewable electricity technology (RET) which might contribute substantially to a sustainable energy transition especially in countries with high solar irradiation (DNI), in tandem with an increasing penetration of variable RETs. According to the IEA (2014), it could represent as much as 11% of electricity generation in 2050, with 954 GW of installed capacity (up from 5 GW today).

Compared to intermittent RETs, CSP has a main distinguishing feature: It is able to provide dispatchable electricity, which allows balancing intermittent renewable electricity sources if these achieve a high penetration in the future. CSP plants contribute to grid balancing, spinning reserve, and ancillary services. They can also shift generation to when the sun is not shining and/or maximise generation at peak demand times (World Energy Council, 2016, p. 31). However, the technology currently plays a minor role in the power mixes everywhere and also in the EU. Its share in electricity generation worldwide is 0.1% (REN21, 2018). Spain and the US together account for 80% of global installed capacity as of 2017 (2.3 GW in Spain and 1.7 GW in the US), although expansion in those two countries stopped a few years ago. The interest has shifted to emerging economies, including South Africa, the United Arab Emirates (UAE), China, India and Morocco, which are playing an increasingly important role in this context.

Although cumulative CSP capacity grew tenfold worldwide between 2006 and 2016, mostly due to incentive schemes in key markets (IRENA, 2018a), it lags behind other RETs in terms of installed capacity. According to (IRENA, 2018b), there are currently 5 GW of CSP installed capacity worldwide, versus 513 GW for wind, 385 GW for PV, 1270 for hydro, 109 GW for bioenergy and 12 GW for geothermal. Its costs have substantially been reduced in the last ten years from USD 0.3/kWh ten years ago to US 0.12/kWh today (Lilliestam, 2018). A main reason to support it is that, compared to other RETs, it is still a high-cost gap maturing technology in the early stages of deployment and with large cost reduction potentials. 1.2 GW of CSP have been auctioned in 2017-2018 (compared to an overall volume of 97 GW of all renewables being auctioned) (IRENA 2019).

2 CSP auctions in the past: design elements

CSP has been promoted through technology-specific auctions in several countries from around the world (South Africa, Dubai and Abu Dhabi in the United Arab Emirates, South Australia and India). In addition, CSP has participated but has not been awarded in the technology-neutral auction in Chile. Table 1 summarises the goals, main features and outstanding design elements of those auctions. Table 2 provides details on the design elements selected.

Table 1. Goals and description of CSP auctions and outstanding features of CSP auction design.

Country	Goals of the auction	Brief description of the auction	Outstanding features of auction design
South Africa	-Fast deployment (in order to meet an increasing electricity demand) -Contribution to local socioeconomic development (given its high unemployment and poverty levels).	The Department of Energy introduced the REIPPP, structured in bidding windows, in August 2011. It replaced the REFIT program, in order to implement the renewable energy allocations of the IRP (3300 MW in 2013). Overall, 600 MW were awarded to CSP in four rounds in the period 2011-2014.	-Two-tier tariff structure in order to encourage dispatchable CSP plants to deliver peak energy. A multiplier of 270% of the base tariff applies to peak load hours, and no tariff applies to the night hours. -Bids were reviewed based on weighted criteria: 70% for their price offer and 30% for their additional contribution to economic development. Of the 30 points awarded for economic development, job creation counts for 25%, local content for 25%, ownership for 15%, management control for 5%, preferential procurement for 10%, enterprise development 5%, and socio-economic development 15%
Morocco	-To increase the dispatchability of low carbon electricity generation sources (meeting the evening peak) -To deploy CSP at the lowest policy support costs. -To deploy CSP fast (in order to meet an increasing electricity demand) -To encourage local economic development (given the relatively high unemployment rate among the young).	The CSP projects are designed as a public–private partnership between MASEN and a private sponsor selected through the auction. The 25-year PPA specifies two different prices (for base and peak load) to better remunerate the power that the plant will dispatch at times of peak electricity demand. Three rounds of CSP auctions have taken place between 2011 and 2016, with three projects being awarded contracts. They started production in 2016 (NOOR I) and 2018 (NOOR II and NOOR III).	-There are two different prices (for base and peak load) to better remunerate the power that the plant will dispatch at times of peak electricity demand. -Active role of the Moroccan Agency for Sustainable Energy (MASEN) within a public-private partnership and de-risking instruments. -Existence of local content. Bidders are encouraged to promote local manufacturing. For example, in NOOR I, a 42% local content portion was included.
UAE (Dubai and Abu Dhabi)	-To increase the dispatchability of low carbon electricity generation sources (meeting peak demand). -To deploy electricity generation capacity to meet an increasing electricity demand and do so at the lowest policy support costs.	Solar power has been the primary focus of UAE efforts to date. CSP has been promoted through auctions in the UAE, both in Abu Dhabi (Shams1) and Dubai (the Mohammed bin Rashid Al Maktoum Solar Park). A CSP-specific, price-only, site-specific auction was organized in Dubai in 2017 (700 MW project). In Abu Dhabi the Shams1 project (100 MW) was also awarded. The government typically retains a majority stake in the project, with independent power producers taking the remainder.	Dubai: -The project is required to generate power from 4 pm to 10 am. -A 35 year PPA has been awarded. Abu Dhabi. -Tariff agreed between the consortium and Abu Dhabi's utility (ADWEA), and approved by the Regulation and Supervision Bureau (IRENA 2015: 16). -No thermal storage was required.

South Australia	-To increase the dispatchability of low carbon electricity generation sources -To deploy CSP at the lowest policy support costs	The South Australian government organized tenders for two power supply contracts in order to meet its long term power needs: 1) 75% is open to any dispatchable technology; 2) 25% is constrained to dispatchable RETs. A technology-neutral auction was organized in 2017 with an auction volume of 150 MW in order to cover the peak government load of 125MW. Fossil-fuels were eligible to participate.	-The operator is allowed to sell the excess electricity after covering the peak government load in the wholesale market. -Technology-neutral auction. -No prequalification requirements (project subject to preapproval by the SA government). -Renewable Energy Certificates are an additional source of revenue.
India	-To deploy CSP at the lowest policy support costs -To deploy CSP fast (in order to meet an increasing electricity demand), -To encourage local economic development given the relatively high poverty levels. -To reduce high and increasing import dependence.	The solar power capacity target in the Jawaharlal Nehru National Solar Mission (JNNSM) is to achieve 100 GW by 2022, 60 GW of which are medium and large scale grid connected power plants. Initially, 500 MW were allocated to PV and another 500 MW to CSP technologies in Phase-I. For CSP, 7 projects (470 MW) were awarded, although only 225 MW had been implemented by the end of 2015. The share of CSP was reduced to 30% in Phase-II, and states were asked to fulfill 60% of these targets. State-level policies play a crucial role in the deployment of solar power, and particularly CSP.	-Differently from the other countries, higher tariffs are not provided for peak power or for dispatchability and, thus, the winning bids did not have a thermal storage component -A prequalification requirement of 30% local content rule (LCR) was adopted.

Source: Own elaboration based on del Río (2019) and del Río and Mir-Artigues (2019).

CSP deployment support is usually based on auctions. Two main exceptions in the past have been China and Spain. In addition to the reliance on auctions, long-term PPA to provide long-term revenue certainty to solar power generators and guaranteed off-take from the government have been main elements of this support.

Tables 1 and 2 show that the design of the auctions are quite different across countries, reflecting the goals of the government when organising those auctions which, in turn, partly depend on the specific characteristics of the country (socioeconomic conditions and institutional features, including the current design of their electricity system). In particular, design elements in CSP auctions have often been applied in order to reward dispatchability and encourage local socioeconomic development.

Some design elements are common or predominant in all the CSP auctions being analysed: they are often technology-specific, site-specific and size-specific auctions. The volume is set in capacity terms and remuneration is generation-based. Static auctions have been adopted everywhere, with PAB as the pricing rule. However, the design elements in the countries differ in other respects and, most importantly, regarding the stringency of prequalification requirements. Although price-only auctions dominate, some countries have local content rules.

Even if in most of these countries dispatchabilty is rewarded, reflecting the countries' policy goal, the way it is done clearly differs. South Africa rewards electricity at peak times. In rounds 1 and 2, there was a flat remuneration at all times, but in rounds 3 and 3.5 the remuneration was established based on the "time of day" scheme, with a premium of 270% of the tariff for the generation between 16:30 and 21:30 hours, and not remunerating generation at all between 22:00 and 5:00 of the next day. The aim was to increase the contribution of renewables to the electrical system in the hours of highest consumption, to compensate for the lack of flexibility of the variable renewable sources of their system (Souza 2018). This is also the case in South Australia and Morocco, where the aim is to cover the peak load[1]. In Dubai the goal is to provide electricity at night, i.e., to reduce the back-up required in the hours in which PV, after sunset, would not be able to generate electricity, to achieve a greater contribution of solar energy without exceeding the thresholds of PV power that could lead to curtailments (Souza 2018). The design elements being used are also different in this regard. In Dubai dispatchability is a prequalification requirement, whereas, as mentioned above, a different remuneration applies for peak vs. base load periods in South Africa.

Although the focus of this report is on design elements in CSP auctions, it should be mentioned that these countries put auctions at the center of CSP deployment support, but they use complementary policies as well to reduce risks, effectively leading to a policy mix. This is particularly the case in Morocco and India. In Morocco, the private–public partnership allows the government to share the costs and risks with international and private financiers and project developers. In order to mitigate the off-taker default risk, the government has provided the Moroccan Agency for Sustainable Energy (MASEN) with a guarantee to ensure its financial viability. International financial institutions have awarded the government a credit facility to be used to cover MASEN financial obligations (Frisari and Stadelmann 2015, p.15). In India, the Jawaharlal Nehru National Solar Mission (JNNSM) includes a Payment Security Scheme to provide partial payment security for solar project developers in case of a default by state distribution utilities, ensuring financial closure of projects.

[1] According to Souza (2018, p.46), with 7.5 hours of storage, Noor III was optimized to meet the demand during five peak hours daily, in which the electricity price is 18% higher. The first two CSP plants at Ouarzazate, Noor I and Noor II, both parabolic troughs, have 3 and 6 hours of storage respectively.

Table 2. Main design elements in CSP auctions.

Characteristics	South Africa	Morocco	Dubai	Abu Dhabi	South Australia	India
Contractual counterparty (auctioneer? provider of support?)	ESKOM (State-owned power utility)	ONEE (National Office for Eletricity and Drinking Water)	DEWA (Dubai Electricity and water Authority)	ADWEA (Abu Dhabi Water and Electricity Authority)	South Australian government	State distribution companies
Min./max. size of project	Max. size (100 MW)	No	Min. size (100 MW)	N.A.	Fixed size (150 MW)	No
What is auctioned? Auctioned bids (in terms of budget, electricity or installed capacity)	Capacity	Capacity	Capacity	Capacity	Capacity	Capacity
Frequency of auctions	Annual between 2011 and 2014	Irregular	One-off (2017)	One-off (2010)	One-off (2017)	One-off (2010)*
Volume of the tender (MW)	650 MW in total (200+50+200+200)	580 MW in total	200	100	150	500
Balancing and profile costs	RES-E operators do not pay balancing costs	RES-E operators do not pay balancing costs	RES-E operators do not pay balancing costs	RES-E operators do not pay balancing costs	RES-E operators do not pay balancing costs	RES-E operators do not pay balancing costs
Auction format	Multi-unit	Single-unit	Single-unit	Single-unit	Single-unit	Multi-unit
Auction procedure	Static	Static	Static	Static	Static	Static
Pre-qualification requirements - Financial - Material (falling either on the project developer (e.g. experience in RES development), or the project (e.g. building requirement or environmental impact assessment, grid connection, etc.)	Qualification requirements: financial, technical, commercial and legal, land, economic development, and environment. Need to demonstrate the readiness of the project (land acquisition, funding, technologies, suppliers, ability to meet deadlines, environmental consent, etc.), its financial viability and minimum requirements in terms	Pre-qualification of bidders based on project experience and financial background. Financial guarantees requested from winning consortium and penalties for delay, but details remain confidential in contracts.	Plants should be able to generate from 4 p.m. to 10 a.m.	N.A.	No prequalification requirements	Financial (bidders should have a minimum net worth of $3 million), technical (technology experience by the bidder/developer), connectivity to the grid, water availability and domestic content. Project developer needs to submit proof of land possession. 30% LCR as a prequalification requirement (not as a weighted parameter in the winner selection

	of economic development.					process) (del Río and Mir-Artigues 2019).
Pricing rule	PAB	PAB	PAB	PAB	PAB	PAB
Award procedure	Multicriteria	Price-only	Price-only	Price-only	Price-only	Price-only
Price limits	Yes In BW1, price caps were disclosed before the bidding procedure and based on the previously administratively set FITs. Since BW2, they are disclosed after the bidding procedure.	No	No	No	Yes (disclosed)	Yes (disclosed)
Support period (years)	20	25	35	25	20	25
Favourable treatment of specific actors	Geographically-neutral No special treatment of small actors	Site-specific No special treatment of small actors	Site-specific No special treatment of small actors	Site-specific No special treatment of small actors	Site-specific No special treatment of small actors	Site-specific No special treatment of small actors
Realisation time limit	N.A.	N.A.	2021	N.A.	2021	28 months after PPA signing
Form of support auctioned	PPA	PPA	PPA	PPA	PPA	PPA
Dispatchability requirements	A two-tier tariff applied in BW3 and BW3.5 whereby CSP remuneration was differentiated with a base and a peaking rate component. A 270% of the base tariff applies in peak hours	Dual-price system	Plants should be able to generate power from 4 pm to 10 am.	None	To cover the peak government load of 125 MW	None
Local content requirements	Yes	Yes	No	No	No	Yes
Other	PPA rate indexed to inflation. Assessment of bids based on the offered price (70%) and the project's contribution to economic development (e.g., job creation, local				*8	Seller concentration rules

	content…)(30%). Targets for local content for CSP (as a percentage of total project costs) have increased over time: 50% (BW1), 60% (BW2) and 65% (BW3 and 3.5).					

Source: Own elaboration. *Three phases at central government level: I (2010-2013), II (2013-2017) and III (2017-2022). CSP was awarded only in Phase I (although also at state level). 500MW were auctioned in August 2010 (del Río and Mir-Artigues 2019). N.A.= non available (no information found).

3 Evaluation of past CSP auctions.

An empirical assessment of the design elements and functioning of CSP auctions in the past, according to two assessment criteria (effectiveness and awarded bid prices), was carried out by del Río and Mir-Artigues (2019) and Mir-Artigues et al (2019). The authors found that the auctions have led to relatively low and/or decreasing prices over time. In contrast, they observe mixed results with respect to effectiveness, with delays and even failure to build the projects being awarded in India, some delays in the last two rounds in South Africa and good performance for Morocco. It is still too early to conclude on the effectiveness of the auction in Dubai and South Australia, since both took place in 2017. The following table provides details on the assessment of the CSP auctions.

Table 3. Effectiveness and bid prices in CSP auctions.

Country	Comments/explanation
South Africa	Awarding and effectiveness 600 MW have been awarded (versus 650MW being auctioned) in 7 projects. Of these 600MW, only 2/3 (400MW) are operational as of May 2018: KaXu (BW1, 100MW) in 2015, Khi (BW1, 50MW) and Bookport (BW2, 50MW) in 2016, XiNa (BW3, 100MW) in 2017 and Kathu (BW3.5, 100MW) in 2018. Another 2 are under development: Ilanga I (BW3, 100MW, start expected in 2020) and Redstone (BW3.5, 100MW, PPA signed in 2018). Grid connection issues have delayed projects in BW3 and BW3.5. Prices Average tariffs have significantly gone down over successive rounds. Average PPA (base) prices in each round (indexed to April 2014): 0.22 USD/kWh (BW1), 0.21 USD/kWh (BW2), 0.12 USD/kWh (BW3) and 0.11 USD/kWh (BW3.5). Average prices in the peak periods: 0.33 USD/kWh (BW3) and 0.30 USD/kWh (BW3.5)(Gauche et al 2017).
Dubai	Awarding and effectiveness One project with a combination of a solar tower (ST)(100MW) and three parabolic troughs (PTs)(200 MW each) was awarded (total of 700MW). ST will provide fifteen hours of storage, while the PT will provide eleven hours. There were 30 expressions of interest. 4 international consortiums submitted bids. It is still too early to judge effectiveness. Prices Very low price of 7.3 USD cents/KWh. Highest bid: 17.3 USD cents/kWh.
Abu Dhabi	Awarding and effectiveness The Shams1 project was awarded in the auction. The first invitation to bid for the construction of the CSP plant was made in 2008. Abengoa Solar, Total, ACWA Power, Iberdola, Grupo Cobra, Grupo Sener, MAN Ferrostaal and Solar Millenium participated in the bid. The bid selection process was delayed for two years. The design, build and operate contract was finally awarded to Abengoa Solar and Total in June 2010 (Power Technology 2014). It is structured as an Independent Power Producer project, which is developed, owned and operated by Shams Power Company PJSC, a joint venture between Masdar (60%), Total (20%) and Abengoa Solar (20%) (Crespo 2017). The project has been in operation since 2013. Prices Information about the bid prices and the 25-year PPA are not publicly available.
Morocco	Awarding and effectiveness Three CSP projects have been awarded contracts: NOOR I (160MW, started production in 2016), NOOR II (200MW, started production in 2018) and NOOR III (150MW, which started operation in December 2018). NOOR I and II are PT, NOOR III and IV are ST. The ACWA consortium was the winning bidder. A main priority has been to ensure that awarded projects are built, leading to stringent prequalification requirements, although this limited competition in the first rounds (IRENA 2015). Prices Winning prices (NREL 2018): NOOR I (0.189 USD cents /kWh), NOOR II (0.14 USD cents/kWh) and NOOR III (0.15 USD cents /Kwh). In the 1st tender, the final price of the solar bids was 1/3 lower than expected (de Lovinfosse et al 2013).

South Australia	Awarding and effectiveness. The SA government organized tenders for two power supply contracts in order to meet its long-term power needs: 1) 75% is open to any dispatchable technology; 2) 25% is constrained to dispatchable RETs. SolarReserve was the awarded bidder. It beat other bidders in both categories. It is too early to assess the effectiveness of the auction. Prices. The awarded bidder receives 0.61USD/KWh (for power of 125MW from the 150 MW plant).
India	Awarding and effectiveness Delays, ineffectiveness and signs of winners' curse have generally been reported. In Phase I, 470MW were awarded to CSP (seven plants). Most of these projects are PT (76%, 380MW), followed by Fresnel (20%), ST (2%) and Stirling (2%). However, as of 2018, only 229MW have been built and entered into operation (IRENA 2018a), although those 470MW were scheduled to be commissioned by March 2013. Indeed, by 2014, only 50MW were operational (the Godawari project) (Stadelman, 2014). Prices Final prices paid in the Phase I Batch I were between 175 and 204 USD/MWh, a considerable reduction from the ceiling price of 255 USD/MWh from which bidders had to offer reductions.

Source: Adapted from del Río and Mir-Artigues (2019) and Mir-Artigues et al (2019).

Del Río and Mir-Artigues (2019) and Mir-Artigues et al (2019) discuss the impact of different design elements on the results of CSP auctions in the past, concentrating on effectiveness and bid prices. Regarding effectiveness, the case of India suggests that both design elements and other factors have led to delays, including the overestimation of DNI levels, a relatively recent technology, a weak supply chain, depreciation of the rupee, the drastic reduction in PV costs, too short lead times which prevented bidders from obtaining serious EPC offers, too short realization periods, lenient qualification requirements, problems of grid connection, expensive financing and difficulties in securing land and water.

On the other hand, several reasons explain the low prices in South Australia, Morocco and Dubai. In the first two countries, solar resources (direct normal irradiation, DNI) are very good. In South Australia the low price is related to the possibility to sell the excess production into the market and the additional revenue coming from the sales of renewable energy certificates. In Morocco, it is related to the aforementioned active role of MASEN, which carries out an initial environmental impact assessment (EIA) for each site, commissions pre-feasibility studies, provides financial backing to the bidders and secures concessional low-interest loans from international finance institutions (IRENA 2013). In Dubai, lenient prequalification requirements, the low cost of finance, the provision of land at nominal costs, a large project benefiting from economies of scale, long deadlines and long PPA duration are behind the low prices in that auction (see Padmanathan 2017 for further details).

It should be taken into account that, in addition to different policy goals (stemming from different context conditions), crucial non-design elements affecting the outcome of the auctions (e.g., public-private partnerships in Morocco, existence of complementary instruments etc.) may differ per country. This makes it challenging to compare them between each other. Still, useful lessons for the future design of CSP auctions can be inferred, as discussed in the next section.

4. The future outlook of CSP auctions

The five cases suggest that, although design in CSP auctions is strongly influenced by the respective policy goals, some design elements have been particularly suitable for CSP. These include technology-specific auctions (which create a niche for CSP), site-specific auctions (which facilitate coordination of the auction and grid connection procedures and secure land and water), long lead times and long deadlines for construction of projects, stringent prequalification requirements (developer experience), provision of DNI measurements and valuation of dispatchability. Given the importance of large size and economies of scale in CSP cost reductions (IRENA 2012, IEA 2014), a maximum size of projects should not be required.

Valuation of dispatchability will be a common design element in CSP auctions. This may come in the form of a requirement for a given dispatch profile. As argued above, renewable electricity generation technologies are quite different from each other, especially regarding their dispatch profile. Policy-makers must understand their differences in order to achieve an optimum generation structure with the minimum fossil-fuel back-up and lowest system costs. A main feature of CSP plants with storage is that they can produce high-value dispatchable power on demand. In the future electricity systems with a high penetration of variable RES, electricity generation technologies with flexible dispatch, such as the one which can be provided by CSP with storage, will be needed.

The above means that technology-specific auctions may not be required. At least in places with medium/high DNI, CSP may compete in technology-neutral auctions as long as the dispatch profile which is complementary to such variable RES (and particularly PV) is auctioned. They will be needed for technologies that respond to the needs of the system at specific times of the day, as the current conventional generation is replaced. In the case of dispatchable technologies, which can solve the problems related to the "duck curve" associated to the shutting down of PV every afternoon and can deliver firm and synchronous power at evening and night, competitive auctions would establish conditions to their dispatch profile that contribute to the techno-economic optimization of the whole system.

There is only one example where CSPs were competing in a technology-neutral auction which was in Chile, 2016. The experiences from that auction can serve as a basis for future participation possibilities for CSPs in such auctions. Even though the participating CSP plant was outcompeted in the Chilean auction by other technologies it was the lowest ever bid that have been placed by a potential CSP power producer, with a bid less than 50 USD/MWh (Power Technology, 2019). According to these results it seems that letting CSP to compete with other technologies can significantly reduce prices, if the auctions setup and the radiation level is proper for the technology.

Dispatchability requirements may lead to the success of the technology in technology neutral auctions in the future (especially in places with a high DNI), while simultaneously contributing to the minimization of system costs. This dispatchability feature is often not taken into account in RES auctions. Three design elements could include this feature in auctions: time-diverse auctions (i.e., different auctions are organized according to the generation profile, e.g. base-load, non-peaking and peaking, as in California), higher remuneration at times of higher demand (as in RES auctions in Mexico, Abu Dhabi and South Africa) and prequalification requirements prescribing a minimum number of hours of storage (Dubai)(del Río and Mir-Artigues 2019).

However, although design elements will be crucial to encourage the effective and efficient uptake of this technology, auctions can't do everything and need to be complemented with other policy interventions, including de-risking instruments which facilitate financing (or reduce financing costs) and support for R&DD, and particularly demonstration.

Appropriate framework conditions may play a role here too. Beyond specific instruments, the definition of long-term political frameworks supported by regulatory schemes is a crucial element to encourage private R&D investments. In fact, given the relevance of framework conditions as drivers of CSP deployment in the future, as stable and credible support as possible should be provided (del Río and Kiefer 2018). This entails setting long-term targets, ensuring predictable changes in the remuneration for new plants and avoiding retroactive changes for existing plants. These framework conditions provide a positive signal for investors throughout the whole value chain and, thus, induce the required investments which would reduce costs through learning effects (deployment) and private R&D.

All in all, when assessing the pros and cons of different design elements in CSP auctions, the policy goals of the countries organizing these auctions, which partly depend on their context conditions, should be taken into account in addition to the specific features of this technology. This may lead to the adoption of one design element over another.

5. Conclusions

CSP is expected to play a non-negligible role in the future power mix worldwide due to its flexibility and dispatchability. The exact volume of CSP needed in a sustainable power system will depend mainly on its future costs as well as the availability and cost of alternative flexibility options. The widespread implementation of RES-E auctions has a role to play in decreasing the costs of CSP, by supporting renewable energy technologies effectively and efficiently.

In the past, auctions have led to relatively low and/or decreasing prices of CSP over time. In contrast, mixed results with respect to effectiveness can be observed or it is still too early to infer conclusions with respect to this criterion. The analysis above suggests that some design elements may be particularly suitable for CSP, including technology-specific auctions, site-specific auctions, long lead times and long deadlines for construction of projects, stringent prequalification requirements and valuation of dispatchability.

The latter can be expected to be the key factor driving the technology, since dispatchability is also the main distinguishing feature of this technology with respect to other RETs. Future auctions will need to put more emphasis on the dispatchability value of CSP, combined with technology-specificity. Dispatchability requirements may favour this technology in the future, while simultaneously contributing to the minimization of system costs.

Furthermore, complementary instruments might be particularly useful for CSP, including de-risking instruments which facilitate financing (or reduce financing costs) and support for R&DD, especially demonstration. Beyond instruments, appropriate framework conditions will play an important role in contributing to the deployment of this technology and innovation which in turn leads to cost reductions and feeds back into further deployment.

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AURES II is a European research project on auction designs for renewable energy support (RES) in the EU Member States.

The general objective of the project is to promote an effective use and efficient implementation of auctions for RES to improve the performance of electricity from renewable energy sources in Europe.

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