Report D4.2, June 2016

Auctions for Renewable Support: Lessons Learnt from International Experiences

AURES

European Commission

HORIZON 2020

About the project

Auctions for Renewable Energy Support: Effective use and efficient implementation options (AURES)

This project helps assessing the applicability of different auction types to renewable support under different market conditions. It also explores which auction types and design specifications suit particular requirements and policy goals in European countries. By establishing best practices and a knowledge sharing network, we contribute to informed policy decision-making and to the success of auction implementations across Europe.

Target-oriented analysis: Through analysis of empirical experiences, experiments and simulation, we will create a flexible policy support tool that supports policy makers in deciding on the applicability of auction types and certain design specifications for their specific situation.

Capacity building activities: We undertake specific implementation cases to derive best practices and trigger knowledge sharing amongst Member States. We strive to create a strong network with workshops, webinars, bilateral meetings, newsletters, a website that will serve as capacity building platform for both policy makers and market participants (including project developers, auctioneers, etc.). Wherever required, we can set up specific bilateral and multilateral meetings on specific auction issues and facilitate cooperation and knowledge sharing. Additionally, we offer sparring on specific implementation options, drawing from insights gained during the first phases of the project (empirical analysis of previous auctions in Europe and the world), conceptual and theoretical analysis on the applicability of specific designs in certain market conditions and for certain policy goals issues and facilitate cooperation and knowledge sharing. Additionally, we offer sparring on specific implementation options, drawing from insights gained during the first phases of the project (empirical analysis of previous auctions in Europe and the world), conceptual and theoretical analysis on the applicability of specific designs in certain market conditions and for certain policy goals.

Project consortium: eight renowned public institutions and private firms from five European countries and combines some of the leading energy policy experts in Europe, with an impressive track record of successful research and coordination projects.

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Project deliverable:
WP4 - Empirical aspects of auctions for RES-E: Learning from real experiences.
Task 4.3

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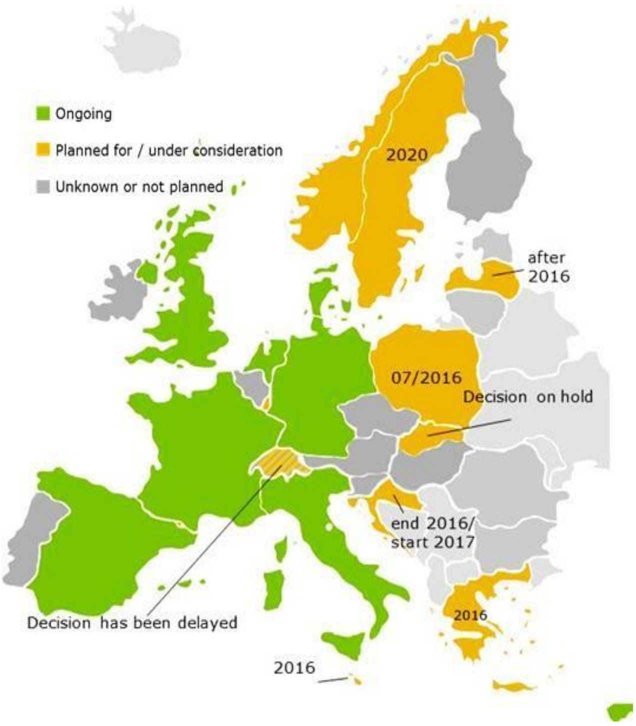
Executive Summary

There has been a revived interested in RES auctions in Europe, as a market mechanism that allows for the control of support costs and RES volume deployment. More importantly, the European Commission State Aid Guidelines for Environmental Protection and Energy 2014-2020, state that by January 2017 all Member States seeking state-aid clearance shall set up competitive bidding process to grant support to all new installations, with only very few exceptions (European Commission, 2014). Figure 1 shows that, as of March 2016, eight Member States had introduced auction schemes for at least some technologies, with another seven considering their introduction before 2020.



Source: Ecofys, 2016

Figure 1 - RES-E auction implementation in Europe

This report synthesizes the findings of Work Package 4 (WP4) of the AURES project. The report presents the main trends in auction design in eight EU and four non-EU countries, assesses their performance against four criteria, and derives lessons that will serve as input for the formulation of specific recommendations in later work packages. Statements made about these countries are limited to the scope defined in each of the case studies (see Figure 2 below).

EU country case	Scope
Denmark	Wind offshore and nearshore auctions since 2004
France	Solar PV 100-250 kW auctions in 2011-2014
Germany	Ground-mounted solar PV pilot auction in 2015 (two first rounds)
Ireland	Auction rounds (AER I – AER VI) in 1995-2003
Italy	Lowest Bid Auctions that took place in 2013-2015
Netherlands	SDE+ auction rounds in 2011-2015
Portugal	Wind auction rounds in 2006-2008
United Kingdom	CfD auction round in 2015

Non-EU country case	Scope
Brazil	Wind onshore auctions in 2009-2013
California (US)	RAM auctions 2011-2015
China	Wind onshore auctions in 2003-2007
South Africa	REI4P auctions in 2011-2015

Figure 2 - Selected country case studies

Trends in auction design across selected case studies

All analysed auction schemes required bids to be submitted in **capacity (MW)**, with the exception of Brazil. In Brazil, auctioned volume was expressed in energy (MWh) instead. **Technology-specific** auctions for eligible technologies were applied in 9 out of 12 countries, either alone or in parallel with technology-neutral auctions (Brazil). **Multi-technology** auctions were implemented in two cases: in California technologies were grouped according to their generation profile, while the UK set specifics pots for mature and non-mature technologies. The Dutch SDE+ includes a “free category” in each round, which allows bidders -independent of technology- to access the scheme sooner, albeit at lower tariffs. Brazil’s new energy auctions were usually technology-neutral, but have in the past restricted participation to certain technologies.

Volume caps have been the most common method of limiting the total amount of RES-E capacity that is to be allocated in a given auction round or year. **Budget caps** have been introduced in three of the examined countries (Netherlands, Italy and the UK), in order to make sure deployment is achieved within a defined budget.

Restricted project sizes have been implemented in nine out of 12 countries. Moreover, only three EU countries (Germany, Italy, and the Netherlands) **scheduled** auctions at least once a year. In the studied non-EU countries, at least one auction round took place every year.

Most EU countries (Denmark, Germany, Italy, Netherlands, and the UK) awarded **sliding FIPs** to auction winners, i.e., a subsidy per produced electricity (kWh) on top of the wholesale market price, which is adjusted according to the electricity price development[1]. In contrast, power purchase agreements (PPAs) paying a **FIT** to auction winners were awarded in all non-EU case studies.

Design features defining how are bids awarded

Multi-item auctions were implemented in all auction schemes, yet some countries also implemented single-item auctions in order to procure capacity from offshore wind with predefined size and location (Denmark) or a specific bio-waste incineration plant (Ireland).

With the exception of the Netherlands and Brazil, all analysed schemes operated as **static (sealed-bid) auctions.** The Dutch scheme operates as a **dynamic** (**ascending) auction** in the form of sequential bidding phases with increasing prices. Brazil uses a **hybrid between dynamic and static auctions**: phase one operates as a descending-clock auction, while phase two consists of a final pay-as-bid round for the winners of phase one (Maurer & Barroso, 2011).

The pricing rule most often applied was **pay-as-bid**, with nine out of 12 countries opting to pay successful projects what was offered in their bids. The Netherlands and the UK opted for a **uniform (pay-as-cleared) pricing rule** instead, by which all bids receive the clearing price, i.e. the price of the last bid accepted (or the first bid not accepted) to match supply and demand. China changed its pricing rule in 2007 from a simple minimum-price to an **average-price** rule, with the aim to discourage bidders from offering below-market prices.

Price-only auctions have been the most common method of bid evaluation in EU countries. The examined Non-EU countries, on the other hand, opted for the combination of bid price with other criteria in the selection of winning bids (i.e. **multi-criteria auctions**), except for Brazil. Lastly, most countries implemented **ceiling prices**, with the exception of France and China.

Design features regarding project realisation

The use of **pre-qualification criteria** was widespread in both EU and non-EU countries. In most of the country cases, the regulator decided to implement "late auctions", i.e. the auctioneer sets the timing of the auction at a late stage of project development. Interested bidders were required to procure several permits (e.g. building, environmental), so that winning bids were more or less ready to begin project construction.

Regarding **penalties**, all countries have chosen a mix of strategies to discourage delays and non-realisation of projects, including the enforcement of bid bonds, support reduction, and reductions in support duration. In China, no clear penalties were defined, yet the government could terminate the support contract in case delays were not sufficiently justified.

[1] In the case of a CfD, this premium can also get negative, in case the electricity price rises above the strike price.

Assessment

Policy effectiveness

The effectiveness of auctions was assessed in two ways: their ability to contract new RES-E capacity, and project realisation. An important limitation in the assessment is that the realisation periods of some winning projects have not yet finished, due to their different durations or the recent introduction of auction schemes. In these cases, it is too early to conclude on the realisation rate.

As a volume or budget allocation instrument, auctions successfully contracted desired capacities in nine of the twelve case studies. In the UK, Netherlands, and Italy targeted budgets or capacities were not fully allocated in certain delivery years (UK), auction rounds (NL), or technologies (IT). The case studies also showed that full project realisation is rarely achieved, and delays are frequent. Auction schemes in China, Denmark, and Portugal have now commissioned 100% of contracted capacities, albeit not without delays in some cases.

At least 75% of projects -whose realisation period has ended- in California and South Africa have been built. In Brazil, France, and Italy, less than 50% of projects –whose realisation period as ended- have been realised. Grid connection problems have been an important factor behind the construction delays in Italy and Brazil. Effectiveness of these schemes cannot be judged yet because the realisation period of some projects has not ended.

Static efficiency

Static efficiency is achieved if a predetermined target can be fulfilled at the lowest possible overall cost. As it is difficult to determine the lowest *possible* cost, we evaluated if auctions led to lower prices compared to ceiling prices or previous (administratively defined) support levels.

All auction schemes, reported efficiency gains in terms of the contracted price or discounts achieved. Efficiency gains in countries like California, Brazil and South Africa were remarkable. Support levels in California fell from €79.5/MWh in the first round, to €70.5/MWh in the third one (CPUC, 2014). In Germany, the average price of the first auction round was €91.7/MWh (min.: €84.8/MWh, max.: €94.3/MWh), which is significantly below the ceiling price of €112.9/MWh. In the second round, which applied a uniform price, the price further declined to €84.9/MWh.

Although average contract prices achieved in the first auction round in the UK were lower than the ceiling prices, thus leading to efficiency gains, auction results show that the more expensive technology (offshore wind) had the largest share of support overall because the offshore pot was the biggest. In Denmark's Anholt auction only one bidder participated in the auction, which makes it questionable that the auction helped identify the least-cost supplier. Other producers likely abstained due to financially more attractive markets at the time, especially in UK (Kitzing & Wendring, 2015). This, together with the supply bottlenecks experienced at the time in the region, led to a high contracting price (€141/MWh).

Dynamic efficiency

In contrast to static efficiency, dynamic efficiency evaluates the costs of target achievement over the long-term, and considers whether a policy instrument helps drive down costs of less mature technologies. Overall, it is not possible to thoroughly assess dynamic efficiency because its measurement requires longer time spans than the ones considered in the auction schemes.

Case studies showed there may be a trade-off in the short term between high competition and fostering innovative RES-E solutions. Still, technology differentiation seems to be more suitable due to the diversity it promotes. Both EU and non-EU countries have some form of differentiated support that reflects technology-specific costs, be that in the form of technology-specific or multi-technology auctions. However, the ability of reviewed auction schemes to foster dynamic efficiency was limited, to varying degrees.

Lessons learnt from international experience

General lessons

General auction implementation
Competition or the lack thereof is, to a large extent, related to structural issues but also influenced by auction design. Determining volumes according to the anticipated level of demand, having transparent rules and low access barriers are all aspects within auction design that are conducive to competition. The absence of appropriate infrastructure for project development in locations with high RES potentials can negatively affect the efficiency (Portugal) and effectiveness (Brazil) of auctions. Facilitating the entry of as many bidders as possible requires, among others, good communication about auction rules. A transparent and inclusive design and implementation, together with the incorporation of feedback from developers, facilitate participation. Technology-specific auctions can address several policy goals, such as regional distribution, actor diversity or the development of local manufacturing industries. An analysis of the market situation and project structure for each technology is crucial in determining the appropriate auction type and deciding whether technology-neutral auctions are appropriate for a particular context or not. Although auctions have been applied to support small- (France) to medium-scale technologies (California), and do not *per se* exclude smaller players, experience shows that large and experienced/professionalised project developers win the largest share of the auctioned capacities or energy.

Lessons regarding the auction procedure and remuneration

Auction procedure & remuneration	
Auction format	The trend to implement **static (sealed-bid)** auctions in both EU and non-EU countries (except in Brazil and the Netherlands) is likely due to their relative simplicity, and the familiarity of sealed-bid processes from the regulators' and bidders' standpoint.
Frequency	**Continuity in the implementation** of auction rounds, as opposed to a "stop-and-go" implementation, increases long-term planning certainty for market players. Auction **frequency** is context-dependent, and should allow regulators to adjust according to perceived shifts in market conditions. A frequency of more than one round per year can limit project development risks.
Ceiling price	**Ceiling prices** that define the maximum possible support level limit the risk of high support costs for governments/consumers. Determining appropriate **ceiling prices** remains challenging, and may involve relatively high transaction costs.
Auction volume	Setting **volume caps** below the potential market volume enhances competition, which can lead to price reductions. South Africa's first auction (2011) was not very successful in enhancing competition, given that there was no capacity limit attributed to this first phase except the overall programme volume, which meant that the auction volume far outstripped demand.
Bid evaluation criteria	A purely **price-only** selection process is associated with lower support and transaction costs, while the inclusion of other criteria imposes restrictions that might lead to higher costs and decreased transparency. However, **multi-criteria** auctions can also help promote social acceptability and local economic development
Pricing rule	**Pay-as-bid** has been the preferred pricing rule in most EU and non-EU schemes. Pay-as-bid tends to be more robust against undesired, strategic behaviour than uniform pricing, despite some advantages in auction theory. In addition, and since it offers bidders no more than their bid, this pricing rule usually finds high public acceptance.
Awarded contract or remuneration	What is auctioned can be as important as how it is auctioned. Using standardised, **long-term PPA**s with conditions known in advance by bidders can lower risk premiums. Moreover, making contract duration compatible with the duration of the typical financing maturity given by banks can increase a project's bankability. **Investor confidence** can be enhanced through different methods of sharing financial risks related to exchange rate and/or inflation that can impact income throughout the contract period. In liberalised markets, auction winners can be required to sell the electricity on the market, with the auction award being a sliding or, with higher risks, fixed premium on top of the market revenues (feed-in premium). Most European countries use sliding premiums to limit the revenue risk for RES-E generators.

Lessons regarding eligibility requirements

Eligibility requirements	
Pre-qualification requirements	**Pre-qualification requirements** have been set in all the examined countries. They help to identify “serious” (i.e. reasonably-calculated) bids, and sort out projects with low realisation probability. Implementing low pre-qualification and penalty levels at the same time might attract speculation and result in poor realisation rates. Risks should be allocated to the actor best able to deal with them. Establishing a **one-stop shop for permits** (e.g. Denmark), for example, could be done by public entities, while issues related to project development are probably better dealt with by the project developer. This would reduce transaction costs for bidders and reduce the probability of non-realisation.
Location and project size requirements	Implementing **minimum project size requirements** has the potential to reduce the transaction costs associated with small bids, although potentially deterring their participation, which may have detrimental effects on competition. Maximum size requirements can encourage the participation of smaller actors and help avoid market concentration, but limit economies of scale. **Location constraints,** such as regional quota or reference yield models, are intended to, among others, achieve greater geographic diversity of projects, and ensure proximity to the grid and/or loads. If sites are pre-developed by the auctioning authority (single item auction), care must be given to provide correct information in order to avoid unnecessary risks for bidders.

Lessons regarding project realisation

Project realisation
Next to pre-qualification requirements, strict compliance rules help to ensure serious bids, but they can also lead to low participation and competition. Lower penalties reduce the risk related to construction delays and failure, which could stimulate a higher number of bids, but they do not encourage project realisation. **Striking a balance** between pre-qualification requirements and penalties is therefore of key importance, as well as adapting penalties to local circumstances. Case studies show that **penalties are not a guarantee for project realisation**. Pre-qualification requirements seem especially important for selecting realisable projects from the beginning, especially when dealing with unexperienced bidders. Looking at penalties, reviewed schemes also show the importance of **differentiating between delays** caused by the project developer or by external factors (e.g. environment licence or grid connection).

Policymakers should closely **monitor potential loopholes** or other factors that could render penalties toothless. Also, leaving room for legal dispute about who caused the delays can block project pipelines and prolong project realisation.

A **'waitlist' system**, by which developers unable to sign the auction contract are replaced by second-best projects like in the state of California, can potentially lower the risk of non-target achievement. However, 'waitlist' systems are only viable if there are enough serious bids to choose from and if remaining on the waitlist is not linked to substantial risks for project developers.

Settlement rules to manage production deviations can help discourage developers from systematically over- or underestimating their generation expectations.

Setting up **early warning systems** to identify delays at early stage helps to constructively address delays in a timely manner.

1. Introduction

While many countries have used auctions in regular public procurement processes, experiences with the use of auctions for RES-E support are limited, and early examples have indicated the existence of implementation problems. The European Commission recommends that Member States increasingly adopt more market-based based instruments, including competitive bidding processes. Current State Aid Guidelines for Energy state that by January 2017 all Member States shall set up competitive auctions to grant support to all new installations, with only very few exceptions (European Commission, 2014). In this context, international experiences with auctions provide important lessons for the reform of existing or the implementation of new auctions schemes.

This report synthesizes the findings of Work Package 4 (WP4) of the AURES project. WP4 assessed existing experiences with RES-E auctions from 12 countries around the world, and derived lessons that will be used as input in the formulation of specific recommendations in later WPs. WP4 applied the following methodology: First, information on past auctions in the selected countries was gathered through a desktop study, which included existing scientific literature and reports on auctions. And second, expert interviews (one or two per case study) were conducted with market experts and public officials directly involved in auction design and implementation. Interviews provided input regarding auction outcomes, particularly those on project realisation that were not publicly available. Reports on all case studies, together with a webinar hosted by Ecofys on "How to design RES auctions: practical and empirical aspects" presenting some of the main findings, can be found on the AURES website.[2]

Results from the desktop research and the expert interviews, and input from the webinar, were used to characterise past auctions in the selected countries, assess them according to six criteria identified and elaborated by WP1 and WP2, and extract case-specific lessons learnt. This report builds up on this, identifying general trends in auction design and implementation, and combining lessons learnt from all case studies. Moreover, the report highlights the framework conditions that both enabled successful auctions but also led to suboptimal outcomes.

[2]Please see http://www.auresproject.eu/events/aures-auction-academy-4 for the webinar and http://www.auresproject.eu/publikationer/report for the reports.

The report is structured in five chapters. Chapter 2 gives a summary of each of the 12 case studies analysed in WP4. A link to each of the case studies is provided at the end of each summary. Chapter 3 presents the main trends in action design features identified across selected EU and non-EU case studies: first by making a general characterisation of the schemes, second by presenting trends in design elements that define how bids are awarded and those that contribute toward project realisation.

Chapter 4 assesses the performance of the selected EU and non-EU case studies based on the four criteria where there were more solid results to built upon: policy effectiveness, static efficiency, actor diversity, and dynamic efficiency. Chapter 5 presents a compilation of general lessons on auction implementation, as well as lessons specific to eligibility requirements, the auction procedure, and project realisation.

Statements made about EU and non-EU countries only cover the sample of 12 case studies analysed, and therefore should not be taken as descriptive of all auction schemes in these regions. Several of these countries run auctions with a wider scope of technologies and capacities than the ones analysed in the case studies. The assessment is limited to the scope defined in each of the case studies (see Chapter 2): only certain RES-E and time periods are covered. Moreover, some of the assessments made on the effectiveness of auction schemes are preliminary because some schemes have been recently introduced, capacities awarded have different delivery dates, or simply because more recent information was in some cases not available.

2. Summary of case studies

The following section summarizes the eight EU and four non-EU countries analysed in WP 4 of the AURES project. For each country, a brief description of the time period and technologies covered by the case study is made, followed by an overview of the main auction design features, and concluding with a short assessment of the efficiency and effectiveness of the scheme. A detailed description of auction design features and assessment criteria can be found on the AURES website[3].

2.1 Denmark

Denmark is one of the leading countries in the world in terms RES deployment other than hydro. Several different instruments are used for the promotion of renewable energy, including feed-in tariffs (FITs), premiums, and tax incentives (Kitzing et al., 2012). Auctions for RES support are currently used for offshore and nearshore wind, with a pilot auction for solar PV planned for 2016 (Danish Energy Agency, 2016). The case study focuses on the five auctions rounds for offshore wind power that have taken place since 2004 and, to a lesser extent, the two nearshore and offshore wind power auctions currently ongoing.

The Danish scheme operates as a static (sealed-bid), pay-as-bid auction, in which sliding feed-in premiums (FIPs) are paid for a fixed volume of produced electricity for about 12-15 years. Auctions are single-item, with the exception of the ongoing nearshore round (multi-item), in which a maximum capacity of 350 MW is

[3] For a description of design features see del Rio et al. (2015): Overview of Design Elements for RES-E Auctions. Available from: http://auresproject.eu/files/media/documents/design_elements_october2015.pdf. For a definition of assessment criteria see del Rio et al. (2016): Assessment criteria for RES-E Auction. Available from: http://www.auresproject.eu/files/media/documents/assesment_criteria_october2015.pdf

distributed over 6 predefined areas. The first two rounds (Horns Rev 2, Rødsand 2 – 1st attempt) were multi-criteria auction, while subsequent rounds were price-only, in all cases preceded by a pre-qualification stage.

A distinguishing feature of the Danish scheme has been the implementation of stakeholder dialogues during the auction procedure. Starting in Horns Rev 3 (2014/5), the Danish Energy Agency (Energistyrelsen (ENS), in Danish) held meetings with pre-qualified bidders to discuss auction conditions before they submit their final offer. For the two upcoming auctions, preliminary technical dialogues between potential bidders and ENS were held before the auction specifications were announced the first time. Though this mechanism was praised by investors because it helped reduce risk, it also may have weakened the competitive nature of auctions.

All auctioned Danish offshore wind projects have been realised, which helped increase installed capacity from 455.2 MW before the auctions to currently 1271.5 MW, at an average price of €99.5/MWh. In the Anholt auction (2009/10), only one bidder participated in the auction due to high risk (i.e. high penalties, short realization time, strict 'waiting list' requirements for the bidder that comes in second), and a more attractive offshore market in the UK. This lack of competition led to high support prices of €141.4/MWh.

The case study for the Danish auction scheme can be found on the AURES website:
http://auresproject.eu/files/media/countryreports/pdf_denmark.pdf

2.2 France

Electricity from renewable sources in France is promoted through FITs, tax benefits, and auctions for solar PV & CSP, wind onshore & offshore, hydro, and biomass[4]. Two different auction schemes for solar PV exist: one for solar PV with installation capacity between 100 and 250 kW, and one for projects larger than 250 kW. The case study focused on the 100-250 kW solar PV auctions that took place between 2011 and 2014.

Since 2011, France has conducted multi-item, static (sealed-bid), pay-as-bid, online auctions for solar PV installations between 100 and 250 kW. Initially, seven auction rounds were scheduled for 2012-2013 for a total of 120 MW. However, the last two rounds were cancelled in order to improve auction design, including a revision of the pre-qualification requirements. In 2013-2014, three rounds took place for a total of 120 MW (CRE, 2013).

Except for the first round of auctions in 2012, offered capacity exceeded the auctioned volume required to meet the targets set by the French government, showing that the auction scheme has the potential to be effective. However, only 60% of submitted bids were eligible, which was likely the result of unclear pre-qualification requirements (e.g. regarding the CO2 assessment).

The fact that many bids were excluded for formal reasons negatively affected competition levels, and projects offering relatively high prices managed to be successful. In addition, the amount of eligible bids in the 2013/4 rounds was less than 1 MW above the auctioned volume, which indicates that there was barely any competition, and may have compromised the efficiency of the auction. Indeed, the average support price for these solar PV systems was €193.4/MWh or €20-30 above that paid under the previous FIT.

[4] For more information on France´s auction scheme visit the Energy Regulatory Commission (CRE, in French) website under: http://www.cre.fr/documents/appels-d-offres

The case study for the French auction scheme can be found on the AURES website:
http://www.auresproject.eu/files/media/countryreports/pdf2_france.pdf

2.3 Germany

The auction scheme in Germany was implemented with three objectives in mind: to determine the required level of support for RES-E in a competitive manner, manage the capacity expansion of renewables while staying on track with targets, and allow the participation of a variety of market players (§2 (5) EEG 2014). Moreover, and like in other EU countries, auctions in Germany were introduced to comply with the current EU State Aid Guidelines. The first round of the pilot auction was held in April 2015, with future auctions planned for rooftop solar PV, wind onshore and offshore from 2017 onwards. The case study focused on the first two rounds of the ground-mounted solar PV auction pilot taking place in 2015.

The pilot scheme operates as a multi-item, static (sealed-bid), pay-as-bid auction (except for two rounds in 2015 using uniform pricing). The scheme is technology-specific, as only ground-mounted PV plants between 100 kW and 10 MW may participate. To meet pre-qualification requirements, bidders need to specify the location of the project, include proof of a zoning approval by the responsible authority, and hand in a first bid bond worth €4/kW. The bid bond is halved if the bid includes a definitive zoning approval, instead of a preliminary one.

All actors participate on equal conditions, regardless of the type or size of the participant. Price is the only evaluation criterion for eligible bids. Auction winners are required to submit a second bid bond worth €50/kW, which is halved if the submitted zoning approval is a definitive one, a distinction introduced to assist smaller actors.

Both rounds exhibited high levels of competition: in the first round, the auctioned volume (150 MW) was exceeded four times, while in second round the volume (159 MW) was exceeded three times. Effectiveness in terms of the timely commission of projects cannot be yet evaluated due to the 18-month realisation period. The first two rounds led to lower support costs: the average price of the first auction round (pay-as-bid) was €91.7/MWh, which was significantly below the ceiling price of €112.9/MWh. In the second round (uniform price), support level further declined to €84.9/MWh.

The case study for the German auction scheme can be found on the AURES website:
http://www.auresproject.eu/files/media/countryreports/pdf_germany.pdf

2.4 Ireland

The first round of the Alternative Energy Requirement (AER) programme took place in 1995. The initial RES-E target of 75 MW of additional installed capacity by 1997, was later extended by a further 100 MW by 1999, and then to an additional 500 MW by 2005 (Government of Ireland, 1999). Technology focus varied across rounds but included wind, hydro, biomass, and CHP. Though the main goal of the AER programme was least-cost, some weight was given to actor diversity, which was assumed to promote public acceptance. This case study focused on the six auction rounds (AER I – AER VI) taking place between 1995 and 2003.

The AER programme operated as a multi-item, static (sealed-bid), pay-as-bid auction. One exception was AER II, which operated as a single-item auction aimed at contracting a specific biomass project in north Dublin. With the exception of AER I, support auctioned was a FIT per kWh. In AER I, on the other hand, support was given in the form of a capital grant. In all auction rounds, PPAs for up to 15 years were provided to successful bidders.

In anticipation of non-realisation of some projects, more projects were contracted than initially planned in most auction rounds. However, realisation rates were poor, with only about a third of all contracted capacities actually been installed by 2005 (IZES, 2014, DMNR, 2005). An assessment of support costs resulting from the AER scheme is difficult to make, as these are not publicly available. However, a comparison of AER VI's ceiling price (wind onshore, €56/MWh) with the guaranteed price of the FIT scheme (wind onshore, €62/MWh) that followed shows that support paid under AER VI was relatively low.

The case study for the Irish auction scheme can be found on the AURES website:
http://www.auresproject.eu/files/media/countryreports/pdf3_ireland.pdf

2.5 Italy

Since 2012, support for renewables is regulated by three instruments: (1) Direct access allows small plants[5] to receive an administratively-set FIT once commissioned. (2) The Registry is for medium-sized plants[6] who receive a technology-specific FIT or premium after having obtained the building permit. (3) Large RES-E plants[7] participate in Lowest Bid Auctions to receive a sliding FIP. All technologies are eligible except for solar, which since 2016 no longer receives support. The case study focuses on the three rounds of the Lowest Bid Auctions that took place between 2013 and 2015.

The auction scheme operates as a multiple-item, static (pay-as-bid) auction, where project developers bid a discount from the base tariff (i.e. ceiling price). Those meeting the pre-qualification criteria are ranked based solely on price, until the technology-specific auctioned volume is reached. In order to prevent under- or overbidding, Italy has prescribed floor (-30%) and ceiling (-2%) deductions for all technologies.

Except for onshore wind, the number of bids offered was below the auctioned capacity, which means there was no real competition. In the case of onshore wind the auction led to efficiency gains, which are seen in the tariff bid reductions: the average price went from €118/MWh in round 1 to € 87/MWh in round 3 (Negri, 2015). As for the effectiveness of the scheme, results show it was modest, with only 50% of the projects contracted in the first round (2012) starting operations on time. A further 25% is under construction and expected to enter into operation before May 2017 by accepting to pay a small penalty.

The case study for the Italian auction scheme can be found on the AURES website:
http://www.auresproject.eu/files/media/countryreports/pdf_italy.pdf

[5] RE projects eligible for Direct Access support: < 60 kW wind, < 50 kW hydro, <200 kW biomass, and <100 kW biogas
[6] RE projects larger than the Direct Access threshold but smaller or equal to 5 MW (except for hydro ≤ 10 MW and geothermal ≤ 20 MW)).
[7] RE projects larger or equal to 5 MW, except hydro > 10 MW and geothermal > 20 MW

2.6 Netherlands

In 2011, the Dutch government replaced the FIP scheme SDE with SDE+, a sliding FIP determined in auctions. The SDE+ scheme aims to incentivise the deployment of RES at the lowest possible cost, and is open to a wide selection of pre-defined technologies in the electricity, heating & cooling, and gas sectors. For each of the individual technologies a maximum price and eligible full-load hours are determined annually. This case study focused on the auction rounds that took place between 2011 and 2015.

The SDE+ operates as a multi-item, dynamic (sealed-bid), uniform price auction. Each auction round encompasses several sequential phases with increasing prices. The government defines ceiling prices for each phase, and bidders offer a corresponding volume. As long as the maximum technology price is not met by the ceiling price of the phase, developers can choose to wait for the next phase to optimise their subsidy. However, the risk is that the SDE+ will be closed before, if the annual budget cap has been reached. Therefore, there is an incentive to participate earlier at very low support levels to avoid being left out in case there are no further rounds.

Although the design of the instrument differentiates between technologies, in practice it resembles a technology-neutral scheme due to the existence of the ‘free category’. This category is open for projects that are able to produce at lower costs than the ceiling price for the specific technology, and so, allows bidders to access the scheme sooner, at lower tariffs.

By the end of 2015, 68% of projects awarded SDE+ in 2011 had been built (RVO, 2014). Moreover, demand has been structurally higher than the budget available, which leads to a relatively high level of competition. Average support granted for new onshore wind projects in 2015 ranged between €41 and €65/MWh[8] (RVO, 2015). Because more expensive technologies have an incentive to apply in the ‘free category’, the scheme may also encourage underbidding for technologies like solar PV. The fact that 70% of solar PV capacity awarded since 2012 has been built, however, suggests project realisation may not have been affected by underbidding so far.

The case study for the Dutch auction scheme can be found on the AURES website:
http://www.auresproject.eu/files/media/countryreports/pdf_netherlands.pdf

2.7 Portugal

Renewables account for 58% of total power installed capacity (hydro 28% / wind 24%) in Portugal, one of the highest shares in Europe. Between 2006 and 2008, the government conducted auctions for wind onshore and, to a lesser extent, biomass. The duration of the scheme was limited to this period because it aimed to contract a certain volume of wind capacity (1800 MW), and cement the foundation of an industrial cluster for wind energy in the country. The new remuneration model introduced in 2015 foresees, among others, the use of competitive bidding for the allocation of feed-in premiums (FIPs). This case study focuses on the three wind auction rounds that took place in 2006-2008.

[8] The maximum SDE+ basisbedrag for typical wind onshore ranged between 74-98 €/MWh. The correctiebedrag (average electricity price) over 2015 had been determined at 33 €/MWh (Staatscourant, 2016).

These auctions were organised as static (sealed-bid), pay-as-bid auctions, with the 2006 and 2007 auctions being single-item and the 2008 one multi-item. The scheme was designed as a technology-specific auction, where only wind and biomass participate. Project developers offered discounts with respect to a reference tariff set by the government. Among the bid evaluation criteria, the creation of an industrial cluster[9] was the most prominent one (45%), followed by technical management of the project (25%) and offered price (20%). Moreover, the winner (i.e. consortium with EDP) in the first round was excluded from participating in the second round, to ensure that at least two different entities will construct and operate the plants.

These auctions had a positive impact on the licensing of new RES-E capacity, and on the number of new jobs and industrial development in the country (Winkel et al., 2011). Wind capacities auctioned in 2005 started to be implemented in 2008, and were completed in 2014 (Peña, 2014). The projects were realised despite concerns at the time from some experts, that auction winners may have overestimated their capacity factors and/or underestimated their costs (del Rio, 2016a). Though the allocated support for wind was lower than under the previous FIT (5%-23% discounts), the scheme may have not led to the lowest possible bids since the development of industrial clusters was the most important criterion (Heer & Langniss, 2007).

The case study for the Portuguese auction scheme can be found on the AURES website:
http://www.auresproject.eu/files/media/countryreports/pdf_portugal.pdf

2.8 United Kingdom

Renewable electricity in the UK has been supported since 1990. The Non Fossil Fuel Obligation (NFFO) auction ran from 1990 to 1998, after which it was replaced by the Renewables Obligation (RO) quota in 2002. The RO is currently being phased out, with large scale solar (>5MW) being excluded from it since April 2015, and onshore wind since April 2016. The RO will expire for all other technologies in 2017, and be fully replaced by the Contracts for Difference (CfD) auction scheme. This case study focuses on the first (and so far, only) round of the scheme in 2015.

The CfD auctions are multi-item, static (sealed-bid), uniform-price auctions. In the first auction, technologies were divided into 3 pots: established (onshore wind, solar PV), less established (offshore wind, geothermal, wave etc) and biomass conversion, with different ceiling prices (known as “administrative strike prices”, ASP) set for each of the technologies in the pots. There is an overall budget for each of the pots, which is capped per year of delivery rather than the overall spending implications of a given auction round. Within each pot, bids are stacked according to price, independent of technology or delivery year: this means, the cheapest bids are selected first. Projects are rejected if overall projected costs of all projects exceed the budget in any of the relevant allocation years

Given the current political discourse about renewables in the UK, the government is likely to view RES-E deployment within the established budgets as the most reliable indicator of social acceptability (Fitch-Roy & Woodman, 2016). Competition in pots 1 (established) and 2 (less established) led to efficiency gains *within* each pot, as shown by the final strike prices being lower than the ceiling price (ASPs). O*verall* support cost

[9] In Portugal, one of the express objectives of the auction, besides increasing installed wind capacity, was the development of a wind turbine manufacturing Industry (Heer & Langniss, 2007)

reductions across technologies, however, were not achieved because wind offshore (i.e. the most expensive technology) was allocated the largest share of support. This was because the size of pot 2 (e.g. offshore wind) was nearly three times the size of pot 1 (e.g. onshore wind, solar PV). Since the projects awarded contracts are still under construction, it is too early to make definitive statements about the effectiveness of the scheme

The case study for the UK auction scheme can be found on the AURES website:
http://auresproject.eu/files/media/documents/pdf_uk_rev1.pdf

2.9 Brazil

The government has set a target to increase non-hydro RES-E generation to 20% of total electricity by 2030, and is likely to reach it as early as 2017. Auctions were introduced in 2004 for distribution companies to acquire electricity to serve their captive customers. The first wind-specific auction in 2009 aimed to take advantage of the 2008-2009 financial crisis that lowered equipment cost. This case study focused on onshore wind auctions taking place between 2009 and 2013.

Two types of auctions have been used in Brazil for the development of RES: new energy auctions and reserve energy auctions. New energy auctions are carried out to supply the demand reported by distribution companies according to their expected load growth, and aggregated by the auctioneer (Elizondo et al., 2014). These auctions are usually technology-neutral. Reserve energy auctions are carried out sporadically at the government's discretion to contract surplus energy, they are technology-specific, and have been extensively used to promote RES-E. Onshore wind has been participating in both technology-specific (since 2009) and technology-neutral auctions (since 2011), in which it competed with other technologies, such as natural gas (Lucas et al., 2013).

The Brazilian scheme operates as a multi-item, hybrid auction, in which the first phase runs as a descending-clock auction, followed by a pay-as-bid phase. Auctions do not disclose the auction's volume to avoid collusive behaviour. Project developers, who wish to participate in auctions in Brazil, have to fulfil several technical and financial requirements, but there are no past-experience requirements[10]. Moreover, local content requirements (LCR) are not part of the pre-qualification or the bid evaluation criteria. However, to qualify for subsidised loans by the Brazilian Development Bank (BNDES), wind manufacturers have to produce or assemble at least three of the four main wind farm elements (i.e. towers, blades, nacelles and hubs) in Brazil (IRENA & CEM, 2015).

The chosen auction award (i.e. PPAs), favourable financing conditions offered by the BNDES, physical site conditions, and the international market environment increased competition. This led to a 60% reduction in support costs, from an average €135.7/MWh under the previous FIT scheme, to an average €54/MWh in 2009-2013. Regarding ongoing project realisation, only 30% of the capacity contracted in the first three rounds (2009-2010) had started operations on time by the end of 2014, largely due to delays in the construction of transmission lines and substations (Elizondo et al., 2014).

[10] Past experience requirements imply the bidding company or consortium must prove its competence by indicating that it has successfully completed similar projects (IRENA & CEM, 2015)

The case study for the Brazilian auction scheme can be found on the AURES website:
http://www.auresproject.eu/files/media/countryreports/pdf3_brazil.pdf

2.10 California

Since 1970s there have been several RES-E support instruments in California. The Renewable Auction Mechanism (RAM) complements other programmes, since it delivers capacity that contributes to the state's Renewable Portfolio Standard (RPS), and influenced the priced offered by California's small-scale "ReMAT" FIT. The RAM is open to all RES-E within three demand bands based on their generation profile. The case study focused on the 6 auction rounds that took place in 2011-2015.

The RAM was introduced to support the growth of distributed generation between 3 and 20 MW in support of the RPS target, with smaller projects able to access the FIT and larger ones still expected to contract with utilities bilaterally under the RPS. The current price of solar power in California, together with the number of solar projects that can be quickly realised, means that a technology-neutral auction would receive an overwhelming majority of bids from solar PV. In order to have a mechanism that reflects the technologies' different market values, and better manage system integration costs, Investor Owned Utilities (IOUs) are required to procure three 'product types' (i.e. demand bands), and to target at least 3MW per auction in each category (Wentz, 2014).

The RAM operates as a multi-item, static (sealed-bid), pay-as-bid auction, in which bids are selected up to 'product-types' procurement targets. Despite access to the scheme being limited to bidders with demonstrable experience, a wide range of actors, yet a less diverse population of actors was successful in the process. Nearly three quarters of projects are online or 'on schedule', probably implying that the eventual realisation rate will be somewhat higher than 60% of the total contracted volume. CPUC (2014) reports that average RAM contract prices across all utilities fell across the first three rounds from $90/MWh (approx. €79.5/MWh) in RAM 1 to $79.82/MWh (approx. €70.5/MWh) in RAM 3.

The case study for the Californian auction scheme can be found on the AURES website:
http://auresproject.eu/files/media/countryreports/pdf_california.pdf

2.11 China

China's RES sector is rapidly growing. In 2014, installed capacities (excluding hydro), stood at 153 GW, making China the world's biggest RES market. The country currently supports RES deployment through technology-specific, administratively-set FITs, and auction schemes, among other instruments at the regional level. This case study focused on the Chinese auctions for onshore wind between 2003 and 2007. This auction scheme was deliberately limited to this period because its results were, among others, intended to help determine subsequent FITs. Separate auction schemes were launched for offshore wind, large-scale PV, and CSP.

The Chinese scheme operated as a single-item, static (sealed-bid) auction, where concessions for pre-defined project sites were allocated to winning bidders. As such, the government was responsible for securing the land and procuring environmental permits, while the local utility was responsible for an adequate grid connection. Non-price criteria, including LCR and technical experience, were allocated increasing weights over the rounds. Each auction was followed by negotiation rounds with the highest-ranked bidders. Only after these negotiation rounds concluded, which often involved changes to the capacity volume or price initially awarded, were projects officially contracted.

Most of the participating bidders were state-owned companies, which were able to cross-subsidise their wind projects, and thus "bid prices as low as €38/MWh (round 2, 2004), in order to gain market share in the wind sector" (Li et al., 2006, p. 41). Despite the aggressive bidding that was observed mainly in the early rounds, the projects saw good realisation rates. All of the concessions granted in the 2003 and 2004 rounds were realised by 2007. In total, all auction rounds incentivised the construction of almost 3.5 GW of capacity (Elizondo et al., 2014). The main policy goal of the Chinese wind concession scheme was not least-cost RES deployment or the achievement of allocative efficiency, but rather to foster the domestic wind industry by putting in place a support scheme which was both national in scale and had an ambitious LCR.

The case study for the Chinese auction scheme can be found on the AURES website:
http://auresproject.eu/files/media/countryreports/pdf_china.pdf

2.12 South Africa

South Africa aims to increase its RES-E generation capacity to 9% by 2030, which will require 17.8 GW of additional capacity. The Renewable Energy Independent Power Producer Procurement Programme (REI4P) was launched in 2011, after a failed attempt to implement a FIT (REFIT). Eligible technologies include solar PV, onshore wind, CSP, small-hydro, landfill gas, and biomass. The program is aimed at projects with capacities larger than 5 MW, though projects larger than 1 MW are eligible to participate[11].

The REI4P auctions are multi-item, static (sealed-bid), pay-as-bid auctions, which operate in two stages: a pre-qualification stage and a selection stage. At this second stage, pre-qualified bidders are assessed on two criteria: the price they offer (70%) and the local economic development (30%) they will induce. Successful bidders sign a PPA for 20 years with the transmission system operator Eskom, and an implementation agreement with the Department of Energy (DOE)

The first auction round, known as Bid Window 1 (BW1), failed to achieve enough scarcity to drive down prices because no volume caps where defined for this round, other than the 3,725 MW target of the programme. Despite these initial problems, the system has been flexible enough, so that lessons from past auction rounds have been incorporated in the subsequent ones (Ecofys, 2013). The REI4P has procured 6.3 GW from 92 IPPs between BW1 and BW4. Of this, 3.9 GW (from BW1, BW2 and BW3) are at various stages of construction or have started commercial operation. Moreover, prices have gone down in successive rounds: the price for wind power has dropped by 50% to R0.71 (€40)/MWh, with the BW4 price directly comparable to that of new coal generation. Solar PV has seen a price decrease of 75% to R0.85 (€50)/MWh between BW1 (2011) and BW4 (2014). The scheme has likely led to technological diversity and local economic development on communities near the project (Fourier et al., 2015).

The case study for the South African auction scheme can be found on the AURES website:
http://auresproject.eu/files/media/countryreports/pdf2_south_africa.pdf

[11] Projects between 1 and 5 MW have a specific support program called the Small Projects IPP Procurement Programme, which was launched in 2013.

3. Trends in auction design across the selected case studies

This chapter presents the main trends in auction design features identified across selected EU and non-EU case studies. Statements made about EU and non-EU countries only cover the sample of 12 case studies analysed, and therefore should not be taken as descriptive of all auction schemes in these regions.

3.1 Characterisation of auctions in the selected countries

3.1.1 EU countries analysed

All of the selected schemes asked for **capacity (instead of energy) bids**, i.e. bidders would offer to install a certain amount of kW or MW**.** Many but not all countries also defined the overall auction volume as capacity (see below). Most countries implemented **technology-specific auctions** for eligible technologies, with the exception of the Netherlands. The UK applied multi-technology auctions in which technologies are grouped into three groups (i.e. pots): established (e.g. solar PV, onshore wind), less established (e.g. offshore wind, ocean energy), and biomass. Countries have limited which technologies can participate to varying degrees depending on existing RES market conditions. In Germany, for instance, the scheme was only open to ground-mounted solar PV because it served as a pilot for other RES technologies (i.e. large rooftop solar PV, onshore and offshore wind).

Volume caps have been the most common method of limiting the total amount of capacity that is to be allocated in a given auction round or year. It has not been uncommon to adjust the planned volume caps upwards during the auction, in order to make up for eventual project non-realisation (Ireland) or due to a bid's "exceptional merit" (Portugal), which in this case could be granted if the project scored at least 75% of the maximum possible score. **Budget caps** have been introduced in three of the examined countries (Netherlands, Italy and the UK), in order to make sure RES deployment is achieved within a defined budget.

The European Commission (2005) regards the stop-and-go nature of support schemes for RES-E as a source of instability which creates investment risks, normally taking the form of higher costs for consumers. Only three countries (Germany, Italy, and the Netherlands) **scheduled** auctions at least once a year. In Ireland, irregular auction intervals were the result of the technology and market situation, with fewer rounds scheduled for technologies with potentially fewer actors (offshore wind).

Restricted project sizes have been implemented in most of the analysed countries (Germany, France, Ireland, Italy, and the UK). One goal of the French PV online tender is an easy access for small actors to increase the level of competition. Although Portugal did not establish project size limits, it applied an explicit **seller concentration rule** to mitigate market concentration: auction winners were automatically excluded from the next bidding round.

Most schemes (Denmark[12], Germany, Italy, Netherlands[13], and the UK[14]) award **sliding FIPs** to auction winners, i.e., a subsidy per produced electricity (kWh) on top of the wholesale market price, which is adjusted according to the electricity price development. This, together with the requirement to sell their electricity in the market, is indicative of policymakers' effort to foster market exposure of RES-E producers for improved market integration. The French scheme awarded FITs instead. Lastly, though energy-related compensation has been the norm, in Ireland's AER I auction winners were given a capacity-based remuneration (i.e. capital grants).

Table 1 - Trends in auction design in EU countries

	Denmark	France	Germany	Ireland	Italy	Netherlands	Portugal	United Kingdom
Year of introduction[15]	2004	2011	2015	1995-2003	2013	2011	2006-2008	2014
Auction product	Capacity (MW)	Capacity (MW)	Capacity (MW)	Capacity (MW)	Capacity (MW)	Capacity (MW)	Capacity (MW)	Capacity (MW)
Technology focus	Offshore wind, some nearshore areas	Solar PV 100-250 kW (separate auctions for other RES)	Ground-mounted solar PV (pilot auctions for other RES planned)	Wind, hydro, biomass, waste & biomass, CHP[16]	All RES except solar	All RES for electricity, heating and cooling, and biogas	Onshore wind and biomass	All RES
Technology differentiation	Technology-specific	Technology-specific	Technology-specific	Technology-specific	Technology-specific	Technology-neutral	Technology-specific	Multi-technology (i.e. "pots")
Volume or budget cap	Volume cap (given by the size of the pre-developed location)	Volume cap	Volume cap	Volume cap	Budget cap	Budget cap	Volume cap	Budget cap (per year, per pot)
Frequency	Variable: 5 rounds since 2004, 2 rounds ongoing	Variable: 5 rounds in 2011/2012, 3 rounds in 2013/2014	3 rounds per year	Variable: 6 rounds between 1995 and 2003	1 round per year	1 round per year (with several phases)	Variable: 1 round in 2006 and 2007, 2 rounds in 2008	1 round per year (second on hold)
Min. / max. size of project	None in multi-item auctions (nearshore).	Min. 100 kW, max. 250 kW	Min. 100 kW, max. 10 MW	Variable: None for large-scale onshore wind. Max. for small-	Min. >5 MW for all RES except hydro (> 10 MW) and geothermal	No	No	Min. > 5 MW

[12] In Denmark, both fixed and sliding FIPs are currently used for new installations. The sliding FIP is designed as a firm cap, leaving no market price upside to the operators.

[13] In the Netherlands, there is a ceiling price for each technology, i.e. a maximum basisbedrag. Technologies can never obtain a higher premium than the maximum basisbedrag

[14] The UK uses a Contract for Difference (CfD), which is a contract between a low carbon electricity generator and the Low Carbon Contracts Company (LCCC), a government-owned company. A generator party to a CFD is paid the difference between the 'strike price' – a price for electricity reflecting the cost of investing in a particular low carbon technology – and the 'reference price'– a measure of the average market price for electricity in the GB market. See Department of Energy & Climate Change (2015) for more information.

[15] Year of introduction denotes the year in which the first round of the auction scheme covered in a case study was launched.

[16] Technology focus in Ireland varied across auction rounds. Therefore, it does not mean all RES listed in this cell were allowed to participate in all auction rounds.

				scale onshore wind (max. < 3 MW in 2001, < 5 MW in 2003) and offshore wind ≤ 25 MW)	(> 20 MW)			
Form of support auctioned	Sliding FIP (50,000 full-load hours)	FIT[17]	Sliding FIP	FIT[18]	Sliding FIP	Sliding FIP	FIT	Sliding FIP (CfD)
Support duration	~ 12-15 years[19]	20 years	20 years	15 years	20 or 30 years (depending on the RES)	15 years (max.)	Not available	15 years

3.1.2 Non-EU countries analysed

In general, auction schemes in non-EU countries have been implemented earlier than in Europe. The duration of the programs in California and China was deliberately limited to a specific period because results were, among others, intended to help determine subsequent FITs. Moreover, and with the exception of Brazil, selected schemes also auctioned **capacity (MW) instead of energy**. In Brazil, however, auctioned volume is expressed in energy (MWh) because the regulator requires all loads to be fully covered by firm energy certificates to ensure security of supply.

Similar to Europe, all non-EU countries apply some form of **technology-differentiated support** across eligible technologies. California conducts multi-technology auctions based on three demand bands according to generation profile: baseload (biomass), peaking (solar PV), and non-peaking (wind). New energy auctions in Brazil are technology-neutral.

Volume caps in MW have been the norm in limiting total auctioned capacity. In order to incentivize competition, auctioned volumes are kept undisclosed in Brazil and South Africa. In China, awarded capacities have been larger than planned as a result of negotiations in the contracting phase.

Regarding auction **frequency,** at least one auction round has taken place every year in all countries. Though only California and China operate according to a relatively fixed schedule, in practice there has been an overall regularity between auction rounds, with no abrupt interruptions. **Restrictions on project size** were implemented in all cases except in Brazil. Besides a project-size restriction, California also had a **seller's concentration rule**: one actor cannot contract more than 50% of the capacity or revenue cap in each auction.

PPAs paying a **FIT** to auction winners were awarded in all cases. Duration of these PPAs differed according to technology, in order to reflect particular investment and bankability needs. In California bidders were able to choose support duration, while in China support level decreased toward average market prices after the first 30,000 full-load hours (i.e. 3 years).

[17] 20% of the support is indexed with annual income levels in the energy industry and an industry-specific price index

[18] In Ireland auction winners could opt for front loading payment of support

[19] Based on the assumption of 4,000 full-load hours per year

Table 2 - Trends in auction design in non-EU countries

	Brazil	California	China	South Africa
Year of introduction	2007 (biomass), 2009 (wind), solar PV (2014)	2011-2015	2003-2007	2011
Auction product	Energy (MWh)	Capacity (MW)	Capacity (MW)	Capacity (MW)
Technology focus	All RES	All RES	Onshore wind	Solar PV, onshore wind, CSP, small-hydro, landfill gas and biomass
Technology differentiation	Technology-neutral (new energy[20] auctions) and technology-specific (reserve energy auctions)	Multi-technology according to generation profile: baseload (e.g. biomass), peaking (e.g. solar PV), and non-peaking (e.g. wind)	Technology- and site-specific auctions for onshore wind >50MW	Technology-specific
Volume or budget cap	Volume cap	Volume cap	Volume cap	Volume cap
Frequency	>1 round/year, but no fixed schedule (2 rounds/year for new energy auctions, ~1 round/year for reserve energy auctions)	2 rounds/year in 2011-2013, 1 round/year in 2014-2015	1 round/year	Variable: 5 rounds since 2011. Five auction rounds are planned for 2016
Min. / max. size of project	None	Min. 3 MW, max. 20 MW	Min. 100 MW	Min. 1 MW, max. 75 MW (solar PV), 150 MW (CSP), and 140 MW (onshore wind)
Form of support auctioned	FIT	FIT	FIT	FIT
Support duration	15 (biomass) 20 years (wind) or 30 (hydro) years	10,15 or 20 years (up to the bidder)	25 years	20 years

[20] In Brazil, new energy auctions have been used for large-scale RES and conventional power, but have occasionally limited participation to RES.

3.2 Design elements defining how bids are awarded

3.2.1 EU countries analysed

Multi-item auctions were implemented in all EU auction schemes, yet some countries also implemented single-item tenders in order to procure capacity from offshore wind with predefined size and location (Denmark) or a specific bio-waste incineration plant (Ireland). With the exception of the Netherlands, selected schemes operated as **static (sealed-bid)** auctions. In a sealed-bid auction, bids including price and volume are submitted by each bidder at once, without knowing the bids of the competitors. Bids are then accepted until the predetermined volume is met, and winners will receive different prices based on their offers.

The Dutch scheme operates as a **dynamic auction** in the form of sequential bidding phases with increasing prices. Selection takes place on a "first come, first served" basis in order to foster procurement through low-cost technologies/projects. Pay-as-bid was the pricing rule most often used, with six out of eight EU countries opting to pay successful projects what was offered in their bids. Similarly, both the Netherlands and the UK opted for a **uniform (pay-as-cleared) pricing rule** by which all bids receive the price or discount of the last bid accepted when supply equals demand. Germany applied this rule during two auction rounds in 2015 to gain experience with this pricing rule, before switching back to pay-as-bid as originally planned.

Price-only auctions have been the most common method of bid evaluation. In France, however, solar PV auctions are based on a **points-based system**, with an overall maximum score of 30 points. While the actual tariff level (price) still receives most points (20), environmental impact in the form of the panels' carbon footprint counts for the remaining points. In Portugal, on the other hand, tariff discounts weighted 20%, while the development of industrial clusters for wind alone weighed 45%.

Lastly, all schemes implemented **ceiling prices**, with the exception of France. Fully disclosed ceiling prices in Italy are an intrinsic feature of this scheme, since bids are made in the form of a "discount" over an administratively-set reference tariff (e.g. €127/MWh for onshore wind[21]).

Table 3 – Design elements that define how bids are awarded in EU countries

	Denmark	France	Germany	Ireland	Italy	Netherlands	Portugal	United Kingdom
Multiple- or single-item	Single-item (offshore wind), multi-item (nearshore wind)	Multi-item	Multi-item	Multi-item (except for waste incineration, 1995)	Multi-item	Multi-item	Single-item (2006 and 2007), multi-item (2008)	Multi-item
Auction procedure	Static (sealed-bid)	Static (sealed-bid, online)	Static (sealed-bid)	Static (sealed bid)	Static, (sealed-bid, discount from max. price)	Dynamic (ascending clock)	Static (sealed bid), discount from max. price)	Static (sealed-bid)
Evaluation	Price-only	Multi-criteria: price &	Price-only	Price-only	Price-only	Single criteria: price	Multi-criteria: price &	Price-only

[21] O Brien, H. (2013)

criteria		carbon footprint				& timing of application	development of industrial clusters (wind)	
Pricing rule	Pay-as-bid	Pay-as-bid	Varying btw. pay-as-bid & uniform	Pay-as-bid	Pay-as-bid	Uniform per auction round	Pay-as-bid	Uniform (by delivery year)
Ceiling price	Yes (only nearshore)	No	Yes	Yes	Both floor (-2%) and ceiling (-30%)	Yes	Yes	Yes

3.2.2 Non-EU countries analysed

Multi-item, static (sealed-bid) auctions were implemented in three of the four non-EU countries with the exception being Brazil. In this sense, both EU and non-EU countries reflect the worldwide trend to implement sealed-bid schemes, likely due to their simplicity and the familiarity of sealed-bid processes from the regulators' and bidders' standpoint. Brazil, on the other hand, uses a **hybrid between dynamic and static auctions**, which consists of two phases. Phase one operates as a descending-clock auction, while phase two consists of a final pay-as-bid round for the winners of phase one.

Hybrid auction designs aim to combine the advantages of the described auction formats (Maurer & Barroso, 2011). The dynamic nature of phase one allows participants to adapt their bids throughout the process, and leads to some price discovery. Though results from phase one are published, bidders in phase two still have incomplete information since the "adjustment factor" on the auctioned volume is kept undisclosed. Hence, they only know there is some surplus in supply left, which incentivises them to further lower their bids in the second (sealed-bid) phase (IRENA & CEM, 2015).

Unlike reviewed EU countries, most non-EU schemes opted for the combination of bid price with other criteria in the selection of winning bids (i.e. **multi-criteria auctions**), in order to pursue multiple policy goals. In China, the pricing rule was changed in the fifth wind auction (2007), from a simple minimum-price to an **average-price** one. This meant that bids closest to the average would score best, with the highest and lowest bids being excluded. This change aimed to discourage bidders from offering below-market prices.

Lastly, three out of the four non-EU schemes implemented **ceiling prices**. South Africa initially disclosed its ceiling price, which was based on the previously administratively-set FITs (Eberhard et al., 2014). Since round two of the auction scheme, these are no longer published since disclosure combined with a volume cap above demand, resulted in high prices. Brazil, on the other hand, chose to disclose ceiling prices but keep auctioned volume secret, in order to incentivise competition among bidders.

Table 4 - Design features that define how bids are awarded in non-EU countries

	Brazil	California	China	South Africa
Multiple- or single-item	Multi-item	Multi-item	Multi-item	Multi-item
Auction procedure	Hybrid: dynamic (descending-clock auction) in the first phase and static (sealed-bid auction) in the second phase	Static (sealed-bid)	Static (sealed-bid). Conducted negotiations with highest-ranked bidders before contracting capacity.	Static (sealed-bid)
Evaluation criteria	Price-only	Multi-criteria: price, required transmission costs, potential resource adequacy benefits	Multi-criteria: price (bid closest to the average price scored highest), LCR, technical experience	Multi-criteria: price (70%) and contribution to economic development (30%)
Price rule	Pay-as-bid	Pay-as-bid	First-price bid, average-price bid since 2007	Pay-as-bid
Ceiling price	Yes	Yes	None	Yes

3.3 Design elements that ensure projects are realised

3.3.1 EU countries analysed

The use of **pre-qualification criteria** is widespread in the EU. In most country cases the regulator decided to implement “late auctions”. In “late auctions”, the auctioneer sets the timing of the auction at a late stage of project development, thus only allowing projects with relatively high realisation probability to participate. Interested bidders are required to procure several permits (e.g. building, environmental), so that winning bids are more or less ready to begin project construction. Project-specific auctions in Denmark establish less-stringent documentation requirements because the government plays a stronger role in the auction, and so assumes more of the risk (IRENA & CEM, 2015).

In Germany, auctions for ground-mounted solar PV take place at an “early-medium” stage of project development, since bidders need to specify the location of the project and can submit a preliminary zoning approval, instead of a definitive one. The Irish scheme, moreover, moved from “early auctions” (i.e. no pre-qualifications) in the first three rounds, to “late auctions” due to high project non-realisation.

Similar to pre-qualification requirements, strong **penalties** aim at ensuring the effectiveness of the scheme, and reducing the possibility of delays, underperformance, and non-realisation. All EU countries have chosen a mix of strategies to discourage this behaviour, including the enforcement of bid bonds, support reduction, and reductions in support duration. **Bid bonds,** which are payments required from auction participants to prove their serious intent to realise projects, were used in four (Denmark, Germany, Italy, and Portugal) of the eight case studies.

The UK foresees two scenarios in which auction winners can be penalised: winning a CfD and refusing to sign it, or failing to deliver the project / accomplish defined project milestones. In both cases, bidders are excluded from future rounds taking place within 13 months, which renders the penalty 'toothless' at the moment, since future rounds are not planned yet. Likewise, the Netherlands rely on the exclusion from future auction rounds as penalty: if projects are not operational within the realisation period (3-4 years), they lose the FIP and are excluded from the scheme for three years. However, it is possible that some bidders work around this exemption by "redefining" the project (e.g. by slightly changing the capacity or the location) and applying again.

Table 5 - Design features in EU countries that ensure projects are realised

	Denmark	France	Germany	Ireland	Italy	Netherlands	Portugal	United Kingdom
Timing of the auction	Late	Late	Early-medium	Early at first, late afterwards	Late	Late	Late	Late
Pre-qualification requirements	Proof of financial capability, developer experience, bid bonds. State pre-development of permits	Building permit, CO2-assessment, proof of capital or bank loan offer	Location specified, bid bond, (preliminary) zoning approval	Secured planning permit & cash flow statement	Building permit/ concession, connection offer, bid bonds22	Permits, proof of ownership, feasibility study for projects >0.5 MW	Proof of financial & technical capability, bid bond	Planning consent, connection agreement
Penalties	No penalties in the first 2 rounds. Since 3rd round, enforcement of bid bonds in case of delayed grid connection/ construction.	Support duration reduced by delay x 2	Reduction of FIP (€0.3 cent/kWh) for delays >18 months. Enforcement of 1st bid bond (€4/kW) for withdrawing a bid. Enforcement of 2nd bid bond (€50/kW) for delays >24 months.	Delayed projects do not get support beyond the end of the original support period	FIP reduced 0.5%/month of delay. >24 month delay, FIP is withdrawn, bid bond enforced	Exclusion from SDE+ for three years, fine for projects >€400M	Not available	Exclusion from scheme for 13 months
Realisation period	~ 32 months	18 months (solar PV)	18 months, 6 month tolerance	No information found	28 months (onshore), 40 months (all other RES)	3- 4 years (depending on technology)	No information found	6 months–2 years (bidding for different delivery years)

3.3.2 Non-EU countries analysed

Non EU-countries have also made use of **pre-qualification criteria.** In the state of California, project viability requirements were set to prevent speculative bidding. They require evidence of developer experience, 100% site control, interconnection studies, and a development schedule. In Brazil, project developers have to

[22] In Italy, bidders have to hand in financial bid bonds: 5%of the administratively estimated investment cost per technology upon application, increased to 10% after successful participation. Source: DM 06/07/12

secure, among others, an environmental licence, a preliminary grid access authorisation, and bid bonds. However, there are no past-experience requirements.

Regarding **penalties**, all non-EU countries have mechanisms in place to encourage the timely realisation of projects, although not clearly defined in the case of China. A common element in the across the other three case studies is that financial penalties are backed by bid bonds (Brazil, South Africa) or development/performance deposits (California). However, neither these nor other penalties have been enforced in any of the four case studies. This suggests the effectiveness of penalties in discouraging non-realisation or delays relied more on the possibility to enforce them, rather than on their actual implementation. Moreover, an often cited reason for not enforcing penalties has been project developers arguing delays were the result of factors beyond their control (e.g. grid and transmission problems in Brazil). Lastly, though clear penalties were not defined in China, the government kept the prerogative to withdraw from the support contract in case project delays were not sufficiently justified.

Table 6 - Design features in non-EU countries that ensure projects are realised

	Brazil	California	China	South Africa
Timing of the auction	Late	Late	Late	Late
Qualification requirements	Environmental permits, grid access approval, resource measurements by an independent authority, bid bonds	Proof of developer experience, site control, use of a commercial technology, grid connection study	LCRs, proof of financial viability and project experience	Proof of project readiness (land acquisition, suppliers, and environmental consent), financial viability, contribution to economic development, bid bond
Penalties	Delay > 1 year: contract can be terminated without justification, bid bonds not reimbursed. Complex system of penalties for deviation in electricity production	Development deposit and performance deposit are withheld if projects are not commissioned or plant operation is unsatisfactory	No clear penalties defined. Government withdrawal from support contract in case of unjustified delays possible	Contract termination, bid bond withheld
Realisation period	Depending on the type of auction (A-1, A-3, and A-5 = 1, 3, or 5 years).	18 months of approval by the CPUC	3 years	180 days

4. Assessment

The following section assesses the performance of the selected EU and non-EU case studies based on four criteria: policy effectiveness, static efficiency, actor diversity, and dynamic efficiency. These criteria were deemed relevant for policymakers considering to implement or revise auction schemes for RES-E, though not all of them can be equally influenced by auction design. Moreover, besides the design features, factors external to an auction scheme also play a decisive role in its outcomes. The assessment that follows is based on the 12 case studies analysed. It explains auction outcomes for each of the four evaluation criteria, in light of auction design choice and the particular framework conditions a scheme operated in.

4.1 Policy effectiveness

The effectiveness of auctions was assessed in two ways: auctions' ability to contract new RES-E capacity, and project realisation. An important limitation in the assessment is that the realisation periods of some winning projects have not yet finished, due to the different lengths of the realisation periods or the recent introduction of auction schemes. In these cases it is too early to conclude on the realisation rate.

As a volume or budget allocation instrument, auctions successfully contracted desired capacities in nine of the twelve case studies, while the UK, Netherlands, and Italy had limited effectiveness. In the UK, the failure of the CfD auction to allocate much of the pot 1 budget in the first three delivery years (2015-2017) may be attributed to the external policy environment (Fitch-Roy & Woodman, 2016). Indeed, few solar PV projects appear to have even bid, perhaps because developers choose to finish RO projects before their cut-off, and focus on the non-CfD < 5MW projects to avoid the cost/risk of an auction. Moreover, the quite short realisation period for the first delivery year (2015) meant its budget could only be filled up with projects wishing to start on that date, which may have also deterred developers from making bids for this year.

Similarly, 20% of the available budget in the Dutch SDE+ scheme has not been used in 2011-2013 (Noothout & Winkel, 2016), though this was not the result of the auction. SDE+ budget claims are calculated based on a maximum eligible subsidy, in order to prevent the government from spending more than what was planned for in the budget. This maximum eligible subsidy, in turn, is based on a theoretical base energy price. Because paid SDE+ subsidies are based on the actual energy price at which the energy is sold, and these are generally higher than the base price, actual payments are lower than the budget claims. In Italy, and except for onshore wind, the number of bids was below the offered capacity. The relatively low capacity of onshore wind offered in the first round may be explained by a transitory arrangement, according to which plants could still be partially constructed under the old system (Tiedemann, 2016).

France and South Africa are examples of countries where auctions failed to allocate the target volume at early stages of implementation, but took corrective measures to address this. In South Africa, as previously mentioned, no volume cap was set for the first auction round in 2011 apart from the total 3,725 MW target of the programme (del Rio, 2016). After a lower volume cap was introduced in later rounds, capacity has been successfully procured, with only 700 MW remaining to be auctioned in order to meet the 2020 installation target.

Though auctions are designed for the procurement of a specific amount of electricity or capacity, case studies show that full project realisation is rarely achieved, and delays are frequent. Auction schemes in China, Denmark, and Portugal have now commissioned 100% of contracted capacities. The Portuguese auction scheme stands out in particular because, at the time, it was believed that projects would not be built due to concerns about inflated capacity factors and/or underestimated costs (Heer & Langniss, 2007). However, wind capacities tendered in 2005 started to be implemented in 2008 and are now connected (Peña, 2014), albeit substantially later than planned.

With the exception of the first attempt of Rødsand 2 (2004/6), wind projects in Denmark were commissioned ahead of time, including the second attempt of Rødsand 2 (2008). In the first attempt, the winning consortium withdrew from the contract alleging heavily increased prices for turbines by the (at that time) only two suppliers of large offshore turbines (Vestas and Siemens). Though this external factor may have substantially altered the bidder's cost calculation, it is possible some underbidding took place given that the winning party of the second attempt, E.ON Sverige, was also part of the winning consortium in the first attempt (Kitzing & Wendring, 2015). After that, penalties were introduced. In China, despite the aggressive bidding observed mainly in early auction rounds, onshore wind concessions granted in 2003 and 2004 were realised on time by 2007. In total, all auction rounds incentivised the construction of almost 3.5 GW of capacity (Elizondo et al., 2014).

At least 75% of projects -whose realisation period has ended- in California and South Africa have been built. In South Africa, 87% (1,860 MW out of 2,143 MW) of IPPs scheduled to be operational have started commercial operations (SA government, 2015d). Similarly, 75% of the projects contracted through the California RAM are online or 'on schedule'. In the Netherlands, 68% of projects awarded SDE+ in 2011 have been realised (Noothout & Winkel, 2016).

Realisation rates for projects -whose realisation period has ended- have been lower in Brazil, France, and Italy, at 50% or lower. Grid connection problems have been an important factor behind the construction delays in Italy and Brazil. In fact, almost 70% of project delays greater than 1 year in Brazil could be attributed to problems in the construction of transmission lines and substations (Elizondo et al., 2014). In Italy, non-reliable bid-bonds failed to provide an adequate incentive to realise projects (Tiedemann, 2016). Effectiveness of these schemes cannot be judged yet because realisation periods for some projects have not ended.

In Ireland, auction rounds underperformed to varying degrees: only about a third of all contracted capacities had actually been installed by 2005 (IZES, 2014; DMNR, 2005). This was in spite of the deliberate contracting of extra capacity in most auction rounds to make up for the eventual non-realisation of some projects. In the UK and Germany, it is too early to make an assessment in terms of project realisation, since auction schemes have been recently introduced, and first realisation periods have not yet ended.

4.2 Static efficiency

Static efficiency is achieved if a predetermined target can be fulfilled at the lowest possible overall cost. As it is difficult to determine the lowest *possible* cost, we evaluate if auctions led to a price decrease over time or compared to previous support levels. We call such digressions "efficiency gains". In summary, all auction schemes, reported efficiency gains in terms of the contracted price or discounts achieved.

In Italy, the auction scheme only led to efficiency gains for onshore wind, since there was no competition within the other RES technologies. Compared to other countries, remuneration levels for onshore wind are still relatively high, with average results of €87/MWh in round 3 (Negri, 2015).

Efficiency gains in countries like California, Brazil and South Africa were remarkable. Average contract prices across all utilities in California fell from €79.5/MWh in the first round, to €70.5/MWh in the third one (CPUC, 2014). This is attributed to the very large interest in the programme with an approximately 10:1 bid to contract ratio (CPUC, 2014). Moreover, and according to accounts from developers, utilities and the regulator, the transaction and administrative costs were markedly reduced compared with the direct alternative, the RPS solicitation route (Fitch-Roy, 2016).

In Brazil, the significant price reductions compared to the former FIT (i.e. Proinfa) indicate a high level of competition in the auction, which led to important efficiency gains (Held et al., 2014). Between 2009 and 2013, auctions resulted in approximately 11.7 GW of contracted wind capacity, as opposed to the 1.4 GW contracted with Proinfa subsidies, at an average final price of €54/MWh, or about 60% lower than under Proinfa.

Similarly, prices in South Africa have gone down in successive rounds, from R3.27 (€19ct) / kWh in the first round to R0.77 (€4ct)/kWh in the fourth round. The price of R0.71 (€4ct) / kWh for wind energy was directly comparable to that of new coal generation. Administrative costs for project developers like those associated with hiring experts and advisors are substantial and can represent up to 15% of project development costs (Montmasson & Ryan, 2014; Yuen, 2014). Acknowledgement of the high transaction costs has led to streamlined procedures in BW4 (Allen & Overy, 2015).

In Germany, the average price of the first auction round was €91.7/MWh (min.: €84.8/MWh, max.: €94.3/MWh), which is significantly below the ceiling price of €112.9/MWh but exceeded the administratively set support level (EEG 2014) for April 2015 of €90.2/MWh. In the second round, the price further declined to €84.9/MWh and was therefore below the EEG for September 2015 (€89.1/MWh). In the UK, the average contract prices achieved in the first auction round was lower than the ceiling prices (i.e. ASPs), as well as the Final Investment Decision (FIDeR) contracts awarded to several offshore wind farms earlier in 2014 (Fitch-Roy & Woodman, 2016). In spite of this efficiency gain, the auction resulted in the more expensive technology (wind offshore) having the largest share of support because the offshore pot was the biggest.

In Denmark, only one bidder participated in the Anholt auction, which makes it questionable that the auction helped identifying the least-cost supplier. Other producers likely abstained due to financially more attractive markets at the same time, especially in the UK (Kitzing & Wendring, 2015). This, together with the supply bottlenecks experienced at the time in the region, led to high contracting prices (€141/MWh).

Lastly, policymakers in Portugal pursued parallel policy objectives such as the development of a wind industrial cluster. This did not guarantee that selected sites by the wind developers in Portugal were optimal, but that they were appropriate for large industrial investment. Though wind prices were lower than the previous FIT, with discounts of between 5% and 23%, a 5% discount already granted the maximum score for the price criterion during the evaluation of the bids (Heer & Langniss 2007). This means that bidders did not have an incentive to bid prices that are 5% lower than the FIT.

4.3 Actor diversity

The actor diversity and social acceptability criterion looks into the accessibility of the scheme to a variety of actors. Out of the 12 case studies reviewed, only three - all of them in Europe – explicitly considered the needs of smaller actors. In Germany, although all actors participate on equal conditions, the second financial security is halved if project planning is more advanced, which can potentially benefit smaller actors. However, neither cooperatives nor individuals were among the 25 winners of the first auction round, though this changed in the third round (Tiedemann, 2016). In France, the target audience of the online auctions are private, rather small actors with large roofs (100-250 kW), with separate auctions being held for projects with larger capacities, while in Ireland the regulator was willing to pay higher support prices to small projects (Steinhilber, 2016b).

Large, experienced project developers appear to have won the largest share of the auctioned volumes in several countries. This trend could either indicate that smaller actors could not match the prices offered by larger actors (Italy), and/or prices that required financial guarantees have posed significant barriers for smaller potential bidders (Brazil) (Held et al., 2014). Auction schemes like those of Germany and France saw participation from numerous different actors, but established project developers won the highest shares.

In the UK and the Netherlands, actor composition was diverse. A wide range of actors, from large utilities to small independent developers, were able to participate in the UK auction and no participant won more than a single contract. In the Netherlands, the large majority of parties that apply for SDE+ are (small) SMEs (>80%), followed by non-profit organisations. A small percentage of applicants may be grouped as larger (multi-national) companies and utilities[23].

4.4 Dynamic efficiency

In contrast to static efficiency, dynamic efficiency evaluates the costs of target achievement over the long-term, and considers whether a policy instrument helps drive down costs of less mature technologies. Overall, it is not possible to thoroughly assess dynamic efficiency because of its measurement requires longer time spans than the ones considered in the auction schemes. In general, auctions are rather an instrument that focuses on short-term (static) than on long-term efficiency.

Still, technology differentiation seems to be more suitable due to the diversity it fosters. Both EU and non-EU countries have some form of differentiated support that reflects technology-specific generation costs, be that in the form of technology-specific or multi-technology auctions. However, the ability of reviewed auction schemes to foster dynamic efficiency was limited, to varying degrees. Auction schemes that reward a project's contribution to R&D exist (e.g. France's solar PV >250 kW), but this provision was not taken into account in any of the 12 case studies examined. In Germany, there is no incentive for innovative concepts to participate in the auction, yet German law foresees a tailor-made policy for innovative projects, which is yet to be designed (Tiedemann, 2016).

[23] The RVO website publishes lists of SDE+ winners albeit with no information regarding how much capacity or SDE+ subsidy was allocated to each winner. A list with the SDE+ winners in 2015 can be found here: http://www.rvo.nl/sites/default/files/2015/11/SDE%202015%20Projecten%20in%20beheer%20-%20januari%202016.pdf

It is worth noting that, although auction design can contribute towards dynamic efficiency, gains in this domain are often the product of factors beyond the scope of the auction. In China, learning effects in the domestic wind industry could be seen during the observed timeframe, although this cannot be solely attributed to the auctions. Companies such as Sinovel, Goldwind, and Dongfang, all of them Chinese wind power equipment manufacturers, had risen to the top ten in their field by 2010 (Steinhilber, 2016b).

5. Lessons learnt from international experiences

The following section presents a compilation of general lessons on auction implementation, as well as lessons specific to eligibility requirements, the auction procedure, and project realisation. The list that follows is by no means exhaustive, but rather a synthesis of ‘good’ and ‘bad’ experiences observed in the 12 case studies. Lastly, lessons discussed next are not prescriptive, not only because design features need to be adapted to the particular context, but also because auction outcomes are also dependent on framework conditions.

5.1 General lessons

An effective auction depends on the **existence of competition,** i.e. that the volume of bids exceeds the auction volume. Competition or the lack thereof is:

- To a large extent related to **structural issues**, which depend on the number and nature of players, market concentration, types of products being offered, and specific regulations.
- Influenced by **auction design**, by determining volume according to the anticipated level of demand, having transparent rules, and low access barriers.

Experience with auctions schemes in both EU and non-EU countries show that the outcomes of an auction not only depend on the design of the procedure, but also on factors beyond it such as the **regulatory and administrative framework for RES**. Some examples:

- Netherlands: **availability of permitting and spatial planning**, which is critical for technologies like wind, can positively influence the level of competition in an auction.
- Ireland: project realisation was severely reduced due to a **misalignment between spatial planning and the auction scheme**. While some of the winning bidders had difficulties obtaining planning permits, there were wind parks (155 MW in 1999) holding a planning permit but not an AER contract. This problem could have been solved by making the planning permit a pre-qualification requirement.

The **absence of appropriate infrastructure** for project development in locations with high RES potentials can negatively affect the efficiency (Portugal) and effectiveness (Brazil) of auctions.

- Portugal: absence of good grid connections to high RES potential sites was a barrier for the deployment of projects in the best places, leading to a suboptimal outcome in terms of static efficiency.
- Brazil: issues with access to transmission infrastructure help explain the delayed project realisation.

Facilitating the entry of as many bidders as possible requires, among others, **good communication about auction rules**.

- France: only 60% of bids submitted during the first five auction rounds (2011/2012) were eligible. This was seemingly due to unclear documentation requirements (e.g. regarding the CO_2 assessment), which resulted in reduced competition and relatively high prices.

A **transparent and inclusive design and implementation** facilitates participation and the incorporation of feedback.

- South Africa: a conference is organised at the beginning of the auction, which, together with a dedicated website, allows the government to communicate any changes to all market agents equally.
- Denmark and California: open dialogue between investors and contracting authorities was seen to improve auction results.

An analysis of the market situation and project structure for each technology helps policymakers determine the appropriate auction design for each technology, and decide whether technology-neutral auctions are appropriate for a particular context or not (Klessmann et al., 2015). A **technology-neutral** auction can help promote strong competition due to a potentially higher number of participants, compared to auctions with separate slots for different technologies. On the other hand, **technology-specific** auctions encourage a certain level of deployment per technology, while technology-neutral ones can be less conducive to the market development of more expensive technologies. Also, the value of the auction product might not be homogeneous in a technology-neutral auction, as different technologies have different values and system integration costs.

- Netherlands: established a technology-neutral scheme with strong focus on static efficiency, combining renewable electricity, heat and gas technologies. This lead to strong competition, but also interrupted new onshore wind deployment in 2012 and 2014. In these years the relatively cheaper options (e.g. geothermal and biomass heat) claimed most of the budget before wind projects applied for SDE+.

Nearly all countries analysed have implemented a **technology-specific** auction scheme in light of various policy goals (GIZ, 2015): building up local industries (China, Brazil, France, Portugal, and South Africa), system integration (California, France, Germany), and participation of small actors or social acceptance (Denmark, France).

A high level of competition can also be realised in technology-specific auctions, such as those for ground-mounted solar PV in Germany, since this seems to be more influenced by sector-specific characteristics (e.g. previous level of support and number of market participants).

5.2 Lessons regarding the auction procedure and remuneration

5.2.1 Auction format

The trend to implement **static** (**sealed-bid)** auctions in both EU and non-EU countries (except in Brazil and the Netherlands) is likely due to their relative simplicity, and the familiarity of sealed-bid processes from the regulators' and bidders' standpoint.

Though **multi-item** auctions are more often implemented, single-item auctions were also implemented for large technologies with restricted availability of locations, particularly for offshore wind (Denmark) and a bio-waste incineration plant (Ireland).

5.2.2 Frequency

Continuity in the implementation of auction rounds, as opposed to a "stop-and-go" implementation, increases long-term planning certainty for market players. Auction **frequency** is context- and technology-dependent. A frequency of more than one round per year (e.g. three rounds in Germany) can limit project development risks, such as expiration of permits, but may also increase transaction costs. As a safeguard, regulators should be allowed to adjust auction schedules according to perceived shifts in market conditions. The important point for making auctions attractive to investors is that there is an overall reliability in the scheme.

- California: the visibility of the upcoming rounds on more-or-less fixed dates in California enabled the supply chain to plan for participation, and develop projects to suit the RAM programme, which added to the very high developer interest in the programme

5.2.3 Ceiling price

Ceiling prices that define the maximum support level limit the risk of high support costs for governments/consumers and are frequently applied. Determining the ceiling prices remains challenging, and may involve relatively high transaction costs.

- Netherlands: ceiling prices are currently set by experts from the energy research centre after extensive consultations and are adjusted each year according to market and technology (price) developments.

5.2.4 Auction volume

Setting volume caps below the potential market volume enhances competition, which can lead to price reductions. South Africa’s first auction (2011) was not very successful in enhancing competition, given that there was no capacity limit attributed to this first phase except the overall programme volume, which meant that the auction volume far outstripped supply.

It has not been uncommon to adjust the planned **volume cap**s upwards during the auction, in order to make up for eventual project non-realisation (Ireland) or due to a bid’s “exceptional merit” (Portugal).

In case that strategic bidding is expected, keeping auctioned volumes undisclosed can incentivize competition, since it reduces the likelihood of strategic bidding that could end the auction prematurely and lead to artificially high support levels. On the other hand, a disclosed, reliable auction volume can also create competition by sending a strong signal to investors to develop the required project pipeline.

- Brazil: complements the non-disclosure of the auction volume with a “demand parameter” to force a minimum level of competition: if equal to 1.5, the auction’s supply must be at least 50% higher than the total volume

5.2.5 Bid evaluation criteria

A purely price-based selection process is associated with lower support costs, while the inclusion of criteria implies restrictions that might lead to higher costs. **Price-only** auctions have been the most common method of bid evaluation in the EU case studies. Selected non-EU country cases, on the other hand, show that winners are typically not solely selected by pricing.

- Portugal: price (in form of tariff discounts from the ceiling price) weighted 20% of a bid's score, while the development of industrial clusters for wind alone weighed 45%. Though the trade-off between static efficiency and other policy goals cannot be fully eliminated, a less uneven weight distribution could lead to lower cost procurement.

Multi-criteria auctions can also help promote social acceptability and local economic development

- South Africa: local content development counts for 30% of the total score given to a bid, which includes a component measuring share ownership by black South Africans and local communities.

5.2.6 Pricing rule

Pay-as-bid has been the preferred pricing rule in most EU and non-EU schemes. Pay-as-bid tends to be more robust against undesired, strategic behaviour than uniform pricing, despite some advantages in auction theory. In addition, and since it offers bidders no more than their bid, this pricing rule usually finds high public acceptance.

Uniform pricing can ideally incentivise bidders to bid their true costs, but has in practiced misled unexperienced bidders to submit offers below what is financially sustainable just to make sure they are awarded some capacity.

- UK: uniform pricing may have contributed to the perception by some bidders that a very low bid was the only way to win a contract. This, together very small penalties, and the fact that solar PV > 5 MW was excluded from any other policy revenue stream in the run up to the auction, may have also been a factor in this strategy.

5.2.7 Awarded contract or remuneration

What is auctioned can be as important as how it is auctioned. Using standardised, **long-term PPA**s with conditions known in advance by bidders can lower risk premiums. The auction award provides project developers with revenue stability and eases financing (Del Río & Linares, 2014). Moreover, making contract duration compatible with the duration of the typical financing maturity given by banks can increase a project's bankability.

- California: bidders were able to choose support duration and define how the price evolves through the contract at yearly intervals to account for anticipated changes to their costs.

Investor confidence can be enhanced through different methods of allocating financial risks related to exchange rate and/or inflation that can impact income throughout the contract period.

- Brazil: PPAs are denominated in local currency but adjusted yearly for domestic price inflation.

In liberalised markets, auction winners can be required to sell the electricity on the market for improved market integration, with the auction award being a sliding or, with higher risks, fixed premium (feed-in premium).

- Most EU schemes award **sliding FIP**s to auction winners, i.e., a subsidy per produced electricity (kWh) on top of the wholesale market price, which is adjusted according to the electricity price development.

5.3 Lessons regarding eligibility requirements

5.3.1 Pre-qualification requirements

Pre-qualification requirements have been set in all case studies to help identify “serious” (i.e. reasonably-calculated) bids, and sort out projects with low realisation probability.

- Brazil started requiring a grid access permit since 2013 after seeing low project realisation rates

It is not recommended to impose low pre-qualification and low penalty levels at the same time, as this might attract speculation and result in poor realisation rates (see lessons on project realisation).

- Ireland: Moved from “**early auctions**” (i.e. no pre-qualifications) in the first three rounds, to “**late auctions**” due to non-realisation of project
- Netherlands: Project non-realisation led to revisions of the auction scheme, and the introduction of a feasibility study (projects > 0.5 MW) in 2014 and penalties (bid bond and exclusion from SDE+) in 2012

Documentation requirements should be kept **clear, simple and straightforward**, yet additional measures might be required in order to ensure actor diversity.

- Germany: Each bidder must provide a bid bond worth €4/kW to participate in the auction. This deposit is halved if the bidder already has a building permit (i.e. zoning plan), which can potentially facilitate the participation of smaller players.

5.3.2 Location and project size requirements

Implementing **minimum project size requirements** has the potential to reduce the transaction costs associated with handling small projects, although potentially deterring their participation. Maximum size requirements can encourage the participation of smaller actors, and help avoid market concentration.

- Restricted project sizes have been implemented in most of the EU case studies. Seller concentration rules (Portugal) also help mitigate market concentration.

Location constraints are intended to, among others, achieve greater geographic diversity of projects, and ensure proximity to the grid and/or loads.

If sites are pre-developed by the auctioning authority, care must be given to provide correct information in order to avoid unnecessary risks for bidders.

- China: errors in the information given by the government about project sites in the first wind auction rounds were an additional source of risk for the winning projects

5.4 Lessons regarding project realisation

Next to pre-qualification requirements, strict compliance rules help to ensure serious bids, but they can also lead to low participation and competition. Lower penalties reduce the risk related to construction delays and failure, which could stimulate a higher number of bids, but they do not ensure project realisation. **Striking a balance between pre-qualification requirements and penalties** is therefore of key importance, as well as adapting penalties to local circumstances.

- Denmark: High penalties for delays and a very strict time plan, among other external factors, resulted in low interest in the Anholt tender in Denmark and a low competition level.

Case studies show that **penalties are not a guarantee for project realisation**. Pre-qualification requirements seem especially important to select realisable projects from the beginning, especially when dealing with unexperienced bidders.

- Brazil: penalties and pre-qualification requirements have not been enough to raise project implementation rates. Concerns about the financial feasibility of some projects, difficulties to secure financing, and issues with access to transmission infrastructure help explain the country's relatively low/uncertain realisation rates
- China: wind concessions granted in 2003 and 2004 were realised on time by 2007, despite a lack of clear penalties, and the aggressive bidding observed mainly in early auction rounds. This case suggests the type of project developers (i.e. state-owned companies with implicit subsidies) played a more decisive role.

Looking at penalties, reviewed schemes also show the importance of **differentiating between delays** caused by the project developer or by external factors (e.g. environment licence or grid connection).

Policymakers should closely **monitor potential loopholes** or other factors that could render penalties toothless. Also, leaving room for legal dispute about who caused the delays can block project pipelines and prolong project realisation.

- UK: refusal to sign a CfD or failure to meet project milestones carries a penalty of exclusion from auction rounds taking place within the next 13 months. Because future auction rounds are not yet planned, this penalty is currently inapplicable[24].
- Netherlands: delayed projects can work their way around the penalty by "redefining" the project (e.g. by changing the offered capacity or the location), and applying again.

[24] The Government is currently proposing that the exclusion is extended to 24 months instead because they realise that 13 months was meaningless.

A **‘waitlist’ system**, by which developers unable to sign the auction contract are replaced by second-best projects like in the state of California, can potentially lower the risk of non-target achievement. However, ‘waitlist’ systems are only viable if there are enough serious bids to choose from and if remaining on the waitlist is not linked to substantial risks for project developers, like in one of the offshore tenders in Denmark.

Settlement rules to manage production deviations can help discourage developers from systematically over- or underestimating their generation expectations.

- Brazil: annual underperformance penalties are applied when the average annual generation is less than 90% of the contracted amount. Upper limits are also established, so that any generation that surpasses the upper limit can be sold at the spot market price (IRENA & CEM, 2015).

Setting up **early warning systems** to identify delays at early stage helps to constructively address delays in a timely manner.

- Netherlands: regular evaluations and subsequent improvements were done over the past six years, which led to the introduction of a feasibility study as a pre-qualification criteria and bid bonds to increase policy effectiveness

Penalty design can be improved by **taking investor considerations into account**.

- Denmark: penalty scheme reduces support duration instead of support level puts investors in a better position towards loan-giving banks

6. References

Algemene Rekenkamer (2015): Stimulering van duurzame energieproductie (SDE+) (Court of Audit, 2015: Stimulating renewable energy production (SDE +)). Available from: http://www.rekenkamer.nl/Publicaties/Onderzoeksrapporten/Introducties/2015/04/Stimulering_van_duurzame_energieproductie_SDE

Allen & Overy (2015): South African Renewable Energy Independent Power Producer Procurement Programme (REIPPPP): Salient features of and changes to the Bid Window 4 RFP for purposes of the 1800 MW expedited Bid Submission Window. Available from: http://www.jdsupra.com/legalnews/south-african-renewable-energy-80365/

CPUC (2014): Decision 14-11-042 Decision 14-11-042 November 20, 2014. Available from: http://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M143/K313/143313500.PDF

CRE (2013): Appel d'offres portant sur des installations photovoltaïques sur bâtiment de puissance crête comprise entre 100 et 250 kW (Regulatory Commission of Energy, 2013: Tender for photovoltaic installations with peak power between 100 and 250 kW) Available from: http://www.cre.fr/documents/appels-d-offres/(annee)/2013

Danish Energy Agency (2016): Denmark to run pilot solar PV tender in 2016. Available from: http://www.ens.dk/en/info/news-danish-energy-agency/invitation-consultation-danish-pilot-tender-solar-pv

Decreto Ministeriale (DM) 6 luglio 2012 (2012): Ministerial Decree 6 July 2012. Incentives for electricity from renewable energy sources other than solar PV. Available from: http://www.sviluppoeconomico.gov.it/images/stories/normativa/DM_6_luglio_2012_sf.pdf

del Rio (2016a): Auctions for renewable energy support in Portugal: instruments and lessons learnt. Report D.4.1-PT. CISC. Available from: http://www.auresproject.eu/files/media/countryreports/pdf_portugal.pdf

del Rio (2016b): Auctions for renewable energy support in South Africa: Instruments and lessons learnt. Report D.4.1-ZA. CISC. Available from: http://auresproject.eu/files/media/countryreports/pdf2_south_africa.pdf

del Río, P. & Linares, P.:(2014). Back to the future? Rethinking auctions for renewable electricity support. *Renewable and Sustainable Energy Reviews*, 35, 42-56. Available from: http://www.ieb.ub.edu/files/Del%20Rio.pdf

del Rio, P., Haufe, M., Wigand, F. & Steinhilber, S. (2015): Overview of design elements for RES-E Auctions. Report D2.2 (a). CSIC, TAKON, Ecofys and Fraunhofer-ISI. Available from: http://auresproject.eu/files/media/documents/design_elements_october2015.pdf

del Rio, P., Steinhilber, S., & Wigand, F. (2016): Assessment criteria for RES-E Auctions. Report D2.2 (b). CISC, Fraunhofer-ISI, and Ecofys. Available from: http://www.auresproject.eu/files/media/documents/assesment_criteria_october2015.pdf

Department of Energy & Climate Change (2015): Electricity market reform: Contracts for Difference. Available from: https://www.gov.uk/government/collections/electricity-market-reform-contracts-for-difference

DMNR (2005): Alternative Energy Requirement Programme - AER V & VI update.

Eberhard, A., Kolker, J. & Leigland, J. (2014): South Africa's Renewable Energy IPP Procurement Program: success factors and lessons. Public-Private Infrastructure Advisory Facility (PPIAF) and World Bank Group. Available from: http://www.gsb.uct.ac.za/files/ppiafreport.pdf

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

Ecofys (2016): Status of RES-E support schemes in Europe by Corinna Klessmann. Thursday Lecture on May 26, 2016.

Elizondo Azuela, G., Barroso, L., Khanna, A., Wang, X., Wu, Y., & Cunha, G. (2014): Performance of renewable energy auctions: experience in Brazil, China and India. Policy Research Working Paper 7062. World Bank Group. Available from: http://elibrary.worldbank.org/doi/pdf/10.1596/1813-9450-7062

Erneuerbare-Energien-Gesetz - EEG 2014 (Renewable Energy Law 2014) (2014). Available from: http://www.gesetze-im-internet.de/eeg_2014/

European Commission (2014): Guidelines on State aid for environmental protection and energy 2014-2020. Available from: http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52014XC0628(01)&from=EN

Fitch-Roy, O. & Woodman, B. (2016): Auctions for renewable energy support in the United Kingdom:

Förster, S. (2016): Small-scale PV auctions in France: instruments and lessons learnt. Report D4.1-FR. Ecofys. Available from: http://www.auresproject.eu/files/media/countryreports/pdf2_france.pdf

Fourie, D., Kritzinger-van Niekerk, L. & Nel, M. (2015): An overview of the renewable energy independent power producers procurement programme (REIPPPP). Energize RE: Renewable Energy Supplement - June 2015, PP.9-12.

GIZ (2015): Renewable energy auctions. Goal-oriented policy design.

Government of Ireland (1999): Green Paper on Sustainable Energy

Hauser, E., Weber, A., Zipp, A., & Leprich, U. (2014): Bewertung von Ausschreibungsverfahren als Finanzierungsmodell für Anlagen erneuerbarer Energienutzung. IZES. Available from: http://www.bee-ev.de/fileadmin/Publikationen/Studien/IZES20140627IZESBEE_EE-Ausschreibungen.pdf

Heer, K. & Langniss, O. (2007): Promoting renewable energy sources in Portugal: possible implications for China. Centre for Solar Energy and Hydrogen Research Baden-Württemberg, Stuttgart. Available from: http://www.resource-solutions.org/pub_pdfs/Heer.and.Lagniss.Portugal.Study.pdf

Held, A., Ragwitz, M., Gephart, M., de Visser, E., & Klessmann, C. (2014): Design features of support schemes for renewable electricity. Fraunhofer ISI and Ecofys. Available from: https://ec.europa.eu/energy/sites/ener/files/documents/2014_design_features_of_support_schemes.pdf

IRENA & CEM (2015): Renewable energy auctions – A guide to design. Available from: http://www.irena.org/DocumentDownloads/Publications/Renewable_Energy_Auctions_A_Guide_to_Design.pdf

IZES (2014): Ausschreibungsmodelle für Wind Onshore: Erfahrungen im Ausland. Available from: https://www.wind-energie.de/sites/default/files/download/publication/ausschreibungsmodelle-fuer-wind-onshore-erfahrungen-im-ausland/bwe_ausschreibungen_wind_onshore_endbericht_09-2014_final.pdf

Kitzing et al. (2012), Renewable energy policies in Europe: converging or diverging? Energy Policy 51, 192-201, http://dx.doi.org/10.1016/j.enpol.2012.08.064

Kitzing, L. & Wendring, P. (2015): Auctions for renewable support in Denmark: instruments and lessons learnt. Report D4.1-DK. DTU. Available from: http://auresproject.eu/files/media/countryreports/pdf_denmark.pdf

Klessmann, C., Wigand, F., Tiedemann, S., Gephart, M., Maurer, C., Tersteegen, B., Ragwitz, M., Höfling, H., Winkler, J., Kelm, T., Jachmann, H., Ehrhart, K., Haufe, M., Kohls, M., Linnemeyer, M., Meitz, C., Riese, C., & Nebel, J. (2015):

Ausschreibungen für erneuerbare Energien. Wissenschaftliche Empfehlungen. Ecofys, Consentec, Fraunhofer ISI, ZSW, Takon, BBG und Partner, GÖRG Partnerschaft von Rechtsanwälten mbB. Available from: https://www.bmwi.de/BMWi/Redaktion/PDF/Publikationen/ausschreibungen-eeg,property=pdf,bereich=bmwi2012,sprache=de,rwb=true.pdf

Li, J., Shi, J., Xie, H., Song, Y. & Shi P. (2006): A study on the pricing policy of wind power in China. Available from: http://www.greenpeace.org/eastasia/Global/eastasia/publications/reports/climateenergy/2006/study-pricing-policy-of-wind-power-in-china.pdf

Lucas, H., Ferroukhi, R., & Hawila, D. (2013): Renewable energy auctions in developing countries. IRENA. Available from: https://www.irena.org/DocumentDownloads/Publications/IRENA_Renewable_energy_auctions_in_developing_countries.pdf

Maurer, L., & Barroso, L. (2011): Electricity auctions: an overview of efficient practices. World Bank Group. Available from: http://www.ifc.org/wps/wcm/connect/8a92fa004aabaa73977bd79e0dc67fc6/Electricity+and+Demand+Side+Auctions.pdf?MOD=AJPERES

Montmasson-Clair, G. & Ryan, G. (2014): Lessons from South Africa’s Renewable energy regulatory and procurement experience. Journal of Economic and Financial Sciences. September 2014 7(S), pp 507-526.

Negri, A. (2015): Auctions design for the renewable energy aid: the Italian experience. Presentation at IRENA Workshop: Renewable Energy Auctions Design and Best Practice. 17 June 2015. Available from: http://www.gse.it/it/Qualifiche%20e%20certificati/Incentivi_DM_06_07_2012/Pagine/default.aspx)

Noothout, P. & Winkel (2016): Auctions for renewable energy support in the Netherlands: instruments and lessons learnt. Report D4.1-NL. Ecofys. Available from: http://www.auresproject.eu/files/media/countryreports/pdf_netherlands.pdf

Noothout, P. (2016): International Experiences with wind auctions in the Netherlands. AURES workshop presentation. March 15, 2016

O’Brien, H. (2013, January 17): Italy's FIT bids fall below auction capacity. Wind Power Monthly. Available from: http://www.windpowermonthly.com/article/1167266/italys-fit-bids-fall-below-auction-capacity

Peña, I. (2014). Retrospective and prospective analysis of policy incentives for wind power in policy 2007-2013. Task 1. Policy paper on renewable energy and energy efficiency of residential Portugal. Submitted in partial fulfilment of the requirements for the degree of Doctor of Philosophy in Engineering and Public Policy. Carnegie Mellon University Pittsburgh, PA. August, 2014.

RVO -Netherlands Enterprise Agency- (2014): Award and realization. SDE+ status as of July 2014. Available from: http://www.rvo.nl/subsidies-regelingen/toezeggingen-en-realisatie-sde

RVO (2015): SDE+ 2015. Available from: http://www.rvo.nl/sites/default/files/2015/02/Digitale%20Brochure%20SDE%2B%202015%20kleur.pdf

Sciaudone, C. (2014, February 6): Unplugged wind farms sit unused as drought strains grid. Bloomberg. Available from http://www.bloomberg.com/news/articles/2014-02-06/unplugged-wind-farms-sit-unused-asdrought-strains-grid

Staatscourant (2016): Nr. 17860, published at 5 April 2016. Available from: https://zoek.officielebekendmakingen.nl/stcrt-2016-17860.html

Steinhilber, S. (2016a): Onshore wind concession auctions in China: instruments and lessons learnt. Report D4.1-CN. Fraunhofer ISI. Available from: http://auresproject.eu/files/media/countryreports/pdf_china.pdf

Steinhilber, S. (2016b): Auctions for renewable energy support in Ireland: instruments and lessons learnt. Report D4.1-IE. Fraunhofer ISI. Available from: http://www.auresproject.eu/files/media/countryreports/pdf3_ireland.pdf

Telha, J. (2014): Expert evaluation network delivering policy analysis on the performance of cohesion policy 2007-2013. Task 1. Policy paper on renewable energy and energy efficiency of residential housing. Portugal. A report to the European Commission Directorate-General Regional Policy

Tiedemann, S. (2015): Auctions for renewable energy systems in Germany: pilot scheme for ground-mounted PV. Report D4.1-DE. Ecofys. Available from: http://www.auresproject.eu/files/media/countryreports/pdf_germany.pdf

Wentz, J. (2014): Balancing economic and environmental goals in distributed generation procurement: a critical analysis of California's Renewable Auction Mechanism. Journal of Energy & Environmental Law. pp. 30–53.

Winkel, T., Rathmann, M., Ragwitz, M., Steinhilber, S. Winkler, J., Resch, R., Panzer, C., Busch, S., Konstantinaviciute, I. (2011). Renewable energy policy country profiles. Based on policy information available in March 2011. Intelligent Energy Europe RE-SHAPING project. www.reshaping-respolicy.eu

Yuen, K.S.E. (2014): REIPPP - A New Dawn for South African Renewables? An analysis of renewable energy prices in the South African Renewable Energy Independent Power Producer Procurement programme. Master Thesis by Kai Simon Eikli Yuen M.Sc. International Energy Sciences Po, Paris School of International Affairs. June 2014.