D4.1, July 2020

# Effects of auctions on RES value chains

AURES II has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 817619

## D4.1, July 2020, Effects of auctions on RES value chains

Authors: Pablo del Rio (CSIC), Christoph Kiefer (CSIC), Craig Menzies (Factor), Mats Marquardt (Factor), Oscar Fitch-Roy (University of Exeter, UK), Bridget Woodman (University of Exeter, UK)

Reviewed by: Robert Brückmann, Agustin Roth (Eclareon)
Submission date: 31 July 2020
Project start date: 01 November 2018
Work Package: WP4
Work Package leader: CSIC

Dissemination level: PU (Public)



# Contents

# Boxes, Figures and Tables

# List of Acronyms

| | |
|---|---|
| AD | Actor Diversity |
| AURES | Auctions for Renewable Energy Support |
| BBBEE | Broad-Based Black Economic Empowerment |
| BW | Bidding Window |
| CfD | Contract for Differences |
| CSP | Concentrated Solar Power |
| DE | Design Elements |
| FiP | Feed-in Premium |
| FiT | Feed-in Tariff |
| GW | Gigawatt |
| GWh | Gigawatt Hours |
| HHI | Herfindahl-Hirschman Index |
| IPP | Independent Power Producer |
| IQR | Inter-Quartile Range |
| kW | Kilowatt |
| kWh | Kilowatt hour |
| MC | Market Concentration |
| MW | Megawatt |
| MWh | Megawatt Hours |
| NFFO | Non-Fossil Fuel Obligation |
| LCR | Local Content Requirements |
| PAB | Price-As-Bid |
| PV | Photovoltaic |
| RE | Renewable Energy |
| REIPPP | Renewable Energy Independent Power Producer Programme |
| RES | Renewable Energy Support |
| Rinv | Remuneration for the Investment |
| SC | Supply Chain |
| WP | Work Package |

# 1 Executive summary

It is often argued that a key feature of auctions is the competitive pressure created on the overall value chain, and indeed on all actors of the renewable energy (RE) sector. Moreover, it is often argued that auctions can induce a reduction in the level of actor diversity (AD) in some segments of the value chain, and especially in the project development sector. In the process of designing an auction, policy makers must make specific decisions and trade-offs related to the auction design elements (DEs). Depending on those trade-offs, auctions may favour certain types of actors over others, and this may lead to increased levels of market concentration (MC).[1] This present study empirically analyses the following two topics:

- The impacts of different auction DEs on MC in the project development and component manufacturing segments of the RE value chain.
- The relative impact of auctions (as compared to other (contextual) factors influencing the value chain) on MC in the project development and component manufacturing segments of the value chain.

Case study analysis were undertaken in four countries, namely Peru (solar PV; wind power), Spain (onshore wind power), South Africa (solar PV; wind power; and concentrated solar power (CSP)), and the United Kingdom (offshore wind). In order to get an in-depth and up-to-date understanding of how auctions and their DEs influence project developers and component manufacturers, country and technology level case studies were undertaken based on structured interviews with key experts in the respective countries.[2]

The main findings of this study are set out below.

Auction DEs

The relative importance of the perceived impact of auction DEs on the MC of project developers and component manufacturers across all case countries is shown in Figure 1 (number of actors) and Figure 2 (diversity of actors). A broad spread can be observed in terms of how DEs affect MC.

The positive and negative impacts of specific DEs on MC are perceived to be more pronounced for project developers, than for component manufacturers. In other words, project developers seem to be more "exposed" and affected by auction DEs as regards the two considered measures of market concentration. As one expert phrased it, "project developers find themselves at the sharp and business end of RE auctions, whereas component manufacturers are relatively more shielded."

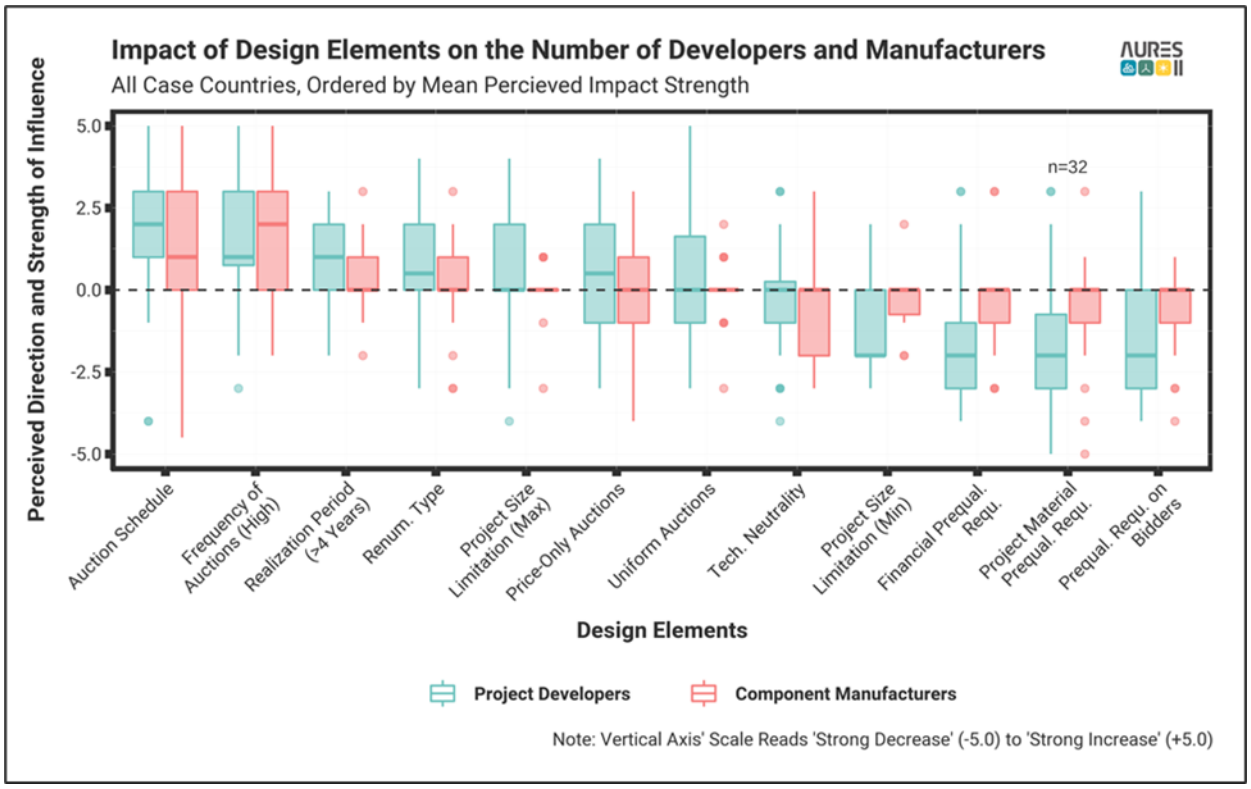
Certain DEs stand out as having a consistently strong positive (increasing) or negative (decreasing) impact on the number and diversity of project developers and component manufacturers; impacts that are observed in all four countries of analysis. The use of transparent publicly-disclosed auction schedules, as well as conducting auctions with high frequency, are clearly considered to be elements which increase both the number and diversity of actors in project developer and component manufacturer value chain segments; a trend that was also observed in all four countries. The opposite is true for all kinds of prequalification requirements.

[1] MC is defined as the distribution of a given market among the participating companies. MC reflects both the number of firms within the market/sector (and/or participating in the auction) and the diversity of those firms (i.e. the degree of heterogeneity with respect to the size of those firms). To date, very limited empirical analysis has been undertaken on the impacts of auctions on MC in renewable energy supply chains.

[2] Expert elicitation-based interviews were used, given the difficulty to gain representative samples on developers and equipment manufacturers (an issue that effectively ruled out the possibility of using a large multivariate sample methodological approach). In addition, surveys are more data-intensive, require a greater length of time and there is a much higher risk of non-response than compared with the use of expert elicitations.

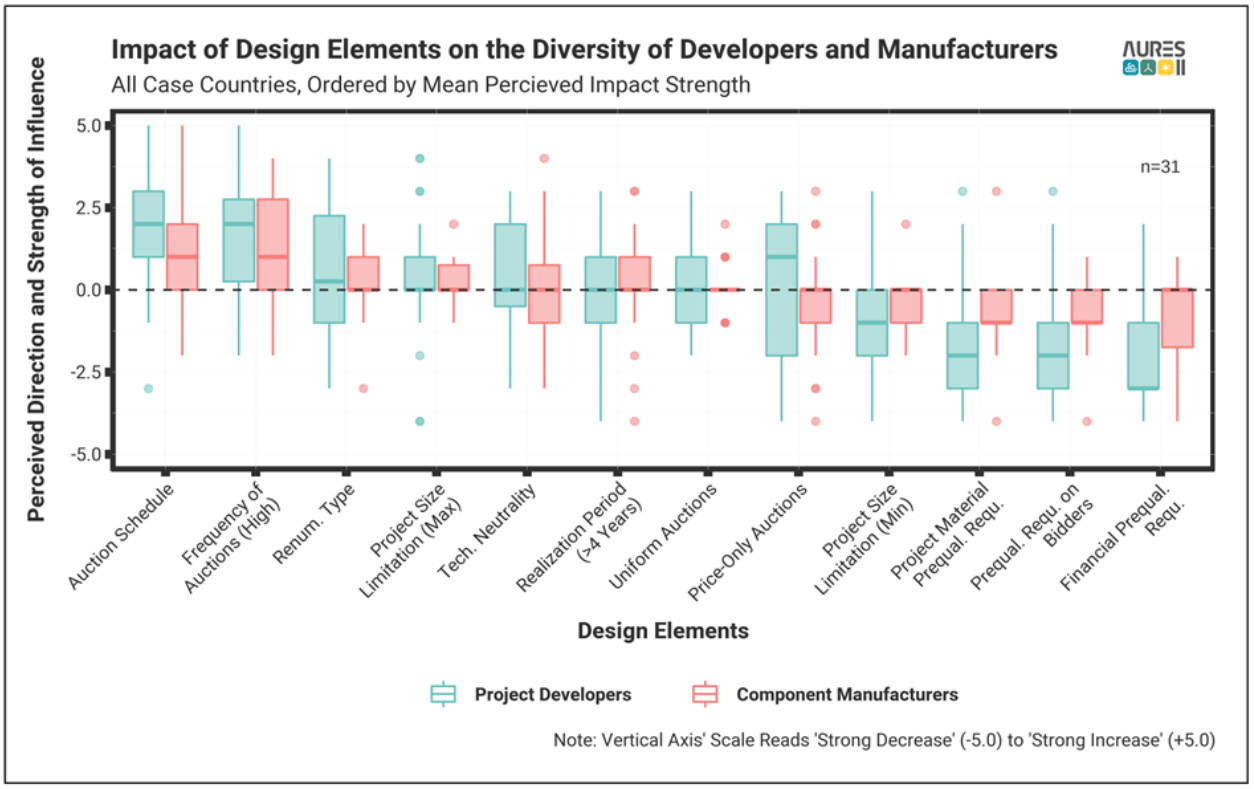
The interviewed experts were selected based on their being very well-acquainted with the country level auction programme, and their significant knowledge of the value chain (particularly as regards project developers and component manufacturers). The selected experts came from a broad range of backgrounds. These included, for instance, policy makers, energy sector and market experts, stakeholders from financial institutions that regularly invest in renewable energy projects, RE industry association representatives, and other relevant actors.

Figure 1: Ranking of DE impact strength on number of developers and component manufacturers




Source: Own elaboration (2020)

Figure 2: Ranking of DE impact strength on diversity of developers and component manufacturers




Source: Own elaboration (2020)

The perceived relative importance of auctions, as compared to specific auction DEs and context conditions, varies considerably between countries with respect to their impact on the two measures of MC. If anything, this confirms the assumption that auctions themselves are by no means the major determinant of MC in the two considered stages of the value chain. Country-specific context (and other) factors will always also play a certain role in shaping the prevailing MC.

- In Peru, for example, the use of auctions themselves (and not specific auction DEs, or context factors) is clearly considered to be the most important determinant of MC.
- In South Africa, however, there is no clear distinction between auctions, auction DEs and contextual factors, in terms of their respective perceived levels of importance in affecting MC. However, as concerns actor diversity, the conclusion is far clearer: auction DEs are the most important determinant of MC (for both project developers and component manufacturers).
- The results for Spain suggest that the use of auctions is the least important determinant of number and diversity (MC) in that country's wind power markets, whereas contextual factors are of highest importance in determining MC for component manufacturers. One possible reason for the relative high degree of importance awarded to contextual factors could be that RE auctions are mandated to be used for all EU Member States, and as such, are now simply part of the landscape. Perhaps what matters most now are (stable) macro-economic conditions and an unambiguous commitment at the national level to continue to decarbonise the country's power sector and broader economy.
- In the case of the UK (offshore wind), a range of views were shared and there is no consensus among interviewed experts regarding the most important determinant of MC amongst project developers and component manufacturers.

The DEs which tend to affect MC to a greater extent (i.e. the frequency of auction rounds, the existence (or not) of a transparent auction schedule, and prequalification requirements), are the DEs that are most likely to get tangled up with non-auction policy areas. These DEs have implications for, and are affected and shaped by, certain factors that lie outside of auction theory. For instance, the schedule of future auctions can be an element of broader industrial development policy, climate policy and wider economic policy making.

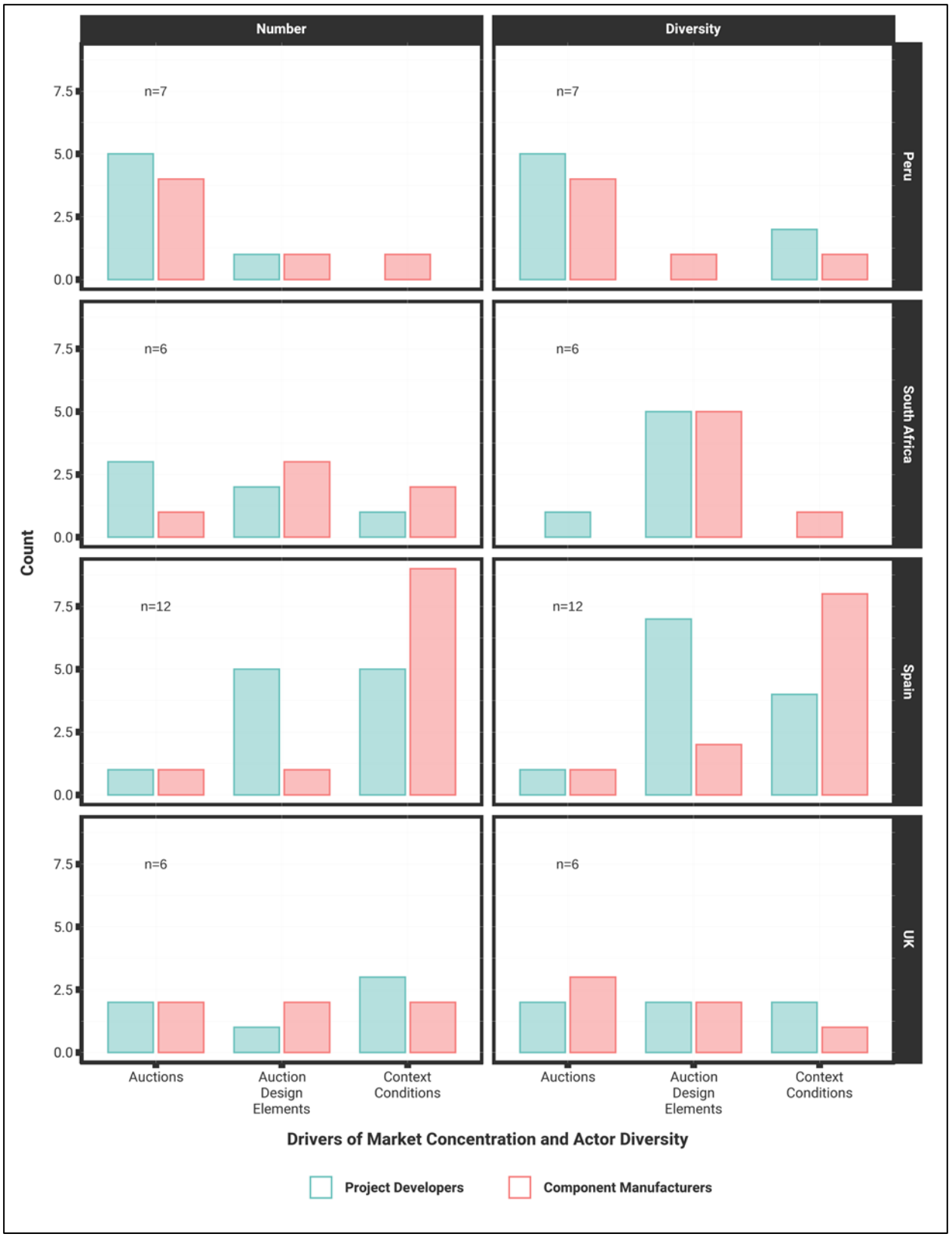
The relative importance of auctions

In general terms, interviewed experts held a range of diverging views as to whether auctions, auction DEs, or context conditions, are most important in terms of shaping the number and diversity of actors in the two value chain segments of interest (see Figure 3).

In Peru, for example, the overall use of auctions (as opposed to context factors, and specific auction DEs), were perceived to be a relatively more influential determinant of the number and diversity of project developers and component manufacturers, while specific auction DEs or context conditions were found to be of secondary importance.[3] In South Africa, the overall picture is less clear, with recorded responses not allowing for the clear identification of a most influential determinant of the number of project developers or component manufacturers. With respect to the diversity of project developers and component manufacturers, however, specific DEs may have represented a defining factor in South Africa. In Spain, experts' judgements clearly point towards the relative importance of context conditions for both the number and diversity of component manufacturers. With respect to project developers, experts' responses indicate that both context conditions and specific DEs may have been critical for the number of developers, while the latter may have been slightly more influential for component manufacturers. In the case of the UK, there is no consensus among interviewed experts regarding the most important determinant of MC amongst project developers and component manufacturers.

[3] Peruvian experts also reported that auctions are seen to be a well-established tool in the international context, and a critical part of helping attract international attention towards investing in renewable energy projects in Peru. Several interviewed experts mentioned that for Peru to develop a competitive and scaled-up renewable energy sector, it is vital that it develops a market that can compete internationally, including with, for example, neighbouring Chile and Brazil, which may be viewed by some as currently being more established and experienced markets.

Figure 3: The relative importance of auctions, DEs and context conditions

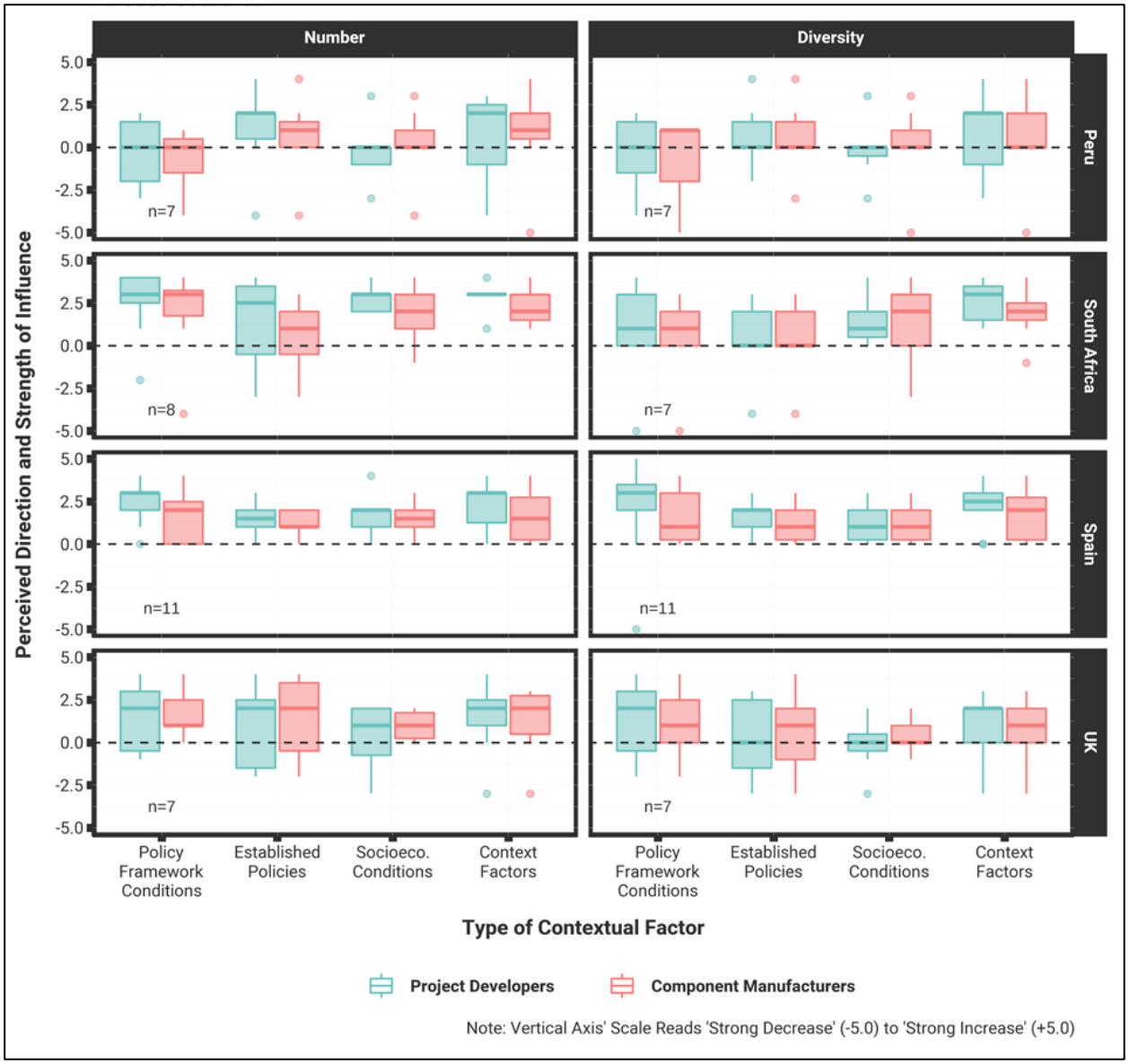



Source: Own elaboration (2020)

The relative importance of contextual factors

Context conditions and related factors were found to affect the number and diversity of project developers and component manufacturers in an overall neutral or positive way, as shown in Figure 4.

Figure 4: Contextual factors' influence on project developers and component manufacturers




Source: Own elaboration (2020)

An important aspect to bear in mind is that the RE sectors of the four countries that were analysed in this study already had relatively high levels of MC. This is an important contextual factor, and any specific decisions concerning auction-related or contextual factors that are understood to increase MC (even) further could be of relatively higher importance compared to decisions on the same factor in a RE market with generally lower market concentration. One might argue that, where a central policy objective is to increase market competition (i.e. increase the number and diversity of actors) in a RE market that is currently highly concentrated (i.e. low competition), there is relatively less margin for error in setting the auction DEs at the "right" levels.

This study has identified patterns of DEs with similar effects on MC (number and diversity) across countries, which may hint towards the existence of globally relevant effects. This suggests the existence of important

implications for policy makers and authorities responsible for the design of RE auctions, in their efforts to balance sector and market development objectives, MC objectives, and other explicit auction outcome objectives (such as yielding competitive prices, and the timely development of projects, amongst other things).

# 2 Background and context

Work Package 4 (WP4) of the AURES 2 project focuses on the effects of RE auctions on the RE sector. The overall aim of WP 4 is twofold. On the one hand, within WP 4.1 and WP 4.2, the impacts of RES auctions and the DEs of auctions on the RE sector supply chain (SC) (market concentration (MC), reflected on the number and diversity of firms) will be identified, focusing on two main stages of the value chain (i.e. component manufacturing, and project development). On the other hand, in WP 4.3, the impacts of auctions as well as auction DEs on technological innovation will be analysed. This report focuses on the first of the above-described aims: *an empirical analysis of the impacts of auctions on the supply chain*.

## 2.1 Focus of this study

It has traditionally been argued that a main feature of auctions is the competitive pressure created on the overall value chain and on all actors of the RE sector. Moreover, it is often argued that auctions can induce a reduction in the level of actor diversity (AD) in some segments of the value chain (and the project development sector, in particular).

The two above-mentioned arguments apply to both the overall use of auctions (as opposed to administratively-set remuneration, e.g. Feed-in tariffs (FiTs)), and the specific choices concerning the DEs used in auctions. In other words, depending on the specific DEs chosen, auctions may favour certain types of actors over others. This may lead to increased levels of market concentration.

MC is defined as the distribution of a given market among the participating companies. MC reflects both the number of firms within the market/sector (and/or participating in the auction) and the diversity of those firms (i.e. the degree of heterogeneity with respect to the size of those firms). To date, very limited empirical analysis has been undertaken on the impacts of auctions on MC in RE supply chains. As such, the objectives of this study include:

- The estimation of the perceived impacts of different DEs on the number and diversity of firms in two stages of the RE value chain (i.e., project developers and component manufacturers).
- The estimation of the perceived relative impacts of auctions and auction DEs on the number and diversity of firms as compared to other (contextual) factors influencing the value chain.

Based on the study's objectives, a central hypothesis emerges:

> *Some DEs in auctions are likely to have a considerable impact on the number and diversity of project developers and component manufacturers, whereas the effects of other DEs are likely to be very small or negligible. In particular, it is hypothesised that a high frequency of auctions (more than once a year), a transparent schedule of auctions, as well as stringent prequalification requirements are relevant in this regard.*

The MC of RE supply chains can be expected to be affected by many factors, including key government policies on energy, industrial development, trade, and the environment, as well as socioeconomic and country-context factors (ICSTD 2017). Both local policies and policies in the international context will have an influence to this end, i.e., firms participating in auctions abroad, instead of auctions within their home country, because they see higher profitability there; or local content requirements (LCRs) in non-EU countries affecting European industry. With respect to local policies, the instruments (e.g., auctions, versus administratively-set remuneration), the choices around specific auction DEs, and the prevailing policy framework conditions in a country (and especially, the existence (or not) of targets and policy stability) are all highly influential factors in this regard.

Therefore, auctions and auction DEs are expected to be one among many possible factors that impact on MC in the supply chain. One implication of this is that authorities' attempts to improve the number and diversity of firms in RE supply chains by including and/or adjusting some auction DEs may meet (only) limited "success" in terms of their effects on the supply chain. Potentially, some adjustments may have detrimental effects on other measures, such as the effectiveness or efficiency of auctions. The impact of auctions and auction DEs can be expected to be both RE technology-specific and country-specific, and may depend on the prevailing local conditions (including, for instance, the existence of an industrial base; workforce and firms' capabilities; and access to financial and technical resources, etc.).

## 2.2 Market Concentration in the Context of Auctions

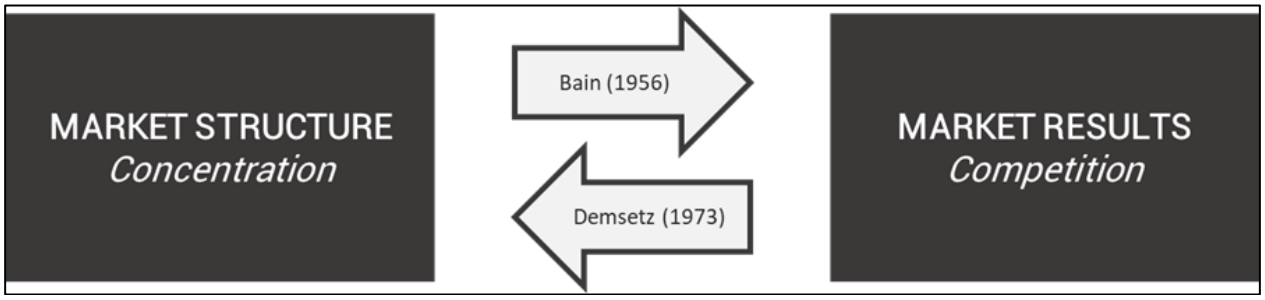
Some authors have argued that whilst auctions can yield an economically efficient allocation of resources from a competitive market perspective, their outcomes are not so optimal from other perspectives (IRENA, 2019). (Fell, 2019), for example, claims that auctions may not produce a diversified landscape of actors or generate the shared benefits envisioned for a just and inclusive energy transition (when such objectives are not integrated in their design). Usually, auctions are cost-based, i.e. the bidders that offer the lowest bids are awarded. Large and established companies are well-placed to offer relatively lower than average bid prices, making use of economies of scale or a vertically integrated value chain. Smaller scale actors can face two main problems, namely: (i) they can have systematically higher generation costs compared to those of large actors, due to their lacking economy of scale advantages; and (ii), they are generally less able to spread their (investment) risks as broadly as larger actors are able to, due to their typically smaller project portfolios (Simone Steinhilber; Emilie Rosenlund, 2016). As such, purely price-centric auctions may crowd out small project developers, thereby centralizing market power, and excluding local communities from decision making processes (IRENA (2019); Fell (2019); Del Río & Linares (2014). However, the presence of small scale and new entrant players in RE markets, and the development of local RE industries and supply and value chains, are all important components of a just and inclusive energy transition (IRENA, 2019).

### 2.2.1 Market Concentration: Good or Bad?

Market concentration can be expected to affect the efficiency of support schemes and support costs. Auction designs that limit actor diversity can have long-term implications for the market and sector as a whole: providing a level playing field for small, medium and large scale participants would be more likely to lead to the inclusion of all, an outcome that has positive implications for competition, innovation and local "buy-in" to the energy transition. Highly concentrated markets can also be problematic for the price outcomes of auction themselves. The presence of a sufficient number of actors (i.e. low market concentration) is a prerequisite for competition, free price formation and, as a result, for the lowest possible auction prices (Bayer, Schäuble, et al., 2018, p.310).

Market concentration is traditionally understood as problematic from a public benefit perspective, especially as regards the intuitive relationship between high market concentration and collusion (Bayer, Schäuble, et al., 2018). This appears to suggest that a high participation of small-scale actors should be a clear objective for policy makers. However, small might not always be so beautiful. There is a presumption that the relationship between market concentration and competition is unidirectional and negative; specifically, that a sufficiently high number of actors (i.e. low market concentration) is a prerequisite for competition and free price formation. According to the seminal approach of Bain (Bain, 1951) (Bain 1956) market structure determines the results of the market in terms of competition. However, Demsetz (1973) highlighted that this relationship is bidirectional, with structure (concentration) influencing the results (competition), but also the other way around (as shown in Figure 5).This suggests a circular relationship, with continuous feedbacks between market structure and competition.

Figure 5: The bi-directional relationship between MC and competition




Source: Own elaboration, based on (Bain, 1956) and Demsetz (1973)

A further important point of note is that policy objectives of increasing the diversity of firms (a component of market concentration) may be reached at the expense of worsening other policy goals, such as efficiency or effectiveness. If incumbent actors have a long track record and significant experience in developing and

constructing RE generation projects, the introduction of new (and far less experienced) actors may lead to overall lower project realization rates. Synergies are also possible: increased diversity of bidders may enhance the public acceptance[4] of the auction.

### 2.2.2 Factors Influencing Changes in Market Concentration

Both the theoretical and empirical industrial organization literature suggests that there are several key factors affecting market concentration. A traditional distinction between two categories of determinants of the level of concentration in a market is:

I. Technological reasons: They determine the need for a large plant size in order to reach an efficient production level, i.e. the existence of economies of scale in the section of the production function being considered.
II. Barriers to entry: Entry barriers in the market which prevent the entry of new firms and which can be due to legal restrictions, product differentiation or technical capabilities.

There is a long tradition of empirical studies on the sources of market concentration, as well as on classifications of the type of drivers (Pickford 1983, (Ratnayake (1999); Bhattacharya & Bloch (2000); Mueller et al. (1974); Jenny & Weber (1978), among others). However, the classification of Lypczynski et al (2005) is deemed particularly useful for the purposes of this report, since it facilitates linking the causes of market concentration with DEs in RE auctions in a more straightforward way. These authors distinguish between economies of scale, barriers to entry, sunk costs, regulation, industry lifecycle, distinctive between economies of scale, barriers to entry, sunk costs, regulation, industry lifecycle, capabilities and core competencies as the sources of market concentration. The authors of this study consider that economies of scale, barriers to entry and sunk costs are the most relevant drivers of market concentration in the context of this report, and hence the analysis presented in this paper focuses on the influence of auctions and DEs with respect to these three drivers.

### 2.2.3 The Impact of Auction Design Elements on Project Developers[5]

Project developers' and component manufacturers' economies of scale, barriers to entry and sunk costs are directly or indirectly affected by auctions, and specifically by their design elements.

This section describes the main design elements in RE auctions, and for which the impact on the market concentration of project developers and component manufacturers is being analysed in this study.

I. Volume: There are three main ways to set the volume auctioned:
    a. Capacity targets: A total quantity in terms of MW is auctioned.
    b. Electricity generation targets: There is a goal of a total amount of MWh.
    c. Budget (financial support) targets: There is an overall amount of support to be provided. It can be combined with the other two alternatives.

    A main challenge in RE auctions is to set the volume at an "appropriate" level, i.e., neither too high nor too low. Whether or not to publicly disclose the volumes is also an important decision to be taken.

II. Timing: The duration of the period between the announcement of the call for the auction and the time when the actual bidding occurs is also a key feature of the auction. Most importantly, the existence of regular auction rounds, with a clear schedule is a critical design element. Setting the number of rounds to be undertaken in a given year is a difficult, technology-specific issue.

[4] CEER (2016) stresses that ensuring a high diversity of bidders (investment groups, energy suppliers, project firms and private investors) is a potentially important aspect for achieving overall public acceptance of the auction. A higher degree of diversity (and number) of bidders reduces the risk of not meeting official RE targets due to the non-compliance of a single bidder, although the risk of ineffectiveness is probably higher with new entrants and smaller actors (versus experienced and larger companies).
[5] This subsection heavily draws on del Río (2017c).

III. **Diversity:** Policy makers may be willing to introduce DEs which increase diversity with respect to technologies, locations, actors and sizes of the installations for a number of reasons (see del Río 2017c for an extensive explanation). Diversity could be promoted in an auction by organizing different auctions per alternative (e.g., technology-neutral vs. technology-specific), by including minimum quota per alternative, by providing different remuneration levels for different alternatives, or by lowering prequalification requirements or penalties for specific actor categories (i.e. small sized actors).

IV. **Participation Conditions (Facilitation and Requirements):** Several elements may facilitate the participation of actors in an auction, while others are rather requirements for this participation:

a. Streamlining administrative procedures: Administrative procedures may severely restrict participation in an auction and, thus, competition levels. Therefore, measures to streamline them may facilitate higher levels of participation.

b. Supporting dialogue with stakeholders and information provision: In some countries, policy makers meet with potential bidders to inform them about auction design and to canvass their views in order to incorporate their feedback into (improved) auction design. Critical information that could enhance participation in the auction may be provided (e.g. RE resource potentials).

c. Prequalification requirements: These are the requirements to be met to participate in the bidding procedure. Potential bidders' compliance (or not) with prequalification requirements are checked before the auction takes place.

   Prequalification requirements can apply to the specifications of the offered project (such as technical requirements, documentation requirements and preliminary licenses), and to the bidding party (providing evidence of the technical or financial capability of the bidding party) (Held et al., 2014). They are used to help prove the seriousness of the bid and/or the probability of realization of the project. As with other auction DEs, the challenge is to set them at appropriate levels (i.e. neither too stringent, nor too lenient). Viscid (2019) distinguishes between Preliminary Grid Access, Environmental Permitting, Environmental Impact Assessment, Land Use Rights, Company Net Worth, Previous Experience (Technology), Previous Experience (Size), Previous Experience (Financing), Resource Assessment, Energy Output Studies, Connection to Grid Study, Local Subsidiary Formed and Credit Rating.

d. Local content rules refer to the requirement to use RE equipment which is manufactured by local firms.[6]

e. Seller concentration rules might be implemented (such as in California, India and Portugal) in order to mitigate the risk of market power. Successful winners in one round may be prevented from participating in a later round or the size of the bidding share by a single actor might be limited.

V. **Support Conditions (Types and Forms of Remuneration):** Remuneration in an auction can be provided for generation (MWh, generation-based) or capacity (MW, investment-based). In addition, there are several instruments to set the remuneration for energy, including Feed-in Tariffs (FiTs) and Feed-in Premiums (FiPs):

a. Under FiTs, a total payment per kWh (or MWh) of RES-E generated, paid in the form of guaranteed prices and combined with a purchase obligation by the utilities is provided.

b. Under FiPs, a payment per kWh on top of the electricity wholesale-market price is granted. Within FiPs, a main distinction is between fixed and sliding FiPs. Fixed FiPs are set once and do not alter. The total remuneration thus depends on the market prices and is therefore more uncertain, which raises investors' risks and ultimately increases the cost of capital and the levelized cost of electricity (LCOE). Sliding FiPs are set at regular intervals to fill the gap

[6] They can be set by requiring that a percentage of the renewable energy equipment is manufactured by local firms or by organizing two auctions: one with domestic content requirements and the other one without.

between the average market price perceived by all generators of a given technology and a pre-determined strike price. The difference in returns is more modest than with ex ante FiPs, and the increases in risks and costs of capital are less pronounced.

VI. Selection Criteria: Price-only auctions are organized using only one criterion (the bid price). In multi-criteria auctions, the price is the main criterion among other criteria (e.g. local content rules, impact on local R&D, industry and jobs and environmental impacts) (see, for example, (Held et al., 2014).

VII. Auction Format: Depending on whether the auctioned object can be split between multiple winning bidders, auctions are referred to as single-item or multi-item auctions. In a single-item auction there is a single product which is allocated to a single owner and the product cannot be split. In a multi-item auction the auctioned product is split among different owners and bids are submitted for only part or the total auctioned amount (AURES 2016).

VIII. Auction Type: An important distinction is between static (i.e. sealed bid) and dynamic auctions. Under sealed-bid auctions, project developers simultaneously submit their bids with an undisclosed offer of the price at which the electricity would be sold. An auctioneer ranks and awards projects until the sum of the quantities offered covers the volume of energy being auctioned. In dynamic auctions, for example under the multi-round descending-clock auction, the auctioneer offers a price in an initial round, and developers bid their offers of the quantity they would be willing to provide at that price. The auctioneer then progressively lowers the offered price in successive rounds until the quantity in a bid matches the quantity to be procured (previously decided by the auction authority). Hybrid models may use the descending clock auction in a first phase and the sealed-bid auction in a second phase, as in Brazil (Hawila et al., 2013).

IX. Pricing Rules: There are basically two different ways to set support levels in sealed-bid auctions. Under uniform pricing all winners receive the strike price set by the last bid needed to meet the quota or the first bid that does not meet the quota. Thus, either the highest accepted bid determines the award price, or the lowest rejected bid determines the award price (highest accepted bid, or HAB and lowest rejected bid, or LRB, respectively). Under the pay-as-bid (PAB) alternative, the strike price sets the amount of generation eligible for support and each winner receives his/her bid.

X. Price Ceilings: In order to limit the costs of support, the auctioneer can set a ceiling (reservation) price for each technology, above which projects are not considered (Hawila et al., 2013). An important choice to be made if a maximum price is implemented is its level. Again, setting the ceiling price at an "appropriate" level is not a trivial exercise. A further important decision is whether or not to publicly disclose this price.

XI. Realization Period: Deadlines need to be established, setting the date by which the awarded projects need to be built. The duration of this "grace period" is a key issue, with a risk of too long or too short periods.

XII. Penalties: Penalties can take different forms: for example, they can forbid participation in successive auctions, reduce the level of support, reduce the length of the support period by the time of the delay, lead to the confiscation of bid bonds and result in penalty payments. Again, a main issue is whether they are set too high or too low.

### 2.2.4 The Stages of the Value Chain of Interest and the Role of Contextual Factors

This study seeks to analyse the impact of auctions and DEs on two stages of RE value chains, i.e., project developers and component manufacturers. The impact of auctions and DEs on project developers is direct, given that DEs directly affect the participation of project developers in the auction. With respect to component manufacturers, the impact is expected to be less direct and potentially more difficult to observe, but nonetheless it is worthy of analysis.

One main assumption is that local component manufacturers would benefit from higher profit margins by the participants in the auctions (bidders) who would then have to buy their products. DEs in the auction which lead to squeezing profit margins would tend to put pressure on them to also cut down profit margins and produce more efficient components (either cost-reducing or revenue-increasing technologies). It is important

to consider not only short-term effects, but also long-term effects and, in particular the impact on future investments. It can be expected that lower profit margins by equipment manufacturers would affect the possibility to carry out investments in the future.

The impact of auctions on project developers and component manufacturers can only be considered as one among various influences. In general, energy policy is as relevant as industrial policy in this context. In fact, as argued in (IRENA, 2019), for countries with weak domestic supply chains, measures are needed to augment industrial capabilities within and beyond the energy sector; incubate and develop supplier firms; engage in joint ventures for learning-by-doing processes; step up education and training efforts; and pursue opportunities for regional cooperation and shared advancement.

A stable policy framework is a central determinant of market concentration, but also for the functioning of the auction itself. Holding a reputation for having an unstable policy framework – for instance, due to sudden legal and regulatory framework changes that affect the financial viability of potential investments, or (even worse) retroactive changes that affect existing projects – can have negative impacts on the confidence and interest of private sector firms to develop projects (Botta, 2019). The degree of ambition in RE targets is also relevant in this context. For example, according to Viscidi and Yépez (2020), ambitious RE targets in Chile and announced auctions in 2019 and 2020 have created long-term confidence in the market and are behind the large level of participation in the recent auction held in that country.

One aspect related to regulation is the ease of obtaining the necessary administrative permits. Several aspects of the regulatory environment may entail risks for investors, including land lease agreements, land use consent, construction permits, environmental permits, grid connection permits, generation licenses, power system dispatch rules, etc. (Dobrotkova et al 2018). Auctioneers may address some of these issues before the auction and reduce risks through minimizing long and cumbersome bureaucratic processes, regulatory barriers and uncertainty related to permitting and licensing that the project developer would otherwise need to face with multiple central and state government agencies (Dobrotkova et al 2018, p.135). It should be taken into account, however, that risks are sometimes not reduced, but transferred. The issue is also if they are transferred to the actor who is better able to address them, as it is the case with administrative permits.

On the other hand, there are factors which influence the levels of participation, but which are external to the auction design and to RE policy in general. Viscidi and Yépez (2020) mentions the overall investment climate of the country, the credit risk profile of the off-taker, the size of the market, the availability of transmission and distribution infrastructure, and the RE resource potential. Low levels of investor confidence in the market and the lack of an enabling environment would negatively influence participation in the auction. IRENA (2019) groups those RE non-policy factors into two categories, i.e., (i) country-specific conditions, such as the potential of RE resources, financing costs, installation and building costs (land, labour, energy, etc.), the ease of access to equipment, foreign exchange rates, general fiscal legislation); and (ii) investor confidence and learning curve, such as influenced through the credibility of the off-taker and additional guarantees, the presence of a stable and enabling environment that is conducive to market growth and past experience with auctions for both auctioneer and developers.

## 2.3 An Integration of Approaches on the Impact of Auction Design Elements on Market Concentration

In this section, the concepts of market concentration and auctions are more formally linked and integrated. The aim of this integration is to provide an analytical framework which serves as the basis to identify the impact of those design elements on market concentration, taking different determinants of market concentration into account and, particularly, barriers to entry and sunk costs. The main assumption is that, with respect to its alternative, the choice of a design element will affect at least one of those determinants and, thus, influence one of the two aspects of MC (number and diversity of firms).

Changes in MC may be due to:

I. Changes in the degree of homogeneity of firm sizes.

II. Changes in the number of existing firms (given the entry and exit of firms).

In the "Bain model", structure refers to those two aspects:

I. The distribution of the sizes of the firms present in the market.

II. The degree of concentration of the activity in a limited number of (large) firms which, thus, enjoy a high degree of market power.

Our starting point is that both fields of research (the industrial organisation literature and auction theory) can be connected through the impact of DEs on some intermediate variables (revenues, costs and risks of participating in an auction) which affect the participation in the auction. These variables influence the determinants of MC (see Section 2.2) and, thus, market concentration. The design of auctions can vary significantly, with important effects on the number and quality of bidders (Viscidi and Yépez 2020, p.5). Alternative DEs in auctions have differing impacts on potential bidders, since they affect those revenues, costs and risks. In other words, revenues, costs and risks are (partly) dependent on the specific design of tenders. Clearly, these three factors are somehow related since investors are encouraged to participate in the auction by an attractive risk-return profile. As Botta (2019, p.1) puts it, "riskier or less well-designed policy instruments would lead risk-adverse investors to seek higher returns for their investment. Given the State supported nature of RE investments, higher subsidies would be therefore necessary to generate an attractive risk-return profile".

Only those project developers who offer the lowest remuneration rates (e.g. in €/MWh) receive remuneration. As indicated by Bayer et al (2018, p.314) "for the project developers, the remuneration rates offered are composed of, in simplified terms, the sum of expected costs (including risk markups) and the desired profit margins, divided by the expected electricity generation. The competition in auctions creates cost pressure and reduces the bidders' expectations with regard to returns" (Bayer et al 2018).

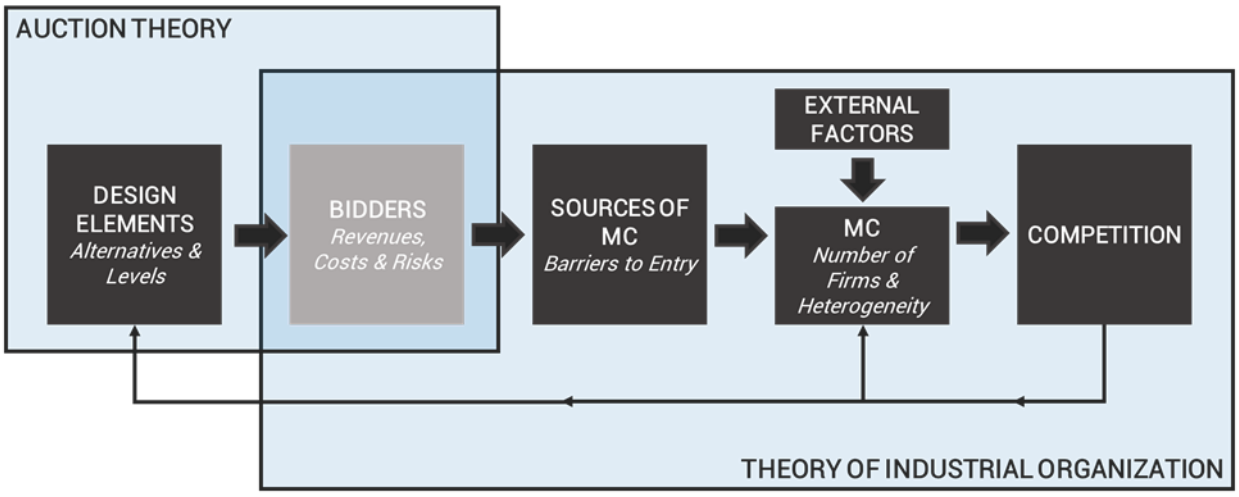
Very low expected revenues would lead to low incentives to participate in the auction. As put by Botta (2019, p.6), "Speculative bidding, broadly defined as bids that are priced too low to be economically viable, can severely weaken investment attractiveness."

High costs and risks would deter participation in the auction (lower number of firms) and also probably fall asymmetrically on different types of actors (large vs. small).

Costs and risks are interrelated to some extent, since higher risks increase the costs of capital and, thus, overall levels of CAPEX for projects. However, they are kept separate in order to better illustrate the influence of DEs on those variables.

In turn, high/lower revenues, costs and risks probably influence different types of actors (e.g. large vs. small, incumbents vs. new entrants) in a different manner. This has an impact on both aspects of MC (number of firms, and heterogeneity of firms). DEs may have an indirect impact on MC, whereas others may affect MC directly (e.g. seller concentration rules). A schematic overview of the analytical framework is shown in Figure 6.

Figure 6: Analytical framework overview




Source: Own elaboration (2020)

Thus, compared to administratively-set remuneration levels, project developers (bidders) compete between each other for a given remuneration level in auctions. In addition, in administratively-set remuneration schemes, all project developers are eligible to receive support. By contrast, auction participants may not be awarded in the auction and, thus, incur sunk costs. This leads to greater costs in an auction compared to administratively-set support. The restrictions in the access to support and the lower profit margins result in a lower number of project developers than with administratively-set support. This means a lower number of companies, but also ones that are better able to cope with the relatively lower revenues and higher costs and risks (hence, lower profit margins).

Some DEs may induce a greater level of competition and/or greater costs (i.e., more stringent prequalification requirements) and, thus, lead to lower profit margins than others. In particular, some DEs may induce a greater level of competition, leading to low bid prices. We could expect that those DEs would lead to a lower incentive to participate in the auctions, i.e., a lower entry of firms in the market. This would induce a greater level of MC in both senses, i.e. lower numbers firms as well as less diversity of actors. Large players are more likely to cope better with low profit margins, given that size matters, i.e. due to economies of scale and financial strength, but also because lower profit margins are likely to lead to mergers and acquisitions. When price competition is fierce, firms must produce at large scales if they want to survive and this limits the number of firms in the market. A higher level of profit encourages entry, whereas a lower profit induces exit and mergers (consolidation).

The opportunity to drive down costs through scale effects can be an important motive to offer low-price bids (Amazo et al (2018). In Germany, synergies between nearby offshore wind farms can help reduce the high cost for tailor-made maintenance concepts and downtime management. Ørsted, for example, plans to combine the OWP West and Borkum Riffgrund West 2 projects into one large-scale project with the option of adding more volume in the 2018 auction, which they successfully achieved.

Therefore, although lower prices in the auction is good news for the minimization of support costs in the short term, they may lead to fewer project developers (owners), a more concentrated market, and possibly to a lower level of competition in the future. In other words, there might be detrimental effects in the longer term.

Lower profit margins for the project developers and investors awarded in the auction could be expected to influence other stages of the value chain. We could hypothesize that lower profit margins would push equipment manufacturers to produce low-cost (or revenue-increasing) equipment. In turn, very low profit margins may entail a huge challenge for future investments. Who would invest in a sector with very low rates of return?

Note that it is not only an issue of lower revenues, but also of greater costs and risks. Most risks are related to the sunk costs before the auction, since bidders will incur those costs without knowing whether their bids

will be awarded. And it is also an issue of different types of actors having different capacities to cope with lower profit margins and greater risks. In particular, small actors may be detrimentally affected in this context.

MC may be affected by other factors which are not related to the auction. What these factors are is a purely empirical issue, and they are context-specific (related to country, technology and time). Policy risk is an important factor that affects participation (or not) in the auction. Policy risks might be affected by the anticipated changes in revenues generated via the implemented RE policy instrument (e.g. FiTs or green trading schemes, for instance). They are also affected by the policy framework conditions (e.g. the presence of guaranteed grid connection, the complexity in obtaining permits or the effectiveness of the judicial system) (Botta 2019).

These external factors need to be taken into account in the empirical analysis. Furthermore, these factors probably differ per technology. Some studies carried out for other markets using the theory of industrial organization suggest the existence of a strong relationship between MC and the features of the technologies which are used in the market and which make up the minimum efficient size. Finally, it is beyond the scope of this present analysis (i.e. WP4 of the AURES 2 project) and, thus, of this report, to assess the influence of MC on competition.

Finally, it is worth underlining that the existence of a given market structure conditions the design of auctions to some extent, which, in turn, may influence MC. For example, in markets with low penetration of renewables and few players, governments tend to implement technology-specific auctions. In more mature markets with large scale and many project developers, governments tend to transition to multi-technology auctions (Saygin et al 2018). Mora et al (2017) found that several market characteristics influence the design of auctions, including the expected market potential (project pipeline) and how this relates to the auction volume (timing of the next round and long term auction schedules), the average project size (per technology) and how this relates to auction volume and frequency (number of auction rounds per year), the expected number of bidders and bids, the distribution of project costs among bidders (how asymmetric, and systematically different project costs are) and the relative strengths of bidders and how familiar they are with each other (including, for example, how well they can assess each other's costs).

## 2.4 Scope of the Analysis

Project developers and component manufacturers were chosen as the two stages of the RE value chain for the analysis conducted in this study, as opposed to the several alternatives that exist in this context, i.e., bidders, material suppliers and O&M service providers. The boundaries between these stages are sometimes blurry, which hampers the analysis of distinct stages at times. For example, awarded bidders are different to developers, as some firms participate in the auction, initially develop the projects, and sell them to third parties. Thus, those actors (bidders) being awarded in the auction are not necessarily those who will develop the project. It is for this reason that the analysis undertaken and presented in this report focuses on project developers, and not project bidders (whom may, or may not, develop the project). Specifically, the study focuses on MC in the project development and manufacturing stages.

Project developers buy the projects from these bidders / intermediaries and this may result in developers being large actors (since they are the ones able to pay for those built projects). This means that it is incorrect to assume that the bidders are "new entrants", since what really matters is who develops the project in the end. These bidders / intermediaries may be reducing competition in the project development stage, leading to a higher market concentration. In practical terms, this means that project-by-project research is required in order to identify the actual developers of the project.

Another defining factor is that project development and component manufacturing are the two stages in the value chain that are more directly impacted by auctions (i.e. the scale of impact reduces as one moves downstream in the value chain). This has practical advantages, given that the potentially small impact of auctions, and especially the specific DEs, on market concentration will be easier to record for those stages of the value chain that are directly affected.

Project developers and component manufacturers are also the two most important stages in terms of value creation for a sector (PV, CSP and onshore wind). The value chain of both wind and solar technologies are incredibly complex and involve several players as well as processes (ICSTD 2019). Therefore, a focus on

particular stages and actors is recommendable. The focus of this study for component manufacturers for wind is on turbine manufacturers, whereas for solar PV the focus has been placed on module manufacturers. They have the greatest importance in wind and solar PV value chains, respectively. According to Wind Europe (2019), wind turbine manufacturers are the largest contributor to wind energy total revenues (EUR 16.6/55.6 billion) and KPMG (2019) shows that turbine costs represent 70% of the cost of a wind farm. According to UNEF (2019), modules represent 50% of the costs of a solar PV installation in Spain.

Lastly, reasons for the choice of countries include relatively long experience in the organisation of auctions, easiness of access to data, well-established local supply chains and a suitable balance between EU and non-EU countries.

Table 1 lists some of the fundamental assumptions on the scope of the empirical analysis as well as the rationale behind them.

Table 1: Scope of the empirical analysis: choices and assumptions

| Item | Proposed choice | Rationale |
|---|---|---|
| Features of the value chain (number, diversity, strength and depth) | Number and diversity | Three aspects of the supply chain (SC) can be studied: number (how many firms), diversity (how different they are), depth (integration of different actors) and strength (how "good" they are) (IRENA 2019). First, the depth and strength of the supply chain are rather abstract concepts in the literature, whereas the former two are clearer (there are indicators). Second, the depth and strength entail quantitative and qualitative aspects which are very difficult to capture without modeling tools. Third, and perhaps more importantly, the breath and diversity of the SC on the one hand, and the strength of such SC might be interrelated with the former two being main drivers of the latter one (strength). For example, in the CSP market, numerous new actors have entered the market – a desperately needed development, given the thinning out of CSP supply chains in the last years. New actors are likely to bring innovation to the CSP value chain and, even more importantly, if at least some of them survive, the CSP value chain will become more robust and less dependent on single companies (Lilliestam 2018). |
| Aspect of diversity being analysed: size and new entrants (vs. incumbents) | We focus on one aspect of actor diversity: size (small/large) | We focus on size given: 1) The importance attached to this aspect in the literature of auctions, as well as in relevant policy-relevant documents by worldwide institutions (EU Guidelines on State Aid, IRENA, USAID…); 2) The relevance attached to this issue in the current Directive 2001/2018 (see number (17) and article 4); 3) The finding that the new entrants category is often closely (albeit not perfectly) related to the small actor category. |
| Stage of the supply chain: bidders, project developers, equipment manufacturers, component manufacturers, material suppliers, O&M | Project developers and equipment manufacturers | There are at least three reasons for this choice. First, awarded bidders are not necessarily those developing the project. Second, these are the two stages in the SC more directly impacted by auctions. Third, they are also the two most important stages in terms of value creation for a sector (PV, CSP and wind onshore). |

| | | |
|---|---|---|
| Comparative impact of auctions or DEs on MC | Impact of both auctions or DEs on MC | This is the focus of the project (i.e. on auctions and its DEs). |
| Geographical scope: global, national, regional or local | Local impacts at the national level | The impacts of auctions on supply chains may affect different countries at the same time. This may involve a positive impact at the local (national) level and a negative impact at the aggregate level (e.g., local content requirements). However, we focus on the national level.<br><br>Despite the traditional discussion in economics about the focus on the aggregate level, in the last decade a parallel (perhaps even dominant) idea is that industrial policy has important local effects which should be analyzed and that the issue is not whether to use industrial policy (something that was not recommended by economists in the past), but rather how to use such policy (Rodrick 2014, The Economist 2010). |
| An analysis of the perception of what the impacts are vs. and analysis of what the impacts are | An analysis of the perception of what the impacts are | Data are simply not available to carry out a complete, panel-data multi-variable regression of how auctions and different auction DEs impact the two aspects of the supply chain (breath and diversity), controlling for other effects. Therefore, in addition to some hard data, we have to go for a second best and analyze what key actors in the sector (very involved, very knowledgeable, etc.) believe is the impact of auctions and auction DEs through an expert elicitation survey. |

## 2.5 Markets of focus

### 2.5.1 Peru

Peru is the fourth-largest country in Latin America, with strong economic and electricity demand growth. To date, Peru's power generation sector has been dominated by hydropower and natural gas fired power. Non-hydro RE continues to make a relatively small contribution to the country's generation mix, but with significant solar irradiance and wind energy resources, there is significant potential for scaling up the roles of solar PV and wind power within Peru's generation mix.

In 2008, Peru created the legal framework for holding RE auctions through the introduction of Legislative Decree 1002, and which set RE as a national priority. The key details of Peru's RE auction programme are summarised in Table 2. The first auction was held in 2009; a second was then held in 2011, a third in 2013 and a fourth in 2015/16. Prior to the introduction of Legislative Decree 1002, there was no stable and transparent framework in place governing the remuneration of non-hydro RE power generation projects in Peru. The growth of Peru's solar PV and wind power (as well as biomass power) sectors have been inextricably linked with that country's use of RE auctions. More specific details of the auction characteristics are set out below.

It is worth underlining that Peru's solar PV and wind power markets are relatively highly concentrated, dominated by a relatively low number of larger scale organisations.

Table 2: Summary of the Peruvian RE auction programme

| Topic / Aspect | Description | |
|---|---|---|
| Description of when RES auctions were initiated, how many undertaken so far, which technologies | Peru has conducted a total of four RE auctions since 2009, for both grid-connected and off-grid electrification. The auction scheme in Peru is based on Law No. Law No. 28832 and Decree 1002, established in 2006 and 2008, respectively.<br>The most recent auction round (i.e. the fourth round) of the Peruvian RE auction scheme was conducted in 2016. The Peruvian auctions were technology specific and used a non-disclosed price-cap per technology, with offers above the cap automatically disqualified. | |
| High level description of the results of the most recent auction | In the fourth round of the Peruvian RE auction, more than 1700 GW/h per year of generation were awarded, roughly 740 GW/h per year of wind, around 520 GW/h per year of solar, around 450 GW/h per year of hydro, and just below 30 GW/h per year of biogas power. | |
| Any outstanding or unique characteristics of the auction programme / DEs to mention | Over the course of the four Peruvian RE auctions the price for electricity generated from wind has decreased by more than 40%, and for solar PV generated electricity, the price has been pushed down by almost 80%. Key to the success of the scheme have been: (i) clear medium-term renewable electricity targets; (ii) analysis of the results and revision of the auction design based on the lessons learned, and (iii) transparency in the process (Lucas & Gómez, 2017).<br>The auction is for generation (GWh). Electricity produced above the cap is sold at market prices, and projects that produce less than the amount specified in the bid are penalised by a reduction in the tariff. (Del Río, 2017a) | |
| Market concentration as measured through the Herfindahl-Hirschman Index (HHI) | Solar PV | AR4 (2 projects) – HHI 6716 |
| | Wind power | AR4 (3 projects) – HHI 6259 |

### 2.5.2 South Africa

South Africa is a middle-income country and is the second largest economy in Africa. It has the largest power system of any country in Africa, and the generation mix is dominated by thermal power (especially coal-fired generation). The contribution of RE technologies to the overall mix continues to grow. RE will have a central and key role in South Africa's energy future, not least in the context of the country's excellent solar radiation and wind energy resources, its competitive industrial base, and the pressing need to achieve greater supply stability (for end-users) and improve the financial health of the overall power system.

South Africa initiated its RE Independent Power Producer Procurement Programme (REIPPPP) in 2011, making it the first country on the African continent to implement a RE auction programme. To date, South Africa has held four auction rounds, which attracted very high levels of interest and bidding (oversubscription). This present study focuses on auctions for solar PV, wind power and CSP in South Africa. The key details of South Africa's RE auction programme are summarised in Table 3.

A single-round bidding programme was used, primarily with the aim of fast-tracking the power procurement process, as the country faced chronic and significant system capacity constraints. Hence there was a need to contract, construct and commission new (renewables-based) generation capacity in a timely way. In the absence of a prequalification round, but with the need to select only serious and quality bidders, a screening approach based on various stringent bidder qualification requirements was employed.

The REIPPPP is unique in the context of the four country case studies because that programme established significant multicriteria requirements on bidders (i.e. the auction is not decided on price-only criteria). In particular, for a bid to be considered, two key economic development thresholds were required to be met:

1. There must be a minimum of 40% "South African Entity Participation" in the bidding project company, and wherein South African citizens are defined as "the ultimate natural citizens to whom the shareholding benefits would accrue" (DOE SA, 2013).
2. Bidders based in South Africa were required to achieve a Broad-Based Black Economic Empowerment (BBBEE) contributor status level (CSL) of at least five, based on defined BBBEE codes and evaluation criteria.

These and certain other aspects of the REIPPPP make South Africa's auction programme stand out somewhat as being relatively progressive in the broader international context, through its clear goals of promoting a just energy transition (e.g. via local community and minority economic group participation in projects; stimulatation of the local industry base, etc.) whilst also yielding competitive power prices via auction.

Table 3: Summary of the South African RE auction programme

| Topic / Aspect | Description |
|---|---|
| Description of when RES auctions were initiated, how many undertaken so far, which technologies | South Africa's RE Independent Power Procurement Programme (REIPPP) has conducted four competitive auctions (known as bidding windows, BW) for independent power producers (IPP) RE projects since 2011.[7] The most recent bidding window (BW 4(b)) was implemented in 2015.<br>The auctions are technology specific. Technology specific capacity limits are set for each BW tender. The largest capacity allocations were for wind power and solar PV, with smaller capacity limits set for CSP, biomass, biogas, landfill gas, and hydropower. |
| High level description of the results of the most recent auction | 102 IPP projects, comprising 6400 MW of RE capacity, have been procured from four bidding round windows with further windows expected to be announced in the future. |

[7] BW 1(2011), BW2 (2012), BW3 (2013), BW3.5 (2014), and BW4(a) (2014) and BW4(b) (2015).

| | | |
|---|---|---|
| Any outstanding or unique characteristics of the auction programme / DEs to mention | Besides the main objective to secure electrical energy from the private sector via RE sources to add to the national grid, the programme and the auctions itself are also structured to contribute to broader national development objectives, such as job creation, social inclusion, as well as a broadening of economic ownership. | |
| Market concentration as measured through the Herfindahl-Hirschman Index (HHI) | Solar PV | The market concentration has increased over the course of the 4 bidding windows.<br>HHI Solar PV BW1: 1025<br>HHI Solar PV BW2: 1850<br>HHI Solar PV BW3: 2747<br>HHI Solar PV BW3.5: 10000<br>HHI Solar PV BW4: 3364 |
| | Wind power | The market concentration has remained mostly stable over the course of the first 3 bidding windows, but has increased significantly in the last bidding window:<br>HHI Wind BW1: 1563<br>HHI Wind BW2: 1871<br>HHI Wind BW3: 1724<br>HHI Wind BW4: 3142 |
| | CSP | The market concentration for CSP over the course of the four bidding windows has remained unchanged at 10000, due to the fact that the auction has been a single item auction. |

### 2.5.3 Spain

Spain is a high-income country located in south-west Europe and with a population of around 47 million. It is a world leader in terms of the integration of variable RE, and it has a diversified electricity generation mix comprised mainly of wind, solar PV, natural gas fired plant, nuclear, hydropower, and negligible levels of coal fired power.

Spain has tracked a pathbreaking and frenetic pathway with RE so far. It was an early leader in renewables and was broadly considered to be one of the most attractive markets in the world to invest in solar PV, wind power and CSP projects in the mid-late 2000s.

Prior to its first RE auction (in 2016), Spain had significant experience in the use of administratively-set remuneration for RE generation through a FiT/FIP system. The administratively-set remuneration system was initially introduced in 1998 (and modified in 2004 and 2007). As a result of FiT conditions that were widely interpreted as attractive in the international context, a large wind and solar power industrial base quickly built up in Spain in the 2000s, and investment levels were high.

However, from 2010 onwards, a series of significant (and sometimes retroactive) changes to the FiT system were made, before the system was discontinued for any new projects. It is worth mentioning that this major change in the outlook of Spain's RE sector had severe negative impacts on the solar and wind energy industrial bases that had been built up in the preceding 15 years or so. A period then followed during which no investments were made in new RE projects, before Spain's RE auction programme was initiated. Since the uptake of the auction programme (the key details of which are summarised in Table 4), investments in new RE generation capacity have grown markedly. Spain has set itself the target of significantly scaling up

renewable generation capacity, achieving a 74% share of RE in the generation mix[8] by 2030 (up from around 49% at the end of 2019).[9]

Firstly, it is important to take into account the Spanish energy context in which auctions were adopted in 2016 and 2017 (see del Río 2017b for further details). Spain is essentially an electricity island with limited interconnections with other countries and with electricity generation overcapacity. It has a comparatively high penetration of RE and during the first years of this decade was on track to meet its 2020 RE targets.[10] Retail electricity prices are higher than the EU average, coupled with a deep economic crisis, a chronic electricity system tariff deficit, a perceived large increase in the costs of RE support and sluggish electricity demand (resulting from the economic crisis) led the then central Spanish government to stop financial support for new RE installations in 2012. Between 2012 and 2015, new RE capacity additions were very limited, representing around just 3% of the total installed capacity in 2015. However, from 2014 onwards economic growth started to recover (3.84% GDP growth rate in 2015) and this pushed energy demand upwards. Together with the difficulties of incorporating RE into the non-electricity sectors (transport and heating/cooling), this led the government to be concerned about the country's ability to reach its 2020 RE target. Therefore, two "pilot" auctions, both with relatively low volumes (200 MW for biomass and 500 MW for wind), were organized in 2015, and took place in 2016, followed by two larger auctions in 2017.

On the other hand, Spain has quite a complete wind supply chain, with a presence of firms in all its stages, from project development to equipment manufacturing and O&M.

Table 4: Summary of the Spanish RE auction programme

| Topic / Aspect | Description |
|---|---|
| Description of when RES auctions were initiated, how many undertaken so far, which technologies | After several years without new renewable electricity installations being supported, three auctions were organized between 2016 and 2017 in Spain. Overall, more than 8 GW were awarded via these auctions.<br><br>The three auctions differ with respect to their technology-neutrality/specificity. The first auction took place in January 2016. It was a technology specific auction, so in reality two separate auctions took place: one for biomass (with a volume of 200 MW) and another one for wind (500 MW). The second auction (May 2017) was technology-neutral in the sense that all technologies were eligible to participate in it (but it included some design elements which favoured wind over PV). 3000 MW were awarded. The third auction (July 2017) was multi-technology, since only wind and PV could participate. 5037 MW were awarded (see del Río 2017b and 2018 for further details). |
| High level description of the results of the most recent auction | In the 2nd auction, 2979 MW were awarded to wind, with PV being awarded only 1 MW and other technologies accounting for the rest.<br><br>In total, 5037 MW were awarded in the third auction, 77% went to PV (3909 MW) and 23% to wind (1128 MW).<br><br>All winning bidders in the 3rd auction bid for the maximum discount allowed. The government decided that all the bids which offered the maximum discount would be awarded contracts. The result for all of them is zero remuneration for the investment (Rinv). The discounts "will guarantee that the energy produced will be remunerated at market prices (…), without an additional premium being provided by the electricity system in the central |

[8] MITECO, 2020. Integrated Energy and Climate Change Plan. Received from: https://www.miteco.gob.es/images/es/pnieccompleto_tcm30-508410.pdf

[9] Red Eléctrica España, 2019. Spain closes 2019 with 10% more installed renewable power capacity. Received from: https://www.ree.es/en/press-office/news/press-release/2019/12/spain-closes-2019-10-more-installed-renewable-power-capacity

[10] Spanish RES target for 2020 is 20%. In 2014, RES penetration was 17.3%, versus the expected indicative RES Directive trajectory (2-year averages) for 2013-2014, which was 12.1%.

| | | |
|---|---|---|
| | scenarios of pool electricity prices" (MINETAD Press note on July 26th 2017). Beneficiaries will receive compensation (Rinv) only if, in the coming years, the wholesale electricity price drops to a very low level in order to recover the investment (remaining after the discount in the third auction). See del Río 2018 for further details. | |
| Any outstanding or unique characteristics of the auction programme / DEs to mention | The design of these auctions has been deemed complex and they certainly are very different to those being organized in other countries (see del Río 2017b).<br>In the Spanish auctions, plants producing electricity from RE sources would receive the market price plus a "specific complementary remuneration" (Rinv). The Rinv is a payment per kW that allows installations to recover those investment costs which cannot be recovered by the sale of electricity in the market. Each installation receives the market price plus the Rinv of the plant type taking into account that a "reasonable profitability level" cannot be exceeded. | |
| Market concentration as measured through the Herfindahl-Hirschman Index (HHI) | Solar PV | No specific auction for PV |
| | Wind power | No specific auction for wind.<br>The market concentration for successive auctions has decreased over time, an inverse relationship with the higher volumes over time. The respective HHI for bidders these auctions have been:<br>HHI 1st auction (wind, January 2016): 4364<br>HHI 1st auction (biomass, January 2016): 3966<br>HHI 2nd auction (technology-neutral, mostly wind awarded May 2017): 2853<br>HHI 3rd auction (multi-technology, only for wind and PV, mostly PV awarded, July 2017): 1422 |

### 2.5.4 United Kingdom

The UK is located in northern Europe, between the Atlantic Ocean to the west and the North Sea to the East; and enjoys significant wind resources throughout the extension of the island and especially in its coastal and offshore regions.

In 2019, the power generation mix in the UK was dominated by natural gas fired plant (33%), nuclear power (14%), and wind and solar energy (21%). The country has a clear goal of scaling up its RE sector and decarbonising its power and other key economic sectors through the switch to the use of RE (electricity). Auctions for UK offshore wind project development were introduced in 2015.

The UK's offshore wind sector has matured rapidly over the past few years. This is a relatively new development in terms of the UK's experience with RE. Until recently, successive governments' focus was primarily on onshore wind, plus solar energy and hydropower.

In 2019-2020, the UK is now a world leader in offshore wind, with the highest level of installed offshore wind power generation capacity of any country. It is also something of a pioneer in terms of the size and power rating of the offshore wind farms, and a robust and extensive offshore wind supply chain now exists in the UK. A summary of the RE auction programme used in the UK for offshore wind is provided in Table 5.

Table 5: Summary of the UK offshore wind RE auction programme

| Topic / Aspect | Description | |
|---|---|---|
| Description of when RES auctions were initiated, how many undertaken so far, which technologies | The UK has been a frontrunner in the use of RES auctions. From early experiences with the Non Fossil-Fuel Obligation (NFFO) auctions in the 1990s to the current auction system, first announced in 2011, the use of competitive allocation mechanisms has been central to the UK's approach to supporting new renewable electricity generation projects.<br><br>To-date, three auctions have been held under the current system. The original policy objectives of the CfD auctions for renewables were primarily to introduce competition among technologies of similar maturity. Technologies are divided into 2 'Pots' according to their technological maturity. Pot 1 is for established technologies, Pot 2 for less established technologies. There is an additional pot (Pot 3) for biomass conversion which has not been included in any auction to date.<br><br>There have been some slight amendments in the requirements for technologies eligible for auctions, particularly the requirement for CHP (or not) in Pot 2 projects. AR3 includes a new category of Remote Island Wind, an exception to the policy that there should be no further subsidies for onshore wind.<br><br>The 2015 Auction (AR1) was for Pots 1 and 2 and covered:<br><br>Pot 1: Onshore wind (>5MW), solar PV >5MW, Energy from Waste with CHP, Hydro >5MW and <50MW, Landfill Gas, Sewage Gas<br><br>Pot 2: Offshore wind, Tidal Stream, Wave, ACT with or without CHP, Anaerobic Digestion with or without CHP >5MW, Dedicated Biomass with CHP, Geothermal with or without CHP<br><br>The 2017 Auction (AR2) was for Pot 2 technologies only:<br><br>Offshore Wind, ACT with or without CHP, Anaerobic Digestion with or without CHP, Dedicated Biomass with CHP, Wave, Tidal Stream, Geothermal with or without CHP<br><br>The 2019 Auction (AR3) was also for Pot 2 technologies only:<br><br>ACTs, Anaerobic Digestion >5MW, Dedicated Biomass with CHP, Geothermal, Offshore wind, Remote Island Wind >5MW, Tidal Stream, Wave. | |
| High level description of the results of the most recent auction | The outturn prices are considered low with the third auction clearing at approximately £40/MWh (€44.96) for projects delivered between 2023 and 2025.<br><br>A striking feature of the results is the success of offshore wind projects in capturing the limited budget. Overall, 87% (almost 10GW) of the capacity offered contracts in the first three rounds was to offshore wind projects (Woodman and Fitch-Roy, 2019) | |
| Any outstanding or unique characteristics of the auction programme / DEs to mention | The UK CfD auction system is relatively complex, which may be a barrier to smaller market actors. Also notable is the high degree of discretion over technology outcomes afforded to policymakers by the 'pot' system. | |
| Market concentration as measured through the Herfindahl- | Offshore wind | • AR1 (2014/15) (2 projects; 4 owners) – HHI 2707<br>• AR2 (2017) (3 projects; 8 owners) – HHI 2552<br>• AR3 (2019) (4 projects; 5 owners) – HHI 3128 |

| | | |
|---|---|---|
| Hirschman Index (HHI) | development | • AR1,2&3 (9 projects; 16 owners) – HHI 1423 |
| | Offshore wind turbine supply | • AR1 (1 supplier) – HHI 10,000<br>• AR2 (2 suppliers) – HHI 5088<br>• AR3 (≥3 suppliers) – HHI 5062-5091<br>• AR1,2&3 (≥3 suppliers) – HHI 2146-2156 |

# 3 Methodology

## 3.1 Expert Elicitations

In order to get an in-depth and up-to-date understanding of how auctions and their DEs influence project developers and component manufacturers, country and technology level case studies were undertaken based on structured interviews with key experts in the respective countries.

Expert elicitation-based interviews were used, given the difficulty to gain representative samples on developers and equipment manufacturers (an issue that effectively ruled out the possibility of using a large multivariate sample methodological approach). In addition, surveys are more data-intensive, require a greater length of time and there is a much higher risk of non-response than compared with the use of expert elicitations.

The interviewed experts were selected based on their being very well-acquainted with the country level auction programme, and their significant knowledge of the value chain (particularly as regards project developers and component manufacturers). The selected experts came from a broad range of backgrounds. These included, for instance, policy makers, energy sector and market experts, stakeholders from financial institutions that regularly invest in RE projects, RE industry association representatives, and other relevant actors. Central to the success of expert elicitation methodologies is to have a high-quality sample of high diversity of experts, while the actual sample size is less relevant. The following box briefly describes the expert elicitation method (see del Río and Kiefer 2018 for further details).

Box 1: A short description of the expert elicitation process, based on del Río and Kiefer (2018)

Expert elicitations are a proven method when the research interest does not focus on a defined target universe, i.e., usually proxied by representative individual observations that are extrapolated to that universe, but rather when the aim is to capture a body of knowledge (Chan et al., 2011; Tversky & Kahneman, 1974), usually closely related to a specific technology paired with high technological uncertainty.

In recollecting knowledge and assessing probabilistic estimations about uncertain quantities, expert elicitations are fundamentally different from other survey types. Thus, they have to follow a strict and robust protocol to ensure uncovering the experts' deep information which is not available elsewhere whilst minimizing potential biases. Robust expert elicitation protocols harness principles from decision theory, risk analysis, psychology, statistics and economics (Cooke, 1991; Hogarth, 1987) to counteract several biases and heuristics (see Table 6).

Table 6: Description of biases and heuristics in expert elicitation protocols

| Bias / heuristic | Description |
|---|---|
| Availability heuristic | Greater weights are attributed to events with higher visibility and therefore more easily memorable |
| Anchoring heuristic | Previous known values are only adjusted instead of performing independent estimations. |
| Representativeness heuristic | Separate events, that look "similar", are treated as symmetrically conditional. |
| Control heuristic | It is assumed to have a minimum level of control or influence over all (future) events. |
| Base-rate fallacy | Case-specific information is attributed more importance than "general" or base-rate information, leading to conclusion of uniqueness of each event. |
| Overconfidence | More optimistic estimations due to heightened confidence. |
| Egocentric attribution | Behavioural choices of the group an expert belongs to are considered |

| | |
|---|---|
| | to be more common than alternative choices. |
| Motivational bias | Intentional change of answers in order to influence the studies outcome. |

Source: Own elaboration from (Kahneman & Tversky 1984; Durbach et al. 2017; Keeney & Von Winterfeldt 1991; Cooke 1991a; Ross & Anderson 1982; Cooke 1991b; Baker & Keisler 2011; Bistline 2014; Hultman & Koomey 2007)

In order to achieve maximum robustness and minimize biases, state-of-the-art debiasing strategies should be employed during the elicitation (Fischhoff, 1984; Kahneman & Tversky, 1984). All experts should receive a brief formation session on potential biases and be asked to self-assess their level of expertise. The specific purpose of the study needs to be explained and any questions or reservations should be taken into account. It is recommended to ensure confidentiality. The experts are asked to expand their information and assumptions and explain their reasoning and thoughts in addition to giving a numerical answer. Any potential inconsistencies in answers (both between the same interviewee or between different ones) should be pointed at and resolved with the expert. Also, answers should be validated and corrected for non-regressiveness. After the elicitation, the outcome of the studies should be checked for motivational influence.

The choice of experts in this approach is critical. They need to be representative actors in the entire technology value chain who are active around the technology. The experts should be selected based on hard criteria in their corresponding reference class: academia, industry, policy makers and thought leaders/other indirect stakeholders.

No hard rules on the optimum number of experts exist. Whereas additional experts increase the diversity of judgement, their marginal usefulness decreases. Almost all past expert elicitations have a range of 6 to 12 experts. Right after each elicitation, the analysts should proceed to post-elicitation, including highlighting the most important aspects, detection of confirmation or contradiction with other experts previously elicited, and transcription of the main judgements by the expert.

Source: Based on del Río and Kiefer (2018)

### 3.1.1 Operationalization of the Concept of Market Concentration

Market (or industry) is the degree to which production in an industry is dominated by a few large firms (Shughart 2019). According to OECD (2018), "market concentration measures the extent to which market shares are concentrated between a small number of firms". The concentration of markets is measured in different ways. Concentration ratios (i.e., the total share of the 3, 4, or 10 companies with the largest share) and the Herfindahl-Hirschman Index (HHI) are the standard tools of competition economists and competition authorities to measure market concentration.

As previously mentioned, market concentration, as operationalized in this study, has two main aspects which are relevant in the context of this report: (i) the number of firms in a given sector (market) of interest, and (ii) the diversity of those firms. Diversity refers to the relative distribution of the market between small, medium and large-scale market players. This approach corresponds to two approaches in the analysis of market concentration in Industrial Economics:

I. The deterministic approach (number of firms): The simplest version of the standard perfect competition model considers the number of firms as the basic variable which determines the type of market structure. As the number of firms in a market goes down, *cæteris paribus,* market concentration increases. From the perspective of an explanation based on economies of scale, this is the basic factor which better expresses the evolution of MC.

II. The stochastic view (heterogeneity of firms): In contrast, the stochastic perspective suggests that the heterogeneity of firms is the crucial aspect which is behind changes in MC. However, compared to the identification of the number of firms (point 1 above), determining the degree of similarity of the firms which make up a market is more difficult (Furió and Alonso 2008).

Given the complexity of expert elicitation processes and the challenging requirements on participants who respond to them, the simplified operationalization of market concentration through the limitation of the

concept to only represent the number and diversity of firms, was found to be sensible.

### 3.1.2 Elicitation Protocol

The survey design follows a structure standardized across all technologies and value chain phases (project developers and component manufacturers). Each question form had three sections, and for each question, the expert was asked to provide both closed (explicit / quantitative) and open (qualitative) answers:

I. Assessment of the number and diversity and self-assessment: The experts were asked to provide an assessment of the current status of market concentration and actor diversity in simplified terms. Where hard data is available, this question also served to assess the expert's level of expertise. Furthermore, self-assessment questions were used, where the expert assessed their level of knowledge with respect to auction DEs, the specific auction of the country case, as well as regarding the respective technology's project developers and component manufacturers. A Likert scale was used to record the expert's responses.

II. Assessment of Context: The expert was asked to estimate the impact of specific contextual factors on the number and diversity of project developers and component manufacturers. The context conditions analyzed comprised:

   a. Policy framework conditions in the country of interest (ambitious targets, policy stability).

   b. Broader policies (energy, industrial development and environmental) in the country of interest or in other countries.

   c. Socioeconomic conditions in the country of interest (i.e. the existence of an industry, capabilities in the country, resources, etc.).

   d. Context factors in the country of interest (investment climate in the country, size of the market, availability of transmission/distribution infrastructure, RE resource potentials, financing costs, installation and building costs, ease of access to equipment).

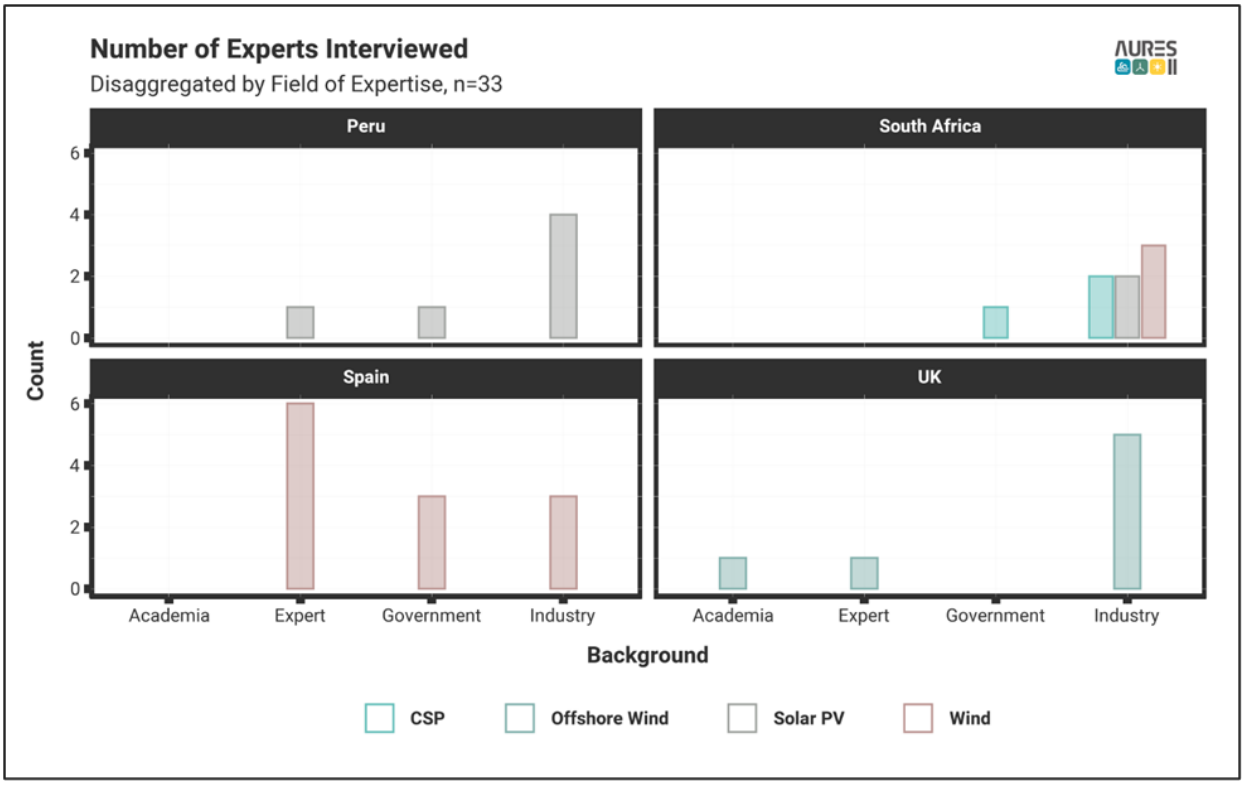
   A Likert scale was used to record the expert's responses, ranging from 0-10.

III. Assessment of Auction and DEs: The experts were asked to assess the strength and direction of impacts of the auction in general, as well as for 12 DEs, on the number and diversity of project developers and component manufacturers. A Likert scale was used to record the expert's responses, ranging from 0-10.

### 3.1.3 Choice of Experts

The choice of experts for the implementation of robust expert elicitation methodology is vital. More important than the quantity of experts is their quality and diversity. A shortlist of highly qualified and diverse experts was contacted in each of the 4 case countries, of which between five and 12 experts have participated in the expert elicitation process per country. The selection of experts represented a largely balanced distribution of backgrounds and technology association (see Figure 7).

Figure 7: Overview on sectoral background and technology focus of interviewed experts



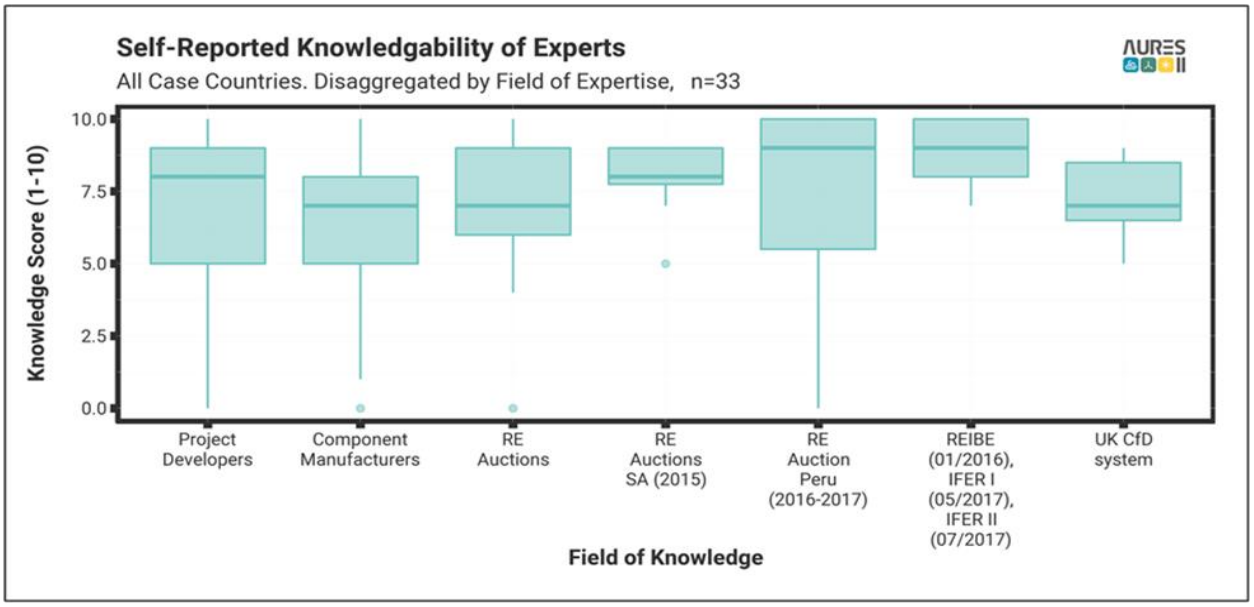

Source: Own elaboration (2020)

In order to establish a metric that could be used to evaluate the quality of different experts' responses, self-assessment questions were used in the survey. As can be seen in Figure 8,[11] the interviewed experts self-assessed themselves and reported having a high level of knowledge on country-specific project developers and component manufacturers, on RE auctions in general, as well as on the specific auction scheme in the respective countries.

Broadly speaking, the interviewed experts consider that they have a more solid understanding of the specific RE auction programme in their respective country of focus, as compared with their understanding of auctions in general (internationally). This is primarily due to their having worked intensely in their country's RE sector, with only some of the experts having worked in, and actively tracked, developments in the broader international context as regards RE auctions.

[11] The upper and lower edges of the box correspond to the first and third quartiles (the 25th and 75th percentiles). The upper whisker extends from the box to the highest value that is within 1.5 * IQR of the box, where IQR is the interquartile range, or distance between the first and third quartiles. The lower whisker extends from the box to the lowest value within 1.5 * IQR of the box. Data beyond the end of the whiskers are outliers and plotted as points.

Figure 8: Results – expert self-assessment



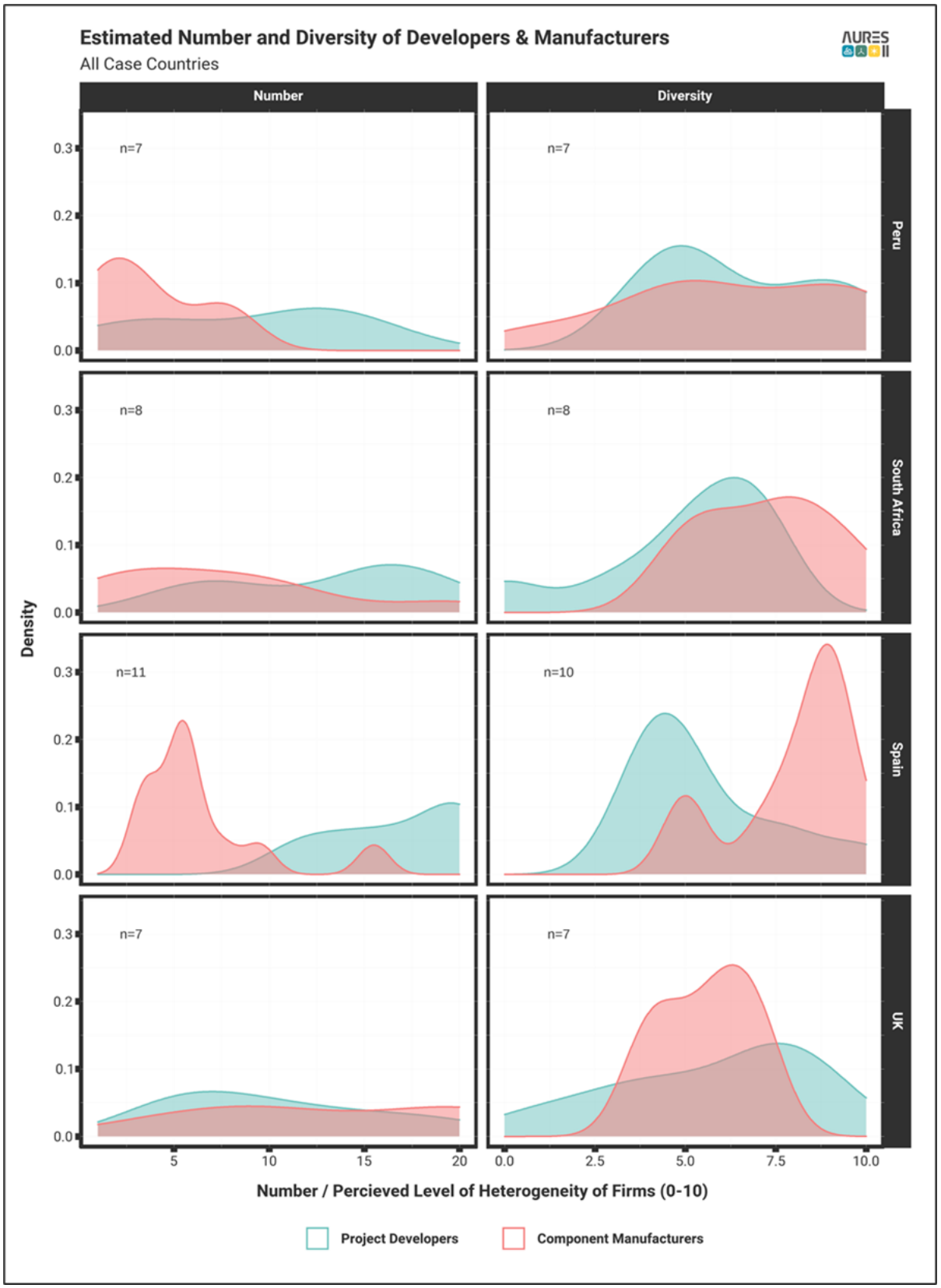

Source: Own elaboration (2020)

The quality of experts' judgements was further evaluated through the use of calibration questions. Judgements were recorded on the perceived number and diversity of project developers and component manufacturers, respectively, for each country case. The analytical approach used gave equal weighting to all experts' responses.

Generally, the perceptions on the number of developers and manufacturers were found to differ substantially amongst the experts (high variance) in some countries (e.g., Peru or South Africa), while the experts' perceptions on the degree of diversity of project developers and component manufacturers were found to be more aligned. This is interesting, given that some of the interviewed experts explained that they generally found it more straightforward to estimate the numbers of project developers and component manufacturers, as compared to estimating the level of actor diversity amongst firms.

These estimations of the number and diversity of project developers and component manufacturers were compared to true data as obtained from official auction statistics subsequent to the interview, and were confirmed to show no significant deviation, on average.

Figure 9: Perceived number and diversity of component manufacturers and project developers




Source: Own elaboration (2020)

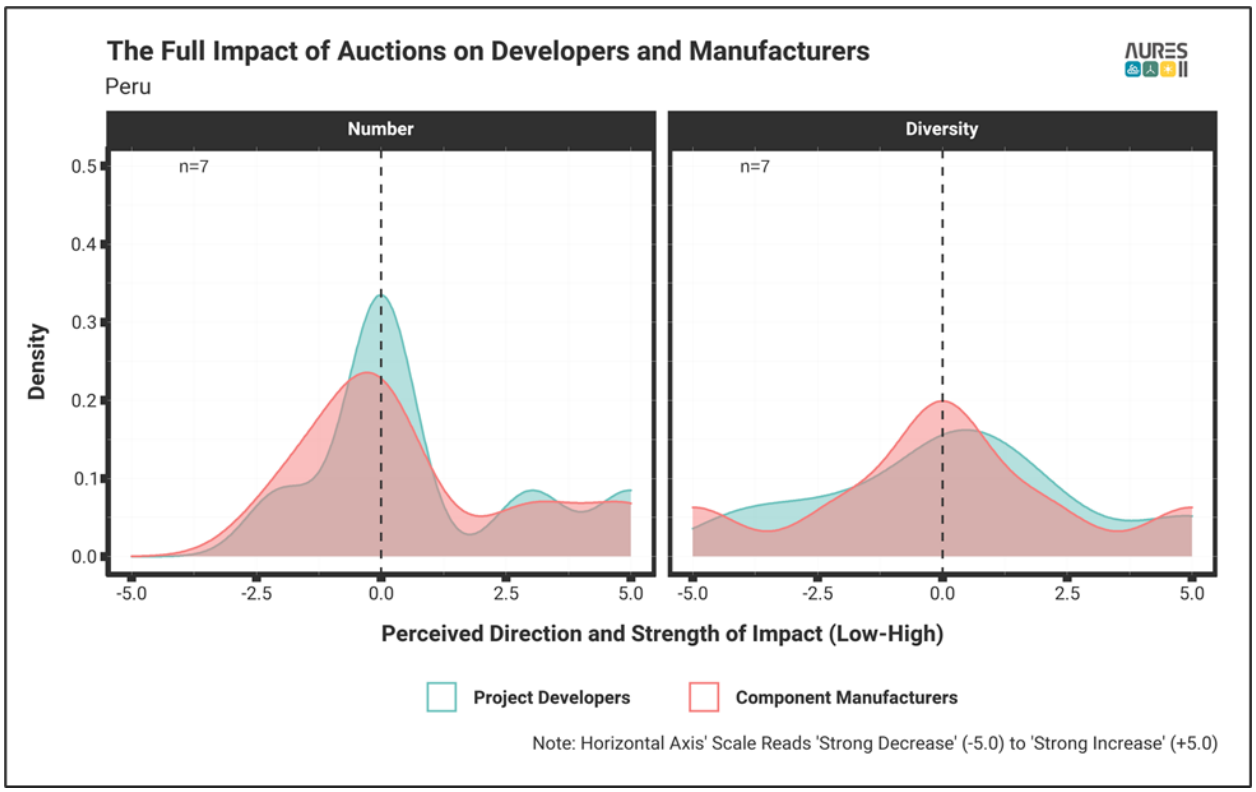
# 4 Case Country Results

## 4.1 Peru

### 4.1.1 The Impact of Auctions and Specific Design Elements in Peru

Figure 10 reflects the distribution of experts' perceptions on the impact of Peru's fourth RE auction on the number and diversity of project developers and component manufacturers, as compared to a hypothetical counterfactual assuming the existence of administratively set remuneration support system.

Figure 10: The Full Impact of Auctions on the Number and Diversity of Developers and Manufacturers in Peru

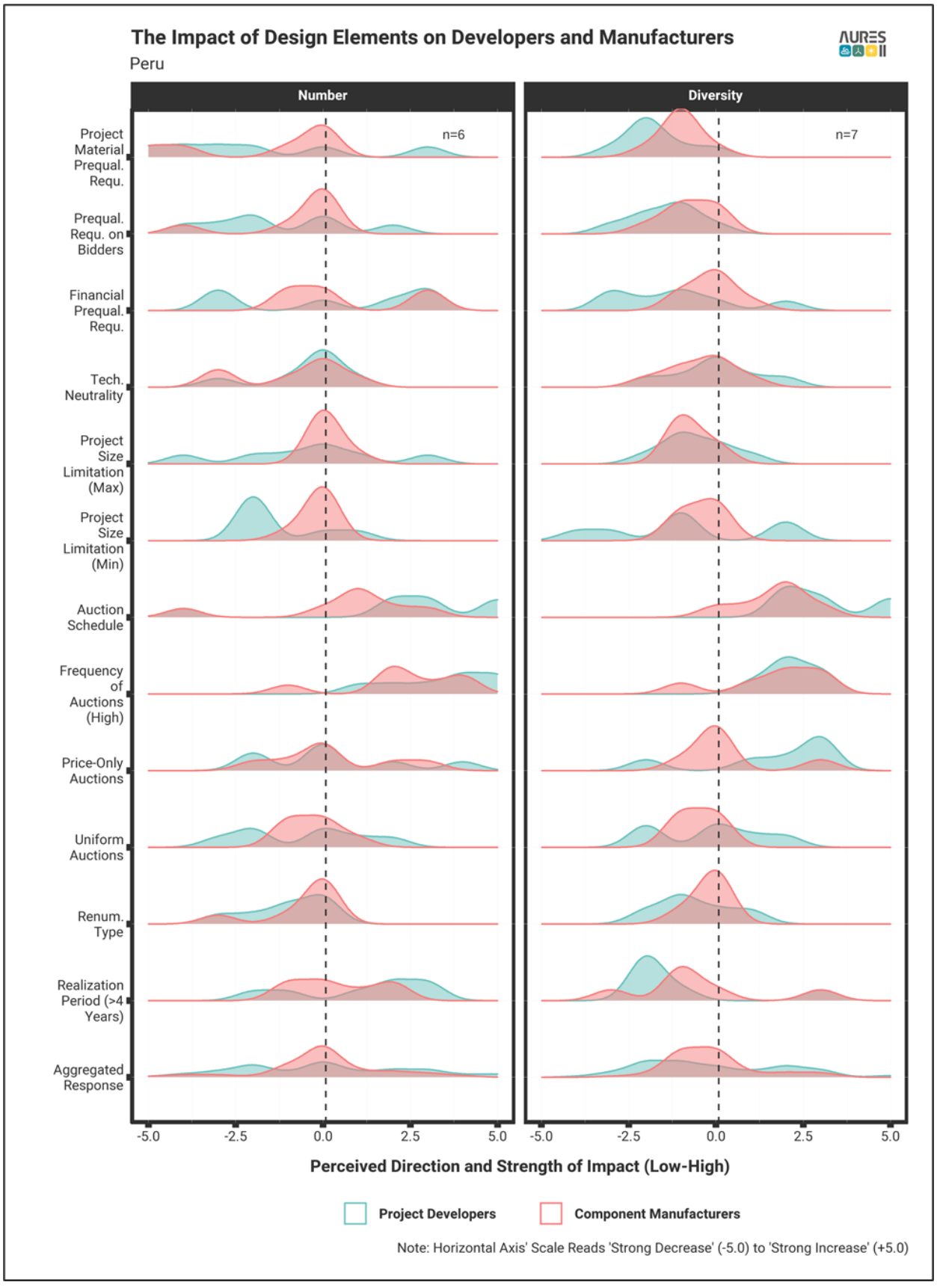



Source: Own elaboration (2020)

Figure 11 provides an overview of experts' estimates of the impact of the 12 auction DEs analysed in the Peruvian auction on the number and diversity of project developers and component manufacturers. Additionally, an aggregated response comprising the combination of all design element-related responses is presented, i.e., Aggregated Response, that is an unweighted aggregation of estimated direction and strength indicated across all analysed DEs in the country.

The estimated full impact of the auction on both the number and diversity of project developers and component manufacturers peaks around the "neutral" level in Figure 11. At the same time, some experts see the number of project developers and component manufacturers to be positively impacted by the current auction scheme, while judgments diverge on the direction of impact of the scheme on the diversity of developers and manufacturers. These perceptions on the overall impact of the auction scheme as compared to a hypothetical counterfactual based on administratively set support is reflected by the aggregation of the estimated impacts of isolated DEs (see the last row of Figure 11), in that the perceived impact on the number and diversity of project developers and component manufacturers is confirmed to largely peak at the neutral or balance across the full spectrum.

Figure 11: The Perceived Impact of Design Elements on Number and Diversity in Peru




Source: Own elaboration (2020)

Prequalification Requirements: The number of project developers is perceived to be affected both positively and negatively, in equal proportion, by stringent material prequalification requirements on the project and the bidder, as well as by stringent financial prequalification requirements.

The impact of prequalification requirements on the number of component manufacturers is also considered to be relatively neutral, except for in the presence of stringent financial prequalification requirements, where some experts tend to see positive impacts on the number of manufacturers.

All types of prequalification requirements are perceived to decrease the diversity of project developers, with project material prequalification requirements potentially having the strongest impact. A similar trend is observed for component manufacturers, for whom the prequalification requirements on bidders and stringent financial prequalification requirements are perceived to reduce diversity.

Technological Neutrality: The average view of experts is that the fact that an auction is technologically neutral is of little influence on both the number and diversity of project developers and component manufacturers. Nonetheless, some experts expressed the view that technological neutrality can reduce the number of project developers and component manufacturers, and a positive impact on the diversity of project developers.

Project Size Limitations: There seems to be little consensus on the direction of the impact of maximum project size limitations on the number of project developers, with recorded responses ranging across the full spectrum of possible responses. For component manufacturers, on the other hand, there is strong consensus that maximum project size limitations are of little relevance to the number of firms.

The impact of maximum project size limitations on the diversity of project developers and component manufacturers is perceived to be very similar, with the average responses peaking just left of the neutral (slightly negative perceived impact on diversity).

Minimum project size limitations are also perceived to not significantly affect the number of component manufacturers, but experts generally believe that such size limitations will slightly decrease the number of project developers.

The impact of minimum project size limitations, on the other hand, have no clear impact on the diversity of project developers, with recorded responses indicative of both positive and negative impacts. Component manufacturers, however, are perceived to be less significantly affected by minimum project size limitations.

Schedule and Frequency: The impact of having a transparent auction schedule, as well as a high frequency of auctions, was perceived to significantly increase both the number and diversity of project developers and component manufacturers, albeit less strongly in the case of the latter. One expert, however, has indicated his conviction that a transparent auction schedule may strongly reduce the number of project developers and component manufacturers.

Price-Only, Uniform & Renumeration Type: With only minor deviations, the perceived impact of conducting price-only auctions with uniform pricing rules and a FiT based renumeration type on the number and diversity of component manufacturers was recorded to be very marginal.

Responses were much more varied concerning the impact of these three DEs on the number and diversity of project developers. Experts indicated that price-only auctions can be associated with positive and negative impacts on both the number and diversity of project developers. A similarly balanced response pattern was recorded for the impact of uniform pricing rules. Also, the impact of FiT based renumeration types was perceived as variable but skewed to the left (negative impact).

Realization period: With respect to the impact of long (>4 year) realization periods on the number of developers and manufacturers, experts' judgments again are widely varied.

The diversity of developers and manufacturers is perceived to be impacted more distinctively by provisions for extended realization periods, with both stages of the value chain being perceived to be on average negatively impacted by this design element.

### 4.1.2 Discussion of Expert Responses

In general terms the experts' responses were roughly in line with expectations as regards the central hypothesis of the study.

It is worth mentioning that no consensus was achieved as regards the impact of certain DEs on MC, for instance, (strict) prequalification requirements on bidders and financial prequalification requirements. This is slightly surprising, as one might expect that the use of strict prequalification requirements would tend to make it harder for smaller size actors to get a foothold in the market and compete in auctions. As concerns the perceived impact of strict prequalification requirements on bidders and strict financial prequalification requirements, there were lower levels of consensus concerning the impact on MC in the project developer stage of the value chain, as compared within the component manufacturer stage.

The majority of DEs are perceived to impact the MC of project developers and component manufacturers in generally similar ways. But it is typically the case that the impact on the project developer value chain stage are perceived to be more acute, whereas the impacts on component manufacturers are somewhat dampened by comparison. Perhaps the most exemplary case is that of the use of price-only auctions (as compared to multi-criteria auctions). In that instance, MC in the project developer stage is expected to be significantly increased, whereas the overall effect on MC in the component developer stage is relatively neutral.

The trend of DEs affecting MC in the project developer value chain stage to a greater extent than for component manufacturers is quite in line with expectations. Component manufacturers may be more shielded from the direct effects of DEs, being further upstream in the value chain. It is also worth noting that Peru's RE sector is in a relatively nascent stage of its development, and as one interviewed expert pointed out, the country "has not yet developed a robust and competitive RE component manufacturing sector: components used in RE projects in Peru are all sourced from the international market."

One DE that is clearly perceived to reduce the number of project developers in the market is the use of minimum project sizes. This is as expected, given that broadly speaking smaller scale project developers do not have access to the same financial and human resources required to develop large scale projects, and may therefore be effectively shut out of the auction. Smaller scale actors do not typically have the same access to capital from lending institutions and are unable to spread their investment risks over as broad a portfolio as those of larger scale actors. The perceived impact of minimum project sizes on the number of component manufacturers, however, was perceived to neutral overall.

Overall, the two DEs perceived to induce the greatest increases in the diversity of project developers and component manufacturers were the existence of a (publicly disclosed) auction schedule and a high frequency of auctions. Several experts commented that actors within Peru's RE sector crave, more than anything else, stability and guarantees of the existence of a medium- to long-term market.

The use of relatively long realization periods is understood to increase the number of both project developers and component manufacturers. However, somewhat surprisingly, experts perceived that long realization periods would tend to reduce the level of diversity in both value chain stages. In other words, smaller sized actors would struggle to compete and win in auctions with longer realization periods. As one expert pointed out, during the country's initial auction, the realization period was "set too short and there was a high level of non-realization of projects within the set realization period."

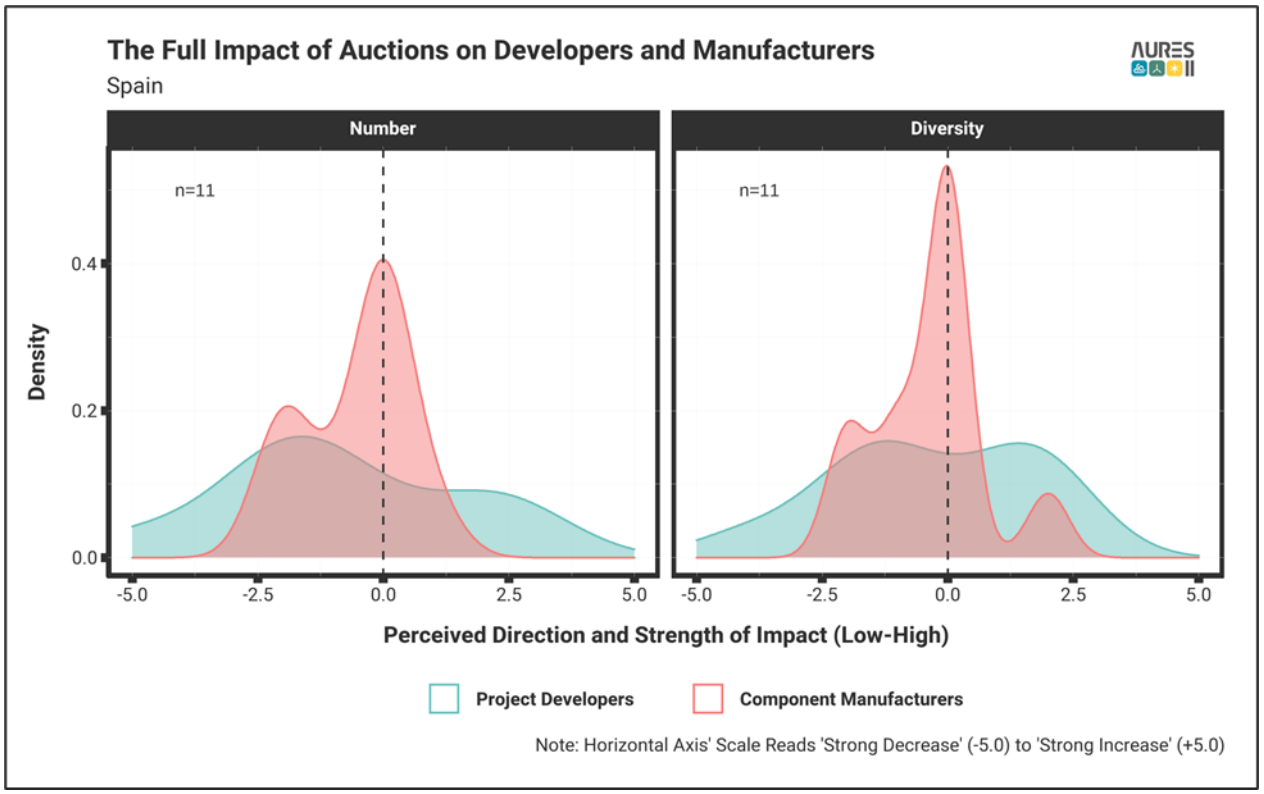
Finally, looking at the aggregated response, interviewed experts were in broader agreement concerning the overall impact of the 12 DEs on MC of component manufacturers, as compared with the case for project developers. A broad spectrum of views exists concerning the aggregate effect of the 12 considered DEs on MC of project developers. Given that Peru's solar PV and wind power sectors were initiated through the use of RE auctions (i.e. there was no preceding FiT system operating prior to the use of auctions), as well as the country's relatively limited experience in using auctions, it may be the case that clear conclusions are difficult to draw as concerns the specific and varied impacts of DEs on MC.

## 4.2 Spain

### 4.2.1 The Impact of Auctions and Specific Design Elements in Spain

Figure 12 shows the distribution of experts' perceptions on the impact of Spain's third RE auction on the number and diversity of project developers and component manufacturers, as compared to the previous administratively set remuneration support system in place in Spain.[12]

Figure 12: The Full Impact of Auctions on the Number and Diversity of Developers and Manufacturers in Spain

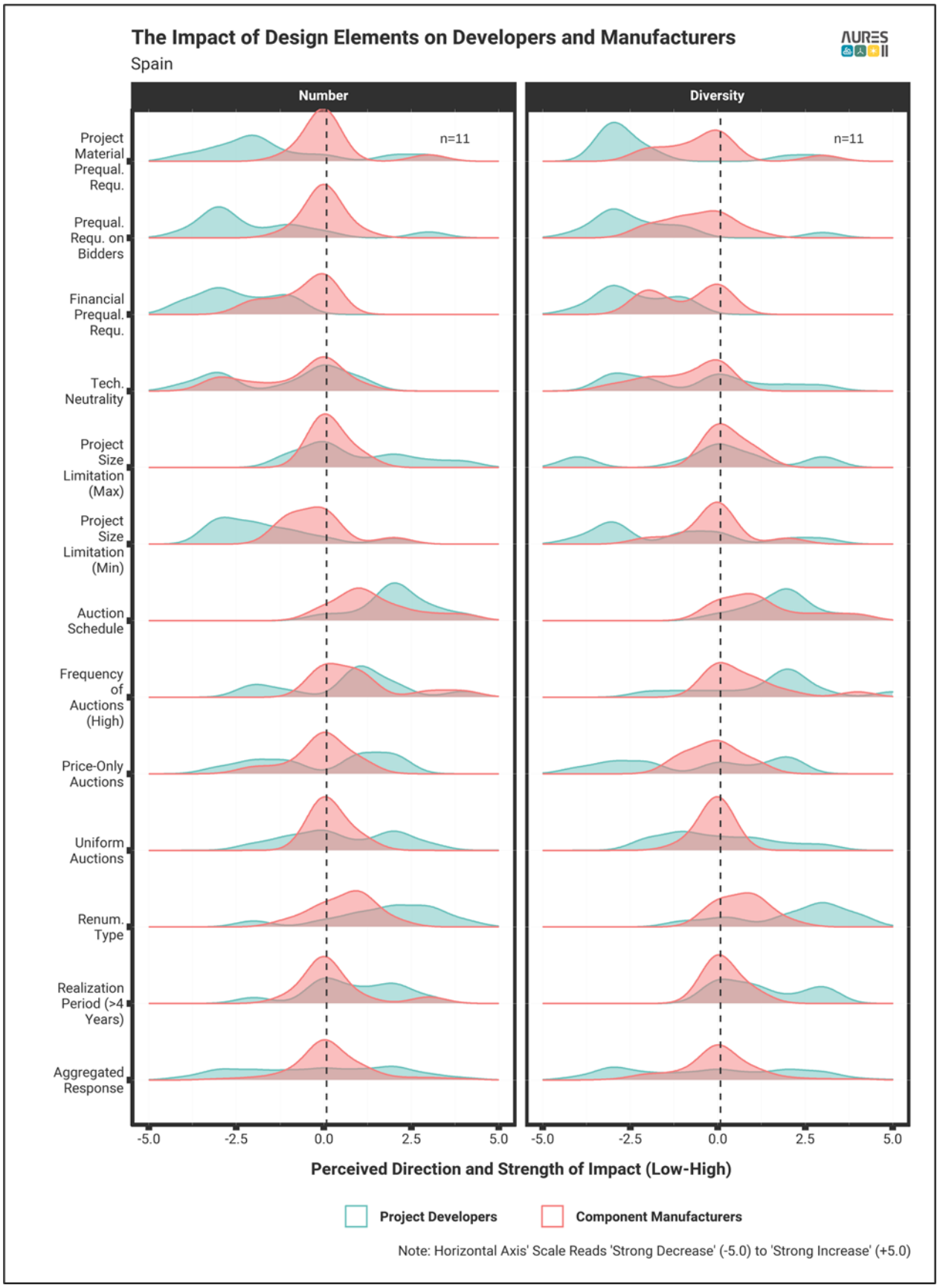



Source: Own elaboration (2020)

The results of the interviews of experts on their perception of the influence of different auction DEs on the number and diversity of firms, in the Spanish context, both with respect to project developers and component manufacturers, is provided in Figure 13.

[12] Specifically, this was the FiT/FiP-based remuneration system that was in effect in Spain between 2004 and 2007 (established by Royal Decree 436/2004) and between 2007 and 2011 (established by Royal Decree 661/2007).

Figure 13: The Perceived Impact of Design Elements on Number and Diversity in Spain




Source: Own elaboration (2020)

Prequalification Requirements: As expected, both the number and diversity of actors are perceived to be negatively affected by stringent prequalification requirements (compared to lenient ones). This is the case with respect to, both, project developers and manufacturers. However, a major finding is that the impact is greater on project developers than on the latter actors, suggesting that the impact of the design of the auction on actors in the value chain vanishes as we move upstream such value chain. Our results also indicate that not all types of prequalification requirements are perceived to have the same effect. Regarding project developers, material prequalification requirements on the project are considered to discourage less the number of project developers than the other two types (material prequalification requirements on the bidders and financial prequalification requirements). In contrast, material prequalification requirements on the project are perceived to have a greater impact on the diversity of firms than the other two types of prequalification requirements. In the case of manufacturers, most interviewees do not see a relevant impact (neither positive nor negative) of prequalification requirements on the number of manufacturers. This is the case for all types of prequalification requirements, and major differences cannot be observed in the regard, with the possible exception of financial prequalification requirements, which have a slightly more negative effect on the number of firms than the other prequalification requirements. In contrast to their small impact on the number of firms, all the prequalification requirements are perceived to negatively affect actor diversity, with very small differences across them.

Technological Neutrality: The results show a slightly negative perceived impact of technology-neutral auctions on the number of firms compared to technology-specific ones. This is the case for both project developers and manufacturers, and significant differences on these two types of actors cannot be observed. The negative impact on actor diversity is similar to the impact on the number of firms, and both for project developers and manufacturers. Nevertheless, some interviews perceive a positive impact on both types of actors, and also on the number of firms, suggesting that there is less agreement on the direction of the perceived influence than with the previous design element.

Project Size Limitations: Restrictions on the maximum and minimum size of projects which can be awarded in the auction can be expected to affect the number of firms and their diversity. However, experts do not perceive a major impact with respect to maximum project limits. Somehow unexpectedly there is a lack of agreement on their effects on the number and diversity of both project developers and manufacturers, with a wide distribution of interviewees' responses. In contrast, the impact of minimum size restrictions is strong, and of a negative sign. This is particularly so concerning the number of firms (especially for project developers), but a negative impact of minimum size limitations on actor diversity can also be discerned according to the perception of the interviewees, particularly for project developers as well. The softer effects on manufacturers could be expected.

Schedule and Frequency: These are two DEs with the strongest perceived impact both on the number of firms and actor diversity and for both types of actors considered in this study. Particularly, the existence of a schedule is regarded to have more positive effects (on the number of firms and actor diversity) for project developers compared to manufacturers. A similar conclusion can be drawn with respect to highly frequent auctions, which are perceived to increase the number of firms and actor diversity, with stronger effects on project developers than manufacturers.

Price-Only, Uniform & Renumeration Type: In contrast to the previous design element, it is not straightforward to draw clear conclusions on the influence of price-only auctions on the numbers of project developers and component manufacturers (compared to multicriteria ones) The picture is balanced: Some experts foresee a positive impact of price-only auctions on the number of actors, but others see a negative one. The influence of price-only auctions on actor diversity is mostly regarded as neutral, both with respect to project developers and manufacturers. A similar picture emerges in the case of uniform pricing vs. price as bid (PAB). There isn't an agreement among experts on the direction of influence of uniform pricing on the number of actors (neither with respect to project developers nor manufacturers). And their perception on the effects on actor diversity are mostly neutral, i.e., no influence, neither on the number of firms nor on actor diversity. Finally, a clear perceived positive impact on the number of firms of FiT (vs. Feed-in Premium (FiP)) can be observed, especially on project developers, and less so on manufacturers. This is also the case with the impact of FiTs on actor diversity. FiTs are perceived to increase actor diversity, especially for project developers.

Realization periods: As reported by the experts, realization periods of above 4 years positively affect the number and diversity of firms. This is especially so for project developers. The expected influence on manufacturers is lower.

### 4.2.2 Discussion of Expert Responses

The expert responses in the Spanish case are broadly as expected, with some exceptions. In some cases, there isn't an agreement between the interviewees on the direction of the influence of a given design element on the number of firms and actor diversity. In other cases, the effects are regarded as neutral.

The results show that the direction of the impact of a given design element on the number of firms and actor diversity is similar for project developers and manufacturers. One interviewee argues that one of the reasons for the similar impact is related to "verticalisation". "This is a main feature of this sector in Spain. The project developer is a vertical one, e.g., it has backward linkages in the value chain, particularly, with manufacturers".

However, our results also show that the perceived impact is lower for manufacturers than for project developers. This confirms our expectation that the effects of a given design element in the auctions loses importance as we move upstream in the value chain.

On the other hand, it is interesting to note that, for a given design element (and a given actor), there is not much difference regarding the direction and extent of the perceived influence between the effects on the number of firms and actor diversity. In general, a slightly greater impact on actor diversity than on the number of firms can be observed.

Regarding project developers, the existence of a schedule seems to have a large perceived influence on the number and diversity of firms. There is a widespread agreement that a schedule would increase both the number of project developers and manufacturers as well as their diversity. According to one interviewee, the existence of a schedule "is the most influential design element on the number of firms. You need to know that there is a market without ups and downs. This allows continuous planning on the part of the manufacturer and the project developer".

In contrast, stringent prequalification requirements are perceived to have the largest negative effect on the number of firms and the diversity of actors. The direction of the influence is the same for the three types of prequalification requirements (material requirements on the project or the bidder and financial prequalification requirements). It is interesting to note that they are not only perceived to impact the number of firms and their diversity, but also the type of firms that bid in the auction. Several interviewees stress that lax prequalification requirements may increase the number of bidders going to the auction, but not necessarily the "quality" of those bidders, i.e., encouraging the participation of less "serious" (or weaker ones).

Size limitations have some effects on project developers, but their impact on manufacturers is generally regarded as neutral, both regarding maximum and minimum size limitations. It is surprising to see that the existence of a maximum project size does not have a large effect on the diversity of firms. A priori, it could be expected that such requirement would encourage projects and actors with smaller sizes. But this is not the case. An interesting, although expected finding is that a minimum size limit tends to impact size diversity positively, i.e., it encourages smaller actors. The existence of lower or upper size requirement may have detrimental effects on the number of firms. This is perceived to clearly be the case for a maximum size. However, although the picture is more balanced regarding the existence of a minimum size, some interviewees also perceived a negative impact on the number of firms in this regard. For example, one interviewee argues that "there would be a lot of people who would not go to the auction if they are required to build projects with a small size. In particular, medium-size project developers who would not go to the auction if the required size of projects is below 50MW".

One of the DEs with the largest impact on the number of firms and actor diversity is the remuneration type (FiT vs. FiP). In this case, compared to FiPs, FiTs are perceived as very positive to increase the number of firms as well as their diversity, both concerning project developers and equipment manufacturers, although with a greater effect on the latter. As mentioned by one interviewee, "investors look at the stability of such price rather than the final value of its level. FiTs give more security to investors and, thus, their number of firms would increase".

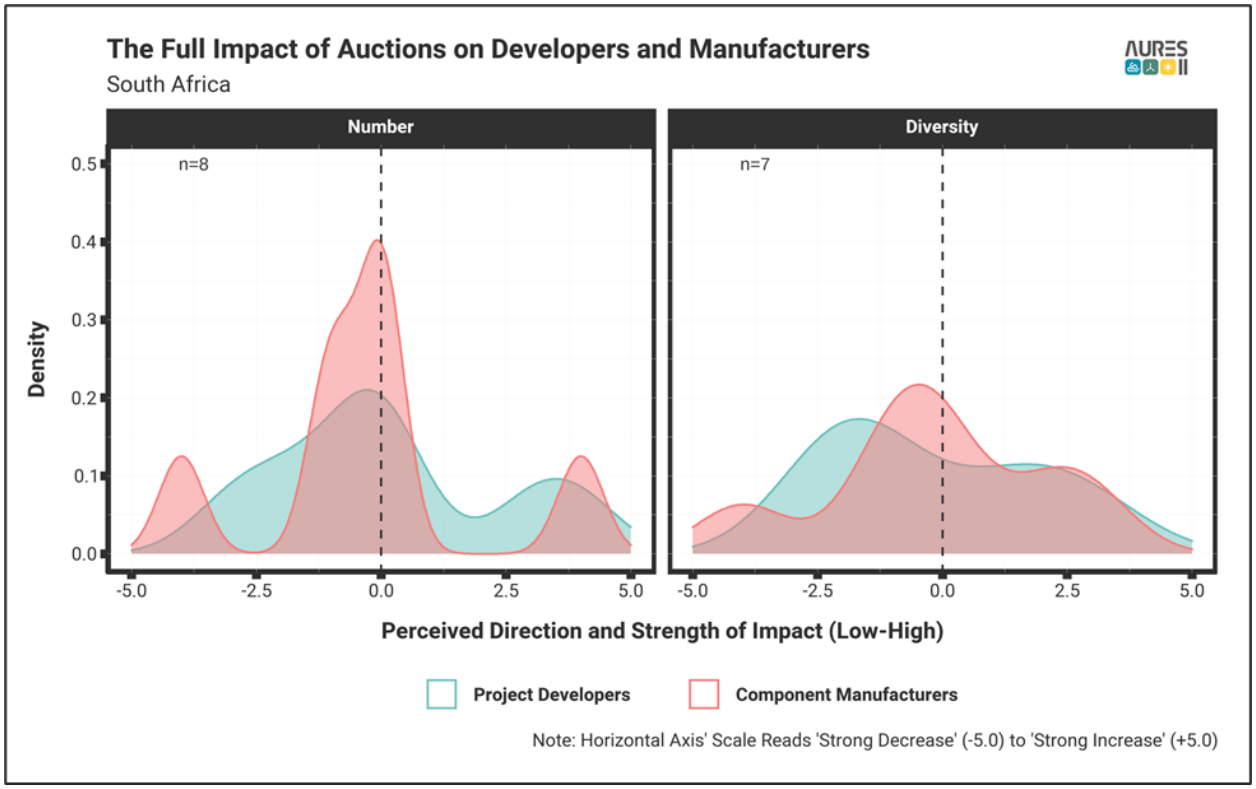
Finally, a quite influential design element is a long realization period. They are regarded as very positive to encourage, both, the number of firms and actor diversity.

## 4.3 South Africa

### 4.3.1 The Impact of Auctions and Specific Design Elements in South Africa

Figure 14 shows the distribution of experts' estimations on what the impact of South Africa's REIPPP BW 4 had been on the number and diversity of project developers and component manufacturers. Figure 15 provides an overview of experts' perceptions of the impact of 12 auction DEs relevant to the fourth bidding window, on the number and diversity of project developers and component manufacturers.

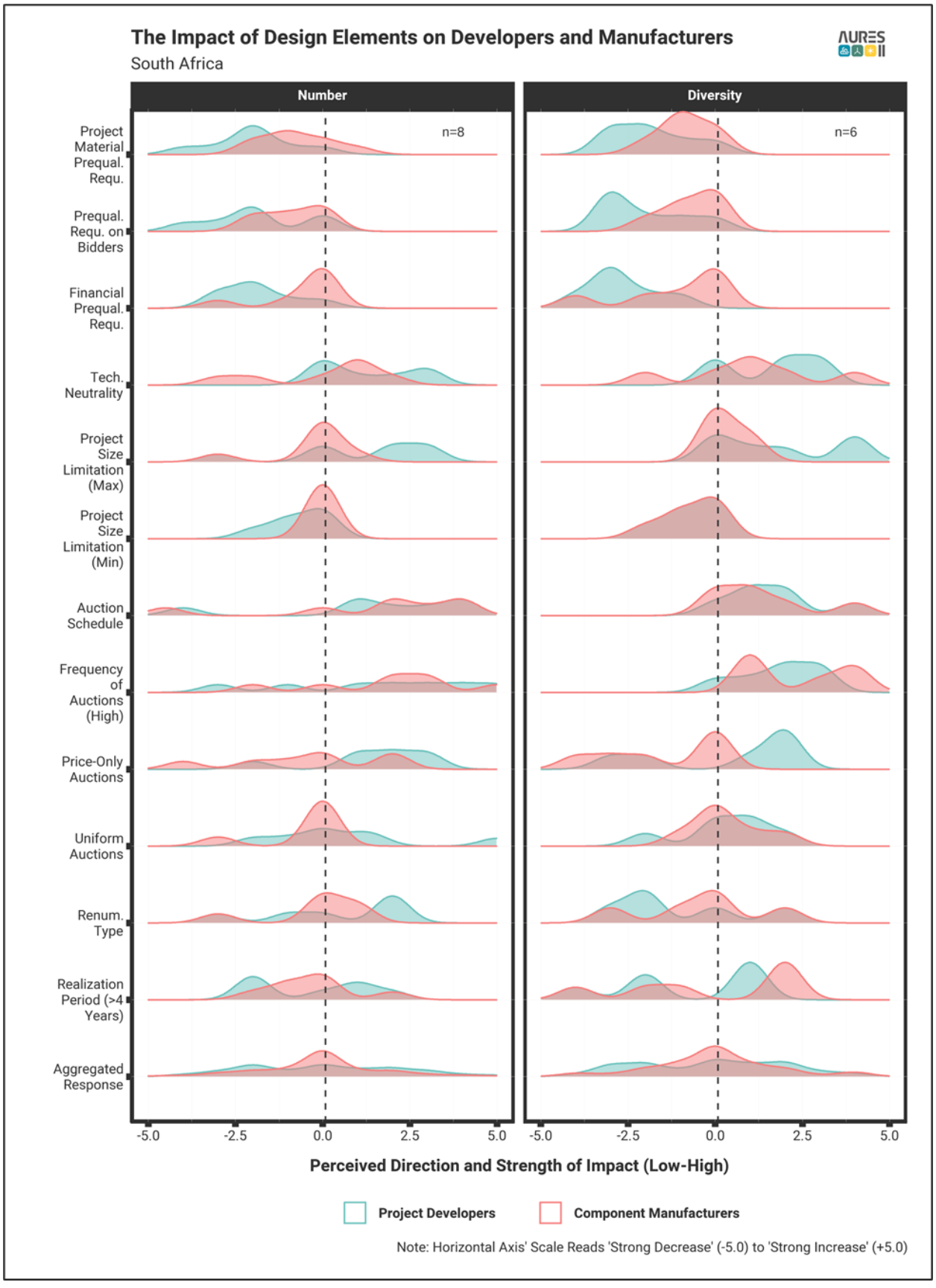
Figure 14: The Full Impact of Auctions on the Number and Diversity of Developers and Manufacturers in South Africa




Source: Own elaboration (2020)

The estimated full impact of the auction on the number of project developers and component manufacturers is largely balanced in Figure 14, however, with some experts reporting extreme positive and negative impacts. This is reflected by the aggregation of the estimated impacts of isolated DEs (last row of Figure 15). The diversity of project developers was believed to be slightly more negatively affected by the use of auctions (as compared to under a hypothetical administratively-set remuneration arrangement), while the impact on the diversity of component manufacturers remained neutral (see Figure 15). Interestingly, the degree of negative impact on diversity of project developers is more acute than would be anticipated based on the aggregated responses (last row of Figure 15.)

Figure 15: The Perceived Impact of Design Elements on Number and Diversity in South Africa




Source: Own elaboration (2020)

Prequalification Requirements: The number and diversity of project developers is negatively affected by stringent material prequalification requirements on the project and the bidder, as well as by stringent financial prequalification requirements. The number and diversity of component manufacturers is considered to be negatively affected by stringent prequalification requirements, but to a lesser extent than is the case for project developers. A similar impact (both project developers, and component manufacturers, respectively) is considered to hold for prequalification requirements on bidders. One interviewee commented that South Africa's challenging local content requirements and rules sometimes mean that some projects do not pass through the project development stage, thus affecting the number of project developers.

Technological Neutrality: The impact of technology neutral auctions was perceived to be rather positive on both the number and diversity of project developers and component manufacturers. However, interviewees' responses were widely distributed, showing an overall lack of consensus amongst interviewed experts regarding the effects of technological neutrality.

Project Size Limitations: Project size limitations, both minimum and maximum, were found to be largely irrelevant in determining the number and diversity of component manufacturers. This is because there is likely to be a similar aggregate level of demand for specific technical components, regardless of whether a relatively-large number of small-scale projects, or a relatively-low number of large-scale projects are to be developed following an auction, and taking into account the modular nature of solar PV and wind power projects.

However, maximum project size limitations were reported to positively affect the number and diversity of project developers. Minimum project size limitations are expected to reduce the number of project developers (albeit not very significantly). Interviewed experts understand this to be the case because smaller project developers struggle to raise the finance required for relatively-large scale investments (with minimum project sizes), whereas larger-scale firms can raise the required levels of debt and equity with relative ease. Hence, the smaller firms are pushed out of the market, leaving a smaller number of larger-sized firms (i.e. lower diversity).

Schedule and Frequency: It is not straightforward to draw clear conclusions on the relationship between a high frequency of auctions or the existence of predefined schedules, respectively, on the numbers of project developers and component manufacturers. On average, there is a general tendency to perceive these two DEs as positively impacting on the number of project developers and component manufacturers. Regarding the diversity of project developers and component manufacturers, the picture is much clearer. Both DEs are understood to increase the level of diversity. In particular, the frequency of auctions is expected to create a strong impact on the number and diversity of component manufacturers.

Price-Only, Uniform & Renumeration Type: The impact of price-only auctions, uniform pricing and a FiT renumeration type on both the number and diversity of component manufacturers seems to be perceived as balanced on average, but with strong variance. With respect to the number of project developers, the three DEs were perceived to have a clear positive effect on average.

Price-only auctions were reported to be more likely to increase both the number and diversity of project developers. It is worth noting that South Africa has previously applied multicriteria requirements that project developers must comply with, and which are considered to be relatively demanding in the international context of RES auctions.

Realization: Realization periods of above 4 years do not seem to decisively affect the number of project developers and component manufacturers, as reported by the experts. While there is no clear agreement overall, the use of relatively long realization periods is perceived to hold the potential to increase the diversity of both project developers and component manufacturers.

### 4.3.2 Discussion of Expert Responses

In general terms, the findings are overall in line with expectations as regards the hypothesis being scrutinised within this analysis. Different DEs do affect MC in different ways, and a broad range of effects shown. Specific DEs tend to affect MC in the project development value chain stage to a greater extent than is the case for (solar PV, wind power and CSP) component manufacturers.

Stringent financial prequalification requirements are expected to significantly reduce both the number and diversity of project developers. By contrast, the impact on component manufacturers is considered to be

relatively neutral. Some interviewees underlined their view that the threshold for what is considered stringent or challenging, in terms of financial prequalification requirements, is very much specific to each organization, which will have its respective internal decision-making criteria (e.g. organization-specific hurdle rates, etc.).

With respect to technological neutrality, one interviewee suggested that technology neutral auctions can cause a reduction in the number and diversity of component manufacturers because of the uncertainty around which RE technologies will win the auction, and hence the level of demand for different technology components. Under such conditions, only a few (and large-sized) firms may be able to deal with this uncertainty, from a business point of view.

Some experts suggested that having a clear understanding of the calendar of future auctions is very significant because it assists in developing a planning horizon for projects and business decisions. It was commented that when there is a lack of clarity on when future auctions will take place, smaller scale firms are more likely to stop operating, and to mothball their operations, perhaps re-locating to other international markets. The likelihood of this occurring is directly related to the period of time during which there is a lack of clarity on the future auction calendar. Amongst other things, some experts considered this to be the case because smaller-scale firms with overhead costs and a lack of clarity on future revenues (via sales of generated electricity, or components), tend to struggle more than larger-scale firms in their efforts to remain financially solvent and to raise capital from lending institutions to maintain their business afloat. One expert highlighted that several component manufacturers that were located in South Africa, supplying componentry to the solar PV sector, decided to close their South African operations and relocate overseas, specifically due to the considerable uncertainty over the timing of future auctions, with planned auctions being cancelled on several occasions over a period of years.

However, it is important to note that there is very low consensus on experts' views on the impact on the number of project developers and component manufacturers as a result of the existence of a high frequency of auctions (i.e. more than 1 auction per year). This contrasts somewhat with the much higher level of consensus in experts' views of the impact of a high frequency of auctions on the diversity of project developers and component manufacturers (i.e. strong increase in diversity).

Some experts expressed an opinion that whilst the use of multicriteria requirements in South Africa's most recent auction probably resulted in a lower number of project developers participating in the auction (compared the hypothetical case of a price-only auction), there was still a satisfactory level of interest and participation (from a public policy point of view) and that "auctions have consistently been oversubscribed", thereby showing that the country's use of multicriteria requirements – which may be considered to be relatively progressive in the international context, and demanding on bidders in terms of the criteria they need to comply with to qualify – has not had a negative impact on market concentration and competition per se.

It is perceived that when a FiT remuneration-type system is used (as opposed to a FiP remuneration system), the number of project developers is expected to increase, whereas there is likely to be no notable effect on the number of component manufacturers. As far as actor diversity is concerned, experts perceive that the use of FiT remuneration (as compared to FiP remuneration) will tend to reduce the diversity of project developers; the effect on the diversity of component manufacturers is less clear and unanimous.

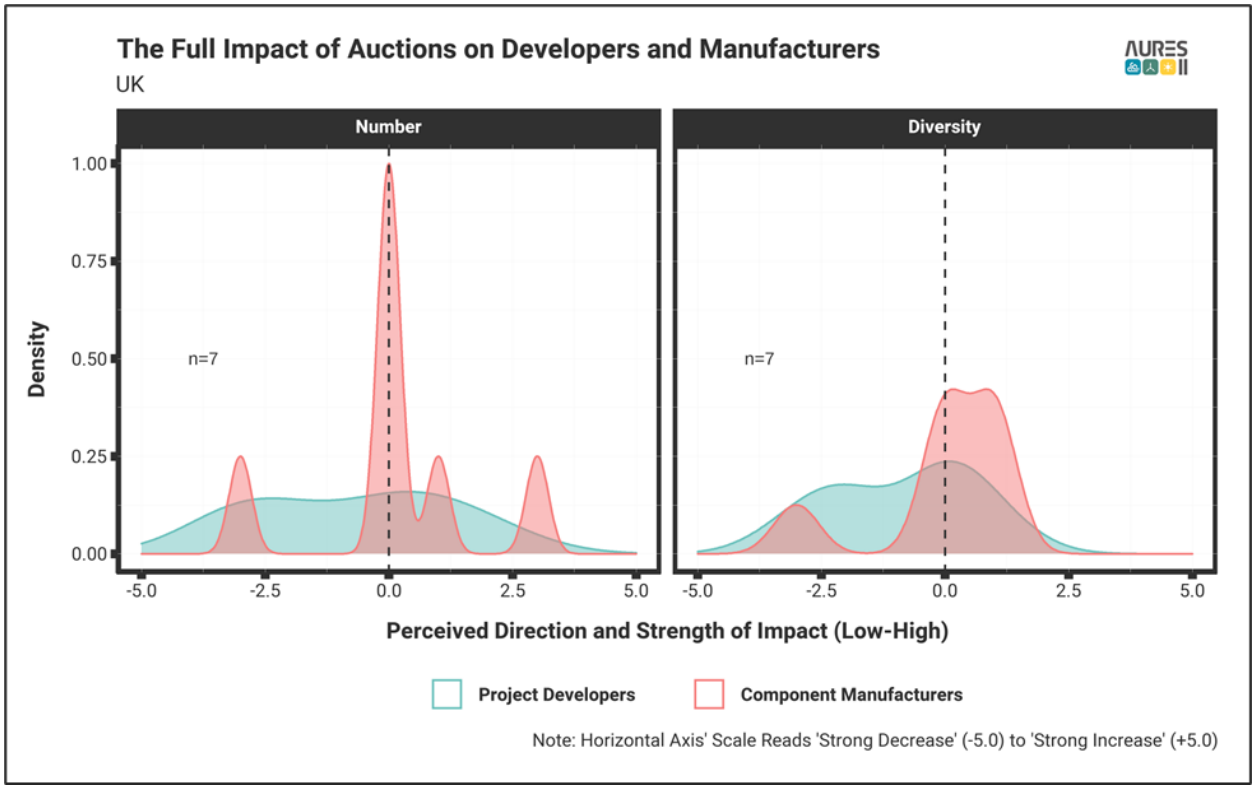
Lastly, it is worth highlighting that some experts suggested that realization periods of 4 years duration or more are not challenging to comply with. It was commented that the vast majority of project developers, of all sizes, would be able to develop and commission their projects within such a timeframe, especially as regards solar PV and wind power projects.

## 4.4 United Kingdom

### 4.4.1 The Impact of Auctions and Specific Design Elements in the UK

Figure 16 illustrates the overall impact of auctions on the number and diversity of firms in the UK offshore wind market relative to a non-auction counterfactual (such as the preceding Renewables Obligation quota scheme). The expert interviews indicate a perception that auctions somewhat reduce the number and diversity of actors in project development, with a quite strong indication of a more neutral impact on component manufacturers.

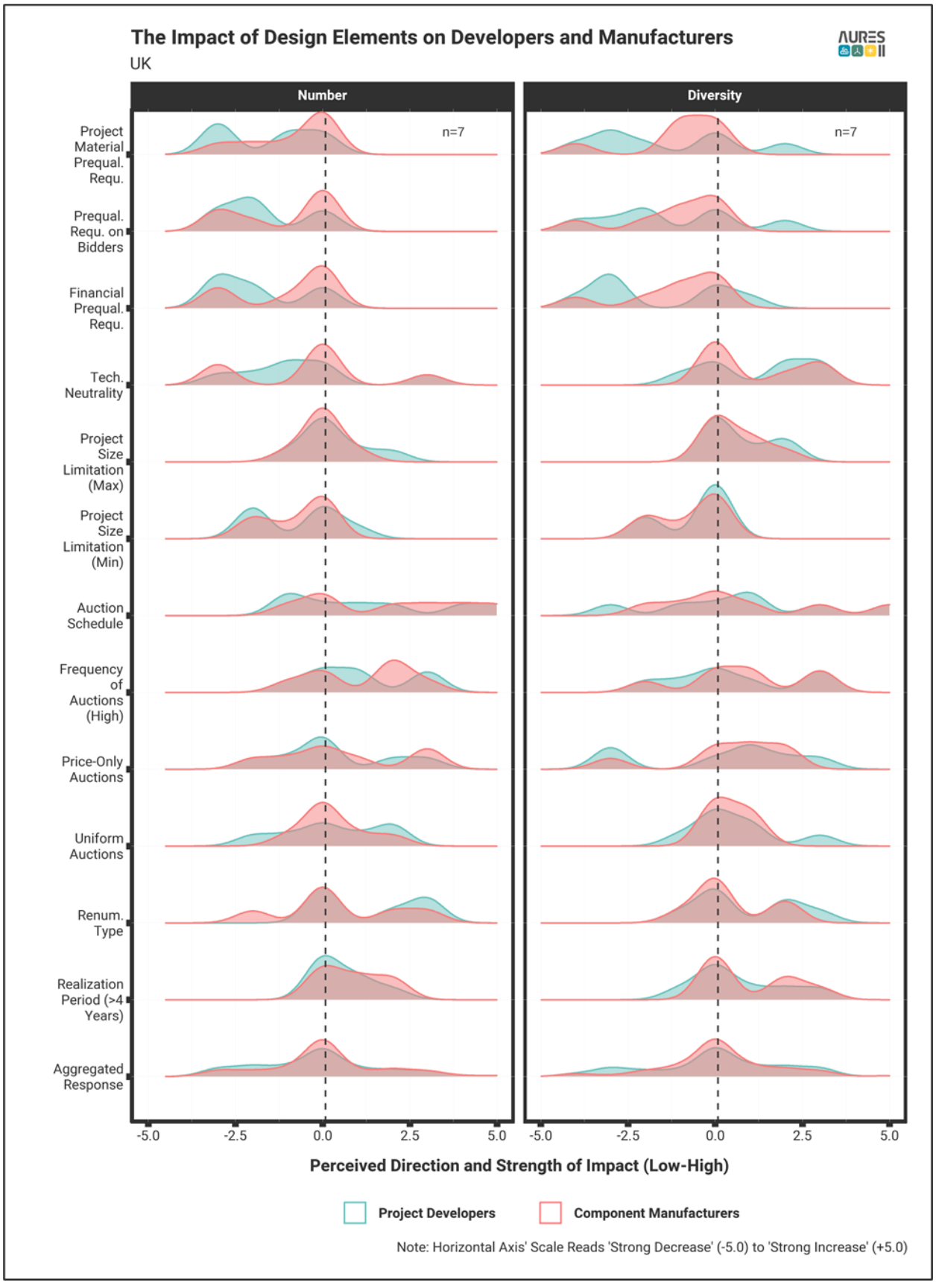
Figure 16: The Full Impact of Auctions on the Number and Diversity of Developers and Manufacturers in the UK




Source: Own elaboration (2020)

Figure 17 provides an overview of experts' perceptions of the impact of 12 analysed auction DEs, on the number and diversity of project developers and component manufacturers.

Figure 17: The Perceived Impact of Design Elements on Number and Diversity in the UK




Source: Own elaboration (2020)

Prequalification Requirements:

Figure 17 shows a general perception that prequalification requirements on projects, bidders and financial penalties all reduce the number of market participants, particularly in project development to a similar degree. The perceived impact on actor diversity is also generally negative, indicating that respondents tend to view such requirements as a barrier to market entry. However, the effect on diversity shows greater variance than the effect on the number of firms, with some respondents reporting a mildly positive effect.

Technological Neutrality:

The effect of enabling competition between technologies is perceived by interviewees to reduce the number of participants in both project development and equipment supply. Conversely, however, it is also expected to increase the diversity in both market segments.

Project Size Limitations:

Overall, the impact of size constraints on the number of firms is broadly neutral while a maximum size limit tends to be perceived as increasing diversity and minimum size limit decreasing diversity. However, these are rather weak expectations.

Schedule and Frequency:

The impact of regular auctions and a published schedule are both perceived to increase the number of firms participating in both market segments. However, there is no associated expectation that the same can be said for actor diversity, with weak but neutral perceptions.

Price-Only, Uniform & Renumeration Type:

The effect of the auction price rule and the remuneration structure are broadly neutral for both market segments across number and diversity of firms. A slightly positive expectation can be seen for the use of price-only and uniform price auction, but it is rather weak.

Realization:

A long realization period is expected by the experts interviewed to have a moderate positive effect on the number and the diversity of market participants.

### 4.4.2 Discussion of Expert Responses

Interviewees in finance, equipment supply and in project development perceive the UK CfD allocation system to be broadly effective for enabling offshore wind investment in the UK. The contract form (sliding premium) is considered appropriate to the task of managing revenue risk in the UK electricity market but there were few strong expert opinions on how this would shape market concentration.

A general observation in the UK offshore wind sector is the expert view that the impact of auction design on both the number and diversity of firms is relatively muted compared to the general policy environment. An explanation for this trend is proposed by multiple interviewees is the nature of the UK offshore wind project timeline. In order to participate in the financial support allocation, project developers must successfully acquire legal access to the seabed from The Crown Estate, a statutory corporation responsible for managing the UK seabed (Fitch-Roy, 2016).

Seabed leases are allocated in a series of 'rounds' which entail substantial commitment from project developers and, in the most recent fourth round, some competition between bidders for leases (The Crown Estate, 2019).

An important observation here is that the detailed auction design was not known at the time when developers were required to commit to very large investments in project development to secure a lease.

Consequently, the market in project development is largely shaped by the leasing process, rather than the support allocation process. There are few if any opportunities for new entrants once the leasing is concluded and the sunk costs involved in reaching that stage of the process act to deter market exit.

Another way to consider the leasing process is as an extremely stringent pre-qualification process within the overall allocation system, although this is not how the interviewees tend to perceive it with most considering it a separate policy area.

In many ways, the auction design has followed the demands of the leasing programme, for example project sizes in the auction must reflect the sizes of the projects in the pipeline, leading to experts reporting little impact of these DEs on market concentration.

Future research into the effect of the leasing arrangements on market concentration could be very valuable.

Among DEs, the most consistently positive impact on the number of actors is observed in the publication of an auction schedule and regularity of auctions, which is borne out in the increasing number of financial actors taking stakes in projects at increasingly early phases of project development.

Interestingly, this tendency is not seen by experts to apply equally to the diversity of actors, perhaps underlining the limited scope for participation by small firms in offshore wind development.

Interviewees were generally ambivalent about the potential effect of technology neutrality, with the effect on the number of participants negative but a positive impact on their diversity. But it is also important to note that the technology basket auction system has been designed to particularly favour offshore wind, and previous research has shown that proponents of other technologies participating the CfD auctions may not have had an equally positive experience (Fitch-Roy & Woodman, 2016; Woodman & Fitch-Roy, 2019). The observed results in Figure 17 may indicate an expectation that a technology neutral auction would limit the success of offshore wind in favour of (presently) cheaper technologies for which the typical market participant is smaller, such as onshore wind and solar PV.

Interviewees noted that while the market for turbine supply was highly international, the relative size of the UK market meant that a clear timeline for auctions, and a generally supportive policy environment (especially industrial policy) could have some positive impact on the entry of new OEM actors. The success of small but innovative floating offshore wind projects raise the possibility of specialist OEMs entering the UK market, but interviewees anticipate that turbine supply in the UK offshore wind sector will remain highly concentrated.

## 4.5 The Relative Importance of Auctions

In general terms, interviewed experts held a range of sometimes diverging views as to whether auctions, auction DEs, or context conditions, are most important in terms of shaping the number and diversity of actors in the two value chain segments of interest (as shown in Figure 18).

In Peru, for example, the overall use of auctions (as opposed to context factors, and specific auction DEs), were perceived to be a relatively more influential determinant of the number and diversity of project developers and component manufacturers, while specific auction DEs or context conditions were found to be of secondary importance.[13] Overall, interviewed experts consider that auctions have an important role to play in establishing competitive electricity prices, and thereby helping to solidify ambition around transitioning towards a low-carbon power system and away from a coal-fired power system that many perceive as inefficient, polluting and heavily subsidised. Auctions are generally seen as an important tool for realising competitive electricity prices.

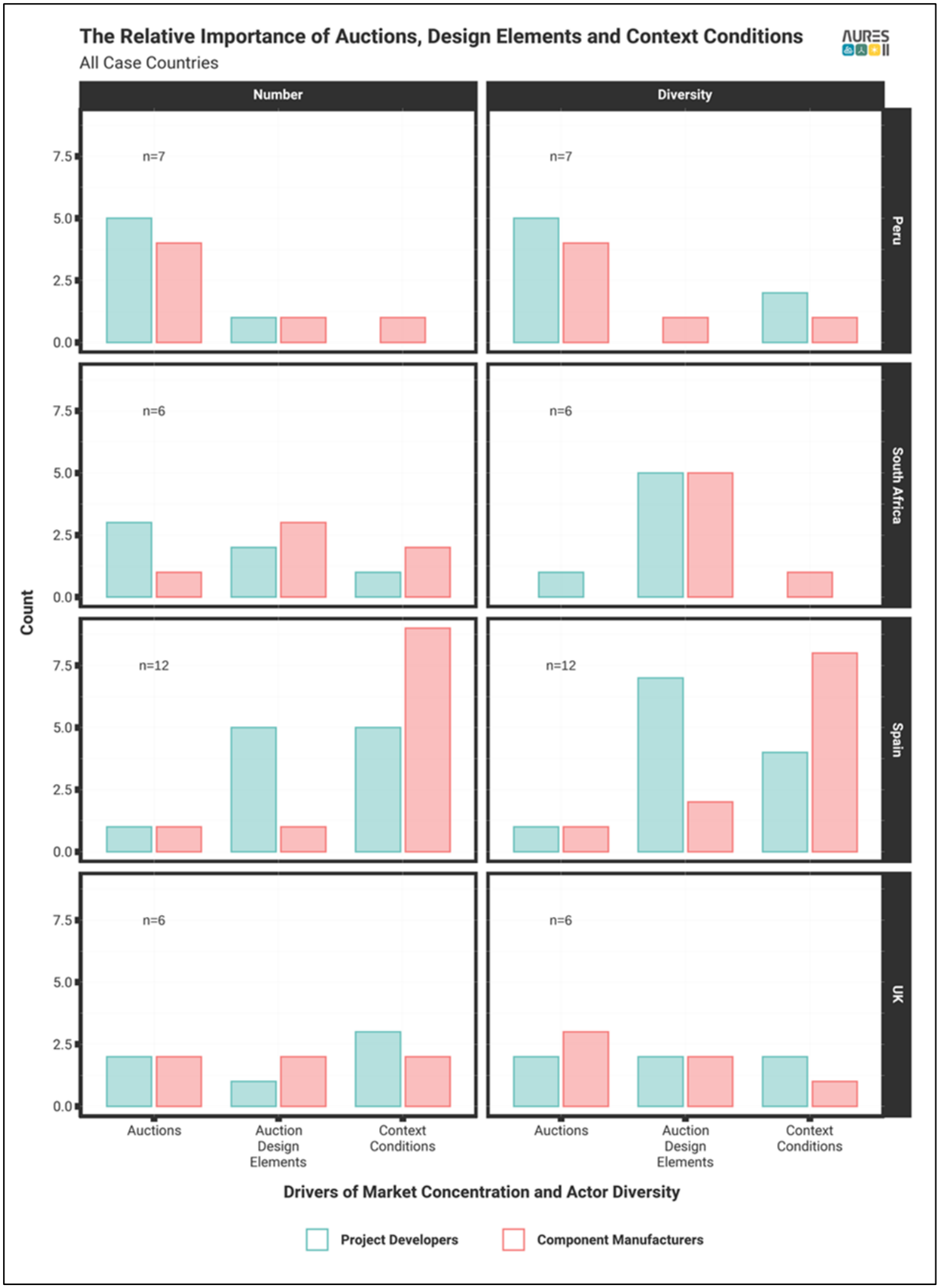
In South Africa, the overall picture is less clear, with recorded responses not allowing for the clear identification of a most influential determinant of the number of project developers or component manufacturers. With respect to the diversity of project developers and component manufacturers, however, specific DEs may have represented a defining factor in South Africa.

In Spain, experts' judgements clearly point towards the relative importance of context conditions for both the number and diversity of component manufacturers. With respect to project developers, experts' responses indicate that both context conditions and specific DEs may have been critical for the number of developers, while the latter may have been slightly more influential for component manufacturers.

In the case of the UK, there is no consensus among interviewed experts regarding the most important determinant of MC amongst project developers and component manufacturers.

[13] Peruvian experts also reported that auctions are seen to be a well-established tool in the international context, and a critical part of helping attract international attention towards investing in renewable energy projects in Peru. Several interviewed experts mentioned that for Peru to develop a competitive and scaled-up renewable energy sector, it is vital that it develops a market that can compete internationally, including with, for example, neighbouring Chile and Brazil, which may be viewed by some as currently being more established and experienced markets.

Figure 18: The relative importance of auctions, design elements and context conditions




Source: Own elaboration (2020)

## 4.6 The Relative Importance of Design Elements

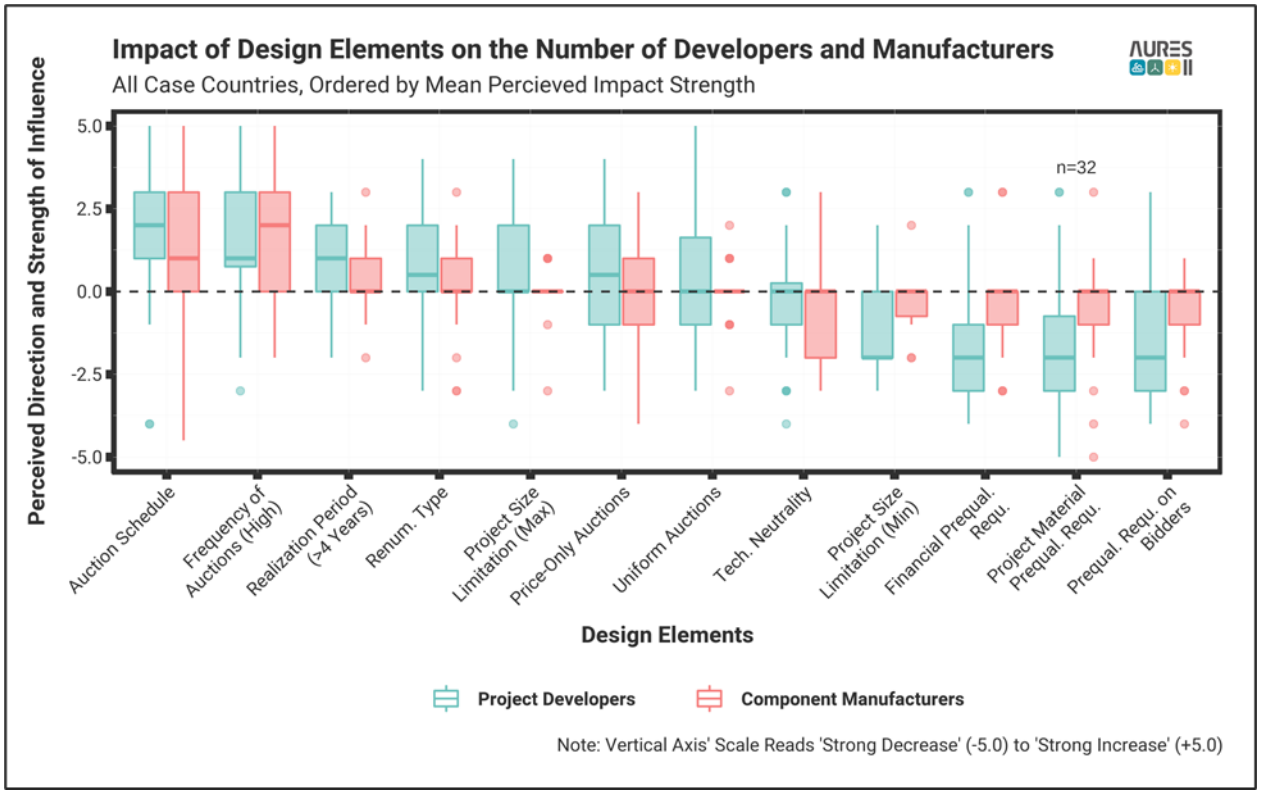
The relative importance of the perceived impact of auction DEs on the number and diversity of project developers and component manufacturers across all case countries is shown in Figure 19 and Figure 20, respectively. It can be observed that there is a broad spread in terms of how DEs affect MC.

As a general observation, many auction DEs appear to impact MC in the project developer segment of the value chain to a greater extent than compared with their level of impact on the component manufacturer segment of the value chain, including for both positive and negative effects. This is reasonable, given that that stakeholder group is more directly affected by certain specific DEs which, by definition, apply more directly to them (e.g. bidder technical and financial prequalification requirements, etc.). It may also be due to the interviewed experts' suggestions that it is more straightforward to observe the dynamics in the project developer stakeholder group, and to reason on the internal business decision-making criteria of project developers as a group, as compared to component manufacturers.

Frequently implementing auction rounds, as well as having a transparent and credible schedule of upcoming auctions, was unambiguously found to be the most important (increasing) driver of both the number and diversity of project developers and component manufacturers. At the other end of the spectrum, prequalification requirements of all types were reported to be the design element that most negatively affects (decreasing) the number and diversity of project developers in particular; and, to a lesser extent, component manufacturers.

The perceived impact of some DEs (see, for example, maximum project size limitations) on the number or diversity of component manufacturers was found to be strongly concordant, with only few deviations and / or outliers. These observations appear in Figure 19 and Figure 20 as lines without boxes and whiskers.

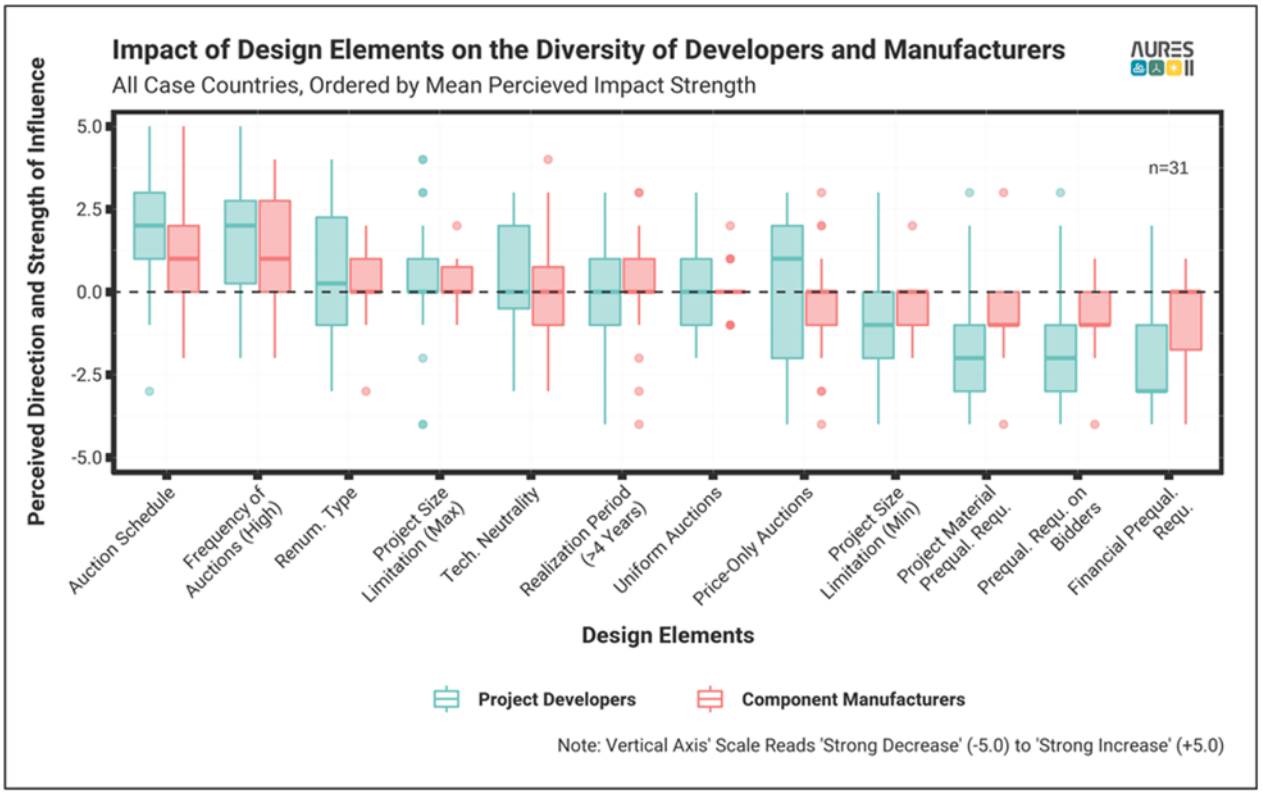
Figure 19: Impact of Design Elements on the Number of Developers and Component Manufacturers




Source: Own elaboration (2020)

Figure 20: Ranking of Design Element Impact Strength on Diversity of Developers and Component

Manufacturers




Source: Own elaboration (2020)

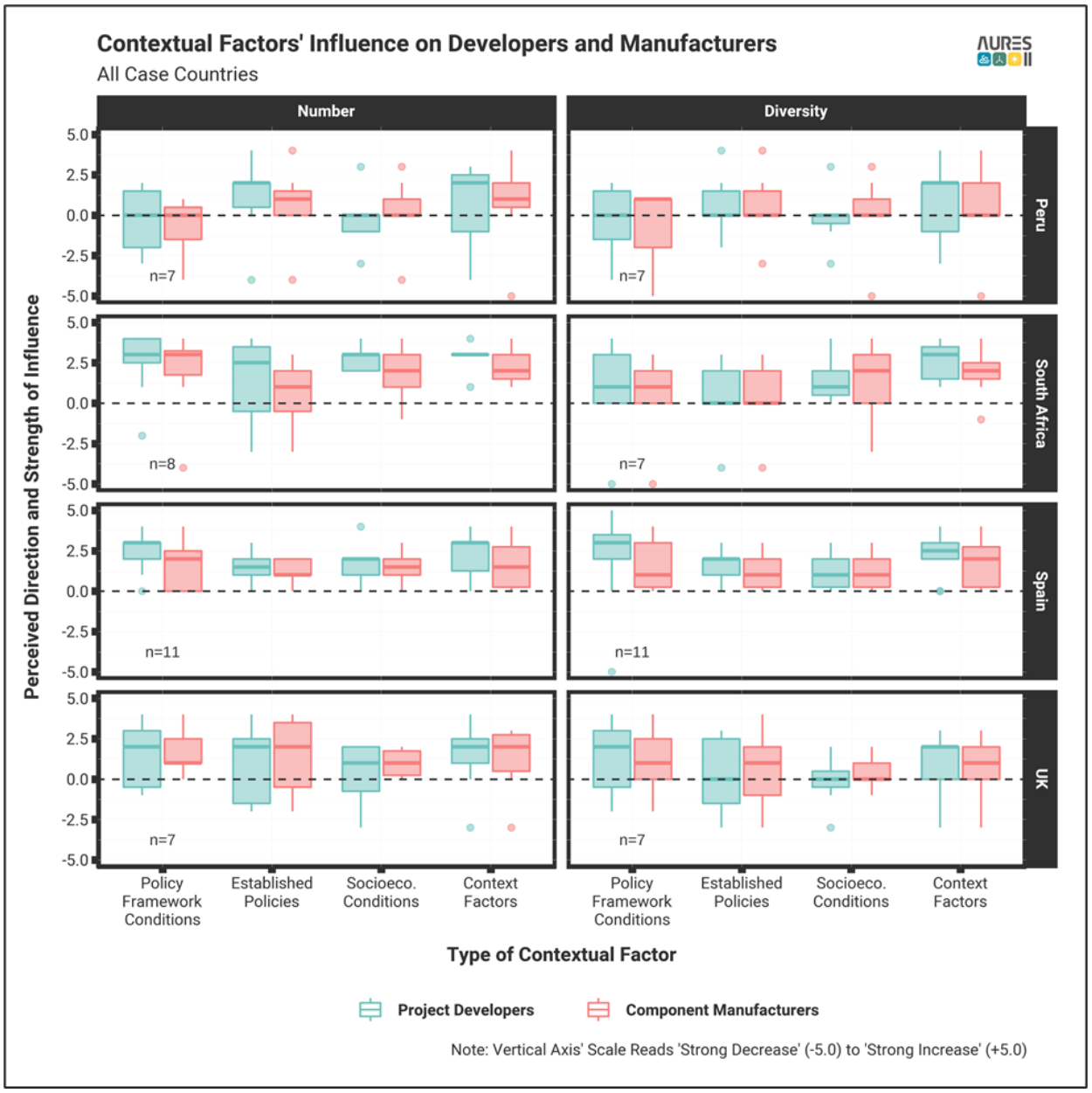
## 4.7 The Relative Importance of Context Conditions

Context conditions and related factors were found to almost exclusively affect the number and diversity of project developers and component manufacturers in a neutral or positive way (see Figure 21).

In South Africa, the perceived positive effect seems to be especially strong on the number of project developers and component manufacturers where Policy Framework Conditions, Socioeconomic Factors and Context Factors are concerned. Some interviewed experts underlined their view that South Africa has a well-developed and capable financial services sector, which facilitates the timely development of competitive and viable RE projects. Moreover, experts consistently expressed that South Africa has a relatively comprehensive and clear RE strategy and policy framework in place. However, the role of key public institutions could be improved, especially in terms of offering a clear timetable for future auctions and, most importantly, sticking to that timetable.

It was also mentioned that South Africa's project developers and component manufacturers have benefitted from the experience obtained and lessons learned during the country's initial RE auction rounds. This has allowed them to improve their operational approaches and for a more mature value chain to become established. On the other hand, it was mentioned during some interviews that South Africa's Established Policies category can be a negative impactor on the prevailing state of the project developer and component manufacturer value chain segments, as a consequence of the continued importance of the coal- and coalfired power generation sector in the South Africa. The coal industry has considerable lobbying powers and continues to exert a strong influence on broader energy sector policy making. It was suggested that this may hamper the development of country's RE sector, which could in turn lead to overall more concentrated RE project developer and component manufacturing value chain segments.

Figure 21: The Influence of Contextual Factors on the Number and Diversity of Developers and Manufacturers




Source: Own elaboration (2020)

# 5 Discussion

## 5.1 Overall Findings

The country level analysis, as well as the cross-sectional comparison, show that the auctions and auction DEs have a marked effect on the number and diversity of project developers and component manufacturers. Some DEs appear to induce large impacts MC, whereas others have a very modest influence.

The positive and negative impacts of specific DEs on MC are perceived to be more pronounced for project developers, than for component manufacturers. In other words, project developers seem to be more "exposed" and affected by auction DEs as regards the two considered measures of market concentration. As one expert phrased it, "project developers find themselves at the sharp and business end of RE auctions, whereas component manufacturers are relatively more shielded."

Some DEs stand out as having a consistently strong positive (increasing) or negative (decreasing) impact on the number and diversity of project developers and component manufacturers; impacts that are observed in all four countries of analysis. The use of transparent publicly-disclosed auction schedules, as well as conducting auctions with high frequency, are clearly considered to be elements which increase the number and diversity of project developers and component manufacturers; a trend that was also observed in all four countries. The opposite is true for all kinds of prequalification requirements. Whilst many interviewed experts stated that prequalification requirements are clearly necessary to ensure that bids are received from serious and capable bidders (i.e. increasing the likelihood of relatively high project realisation rates), strict prequalification requirements can strongly limit the ability of smaller scale organisations to participate in the auction.

It seems that certain "hot" DEs will, other things being equal, tend to push the project development segment of a solar PV, wind power, or CSP market to become more, or less, concentrated, than is the case for the component manufacturing segment. This does not mean that the presence of a certain hot DE will automatically result in a market becoming more concentrated, or less concentrated. For one thing, tangible impacts on MC may depend on two (or more) DEs being simultaneously adopted (e.g. strong prequalification and a schedule, but not lenient prequalification and a schedule). Moreover, broader context conditions also play a role in shaping MC. The overall degree of influence of auctions and auction DEs is limited.

With respect to project developers, there is significant variance in responses indicating quite a high degree of uncertainty with respect to the impact of some DEs. On the other hand, for other DEs (e.g. prequalification requirements, the existence of a schedule of auctions), there is markedly little variation in experts' responses and the perceived relationship of those DEs on MC is clear. The perceived impacts on component manufacturers that are centred around the neutral are much more concentrated. It is, however, uncertain whether low variance around the neutral can be understood as a sign of consensus of experts' judgments, or whether a neutral response rather reflects the expert's lack of knowledge of the true effect.

The perceived relative importance of auctions, as compared to specific auction DEs and context conditions, varies considerably between countries with respect to their impact on the two measures of MC. If anything, this confirms the assumption that auctions themselves are by no means the major determinant of MC in the two considered stages of the value chain. Country-specific context (and other) factors will always also play a certain role in shaping the prevailing MC.

In Peru, for example, the use of auctions themselves (and not specific auction DEs, or context factors) is clearly considered to be the most important determinant of MC. Possible reasons for this general viewpoint include that Peru's RE sector and market has been built up entirely through the use of auctions. Prior to the first use of auctions, Peru did not operate a FiT remuneration system for renewable. Several interviewed experts consider that the use of auctions is critically important as a means of uncovering real and competitive power prices, which is a prerequisite if solar PV and wind power projects are to be able to compete with fossil fuel fired generation plant which benefit from substantial subsidies from government, and hence facilitate eating into the market shares of incumbent firms.

This is broadly in line with the findings of research conducted within the first AURES project (please refer to Del Río 2017a). That research, which also focused on the most recent auction round held in Peru, uncovered that "motivations to implement auctions include perceived technical capacity constraints by the regulator in

defining administratively-set FiTs." This viewpoint does not seem to have shifted much in the interim period from 2018 to spring 2020. Despite their relative complexity and the various trade-offs that need to be taken in their design, key experts on Peru's RE auction continue to perceive that the use of auctions is critical in the context of the ongoing development of the country's RE sector.

In South Africa, however, there is no clear distinction between auctions, auction DEs and contextual factors, in terms of their respective perceived levels of importance in affecting MC. However, as concerns actor diversity, the conclusion is far clearer: auction DEs are the most important determinant of MC (for both project developers and component manufacturers). South Africa's RE auction programme includes certain measures (requirements on bidders) that ensure a (minimum 40%) participation of the local South African workforce in projects as well as the use of broad evaluation criteria for black economic empowerment. In terms of the diversity of operational companies, there is a stark contrast between South Africa's pre-RE power market and sector (i.e. up to 2011) which was heavily dominated by the State-owned enterprise (Eskom) on the one hand, and the power sector that is evolving from 2011 onwards, on the other hand. Interviewed experts broadly consider that such a level of diversity (and hence lowered MC) would not have been realised without it being required vis-à-vis the relevant auction DE.

The results for Spain suggest that the use of auctions is the least important determinant of number and diversity (MC) in that country's wind power market, whereas contextual factors are of highest importance in determining MC for component manufacturers. One possible reason for the relative high degree of importance awarded to contextual factors could be that RE auctions are mandated to be used for all EU Member States, and as such, are now simply part of the landscape. Perhaps what matters most now are (stable) macro-economic conditions and an unambiguous commitment at the national level to continue to decarbonise the country's power sector and broader economy. In addition, the retroactive cuts adopted in Spain in the past, which are an important part of the context conditions (policy stability) and not related to the type of RE support scheme in place (whether administratively-set remuneration or remuneration set via auctions) probably figure prominently in the minds of experts as a major aspect influencing RE deployment.

In the case of the UK (offshore wind), a range of views were shared and there is no consensus among interviewed experts regarding the most important determinant of MC amongst project developers and component manufacturers. In this context, it's important to bear in mind that offshore wind project development rights are awarded at much larger scale (i.e. a project developer wins the rights to develop a single major-scale (e.g. 1 GW) offshore wind project in a pre-defined site); this is a different approach overall to the approach used in Peru, South Africa and Spain for solar PV and wind power.

# 6 Conclusions

## 6.1 Summary of Findings

This study has attempted to analyse the hypothesis that:

*Some design elements in auctions are likely to have a considerable impact on the number and diversity of project developers and component manufacturers, whereas the effects of other DEs are likely to be very small or negligible. In particular, the existence of a high frequency of auctions (more than once a year), a schedule of auctions and stringent prequalification requirements are expected to be very relevant in this regard.*

The findings of the expert elicitation process conducted on the case countries of Spain, South Africa, Peru and the United Kingdom suggest that the hypothesis cannot be rejected. The expert elicitation process has established support for the existence of impactful DEs that are expected to affect the number and diversity of project developers and component manufacturers. Broadly speaking, DEs tend to affect the value chains of the four considered countries in quite similar ways. However, there are substantial technology and country differences, in line with our idea that the impact of auctions and auction DEs can be expected to be both RE technology-specific and country-specific

The DEs which tend to increase the number and diversity of project developers and component manufacturers to the largest extent include a high frequency of auction rounds and the existence of a transparent schedule of auctions. The DEs that tend to decrease the number and diversity of project manufacturers and component manufacturers to the largest extent include the use of strict prequalification requirements (including those of a technical, financial or other nature).

It is worthwhile underlining that the DEs which tend to affect MC to a greater extent (i.e. the frequency of auction rounds, existence (or not) of a transparent schedule, and prequalification requirements), are the DEs that are most likely to get tangled up with non-auction policy areas. These DEs have implications for, and are affected and shaped by, certain factors that lie outside of auction theory. For instance, within auctions in the UK offshore wind sector, the frequency of holding auctions interacts with inter alia the expansion of the (offshore) electricity network; and the requirements and process around bidder prequalification is affected by the approach towards the lease of the seabed. The schedule of future auctions can be an element of broader industrial development policy, climate policy and wider economic policy making. In Spain's onshore wind sector, decisions related to the frequency and schedule of auctions are also not taken in the isolation of auction policymaking. Spain has established, via its National Integrated Energy and Climate Change Plan, that auctions will be held at least once per year during the period 2020 to 2030, awarding at least 3000MW rights, per year. At the same time, this commitment can be revised in function of progress in meeting climate change mitigation targets, and broader industrial policy (including progress in promoting the establishment of strong and competitive value chains).

Whilst some DEs appear to affect MC is discernible and important ways, it also appears that some DEs have only a marginal impact, or indeed no discernible impact whatsoever, on the level of MC (i.e. the number and diversity) of project developers and component manufacturers. Some examples of DEs in this regard include for instance the use of price only (i.e. not multicriteria) auctions, and the use of uniform (as opposed to pay-as-bid) auctions. In the case of some DEs, this seems to be because the effect is generally marginal (neutral); and in the case of other DEs, the perceived positive and negative impacts on MC effectively cancel each other out.

These results suggest some policy implications. First, if the number and diversity of firms is to be increased, then those DEs which appear to have the largest influence on MC should be adopted, taking into account that this may entail conflicts with other goals. Second, in addition, these can be complemented with other design elements which directly influence MC and the diversity of firms, such as seller concentration rules and contingents or special rules for small projects.[14] Notwithstanding, our results also indicate that those

[14] See, for example, "Auctions and Renewable Energy Communities" (February 2020), as published by the AURES 2 consortium. Accessible via: http://aures2project.eu/wp-content/uploads/2020/02/AURES_II_D4_2_energy_communities.pdf

measures will necessarily be limited, taking into account that auctions and auction DEs are only part of the story. In other words, auctions and auction DEs are only a restricted subset of all the factors with a potential influence on the number and diversity of firms.[15]

## 6.2 Limitations of the Study and Methodology

Certain limitations exist as regards the validity of the study and the robustness of the findings. These can be attributed to the methodology itself and its implementation.

The expert elicitation approach must follow a strict and robust protocol to facilitate the uncovering of experts' understandings and views which are not available or observable elsewhere, whilst at the same time ensuring minimizing potential biases. While a robust protocol was developed for this study, expert elicitations have neither been previously conducted in this study's field of research, and seldomly with qualitative data (although Likert scale responses can also be quantitative).

Limitations of the study's external validity also include the inherent difficulty of extrapolating findings from the country cases to the global level. Context factors define the socio-economic landscape in which RE auctions take place. This study has found that country-specific contextual factors are important determinants of the number and diversity of project developers and component manufacturers in each respective country. Whilst country-specific contextual factors were considered within the study, they were not empirically evaluated. Case country findings are case country specific because the effect stemming from auctions and DEs cannot be disentangled from its context.

Nevertheless, this study has identified patterns of DEs with similar effects on MC (number and diversity) across countries, which may hint towards the existence of globally relevant effects. This suggests the existence of important implications for policy makers and authorities responsible for the design of RE auctions, in their efforts to balance market development and MC objectives, with more explicit auction outcome objectives (such as yielding competitive prices, and the timely development of projects, amongst other things).

[15] This study has focused on two segments of the RE value chain, namely project developers and component manufacturers. Future research around this topic could be expanded to also focus on other value chain segments, such as O&M service providers, and other key stakeholder groups which impact on the dynamics of RE markets (e.g. banks and lending institutions).

# 7 References


Amazo, A., Tiedemann, S., Tay, S., Bieri, M. 2018. *Why there is so much aggressive bidding at renewables auctions – and what the risks are.* Energy Post https://energypost.eu/why-there-is-so-much-aggressive-bidding-at-renewables-auctions-and-what-the-risks-are/#:~:text=If%20aggressive%20bidding%20results%20in,and%20effectiveness%20of%20an%20auction.

AURES 2016. Website of the EU-funded AURES project. http://www.auresproject.eu

Bain, J. S. (1951). Relation of Profit Rate to Industry Concentration: American Manufacturing, 1936-1940. *The Quarterly Journal of Economics*, *65*(3), 293. https://doi.org/10.2307/1882217

Bain, J.S., (1956). Barriers to New Competition Harvard University Press, Cambridge, MA.

Bayer, B., Berthold, L., & Moreno Rodrigo de Freitas, B. (2018). The Brazilian experience with auctions for wind power: An assessment of project delays and potential mitigation measures. *Energy Policy*, *122*, 97–117. https://doi.org/10.1016/j.enpol.2018.07.004

Bayer, B., Schäuble, D., & Ferrari, M. (2018). International experiences with tender procedures for renewable energy – A comparison of current developments in Brazil, France, Italy and South Africa. *Renewable and Sustainable Energy Reviews*, *95*(May), 305–327. https://doi.org/10.1016/j.rser.2018.06.066

Bhattacharya, M., & Bloch, H. (2000). Adjustment of profits: Evidence from Australian manufacturing. *Empirica*, *27*(2), 157–173. https://doi.org/10.1023/A:1026532531486

Botta, E. (2019). An experimental approach to climate finance: the impact of auction design and policy uncertainty on renewable energy equity costs in Europe. *Energy Policy*, *133*. https://doi.org/10.1016/j.enpol.2019.06.047

Cassetta, E., Meleo, L., Monarca, U., & Nava, C. R. (2017). Is the answer blowin' in the wind (auctions)? An assessment of Italian auction procedures to promote onshore wind energy. *Department of Economics and Statistics Cognetti de Martiis. Working Papers*. https://ideas.repec.org/p/uto/dipeco/201709.html

CEER 2016. *Key support elements of RES in Europe: moving towards market integration*

Chan, G., Anadon, L. D., Chan, M., & Lee, A. (2011). Expert elicitation of cost, performance, and RD&D budgets for coal power with CCS. *Energy Procedia*, *4*, 2685–2692. https://doi.org/10.1016/j.egypro.2011.02.169

Cooke, R. M. (1991). Elicitation and Scoring. In *Experts in Uncertainty. Opinion and Subjective Probability in Science* (pp. 121–135). Oxford University Press.

del Río, P. (2017a). A*uctions for renewable support in Peru: Instruments and lessons learnt*. Report of the EU-funded AURES project.

del Río, P. (2017b). Designing auctions for renewable electricity support: the case of Spain. Renewable Energy Law & Policy Review, 8(2), 23-37(15).

del Río, P. (2017c) Designing auctions for renewable electricity support. Best practices from around the world. Energy for Sustainable Development 41, 1-13.

del Río, P. (2018). An analysis of the design elements of the third renewable energy auction in Spain Renewable Energy Law & Policy Review 8(3), 17-30(14).

del Río, P., Kiefer, C.P., (2018). Analysis of the Drivers and Barriers to the Market Uptake of CSP in the EU, Deliverable 4.3 of the EU-funded MUSTEC project, Madrid. https://mustec.eu/sites/default/files/reports/4.3Analysis_of_the_drivers_and_barriers.pdf

del Río, P., & Linares, P. (2014). Back to the future? Rethinking auctions for renewable electricity support. In *Renewable and Sustainable Energy Reviews* (Vol. 35, pp. 42–56). Elsevier Ltd. https://doi.org/10.1016/j.rser.2014.03.039

Demsetz, H. (1973). Industry Structure, Market Rivalry, and Public Policy. *The Journal of Law and Economics*, *16*(1), 1–9. https://doi.org/10.1086/466752

DOE SA (2013), "*Request for qualification and proposals for new generation capacity under the IPP procurement programme - Part A: General requirements, rules and provisions*", DOE SA, Cape Town http://tlamelo.com/RFP%20PART%20A%20-%20GENERAL%20REQUIREMENTS%20RULES%20-%20BW3.pdf.

Fell, H. (2019). The Shift from Feed-In-Tariffs is Hindering the Transformation of the Global Energy Supply to Renewable Energies. *Energy Watch Group Policy Paper*, *1*, 1–22.

Fischhoff, B. (1984). Debiasing. In D. Kahneman, P. Slovic, & A. Tversky (Eds.), *Judgement under Uncertainty: Heuristics and Biases* (pp. 422–444). Cambridge University Press.

Fitch-Roy, O. (2016) An offshore wind union? Diversity and convergence in European offshore wind governance. *Climate Policy* 16(5): 586–605.

Fitch-Roy, O., and Woodman, B. (2016) *Auctions for Renewable Energy Support in the United Kingdom: Instruments and lessons learnt*. Report of the EU-funded AURES project

Hawila, D., Lucas, H., & Ferroukhi, R. (2013). Renewable Energy Auctions in Developing Countries. *Irena*, 1–52. https://doi.org/10.1007/s12311-018-0921-x

Held, A., Ragwitz, M., Gephart, M., de Visser, E., & Klessmann, C. (2014). *Design features of support schemes for renewable electricity*. 104. https://doi.org/DESNL13116

Hogarth, R. (1987). *Judgement and Choice: The Psychology of Decision . Chichester, New York, Brisbane*. Toronto: John Wiley & Sons.

ICSTD 2017. B*uilding Supply Chain Efficiency in Solar and Wind Energy. Trade and Other Policy Considerations*. International Centre for Trade and Sustainable Development

IRENA. (2019). *Renewable Energy Auctions - Status Beyond Price* (Vol. 1, Issue 14). https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2017/Jun/IRENA_Renewable_Energy_Auctions_2017.pdf

Jenny, F., & Weber, A.-P. (1978). The Determinants of Concentration Trends in the French Manufacturing Sector. *The Journal of Industrial Economics*, *26*(3), 193. https://doi.org/10.2307/2097864

Kahneman, D., & Tversky, A. (1984). Intuitive Prediction: Biases and Corrective Procedures. In D. Kahneman, P. Slovic, & A. Tversky (Eds.), *Judgement under Uncertainty: Heuristics and Biases* (pp. 414–421). Cambridge University Press.

Klemperer, P. (2002). What really matters in auction design. In *Journal of Economic Perspectives* (Vol. 16, Issue 1, pp. 169–189). https://doi.org/10.1257/0895330027166

KPMG 2019. T*he socioeconomic impacts of wind energy in the context of the energy transition*.

Lilliestam, J. 2018. W*hither CSP? Taking stock of a decade of concentrated solar power expansion and development*. Deliverable 4.2 of the EU-funded MUSTEC project

Lucas, H., & Gómez, J. C. (2017). Renewable Energy Auctions in Latin America and The Caribbean. *Factor*, 108. https://www.wearefactor.com/docs/RE_LAC.pdfLypczynski, J., Wilson, J.O.S. & Goddard, J.A., eds. 2005. I*ndustrial organization: Competition, Strategy, Policy*. Pearson Education

Ministerio de Energía, Turismo y Agenda Digital (MINETAD) 2017. *El gobierno adjudica un total de 5037 MW de renovables sin coste para el consumidor*. MINETAD Press note 26/7/2017.

Mueller, W. F., Hamm, L. G., Mueller, W. F., & Hamm, L. G. (1974). Trends in Industrial Market Concentration, 1947 to 1970. *The Review of Economics and Statistics*, *56*(4), 511–520. https://econpapers.repec.org/RePEc:tpr:restat:v:56:y:1974:i:4:p:511-20

Ratnayake, R. (1999). Industry concentration and competition: New Zealand experience. *International Journal of Industrial Organization*, *17*(7), 1041–1057. https://doi.org/10.1016/s0167-7187(97)00069-6

Shughart, W. (2019). Industrial Concentration. Econlib. https://www.econlib.org/library/Enc/IndustrialConcentration.html#:~:text=By%20William%20F.,Shughart%20II&text=Industrial%20concentration%E2%80%9D%20refers%20to,by%20a%20few%20large%20firms.

Simone Steinhilber; Emilie Rosenlund. (2016). Secondary objectives Secondary objectives in auctions. *Policy*

*Memo*, *1*.

Tirole, J. (1988). The Theory of Industrial Organization. *MIT Press Books*, *1*. https://ideas.repec.org/b/mtp/titles/0262200716.html

Tversky, A., & Kahneman, D. (1974). Judgment under Uncertainty: Heuristics and Biases. *Science*, *185*(4157), 1124–1131. https://doi.org/10.1126/science.185.4157.1124

Viscidi L, Yepez A. *Clean energy auctions in Latin America*. Inter-American Development Bank; 2020.

Wind Europe (2017). *Local impact, global leadership. The impact of wind energy on jobs and the EU Economy.*

Woodman, B., and Fitch-Roy, O. (2019) *Auctions for the support of renewable energy in the UK: Updated results and lessons learnt*. Report of the EU-funded AURES II project.

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

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

www.aures2project.eu

AURES II has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 817619