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The impact of auctions on financing conditions and cost of capital for wind energy projects

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\textbf{A B S T R A C T}

The recent rise of auctions to allocate support payments for renewable energy projects creates new uncertainties during project development and causes a decrease in support levels. We investigate the effects of the shift to auctioning on costs of capital (CoC) and financing conditions through semi-structured and focus group interviews with 40 experts in onshore and offshore wind project development and financing in Europe. We find that auctions create a competitive environment that pressures the industry into accepting higher risks and lower returns. Banks have reduced debt margins, while large investors decreased hurdle rates and equity returns, despite additional risks from auctions, such as uncertainty about future award prices, allocation and qualification risks. The risk of being awarded support and incurring sunk costs makes smaller bidders averse to participating in auctions. Competitive bidding may also decrease secured revenues and increase off-taker risks, especially when combined with sliding premiums. Despite increased price risk, the competitive pressure driven by project sponsors, seems to lower financing costs and hurdle rates, thus decreasing CoC for offshore projects. To reduce negative impacts on CoC and financing, policymakers can minimise additional risks, by adopting remuneration schemes that stabilise revenues, and supporting smaller actors through removing participation hurdles.

\section{Introduction}

Policymakers increasingly use auctions to allocate renewable energy (RE) support (IRENA, 2019b). In 2011, only five European Member States used auction-based support schemes (Kitzing et al., 2012). Since then, legislative changes such as the EU State Aid Guidelines (European Commission, 2014), lead to more auction implementations, so that today, there are 19 active schemes (Szabó et al., 2020). In an auction-based support scheme, eligible bidders compete, typically based on their required support level, to obtain support rights for a limited quantity of additional renewable energy capacity that a state authority is procuring (Mora et al., 2017). In Europe, successful bidders typically receive support in form of access to a fixed remuneration or premium – essentially an add-on to the wholesale electricity price – that exposes them to different levels of price risk, depending on the individual designs (CEER, 2016). This is unlike the early expansion of RE in Europe, where support policies such as the feed-in-tariff prevailed (Kitzing et al., 2012), and that offered guaranteed price certainty and a low-risk investment profile (Held et al., 2006). Auctions induce new risks into RE, such as the risk of qualifying and winning the auction - and their introduction coincides with increased price risk, which has become one of the main risk sources for renewables in Europe (Egli, 2020).

As renewable energy investments are mainly composed of upfront capital costs, and their economic feasibility is more sensitive to changes in costs of capital than their fossil fuel alternatives (Hirth and Steckel, 2016; Schmidt, 2014), de-risking renewable energy investments could increase the cost-effectiveness of the energy transition (Komendantova et al., 2019; Ondraczek et al., 2015; Schinko and Komendantova, 2016). Accordingly, policy makers need a better understanding of the impacts of auctions on costs of capital and financing.

To this end, Pahle and Schweizerhof (2016) conceptually analyse the effects of introducing auctions and remuneration scheme changes in the German renewable energy law on price risks, volume risk, off-taker risk and support allocation risk. Polzin et al.’s (2019) literature review outlines the potential impacts of different auction and Power Purchase Agreement (PPA) designs on risk and return for investors, while Shirimali et al. (2016) investigate auction cost-effectiveness in India through a risk perspective. Kruger et al. (2019) assess the impact on project risks of different site selection procedures for projects in solar PV auctions in South Africa and Zambia. Botta (2019) explores the relation between...
2. Potential effects of auctions on financing and costs of capital

Within this section we first present the corporate finance theory that underpins our analysis, whereby we also define more precisely the elements of CoC and financing that we investigate. After this we formulate the eight potential effects, outlined in Fig. 1 according to project development stages.

2.1. Elements of costs of capital and financing

Cost of capital refers to the costs under which capital providers lend or invest debt or equity into a company or project (Pratt and Grabowski, 2014). The overall costs of capital, weighted by the shares and costs of debt and equity in overall financing, forms the weighted average costs of capital (WACC) (Brealey and Myers, 2002). Companies use the WACC in project valuation to discount cash flows and calculate Net Present Value (NPV) (Ross et al., 1993). A positive NPV indicates that projects generate internal rates of return (IRR) higher than the WACC, meaning they create value and companies should undertake them (Pratt and Grabowski, 2014; Titman and Martin, 2007). However, in practice companies only initiate projects whose expected IRR equals or surpasses an internally determined hurdle rate. This oftentimes exceeds the WACC, to filter through multiple IRR-positive investment opportunities due to capital constraints (Helms et al., 2015), or adjust for project specific risks that differ from the companies risk profile (Hürlimann and Bengoa, 2017). When hurdle rates are higher than the WACC, companies apply positive hurdle rate premiums. Because of strategic reasons - such as gaining an advantage in a new market - companies may also decrease hurdle rates and accept projects with negative hurdle rate premiums, whose expected IRR is lower than the WACC. Assuming debt obligations are fixed, under such conditions companies accept lower equity returns i.e they apply lower costs of equity, as illustrated in Fig. 2.

According to the Modigliani and Miller (1958) capital irrelevance theory, in perfect markets, companies are indifferent to financing projects through debt or equity. For example, increasing the debt share to benefit from lower cost of debt as compared to equity would be futile, as this would increase the cost of equity (due to increased equity risks) and perfectly balance the benefits of higher leverage. Therefore, under perfect market conditions, a company’s WACC should be constant. However, markets are subject to numerous imperfections, including taxation, financial distress costs, agency costs and asymmetric information (Berk and DeMarzo, 2018). Considering this, companies typically strive in practice to leverage their projects by maximising debt size, to lower their WACC. Recent surveys on costs of capital of onshore wind energy projects across the EU find shares of debt between 55% and 80% (Brückmann, 2018; Noothout et al., 2016; Tesniere et al., 2017), largely because debt minimises project costs, as it is cheaper than equity (Gruellos Alonso, 2015). Onshore and offshore wind investors increasingly employ debt through project financing (Wind Europe, 2019), where they create a financially and
Material and financial pre-qualifications such as planning permits, grid concessions from bidders investing into qualifying for the auction through obtaining scheme, bidders are not guaranteed support until winning a tender. This underscores the importance of material pre-qualifications as qualification risk.

2.2. Auctions could affect the cost and availability of project development capital

Auctions for renewable energy support have created new uncertainties during project development, which may affect the above outlined CoC and financing elements. In an auction based support scheme, bidders are not guaranteed support until winning a tender. This so called allocation risk increases the likelihood of sunk costs, arising from bidders investing into qualifying for the auction through obtaining material pre-qualifications such as planning permits, grid concessions etc. (Mora et al., 2017). Auctioneers also require bidders to satisfy financial pre-qualifications, by submitting bond collateral to demonstrate their financial capability (Kreiss et al., 2017). Most often these are bank guarantees and the auctioneers sometimes use them to enforce penalties, by retaining and drawing on them in case of project delay or non-realisation (Goysal and Kurgpold, 2016). While the auctioneer returns the bonds to unsuccessful bidders, banks may require bidders to submit cash collateral in exchange for issuing the guarantee, meaning the bidder may suffer a temporary decrease in liquidity. We define the risks of material and financial pre-qualifications as qualification risk.

Bidders might respond to allocation and qualification risk by adjusting their hurdle rates and equity returns in several ways, which we discuss below.

**Potential effect 1:** Allocation risk might impact hurdle rates and costs of equity in three ways. First, it might incline potential bidders to use higher hurdle rates in project valuation, in order to account for the sunk costs of failed bids (PE 1a). Second, the bidder might decrease hurdle rates to increase the probability of being awarded. Assuming that the company’s debt obligations towards external creditors are fixed, this would mean accepting a lower return on equity (PE 1b). Third, the bidder might decide not to enter the auction (PE 1c).

The literature related to the effect of allocation risk on cost of capital of renewable energy investments is scarce. While Hern et al. (2015) estimate the impacts of introducing auctions for Contracts for Difference in the UK, and conclude that a 50% probability of winning could translate into a hurdle rate mark-up of between 0.75% and 1.3%, we are unaware of other literature that directly relates to PE 1.

Material and financial pre-qualifications might impact the bidders similarly as allocation risk.

**Potential effect 2:** First, the bidder could incorporate the costs of qualifying into capital expenditures by increasing the cost of capital, and hence bid higher to maintain the hurdle rate level (PE 2a). Second, the bidder could maintain the bid level, and hence accept a lower hurdle rate (PE 2b). Third, the bidder could also decide not to enter the auction because of the qualification risk (PE 2c).

Larger actors are more likely to accept allocation and qualification risk, and adjust hurdle rates according to their strategy. The additional material and financial pre-qualifications might even improve their debt financing since they ensure the seriousness of their bids and prevent speculative bidding (Botta, 2019). However, smaller bidders like community energy groups are most likely to withdraw from auctions with strict prequalification’s, as they lack scale to bid multiple projects simultaneously and diversify away allocation risk (Grashof, 2019; Grashof and Dröschel, 2018; Lucas et al., 2017).

Auction volumes and frequencies might also impact project development capital. While auction based support mechanisms can create stability by enabling governments to control support costs (Mora et al., 2017), they are vulnerable to lack of long-term political commitment. Intermittent auction rounds decrease planning security, needed to develop solid project pipelines (Del Río and Linares, 2014), while endogenous reductions of auction volumes or reserve prices also decreases competition (Ehrhart et al., 2020).

**Potential effect 3:** Auction schemes with clearly defined auction round frequency, auction dates and auction volumes might have positive effects on cost of equity, cost of debt and debt terms through improving planning uncertainty, especially in previously unstable markets (PE 3a). However, sudden changes and lack of clear schedules could increase the cost and decrease availability of project development capital, and possibly increase market and industry-wide risk premiums (PE 3b).

2.3. Penalties could impact both financing conditions and equity returns

Depending on their design, penalties might impact project bankability or trigger similar effects as allocation and qualification risk. The auctioneer can implement penalties by reducing support level or duration, terminating the support contract, or excluding bidders from future rounds, and enforce them by retaining parts of the submitted bid bond (Gephart et al., 2017). Lower remuneration levels or duration could endanger the projects ability to meet DSCR requirements, while penalties where the auctioneer retains parts of the bid bond may create additional costs, affecting equity returns and hurdle rates in similar ways as described in potential effects 1 and 2. However, while penalties increase costs in case of completion failure, their occurrence is not directly linked to completion risk, as the latter depends on factors outside the scope of the penalty itself, for instance the permitting environment.

**Potential effect 4:** Penalties, where the auctioneer reduces support duration or level might affect the projects ability to repay banks loans and could ultimately lead to lower debt capacity and a higher WACC (PE 4a). Penalties that are implemented by retaining parts of the bid bond might increase hurdle rates, if the additional costs nudge the bidder to bid higher, or decrease them if the bidder reduces expected return on equity (PE 4b).
2.4. Auction competition could decrease equity and debt margins

As auctions create a highly competitive environment, the renewable energy industry is likely to transition into a state with lower margins. Companies often operate with positive hurdle rate premiums in situations of industry growth and financial health (Meier and Tarhan, 2007) - an environment resembling the RE industry prior the introduction of auctions. However, they might accept lower equity margins, when securing a strategic market position, and in situations of high competition (Driver and Temple, 2009). Furthermore, in auctions with long realisation deadlines and lenient penalties, the project’s option value (Dixit and Pindyck, 1994) might drive a bidder’s decision to bid aggressively (Matthias et al., 2019).

Potential effect 5: Faced with high auction competition, bidders might reduce equity return requirements (by reducing their hurdle rate), allowing them to become more competitive by bidding lower (PE 5).

Debt margins depend on many factors, including financing learning rates, which might have decreased them by 11%, for both onshore wind and solar PV, for every doubling of installed capacity (Egli et al., 2018). However, since banks compete for market share by decreasing lending interest rates (Leroy and Lucotte, 2015; Leuvensteijn et al., 2008, 2013), banking competition also plays a role.1 Auctions might have intensified this, as sponsors negotiate financing offers and select the one that decreases their CoC the most, although the European Central Banks (ECB) monetary policy since the 2008 financial crisis also played a critical role in decreasing lending interest rates (Claeys et al., 2015).

Potential effect 6: When bank competition is high and sponsors pressure banks to offer better terms to become more competitive in auctions, banks might respond by decreasing debt margins (PE 6).

2.5. Auctions could lower secured revenues and worsen project financing conditions

Policymakers usually introduce auctions along with market based remuneration schemes, which in combination with high auction competition might expose projects to large merchant and market risks, and deteriorate their project financing conditions. With sliding premiums where bidders retain excess revenues when the electricity price exceeds the bid level (Klobasa et al., 2013), low bids expose bidders to merchant risks of directly selling electricity on power markets. While they mitigate this through corporate Power Purchase Agreements, PPA contractors might be inaccessible in time of bidding, exposing the bidder to the market risk of acquiring one. Additionally, if the bidder contracts off-takers with a lower credit rating, banks might offer less favourable financing due to increased credit exposure. Fixed premiums that top-up the electricity price with a premium, expose RE producers fully to price fluctuations, and create similar market and merchant risks. Conversely, with Contracts for Difference (CfD) bidders receive a government-backed contracted price, therefore eliminating price risks. However, recent auctions for CDs also produced record low results (Woodman and Fitch-Roy, 2019), which may increase DSCR requirements due to lower revenue levels.

Potential effect 7: Auctions lead to projects with low levels of revenues from secured support payments and/or higher market risk exposure, leading to higher DSCR requirements. This could translate into lower debt sizes, higher WACC values and potentially shorter loan tenors (PE 7).

2.6. Auctions may cause a shift from project to balance sheet financing

Renewable energy sponsors can finance projects without banks, by employing their balance sheets directly. In such cases companies issue corporate bonds (Wind Europe, 2019) or use other capital sources, such as retained earnings to fund projects. However, balance sheet financing might be unavailable to smaller sponsors. Through using project financing, they overcome their size limitation, and incorporate projects into a separate SPV (Gatti, 2013). By not employing their balance sheet directly, renewable energy sponsors initiate projects despite existing debt, and overcome their debt overhang problem (Steffen, 2018). However, as banks provide loans only against projects’ assets and revenue streams, project financing might become less available in an environment with higher market and merchant risks.

Potential effect 8: The potential decrease in secured revenues, greater revenue volatility and exposure to less creditworthy off-takers, may worsen project financing loan conditions to an extent that forces sponsors to switch to balance sheet financing or find other risk sharing arrangements. This could especially happen in countries, where banks have little experience of dealing with market-based support instruments, or where high price risks prevail (PE 8).

3. Research design

To understand the effects of auctions on CoC and financing we conducted semi-structured and focus group interviews with stakeholders from onshore and offshore wind financing and project development. According to Patton (2015), both of these interview types enable the researcher to pre-define a research structure (as opposed to open-ended interviews), while allowing sufficient flexibility to explore new and unforeseen concepts. Moreover, focus groups enable cost effective data collection with more participants, and they facilitate a discussion between conflicting perspectives, which enhances the data quality.

Our study is based on an objectivist grounded theory approach (Su, 2018), which we conducted in five steps: i) we consulted corporate finance theory, and literature on auctions for renewable energy support. This was necessary to identify meaningful questions and effectively engage with the interviewees (Alvesson, 2012); ii) we conducted the first interview round, consisting of six semi structured interviews and one focus group with eight participants iii) based on this we validated early theoretical findings, restructured the questions to embrace new emerging themes and formulated the eight potential effects; iv) we then conducted the remaining interviews and focus groups, while asking questions targeted at the eight potential effects; iv) we finally coded the interviews to assess if the interviewees spoke in favour of or against the effects. To conclude if the interviews affirm a potential effect, we applied a threshold equalling at least 60% of the coded segments of that effect.

Altogether, the data comprises of 17 semi-structured interviews with 19 interview respondents, and four focus groups with 21 participants, which we conducted between March 2019 and February 2020. To enrich our data sample, we also participated in an offshore wind finance conference, and took extensive notes. We focused on stakeholders active in onshore and/or offshore wind. Although we limited our scope to EU 27 and UK, our data sample comprises one interview that mentions only North African experiences with auctions. We acquired the first six interviews based on the networks of the authors and the AURES2 project (AURES2, 2020), and the remaining ones through referrals or snowball sampling (Egli et al., 2018). Finally, we acquired the focus group participants with the help of Wind Europe, a wind energy industry association (Wind Europe, 2020). As can be seen in Table 1, our sample consists of 17 project developers, five bankers, three OEM representatives, and other interviewees (see Table 2 in Annex for a more detailed description). We acquired a broad group of interviewees because of the exploratory nature of our study, where we aimed to understand all possible effects of auctions on financing and CoC.

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1 Leroy and Lucotte (2015) measure bank competition through the Lerner Index that measures competition as the price-cost margin where 0 indicates perfect competition (prices equal costs) (Lerner, 1934), while Leuvensteijn et al. (2008) and Leuvensteijn et al. (2013) apply the Boone Indicator, where “more efficient firms (that is, firms with lower marginal costs) will gain higher market shares or profits, and this effect will be stronger the heavier competition in that market is”. Therefore unlike the Herfindahl-Hirschman Index (HHI) that is used to measure concentration in the banking industry (Yipuric et al., 2002), the measures that we refer to focus on efficiency and the price-cost margin.
4. Results

We display co-occurrences between potential effects and assigned categories in Fig. 4 and characterise the results by counting the number of coded segments \( (n) \), and interviewees \( (i_p) \) that affirm or deny the effects or their 2nd Order Themes. Moreover, our results confirm that auctions might increase planning risks and affect corporate financing of project pipelines. A number of onshore developers and bankers expressed this view, mainly because of fluctuations in average awarded bids, and endogenous rationing of auction volumes and reserve prices (PE 3b). Nonetheless, since auctions enable governments to control support costs, our interviewees also confirm that their introduction might positively affect financing, especially in countries that have a history of retroactive policy changes (PE 3a).

The results confirm the connection between auction competition and the pressure among sponsors and banks to reduce their equity and debt margins (PE 5 and PE 6), while our interviewees contradict regarding the effect of auctions on revenues (PE 7). Although some ascribe a decrease in secured revenues and larger revenue volatility to auctioned sliding premiums, others argue that auctions do not affect financing conditions, and instead connect the increased price risk only to remuneration scheme designs. Finally, the interviewees dismiss the connection between financing types and auctions. For instance, within offshore wind, corporate practices dominate the choice of financing type, and developers adjust financing structures on a project basis, irrelevant of the auctions (PE 8).

We summarise the findings in Fig. 5 where we divide the potential effects according to their subsections. We proceed by discussing each potential effect in order in which we outlined them in Section 2. Additionally, for each effect we present a code co-occurrence model (Kuckartz and Radiker, 2019), which records the frequency of the links between each 2nd order theme, the potential effects and whether or not these links are affirmative (green) or denying (red).

4.1. PE 1: Allocation risk mainly impact bidders decision to participate in auctions

A total of 11 interviewees confirmed 27 times the effect of allocation risk on hindering bidders from participating in auctions (PE 1c), making it the most significant auction-related source of risk, especially for

<table>
<thead>
<tr>
<th>Table 1</th>
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<tbody>
<tr>
<td>Brief description of interviewees.</td>
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<tr>
<td>Interviewee type</td>
</tr>
<tr>
<td>Project developer</td>
</tr>
<tr>
<td>Banker</td>
</tr>
<tr>
<td>OEM</td>
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<tr>
<td>Insurance provider</td>
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<tr>
<td>Government organisation</td>
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<tr>
<td>Legal expert</td>
</tr>
<tr>
<td>Consultant</td>
</tr>
<tr>
<td>Association representative</td>
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<tr>
<td>Academic</td>
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</table>

We asked the interviewees broad questions related to the change in financing conditions and CoC due to the shift to auctioning, and to comment if any auction design in specific affected their investment risk more than the others. As our interviewees have experiences with diverse auction schemes, we asked them to comment on auction designs within a specific country and technology context. This enabled us to compare the effects within different schemes and draw general conclusions (see Annex for more details).

We conducted the semi-structured interviews in English under Chatham House Rules, over the phone or in person, while we held three focus groups in person and one via online conference. Each semi-structured interview lasted between 45 to 60 min, while each focus group lasted for at least 60 min. With the permission of the interviewees, we recorded the semi-structured interviews, with the exception of two where the interviewee declined recording, and one where the recording equipment failed. We transcribed verbatim the recorded interviews, while the data from the unrecorded ones comprise of notes. We did not record the focus group interviews. Instead, at least two persons moderated each group, where one moderated the discussion, while the other took notes. We formed the interviewee groups randomly. In addition, we used a visual aid to stimulate the discussion, which comprised of a chart with project development stages and risk scales, ranging from “large worsening” to “large improvement”. Each moderator asked the participants to evaluate and explain if at any project development stage, an auction design affected their investment risk, in comparison to project development within a non-auction based support scheme (see Fig. 14 in Appendix for a visual summary of the results). Afterwards, we developed one results summary, which we circulated to the interviewees for verification. We treated the focus group results as one interview transcript during data analysis.

We coded the interview transcripts and notes using MaxQDA 2020 in three rounds. First we conducted a lexical search of the transcripts using pre-defined search strings, to identify the broad thematic areas of our research. We then proceeded by allocating first order codes, however we did not strictly apply open coding, as suggested in Gioia et al. (2013), since this would have substantially increased the complexity of our codebook. Second, we assigned the codes to one of the eight potential effects and developed code theory models (Kuckartz and Radiker, 2019) to group the first order codes into sub-findings or 2nd order themes. Third, we then assigned the 2nd order themes additional categories to distinguish if the interviewees’ answers could affirm or deny a potential effect, along with other codes indicating the actor type, size and technology (see Fig. 15 to Fig. 17 in the Appendix, and the supplementary material for more details). Therefore, unlike a traditional statistical analysis, our results indicate to a direction of the answers, rather than confirm or reject hypothesis. We summarise this process in Fig. 3, and provide a detailed example of this in the Annex and supplementary materials.
community energy organisations ($n_i = 14.5$). Our interviewees, including both onshore and offshore actors, stress the importance of diversification, through developing multiple projects, in mitigating allocation risk ($n_i = 7.4$). As one renewable energy cooperative association representative commented:

“If you invest one hundred thousand euros for the planning and project development of a wind turbine and you only have one or two wind turbines to go into the tender. That is an “all in” like in a casino. You can’t share risk!”

Our findings imply that allocation risk primarily depends on bidder size. A banker comments that larger project developers have more diverse cash inflows coming from ownership of projects, O&M contracts and project sales – therefore, they are more resilient to potential losses, and more able to diversify their project portfolio. Larger actors also benefit from network effects – for instance an offshore developer comments that OEMs choose between actors they perceive have a higher chance of winning, and only engage with them in negotiations. However, as shown in Fig. 6, our interviews did not record any findings regarding the effect of allocation risk on hurdle rate setting (PE 1a, PE 1b).

4.2. PE2: Qualification risk could impact both larger and smaller bidders

Our interviewees mainly confirm that bid bonds could hinder smaller onshore wind developers and community energy groups in submitting bids (PE 2c). An OEM interviewee explains that sometimes his company helps smaller developers submit the bid bond:

“[…] the bank only gives this bid bond against the company risk of the developer or the sponsor and this is sometimes really difficult for small developers. They have 1 or 2 projects, they have a very cyclical business so they usually do not have the credit lines to give this bid bond so either they have to provide cash collateral […] or as I said they find a partner helping them with this bid bond”

On the opposite side, offshore project developers in our sample largely agree that financial pre-qualifications are needed to reduce frivolous bids, and commit bidders to realise the projects ($n_i = 8.3$) – therefore they are not an obstacle. In the words of an offshore developer:

“For offshore wind you do want a threshold. Smaller players are not the most qualified to do these large projects. And having a threshold like this to test the seriousness is a good thing.”

Permitting regimes might also hinder potential bidders from bidding (PE 2c). For instance, in case of UK offshore wind auctions the bidder needs to spend “tens of millions of EUR” while in the Netherlands the government develops the site, and the bidder invests only “a million euro or two”, leading to a “massive difference”. Similarly as for PE 1, our interviews did not record any findings regarding the link between qualification risk and hurdle rate adjustment (PE 2b, PE 2c), as indicated in Fig. 7.

4.3. PE3: Auctions have both a positive and negative effect on planning risk

Our findings confirm that auctions affect planning risk both positively and negatively. According to a banker, the substitution of price-based support schemes with auctions could positively impact costs of debt, because it reduces overcompensation risk and improves financial sustainability (PE 3a). As the interviewee points out in regards to an unstable country with a feed in tariff system:

“… if we have another project on a feed in tariff which isn’t part of our existing timeline you could think of our cost of debt as being basically infinite because we simply won’t do it […] but for a new project under a sound auction scheme, we’re back in business …”

However, the effect of auctions on stability mainly depends on the auctionee discipline in adhering to announced designs (PE 3b). Another banker illustrates this through a French example where the auctioneer decreased reserve prices after an onshore wind auction, to decrease the average awarded price:

“… in France what happened last time, the responsible Minister was just rejecting certain projects from the auction, because according to the law, that actually stipulated the regulation of the auction system, he has the right to do so …”

Auctions, in which the average awarded price fluctuates, might also affect stability negatively (PE 3b). Five interviewees and our focus groups - among them experts who are mainly active in onshore wind in Germany - shared this view. They stressed that award price fluctuations have a large impact on project pipeline planning and development, because average award prices might differ though time i.e. they could be high when project development starts, but low when the project is finally ready for participating in an auction. Therefore, our interviewees have validated both aspects of PE3, as shown in Fig. 8.

4.4. PE4: Penalties mostly have no effect on financing

On the question of penalties, an offshore developer explains that a reduction in support level or duration would decrease the projects expected returns, but it would not significantly impact its bankability (PE 4a). Furthermore, penalties in offshore wind could only have an effect if they are “cliff edge”, meaning that the auctioneer cancels the support contract in case of missing the initially agreed realisation period. Otherwise, gradual penalties do not seem to have a large impact (PE 4a, PE 4b). However in case of onshore wind, factors that are outside the auction design such as lawsuits increase the chances of breaching realisation timelines ($n_i = 5.3$), and therefore increase non-compliance risk. Overall, our interviewees did not confirm either PE4a or PE4b, as depicted in Fig. 9.

4.5. PE5: Auctions affect equity margin reduction, mainly in offshore wind

Our interviewees indicate that a number of reasons including country risk, large capital liquidity and lack of investable projects, affect equity margins. For instance, a banker comments that projects in Italy have a 1–1.5% higher equity return than in Germany, only because of higher country risk. Further, an OEM representative comments that large capital liquidity and low interest rates, combined with a lack of investable projects, are incentivising large institutional investors to
Fig. 4. Summary of the categorisation of the coded segment including segments from the semi structured and focus group interviews. Top row: assigned categories. Leftmost column: potential effects, divided where applicable into their sub-effects. Each number represents the number of coded segments per each category and per each potential effect and sub-effect.
Fig. 5. Summary of findings divided as per subsections of each individual Potential Effect. Here an effect is considered as confirmed if at least 60% of its coded segment are affirmative.

<table>
<thead>
<tr>
<th>Potential Effect</th>
<th>Affirm</th>
<th>Deny</th>
<th>Partially affirm</th>
</tr>
</thead>
<tbody>
<tr>
<td>PE 1A: Bidders use higher hurdle rates to account for sunk costs of failed bids</td>
<td>0 (-%)</td>
<td>0 (-%)</td>
<td>n/a</td>
</tr>
<tr>
<td>PE 1B: Bidder might decrease hurdle rates to increase probability of being awarded</td>
<td>0 (-%)</td>
<td>0 (-%)</td>
<td>n/a</td>
</tr>
<tr>
<td>PE 1C: Bidder might decide not to enter the auction</td>
<td>27 (96%)</td>
<td>1 (4%)</td>
<td>Affirm</td>
</tr>
<tr>
<td>PE 2A: Bidders incorporate the costs of qualifying by adjusting hurdle rate upwards and bidding higher</td>
<td>0 (-%)</td>
<td>0 (-%)</td>
<td>n/a</td>
</tr>
<tr>
<td>PE 2B: Bidders incorporate the costs of qualifying by maintaining bid level and accepting a lower hurdle rate</td>
<td>0 (-%)</td>
<td>0 (-%)</td>
<td>n/a</td>
</tr>
<tr>
<td>PE 2C: Bidder might decide not to enter the auction</td>
<td>18 (62%)</td>
<td>11 (38%)</td>
<td>Affirm</td>
</tr>
<tr>
<td>PE 3A: Auction schemes with clear volumes and frequency positively affect debt and equity financing</td>
<td>15 (79%)</td>
<td>4 (21%)</td>
<td>Affirm</td>
</tr>
<tr>
<td>PE 3B: Sudden changes and lack of schedule increase costs of financing and industry wide risk premiums</td>
<td>14 (88%)</td>
<td>2 (12%)</td>
<td>Affirm</td>
</tr>
<tr>
<td>PE 4A: Support level and duration reduction penalties negatively affect debt financing</td>
<td>0 (0%)</td>
<td>4 (100%)</td>
<td>Deny</td>
</tr>
<tr>
<td>PE 4B: Bid bond retention penalties might affect hurdle rate adjustment</td>
<td>0 (0%)</td>
<td>2 (100%)</td>
<td>Deny</td>
</tr>
<tr>
<td>PE 5: Auctions might induce bidders to reduce equity margins</td>
<td>10 (58%)</td>
<td>7 (42%)</td>
<td>Partially affirm</td>
</tr>
<tr>
<td>PE 6: Auctions might induce banks to reduce their debt margins</td>
<td>11 (73%)</td>
<td>4 (17%)</td>
<td>Affirm</td>
</tr>
<tr>
<td>PE 7: Auctions could lower secured revenues and worsen financing</td>
<td>33 (60%)</td>
<td>22 (40%)</td>
<td>Affirm</td>
</tr>
<tr>
<td>PE 8: Auctions may cause a shift from project to balance sheet fin.</td>
<td>2 (11%)</td>
<td>16 (89%)</td>
<td>Deny</td>
</tr>
</tbody>
</table>

Fig. 6. Potential Effect 1 code co-occurrence model. Left – the potential effect. Middle – 2nd order themes. Right – affirmative or denying coded segments. Green lines – indicate to coded segments that have been grouped into 2nd order themes and which affirm the potential effect. Red lines – indicate to coded segments that have been grouped into 2nd order themes and which deny the potential effect. The thickness of the lines and the number allocated to each line, indicate the frequency r of coded segments. For instance, the 2nd order theme “Risk of getting awarded increased by auctions” has 14 affirmative and 1 denning coded segment that together make 15 segments that link to the potential effect. Note: same explanation holds for Figs. 7-13. (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)
decrease their equity returns for onshore wind projects. Nevertheless, our interviewees also stress the importance of competition \((n, i_p = 7.3)\), especially in offshore wind auctions. An offshore developer comments on the downward pressure of auctions on equity margins:

“you don’t have a choice when you are in an auction scenario because at the end of the day the biggest determinant of your price […] is the return you require on your equity. And so if you want to win you need to lower it.”

An onshore developer also argues that the auction price pressure may incentivise investors to decrease their hurdle rates closer to their objective costs of capital. Therefore they argue auctions play a revealing role. Overall our interviewees only partially affirmed Potential Effect 5, as shown in Fig. 10.

4.6. PE6: Auction induced competition contributes to debt margin reduction

Our findings indicate that financing terms have improved for wind
Two bankers and one offshore developer stressed that debt margins in Germany decreased between 20 and 30 basis points, while DSCR requirements for offshore wind decreased from around 1.40 to 1.25. The ECB’s monetary policy played an important role in the decrease.

When asked about wind energy related reasons, an offshore developer also named increasing technology learning rates in the financial industry, larger investment “ticket sizes” and auctions as considerable factors driving the decrease. An offshore project developer and former banker, explains banks have accepted that today’s projects have lower remuneration levels, and they adapted by charging lower interest margins. Further, the interviewee explains a dynamic where bankers “deep dive” into offshore wind risk faster than before, to help their clients win tenders. According to another offshore developer, sponsors also pressure banks to offer better terms:

*Sponsors […] are pushing them to do more. But the banks are responding because they realize that their choice is to do that or to do no deals. So the auction is quite binary for everybody. It’s either participate in the auction competitively or you don’t do anything […] everybody now knows we’ve got to work harder and take a bit more risk to try and do business.*

Therefore the interviewees mostly affirmed PE 6, as indicated in Fig. 11.

### 4.7. PE 7: Decrease in secured revenues and increase in revenue volatility

On the connection between auctions, lower secured revenue, and increase in revenue volatility, this study finds contradictory results, with 33 affirmatory and 22 denying coded segments from 15 participants. Our interviewees affirm that auctions could lower secured revenues and increase revenue volatility, and mainly connect this to sliding premiums that incentivise underbidding by enabling bidders to retain excess revenues when the electricity price exceeds their bid level \((n, L_p = 14.8)\). Both onshore and offshore project developers, and bankers in our sample clearly prefer financing projects under a CfD scheme, as opposed to sliding or fixed premiums \((n, L_p = 12.7)\). As one offshore developer points out regarding the increase in merchant revenues:
Absolutely! [...] certain companies were just saying to the authorities “well look rather than bidding at let’s say 25 EUR/MWh, when the market price is at 30 EUR/MWh, I’d rather have the right to develop this project and take the price risk myself. So I don’t want a subsidy” [...] but the guy that’s bidding at 35 gets certainty on his revenue [...] of course they (auctions) introduce more risk because now you’re bidding at 0, [...] the result of this auction is now, the subsidy regimes have been pulled to the ground.”

Low bid levels in effect do not necessarily lead to merchant price exposure, if e.g. a corporate PPA is concluded for the project. However, our results indicate that auctions still increase offtaker risks. An offshore developer explains that most corporates typically have lower credit ratings than government offtakers in Western and Northern European markets and as a result, banks might offer less favourable financing. Moreover, he explains that the corporate PPA market is not “deep enough” as “there aren’t that many companies that are so intensive in their electricity consumption that they can buy huge amount of power over a long period of time”.

In contrast, several interviewees do not connect auctions with worse financing conditions and higher WACC. Instead, they negate the role of auctions and stress that only remuneration schemes cause additional price risk (n.i_p = 13.9). They argue that banks do not differentiate between support awarded through an auction or other allocation mechanism.

### 4.8. PE8: Auctions do not affect choice of financing type

This study has been unable to demonstrate that auctions affect financing types (affirmatory = 2, denying = 16). Our interviewees state that they neither cause offshore (n.i_p = 4.3) nor onshore project developers (n.i_p = 2.2) to shift between project and balance sheet financing.
For offshore wind sponsors, the connection between financing type and auctions seems to be irrelevant, since such projects typically achieve financial close around 2 years after support allocation (Pineda et al., 2020) or even longer; for example the 900 MW He Dreiht project has 6 years from award to financial close (Cremer, 2019). Further, large scale bidders like utilities choose between financing types on a project-by-project basis (n,p = 3.3), while in most cases even the companies that finance project development and construction off their balance sheet, refinance projects with debt during operation stage. An onshore wind developer also confirms that companies keep to their traditional way of doing business, for instance smaller developers that are short of liquidity will continue using project financing.

5. Discussion

Our findings affirm that price risk increased in auction-based support schemes that expose sponsors to volatile power prices, including sliding and fixed premiums (PE 7). In that regard, our study is in alignment with Egli (2020). Surprisingly, we find that despite the increase in price risk, financing conditions seem to have improved. Banks have decreased their debt margins (PE 6) but also increased debt size, lowered DSCR requirements and increased loan duration, especially for offshore wind projects. While other external effects including the European Central Banks’s expansionary monetary policy and financing learning curves might explain this (Egli et al., 2018), we find that auction competition also plays a role, specifically through the pressure from sponsors to negotiate better financing.

The competitive nature of auctions also seems to have reduced hurdle rates, as bidders decrease their costs of capital to remain price competitive (PE 5). In auctions with high competition, bidders might bid aggressively because of the project’s option value or in anticipation of technology cost decrease, better financing conditions and optimistic electricity price projections. On the other hand, when competition is low, bidders may be inclined to increase hurdle rates to maximise their equity returns and/or recover sunk costs as reported by Hern et al. (2015). This would explain why the under subscribed German onshore auctions attracted bids at the ceiling price (Sach et al., 2019).

Therefore, our findings suggest auctions have nudged the industry into accepting higher risks and lower returns, therefore creating a risk-return misalignment – however, this is a hypothesis that should be verified by further research. The low margins might also affect technical quality and reliability of projects (Balfour, 2017). While auctions help policymakers to cost-effectively achieve climate and energy targets, the low margin environment they create endangers other goals including maintaining of actor diversity. For these reasons, it could be beneficial to establish additional revenue stabilisation and to reduce additional risk as much as possible, for instance through a floor and ceiling price (see for example Kitzing and Breitschopf, 2019; Wind Europe, 2018).

Our results confirm the general view that systematic auction round scheduling with well-defined volumes and frequencies facilitate long term planning for bidders (PE 3a), as e.g. expressed in IRENA and CEM (2015). However, fixed auction schedules where the policy maker does not have the ability to respond to changes in project supply, could in the short term lead to fluctuations in average awarded prices, for instance like in German onshore auctions where the average awarded price first decreased 38 EUR/MWh in May 2017, and then increased to the ceiling level of 62 EUR/MWh in October 2018, and remained there ever since (Sach et al., 2019). Our interviewees commented that reduced clarity regarding future offtake prices creates uncertainty in project development (especially during low price periods), by preventing developers and bankers from assessing the expected future offtake price, and therefore the feasibility of projects in the development pipeline. According to our interviewees this negatively affects corporate financing of project development (PE 3b). While policymakers could respond to changing market conditions through endogenously adjusting auction volumes or ceiling prices, this could damage the reliability and trustworthiness of the auctioneer and decrease competition further (Hanke and Tiedemann, 2020).

While auction price competitiveness may incline bidders to adjust their hurdle rates (PE 5), we find no evidence that allocation risk of qualification risk affect hurdle rate adjustment (PE 1a, PE 1b, PE 2a, PE 2b). Allocation risk and qualification risk could mainly affect a potential bidders decision to participate (PE 1c, PE 2c), indicating that strict designs such as costly financial and material pre-qualifications could primarily decrease participation rates. This could change the ownership structure of renewable energy projects, where smaller developers avoid allocation risk by selling projects before the auction, and community energy groups either enter co-ownership arrangements with developers or avoid allocation risk by refraining from bidding. This validates earlier findings regarding the negative effects of auctions on citizen participation (Grafshof, 2019; Grafshof and Dröschel, 2018; Lucas et al., 2017).

Our interviewees denied the proposition that auctions cause project sponsors to shift between project and balance sheet financing (PE 8). While we acknowledge the result, we also wonder if this finding might have been influenced by the project experience of our interviewees being predominantly in Northern and Western European markets. The effect might differ in countries where banks are not accustomed to financing projects that have less predictable revenues, for example in South-Eastern Europe, where electricity markets are just being established (IRENA, 2019a). In such markets, it is more likely that banks might shield themselves against credit risk, e.g. by denying non-recourse financing arrangements, thus making balance sheet financing and
collaterals more prevalent. This remains a topic for future research.

6. Conclusion and policy implications

This study aimed to determine the impacts of auctions for renewable energy support on costs of capital and financing conditions, by eliciting and analysing information from semi-structured and focus group interviews with onshore and offshore wind project developers, bankers and financing experts.

First, our results from stakeholder interviews suggest that despite the increase in risk that coincided with the introduction of auctions, financing conditions seem to have improved, especially for offshore investments. The price pressure that auction competition creates seems to play a key role, where project sponsors (the winners of the auction bids) may pressure banks to offer better terms, who respond due to increasing competition in the banking industry in regard to financing the green transition. We have found indication that, simultaneously, bidders reduce their hurdle rates. Second, remuneration scheme designs appear to drive price risk the most, where in combination with high competition and very low auction prices they expose bidders to greater merchant risks, which may worsen financing conditions. Third, pre-qualification requirements and allocation risk seem to mainly effect the bidders’ decision to participate in an auction and we could not determine an effect on cost of equity or hurdle rates, due to lack of relevant interview responses.

Fourth, stakeholders emphasised that auctions can decrease planning risk when a long term auction roll out schedule is created and predictability regarding expected support costs exists. This positively effects risk perception of debt providers, especially in markets that had previously experienced retroactive policy changes. However, auctions could increase planning uncertainty in case of large fluctuations in average award prizes, or in case of designs that aim to increase competition through endogenous rationing. Such instabilities may worsen access to project development capital. Finally, we find no evidence that auctions have impacted the choice of financing type.

While acknowledging that we are drawing upon a limited number of interviews and idiosyncratic empirics, some of the insights derived above are general enough to indicate to several potential courses of policy action that can help creating a low-risk auction environment: First, combining auctions with remuneration schemes that stabilise revenues could create a better balance between risk and return, while simultaneously increasing debt capacity and reducing WACC. Replacing a fixed or sliding premium with a Cfd could ensure revenue predictability and better financing, especially in highly competitive offshore wind auctions. Such schemes disincentivise bidding on electricity price expectations, and decouple revenues from power price volatility, thus making projects more resilient to merchant, market and credit risks. Second, whereas support schemes such as feed-in-tariffs controlled prices, auctions control quantities of procured project capacity. Changes in the supply of projects submitted into the auction, leads to fluctuations in average awarded prices, and may create undesired financial consequences, like worsening of conditions for project development loans. Our findings indicate that policymakers should not respond to short term changes in project supply by endogenously changing auction volumes and ceiling prices, as this could further worsen access to capital. Third, policymakers should target measures to de-risk auction designs in the project development stage, mainly as means of reducing participation hurdles, for instance for community energy groups.

Our analysis is limited in several ways. We draw conclusions from a limited number of interviews based on a selected number of countries. Such conclusions are never fully conclusive, but they enrich our understanding of certain complex issues, and can be used (together with other studies) to further our understanding of the subject. Furthermore, the study deals with onshore and offshore wind only, whereas it does not investigate the effects on other renewable technologies supported by the same auction mechanisms. Understanding the differences in effects between technologies could help policymakers design effective multi-technology auctions. In regard to auction designs, our study does not cover the effects of award criteria and pricing rules. These may impact bidder behaviour and bid levels, and hence revenues and financing. Finally, further research is needed to quantify the impacts of auction designs on costs of capital and financing, and to establish firm cause-effect relations. Such efforts could further help design auctions that ensure a low-risk investment environment, which we see as an enabler for a comprehensive and rapid energy transition.

Data availability

The data that has been used is confidential.

CRediT authorship contribution statement

M. Dukan: Conceptualization, Methodology, Investigation, Writing – original draft, Writing – review & editing, Visualization. Lena Kitzing: Conceptualization, Methodology, Investigation, Writing – original draft, Writing – review & editing, Supervision, Funding acquisition.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.enpol.2021.112197. This includes a code-theory model that we use to derive second order concepts.
Annex.

8.1. List of interviewees

Table 2
List of interviewees according to interview type, interviewee type, country, technology type and size

<table>
<thead>
<tr>
<th>ID</th>
<th>Interview type</th>
<th>Actor type</th>
<th>Organisation</th>
<th>Position</th>
<th>Country</th>
<th>Technology</th>
<th>Actor size</th>
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<td>Project developer</td>
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<td>Swiss university</td>
<td>Research assistant</td>
<td>CH</td>
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</table>

8.2. Semi structured Interview questions

1. What technologies does your organization invest in? In which countries are you active? Have you invested in projects that were awarded support through auctioning?
2. How do you typically finance the following individual project phases?
   - Development (permitting procedures and studies) > pre financial close
   - Construction > pre commercial operation date
   - Operation
3. How did financing conditions change because of the shift from administrative support schemes to auctioning? Why have these changes occurred?
   - Cost of capital
     - Cost of debt
     - Cost of equity
     - Debt to equity ratio
     - Weighted Average Cost of Capital (WACC)
   - Loan conditions
     - Debt Service Coverage Ratio (DSCR)
     - Loan tenor
   - Financing type
     - Project vs. balance sheet financing
     - Should we consider any other financing indicators or aspects (for instance syndicated lending)?
4. Are there any auction design elements that affect your investment risk? And if yes, could you please describe their effect?

5. Has the introduction of auctions for renewable energy support caused any other market-level changes that directly or indirectly affect financing conditions?
   - Sustainability of support scheme
   - Debt and equity margin changes
   - Effects on actor diversity
   - Cyclical market behaviour

6. Could you give us your overall opinion of the main effects of auctions on financing for renewable energy projects?

8.3. Focus group visual aid and brief clarification of process

**ALL GROUPS**

**How does an auction-based support allocation scheme impact financing conditions in comparison with a non-auctioned fixed remuneration scheme – e.g. FIT?**

![Diagram showing the impact of auction-based support allocation scheme](image)

- **Main effects**: UK permitting regime for offshore wind
- **Main effects**: Bid bonds and permitting risk (especially in DE for onshore wind)
- **Main effects**: One-sided CER risk due to unascertained revenue stream (e.g., example in Germany)
- **Main effects**: Two-sided CER and more secure perceived revenue stream (like in UK)

<table>
<thead>
<tr>
<th>Impact on financing conditions</th>
<th>AUCTION</th>
<th>Financial close</th>
<th>Commercial operation date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Large worsening</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Moderate worsening</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Slight worsening</td>
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<tr>
<td>Benchmark</td>
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<tr>
<td>Slight improvement</td>
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<td>Moderate improvement</td>
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<tr>
<td>Large improvement</td>
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</tr>
</tbody>
</table>

- **Main effects**: CENTRAL PERMITTING IN NL (and it DE in future) for offshore wind systems
- **Side note**: Many participants also saw no change in comparison to FIT

**Key terms:**
- Project developer
- Banker / debt provider
- Equity investor
- Other
Fig. 14. Graphical aid used during focus groups and results summary for all groups. The differently coloured dots represent different actor types, while the dot represents the interviewees’ evaluation of the change in costs of capital and financing in comparison to a support scheme without auctions.
- Each focus group was given a conference poster size print out containing 1) the headline question “How does an auction based support allocation scheme impact financing conditions in comparison with a non-auctioned fixed remuneration scheme – e.g FIT?, 2) project development stages and 3) a scale consisting of categories that range from “large worsening” to “large improvement” and in relation to the impact on financing
- The interviewees were then asked to mark with a coloured dot - where different colours indicated the types of actor they consider themselves – each project development stage
- Following this they were asked to explain their choice

8.4. Example of the process of obtaining 2nd order themes from first order concepts

Fig. 15. First order concepts related to the effect of bid bonds. Each row represents a first order concept, while the numbers in the image indicate the number of times we used the concept in an interviews. Each column represents one interview, which has been anonymised due to confidentiality. From there onwards we compress the first order concepts into second order themes, as shown in Fig. 16

Fig. 16. Second order themes related to the effect of bid bonds. Similarly to Fig. 15, the 2nd order themes are in the rows while individual interviews are grouped into columns. Again the numbers show the number of times a 2nd order concept was used while coding an interview transcript. As can be seen, the number of 2nd order themes is much smaller than the 1st order concepts. We derived the 2nd order themes through developing code theory models. We present the code theory model for the effect of bid bonds in the supplementary materials, and show how we further treat the data in Fig. 17.

Fig. 17. Code relations browser for the second order themes related to the effects of bid bonds. Unlike in the previous two Figures, the columns contain the categories that we assigned to the 2nd order themes in third step of our coding process. These categories include: offshore wind, onshore wind, small sized actor, large sized actor, medium sized actor, banker, project developer, other actor, very negative, negative, neutral, positive and very positive. Each number indicates the number of times we have assigned each of these categories to one of the 2nd order themes.

References


