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Options for the auction of wind farm site permits in the IJmuiden Ver wind area (sites I – IV)

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This note sets out options for the use of an auction mechanism for the assignment of permits for the construction and operation of wind farms in the offshore wind area IJmuiden Ver (IJVER), sites I – IV, and for future assignments more generally.

It builds on a report prepared in 2018 by NERA that develops auction format recommendations for the assignment of a single permit or two permits. For these assignments, NERA recommends a multi-round ascending auction (MRA) format. Given that permits for four if the six IJVER sites will be included in this assignment (with future assignments also likely to include more than two permits) and that there are clear benefits to auctioning permits simultaneously, we have been asked to consider how the NERA recommendations may need to be adjusted when auctioning more than two permits.

Importance of synergies

As the NERA report already indicates, a key issue when awarding multiple permits is the potential for synergies across sites. Where such synergies exist, the auction format should allow bidders to take these into account when placing their bids. NERA addresses this issue in their recommended design for a two-permit auction by allowing for the withdrawal of a provisionally winning bid for a single permit in the case where a bidder who has been bidding on both permits wishes to leave the bidding process without winning a single permit. However, with more than two permits in play, and potential synergies across more than two sites, adjustments to the auction design would need to be made.

We understand that some, though not necessarily all, prospective operators of wind farms are likely to enjoy synergies across multiples sites, arising, for example, from construction and maintenance cost savings and ecological synergies from co-designing adjacent sites. The magnitude of these synergies and whether they extend across two, three or all four sites, however, is not known with certainty and may in any case vary across prospective operators.

The benefit of using an auction is that the auctioneer does not need to have detailed information about synergies to achieve an efficient outcome. Provided that the auction design allows bidders to reflect in their bids any synergies they would enjoy from acquiring multiple sites, an efficient outcome that takes

account of such synergies should emerge from the bidding process.

For the avoidance of doubt, because of the potential for such synergies whose precise nature is unknown, and which might vary across potential users, we advise against the use of a mixed process in which some permits are assigned through a comparative selection process and the remainder are offered for auction. To produce an efficient outcome through a comparative selection process would require detailed knowledge of the nature of these synergies for all prospective users. This is not available at the requisite level of detail and certainty. Moreover, in the case of a mixed award, any synergies across permits offered in the auction and permits offered in the comparative award would distort bidding in the auction. If the auction were run before the comparative selection process, bidders would need to bid without knowing whether (and how many) permits they might be assigned in the comparative selection process. Conversely, if the auction were run after the comparative selection process, some bidders would be advantaged by having already obtained permits in such a process, and others disadvantaged by having failed to do so. Such distortions would also affect the comparative selection process.

In terms of designing an appropriate auction for the assignment of multiple permits in the presence of moderate synergies, we consider small adjustments to the design proposed by NERA. Specifically, we believe that rather than designating standing high (provisionally winning) bidders at the end of each round and permitting withdrawals under certain conditions, it would be simpler to use a straightforward clock auction that does not use the notion of provisionally winning bids. Under this format, bidding would proceed over several clock rounds:

- in each round, the auctioneer announces a price for each permit (the 'round price');
- bidders can then bid for the different permits at the round price (simply indicating, for each permit, whether they want to acquire the permit at the round price), subject to an activity rule which requires that the number of permits on which a bidder places a bid must not increase from round to round;
- if any of the permits receives bids from more than one bidder in that round, then there will be a further round, with the round price of permits that have received multiple

bids increasing and the round prices of other permits remaining unchanged; and

- if none of the permits receive more than one bid in that round, then the bids submitted in that round become winning bids for the corresponding permits (at the round price).

If any of the permits remains unassigned after the clock rounds, a follow-up round is run, in which bidders can bid for these permits. In their bids, bidders can specify the price they are willing to pay for these permits, subject to the requirement that the price cannot be lower than the round price of the permit in the last round in which any of the bidders could have bid for the permit in addition to the permits it has been assigned at the final clock price without violating the activity rule. The highest bid on each these permits will then also become winning bids (at the price specified in the bid).

This design is a minor variation of the NERA proposal. It is suitable for offering multiple (two or more) permits subject to potential synergies in a single award. The follow-up round deals with permits that would otherwise remain unassigned (which could also happen under the NERA proposal if a provisionally winning bid were withdrawn).

This auction design should work well unless synergies are so strong that the efficient assignment would require rejecting bids made in the final clock round to give the corresponding permits to other bidders in combination with permits that would have remained unsold at the end of the clock rounds).

Iterative package auction as an alternative in the case of very strong synergies

However, if synergies are very strong, it may be more appropriate to use a fully combinatorial format. In this case we would suggest an alternative multi-round auction format in which:

- the auctioneer announces a round price for each possible combination of permits;
- bidders make one or more bids for the combination(s) of permits they would be happy to acquire at the round prices;
- the auctioneer determines a provisionally winning combination of bids, by finding the combination of bids with maximum value that can be accommodated, taking at

most one bid from each bidder (with ties broken according to a well-specified tie-breaking rule[1]);

- the price of combinations that received new bids increases; provisionally winning bids are automatically carried over to the next round;
- bidding ends when there are no new bids.

This iterative package bidding design is more flexible but also potentially more complex than the clock auction design, with which stakeholders should be reasonably familiar given that it is only a minor modification of the format proposed by NERA.

Recommendation: run consultation with clock auction as the leading option and iterative package auction as an alternative

On this basis, we recommend:

- to include a consultation phase in any forthcoming auction process;
- to put forward, in this consultation, the clock auction design as the leading proposal; and
- to offer the iterative package auction design as an alternative to be used if bidders expressed the view that the clock auction design is not sufficiently flexible to allow them fully to express the value of synergies across permits.

This would give prospective bidders the opportunity to express their views on the strength of synergies with a clear understanding of the implications for the auction process.

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[1] This means a rule to ensure that there will not be any unresolved ties. This will typically be a random tie break but may include a hierarchy of criteria that would be applied to reduce or eliminate tied outcomes before the random selection takes place (e.g. first select the combination that has the largest number of winning bidders; if that leaves multiple combinations choose the one with the smallest variation of prices etc. with an ultimate random tie break).

1 Introduction and background

Scope of work

We have been asked by the Netherlands Enterprise Agency (RVO) and the Ministry for Economic Affairs and Climate Policy (MinEZK), to suggest an appropriate auction design for the assignment of permits for the construction and operation of wind farms in the offshore wind area IJmuiden Ver (IJVER).

The assignment of these permits is part of a programme aimed at reaching an offshore wind generation target of about 21 GW by around 2030, covering eight offshore wind areas. Existing wind farm sites occupying four areas (most in part) provide generating capacity of around 2.5 GW.

The IJVER wind area

IJVER is located 62 kilometres off the Dutch coast, and comprises a total area of 388 km^2. We understand that IJVER comprises six sites overall, of which four (I - IV) will be tendered in 2023 (with the remaining sites to be offered at a later date). On each site a wind farm with a capacity of at least 1 GW[2] will be built.

All four sites represent considerable economic value, but they differ in terms of size, wind speeds, water depths and soil conditions; this may result in material differences in the value of individual sites. We understand that differences in the energy yield across sites alone are estimated to be potentially up to around 10%, which in combination with potential differences in construction and maintenance costs implies potentially substantial value differences.

At the same time, there may be substantial synergies across multiple sites in terms of saved construction costs and lower ongoing maintenance costs. Maintenance cost synergies may exist across all four sites (and may be stronger for adjacent sites), but construction cost synergies are likely to be greatest for combinations of two or three sites based on the number of turbines and the size of the installation ships, which can handle a certain number of turbines per 'installation season'. There can also be ecological synergies in co-designing two adjacent sites, for example by creating bird corridors. Synergies may vary

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[2] Each site has an area of about 100 km^2 and the Ministry assumes a power density of 10 MW/km^2, which is crucial in achieving the Dutch climate targets. Developers will be allowed to 'overplant' above 1 GW but this is not guaranteed to happen.

across bidders, e.g. there may be bidders who lack the capacity to develop multiples sites.

Historically, permits for offshore wind farms have been assigned through comparative selection mechanisms based on qualitative criteria, such as certainty of realisation, innovation, ecology and system integration. We understand that tenders initially involved an element of subsidy but that the most recent tender also included a capped financial bid of up to €50 million for additional points in the assessment.

Previous advice covering auction of a single permit or two permits suggests simple multi-round designs with limited package bidding

MinEZK has previously explored the options for using auctions to assign permits for the development of offshore wind farms. A report commissioned from NERA[3] identified the basic principles on which a suitable auction design should be based and suggested a design for the award of a single permit or of two permits. The proposed design is based on the standard simultaneous multi-round ascending auction, but with provisions for exit bids to ensure an efficient outcome at the market-clearing price. The proposed design is simple and straightforward to implement and works well for the auction of a single permit and for multiple permits if synergies across sites are negligible.

For the case of two permits with potentially material synergies, NERA suggests using limited withdrawals to address the aggregation risks faced by bidders, noting that "*this proposal … is not a full package bid format that addresses all problems with synergies between permits [and] may result in an unallocated permit … This could be addressed through a follow up single permit auction. In the circumstances of the Dutch offshore wind auctions, where economies of scale across permits are likely significant and where there are strong benefits from adopting a simple auction format, we consider this an acceptable risk*."

NERA also considers that to "*minimize the risk of unsold permits in the event of a withdrawal, exit bids placed above the previous round price could be retained and replace withdrawn bids. The conditions under which exit bids can be revived need to be carefully drafted such that they do not expose other bidders to aggregation or substitution risk.*" Moreover, "*[i]f the Ministry is concerned about this issue, it could also consider a variant of the withdrawal rule that specifies a withdrawal penalty as a percentage of the withdrawn bid amount in case the permit*

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[3] 'Auction design for offshore wind site licence auctions', A report for the Netherlands Ministry of Economic Affairs and Climate Policy, NERA, March 2018

remains unallocated. Penalties would discourage bidders from using withdrawals by diminishing the value of the option to withdraw."

NERA's recommendations for a small modification of the simple design in case of synergies across two permits is at least in part driven by the fact that "*[a]s the auction formats that we have been asked to consider will only feature at most two permits sold simultaneously, the scope for package bidding is modest. For this reason … we focus on simpler solutions for allowing bidders to express demand between and across permits – i.e. the SBCA and SMRA with package bidding – rather than the more complicated CCA.*" A brief recap of NERA's proposals can be found in Section 3 below.

With more than two permits, use of a simultaneous multi-round process remains appropriate, but more extensive package bidding may be required

As the assignment of the IJVER permits may include up to four permits and further permits may be assigned in future processes, the assumed limitation to (at most) two permits no longer holds. It is therefore reasonable to consider whether the inclusion of more than two sites in the forthcoming award (and potential future awards) may require a more complex combinatorial format, or whether alternative options for extending a simple multi-round ascending format would be appropriate.

We take as given that multiple permits should be auctioned simultaneously and that the auction should use an open multi-round format to support price discovery and make it easier for bidders to establish appropriate corporate governance processes. The reasons for these key choices are discussed extensively and explained in detail in the NERA report and do not need repeating here.

On this basis, we have been asked to advise on the implications for auction design of offering permits for more than two sites (within a particular wind area, and potentially across areas in future awards) with some differences in values and the possibility of non-trivial synergistic valuations, noting that:

- the proposals should be suitable for future awards so that a consistent approach can be taken across all tenders in the roadmap; and
- the number of sites that might be offered in any future award will not be substantially larger than four or five sites (and may actually be smaller).

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<tr><td>Additional questions in relation to fall-back solution, non-financial criteria and minimum prices</td><td>

We have also been asked to discuss:

- the options for a fall-back solution in case of insufficient participation in an auction process (including a brief discussion of the relative merits of using a comparative selection process for some of the sites in combination with an auction for the remainder);
- the potential inclusion of non-financial criteria in an auction process; and
- the considerations that apply to setting minimum prices.

We understand that, at present, there are no competition concerns that might require imposing constraints on the number of permits that specific bidders could win, though such constraints might become relevant in future awards if there were an undue concentration of generating capacity in the hands of too few companies. We therefore do not consider the imposition of limits or caps at this point but note that the possibility of such constraints being imposed in the future ought to be communicated to bidders.

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Structure of report　The remainder of this document is structured as follows:

- In Section 2, we briefly discuss the concept of aggregation risks in auctions with synergies across multiple lots and assess the extent to which the modification proposed by NERA can be expected to work well with multiple sites.
- In Section 3, we discuss alternative approaches to auctioning multiple permits, including a discussion of the relative merits of splitting the available permits across an auction and a comparative selection process.
- In Section 4, we discuss the role of minimum prices and the options for a fall-back process.
- Section 5 considers the use of non-financial criteria.
- Section 6 presents our overall recommendations.

2 Aggregation risks and NERA's recommendations for limited package bidding

Strong complementarities between goods are a challenge for any market mechanism. With such complementarities, the assumption of decreasing marginal valuations that yield smooth and well-behaved demand curves no longer holds and there may not be a single market-clearing price.

If all potential users were to experience the same complementarities, there would be an obvious solution: goods that are complements for all potential buyers (like left shoes and right shoes) should be sold as bundles (like pairs of shoes). However, this does not work when different potential users enjoy different synergies or if the range of sites over which synergies exist is not known.

A simple stylised example helps with illustrating these issues.

A stylised example of synergies

Assume that there are two sites available and two bidders who are interested in building wind farms. Suppose that bidder A has decreasing marginal valuations, i.e. the value of acquiring the second site is lower than its valuation of the first site, so that the value of two sites is less than double the value of a single site. By contrast bidder B can exploit synergies so the value of acquiring two sites is more than double its valuation for a single site. Let the value of a single site for bidder $i \in \{A, B\}$ be v_i and the value of two sites be V_i, so $V_A < 2v_A$ and $V_B > 2v_B$.

Aggregation risks if there is no package bidding option

Now assume that we are running a multi-round auction as suggested by NERA, but without allowing for withdrawals, i.e. bidders place bids on individual permits and the auctioneer will designate a standing high bidder for each site at the end of each round, with standing high bids becoming winning bids after a round in which no new bids are placed.

Bidder A will be bidding on both permits up to a price $p = V_A - v_A$ and will then continue bidding on a single permit up to $p = v_A$ (as $V_A < 2v_A$ implies that $V_A - v_a < v_A$).

Bidder B will want to acquire two permits up to a price per permit $p = \frac{V_B}{2}$. However, if $v_A > \frac{V_B}{2} > V_A - v_A > v_B$ and bidder B is willing to bid for both permits up to $p = \frac{V_B}{2}$, then the auction will end with bidder B winning one permit at a price above v_B.

This is because as soon as the price rises above $V_A - v_A$, the Bidder will always hold a standing bid on one permit and be outbid only on the other, so it can carry on bidding on both permits in the hope eventually to win both and eventually pay $\frac{V_B}{2}$ or more[4], or stop bidding as soon as the other bidder reduces demand to a single permit and pay around $V_A - v_A$. Given this, placing any bids beyond v_B exposes bidder B to the risk of winning a single permit at a price above its valuation for a single site. This is known as aggregation risk.

Bidders may want to limit this risk by bidding cautiously, but this means that they cannot express their synergistic valuations. This can result in inefficient outcomes. For instance, in the example above, if bidder B were to bid only for permits up to a price $p = v_B < V_A - v_A$, then bidder A would win both permits even though $V_A < V_B$.

Limited package bidding options remove aggregation risk but create risk of unsold permit

Aggregation risk can be removed by allowing bidders to withdraw their standing high bids for permits that they no longer wish to win if they cannot realise synergies. This is the reason for NERA's suggestion of permitting withdrawals in the case of strong synergies in the two-permit auction. A simpler way of removing aggregation risks is to run a simple clock auction, which does not use the notion of standing high bidders, so that bidder B can simply drop back from bidding for two permits to bidding for zero permits (in the example above, once the price reaches $\frac{V_B}{2}$).

In both cases, removing aggregation risk comes at the cost of potentially ending up with one unsold permit, which is clearly inefficient. In the example above, the efficient outcome would be:

- to assign the unsold permit to bidder A if $V_A - v_a > v_B$, i.e. the second permit is worth more to A than a single permit for bidder B;[5]

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[4] The bidder may rationally decide to bid beyond $\frac{V_B}{2}$ if she expects to be able to win both permits at a price below $3V_B - 2v_b$. In this case, the bidder would overpay as well, but the loss from overpaying for two permits would be smaller than the loss of winning a single permit at $\frac{V_B}{2}$. If that expectation turns out to have been wrong, the loss suffered will of course be even greater.

[5] For a numerical example, consider $v_A = 11, V_A = 19, v_B = 6, V_B = 18$. Bidder A reduces demand at a price of 8 and bidder B stops bidding for two permits at a price of 9. Giving a second permit to A would yield a total value of 19, giving the unsold permit to B would yield 17, and giving both permits to B would yield 18.

- to assign the unsold permit to bidder B if $V_A - v_A < v_B$, i.e. the second permit is worth less to A than a single permit for bidder B;[6] or
- to assign both permits to bidder B if $V_A < V_B$.[7]

Provisions for dealing with unsold permit can remedy some, but not all inefficiencies

The first two outcomes might be achieved by running a follow-up process for the unsold permit, though care must be taken to ensure that the prospect of a follow-up process does not distort bidding incentives. For example, bidder A might have an incentive to stop bidding on the second permit earlier in the expectation that this would result in an unsold permit that can then be picked up for a low price in the follow-up auction. This means that the minimum bid for this follow-up auction needs to be set sufficiently high not to create the temptation to reduce demand to create unsold lots long before prices approach valuations. At the same time, the minimum bid should be sufficiently low to allow effective competition for the single permit.

These outcomes may also be achieved by inviting bidders to place exit bids whenever they reduce demand, which can then be considered for assigning permits that would otherwise go unsold. Typically, such exit bids are linked to the prices at which a bidder reduces demand, but this would prevent achieving the second outcome when synergies are strong (if bidder B bids for two permits up to $\frac{V_B}{2}$, then it might not want to place an exit bid for a single permit at or slightly below this price, as it is above v_B).

Neither of these approaches could, however, lead to the third outcome because both respect the results of the last round, which may not be compatible with the efficient outcome.

Whether this limitation of the approach suggested by NERA is acceptable in exchange for using a relatively simple auction design (an SMRA with the option for withdrawing standing high bids or an equivalent simple clock auction without the notion of

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[6] For a numerical example, consider $v_A = 11, V_A = 18, v_B = 8, V_B = 18$. Bidder A reduces demand at a price of 7 and bidder B stops bidding for two permits at a price of 9. Giving a second permit to A would yield a total value of 18, giving the unsold permit to B would yield 19, and giving both permits to B would yield 18.

[7] For a numerical example, consider the following values: $v_A = 11, V_A = 18, v_B = 8, V_B = 20$. Bidder A reduces demand at a price of 7 and bidder B stops bidding for two permits at a price of 10. Giving a second permit to A would yield a total value of 18, giving the unsold permit to B would yield 19, but giving both permits to B would yield 20.

standing high bids) is a difficult question whose answer depends on an assessment of the potential efficiency loss that might be suffered. Indeed, as NERA indicates, the question whether the option of limited package bidding should be offered in a particular auction "*would require a judgement call by the Ministry in advance of the auction, possibly based on industry consultation*." In any case NERA's recommendation of the "*simple approach of adding a limited withdraw option to the standard SMRA/clock, as opposed to embracing a fully combinatorial format*" is predicated on the Ministry not anticipating selling more than two permits simultaneously.

Offering more than two permits obviously increases the range of possible outcomes and the scope for simple auction formats to result in inefficiencies.[8] It is therefore important to consider the options for running a process that offers greater scope for full package bidding.

We discuss these options in the following section.

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[8] In addition, one may have to consider that unsold permits are not necessarily inefficient – there may be efficiently unsold lots. For example, consider the case where three permits are offered but the only economically viable option is the combined operation of two sites, so that it is efficient to have one unsold permit. Such cases may be extremely unlikely and may indicate flaws in the design of the products on offer (i.e. the definition of sites for which permits are issued), but they cannot be entirely ruled out.

3 Auction design for multiple permits with value differences and synergies

In this section we set out proposals for an auction design that is suitable for offering more than two permits with value differences and synergies. We start, however, by considering the relative merits of splitting the award into a comparative selection procedure for some permits and an auction for the remainder, which might also be seen as an option for reducing the number of permits that are included in an auction, potentially to the two-permit case covered by the NERA proposal.

3.1 Splitting award into auction and comparative selection procedure

Using a comparative selection process for some permits alongside an auction would reduce number of permits in auction, but is not advisable

We understand that the Ministry might consider splitting the award of the four IJVER permits across an auction and one or more comparative selection processes, potentially with a financial bid (as in the previous award process). This might reduce the number of permits offered via auction, potentially to one or two, in which case the format suggested by NERA recommendations might be used.

Irrespective of any potential benefits (if any) of reducing the number of permits in an auction, we see no merit in such a split award, particularly when there are likely to be synergies across sites. The reasons for this are as follows:

First, it is very difficult to capture synergistic valuations in a comparative selection process – should there be a single process for multiple sites, selecting a single successful bidder? This would presuppose the existence of strong synergies rather than put them to the test in the way a well-designed auction process would. Conversely, if single comparative selection processes are run for individual permits, then bidders who could benefit from strong synergies may be disadvantaged as they are exposed to the same aggregation risks as in an auction without any package bidding option. These concerns apply regardless of whether the comparative selection process would cover all or only some of the available permits.

Second, combining one or more comparative selection processes with an auction for permits that might be substitutes or complements (or both) creates further problems. The concerns are the same as those discussed by NERA in relation to the sequential award of multiple permits: there is no opportunity for prospective users to switch between sites that are potential substitutes across the two processes, and there is no possibility for prospective users to express the value of synergies in relation to sites offered in separate processes. In addition, with synergies, there may be concerns about competition in an auction if it is held after the comparative selection process, as those bidders who have already obtained permits are in an advantageous position. This could make the entire process vulnerable to legal challenges.

3.2 An adjusted limited package bidding design

An obvious question is whether the limited package bidding design set out in the NERA report could be adjusted to work with auctions in which more than two permits are on offer.

A brief recap of the design proposed by NERA

A brief recap of the essential features of NERA's proposals is provided below.

A brief summary of NERA's proposed auction design

The NERA proposal envisages a design in which bidders place bids on individual permits (say I and II), which means either accepting the round price of the permit posted by the auctioneer or submitting an exit price that is lower than the current round price but at least the round price in the previous round (or the reserve price in the first round). At the end of each round, the auctioneer determines a standing high bidder for each permit, which is the bidder who has placed the highest bid with ties between bids at the same price being broken at random.

The number of permits on which a bidder can bid is determined by the bidder's eligibility. The initial eligibility of a bidder is set by the number of permits for which the bidder has applied. The eligibility of a bidder in any subsequent round is determined by the bidder's activity in the preceding round. Activity is measured by the total number of permits for which the bidder has accepted the round price or on which the bidder has held a standing high bid after the previous round (regardless of whether the bidder then accepts the round price or submits an exit price for that permit). This means

that a reduction in activity in one round results in a loss of eligibility going forward. [1]

This allows bidders bidding on a single permit to switch their demand across permits in response to price movements: a bidder who is not holding a standing high bid is free to bid on either permit (whilst a bidder with a standing high bid can only maintain this or place a new, higher bid on the same permit because of the activity rules). Standing high bids are therefore binding: unless being outbid on a permit, a bidder will be committed by a bid that has become a standing high bid.

Bidding ends after a round in which no new bids at the round price have been received. At this point, standing high bidders become winning bidders and pay the amount of their standing high bid.

Because a bidder who has been bidding on two permits in the expectation of winning both may become standing high bidder on only one of these when the auction ends, there is a penalty-free option to withdraw her standing high bid in this specific case (i.e. the bidder must have been bidding on both permits and be standing high bidder on only one of these in order to be allowed to withdraw). This strict condition is necessary to prevent the strategic use of withdrawals.

As noted, the exercise of this withdrawal option may result in unsold permits which would need to be allocated through a follow-up single-permit auction or using exit bids from previous rounds. NERA does not further specify the conditions under which such exit bids should be taken into consideration, but simply notes that "[*t*]*he conditions under which exit bids can be revived need to be carefully drafted such that they do not expose other bidders to aggregation or substitution risk.*"

Adjustment of the condition for the withdrawal of standing high bids

This format should in principle be applicable to the case of more than two permits. Given the value differences across sites, we would still need to allow bidders to bid on permits for specific sites, rather than first auctioning several generic permits and then assigning individual sites to the winner(s) of permits in

a follow-up process.[9] However, the condition for the withdrawal of standing high bids would need to be adjusted.

A more general formulation of the conditions for withdrawal of standing high bids would be the following:

> *A bidder who has been bidding on $n \geq 2$ permits and becomes standing high bidder on $m < n$ permits will be allowed to withdraw all (but not only some) of these standing high bids, in which case the bidder shall not be allowed to place any further bids in the auction.*

Strict withdrawal rule does not work with different valuation structures

This condition, however, is overly restrictive and would not cater for all types of synergies.

First, we understand that some synergies may not simply depend on the number of sites that a bidder acquires, but also on the identity of these sites. For example, the optimal three-site configuration from a bidder's perspective might involve permits I, II and III, but if the bidder no longer can secure three sites and must reduce to two, the best combination may then be a combination of permits III and IV. However, the bidder may be 'stuck' on one of sites I and II through a standing high bid there. Such a bidder would not benefit from this all-or-nothing withdrawal option.

Moreover, synergies may be more complex. For example, a bidder may have substantial value for a single site, a smaller value for an incremental second site but then again substantial value from winning a third site. For illustrative purposes, assume that a bidder has a valuation of 25 for a single permit, 35 for two permits and 60 for three permits. Such a bidder would be prepared to pay up to 20 per permit if she wins three sites but would not wish to win two sites at any price above 17.5. A single site would however be worth up to 25. Under the modified withdrawal rule given above, such a bidder would be able to withdraw her standing high bids on two permits if she had

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[9] This is now the common approach in spectrum auctions where the available bandwidth is offered in the form of small blocks. As the value of these frequency blocks within a band typically does not vary (at least not substantially) and there is benefit from winners of spectrum being assigned contiguous frequencies, auction designs typically involve the assignment of bandwidth in the form of generic spectrum lots (e.g. a bidder may win eight blocks of 10 MHz each in a band spanning the frequencies from 3600 to 3800 MHz) followed by an assignment of specific frequencies (i.e. this winner would receive a contiguous assignment of 80 MHz within the band such that all other winners will also be able to receive contiguous assignments) with the specific assignment decided through a separate bidding process.

previously been bidding on three permits but would then be out of bidding completely. She would no longer have the option to acquire a single permit, which might well be part of an efficient outcome.

Even though synergies of this form may not be very likely, it would be prudent to ensure that bidders who might have such valuations are not put at a disadvantage through the auction design. Unless such valuations can be ruled out with a sufficient degree of certainty, a withdrawal option that requires the bidder to cease bidding completely is overly restrictive and carries the risk of the auction failing to produce an efficient outcome.

Relaxation of withdrawal restrictions or use of clock auction rules

In principle, it should be possible to be more permissive about the conditions under which withdrawals are allowed (e.g. allow bidders, under certain conditions, to withdraw some bids and continue to bid in the auction), but this will complicate the auction rules and may create difficulties for bidders (and potentially the implementation of the rules in an auction system). Therefore, it is in our view preferable to abandon the notion of standing high bids and move to a straightforward clock auction format, even if we are dealing with lot categories that include a single permit each.

Clock auctions are typically used when selling many items that can be grouped into categories of identical (or very similar) lots because they are an efficient procedure for finding market-clearing prices. The auctioneer posts a price (the clock price) for each category and bidders specify how many lots they wish to acquire at this price. If demand aggregated across all bidders exceeds supply in at least one category, the price of lots in the category with excess demand increases and another round is run. Bidding ends as soon as there is no more excess demand in any category. By asking bidders who reduce demand from one round to the next also to specify the price(s)[10] at which they at which they do so then allows the auctioneer to establish a market clearing price (at least as long as there are no complementarities that make bidders want to reduce demand not smoothly, but in larger steps and without specifying a drop-down price).

The approach also works when there is only a single item available in each category, as in the case of an auction of permits. The auctioneer specifies a price for each permit and bidders state whether they wish to bid at this price (or specify a

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[10] If a bidder reduces demand by more than one unit from one round to the next, she may specify a price point for every reduction.

lower price up to which they would be interested in the permit). Bidding mechanics are the same as in the format proposed by NERA, which then however also introduces the notion of standing high bids. These standing high bids add unnecessary complications when we want to allow for the possibility of withdrawal of standing high bids in a potentially wide range of circumstances.

Not defining standing high bids has the same effect as allowing for the general withdrawal of standing high bids. It removes aggregation risks, albeit at the cost of creating scope for unsold lots in the same way that withdrawals of standing high bids do. The question then is how one should deal with such unsold lots.[11] is key (and would also need to be addressed).

Dealing with unsold permits in a follow-up round

It may be possible efficiently to assign permits that would otherwise be unsold by running a follow-up bid round, unless the efficient outcome involves some bidders obtaining fewer permits than they win in the last clock round.[12] In this follow-up round, bidders would be invited to specify a bid amount for each unsold permit, with the highest bidder winning the permit.

Note that such a follow-up round is similar to using exit bids placed during the clock rounds to assign otherwise unsold lots, but it is procedurally simpler and also provides greater flexibility in terms of defining constraints on the bids for otherwise unsold permits. The obvious procedural advantage is that the round will only need to be run if there are unsold permits (whereas exit bids placed during the clock rounds would be collected even for permits that eventually end up being assigned through clock bids) and that bidders will know exactly how many permits they have already won when having to make these bids. For these reasons, we prefer running a follow-up round to the use of exit bids.

The challenge here is to avoid distorting bidding incentives in the clock auction, i.e. to avoid creating an expectation that bidders may be able to pick up additional permits for a very low price which could then result in bids that are deliberately creating unsold permits.

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[11] This question also needs to be addressed under NERA's proposed two-permit auction format with limited package bidding, though in this case there could be at most one unsold permit suggesting a single-permit auction as a follow up as an obvious solution.

[12] Note that the follow-up process could include multiple rounds, though this would have limited benefits given that a price discovery process has already taken place.

The starting point would be to require bidders to bid for additional permits (additional to those won through their bid in the final clock round) at prices that must not be lower than the last bid they made for these permits and must not exceed the round price at which they stopped placing bids. However, such a constraint might be too tight if there are strong synergies, as bidders who have bid for multiple permits at prices that include the synergy value will not want to place bids at that level for fewer permits that do not give rise to such synergies.

We can revert to our simple stylised example from section 2 to analyse this issue. In this example, we end up with an unsold permit in the case where $v_A > \frac{V_B}{2} > V_A - v_A$. Let us consider the case where $v_B > V_A - v_a$ and look at three price levels p', p'', p''' such that $p' < V_A - v_A < v_B < p'' < \frac{V_B}{2} < p''' < v_A$. At these prices, we get the following bid decisions and outcomes:

Price	Bids	Outcome
p'	A bids for both permits B bids for both permits	Excess demand of two, bidding continues
p''	A bids for a single permit B bids for both permits	Excess demand of one, bidding continues
p'''	A bids for a single permit B makes zero bid	Excess supply of one, bidding ends

Minimum prices in a follow-up round

If we now run a follow-up round and require each bidder to place bids that are at least as high as the round price in the last round in which the bidder made a bid for the unsold permit:

- A would be able to place a bid at or above p'; but
- B would not place a bid, as she would be required to specify a price at or above p'', which is more than her valuation for a single permit.

Therefore, A would win the unsold permit (and would do so without facing any competition), but this is inefficient: because the value of a single permit to B is greater than the value of a second permit to A by assumption, the unsold permit should go to B.

This problem can be avoided if we use p' as the minimum bid for the unsold permit that applies to all bidders in the follow-up round. We know that A has a value for the permit that is at or above this level (although he could face budget constraints that might prevent her from bidding her valuation for the second permit in addition to the final price she has to pay for her

winning clock bid), and setting this minimum price would also provide B with an opportunity to express her valuation for a single permit and win if her valuation is above A's valuation of the second permit.

Moving away from the simple example and covering the case of multiple lots and multiple bidders, we can generalise this principle by determining the minimum price for an unsold permit in a follow-up round in the following manner:

> *For each bidder who could win the unsold permit in addition to their final clock bid without exceeding initial eligibility, we establish the highest price at which the bidder placed a bid on the unsold permit prior to reducing demand.*

> *The minimum price for the unsold lot is then set by the minimum across these prices.*

> *If no such price exists, the minimum price for the unsold lot is set to reserve.*

Activity rules an information policy

The activity rules would be the same as those proposed by NERA for its two-permit auction: the number of permits on which a bidder can bid in the first round is limited to the number of permits for which the bidder has applied. In any subsequent round, the number of permits on which the bidder can bid is determined by the number of permits on which the bidder has placed a bid in the previous round. As there are not standing high bids, we do not need to consider these (or any withdrawals).

With a view to providing information that allows bidders to update valuations – which is one of the main reasons for using an open, multi-round format in the first place – we propose to inform bidders about the number of bids received for each permit. As each permit would have its own price in each round, this also identifies the number of other bidders who are prepared to pay this amount for the permit.

On the other hand, we would not necessarily wish to disclose information about the identity of the individual bidders, as this could be used for signalling and for implementing retaliatory strategies aimed at promoting a collusive outcome. There are arguably reasons why disclosing the identity of bidders may provide valuable information (e.g. in the case where some bidders are known to be more experienced in relation to the valuation of wind farm sites), but the putative benefits of doing so need to be weighed carefully against the increase scope for strategic bidding that this creates.

A simple example helps illustrating the proposed bidding process.

Consider that we have three bidders, A, B and C, competing for two permits, I and II. Assume that the bidders have the following valuations:

Package	Bidder A	Bidder B	Bidder C
I	4	4	4
II	5	3	5
I & II	8	10	0

Round 1

Now assume that the asking prices are 3 for I, 3 for II. At these prices:

- Bidder A would enjoy a surplus of 1 for I, 2 for II and 2 winning both I & II. Therefore, Bidder A wants to bid for both permits.
- Bidder B would enjoy a surplus of 1, 0 and 4. Therefore, Bidder B also wants to bid for both permits.
- Bidder C would enjoy a surplus of 1 for I and 2 for II, but has no interest in winning both. At these prices, Bidder C prefers permit II.

Thus, Bidders A and B bid for both I and II, and Bidder C bids for II. Aggregate demand is 2 for permit I and 3 for permit II.

There is excess demand for both I and II, so the price increases for both permits. Assume the price increment is 20%, so the price increases to 3.6 for both permits.

Round 2

The price is 3.6 for both permits I and II. At the new asking prices:

- Bidder A would enjoy a surplus of 0.4 for permit I, 1.4 for permit II and 0.8 for both permits. At these prices, Bidder A's valuation for the two permits still exceeds their cost, but its surplus is greater if it bids for permit II alone.
- Bidder B would enjoy a surplus of 0.4 for permit I, -0.6 for permit II and 2.8 for both, so it will continue to bid for both. Notice, however, that Bidder B's valuation for permit II is below its price, so it would not want to win permit II on a standalone basis.
- Bidder C would enjoy a surplus of 0.4 and 1.4, so continues to bid for II.

Aggregate demand is 1 for permit I and 3 for permit II. There is excess demand only for II, so the price increases only for permit II, to 4.32.

Round 3

The price is 3.6 for permit I and 4.32 for permit II. At the new asking prices:

- Bidder A would enjoy a surplus of 0.4 for permit I, 0.68 for permit II and 0.08 for both permits. At these prices, Bidder A continues to prefer permit II, and bids for II only.
- Bidder B would enjoy a surplus of 0.4 for permit I, -1.32 for permit II and 2.08 for both, so it will continue to bid for both.
- Bidder C would enjoy a surplus of 0.4 and 0.68 respectively, so continues to bid for II.

Aggregate demand is again 1 for permit I and 3 for permit II. There is excess demand only for II, which has its price increased to 5.184.

Round 4

The price is 3.6 for permit I and 5.184 for permit II. At the new asking prices:

- Bidder A would enjoy a surplus of 0.4 for permit I, but the price of permit II is above its valuation. Bidder A now switches to permit I.
- Bidder B would enjoy a surplus of 0.4 for permit I, -2.184 for permit II and 1.216 for both, so it will continue to bid for both.
- Bidder C would enjoy a surplus of 0.4 for permit I, but the price of permit II is already above its valuation, so also switches to I.

Aggregate demand is now 3 for permit I and 1 for permit II. There is excess demand only for I, which has its price increased to 4.32.

Round 5

The price is 4.32 for permit I and 5.184 for permit II. At the new asking prices:

- Bidder A does not bid for any permits, as both are priced above its valuations.
- Bidder B would not wish to bid for individual permits, as prices are above individual valuations, but still wishes to bid for both permits, which still yields a surplus of 0.496 for both.

- Bidder C also has valuations below prices and does not bid.

Aggregate demand is now 1 for permit I and 1 for permit II. Bidder B wins both permits.

3.3 A full package bidding auction

As noted above, using a follow-up round for the assignment of unsold permits can produce efficient outcomes if such outcomes involve each winner being assigned at least the permits in its final clock bid, but not in the case where they require some re-assignment of permits relative to the final clock outcome.[13] To ensure that the auction process results in an efficient assignment in general, a fully combinatorial auction format is required.

The range of package bid auctions considered by NERA (as well as by Ausubel and Cramton in their work for the US Bureau of Ocean Energy Management, Regulation and Enforcement[14]) is somewhat limited, considering only the combinatorial sealed bid auction and package clock auctions, specifically the combination of a simultaneous clock auction with a sealed-bid supplementary round, known as combinatorial clock auction (CCA).

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[13] Consider the following illustrative example: assume that there are three permits and three bidders. Bidders A and B value a single permit at 6, two permits at 8 and three permits at 10, so their incremental valuation for the second and third permit is 2. Bidder C, by contrast, values a single permit at 2, two permits at 6 and three permits at 15, so would be prepared to pay at most 5 per permit for three permits, 3 per permit for 2 permits and 2 for a single permit. The efficient outcome requires that all three permits be assigned to C.

Assume that we are running a clock auction with a starting price of 1. All three bidders would ask for three permits. Bidder A and B would reduce their demand to a single permit as soon as the price exceeds 2, but then carry on bidding up to a price of 6. Bidder C would drop out at a price of 5, and therefore the clock rounds would end with bidders A and B winning one permit each and one permit remaining unassigned.

This permit can of course be assigned in a follow-up round, but the outcome would not be efficient as the efficient outcome would require re-assigning the permits won by A and B at the end of the clock rounds.

[14] See Ausubel, L M and Cramton, P, 'Auction Design for Wind Rights', August 2011; 'Comparison of Auction Formats for Auctioning Wind Rights', September 2011; both available from the BOEMRE website https://www.boem.gov/renewable-energy/auction-formats.

Wide range of package bidding formats used in procurement and resource allocation

Other iterative package bidding formats that are used in procurement processes or complex resource allocation problems in the private sector might provide a suitable alternative.[15] Given that we will be dealing with a relatively small number of packages, it should be possible to adapt one of these approaches, which do not include a sealed bid component, for the assignment of permits.

Specifically, with four (or at most five) permits in any specific award process, the number of possible combinations on which bidders could bid is limited. Excluding the option of not bidding on any permit, there would be at most 15 (31) possible combinations.

It would therefore be perfectly feasible to run an auction in which:

- bidders can place bids on specific packages;
- the auctioneer determines the provisional winning combination of package bids at the end of each round;[16]
- bidders can adjust their bids if they are unhappy with the outcome; and
- the auction ends after a round in which no new bids are placed.

Key questions: how to update prices and how to ensure auction progresses towards market clearing

The key issues in implementing such an iterative package bidding process are:

- what price updates should be provided to bidders to allow them to identify how they should adjust their bids if they are not content with the current outcome; and
- what constraints may be imposed on bidding so that the auction progresses towards a market-clearing outcome, i.e. what should replace the standard activity rule in the clock auction.

In terms of price updates, the information given to bidders ranges from simple linear prices on the individual items (in this case: prices for each permit that are the same for all bidders) to

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[15] See, for example, Ledyard, J O, Olson, M and Porter, D, Swanson, J A and Torma, D P, 'The First Use of a Combined-Value Auction for Transportation Services', Interfaces, 32(5), 2002 ; Kwasnica, A M, Ledyard, J O, Porter, D and DeMartini, C, 'A New and Improved Design for Multiobject Iterative Auctions' Management Science 51(3), 2005;

[16] Such winner determination problems can be computationally challenging if there are many possible bids and many possible bidders, but there are no implementation issues if we are dealing with a few hundreds or thousands of bids.

personalised bundle prices (in this case, prices for combinations of permits that may vary across bidders).[17]

A simple package bidding format

A relatively simple combination of price updating and activity rules that avoids the auctioneer having to define a price for each item (which in the winning outcome do not need to add up to package prices as non-linear prices may be required to support an efficient assignment) is the following:[18]

- The auctioneer specifies an asking price for each package, which initially is set at the reserve price for individual permits and the sum of reserve prices (or the largest price of any sub-package) for larger packages.[19]
- In each round, bidders can place one or more mutually exclusive bids for packages at the asking price or at a price that is below the asking price but above the previous round's asking price; however, in the latter case, the bidder will not be able to place any further bids on the package.
- At the end of the round, the auctioneer considers the new bids received and any provisionally winning bids from the previous round and selects the value-maximising combination of bids that are feasible, taking at most one bid from each bidder. Ties may be broken first by maximising the number of successful bidders, then retaining the greater number of provisionally winning bids from the previous round, and then at random.
- If any new bids have been received, then a further round is needed, with the price of packages that received new bids increased, and the price for other packages unchanged.

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[17] For an overview, see Parkes, D C ,'Iterative combinatorial auctions', in: Cramton, P Shoham, Y and Steinberg, R (eds), Combinatorial Auctions, Cambridge, Mass, 2006

[18] These rules are similar to those for the simplest version of the iBundle auction proposed by Parkes (see Parkes, D, iBundle; An Efficient Ascending Price Bundle Auction, in Feldman, S (ed9, Proceedings of the ACM Conference on Electronic Commerce, New York, 1999; see also Parkes, D C and Ungar, L H, 'Iterative Combinatorial Auctions: Theory and Practice', in Proceedings of the 17th National Conference on Artificial Intelligence, 2000.

[19] Setting the price of packages to the largest price of any of its sub-packages caters for (strongly) decreasing marginal valuations. Therefore, we will certainly want to set prices in this manner if we have fewer applicants than permits as in this case the efficient outcome will require the assignment of more than one permit to at least one of the winners. If for each bidder there is at least one bidder who is interested in taking this permit at reserve, we can use the sum of reserve prices as it would always be preferable to assign a permit to that bidder rather than incrementally to another bidder if the incremental value is below the reserve price.

- Bidding ends after a round in which no new bids are received.

A simple example

A simple example helps illustrating the bidding process.

Consider the same example of three bidders, A, B and C, competing for two permits, I and II used above. The bidders have the following valuations:

Package	Bidder A	Bidder B	Bidder C
I	4	4	4
II	5	3	5
I & II	8	10	0

Round 1

As above, assume that the asking prices are 3 for I, 3 for II and 6 for I & II. At these prices:

- Bidder A would enjoy a surplus of 1, 2 and 2 respectively.
- Bidder B would enjoy a surplus of 1, 0 and 4.
- Bidder C would enjoy a surplus of 1, 2 and -6

Thus, Bidder A places a bid on packages II and I & II at those asking prices. Bidder B bids on I & II and Bidder C bids on II.

Assume that the auctioneer selects Bidder A's bid as provisionally winning by random draw (as accepting Bidder A's bid or bidder B's bid would imply the same number of successful bidders).

Packages II and I & II received new bids in the round, so will require a price increment. However, package I did not receive new bids in the round, so its price will remain unchanged. Assume that the price increment is 20%, so we now have the new asking prices of 3 for I, 3.6 for II and 7.2 for I & II.

Round 2

The prices are now 3 for I, 3.6 for II and 7.2 for I& II. At the new asking prices for I, II and I & II:

- Bidder A would enjoy a surplus of 1, 1.4 and 0.8 respectively, a can simply maintain its provisional winning bid for I & II giving a surplus of 2.
- Bidder B would enjoy a surplus of 1, -0.6 and 2.8.
- Bidder C would enjoy a surplus of 1, 1.4 and -7.6

Thus, Bidder A maintains its provisionally winning bid. Bidder B places a bid on I & II at 7.2. Bidder C bids on II.

Bidder B's bid on I & II becomes the winning bid.

As before, only packages II and I & II received new bids and will require a price increment. The price of package II increases to 4.32 and the price for I & II increases to 8.64.

Round 3

The prices are now 3 for I, 4.32 for II and 8.64 for I& II. At the new asking prices for I, II and I & II:

- Bidder A would enjoy a surplus of 1, 0.68 and -0.64 respectively.
- Bidder B would enjoy a surplus of 1, -1.32 and 1.36, but can simply maintain its provisionally winning bid for I & II to enjoy a surplus of 2.8.
- Bidder C would enjoy a surplus of 1, 0.68 and -8.64.

Thus, Bidders A and C submit a bid for I whilst Bidder B maintains its provisionally winning bid for I & II.

Bidder B's bid remains the provisionally winning bid, and the price increases only for I to 3.6.

Round 4

The prices are now 3.6 for I, 4.32 for II and 8.64 for I & II. At the new asking prices for I, II and I & II:

- Bidder A would enjoy a surplus of 0.4, 0.68 and -0.64.
- Bidder B would enjoy a surplus of 0.4, -1.32 and 1.36, but can simply maintain its provisionally winning bid for I & II to enjoy a surplus of 2.8.
- Bidder C would enjoy a surplus of 0.4, 0.68 and -8.64.

Thus, Bidders A and C submit a bid for II whilst Bidder B maintains its provisionally winning bid for I & II.

Bidder B's bid remains the provisionally winning bid, and the price increases only for II to 5.184.

Round 5

The prices are now 3.6 for I, 5.184 for II and 8.64 for I& II. At the new asking prices for I, II and I & II:

- Bidder A would enjoy a surplus of 0.4, -1.84 and -0.64.
- Bidder B would enjoy a surplus of 0.4, -2.184 and 1.36, but can simply maintain its provisionally winning bid for I&II to enjoy a surplus of 2.8.
- Bidder C would enjoy a surplus of 0.4, -1.84 and -8.64.

Thus, Bidders A and C submit a bid for I whilst Bidder B maintains its provisionally winning bid for I & II.

Bidder B's bid remains the provisionally winning bid, and the price increases only for I to 4.32.

Round 6

The prices are now 4.32 for I, 5.184 for II and 8.64 for I& II. At the new asking prices for I, II and I & II:

- Bidder A would enjoy a surplus of -0.32, -1.84 and -0.64.
- Bidder B would enjoy a surplus of -0.32, -2.184 and 1.36, but can simply maintain its provisionally winning bid for I&II to enjoy a surplus of 2.8.
- Bidder C would enjoy a surplus of -0.32, -1.84 and -8.64.

Thus, Bidders A and C do not submit any bids whilst Bidder B maintains its provisionally winning bid for I & II.

As no new bids are received, the auction ends, and Bidder B wins package I & II.

4 Reserve prices and fall-back options

Any auction mechanism needs to specify a minimum bid or reserve price above which all bids must lie. This could be as low as zero but might also be higher. For the avoidance of doubt: If successful bidders have to pay ongoing cost over the duration for which the permit is issued (e.g. if the cost of site development are recovered through annual charges), then the discounted value of these future payments contributes to the effective reserve price, as the minimum financial commitment of winning a permit is given by the sum of the minimum bid and the net present value of the annual payments to which a successful bidder is committed.

Role of reserve price

The reserve price typically reflects the value of the item to the seller, i.e. the price below which the seller would not be willing to sell. This 'opportunity cost of selling' may be the value of retaining the item, or the cost associated with making the item available (e.g. the cost of developing the site and a contribution to other costs associated with mitigating the impact of increasing the areas used for the construction of windfarms, e.g. on shipping, fishing, dredging or the environment).

Where bidding is competitive, the final price will be determined by the valuation of the bidders and the reserve price will not have any impact. It simply provides a safeguard against the case that the value that potential buyers place on the item is lower than the value to the seller, which would make selling an inefficient outcome. If the final price is determined by the valuation of bidders, then setting the reserve price closer to the final price will only have the effect of shortening the bidding process.

Low reserve prices may encourage collusion

However, where there are few bidders who may attempt to co-ordinate their bidding behaviour, i.e. (tacitly) collude, to keep prices low (either across a sequence of auctions or within a single multi-unit auction), the reserve price can have an impact on the outcome. This is because the lower the price at which the items could be bought, the larger the gains from collusion and the greater the incentive to try and pursue a collusive strategy. Such a collusive strategy will not only reduce revenues for the auctioneer but can also lead to inefficient outcomes.

Consider the stylised example of two bidders competing for two items from section 2 and assume that the reserve price is $r <$

$\min [v_A, V_A - v_a, \frac{V_A}{2}, v_B, V_B - v_b, \frac{V_B}{2}]$. At this price, each bidder would prefer to acquire both items. However, each bidder knows that competition will increase the price whereas settling for a single item could immediately bring bidding to an end. Each bidder will compare the expected surplus it would enjoy from competing for both items (which of course involves forming an expectation of the price at which bidding would end and whether the bidder would at this point win both items, one item or nothing) against the surplus of settling at r, which is simply $v_i - r, i \in \{A, B\}$. The lower r, the greater this surplus and the greater the incentive not to compete for two items. The incentive not to contest the second item exists under both the clock auction and the package bidding formats and will result in an inefficient outcome whenever $V_B > V_A$ or $V_A - v_a > v_B$.

For this reason, it may be preferable to set reserve prices higher than the opportunity cost of selling, closer to the market-clearing price(s). Of course, the problem is that the market clearing price is unknown[20] and thus increasing the reserve price above the minimum level creates the risk of pricing off demand and leaving items inefficiently unsold.

However, where there is a large gap between the value to the seller of retaining an item and the likely market value of the item, it should be possible safely to increase reserve prices above the minimum level defined by the opportunity cost of selling. This would address concerns about weak competition and have the procedural benefit of reducing the number of rounds that are required in a multi-round auction needed to resolve excess demand.

Role of fall-back option

The impact of reserve prices on the decision of prospective bidders whether to take part in an auction process of course also depends on the provisions for the case that the auction draws insufficient participation. Specifically, if bidders know that in the case of insufficient participation in the auction permits would be assigned through a comparative selection process that offered the opportunity to obtain permits for a much lower price, this might undermine incentives to express interest in the auction. Rather than bidding for permits, prospective users might be tempted not to apply to take part in the auction in the expectation of being able to pick up unassigned permits cheaper under the fall-back option, albeit at the risk of not being successful. Prospective users might be tempted more

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[20] If the market clearing price were known, the seller could simply make a take-it-or-leave-it offer at this price.

strongly to gamble on such a fall-back process the higher the reserve price set for the auction, which is a certain lower bound on the cost of winning a permit through this route.

We understand that in past awards provisions were made for running a subsidy auction if a zero-bid competitive tender would fail to draw sufficient interest, but that this was not communicated to prospective applicants. We would suggest a similar approach in case an auction process were to be used in the first instance. There should be no announcement of whatever provisions have been made for a fall-back option in case of insufficient interest.

Should this not be possible, the question arises how this fall-back option should be structured to minimise the risk that it might undermine incentives for applying to take part in an auction.

The impact of bidders knowing about the fall-back option on participation incentives depends on the number of entities who might be interested in obtaining a permit and the difference in the likely cost of winning permits through an auction or a competitive selection process.

- The higher the reserve price, the greater the temptation to pass on the auction in the hope of winning the competitive tender.
- The greater the number of entities interested in a permit, the smaller the chance that an individual decision not to apply for the auction will trigger the use of the fall-back option, and the smaller the chance of being successful in a comparative assessment if it did.
- The greater the number of interested parties, the smaller is also the risk of prospective applicants colluding on withholding their interest in an auction.

This would suggest that details about the fall-back option might be safely disclosed if there are many parties who are potentially interested in obtaining a permit. Of course, this is precisely the case where the need for a fall-back option is smallest.

Otherwise, we would suggest that any comparative assessment process identified as the fall-back option includes a financial component which could be used partly to counter incentives not to apply for the auction.

For example, if all applications in the last tenders, Hollandse Kust (west), included a financial bid up to the maximum, this would suggest that applicants do not wish to take the risk of missing points from the financial bid in the evaluation. In this

case, setting the maximum financial contribution to the level of the reserve price of an auction could be an effective remedy, especially when combined with a limit on the number of potential winners of a comparative tender procedure to a number smaller than the number of parties that are potentially interested as this would make relying on the fall-back process risky. As we understand, there are at present no concerns about limiting the number of winners of permits or excluding some existing windfarm operators from winning the new permits, and therefore this option should be available.

In broad terms, the following cases may be distinguished:

Number of expected participants	Implications for auction	Fall-back option (competitive tender)
Greater than number of permits	No concern about competitiveness of auction	Unlikely to be needed, but design will have limited impact on participation decisions
Smaller than number of permits, but greater than one	Limited competition is a concern – suggests a higher reserve price (all other things being equal)	Fall-back option could provide an incentive not to apply to take part in auction Limit the number of potential winners of a competitive tender and include financial component up to at least the level of the reserve price
Only one	No scope for a competitive auction; incentives to apply at any reserve price above zero will be undermined by existence of a fall-back option	No meaningful competitive tender; Introducing financial component is ineffective.

In the last case one would not expect to be able to recover the opportunity cost of assigning the permit (i.e. site development and mitigation costs) through either an auction reserve price or a financial contribution with a sufficiently large cap in a competitive tender. It may therefore be necessary to include this as an explicit cost (whether one-off or ongoing) that must be paid by any entity assigned a permit.

5 Taking account of non-financial criteria

Concerns about pure financial bids not reflecting wider range of policy objectives

When using auctions for the assignment of valuable public resources, there may be concerns that using the amount that potential users are prepared to bid as the sole criterion does not take account of all the policy objectives that the awarding body may pursue.

Pre-qualification criteria are typically used to ensure that anyone who wishes to bid in an auction meets minimum requirements in relation to these policy objectives. For example, bidders would need to provide evidence that they will be able successfully to complete the project, contribute to energy supply and to the integration of the generating capacity into the energy system.

In terms of the criteria that would be used for scoring applications in a comparative selection procedure, this would amount to a requirement to achieve a minimum score. In addition, constraints on bids may be used to address concerns about trying to distort competition in downstream markets.

However, these measures do not exploit the rivalry amongst potential users to make them exceed the minimum requirements set out in the prequalification criteria. There may also be concerns about setting prequalification thresholds too high, which could discourage participation and potentially exclude bidders who would be best placed to deliver a project but might fail on overly onerous prequalification criteria.

This raises the question to what extent auction mechanisms can include additional factors so that competition might be leveraged to extract commitments from successful bidders that promote these wider policy objectives above and beyond the minimum requirements that all applicants must meet to qualify for participation in the auction.

Comparative assessment with well-defined scoring criteria is like an auction (scoring auction)

Comparative assessments in which applications are scored according to a pre-defined set of criteria and the available permits are assigned to those who have submitted the highest-scoring application(s) can be regarded as a single-round sealed bid auction in which the bidding currency is not money, but the commitments given in relation to the scoring criteria.

A well-designed scoring mechanism needs to capture the relative importance of different policy objectives and the trade-

offs that the awarding body is prepared to make, whilst at the same time supporting an objective assessment of applications. This is by no means a simple task, not least when considering that it must be possible to check that successful bidders deliver on their commitments. Without being able to monitor and enforce compliance with what the bidder has offered, whatever is stated in an application would be meaningless. This is of course a general problem, but more relevant in the case where the decision about whether a permit should be awarded to applicant A or applicant B is determined by who promises to do more in relation to specific criteria.

The scoring system already establishes a common currency (points) that makes the degree to which different policy objectives are promoted comparable and exposes the implicit trade-offs and the relative value placed on different objectives. Adding a financial component then makes explicit how much the various policy objectives are worth in money terms.

Such 'scoring auctions' can in principle also be run as ascending multi-round auctions in which bidders who are unsuccessful in one round may improve their offer in any respect they choose to gain a higher score. There may be practical issues with the implementation (e.g. with regard to the submission of 'bids', which are essentially full applications that need to be scored), but more importantly, such scoring auctions only work well if one can define quantifiable and objective criteria sufficiently fully and accurately to permit not just the calculation of a meaningful score but also to allow bidders to improve their bids in relation to any of the criteria.

Conditions for effective scoring auction are very restrictive and not typically met in practice

As Ausubel and Cramton[21] note, the good performance of scoring auction in some assessments in the literature is generally

> *"based on theoretical scenarios that seem implausible for the auction of wind rights. ...*
>
> *First, it assumes that all criteria that are relevant to the auction are quantifiable and objective.*
>
> *Second, the results assume that the bid taker—the government—fully understands the tradeoffs across all factors and can perfectly express those factors in the scoring rule. Governments often have limited*

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[21] Ausubel, L M and Cramton, P, 'Multiple Factor Auction Design for Wind Rights', September 2011; available from the BOEMRE website https://www.boem.gov/renewable-energy/auction-formats

information about these tradeoffs and make mistakes with respect to their representation. Bidders sometimes understand the tradeoffs better than the government and can exploit any government misunderstanding in their bids. In practice this leads to bid-skewing, making extreme bids either low or high on particular factors that are either expensive or inexpensive from the bidders' perspective. Bid-skewing is seen in timber auctions, Medicare auctions, and electricity auctions.

Third, many of the results apply to the auctioning of a single item. The generalization to auctioning many interrelated items often is far from trivial."

Combining a money-only auction with bidding credits determined through a scoring approach mitigates these problems

In recognition of these problems, they recommend the use of a two-stage approach in which the assessment of non-financial criteria is converted into bidding credits. Like the comparative assessment with a financial component this would require converting commitments given in relation to specific policy objectives in the bidder's application into money terms, with the resulting total amount being subtracted from the bidder's winning bid(s).

This would seem to be particularly straightforward where these other policy objectives can be met through investment into specific projects (such as investment into energy system integration/system services or into environmental protection measures, though the precise nature of these investments would obviously need to be specified). In this case, the auctioneer might specify a range of specific projects with an associated cost (based on an assessment of what it would cost a hypothetical efficient firm to deliver the project). Bidders could then choose to offer a commitment to make the investment and have the associated costs added to their bid amount.[22]

Where the amount of money associated with specific investments is not a good measure of the degree to which a particular objective will be met, the conversion of bidder commitments into bidding credits becomes more complicated,

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[22] It would then be also possible to adjust the associated investment cost dynamically. The bidding credit available from accepting a particular investment commitment would be reduced if the option is oversubscribed (i.e. if more bidders than desired would commit to deliver the project). This would help with identifying the bidder who can deliver at the lowest cost. However, such an approach requires a more complex auction design that allows bidders to bid on combinations of permits and investment commitments.

but not more so than the scoring of applications in a comparative assessment procedure with a financial component.

The framework used at present for scoring applications[23] should provide a good starting point. Applications would be scored using the non-financial criteria[24] as is the case at present and applicants need to reach a minimum score in relation to each criterion to qualify for participation in the auction. Scores in excess of the minimum threshold are then converted into bidding credits at a given amount per point (e.g. at the EUR 2.5m per point that is implied by the current weighting of the financial component). Additional criteria for which appropriate scores can be calculated can of course be added.

This approach does not overcome the fundamental challenges of scoring applications. However, it does not require recalculating scores after each round in which bidders can improve on their applications and avoids the compounding effect that any deficiencies in the scoring approach would have when applied in a multi-round setting:

> *"[a] key insight in MFA design is that it often is best to accommodate additional factors in a manner that allows a price-only auction, for example by setting key qualification requirements by giving a bidder satisfying certain factors an appropriate discount in the price-only competition. Such discounts should be kept to a minimum, and should only relate to factors that do not have an influence on the bidders own valuation of the tract. If the technical factors do impact the bidders valuation, such as investments already made by the bidder, these will be represented in the bidders bid (e.g. the bidder that has made the investment will be able to put forward a more favorable bid). Thus, including bidder discounts for these factors would potentially double count these factors and prevent meaningful competition."*

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[23] This would correspond to a minimum score required in relation to the criteria set out in Appendix (see Hollandse Kust (west) Wind Farm Zone, Appendix A: Applicable Law, Sections 2 and 3)

[24] Certainty of wind farm being completed, contribution to energy supply, contribution to the ecology of the North Sea (Hollandse Kust (west) site 6), contribution to integration into the Dutch energy system (Hollandse Kust (west) site 7).

6 Overall recommendations

Based on the preceding discussion, we would recommend the following approach for using an auction instead of a comparative selection procedure for the assignment of permits in the IJVER wind area.

For the avoidance of doubt, we would strongly advise against combining an auction for a subset of permits with a comparative assessment process for the remaining permits.

Reserve price setting

Reserve prices for permits should be determined based on the opportunity cost of assigning these permits, i.e. at least at the level of the cost of developing the site (and potentially an appropriate contribution to other costs incurred in relation to mitigating the impact of licensing parts of the seabed for the construction of windfarms). If these reserve prices are substantially below the likely market value of permits, consideration should be given to increasing them whilst being mindful of the risk of pricing off demand.

Fall-back option

Ideally, we would recommend to limit disclosure of any details about the fall-back option that would be used in the case of insufficient interest in participating in an auction to the absolute minimum and to use any flexibility that exists in relation to specifying detail to use this so that the incentives to apply to take part in an auction are not distorted. Where possible, the financial contribution that would be expected from successful applicants in a comparative selection process should not be (materially) lower than the reserve price. If necessary, the reserve price might need to be adjusted to ensure that there is no temptation to pass on the auction in the hope of being able to pick up permits for a much lower price in the fall-back option.

Choice of format

Unless synergies are very strong (i.e. efficiency may require that the outcome of an ascending clock auction be disregarded) a simple clock auction format with deferred exit bids for the assignment of unsold permits, if any should be used. Otherwise, an iterative package bidding auction should be considered.

Consultation process to help identify strength of synergies

Given that the clock auction format is a minor variation of the design already discussed with stakeholders, no further consultation may be needed, but we would recommend seeking stakeholders' views on whether they consider that the clock auction sufficiently well deals with synergies. This would suggest a consultation process offering the clock auction format as the

leading option and the iterative package design as an alternative if stakeholders expressed the view that they would not be able fully to express synergistic valuations if the clock auction design were to be used.

Application and pre-qualification

Applications from interested parties for the permits on offer should set out the criteria that applicants need to meet to qualify for taking part in the bidding process (or acquire permits at reserve, if such an assignment is possible). In their applications, bidders must specify what combinations of permits they would be willing to acquire at the reserve price. In the (unlikely) case that there is no overlap between the packages specified by the bidders, each bidder will receive the package(s) specified at reserve. Otherwise, the bidding process will be run.

If an incentive for bidders to exceed minimum prequalification requirements should be provided, offering bidding credits in exchange for certain well-defined commitments in relation to policy objectives (noting that such commitments must be enforceable, i.e. it must be possible to monitor compliance and take action in case of the commitments not being met) could be offered.