

Commission regarding preparatory work for the expansion of the transmission grid into Swedish territorial waters

Connection of offshore electricity generation



Svenska kraftnät

Svenska kraftnät is a state owned enterprise with the task of maintaining Sweden's electricity transmission grid, which consists of about 16,000 kilometres of 400 kV and 220 kV transmission lines with substations and interconnectors. Svenska kraftnät is also the system operator for electricity in Sweden. Svenska kraftnät is developing the transmission grid and the electricity market to meet society's need for a secure, sustainable and cost-effective supply of electricity. In this, Svenska kraftnät plays an important role in implementing national climate policies.

Version 1.0

Org. Nr 202 100-4284

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Summary

The state-owned enterprise Affärsverket svenska kraftnät (Svenska kraftnät), has been commissioned to carry out preparatory work for the expansion of the transmission grid into Swedish territorial waters in accordance with Government Decision I2021/02682. This work is to take into account the state's maritime spatial plans, adopted on 10 February 2022.

On 1 January 2022, the Government supplemented Ordinance (2007:1119), instructing the state-owned enterprise Svenska kraftnät to expand the transmission grid into areas in Sweden's territorial waters where there is the potential of connecting additional electricity generation facilities. The expansion of the grid will further the fulfilment of Sweden's renewable electricity generation targets.

Instructions for project promoters wishing to connect offshore electricity generation to an offshore connection point

To fulfil its commission, Svenska kraftnät sees a need for two different customer processes for project promoters who want to connect offshore electricity generation. On the one hand, an arrangement is needed whereby a project promoter connects offshore electricity generation to the transmission grid inside Sweden's territorial waters. In this arrangement the cost of connection is partly borne by Svenska kraftnät. A development of the current process, in which a project promoter connects offshore electricity generation to an onshore connection point, is also necessary; in this case the full cost is to be borne by the connecting party.

The Government's expansion model has been adapted to be compatible with EU state aid rules. The new model means that a new customer process for connection to offshore connection points needs to be developed. In developing this process, Svenska kraftnät will work to establish connection criteria that will lead to the project promoter who first obtains the necessary permits also being the one who is first offered connection.

Project promoters wishing to connect to one of Svenska kraftnät's offshore connection points will be organised in new investor pools instead of in connection queues. Svenska kraftnät intends to publish the investor pools, to provide increased transparency and to encourage collaboration between project promoters.

Criteria for project promoters regarding geographical areas and time schedules for grid expansion

Grid expansion within Sweden's territorial waters will be organised by way of calls for applications for offshore connection points. The first call for applications will be published with the publication of this report, the second in 2025 at the earliest, following a decision on new maritime spatial plans, and provided that the need for, and interest in further development is deemed to exist. The first call for applications contains a total of six prioritised maritime areas for grid expansion: The southern coast of Scania (Skåne), the coast of Halland (Halland), the southeastern Baltic, the northern North Sea (Gothenburg), the southern Bothnian Sea and the Bay of Bothnia. These areas will be prioritised by Svenska Kraftnät in the order above. The aim is for the first offshore connection point to be established in the period 2029-32 and the last in 2035.

In Scania, Halland and the southeast Baltic, there are already capacity reservations linked to the connection of offshore wind power to onshore connection points. An offshore grid expansion under the auspices of Svenska kraftnät is only possible in these three areas if the project promoters who currently have capacity reservations, and thus the agreed potential for expanding offshore electricity connections at their own expense, do not implement this expansion.

For each of the prioritised maritime areas for grid expansion, Svenska kraftnät will need to carry out a siting investigation in order to determine the appropriate location for the offshore connection point in territorial waters. A number of analyses are also required to determine the appropriate technical configuration of connection systems between the offshore connection point and the onshore transmission grid. Once the position and transmission capacity of an offshore connection point has been established, Svenska kraftnät will communicate this information and invite project promoters to register for the investor pool for that offshore connection point.

The criteria in Svenska kraftnät's instructions - such as that grid expansion under the auspices of Svenska kraftnät must take place within Sweden's territorial waters, and that the conditions necessary for the connection of multiple electricity generation facilities must be in place - stipulate the technical structure of the new offshore transmission grid and will have consequences for, among other things, coordination requirements and efficiency.

Instructions for project promoters wishing to connect offshore electricity generation to an onshore connection point

The current process regarding connection to onshore connection points, i.e., the process in which project promoters themselves choose to bear the full cost of their connection, needs to remain in place. However, there is a need for the further development of the process to make it more suitable for large-scale offshore wind power.

To create more transparent conditions for offshore electricity generation project promoters who are interested in connecting onshore at their own expense, Svenska kraftnät intends to initiate an investigation, so that it can communicate suitable onshore connection points and available transmission capacity at these prepared points. Available transmission capacity and appropriate onshore connection points will be communicated for a total of nine different coastal areas, referred to as maritime capacity zones. In its work of establishing transmission capacity for onshore connection, Svenska kraftnät will initially prioritise those maritime capacity zones not already prioritised for offshore transmission grid expansion.

Criteria for project promoters who have already submitted a connection application

Svenska kraftnät is examining the applications for connection of offshore wind power that have so far been submitted as requests for connection to an onshore connection point in the transmission grid. The connecting party is expected to pay for the entire connection.

Following a dialogue with each applicant, project promoters with applications in the current connection queue will gradually be transferred to new investor pools for onshore connection. There will be an investor pool for each maritime capacity zone. A time schedule for the implementation of a modified process for the connection of offshore electricity generation to onshore connection points will be communicated in the autumn of 2022.

Svenska kraftnät intends to fulfil its agreed investigative obligations towards project promoters with an agreement of intent regarding connection. If a project promoter with an agreement of intent regarding connection is interested in connecting to an offshore connection point in the transmission grid, such a connection point can only be realised after the capacity reservation has expired and transmission capacity has reverted to Svenska kraftnät.

Bidding zones for offshore connections

The regulatory frameworks and procedures for review and amendment of the bidding zone configuration applies both onshore and offshore. The connection of large volumes of offshore electricity generation will affect the onshore transmission system and may give rise to new flow patterns. The new flows may create new structural congestions in the grid, which can lead to the initiation of a bidding zone review and a potential adjustment of the existing bidding zone delineation.

Offshore bidding zones are mainly of benefit when offshore electricity generation is combined with interconnectors. In this context, offshore bidding zones have advantages for transmission system operators in terms of regulatory compliance and balancing. Also, offshore bidding zones reflect the constraints in the transmission grid more clearly to the market than the solution with home markets. Market participants have identified a number of disadvantages of offshore bidding zones, mainly related to uncertainties regarding pricing and anticipated revenue from electricity generation in offshore bidding zones, which affect the conditions for planning offshore electricity generation projects.

In the continued work to plan the development and expansion of the offshore grid, Svenska kraftnät will prioritize to avoid new structural congestions following offshore connections. However, given the rapid pace of change in the power system, the need for future bidding zone reviews cannot be ruled out as they might be necessary to comply with the legal framework and to handle structural congestions caused by large volumes of electricity generation in new geographical areas. In the first call for applications for offshore connection points, Svenska kraftnät's starting point is that it should be possible to manage the change in trade patterns that may arise as a result of additional electricity generation at these points through already planned measures to reinforce the onshore transmission grid.

1 Introduction

1.1 The commission

On 1 January 2022, the Government's instructions to the state-owned enterprise, Svenska kraftnät, tasked it with expanding the transmission grid offshore into areas in Sweden's territorial waters where there is the potential of connecting additional electricity generation facilities, and where such an expansion will promote the fulfilment of Sweden's renewable electricity generation targets.

Section 3 Svenska kraftnät shall also:

1. expand an electricity transmission grid in Sweden and connections to electricity grids in other countries, based on socio-economic cost-benefit assessments,
2. expand the transmission grid into areas in Sweden's territorial waters where there is the potential to connect additional electricity generation facilities, and where such an expansion will promote the fulfilment of Sweden's renewable electricity generation targets

On 15 October 2021, the Government commissioned Affärsverket Svenska kraftnät with undertaking a preliminary investigation into the expansion of the offshore transmission grid (Government Decision I2021/02682). The objectives of this commission are to:

1. highlight whether there is a need for Svenska kraftnät to develop new guidelines and instructions for project promoters wishing to connect offshore electricity generation facilities
2. where possible, describe and clarify the criteria for developers regarding, for example, time schedules and geographical areas for the expansion of transmission grids
3. clarify the criteria for developers who have already submitted a connection application, and
4. describe the criteria, advantages and disadvantages, as well as the consequences, for connected project promoters of introducing their own offshore bidding zones.

When undertaking this commission, Svenska kraftnät is to take into account Sweden's future maritime spatial plans.

The Government's reasoning behind the decision to commission Svenska kraftnät to expand the transmission grid in Sweden's territorial waters is in part because

- i. offshore electricity generation has the potential to contribute to achieving renewable electricity generation targets by 2040;
and in part
- ii. to meet the increased demand for electricity in the future.

Furthermore, the grounds for the decision state that it is important to develop offshore wind power in a way that maximises its benefits in the most cost-effective manner possible, and that offshore wind energy has the ability to supply large volumes of electric power.

Commission I2021/02682 regarding preparatory work for an expansion of the transmission grid into areas in Sweden's territorial waters is to be submitted to the Government Offices no later than 15 June 2022. This report constitutes Svenska kraftnät's account of this commission.

The term "electricity generating facility" here refers to one or more production units behind the same meter, a wind farm for example.

1.2 Related government commissions

Following the initiation of the present commission, the Government decided on 10 February 2022 to adopt Sweden's first national maritime spatial plans. In connection with this decision, the Government initiated a further official commission aimed at identifying new areas suitable for energy extraction, and at identifying the need for changes in previously designated areas of energy extraction (Government Decision M2022/00276). The aim of this commission is to identify new or changed maritime areas with an extraction potential of an additional 90 terawatt-hours (TWh) of annual electrical energy generation, in addition to the 20-30 TWh identified in the adopted plans. The commissioning authorities for M2022/00276 are the Swedish Energy Agency (with coordination and budget responsibility), Svenska kraftnät, the Swedish Armed Forces, the Swedish Agency for Marine and Water Management, the Swedish Environmental Protection Agency, the Swedish National Heritage Board, the Swedish Maritime Administration, the Swedish Board of Agriculture and the Geological Survey of Sweden.

2 Background

2.1 Offshore electricity generation in Sweden

Until now it has been difficult for offshore electricity generation to establish itself on the Swedish electricity market. The main reasons for this have been weaker competitiveness and a more complicated permitting process relative to onshore electricity generation.

The 2016 Energy Agreement constituted a political commitment to scrap connection costs for offshore wind power. This at once revitalised interest in this type of offshore electricity generation in Sweden. The proportion of the connection cost as part of the total cost of offshore wind power is project-specific, but is typically somewhere in the region of 15-30%. Scrapping connection costs thus normally create a significant improvement in the economic viability of projects for a wind power project promoter.

Offshore wind power has the potential to supply large volumes of electricity to Sweden. However, like other intermittent forms of electricity generation, large volumes of grid-connected offshore wind power pose new and greater demands on ancillary services to maintain adequate stability in the power system. For example, larger reserves may be required to balance fluctuations in the power system due to rapid changes in weather. Clear requirements will also be necessary for the capacity of this additional electricity generation to support the power system.

2.2 Description of the current interest in connection

For Svenska kraftnät, the renewed commercial interest in offshore wind power in Sweden has taken the form of an increased number of applications for connection to the transmission grid. From 2017 to 2019, Svenska kraftnät received connection requests corresponding to a power volume of 17 gigawatt (GW). Initially, these were previously designated offshore wind power development areas, which already had, at least in part, all the necessary exploitation and environmental permits, but which had not been built due to inadequate profitability. The problem with the lack of exclusivity regulation for project promoters in common waters and the Swedish exclusive economic zone became clear in the summer of 2019, when two connection requests for the same development area for offshore wind power were registered.

In 2020 there were requests for the connection of offshore wind power to the transmission grid corresponding to 19 GW. The number of new exclusivity conflicts linked to establishment was relatively limited that year.

Finally, in the wake of the Government memorandum *Minskade anslutningskostnader för elproduktion till havs* [Reduced connection costs for offshore electricity generation] (dated 2 February 2021), further connection requests equivalent to a total power volume of approximately 90 GW have been received by Svenska kraftnät. This last wave of applications has led to more exclusivity conflicts. In total, there are now sixteen geographical maritime areas in which two or more developers are simultaneously investigating conditions for the establishment of offshore wind power. In most cases, this involves the partial overlapping of adjacent areas of investigation, and in a few cases more or less identical proposed projects. At one specific location, Svenska kraftnät has received a total of four connection requests for the same area of investigation. In two other locations there is an exclusivity problem between three different developers. In the remaining thirteen cases, there is a conflict between two developers.

As a result of the problematic issue of exclusivity of establishment, the total current volume of applications, corresponding to 125 GW, cannot be seen as a theoretically realisable volume of offshore wind power. Svenska kraftnät's latest estimate is that the area of overlap in the connection queue amounts to approximately 35 GW. This means that the theoretical power volume in the connection queue – which is based on the developers' own perception of where it may be appropriate to build offshore wind power – currently amounts to 90 GW. To put it another way, the proportion of exclusivity conflicts in the connection queue is barely 30%.

Approximately 26 GW of the 90 GW net volume corresponds to areas located in Sweden's territorial waters. The remaining 64 GW can be found in the Swedish exclusive economic zone.

Based on the three Swedish maritime spatial plans, the unique areas of investigation in the current connection queue are, in terms of power, 9 GW in the North Sea, 59 GW in the Baltic Sea and 22 GW in the Gulf of Bothnia. Simply put, if offshore wind power is to contribute 100 terawatt-hours (TWh) of energy on an annual basis, this means that between 25-30% of this initial commercial interest must be realised.

3 Instructions for project promoters wishing to connect

3.1 The development of the offshore transmission grid requires a new connection process

The formulation of the Government's instructions regarding the expansion of the offshore transmission grid contains framework requirements that direct Svenska kraftnät to configure the offshore electricity grid, and to connect electricity generation facilities to this grid, in such a way that there is no need for the Swedish state to apply to the European Commission for an exemption from EU state aid rules. It is Svenska kraftnät's assessment that the current connection process will not be able to fulfil the framework requirement of creating the conditions for the connection of several project promoters in a transparent and timely manner. In order to promote Swedish renewable energy targets, there is therefore a need to develop a new process.

The current connection process is based on a queueing principle, whereby a place in the queue is allocated to a project promoter when it submits an application for connection. If the requested need for transmission capacity can be met, the first project promoter in the connection queue is asked to sign an agreement of intent for connection. If the connection is then deemed feasible, the project promoter is given the opportunity to connect to the transmission grid at their own expense. This procedure rewards those who submitted their application early in their project planning process. This means that there is a risk that the first project in the queue is not the project with the greatest degree of maturity when it comes to the permit process, or the practical potential to be connected first. The first project thus risks blocking other projects in the queue that have the potential for an earlier contribution to Sweden's renewable energy targets.

Offshore connections are normally very large and a single connection case risks absorbing all of the available transmission capacity in a coastal area. If the first project promoter in the queue is not in fact in a position to be connected first, this blocks other project promoters in the area. To avoid this, a completely new and tailored connection process for offshore electricity generation facilities needs to be developed.

Svenska kraftnät has initiated preparatory work to develop a new connection process for project promoters wishing to connect offshore electricity generation facilities to the offshore transmission grid that will be constructed under the auspices of Svenska kraftnät. The aim is for this process to be launched in the second quarter of 2023. A dialogue with the industry regarding the new

connection process for offshore electricity generation facilities will be provisionally be conducted in the autumn of 2022.

During its preparatory work, Svenska kraftnät has already been able to ascertain that the instructions of the Government that it has to follow means that both the connection process and the fundamental technical configuration of the new offshore electricity grid will differ from the principles applied in other Member States in the EU and the rest of Europe. One important difference is the decentralised Swedish siting model for offshore wind power, where the developers themselves can choose where to plan facilities and apply for permits for these. This procedure exists in some other countries, but is relatively rare in a wider international context. Another important difference is that the connection processes chosen by several other EU countries require derogations from the EU regulations on state aid. The Swedish model as a whole has no equivalent in the wider world.

The international wind power companies that have expressed an interest in Swedish waters following the Energy Agreement in 2016, can be characterised by their experience of the British, Danish, Dutch or German processes for the grid connection of offshore wind power. To avoid the risk of unfounded expectations regarding the conditions offered by the Swedish grid connection model, it is important that an indicative practical interpretation be provided of Svenska kraftnät's instructions. The aspects that need to be highlighted in such an interpretation include the technical configuration of the proposed Swedish offshore transmission grid, how transmission capacity will be allocated, and the criteria that will be set for obtaining an offer to connect to the offshore grid. A description of the overall process and the necessary conditions for expansion that Svenska kraftnät envisages, is also justified in the light of the expectation of a rapid expansion of offshore wind power in Sweden. In their dialogue with Svenska kraftnät, wind power project promoters often return to the need for greater clarity. By describing the practical implications of Svenska kraftnät's instructions from the Government at this time, these project promoters also have the necessary opportunity to revise their project proposals in order to meet the requirements of the future Swedish grid connection framework.

An interpretation of the practical implementation of the instruction is detailed below. This description is preliminary, and is provided with the clear proviso that an investigation into the details of the new connection process is underway. Some changes may therefore be necessary after further dialogue with the industry. The concepts used may be renamed when the connection process is complete, and some new elements may be added.

3.2 Connection and expansion process for offshore connection points

3.2.1 Calls for applications and the provision of transmission capacity for offshore electricity generation

Svenska kraftnät will organise the development of the offshore transmission grid in Sweden's territorial waters by way of successive calls for applications. Each call for applications will provide a given volume of transmission capacity. In each call for applications, the transmission capacity will be divided between two to six connection systems, each linking one or more onshore connection points with an offshore connection point in Sweden's territorial waters. The scope of the first calls for applications of offshore connection points and their associated connection system will be formally announced with the publication of this report. A second call for applications will be announced at the earliest in 2025, following the drafting and adoption of new maritime spatial plans with further designated maritime areas for energy extraction.

Transmission capacity for offshore electricity generation will be provided at offshore connection points constructed within Sweden's territorial waters under the auspices of Svenska kraftnät. Svenska kraftnät will need to reserve transmission capacity at multiple points on the onshore transmission grid so as to be able to provide offshore capacity. The basic principle of these reservations will be to reserve transmission capacity for connection systems for offshore electricity generation only in areas where:

- (a) there is a low likelihood of capacity conflicts with onshore electricity generation
- and where:
- (b) the risk of increased exposure to bottlenecks in the onshore transmission grid with an impact on cross-zonal trade is limited.

Reservations of transmission capacity in favour of connection systems for offshore electricity generation will be taken into account in the ongoing analyses and long-term planning of the onshore transmission grid.

3.2.2 Technical configuration of offshore connection systems

Svenska kraftnät will investigate and adapt the choice of transmission technology – high voltage direct current (HVDC) or alternating current – to the regional conditions prevailing in areas where offshore grid expansion has been announced. This provides the potential to achieve a solution that is as suitable, cost-effective and environmentally sound as possible in each area.

In its first call for applications Svenska kraftnät will not consider HVDC as a technical configuration for offshore connection points where more than 1,400 MW of transmission capacity is to be provided. The reason for this is so as not to exceed the current dimensioning loss of generation in the Nordic power system.

With regard to connection systems that are constructed using an alternating current configuration, Svenska kraftnät's is planning for them to have a nominal voltage level of 220 kV. However, higher voltage levels may be considered if there are clear advantages to this. For example, 400 kV may be used for short distances.

The choice of transmission technology and distance to the electricity generation facilities requiring transmission capacity at an offshore connection point will influence the electrical configuration of the latter. In principle, Svenska kraftnät understands that several different electrical configurations for offshore connection points may be applicable. Svenska Kraftnät can develop connection systems in either DC or AC configurations. Connection on the platform is provided in AC distribution switchgear at a nominal voltage level of 220 kV. If connected electricity generation facilities are close to the platform, connection can be provided at the same voltage level as the electricity generation facility's internal cable network, at 66 kV for example.

The standard concepts for the electrical configuration of offshore connection points will need to be developed over time, taking account of future advances in technology.

New connection systems for offshore electricity generation, constructed in accordance with Svenska kraftnät's instructions from the Government, can either be connected radially to the Swedish onshore transmission grid or combined with an interconnector between bidding zones. While the former simple connection systems need not be based on a socioeconomic cost-benefit assessment when they are constructed in accordance with Svenska kraftnät's instructions from the Government, Section 3.2, the latter combined hybrid systems require a review of the cost-benefit for society when they are constructed in accordance with Section 3.1 in Svenska kraftnät's instructions from the Government. Radial connection systems generally entail significantly lower technical complexity and shorter implementation times, which is important in helping to meet climate targets. The first grid expansion phase therefore focuses on radial network solutions. Svenska kraftnät, however, is monitoring the issue of future hybrid systems, and has an ongoing dialogue on this subject with the transmission system operators of neighbouring countries.

3.2.3 Position and transmission capacity of offshore connection points

When Svenska kraftnät announces areas for the expansion of the transmission grid in Sweden's territorial waters as part of a new call for applications, the announcement will be accompanied by preliminary information on the transmission capacity made available to electricity generators in each area. Svenska kraftnät will, when the call for applications is announced, also provide information on a mutual order of priority between the areas and a preliminary date for when transmission capacity in each area can be provided. The dates are indicative, and will also depend on the availability of a sufficient number of offshore electricity generation facilities with a permit and suitable for connection in the relevant area.

When Svenska kraftnät has published the offshore grid expansion areas that form part of a call for applications, siting investigations and technical analyses will be initiated in each expansion area in line with the order of priority and time schedule announced by Svenska kraftnät. These investigations determine the connection point(s) to the onshore grid, the technical solution for the connection system and the location of the offshore connection point in Sweden's territorial waters. The technical analyses will also result in a confirmation or revision of the preliminary transmission capacity data announced in connection with the publication of the relevant call for applications.

Once the investigation of an offshore connection point and associated connection system has been completed, Svenska kraftnät will communicate the position of the offshore connection point and the transmission capacity made available to electricity generators at the connection point. This communication will also be accompanied by an updated target regarding the completion dates for the rollout of grid expansion.

In maritime areas where the commercial interest for the establishment of offshore wind power lies almost exclusively in Sweden's exclusive economic zone, Svenska kraftnät, in view of its mandate, will endeavour to locate the platform that houses the offshore connection point adjacent to the border of Sweden's territorial waters with the exclusive economic zone.

Svenska kraftnät's goal is to provide transmission capacity in the region of 1,200 – 2,000 MW at the offshore connection points.

3.2.4 Investor pools for offshore connection points

Once the position and transmission capacity of an offshore connection point has been announced, Svenska kraftnät will offer project promoters wishing to connect offshore electricity generation facilities the opportunity to register

their interest in connection to the transmission grid at the point in question. Project promoters with a connection application in the applicable maritime area who have submitted this request within the framework of the current connection process, will be contacted directly with information about this opportunity. New entrants with project ideas with no corresponding connection case drafted earlier, will be publicly offered the opportunity to register their interest in connection.

On the basis of the expressions of interest received regarding connection to an offshore connection point, Svenska kraftnät will establish a specific investor pool for the transmission capacity provided at that specific point. In relation to that, Svenska kraftnät sees a need to raise the level of requirements for expressions of interest in offshore connection points compared with today's applications for connection to the onshore transmission grid. Interested parties will be asked for a detailed report regarding the status of permits applied for and obtained, as well as their position and impact on the projects. Svenska kraftnät will publish submitted information. An investor pool charge may be applicable in order to cover the cost of managing these pools.

In the application to an investor pool, parties interested in connection will need to declare the volume of transmission capacity required. At each offshore connection point, there will need to be a cap at which the transmission capacity of an individual project promoter can be set to comply with the requirement to allow the connection of multiple electricity generation facilities and not trigger the EU state aid rules.

The investor pools for the offshore connection points, constructed under the auspices of Svenska kraftnät, will need to be published to allow reasonable transparency between project promoters in the same investor pool.

3.2.5 Allocation of transmission capacity at an offshore connection point

Svenska kraftnät's instructions from the Government regarding offshore grid expansion are designed to avoid the selective favouring of any individual project promoter. To provide reasonable conditions for complying with the requirement to allow the connection of multiple electricity generation facilities, the first project promoter that fulfils the set criteria for signing a connection agreement, cannot be allocated all available transmission capacity at the offshore connection point. A certain volume of transmission capacity must be set aside for other electricity generation facilities. At the same time, the capacity volume made unavailable to the first project promoter must be sufficient to provide adequate commercial viability for another project promoter to invest in a neighbouring electricity generation facility.

Svenska kraftnät deems that an appropriate benchmark for the volume of transmission capacity that needs to be set aside for electricity generation facilities other than the one first offered, at an individual offshore connection point is 600 MW. In engineering terms, this corresponds to approximately two three-phase 220 kV submarine cables. The volume of transmission capacity allocated to electricity generation facilities other than the one first offered, may need to be adjusted. It may therefore be appropriate to offer both smaller or larger volumes than the 600 MW benchmark to project promoters other than the one initially offered a connection, provided that there are expressions of interest for an output that justify this. It will also be necessary to develop principles for capacity allocation in a situation where two project promoters are offered connection at the same time.

As a consequence of the requirement to share offshore connection points between multiple generation facilities, there will be ceilings on the amount of transmission capacity that can be subscribed by individual project promoters. For an offshore connection point with a total transmission capacity of 1,200 MW, the maximum possible subscription for a single project promoter will be 600 MW. Correspondingly, for an individual project promoter at an offshore connection point with a transmission capacity of 2,000 MW, the highest possible subscription will be 1,400 MW.

Criteria will need to be developed to determine which project promoters are offered connection at an offshore connection point. Svenska kraftnät judges that these criteria need to be designed so that the electricity generation facilities that first obtain the necessary permits, and thus can be realised first, are also to be the electricity generation facilities that are connected.

At the beginning of April 2022, the Swedish Agency for Marine and Water Management was commissioned by the Government to investigate how exclusive rights to areas in common waters and Sweden's exclusive economic zone should be regulated (Government Decision M2022/00768). In relation to this, Svenska kraftnät notes that a connection process in accordance with the Electricity Act always has the potential to result in an exclusive offer of connection. However, it is not desirable for the connection process to be decisive in matters regarding which electricity generating facility should be realised in a maritime area. Svenska kraftnät advocates that the exclusive rights to an area be determined in a permitting process.

3.3 Further development of the onshore connection point process

The sixty plus applications for the connection of offshore wind farms that have been received by Svenska kraftnät, are currently being handled in line with the

current process for connection to the transmission grid. The starting point for this type of application is that the applicant pays for its entire electricity connection itself, as well as for Svenska kraftnät's customer-specific costs. The volume of applications far exceeds the available transmission capacity, even in coastal areas where there is currently a significant electricity generation shortfall.

The opportunity for a wind power developer to connect to an onshore point in the transmission grid, i.e., a self-financed electricity connection, needs to continue to exist in parallel with the opportunity to connect to an offshore connection point constructed by Svenska kraftnät. Today the extent to which the onshore connection point procedure will be utilised in practice is difficult to assess and depends on a number of factors.

A typical situation for which the procedure could be updated, is where there is a development area for wind power with a permit and with good economic potential in an area that has not been prioritised for the expansion of Svenska kraftnät's transmission grid. If, in this situation, the wind power developer does not want to wait for that area to be prioritised in any future call for applications under the auspices of Svenska kraftnät, there should be an "open-door" for the wind power developer to build the entire grid connection itself at its own expense. With regard to this metaphor, the process by which a project promoter plans and builds the connection of offshore electricity generation to an onshore connection point at its own expense, is referred to in this report as an open-door procedure.

Applications for connection are currently queued according to the date of registration with Svenska kraftnät. The current process for applications relating to the connection of offshore wind power, due to the magnitude of the applications in terms of output, only allows a limited number of connection cases to be taken forward to the investigation phase that Svenska kraftnät refers to as a feasibility analysis. This takes place through an agreement of intent regarding connection. However, the majority of cases cannot be taken forward in the connection process because transmission capacity has already been reserved for the cases that were submitted first. If further agreements of intent are signed, the capacity of the transmission grid will be overbooked. This would mean that Svenska kraftnät could run a clear risk of not being able to fulfil its part of the connection and agreement of intent it had entered into.

If the connection cases with signed agreements of intent regarding connection also correspond to the offshore wind farms that in practice are best placed to be granted a permit, and thus realised first, this would be beneficial in promoting Sweden's renewable electricity generation targets. The current connection process must then be considered to also be appropriate for offshore wind power and to serve its purpose well.

However, Svenska kraftnät concludes that it is currently not possible to ensure that this can work in reality. The reason for this is that the project promoter who is at the front of the queue and has signed an agreement of intent regarding connection, may not work with the electricity generating facility that first obtains all of the necessary permits and be realised. If any project promoter further back in the queue is ready to connect before the project promoter with an agreement of intent, the former will be blocked by the electricity generation facility not granted a permit for which capacity has been reserved in the agreement of intent.

Svenska kraftnät's overall assessment, which is based on the experience gained from 2017-2020, is that a need exists to allow more project promoters to work relatively independently on the grid connection issue. It is therefore not only a new process for connection to the offshore connection points - constructed within the framework of Svenska kraftnät's instructions - that is necessary. The process for project promoters willing to pay for the entire electricity connection and to connect to an onshore connection point also needs to be reviewed and made more efficient.

In order to address the challenges identified in the current onshore connection process, Svenska kraftnät has also initiated a review of the framework for this process.

Svenska kraftnät can already describe the main features of the new administrative process for this type of connection case. Due to the great interest of the project promoters in this issue, it is necessary to qualitatively describe a number of key concepts in this report. The description, which does not constitute a formal commitment, creates the necessary conditions for a continued constructive dialogue with the industry throughout the remainder of 2022; this will be important if grid expansion and its associated connections are to be implemented quickly. As this description is preliminary, Svenska kraftnät wishes to make a clear its reservations regarding the changes that may be made in the continued work on process development.

3.3.1 Maritime capacity zones and capacity maps

In order to structure grid planning and management of the large number of connection cases in this context, Svenska kraftnät has divided the three maritime spatial plans into nine *maritime capacity zones* in accordance with Figure 1.

- > **The North Sea maritime spatial plan** is divided into two maritime capacity zones; (1) northern North Sea and (2) the Kattegat.
- > **The Baltic Sea maritime spatial plan** is divided into five maritime capacity zones; (3) the southwestern Baltic Sea, (4) the southeastern Baltic Sea, (5) the central Baltic Sea 1, (6) the central Baltic Sea 2 and (7) the northern Baltic Sea.
- > **The Gulf of Bothnia maritime spatial plan** is divided into two maritime capacity zones (8) the Bothnian Sea and (9) the Gulf of Bothnia.

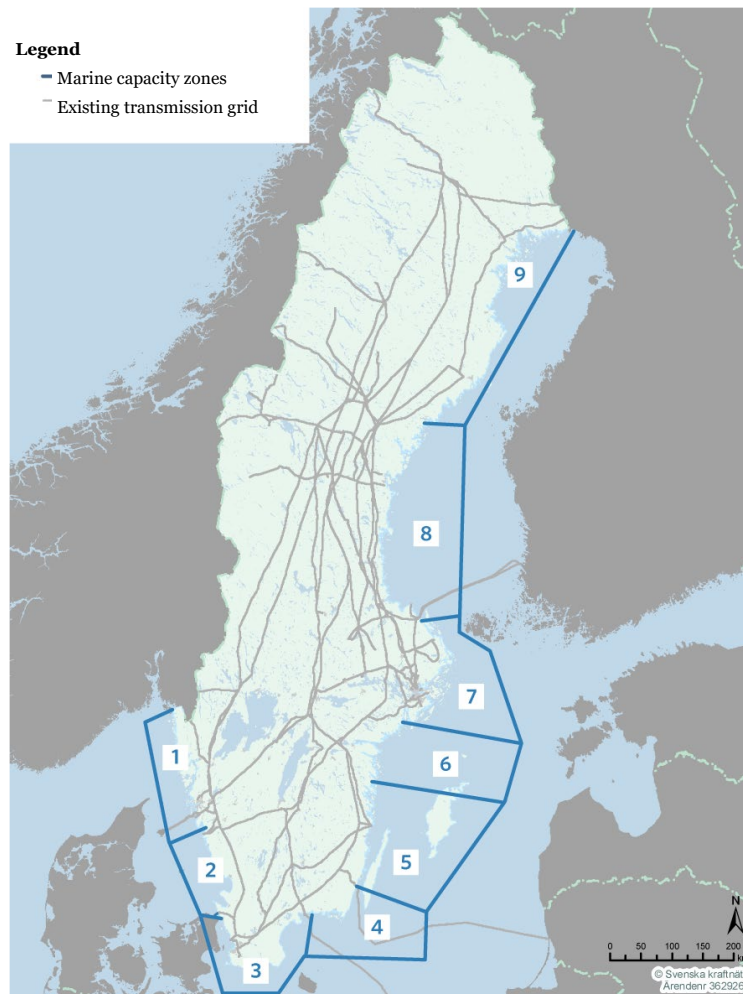


Figure 1. Maritime capacity zones.

In each maritime capacity zone that Svenska kraftnät announces the expansion of an offshore transmission grid, a proportion of the zone's available transmission capacity needs to be reserved for the offshore connection points constructed under the auspices of Svenska kraftnät. In some cases, a large part of the available transmission capacity of the maritime capacity zone for power input along the coastal zone will need to be used for the offshore connection points. In other cases, there will be transmission capacity left to be allocated at onshore connection points. This may be the case in the maritime capacity zones that Svenska kraftnät does not prioritise in a first call for applications for its own offshore connection points

In order to create transparency and a level playing field for all project promoters competing for transmission capacity in the same marine capacity zone, Svenska kraftnät intends to publish a *capacity map for offshore electricity generation*. This capacity map will detail the transmission capacity that Svenska kraftnät can make available for onshore connection points in each maritime capacity zone. The analyses underlying the assessment of available transmission capacity volumes for offshore electricity generation, need to take into account both reserved transmission capacity at offshore connection points and estimates of the future needs for onshore electricity generation.

To ensure predictability, the publicly announced transmission capacity in each maritime capacity zone will be locked for a provisional period of four years at a time. If, after that time, transmission capacity has not been reserved for the benefit of any offshore electricity generation facility, Svenska kraftnät reserves the right to use part or all of this capacity for onshore electricity generation if this is needed at that time. Svenska kraftnät will also be able to use the transmission capacity to benefit the next call for applications for offshore connection points when these four years have passed. In other words, the transmission capacity can also be used in a new preliminary booking for a call for applications for offshore connection points constructed under the auspices of Svenska kraftnät.

When the four years have passed, and Svenska kraftnät may have reserved part of the available transmission capacity for open-door connections of offshore wind power for other purposes, the capacity map is updated and locked for a further four-year period. The available transmission capacity announced in the maritime capacity zones may then have decreased or increased, depending on whether there has been grid reinforcement in the onshore transmission grid or if any other systems engineering conditions have changed.

During the time that the capacity map is locked, it is possible for network companies that can commit to providing electricity connections for offshore wind farms to the Swedish onshore transmission grid to register their interest in publicly announced open-door capacity. Expressions of interest will be

administered in special open-door connection pools linked to each maritime capacity zone.

3.3.2 Investor pools for connection to onshore connection points

Once the new open-door process for offshore power generation facilities has been implemented, registered applications for connection from project promoters without an agreement of intent regarding connection, will be transferred to a new investor pool for the maritime capacity zone where the development area for offshore wind power for which the application has been made is located. An open-door connection investor pool will be established for each maritime capacity zone. Project promoters will be informed when the applications in the current connection queue are transferred to the new investor pools.

When the investor pools are established, the applicants will be required to supplement their applications, detailing their permit status in a format defined by Svenska Kraftnät. Svenska kraftnät's starting point here will be that the required information will be made public. This will include information such as the location and size of projects. By publishing the investor pools for open-door connections for each maritime capacity zone, each project promoter will gain an insight into the situation with regards regional competition for available transmission capacity. This can serve as a basis for the project promoters' decisions as to whether time and resources should be invested in obtaining a line concession for connection lines.

It is Svenska kraftnät's preliminary assessment that a project promoter should not be permitted to be in both an investor pool for an open-door connection and in an investor pool for an offshore connection point if the project promoter's development area is located in a maritime capacity zone where there is capacity scope for both types of connection. However, it should be possible to move the expression of interest between the two investor pools during the four-year period when the capacity map for open-door connections is locked.

A project promoter may utilise all of announced open-door capacity in a given maritime capacity zone. This differs from the procedure for connection to an offshore connection point in the instructions from the Government, under which capacity is to be provided to several project promoters.

As the main criterion for a formal allocation of transmission capacity at an onshore connection point, Svenska kraftnät intends to introduce an improved priority principle based on the fundamental idea that the project promoter who first obtains the necessary legally binding permits, will be the one who is first offered connection. It is intended that the capacity allocation criteria for

offshore electricity generation connected to the onshore and offshore transmission grids respectively, be as similar as possible.

3.3.3 Notification of the locations of possible onshore connection points

The purpose of announcing capacity pots for open-door connections in geographically well-defined sea capacity zones, is to enable more project promoters to independently carry out the preparatory work required to be able to apply for line concessions for connection lines to an offshore electricity generation facility.

In order for those actors that are willing to take responsibility for the construction of offshore wind connection systems to be able to prepare a line concession application, Svenska kraftnät needs to provide locations onshore suitable for building onshore converter stations in the maritime capacity zones where there is capacity available for open-door connections.

As part of the connection process today, Svenska kraftnät issues a notice of a connection point within the framework of a detailed feasibility analysis preceded by an agreement of intent regarding connection. In a further development of the open-door process, Svenska kraftnät intends instead to proactively develop connection points on land, without there being an agreement of intent in place. The location of these points will then be communicated to all those who have expressed an interest in open-door connection in the applicable maritime capacity zone. The project promoters' own investigations into suitable corridors for connection lines can be used as a basis for station location investigations.

3.4 Description of the techno-economic consequences

The legal framework of Svenska kraftnät's instructions from the Government will essentially inform the structure of the new offshore transmission grid. From an international perspective the expansion principles will be unique. This may pose challenges in a relatively mature industry where there is international industry best practice on how to connect offshore wind farms so as to achieve a technical solution at the lowest possible total cost and minimum possible environmental disruption.

The main difference between the Swedish model and the expansion models in other European countries is that the latter adopt a more integrated approach in which grid connection and wind farms are developed together holistically. For example, the continental expansion models always mean that the location of the offshore connection point is co-optimised with the configuration of the wind farm's internal cable network, as this provides the most efficient technical solution. The models in other European countries are based on a government-led auction model, in which the transmission system operator, together with the competent authority for maritime planning, prepares the offshore project. Project promoters wishing to build offshore electricity generation subsequently compete by way of an auction. This model means an increase in planning for all project promoters, with a reduction in permit issues and reduced risk in terms of time and cost.

The connection point, which is made up of a transformer substation or converter substation, is always located in the direct vicinity of the electricity generation facility, regardless of whether it is located in the country's territorial waters or in its exclusive economic zone. Common to models with co-optimised electricity connection and electricity generation facility development, is that the owner of the electricity generation facility does not need to pay for the entire investment in the electricity connection. Who constructs the connection can vary. Furthermore, the entire connection system is often owned and managed by a transmission system operator.

Due to the legal framework, the Swedish offshore grid expansion process will need to run in parallel and be coordinated with the development work of several wind power developers. This entails a greater risk of time schedules and permit processes being out of step with each other compared to the expansion models used by other EU member states.

One distinctive factor that departs from international industry practice for offshore grid expansion is the existence of "intermediate platforms", as several of the project applications received so far are outside Swedish territorial limits. These intermediate platforms will house offshore connection points where

multiple electricity generation facilities will be connected to a common onshore link. From a technical point of view, it would be advantageous in many cases if the intermediate platform within the maritime territory could be dispensed with. The existence of intermediate platforms and several smaller electricity generation facilities may lead to greater physical intrusion and a more widespread visual impact compared with larger, coherent offshore electricity generation facilities. The grid design principle with intermediate platforms will increase the total cost of connecting offshore electricity generation in Sweden. One reason for this is that there will continue to be a need for platforms located adjacent to the electricity generation facilities.

The economic benefit for project promoters wishing to connect offshore electricity generation located in Sweden's exclusive economic zone, is that they do not have to bear the costs of the onshore converter station and the connection line out to the intermediate platform.

There is a practical upper limit to the amount of transmission capacity that it is appropriate and practical to provide at an individual offshore connection point. The condition imposed by Svenska kraftnät's instructions from the Government, that it must be possible to connect multiple electricity generation facilities, means that the available transmission capacity needs to be distributed among several project promoters. This limits the amount of transmission capacity to which an individual project promoter can be allowed to subscribe. Two or more small electricity generation facilities will be connected at each connection point, instead of one large one.

A substantial sized offshore wind farm is particularly important in order to keep the return on investment period down for projects planned in deeper waters some way out in Sweden's exclusive economic zone. So, the condition that there is to be the possibility of connecting several project promoters can have an impact on the willingness of the project promoters to invest.

A practically acceptable upper limit for the volume of transmission capacity that can be provided at an offshore connection point is in the range 1,800 – 2,000 MW. These levels require that the connection systems providing transmission capacity to the offshore connection point are configured for alternating current. If the transmission capacity at the offshore connection point is to be distributed as equitably as possible between two project promoters, this means a possible capacity allocation of up to, at most, 900 – 1,000 MW per electricity generating facility. However, the typical size of an application in Svenska kraftnät's connection queue is currently in the region of 1,200 – 2,000 MW. In terms of volume, this means that even at the very largest offshore connection points, the allocation potential will be less than the requirements contained in the majority of applications in Svenska kraftnät's connection queue.

The preliminary benchmark of setting aside at least 600 MW of transmission capacity to a project promoter other than the one initially offered a connection, creates the conditions in the largest offshore connection points for connecting a coherent electricity generation facility in the order of 1,200 – 1,400 MW. However, such an allocation of transmission capacity at a single offshore connection point, presupposes that there is a genuine interest in connecting a small-scale electricity generating facility with an installed capacity of 600 MW in the applicable maritime area.

In summary, the Swedish model will differ in some respects from the situation in other countries. Above are some areas where an adjusted framework could contribute to, among other things, increased efficiency and lower total costs.

4 Offshore grid expansion areas

4.1 Siting considerations

In selecting maritime areas for grid expansion, the fundamental criterion for selection is that there is a documented interest from several project promoters to construct electricity generation facilities. In addition, new offshore connection points for the connection of new electricity generation should preferably be located in coastal areas with a clear shortfall of electricity generation or in coastal areas where electricity consumption is expected to increase sharply over the next 10-15 years. This makes it possible for the additional electricity generation connected to a new offshore transmission grid to benefit consumers and the climate as much as possible.

In addition, the regional availability of transmission capacity in the onshore transmission grid needs to be good along the coastal areas where offshore grid expansion is being considered. Furthermore, grid expansion needs to be planned in such a way that no significant additional regional electricity generation in the future will introduce a new barrier to cross-zonal electricity trade. In assessing the availability of transmission capacity, announced grid investment plans and anticipated changes to electricity trade patterns now need to be taken into account.

In the siting and configuration of connection systems to provide transmission capacity to offshore connection points, it is important to aim for the widest possible geographical distribution. This ensures an even distribution of electrical power input into the transmission grid, and thus a more optimal grid utilisation. Geographical distribution across many coastal areas may also have a smoothing effect on variations in wind power generation.

In order to meet the requirement of enabling additional connections, the new offshore connection points can only be sited in maritime areas where there is an identified commercial interest from several project promoters to build offshore electricity generation. In prioritising marine areas where such an interest exists, the existence of development areas, where one or more project promoters have already obtained an exploitation or environmental permit, is an important parameter. This is because permits that are in place constitute an acknowledgement that the offshore transmission capacity provided by Svenska kraftnät may be utilised relatively quickly.

Finally, predictability and planning for both the permit granting authorities and other relevant public actors are a key factor. Here the adopted maritime spatial plans are a guiding principle in joint planning by the state. Therefore,

the existence of designated energy extraction areas or investigation areas in the applicable maritime spatial plans are also an essential selection parameter.

4.2 The first call for applications for offshore connection points

4.2.1 Three to six prioritised grid expansion areas

It is the overall assessment of Svenska kraftnät that including a minimum of three and a maximum of six grid expansion areas in a first call for applications for offshore connection points will be appropriate. The number of prioritised grid expansion areas cannot be accurately identified at present because all available transmission capacity in three of these areas is currently reserved at onshore connection points by three different offshore wind power project promoters. The capacity reservations in question are premised on these project promoters paying for the entire connection themselves.

If any project promoter, that currently has an agreement of intent regarding connection in accordance with the current connection principle, does not fulfil its obligation, the agreed reservation of transmission capacity expires. If this is the case, and assuming that the capacity reservation is related to a prioritised area for grid expansion, Svenska kraftnät intends to initiate an investigation into a new offshore connection point in the relevant maritime area within the framework of its instructions.

Once the position and transmission capacity of the offshore connection point has been communicated, an investor pool will be established for it. The project promoter that previously had an agreement of intent regarding connection to an onshore connection point can then, on the same terms as other project promoters wishing to establish offshore electricity generation in the same geographical area, register their interest in a connection to the offshore connection point provided by Svenska kraftnät.

The different terms of reference for commitments linked to existing capacity reservations make it appropriate to categorise the prioritised areas for grid expansion as follows:

Type U Area announced for grid expansion

A U area refers to a prioritised grid expansion area where there are currently no project promoters with an agreement of intent regarding connection to an onshore connection point (according to the open-door principle).

In these areas, Svenska kraftnät can immediately initiate an investigation into location and potential transmission capacity that can be provided at an offshore connection point.

Type UR Area announced with an existing capacity reservation

A UR area refers to a prioritised grid expansion area where there are project promoters with an agreement of intent regarding connection to an onshore connection point (according to the open-door principle). If the agreed reservation of transmission capacity is not utilised, Svenska kraftnät intends to provide at least the equivalent capacity at an offshore connection point to which several electricity generation facilities must be able to connect.

Of the six prioritised areas in total in the first call for applications, three are Type U areas and three are Type UR areas. Consequently, the scope of the call for applications can be three to six offshore connection points, depending on the number of project promoters with an agreement of intent regarding connection who choose to pursue their current plans.

4.2.2 Prioritised Type U expansion areas - where Svenska kraftnät intends to investigate the location and potential transmission capacity of an offshore connection point

Svenska kraftnät will initiate preparatory work for a grid expansion aimed at connecting offshore electricity generation in the following geographical areas.

- > Gothenburg
- > Southern Bothnian Sea
- > Bay of Bothnia

An investigation into the siting of an offshore connection point in the North Sea west of Gothenburg will provisionally focus on Sweden's territorial waters in the area between Lysekil to the north and Billdal to the south. The target for the

northern North Sea off Gothenburg is to be able to provide at least 1,200 MW of transmission capacity.

An investigation into the siting of an offshore connection point in the southern Bothnian Sea will provisionally focus on Sweden's territorial waters in the area between Hudiksvall to the north and Axmar bruk to the south. In the southern Bothnian Sea, Svenska kraftnät's target is to be able to provide at least 1,400 MW of transmission capacity.

An investigation into the siting of an offshore connection point in the Bay of Bothnia will provisionally focus on an area in Sweden's territorial waters in the area between Malören to the north and Pite-Rönnskär to the south. In the Bay of Bothnia, Svenska kraftnät's target is to be able to provide at least 1,400 MW of transmission capacity.

At all locations, the expansion of transmission capacity may be rolled out in several phases.

In both Västra Götaland and Norrbotten counties, there are plans for extensive electrification, both of existing industry and also of startups. The increased use of electricity in these regions aims to reduce the use of fossil fuels in the iron and steel industry among others, having the potential to become an important part of Sweden's and Europe's climate efforts. It is generally desirable, when the potential for this is available, to direct new electricity generation towards areas where the electricity will be consumed. This can reduce both the need for grid reinforcement onshore and transmission losses in the transmission grid.

Regarding the southern Bothnian Sea, there are several designated energy extraction areas or areas of investigation in the adopted maritime spatial plans for this maritime area. It is predicted that in proximity to this coastal area there will be a sharp increase in electricity consumption linked to, among other things, the data centre industry and new process industries. The planned reinforcement of the transmission grid towards Mälardalen creates the conditions for balancing the increased electricity consumption linked to growth and electrification in this geographical area.

In all Type U call for applications areas (Gothenburg, the southern Bothnian Sea and the Bay of Bothnia), Svenska kraftnät already has plans in place to take reinforcement measures in the onshore transmission grid. The completion of at least part of this ongoing grid reinforcement is a necessary condition for providing transmission capacity to the offshore connection points.

In the Gothenburg area there is some dependence for capacity on the planned new 400 kV line between Skogssäter and Ingelkärr, in the area between Trollhättan and Gothenburg. In the southern Bothnian Sea, the Kustpaketet (coastal package) is part of the NordSyd (North South) investment programme. Finally, for the Gulf of Bothnia, there is the recently adopted investment

package along the Norrland coast. Because the measures to reinforce the grid are not expected to be fully implemented until 2030-2033, this affects the timing of the provision of transmission capacity to project promoters wishing to connect offshore electricity generation in these areas.

With the proviso that time schedules will need to be refined, and that priorities may have to be looked at, Svenska kraftnät aims to provide transmission capacity for offshore electricity generation in 2032 for Gothenburg, in 2033 for the southern Bothnian Sea and for the Gulf of Bothnia in 2035.

4.2.3 Prioritised Type UR expansion areas - areas with capacity reservations at onshore connection points

If current capacity reservations at onshore connection points expire, Svenska kraftnät also intends to undertake grid expansion aimed at connecting offshore electricity generation in the following geographical areas.

- > The southern coast of Scania (southwestern Baltic Sea)
- > Halland (Kattegat)
- > Southeastern Baltic Sea

An investigation into the siting of an offshore connection point to the south of Scania will provisionally focus on Sweden's territorial waters in the area between Trelleborg to the west and Ystad to the east.

An investigation into the siting of an offshore connection point in the Kattegat off the coast of Halland will provisionally focus on Sweden's territorial waters in the area between Falkenberg to the north and Laholm to the south.

An investigation into the siting of an offshore connection point in the southeastern Baltic Sea will provisionally focus on an area in Sweden's territorial waters that includes the southern part of Mörbylånga municipality and the eastern part of Karlskrona municipality.

The aim is to provide between 1,400 and 2,000 MW at an offshore connection point in each of these expansion areas. The expansion of transmission capacity may take place in several stages.

The applicable coastal areas are all outside current bidding zone 4, which is a deficit area in terms of electricity generation. The connection of offshore wind power in these areas has the potential to benefit Swedish, Nordic and European consumers. The proximity to the interconnectors in southern Sweden also means that new electricity generation connected in the area will occasionally contribute system benefits to the transmission grid further north. This is because the internal bottlenecks in bidding zone 3, currently brought to light in

connection with the high volumes of electricity exports from Sweden, may be relieved.

Svenska kraftnät judges that it could be possible to provide transmission capacity at offshore connection points in the current Type UR areas in the period 2029-32. However, this assumes that the current capacity reservations for connection to onshore connection points are not utilised. Svenska kraftnät may return to this issue with a more precise commitment regarding the date for each Type UR call for applications area if grid expansion in Sweden's territorial waters becomes a fact for these areas under the auspices of Svenska kraftnät.

4.2.4 Order of priority for call for applications 1, offshore connection points

For continued planning, Svenska kraftnät has established a preliminary order of priority that includes all six areas included in the first call for applications for offshore connection points. The three highest priority geographical maritime areas for grid expansion are all of Type UR; in other words there are capacity reservations at onshore connection points that need to be respected.

The following overall order of priority for grid expansion in territorial waters applies:

1. Southern coast of Scania (UR)
2. Halland (UR)
3. Southeastern Baltic Sea (UR)
4. Gothenburg (U)
5. Southern Bothnian Sea (U)
6. Bay of Bothnia (U)

If the capacity reservation in any of the Type UR areas Scania's south coast / Halland / Southeastern Baltic Sea expires, a grid expansion in that area will be prioritised over grid expansion in the three Type U areas. This prioritisation may affect the time schedules for grid expansion in the Type U areas of Gothenburg, the southern Bothnian Sea and the Bay of Bothnia.

4.2.5 Summary of call for applications 1- offshore connection points

Svenska kraftnät's guidance regarding the areas for grid expansion in Sweden's territorial waters to enable the connection of several offshore electricity generation facilities is summarised in Figure 2 and Table 1. In total, this is a very comprehensive commitment which, depending on the further development of the Type UR call for applications areas, could result in a new transmission grid with a total transmission capacity of between 4,000 MW and at most 10,000 MW. The configuration of each individual connection to the onshore transmission grid needs to be tailored so as not to introduce new design faults into the Nordic electricity system.

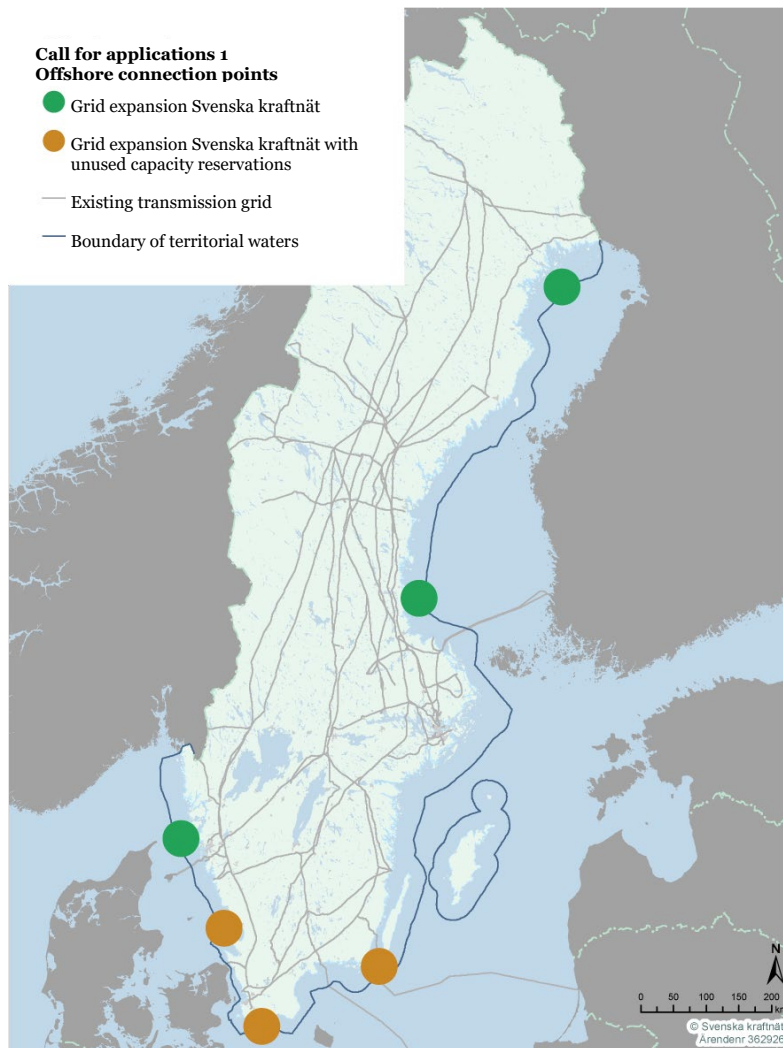


Figure 2. Offshore connection points in call for applications 1.

Table 1. Summary of the first call for applications for offshore connection points.

Priority	Offshore connection point	Type	Transmission capacity (MW)	Preliminary date (year)
		U = grid expansion letter of intent UR = grid expansion will take place if the current capacity reservations for onshore connection are not utilised		
1	Scania	UR	1,400 – 2,000 MW	2029-2032
2	Halland	UR	1,400 – 2,000 MW	2029-2032
3	Southeastern Baltic Sea	UR	1,400 – 2,000 MW	2029-2032
4	Gothenburg	U	At least 1,200 MW	2032
5	Southern Bothnian Sea	U	At least 1,400 MW	2033
6	Bay of Bothnia	U	At least 1,400 MW	2035
Total			8,200 – 10,000 MW	

4.3 Considerations for the selection of sites for the next call for applications

The first call for applications for an offshore transmission grid is a major commitment for Svenska kraftnät. Despite the scope of the call for applications, it has not been possible to prioritise all of the areas in which Svenska kraftnät has identified a clear and relatively consistent commercial interest and where there may in practice be the potential capacity to connect offshore electricity generation. With a more efficient and effective process for the connection of offshore wind power to the onshore transmission grid, Svenska kraftnät hopes to create better conditions for project promoters operating in areas that have not been prioritised for grid expansion to continue their work.

A second call for applications will be announced at the earliest in 2025, following the drafting and adoption of new maritime spatial plans with further designated maritime areas for energy extraction. A necessary condition for initiating work on subsequent calls for applications is the need for more transmission capacity for offshore electricity generation. The announcement of more offshore access points within the framework of a second call for applications may take place in part in the same areas as the first call for applications or in completely new maritime areas.

In its continued work on the government commission associated with the updated maritime spatial plans, Svenska kraftnät wishes to highlight the central and northern Baltic Sea in particular as maritime areas where it is important to identify locations where the coexistence of offshore wind power and other opposing interests is possible.

In parallel with the Government commission regarding preparatory work for an expansion of the offshore transmission grid, Svenska kraftnät is conducting a study into Gotland's future electricity supply together with the relevant grid owners, Vattenfall Eldistribution and Gotland Energi. The aim of the Gotland study is to identify the most appropriate way to improve the security of electricity supply for Gotland's electricity customers by 2030. In order to achieve this goal within the set time frame, a new Gotland connection will only be dimensioned for its main objective, electricity supply, adapted to the capacity and technology of the Gotland electricity grid. This means that the transmission capacity between Gotland and the mainland will not initially be expanded in order to redundantly export large amounts of renewable electricity generation to the mainland. However, in practice the requirement for a redundant supply for the end consumers on Gotland will result in the need for a considerable amount of variable electricity transmission being met.

During the Gotland study, it has become clear that there are relatively well-developed plans and ambitions for a major expansion on the island of both

onshore renewable energy and offshore electricity generation. In the long term, only when account is taken of the onshore plans, is there a potential surplus of 1,000 – 2,000 MW of renewable power on the island. The Gotland study will refer this additional generation capacity to a second phase of development in which renewable electricity generation (onshore or offshore) will be transferred from a new onshore hub on southern Gotland to the mainland. If the hub is connected to the Gotland electricity grid, Gotland's end consumers will get an additional connection to the mainland.

A future connection to the mainland dedicated to renewable electricity exports would ideally be built using HVDC technology taking account of distance and capacity. This choice of technology also creates an opportunity for a later expansion towards the Baltic States to complement NordBalt. The dimensioning and timing of the starting point for work on such a future link must be carefully planned and implemented jointly between all stakeholders.

5 The necessary conditions for project planners who have submitted an application for connection, or signed an agreement of intent regarding connection

Svenska kraftnät is processing applications for the connection of offshore wind power submitted within the framework of the current connection process as requests for connection to an onshore connection point in the transmission grid where the connecting party is paying for the entire connection.

Project promoters with applications for connection in areas not prioritised for offshore grid expansion in the first call for applications must await the implementation of a new and modified process for the connection of offshore electricity generation to onshore connection points. As described above, the new process will establish completely new investor pools for geographically defined maritime capacity zones. Cases in the current connection queue will be transferred to the correct investor pool following a dialogue with the applicant. The applicable project promoters will be notified when work starts on transferring their cases from the current queue system to a new investor pool. In the autumn of 2022, Svenska Kraftnät will announce a timetable for the implementation of a modified process for project promoters who wish to connect offshore electricity generation to an onshore connection point (open-door connection).

During the implementation of a new process for the open-door connection of offshore electricity generation, no new agreements of intent regarding connection can be reached under the current connection process.

With regard to project promoters with an agreement of intent regarding connection, where Svenska kraftnät has either not initiated a feasibility analysis regarding the connection onshore, or where the feasibility analysis is currently ongoing, Svenska kraftnät intends to fulfil its agreed investigative obligations. Formal capacity allocation to these connections can take place when the parties sign a connection agreement, this requires the submission of an application for a line concession by the connecting party in accordance with the time limits applicable in the current connection process. If the time limits cannot be met, no connection agreement can be signed. This means that the capacity reservation expires.

With regard to cases with an agreement of intent regarding connection according to the existing connection process, that these connections are implemented is positive for the power system, regardless of which project promoter is constructing them. However, there have been signals from several project promoters – both with and without an agreement of intent – that the expectation is that an agreement of intent could ultimately lead to Svenska kraftnät acquiring electricity connections to individual wind farms. In the light of the commitments made in connection with the Energy Agreement of 2016, there is naturally some justification for this expectation.

In this context, however, Svenska kraftnät wishes to emphasise that the instructions regarding offshore grid expansion do not allow this type of bilateral transaction. If a project promoter with an agreement of intent regarding connection is, in practice, only interested in connecting to an offshore connection point in the transmission grid, such a connection point can only be realised after the capacity reservation has reverted to Svenska kraftnät.

6 Bidding zones for offshore connections

6.1 Basis regarding bidding zones for offshore connections

The fourth point of the Government's commission to Svenska kraftnät regarding preparatory work for the expansion of the transmission grid into Swedish territorial waters, tasks Svenska kraftnät with describing criteria, advantages, disadvantages and consequences for connected market participants, of introducing offshore bidding zones.

The topic of offshore bidding zones is discussed in multiple EU fora, and is mainly relevant for scenarios where offshore electricity generation connections are combined with interconnectors (hybrid constellations). However, offshore bidding zones are not expected to be relevant in the first call for applications as the first call relates to offshore connection points radially connected to the onshore transmission grid. The establishment, or further development of hybrid constellations can only be considered at a later stage of the expansion of the offshore transmission grid.

6.1.1 Regulatory framework for bidding zone delineation

The delineation of bidding zones is governed by the European regulatory framework, and in particular by Article 14 of Regulation (EU) 2019/943 of the European Parliament and of the Council on the internal market for electricity (Electricity Regulation), and Articles 32 and 33 of Commission Regulation (EU) 2015/1222 establishing guidelines on capacity allocation and congestion management ('CACM'). The principles in the regulations apply both for bidding zones offshore and onshore. According to the regulatory framework, bidding zone borders shall be based on long-term, structural congestions in the transmission grid. The bidding zone configuration is to be reviewed on a regular basis. If structural congestions are identified, a bidding zone review is initiated, whose result may affect the bidding zone configuration. Connection to the offshore transmission grid does not mean that an offshore bidding zone automatically needs to be established. However, new connections to the grid can affect the power system in such a way that new structural congestions in the grid arise, which in turn can initiate a bidding zone review.

Article 16 (8) of the Electricity Regulation concerning the requirement to make 70% of the capacity respecting operational security limits available for cross-zonal trade (the 70% target) also has an impact on the configuration of bidding

zones. In case a transmission system operator encounters difficulties in complying with the 70 % requirement, remedial actions in form of counter trade and redispatch can, if available, be used to reach the target. Should the available resources for countertrade and redispatch be insufficient, a change in the bidding zone configuration may be the only remaining solution as the lead times for reinforcing the transmission grid are normally long.

6.1.2 The market concepts home markets and offshore bidding zones

For connections to offshore transmission grid there are primarily two market solutions: home market and offshore bidding zones. Today, the home market concept is common for radial connections of offshore electricity generation, but it can also be applied to hybrid constellations. When applying the home market solution, facilities connected offshore belong to an onshore bidding zone. This differs from the concept of offshore bidding zones, where facilities connected to the offshore transmission grid instead belong to bidding zones located offshore. The concept of offshore bidding zones is theoretically applicable to both radial connections and hybrid constellations. In addition, both offshore bidding zones may, like onshore bidding zones, be connected to one or more other bidding zones both onshore and offshore.

Offshore bidding zones can be established either at a national level, within a country's exclusive economic zone, or at multinational level. The European Commission, ENTSO-E¹ and ACER² have all identified offshore bidding zones as an efficient alternative for integrating offshore hybrid constellations into the electricity market, among other things because they reflect flows and congestion in the grid better than home markets. The figures 3-6 are outline sketches of the various market solutions for radial and hybrid configurations.

¹ European Network of Transmission System Operators for electricity

² Agency for the Cooperation of Energy Regulators

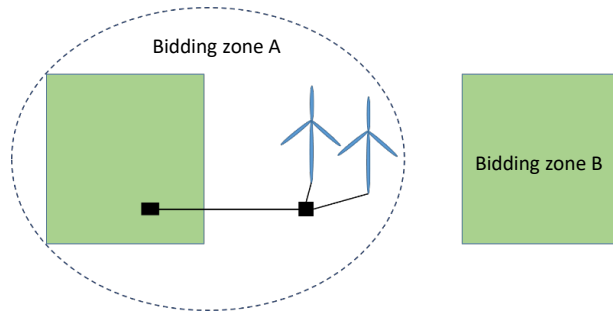


Figure 3. Radial connection of an offshore electricity generation facility with bidding zone A as the home market.

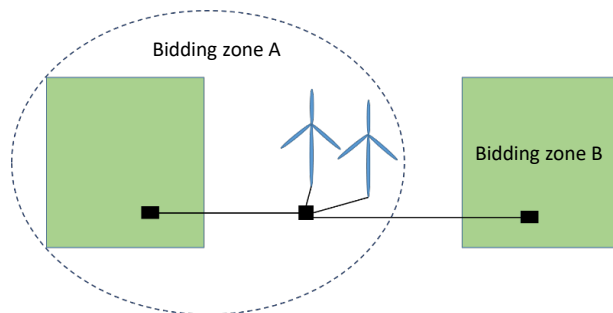


Figure 4. Hybrid connection of an offshore electricity generation facility with bidding zone A as the home market. ³

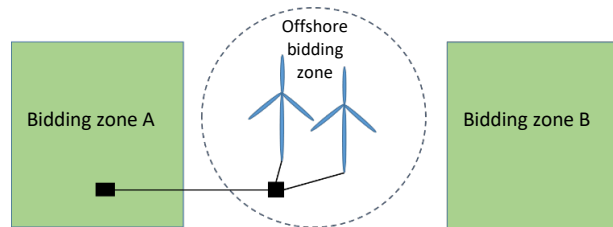


Figure 5. Radial connection of an offshore electricity generation facility in an offshore bidding zone.

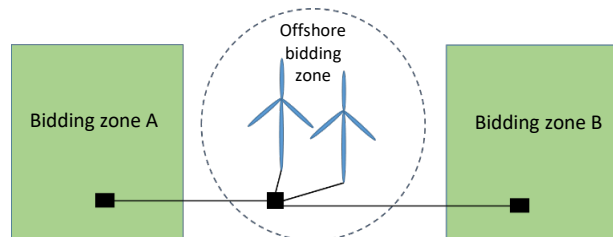


Figure 6. Hybrid connection of an offshore electricity generation facility in an offshore bidding zone.

³ In practice, radially connected offshore facilities are not likely to end up in own offshore bidding zones as the connection to shore is dimensioned for the size of the connection, and is therefore not expected to cause structural congestion.

6.1.3 Market conditions for offshore market participants

Capacity calculation

The Nordic capacity calculation region will implement the flow-based capacity calculation methodology (as set out in CACM article 20) for the day-ahead market in 2023⁴. With this implementation, the description of transmission capacity to the market coupling will change and this also means that power flows and bidding zone prices are determined in another way than with the current methodology.

Electricity trade and pricing of electricity generated offshore

The principle that market participants trade electricity on the day-ahead market at the electricity price in the bidding zone to which they belong applies both onshore and offshore. Market participants in an offshore bidding zone connected to one or more bidding zones generally receive the same electricity price as the adjacent bidding zone with the highest price if there is no congestion⁵ on the connection to the adjacent bidding zone. Regardless of whether a connection belongs to an offshore bidding zone or a home market, connected market participants have the opportunity to trade electricity in any time frame.

Balancing

The regulatory framework covering responsibilities for transmission system operators, balance responsible parties, and balance service providers applies regardless of whether facilities are connected to onshore or offshore bidding zones. Balance responsible parties continue to bear the financial responsibility for imbalances in the connection point and will receive the imbalance price for the bidding zone to which they belong. Svenska kraftnät will continue to be responsible for balancing the transmission system in real time, both for the transmission system onshore and offshore. Transmission system operators will use the existing market platforms for the acquisition of balancing capacity and balancing energy, which can also be used by balance service providers to trade. If the owner of a facility located in an offshore bidding zone wishes to provide ancillary services for balancing, the owner have to prequalify the facility and to become a balance service provider in the same way as if the facility had been established in a bidding zone onshore.

⁴ [All TSOs' of the Nordic Capacity Calculation Region proposal for capacity calculation methodology in accordance with Article 20 \(2\) of Commission Regulation \(EU\) 2015/1222 of 24 July 2015 establishing a guideline on capacity allocation and congestion management \(svk.se\)](#)

⁵ Congestion means that the full trading capacity of the connection is utilised, i.e., when the market's demand to transfer electricity exceeds the transmission capacity of the transmission line(s).

Tariffs

The terms for using the transmission grid are regulated in usage agreements that are entered into each year between Svenska kraftnät and the parties that have facilities connected to the transmission grid. The agreement contains tariff provisions and the terms governing the obligations of the grid customer and Svenska kraftnät to each other.

All parties who own a facility that is connected to the transmission grid have to pay a fee to Svenska kraftnät. The current tariff model consists of two parts, a power charge and an energy charge.⁶

6.2 Impact assessment of the possible introduction of offshore bidding zones

This section highlights the advantages, disadvantages and consequences for connected market participants of the potential introduction of offshore bidding zones compared to belonging to a home market. The section is divided into three parts: socioeconomic impacts, consequences for the transmission system operator, and consequences for connected market participants.

6.2.1 Socioeconomic effects

Access to the electricity market for offshore electricity generation

According to Article 16 (8) of the Electricity Regulation, at least 70% of the transmission capacity should be made available for cross-zonal trade by the transmission system operators. This means that offshore electricity generation, on the same terms as other production and consumption, will get access to the market both through necessary grid investments as well as through potential changes of bidding zone configuration. A potential establishment of offshore bidding zones for hybrid constellations allows electricity from offshore generation to flow to where it is most needed, and it will compete for transmission capacity on the market on an equal terms with other forms of generation. For hybrid constellations belonging to a home market, offshore electricity generation may need to be curtailed in order to comply with the regulatory framework covering the equal treatment of cross-border flows.

Impact on pricing of the connection of new electricity generation

If electricity generation is situated where there is a generation surplus at the time of the connection, the facilities will further enhance the existing imbalance

⁶ More information about the current tariff is available at www.svk.se/tariff.

between production and generation within the bidding zone. Due to the emphasized imbalance between supply and demand, the electricity price in the bidding zone can be expected to fall from its previous level.

Distributional effects on the day-ahead market with offshore bidding zones

Market participants are exposed to the electricity price in the bidding zone to which they belong, irrespective of whether it is an onshore or offshore bidding zone. The difference in price between the offshore and the onshore bidding zone(s) corresponds to the congestion income collected by the transmission system operator. At present there are no mechanisms for the redistribution of congestion income to compensate market participants in offshore bidding zones. Also, ACER has expressed their doubts to such a redistribution of congestion income.⁷

6.2.2 Consequences for transmission system operators

Compliance with the 70% target

The addition of large volumes of offshore electricity generation may pose challenges for a transmission system operator to comply with the 70% target. Consequently, Svenska kraftnät needs to ensure compliance with the 70% target in planning the expansion of the offshore transmission grid. This can be undertaken by reinforcing the transmission grid sufficiently to meet the 70% target, even when large volumes of offshore electricity generation are connected to the grid. In general, intermittent electricity generation such as wind power imposes higher demand on the availability of transmission capacity to meet with the 70% target, either through physical transmission capacity or through the potential for large-scale redispatch or counter trade, than does predictable generation. If the 70% target cannot be met, a bidding zone review will be initiated.

Balancing of the transmission system

The connection of offshore electricity generation will, in a first phase, be carried out radially to the onshore grid and the additional electricity generation facilities will belong to an onshore bidding zone. In the short term, this means that Svenska kraftnät's costs for balancing will probably increase as a result of the additional intermittent generation of electricity. Hybrid constellations with a home market solution would entail a greater need for more frequent redispatch and counter-trade measures compared to a scheme

⁷ [ACER-CEER Reflection on EU offshore strategy \(europa.eu\)](https://europa.eu/press-room/media/30691/en/statement/2017-06-27-acer-ceer-reflection-on-eu-offshore-strategy)

where offshore electricity generation would have belonged to offshore bidding zones. In general, the concept of offshore bidding zones will mean a reduced need for countertrade and redispatch compared with the home market concept.

6.2.3 Consequences for connected market participants

6.2.3.1 Market participants wishing to connect offshore electricity generation

This section presents perspectives highlighted by market participants in dialogue with the Svenska kraftnät within the scope of this Government commission.

Pricing in offshore bidding zones

There is a risk that electricity generators in offshore bidding zones will at times receive lower revenues than if they belonged to an onshore bidding zone, but this risk varies depending on which bidding zones they are connected to and to which bidding zones they are interconnected. Market participants have raised concerns about the price level for offshore bidding zones that are connected to multiple bidding zones. This is because market participants in offshore bidding zones face the electricity price in the neighbouring bidding zone with the highest price and where there is no congestion on the interconnector. In a configuration with an offshore bidding zone connected to two onshore bidding zones, the offshore bidding zone is likely to be on the exporting side of a bottleneck to the importing onshore bidding zone. This means that the price in the offshore bidding zone will be lower than in the onshore bidding zone, and the market participants in the offshore bidding zone will thus receive a lower electricity price to that had they belonged to the importing onshore bidding zone. However, this analogy can also be found in onshore bidding zones dominated by generation.

There are situations where offshore bidding zones are considered more appropriate by market participants. This applies, for example, to hybrid constellations connected to more than two bidding zones and where a market participant would have belonged to the bidding zone with the lowest electricity price with a home market solution, but instead belongs to an offshore bidding zone and has the opportunity to export electricity to multiple bidding zones. In this way the market participant can obtain a higher electricity price than they would have received in the bidding zone they had belonged with a home market solution, because the offshore bidding zone receives the same electricity price as the bidding zone to which the connection is not congested.

Uncertainty regarding revenue linked to bidding zone affiliation

Uncertainties regarding which bidding zone a connection will belong to reduce the predictability of revenues from the trading electricity, which in turn

increases the uncertainty in the return on investment for the market participants. In general, uncertainty in estimations of return on investment contributes to a requirement for higher returns. Uncertainty has a negative impact on the willingness to invest, and thus on the ability of market participants to drive offshore electricity generation projects. Several market participants see a risk of lower revenues if places in an offshore bidding zone compared to an onshore bidding zone, which is seen as a significant disadvantage. However, connections in onshore bidding zones are also exposed to a risk that the bidding zone configuration can be adjusted as the result of a bidding zone review.

Multi-technology projects connected offshore and onshore

Several actors are planning technical solutions in which offshore wind power is combined with hydrogen production for example. The planned siting of facilities, for hydrogen production, for example, is onshore. In the event that offshore bidding zones are introduced, it is possible that the electricity generation facility and hydrogen facility are located in different bidding zones. Market participants consider that it would not be desirable for wind generation and hydrogen production to be in different bidding zones; as would be the case if wind power generation belonged to an offshore bidding zone and hydrogen production to an onshore bidding zone.

Compatibility with energy trade agreements

Bilateral agreements for energy trading, known as power purchase agreements, are common for wind power projects. Market participants have underlined their desire to have both parties to the agreement (producers and energy purchasers) in the same bidding zone, and see a risk that the structure of these contracts could be hampered if offshore electricity generation facilities were located in their own bidding zones.

6.2.3.2 Onshore electricity generators

Connecting a large amount of offshore electricity generation will have an impact on the price in onshore bidding zones, as this will affect the supply offered to the market. To which extent the electricity price is affected depends on a number of factors, including the effect of offshore electricity generation and market conditions in the bidding zone. Regardless of whether offshore electricity generation belongs to a home market or an offshore bidding zone, an increase in supply may affect the price in the onshore bidding zone and thus also the electricity producers in the bidding zone.

6.2.3.3 Electricity consumers

For market participants with consumption facilities, the lower prices that offshore bidding zones may offer compared to onshore bidding zones is an incentive to locate facilities that consume electricity offshore. For example, the facilities could be for energy storage or conversion of electricity to another energy carrier.

The consequences for different market participants based on price level in offshore bidding zones relative to a home market is difficult to assess, as the relationship between generation and consumption in offshore bidding zones can change, thus affecting the price of electricity in the zone.

Svenska kraftnät is a state owned enterprise with the task of maintaining Sweden's electricity transmission grid, which consists of about 16,000 kilometres of 400 kV and 220 kV transmission lines with substations and interconnectors. Svenska kraftnät is also the system operator for electricity in Sweden. Svenska kraftnät is developing the transmission grid and the electricity market to meet society's need for a secure, sustainable and cost-effective supply of electricity. In this, Svenska kraftnät plays an important role in implementing national climate policies.

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